



NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

June 3, 2022

HELICOPTER WRECKAGE EXAMINATION REPORT

NTSB No: WPR20LA211

A. ACCIDENT

Operator Airwest Helicopters LLC
Aircraft: Bell UH-1H Iroquois (Huey), N623PB
Location: Payson, Arizona
Date: July 7, 2020
Time: 1213 MST

B. GROUP

No group formed

LIST OF ACRONYMS

C	Celsius
CCW	Counterclockwise
CW	Clockwise
Mod.	Modification
MST	Mountain standard time
Ng	Engine gas generator speed
No.	Number
NR	Rotor Speed
PN	Part number
psi	Pounds per square inch
rpm	Revolutions per minute
SN	Serial number
STC	Supplemental type certificate
TOT	Turbine outlet temperature

C. SUMMARY

The initial aircraft wreckage examination was conducted at Air Transport salvage yard located at 3011 W Buckeye Rd, Phoenix, AZ, on October 26 and 27, 2020. Representatives from the Federal Aviation Administration (FAA), Honeywell (engine manufacturer), and Airwest Helicopters participated in the wreckage layout and examination.

The wreckage was highly fragmented with a majority of the airframe fire damaged or destroyed. The largest airframe elements that remained were the main rotor head and, transmission, engine, the tail boom aft of the elevator, tail rotor and gearbox. The vertical tail had a fast fin modification (Garlick Supplemental Type Certificate (STC) STC SR09176RC, N# GH080). The internal cargo hook was present with the wreckage. The external load long line, hook, and cargo net were stored in a box. These items were removed and examined. Landing skids had been destroyed; however, the steel skid shoes were present, along with portions of both cross tubes.

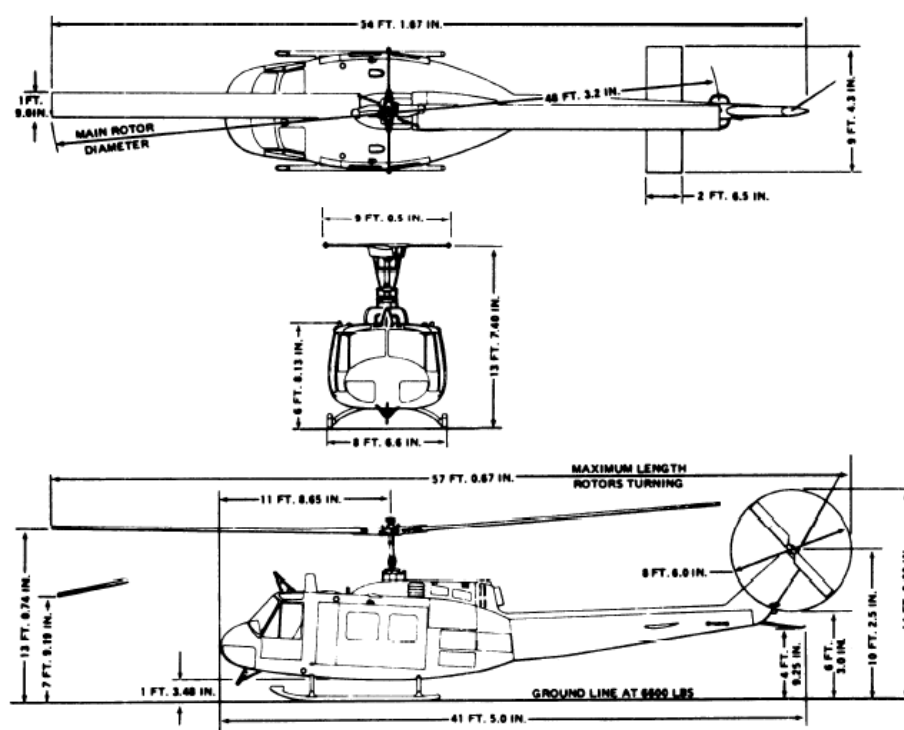


Figure 1.UH-1 Principal Dimensions Diagram

D. DETAILS OF THE INVESTIGATION

1.0 COCKPIT

The cockpit and cabin were extremely fragmented. Pilot's seat feet (left seat) were attached to the seat rails. The seat rails had separated from the cockpit deck which had

