National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

WPR22LA231

# GLOBAL POSITIONING SYSTEM DEVICES

Specialist's Factual Report

February 8, 2023

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## A. ACCIDENT

Location: Missoula, Montana
Date: June 27, 2022
Time: 10:02 mountain daylight time (MDT)
Airplane: Vans Aircraft RV-9A, private operator, N12VV

## B. GLOBAL POSITIONING SYSTEM DEVICES SPECIALIST

Specialist: Kyle Garner
Aerospace Engineer – Recorder Specialist
National Transportation Safety Board (NTSB)

## C. DETAILS OF THE INVESTIGATION

A global positioning system (GPS) group was not convened. The NTSB Vehicle Recorder Division received the following GPS devices:

Recorder Manufacturer/Model: Garmin GDU 460
Recorder Serial Number: 350009211

Recorder Manufacturer/Model: Garmin aera 760
Recorder Serial Number: 6HC001999

### 1.0 Garmin GDU 460 Device Description

The Garmin GDU 460 is a touchscreen display unit that is a component of the Garmin G3X non-certified aircraft avionics system. The unit can display electronic flight instruments, navigation, communication, weather, traffic, and engine information, depending on the configuration.

If not disabled, the unit is capable of logging historical information at a variable rate[1] of about 10 Hertz (Hz) to internal non-volatile memory[2]. Historical logs may be copied to an SD card inserted into the slot provided on the front of the unit. Each record contains UTC date and time, as well as an integer number of milliseconds since the unit was last power cycled.

[1] Each parameter has a logging rate that varies if the values change more than a defined threshold. Thus, parameter values may be repeated across multiple time instances, or rows of data, if the value does not meet the threshold to log a change.
[2] Non-volatile memory is semiconductor memory that does not require external power for data retention.

## 1.1 Garmin GDU 460 Data Recovery

The unit suffered minor damage to the display and external casing in the accident, as shown in Figure 1. Power was applied to the unit and the display would not power on. A replacement display from a surrogate device was installed and the unit then powered on normally. Data were successfully recovered using instructions provided by the device manufacturer.

**Figure 1.** Garmin GDU 460 front (left) and rear (right), as received.

## 1.2 Garmin GDU 460 Data Description

The unit exported data in engineering units and no further conversion was required. The data extracted included track logs from April 7, 2019, through the accident on June 27, 2022. The unit recorded time in UTC. Six hours were subtracted to convert UTC to local time, MDT.

Data from the day of the accident started at 06:01:38 MDT and ended at 10:02:37 MDT.

## 1.3 Garmin GDU 460 Parameters

Table 1 describes data parameters recorded by the Garmin GDU 460 relevant to the investigation.

**Table 1.** Garmin GDU 460 parameters.

| Parameter Name (unit) | Parameter Description |
|---|---|
| Accel Lat (g) | Lateral acceleration |
| Accel Long (g) | Longitudinal acceleration |
| Accel Vert (g) | Vertical acceleration |
| CHT 1/2/3/4 (degF) | Cylinder head temperature - cylinder 1/2/3/4 |
| EGT 1/2/3/4 (degF) | Exhaust gas temperature - cylinder 1/2/3/4 |

| Parameter Name (unit) | Parameter Description |
|---|---|
| Fuel Flow (gph) | Fuel flow |
| Indicated Airspeed (kts) | Indicated airspeed |
| Magnetic Heading (deg) | Magnetic heading |
| Oil Press (psi) | Oil pressure |
| Oil Temp (degF) | Oil temperature |
| Pitch (deg) | Pitch |
| Pressure Altitude (ft) | Pressure altitude |
| Roll (deg) | Roll |
| RPM | Engine revolutions per minute |
| UTC Date (yyyy-MM-dd) | UTC date |
| UTC Time (hh:mm:ss) | UTC time |
| Vertical Speed (fpm) | Vertical speed |
| Wind Direction (deg true) | Wind direction |
| Wind Speed (kts) | Wind speed |

Table 2 describes the unit abbreviations used in this report.

