



Aviation Investigation Factual Report

Location:	Livermore, California	Accident Number:	WPR22LA174
Date & Time:	May 11, 2022, 09:30 Local	Registration:	N999GH
Aircraft:	BELL HELICOPTER TEXTRON CANADA 407	Aircraft Damage:	Substantial
Defining Event:	Miscellaneous/other	Injuries:	1 Serious, 1 Minor
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

On May 11, 2022, about 0930 Pacific daylight time, a Bell Helicopter Textron Canada 407, N999GH, was substantially damaged when it was involved in an accident near Livermore, California. The pilot was seriously injured and the lineman crew member sustained minor injuries. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 133 rotorcraft external-load flight.

The pilot was performing a HEC long-line qualification exam flight at the Livermore Electric Safety Academy, a training operations facility owned by the Pacific Gas and Electric Company (PG&E). The pilot was flying the helicopter solo from the right seat with the door removed so that he could lean outside and observe below. The maneuvers were observed and monitored on the ground by a group of examiners.

The pilot stated that the first 20 minutes of the flight were normal and the accident occurred during the final phase while carrying a PG&E lineman on a 60-ft long line. The pilot was maneuvering the helicopter at an altitude of about 175 ft agl, positioning the lineman against a static line marker ball midway along a 90-ft wire that spanned an 88-ft lattice tower and a 65-ft wood pole. The pilot reported that the engine then lost power and he rolled the throttle out of the "FLY" detent and into the "emergency" range, but the engine did not respond.

He attempted to maneuver the lineman into a clearing and partially raised the collective once the lineman was about 15 ft agl to cushion the lineman's landing. The pilot stated that he then maneuvered the helicopter to a landing spot away from the linemen and, after reaching an altitude of about 30 ft agl, he raised the collective and dropped the HEC line and cargo hooks; the helicopter landed hard. The pilot stated that the engine was still running after landing and he was able to then shut off the main fuel valve and battery. He was extricated from the helicopter about 30 minutes later.

Multiple witnesses recounted observations that matched the pilot's statement. All stated that the helicopter appeared to be operating without issue throughout the maneuvers until they heard a change in engine tone, with some then observing the main rotor blades slowing as the helicopter began to rapidly descend. A video provided by a witness showed the helicopter descending just before impact. It appeared intact and was not emitting smoke or vapors.

Pilot Information

Certificate:	Commercial; Flight instructor	Age:	38, Male
Airplane Rating(s):	None	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	4-point
Instrument Rating(s):	Helicopter	Second Pilot Present:	No
Instructor Rating(s):	Instrument helicopter	Toxicology Performed:	
Medical Certification:	Class 2 Without waivers/limitations	Last FAA Medical Exam:	March 29, 2022
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	February 19, 2022
Flight Time:	3475 hours (Total, all aircraft), 175 hours (Total, this make and model), 3420 hours (Pilot In Command, all aircraft)		

The pilot reported about 3,500 hours of total flight experience including about 1,000 hours as a flight instructor and agricultural pilot. He started working for the helicopter operator about 15 months before the accident. He reported a total of almost 175 hours flight experience in the Bell 407, 10 of which were in the Honeywell engine-equipped 407HP version, all in the accident helicopter.

The pilot's total FAR Part 133 external load time before the accident totaled about 87 hours. Most of the flight time took place in the Eurocopter AS-350, with 2.3 hours in the Bell 407, and 6.7 hours in the 407HP. Two of the flights involved HEC, with all other flights involving training or carriage of cargo or buckets, all flown from the right seat.

The accident flight was a demonstration flight to PG&E so he could be signed off to perform HEC flights for them. According to the helicopter operator, this was the second time he had taken the check ride, having not passed on the first attempt.

The night before the accident he stayed in a hotel and went to bed about 2100. He awoke at 0630 and reported having a normal night sleep and was well rested. The pilot was 6 ft tall.

