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

October 8, 2021

Electronic Devices

Specialist's Factual Report
By Gerald Kawamoto

1. EVENT SUMMARY

Location:	Port Aransas, Texas
Date:	April 24, 2021
Aircraft:	Cirrus SR22
Registration:	N587CD
Operator:	Private
NTSB Number:	CEN21FA199

2. GROUP

A 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:	**Apple iPhone XR**
IMEI:	**35643110036849**
Recorder Manufacturer/Model:	**Avidyne PFD**
Recorder Serial Number:	**20105456**
Recorder Manufacturer/Model:	**Avidyne MFD Compact Flash Card**
Recorder Serial Number:	**N/A**

3.1. Apple iPhone XR

Personal Electronic Devices (PEDs) are a category of devices comprised primarily of portable computing devices and mobile phones. Portable computing devices are typically capable of internet access, email, messaging services, and can run user-installed applications to perform specific tasks. PED user and system data is typically stored on non-volatile memory and can be accessed through manufacturer-provided interfaces.[1]

The content of the device was examined, and it was determined there was no relevant accident-related data.

[1] Non-volatile memory is semiconductor memory that does not require external power for data retention.

3.2. 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 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.

3.2.1. PFD Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an external examination revealed the device had sustained impact damage, as shown in Figure 1, rendering it inoperable. An internal examination revealed the two non-volatile memory chips were undamaged. The chips were removed, read out, and converted to engineering units using laboratory tools.

Figure 1. Avidyne PFD as received.

3.2.2. PFD Data Description

The PFD recording contained records of 68 power cycles. The accident flight was associated with the final session and was approximately 14 minutes in duration. Timing of the PFD data is measured in seconds from power-on.

Conversion of the PFD data from the raw recorded information to engineering units is performed using conversions developed by the NTSB.

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]

Table 1 describes PFD parameters.

Table 1. Avidyne PFD Data Parameters

Parameter Name	Parameter Description
Time	Time (UTC) for recorded data point (HH:MM:SS)
Accel Lat (g)	Lateral Acceleration (g)
Accel Long (g)	Longitudinal Acceleration (g)
Accel Vert (g)	Vertical Acceleration (g)
Airspeed Ind (kts)	Indicated Airspeed (knots)
Airspeed True (kts)	True Airspeed (knots)
Ground Speed (kts)	Ground Speed (knots)
Altitude Press (ft)	Pressure Altitude (feet)
Heading Mag (deg)	Magnetic Heading (degrees)
Pitch (deg)	Pitch Angle (degrees)
Roll (deg)	Roll Angle (degrees)
Altitude Rate (fpm)	Vertical Speed (feet per minute)

3.3. 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 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.

[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.

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.

3.3.1. MFD Data Recovery

The compact flash card was in good condition, as shown in Figure 2, and the data were downloaded using the manufacturer's procedure.

Figure 2. Avidyne MFD Compact Flash card as received.

3.3.2. MFD Data Description

The MFD CF card contained 124 data files from December 14, 2019, through April 24, 2021, Universal Coordinated Time (UTC). One data file was identified as recording during the incident flight and was approximately 14 minutes in duration.

The data files downloaded from the MFD are in engineering units.

Table 2 describes MFD parameters.

Table 2. Avidyne MFD Data Parameters

Parameter Name	Parameter Description
Time	Time (UTC) for recorded data point (HH:MM:SS)
PALT (ft)	Pressure Altitude (feet)
C# (degF)	Cylinder Head Temperature # (degrees Fahrenheit)
E# (degF)	Exhaust Gas Temperature # (degrees Fahrenheit)
FF (gph)	Fuel Flow (gallons per hour)
USED (gal)	Fuel Used (gallons)
MAP (inHg)	Manifold Pressure (inches of Mercury)
RPM	Engine Revolutions Per Minute
OILP (psi)	Oil Pressure (pounds per square inch)
OILT (degF)	Oil Temperature (degrees Fahrenheit)
OAT (degC)	Outside Air Temperature (degrees Celsius)

3.4. Time Correlation

Correlation of the PFD data to UTC was established using the recorded GPS time parameter from the PFD data. Recorded GPS time is updated in 6 second intervals on the PFD.[3] The GPS time is recorded in UTC. 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 milliseconds from power-on. An offset is applied to each power cycle plotted to display the data with UTC. Therefore, for the rest of this report, all times are referenced as UTC, not recorded time.

MFD data was recorded in UTC, and no conversion was applied. 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.

3.5. Plots and Corresponding Tabular Data

PFD data were used to create geographic overlays in Google Earth. GPS information extracted from the MFD CF card was compared to the PFD data and were redundant, thus are not included. Weather and lighting conditions shown in Google Earth may not be representative of the conditions at the time of the accident flight.

