

National Transportation Safety Board

Office of Research and Engineering

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COCKPIT DISPLAYS

Specialist's Factual Report

September 19, 2023

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A. ACCIDENT

Location: Cornelia, Georgia
Date: November 29, 2021
Time: 1447 eastern standard time (EST)
Airplane: Piper PA46, N172MA

B. COCKPIT DISPLAYS SPECIALIST

Specialist David L. Case
Computer Engineer / Vehicle 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 displays:

Recorder Manufacturer/Model: Avidyne Entegra PFD
Part Number: 700-00006-003
Recorder Serial Number: 20097417

Recorder Manufacturer/Model: Avidyne Entegra MFD
Part Number: 710-00030-005
Recorder Serial Number: 21687186

1.0 Avidyne Primary Flight Display Description

The Avidyne 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. 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. 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 was damaged in the event. The extent of the damage is shown in figure 1. The screen was broken but the unit powered on, data were able to be downloaded, and the log for the accident flight was sent to Avidyne to be decoded.



Figure 1. Avidyne PFD, as received.

1.2 Avidyne PFD Recording Description

The duration of the power cycle for the last flight was approximately 1 hour and 45 minutes. Timing of the PFD data is measured in seconds from power-on.

As stated in section 1.0, the PFD records most data at regular time intervals.

1.2.1 Avidyne PFD Engineering Unit Conversions

Conversion of the PFD data from the raw recorded information to engineering units was performed by Avidyne. Acceleration data, as provided by Avidyne, was converted from meters per second-squared (m/s^2) to standard acceleration units (g).

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=+).¹

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

1.3 Avidyne PFD Time Correlation

Correlation of the PFD data to EST 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 coordinated universal time (UTC). The difference between EST and UTC is 5 hours, or 18,000 seconds. The PFD starts recording when power is applied to the unit. Each power cycle 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 EST, not recorded time.

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 the actual GPS time.

2.0 Avidyne Multi-Function Display Description

The Avidyne multi-function display (MFD) unit can display checklists, 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 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 = +, Right Rudder = +.

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.

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 data 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 was in good condition and the data were downloaded using the manufacturer's procedure. (figures 2 and 3)



Figure 2. Avidyne MFD, as received.



Figure 3. Compact flash card as removed from MFD.

2.2 Avidyne MFD Recording Description

The MFD CF card contained 84 data files. One data file was identified as recorded during the accident flight. The data from this device were reviewed and, in consultation with the Investigator-In-Charge (IIC), it was determined that the data was not pertinent to the investigation. Therefore, no data from the MFD was used in this report.

D. FIGURES AND TABULAR DATA

Figures 1 and 2 contain PFD data recorded during the event on November 29, 2021. All the parameters listed in table 1 are plotted except for Latitude and Longitude.

Figure 1 shows data from the entire accident flight. The takeoff from Destin Executive Airport, cruise flight, and the approach to Habersham County Airport can be seen.

Figure 2 shows the final accident sequence at Habersham County Airport. Lines showing the recommended approach speed from the Pilot Operator's Handbook (POH), and landing configuration stall speed (V_{so}) are overlaid on the data.

Figure 3 is a map overlay of the whole flight. Map imagery is taken from Google Earth and is not indicative of the actual weather or lighting conditions on the accident day.

Figure 4 is a map overlay of the accident sequence at Habersham County Airport in Google Earth. Indicated airspeed for each recorded position is shown. The

third from the last GPS position recorded was not consistent with the expected track of the aircraft likely due to filtering or the loss of GPS signal.

Figures 1 and 2 are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

The corresponding tabular data used to create figures 1 through 4 are provided in electronic comma-separated value (CSV) format as attachment 1 to this report.

