

# NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division  
Washington, D.C. 20594

June 15, 2022

## Cockpit Displays - Recorded Flight Data

### Specialist's Factual Report By Michael Portman

#### 1. EVENT SUMMARY

Location: Conway, South Carolina  
Date: March 17, 2020  
Aircraft: Cirrus SR22  
Registration: N150X  
Operator: Private  
NTSB Number: ERA20LA129

#### 2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

#### 3. DETAILS OF INVESTIGATION

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

Recorder Manufacturer/Model: **Avidyne PFD**  
Recorder Serial Number: **Unknown**

Recorder Manufacturer/Model: **Avidyne MFD**  
Recorder Serial Number: **Unknown**

##### 3.1. Avidyne Primary Flight Display (PFD) Description

The 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 recorded 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.

### **3.1.1. PFD Data Recovery**

The recorder was downloaded at the display manufacturer and the resultant files were sent to the NTSB's vehicle recorders lab via electronic file transfer.

### **3.1.2. PFD Data Description**

The PFD recording contained records of 14 power cycles and approximately 19 hours of data. The accident flight was associated with the 13<sup>th</sup> power cycle.<sup>1</sup> The duration of the 13<sup>th</sup> power cycle was approximately 3 hours and 50 minutes. Timing of the PFD data is measured in seconds from power-on.

### **3.1.3. PFD Engineering Units Conversions**

Conversion of the PFD data from the raw recorded information to engineering units is performed by Avidyne. Acceleration data, as provided by Avidyne, was converted from meters per second-squared ( $m/s^2$ ) to standard acceleration units (g).

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=+).<sup>2</sup> APPENDIX A lists the PFD parameters verified and provided in this report.

## **3.2. Avidyne Multi-Function Display (MFD) Description**

The MFD unit is able to 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.

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

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<sup>1</sup> During the normal data retrieval process, power is applied to the PFD. Therefore the accident data is not necessarily the last power cycle recorded.

<sup>2</sup> 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 = +.

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. MFD Data Recovery**

The recorder was downloaded at the display manufacturer and the resultant files were sent to the NTSB's vehicle recorders lab via electronic file transfer.

### **3.2.2. MFD Data Description**

The MFD CF card contained 170 data files. One data file was identified as recording during the incident flight. The data file was approximately three hours and 56 minutes in duration

### **3.2.3. MFD Engineering Units Conversions**

The data files downloaded from the MFD are in engineering units. APPENDIX A lists the MFD parameters verified and provided in this report.

## **3.3. Time Correlation**

Correlation of the PFD data to eastern daylight time (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.<sup>3</sup> The GPS time is recorded in Universal Coordinated Time (UTC). The difference between EDT and UTC is four hours, or 14,400 seconds. The PFD starts recording when power is applied to the unit. Each power cycle the timing begins at 0 seconds and the PFD data is measured in seconds from power-on. An offset is applied to each power cycle plotted to display the data with the local time zone.

MFD data was recorded in Universal Coordinated Time (UTC). The incident flight data has been offset from recorded MFD time to EDT by subtracting 14,400 seconds.

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<sup>3</sup> 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.

Therefore, for the rest of this report, all times are referenced as EDT, not recorded or UTC time. Due to the six second update rate of the GPS time, the times noted in this report could be up to six seconds off from actual GPS time

### **3.4. Plots and Corresponding Tabular Data**

The following 13 figures contain data recorded during the March 17, 2020, event. In several of the plots, excerpts from the air traffic control (ATC) transcript were added for context, using the times provided in the transcript. See the full ATC transcript, included in the docket, for reference.

Figures 1-3 show basic parameters recorded by the PFD during the entire flight, the descent, and the end of the flight, respectively.

Figures 4-5 show select autopilot related parameters during the descent and the end of the flight, respectively.

Figures 6-7 show select vertical profile and autopilot related parameters during the descent and the end of the flight, respectively.

Figures 8-10 show MFD recorded parameters during the entire flight, the descent, and the end of the flight, respectively.

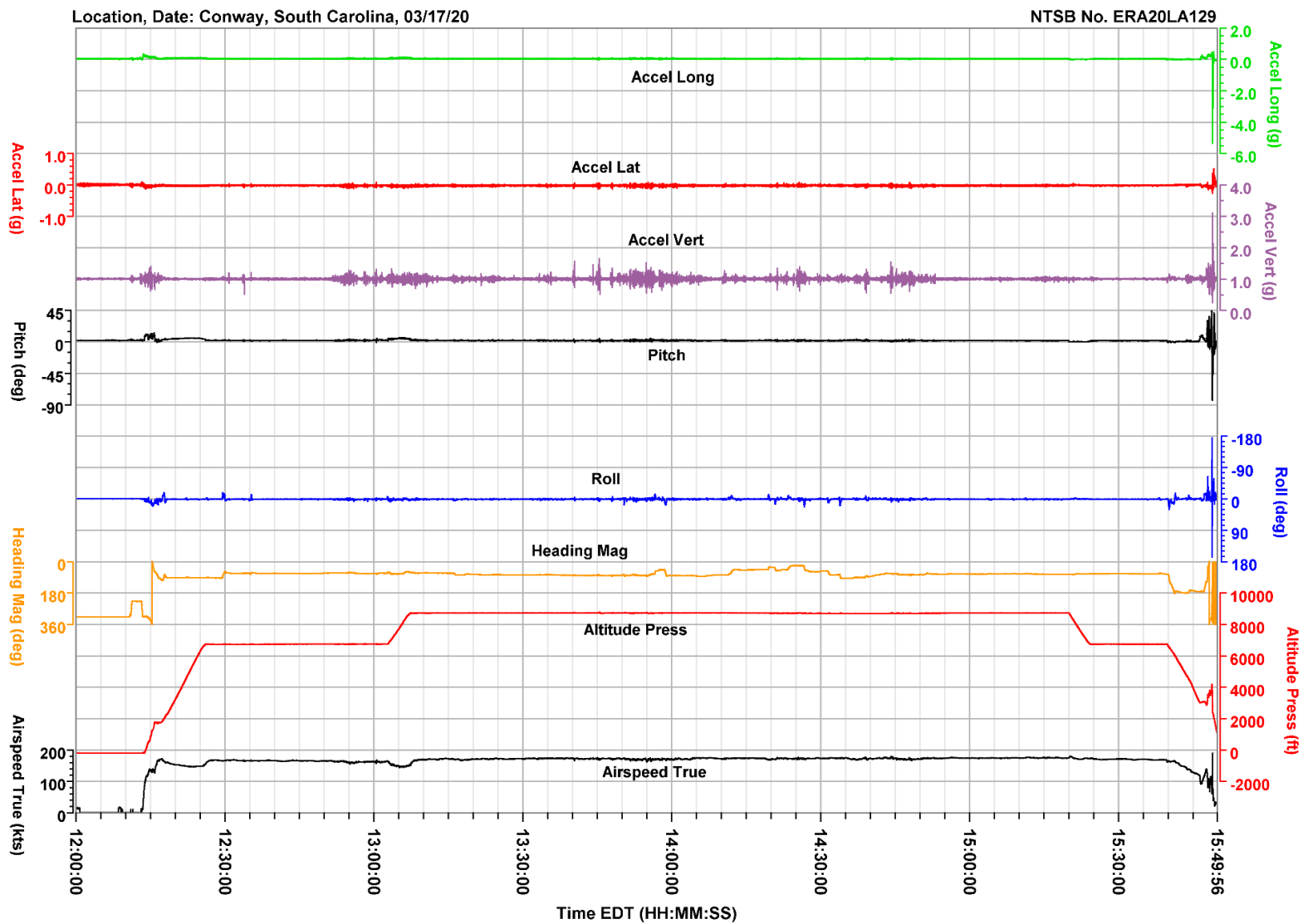
Figures 11-13 show a graphical overlay of the aircraft's flight track on the instrument landing system (ILS) runway 18 approach plate for Myrtle Beach International Airport (MYR) Myrtle Beach, South Carolina, generated using Google Earth. Along with the ATC excerpts, the recorded active autopilot modes are displayed. Note that the weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Flight data for the majority of the flight is unremarkable. The airplane turned to line up with the ILS for runway 18 and was cleared direct to the UXDEP intersection at approximately 15:40:39. Beginning at this time, the autopilot underwent several mode changes for the next several minutes before turning completely off at approximately 15:47:59.

