

National Transportation Safety Board

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COCKPIT DISPLAYS - RECORDED FLIGHT DATA

Specialist's Factual Report

August 8, 2024

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A. ACCIDENT

Location: Jesup, Georgia
Date: April 6, 2023
Time: 0750 eastern daylight time (EDT)
1150 coordinated universal time (UTC)
Airplane: Cirrus SR22, N911TK

B. COCKPIT DISPLAYS - RECORDED FLIGHT DATA SPECIALIST

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National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A cockpit display - recorded flight data group was not convened. The NTSB Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model: Avidyne PFD
Part Number: 700-00006-000
Recorder Serial Number: 21108234

Recorder Manufacturer/Model: Avidyne MFD CF Card
Part Number: 053-00201-100 REV00
Recorder Serial Number: Unknown

Recorder Manufacturer/Model: Appareo Stratus 2S
Part Number: 153510-000008
Recorder Serial Number: 2S016012

1.0 Avidyne Primary Flight Display Description

The Avidyne primary flight display (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.

The 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 Hertz (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.

1.1 Avidyne PFD Data Recovery

The Avidyne PFD had sustained impact damage in the event. The extent of the damage is shown in figure 1. The memory board was extracted from the display and was read out using laboratory techniques.



Figure 1. Avidyne PFD, as received in the lab.

1.2 Avidyne PFD Recording Description

The PFD recording contained records of 27 power cycles. The accident flight was associated with the last power cycle. The duration of the last power cycle was approximately 30 minutes. Timing of the PFD data is measured in seconds from power-on.

1.2.1 Avidyne PFD Engineering Unit Conversions

Conversion of the PFD data from the raw recorded information to engineering units was performed using information provided by Avidyne. Where applicable, changes to the conversions have been made to ensure the parameters conform to the Safety Board's standard sign convention that climbing right turns are positive (CRT=+).¹ Table 1 in Appendix A lists the PFD parameters verified and provided in this report.

1.3 Avidyne PFD Time Correlation

Correlation of the PFD data to EDT was established using the recorded GPS time parameter from the PFD data. Recorded GPS time is updated in 6 second intervals on the PFD.² The GPS time is recorded in UTC. The difference between EDT and UTC is 4 hours, or 14,400 seconds. The PFD starts recording when power is applied to the unit. Each power cycle begins at 0 seconds and the PFD data is measured in seconds from power-on. An offset is applied to the power cycle plotted to display the data with the local time zone. Therefore, for the rest of this report, all times are referenced as EDT, not recorded time. Due to the 6 second update rate of the GPS time, the times noted in this report could be up to 6 seconds off from actual GPS time.

2.0 Avidyne Multi-Function Display Description

The Avidyne multi-function flight display (MFD) unit can display 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.

¹ CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Left Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

² GPS information is recorded at 4 second (0.25 Hz) intervals; however, it is possible to have the same UTC time recorded in consecutive GPS data records due to the 6 second update rate of the GPS time parameter.

The MFD contains a compact flash (CF) memory card located in a slot on the side of the unit. This memory card contains all the software that the MFD needs to operate. Additionally, this card contains all 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 6 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.

2.1 Avidyne MFD Data Recovery

The Avidyne MFD CF card was in good condition and the data were downloaded using the manufacturer's procedure.

2.2 Avidyne MFD Recording Description

The Avidyne MFD CF card contained 79 data files. One data file was identified as recording during the incident flight. The data file was approximately 29 minutes in duration.

2.2.1 Avidyne MFD Engineering Unit Conversions

The accident file was identified and sent to Avidyne for conversion to engineering units. Table 1 in Appendix A lists the MFD parameters verified and provided in this report.

2.3 Avidyne MFD Time Correlation

MFD data were recorded in UTC. The difference between EDT and UTC is 4 hours, or 14,400 seconds. Therefore, the MFD data was offset by 4 hours to convert to EDT.

