

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division

Washington, D.C. 20594

April 23, 2020

Electronic Devices

Specialist's Factual Report

By W. Deven Chen

1. EVENT SUMMARY

Location: Grover, Utah
Date: May 24, 2019
Aircraft: Cirrus SR22
Registration: N809SR
Operator: Private
NTSB Number: WPR19FA154

On May 24, 2019, about 1116 mountain daylight time, a Cirrus SR22 airplane, N809SR, impacted terrain about 6 miles southeast of Grover, Utah. The private pilot and passenger were fatally injured, and the airplane was destroyed. The airplane was registered to Tierra Grande Aviation LLC, and operated by the pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Visual meteorological conditions prevailed in the vicinity of the accident site, and the flight was operated on an instrument flight rules flight plan. The flight departed Canyonlands Field Airport (CNY), Moab UT about 1042 and was destined for Henderson Executive Airport (HND), Las Vegas, Nevada.

2. GROUP

A group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model: **Honeywell EGPWS KGP 560**
Recorder Serial Number: **54050619**

Recorder Manufacturer/Model: **Avidyne MFD Compact Flash Memory Card**
Flash Cart Part Number: **053-00195-110**

Recorder Manufacturer/Model: **Avidyne Primary Flight Display (PFD)**
Recorder Serial Number: **0084078**

3.1. Honeywell EGPWS KGP 560 Description

The Enhanced Ground Proximity Warning System (EGPWS) non-volatile memory¹ (NVM) does not continuously record; rather, the EGPWS device stores data to NVM only when certain criteria are met. The readout process at the manufacturer's facility produces several files of flight history data that encompass operational, documentary, fault, and warning information.

The flight history data warning file outputs performance data as related to the operation of the aircraft. These data only record when an alert or warning related to the EGPWS function activates and the unit then retains data points for 20 seconds prior to the activation of the warning and 10 seconds afterwards. The EGPWS parameters are only sampled 1 time per second, but the actual time of occurrence can be anywhere within the second.

3.1.1. Honeywell EGPWS KGP 560 Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the device sustained severe impact damage, as shown in Figure 1. The NVM chips were damaged and removed from the circuit board, as shown in Figures 2 and 3. The NVM (U24) where the flight data stored was sent to the Integrated Electronic Engineering Center of Binghamton University for damage evaluation. The evaluation results stated that the successful data recovery of the U24 chip was highly unlikely, as shown in Figure 4. Thus, no data were recovered from this device. The full report of the chip damage evaluation is provided as Attachment 1 to this report.

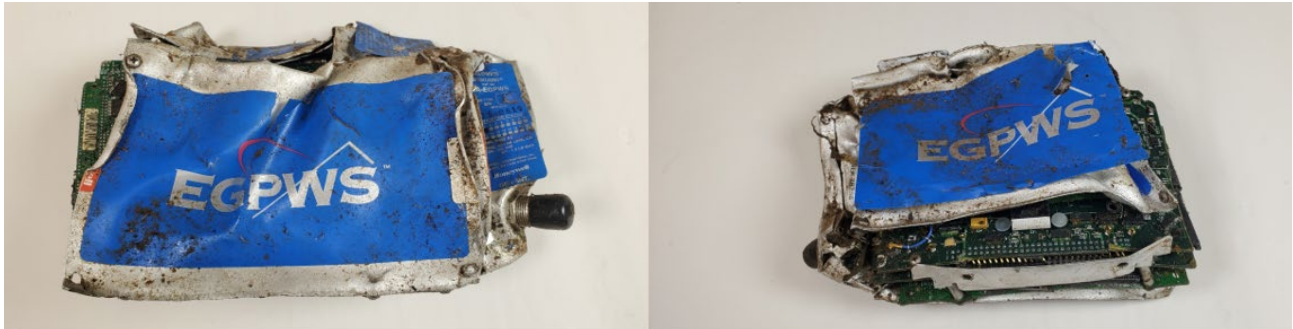


Figure 1: Front and back of Honeywell EGPWS KGP 560 as received.

¹ Non-volatile memory retains information when power is removed.