**Table 2.** Unit abbreviations.

| Unit abbreviation | Description |
|---|---|
| dd | day |
| deg | degrees |
| degF | degrees Fahrenheit |
| deg true | degrees true |
| fpm | feet per minute |
| ft | feet |
| g | gravitational constant |
| gph | gallons per hour |
| hh | hours |
| kts | knots |
| mm | minutes |
| MM | month |
| psi | pounds per square inch |
| RPM | revolutions per minute |
| ss | seconds |
| yyyy | year |

## 2.0 Garmin aera 760 Device Description

The Garmin aera 760 is a portable GPS receiver capable of storing route-of-flight and flight-time information. A log – including latitude, longitude, date, time, altitude, track, and groundspeed information – is stored within the unit and is updated as a function of time or distance moved, depending on how the unit has been configured. All recorded data is stored in non-volatile memory. The unit contains hardware and software permitting the download of recorded waypoint, route, and tracklog information to a computer via a built-in USB port. An internal battery is used as backup power to the internal memory and real-time clock during periods when the main power is removed.

## 2.1 Garmin aera 760 Data Recovery

The unit arrived in good condition and had no visible damage, as shown in Figure 2. Data were successfully recovered using instructions provided by the device manufacturer.


**Figure 2.** Garmin aera 760 front (left) and rear (right), as received.

## 2.2 Garmin aera 760 Data Description

The unit exported data in engineering units and no further conversion was required. The data extracted included track logs from July 2, 2021, through the accident on June 27, 2022. The unit recorded time in UTC. Six hours were subtracted to convert UTC to local time, MDT.

Data from the day of the accident started at 06:00:49 MDT and ended at 13:04:11 MDT. Data after approximately 10:03 MDT was determined to be post-accident, likely because the device did not lose power during the accident sequence.

## 2.3 Garmin aera 760 Parameters

Table 3 describes data parameters recorded by the Garmin aera 760 relevant to the investigation. Refer to Table 2 for the unit abbreviations used in this report.

**Table 3.** Garmin aera 760 parameters.

| Parameter Name (units) | Parameter Description |
|---|---|
| GPS Alt (ft) | GPS altitude |
| Groundspeed (kts) | GPS derived groundspeed |
| Latitude (deg) | Latitude |
| Longitude (deg) | Longitude |
| UTC Date (MM-dd-YYYY) | UTC date |
| UTC Time (hh:mm:ss) | UTC time |

# D. OVERLAYS AND TABULAR DATA

Figure 3 is a graphical overlay of the Garmin aera 760 data generated using Google Earth for the entirety of the accident flight. Note that the weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording. The location of Missoula Montana Airport (MSO), Missoula, Montana is also annotated for reference.

Figure 4 is a graphical overlay of the Garmin aera 760 data generated using Google Earth for the final portion of the accident flight. The final recorded accident flight data point on the Garmin aera 760 was at 10:02:53 MDT with a GPS altitude of 3458 feet above Mean Sea Level (MSL) and a ground speed of 65 knots.

Figure 5 is a plot of basic parameters for the accident flight, from 08:47:00 MDT to the end of the recorded data at 10:02:53 MDT.

Figure 6 is a plot of basic parameters for the final portion of the accident flight, from 09:58:00 MDT to the end of the recorded data at 10:02:53 MDT.

Figure 7 is a plot of engine parameters for the accident flight, from 08:47:00 MDT to the end of the recorded data at 10:02:53 MDT.

Figure 8 is a plot of engine parameters for the final portion of the accident flight, from 09:58:00 MDT to the end of the recorded data at 10:02:53 MDT.

The corresponding tabular data used to create figures 3 to 8 are provided in electronic comma-separated value (CSV) format as attachment 1 to this report.

