

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, DC 20594

July 8, 2016

Cockpit Displays – Recorded Flight Data

Specialist's Factual Report
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1. EVENT SUMMARY

Location: Navasota, Texas
Date: February 28, 2016
Aircraft: Cirrus SR20
Registration: N477TC
Operator: Private
NTSB Number: CEN16FA111

On February 28, 2016, about 0859 central standard time (CST), a Cirrus SR20, registration N477TC, collided with terrain following a loss of control in Navasota, Texas. The airline transport rated pilot/certificated flight instructor, a passenger receiving instruction, and two other passengers were fatally injured. The airplane was substantially damaged. The airplane was registered to Air Akhtar Heating & Air Conditioning LLC and was operated by an individual under the provisions of 14 *Code of Federal Regulations* Part 91 as a personal flight. Visual meteorological conditions prevailed and no flight plan was filed. The flight originated from the David Wayne Hooks Airport (DWH), Spring, Texas, at 0818.

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 Entegra Primary Flight Display (PFD)**
Recorder Serial Number: **1271**

Recorder Manufacturer/Model: **Compact Flash (CF) Card**
Origin of Device: **Avidyne Entegra Multi-Functional Display (MFD)**

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

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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.

3.1.1. Avidyne PFD Data Recovery

A visual inspection of the Avidyne PFD exterior revealed impact damage including a cracked screen (Figure 1). Additional effects of impact disabled the ability to read data from the PFD under normal procedures, so an extraction of the interior memory module was performed.



Figure 1. Avidyne PFD as received.

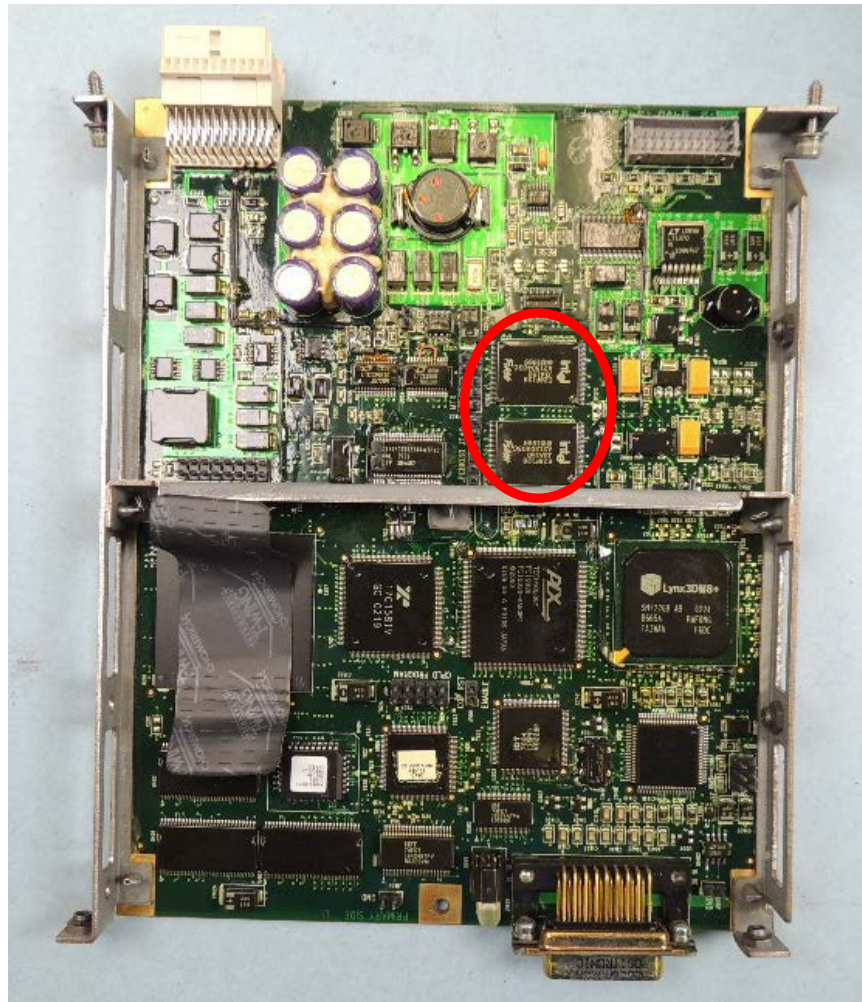


Figure 2. Interior view of Avidyne PFD memory module (memory devices circled).