3.0 Appareo Stratus 2S Description

The Appareo Status 2S device is a self-contained battery powered unit that contains an internal AHRS, GPS/WAAS receiver, and ADS-B receiver in one compact

unit.^{3, 4, 5} The unit communicates wirelessly with the pilot's iPad or iPhone ("iOS Device") to display all the acquired information. The pilot needs to have the software application called ForeFlight installed on their iOS Device to view the Stratus data.⁶ In addition to communicating with the iOS Device, the Stratus device records GPS position and AHRS information internally on a non-volatile flash memory chip.⁷ Internal memory has the space to store over 13 hours of data.

3.1 Appareo Stratus 2S Data Recovery and Review

The Appareo Stratus 2S was in good condition and the data were downloaded using the manufacturer's procedure. Upon review of the event data, it was evident that the device contained no additional accident pertinent data to that recorded in previously mentioned devices. Therefore, no data from this device is included in this report.

D. FIGURES AND TABULAR DATA

Figures 2 to 6 contain PFD data recorded during the event on April 6, 2023. Additionally, figures 7 and 8 contain MFD data recording during the event. All the parameters listed in table 1 are plotted except UTC Hours, UTC Minutes, and UTC Seconds.

Figures 2 and 3 are graphical overlays of the flight track for the entire flight and final portion of the flight, respectively. The graphical map overlays were generated using Google Earth for 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.

Figures 4 through 6 show basic PFD parameters for the entire flight, the descent portion of the flight, and the final portion of the flight, respectively. Figures 7

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 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 global navigation satellite system (GNSS) 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).

⁶ iOS Device app (program) that communicates wirelessly with the Appareo Status unit to display aircraft's attitude, navigation, weather, and traffic information.

⁷ Type of solid-state memory that does not require electrical power to retain information.

and 8 show MFD parameters for the entire flight and final portion of the flight, respectively.

These figures are 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.

In summary, the aircraft took off from Fernandina Beach Municipal Airport (FHB), Fernandina Beach, Florida at approximately 0728, climbed to approximately 1,800 feet (ft), and flew north-northwest. At about 0746, the aircraft began descending. As the aircraft approached Jesup-Wayne County Airport (JES), Jesup, Georgia, it slowed to an indicated airspeed of approximately 75 knots (kts) and maintained this airspeed within ± 5 kts for the remainder of the recording. At 07:50:03, the aircraft began to roll right to an ultimate bank angle of approximately 40 degrees at 07:50:37, and then immediately rolled left to 40 degrees. The aircraft subsequently began to roll slightly back towards wings level before the aircraft rolled over on its left and pitched down. The MFD stopped recording at 07:51:00, and the PFD stopped recording at 07:51:09.

The corresponding tabular data used to create figures 2 to 6, including UTC Hours, UTC Minutes, and UTC Seconds, are provided in electronic comma-separated value (CSV) format as attachment 1 to this report. The corresponding tabular data used to create figures 7 and 8 are provided in electronic comma-separated value (CSV) format as attachment 2 to this report.

Submitted by:

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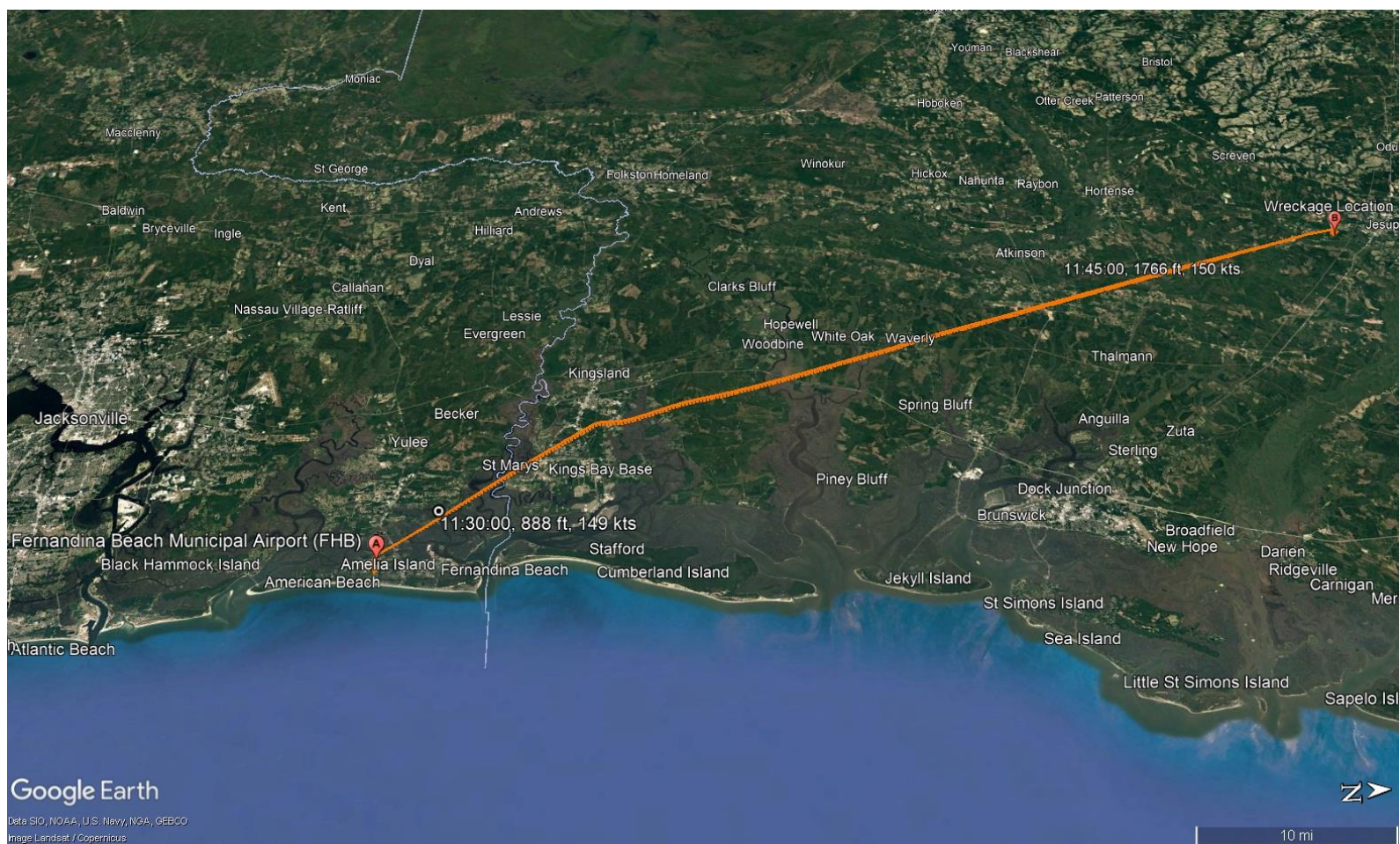
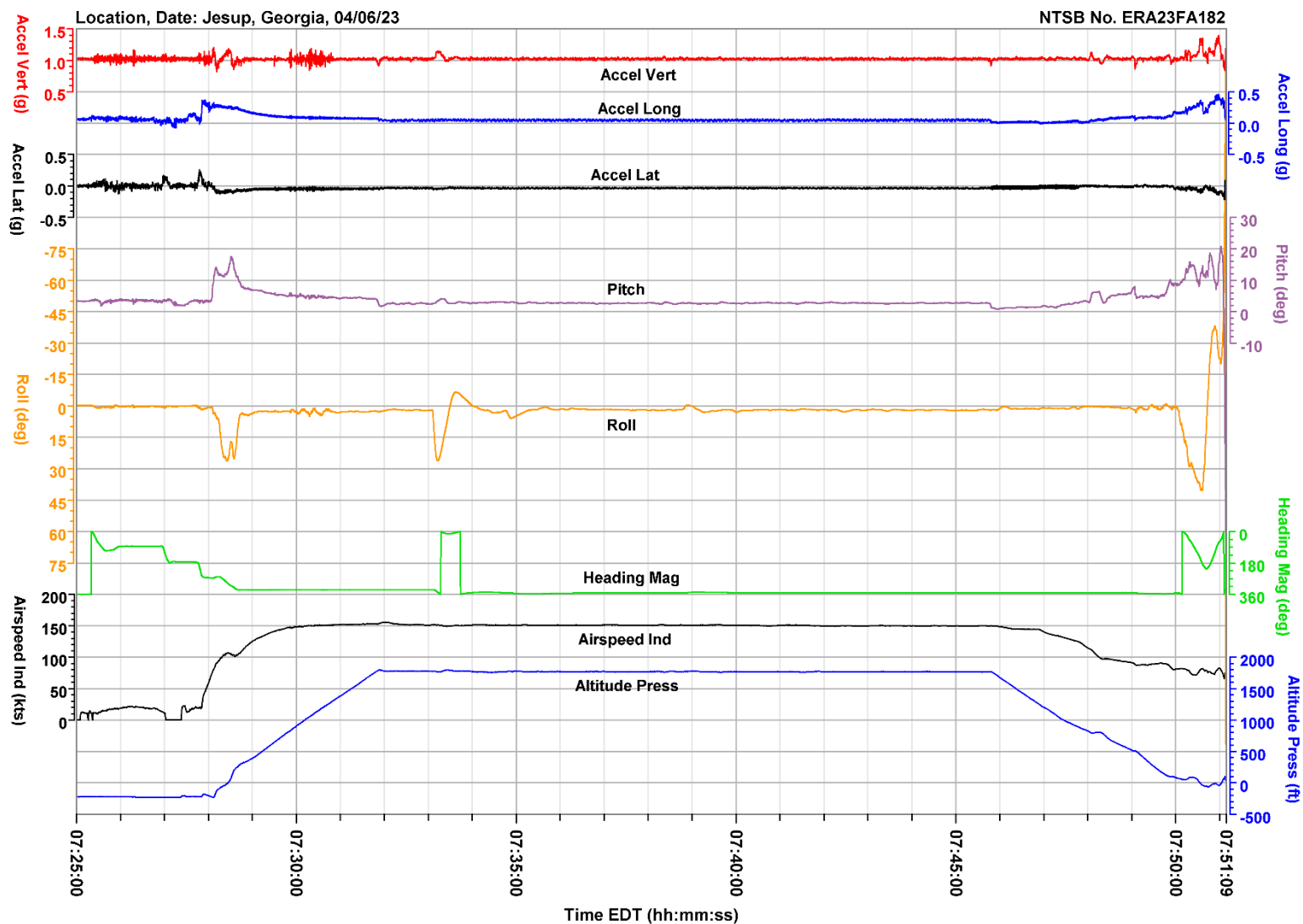


