National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594

ANC23FA031

WRECKAGE EXAMINATION

May 15-17, 2023

TABLE OF CONTENTS

A. ACCIDENT

Location: Nuevo, CA
Date: 3/24/2023
Time: 1217L
Helicopter: Bell 407

B. WRECKAGE EXAMINATION

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C. SUMMARY

On March 24, 2023, at 1217 Pacific daylight time, a Bell 407, N14Z, was destroyed when it was involved in an accident near Nuevo, California. The pilot and pilot-rated passenger were fatally injured. The helicopter was operated as a Title 14 Code of Federal Regulations Part 91 personal flight.

The helicopter was equipped with Automatic Dependent Surveillance–Broadcast (ADS–B), which provides aircraft tracking to determine its position via satellite navigation or other sensors and periodically broadcasts it, enabling it to be tracked. The information can be received by air traffic control ground stations as a replacement for secondary surveillance radar, as no interrogation signal is needed from the ground.

According to archived Federal Aviation Administration (FAA) ADS-B data, the helicopter departed French Valley Airport (F70), Murrieta/Temecula, California, at 1205. The helicopter proceeded in a northernly direction. According to a family friend the helicopter was flying to Big Bear, California. The last ADS-B reporting point was about 18 miles north of F70 at 1217 located at the accident site. The pilot had a cell phone with a "crash notification" feature, which triggered the cell phone to automatically call a family member and notify that person that the cell phone owner may have been in an accident. The family member notified first responders who located the wreckage near the peak of a rocky hilltop at 1243.

The helicopter came to rest about 100 M downslope on a rocky and hilly terrain on the north facing side of the hill at an elevation of 2,560 ft above mean sea level (msl). All components were located within the main wreckage site. The debris field extended along the approximate course of flight, starting at the top of a small hill and extending down the hillside. The beginning of the debris field consisted of very small (toothpick-sized) fragments of fiberglass, consistent with main rotor blade material. These fragments were located on top of, and immediately adjacent to, a large rocky outcropping at the very top of the hill. The impact evidence suggests the aircraft wreckage continued along the general direction of flight and broke up as it tumbled down the hillside. Roughly 20 meters past the initial point of impact, gouges were located in the soil that were consistent with multiple tail rotor blade strikes; however, no evidence of main rotor strikes were found after the initial point of impact on the rocky outcropping. The end of the debris field was marked by the aircraft's battery, which had separated from the battery compartment and cables, and came to rest roughly 15 meters downhill from the main wreckage.

The airframe was extensively damaged with the tail boom separated. The main rotor hub remained attached to the main transmission, but the transmission deck was fractured from the passenger compartment. Two main rotor blades exhibited extensive damage from apparent impact with a solid object. The two other main rotor blades were damaged to a much lesser extent. The cockpit was largely destroyed by impact forces.

D. DETAILS OF THE EXAMINATION

1.0 Airframe Examination

1.1 Fuselage

Overview of fuselage damage. Fuselage was intact from tail boom attachment point to the last row of seating in the passenger compartment. Separating from under the main fuel tank and up along the passenger seating compartment. From the last row of seating only the floor portion of the fuselage remains to include the forward fuel tank, flight control closet, crew seats to the about the start of the aft portion of the chin bubble.

Figure 1 Right rear of fuselage of accident helicopter

Figure 2 Under side aft of passenger compartment and right side of passenger compartment,

Figure 3 Right side view of cockpit.


Figure 4 Left side of cockpit and passenger compartment

1.2 Tail Boom

Tail boom separated about 2 feet from the tail boom attachment point on fuselage. Separation from impact with terrain and overload. Tail rotor moved freely and moved when twisting the tail rotor drive shaft. Chip detector was removed and was clean. One tail rotor blade was undamaged, one had tip damage from contact with the vertical fin from impact with terrain.


Figure 5 View of tail boom.

