

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR22FA298

COCKPIT DISPLAYS - RECORDED FLIGHT DATA

Specialist's Factual Report

December 15, 2022

A. ACCIDENT

Location: Blyn, Washington
Date: August 10, 2022
Time: 1459 Pacific daylight time (PDT)
Airplane: Cirrus SR22, N379DH

B. COCKPIT DISPLAYS - RECORDED FLIGHT DATA SPECIALIST

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National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

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

Recorder Manufacturer/Model: Avidyne PFD
Part Number: 700-00006-000-31
Recorder Serial Number: 20355305

Recorder Manufacturer/Model: Avidyne MFD
Part Number: 700-00004-008-00
Recorder Serial Number: 20103315

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. 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.

1.1 Avidyne PFD Data Recovery

Upon arrival at the vehicle recorder laboratory, it was evident that the Avidyne PFD had received minor impact damage in the event, including minor denting and a cracked screen, which rendered the screen unusable. The extent of the damage is shown in figure 1. The internal circuit board containing the memory chips was identified and swapped into a laboratory surrogate.



Figure 1. PFD as received.

1.2 Avidyne PFD Recording Description

The PFD recording contained records of 62 power cycles and approximately 22 hours of data. The accident flight was associated with the 56th power cycle.¹ The duration of the 56th power cycle was approximately 18 minutes. Timing of the PFD data is measured in seconds from power-on.

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.

1.2.1 Avidyne PFD Engineering Unit Conversions

Conversion of the PFD data from the raw recorded information to engineering units was performed using documentation provided by the device manufacturer. Acceleration data, as documented 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.

1.3 Avidyne PFD Time Correlation

Correlation of the PFD data to PDT 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 universal coordinated time (UTC). The difference between PDT and UTC is 7 hours, or 25,200 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. Therefore, for the rest of this report, all times are referenced as PDT, 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.

2.0 Avidyne Multi-Function Display Description

The Avidyne multi-function flight display (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

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 = +, Right Rudder = +.

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.

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.

2.1 Avidyne MFD Data Recovery

Upon arrival at the vehicle recorder laboratory, it was evident that the Avidyne MFD had received minor impact damage, including a cracked screen, which rendered the screen unusable. The extent of the damage is shown in figure 2. The CF card was extracted and appeared undamaged, and the data were downloaded normally according to the device manufacturer's procedure.



Figure 2. MFD as received.

2.2 Avidyne MFD Recording Description

The MFD CF card contained 376 data files. One data file was identified as recording during the incident flight. The data file was approximately 19 minutes in duration.

2.2.1 Avidyne MFD Engineering Unit Conversions

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

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

2.3 Avidyne MFD Time Correlation

MFD data was recorded in universal coordinated time (UTC). The difference between PDT and UTC is 7 hours, or 25,200 seconds. The incident flight data has been offset from the recorded MFD time to PDT by subtracting 25,200 seconds. Therefore, for the rest of this report, all times are referenced as PDT, not recorded time.

D. FIGURES AND TABULAR DATA

Figures 3 to 8 contain data recorded during the event on August 10, 2022. All the parameters listed in table 1 are plotted except UTC Hours, UTC Minutes, UTC Seconds, Latitude, and Longitude.

Figures 3 and 4 show basic parameters for the entire accident flight and the end of the flight, respectively. Figures 5 and 6 show engine related parameters for the entire accident flight and the end of the flight, respectively. Figures 7 and 8 are overlays, generated using Google Earth, of the flight track for the entire accident flight and the end of the flight, respectively. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

