

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

November 2, 2020

Cockpit Displays – Recorded Flight Data

Specialist's Factual Report
By Michael Portman

1. EVENT SUMMARY

Location: Kenansville, North Carolina
Date: January 2, 2020
Aircraft: Cirrus SR22
Registration: N323SR
Operator: Cornerstone Aviation LLC
NTSB Number: ERA20LA064

On January 2, 2020, about 1015 eastern standard time, a Cirrus Design Corp. SR22, N323SR, was substantially damaged when it impacted trees and terrain after the Cirrus Airframe Parachute System (CAPS) was activated near Kenansville, North Carolina. The commercial pilot and passenger were not injured. The airplane was registered to Cornerstone Aviation LLC. and operated by the commercial pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Day visual meteorological conditions prevailed, and a visual flight rules flight plan was filed. The flight originated from Worcester Regional Airport (ORH), Worcester, Massachusetts at 0645 and was destined for Curtis L Brown Jr. Field Airport (EYF), Elizabethtown, North Carolina.

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 the following electronic devices:

Recorder Manufacturer/Model: **Avidyne PFD**
Recorder Serial Number: **22422026**

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

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 consists 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 in good condition, as seen in Figure 1 and the data were downloaded using the manufacturers' procedure.



Figure 1. Avidyne PFD as Received.

3.1.2. PFD Data Description

The PFD recording contained records of 35 power cycles and approximately 17 hours and 34 minutes of data. The accident flight was associated with the 35th power cycle.¹ The

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

duration of the 35th 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 raw data to engineering units was performed using documentation provided 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=+).²

Appendix A lists the PFD parameters verified and provided in this report.

3.2. Avidyne Multi-Function Display (MFD) Description

The Avidyne 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.

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. MFD Card Data Recovery

Only the recovered MFD CF (compact flash) card was sent to the Vehicle Recorder laboratory. The card was in good condition, as seen in Figure 2, and the data were downloaded using the manufacturers' procedure.

² 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 = +.



Figure 2. Avidyne MFD CF Card as Received.

3.2.2. MFD Data Description

The MFD CF card contained 308 data files. One data file was identified as recording during the incident flight. The data file was approximately 3 hours and 50 minutes in duration.

3.2.3. MFD Engineering Units Conversions

The data files downloaded from the MFD were 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 EST was established using the recorded GPS time parameter from the PFD data. Recorded GPS time was updated in 6 second intervals on the PFD.³ The GPS time is recorded in Universal Coordinated Time (UTC). The difference between EST and UTC is 5 hours, or 18,000 seconds. The PFD starts recording when power is applied to the unit.

Additionally, MFD data was recorded in Universal Coordinated Time (UTC). The incident flight data has been offset from recorded MFD time to EST by subtracting 18,000 seconds. Therefore, for the rest of this report, all times are referenced as EST, not recorded 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

