

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, D.C. 20594

December 14, 2020

Cockpit Display – Recorded Flight Data

Specialist's Factual Report
By Nick Swann

1. EVENT SUMMARY

Location: Ely, Nevada
Date: February 15, 2019
Aircraft: Cirrus SR22
Registration: N917SR
Operator: Tropical Trading Team LLC
NTSB Number: WPR19FA084

On February 15, 2019, about 1730 Pacific standard time (PST), a Cirrus SR22, N917SR, was destroyed following impact with terrain while maneuvering at a low altitude, about 3.4 nautical miles (nm) north-northeast of Ely Airport (ELY), Ely, Nevada. The private pilot and passenger received fatal injuries. The airplane was registered to and operated by the pilot under the provisions of Title 14 *Code of Federal Regulations* Part 91 as a personal flight. Instrument meteorological conditions prevailed at the time and no flight plan was filed. The flight originated from Craig-Moffat Airport (CAG), Craig, Colorado, about 1525 mountain standard time, and was destined for Twin Falls Regional Airport (TWF), Twin Falls, Idaho.

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: **Unknown**

Recorder Manufacturer/Model: **Avidyne DFC-90 Autopilot**
Recorder Serial Number: **Unknown**

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. The 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 heavily damaged in the accident. The Vehicle Recorder Division received the device in several severely damaged pieces. The printed circuit board containing the non-volatile memory (NVM) was located and is shown below in figure 1. The NVM chips were removed from this board and read using lab equipment.

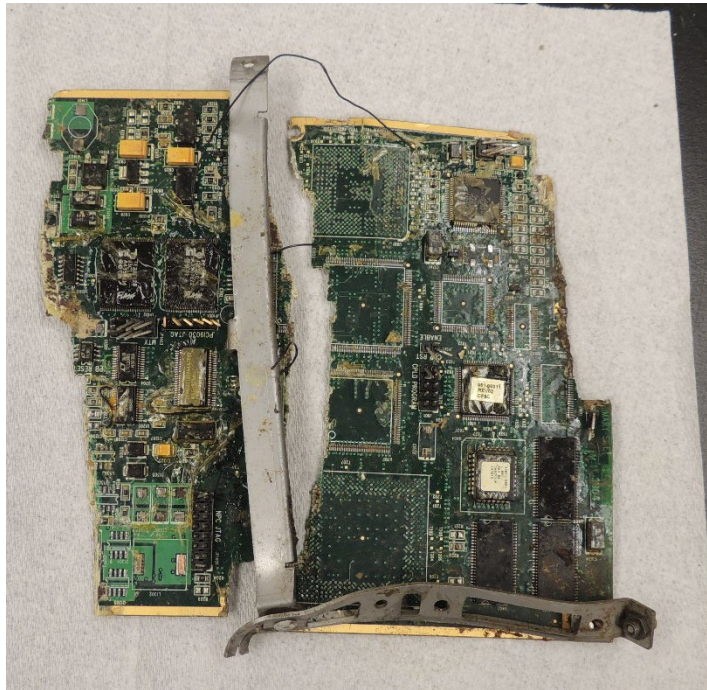


Figure 1. Damage to Avidyne PFD circuitry containing NVM.

3.1.2. PFD Data Description

The PFD recording contained records of 17 power cycles and approximately 10 hours of data. The accident flight was associated with the 17th power cycle¹. The duration of the 17th power cycle was approximately 3 hour and 12 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.

3.1.3. PFD Engineering Units Conversions

Conversion of the PFD data from the raw recorded information to engineering units was performed using conversions developed by the NTSB with the help of the manufacturer. As such, 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 Digital Flight Computer (DFC) Autopilot (AP) Description

The Avidyne DFC-90 is an attitude based flight control system that contains Envelope Protection and Envelope Alerting. Each DFC-90 contains an SD card in a small orange case onboard that records attitudes, attitude rates, and many flight control system related parameters. The data on the DFC-90 is stored sequentially in three sampling rate fidelities in the Common Data Format (CDF) convention.

3.2.1. DFC AP Data Recovery

Upon arrival at the NTSB Vehicle Recorder Laboratory, the DFC-90 Auto Pilot unit showed signs of significant impact damage as shown in figure 2. The device was taken apart and a micro SD card was located within the case of the unit. This SD card was found to contain pertinent flight data and was brought to the manufacturer for download. The condition of the inside of the device and the location of the SD card is shown in figure 3.