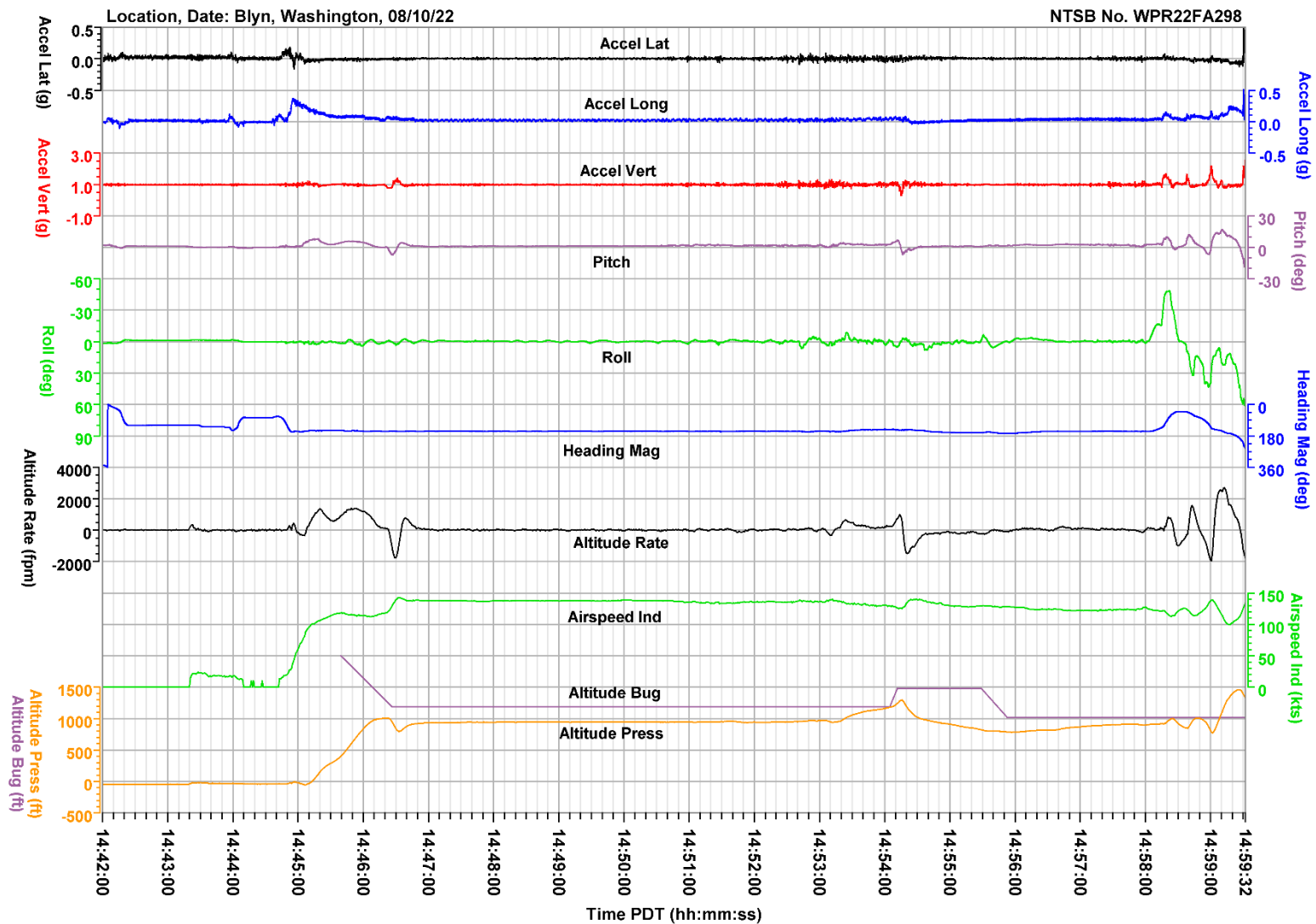
These figures are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

In summary, the aircraft took off at 1444:40 PDT. The aircraft flew south and climbed to a cruising pressure altitude of approximately 1,000 ft. Throughout the majority of the flight, recorded engine data remained mostly constant. Between 1453 and 1458, minor altitude deviations were noted, varying between 780 and 1,260 ft. Starting at 1458, larger altitude deviations were noted, as the aircraft first entered a 50-degree left turn, then a gradually steeper right turn. Vertical speeds during these maneuvers cycled between maximum values of -1,700 and 2,660 feet per minute (fpm). In the last approximately 15 seconds of recorded data, an increase in engine power was noted. The recording ended shortly thereafter, at 1459:32.

The corresponding tabular data used to create figures 3, 4, 7, and 8, including UTC Hours, UTC Minutes, UTC Seconds, Latitude, and Longitude, are provided in electronic comma separated value (CSV) format as attachment 1 to this report. The corresponding tabular data used to create figures 5 and 6 are provided in electronic CSV format as attachment 2 to this report.

