

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

February 26, 2021

Cockpit Display – Recorded Flight Data

Specialist's Factual Report
By W. Deven Chen

1. EVENT SUMMARY

Location: Beverly, Massachusetts
Date: March 12, 2020
Aircraft: Piper PA28-181
Registration: N656ST
Operator: Private
NTSB Number: ERA20LA126

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF INVESTIGATION

On November 12, 2020, the National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following cockpit display:

Device Manufacturer/Model: **Avidyne PFD**
Serial Number: **20030127**

An electronic comma-delimited (.csv) file from the **Avidyne MFD** equipped in the accident aircraft was received electronically from the investigator-in-charge (IIC) on February 8, 2021.

3.1. Avidyne Primary Flight Display (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 1/6 Hz, and information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.

3.1.1. Avidyne PFD Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the device sustained minor impact damage, as shown in Figure 1. The device powered on normally. Its flight data recording log file was downloaded and converted to engineering units.



Figure 1: Avidyne PFD as received.

3.1.2. Avidyne PFD Data Description

The downloaded data contained 16 sessions, ranging from March 1, 2020 to March 12, 2020. One flight log was identified as the recording during the accident flight. The flight log was approximately 49 minutes and 12 seconds, recorded from 15:31:30 to 16:20:42 eastern daylight time (EDT) on March 12, 2020. The data were recorded at various sampling rates, ranging from 1/6 – 5 Hz. The PFD recorded in Universal Coordinated Time (UTC). The difference between EDT and UTC is 4 hours. All times are converted to EDT for the rest of this report.

3.1.2.1. Avidyne PFD Parameters Provided

Table 1 describes data parameters provided by the Avidyne PFD.

Table 1: Validated Parameters from the Avidyne PFD.

Parameter Name	Parameter Description	Sampling Rate (Hz)
Time	Time (EDT) for recorded data point (HH:MM:SS)	1/6
Latitude (deg)	GPS position latitude in degrees	1/6
Longitude (deg)	GPS position longitude in degrees	1/6
Ground Speed (knots)	Aircraft ground speed in knots	1/6
Accel Lat (g)	Latitudinal direction Acceleration in G	5
Accel Long (g)	Longitudinal direction Acceleration in G	5
Accel Vert (g)	Vertical direction Acceleration in G	5
Heading Mag (deg)	Magnetic heading in degrees	5
Roll (deg)	Roll angle in degrees	5
Pitch (deg)	Pitch angle in degrees	5
Airspeed Ind (knots)	Indicated Air Speed in knots	1
Altitude Press (ft)	Pressure Altitude in feet	1
Temp TAT (degC)	Total Air Temperature in Celsius	1

3.2. Avidyne Multi-Function Display (MFD) 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 Data File

The Avidyne MFD data file contained an engine data log of the accident flight. The data recorded in UTC and the time was converted to EDT for the rest of the report. Table 2 describes data parameters provided by the Avidyne MFD.

Table 2: Validated Parameters from the Avidyne MFD.

Parameter Name	Parameter Description	Sampling Rate (Hz)
Time	Time (EDT) for recorded data point (HH:MM:SS)	1/6
Latitude (deg)	GPS position latitude in degrees	1/6
Longitude (deg)	GPS position longitude in degrees	1/6
PALT (ft)	Pressure Altitude in feet	1/6
E1-4 (degF)	Exhaust Gas Temperature Cylinder # in degrees Fahrenheit	1/6
OILT (degF)	Oil Temperature in degrees Fahrenheit	1/6
OILP (PSI)	Oil Pressure in pounds per square inch	1/6
RPM (rpm)	Engine rotational speed in revolutions per minutes	1/6
OAT (degC)	Outside Air Temperature in degrees Celsius	1/6
FF (GPH)	Fuel Flow rate in gallons per hour	1/6
USED (gal)	Used Fuel in gallons	1/6
AMPS (A)	Electric Bus Current in Ampere	1/6
VOLTS (V)	Electric Bus Voltage in Volts	1/6
FQL (gal)	Left tank Fuel Quantity in gallons	1/6
FQR (gal)	Right tank Fuel Quantity in gallons	1/6

3.3. Plots and Corresponding Tabular Data

The following figures contain data recorded during the March 12, 2020 event.

