

# National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN24FA024

## **ELECTRONIC DEVICES**

Specialist's Factual Report

April 22, 2024

## **A. ACCIDENT**

Location: Manitowoc, Wisconsin  
Date: October 25, 2023  
Time: 1829 central daylight time (CDT)  
Airplane: Lancair 320, private operator, N320P

## **B. ELECTRONIC DEVICES SPECIALIST**

Specialist: Steven Smith  
Mechanical Engineer (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: Garmin GPSMAP 496  
Part Number: GPSMAP 496  
Recorder Serial Number: 19704546

Recorder Manufacturer/Model: Dynon EFIS-D10A  
Part Number: 100321  
Recorder Serial Number: 004599

Recorder Manufacturer/Model: Dynon EMS-D120  
Part Number: 100563-001  
Recorder Serial Number: 003067

### **1.0 Garmin GPSMAP 496 Description**

The Garmin GPSMAP 496 is a battery-powered portable 12-channel GPS receiver with a 256-color thin-film transistor (TFT) liquid-crystal display (LCD) display screen. The unit includes a built-in Jeppesen database and is capable of receiving XM satellite radio for flight information including NEXRAD radar, lightning, METARs, TAFs, and TFRs. A built-in AOPA Airport Directory and SafeTaxi Airport Diagrams are included for selected fields.

The unit stores date, route-of-flight, and flight-time information for up to 50 flights. A flight record is triggered when groundspeed exceeds 30 knots and altitude exceeds 250 feet and ends when groundspeed drops below 30 knots for 10 minutes or more. A detailed track log, including latitude, longitude, date, time, and global

positioning system (GPS) altitude information is stored within the unit whenever the receiver has a lock on the GPS navigation signal. Position is updated within the track log as a function of time or distance moved, depending on how the unit has been configured.

Once the current track log memory becomes full, new information either overwrites the oldest information or the recording stops, depending on how the unit is configured. The current track log can be saved to long-term memory and 15 saved track logs can be maintained in addition to the current tracklog. Track log storage may be activated or de-activated at user discretion. All recorded data is stored in non-volatile memory (NVM).<sup>1</sup> The unit contains hardware and software permitting the download of recorded waypoint, route, and track log information to a PC via a built-in serial port. An internal button-battery is used to back-up power to the internal memory and real-time clock during those periods when main power is removed.

### 1.1 Garmin GPSMAP 496 Data Recovery

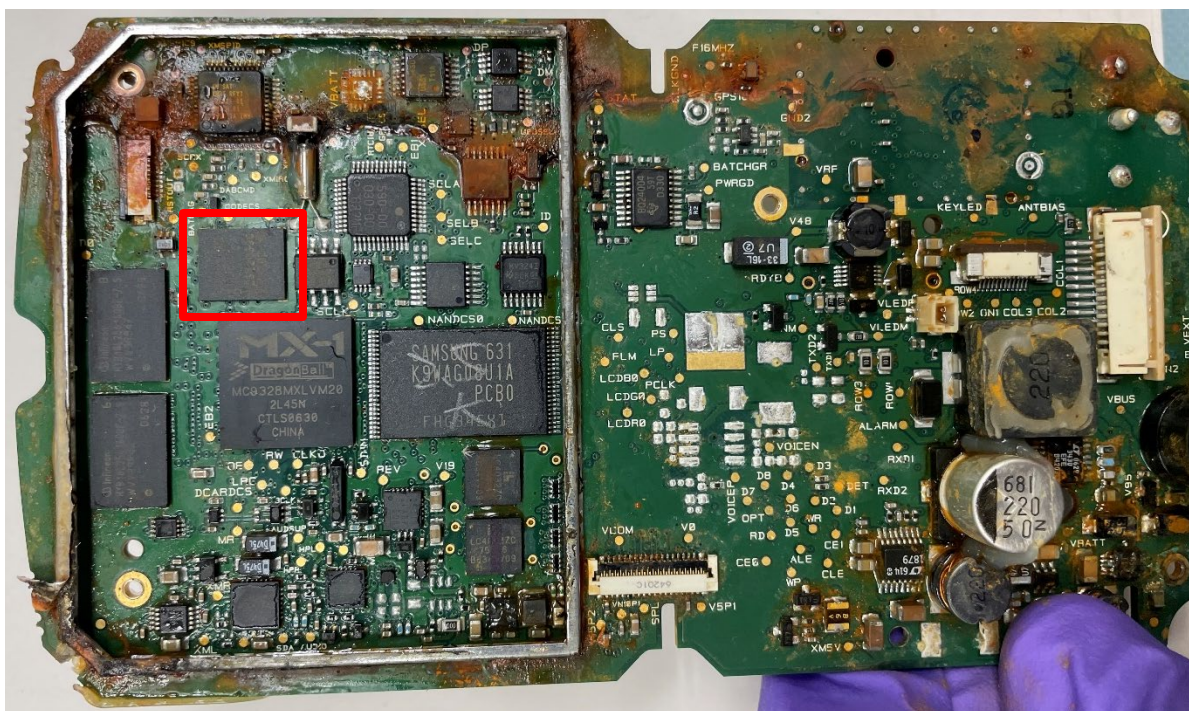
Upon arrival at the Vehicle Recorder Laboratory, an external examination revealed the device had sustained water and corrosion damage, as shown in figure 1. The Garmin GPSMAP 496 was taken apart and the water was drained. The internal circuit boards showed signs of corrosion, as shown in figure 2. The memory chip was identified, cleaned, and removed from the unit. The raw binary data was extracted from the memory chip and was converted into engineering units using laboratory tools.