been destroyed by fire. The seat pan and seat back had been deformed by extreme heat. The copilot's seat frame steel components were identified. Other elements of the seat had been destroyed by fire. Both collective sticks were present. The collective torque tube was identified with control rod ends attached. The pilot's cyclic stick was present and one antitorque pedal, both had been liberated from structure. A force gradient assembly with force spring connected was identified. It could not be determined if it was the lateral or fore-aft force gradient mechanism.

1.1 Instruments

Instrument panel instruments had been displaced from the panel, with the majority of instruments destroyed by fire and unreadable (Table 1).

Table 1. Instruments recovered from the cockpit instrument panel.

Instrument	Reading
Attitude Gyro	Unreadable
Engine Ng	Unreadable
Airspeed	Unreadable
Altimeter	Unreadable

A group of instruments had been installed in the lower portion of the left door (Photo 1 and Table 2). The purpose of these instruments was to allow the pilot to view critical helicopter systems information while looking left and below the helicopter when conducting external load operations.



Photo 1. Instruments installed in the left door.

Table 2. Instrument installed in the left cockpit door.

Instrument	Reading
Engine/Rotor tach	0% revolution per minute (rpm)
N1 Percent RPM	1% rpm
Oil Pressure (psi)	0 psi
Exhaust Temp (TOT) °C	800° C

2.0 FLIGHT CONTROLS

All flight control tubes and connections in the cockpit were fragmented or destroyed. The flight control tubes leading up to the upper deck were destroyed. Three hydraulic servos had been separated from their respective connections. Table 3 provides location and serial numbers of the servos and Photos 2 to 4 show their as-recovered condition.

Table 3. Flight control servo serial numbers.

Part Number ¹	Position on Helicopter	Serial Number
205-076-099-007	Right lateral	15605
205-076-038-007	Left lateral	A1180
205-076-055-101	Collective	HR2422 ²

¹ Part numbers were recorded from the maintenance records, not directly off of the tag on the servo.

² Recorded from the FAA Form 8130-3 Airworthiness Approval Tag



Photo 2 . Right Lateral Servo



Photo 3.- Left Lateral Servo



Photo 4.- Collective Servo

Eleven distinct flight control clevis assemblies were identified, each one had its associated connecting hardware attached (Photo 5).



Photo 5. Flight control tube rod ends (clevis assemblies).

2.1 Upper Flight Controls

The control rod ends remained attached to the collective lever (below the stationary swash plate). The left & right lateral control rods were connected to the stationary swash plate. The swash plate elevator trunnion link was connected but the horn was fractured. Both main rotor blade pitch change links were attached to the rotating swash plate. Both scissor drive links had separated at the rotating swash plate connections (Photo 6).