Figure 2 is a Google Earth overlay showing the overview of the accident flight. The flight started at the Beverly Regional Airport at around 15:31:30. The accident aircraft executed an emergency landing around 16:19:12 after performing multiple takeoffs and landings at the airport. The last GPS location was recorded at 16:20:36 and the 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. Note that the altitudes of the flight path were based on the pressure altitude data, therefore, the flight path might be shown under the terrain on Google Earth at some points.

Figure 3 is a Google Earth overlay showing the overview of the final portion of the accident flight.

Figure 4 is a Google Earth overlay showing the emergency landing portion of the accident flight.

Figure 5 is a plot of the recorded data parameters from the Avidyne PFD of the accident flight. The time interval shown is 15:30:00 to 16:25:00 EDT.

Figure 6 is a plot of the recorded data parameters from the Avidyne PFD of the final portion of the accident flight. The time interval shown is 16:16:30 to 16:21:00 EDT.

Figure 7 is a plot of the recorded data parameters from the Avidyne MFD of the accident flight. The time interval shown is 15:30:00 to 16:25:00 EDT.

Figure 8 is a plot of the recorded data parameters from the Avidyne MFD of the final portion of the accident flight. The time interval shown is 16:16:30 to 16:21:00 EDT.

The corresponding tabular data used to create figures 2-6 were from the Avidyne PFD and are provided in electronic comma-delimited (.csv) format as Attachment 1 to this report. Figures 7-8 were created using tabular data from the Avidyne MFD. The data from the Avidyne MFD are provided in electronic comma-delimited (.csv) format as Attachment 2 to this report. The attachments contain additional parameters that were recorded during the accident flight. Not every additional parameter has been validated by the specialist.



Figure 2: Google Earth overlay showing the overview of the entire flight.

