

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN23FA084

ELECTRONIC DEVICES

Specialist's Factual Report

December 28, 2023

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A. ACCIDENT

Location: Yoakum, Texas
Date: January 17, 2023
Time: 1036 central standard time (CST)
1636 coordinated universal time (UTC)
Airplane: Piper PA46, N963MA

B. ELECTRONIC DEVICES SPECIALIST

Specialist: Gerald Kawamoto
Recorder Specialist
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A group was not convened. The NTSB Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model:	Electronics International MVP-50T
Recorder Serial Number:	240526
Recorder Manufacturer/Model:	Electronics International M-1-T
Recorder Serial Number:	240534
Recorder Manufacturer/Model:	Electronics International M-1-ITT
Recorder Serial Number:	240533
Recorder Manufacturer/Model:	Avidyne MFD
Part Number:	700-00030-805
Recorder Serial Number:	98224353
Recorder Manufacturer/Model:	Avidyne PFD
Part Number:	700-00006-003
Recorder Serial Number:	25597465
Recorder Manufacturer/Model:	Avidyne PFD
Part Number:	700-00006-003
Recorder Serial Number:	M081402224
Recorder Manufacturer/Model:	Avidyne Digital Flight Control
Part Number:	700-00170-002
Recorder Serial Number:	M154777020
Recorder Manufacturer/Model:	Honeywell KMH 820
Part Number:	066-01175-2102
Recorder Serial Number:	KMH820-B1682

1.0 Electronics International MVP-50T Description

The Electronics International MVP-50T is a panel-mounted, color, electronic engine display allowing the operator to monitor and record parameters related to engine operations and user customizable parameters. Depending on the installation, parameters monitored may include oil pressure and temperature, outside air temperature, propeller revolutions per minute (RPM), fuel flow, fuel levels, and battery voltage and amperage. User customizable parameters may be defined by the installation, examples include but are not limited to sensors for door states, annunciators, and flight control positions.

The unit contains non-volatile memory for data storage of the parameters recorded and calculated.¹ The rate at which the data is stored is selectable by the operator. The recording function also records minimum and maximum values for each flight. The data is stored in engineering units in comma separated value (CSV) format on an internal microSD card, using a Linux files system format. The data can be downloaded to a USB memory device via a USB port on the front of the unit or by removing the internal microSD card. Each set of recorded data is grouped by power cycle and identified by and MVP-50T assigned sequential flight number.

1.1 Electronics International MVP-50T Data Recovery

The device was in good condition upon arrival at the Vehicle Recorder Laboratory, as shown in figure 1, and data were downloaded normally using the manufacturer's procedure.

