



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

October 29, 2020

HELICOPTER WRECKAGE EXAMINATION REPORT

NTSB No: WPR20LA280

A. ACCIDENT

Operator Guardian Helicopters USA
Aircraft: Bell UH-1H (Huey) / N711GH
Location: Coalinga, California
Date: August 19, 2020
Time: 0945 Pacific daylight time (PDT)

B. AIRWORTHINES SPECIALIST

Helicopter Specialist Van S. McKenny IV
NTSB / Aerospace Engineer
Washington, DC

LIST OF ACRONYMS

°C	Celsius
CCW	Counterclockwise
CW	Clockwise
Mod.	Modification
MST	Mountain standard time
Nf	Engine free turbine speed
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 wreckage examination was conducted at Air Transport, 3011 W Buckeye Rd, Phoenix, AZ, on October 29 and 30, 2020. Representatives from Honeywell, California Department of Forestry and Fire Protection (Cal Fire), and Guardian Helicopters USA participated in the wreckage layout and examination (figure 1).

The wreckage was highly fragmented and consumed by a post-crash fire (photo 1). The airframe elements that remained were the tail boom aft of the elevator, tail rotor, engine deck, left and right main cabin doors, pilot's left door, sections of the left and right landing skid tubes, one cross tube, and the engine. The helicopter had a BLR Fast Fin & Strake modification (supplemental type certificate (STC): SR01470SE). The main rotor head, main rotor blades, stabilizer bar, and upper transmission including the rotor mast were not present for examination. Wreckage recovery personnel reported that those items were lost during the helicopter lift of the wreckage from the crash site.