The corresponding tabular data used to create figures 1-7 and 11-13 are provided in electronic (\*.csv) format as Attachment 1 to this report.<sup>4</sup> The corresponding tabular data used to create figures 8-10 are provided in electronic (\*.csv) format as Attachment 2 to this report.

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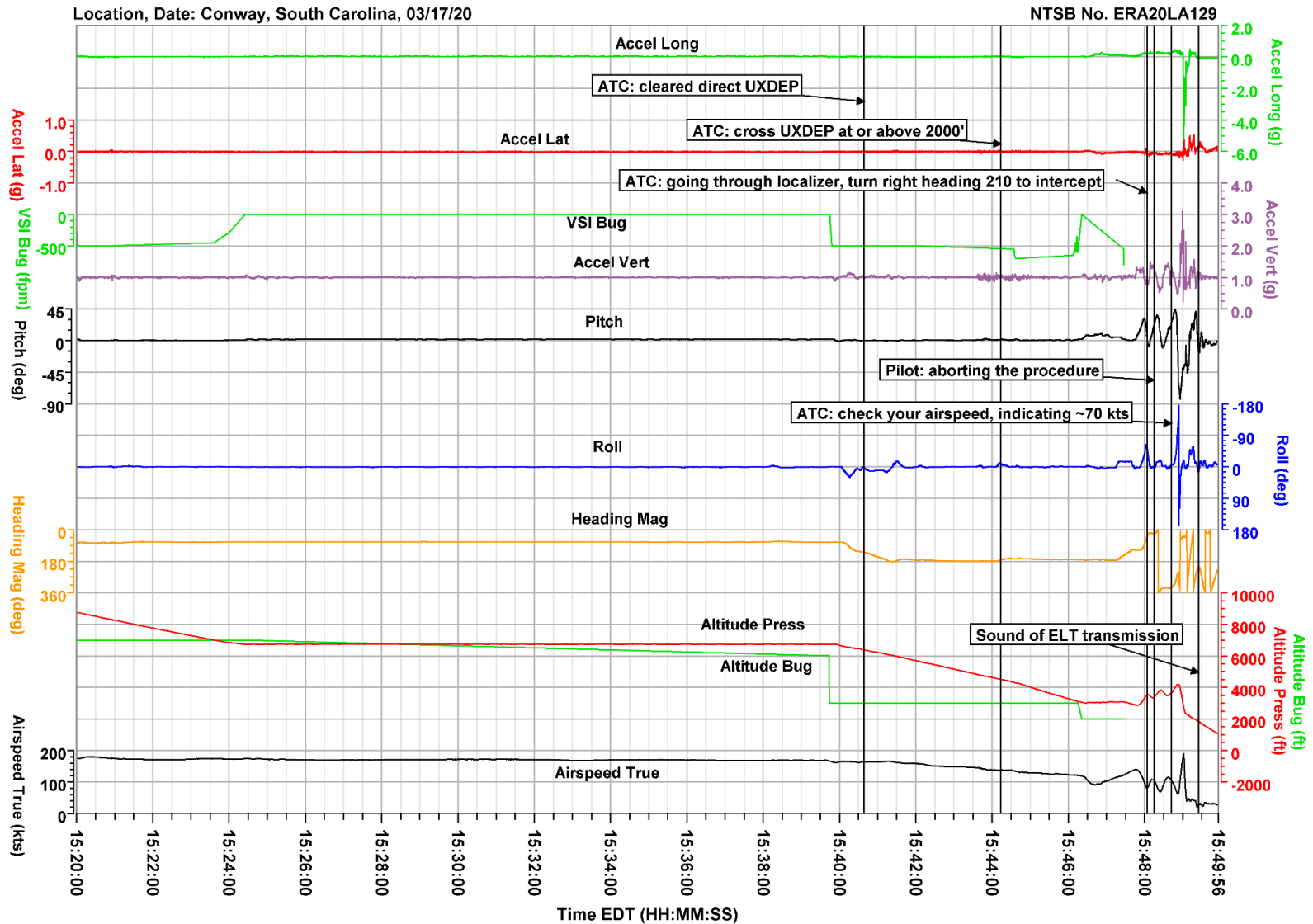
<sup>4</sup> Comma Separated Value format.