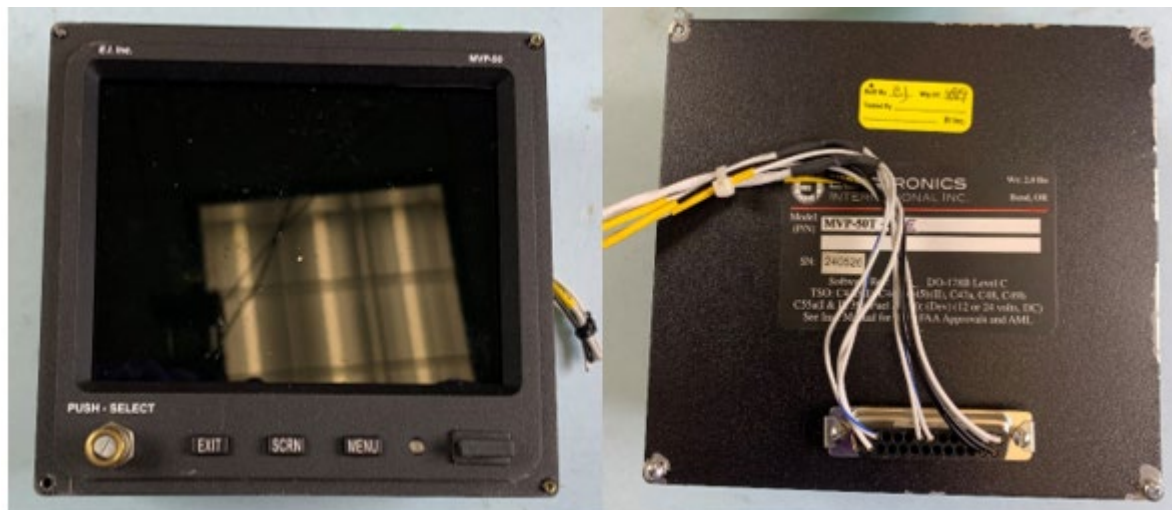


Figure 1. Front and back of the Electronics International MVP-50T as received.

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

1.2 Electronics International MVP-50T Recording Description

Data included files recorded from November 13, 2019, through January 17, 2023, Recorded Time. An offset of 24,911 seconds was applied to the data such that it displays in UTC and all times are presented in UTC for the remainder of this report. The offset was calculated by aligning GPS position data from available ADS-B data with the device's recorded GPS position data.

The accident session started at 13:29:55 UTC and ended at 16:36:49 UTC on January 17, 2023. Data were sampled at 1 Hz. Not all parameters recorded were validated by the recorder specialist. Table 1 describes MVP-50T parameters provided and verified in this report.

Table 1. Verified and provided EI MVP-50T parameters.

Parameter Name (units)	Parameter Description (units)
GPS-LAT (deg)	Latitude (degrees)
GPS-LONG (deg)	Longitude (degrees)
GPS-ALT (ft)	GPS Altitude (feet)
GPS-SPEED (kts)	Groundspeed (knots)
GPS-TRACK (deg)	Ground Track (degrees)
AIRSPD (kts)	Indicated Airspeed (knots)
PR ALT (ft)	Pressure Altitude (feet)
NP (rpm)	Propeller RPM (revolutions per minutes)
NG (%)	Gas Generator Speed (percent)
ITT (degC)	Inter-Turbine Temperature (degrees Celsius)
TORQ (ftlb)	Torque (foot-pounds)
RPM	Engine Revolutions per Minute
FUEL P (psi)	Fuel Pressure (pounds per square inch)
F.FLOW (gph)	Fuel Flow (gallons per hour)
OIL P (psi)	Oil Pressure (pounds per square inch)
OIL T (degF)	Oil Temperature (degrees Fahrenheit)
FUEL L & R (gal)	Left and Right Fuel Indicator (gallons)

2.0 Electronics International M-1-T and M-1-ITT Description

The Electronics International M-1-T and M-1-ITT are electronic instruments capable of displaying information for specific engine related parameters. A limited history of parametric data and instrument settings may be recovered from the non-volatile memory; however, this data may only be recovered by a direct read from the NVM and is intended for manufacturer purposes. The sampling rate of the history is generally greater than once every 2 minutes.

2.1 Electronics International M-1-T and M-1-ITT Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, external examinations revealed the devices has sustained minor damage to their displays, as shown in figure 2 and figure 3. In discussions with the manufacturer, it was determined that data from

these devices would not provide additional data to that already recovered from the MVP-50T, thus, data recovery was not pursued on these devices.



Figure 2. Electronics International M-1-T as received.



Figure 3. Electronics International M-1-ITT as received.

3.0 Avidyne MFD Description

The Avidyne multi-function flight display (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 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.

3.1 Avidyne MFD Data Recovery

Upon arrival at the Vehicle Recorder Laboratory an external examination revealed significant impact damage the MFD unit, rendering it inoperable. The internal CF card was undamaged, as shown in figure 4, and its contents were downloaded using the manufacturer's procedure.



Figure 4. Avidyne MFD CF card as received.

3.2 Avidyne MFD Recording Description

The only output from the card was "Broadcast Data". The manufacturer reviewed the source code of the card and determined that engine data and other historical flight data were not recorded on the MFD as engine data is not configured on the unit under a JetProp Installation.

4.0 Avidyne PFD 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. 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.