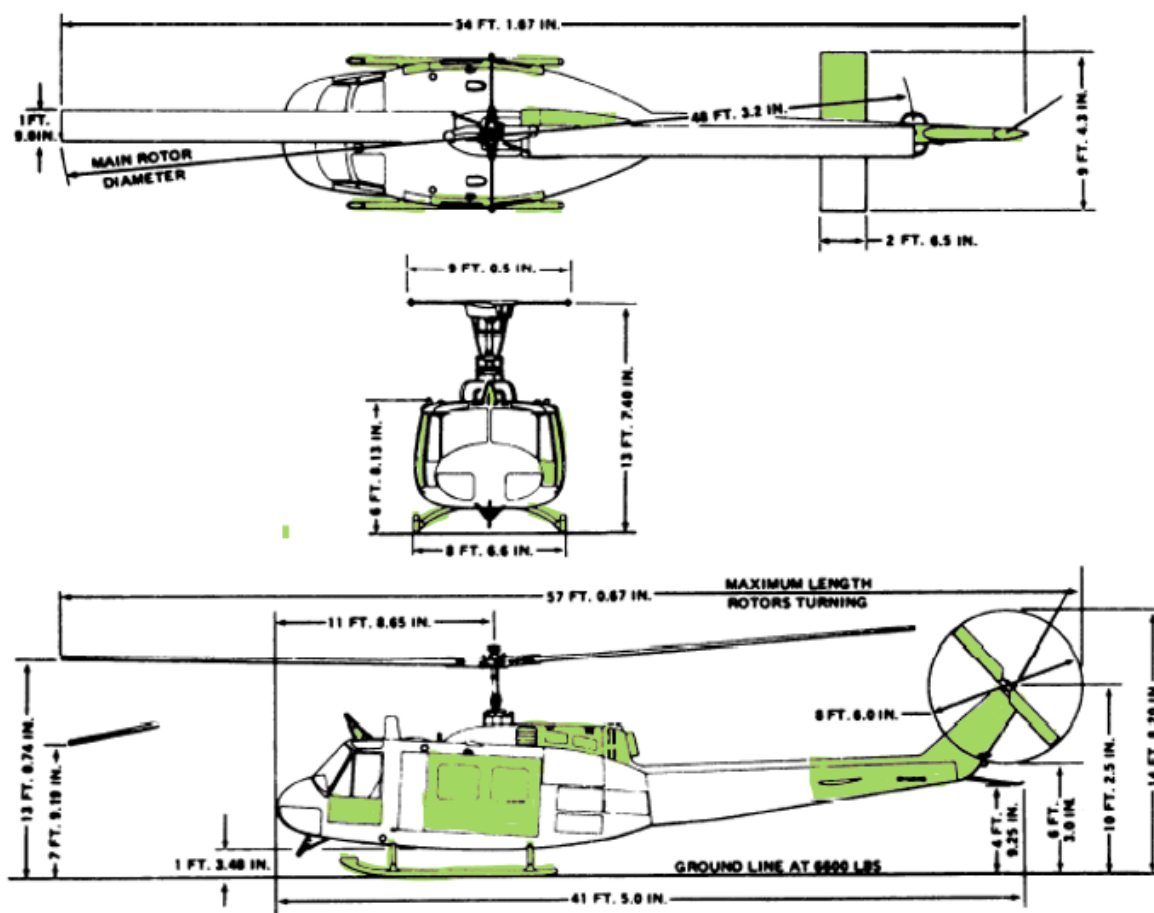


Figure 1. UH-1H Principal Dimensions Diagram. Colored areas indicate airframe sections available for examination (Source: US Army TM 55-1520-210-10).



Photo 1. Wreckage layout overview.

D. DETAILS OF THE INVESTIGATION

1.0 COCKPIT

The cockpit was highly fragmented and damaged by fire. The instrument panel was fragmented, dislocating most instruments out of their respective mounts. All of the cockpit deck had been consumed by fire. The pilot's seat (left) frame was attached to deck seat rails, and all fabric and cushion had been consumed by the post-crash fire. The left cockpit door was crushed, but the 4 indoor mounted instruments remained installed: dual-tach, N1, torque, load cell, and load counter (photo 2). The copilot seat (right) had been deformed, the seat material and cushion had been consumed by fire. One seat harness buckle with both halves connected, and one with buckle tang only, both minus the webbing material was identified. The left and right collectives were present, fire damaged, and not connected to under deck flight control linkages. The base of one of the two cyclics was identified and 90% of the cyclic had been consumed by fire. Portions of all 4 antitorque pedals were identified. All of the center panel and overhead panels were not present. The pitot tube had separated from structure.

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. List of cockpit instruments.

Instrument	Reading
Dual-Tachometer (Left door, Nr & Nf)	R (rotor) - 0 rpm / E (engine) 5600 rpm
N1 Tach (left door) %rpm	41%
Torque (installed in the left door)	0 psi (pounds per square inch)
Turn & slip indicator	Unreadable
Outside Air Temperature (OAT)	Unreadable
Magnetic compass	Unreadable
Airspeed indicator	No needle present
Oil temperature	Middle of arc
Oil pressure	Needle broken at 1/3 arc
Electronic Attitude or Directional gyro indicator	No display
Turbine outlet temperature (TOT)	Needle loose
Oil pressure	60 psi
Engine or transmission oil temperature	85° C
Fire Light	N/A
Master Caution	N/A
2 inch ¹ indicator	Unreadable, has needle attached
2 inch indicator	Unreadable, has needle attached
Fuel pressure (psi)	9 o'clock position
Airspeed (knots)	20 knots
Attitude or directional gyro	Unreadable
Dual-tachometer (Nr & Nf)	2 needles with broken tips but tails are married, oriented pointing in the 3 o'clock position.
Oil pressure	Unreadable
2 FM radios	Fire damaged

¹ 2 inch - represents the face diameter of the instrument. No features identified the specific instrument category

Audio panel	Fire damaged
AKV Cycle counter	N/A
Garmin 420	Fire damaged
Master Caution Panel	Fire damaged with molten debris imbedded in panel face.
Engine Control Panel (Photo 3)	Fuel switch in OFF (down) position. All other switches deformed downward.
N1 Tach (instrument panel) %rpm	15% rpm
Transmission oil pressure	0 psi

A group of instruments had been installed in the lower portion of the left door (photo 2). The purpose of these instruments allows the pilot to view critical helicopter systems information while looking left and below the helicopter when conducting external load operations. The engine control panel (photo 3) had been separated from the center console, all the switches on the panel had been deformed downward.



Photo 2. Left door instrument cluster.