Figure 3 is a Google Earth overlay of the entire accident flight. The flight departed Mustang Beach Airport (RAS) at approximately 18:05 UTC, and the last recorded GPS parameter was at 18:12:06.

Figure 4 is a Google Earth overlay of the end of the accident flight and the wreckage location. The last four recorded GPS data parameters from the PFD are shown. GPS data are recorded once every four seconds.

Figure 5 is a plot of PFD parameters for the entire accident flight. The time interval shown is 17:57:00 to 18:13:00 UTC. The last recorded parameter was at 18:12:07. It should be noted that due to different sample rates of the various parameters, not all parameters recorded until 18:12:07. Speed and GPS parameters recorded until 18:12:06.

Figure 6 is a plot of PFD parameters for the last minute of the accident flight. The time interval shown is 18:11:00 to 18:12:10 UTC.

Figure 7 is a plot of MFD parameters for the accident flight. The time interval shown is 17:57:00 to 18:13:00 UTC. The last recorded parameter was at 18:11:54.

The corresponding tabular data used to create these 5 figures are provided in electronic (*.csv) format as attachment 1 (PFD) and attachment 2 (MFD) to this report.[4]

[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.
[4] Comma Separated Value format.

Figure 3. Google Earth overlay of the entire accident flight.

Figure 4. Google Earth overlay at the end of the accident flight.

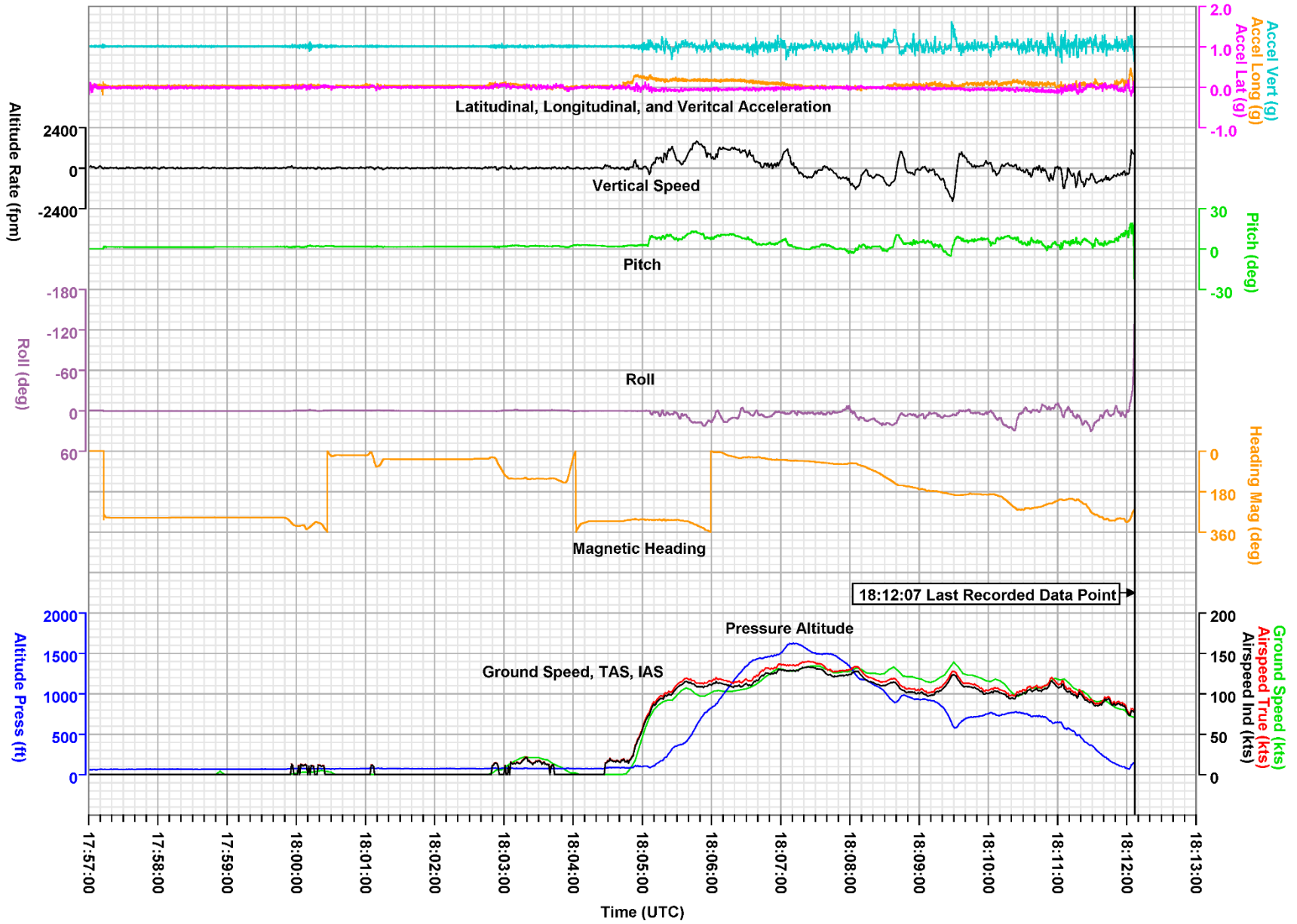


Figure 5. Plot of PFD parameters of the entire accident flight.