4.1 Avidyne PFD Data Recovery

Upon arrival at the Vehicle Recorder Laboratory an external examination revealed impact damage to the display of PFD S/N 25597465, as shown in figure 5. The device was otherwise in good condition and powered on normally using laboratory tools. Data were downloaded using the manufacturer's procedure.



Figure 5. Avidyne PFD S/N 25597465.

PFD S/N M081402224 sustained heavy impact damage to the display, as shown in figure 6, rendering it inoperable. The internal circuit board containing the NVM chips was in good condition and was removed and installed in a laboratory surrogate unit. Data were downloaded normally using the manufacturer's procedure.



Figure 6. Avidyne PFD S/N M081402224.

4.2 Avidyne PFD Recording Description

Data from both PFDs were reviewed and found to be redundant. Due to the varying sampling frequency of parameters on the PFD, not all parameters recorded until the final data point at 16:36:55.8 UTC. Not all parameters recorded were validated by the recorder specialist. Table 2 describes Avidyne PFD parameters provided and verified in this report.

Table 2. Verified and provided Avidyne PFD parameters.

Parameter Name (units)	Parameter Description (units)
altitude (ft)	GPS Altitude (feet)
baroCorrectedAlt (ft)	Barometric Altitude (feet)
indicatedAirspeed (kts)	Indicated Airspeed (knots)
mGroundSpeed (kts)	Ground Speed (knots)
magHeading (deg)	Magnetic Heading (degrees)
roll (deg)	Roll Angle (degrees)
pitch (deg)	Pitch Angle (degrees)
altitudeRate (ft/min)	Vertical Speed (feet per minute)
Norm, Long, Lat Accel (g)	X, Y, Z Acceleration (G)

5.0 Avidyne DFC Description

The Avidyne DFC-90 is a multi-axis flight control autopilot. During normal operation the device is capable of controlling the aircraft's attitude (both pitch and roll) and maintaining a selected altitude. Additionally, the autopilot is capable of maintaining a controlled rate of climb and descent, has a navigation capability and will maintain a pre-programmed flight track profile, and is capable of flying both precision and non-precision approaches. The Avidyne DFC-90 also records flight/navigation data, in addition to operational/fault data, associated with the operation of the autopilot system. The data is stored on a microSD card that is mounted on the main processor board of the autopilot.

5.1 Avidyne DFC Data Recovery

The internal microSD card was in in good condition and data from the card were provided to the manufacturer for conversion. The contents of the card were reviewed by the manufacturer and data are summarized in the Autopilot Analysis report in the public docket.

6.0 Honeywell KMH 820 Description

The KMH 820 enhanced ground proximity warning system (EGPWS) provides terrain and performance warning to the pilot in the event of a hazardous terrain or flight performance encounter. When the EGPWS issues a warning to the pilot, the unit retains in non-volatile memory a snapshot of the flight data it uses for its calculations. The unit also records a data marker for every takeoff and landing that it senses. Additionally, the unit records the status of the pilot inhibits switch which disables the aural warning to the pilot. Time is recorded in elapsed seconds of unit operation. A flight counter for individual flights is also recorded with the data.

6.1 Honeywell KMH 820 Data Recovery

The device was sent to the manufacturer for data extraction and no additional action was performed by the Vehicle Recorder Laboratory.

D. FIGURES AND TABULAR DATA

Figures 7 through 9 are Google Earth overlays of the accident flight recorded on the MVP-50T. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the accident flight. Figure 7 shows the entire accident flight. Figure 8 shows the final two minutes and figure 9 shows the final minute.

Figure 10 is a plot of MVP-50T parameters for the entire accident session. The time displayed is 13:25:00 to 16:40:00 UTC.

Figure 11 is a plot of MVP-50T parameters for the end of the accident session. The time displayed is 16:35:30 to 16:36:50 UTC.

Figure 12 is a plot of parameters PFD parameters for the entire accident session. The time displayed is 13:30:00 to 16:40:00 UTC.

Figure 13 is a plot of parameters PFD parameters for the end of the accident session. The time displayed is 16:36:00 to 16:37:00 UTC.