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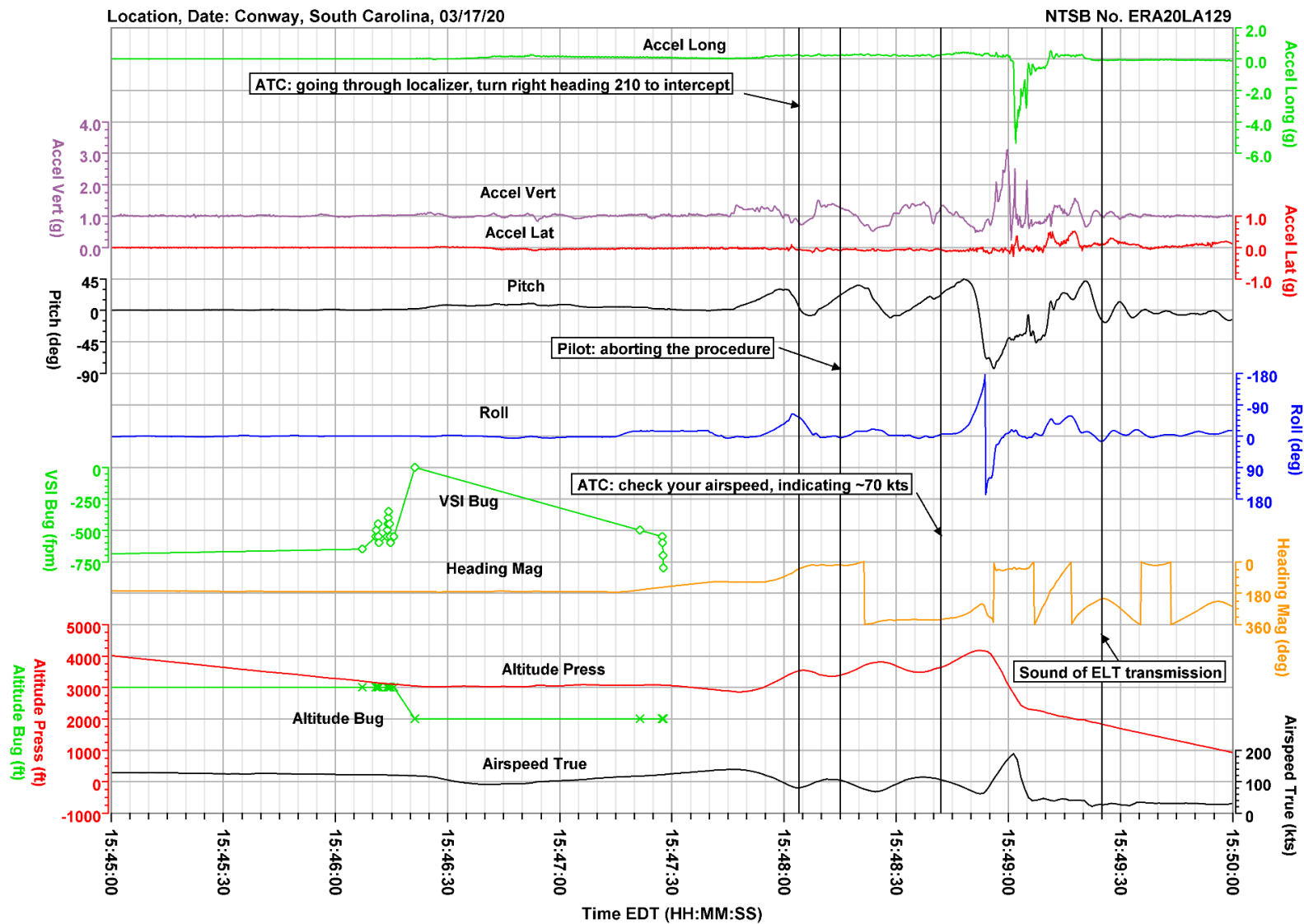
**Figure 1.** Plot of basic parameters for the entire flight.



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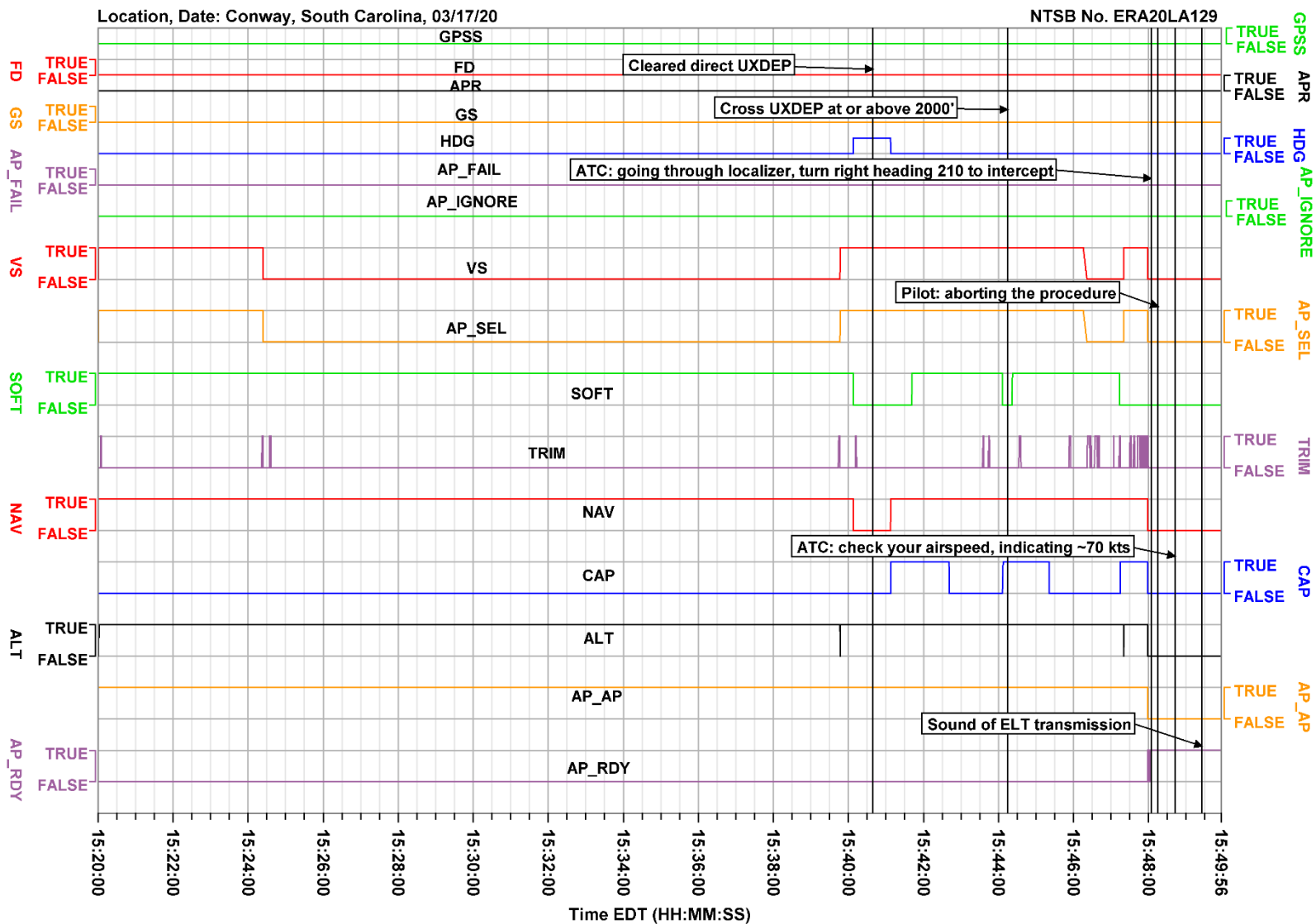
**Figure 2.** Plot of basic parameters during the descent.



