

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



GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

WPR16FA029

**By
Sean Payne**

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

November 7, 2017

Onboard Image and Data Recorders

Specialist's Factual Report
By Sean Payne

1. EVENT

Location:	Carlsbad, CA
Date:	November 18, 2015
Aircraft:	Airbus Helicopters AS350B3E, N711BE
Operator:	Private
NTSB Number:	WPR16FA029

2. SUMMARY

On November 18, 2015, about 1624 Pacific standard time, an Airbus Helicopters AS350B3E, N711BE, departed controlled flight while landing on a moveable helipad at McClellan-Palomar Airport, Carlsbad, California (KCRQ). The pilot, who was the owner, was operating the helicopter under the provisions of 14 *Code of Federal Regulations* Part 91. The private pilot and private pilot-rated passenger were fatally injured; the helicopter sustained substantial damage. The local personal flight departed Carlsbad at 1411. Visual meteorological conditions prevailed, and no flight plan had been filed.

3. GROUP

A group was convened on June 2, 2016. The group consisted of the following members:

Chairman:	Sean Payne Mechanical Engineer National Transportation Safety Board (NTSB)
Member:	Elliott Simpson Investigator-In-Charge National Transportation Safety Board (NTSB)

Member: Seth Buttner
Manager, Accident Investigation
Airbus Helicopters, Inc.

Member: Bryan Larimore
Accident Investigation and Safety
Safran/Turbomeca USA

4. DETAILS OF INVESTIGATION

On February 3, 2016, the NTSB Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model: **Appareo Vision 1000**
Recorder Serial Number: **VIS-FFR7**

4.1.1. 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 SD¹ memory card that is inserted into the unit. 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 crash and fire resistant 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. Anytime 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.

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

4.1.2. Appareo Vision 1000 Recorder Damage

Upon arrival at the NTSB Vehicle Recorder Division, it was evident that the Appareo Vision 1000 had not sustained any heat, water or structural damage and the device's records were extracted from the unit normally, without difficulty.

4.1.3. Appareo Vision 1000 Data Recovery and Video Files

The download of the Appareo Vision 1000's SD card produced 1,064 proprietary files associated with the normal operation of the device. Of those files, 20 were associated with a proprietary image file type, 20 were associated with a proprietary audio file type, and 1,024 were associated with proprietary indexing and parametric data files.

The image files recorded approximately the last two hours of the accident flight.

The imagery files recorded an over the shoulder view of the pilot from a centralized roof mounting position within the cockpit. The pilot's cyclic and pedal movements were visible. The collective and the pilot's left arm movement were not visible to the recorder. Much of the instrument panel and rotorcraft system controls were also visible. A view out of the forward windscreen was also visible. Figure 1 is a copy of the calibration image at the Airbus Helicopter's facility prior to delivery. It shows the Appareo V1000's field of view during the accident flight. The camera position remained in a similar position for the accident flight.



Figure 1. The Appareo Vision 1000's field of view as mounted on the accident rotorcraft during the accident flight.

The parametric data consisted of approximately 1,024 files. The accident flight, as well as a multitude of other previous flights, were captured by the Appareo Vision 1000's parametric data recorder. Relevant recorded parameters were output to .CSV and plotted using NTSB software. Keyhole Markup Language (.KML) files

were constructed and plotted in Google Earth. Attachment 1 is a .CSV file of recorded data from the Appareo device for the accident flight.

4.3. Timing and Correlation

The times used in this report are expressed as local time of the accident (PST).

Timing of the transcript was established by offsetting the recorded GMT time of the Appareo Vision 1000 to local PST. PST is 7 hours behind GMT therefore, the following time correlation was applied:

Appareo Vision 1000 recorded time – 25,200 seconds = PST

4.4. Summary of Recording Contents

In agreement with the Investigator-In-Charge, a video group was convened and the following transcript was developed from the Appareo Vision 1000 imagery and audio data.