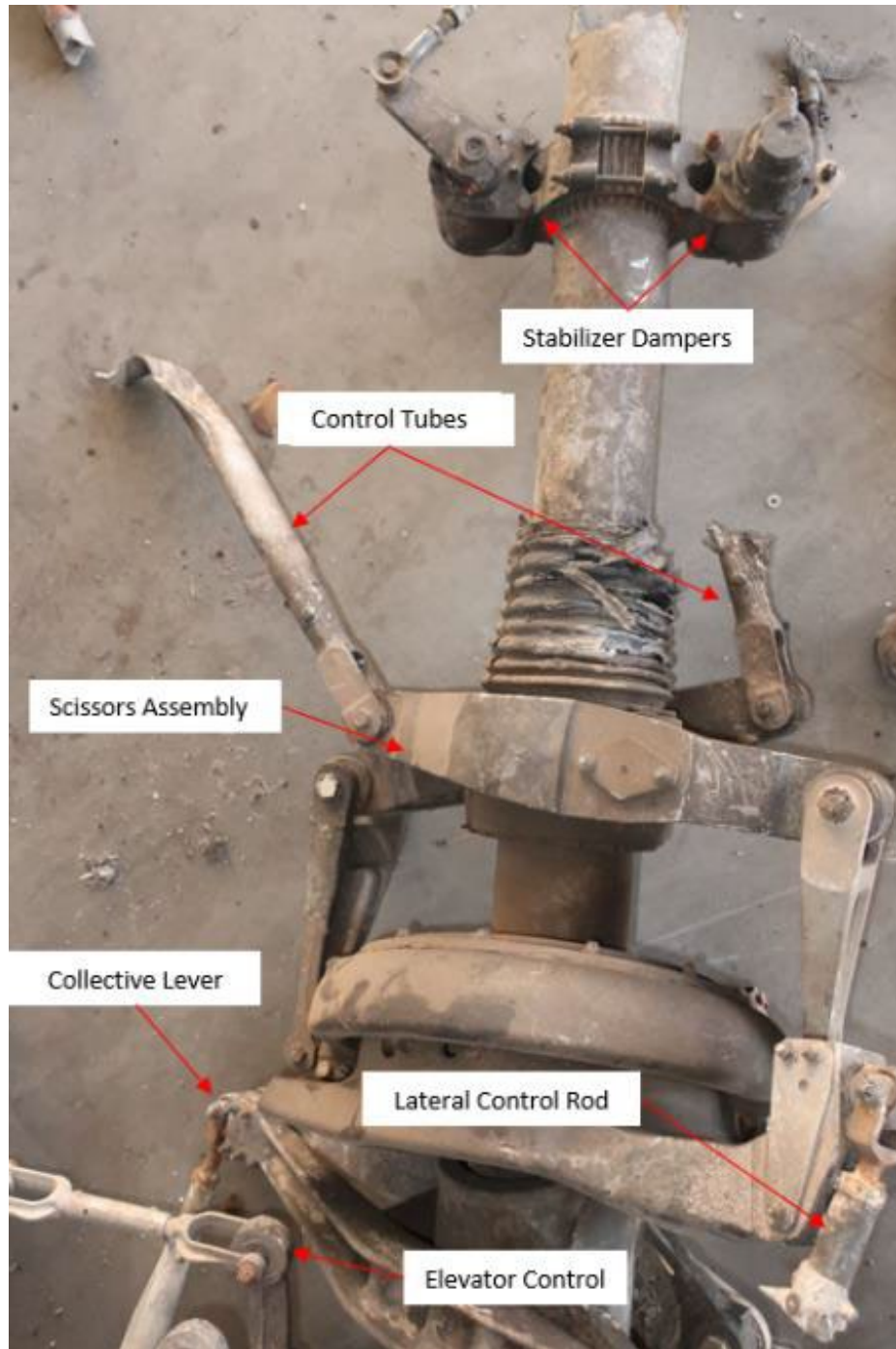


Photo 6. Upper flight controls

2.2 Tail Rotor

The tail rotor control tube rod end to the control cable quadrant was attached (Photo 7). One half of the quadrant was present. Both cables from the quadrant had been cut by the recovery crew. The cables ran continuously to the tail rotor gear box pitch change sprocket (Photo 9). The tail rotor gear box case was fractured and had liberated the tail rotor assembly (Photo 7 & 8).



Photo 7. Tail rotor control quadrant, control rods, and hydraulic servo.