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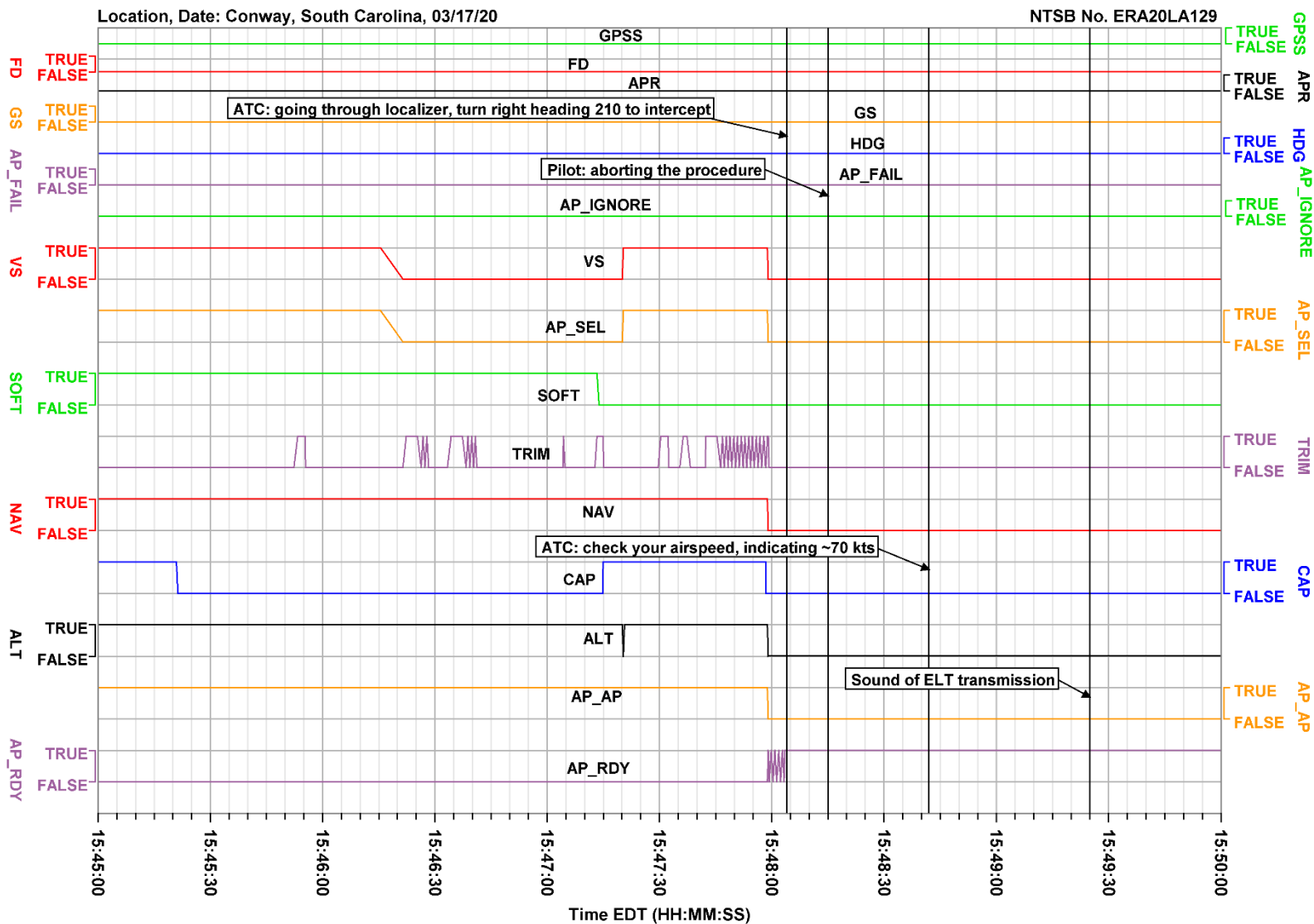
**Figure 3.** Plot of basic parameters at the end of the flight.



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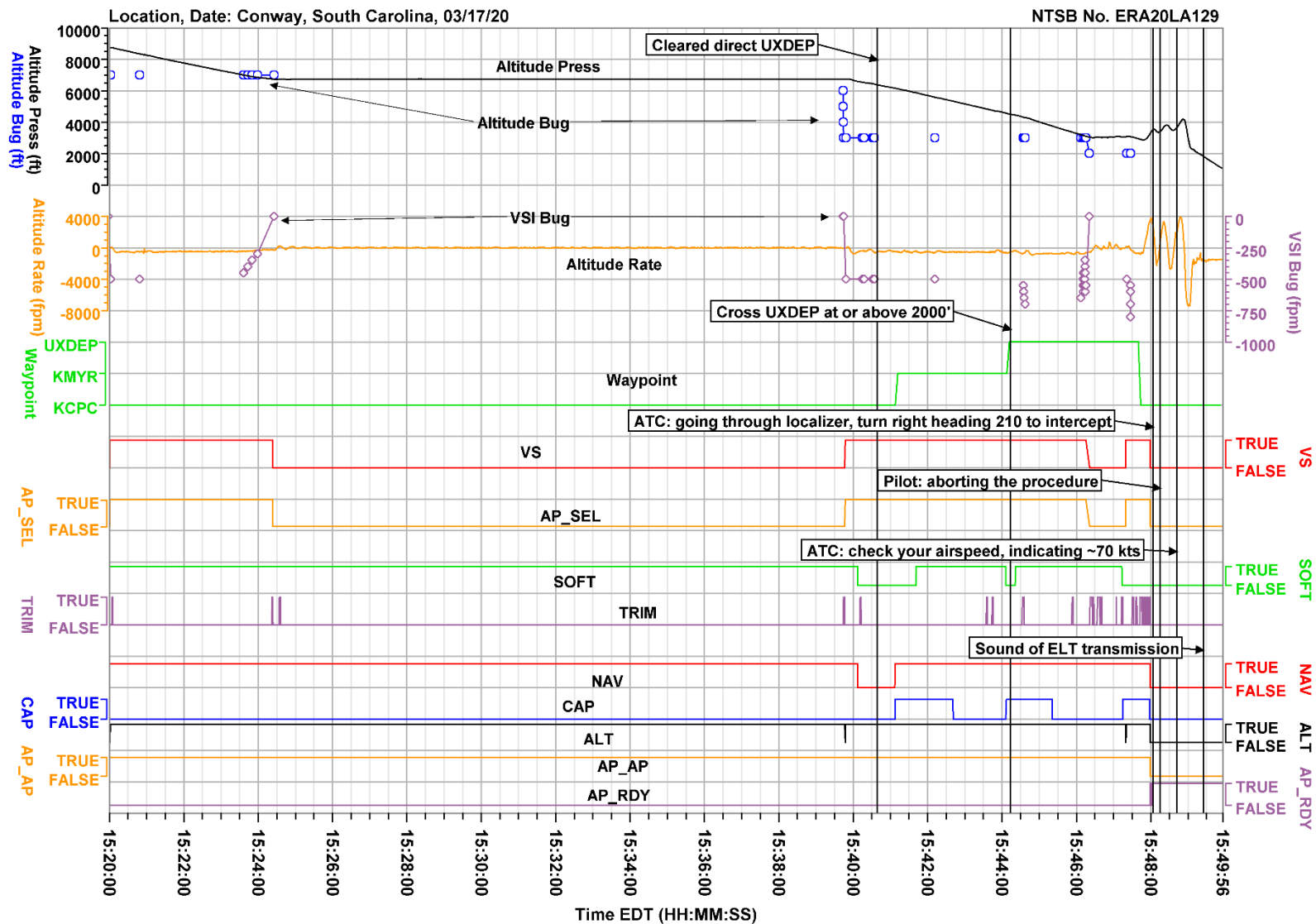
**Figure 4.** Plot of autopilot related parameters during the descent.