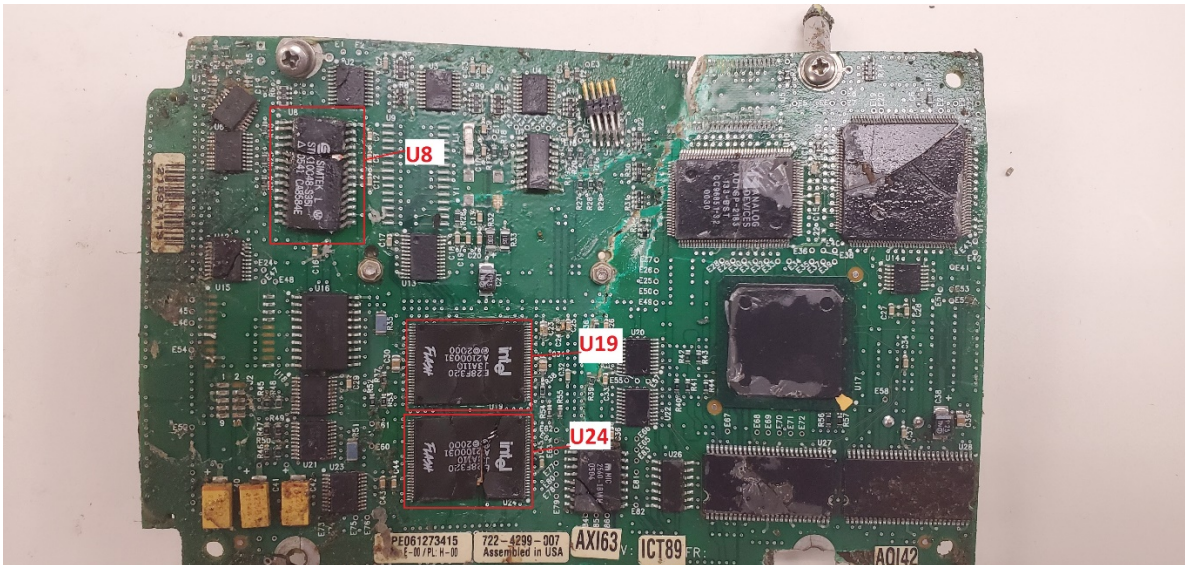


Figure 2: Circuit board containing NVM chips (U8, U19 and U24) of the Honeywell EGPWS.



Figure 3: U8 (left), U19 (center) and U24 (right) of the Honeywell EGPWS.

Overview

- **One part received for analysis**
 - Accident WPR19A154
 - Honeywell EGPWS KGP-500
 - Intel flash E28F320
- **Analyst**
 - S.R. Cain
- **Analyses**
 - Optical microscopy
 - Acoustic microscopy
 - X-ray has already been done by the NTSB
- **Scope**
 - To determine the level of damage to the chip
 - Evaluate the likelihood of successful data recovery
- **Results**
 - The package as received had suffered severe flex damage
 - There was little if any evidence of thermal damage
 - The package was badly fractured, but the segment containing the chip was whole, although damaged
 - Optical inspection showed that the segment containing the chip was badly bent
 - Inspection of the edge showed multiple fractures
 - Sonic imaging could not be done on the entire part due to the severe flex
 - The portion that could be imaged sonically showed evidence of overmold and chip cracking

Disposition: the chip appears to be cracked, successful data recovery is highly unlikely

Figure 4: Screenshot of the Chip Damage Evaluation from Binghamton University.

3.2. Avidyne MFD (Multi-Function Display) Description

The Avidyne MFD unit displays the pilot checklist, terrain/map information, approach chart information and other aircraft/operational information depending on the specific configuration and options that are installed. One of the options available is a display of comprehensive engine monitoring and performance data.

Each MFD contains a compact flash (CF) memory card located in a slot on the side of the unit. This memory card contains all of the software that the MFD needs to operate. Additionally, this card contains all of the checklist, approach charts, and map information that the unit uses to generate the various cockpit displays.

During operation, the MFD display receives information from several other units that are installed on the aircraft. Specifically, the MFD receives GPS position, time and track data from the aircraft's GPS receiver. The MFD may also receive information from the aircraft concerning altitude, engine and electrical system parameters, and outside air temperature. This data is also stored on the unit's CF memory card.

The MFD generates new data files for each MFD power-on cycle. The oldest file is dropped and replaced by a new recording once the storage limit has been reached. MFD data are sampled every six seconds, and is recorded to memory once every minute. If an interruption of power occurs during the minute between MFD memory write cycles, data sampled during that portion of a minute are not recorded.

3.2.1. Avidyne MFD CF Memory Card Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the CF memory card was in good condition, as shown in Figure 5. The data were downloaded using the manufacturer's procedure which involves the use of a surrogate workstation containing a fully functional MFD.



Figure 5: Front and back of Avidyne MFD CF memory card as received.

3.2.2. Avidyne MFD CF Memory Card Data Description

The Avidyne MFD recorded data in GPS time which is Coordinated Universal Time (UTC). All time has been converted to mountain daylight time (MDT) for the rest of this report. The

difference between UTC and MDT is 6 hours. The MFD CF memory card contained 206 data files. One data file was identified as recording during the accident flight. The data file was approximately 41 minutes and 24 seconds, recorded from 10:33:00 to 11:14:24 MDT on May 24, 2019.

3.2.2.1. Parameters Provided

Table 1 describes data parameters provided by the MFD CF memory card.

Table 1: Validated Parameters from MFD CF memory card.