The corresponding tabular data used to create figures 7 through 11 are provided in CSV format as attachment 1 to this report.

The corresponding tabular data used to create figures 12 and 13 are provided in CSV format as attachment 2 to this report.

Submitted by:

Gerald Kawamoto
Recorder Specialist

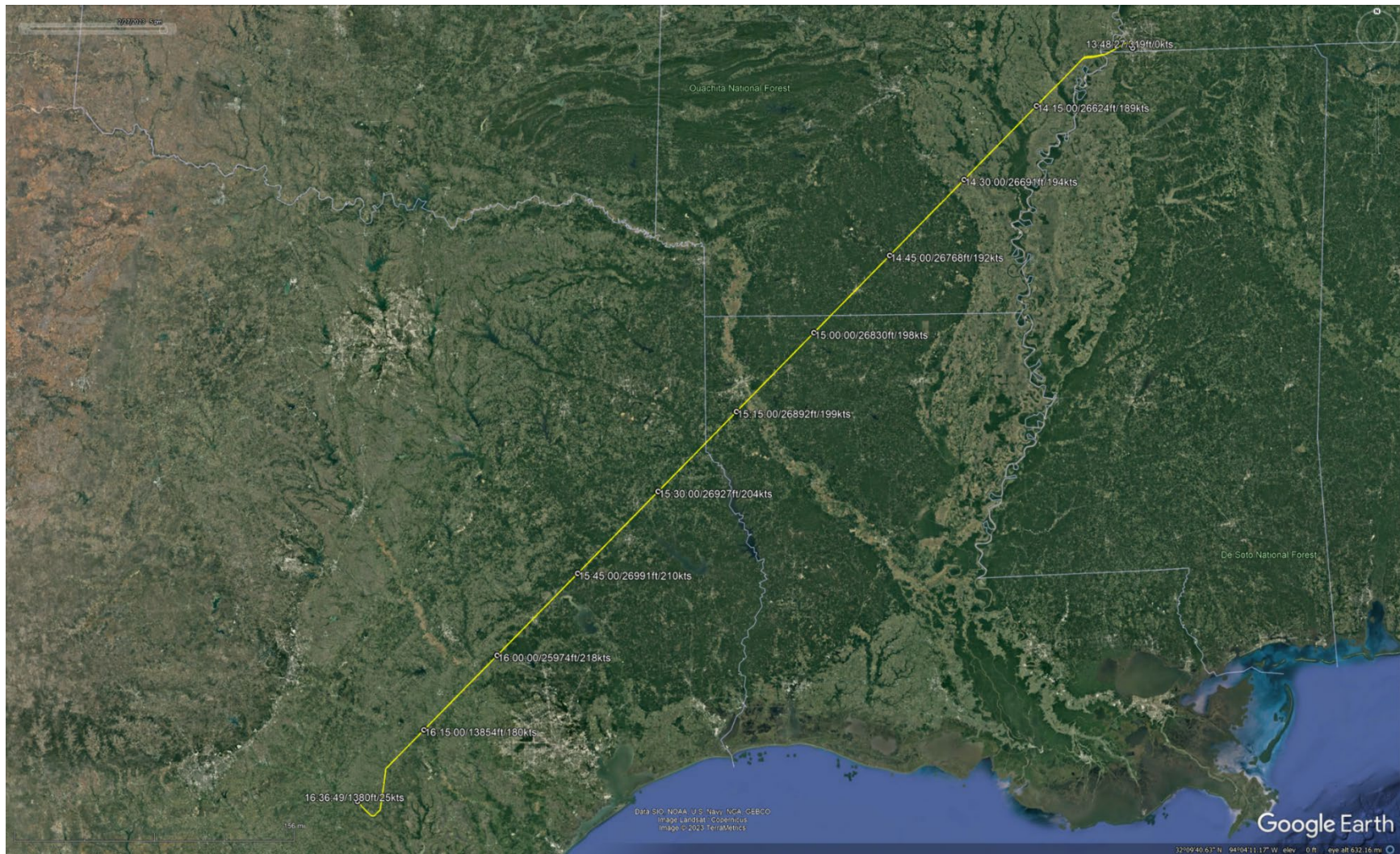


Figure 7. Google Earth overlay of the entire accident flight recorded on the Electronics International MVP-50T.