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 = +, Right Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +.

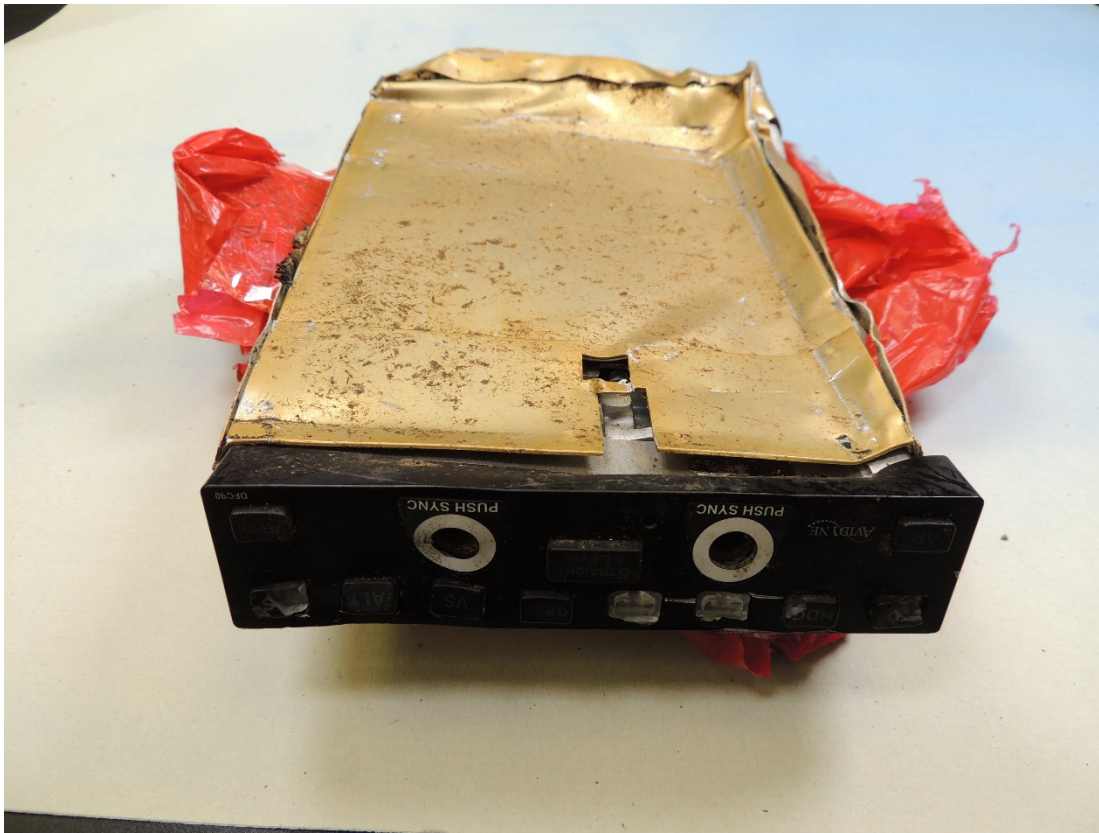


Figure 2. Exterior damage to DFC-90 Auto Pilot head unit.