Parameter Name	Parameter Description
Date	Date of the flight
Time	Time for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
Derived Ground Altitude	Recorded Ground Altitude (feet)
EGT 1-6 (F)	Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)
CHT 1-6 (F)	Cylinder Head Temperature Cylinder # (degrees Fahrenheit)
OIL Temp (F)	Oil Temperature (degrees Fahrenheit)
OIL Pressure (psi)	Oil Pressure ((pounds per square inch)
Engine RPM	Engine Rotational Speed (revolutions per minute)
OAT (F)	Outside Air Temperature (degrees Fahrenheit)
Manifold Pressure (inHg)	Manifold Pressure (inches of mercury)
Fuel Flow Rate (GPH)	Fuel Flow Rate (gallons per hour)
Fuel Used (gal)	Fuel Used (gallons)
Main Bus Voltage (V)	Main Bus Voltage (Volts)
Essential Bus Voltage (V)	Essential Bus Voltage (Volts)

3.3. Avidyne PFD Description

The Avidyne PFD unit includes a solid-state Air Data and Attitude Heading Reference System (ADAHRS) and displays aircraft parameter data including altitude, airspeed, attitude, vertical speed, and heading. The PFD unit has external pitot/static inputs for altitude, airspeed, and vertical speed information. Each PFD contains two flash memory devices mounted on a riser card. The flash memory stores information the PFD unit uses to generate the various PFD displays. Additionally, the PFD has a data logging function, which is used by the manufacturer for maintenance and diagnostics. Maintenance and diagnostic information recording consist of system information, event data and flight data.

The PFD samples and stores several data streams in a sequential fashion; when the recording limit of the PFD is reached, the oldest record is dropped and a new record is added. Data from the Attitude/Heading Reference System (AHRS) is recorded at a rate of 5 Hz. Air data information such as pressure altitude, indicated airspeed, and vertical speed are recorded at 1 Hz. Global Positioning System (GPS) and navigation display and setting

data are recorded at a rate of 0.25 Hz, and information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.

3.3.1. Avidyne PFD Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the device sustained severe damage, as shown in Figure 6. The circuit board containing NVM were found, but one of the two flash memory chips was missing from the device. As shown in Figure 7, the U102 flash memory chip was on the circuit board while the U101 was missing. The U102 was removed from the circuit board, as shown in Figure 8. The extent of the damage precluded normal and advanced recovery procedures and additional attempts were unsuccessful in yielding usable data. Therefore, no data pertinent to the event were recovered.

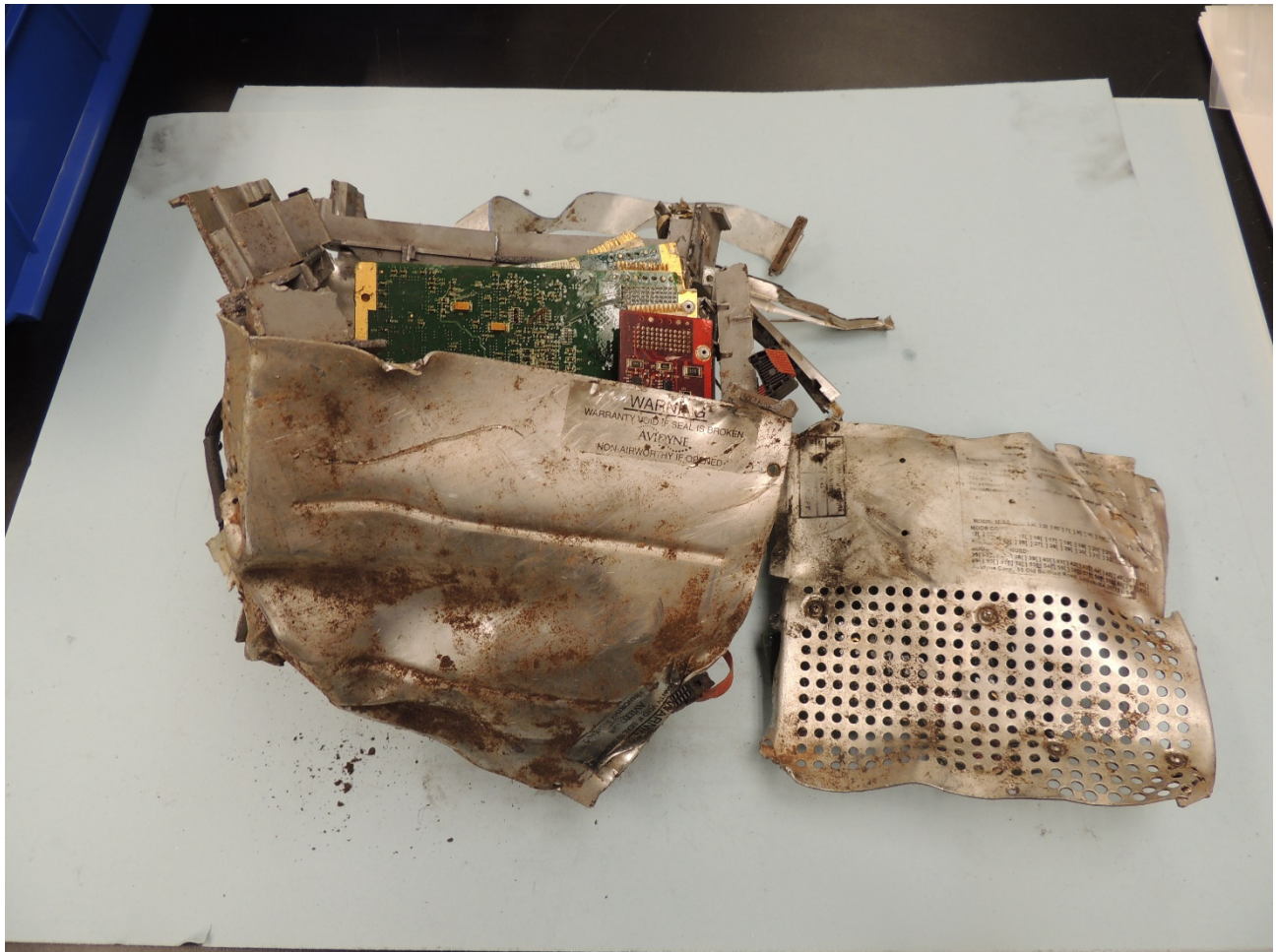


Figure 6: Avidyne PFD as received.