1.3 Flight Control Continuity

- Collective- Left side (co-pilot) collective stick was undamaged, Right-side collective stick was separated at the base from overload/impact damage. Collective flight control tubes were intact from the collective to the push tube extending out of the vertical flight control closet. Collective was moved up and down and the flight control tube moved.

The attachment from the control tube coming out of the vertical flight control closet to the collective servo was separated by overload/impact damage. Collective flight control continuity was established from the collective to main rotor with separations from overload damage. No pre-impact anomalies were observed in the collective flight controls and all observed fractures were consistent with overload forces at impact. The cockpit area where much of the controls are located exhibited significant damage with corresponding damage to the controls. The helicopter was equipped with dual controls. Main rotor flight control continuity for collective systems was confirmed from input sticks to the main rotor hub assembly.

Figure 6 View of left collective.

Figure 7 Right side collective

Figure 8 Attachment point for right-side collective.

- Cyclic – Both cyclic sticks were separated near their attachment point. Separation from overload / impact damage. Flight control tubes from the cyclic stick attachment point were intact to about 2 feet up the vertical flight control closet with signs of separation from overload. No pre-impact anomalies were observed in the main rotor cyclic flight controls and all observed fractures were consistent with overload forces at impact. The cockpit area where much of the cyclic controls are located exhibited significant damage with corresponding damage to the controls. The helicopter was equipped with dual controls. Main rotor flight control continuity for both cyclic and collective systems was confirmed from input sticks to the main rotor hub assembly.

Figure 9 Left side cyclic attachment point.

Figure 10 Right side pilot's cyclic stick.

Figure 11 View looking down the vertical flight control closet.

- Yaw- No pre-impact anomalies were observed in the yaw pedal fight controls and all observed fractures were consistent with overload forces at impact. The cockpit area where much of the controls are located exhibited significant damage with corresponding damage to the controls. The helicopter was equipped with dual controls. Yaw flight control continuity from both pedals was confirmed from input pedals to the tail rotor assembly.