**Figure 1.** Garmin GPSMAP 496 as received by the NTSB Vehicle Recorder Laboratory.

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<sup>1</sup> Non-volatile memory is semiconductor memory that does not require external power for data retention.



**Figure 2.** Garmin GPSMAP 496 internal circuit board with the NVM chip highlighted (red box).

## 1.2 Garmin GPSMAP 496 Recording Description

The data extracted included information from March 21, 2008, through October 26, 2008. The event occurred on October 25, 2023. There were no data pertinent to the event recorded on the device.

## 2.0 Dynon EFIS-D10A Description

The Dynon EFIS-D10A is a 4-inch cockpit display mounted in non-type certificated (experimental) aircraft. The instrument integrates multiple flight instruments including airspeed, altitude, gyro-stabilized magnetic compass, turn rate, slip/skid ball, bank angle, pitch angle and vertical speed. The unit also has other functions that include a clock/timer, g-meter, voltmeter, and a density altitude/true airspeed calculator. The unit contains an Air Data, Attitude and Heading Reference System (ADAHRS) to provide air data, attitude and heading information to the display. Depending on the installation in the operator's aircraft certain parameters might not be displayed, for example angle-of-attack.

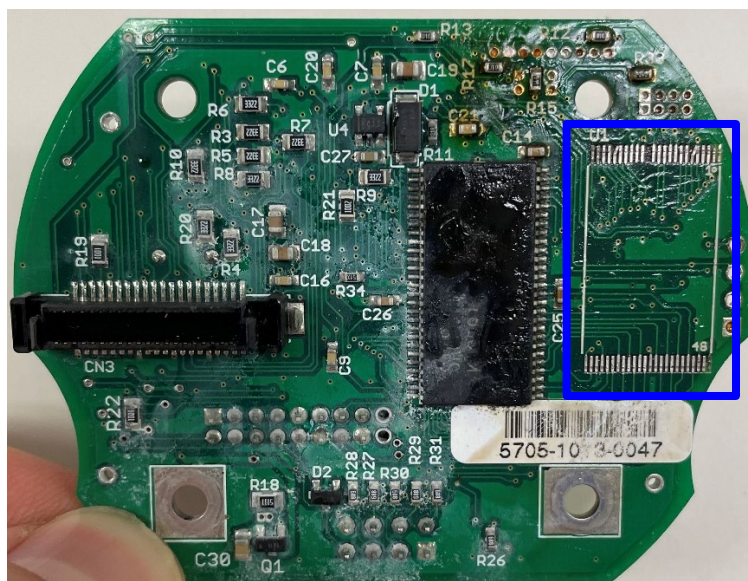
The data logging must be configured by the operator to enable logging and set the data log interval. The unit can also be configured to start logging data automatically at boot-up. The data logging interval can be set to store at 1, 3, 5, 10, 30 and 60 second intervals. The internal memory can store at least 2 hours of cumulative data at a 1 second recording interval or at least 120 hours at a 60 second data recording interval. When the recording limit in the internal memory is reached, the oldest record is erased, and a new record is added.