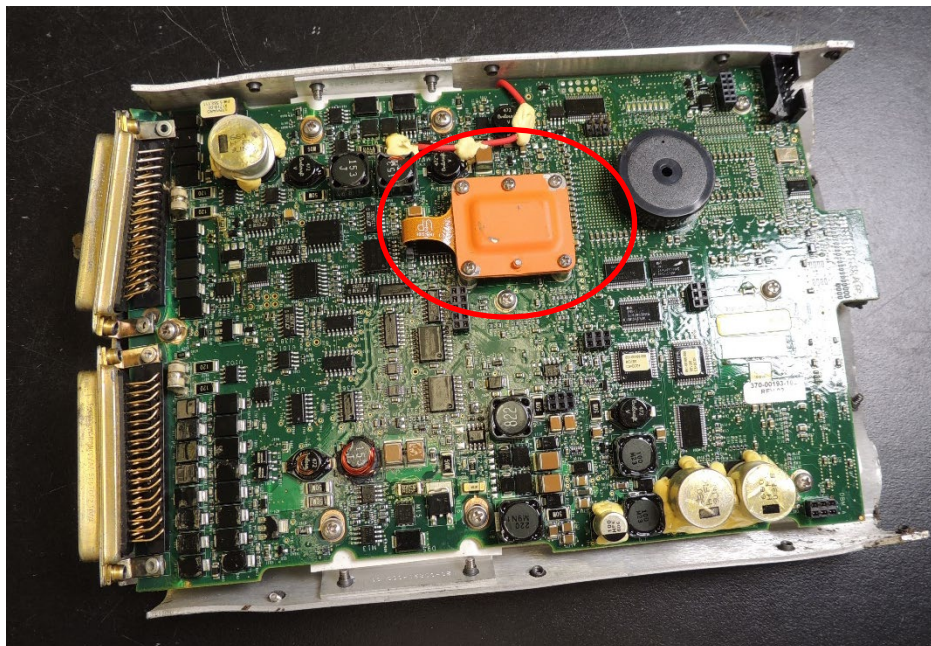


Figure 3. Interior condition of DFC-90 and location of SD card.

3.2.2. DFC AP Data Description

The data extracted from the DFC-90 contained 14 high fidelity CDF files, 51 medium fidelity CDF files, and 363 low fidelity CDF files. The high fidelity files contain data labeled from

December 20, 2018, to February 15, 2019. The medium fidelity files contain data labeled from August 28, 2018 to February 15, 2019. The low fidelity files contain data labeled from March 26, 2015 to February 15, 2019. The high fidelity data from the accident flight was converted from a CDF file to a MATLAB variable file by Avidyne. This data was then processed by the Vehicle Recorder Laboratory into a comma separated format (csv³).

3.2.3. DFC AP Engineering Units Conversions

The data was converted from its raw form to engineering units using specifications provided by the manufacturer.

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=+).

3.3. Time Correlation

Correlation of the PFD data to Pacific standard time (PST) was established using the recorded GPS time parameter from the PFD data. Recorded GPS time is updated in 6 second intervals on the PFD⁴. The GPS time is recorded in Universal Coordinated Time (UTC). The difference between PST and UTC is 8 hours, or 28,800 seconds. The PFD starts recording when power is applied to the unit. For the rest of this report, all times are referenced as PST.

3.4. Plots and Corresponding Tabular Data

The following four figures contain data recorded during the accident flight. Data relevant to the accident investigation was recorded in duplicate by the PFD and the DFC-90. For the following plots, only data from the PFD was used.

Figure 4 shows basic flight parameters for the duration of the accident flight.

Figure 5 shows basic flight parameters for the last 10 minutes of the accident flight.

Figure 6 shows a Google Earth overlay of the flight path for the entire accident flight.

Figure 7 shows a Google Earth overlay of the flight path for the end of the accident flight.

Figure 8 shows a Google Earth overlay of the flight path during a sequence of the accident flight where the aircraft had a very slow airspeed.

The lighting and weather conditions shown in Google Earth overlays are not representative of the lighting and weather conditions present during the accident flight.

The corresponding tabular data used to create these four plots are provided in electronic (*.csv) format as Attachment 1 to this report.

³ Comma Separated Value format.

⁴ 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.

