NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Vehicle Recorder Division
Washington, D.C. 20594

GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

CEN22FA100

By
Joseph A. Gregor

WARNING

The reader of this report is cautioned that the transcription of a cockpit image and audio recording is not a precise science but is the best product possible from a Safety Board group investigative effort. The transcript or parts thereof, if taken out of context, could be misleading. The transcript should be viewed as an accident investigation tool to be used in conjunction with other evidence gathered during the investigation. Conclusions or interpretations should not be made using the transcript as the sole source of information.

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, DC 20594

September 28, 2022

Onboard Image, Audio and Data Recorder

Specialist's Factual Report
By Joseph A. Gregor

1. EVENT

Location:	Houma, LA
Date:	January 14, 2022
Aircraft:	Bell 407, N167RL
Operator:	Rotorcraft Leasing Company
NTSB Number:	CEN22FA100

2. SUMMARY

On January 14, 2022, about 1001 central standard time (CST), a Bell 407, N167RL, was destroyed when it was involved in an accident near Houma, Louisiana. The commercial pilot and a passenger sustained fatal injuries. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 135 on-demand flight.

3. GROUP

A group was convened on March 22, 2022. The group consisted of the following members:

Chairman:	Joseph Gregor Electronic Engineer National Transportation Safety Board (NTSB)
Member:	Mitchell Gallo Investigator-In-Charge National Transportation Safety Board (NTSB)
Member:	Van McKenny, IV Aerospace Engineer – AS-40 National Transportation Safety Board (NTSB)

Member:	Michelle Watters, MD, PhD Medical Officer – Research & Engineering National Transportation Safety Board (NTSB)
Member:	Matthew Rigsby Air Safety Investigator – AVP-100 Federal Aviation Administration (FAA)
Member:	Gary Howe Air Safety Investigator, Flight Safety Dept. Bell / Textron
Member:	Jack Johnson Air Safety Investigator Rolls-Royce
Member:	Jason Melancon VP – Director of Operations Rotorcraft Leasing Company

4. DETAILS OF INVESTIGATION

On January 19, 2022, the NTSB Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model:	**Appareo Vision 1000**
Recorder Serial Number:	**Unknown**

4.1. Appareo Vision 1000 Recorder Description

The Appareo Vision 1000 device is a small self-contained image, audio, and data recorder. The unit is typically mounted in the overhead of aircraft's cockpit and records a cockpit image at a rate of four times per second. In addition to cockpit images, the device is also capable of recording two tracks of audio that are synchronized with the image data. The unit also contains a GPS receiver that receives GPS-satellite based aircraft time, position, altitude, and speed. In addition to the GPS position, the Appareo unit also has a self-contained real-time inertial measuring unit that provides 3-axis accelerations as well as aircraft pitch, roll and yaw data.

The two recorded audio tracks can be wired to record the following inputs: an external audio source such as the aircraft's intercom or radios and audio picked up by a microphone mounted internal to the Vision 1000 unit. In this installation no external aircraft audio was connected to track one and the track two microphone only picked up very loud engine and/or transmission sounds from the helicopter.

The Appareo unit records the image, audio and parametric data on a removable SD[1] memory card that is inserted into the unit. Depending on card size, this removable memory retains approximately the last two hours of image and audio data and about the last 100 hours of parametric data. In addition to the removable memory the Vision 1000 is also equipped with a memory module that is mounted internal to the unit. This internal memory contains an exact duplicate of the data stored on the removable card.

The Appareo unit on this aircraft was connected to the aircraft's electrical bus. Any time the battery switch is turned on the Appareo unit will start to record audio, images and data. The Vision 1000 unit creates a new file for every electrical power application and can create multiple files for the same power cycle if the recording time exceeds a certain time limit.

4.2. Appareo Vision 1000 Recorder Damage

Upon arrival at the NTSB Vehicle Recorder Division, it was evident that the Appareo Vision 1000 had suffered catastrophic damage. All that was recovered was the crash protected memory module and a portion of the external heat sink to which it was attached. In accordance with NTSB procedures for electronic devices recovered from water, the device was shipped to the laboratory in fresh water. Figure 1 is an image of the Appareo Vision 1000 as received, after being removed from a container of fresh water. Figure 2 shows the memory module after removal from the crash protection. The externally removable SD card normally used for recording in the Appareo 1000 was not recovered.

[1] SD – Secure Digital – A type of nonvolatile memory card used extensively in portable devices.