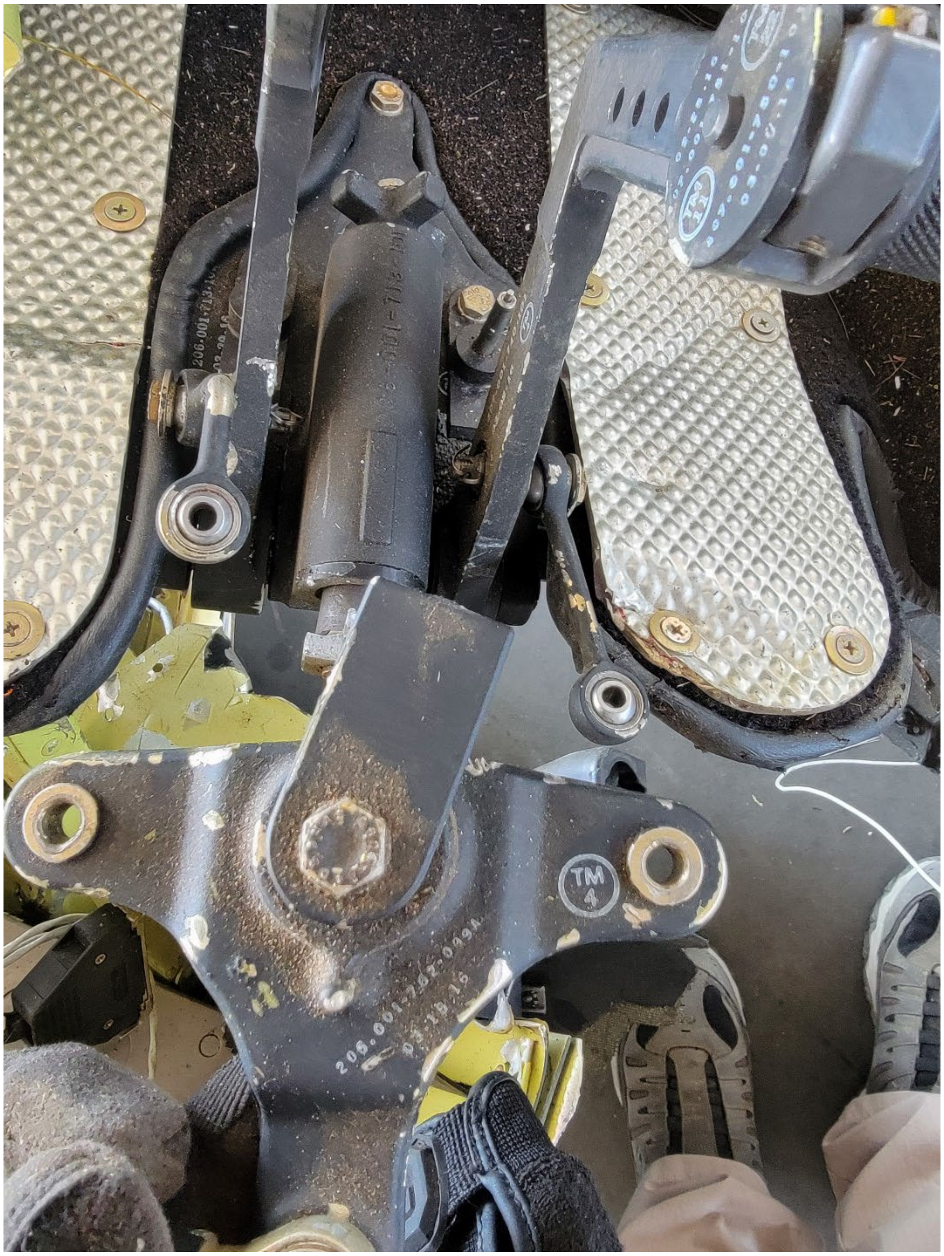

Figure 12 Left side yaw control pedals.

Figure 13 Right side yaw pedals.

1.4 Landing Gear

No pre-impact anomalies were observed with landing gear and all observed fractures were consistent with overload forces at impact.

Figure 14 Front view of high skid landing gear from accident helicopter.

Figure 15 Witness marks on green rotor blade with white paint transfer from impact with heli utility basket.

Figure 16 Witness marks on blue rotor blade with black paint transfer from impact with heli utility basket.

Figure 17 View of heli utility basket with down ski layed on top.

Figure 18 View of heli utility basket with broken ski pole.

1.5 Hydraulics

The main rotor head was turned, and the hydraulic pump pushed fluid out from a broken fitting. The fitting was damaged from impact. Hydraulic pressure and return impending filter bypass buttons were not extended. Hydraulic reservoir still had fluid and the screen was clean.