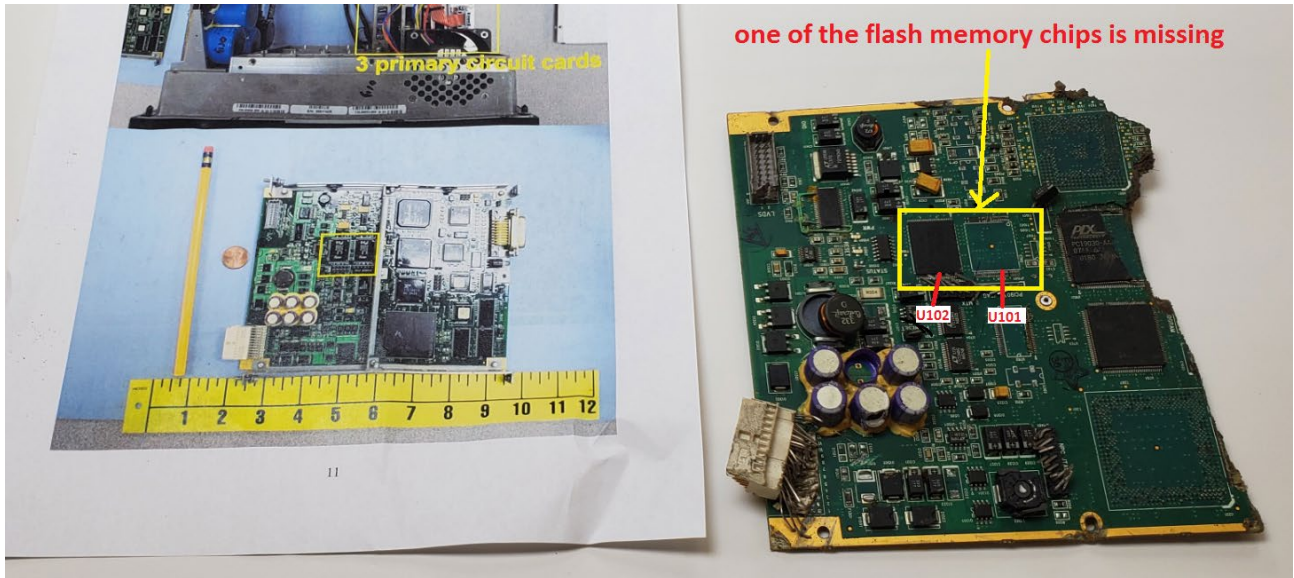


Figure 7: Circuit board containing NVMs of the Avidyne PFD comparing to an undamaged circuit board.

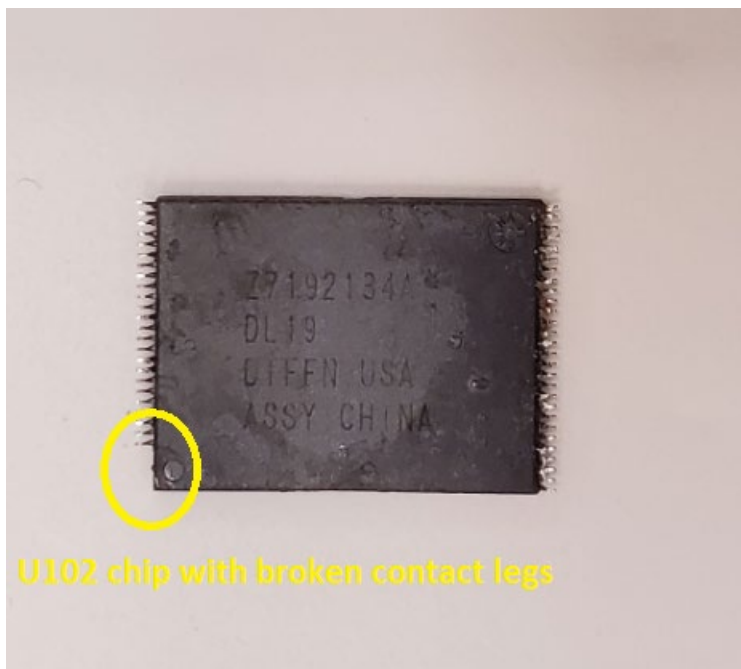


Figure 8: U102 flash memory chip had broken contact legs.

3.4. Plots and Corresponding Tabular Data

The following five figures contain data recorded during the May 24, 2019 event.

Figure 9 is a plot of the recorded data parameters from the Avidyne MFD CF card of the accident flight, from 10:33:00 to 11:14:24 MDT.