Submitted by:

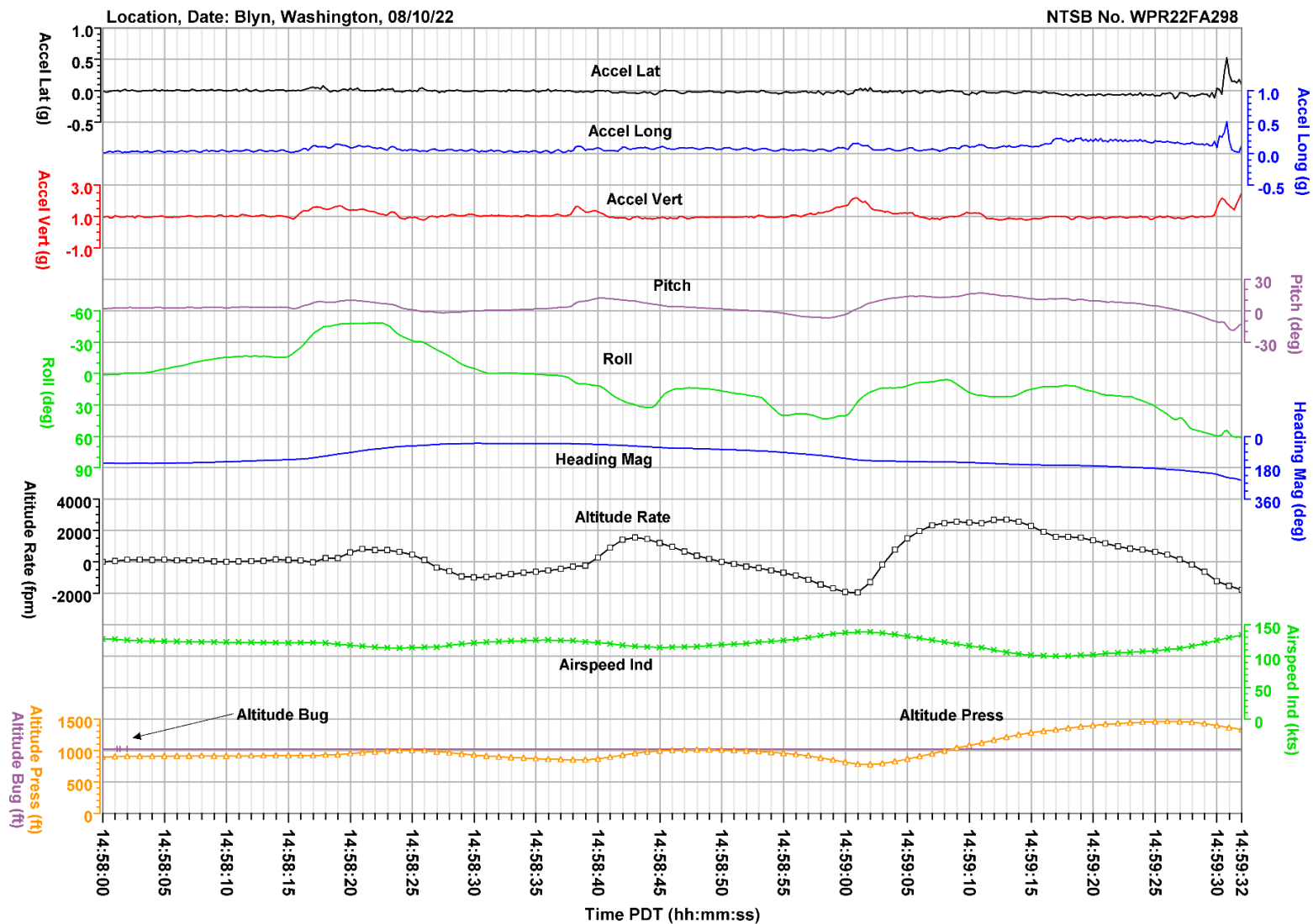
Michael Portman
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