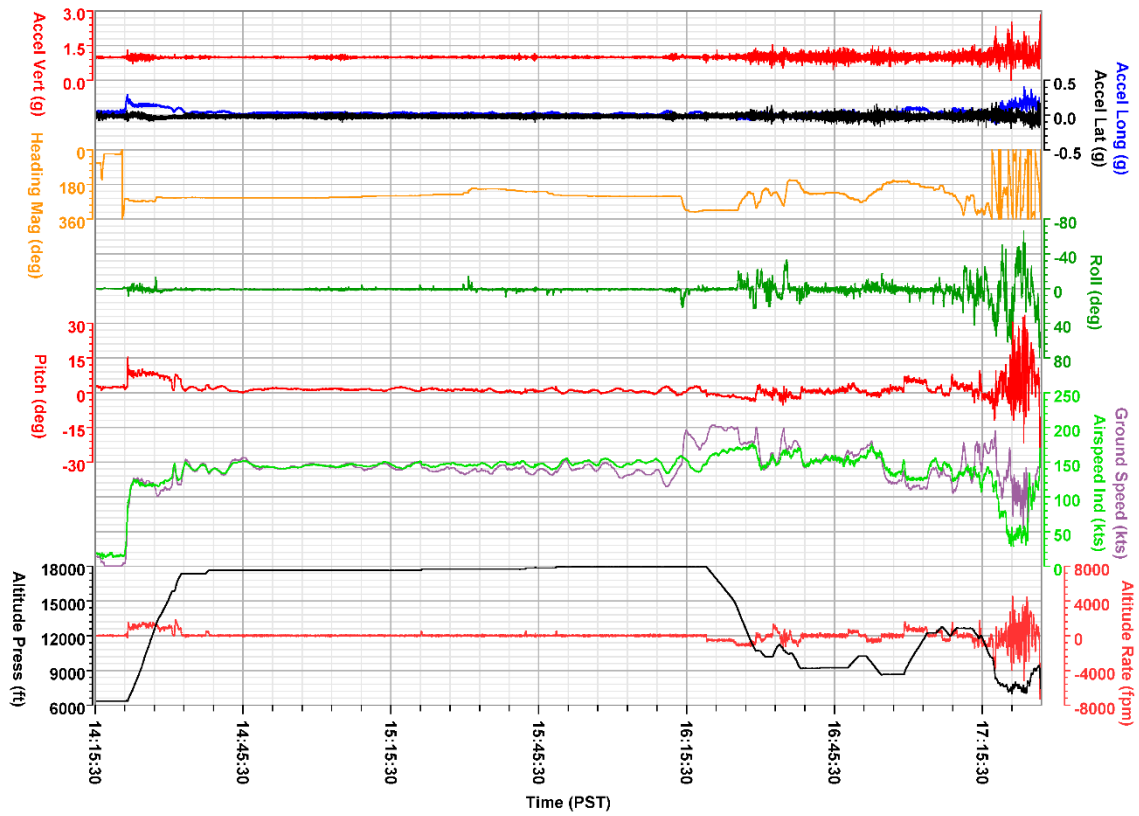


Figure 4. Plot of basic parameters during entire flight.