Figure 10 is a Google Earth overlay showing the overview of the accident flight. The first and last recorded points are shown with yellow bubbles. The reported wreckage location is

shown with a red pin. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

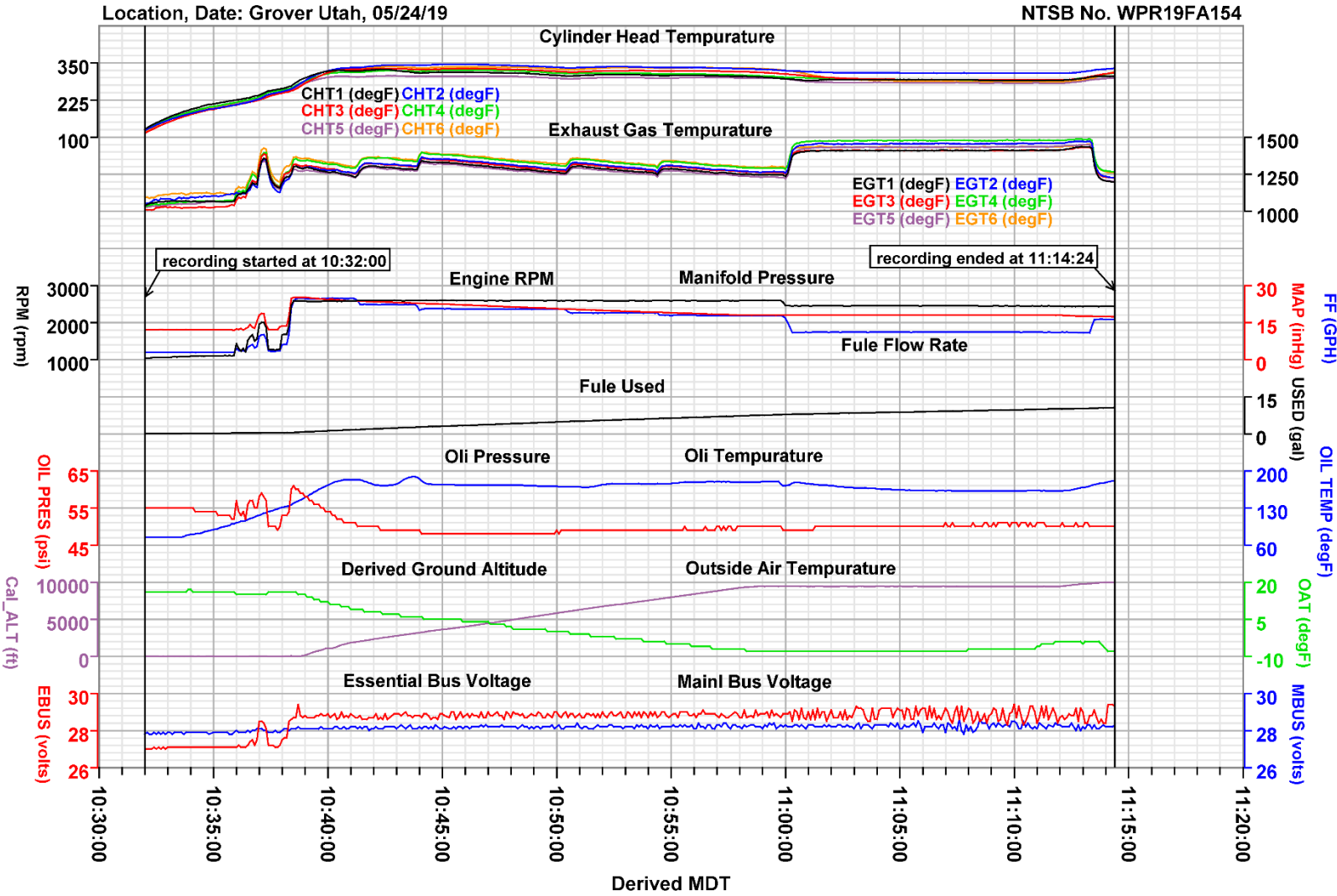
Figure 11 is a Google Earth overlay showing the sideview of the entire flight.

Figure 12 is a Google Earth overlay showing the aircraft took off at Canyonlands Field Airport at about 10:33:00 MDT.

Figure 13 is a Google Earth overlay showing the aircraft was last recorded at 11:14:24 MDT. The reported wreckage location is shown with a red pin.

The corresponding tabular data used to create these five figures are provided in electronic comma-delimited (.csv) format as Attachment 2 to this report.

Cirrus SR22, N809SR, Accident Flight



National Transportation Safety Board
 Figure 9: Plot of data parameters from Avidyne MFD CF memory card of the accident flight.