At times throughout the recording, the pilot leaned forward to the area of his right leg in what was a scratching gesture. This occurred occasionally during the accident flight. It did not appear to interfere with the pilot's ability to fly the rotorcraft or was determined to be related to the accident sequence. The pilot used two different pairs of eye glasses throughout different portions of the recording. The second pair of eye glasses that were in use during the accident sequence appeared to be of transition lens type. The pilot rated passenger occasionally used eye glasses as well. The hydraulic isolation (collective HYD switch) switch was in the forward guarded position throughout the recording. A screenshot of the HYD switch around the time of the accident sequence is shown below in figure 2. A green indicator light for the landing light indicator was shown as active or inactive throughout different portions of the recording and was not specifically document in the transcript of the recording.

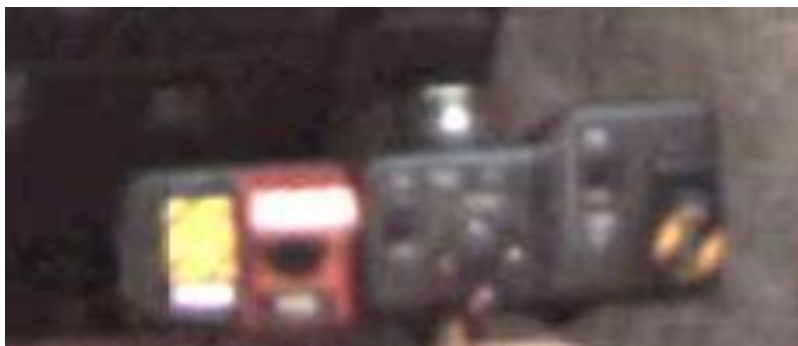


Figure 2. The cropped image from the Appareo Vision 1000 showing the position of the HYD switch just prior to the accident. The forward portion of the switch is hidden under the red switch guard, indicating the switch was in the ON position.

Nominal cockpit actions performed by the pilot were not noted in the transcript. The transcript only describes portions of the flight that may be relevant to the

accident investigation or general flight proceedings necessary to properly characterize the accident flight.

The transcription began as the camera began recording at 14:06:52. The rotorcraft was stationary in the ramp area of KCRQ, the engine was running. The pilot was configuring a page of the GTN-750 avionics unit.

Around 14:12:21, the pilot departed the ramp area of KCRQ near ramp area in the vicinity of an FBO. The pilot raised his left arm above the panel and made a pointing gesture as the rotorcraft departed.

Around 14:14:21, the passenger had his hands and feet near the flight controls. The passenger's hands hovered around the cyclic stick, at times in a loose grip; his feet appeared to rest gently on the rotorcraft's pedals. The pilot rated passenger occasionally brought out an iPad and placed it in his hands or lap and utilized the device's screen gesture controls. The iPad appeared to be running an aviation navigation application for iOS. Throughout the flight, the passenger acted as an observer in this manner. Any detectable transfer of controls is noted later transcript. For most of the flight, the pilot appeared to act as sole manipulator of the controls despite the pilot rated passenger having his hands feet lightly on the controls for most of the flight.

At 14:18:20, the Genesys Aero Systems Stability Augmentation System (SAS) light on the autopilot control panel switched from white to green. Unless otherwise noted in this transcript, the SAS button remained with a white light, indicating it was on standby. The SAS switch at this time was activated by the pilot pressing the SAS button on the control head.

At 14:27:46, the pilot pressed the SAS button on the control head and the indicator light changed from green to white, indicating that SAS was now in standby mode.

Around 14:32:28, the image playback of the Appareo Vision 1000 failed to continue playing linearly. Between this time and approximately 14:39:13, the playback function appeared to freeze on the last frame recorded at 14:32:28. Interspersed within this time interval, a few frames managed to update on the playback software. For the most part, image and audio data was lost during this segment. When images did manage to update in the playback software during this time interval, it was noted that the SAS had once again become active as shown by a green light on the autopilot control panel. The autopilot control buttons for "ALT" (altitude hold mode) and "HDG" (heading hold mode) were also seen light green (active) during some of the image frames that were able to update. At times, when SAS was active during this interval, it was noted that neither the pilot's or the pilot rated passenger's hands were seen manipulating the cyclic. Additionally, a few image frames that updated showed the pilot rated passenger as the sole manipulator of the controls.