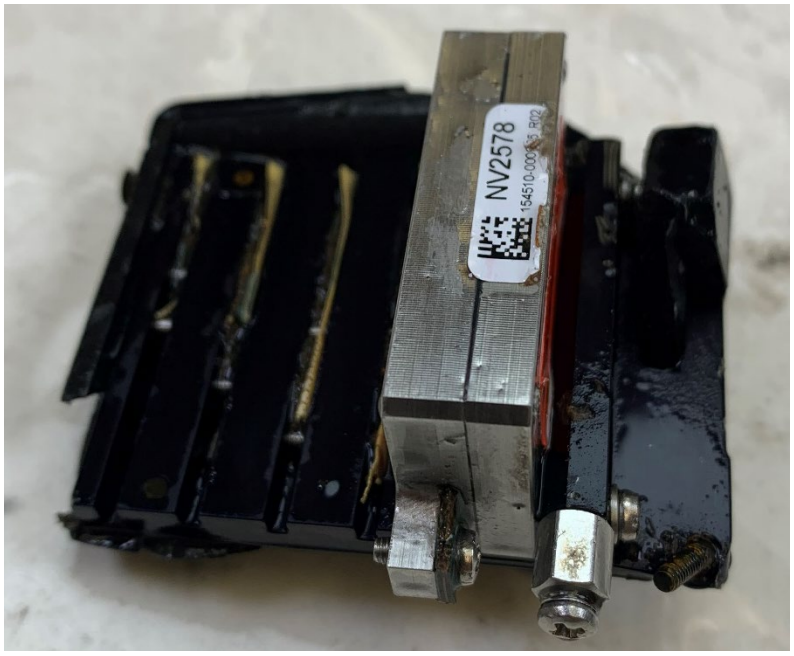

Figure 1. The Appareo Vision 1000 memory module & heat sink, as recovered.

4.3. Appareo Vision 1000 Data Recovery

The unit's memory module was removed from the silver-colored crash case, soaked in deionized water, cleaned, and dried in a vacuum drying oven (see figure 2). The ribbon cable used to transfer data from the PCB[2] was ripped from the board due to the forces of the accident. Two TSOP[3] FLASH memory integrated circuits (chips) that stored the recorded data were mounted on each face of the PCB. These were desoldered from the damaged memory board, cleaned, and re-soldered onto an undamaged memory board. This board was then interfaced into a surrogate Appareo 1000 using the built-in ribbon cable and a normal download performed using manufacturer software.

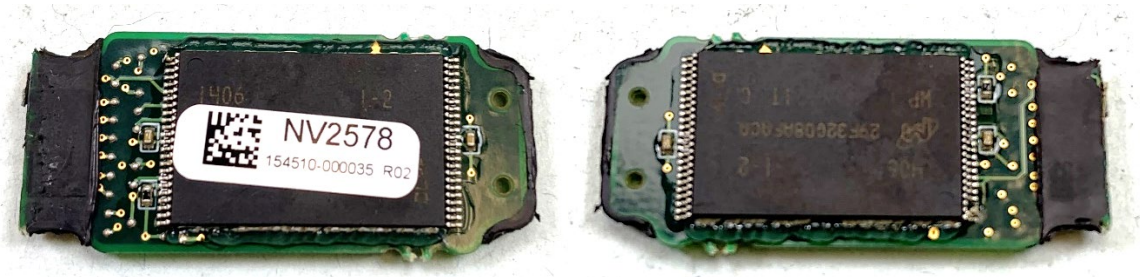

Figure 2. The Appareo Vision 1000 memory board after removal and cleaning.

[2] Printed Circuit Board.
[3] Thin Small Outline Package. A type of packaging style used to house an integrated circuit device.

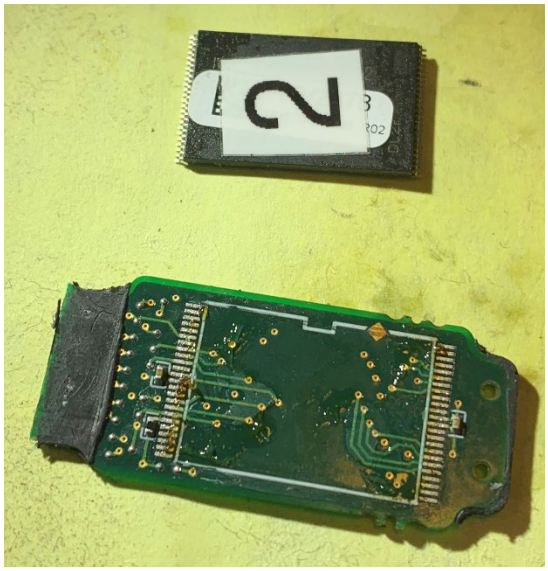

Figure 3. The Appareo Vision 1000 memory board after removal of one TSOP FLASH chip.

