

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

March 8, 2017

Cockpit Displays – Recorded Flight Data

Specialist's Factual Report
By James Cash

1. EVENT SUMMARY

Location: Watertown, Wisconsin
Date: December 27, 2015
Aircraft: Cirrus SR22
Registration: N5PF
Operator: Private
NTSB Number: CEN16LA069

On December 27, 2015, about 1656 central standard time, a Cirrus SR22 airplane, N5PF, was substantially damaged during ground impact after departing from the Watertown Municipal Airport (RYV), Watertown, Wisconsin. The pilot, the sole occupant, sustained serious injuries. The airplane was registered to and operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. Night visual meteorological conditions prevailed for the flight, which was on an instrument flight rules (IFR) flight plan with a destination of Kenosha Regional Airport (ENW), Kenosha, Wisconsin.

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: **21668086**

Recorder Manufacturer/Model: **Avidyne MFD**
Recorder Serial Number: **25356066**

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

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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.

3.1.1. PFD Data Recovery

The recorder was in good condition and the data were downloaded using the manufacturer's procedure

3.1.2. PFD Data Description

The PFD recording contained records of 11 power cycles and approximately 18 hours of data. The event flight was associated with the 11th power cycle. The duration of the 11th power cycle was approximately 47 minutes. Timing of the PFD data is measured in seconds from power-on.

As stated in section 3.1, the PFD records most data at regular time intervals. The recorded data has shown, at times, to drop data records for up to 6 seconds in duration. The dropout condition has been reported to the manufacturer of the PFD. The condition that causes the dropouts is related to time overruns in the low-priority data logging code, which results in the input buffer overflowing. In later PFD software versions, if a drop-out occurs, an event is recorded in the event log.

3.1.3. PFD Engineering Units Conversions

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=+).¹

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

3.2. 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.

¹ 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 = +.

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.

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 are 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.

3.2.1. MFD Data Recovery

The recorder was in good condition and the data were downloaded using the manufacturer's procedure

3.2.2. MFD Data Description

The MFD CF card contained 94 data files. One data file was identified as recording during the event flight. The data file was approximately 46 minutes in duration

3.2.3. MFD Engineering Units Conversions

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

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

3.3. Time Correlation

Correlation of the PFD and MFD data to Central Standard time was established using the recorded GPS time parameter from the PFD data. Therefore, for the rest of this report, all times are referenced as Central Standard time.

3.4. Plots and Corresponding Tabular Data

The following two figures contain data recorded during the December 27, 2015 event.

Figure 1 depicts selected MFD and PFD recorded data from the entire accident flight. Figure 2 depicts the same data but for only the last 17 minutes of the event flight.

The corresponding tabular data used to create these two figures are provided in electronic (*.csv²) format as Attachment 1 to this report.

² Comma Separated Value format.

Figure 1. Plot of MFD and PFD data of entire event flight.