3.1.2. Avidyne PFD Data Description

The PFD memory contained 16 recorded sessions. The accident flight was identified as the last session recorded by comparing the recorded GPS position data with the known route that was flown by the aircraft because the recorded date parameters contained invalid data. The PFD manufacturer believes this to be the result of an undocumented change to the ARINC 429 output from the GPS that did not affect the performance of the PFD. The recorded time of day parameters appeared to be recorded properly.

3.1.3. Avidyne PFD Engineering Units Conversions

Conversion of the PFD data from the raw recorded information to engineering units was performed by the PFD 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=+).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.

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. Avidyne MFD Data Recovery

The internal CF memory card (Figure 3) from the Avidyne MFD had no exterior damage, however the memory card did not contain any data. While the MFD software included engine monitoring and recording capability, the aircraft was not equipped with an engine interface device.

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 = +.



Figure 3. Internal CF Card from Avidyne MFD.

3.3. Time Correlation

Correlation of the PFD data to CST was established using the recorded GPS time parameter from the PFD data. Recorded GPS time is updated in 6 second intervals on the PFD.² The GPS time is recorded in Universal Coordinated Time (UTC). An offset of 6 hours was subtracted from the GPS recorded time to obtain the local CST.

3.4. Plots and Corresponding Tabular Data

Figure 4 is an overlay of the recorded flight path from the accident from 0818 CST to 0859 CST. It displays the aircraft's departure from Runway 17R of David Wayne Hooks Airport (DWH) and the maneuvers leading up to the accident on at Navasota Municipal Airport (60R). Figure 5 shows the traffic patterns flown in the twenty minutes prior to the accident.

Figure 6 shows basic flight data recorded during the accident flight. Figure 7 shows basic flight data from the last 2 minutes of the accident flight, starting at 0857 CST.

Figure 8 shows several data validity flags recorded during the last 2 minutes of the accident flight.

The aircraft departed Hooks Airport at 0818 CST and initially climbed to about 1300 feet on a northwesterly heading. As the aircraft approached Navasota Municipal Airport, it descended and performed a touch and go or a low pass at about 0839 CST and another at 0842 CST. At 0845 CST, the aircraft landed on runway 17 and taxied back for a departure from runway 17. At 0854 CST, the aircraft landed again on runway 17. The aircraft taxied back to runway 17 and departed at 0858:00 CST. At 0859:02, while the aircraft was climbing through 550 feet and 92 knots indicated airspeed, it began to roll to the left and decelerate. Starting at 0859:06 CST, the aircraft started to pitch down and descend. At 0859:13 CST, the aircraft had reached 61° left wing down before starting a rapid roll to the right, through the inverted position. At about the same time, the aircraft began a rapid pitch down, reaching 69° nose down. The aircraft briefly recovered to nearly wings level 0859:18 CST, but began to pitch down until the final data point was recorded at 0859:19 CST with

² 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.

an aircraft attitude of 65° nose down and 45° right wing down at 268 feet and 89 knots indicated airspeed.

At 0859:16 CST, about 2 to 3 seconds after the roll and pitch excursions began, the AHRS goNoGo – Heading Flag and AHRS goNoGo – Flag discrete parameters indicated that the attitude and heading information displayed to the pilot was replaced by a red “X” which specified that the data was no longer valid for display. At 0859:17 CST, the recorded data indicate that the pilot received a message to fly straight and level for 10 seconds and press the “FAST ERECT” button, at which point the attitude data would be restored.

The corresponding tabular data used to create these four plots are provided in electronic (*.csv³) format as Attachment 1 to this report.

³ Comma Separated Value format.