Figure 2. Google Earth overlay of the entire flight track.



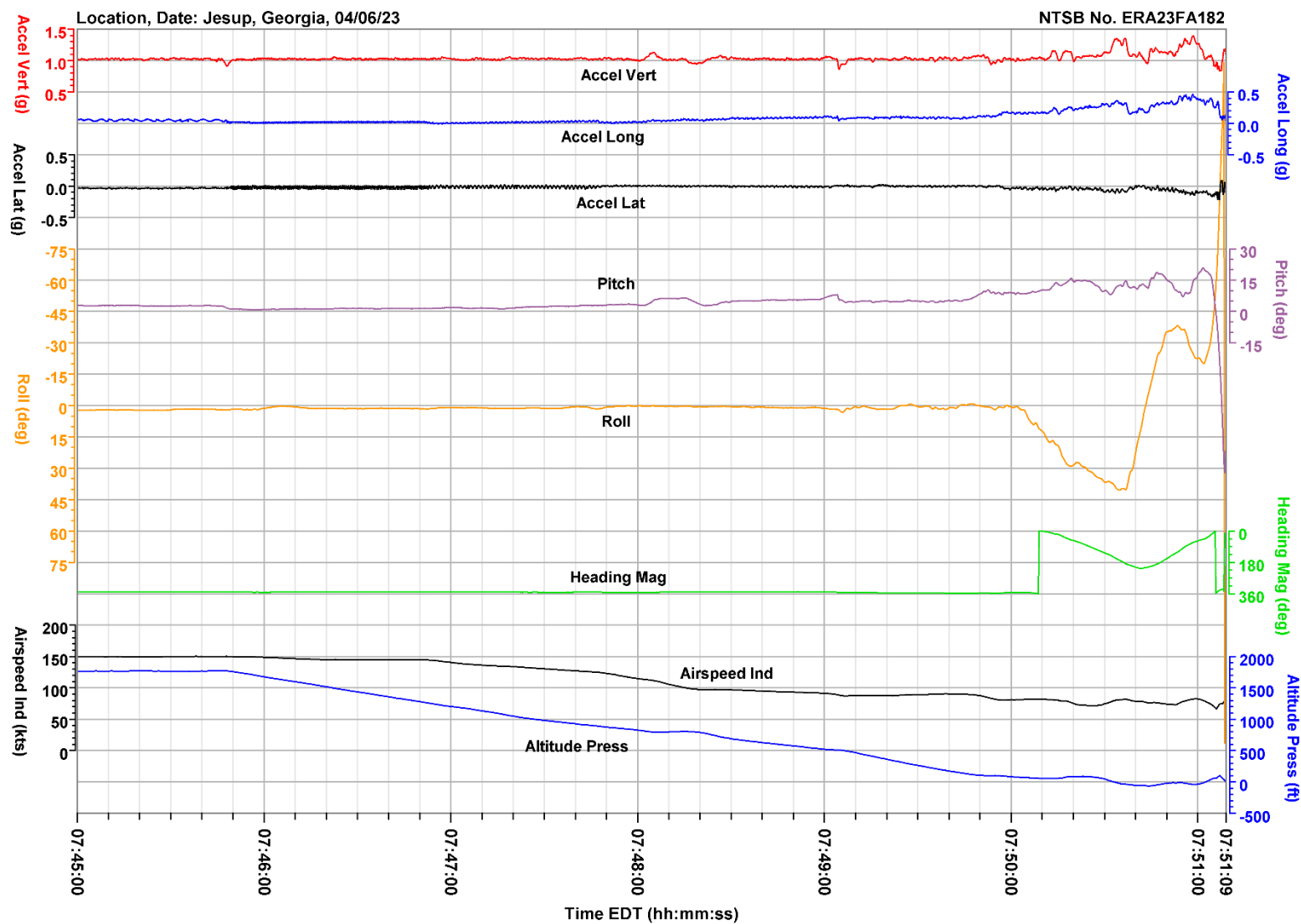
Figure 3. Google Earth overlay of the end of the flight.



