

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, D.C. 20594

March 4, 2022

Cockpit Displays - Recorded Flight Data

Specialist's Factual Report By Charles Cates

1. EVENT SUMMARY

Location: Marana, AZ
Date: March 28, 2021
Aircraft: Cirrus SR22
Registration: N644SR
Operator: Private
NTSB Number: WPR21LA145

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board's (NTSB) Vehicle Recorder Division received the following electronic display from the Cirrus SR22 capable of recording information to non-volatile memory (NVM¹):

Recorder Manufacturer/Model: **Avidyne PFD**
Recorder Serial Number: **24756085**

3.1. 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.

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

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 Condition

The recorder was generally in good condition and the data were downloaded using the manufacturer's procedure. See Figure 1 for an as-received picture of the PFD.



Figure 1. PFD as-received.

3.1.2. Recording Description

The PFD recording contained records from 8 flight cycles and approximately 16 hours of data. The accident flight was the last one on the recorder. The duration of this power cycle was approximately 37 minutes. Timing of the PFD data is measured in seconds from power-on.

3.1.3. Engineering Units Conversions

Conversion of the PFD data from the raw recorded information to engineering units is performed with conversion factors provided by Avidyne.

Where applicable, changes to the conversions have been made to ensure the parameters conform to the NTSB'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. Time Correlation

Correlation of the PFD data to pacific daylight time (PDT) was established using the recorded GPS time parameter from the PFD data. Recorded GPS time is updated in 6 second intervals on the PFD³. The GPS time is recorded in Universal Coordinated Time (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 seconds from power-on. An offset is applied to each power cycle plotted to display the data with the local time zone. For the event flight the final time offset to reach PDT is -8957.0 seconds from power on time. Therefore, for the rest of this report, all times are referenced as PDT, not recorded time.

3.3. PFD Plots and Corresponding Tabular Data

The following seven figures contain PFD data recorded during the March 28, 2021 event. The data from the event flight lasted approximately 37 minutes.

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

Figure 3 shows a Google Earth map overlay of the full event flight, departing Tucson International Airport (TUS) in Tucson, Arizona from Runway 11L. Note that Google Earth images may not be representative of the atmospheric and weather conditions at the time of the event flight.

Figure 4 shows basic parameters from the entire event flight, from the time the engine was started until the aircraft was at rest following the forced landing. Figure 5 shows engine parameters for the same time frame.

The data shows that the engine was started at 1352:30 PDT and the airplane took off from TUS at about 1407:30 PDT. The aircraft climbed steadily at about 500 fpm on a northwesterly heading for almost 14 minutes, reaching a peak altitude of nearly 9,300 ft.

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 = +.

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.

At 1421:23 PDT the engine decreased in speed and power and airframe accelerations increased in all axes.

Following the loss in engine power airspeed decreased to 94 knots and the aircraft began to descend. The aircraft made a right turn of about 120 degrees to an east-northeasterly heading and continued to descend.

The aircraft touched down at 1428:00 PDT and quickly decelerated to a stop. Final static attitude was recorded as 6.5 degrees right wing down, 6.5 degrees nose up, and on a heading of 135 degrees.

The corresponding tabular data used to create the map overlay and plots are provided in electronic (*.csv⁴) format as Attachment 1 to this report.