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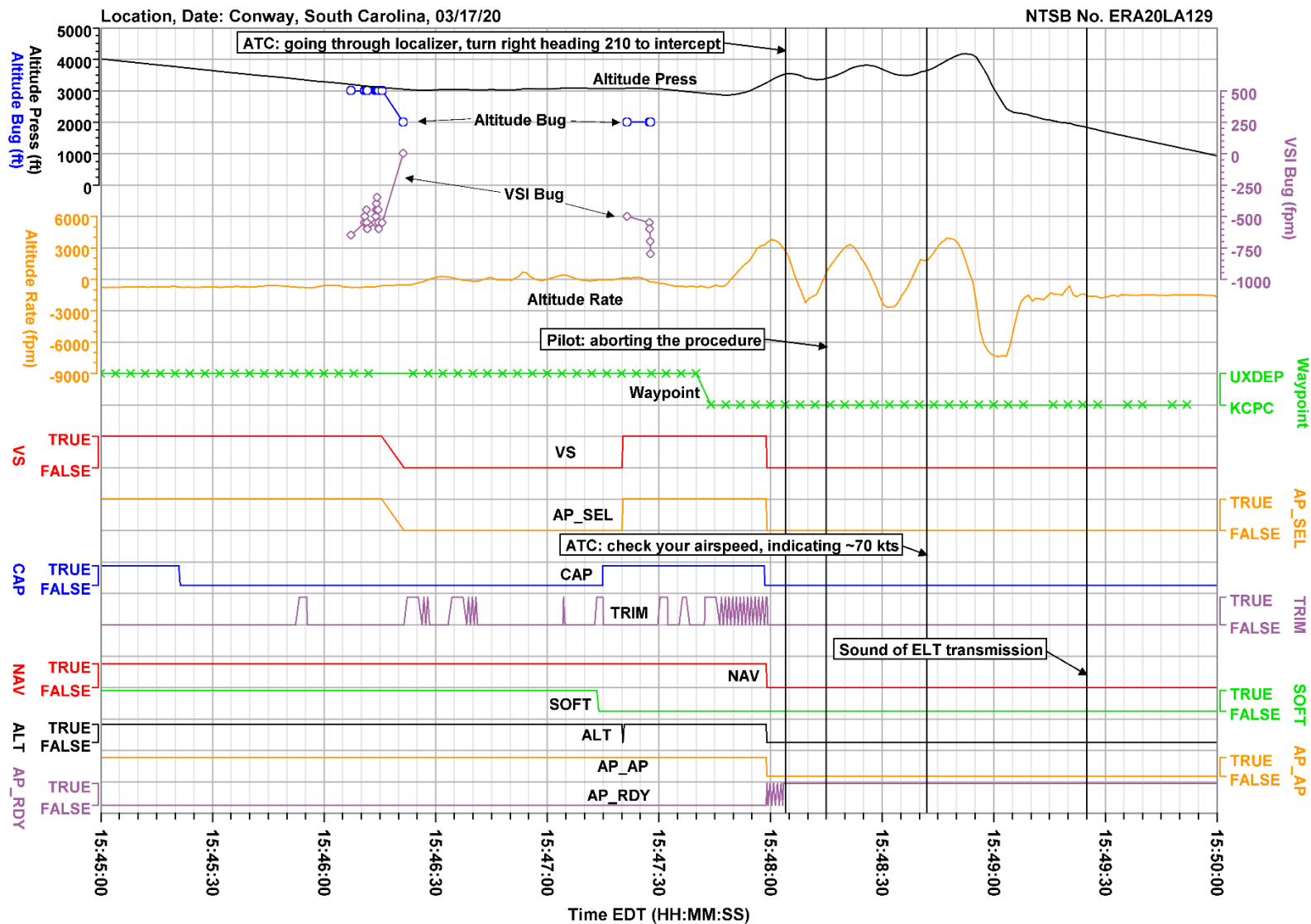
**Figure 5.** Plot of autopilot related parameters at the end of the flight.



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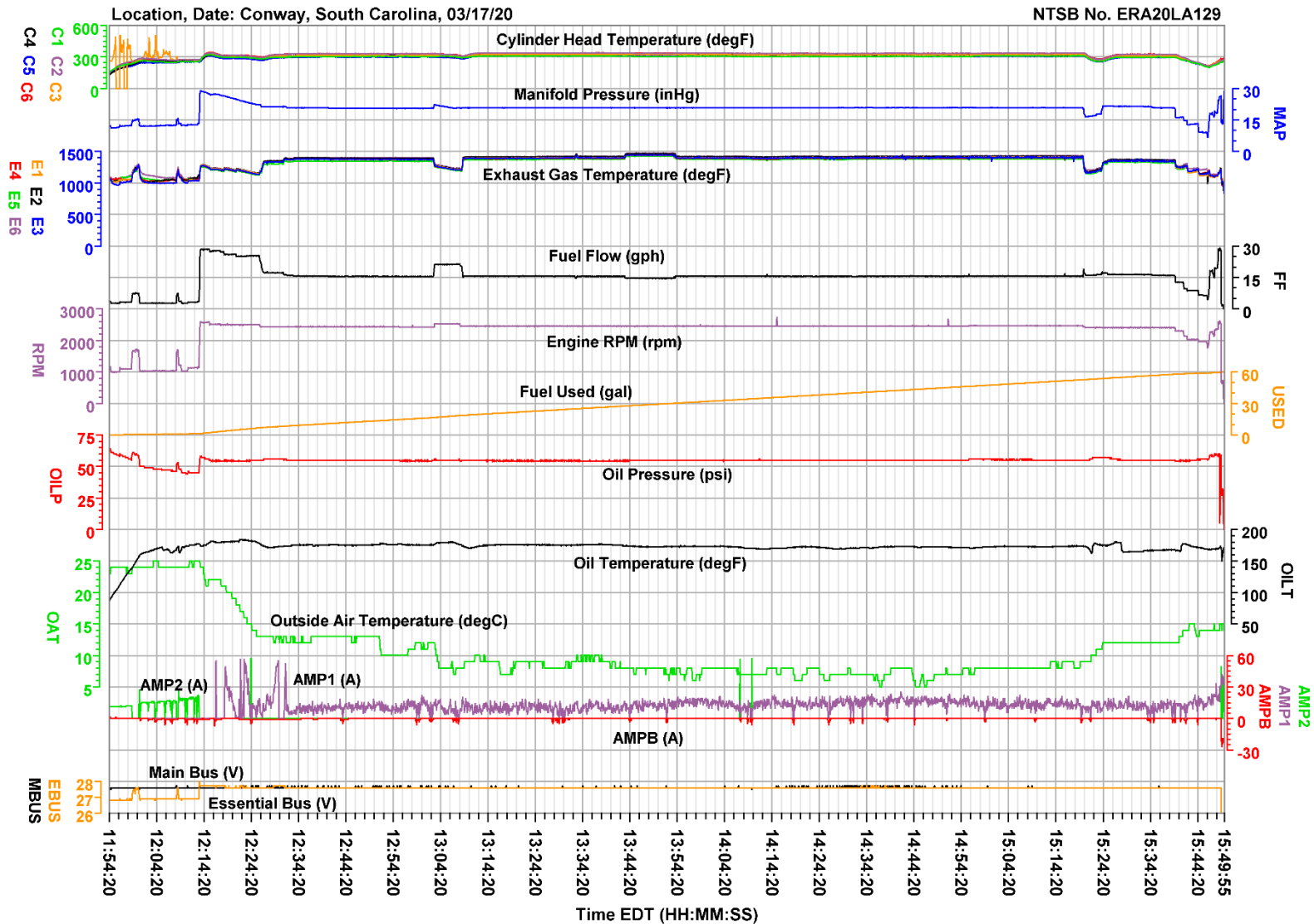
**Figure 6.** Plot of vertical profile and autopilot parameters during the descent.