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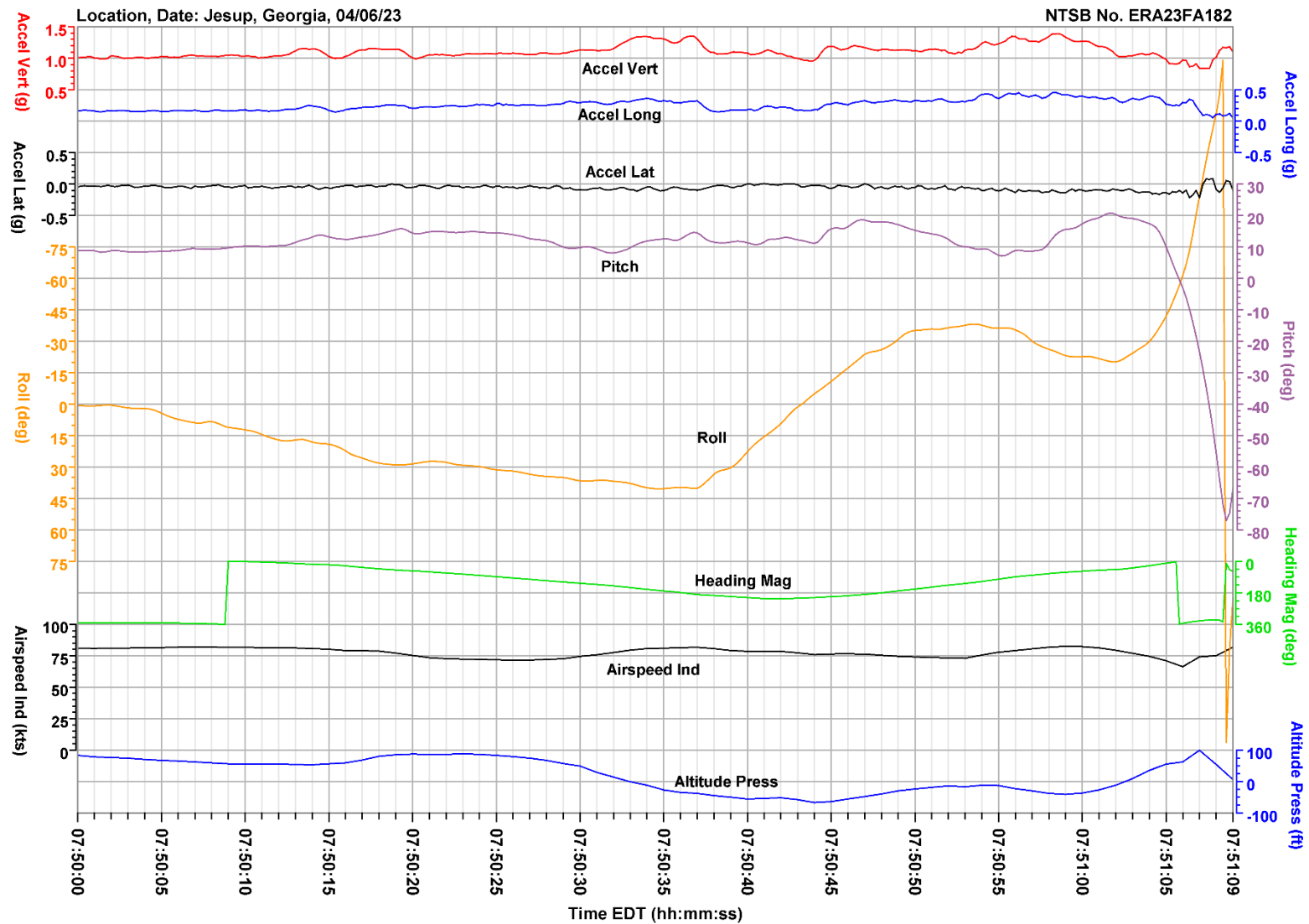
Figure 4. Plot of PFD parameters for the entire flight.



