

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR23FA188

MULTIPLE ELECTRONIC DEVICES

Specialist's Factual Report

November 17, 2023

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A. ACCIDENT SUMMARY

Location: Albany, Wyoming
Date: May 14, 2023
Time: 1135 mountain daylight time (MDT)
1735 coordinate universal time (UTC)
Aircraft: Cessna T182T, N665B

B. MULTIPLE ELECTRONIC DEVICES SPECIALIST

Specialist: W. Deven Chen
Electrical Engineer – Recorder Specialist
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A recorder group was not convened. The NTSB Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model:	JPI EDM-700
Recorder Serial Number:	167#5 ¹
Recorder Manufacturer/Model:	Appareo Stratus
Recorder Serial Number:	230982

1.0 JPI EDM-700 Description

The JPI (J. P. Instruments) EDM-700 is a panel mounted gauge that the operator can monitor and record up to 24 parameters related to engine operations. Depending on the installation engine parameters monitored can include: Exhaust Gas Temperature (EGT), Cylinder Head Temperature (CHT), Oil Pressure and Temperature, Manifold Pressure, Outside Air Temperature, Turbine inlet Temperature, Engine Revolutions per Minute, Compressor Discharge Temperature, Fuel Flow, Carburetor Temperature, and Battery Voltage.

The unit can also calculate, in real-time, horsepower, fuel used, shock cooling rate and EGT differentials between the highest and lowest cylinder temperatures. The calculations are also based on the aircraft installation.

The unit contains non-volatile memory² for data storage of the parameters recorded and calculated. The rate at which the data is stored is selectable by the

¹ The “#” represents a number that was indecipherable due to damage.

² Non-volatile memory (NVM) is semiconductor memory that does not require external power for data retention.

1.1 JPI EDM-700 Condition and Data Recovery

[illegible]

The image displays two views of a small, square integrated circuit (IC) component. The component has a dark, possibly black or dark brown, square body. On the left, the top surface is visible, showing gold-colored markings that read 'ATMEL12', 'C256', and '28'. The bottom surface, shown on the right, features four gold-colored pins extending downwards. The component appears to be a microcontroller or a similar digital IC.

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1.2 JPI EDM-700 Recording Description

The data extracted from the JPI EDM-700 included 14 sessions. The last session recorded on May 14, 2023, was identified to be associated with the accident flight. The data were recorded at a rate of 6 seconds per sample.

1.2.1 JPI EDM-700 Parameters Provided

Table 1 lists the JPI EDM-700 parameters verified and provided in this report.

Table 1. JPI EDM-700 data parameters provided.

Parameter Name (unit)	Parameter Description (unit)
BAT (V)	Circuitry bus voltage (volts)
CHT1-# (degF)	Cylinder head temperature - cylinder # (degrees Fahrenheit)
CLD1 (degF/min)	Shock cooling rate (degrees Fahrenheit per minute)
EGT1-# (degF)	Exhaust gas temperature - cylinder # (degrees Fahrenheit)
FF (GPH)	Fuel flow rate (gallons per hour)

1.3 JPI EDM-700 Time Correlation

The device recorded times based on its internal clock, which was set at the initial installation, if not later adjusted. The internal clock tended to have an offset to the real time as the device operated. Since the device could not be powered on due to damage, this offset could not be determined. Therefore, the times of the data were kept as device time for this report. The duration of the accident recording was 1:06:06, from 18:20:58 to 19:27:04 device time.

2.0 Appareo Stratus Description

The Appareo Stratus device is a self-contained battery-powered unit that contains an internal AHRS³, GPS/WAAS receiver⁴, and ADS-B⁵ receiver in one compact unit. The unit communicates wirelessly with compatible devices (iPad, iPhone, etc.) to display all the acquired information. In addition to communicating

³ The Attitude Heading Reference System consists of a set of 3-axis gyroscope, accelerometers and heading reference sensors that enable the unit to compute pitch, roll, and yaw motions.