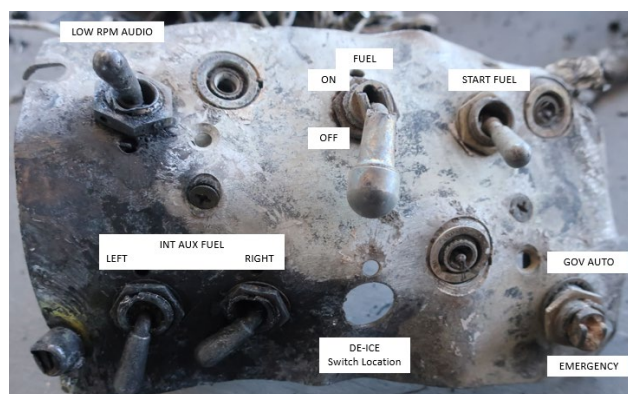


Photo 3. Engine Control panel.

1.2 Caution Warning Panel

The caution warning panel was located within the wreckage debris and had been liberated from the instrument panel (photo 4). The caution panel had been exposed to extreme heat. Soil, rock, and organic debris had adhered on the face of the panel, obstructing view of the individual warning light capsules. The caution panel was sent to the NTSB Materials Laboratory for examination to determine if a lightbulb analysis could be performed.

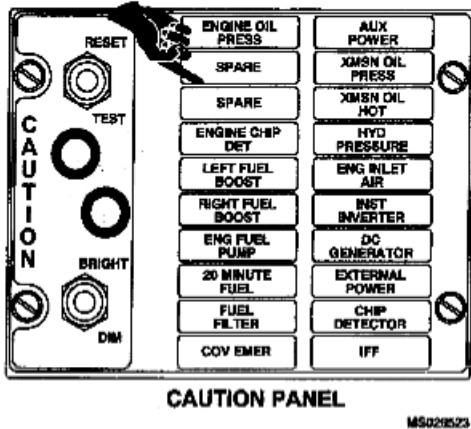


Figure 2. Caution panel configuration (Source: US Army TM 55-1520-210-10).



Photo 4. Caution panel as found in the wreckage.

Each caution light capsule should contain 2 light bulbs, for a total of 40 possible bulbs in the panel assembly. An illustration of the caution panel configuration is in Figure 2. The materials laboratory specialist that examined the caution panel reported² that the interior of the panel exhibited similar damage as the exterior and the individual annunciator positions has shifted as a result, the original position of the light bulbs could not be determined. Nine (9) intact bulbs with filaments were removed from the remnants of the panel. Two (2) bulbs exhibited hot filament stretching. It was not possible to identify the original location of these bulbs within the caution panel.

2.0 FLIGHT CONTROLS

Portions of the cockpit flight controls were identified. Both of the collective jack shaft tubes were present with no control arm or connecting elbow hardware. Portions of both left and right pedal adjustor assemblies were identified as well as portions of two control force gradient mechanisms. Ten control rod ends (clevises) were collected, each one had connecting hardware in place. The main flight control servos (Photos 5, 6, and 7) had separated from their input and output control rods.

Table 2. Flight control servo information.

PN: 205-076-099-007 ³	SN: 58930	Collective
PN: 205-076-099-007	SN: 61393	Left lateral
PN: 205-076-099-007	SN: 40804	Right lateral & control module

² Attachment 1 – Caution Panel Examination

³ Part numbers extracted from the maintenance records.



Photo 5. Collective servo.



Photo 6. Left lateral servo.



Photo 7. Right lateral servo.

Fragments of both sections of the cyclic lateral control tubes but without the fore-aft control tube connections were identified. Fragments of the lower mixing assembly were identified. The upper flight controls consisting of the stationary and rotating swash plates and drive links were not present. One pylon scissors assembly was identified and had been fractured. Two sections of pitch change rod were identified. The elevator spar and pitch horn had remained in the tail boom section. Three elevator control bell cranks were identified. All had connecting hardware was attached.

2.1 Tail Rotor Control

The tail rotor control bell crank quadrant was not located. The tail rotor hydraulic servo had detached from structure, had extreme thermal damage, and the input and output fittings had fractured. The tail rotor control forward cables, speed rig turnbuckles, and aft cables remained on the tail boom.