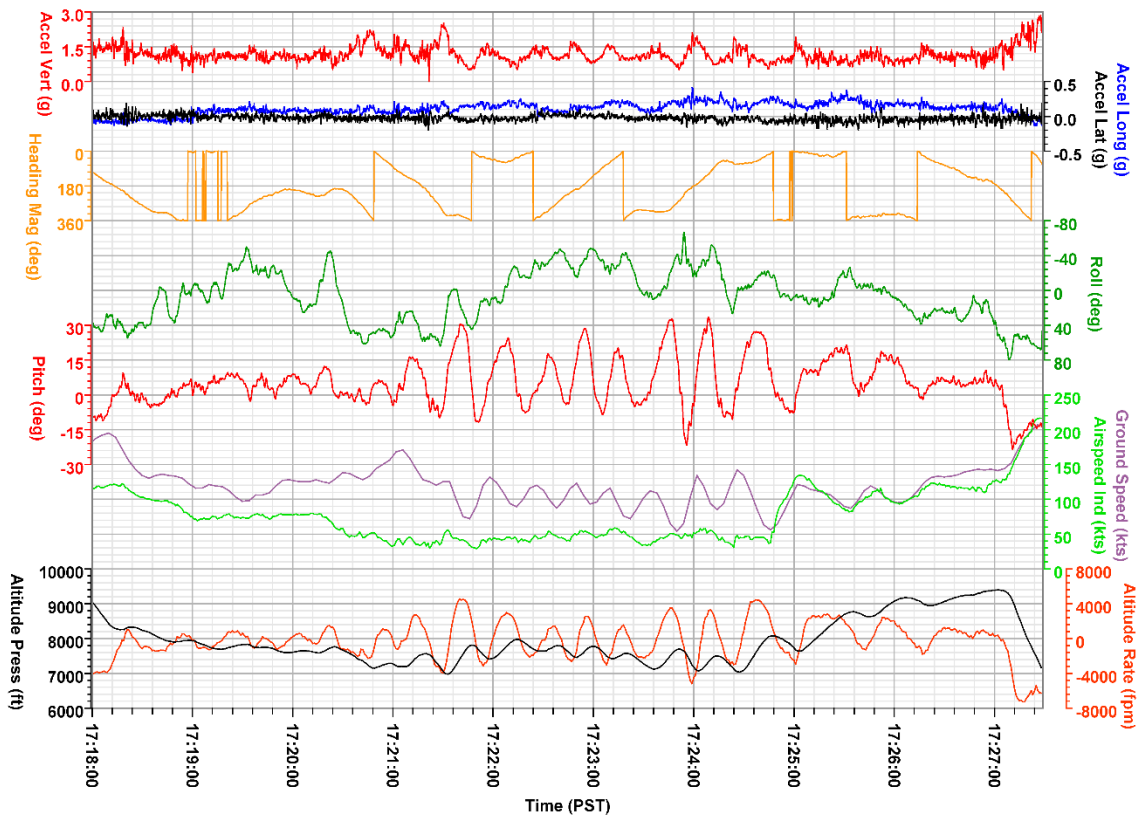


Figure 5. Plot of basic parameters during the last 10 minutes of recorded flight.

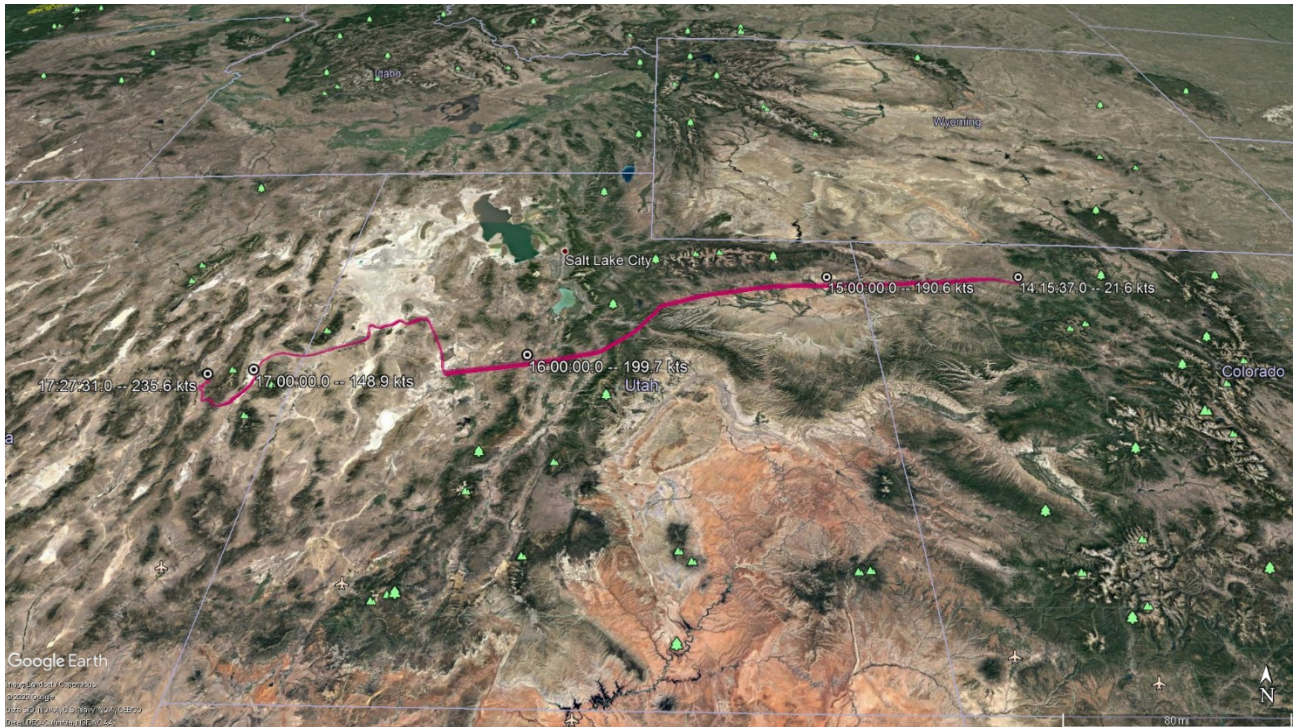


Figure 6. Google Earth overlay of flight path during entire flight.



Figure 7. Google Earth overlay of flight path during the end of the accident flight.



Figure 8. Google Earth overlay of flight path during a period of slow flight.

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	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
Altitude Rate (fpm)	Altitude Rate (Vertical Speed)	PFD
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

The PFD records 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.

Table A-2 - Unit abbreviations.

Units Abbreviation	Description
deg	degrees
ft	feet
fpm	feet per minute
g	acceleration due to gravity
kts	knots
sec	seconds

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