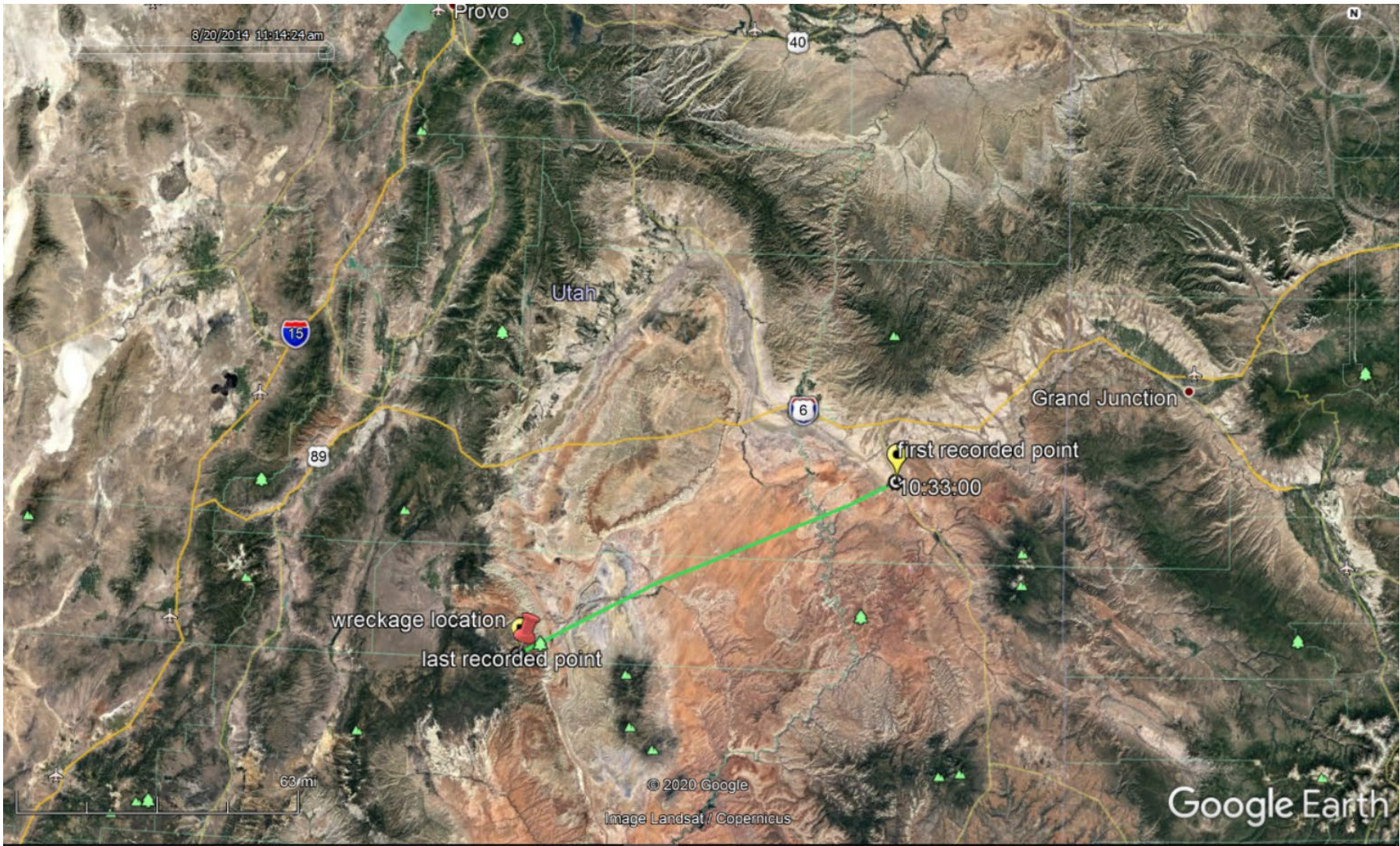


Figure 10: Google Earth overlay showing the overview of the entire flight.