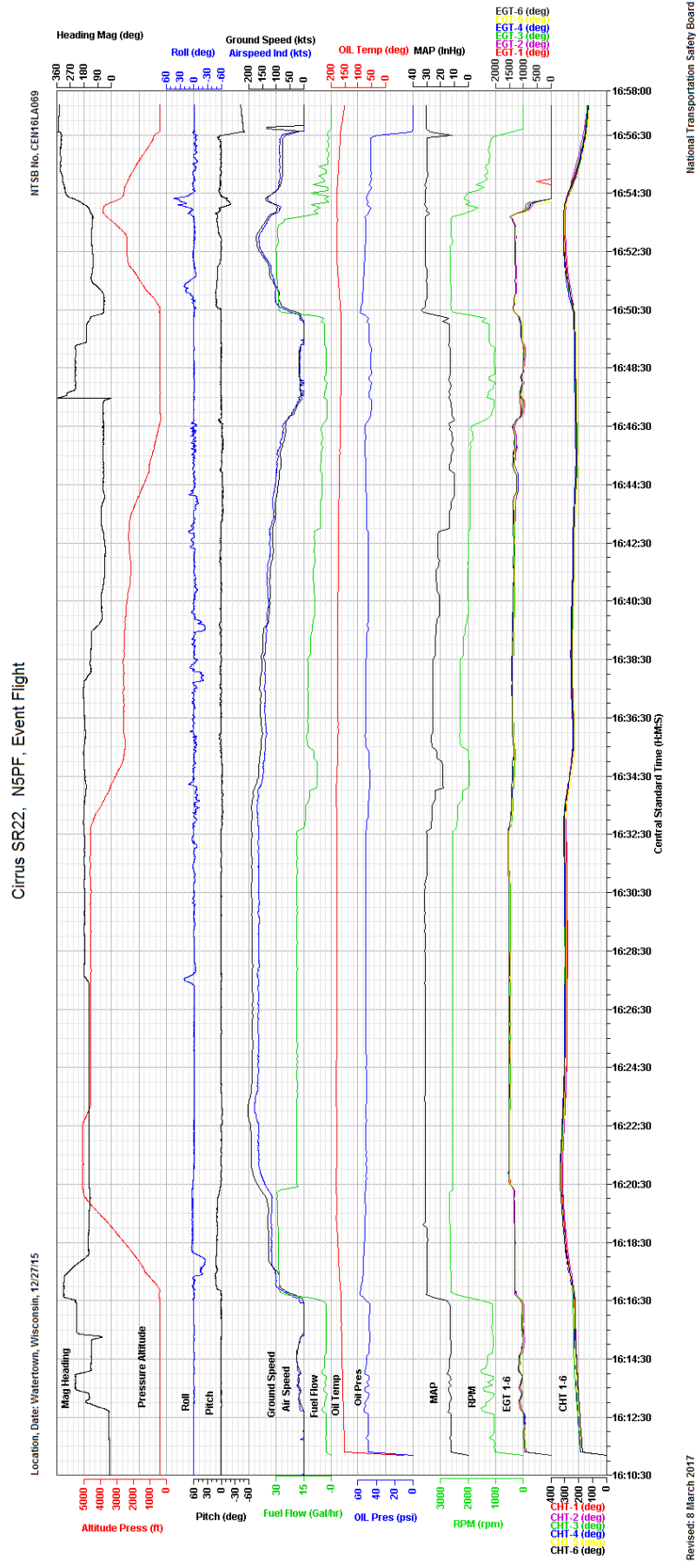
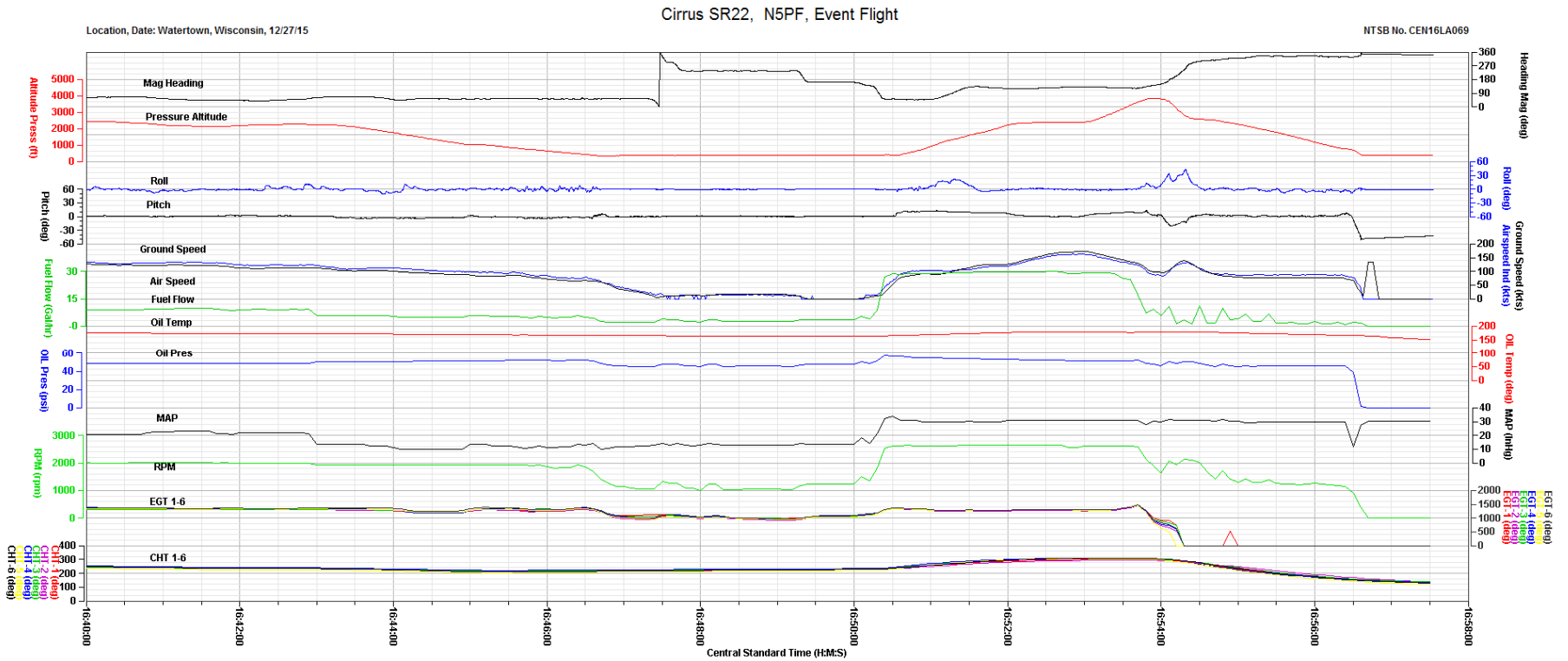