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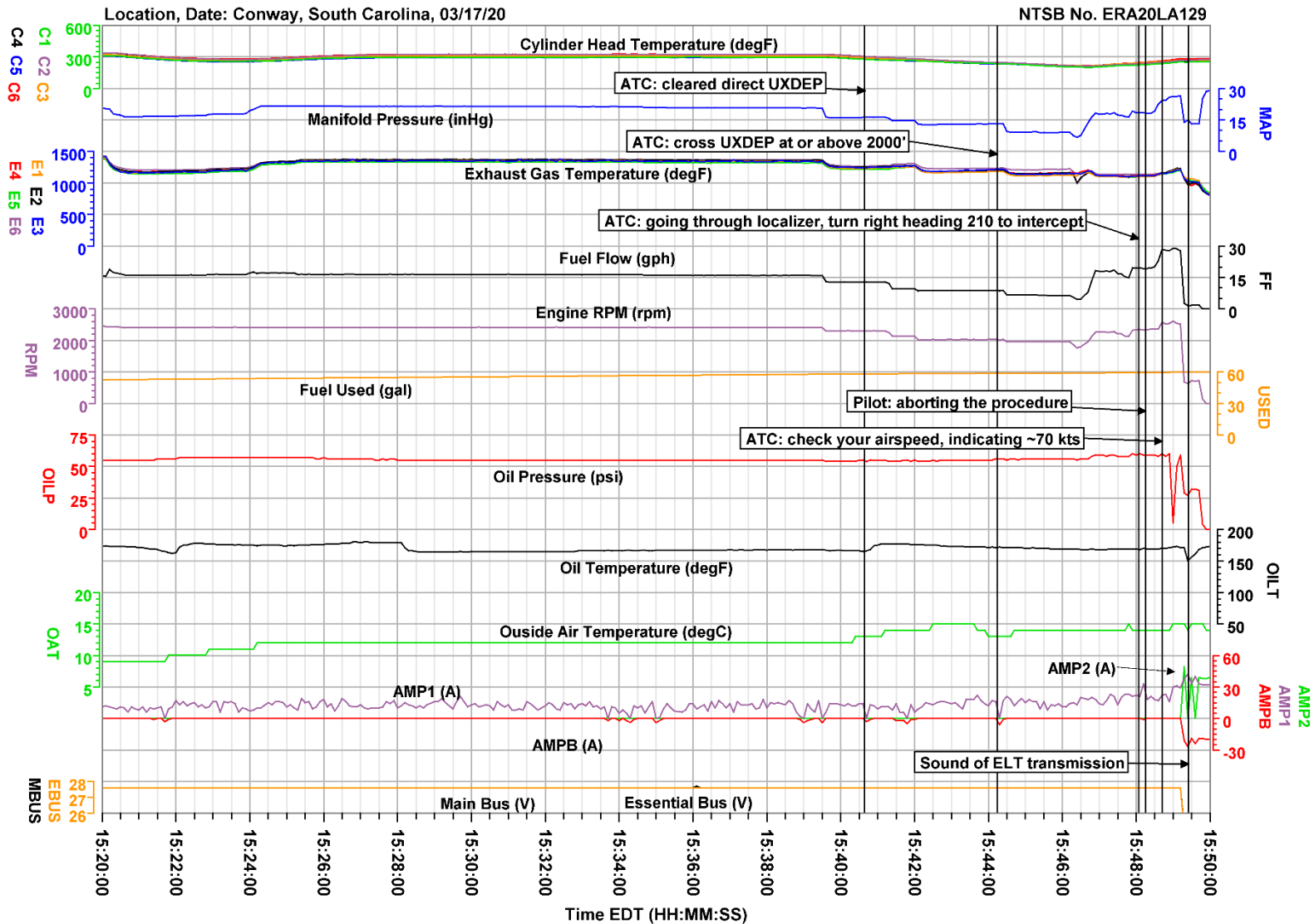
**Figure 7.** Plot of vertical profile and autopilot parameters at the end of the flight.



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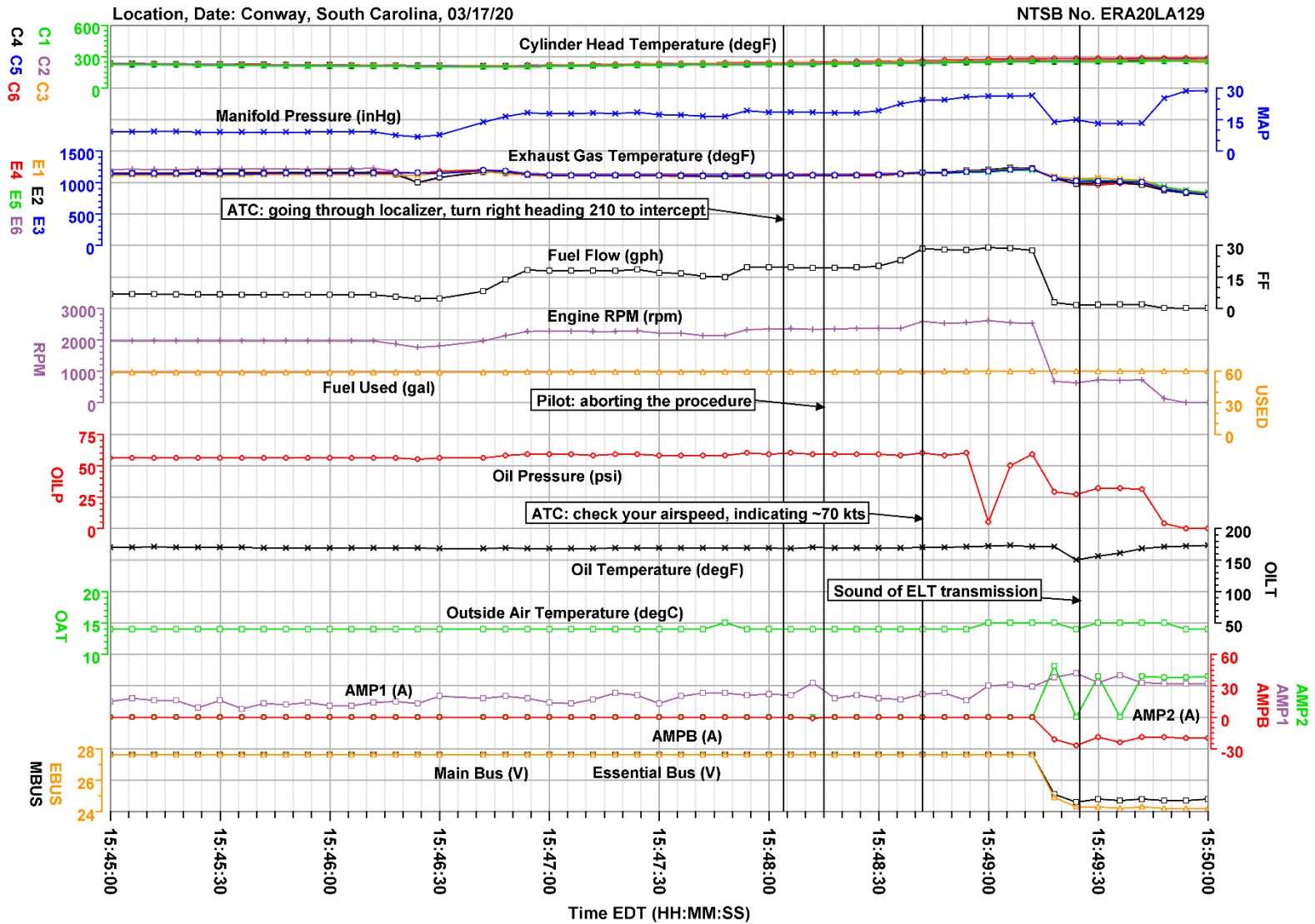
**Figure 8.** Plot of MFD recorded engine parameters for the entire flight.