⁴ The Wide Area Augmentation System (WAAS) is an air navigation aid to augment the Global Positioning System (GPS), by improving its accuracy, integrity, and availability.

⁵ Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance technology deployed throughout the national airspace system. The ADS-B system is composed of aircraft avionics and a ground infrastructure. Onboard avionics determine the position of the aircraft by using the GPS and transmit its position along with additional information about the aircraft to ground stations for use by air traffic control (ATC) and other ADS-B services. This information is transmitted at a rate of approximately once per second. Operators equipped with ADS-B realize additional benefits from ADS-B broadcast services: Traffic Information Service - Broadcast (TIS-B) (traffic information) and Flight Information Service - Broadcast (FIS-B) (weather information).

with compatible devices, the Stratus device records GPS position and AHRS information internally on a non-volatile memory chip.

2.1 Appareo Stratus Condition and Data Recovery

The Appareo Stratus had sustained impact damage, as shown in Figure 3. The NVM of the device was removed, readout, and converted into engineering unit data using laboratory tools.

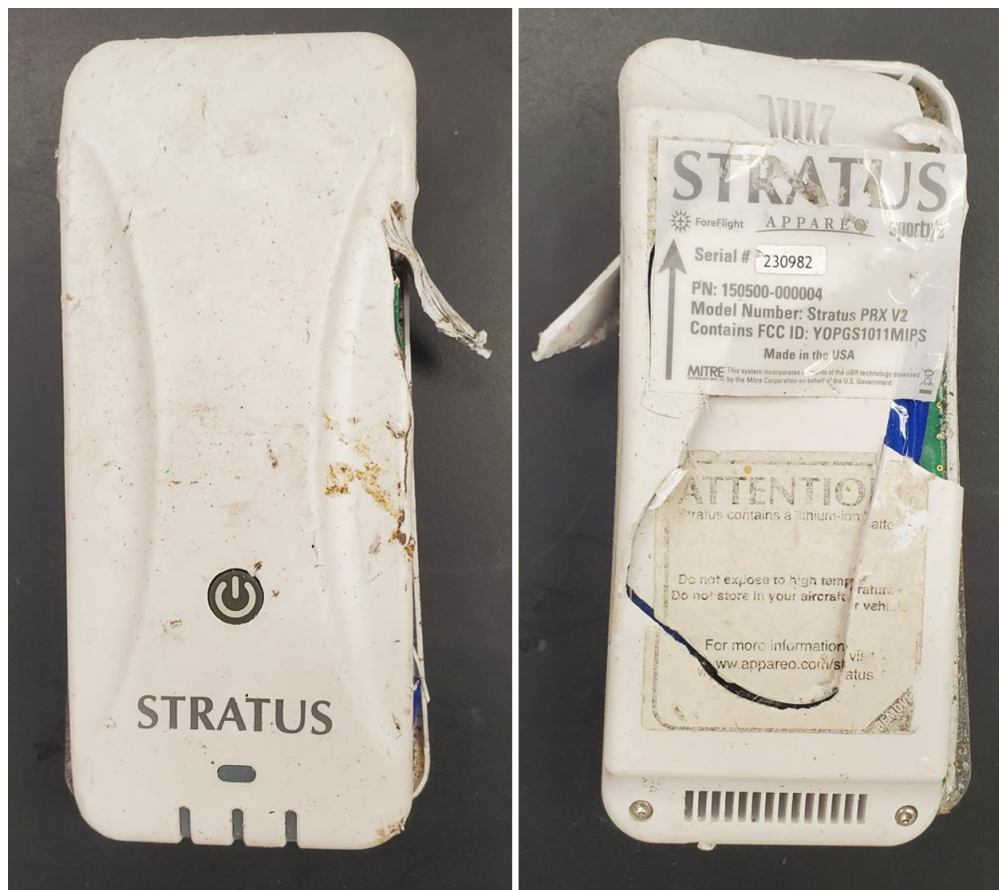


Figure 3. Front and back views of the Appareo Stratus as received.