Figure 8. Google Earth overlay of final 2 minutes of the accident flight recorded on the Electronics International MVP-50T.



Figure 9. Google Earth overlay of final minute of the accident flight recorded on the Electronics International MVP-50T.

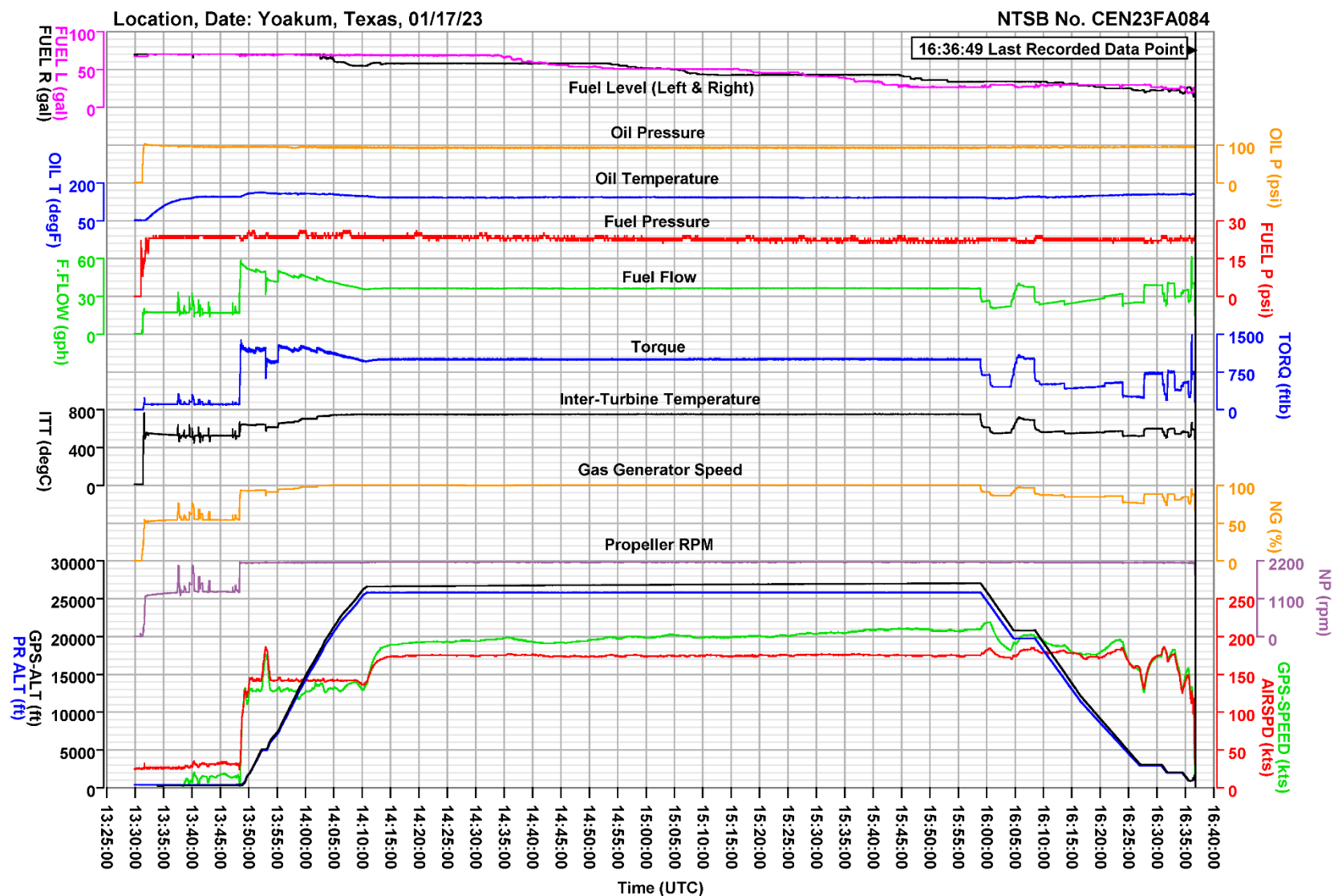


Figure 10. Plot of Electronics International MVP-50T parameters for the accident session.