As noted in the description of the parametric data and during the time in which the playback software failed to play linearly, the pilot was maneuvering for a landing at an open area of land utilizing a left closed traffic approach to the open area of land. Figure 3 shows the rotorcraft's GPS tracks in the vicinity of Palomar Mountain, San Diego County, California.

By approximately 14:39:13, the playback software began playing back the recorded image and audio frames normally. Synchronized parametric data showed the rotorcraft was turning left base to final onto an approach to land near an open area of land. The SAS was in standby and the pilot was hand flying.

At 14:41:04, the pilot landed the rotorcraft after making a long, low approach to an open area of land (reference figure 3). The landing was uneventful.

Around 14:41:25, the pilot activated SAS by pressing the SAS button the Genesys control head.

At 14:41:54, the rotorcraft picked up briefly and turned about 20 to 30 degrees left immediately after breaking free of the ground. By 14:42:14, the pilot had set the rotorcraft back on the ground.

At 14:42:32, the rotorcraft picked up again, yawed right about 120 to 180 degrees immediately after breaking free from the ground. By 14:42:56, the pilot had set the rotorcraft on the ground again.

At 14:43:09, the pilot performed a normal takeoff and the rotorcraft departed the area. At 14:43:20, as the rotorcraft was climbing away from the landing area, the pilot took his left hand off the collective and placed his left hand on cyclic stick next to his right hand which was already gripping the cyclic stick. The collective was set to a position and unguarded. By 14:43:33, the pilot had replaced his left hand on the collective.

Around 14:44:02, the pilot once again removed his left hand from the collective and joined it with his right hand which was still on the cyclic.

Around 14:44:11, the pilot changed SAS to standby mode by using his left hand to press the Genesys control head. He did not replace his left hand to the collective.

At 14:51:51, SAS was changed to active mode by the pilot pressing the autopilot control head.

At 14:53:16, SAS was changed to standby mode by the pilot pressing the autopilot control head.

At 14:58:11, SAS was changed to active mode by the pilot pressing the autopilot control head.

At 15:00:57, SAS was changed to standby mode by the pilot using the Automatic Flight Control System (AFCS) release push button on the cyclic stick.

Around 15:08:21, the pilot moved his body in such a way that the central buckle of his four point harness became visible. The centralized buckle of the four point harness was high on the pilot's belly, above his belly button area. The position of the pilot rated passenger's four point buckle could not be ascertained.

At 15:14:51, the auxiliary fuel tank pump indicator switch was activated. The auxiliary fuel pump gauge was now active and displaying what appeared to be a fuel left (auxiliary) tank. The fuel gauged on the VEMD indicated that the rotorcraft had about ½ tank in the main fuel tank. Around the same time, a transfer of controls occurred and pilot rated passenger was now flying the rotorcraft.

At 15:25:32, the pilot activated the auxiliary fuel pump. The left (auxiliary) tank began to show a decrease in value while the VEMD main fuel tank indicator began displaying that it was filling.

At 15:26:11, the pilot began using his PED as the pilot rated passenger was flying. During this time, the camera system's playback feature occasionally froze as it had earlier. The pilot eventually put his PED back down into the rotorcraft's console area below in the instrument panel. Around 15:31:51, there was a transfer of controls and the pilot was once again the pilot flying.

Around 15:32:21, the pilot rated passenger briefly manipulated a different PED and placed it down out of view of the camera.

The camera system's playback feature continued to freeze and unfreeze over the next few minutes.

At 15:43:41, the pilot rated passenger picks up the rotorcraft's flight manual from out of the camera's view and began looking through its contents.

At 15:46:51, SAS became active as well as ALT and HDG on the autopilot control panel by the pilot pressing the soft keys on the control head. Moments later at 16:47:17, the pilot deactivated ALT and HDG by using the AFCS release pushbutton. SAS remained active.

At 15:47:23, SAS went to standby mode by the pilot pressing the autopilot control head.

At 15:49:04, SAS, HDG and ALT were activated by the pilot pressing the autopilot control head. Additionally, the pilot attempted to press NAV to activate autopilot navigation control. There was no response or light indicator change on the autopilot control panel.²

Around 15:50:21, the pilot rated passenger stowed the rotorcraft's flight manual. At 15:54:07, SAS was placed in standby mode by the pilot using the AFCS release pushbutton.