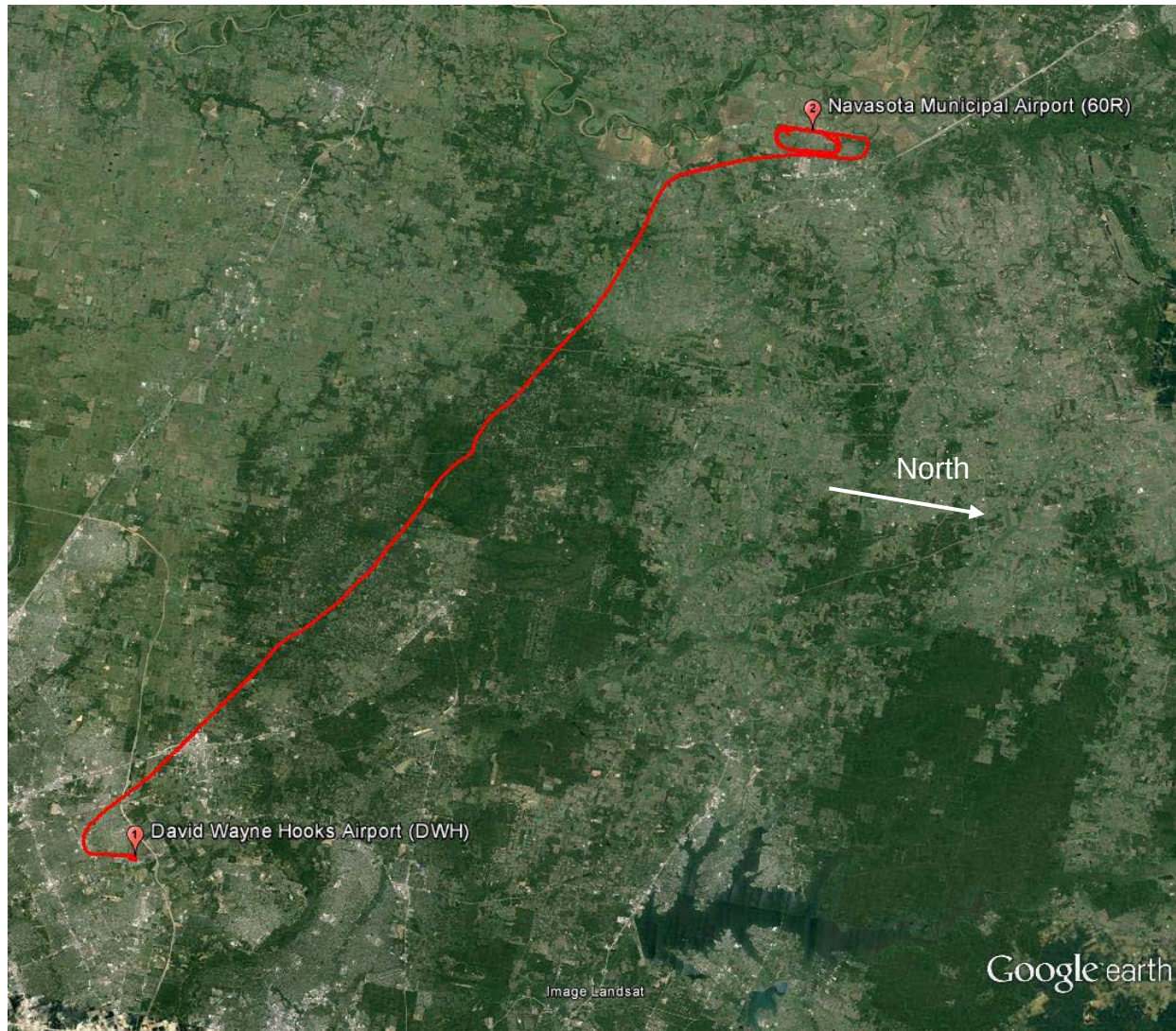


Figure 4. Overlay of the entire accident flight path.