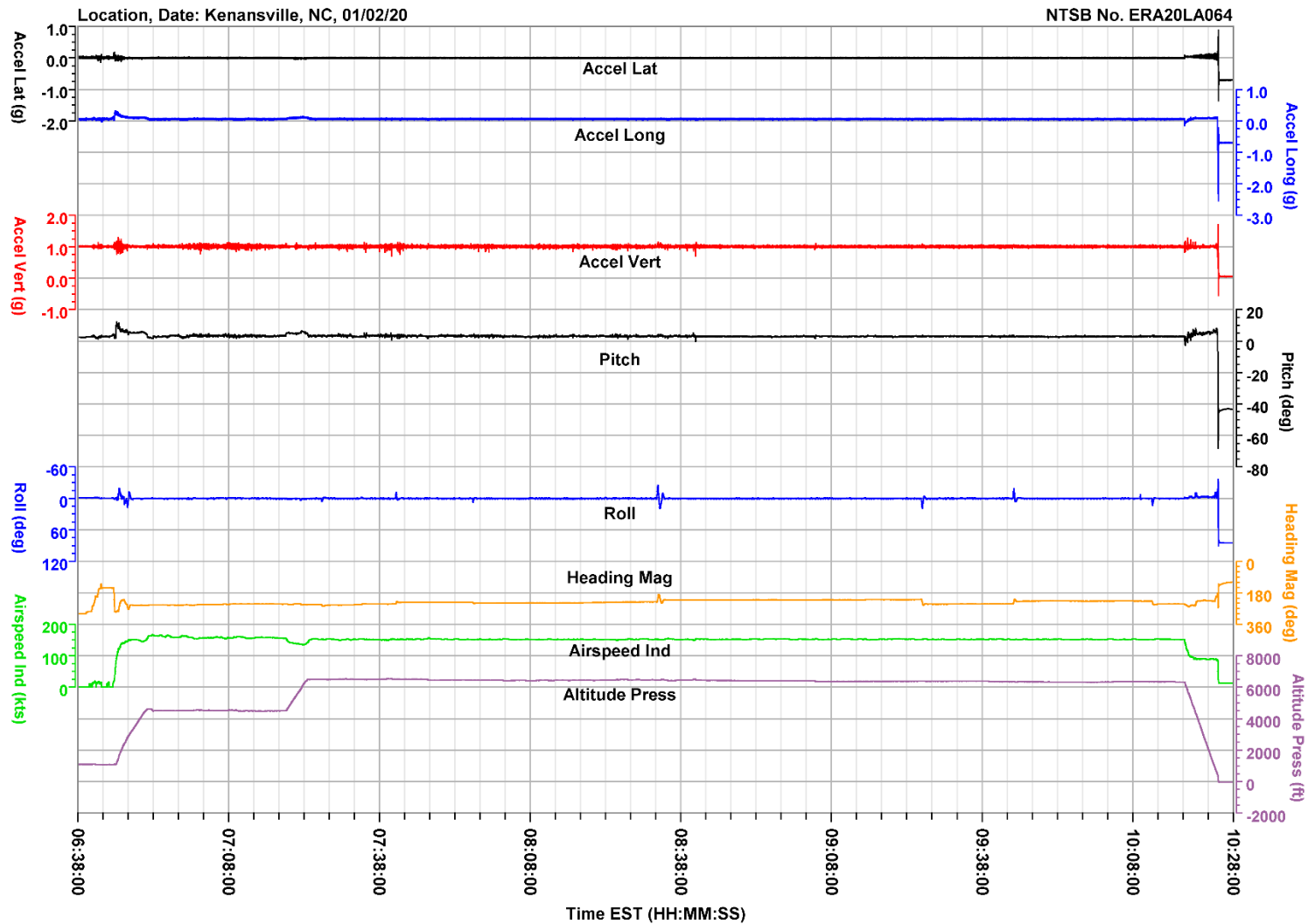
The following six plots contain data recorded during the January 2, 2020 event. The first two plots contain data obtained from the PFD, and the remaining four plots contain data obtained from the MFD.

Figure 3 is a plot of PFD data for the entire accident flight. Figure 4 is a plot of the same PFD data for the final approximately 10 minutes of the accident flight. Figure 5 is a plot of MFD engine related parameters, and Figure 6 shows MFD electrical related parameters, each for the entire accident flight. Figure 7 shows MFD engine related parameters for the

³ 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.

final approximately 12 minutes of the accident flight, and Figure 8 shows MFD electrical parameters for the final approximately 45 minutes of the accident flight.