Submitted by:

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Piper PA46, N172MA

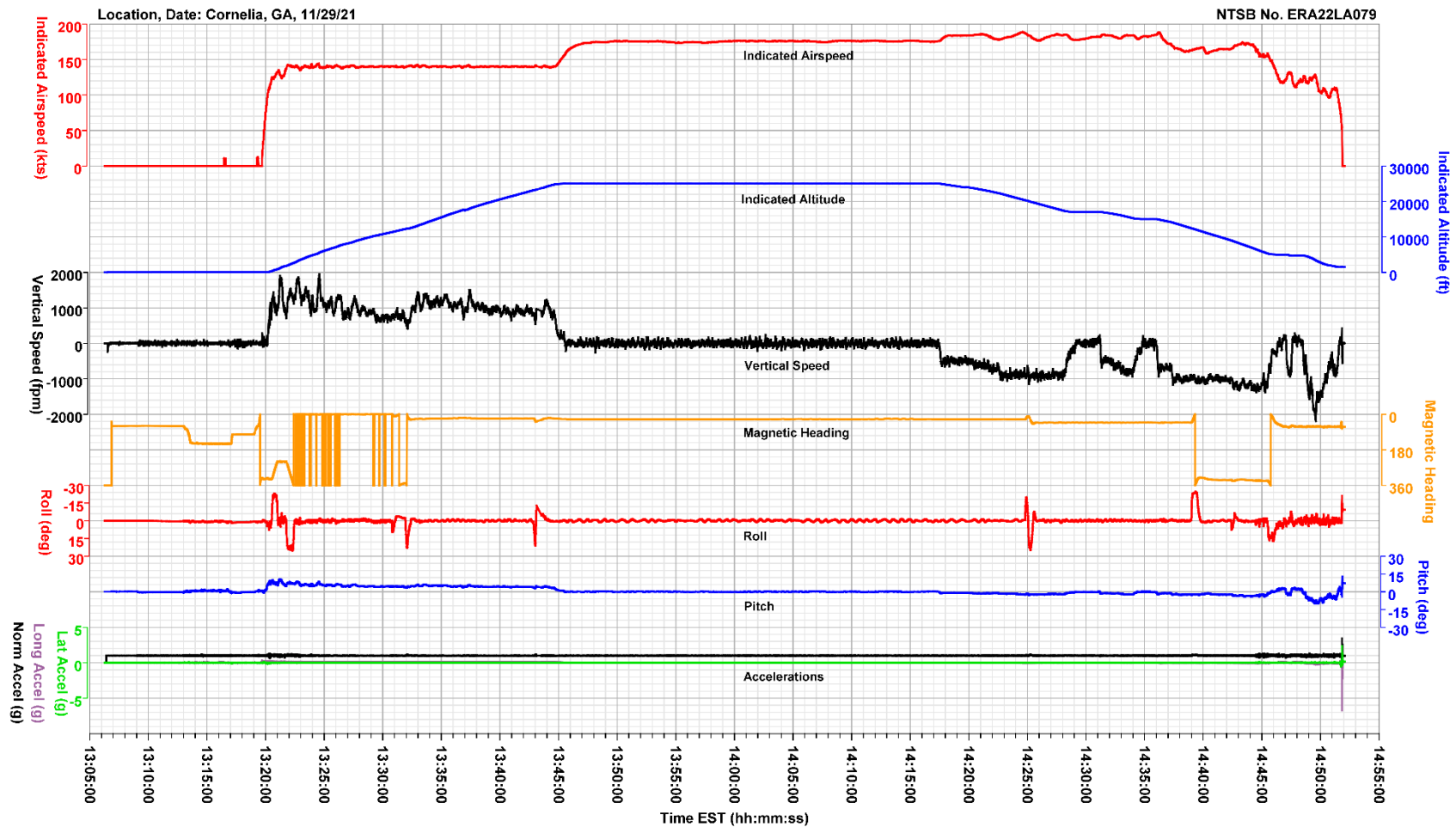
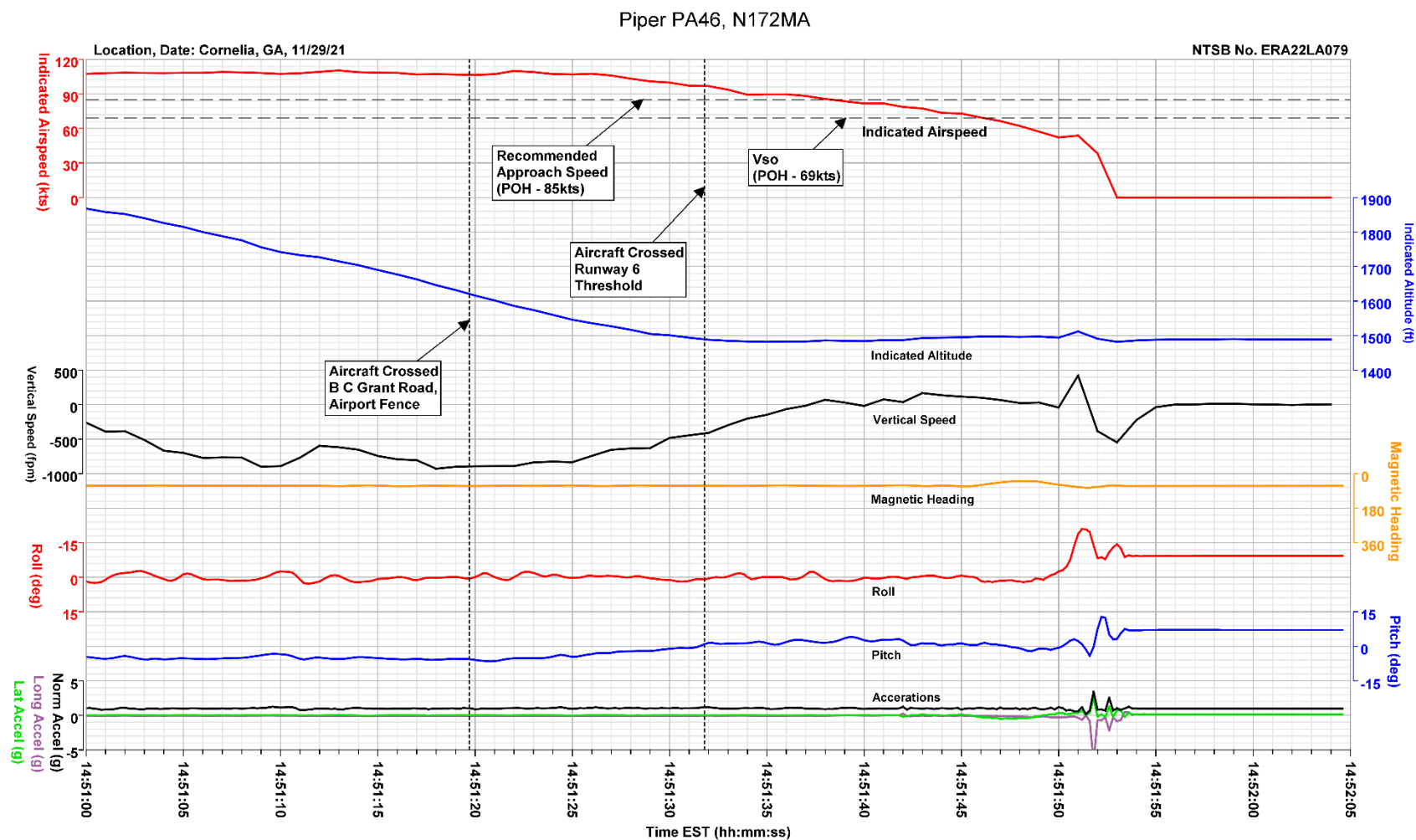