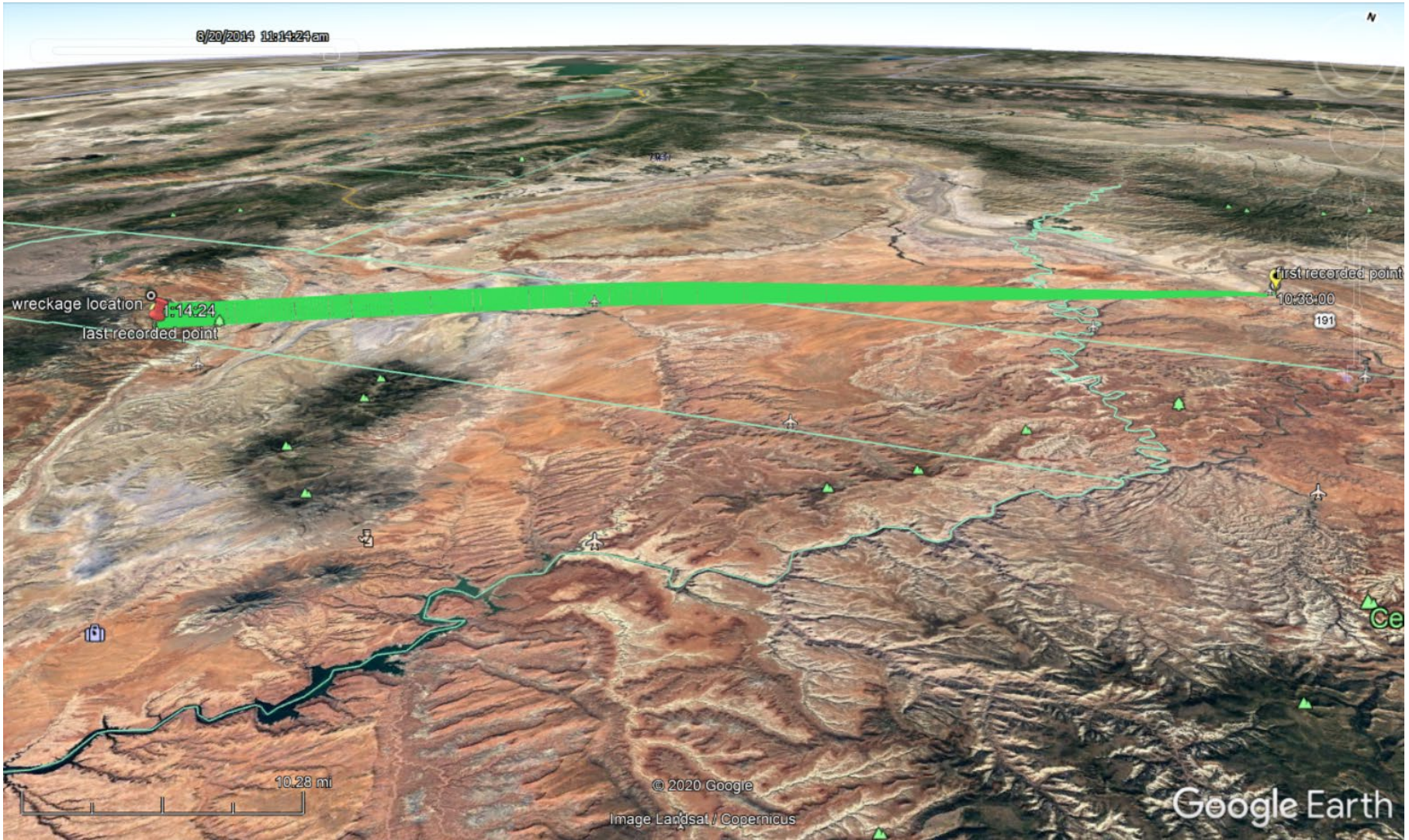


Figure 11: Google Earth overlay showing the sideview of the entire flight.

