

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA22LA275

COCKPIT DISPLAY - RECORDED FLIGHT DATA

Specialist's Factual Report

May 18, 2023

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A. ACCIDENT

Location: Gulf Shores, Alabama
Date: June 15, 2022
Time: 1620 central daylight time (CDT)
Airplane: Cirrus SR22, private operator, N432CD

B. COCKPIT DISPLAY - RECORDED FLIGHT DATA SPECIALIST

Specialist: Steven Smith
Mechanical Engineer (Recorder Specialist)
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A cockpit display group was not convened.

The NTSB Vehicle Recorder Division received the following cockpit display devices:

Recorder Manufacturer/Model: Avidyne PFD
Part Number: 700-00006-00
Recorder Serial Number: 22343014

Recorder Manufacturer/Model: Avidyne MFD Compact Flash Card
Part Number: 053-00201-100 REV 03
Recorder SW PN Number: 530-00201-100 REV 01

Recorder Manufacturer/Model: Avidyne DFC 90
Part Number: 700-00170-000
Recorder Serial Number: M164901796

1.0 Avidyne PFD Device Description

The Avidyne Entegra 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

The Avidyne PFD exhibited signs of fire damage, as shown in figure 1, rendering it inoperable.

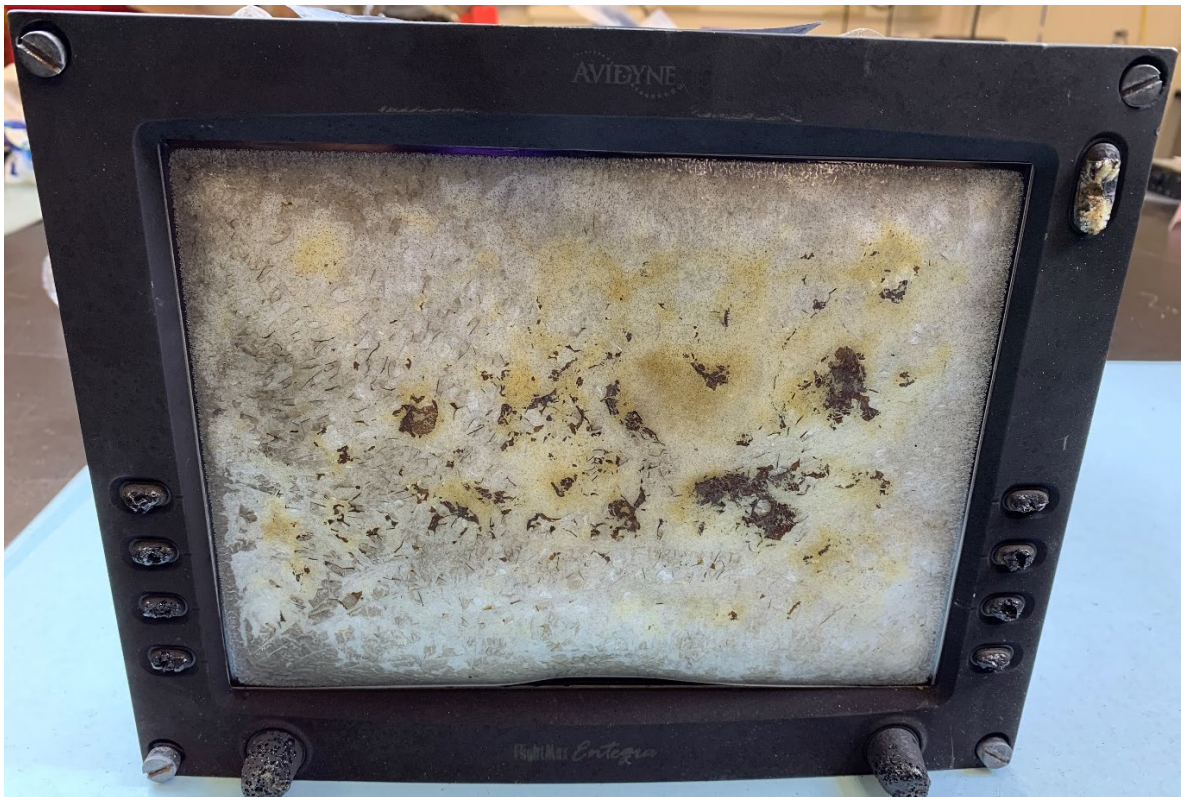


Figure 1. Avidyne PFD as received.

1.2 Avidyne PFD Recording Description

The PFD recording contained records of 22 power cycles and approximately 19.23 hours of data. The accident flight was associated with the last power cycle. The

duration of the last power cycle was approximately 24 minutes. Timing of the PFD data is measured in seconds from power-on.

1.2.1 Avidyne PFD Engineering Unit Conversions

The internal non-volatile memory chips were removed, read-out, and converted to engineering units using laboratory tools.

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

1.3 Avidyne PFD Time Correlation

Correlation of the PFD data to CDT was established using the recorded GPS time parameter from the PFD data. Recorded GPS time is updated in 6 second intervals on the PFD.¹ The GPS time is recorded in universal coordinated time (UTC). The difference between CDT and UTC is 5 hours, or 18000 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 CDT.

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 MFD Device Description

The Avidyne MFD (multi-function flight display) 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

¹ 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.

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

The Avidyne MFD card exhibited signs of fire damage to its exterior as shown in figure 2. The internal components of the CF card were examined, and data were extracted normally using a laboratory surrogate.