Around 15:55:21, the auxiliary fuel pump indicator showed the fuel transfer was complete. Two lights on the indicator began flashing red.

At 16:00:47, the auxiliary fuel pump was switched off by the pilot.

For the next 10 minutes, the rotorcraft began tracking toward KCRQ. The pilot was speaking into his boom mic.

At 16:12:05, the rotorcraft crossed the threshold area for runway 24 at KCRQ. The runway markings were seen in both chin bubbles below the rotorcraft. The rotorcraft had made a straight in approach to the runway. At times, the pilot rated passenger was using his hand and arm to obscure his vision from the sun.

At 16:12:54, the rotorcraft departed the active runway while in a hover taxi.

At 16:13:02, the rotorcraft hover taxied off the runway and crossed the runway 6-24 hold short line. The rotorcraft began to turn towards its first approach to landing as it headed into the sun. The pilot rated passenger obscured his own vision with his right hand from the sun.

At 16:13:38, the dolly area came into sight of the camera. The sun washed out most of the camera's view of the dolly. Figure 4 is a Google Earth overlay showing the rotorcraft's maneuvers in the vicinity of the accident site. Note that some of the GPS tracks recorded were anomalous during the time the rotorcraft was spinning on the ramp area.

At 16:13:48, the dolly came into view in the left chin bubble. Moments later, the rear edge of the dolly was through the left chin bubble, the rotorcraft hovered over the dolly for a moment.

Around 16:14:07, the relation of the rotorcraft to the dolly became difficult to discern. It is unclear if the rotorcraft made contact with the dolly. There was some discernible jostling of the cockpit occupants within their seats. Around this moment, the rotorcraft pitched nose down about 20 degrees. A right roll of about 25 degrees was recorded on the artificial horizon as well as the Appareo Vision

² The group noted the pilot's avionics were not in the right configuration mode for NAV on the autopilot control panel to be activated.

1000 parametric data. The rotorcraft regained attitude control and moved away from the dolly.

Around 16:14:24, the rotorcraft yawed to the right in a right turn and maneuvered in the vicinity of the dolly, setting up for another landing attempt.

At 16:14:56, the rotorcraft landed at a 45 degree angle straddling taxiway A and the airport ramp. This landing was made approximately 50 feet east of the dolly. The pilot made an entry on the GTN-750 display after he landed, it appeared he was opening a frequency entry page. The pilot rated passenger was holding an aeronautical chart with radio frequencies written on the cover page around this time. The written frequencies were noted as follows: "Tower 118.6, ATIS 120.15 and ground 121.8".

At 16:15:05, the pilot entered 121.8 into the GTN-750 and set the frequency to "active".

Around 16:15:34, the pilot reached for his PED. It appeared there was an incoming phone call. The pilot ignored the call and placed the phone back down near a console under the GTN-750 avionics unit. Around this time the pilot was speaking into his boom mic. A flashing "TX" (transmission indication) was at times on the GTN-750 near the frequency display.

Around 16:16:51, a shadow of a person was visible somewhere off the nose of the rotorcraft. The shadow appeared to be a walking person. The pilot looked in the direction of where the shadow was moving. In correlation to other video and audio data discussed elsewhere in the public docket, the dolly had been rotated approximately 180 degrees as a result of the initial failed landing attempt. The ground crew had re-chocked the dolly in this configuration which now required an easterly approach and landing to the dolly.

At 16:17:51, the rotorcraft broke ground as the pilot performed a takeoff and immediately yawed approximately 30 degrees left. After the yawing motion, the rotorcraft sideslipped to the right, to the adjacent taxiway centerline on taxiway A. The rotorcraft flew westbound for a moment and began to circle around to the east (a left pedal turn) back toward the dolly in a second approach.

At 16:18:01, the rotorcraft lined up toward the east from the west side of the dolly.

At 16:18:10, the normally downloaded portion of the Appareo Vision 1000 ended. The parametric data continued to record normally. The image data became corrupted and had to be manually extracted from the raw data using forensic software tools provided by the manufacturer.

During all maneuvers in the vicinity of the dolly and the landing maneuver in the large open field area, the pilot was inputting pronounced cyclic control input. The rotorcraft appeared to be rocking in pitch in roll as it maneuvered close to the ground.