2.2 Appareo Stratus Recording Description

The data recovered from the Appareo Stratus included numerous sessions. The last and sole session recorded on May 14, 2023, was identified to be associated with the accident flight. The duration of the recording was 0:50:11, from 10:36:10 MDT to 11:26:21 MDT. The sampling rate was 5 Hz.

2.2.1 Appareo Stratus Parameters Provided

Table 2 lists the Appareo Stratus parameters verified and provided in this report.

Table 2. Appareo Stratus data parameters provided.

Parameter Name (unit)	Parameter Description (unit)
Altitude HMSL (ft)	Altitude above Mean Sea Level (feet)
Bframe Acceleration X (gs)	Device body frame acceleration in X-axis (gs)
Bframe Acceleration Y (gs)	Device body frame acceleration in Y-axis (gs)
Bframe Acceleration Z (gs)	Device body frame acceleration in Z-axis (gs)
Bframe Rotation X (deg/s)	Device body frame rotational speed in X-axis (degrees per second)
Bframe Rotation Y (deg/s)	Device body frame rotational speed in Y-axis (degrees per second)
Bframe Rotation Z (deg/s)	Device body frame rotational speed in Z-axis (degrees per second)
Ground Speed (kts)	Average groundspeed between current and previous data point (knots)
Ground Track (deg)	Path on the surface of the Earth directly below aircraft (degrees)
Heading (degrees)	Direction relative to true north (degrees)
Latitude (deg)	Geographic latitude (degrees)
Longitude (deg)	Geographic longitude (degrees)
Pitch (deg)	Pitch angle (degrees)
Roll (deg)	Roll angle (degrees)
Vertical Speed (fpm)	Vertical speed (feet per minute)

2.3 Appareo Stratus Time Correlation

The Appareo Stratus data was recorded in GPS time, which was converted to UTC, and then was converted to MDT, the local tie of the event.

D. FIGURES AND TABULAR DATA

Figure 4 shows engine parameter plots of the entire accident flight recording from the JPI EDM-700.

Figure 5 show data parameters plots of the entire accident flight recording from the Appareo Stratus. The plot is configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

Figure 6 and Figure 7 show Google Earth overlays of the accident flight. Figure 6 shows the entire flight recording, and Figure 7 shows the final portion of the accident flight. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

The recorded data indicated that the accident aircraft took off from Northern Colorado Regional Airport (KFNL), Fort Collins/Loveland, CO, at around 10:45:00 MDT. The accident aircraft then travelled northwest and crossed from Colorado to Wyoming at around 11:10:00 MDT. At 11:26:21.4 MDT, the last recorded data point

showed the accident aircraft was at a mountainous terrain with an altitude of 13,241 feet above mean seal level and with a speed of 122 knots.

The corresponding tabular data used to create the above figures is provided in electronic comma-separated value (CSV) format as attachments to this report. Attachment 1 is the JPI EDM-700 data. Attachments 2 and 3 are GPS and AHRS data respectively from the Appareo Stratus data.

Submitted by:

W. Deven Chen
Electrical Engineer – Recorder Specialist

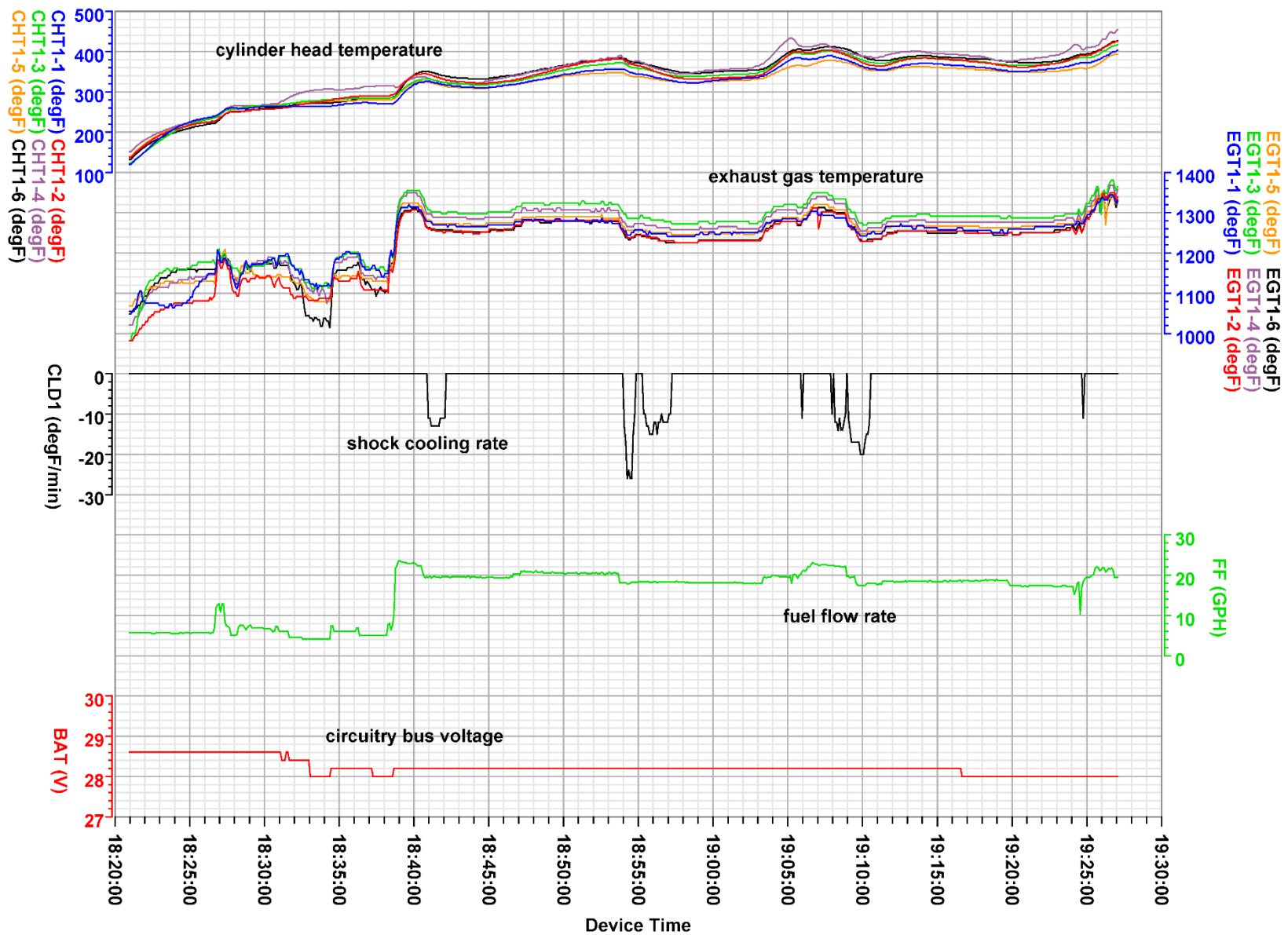


Figure 4. Plot of data parameters of the entire accident flight recording from the JPI EDM-700.