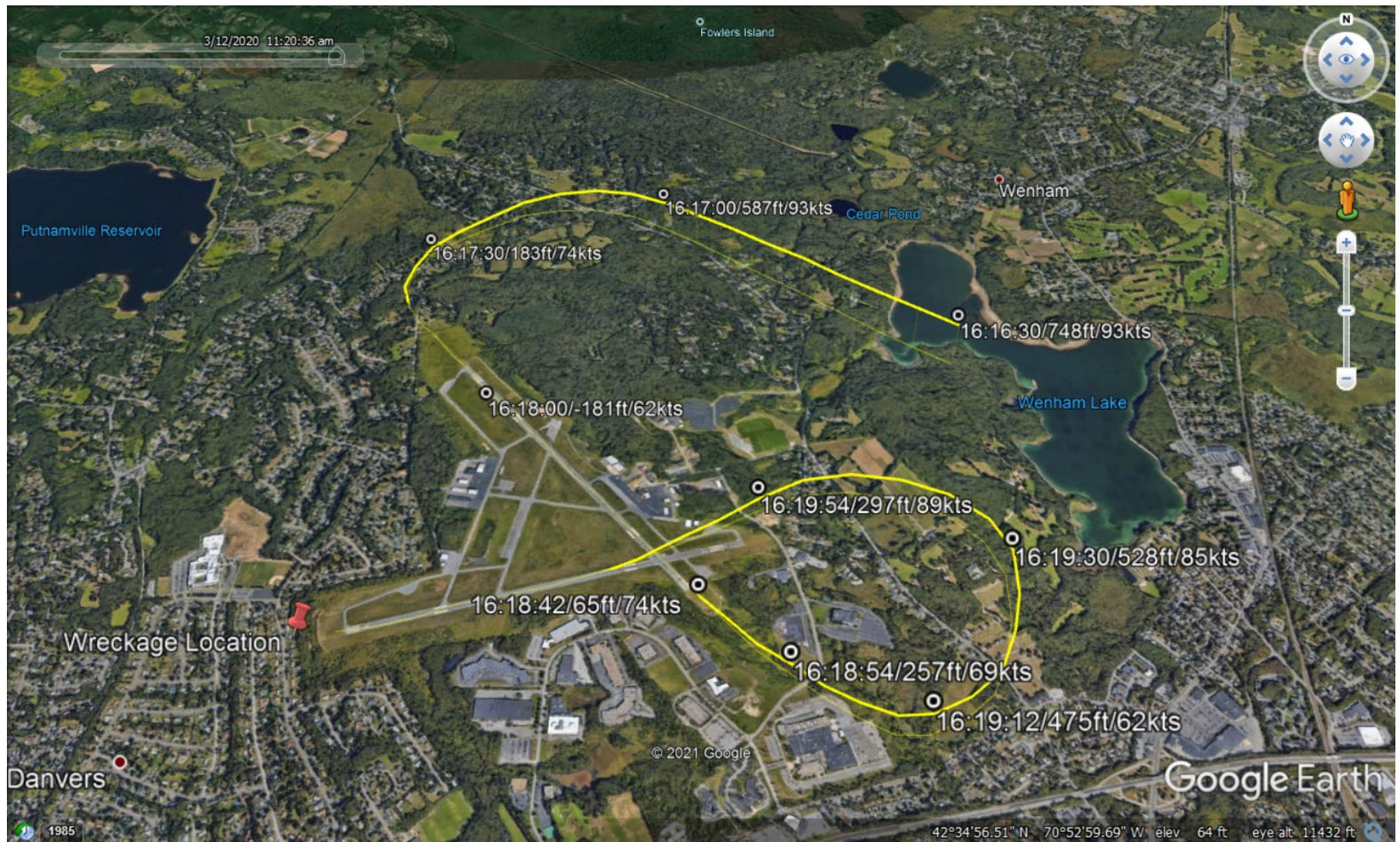


Figure 3: Google Earth overlay showing the overview of the final portion of the accident flight.