At 16:19:48.2, the dolly came into view out of the front left windscreen as the pilot came around to the left and lined up for an approach to land. The yoke of the dolly was facing away from the nose of the rotorcraft.

By 16:20:01.2, the dolly was visible through the left chin bubble. The rotorcraft hovered in the area over the dolly and the rotorcraft appeared to be rocking in both pitch and roll as it held a position above the dolly. By 16:20:04.7, the dolly was no longer visible in either chin bubble as the rotorcraft had moved forward over the dolly itself. Throughout the next few seconds, the pilot maneuvered over the pad, it was unclear from the onboard recording whether or not the rotorcraft made contact with the dolly. By frame 16:20:13.7, taxiway A came into view as the pilot yawed the rotorcraft left and transitioned over the taxiway as he aborted the second attempt to land on the dolly.

Throughout the landing attempts, the pilot rated passenger had his hands not in the vicinity of the controls but rather resting his hands on his knees. His feet were no longer hovering over the pedals but rather resting flat on the floor. It does not appear that the pilot rated passenger interfered with the flight controls at any time during any of the landing attempts.

By 16:20:23.7, the pilot had circled back toward the west and continued to transition back around another 180 degrees to make another easterly approach to the dolly.

By approximately 16:20:59.8, the dolly came back into view out of the front left windscreen as the pilot came around to the left and lined up for an approach to land. The yoke of the dolly was facing away from the nose of the rotorcraft.

By 16:21:09.2, the dolly was visible through the left chin bubble. The rotorcraft hovered in the area over the dolly and the rotorcraft appeared to be rocking in both pitch and roll as it held a position above the dolly. By 16:21:13.7, the dolly was no longer visible in either chin bubble as the rotorcraft had moved forward over the dolly itself.

By 16:22:01.7, the pilot had continued to make a landing attempt on the dolly. At this time, the dolly reappeared under the left chin bubble. The orientation of the dolly suggested the rotorcraft was about 30 degrees nose right of the dolly. The pilot was attempting to realign the rotorcraft with the dolly. During this time, the dolly oscillated in and out of view of the left chin bubble as the rotorcraft wobbled above it.

For the next 40 seconds, the third attempt to land on the dolly continued. The dolly was coming in and out of view of both chin bubbles.

At 16:22:44.7, as the dolly was still visible in both chin bubbles, the rotorcraft occupant's bodies appeared to rock in a simultaneous manner consistent with dolly/ground contact. The dolly then disappeared out of view and pilot hover taxied backward with the dolly coming back into view of the left chin bubble by 16:22:59.2.

As the dolly became visible in the left chin bubble, the pilot continued to make a landing attempt.

At 16:23:20.5, the occupant's bodies again move simultaneously in a manner consistent with dolly or ground contact. The First Limit Indicator (FLI) began to drop rapidly from around a value of 6, at the same moment, the pilot's left hand was rapidly lowering the collective.

In the next two frames, the pilot's body rocked forward, his right hand still on the cyclic stick. The cyclic stick moved forward and to the right in an quantified but seemingly excessive amount.

Immediately thereafter, the pilot's body rocked quickly backward in the seat. The pilot rated passenger's body appeared to mirror the pilot's body movement as if it were a result of an abrupt maneuver. As the pilot's body moved backward, his hand was still gripped on the cyclic, his body, arm and hand motion caused the cyclic to begin moving excessively aft. At the same moment, the pilot appeared to input left pedal strongly. His right foot became free of the right pedal.

In the next frame, at 16:23:22.5, the Emergency Locator Transmitter (ELT) light activated on the instrument panel. The artificial horizon display on the Garmin PFD displayed a red "X". The pilot appeared to be giving approximately full left pedal input, his right foot still off the pedal. The collective appeared to be pulled all the way up. The FLI responded accordingly and increased in value.

In the next few frames the cyclic stick began to move excessively forward in correlation to the pilot's body movement. The pilot rated passenger began gripping the glareshield with his right hand. Although the pilot's body movement had now forced the collective a bit lower, the FLI reached a value of about 9.