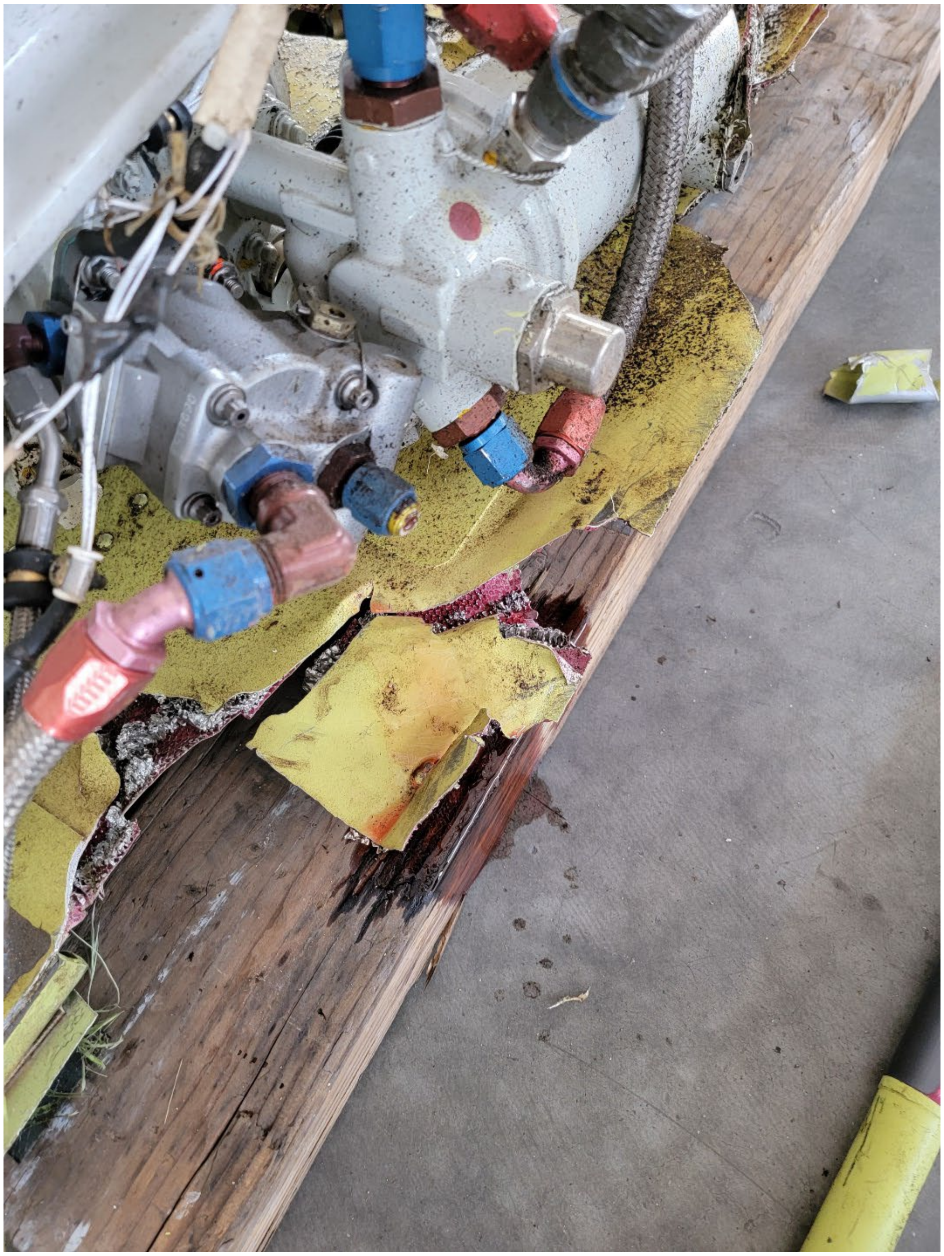

Figure 19 Hydraulic pump, fluid in pictures was from turning the main rotor head.

Figure 20 Hydraulic fluid reservoir.