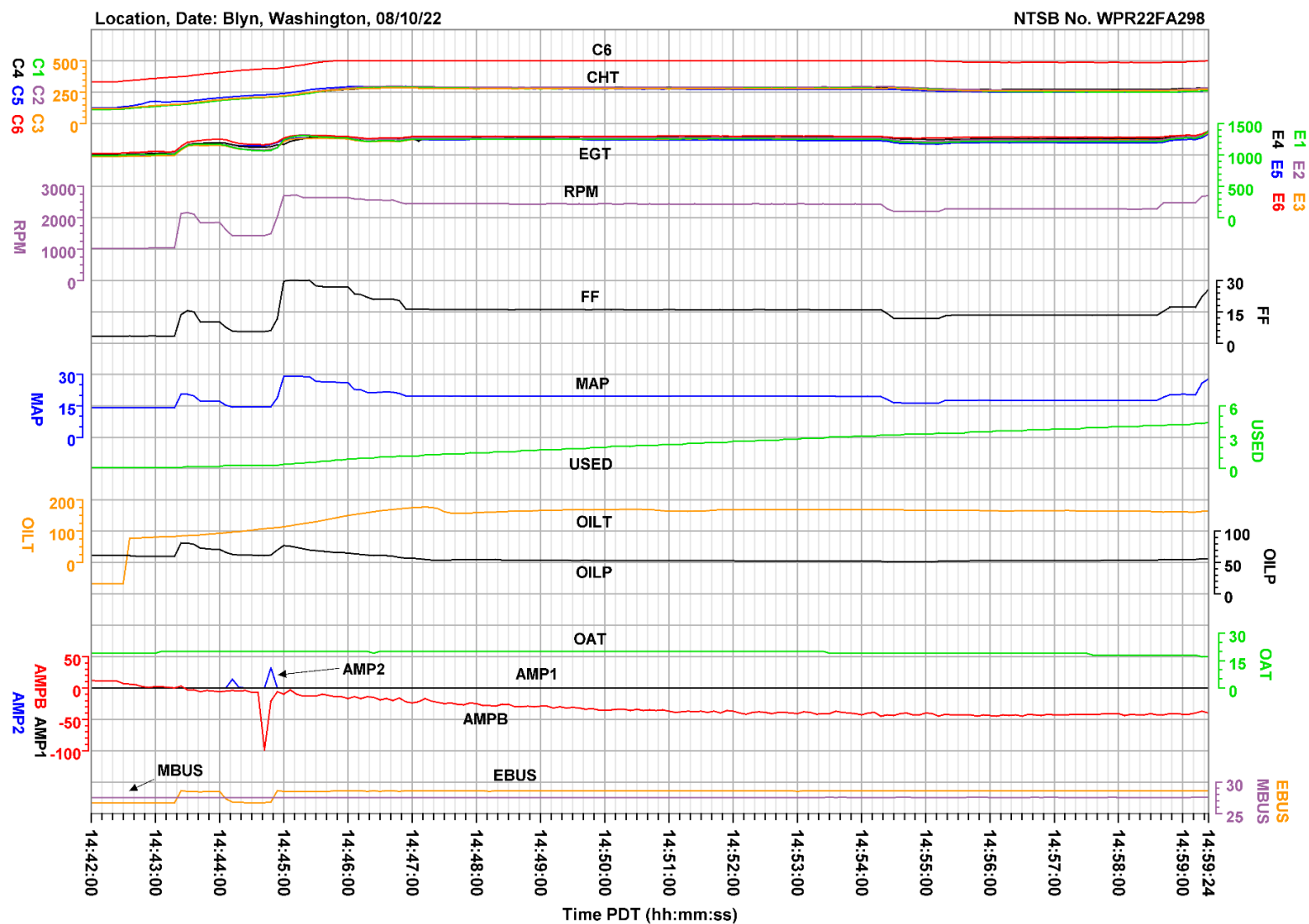
Figure 3. Plot of basic parameters for the entire accident flight.