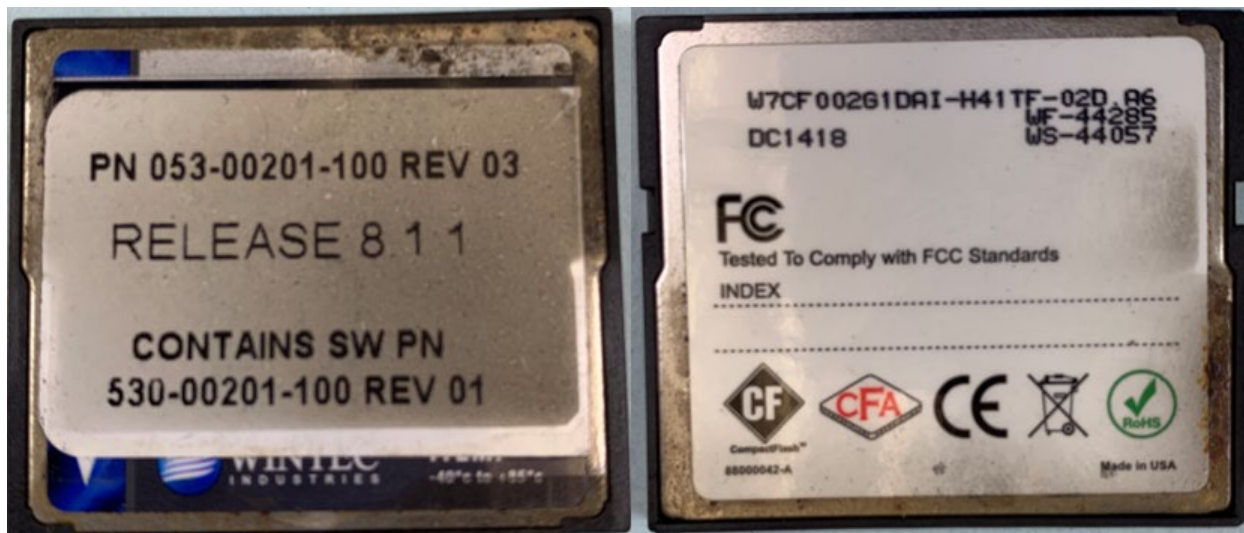


Figure 2. Front and back of MFD CF card as received.

2.2 Avidyne MFD Recording Description

The MFD Compact Flash card contained 68 data files. One data file was identified as the recording during the accident flight. The data file was approximately 23 minutes and 30 seconds 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

Correlation of the MFD data to CDT was established using the recorded GPS time parameter from the MFD data. Recorded GPS time is updated in 6 second intervals on the MFD. The GPS time is recorded in universal coordinated time (UTC). The difference between CDT and UTC is 5 hours, or 18000 seconds.

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.

3.0 Avidyne DFC-90 Device Description

The Avidyne DFC-90 (digital flight computer) is a multi-axis flight control autopilot. During normal operation the device is capable of controlling the aircraft's attitude (both pitch and roll) and maintaining a selected altitude. Additionally, the autopilot is capable of maintaining a controlled rate of climb and descent, has a navigation capability and will maintain a pre-programed flight track profile, and is capable of flying both precision and non-precision approaches. The Avidyne DFC-90 also records flight/navigation data, in addition to operational/fault data, associated with the operation of the autopilot system. The data is stored on a microSD card that is mounted on the main processor board of the autopilot.

3.1 Avidyne DFC-90 Data Recovery

The Avidyne DFC-90 exhibited signs of fire damage to its exterior as shown in figure 3. The internally mounted microSD card was in good condition, and data were extracted from the card using the manufacturer's procedures.



Figure 3. Avidyne DFC 90 as received.

3.2 Avidyne DFC-90 Data Description

The manufacturer indicated that since the aircraft did not takeoff, it is likely that the pertinent autopilot information was not engaged, and therefore would be redundant to the PFD. Therefore, the data are not included in this report.

D. FIGURES AND TABULAR DATA

Figures 4 to 6 contain PFD and MFD data recorded during the event on June 15, 2022. All the parameters listed in table 2 are plotted except UTC Hours, UTC Minutes, UTC Seconds, Latitude, and Longitude.

Figure 4 presents the basic parameters recorded by the PFD for the entire flight.

Figure 5 presents the engine parameters recorded by the MFD for the entire flight.

Figure 6 presents the basic parameters recorded by the PFD for the taxi portion of the flight only.

The aircraft powered up at approximately 15:59:00 CDT and began taxiing from the terminal at approximately 16:09:00 CDT. At 16:11:36 CDT, the aircraft had reached Taxiway A and followed Taxiway A due east all the way to Taxiway A5. At approximately 16:17:44 CDT the aircraft lined up on Runway 27. At approximately 16:18:00 CDT the aircraft began to accelerate, reaching 62 knots airspeed before beginning to decelerate, exiting the runway at Taxiway A3 at approximately 16:18:52 CDT. Table 1 shows the summary of events.

Table 1. Summary of events (Reference the airport diagram, Figure 8).

Time (CDT)	Location
15:59:00 CDT	Power Up
16:09:00 CDT	Taxi from Terminal
16:11:36 CDT	Reached Taxiway A
16:12:00 CDT	Crossed Runway 17-35
16:12:40 CDT	Passed Taxiway A2
16:13:24 CDT	Passed Taxiway A3
16:14:32 CDT	Passed Taxiway A4
16:15:28 CDT	Stopped at Taxiway A5
16:17:44 CDT	Lined up on Runway 27
16:18:00 CDT	Takeoff Roll Began
16:18:52 CDT	Exited onto Taxiway A3
16:20:48 CDT	Last recorded PFD Point

Figure 7 is a graphical overlay generated using Google Earth showing the accident. PFD data were used to generate the overlay in Google Earth. Weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Figure 8 is the airport diagram Gulf Shores International Airport (KJKA).

The corresponding tabular data used to create figures 4 to 7, including UTC Hours, UTC Minutes, and UTC Seconds are provided in electronic comma-separated value (CSV) format as attachment 1 (PFD) and attachment 2 (MFD) to this report.

In addition to the accident flight time history data, ground operations from two previous flights were examined.

Figure 9 is the takeoff taxi sequence for the flight from Abilene, TX to Destin, FL, on May 19, 2022.

Figure 10 is the landing taxi sequence including rollout for the flight from Abilene, TX, to Destin, FL, on May 19, 2022.