Figure 2. Plot of MFD and PFD data during last 17 minutes of event flight.



Revised: 8 March 2017

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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	Source
Accel Vertical	Acceleration Vertical	PFD
Accel Long	Acceleration Longitudinal	PFD
Accel Lat	Acceleration Lateral	PFD
Airspeed Ind (kts)	Indicated Airspeed	PFD
Airspeed True (kts)	True Airspeed	PFD
Altitude Bug (ft)	Altitude Selector Bug	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
Heading Bug (deg)	Heading Bug	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
%	percent
rpm	revolutions per minute
A	Amperes
deg	degrees
char	one character (A-Z, 0-9)
deg/min	degrees per minute
deg/sec	degrees per second
degC	degrees Celsius

Units Abbreviation	Description
degF	degrees Fahrenheit
discrete	discrete
ft	feet
gal	gallons
gph	gallons per hour
hrs	hours
in	inches
inHg	inches of Mercury
kts	knots
psi	pounds per square inch
sec	seconds
V	Volts DC

APPENDIX B - MFD Parameters

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

Table B-1 - Verified and provided parameters.

Parameter Name	Parameter Description
AMP1-MFD (A)	Bus 1 Amps (amps)
AMP2-MFD (A)	Bus 2 Amps (amps)
AMPB-MFD (A)	Battery Bus Amps (amps)
CHT Cyl#-MFD (degF)	Cylinder Head Temperature Cylinder # ³ (degrees Fahrenheit)
EGT Cyl#-MFD (degF)	Exhaust Gas Temperature Cylinder # ³ ⁴ (degrees Fahrenheit)
Fuel Flow-MFD (gph)	Fuel Flow (gallons per hour)
Fuel Used-MFD (gal)	Fuel Used (gallons)
MAP-MFD (inHg)	Manifold Pressure (inches of mercury)
Oil Pressure-MFD (psi)	Oil Pressure (pounds per square inch)
Oil Temp-MFD (degF)	Oil Temperature (degrees Fahrenheit)
RPM-MFD (rpm)	Revolutions Per Minute (revolutions per minute)
Ess Bus-MFD (V)	Essential Bus Voltage (Volts)
Main Bus-MFD (V)	Main Bus Voltage (Volts)
Temp OAT-MFD (degC)	Outside Air Temperature (degrees Celsius)

Table B-2 - Unit abbreviations.

Units Abbreviation	Description
rpm	revolutions per minute
A	Amperes
deg	degrees
degC	degrees Celsius
degF	Degrees Fahrenheit
gal	gallons
gph	gallons per hour
inHg	inches of Mercury
sec	seconds
V	Volts DC

³ Depending on aircraft configuration, the number of cylinders that are instrumented varies. In the data plots the '#' is replaced with the appropriate cylinder ID.

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