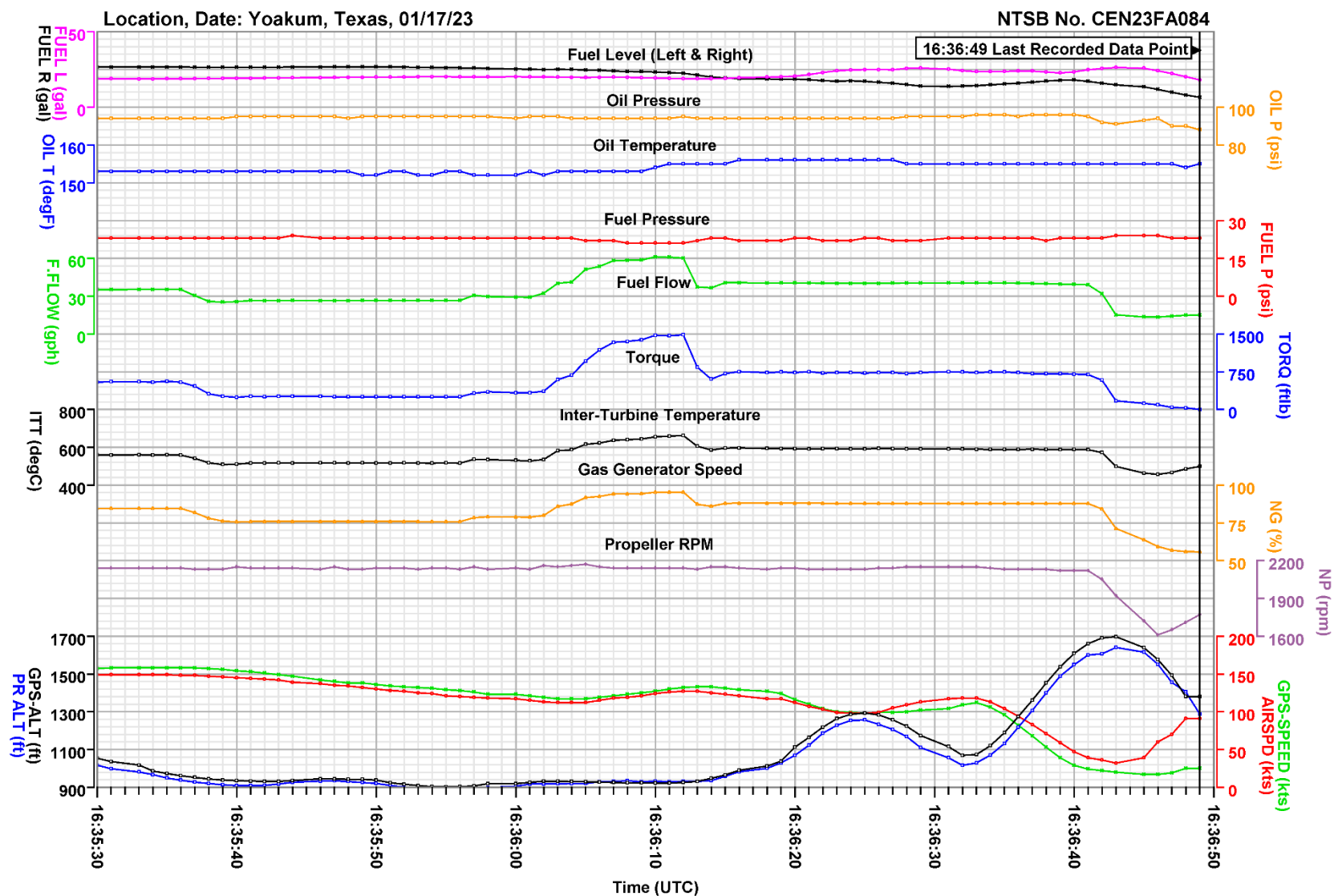


Figure 11. Plot of Electronics International MVP-50T parameters for end of the accident session.