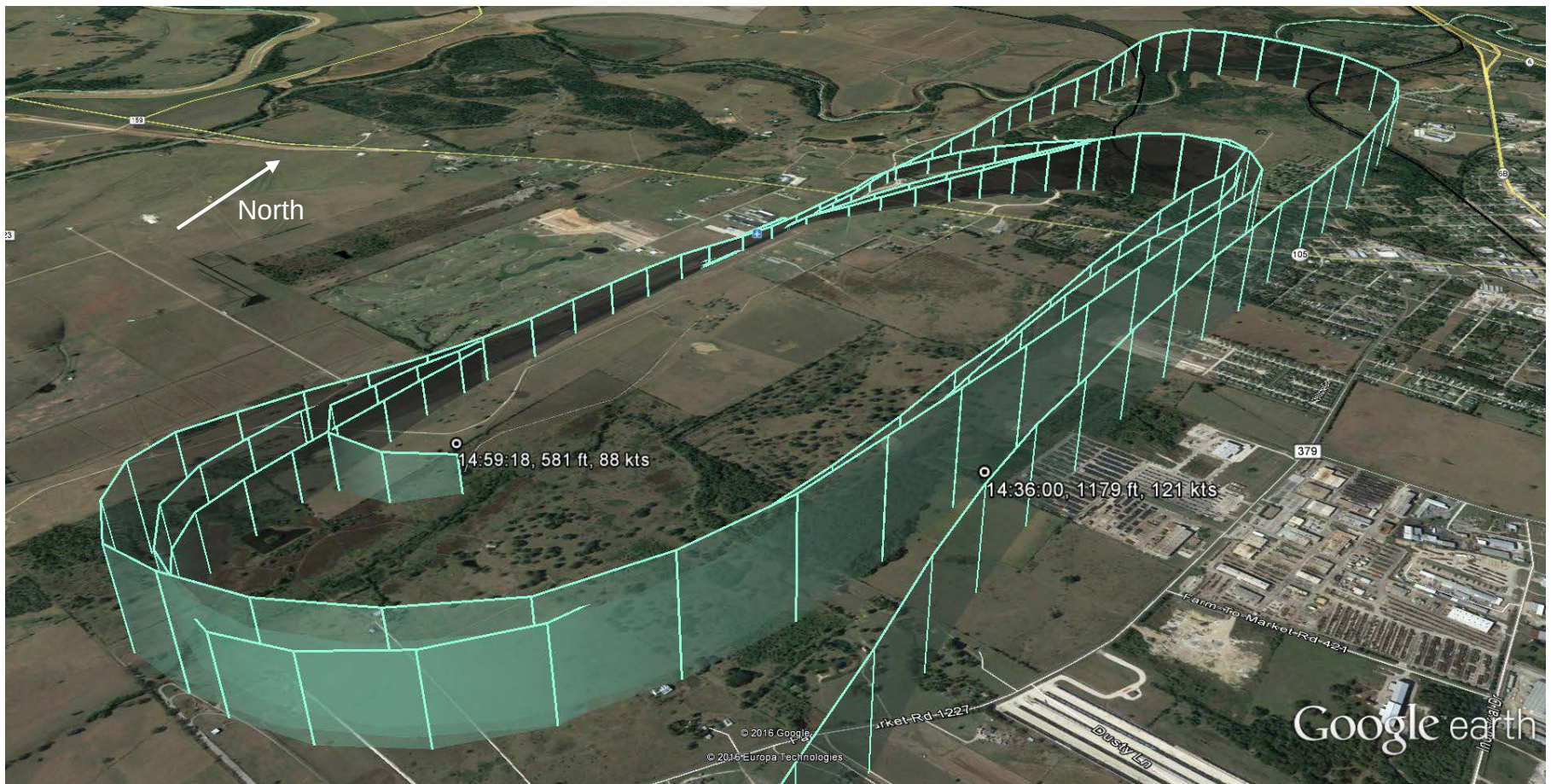


Figure 5. Traffic patterns flown prior to accident (barometric altitude).