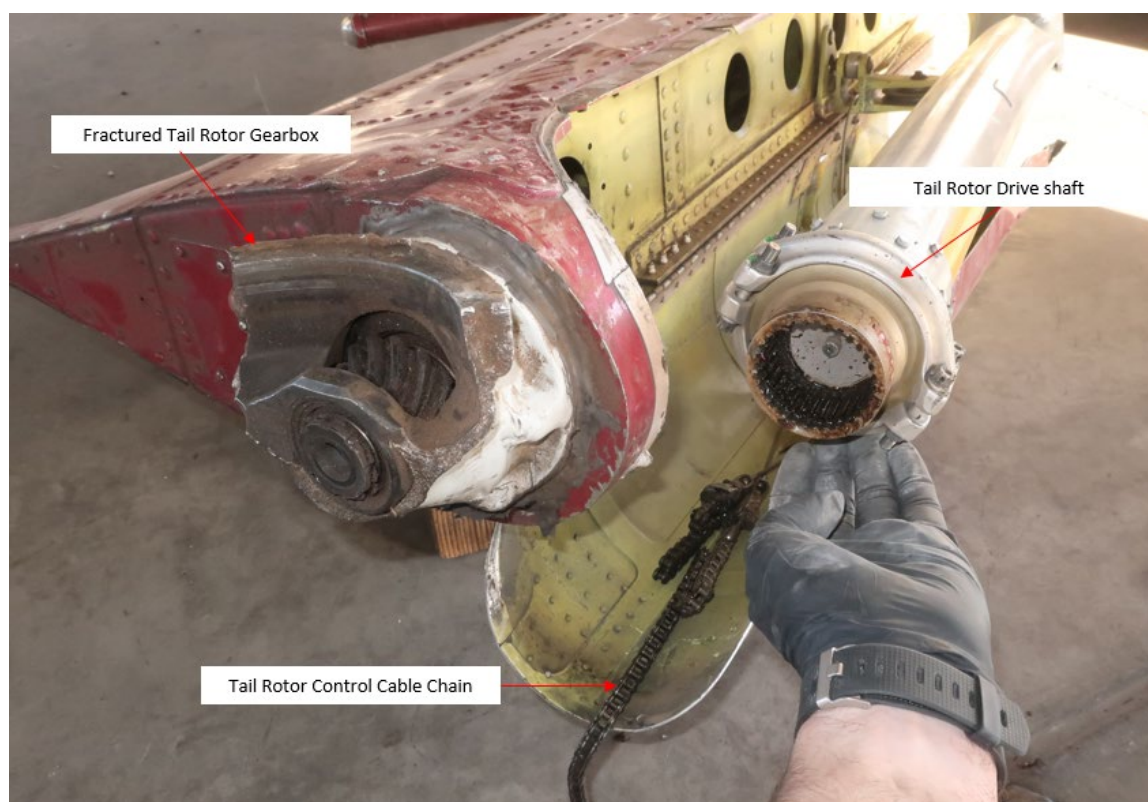


Photo 8. Tail rotor drive shaft, 90° gear box, and control cable/chain.



Photo 9. Tail rotor gear box and control chain segment connected to the pitch change sprocket.

2.3 Elevator

The elevator had separated from the tail boom and had fire damage (Photo 10). The left side elevator spar was fractured mid span, no elevator skin outboard of the fracture. The control tube rod end remained attached the elevator pitch horn. Three elevator control bell cranks were identified, all with the rod ends attached.



Photo 10. Elevator remnants.

2.4 Hydraulic Pump and Filter

The hydraulic pump had separated from the main transmission. The upper cover of the pump, where the drive shaft protrudes, had been thermally damaged. The outer case of the pump had also been exposed to extreme heat and exhibited some deformation. The pump was disassembled (Photo 11). The drive shaft was intact and the splined area had no deformation or smearing of the spline ribs. All 6 pistons were attached to the swash plate. No unusual wear marks or scoring was observed on the pistons or their respective cylinder barrels. The port plate was discolored but otherwise undamaged. The bias spring was intact. Both sets of shaft bearings were unremarkable other than heat damage.