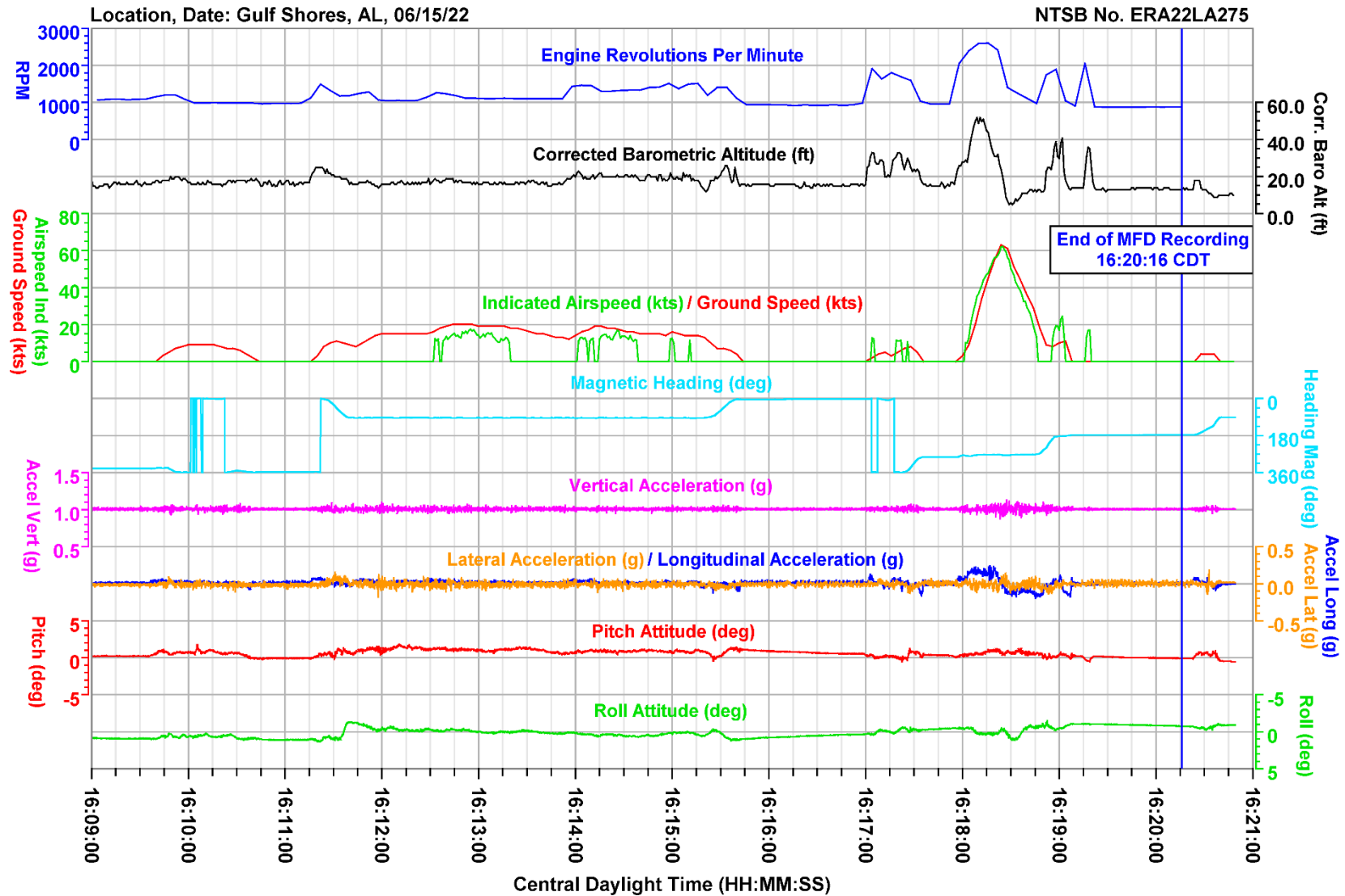
Figure 11 is the takeoff taxi sequence for the flight from Destin, FL to Gulf Shores, AL, on May 27, 2022.

Figure 12 is the landing taxi sequence including rollout for the flight from Destin, FL, to Gulf Shores, AL, on May 27, 2022.

The corresponding tabular data used to create figures 9 to 12, including UTC Hours, UTC Minutes, UTC Seconds, Latitude, and Longitude are provided in CSV format as attachment 3 (May 19 Flight) and attachment 4 (May 27 Flight) to this report.

Submitted by:

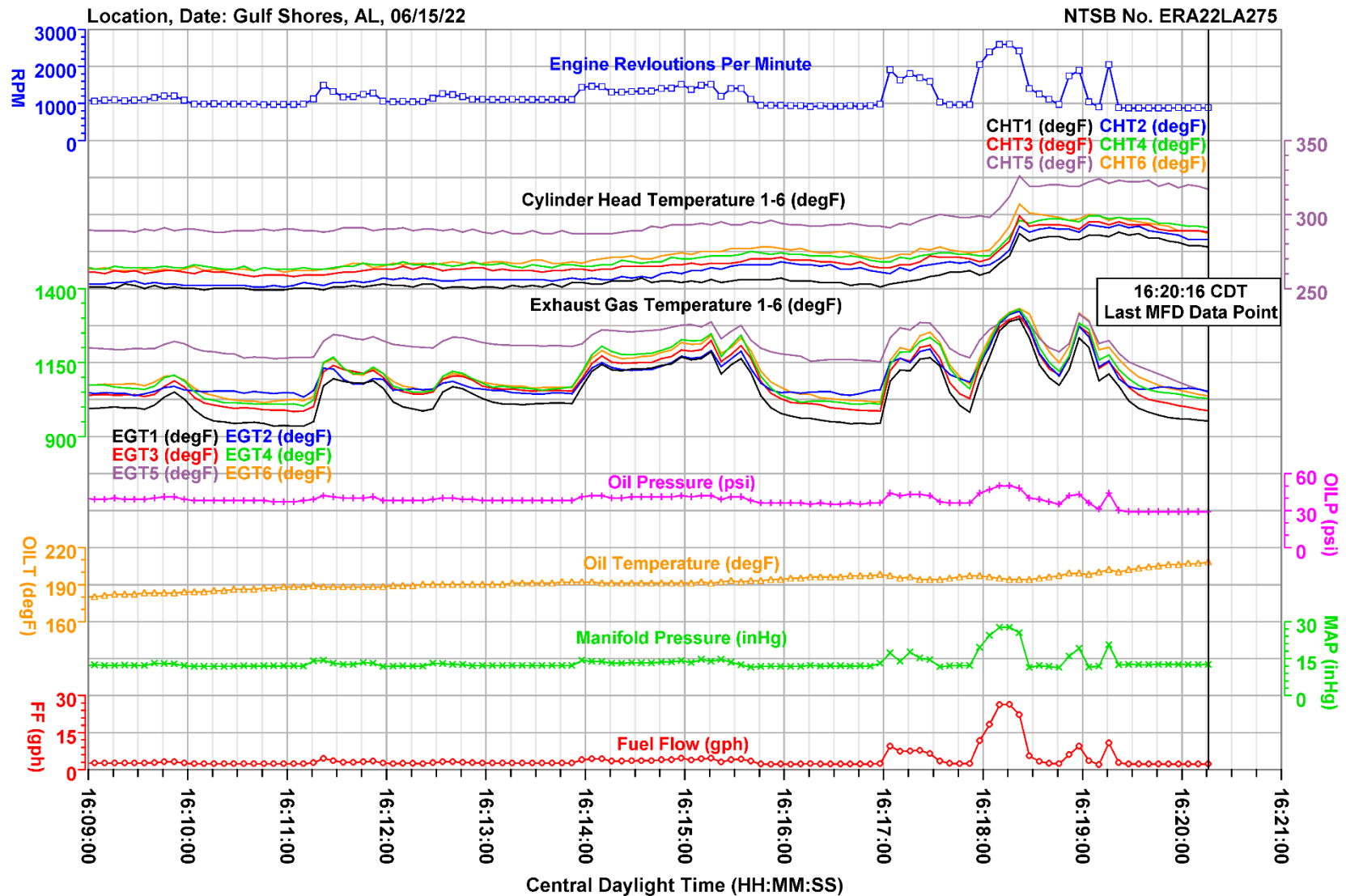
Steven Smith
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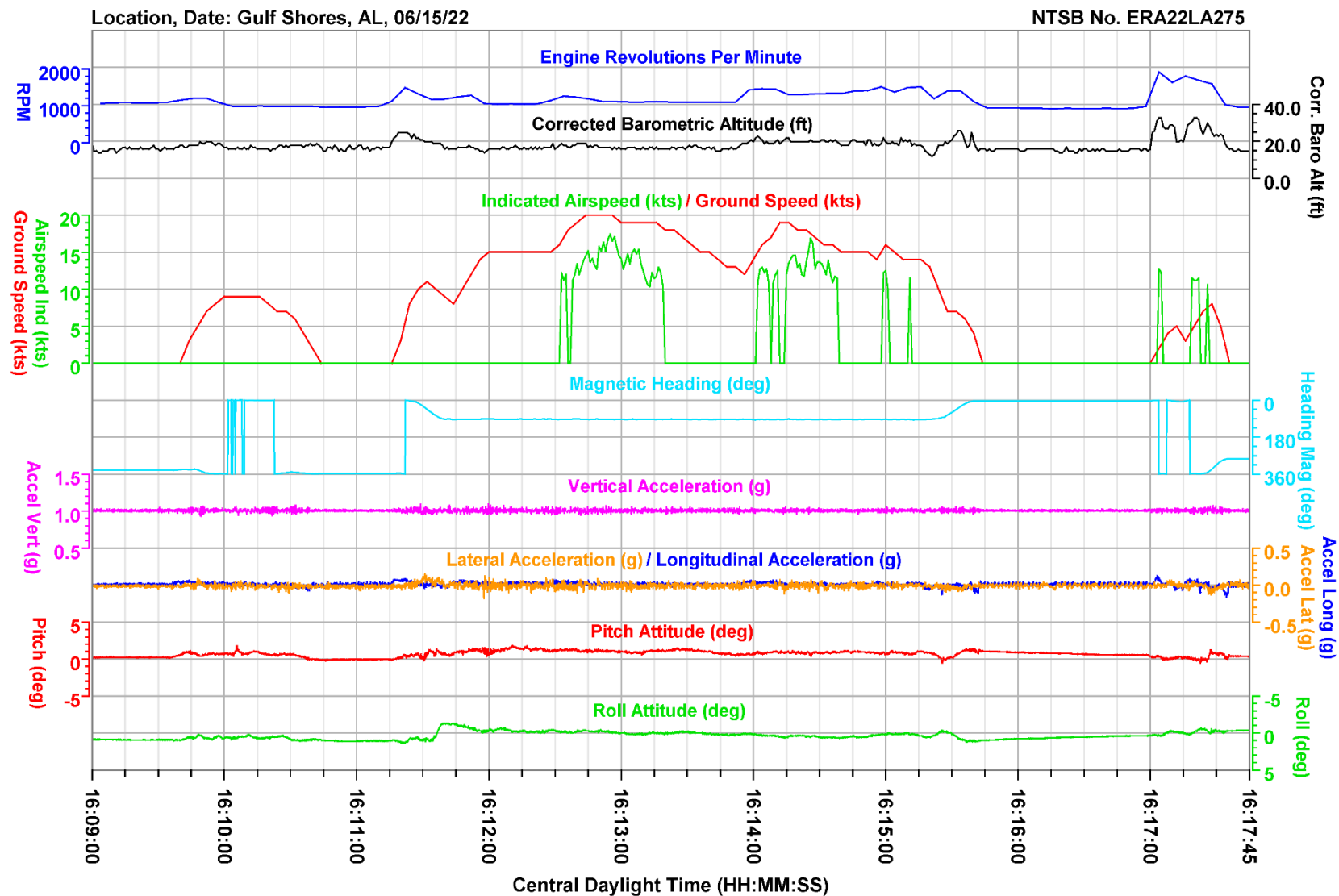
Figure 4. Time history plot of PFD parameters with engine RPM (from MFD) for the entire flight.



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Figure 5. Time history plot of MFD parameters for the entire flight.



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Figure 6. Time history plot of the taxi portion of the flight.