Private, Cirrus SR20, N477TC

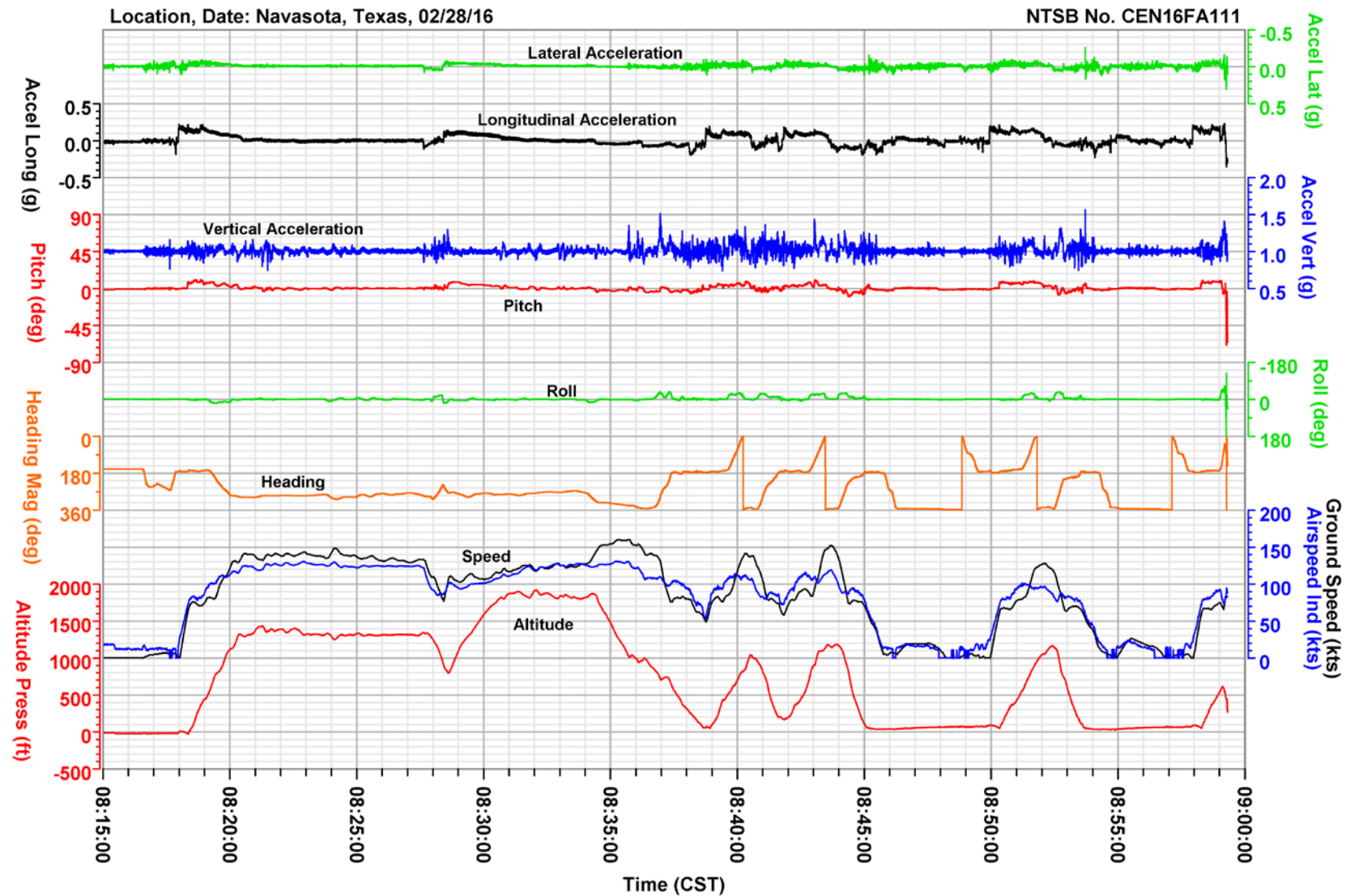


Figure 6. Basic flight data from entire accident flight.