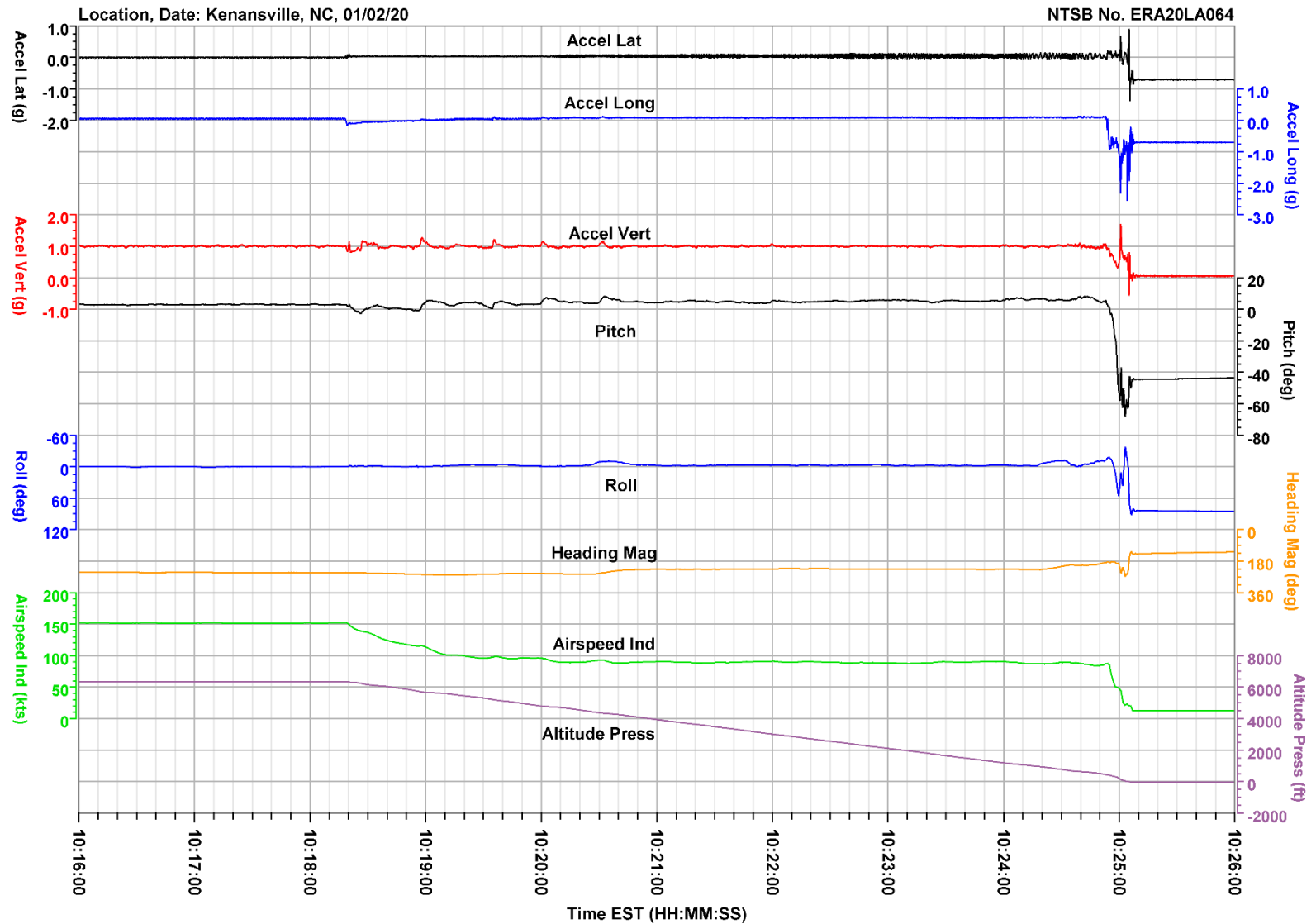
The corresponding tabular data used to generate figures 3 and 4 are included as Attachment 1, and the recorded data used to generate figures 5 through 8 are included as Attachment 2 to this report. These attachments are provided in electronic comma-delimited (.csv) format.