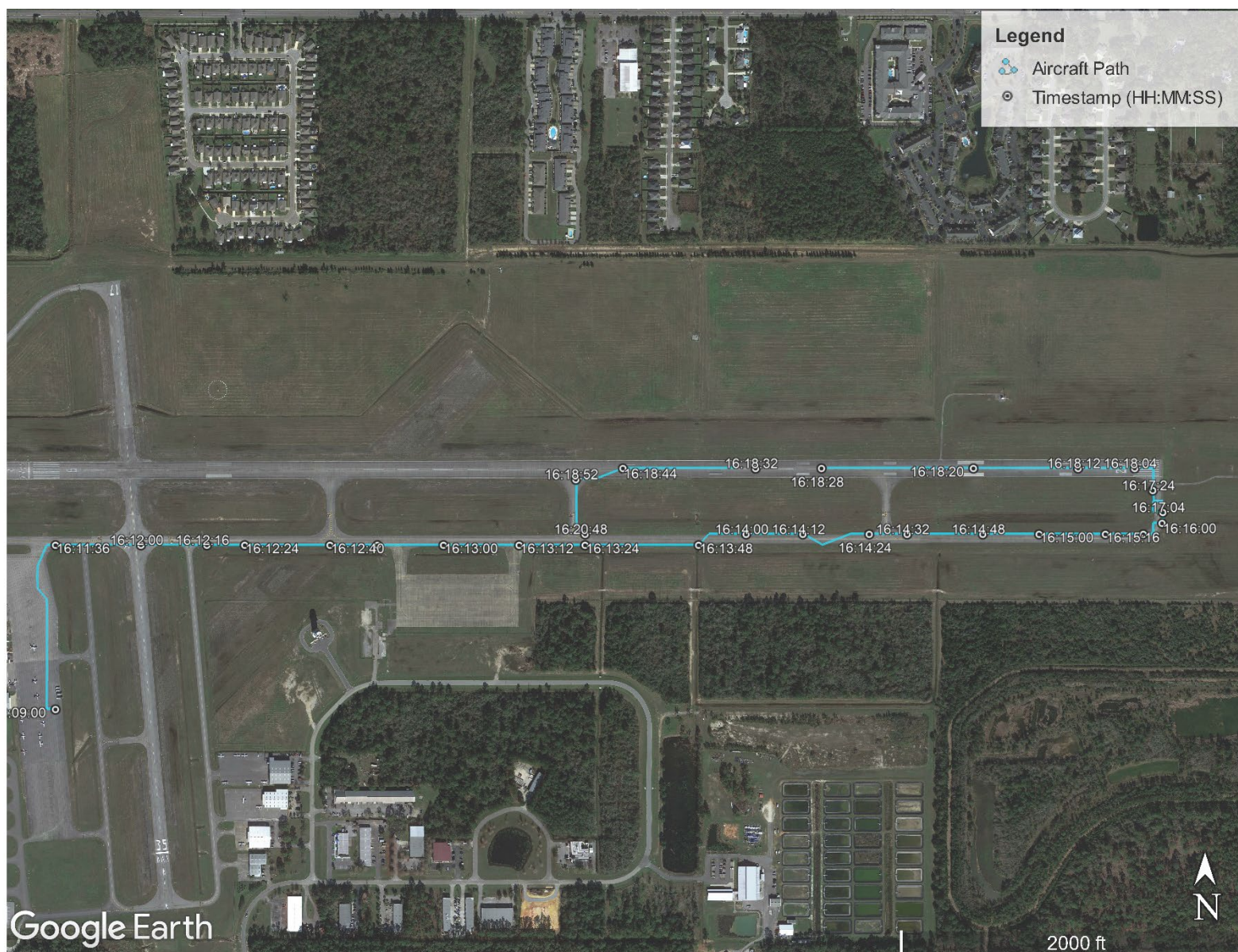


Figure 7. Google Earth overlay of the entire event from the start of taxi to the exit off Runway 27 onto Taxiway A3.