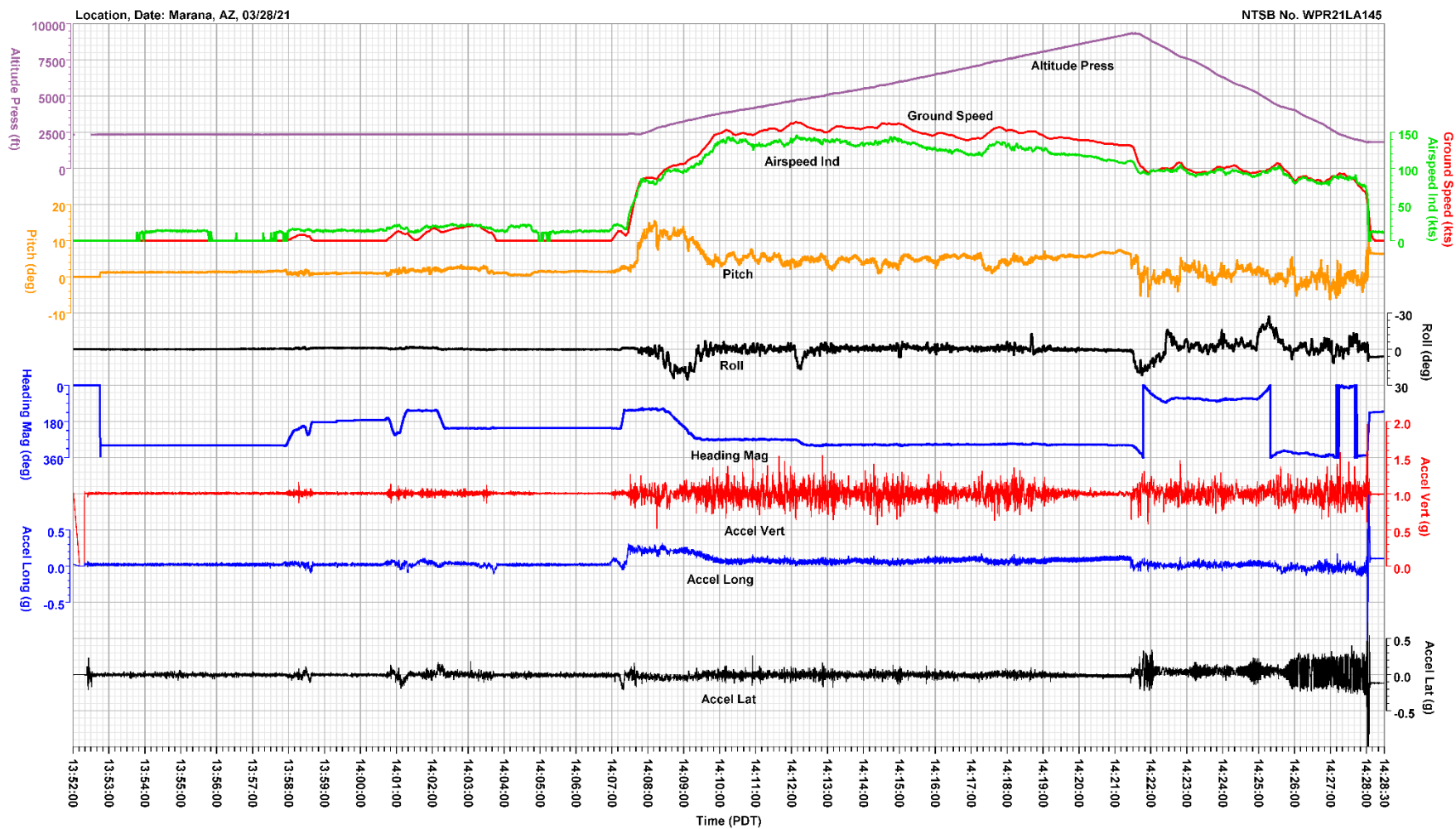
⁴ Comma Separated Value format.