Submitted by:

Kyle Garner
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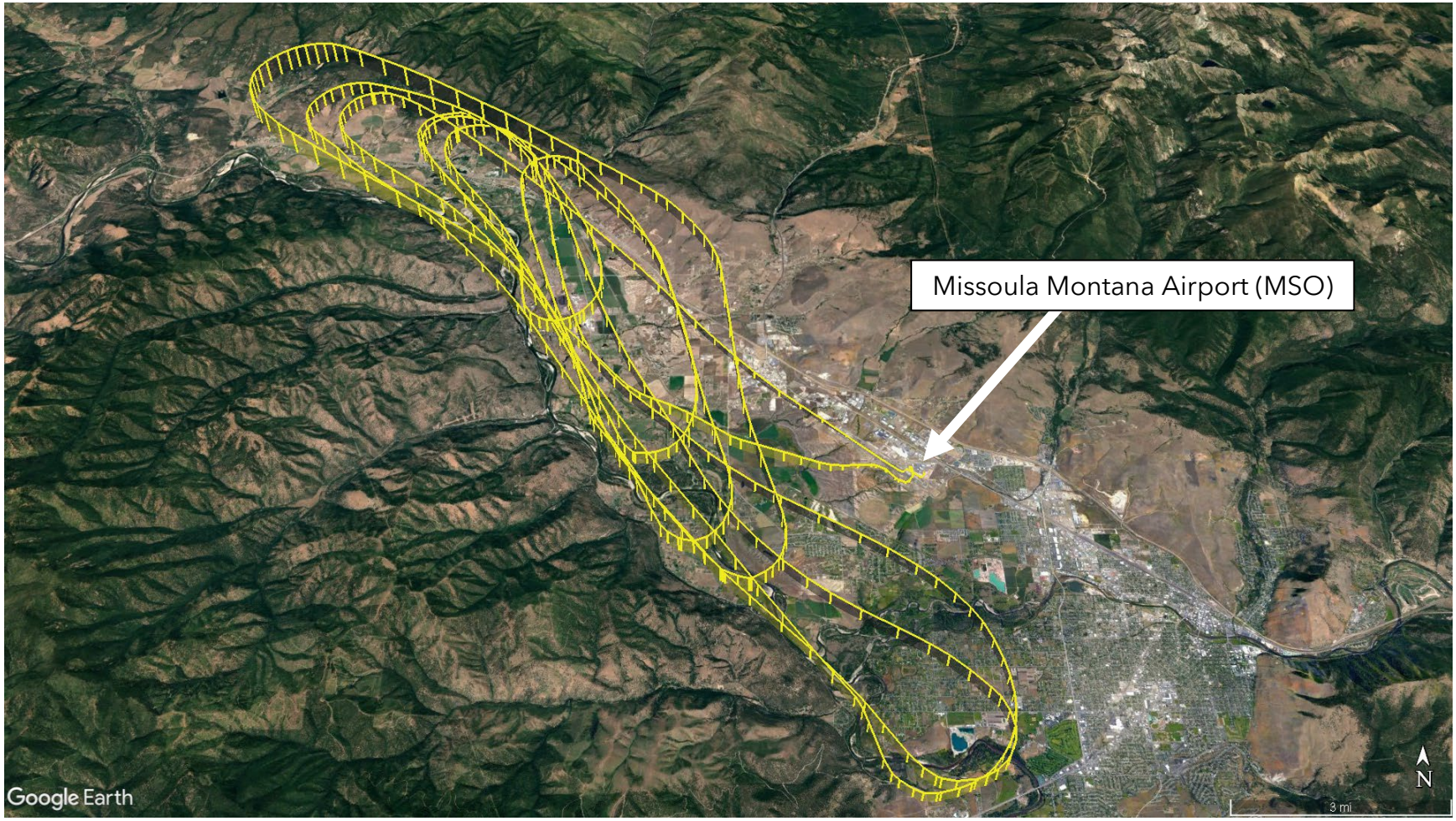


**Figure 3.** Google Earth overlay of the accident flight.


**Figure 4.** Google Earth overlay of the final portion of the accident flight. The start of the accident flight recording, the final recorded data point, and the wreckage location is shown for reference.