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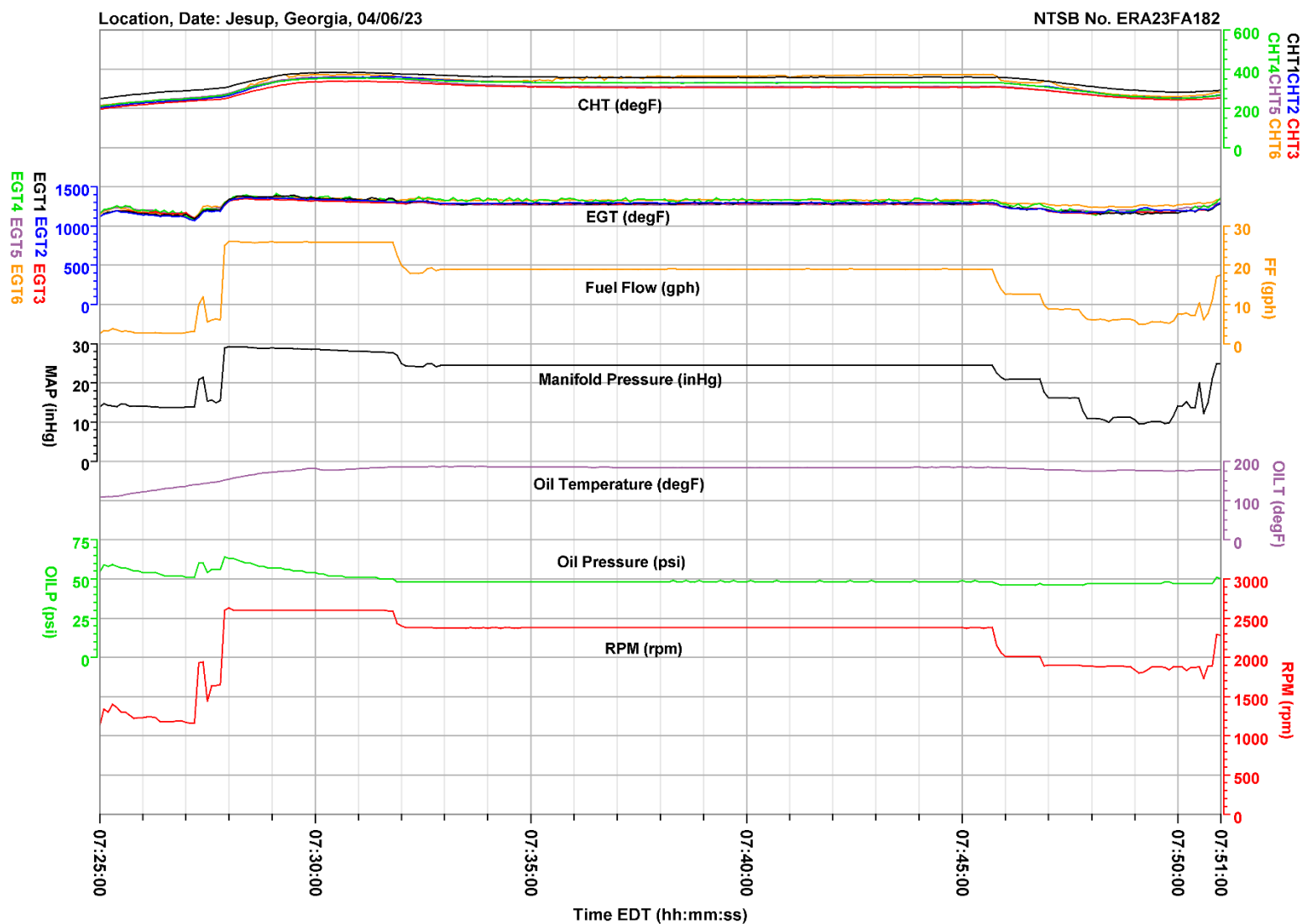
Figure 5. Plot of PFD parameters for the final descent of the flight.