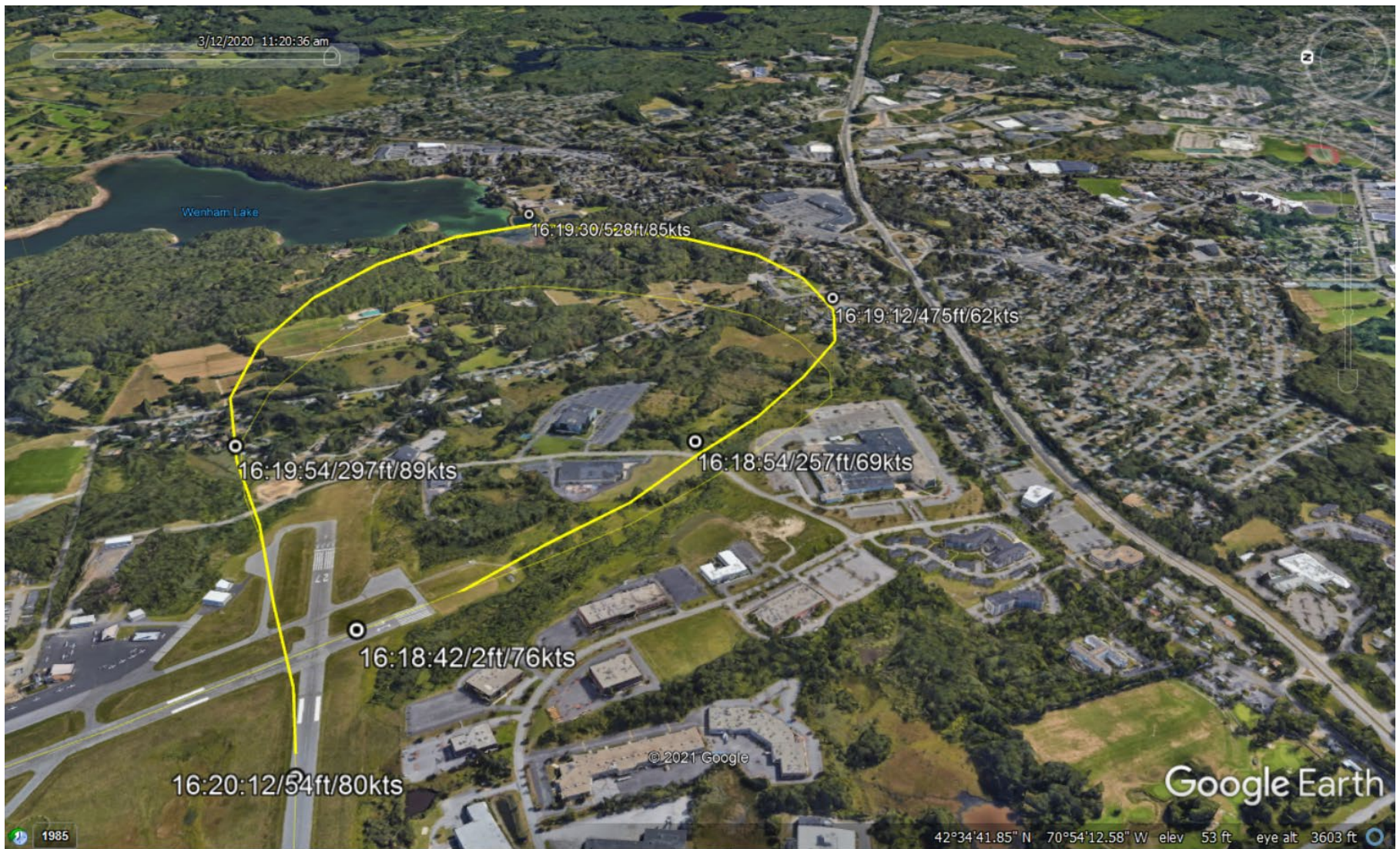


Figure 4: Google Earth overlay showing the portion of the aircraft's emergency landing.