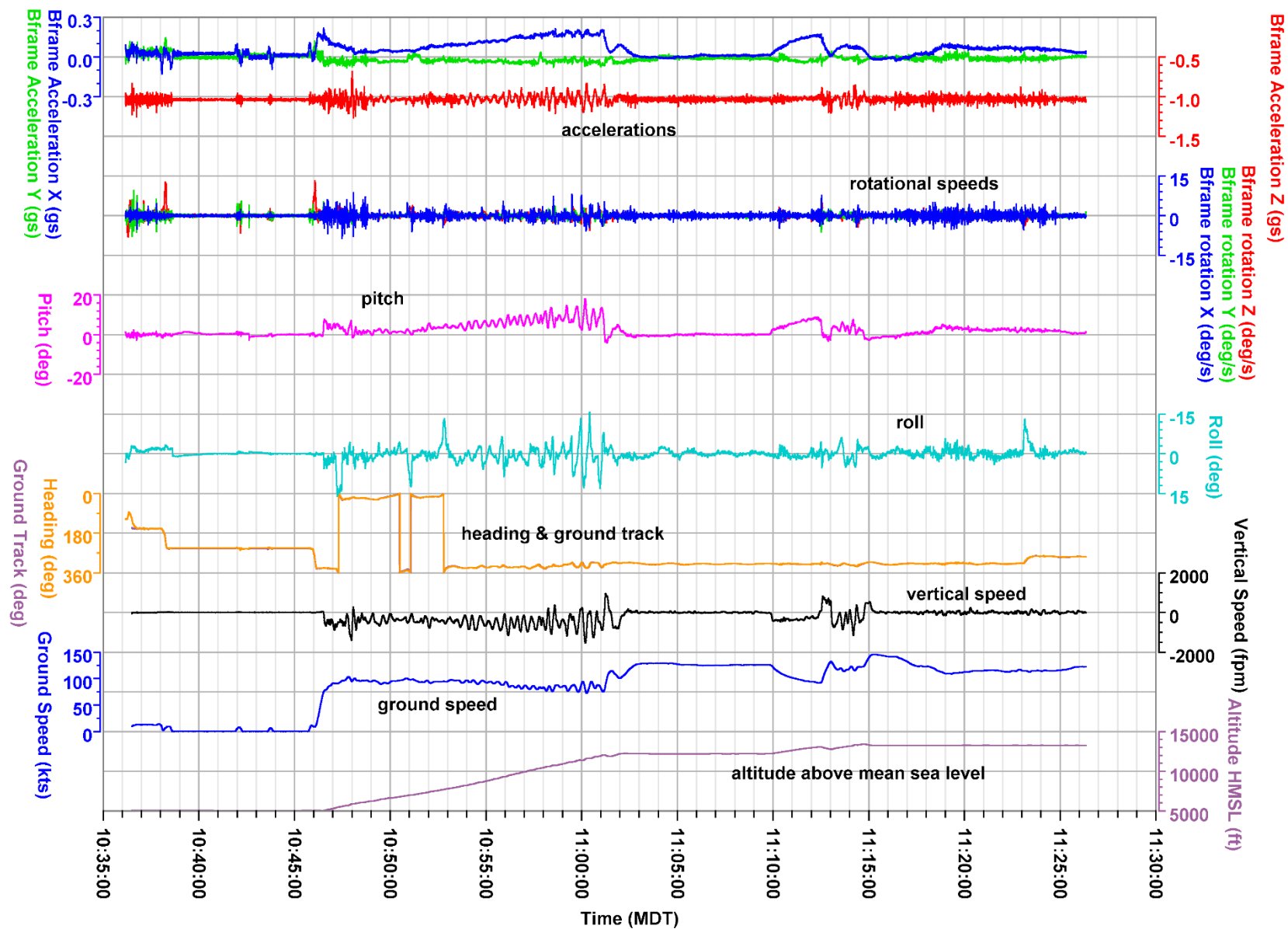


Figure 5. Plot of data parameters of the entire accident flight recording from the Appareo Stratus.