## 2.1 Dynon EFIS-D10A Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an external examination revealed the device had sustained water and corrosion damage, as shown in figure 3. The internal circuit boards showed signs of corrosion, as shown in figure 4. The memory chip was identified, cleaned, and removed from the unit. The raw binary data was extracted from the memory chip and was converted into engineering units using laboratory tools.



**Figure 3.** Dynon EFIS-D10A as received by the NTSB Vehicle Recorder Laboratory.



**Figure 4.** Dynon EFIS-D10A internal circuit board with memory chip removed (blue box).

## **2.2 Dynon EFIS-D10A Recording Description**

The data extracted included information from May 13, 2014, through October 25, 2023. The last recording was from the flight from Grand Prairie Municipal Airport (KGPM) beginning at 12:36:59 CDT. The last recorded data point in the Dynon EFIS-D10A was at 14:55:47 CDT at Jesse Viertel Memorial Airport (KVER). The event flight departed KVER at approximately 15:45:13 CDT on October 25, 2023. There were no data pertinent to the event recorded on this device.

## **3.0 Dynon Engine Monitoring System D120 Description**

The Dynon Engine Monitoring System (EMS) D120 is a 7-inch wide screen display mounted in the cockpit of non-type certificated aircraft. The instrument integrates up to 16 engine related instruments including manifold pressure, temperatures, RPM, and fuel system information. Depending on the type of engine installed in the aircraft and pilot preferences, not all display options can be available.

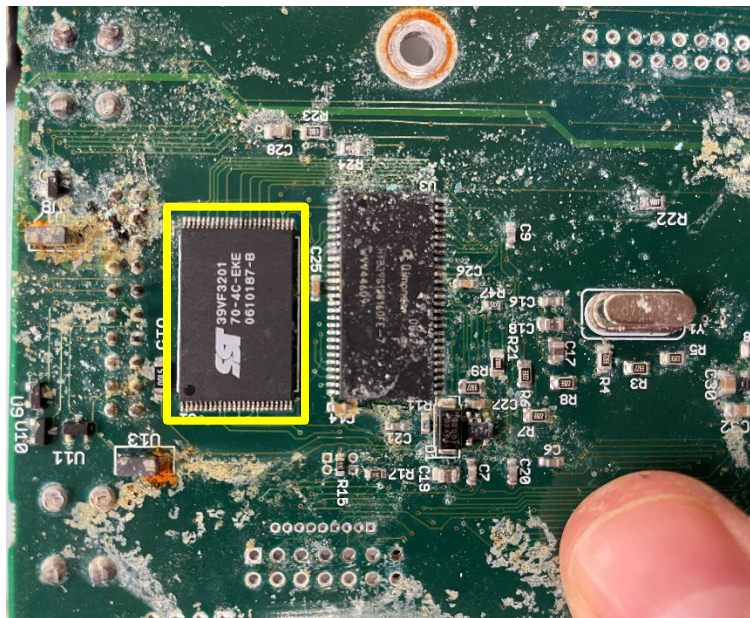
Depending on the firmware version on the unit, the ability to log data to internal memory exists. According to the manufacturer, firmware versions 3.0 and later contain the ability to log certain engine parameters. The data logging must be configured by the operator to enable logging and set the data log interval. The unit can also be configured to start logging data automatically at boot-up. The data logging interval can be set to store at 1, 3, 5, 10, 30 and 60 second intervals. The internal memory can store at least 30 minutes of cumulative data at a 1 second recording interval or at least 30 hours at a 60 second data recording interval. When the recording limit in the internal memory is reached, the oldest record is dropped, and a new record is added.

## **3.1 Dynon EMS-D120 Data Recovery**

Upon arrival at the Vehicle Recorder Laboratory, an external examination revealed the device had sustained water and corrosion damage, as shown in figure 5. The internal circuit boards showed signs of corrosion, as shown in figure 6. The memory chip was identified, cleaned, and removed from the unit. The raw binary data was extracted from the memory chip and was converted into engineering units using laboratory tools.