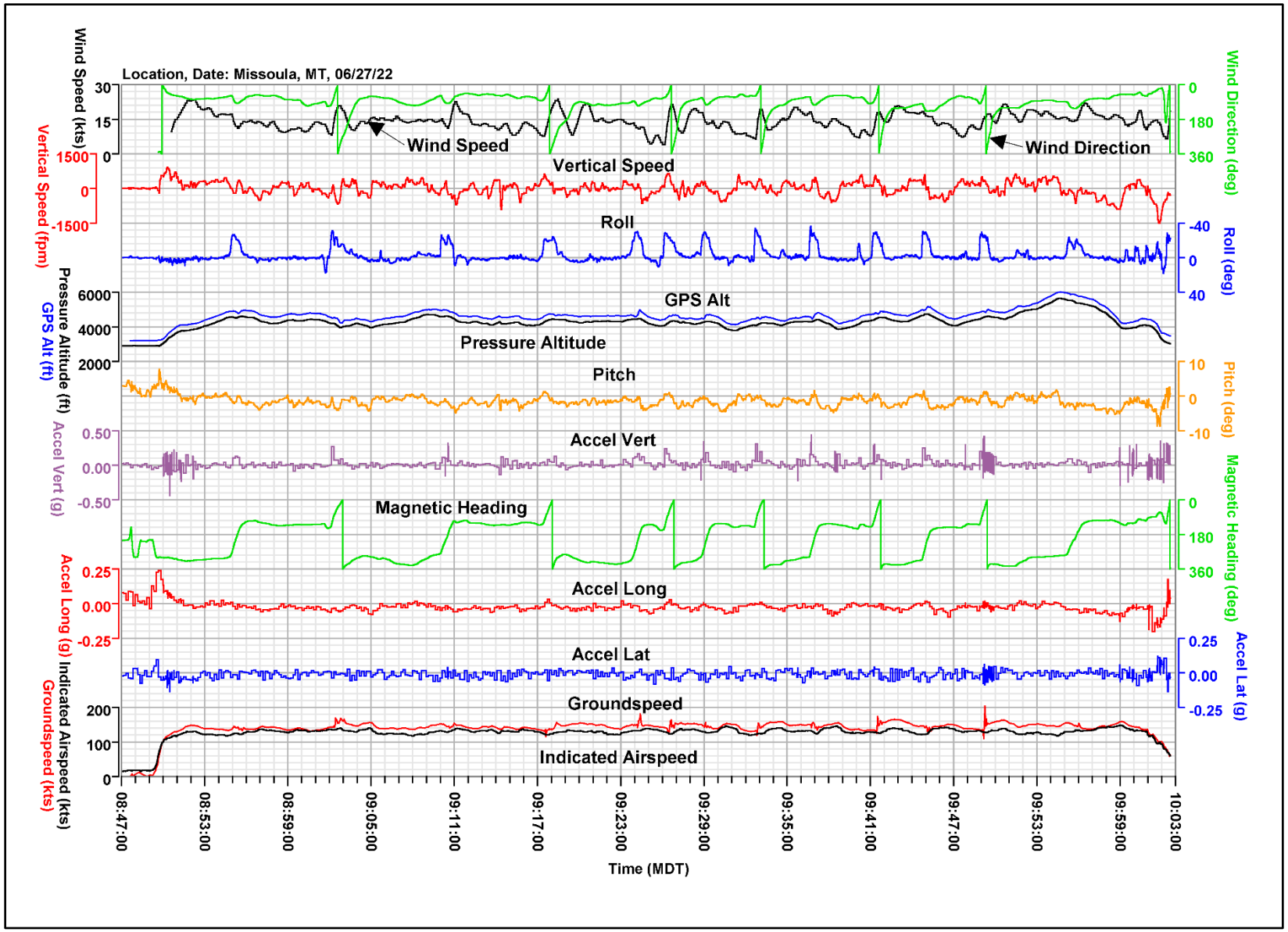


**Figure 5.** A plot of basic parameters for the accident flight.