The internal memory data extraction procedure produced recordings (audio, image and parametric data) from the accident flight which contained data almost until the helicopter's impact with the ground.

Figure 4 is an image from a sister ship to the N167RL, showing the Appareo V1000's field of view of the instrument panel. While this panel is similar to, but not identical with, the instrument panel in N167RL, it does give a good sense of the location of all the instruments described in the following summary.

Figure 4. A capture from an Appareo image recorder installed on a sister helicopter.

Parametric data from the SD card was reviewed. Parametric data related to the last approximately 6 minutes of the Vision 1000's recording system was plotted in figures 5 and 6.

4.4. Appareo Vision 1000 Parametric Data Description

Parametric data for the accident flight was exported and is included as attachment 1. Figure 5 is a plot showing recorded parameters for the last approximately 6 minutes of the flight. Figure 6 is a plot showing recorded parameters for the last approximately 30 seconds of the flight.

4.5. Appareo Vision 1000 Time Correlation

Timing information was recorded as CST. The format given for this report is HH:MM:SS.mS, where HH stands for the number of hours, MM the number of minutes, SS the number of seconds, and mS is the number of milliseconds.

5. Summary of Recording Contents

In agreement with the Investigator-In-Charge, a video group was convened, and a summary was developed from the Appareo Vision 1000 imagery data. Independent timing information was not available and there were long lapses in

recorded video data. No sound information was recovered. The accident was captured during the last continuous 30-seconds of recorded video data. All times prior to the transcript information are given in as elapsed time of the recording as reported by the Appareo playback software.

The recording began at 00:00:00 elapsed time, with the pilot in right seat wearing a tan ball cap and a headset while performing actions consistent with checklist usage and radio/interphone communications. The right arm of the left seat passenger was initially visible as he put on his headset. The view forward out of the windscreen showed the helicopter on the ground on a small concrete pad in a grassy area nearby an outdoor parking lot.

At around 00:03:45, the camera/helicopter began to vibrate consistent with engine start and main rotor movement.

At around 00:05:03, the helicopter lifted off, performed a right 180 degree turn in a low hover, and began to hover taxi over a freshly plowed field. The helicopter climbed to approximately 200 ft as seen on the cockpit altimeter, and taxied down an airport taxiway to land on the apron immediately in front of an FBO.[4] The pilot then performed duties consistent with checklist usage.

At 00:09:00.76, the video recording froze on a frame showing the pilot performing mathematical calculations on a PED.[5]

At 00:25:27.26, video recording resumed with the helicopter in-flight over swampy terrain while flying at approximately 1000 ft as seen on the cockpit altimeter and on a heading roughly in the direction of the sun. The left side of pilot's head and left shirt epaulette were visible. The pilot's actions and gestures were consistent with a normal visual scan while in straight-and-level flight.

At 00:26:47.51, the video momentarily froze and approximately 50 frames were displayed with random spacing until the video froze completely at 00:33:26.01. The detailed group transcript started at 02:20:25.51 elapsed time. The transcript is given in Central Standard Time (CST) using timing information obtained from parametric data recorded by the Appareo, using the assumption that 02:26:12.51 elapsed time into the video recording corresponds to 10:00:50.01 CST.

[4] Fixed-base operator.
[5] Personal electronic device.