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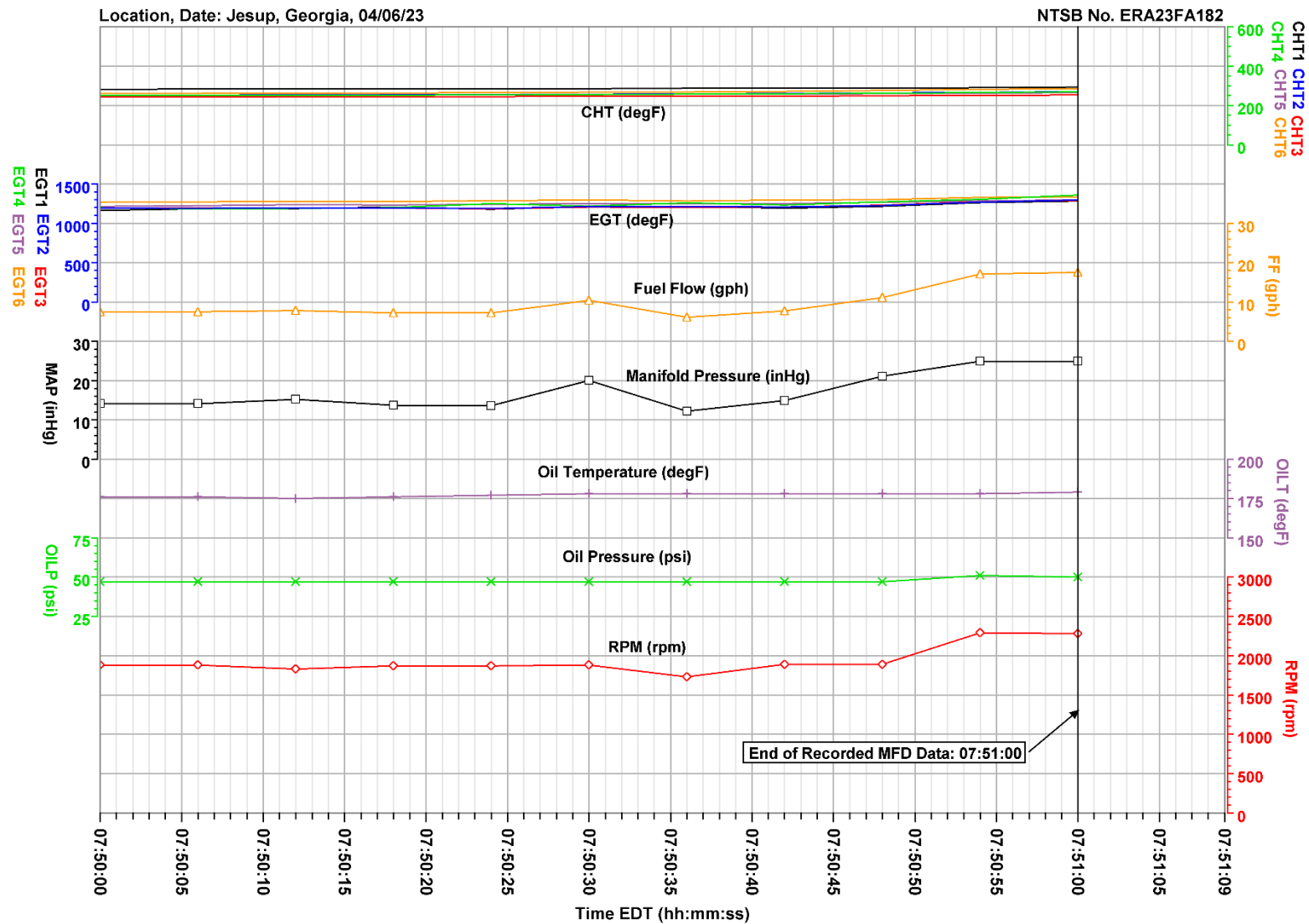
Figure 6. Plot of PFD parameters for the end of the flight.