The hydraulic filter assembly had been liberated from its mount and the IN & OUT port lines had fractured. The filter bowl was removed by unscrewing it from the base. The metal mesh screen filter located within the filter bowl was removed and examined. The bowl contained black brittle debris consistent with carbon like material. Visual examination of the filter screen identified a small number very small shiny specs within the filter element. The filter screen was stretched flat (Photo 12), pulled open, and flushed with alcohol. Small black particles were captured by a blue towel. None of the captured particles responded when probed with a magnet. No obstruction to the flow of fluid by the filter element was observed.



Photo 11. Hydraulic pump disassembled.



Photo 12. Hydraulic filter disassembled.

3.0 MAIN ROTOR DRIVE SYSTEM

The transmission had liberated from its mounts. All five transmission main mounts had been separated from structure, including the 5th pylon mount. The elastomeric material in each mount had been consumed by fire. The transmission power input quill (Photo 13) rotated freely in the counterclockwise (CCW) direction and was not movable by hand in the clockwise (CW) direction. The rotor mast had fractured just below the main rotor head attachment location. Both rotor blade dampers were present on the mast with arms and rod ends attached. Engine-to-transmission drive shaft was not present. Fragments of the KAflex coupling on both ends (engine and transmission) were present (Photos 16 & 17). Rotational

scoring was observed on the engine power output shaft where the KAFlex coupling attaches. Lower half of the transmission was missing due to fragmentation and fire. The hydraulic drive quill had separated from the transmission, the hydraulic pump had separated from the drive quill. The hydraulic pump splined drive shaft was present on the pump. The tail rotor drive quill had separated from the lower half of the transmission. The transmission oil pump drive had separated from the transmission. The oil pump drive shaft remained attached to the quill with the 4 lobed rotating portion of the pump attached to the drive. The outer portion of the oil pump was not present.



Photo 13. Transmission Power Input Quill



Photo 14.- KAFlex fragments

4.0 MAIN ROTOR

Main rotor blades were labeled "A" & "B" for identification purposes. The main rotor had separated from the mast just below the rotor head (Photos 18 & 19). The portion of mast remaining attached to the rotor head fractured in overload and the deformation direction aligned with blade "B" (Photo 19). Both arms of the stabilizer bar had fractured outboard of the hub. Both blades "A" & "B" pitch horns had separated from the blade grip, and both pitch change links remained attached at both ends. The blade retaining bolts were in place on both blade grips. Both blades drag links remained attached at both ends. Multiple fragments of blade skin and honeycomb core had been recovered. These fragments could not be associated directly with a main rotor blade.



Photo 15. Rotor Head with Stabilizer Bar



Photo 16. Rotor Head Main Mast Fracture

4.1 Blade "A"

The entire main spar was missing the honeycomb core, blade skin, and trailing edge (Photo 20). The spar had been exposed to fire. The spar was fractured 2 feet outboard of the blade grip, and it extended 22 feet from the center of the hub. The tip of the spar was fragmented and thermally damaged, leaving loose glass fibers with no matrix. The blade tip weight had separated from the blade.



Photo 17. Overhead View of Blade "A"

4.2 Blade "B"

Entire main spar was missing the honeycomb core, blade skin, and trailing edge (Photo 21). The spar had been exposed to extreme heat. The spar was fractured 6 feet

outboard of the blade grip and the spar extended 23 feet 4 inches from the center of the hub. The blade end cap was present with the blade tie down fitting attached.



Photo 18. Overhead View of Blade "B"

5.0 TAIL ROTOR DRIVE SYSTEM

The tail rotor drive quill was recovered separated from the lower transmission housing. For reference purposes, the tail rotor drive shafts were numbered 1 through 6, with the No. 1 shaft connecting to the transmission. The tail rotor drive shaft located directly beneath the engine (No. 1) was not present. The connecting ends and hanger bearings of drive shaft No. 2 were identified. Drive shaft No 3 had torsionally sheared 1 foot forward of its aft end. Drive shaft No. 4 was sheared about 6 inches from its forward end. The aft end and bearing were attached to the remnant tail boom structure. Drive shaft No. 5 remained attached to the tail boom structure and connected to the 42° gear box; the 42° gearbox was part number 212-010-003-23, serial number AHP-52133.