6. Transcript of Recording

CST [hh:mm:ss.ms]	Description
09:55:03.01	The general area imaged by the Appareo encompassed the area from the center of the left windscreen to approximately ¾ of the right wind screen, and about ¼ down from the top of the wind screen to halfway down the top half of the center mounted GPS display below the instrument panel. A portion of the annunciator panel was brightly lit by the sun with a shadow extending across the instrument panel from the upper left to the lower right. The airspeed indicator showed about 118 knots. The attitude indicator displayed no flag(s) and indicated a wings level and slight nose down attitude. The altimeter indicated about 1,560 feet. The N_R gauge indicated about 100%. The heading indicator showed about 280 degrees. The vertical speed indicator showed about ½ needle width above zero. The turn and slip needle was centered and the ball exhibited ½ ball width deflection to the left. The fuel quantity indicator showed about 650 lbs. The video showed a water bottle and metal clipboard inserted into the map case on top of the glare shield. No portion of the passenger was in view. A portion of the pilot was in view, including the left side of the pilot's head set and the left shirt epaulet along with a turnbuckle for the left shoulder harness. The pilot was wearing sunglasses, a mesh-back ball cap, and a neck gator. The pilot's head was near level and facing forward.
09:59:43.51	The video showed pilot head movements consistent with visual flight rules (VFR) scanning. The altitude indicator initially showed 1,500 ft with a gradual descent to about 1,380 ft. The heading indicator remained steady at about 280 degrees. No annunciator panel lights were illuminated.
10:00:05.51	The pilot's left hand moved to the GPS panel that was displaying a TCAS alert for multiple targets at near the 11, 3, and 7 o'clock positions. The airspeed indicator showed about 122 kts. The heading indicator showed about 280 degrees. The video recorded pilot head movements consistent with a VFR scan up until about 10:00:50.01 CST.

CST [hh:mm:ss.ms]	Description
10:00:50.01	The pilot's head began to slightly fall back in a motion not consistent with VFR scanning or directed attention. The attitude indicator displayed no flags and indicated a slight roll to the right. The airspeed indicator showed 123 knots. The altimeter showed about 1,220 feet. The vertical speed indicator showed a descent rate of about 400 ft/min. The heading indicator showed about 285 degrees. The turn and slip indicator showed the needle centered with the ball deflected about ½ ball to the left. The annunciator lights were not illuminated. [Head movements during this period appeared to be undirected and solely in response to the g-forces resulting from aircraft motion]
10:00:51.51	The pilot's head fell backward and to the left until it blocked about ¾ of the camera view. The remaining view through the left windscreen showed a small portion of the horizon consistent with the helicopter being in a right bank.
10:00:52.51	The passenger's right arm began to move upward toward the center post for the windscreen. The view outside the wind screen was consistent with an approximately 45-degree right bank. The N_R gauge indicated about 100%. The airspeed indicator showed about 129 knots. No annunciator lights were illuminated. The passenger's arm continued to extend upwards to the center post with his hand at the upper limit of the camera view. The view outside the windscreen showed an increasing right bank to approximately 90 degrees.
10:00:53.26	The passenger's right arm was fully extended toward the center post of the windscreen. The pilot's left hand index finger, curled inward, came into view extending from the bottom of the video and blocking the view of the front of the GPS display. The pilot's head was tilted slightly to the left and back. The attitude indicator showed approximately 90-degree of bank and a 10 degrees nose down attitude with no flag(s). None of the annunciators were illuminated. The heading indicator showed about 220 degrees. The airspeed indicator showed about 131 knots.
10:00:53.76	The passenger's right arm remained fully extended toward the center post of the windscreen. The attitude indicator showed a right bank greater than 90 degrees, consistent with the view outside the right windscreen. The airspeed indicator showed approximately 134 kts. No annunciator panel lights were illuminated. The VSI indicated about 800 fpm. The pedal stop limiter annunciator was illuminated green. The pilot's left hand moved further up into view blocking the right side of the GPS panel and the bottom edge of the instrument panel. The pilot's left index finger was curled about 90 degrees and touching the distal end of his thumb. The pilot's head moved slightly to the right consistent with the forces generated by aircraft motion.

CST [hh:mm:ss.ms]	Description
10:00:54.01	The passenger's arm remained fully extended to the center post of the windscreen. The pilot's head had moved to right just out of view and his left hand was also out of view. The bank angle had increased slightly to the right. The pilot's head movements continued to be consistent with the forces generated by aircraft motion.
10:00:55.01	The pilot's head and torso began to flex forward consistent with the forces generated by aircraft motion. The passenger's arm remains fully extended to the center post of the windscreen.
10:00:55.76	The passenger's arm remained fully extended to the center post of the windscreen. The pilot's head was flexed further forward and slightly to the left. There was no visible perspiration on the back of the pilot's head. The view outside the windscreen was consistent with an inverted and nose low attitude for the helicopter.
10:00:56.26	The passenger's arm remained fully extended to the center post of the windscreen. The pilot's head moved to the left toward the center of the video and blocked the majority of the instrument panel. The pilot's right shoulder strap came into view for the first time. The view outside of the windscreen was consistent with an inverted and nose low attitude for the helicopter.
10:00:56.51	The left side of the pilot's head was slumped forward and touching the passenger's elbow. The passenger's arm was still extended to the wind screen center post. The pilot's right shoulder strap became more fully visible. The altimeter was ¾ visible to the right of the pilot's right headset can.
10:00:56.76	The pilot's head began to move toward the right and upward until the end of the recording. The pilot's motion remained consistent with an undirected response to aircraft motion. The view outside the windscreen was consistent with a nose-down, inverted attitude for the helicopter.
10:00:57.76	The last frame showed the pilot's head no longer touching the passenger's elbow. A red warning label on the instrument panel was just fully in view to the left of the pilots left headset can.