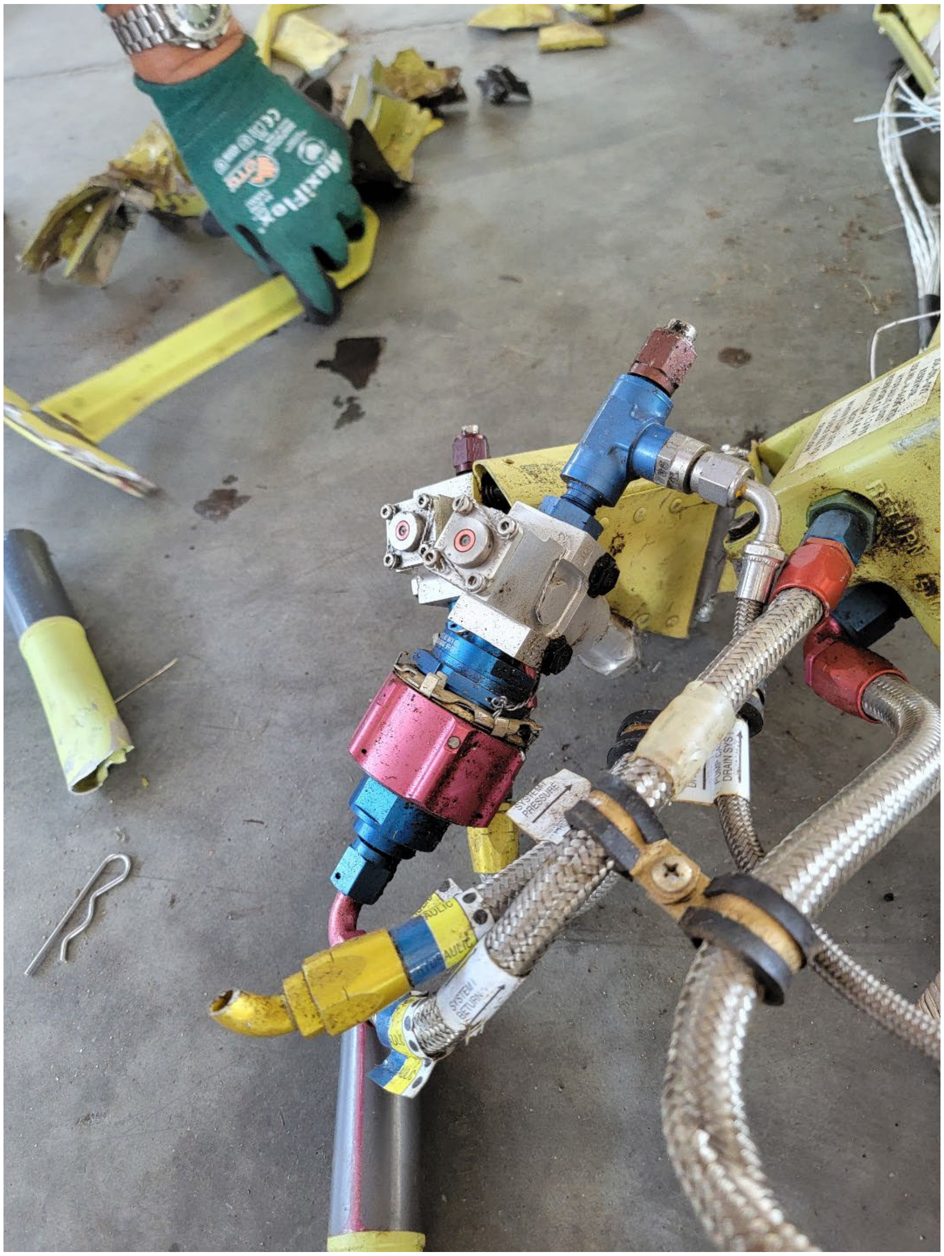

Figure 21 Hydraulic pressure and return impending filter bypass buttons.

1.6 Drive system

No pre-impact anomalies were observed in the main rotor and tail rotor drive system. All observed fractures were consistent with overload forces at impact. Main rotor and tail rotor turned freely by hand. All chip detectors were inspected and were clean.

1.7 Fuel/Fuel System

Fuel lines from engine to the main fuel tank were intact. The bottom of the main fuel cell where the forward fuel tank line connects was separated from impact damage. Fuel was present in the main fuel cell. Collective throttle control was intact from the collective stick attachment point to a throttle cable that separation from overload.

Figure 22 Bottom of main fuel cell. Forward fuel tank connection.

1.8 Other Systems

2.0 Engine Examination

There was impact damage to the outer combustion cannister, and the exhaust duct was crushed down around the exhaust collector. All engine mounts appeared to be intact, with minor deformation.

Figure 23 Top side of engine.

The engine's main drive shaft had separated at the flexible coupling. The surrounding structure exhibited impact damage from the flailing remnants of the coupling, consistent with continued engine rotation after the coupling failed in apparent overload. Rotating the power turbine by hand resulted in smooth rotation of both the tail and main rotor drives, thus confirming N2 drive continuity. The compressor was rotated by hand. Rotation was smooth and resulted in corresponding rotation of the starter/generator, thus confirming N1 drive continuity. The HMU Power Level Angle (PLA) was found at approximately 75 degrees.