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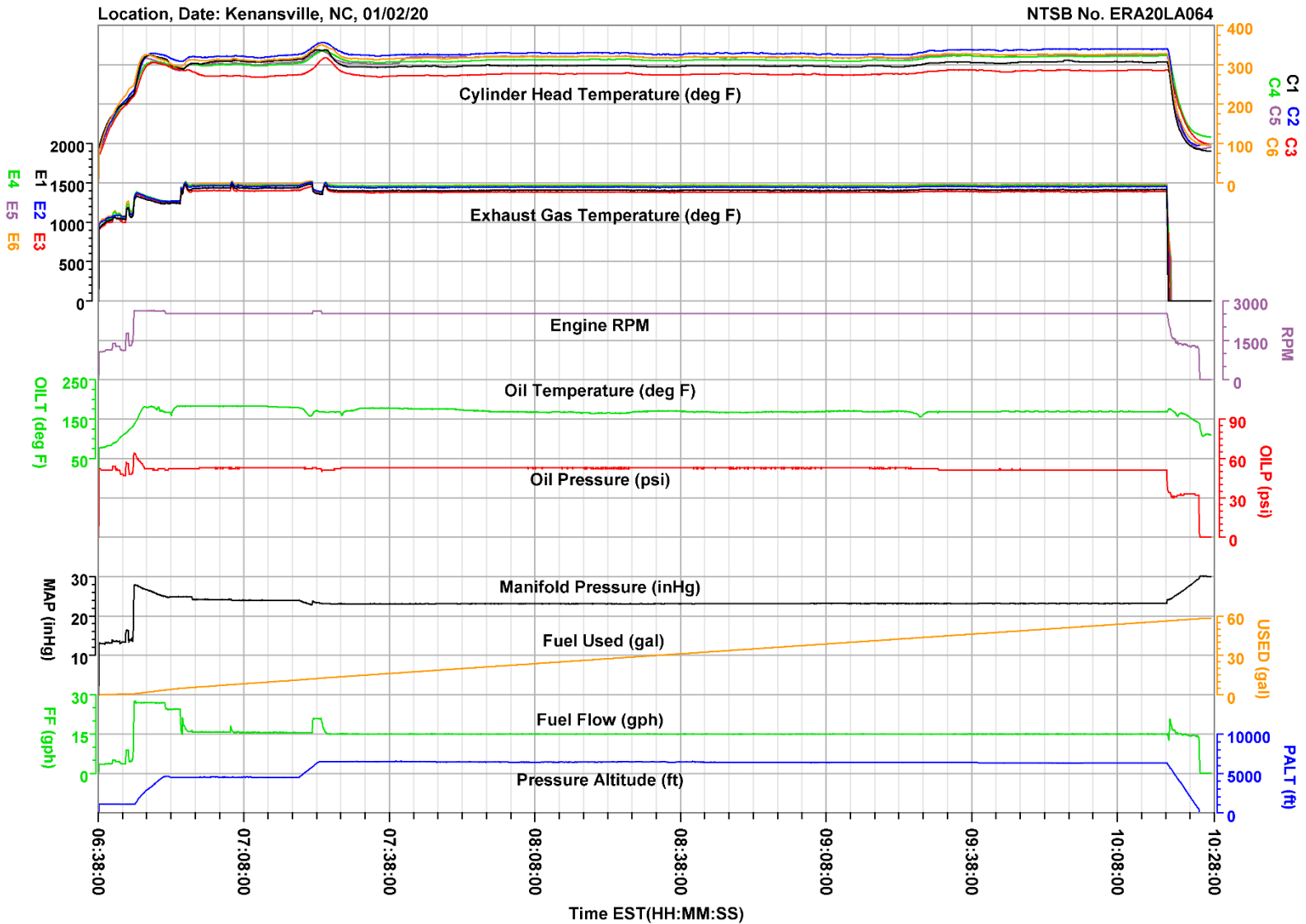
Figure 3. Plot of PFD Parameters for the Entire Flight.