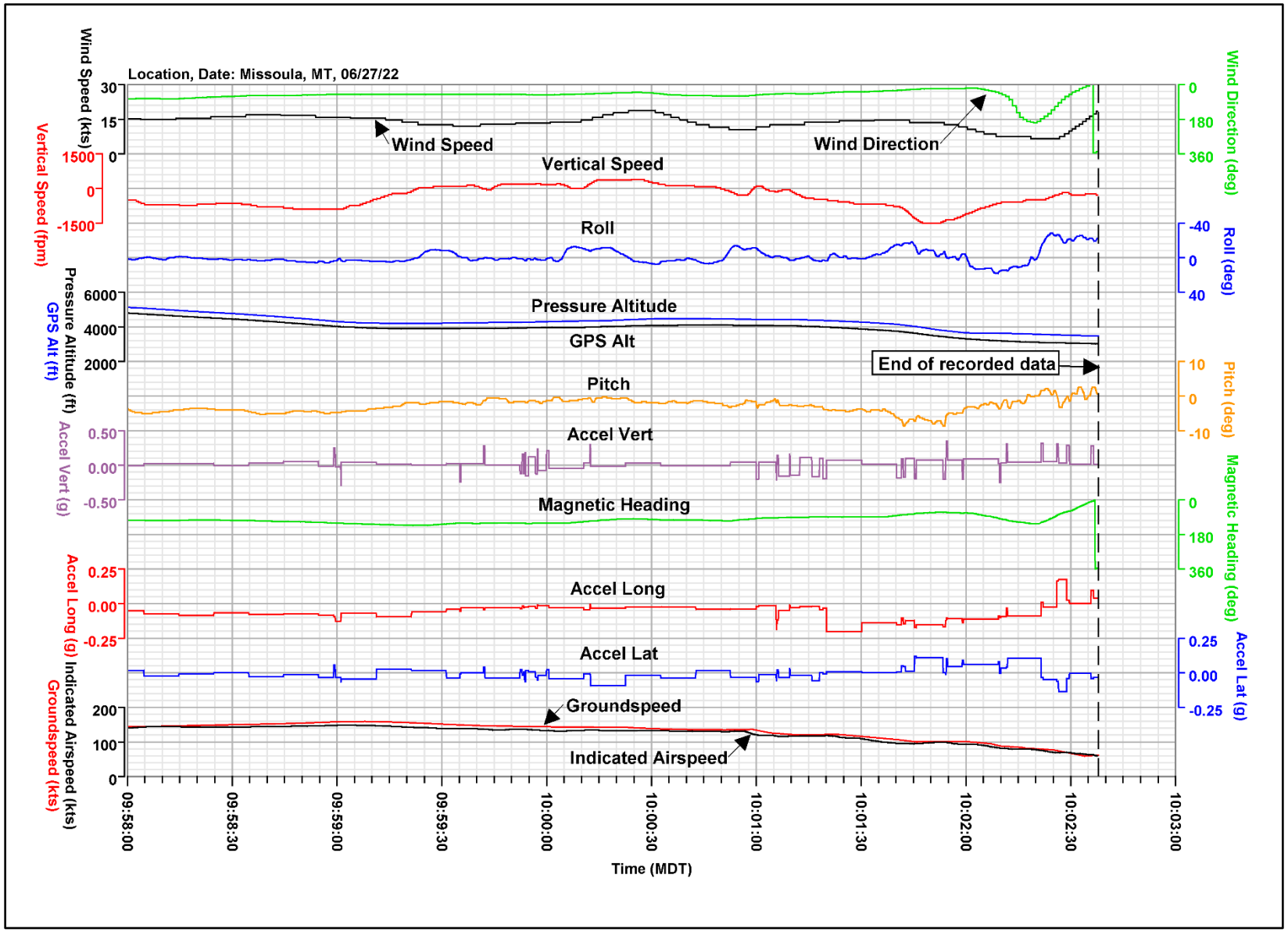


**Figure 6.** A plot of basic parameters for the final portion of the accident flight.