Photo 19. Tail section and tail rotor drive system.

The 42° gear box was undamaged (Photos 22 & 23), and the input and output drives rotated in unison, smooth, with no binding. Drive shaft No. 6 was connected to the 42° gear box. It was buckled and split in 2 locations along its length. The shaft had disconnected from the tail rotor gear box input (Photo 23); the tail rotor gearbox was PN 204-040-012-13, SN B137894, model number TT2936. Tail rotor gear box lower case had fractured, liberating the gear box and tail rotor assembly.



Photo 20. Tail rotor gearbox, rotor hub and blade assembly.

6.0 TAIL ROTOR

The tail rotor gear box and tail rotor mast remained intact (Photo 24). Both tail rotor blades were attached to the tail rotor hub. Tail rotor blades were labeled "red" & "yellow" for identification purposes. Both pitch change links were attached to their respective blades and the pitch change cross head.



Photo 21. Tail rotor head.

6.1 Red Blade

Entire blade was attached to the hub (Photo 25). Blade tip damage, and chord wise scoring evident. A half inch strip of the trailing edge was delaminated at mid span.



Photo 22. Red blade

6.2 Yellow Blade

The blade root was attached to the hub. The outboard 2 feet of blade was fragmented (Photo 26). Blade skins minus the foam core were recovered.



Photo 23. Yellow blade.

7.0 ENGINE

The accident helicopter is equipped with a Honeywell, formerly Lycoming, T53-L-703 (LTC1K-4G) turboshaft engine (Photo 27). The accident engine was SN L-12053Z. The portion of the KAflex coupling on the transmission side was fractured at multiple locations. The portion of the KAflex coupling on the engine side was fractured at multiple locations. The center section of the KAflex coupling between the engine and transmission was not located during the wreckage exam, but photographs show it present at the accident scene. There was rotational score marks around 360 degrees of the KAflex coupling on the engine side, where the drive shaft section would have connected (Photo 28). There was thermal damage all around the engine, but the engine itself wasn't burnt, but was covered in soot. The left rear engine mount was attached to the engine and the airframe with some impact damage present on the strut. The left front engine mount was attached to the engine, but the strut was crushed/broken approximately 8 inches from the engine mount connection point. The right rear engine mount was attached to the engine but separated at the strut attachment. Rotation of the output shaft produced a corresponding rotation of the power turbine rotor. The power turbine spool rotated without resistance.



Photo 24. - External view of the engine.



Photo 25. - Rotational scoring on the engine output flange.

Borescope inspection revealed that the trailing edge of the inlet guide vanes and the leading edge of the 1st stage axial compressor blades displayed tearing and battering damage (Photo 29). The oil filter housing assembly was not equipped with a bypass indicator. The fuel control indicator still had a partial control lever arm attached. The indicator could be moved from stop-to-stop with some resistance in one location that could be overcome by hand strength. The power turbine control governor lever input arm was broken off at the base of the arm. The indicator could be moved from stop-to-stop without resistance. The accessory gearbox chip detector had some debris adhering to the chip detector that appeared to be coked oil, but no obvious metal chips were present. The 2nd stage power turbine blades were all present and appeared undamaged. There was metal spray present around 360 degrees of the 2nd stage power turbine nozzle vanes (Photo 30). Oil was found dripping from the No. 3/No. 4 bearing cavity scavenge line. Oil was found dripping from a line connecting the diffuser to the accessory gearbox.



Photo 26. Borescope image of axial compressor damage.



Photo 27. Metal spray on 2nd stage power turbine nozzle vanes.