By 16:23:23.3, the pilot's body again quickly moved aft, the back of the pilot's head was directly in front of the camera. In the next frame, the pilot's headset was now off of his head. By 16:23:25.3, the pilot had lost his hat and headset, there was a bright flash recorded by the camera. The rotorcraft occupant's bodies were jostled together toward one another.

By 16:23:26.3, some features of the FBO hangar were captured through the windscreen. The motion blur of the hangar suggested the rotorcraft had developed into a quick counterclockwise rotation. The pilot rated passenger was holding his headset in his right hand.

As the rotation developed, the occupant's body motion suggested that centripetal force had began pushing their bodies toward the right of the rotorcraft's cabin. At 16:23:27, the pilot's hand moved up toward and contacted the glareshield. The pilot's right hand was completely off the collective which was in almost a full up position. A Bose headset was hanging on the collective.

At 16:23:27.5, the camera experienced significant motion blur, suggesting that another strong impact had occurred, the occupant's bodies were jostled to the right of the cabin. Almost all of the pilot's torso is out of view of the camera as his body moved to the right. In the next frame, the pilot rated passenger's body is thrown to the right in front of the camera.

At 16:23:28, the motion blur lessened and the pilot was slumped over to the right of the rotorcraft. His left knee and shin was making contact with the cyclic control stick and lower instrument panel. This contact forced the cyclic stick significantly forward and to the right. At this frame, the following annunciator lights came on the caution and warning panel: amber DOOR light (aft sliding door open), amber GOV light (DECU³), amber HYDR light and Main Gear Box Pressure (MGBP) light.

At some point from the previously noted time, the FLI indicator had dropped and was now beginning to rise again. By 16:23:29.7, the FLI had pegged to it's maximum display limit with unintelligible over limit limitations annunciated on the display screen.

The rotorcraft continued in a violent counterclockwise rotation. The pilot rated passenger appeared to be trying to brace himself. There was no obvious movement of the pilot's body. The pilot was still slumped to the right, most of his torso was not visible to the camera. His left knee and shin was still in contact with the cyclic stick and control panel, this contact was still forcing the cyclic stick forward and to the right significantly.

By 16:23:34, the pilot rated passenger had gripped the collective with his right hand. His palm was gripped over the throttle. In the next few frames, he appeared to strengthen his grip around the twist grip on the collective. It could not be determined which way he attempted to twist the twist grip, however, it was clear that the demarcation for FLIGHT on the twist grip had not changed position. By 16:23:36.5, the pilot's rated passenger's right hand had been removed from the collective and twist grip, the twist grip remained in the FLIGHT position.

³ DECU – Digital Engine Control Unit.

The rotorcraft continued to spin counterclockwise. The FLI remained pegged near its maximum value.

By 16:23:39.2, the pilot rated passenger maintained a firm grip with his right hand on the glareshield in the vicinity of the VEMD. The pilot rated passenger's grip on the glareshield had forced the entire glareshield upward.

As the rotorcraft spun violently counterclockwise, the camera's image quality steadily degraded. It appeared as though smoke or dust had begun filling the cockpit. The FLI remained at its maximum value.

By 16:25:02.7, the pilot rated passenger's arm was no longer gripping the glareshield. The rotorcraft continued to spin counterclockwise.

At 16:28:43, a loud bang was recorded and the remains of the rotorcraft appeared to have broken up. Moments later the rotorcraft appeared to come to rest, a sound similar to the engine was still heard. The engine noise would cease shortly thereafter.

As the recording continued, the camera's view appeared to clarify to some extent. The pilot rated passenger's body appeared slumped over to the right in front of the image recorder.

At 16:39:09, there was a shadow of a person near the left chin bubble area of rotorcraft. It appeared to be a first responder.

At 16:39:25, a sound similar to a mechanical sawing machine was heard in vicinity of the rotorcraft. Shadows were seen moving in the vicinity of the rotorcraft.

At 16:41:29, a sound similar to a mechanical sawing machine was again heard. First responder's shadows were still seen moving in the vicinity of the rotorcraft.

The recording ended at 16:42:48.51.

Figure 5 is a north-up overview of the tracklogs from the Appareo device of the entire recording.

Figure 3. The rotorcraft's maneuvers during the accident flight in the vicinity of Palomar Mountain, San Diego County, California.