Aircraft and Owner/Operator Information

Aircraft Make:	BELL HELICOPTER TEXTRON CANADA	Registration:	N999GH
Model/Series:	407 HP	Aircraft Category:	Helicopter
Year of Manufacture:	2008	Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	53868
Landing Gear Type:	None; Skid	Seats:	7
Date/Type of Last Inspection:	April 25, 2022 Continuous airworthiness	Certified Max Gross Wt.:	5250 lbs
Time Since Last Inspection:	48.6 Hrs	Engines:	1 Turbo shaft
Airframe Total Time:	4055 Hrs as of last inspection	Engine Manufacturer:	Honeywell
ELT:	C126 installed, activated, did not aid in locating accident	Engine Model/Series:	HTS900-2-1D
Registered Owner:	Guardian Helicopters	Rated Power:	900 Horsepower
Operator:	Guardian Helicopters	Operating Certificate(s) Held:	Rotorcraft external load (133)
Operator Does Business As:	Guardian Helicopters	Operator Designator Code:	

In 2019, the helicopter was converted from its original Rolls Royce 250-C47 engine to a Honeywell HTS900-2-1D. The conversion was performed in accordance with the Eagle Copters, Eagle 407HP supplemental type certificate (STC) SR03496NY.

The Honeywell engine was controlled by a Full Authority Digital Engine Control (FADEC) system consisting of two redundant electronic control units (ECUs) along with a fuel metering unit (FMU) assembly, permanent magnet alternator, and other engine and airframe sensors. The FADEC system was designed to provide automatic control of the engine during startup, steady state, and transient operation and ensure that operation stayed within specified envelopes.

Pilot-commanded throttle position was monitored by the ECUs through a dual linear variable differential transformer (LVDT) assembly, mounted to the airframe and connected through a series of bellcranks to a conventional twist grip in the collective control column.

The helicopter was configured for operation from the right seat, with the collective control on the pilot's left side. The twist grip had three distinct detent positions: OFF, IDLE, FLY, and an unmarked over-center position beyond FLY. Although it was available, this over-center position had no functional use in the Honeywell engine-equipped version of the helicopter. In the original Rolls-Royce engine-equipped helicopter, the over-center position was marked as the "MaxNG" detent. This position allowed the pilot to manually maintain main rotor/power turbine

(Nr/Np) speed by going beyond the FLY (90% gas producer [Ng] speed) detent in the event of a FADEC failure.

For both configurations, to reduce engine power, rotating the twist grip from FLY to IDLE would have required a rotation in the clockwise direction when facing forward. Additionally, a lockout button was included that needed to be pressed to move the control from IDLE to OFF.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	KLVK,393 ft msl	Distance from Accident Site:	5 Nautical Miles
Observation Time:	09:53 Local	Direction from Accident Site:	266°
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	4 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:		Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30.24 inches Hg	Temperature/Dew Point:	14°C / 3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Livermore, CA	Type of Flight Plan Filed:	None
Destination:	Livermore, CA	Type of Clearance:	None
Departure Time:	09:00 Local	Type of Airspace:	Class G

Airport Information

Airport:	PG&E LIVERMORE TRAINING CENTER LA22	Runway Surface Type:	Asphalt
Airport Elevation:	572 ft msl	Runway Surface Condition:	Dry
Runway Used:	H	IFR Approach:	None
Runway Length/Width:	48 ft / 48 ft	VFR Approach/Landing:	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Serious, 1 Minor	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:		Aircraft Explosion:	None
Total Injuries:	1 Serious, 1 Minor	Latitude, Longitude:	37.699413,-121.70852

The helicopter came to rest on its belly and was tilted slightly to the left (see Figures 1 and 2). The landing skids had spread outwards on both sides. The primary airframe structure was largely intact but had buckled in the roof area below the main transmission, which had moved out of position and was tilted slightly down. All four main rotor blades remained attached to the hub assembly; one blade was essentially undamaged and the remaining three had sustained delamination, aft bending, and buckling damage from midspan outwards. The tailboom remained attached to the aft bulkhead, and both tail rotor blades had detached with their roots remaining on the hub.