8.0 LONG LINE AND HOOK

The long line and external hook were contained in a box, bundled together. The long line was coiled. The line was sheathed with an outer cover that encased both the load bearing line and electrical wire. The long line appeared to have normal wear with no significant damage noted. The helicopter connecting end had the eyelet and "pear ring" attached. The electrical connector was not present, the electrical wires had bare ends. The long line hook end was attached. The electrical connectors between the line and the hook assembly were not present, both sets of wires (from the line and the hook) had bare ends. The hook was able to be opened and locked closed manually. The cargo net was bundled together with the hook/swivel assembly attached.

9.0 MAINTENANCE RECORDS REVIEW

The maintenance records were examined by investigators. The helicopter total time (Hobbs) as of June 29, 2020, was 10,759.2 hours. Table 5 lists the most significant maintenance actions in the 350 hours preceding the accident.

Table 2. Maintenance history table.

Date	Hobbs (hrs)	Discrepancy
6.24.2020	10,750.2	Pilot requested more left hand (L/H) pedal control. Adjusted rigging and mx test flight test
6.21.2020	10,748.7	Tail Rotor (T/R) Binding. Remove and Replace (R/R) T/R pitch change quill. Maintenance test flight.
6.6.2020	10,723.7	Adjusted T/R rigging one tooth on sprocket counterclockwise to give more left pedal.
5.22.2020	10,718.1	12-Month inspection. • 600-hour T/R drive train repack • R/R T/R gearbox. T/R rigging • T/R hub retaining nut torque check • Inspected T/R blades
5.8.2020	10,715.1	25-hour lube. Cleaned & inspected T/R blades
4.17.2020	10,685.5	25 hour/30-day lube. T/R retaining nut torque check.
4.9.2020	10,658.3	25-hour lube
3.20.2020	10,635.6	25/50-hour lube & visual inspection. TR retaining nut torque check. Inspect TR control cable bracket.
2.18.2020	10,604.2	25-hour/30-day lube and inspection
1.30.2020	10,587.4	Completed 150-hour inspection. 25 hour/30-day/50-hour lube.
10/18/2019	10,574.8	25-hour lube
9.16.2019	10,552.4	Main rotor track & balance to below 0.2 IPS (inches per second)
9.16.2019	10,552.0	Main rotor hub Remove and replaced inboard & outboard fittings. Mast overhauled. Inspected TR cable bracket
8.5.2019	10,526.8	25-hour lube. 25 hour/30-day inspection

6.27.2019	10,507.7	25/50-hour lube
5.16.2019	10,484.3	R/R tail rotor hub assembly. TR balancing completed below 0.2 IPS
5.13.2019	10,465.6	Completed 150 / Phase 1-6 inspections. MR track & balance. 600 hour/12-month TR drive train repack
4.23.2019	10,446.2	25-hour lube.
4.2.2019	10,425.1	TR chip light illuminated. Cleaned chip det plug. Operational (Ops)check OK.
3.26.2019	10,422.6	25-hour lube
1.28.2019	10,407.4	Tail rotor chip light. Cleaned and reinstalled 90deg plug. Ops check good.

Table 3. Flight control servo maintenance history³

8.30.2016	10,195.9	Removed collective servo PN: 204-076-052-003, SN: 5640 (TSN: unk) and installed collective servo PN: 205-76-055-101, SN HR2422 (TSN: unk).
2.01.2016	10,158.2	Removed left hand cyclic servo PN 204-076-052-009, SN: 36388 and installed overhauled cyclic servo PN: 205-076-099-007 SN:15605 (TSN: unk).
8.16.2015	10,106.2	Right hand ⁴ cyclic servo had excessive play in the bearing. Removed left hand cyclic servo PN: 204-076-052-9, SN 27790 with servo PN: 205-076-038-007 SN: A1180.

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³ Flight control servos are an on-condition item. No time or cycle limitation.

⁴ The original log book entry stated the left hand servo was replaced. An email from the Director of Maintenance stated that the maintenance log entry for this action was in error, that it was the right hand servo that had been replaced.