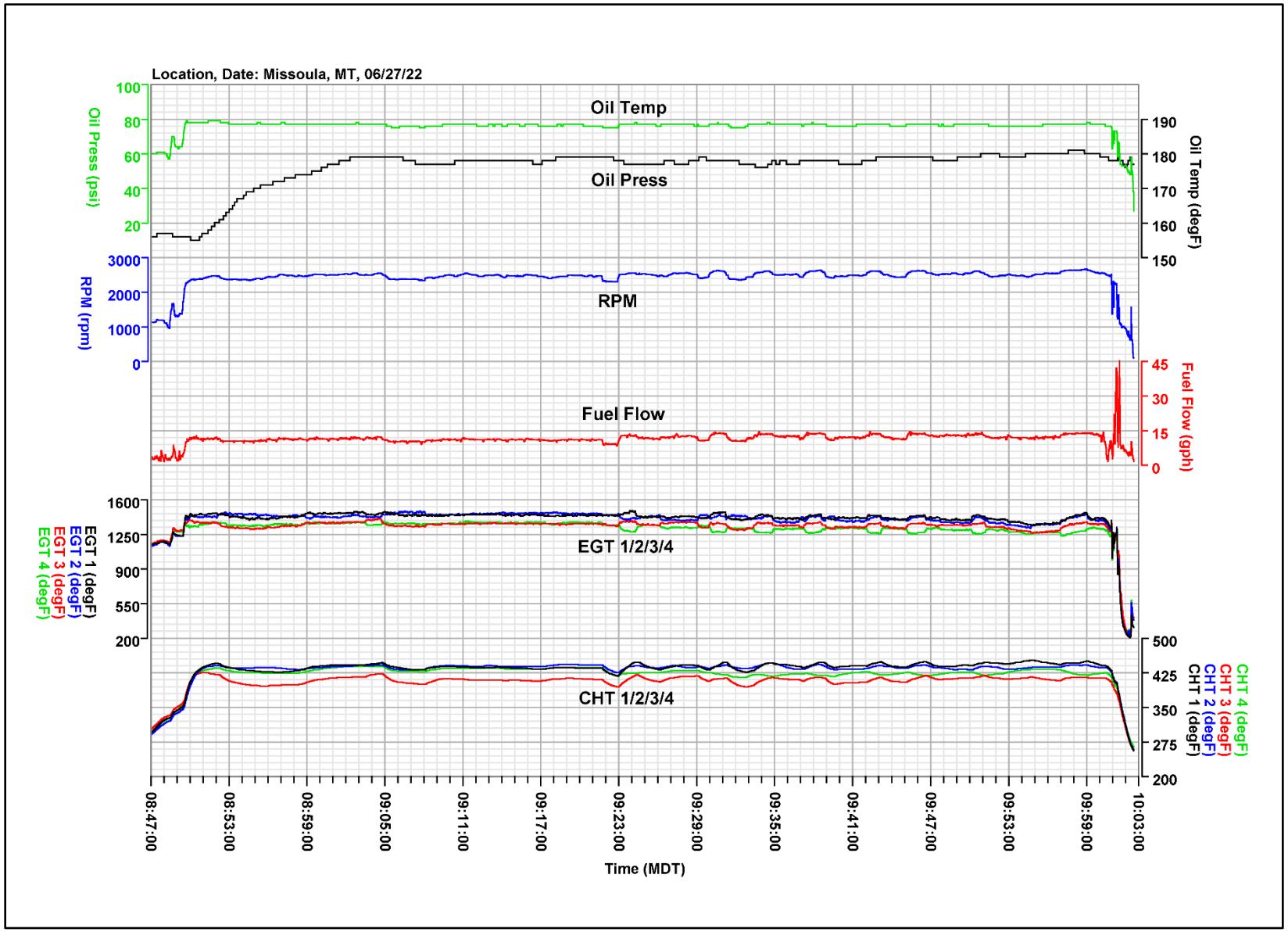


**Figure 7.** A plot of engine parameters for the accident flight.