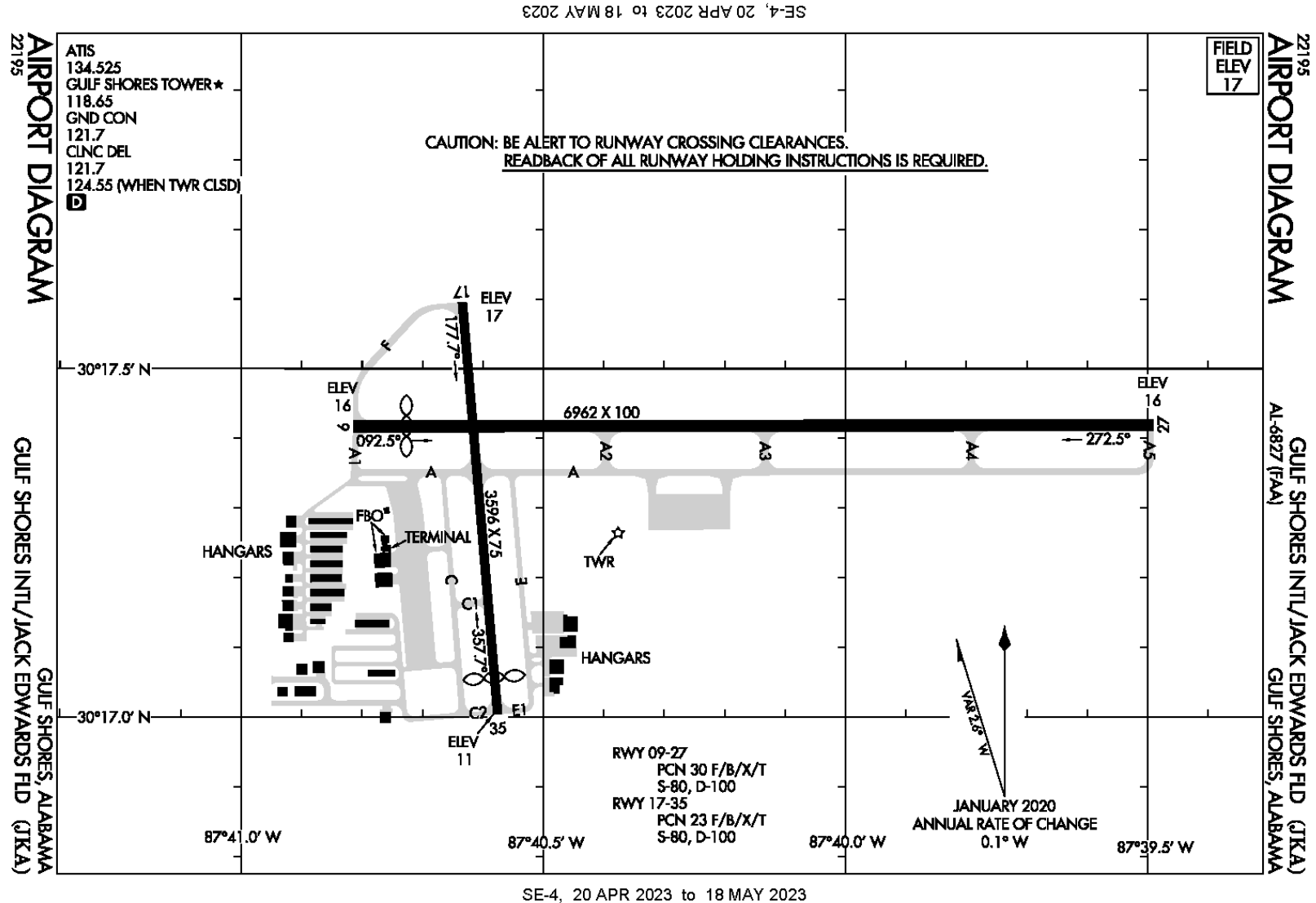
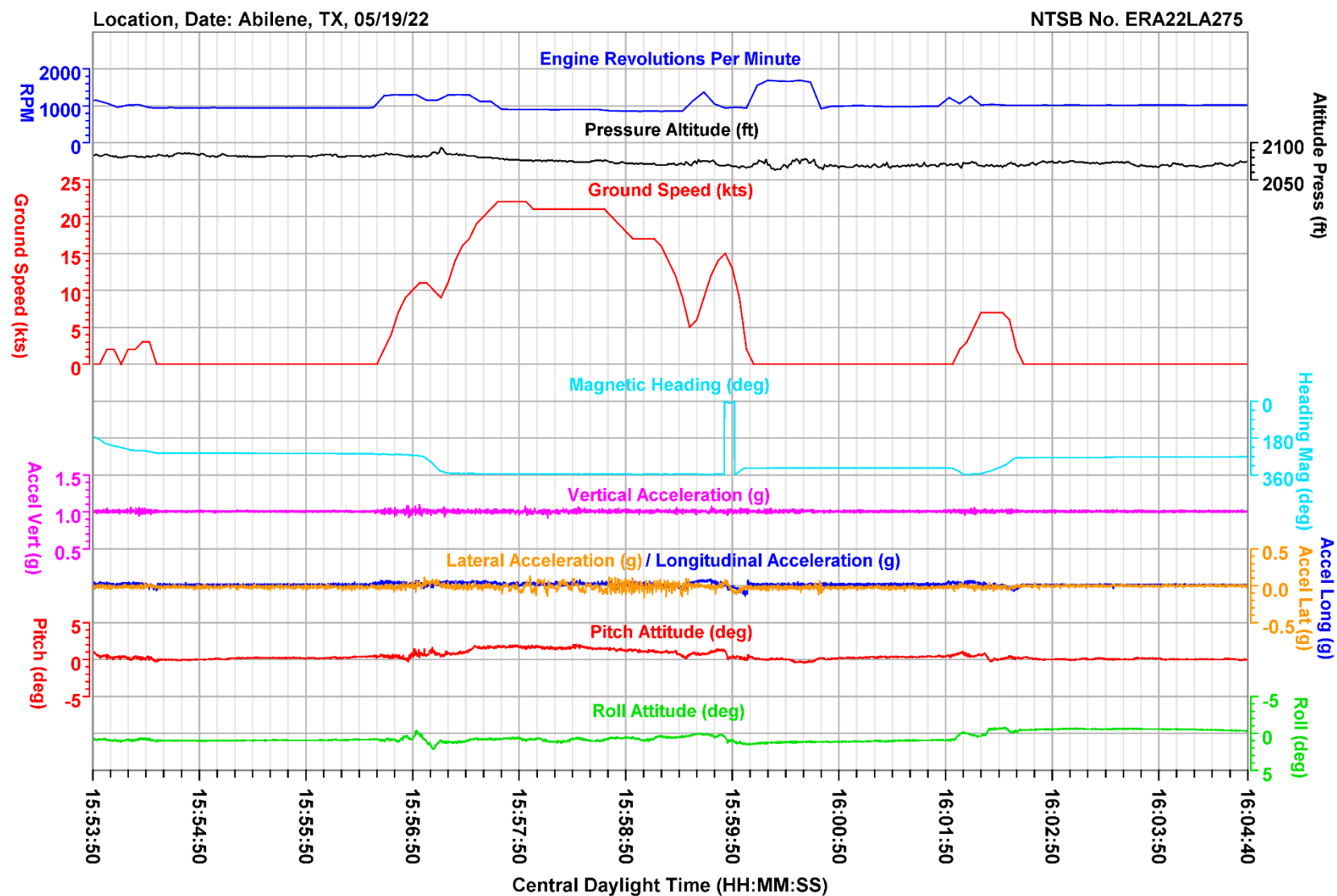


Figure 8. Airport Diagram for Gulf Shores International Airport (JKA).