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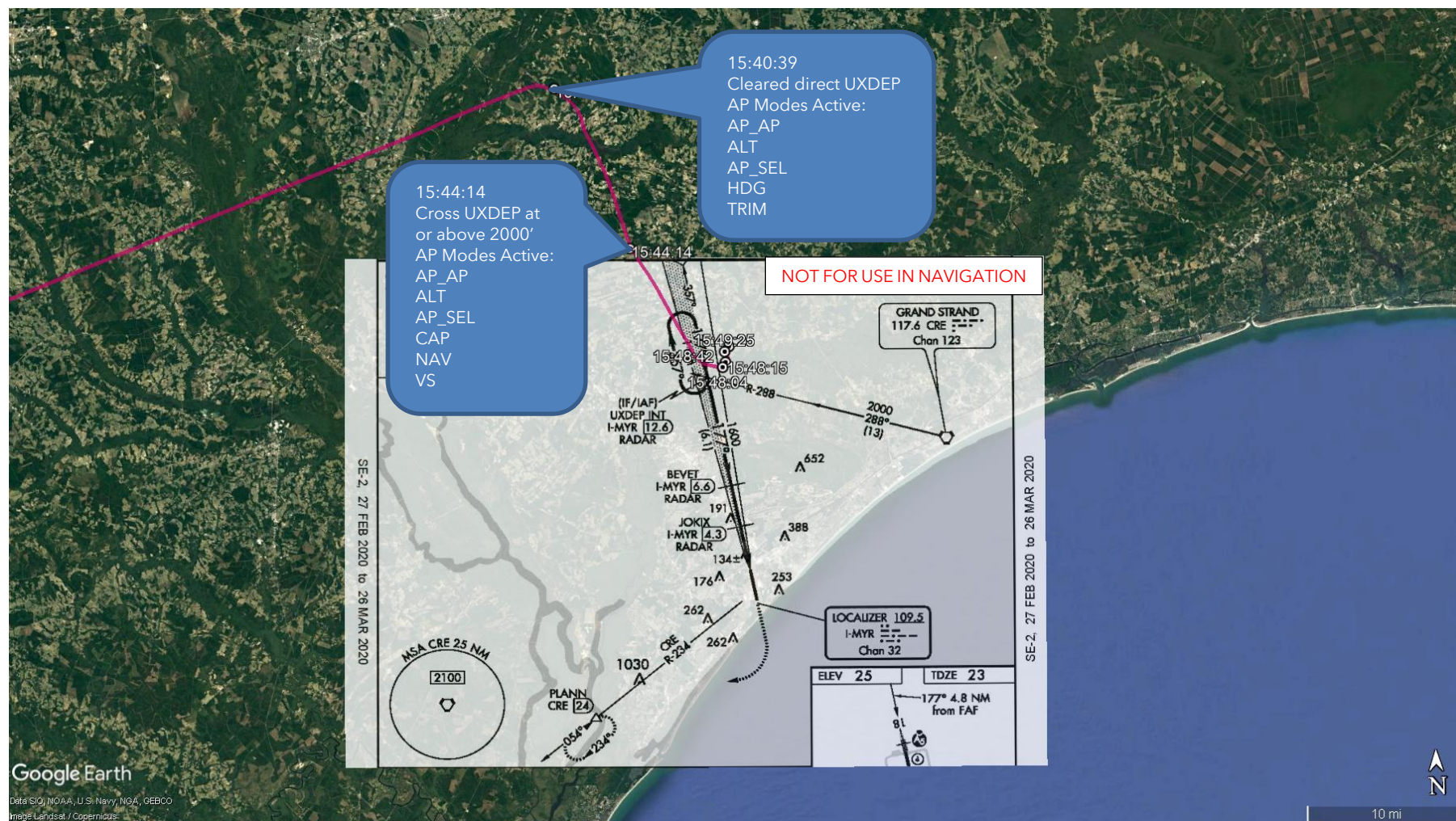
**Figure 9.** Plot of MFD recorded engine parameters during the descent.