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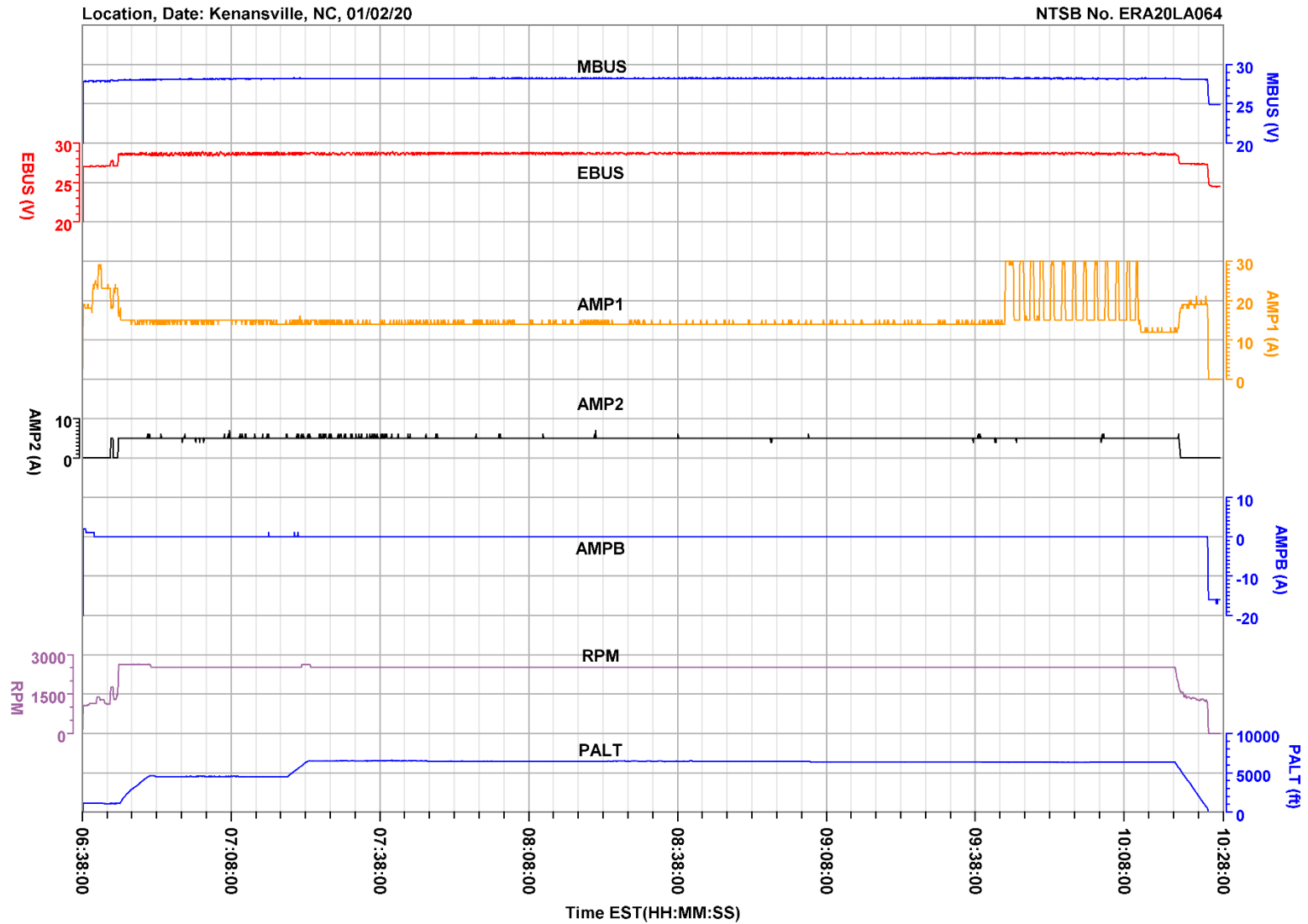
Figure 4. Plot of PFD Parameters for the Final 10 Minutes of the Flight.



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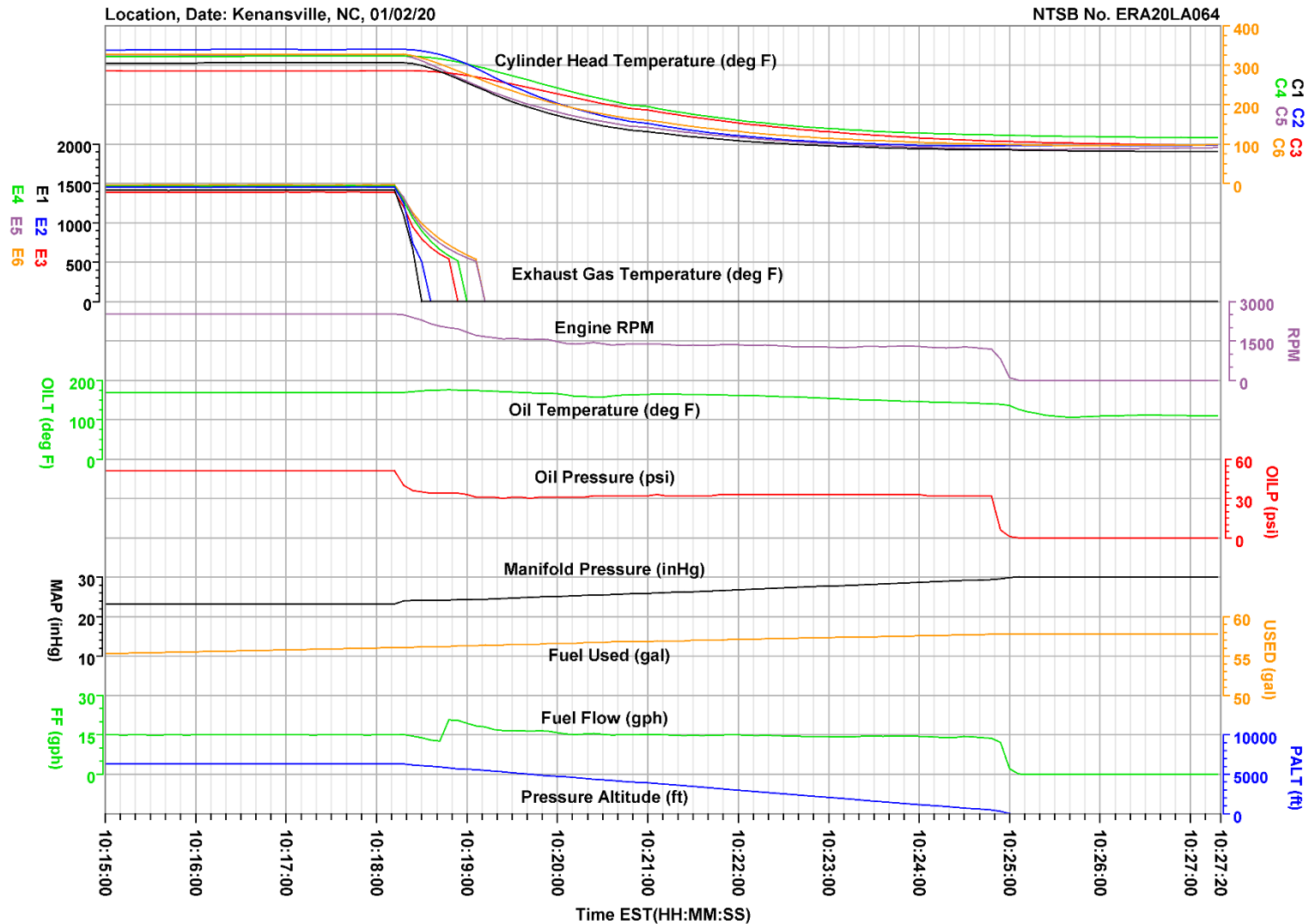
Figure 5. Plot of MFD Engine Parameters for the Entire Flight.