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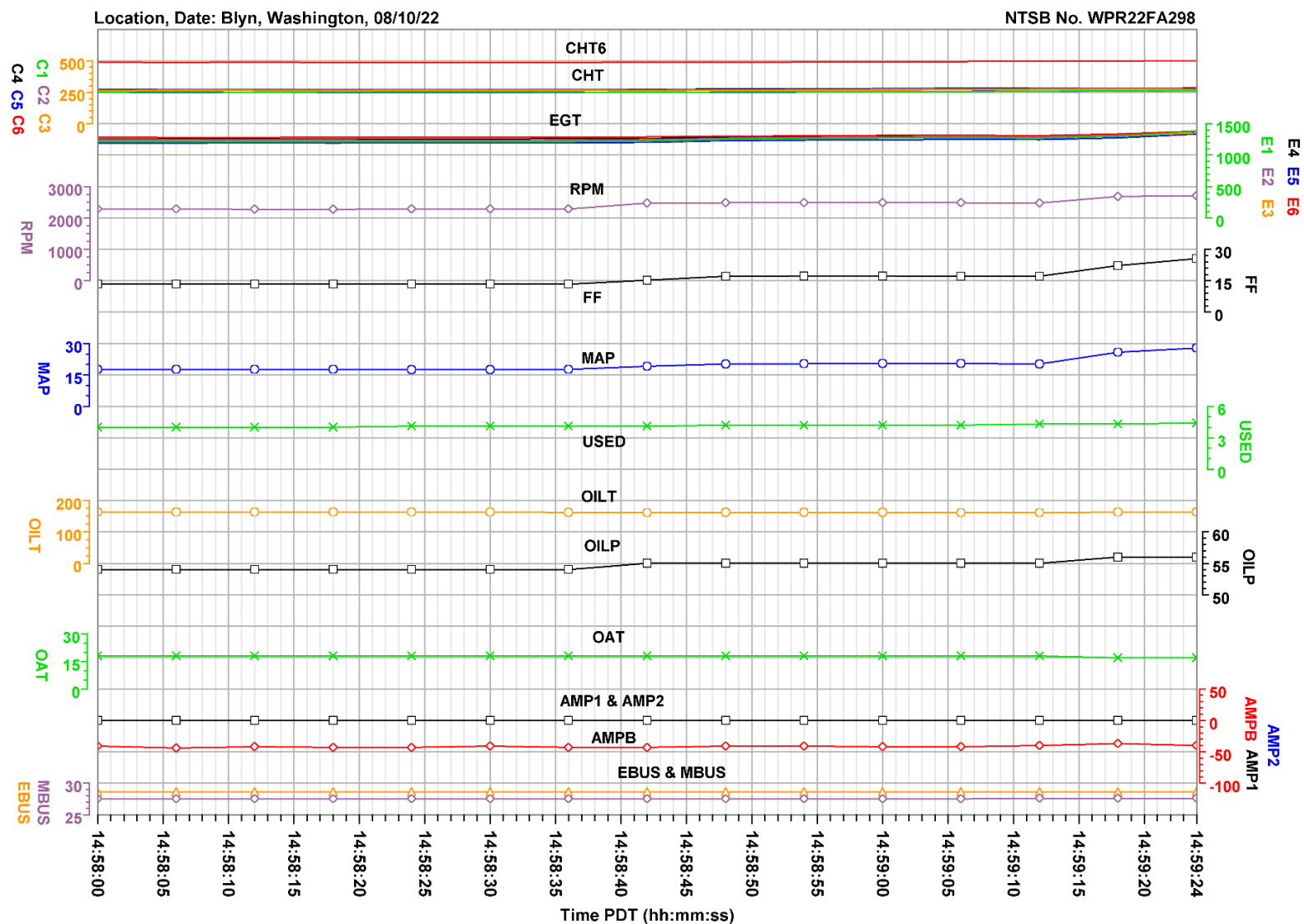
Figure 4. Plot of basic parameters at the end of the flight.