Only when specific engine parameters are exceeded does the ECU record data to electronic memory. During normal engine operation, the ECU will hold performance data for 12 seconds, and then that data is over-written. However, if a parameter exceedance occurs, that 12 seconds of data is stored, and the ensuing 48 seconds of data is also stored. The result is the potential to capture 12 seconds of data before an exceedance occurs, as well as the ensuing 48 seconds of performance data after the exceedance occurs. This set of stored data is called Incident Recorder data, or **IR** data for short. This data is stored only until the engine has been shut-down and restarted three times, then the data is erased. When the Incident Recorder is triggered by an exceedance, data is recorded at 1.2 second intervals. Additionally, a single line of data is recorded at the moment an exceedance occurs and is stored in a separate dataset called “Snapshot Data”. Together, the IR data and Snapshot data can be combined to interpolate engine performance immediately prior to, as well as after an exceedance occurs.

Parameters recorded by the ECU’s Incident Recorder include:
Gas Generator (compressor) Speed: **Ng**, displayed as a percentage of 100%.
Main Rotor Speed: **Nr**, displayed as a percentage of 100%.
Mean Gas Temperature: **MGT**, displayed in degrees Fahrenheit.
Engine Torque: **Q**, displayed as a percentage of 100%.
Power Turbine Speed: **Np**, displayed as a percentage of 100%.
Fuel Flow: **WfAct**, displayed as pounds per hour (pph).
Change in Gas Generator Speed: **NDOTFilt**, displayed as a percentage change in Ng.
Ambient Air Pressure: **P1**, displayed in Pounds Per Square Inch (psia).
Collective Pitch Position: **CP**, displayed as a percentage of 100%.

The ECU was presented for examination, and a full download of data was successfully completed. The ECU lost power before all 12 seconds of data preceding the IR triggering event could be written. Eight complete lines of IR data was recorded, along with three complete and one partial line of Snapshot data. This suggests the ECU lost power only moments after the accident sequence began. Therefore, only 7.2 seconds of data from before the triggering event occurred was written to memory.

ECU Engine Data

Numeric Record	Time Seconds	HH:MM:SS.mmm	Ng %Ng	Nr %Nr	MGT Deg	Q %Q	Np %Np	WfAct pph	NDOTFilt %Ng/Sec	P1 psia	Mode	CP %CP
1	0.000	0000:00:00.000	0	0	0	0	0	0	0	0	0	0
2	1.200	0000:00:00.000	0	0	0	0	0	0	0	0	0	0
3	2.400	0000:00:00.000	0	0	0	0	0	0	0	0	0	0
4	3.600	2096:34:27.888	86	100	940	32	100	172	-0.1	13.43	1	32
5	4.800	2096:34:29.088	87	100	980	38	100	192	1.4	13.43	1	34
6	6.000	2096:34:30.288	87	100	960	36	100	188	0	13.49	1	34
7	7.200	2096:34:31.488	87	100	980	36	100	184	0.4	13.38	1	36
8	8.400	2096:34:32.688	86	100	960	32	100	184	-0.3	13.41	1	36
9	9.600	2096:34:33.888	87	100	960	36	100	200	1.2	13.5	1	36
10	10.800	2096:34:35.088	87	100	960	34	100	180	-0.6	13.44	1	36
SNAPSHOT 1	11.472	2096:34:35.760	87	91	960	68	91	196	-0.2	13.47	1	36
11	12.000	2096:34:36.288	90	76	1060	94	75	308	8	13.44	1	44
SNAPSHOT 2	12.192	2096:34:36.480	92	66	1100	128	67	336	8.6	13.38	1	62
SNAPSHOT 3	13.032	2096:34:37.320	101	64	1320	40	111	492	10.8	13.49	1	72
Partial Snapshot	13.040	2096:34:38.000	101	63	1420	16	124	456	4.2	13.3	1	72