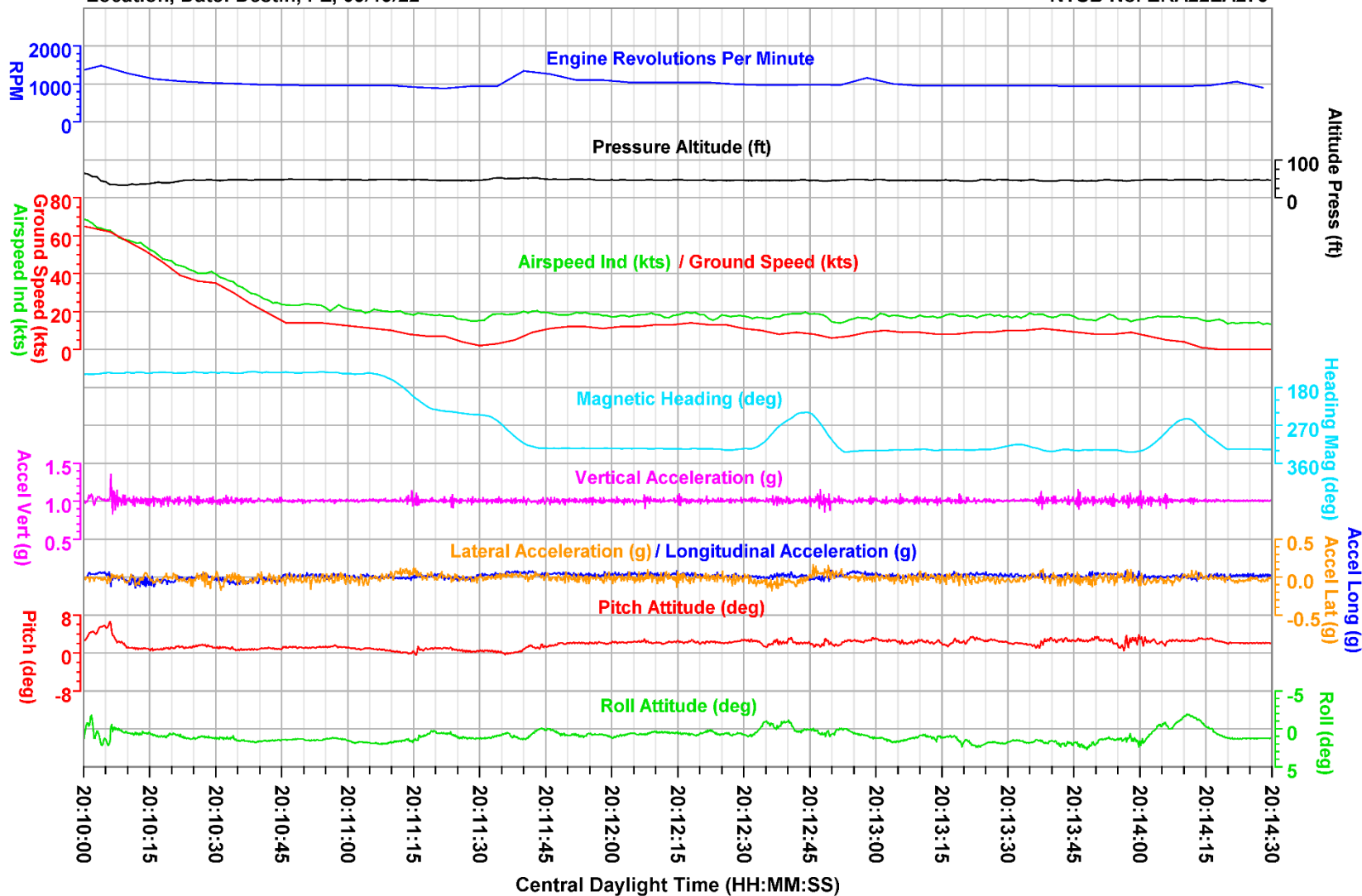
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Figure 9. Time history plot of previous flight takeoff taxi at Abilene, TX, on May 19, 2022.