The cables ran continuously to the tail rotor gear box pitch change sprocket (photo 8 and 9). The tail rotor control chain moved freely and tail rotor blades changed pitch in concert.



Photo 8 .Tail rotor pitch links and cross head.



Photo 9 .Tail rotor pitch change control chain & sprocket.

2.2 Elevator

The elevator spar remained in the tail section. The right-side elevator airfoil remained intact but had been sawed off near the root by recovery personnel. The left spar extended out the left side of the tail boom, the entire air foil was not present on the spar. The elevator control horn assembly was in place in the tail section, the control rod clevis was attached, and a control rod laid near the clevis, the fastening rivets were sheared off (photo 10). Three elevator control bell cranks were identified, and all had connecting hardware attached (photo 11).



Photo 10 .Elevator pitch horn and control tube.



Photo 11 .Elevator control linkages.

2.3 Hydraulic Pump and Filter

The hydraulic pump had separated from the transmission and was missing the splined drive shaft. The pump housing had been exposed to extreme heat revealing the inner assembly. The pump was disassembled by investigators. All pistons were connected to the rotary drive. The inner drive shaft was intact with no unusual wear marks. The pistons moved in and out of the assembly and showed no unusual wear marks. The hydraulic filter had separated from its mount and the input/output connectors were fractured. The filter was disassembled. Some light colored and dark colored flakes were collected. Filter screen was removed and inspected. No debris was identified. The filter screen was backflushed with alcohol onto a blue cloth. No debris was observed from the flush. White material was

observed in the base of the hydraulic bowl and along the outer edge of the filter screen, as well as the mating side of the filter screen cap. This white material could possibly be adhesive material used in assembling the filter element.

3.0 MAIN ROTOR DRIVE SYSTEM

Upper transmission and rotor mast was not recovered to be examined. Four transmission mounts as well as the pylon fifth mount along with portions of the support beam, and engine power input quill were identified. The following lower transmission accessories were identified: oil pump quill, drive shaft, oil pump housing, tail rotor drive quill, the lower mast bearing, the hydraulic pump drive quill. In the engine compartment the oil tank, oil cooler, and cooling fan were also identified.

4.0 MAIN ROTOR

Main rotor head and both main rotor blades were not recovered and were not examined. Both stabilizer bar dampers were recovered.

5.0 TAIL ROTOR DRIVE SYSTEM

Tail rotor drive shaft segments were numbered (No.) 1-6 starting at the tail rotor drive output of the lower transmission. Drive shafts Nos. 1-3 were not recovered and presumed consumed by post-crash fire. However, the drive shaft bearing end that connects to the transmission tail rotor drive quill was identified as well as the drive shaft ends that mate with the support bearings for shafts Nos. 1-3. The aft end of drive shaft No. 4 was connected to shaft No. 5 through the support bearing. Drive shaft No. 5 was connected to the 42° gear box. Drive shaft No. 6 was connected from the 42° gear box to the tail rotor 90° gear box (photo 12). The 42° and 90° gear boxes rotated smoothly in concert with no binding.



Photo 12. Remnants of the tail boom, vertical fin, tail rotor drives shafts, and tail rotor.

6.0 TAIL ROTOR

Both tail rotor blades remained attached to the hub. Pitch change links were attached to the blades and the pitch change cross head. Rotor blades are labeled A & B for identification purposes (Photos 13 and 14).

6.1 Blade A

No observable damage noted on blade A.



Photo 13. Tail rotor blade "A"

6.2 Blade B

Chord wise dirt streaks observed on blade B. The outboard half trailing edge had heat damage and the reverse side 2/3 outboard of blade had fire damage to skin and underlying layers. The blade had a crease in the chordwise direction about 8 inches from the root.



Photo 14. Tail rotor blade "B"

7.0 FUEL SYSTEM

Fuel boost pumps, fuel quantity transmitters, fuel filling port with locking cap were identified. The structural aspects of the fuel tank had been consumed by fire. The auxiliary (AUX) fuel tank quantity gauge and transfer pump were identified.

8.0 ENGINE

The engine data plate was not present on the engine. The engine information per the engine maintenance logbook is as follows; Honeywell, T53-L-703, part number 1-000-060-23, serial number LE-13039Z.



Photo 15. External view of the engine.