The first three lines of IR data are blank, due to the previously-noted truncation from the sudden loss of electrical power. IR Data lines #4 through #10 record the 7.2 seconds of flight before the triggering event. The event that triggered the Incident Recorder was a significant main rotor (Nr) speed droop, recorded as "SNAPSHOT 1". The Nr droop is also accompanied by large engine Torque (%Q) increase. There is no corresponding change in the position of Collective Pitch (%CP). This suggests the main rotor droop was not caused by pilot control inputs, but was caused by the main rotor striking an object. (Discussed values highlighted in yellow) IR data line #11 is written immediately following SNAPSHOT 1. This data shows Nr continuing to decrease, Engine Torque continuing to increase, and Collective Pitch (%CP) beginning to increase. The engine is responding appropriately to the decreasing Nr by increasing power output; the increasing power is indicated by increasing fuel flow (WfAct), Turbine Temperature (MGT) and Compressor speed (Ng). (Discussed values highlighted in green). SNAPSHOT #2 is recorded 0.72 seconds after the initial triggering event of SNAPSHOT #1. SNAPSHOT #2 is triggered by a massive torque spike (Q 128%), which would be consistent with the main rotor striking a solid object at high power. Main Rotor speed (Nr) is recorded as slowing dramatically (66%). It is important to note that Power Turbine speed (Np) is recorded as being slightly higher (67%) than the Main Rotor. This suggests that this is the point during the accident sequence that the Main Rotor Drive Shaft Coupling failed in overload, decoupling the Main Rotor from the engine. This decoupling is confirmed in the next line of data. (Discussed values highlighted in blue). SNAPSHOT #3 is recorded 0.84 seconds after SNAPSHOT #2. It is triggered by a Power Turbine (Np) over-speed condition of 111%. This line of data indicates Main Rotor speed (Nr) is continuing to decrease. The sudden removal of the Main Rotor's load from the engine has caused the Power Turbine to over-speed. Engine Torque (%Q) is also seen to be rapidly decreasing, which would be typical following the decoupling of the Main Rotor from the engine. The engine, however, continues to attempt to restore Main Rotor RPM, as indicated by maximum allowable fuel flow (492 pph) and maximum compressor speed (Ng) of 101%. (The engine is incapable of detecting that it is no longer connected to the Main Rotor). (Discussed values highlighted in red).

The final line of data is labeled "Partial Snapshot". A time stamp was not recorded with this line of data due to the ECU losing electrical power before the line could be fully recorded. The estimated time stamp was manually assigned to this data in order to allow its incorporation into the graphical plot. This line shows Main Rotor speed continuing to decrease while torque values decay towards zero. The engine continues to overspeed in its attempt to restore Main Rotor speed, ultimately triggering the over-speed solenoid (Np 124%), which is the triggering event for this Snapshot data. This is confirmed by fuel flow beginning to decrease from 492 to 456 pph. Collective pitch remains at its maximum, but no other pertinent data is recorded. (Discussed values highlighted in pink).

Two Power Turbine over-speed events were recorded at 2020:04:07 (Hours:Minutes:Seconds) and at 1997:53:08. Peak Np was recorded at 110.32% for a total of 1.34 seconds of operation in

an overspeed condition. No record of these overspeeds were found in the engine logbooks or maintenance records.
There was no evidence of engine fire, failure or malfunction. Even after the initial impact, the engine continued to perform in its attempt to maintain main rotor RPM at 100%.

3.0 Main / Tail Rotor Blades

Figure 24 Top side of main rotor blades.

Figure 25 Top side tip damage to main rotor blades.

Figure 26 Bottom side of main rotor blades.

Figure 27 Bottom side from tips of main rotor blades.

4.0 Video

[redacted]

[redacted]

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