Figure 1– Helicopter at the accident site (photo courtesy of the FAA).



Figure 2 - Accident location within training facility (photo courtesy of PG&E).

The engine was still attached to its mounts and appeared to have sustained minimal damage. The engine output drive coupling had separated where it joined the main transmission. The damage to the coupling appeared to be consistent with movement of the main transmission at impact. There was no evidence of catastrophic engine failure or foreign object ingestion.

The transmission drivetrain was continuous from the engine output drive coupling through to the main gearbox and both the tail and main rotor blades; the freewheeling clutch was operational.

The flight controls sustained damage consistent with impact at the base of the main transmission assembly and the pilot's collective control but were otherwise intact.

Flight recorders

Video

The helicopter was equipped with an Appareo Vision 1000, which was a self-contained image, audio, and parametric data recorder. The parametric data included GPS aircraft time, position, altitude and speed, along with 3-axis acceleration with derived pitch, roll, and yaw.

The unit was mounted on left side of the aft cabin bulkhead, facing forward. The field of view was focused to the left and downward. As such, only a portion of the instrument panel, the left segment of the annunciator panel, and some externally visible features through the helicopter's left chin bubble and left windscreen were visible. The pilot's body was not captured, nor were any of his control inputs.

The recording contained a stereo audio track. One audio channel was of a cockpit area microphone, and the other was recorded from the helicopter's intercom. The intercom track recorded continuously and captured the pilot's voice as a "hot mic" throughout.

Throughout the recording, portions of the video playback were discontinuous and frozen. This condition had been noted previously in other investigations involving Appareo Vision 1000 devices and have been reported to the manufacturer; however, the audio playback was uninterrupted.

No annunciator lights on the visible left side of the panel illuminated during the recording. These annunciators included:

- float test,
- float arm,
- baggage door,
- l/fuel boost,
- r/fuel boost,
- fadec maint,
- engine fire,
- fadec ch fail,
- litter door,
- l/fuel xfr,
- r/fuel xfer,
- start fault,
- engine anti-ice,
- start,
- heater overtemp,
- a/f fuel filter,
- fuel valve,
- fuel flow,

The visible flight instruments were:

- TRQ (Torque),
- MGT (Measured Gas Temperature),
- Ng,
- Oil pressure,

Oil temperature,
Transmission oil temperature,
Transmission oil pressure,
Fuel capacity,
Amperes,
Fuel pressure,

The video began at 0928:38, with the helicopter running in idle on the ground. After a series of routine radio calls, and with all visible gauges in the green range, the helicopter appeared to lift off. The helicopter remained in a low hover and the gauges continued to indicate nominal performance. About one minute later, the helicopter began exhibiting maneuvers consistent with the initiation of the exam.

Throughout the recording the pilot was audible and breathing heavily, and at 0937:10, he was heard to exclaim frustration. At this time the gauges were still showing normal values, and a radio call was audible with the person on the radio stating, "that one hit ground uh pretty good, why don't you do an orbit and start over." The pilot responded, "you got it man."

Over the next 5 minutes, the video continued to intermittently freeze, but the audio track remained continuous. The video fragments and audio indicated the pilot was performing maneuvers under the observation and supervision of the ground examiners. The pilot continued to breathe heavily while showing signs of frustration and often emitting exasperated sighs.

Eventually the ground personnel transmitted, "good job man pick up" And three minutes later the helicopter began performing maneuvers that indicated the pilot had now picked up the lineman and was performing HEC operations.

For the next 11 minutes, HEC operations continued, with the pilot communicating with the lineman as he maneuvered him around the facility. The pilot continued to breathe heavily throughout, while talking himself through the maneuvers with a strained voice.

At 0954:20, the helicopter's heading was 140° magnetic, and the instruments were still indicating nominal values, with MGT indicating 710 °C, Ng 91%, and torque 68%.