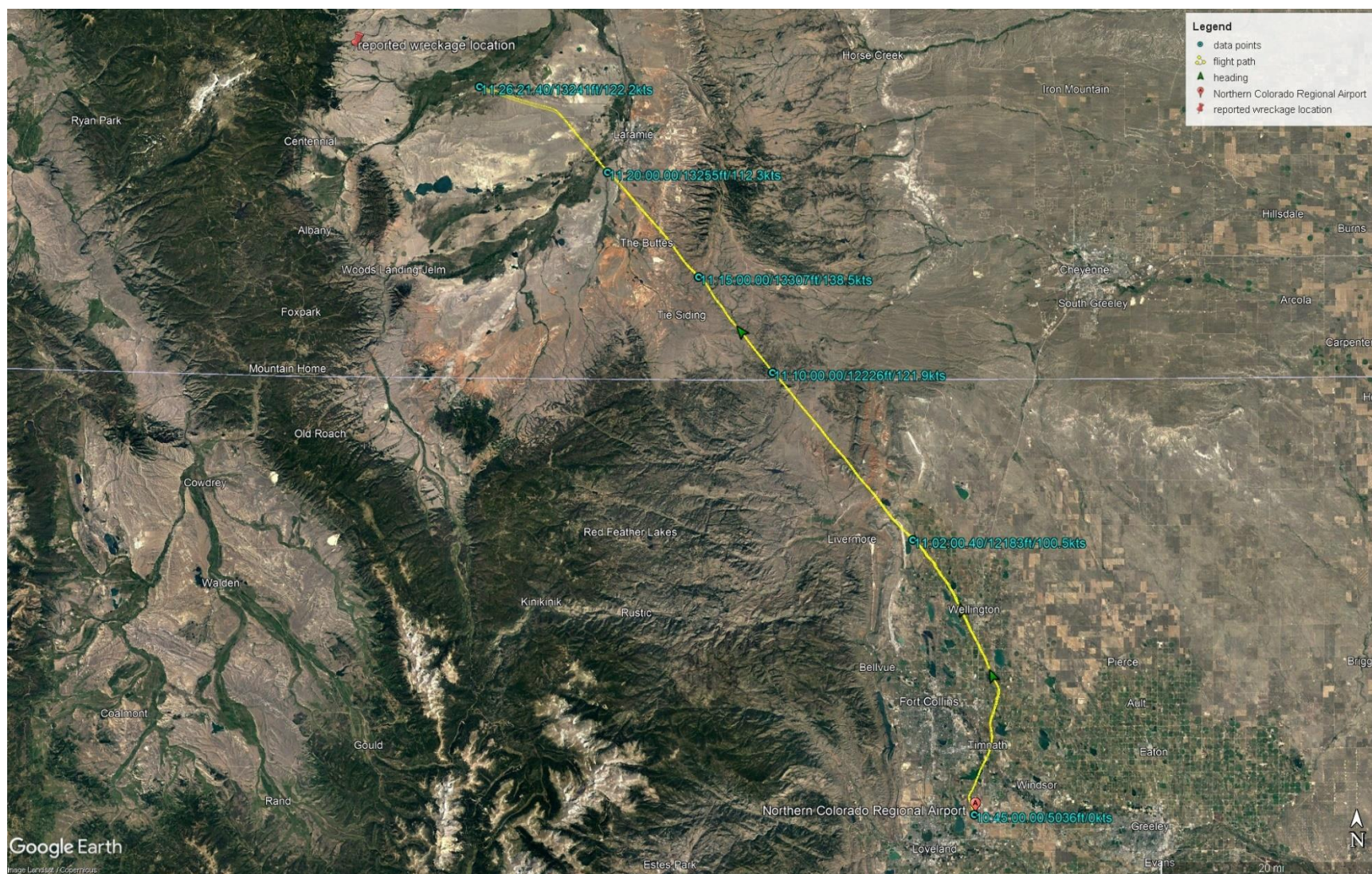


Figure 6. Google Earth overfly of the entire accident flight recording on May 14, 2023.