The recording ended. No further video data was recovered.

7. Recorded Parametric Data

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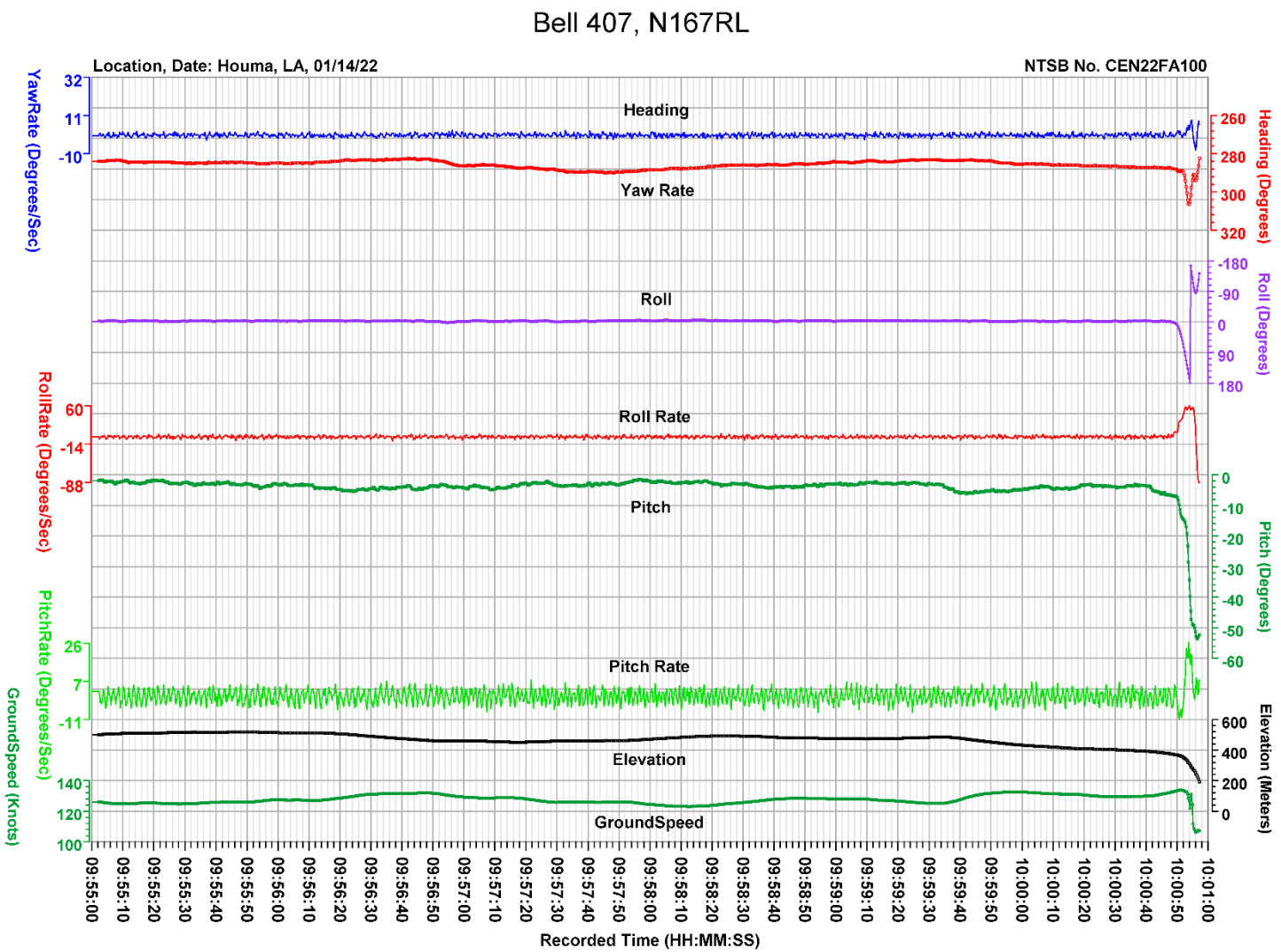

Figure 5. A plot of recorded parameters for the entire flight.