**Figure 5.** Dynon EMS-D120 as received by the NTSB Vehicle Recorder Laboratory.



**Figure 6.** Dynon EMS-D120 internal circuit board with the NVM chip (cleaned) highlighted (yellow box).

### 3.2 Dynon EMS-D120 Data Description

The Dynon EMS-D120 received contained a firmware version that enabled the unit to store data whenever power was applied. The operator had the datalog function enabled and it was set to record information at a 10 second interval and start recording at boot up. The recording contained approximately 19 hours and 49 minutes of data. The last recording was identified as the event flight. The event flight recording was approximately 2 hours and 45 minutes. Timing of the data is measured in seconds.

### 3.2.1 Dynon EMS-D120 Parameters Provided

Conversion of the data from the raw recorded information to engineering units is performed by the Dynon product support download program. Table 1 lists the parameters provided and verified in this report.

**Table 1.** Dynon EMS-D120 Data Parameters Provided and Verified.

| Parameter Name (unit)         | Parameter Description (unit)                          |
|-------------------------------|-------------------------------------------------------|
| Eng CHT-# <sup>2</sup> (degF) | Engine Cylinder Head Temperature (degrees Fahrenheit) |
| Eng EGT-# (degF)              | Engine Exhaust Gas Temperature (degrees Fahrenheit)   |
| Eng Fuel Flow (gph)           | Engine Fuel Flow (gallons per hour)                   |
| Eng Fuel Lvl (gal)            | Engine Fuel Level (gallons)                           |
| Eng Fuel Press (psi)          | Engine Fuel Pressure (pounds per square inch)         |
| Eng MAP (psi)                 | Engine Manifold Pressure (pounds per square inch)     |
| Eng Oil Press (psi)           | Engine Oil Pressure (pounds per square inch)          |
| Eng Oil Temp (degF)           | Engine Oil Temperature (degrees Fahrenheit)           |
| Eng Speed (RPM)               | Engine Speed (rotations per minute)                   |
| Eng Volts (VDC)               | Engine Voltage (volts direct current)                 |
| Time (HH:MM:SS)               | Dynon EMS-D120 Internal Time (hours:minutes:seconds)  |

### 3.3 Dynon Time Correlation

The time recorded on the device was not valid. The device data were correlated to the event by comparing known information, such as the Automatic Dependent Surveillance - Broadcast (ADS-B) data. An offset of -4,749 seconds was applied to the data such that it displays in local time, CDT. The offset was determined by correlating the application of takeoff power from the EMS-D120 data parameters to the GPS data from the ADS-B data.

## D. FIGURES AND TABULAR DATA

Figures 7 to 11 contain data recorded during the event on October 25, 2023. All the parameters listed in table 1 are plotted in addition to ADS-B parameters of latitude, longitude, and geometric altitude.

Figures 7, 8, and 9 are time history plots presenting engine parameters recorded by the Dynon EMS-D120 for the entire flight, the last 5 minutes of the recording, and takeoff for time correlation with the ADS-B data, respectively.

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<sup>2</sup> Depending on aircraft configuration, the number of cylinders that are instrumented varies. In the data plots, the “#” is replaced with the appropriate cylinder ID.

The data show the following:

- **15:45:13 CDT:** N320P began takeoff roll at KVER. The takeoff roll and cruise portion of the flight were uneventful.
- **18:04:53 CDT:** Manifold pressure was 26.63 psi and fuel flow was 6.13 gph.
- **18:05:13 CDT:** Manifold pressure was 22.63 psi and fuel flow was 5.00 gph. ADS-B data show the aircraft was approximately 6 miles from Ephraim-Gibraltar Airport (K3D2) and at 1300 ft geometric altitude.
- **18:07:23 CDT:** Manifold pressure was 17.88 psi, fuel flow was 3.62 gph, and engine speed was 2363 RPM. ADS-B show that the aircraft was climbing and making a left turn southwest of K3D2.
- **18:07:33 CDT:** Manifold pressure was 28.06 psi, fuel flow was 6.75 gph, and engine speed was 2663 RPM.
- **18:28:13 CDT:** Manifold pressure was 19.38 psi, fuel flow was 4.75 gph, engine speed was 2463 RPM, and the fuel level was 2.44 gal.
- **18:28:53 CDT:** Manifold pressure was 11.00 psi, fuel flow was 2.56 gph, engine speed was 2443 RPM, and the fuel level was 2.25 gal.
- **18:29:29 CDT:** The last recorded ADS-B data sample with the aircraft on a south-southeasterly heading towards runway 17 at KVER.
- **18:29:33 CDT:** The last recorded Dynon EMS-D120 data sample. Manifold pressure was 7.50 psi, fuel flow was 1.94 gph, engine speed was 1831 RPM, and the fuel level was 2.06 gal.