Location, Date: Destin, FL, 05/19/22

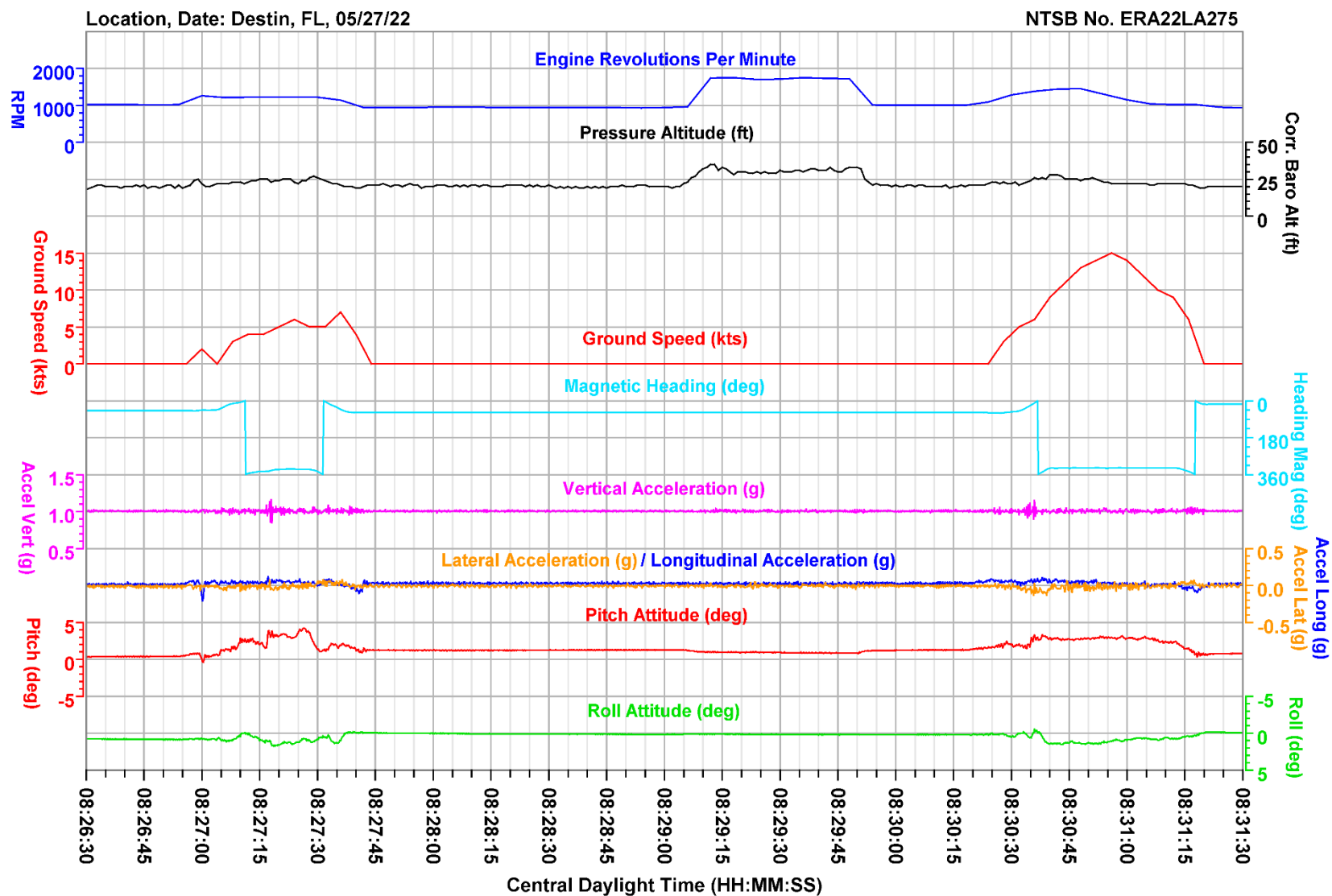
NTSB No. ERA22LA275



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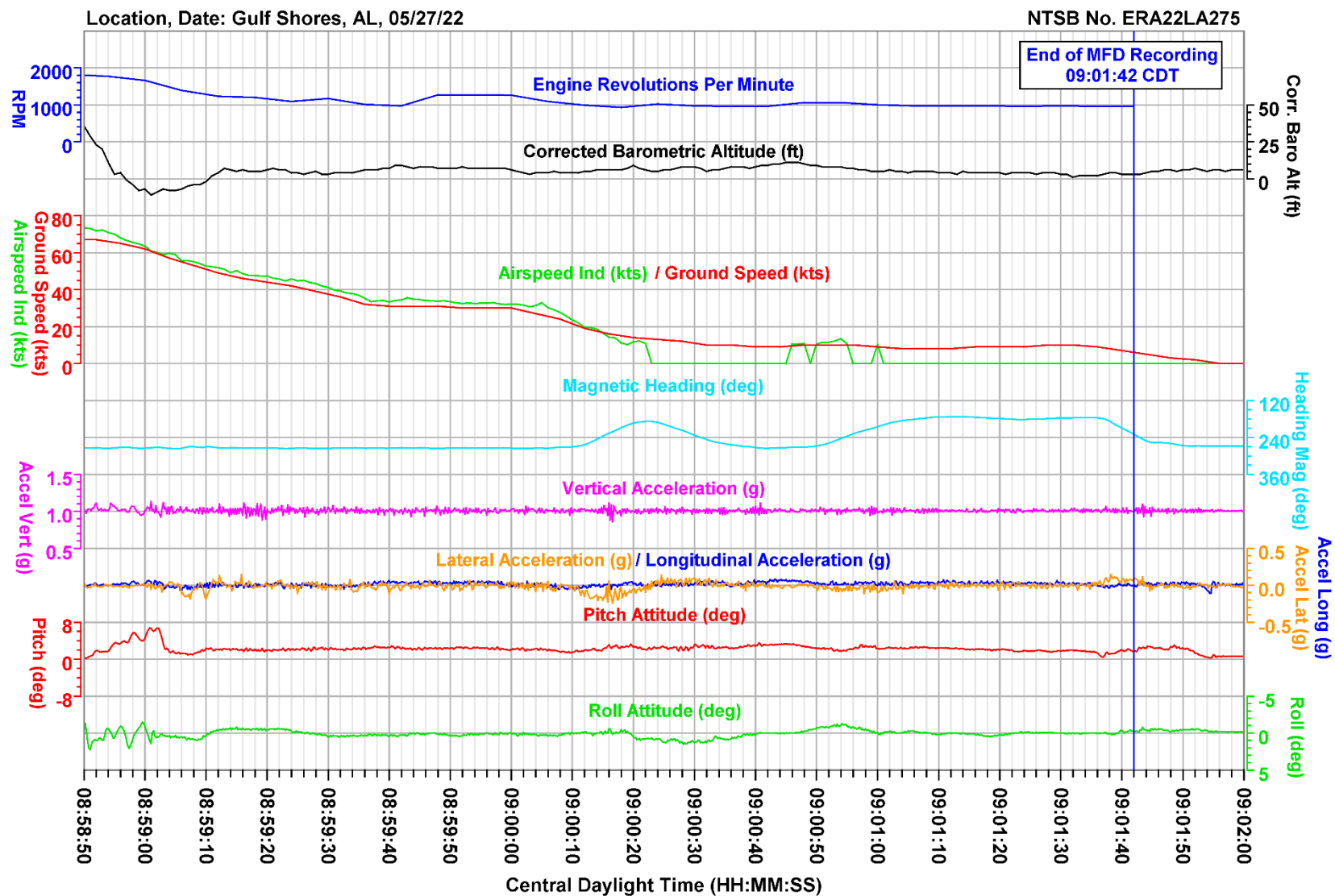
Figure 10. Time history plot of previous flight landing taxi at Destin, FL, on May 19, 2022.



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Figure 11. Time history plot of previous flight takeoff taxi at Destin, FL, on May 27, 2022.



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Figure 12. Time history plot of previous flight landing taxi at Gulf Shores, AL, on May 27, 2022.

APPENDIX A. VERIFIED AND PROVIDED PARAMETERS AVIDYNE PFD/MFD

This appendix describes the parameters provided and verified in this report. Table 2 lists the PFD/MFD parameters and table 3 describes the unit abbreviations used in this report for PFD/MFD parameters.

Table 2. 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 Press (ft)	Pressure Altitude	PFD
Baro Bug (inHg)	Display Barometric Correction Setting	PFD
Corrected Barometric Altitude	Corrected Barometric Altitude	
Ground Speed (kts)	Ground Speed	PFD
Heading (deg)	Heading	PFD
Latitude (deg)	Latitude	PFD
Longitude (deg)	Longitude	PFD
Pitch (deg)	Pitch	PFD
Roll (deg)	Roll	PFD
Time UTC Hrs (hr)	Time UTC Hour	PFD
Time UTC Min (min)	Time UTC Minute	PFD
Time UTC Sec (sec)	Time UTC Second	PFD
VSI Bug (fpm)	Vertical Speed Indicator Bug	PFD
Yaw Rate (deg/sec)	Yaw Rate	PFD
Eng CHT Cyl# (degF)	Engine 1 Cylinder Head Temperature Cylinder # ²	MFD
Eng EGT Cyl# (degF)	Engine 1 Exhaust Gas Temperature Cylinder # ⁴	MFD
Eng Fuel Flow (gph)	Engine 1 Fuel Flow	MFD
Eng MAP (inHg)	Engine 1 Manifold Pressure	MFD
Eng Oil Pressure (psi)	Engine 1 Oil Pressure	MFD
Eng Oil Temp (degF)	Engine 1 Oil Temperature	MFD
Eng RPM (rpm)	Engine 1 Revolutions Per Minute	MFD

The PFD/MFD records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The barometric correction is also recorded by the PFD/MFD. In this report, barometric altitude in feet, Mean Sea Level, is calculated using the pressure altitude and the barometric correction using the following formula:

$$\begin{aligned}
 \text{Altitude}_{\text{Baro}} (\text{ft MSL}) \\
 = \text{Altitude}_{\text{Pressure}} (\text{ft}) + (\text{Baro Correction (inHg)} - 29.92 (\text{inHg})) \times 924.82 (\text{ft/inHg})
 \end{aligned}$$

² Depending on aircraft configuration, the number of cylinders that are instrumented varies. In the data plots the '#' is replaced with the appropriate cylinder ID.

Table 3. Unit abbreviations

Unit Abbreviations	Descriptions
deg	degrees
degC	degrees Celsius
degF	Degrees Fahrenheit
ft	feet
g	Gravitational acceleration
gph	gallons per hour
inHg	inches of Mercury
kts	knots
psi	pounds per square inch
rpm	revolutions per minute