Private, Cirrus SR20, N477TC

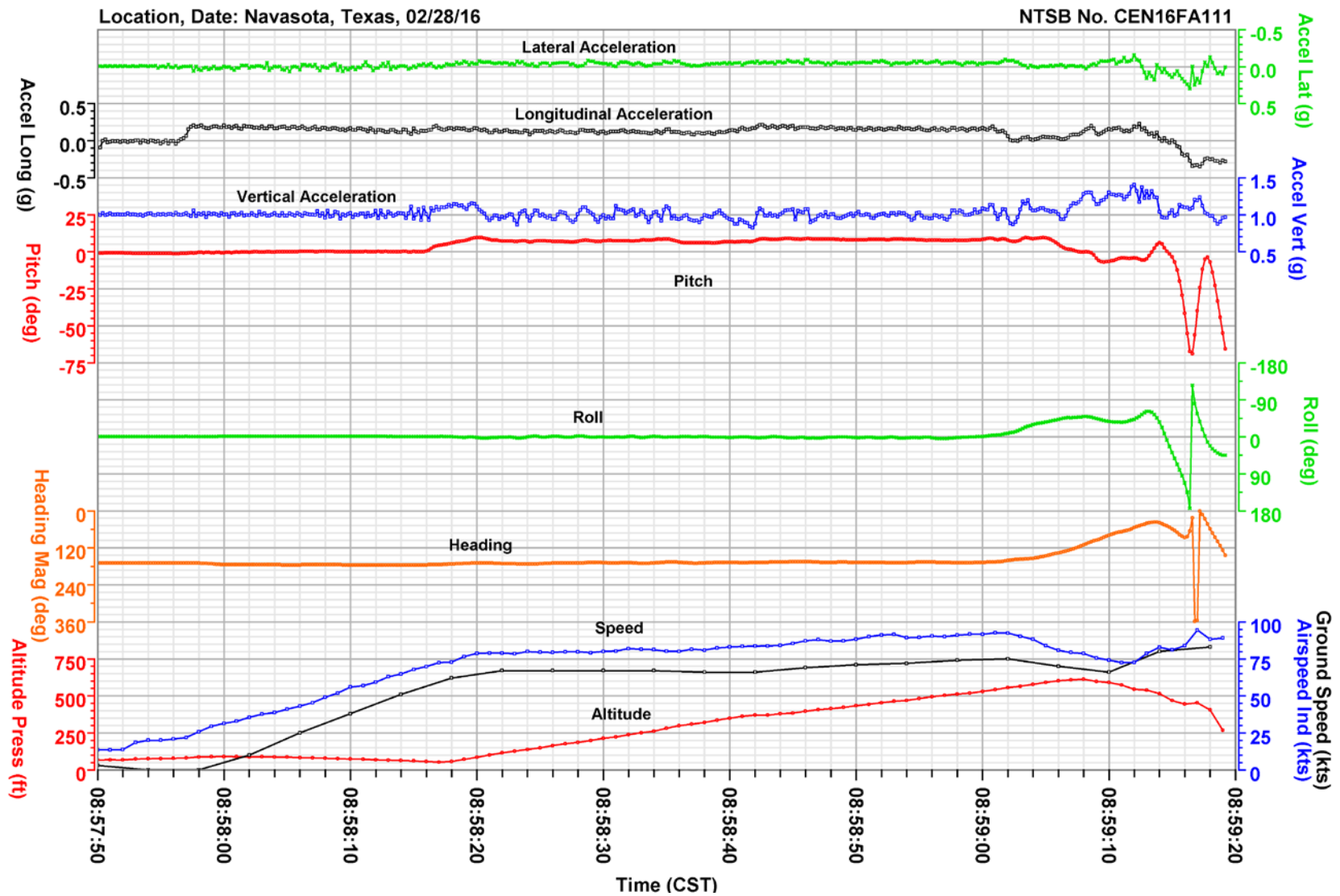


Figure 7. Basic flight data from end of flight.