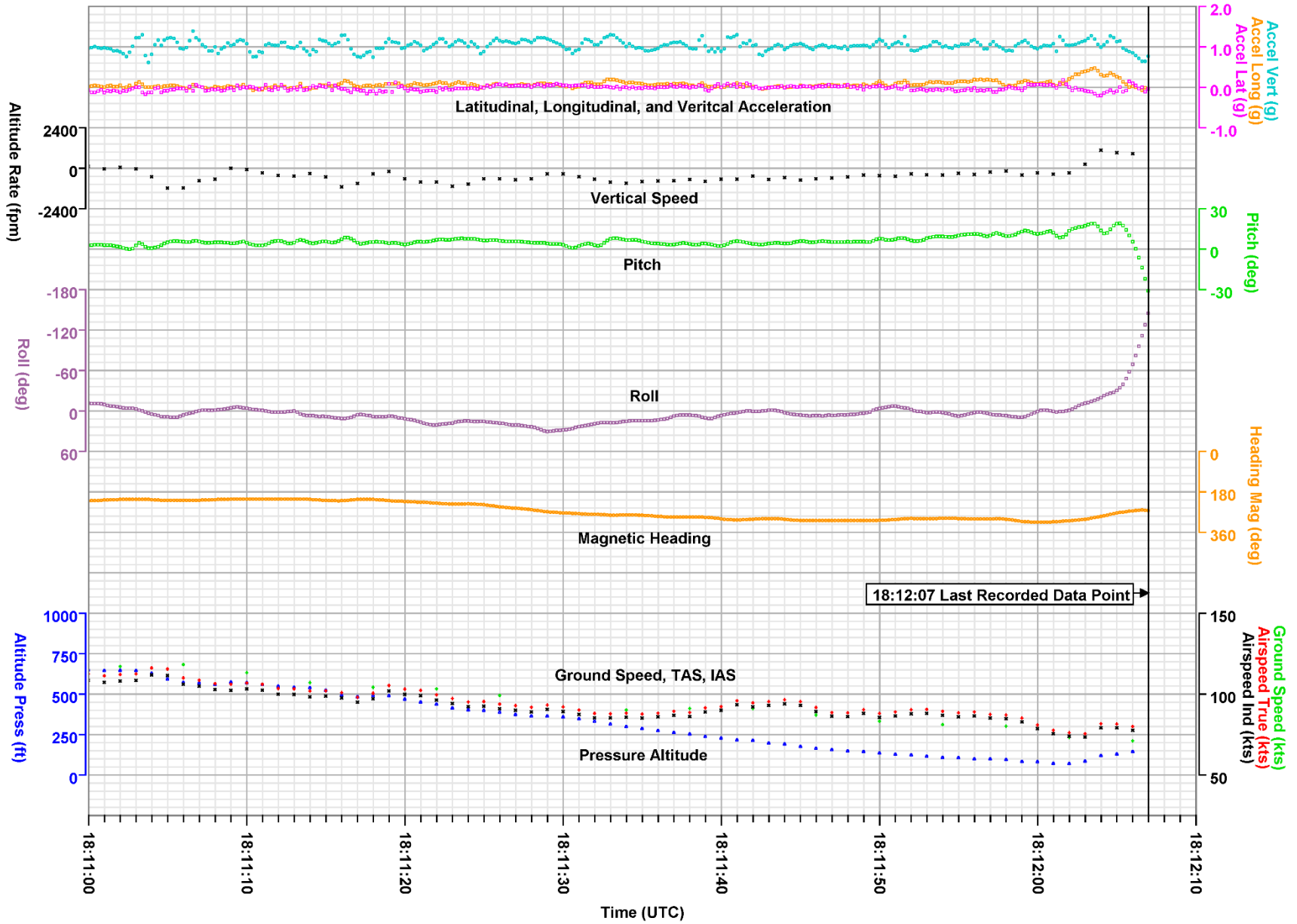
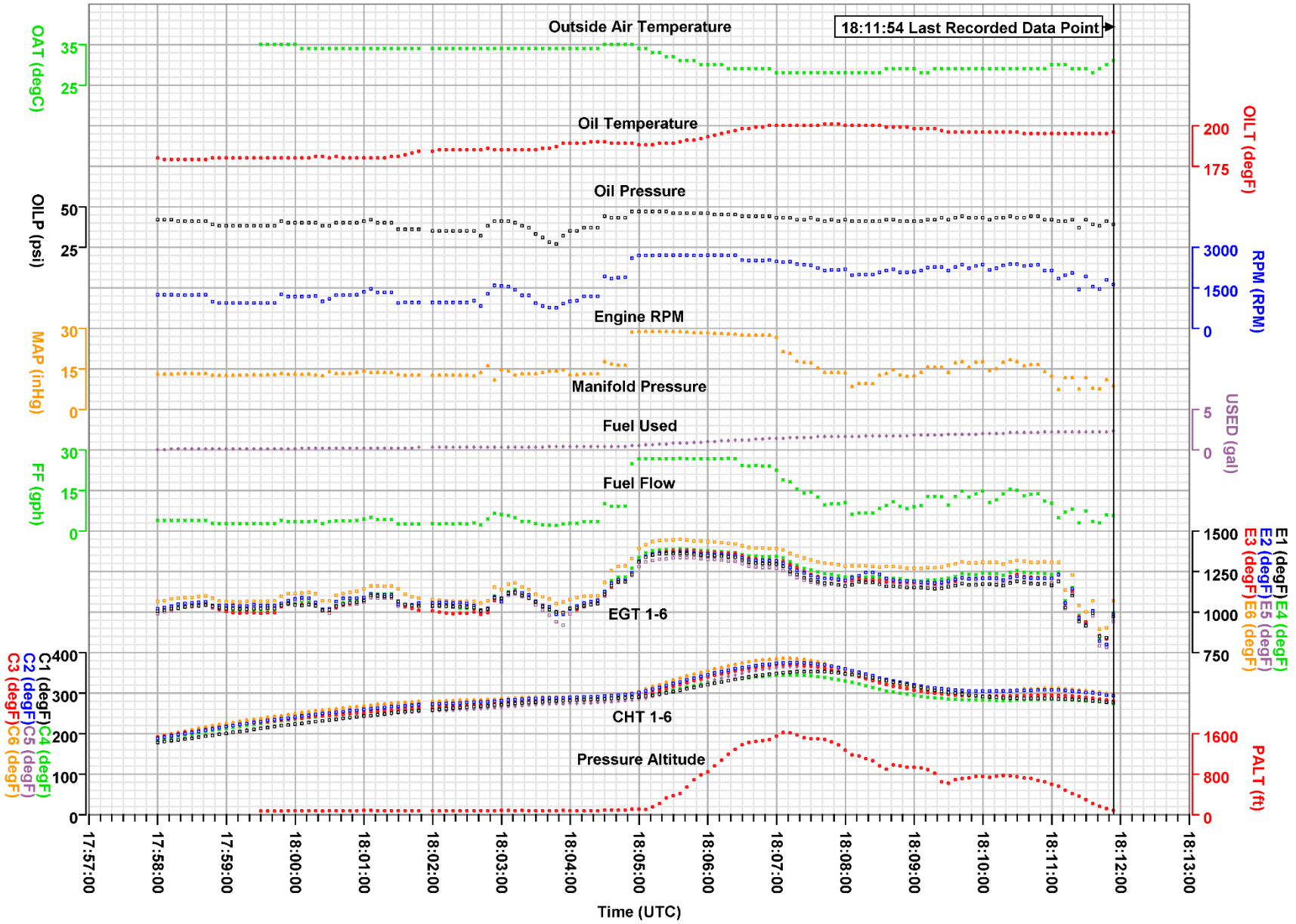


Figure 6. Plot of PFD parameters of the end of the accident flight.


Outside Air Temperature
18:11:54 Last Recorded Data Point
OAT (degC)
35
25
Oil Temperature
OILT (degF)
200
175
Oil Pressure
OILP (psi)
50
25
Engine RPM
RPM (RPM)
3000
1500
0
MAP (inHg)
30
15
0
Manifold Pressure
Fuel Used
USED (gal)
5
0
FF (gph)
30
15
0
Fuel Flow
EGT 1-6
1500
1250
1000
750
E1 (degF)
E2 (degF)
E3 (degF)
E4 (degF)
E5 (degF)
E6 (degF)
C1 (degF)
C2 (degF)
C3 (degF)
C4 (degF)
C5 (degF)
C6 (degF)
400
300
200
100
0
CHT 1-6
Pressure Altitude
1600
800
0
PALT (ft)
17:57:00
17:58:00
17:59:00
18:00:00
18:01:00
18:02:00
18:03:00
18:04:00
18:05:00
18:06:00
18:07:00
18:08:00
18:09:00
18:10:00
18:11:00
18:12:00
18:13:00
Time (UTC)