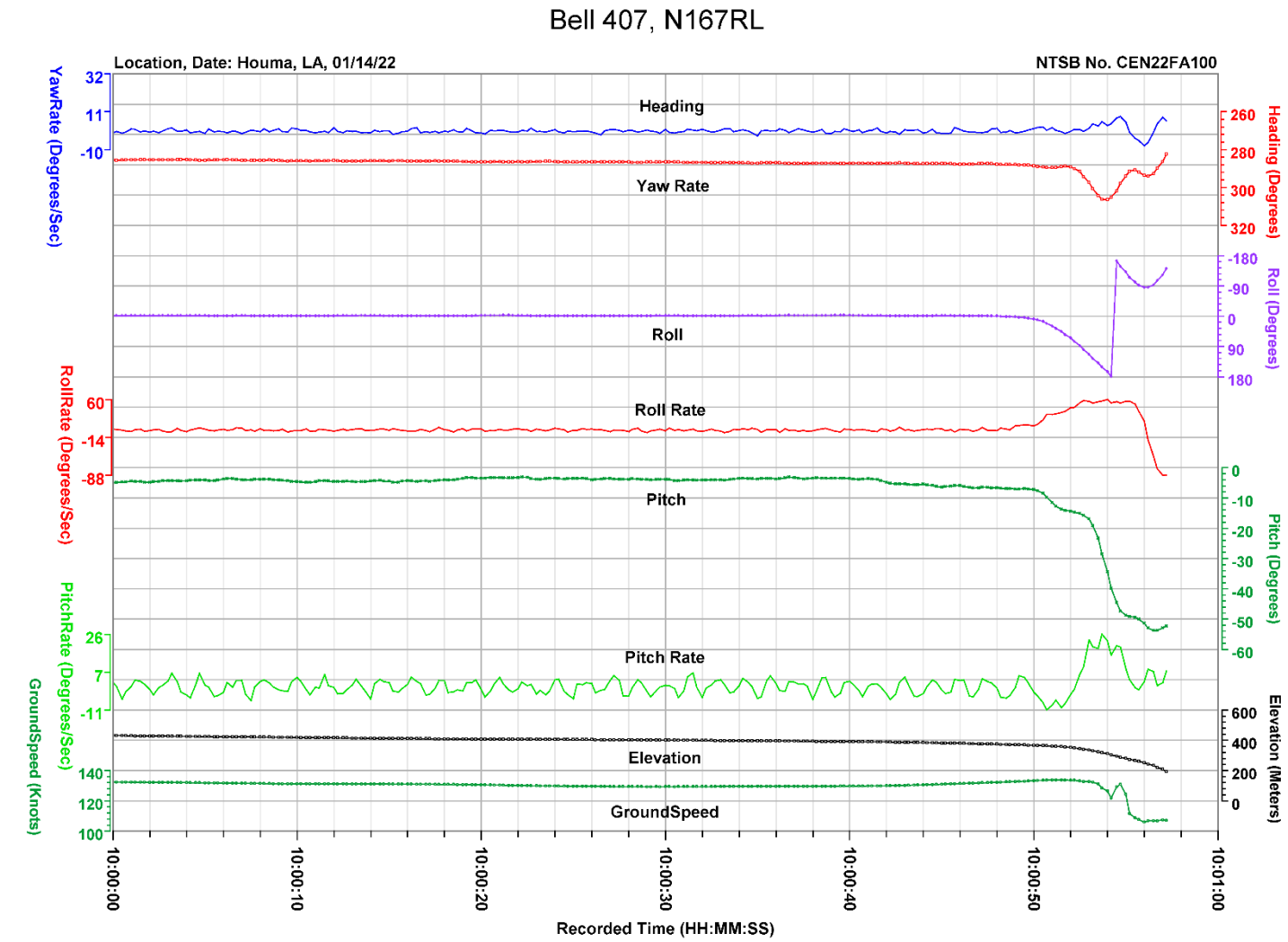

Figure 6. A plot of recorded parameters for the end of the flight.