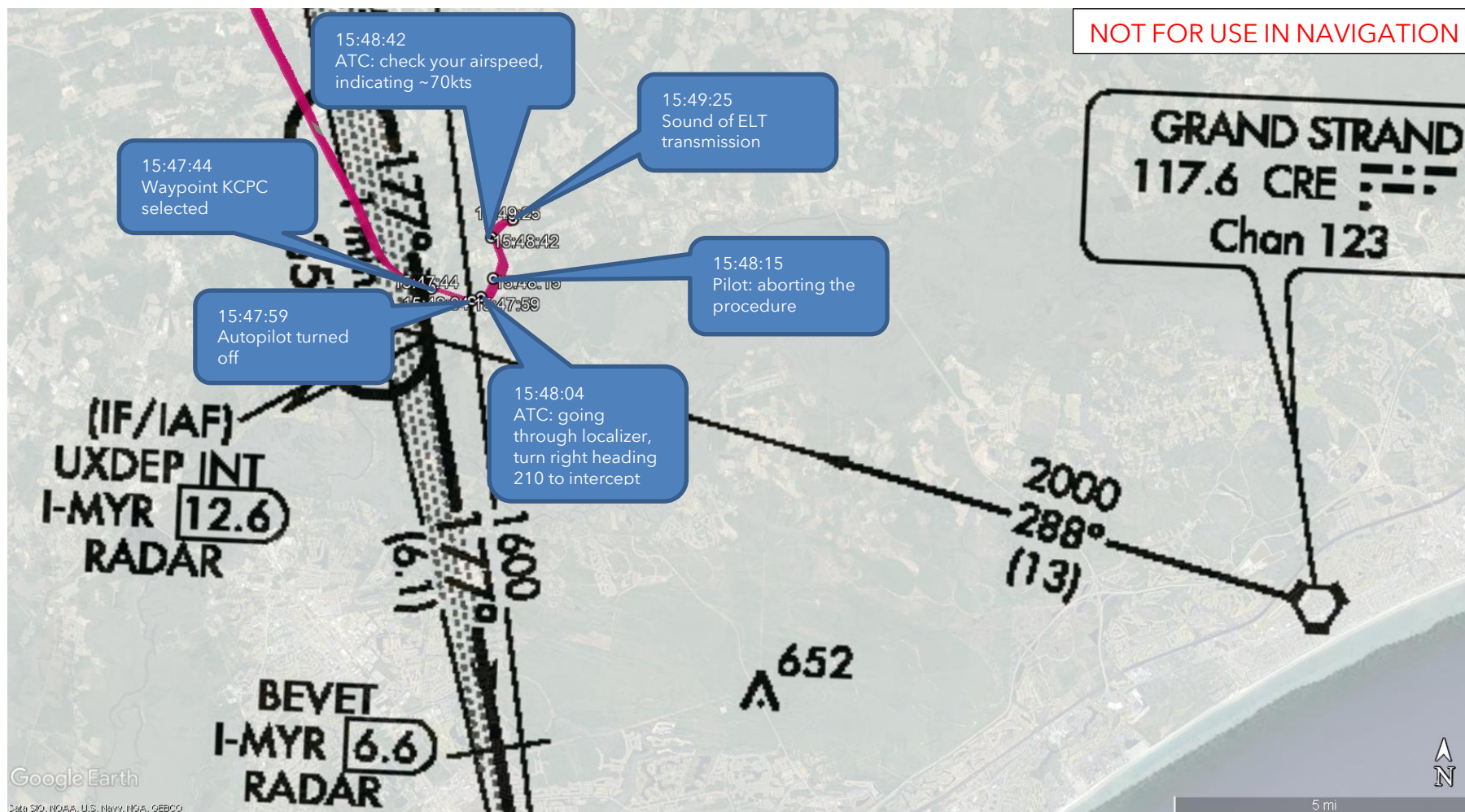
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**Figure 10.** Plot of MFD recorded engine parameters at the end of the flight.



**Figure 11.** Plot of the flight track with selected moments highlighted overlaid on the MYR runway 18 ILS approach plate.



**Figure 12.** Plot of the flight track with selected moments highlighted overlaid on the MYR runway 18 ILS approach plate at the end of the flight.



**Figure 13.** 3D image of the aircraft's track at the end of the flight.

## APPENDIX A - Parameter Descriptions and Units

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

**Table 1** - Verified and provided parameters.

| Parameter Name       | Parameter Description                                    | Source |
|----------------------|----------------------------------------------------------|--------|
| Accel Lat (g)        | Lateral Acceleration                                     | PFD    |
| Accel Long (g)       | Longitudinal Acceleration                                | PFD    |
| Accel Vert (g)       | Vertical Acceleration                                    | PFD    |
| Airspeed True (kts)  | True Airspeed                                            | PFD    |
| Altitude Bug (ft)    | Altitude Bug                                             | PFD    |
| Altitude Press (ft)  | Pressure Altitude                                        | PFD    |
| Altitude Rate (fpm)  | Altitude Rate/Vertical Speed                             | PFD    |
| ALT (discrete)       | Autopilot Altitude hold mode                             | PFD    |
| AMP1 (A)             | Bus 1 Amps (amps)                                        | MFD    |
| AMP2 (A)             | Bus 2 Amps (amps)                                        | MFD    |
| AMPB (A)             | Battery Bus Amps (amps)                                  | MFD    |
| AP_AP (discrete)     | Full Autopilot Mode                                      | PFD    |
| AP_FAIL (discrete)   | Autopilot Failure                                        | PFD    |
| AP_IGNORE (discrete) | Autopilot Ignore                                         | PFD    |
| AP_RDY (discrete)    | Autopilot Off and Ready for Use                          | PFD    |
| AP_SEL (discrete)    | Autopilot PFD Vertical Speed Control                     | PFD    |
| APR (discrete)       | Autopilot Approach Mode                                  | PFD    |
| C# (degF)            | Engine Cylinder Head Temperature Cylinder # <sup>5</sup> | MFD    |
| CAP (discrete)       | Autopilot Course Capture                                 | PFD    |
| E# (degF)            | Engine Exhaust Gas Temperature Cylinder # <sup>5</sup>   | MFD    |
| EBUS (V)             | Essential Bus Voltage                                    | MFD    |
| FD (discrete)        | Autopilot Flight Director                                | PFD    |
| FF (gph)             | Engine Fuel Flow                                         | MFD    |
| GPSS (discrete)      | Autopilot Global Positioning System Steering             | PFD    |
| GS (discrete)        | Autopilot Glideslope Mode                                | PFD    |
| HDG (discrete)       | Autopilot Heading Mode                                   | PFD    |
| Heading Mag (deg)    | Magnetic Heading                                         | PFD    |
| Latitude (deg)       | Latitude                                                 | PFD    |

<sup>5</sup> Depending on aircraft configuration, the number of cylinders that are instrumented varies. In the data plots the '#' is replaced with the appropriate cylinder ID.

| Parameter Name     | Parameter Description                           | Source |
|--------------------|-------------------------------------------------|--------|
| Longitude (deg)    | Longitude                                       | PFD    |
| MAP (inHg)         | Engine Manifold Pressure                        | MFD    |
| MBUS (V)           | Main Bus Voltage                                | MFD    |
| NAV (discrete)     | Autopilot Nav Mode armed/active                 | PFD    |
| OAT (degC)         | Outside Air Temperature                         | MFD    |
| OILP (psi)         | Engine Oil Pressure                             | MFD    |
| OILT (degF)        | Engine Oil Temperature                          | MFD    |
| Roll (deg)         | Roll                                            | PFD    |
| RPM (rpm)          | Engine Revolutions Per Minute                   | MFD    |
| SOFT (discrete)    | Auto Pilot Soft Mode                            | 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    |
| TRIM (discrete)    | Auto Pilot Trim Annunciation (Manual/Automatic) | PFD    |
| USED               | Engine Fuel Used                                | MFD    |
| VS (discrete)      | Auto Pilot Vertical Speed Mode (discrete)       | PFD    |
| VSI Bug (fpm)      | VSI Bug                                         | PFD    |
| Waypoint           | Active Waypoint                                 | PFD    |

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.

| Units Abbreviation | Description            |
|--------------------|------------------------|
| %                  | percent                |
| rpm                | revolutions per minute |
| A                  | Amperes                |
| deg                | degrees                |
| degC               | degrees Celsius        |
| degF               | degrees Fahrenheit     |
| discrete           | discrete               |
| fpm                | feet per minute        |
| ft                 | feet                   |
| gal                | gallons                |
| gph                | gallons per hour       |
| hrs                | hours                  |
| in                 | inches                 |
| inHg               | inches of Mercury      |
| kts                | knots                  |

| <b>Units Abbreviation</b> | <b>Description</b>     |
|---------------------------|------------------------|
| psi                       | pounds per square inch |
| sec                       | seconds                |
| V                         | Volts DC               |

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.