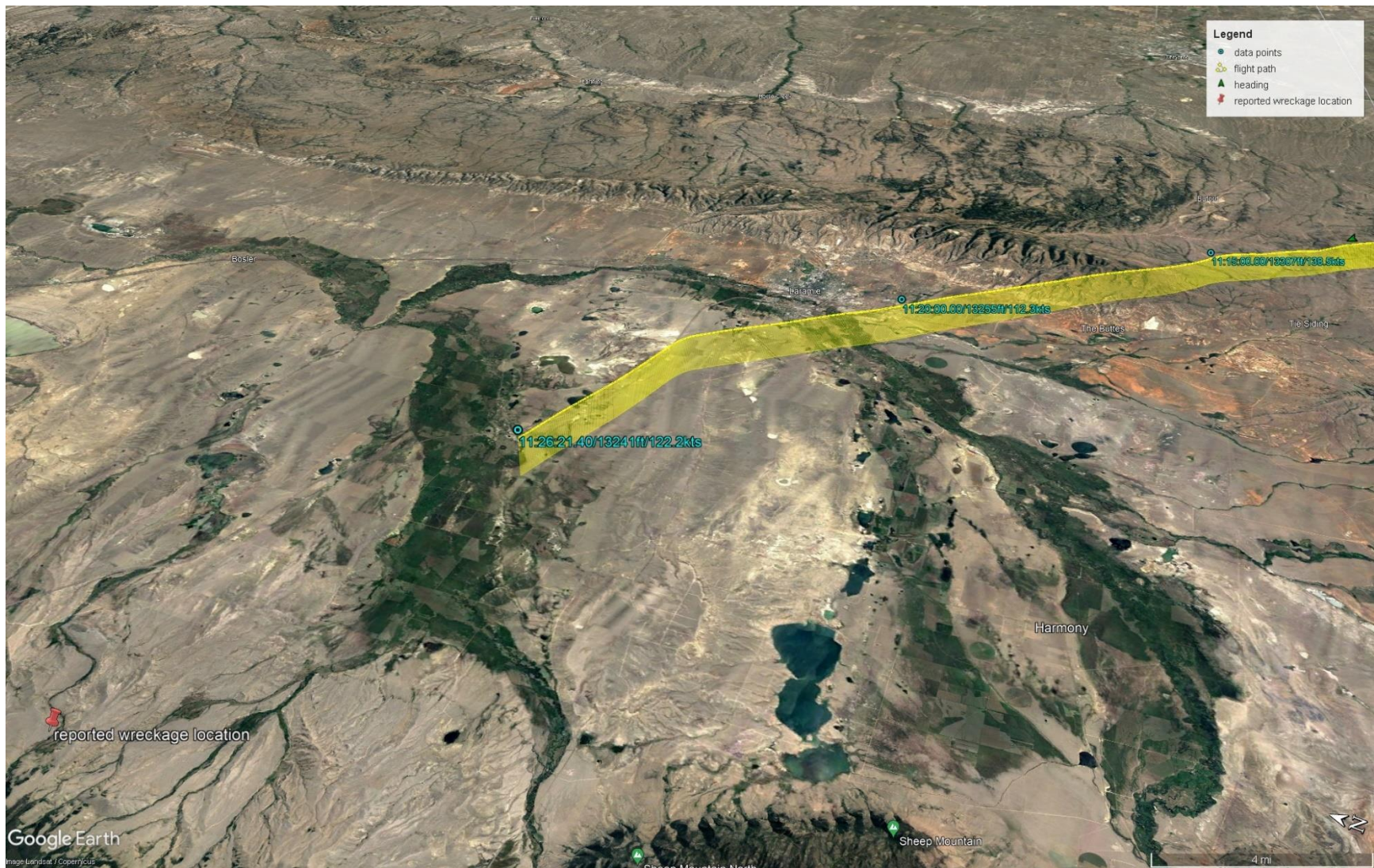


Figure 7. Google Earth overly showing the last portion of the recording.