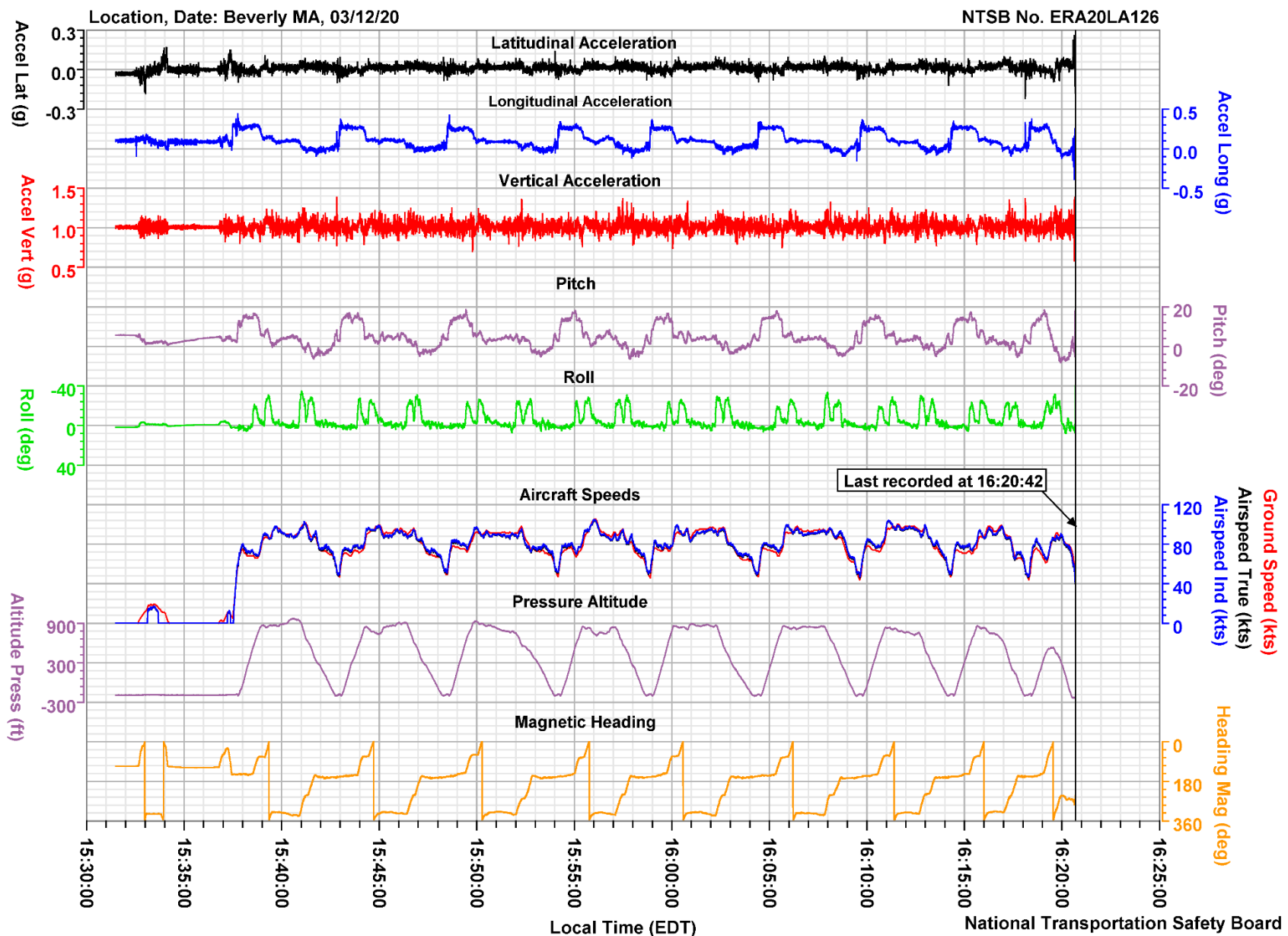


Figure 5: Plot of data parameters from Avidyne PFD of the entire accident flight.

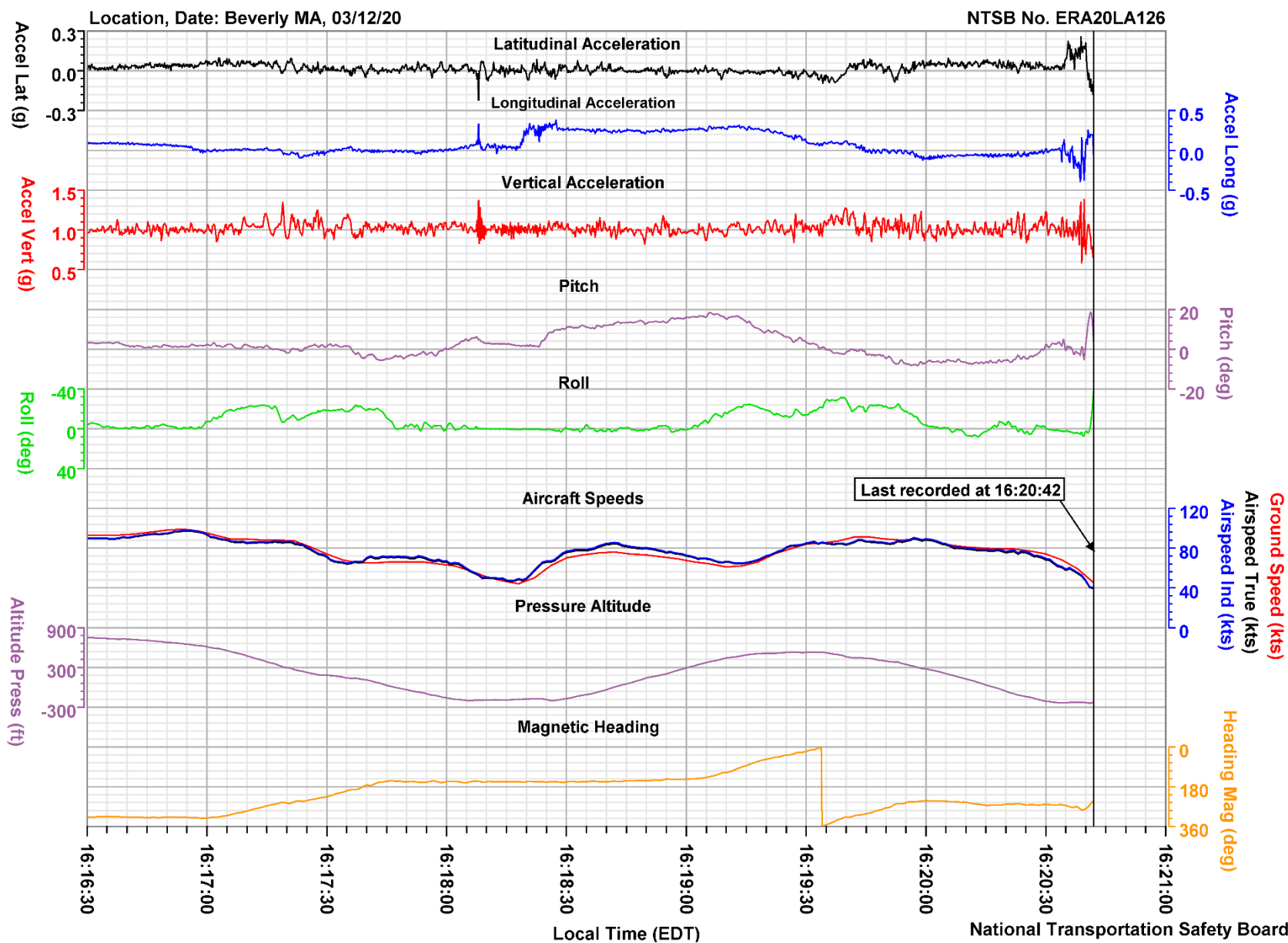


Figure 6: Plot of the data parameters from Avidyne PFD of the final portion of the accident flight.