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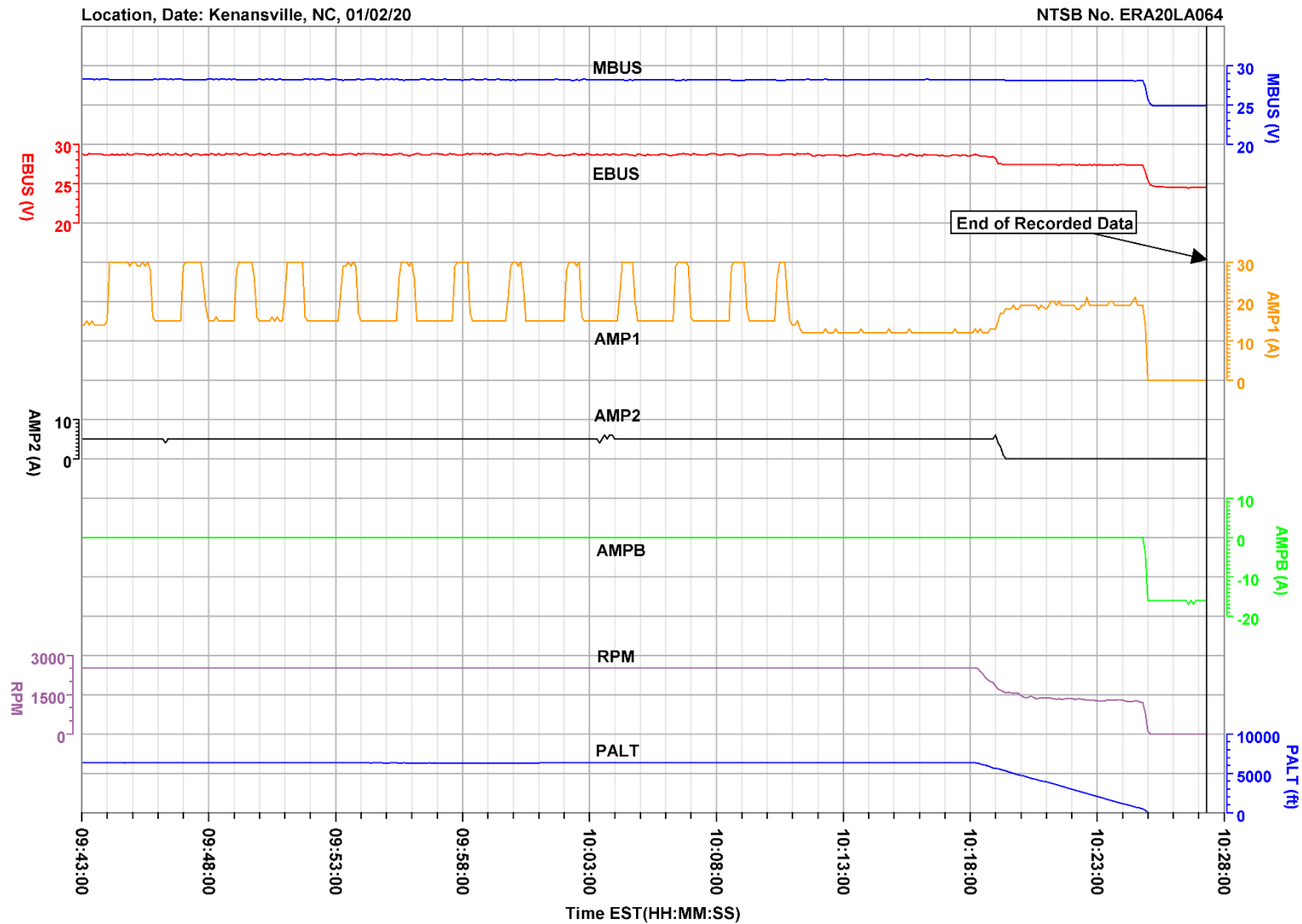
Figure 6. Plot of MFD Electrical Parameters for the Entire Flight.