Figure 4. Overview of recorded data during the entire flight from 13:07:16 to 14:52:06 EST.



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Figure 5. Plot of recorded data at the end of the flight from 14:51:00 to 14:52:05 EST.



Figure 6. Whole flight map overlay.

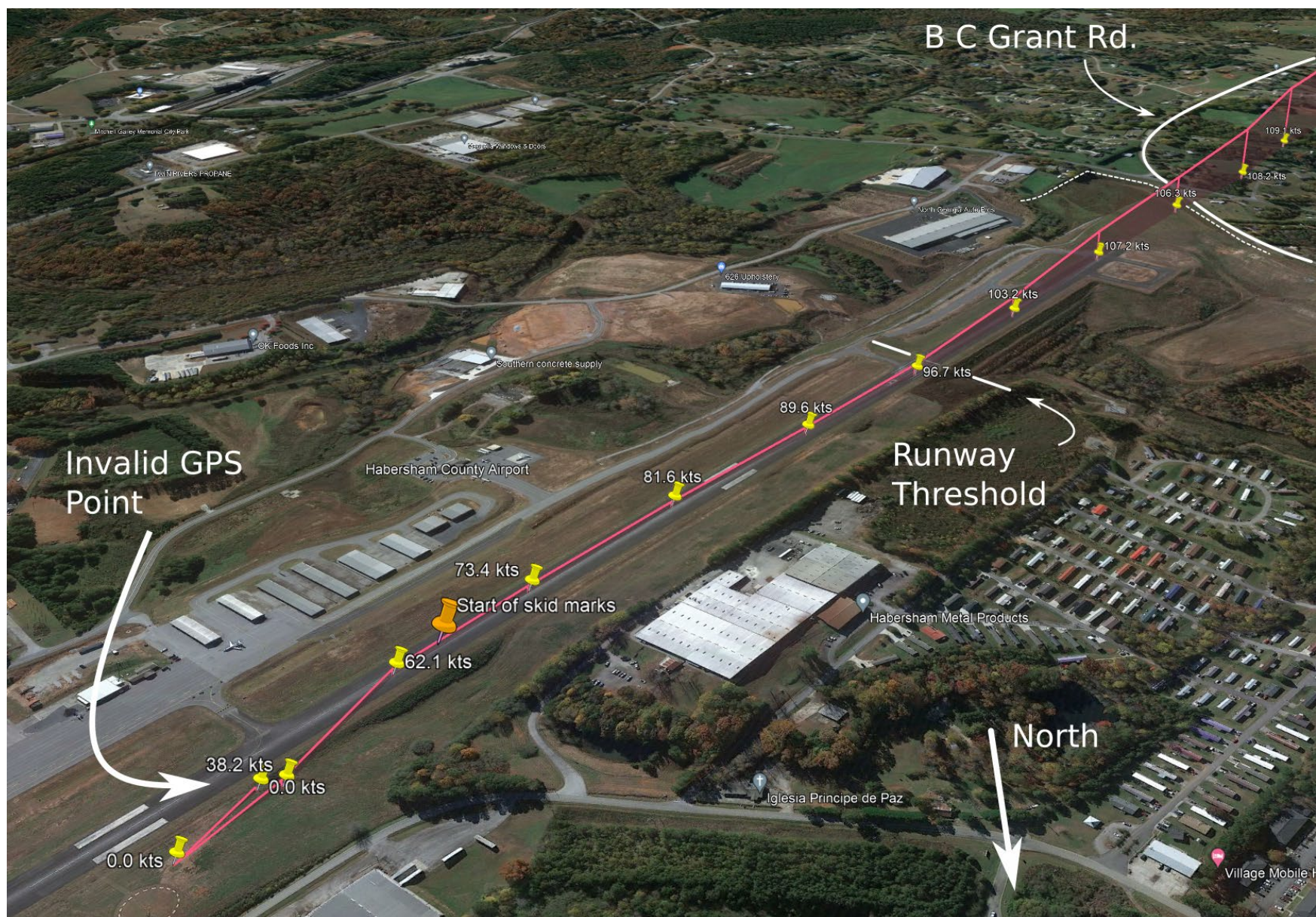


Figure 7. Landing & accident map overlay.

APPENDIX A. VERIFIED AND PROVIDED PARAMETERS FROM AVIDYNE PFD

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

Table 1. Verified and provided parameters.

Parameter Name (units)	Parameter Description	Source
Indicated Airspeed (kts)	Aircraft speed relative to the air around it	PFD
Indicated Altitude (ft)	Barometric compensated altitude, dependent on pressure value set by pilot.	PFD
Latitude (deg)	Latitude position	PFD
Longitude (deg)	Longitude position	PFD
Long Accel (g)	Longitudinal Acceleration (force felt as speeding up, or slowing down)	PFD
Lat Accel (g)	Lateral Acceleration (force felt as being pushed from side to side)	PFD
Magnetic Heading (deg)	Magnetic Heading	PFD
Norm Accel (g)	Normal Acceleration (force felt as being pulled up or down)	PFD
Pitch (deg)	Aircraft angle of pitch	PFD
Roll (deg)	Aircraft angle of roll	PFD
Vertical Speed (fpm)	Aircraft rate of ascent or descent	PFD

Table 2. Unit abbreviations.

Unit Abbreviations	Descriptions
deg	degrees
ft	feet
fpm	feet per minute
kts	knots
g	acceleration in terms of gravity at sea level on the Earth's surface; 9.8 meters per second per second