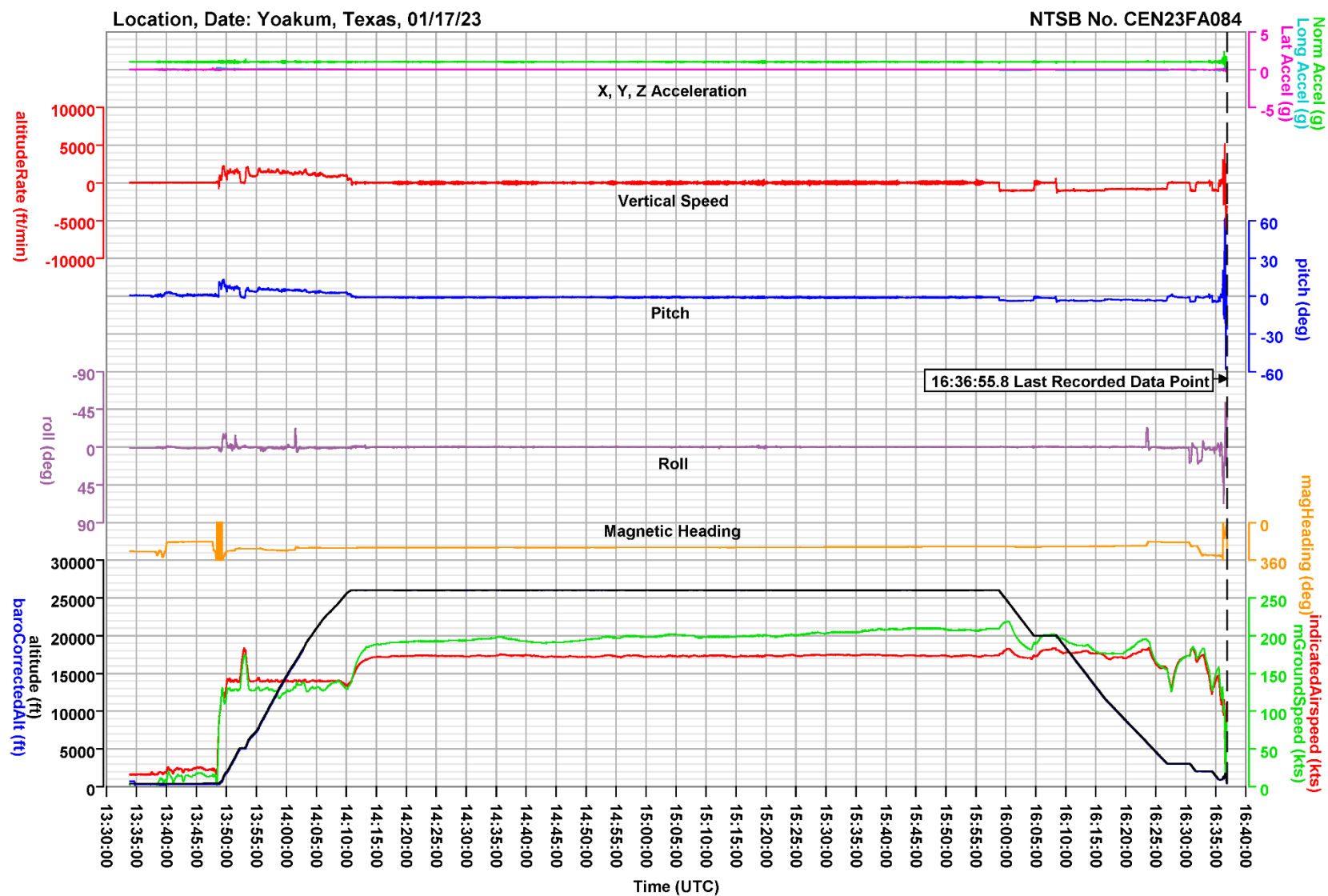


Figure 12. Plot of PFD parameters for the accident session.