A few seconds later, the pilot exclaimed "ugh," and the torque gauge value dropped to 61% and then returned to about 65%. During this time the helicopter changed heading slightly to the left, and about 7 seconds later, a steady 2,850 Hz tone was audible that would last for the remainder of the recording. (A 2,900 Hz [+/- 50 Hz] tone represents either a low rotor rpm horn, an engine out horn, or both).

The pilot then stated, "there ya go," as the heading swung further left to about 125°. MGT continued to trend down to about 680 °C; Ng had reduced to about 88%.

The pilot then swore, and the helicopter heading swung rapidly to the right and the pilot let out another expletive. By this time, MGT had dropped to about 660 °C and Ng was unchanged.

The helicopter appeared to be descending as the heading swung further to the right. MGT had now dropped to 650 °C, and the helicopter began to show evidence of a more rapid descent. MGT then dropped to 600 °C, while Ng was indicating 82% and torque 57%.

The last frame ended about 4 seconds before ground impact with the helicopter now level with the top of a power pole just ahead.

Engine Parameters

The ECU contained an incident recording feature which was designed to provide data in support of engine troubleshooting and maintenance. The system was designed to activate after a successful engine start, then continuously record data every 1.2 seconds over a 12-second loop resulting in the last 10 sets of data always being stored. When an incident was detected, the 10 sets of data recorded preincident were saved, directly followed by an additional 40 sets of postincident data. Each data set included critical parameters such as engine history, discrete words, fault words, and key control inputs.

The ECU was tested using a Honeywell engine simulator and data for the accident sequence was extracted and time-correlated with the Appareo parametric data. The extracted ECU data included core engine and helicopter parameters along with power lever angle (PLA) and collective pitch angle.

Review of the data indicated that the ECU captured data 12 seconds before the main rotor rpm dropped to zero, which was the first event denoting an incident, and would have been about the time of impact.

The first data point in the recording indicated that the helicopter's vertical speed was zero; however, the PLA was 102°, which corresponded to a throttle position between IDLE and FLY. Nr was at 76.6% but was decaying, while Ng remained about 87%.

About 3.5 seconds later, the PLA was at 82°, which was the IDLE position. During this time the helicopter began to descend at a vertical speed of about -500 ft per minute (fpm). Within one second, the PLA had increased back up to 142°, which would have been in the over-center position past the FLY detent. However, by this time Nr had dropped to 50%, and the MGT along with both the Np and Ng speeds began to drop. Five seconds after the FLY over-center position was selected, rapid variations in engine parameters began, along with the engine Np speed accelerating to over 100% when the Nr speed went to zero, consistent with the engine's power turbine shaft decoupling from the main rotor system at impact and accelerating.

According to technical representatives from Honeywell, when the throttle is increased to the FLY position, if the Nr speed is still below 70%, the torque limiter will engage. This limiter was

designed to prevent an over-torque condition and corresponding yaw when accelerating from ground idle before takeoff. The limiter holds engine torque to 50% until 100% Np is reached or 10 seconds has elapsed. Therefore, even if the pilot increased the collective control, the engine would not respond because it was being held by the limiter.

Tests and Research

Engine Tests

The engine sustained minimal damage during the accident sequence and the ECU was intact. However, the FMU was damaged after being struck by the rotating engine output drive coupling during impact.

The FMU was examined and tested at the manufacturer's facility. With the damage sustained, only a partial set of tests were accomplished; however, the unit met the nominal parameters of those tests and disassembly did not reveal any preimpact anomalies or mechanical failures.

The engine was removed, examined, and operated at the facilities of Honeywell Aerospace. No engine anomalies were noted during the examination, and the engine performed nominally when run in a test cell.

The throttle position LVDT was tested in a similarly equipped 407HP helicopter and performed within specifications.

Administrative Information

Investigator In Charge (IIC):	Simpson, Elliott
Additional Participating Persons:	David Jensen; Federal Aviation Administration; Oakland, CA Nora Vallée ; Transportation Safety Board of Canada David Studtmann; Honeywell John McCoy; PG&E Alejandro Alva; Guardian Helicopters/Rotorcraft Support
Report Date:	
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=105065

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