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Figure 7. Plot of MFD parameters for the entire flight.



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Figure 8. Plot of MFD parameters for the end of the flight.

APPENDIX A. VERIFIED AND PROVIDED PARAMETERS

This appendix describes the parameters provided and verified in this report. Table 1 lists the PFD and MFD parameters and table 2 describes the unit abbreviations used in this report for PFD and MFD parameters.

Table 1. Verified and provided parameters.

Parameter Name (units)	Parameter Description	Source
Accel Lat (g)	Lateral Acceleration	PFD
Accel Long (g)	Longitudinal Acceleration	PFD
Accel Vert (g)	Vertical Acceleration	PFD
Airspeed Ind (kts)	Indicated Airspeed	PFD
Altitude Press (ft)	Pressure Altitude	PFD
Heading Mag (deg)	Magnetic Heading	PFD
Latitude (deg)	Latitude Position	PFD
Longitude (deg)	Longitude Position	PFD
Pitch (deg)	Pitch	PFD
Roll (deg)	Roll	PFD
Time UTC Hrs (hr)	Time UTC Hours	PFD
Time UTC Min (min)	Time UTC Minutes	PFD
Time UTC Sec (sec)	Time UTC Seconds	PFD
CHT# (degF)	Engine Cylinder Head Temperature Cylinder # ⁸	MFD
EGT# (degF)	Engine Exhaust Gas Temperature Cylinder # ⁸	MFD
FF (gph)	Engine Fuel Flow	MFD
MAP (inHg)	Engine Manifold Pressure	MFD
OILP (psi)	Engine Oil Pressure	MFD
OILT (degF)	Engine Oil Temperature	MFD
RPM (rpm)	Engine Revolutions Per Minute	MFD

Note: The PFD records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The pressure altitude information presented in the plots and in the electronic data has not been corrected for the local altimeter setting at the time of the event.

Table 2. Unit abbreviations.

Unit Abbreviations	Descriptions
deg	degrees
degF	Degrees Fahrenheit
ft	feet
g	units of gravitational acceleration
gph	gallons per hour
inHg	inches of Mercury
kts	knots
psi	pounds per square inch
rpm	revolutions per minute

⁸ Depending on aircraft configuration, the number of cylinders that are instrumented varies. In the data plots the # is replaced with the appropriate cylinder ID.