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Figure 5. Plot of engine parameters for the entire accident flight.



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Figure 6. Plot of engine parameters at the end of the flight.



Figure 7. Google Earth overlay showing the entire flight path.

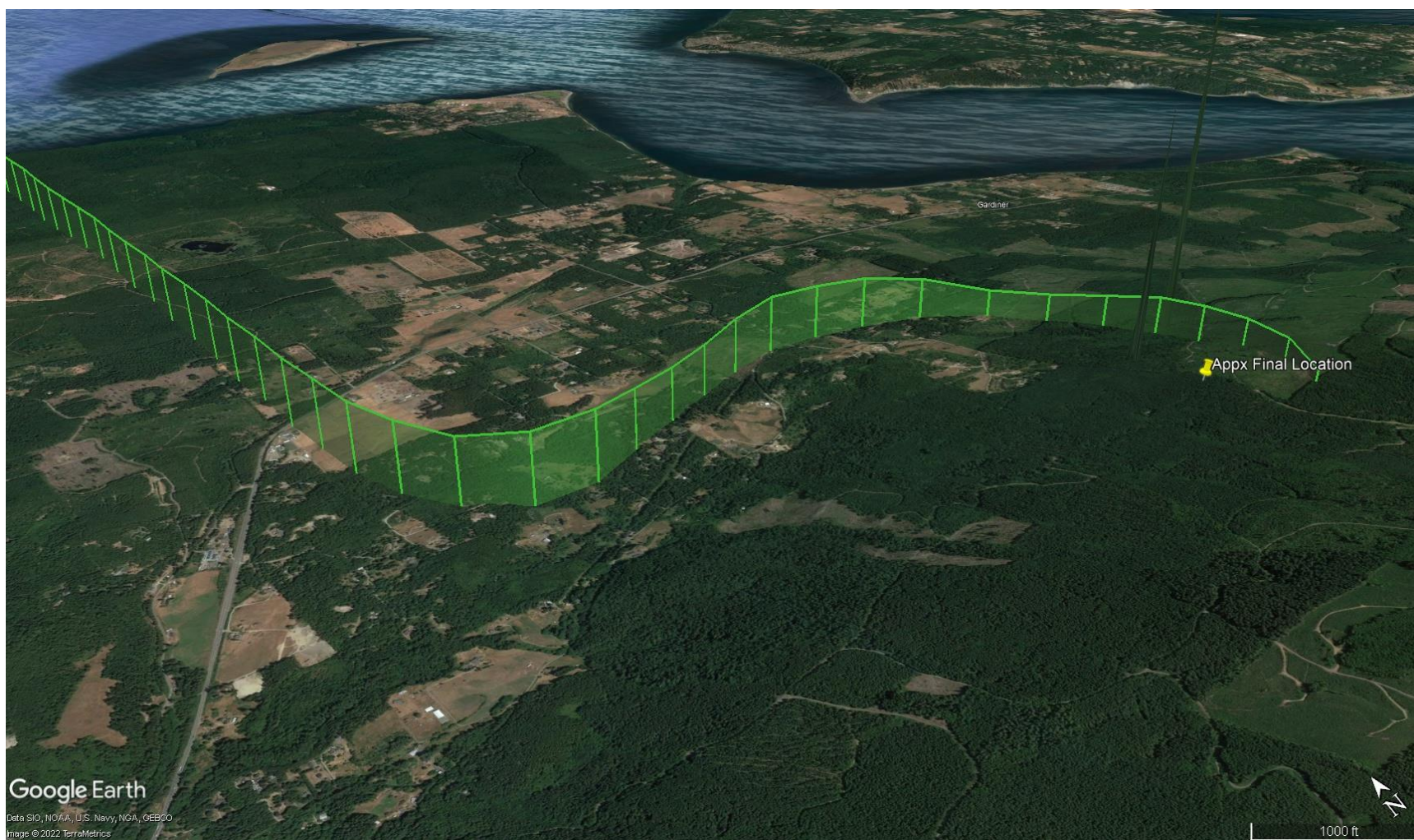


Figure 8. Google Earth overlay of the end of the flight.

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 Bug (ft)	Altitude Selector Bug	PFD
Altitude Press (ft)	Pressure Altitude	PFD
Altitude Rate (fpm)	Altitude Rate (Vertical Speed)	PFD
AMP1 (A)	Bus 1 Amps	MFD
AMP2 (A)	Bus 2 Amps	MFD
AMPB (A)	Battery Bus Amps	MFD
C# (degF)	Engine Cylinder Head Temperature Cylinder # ⁴	MFD
E# (degF)	Engine Exhaust Gas Temperature Cylinder # ⁴	MFD
EBUS (V)	Essential Bus Voltage	MFD
FF (gph)	Engine Fuel Flow	MFD
Heading (deg)	Heading	PFD
Heading Bug (deg)	Heading Bug	PFD
Latitude (deg)	Latitude	PFD
Longitude (deg)	Longitude	PFD
MAP (inHg)	Engine Manifold Pressure	MFD
MBUS (V)	Main Bus Voltage	MFD
OAT (degC)	Outside Air Temperature	MFD
OILP (psi)	Engine Oil Pressure	MFD
OILT (degF)	Engine Oil Temperature	MFD
Pitch (deg)	Pitch	PFD
Roll (deg)	Roll	PFD
RPM (rpm)	Engine Revolutions Per Minute	MFD
Time UTC Hrs (hr)	Time UTC Hrs	PFD
Time UTC Min (min)	Time UTC Min	PFD
Time UTC Sec (sec)	Time UTC Sec	PFD
USED (gal)	Engine Fuel Used	MFD

Note: The PFD/MFD record pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (inHg). 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
A	Amperes
deg	degrees

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.

Unit Abbreviations	Descriptions
degC	degrees Celsius
degF	Degrees Fahrenheit
ft	feet
gal	gallons
gph	gallons per hour
hrs	hours
inHg	inches of Mercury
kts	knots
min	minutes
psi	pounds per square inch
rpm	revolutions per minute
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.