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Figure 7. Plot of MFD Engine Parameters for the Final Approximately 12 Minutes of the Flight.



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Figure 8. Plot of MFD Electrical Parameters for the Final Approximately 45 Minutes of the Flight.

Appendix A - Parameters

This appendix describes the parameters provided and verified in this report. Table A-1 lists the PFD and MFD parameters as well as acronym definitions used in this report.

Table A-1 - Verified and provided parameters.

Parameter Name	Parameter Description	Source
Accel Lat (g)	Lateral Acceleration (g)	PFD
Accel Long (g)	Longitudinal Acceleration (g)	PFD
Accel Vert (g)	Vertical Acceleration (g)	PFD
Airspeed Ind (kts)	Indicated Airspeed (knots)	PFD
Altitude Press/PALT (ft)	Pressure Altitude (feet)	PFD/MFD
AMP1 (A)	Bus 1 Amps (amps)	MFD
AMP2 (A)	Bus 2 Amps (amps)	MFD
AMPB (A)	Battery Bus Amps (amps)	MFD
C# (degF)	Engine Cylinder Head Temperature Cylinder # (degrees Fahrenheit)	MFD
E# (degF)	Engine Exhaust Gas Temperature Cylinder # ⁴ (degrees Fahrenheit)	MFD
EBUS (V)	Essential Bus Voltage (Volts)	MFD
FF (gph)	Engine Fuel Flow (gallons per hour)	MFD
Heading Mag (deg)	Magnetic Heading (degrees)	PFD
Latitude (deg)	Latitude (degrees)	MFD
Longitude (deg)	Longitude (degrees)	MFD
MAP (inHg)	Engine Manifold Pressure (inches of mercury)	MFD
MBUS (V)	Main Bus Voltage (Volts)	MFD
OILP (psi)	Engine Oil Pressure (pounds per square inch)	MFD
OILT (degF)	Engine Oil Temperature (degrees Fahrenheit)	MFD
Pitch (deg)	Pitch (degrees)	PFD
Roll (deg)	Roll (degrees)	PFD
RPM (rpm)	Engine Revolutions Per Minute (revolutions per minute)	MFD
Time - Day (day)	Time - Day	PFD
Time - Month (month)	Time - Month	PFD

⁴ 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
Time – UTC Hrs (hrs)	Coordinated Universal Time (UTC) - Hours (Hours)	PFD
Time – UTC Min (min)	Coordinated Universal Time (UTC) - Minutes (Minutes)	PFD
Time – UTC Sec (sec)	Coordinated Universal Time (UTC) - Seconds (Seconds)	PFD
Time - Year (year)	Time - Year	PFD
USED (gal)	Engine Fuel Used (gallons)	MFD

The displays onboard this aircraft record 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.