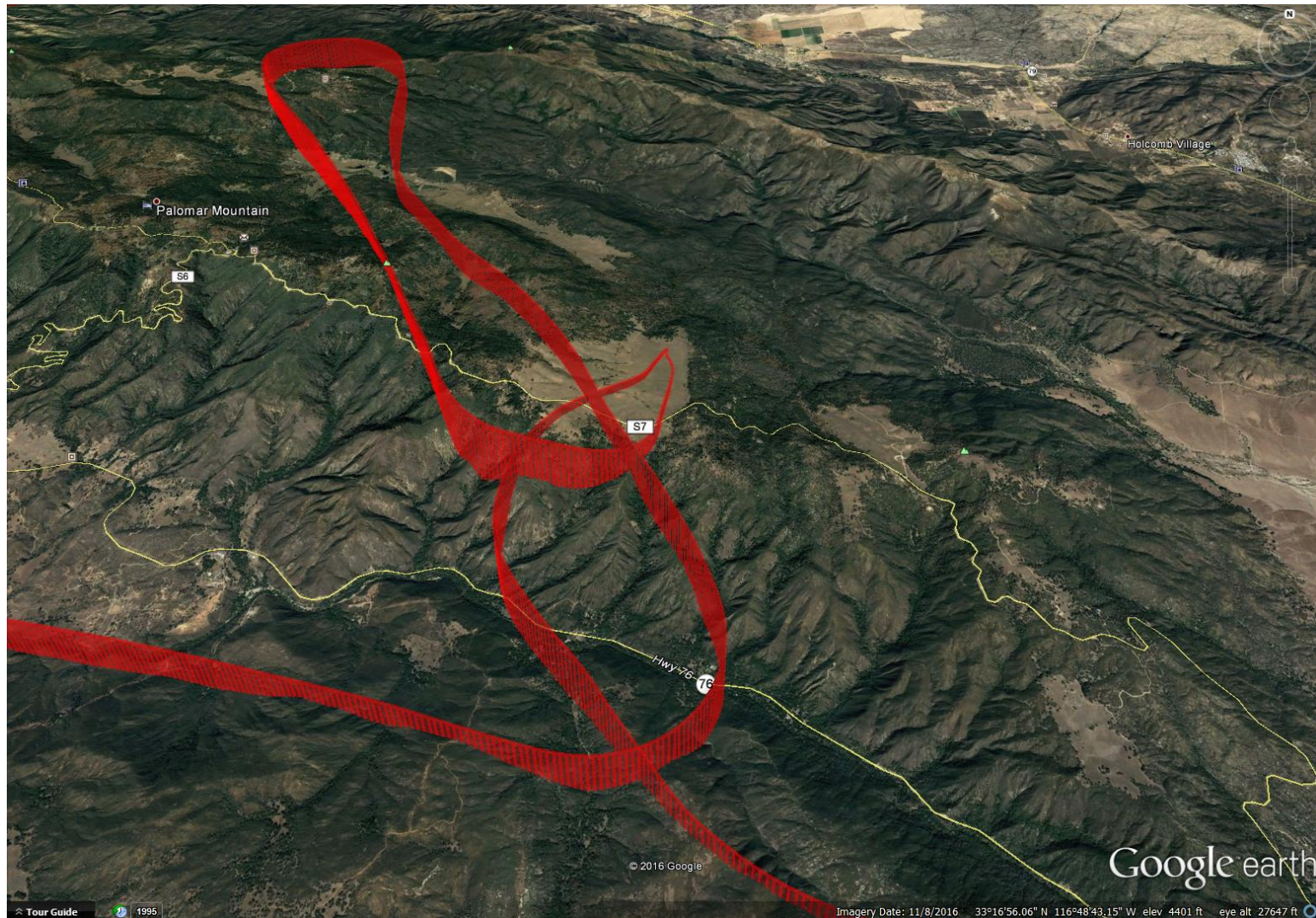


Figure 4. The rotorcraft's maneuvers in the immediate vicinity of the wreckage location. Note that many of GPS tracks recorded in this area are anomalous.



Figure 5. A tracklog generated from the Appareo Vision 1000 device during the entire accident flight.