Figure 2. Map overlay of event flight track



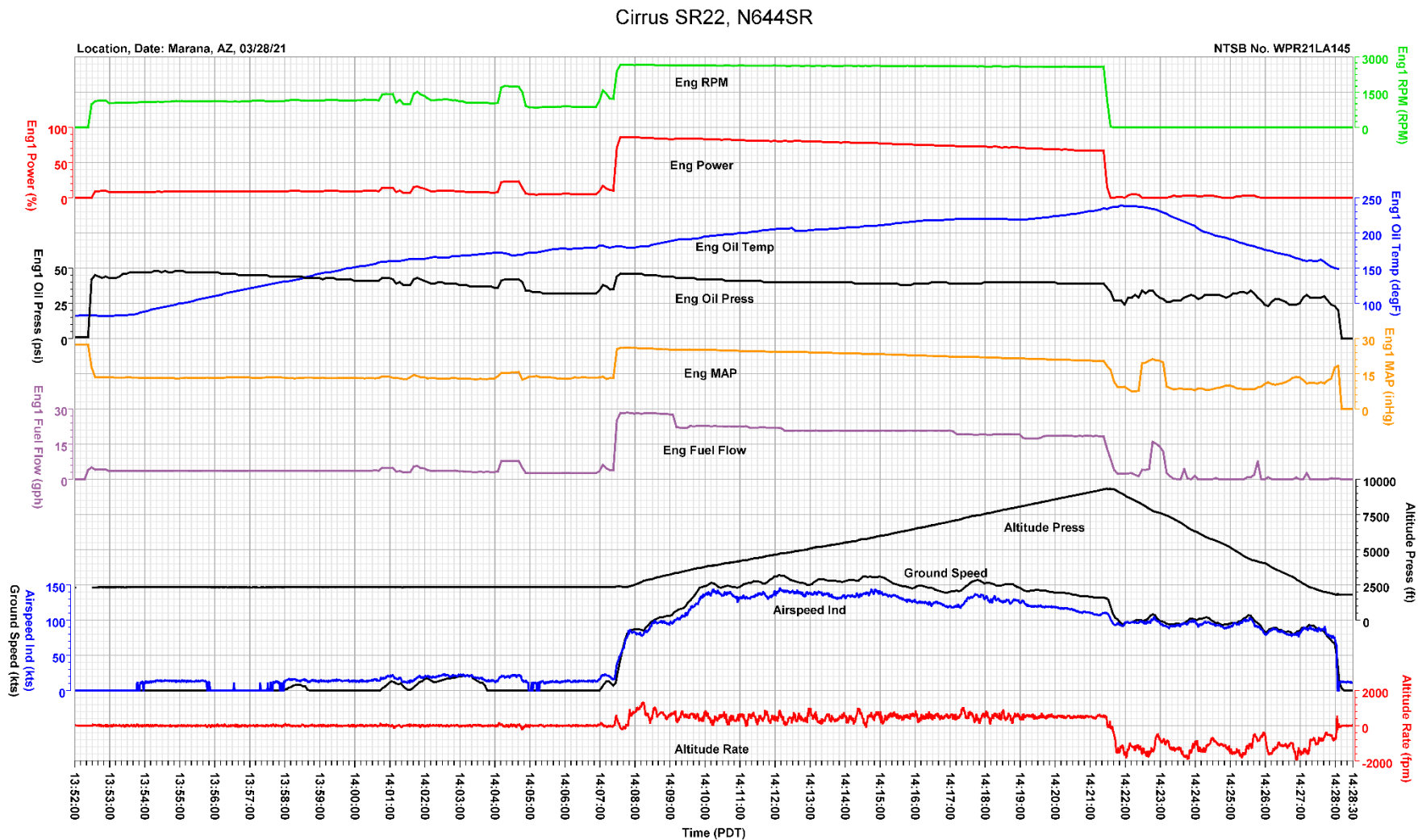
Figure 3. Basic parameters from full accident flight.

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Figure 4. Engine PFD parameters from the entire accident flight.



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APPENDIX A - PFD Parameters

This appendix describes the parameters provided and verified in this report. Table A-1 lists the PFD parameters and table A-2 describes the unit abbreviations used in this report for PFD parameters.

Table A-1 - Verified and provided parameters.

Parameter Name	Parameter Description
1. Accel Lat (g)	Lateral Acceleration
2. Accel Long (g)	Longitudinal Acceleration
3. Accel Vert (g)	Vertical Acceleration
4. Airspeed Ind (kts)	Indicated Airspeed
5. Altitude Press (ft)	Pressure Altitude
6. Altitude Rate (fpm)	Altitude Rate (Vertical Speed)
7. Eng1 Fuel Flow (gph)	Engine Fuel Flow
8. Eng1 MAP (inHg)	Engine Manifold Pressure
9. Eng1 Oil Press (psi)	Engine Oil Pressure
10. Eng1 Oil Temp (degF)	Engine Oil Temperature
11. Eng1 Power (%)	Engine Percent Power
12. Eng1 RPM (rpm)	Engine RPM
13. Ground Speed (kts)	Ground Speed
14. Heading Mag (deg)	Magnetic Heading
15. Latitude (deg)	Latitude
16. Longitude (deg)	Longitude
17. Pitch (deg)	Pitch
19. Roll (deg)	Roll
21. Time - Day (day)	Day
22. Time - Month (month)	Month
23. Time - Year (year)	Year
24. Time UTC Hrs (hrs)	UTC Time Hour
25. Time UTC Min (min)	UTC Time Minute
26. Time UTC Sec (sec)	UTC Time Second

The PFD records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg).

Table A-2 - Unit abbreviations.

Units Abbreviation	Description
%	percent
rpm	revolutions per minute
deg	degrees
degF	Degrees Fahrenheit
ft	feet
fpm	feet per minute

Units Abbreviation	Description
g	units of gravitational acceleration
gph	gallons per hour
hrs	hours
in	inches
kts	knots
psi	pounds per square inch
sec	seconds