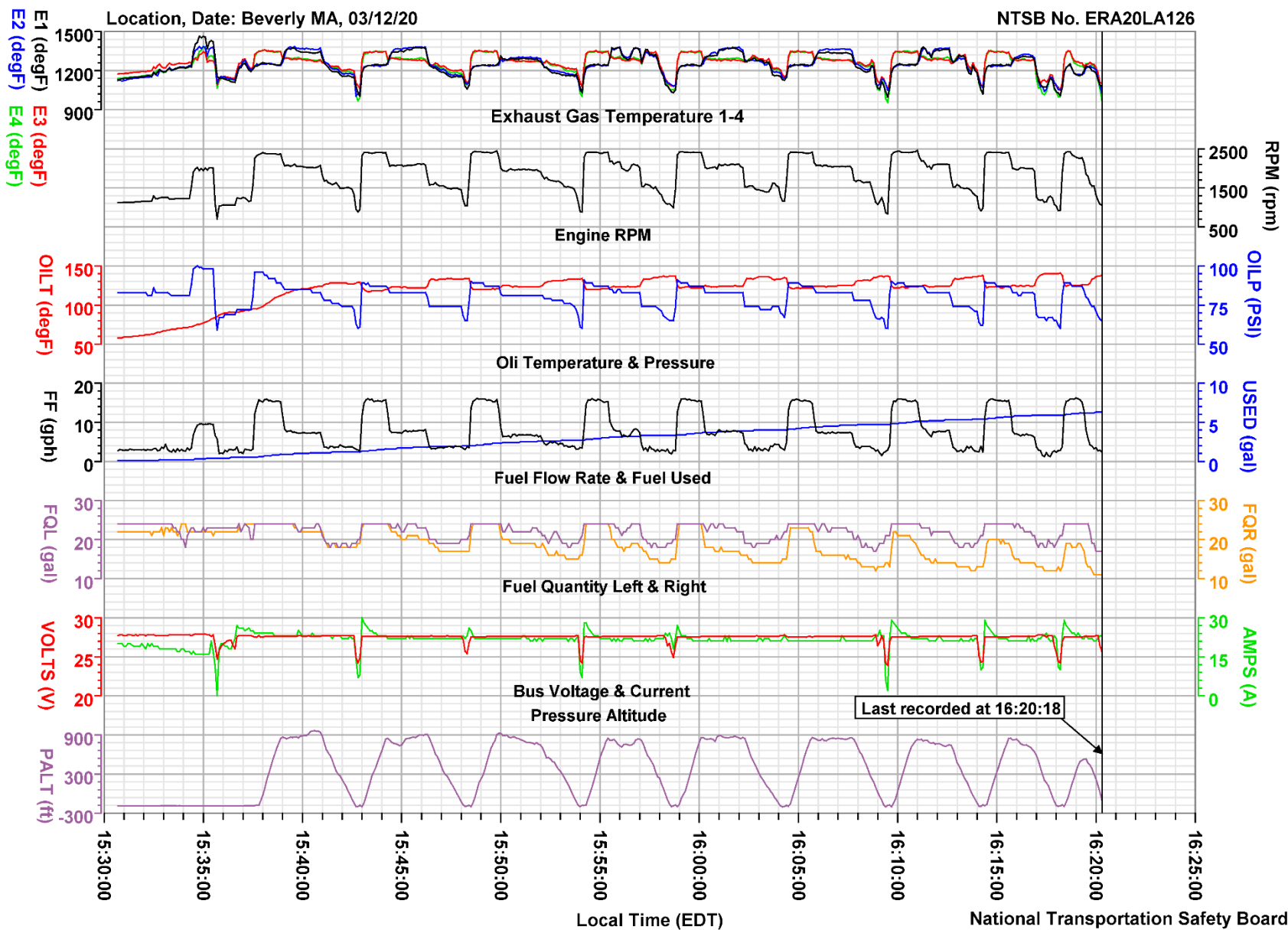


Figure 7: Plot of data parameters from Avidyne MFD of the entire accident flight.