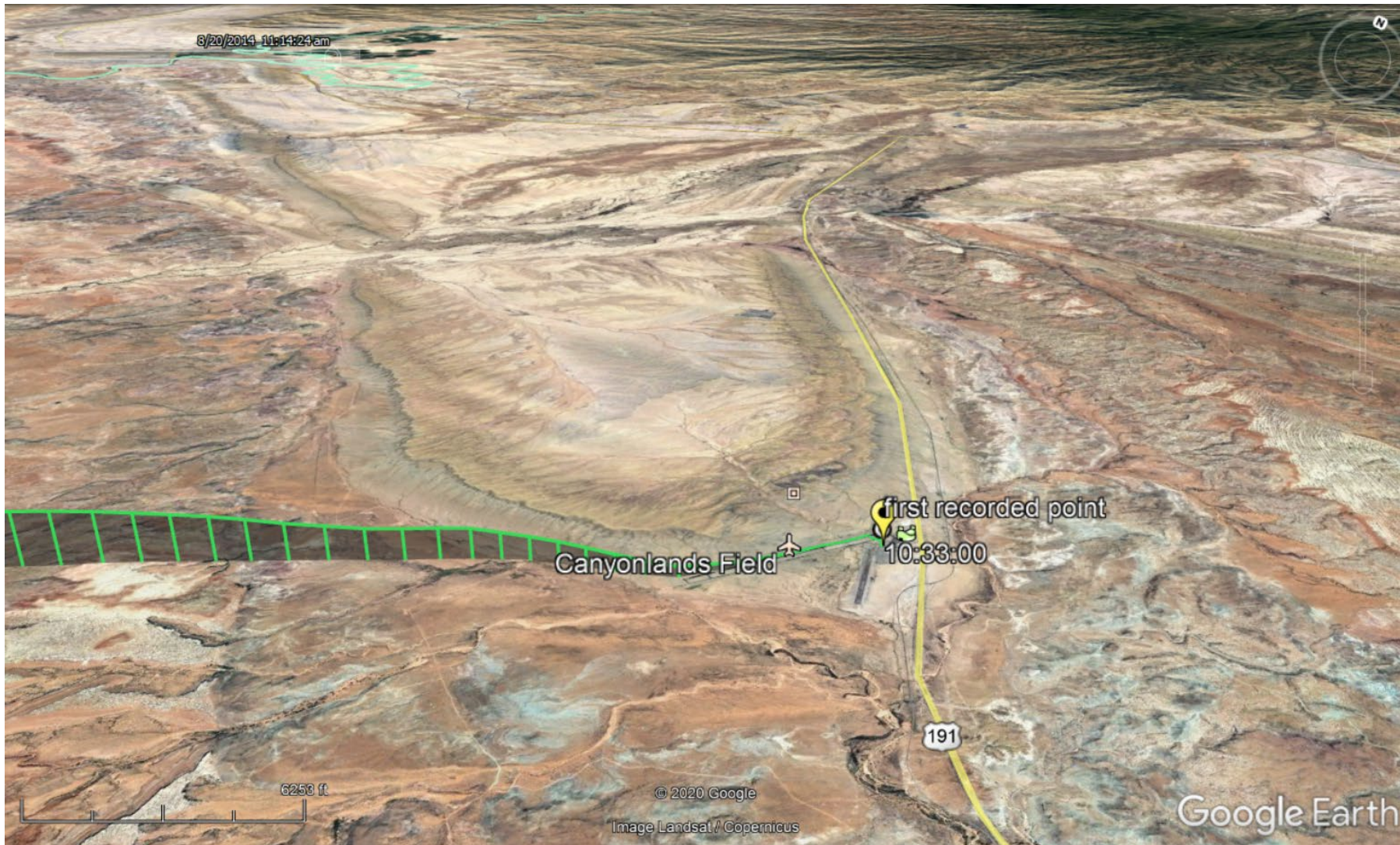


Figure 12: Google Earth overlay showing the flight originated at Canyonlands Filed Airport around 10:33:00 MDT.

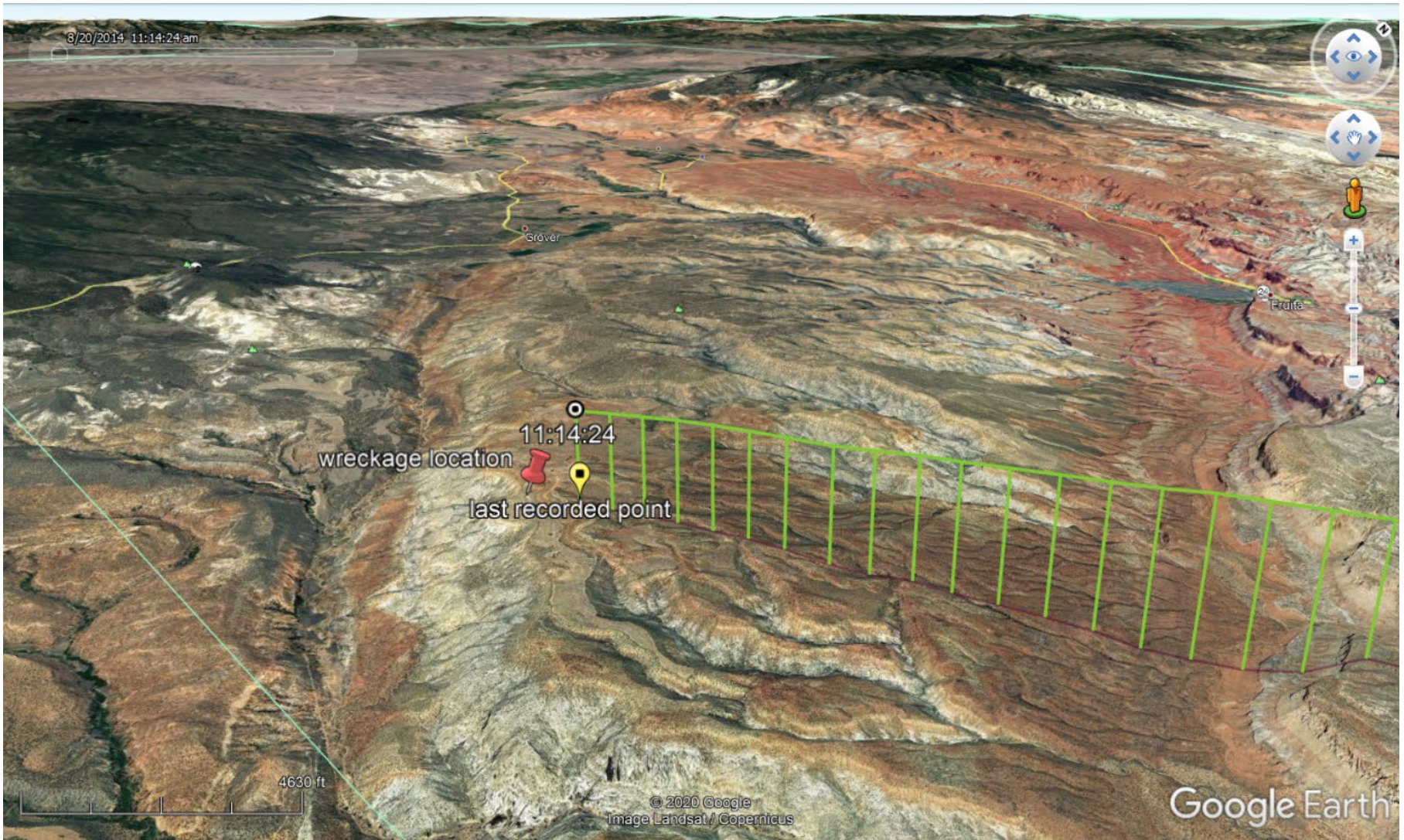


Figure 13: Google Earth overlay showing the last recorded point and the reported wreckage location.