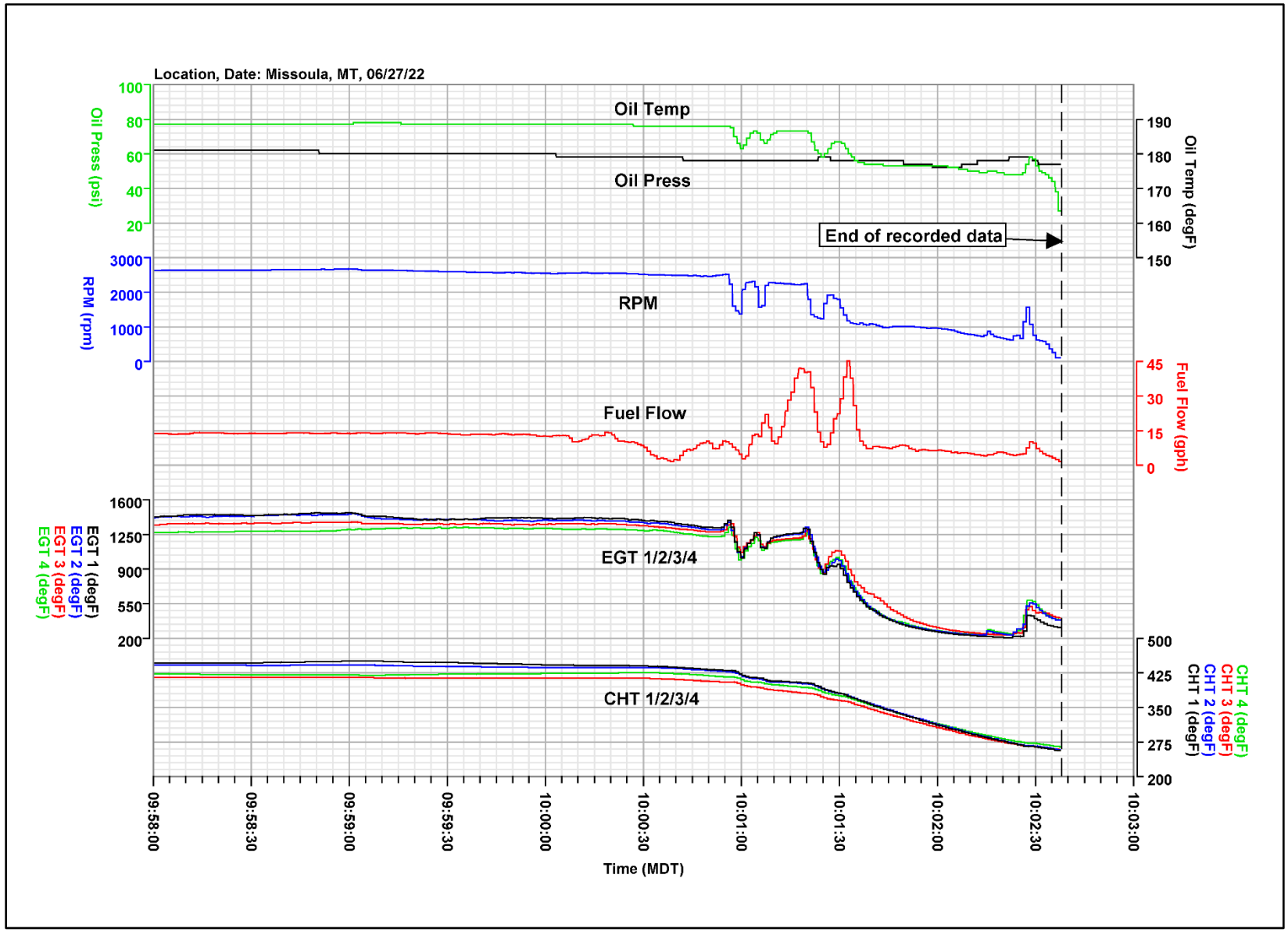


**Figure 8.** A plot of engine parameters for the final portion of the accident flight.