Photo 16. Engine compressor case was consumed by the post-crash fire, revealing the compressor rotor and stator rings.

The air inlet housing, compressor housing, and accessories were not present on the engine. The KAflex coupling on the transmission side and engine side was fractured in multiple locations (Photo 17). The KAflex coupling center section (drive shaft) exhibited some punctures and tearing (photo 18).



Photo 17. KAflex coupling segments and main drive shaft.



Photo 18. Main drive shaft with puncture indentation.

The right rear engine mount was attached to the engine, but the engine mount leg was not present on the engine. The left rear engine mount was attached to the engine, but the engine mount leg was not present on the engine. The left front engine mount/leg was not present on the engine. Engine mount legs were located within the main wreckage debris, two were attached to the engine deck, one was completely separated.

The accessory gearbox was not present on the engine. The lower housing of the bleed band actuator was fire damaged. The helical sun gear-shaft was still attached to the forward end of the power shaft. The helical sun gear-shaft could not be removed by hand from the power shaft. The No. 21 bearing, No. 1 bearing, and the compressor shaft accessory drive bevel gear were exposed and fire damaged. All of the gears of the accessory drive carrier assembly were detached from the engine and located within the main wreckage debris. The accessory drive carrier could not be located. The starter was detached from the engine and located within the main wreckage debris. The starter was fire damaged.

Some internal components of the fuel control were found within the main wreckage debris. The reduction gear assembly was detached from the engine and located within the main wreckage debris. The reduction gear assembly was fire damaged. The housing was not present. A section of the particle separator was found detached from the engine, as well as part of the particle separator cover. They were located within the main wreckage debris. The inlet guide vanes displayed tearing, battering, and thermal damage.

The compressor spool could not be rotated. The first stage axial compressor blades displayed tearing, battering, and thermal damage. The blade tips were bent opposite the direction of rotation. Two halves of axial compressor stator vanes were found detached from the engine. The matching halves remained loosely sitting in the compressor section. The stator vanes displayed leading edge and trailing edge damage, as well as thermal damage. The combustion case drain was still attached to the lines, but no longer attached to the combustion case. The igniter box was found detached from the engine and located within the main wreckage debris. The 2nd stage power turbine blades were all present. Debris was noted on all of the power turbine blades. The power turbine spool had a small amount of

play but could not be rotated. The tail pipe was still attached to the engine. It displayed heavy impact damage. The engine was placed in a shipping container and sealed for further examination at a future date.

8.1 Engine Teardown Examination⁴

An engine teardown examination was conducted on March 9, 2021, at the Honeywell Phoenix, AZ, facility under the oversight of the NTSB. Internal engine component damage consisted of the inlet guide vanes displayed tearing and battering, all five stages of the axial compressor blades were bent opposite the direction of rotation, the interstage bleed centrifugal compressor impeller displayed rotational scoring on the shroud line edges of the blades at the inducer with corresponding rotations scoring through 360°, the inducer of the impeller housing, assembly, and the centrifugal compressor impeller had material build-up on the leading edge concave side of the blades. Documented damage was consistent with engine rotation at the time of impact.

Metallurgical analysis of the first and second stage gas producer turbine blades identified aluminum, stainless steel, and magnesium deposits on the both the suction side and pressure side of the blades. These metal spray⁵ deposits are consistent with the engine operating at the time of impact.

White dust like material covered the interior of the combustion liner. NTSB Materials Laboratory analysis of the white residue material identified it as magnesium oxide using dispersive x-ray spectroscopy (EDS)⁶. The source of the magnesium can be attributed to the engine case which is constructed of magnesium.

E. LIST OF ATTACHMENTS

Attachment 1: Caution Panel Examination
Attachment 2: NTSB Material Laboratory - Email Report WPR20LA280 (unknown residue)

Van McKenny
Aerospace Engineer - Helicopters

⁴ Honeywell Teardown Report of Model T53-L-703 Turboshaft Engine Serial Number LE-13039Z

⁵ Metal spray are particles of compressor shroud material and/or interior engine material, deposited in molten form, on turbine section components.

⁶ Attachment 2 - NTSB Material Laboratory - Email Report WPR20LA280 (unknown residue)