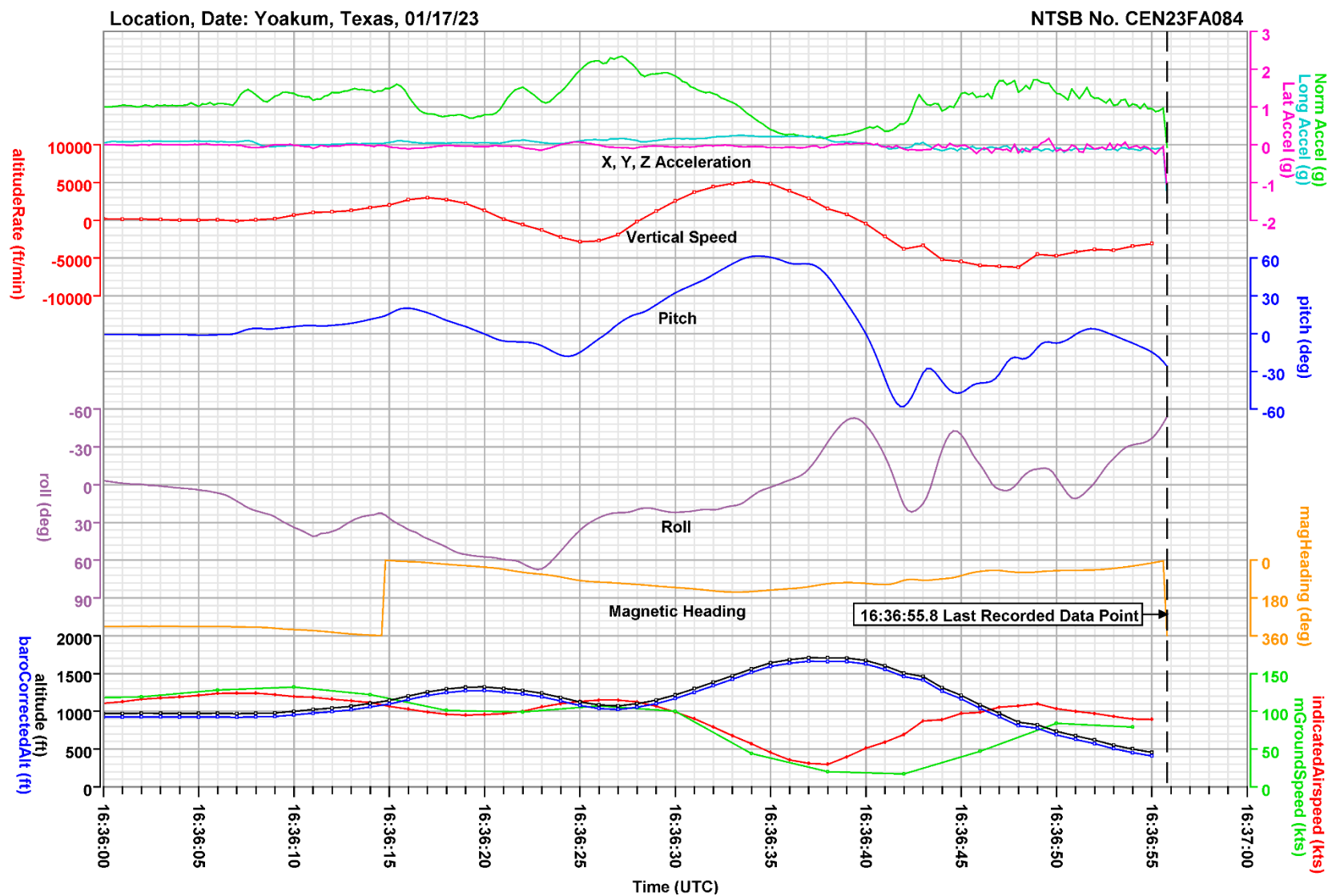


Figure 13. Plot of PFD parameters for the end of the accident session.