Private, Cirrus SR20, N477TC

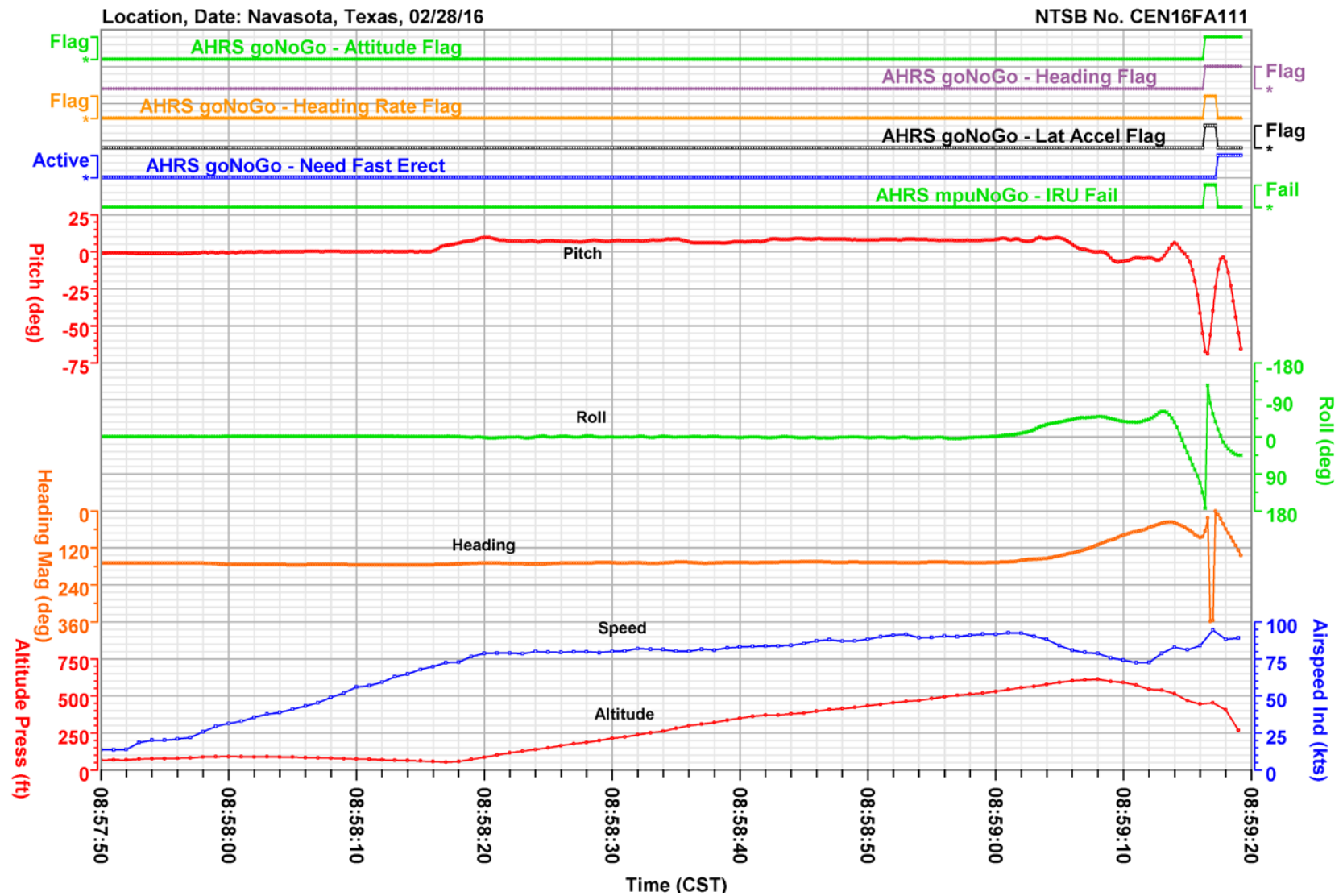


Figure 8. Flag data during end of flight.

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 PFD parameters.

Parameter Name	Parameter Description
Accel Lat (g)	Lateral Acceleration
Accel Long (g)	Longitudinal Acceleration
Accel Vert (g)	Vertical Acceleration
AHRS goNoGo - Attitude Flag (discrete)	AHRS Attitude Validity Flag
AHRS goNoGo – Heading Flag (discrete)	AHRS Heading Validity Flag
AHRS goNoGo – Heading Rate Flag (discrete)	AHRS Heading Rate Validity Flag
AHRS mpuNoGo - IRU Fail (discrete)	AHRS IRU Status Flag
AHRS goNoGo – Lat Accel Flag (discrete)	AHRS Lateral Acceleration Validity Flag
AHRS goNoGo – Need Fast Erect (discrete)	AHRS Fast Erect Mode Status
Airspeed Ind (kts)	Indicated Airspeed
Altitude Press (ft)	Pressure Altitude
Baro Bug (inHg) ^A	Altimeter Setting
Ground Speed (kts)	Ground Speed
Heading Mag (deg)	Heading
Latitude (deg) ^A	Latitude
Longitude (deg) ^A	Longitude
Pitch (deg)	Pitch
Roll (deg)	Roll
Time UTC Hrs (hr)	Time UTC Hrs
Time UTC Min (min)	Time UTC Min
Time UTC Sec (sec)	Time UTC Sec

^A Indicates parameter is available in tabular data only

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
deg	degrees
ft	feet
g	gravitation acceleration
inHg	inches of Mercury
kts	knots
hr	hours
min	minutes
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.