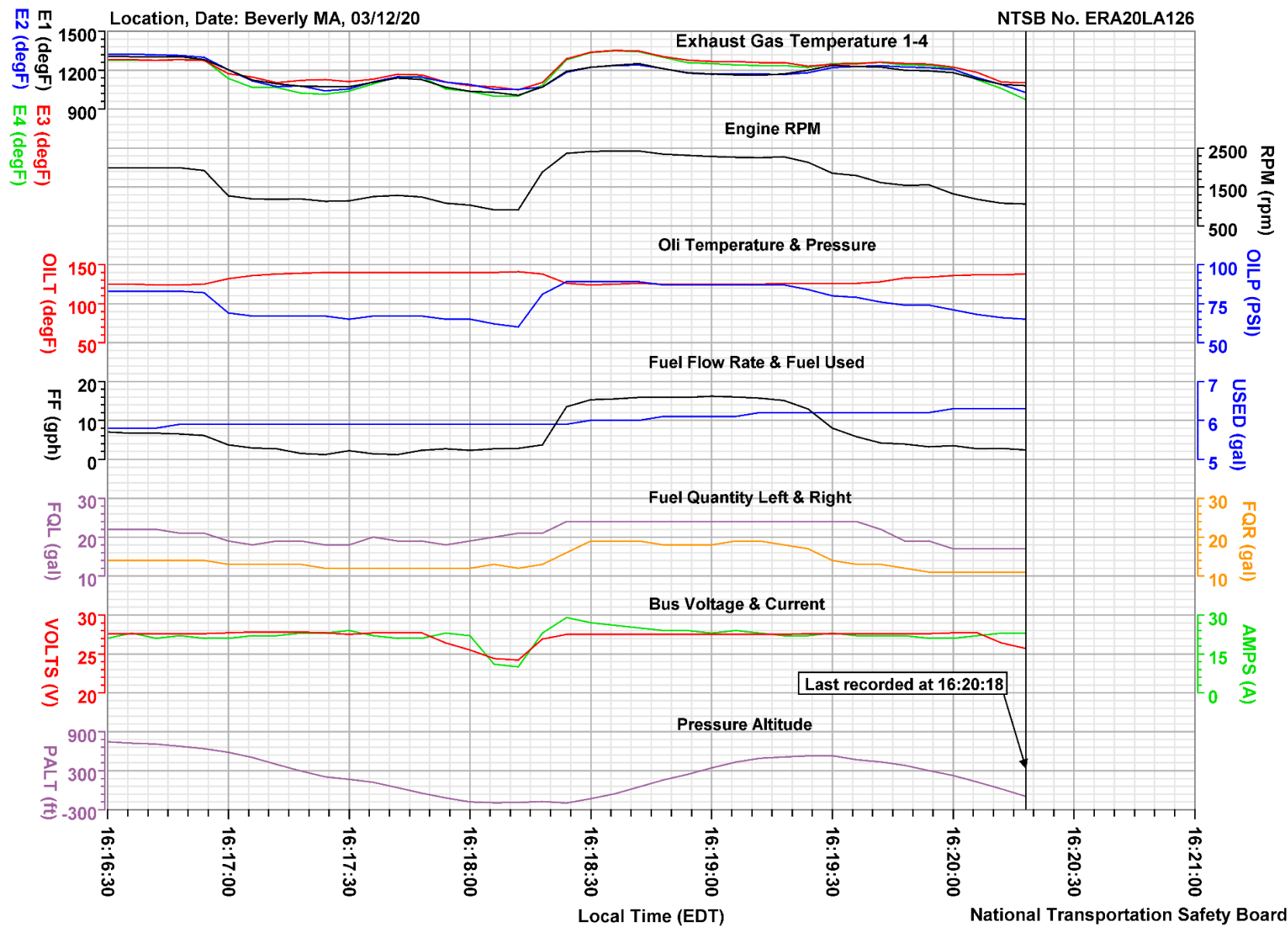


Figure 8: Plot of the data parameters from Avidyne MFD of the final portion of the accident flight.