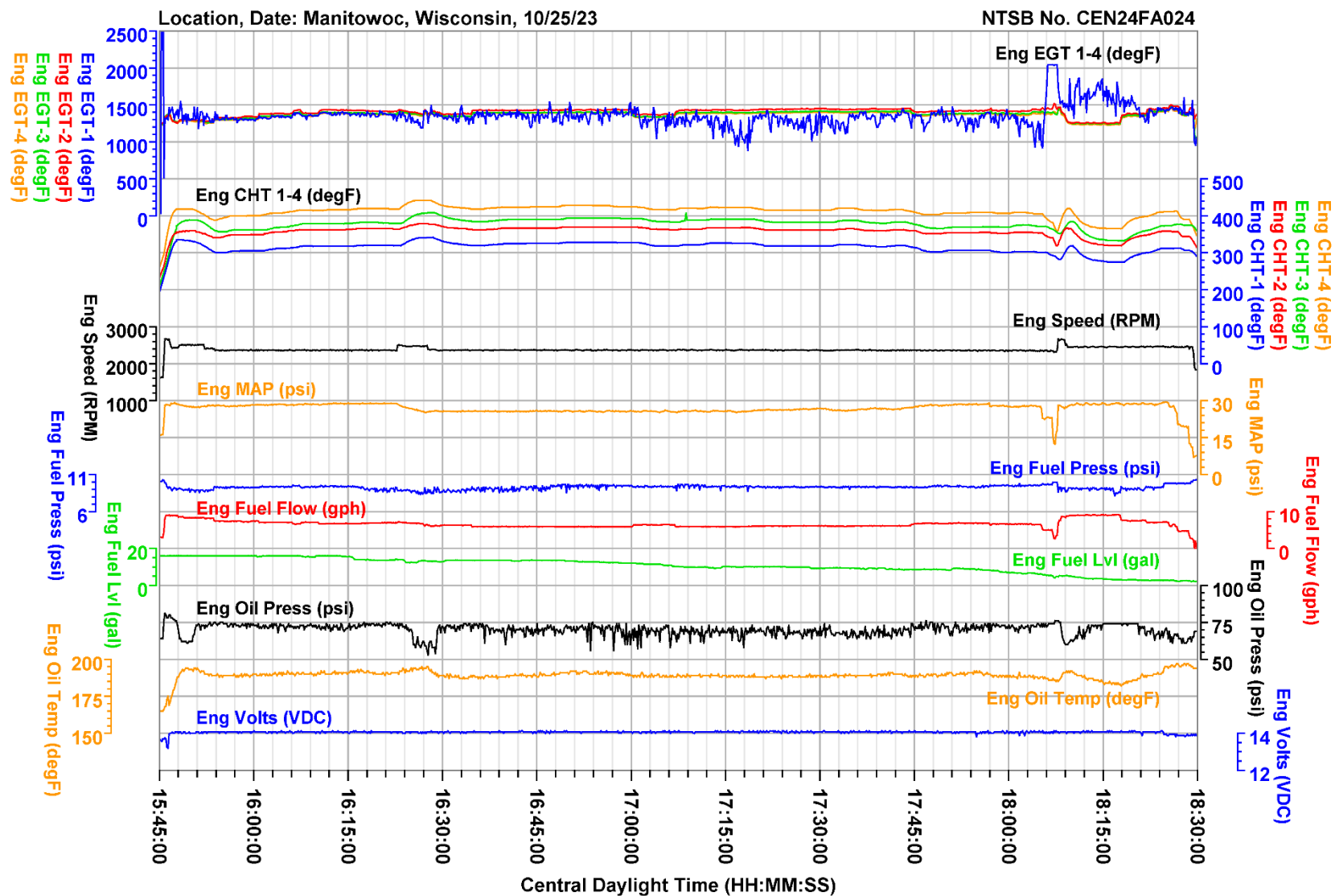
Figures 10 and 11 are graphical overlays derived from the ADS-B data and generated using Google Earth presenting the entire accident flight from KVER and the final 5 minutes of the recording, respectively. Weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

The corresponding tabular data used to create figures 7 to 9 are provided in electronic comma-separated value (CSV) format as attachment 1 to this report.

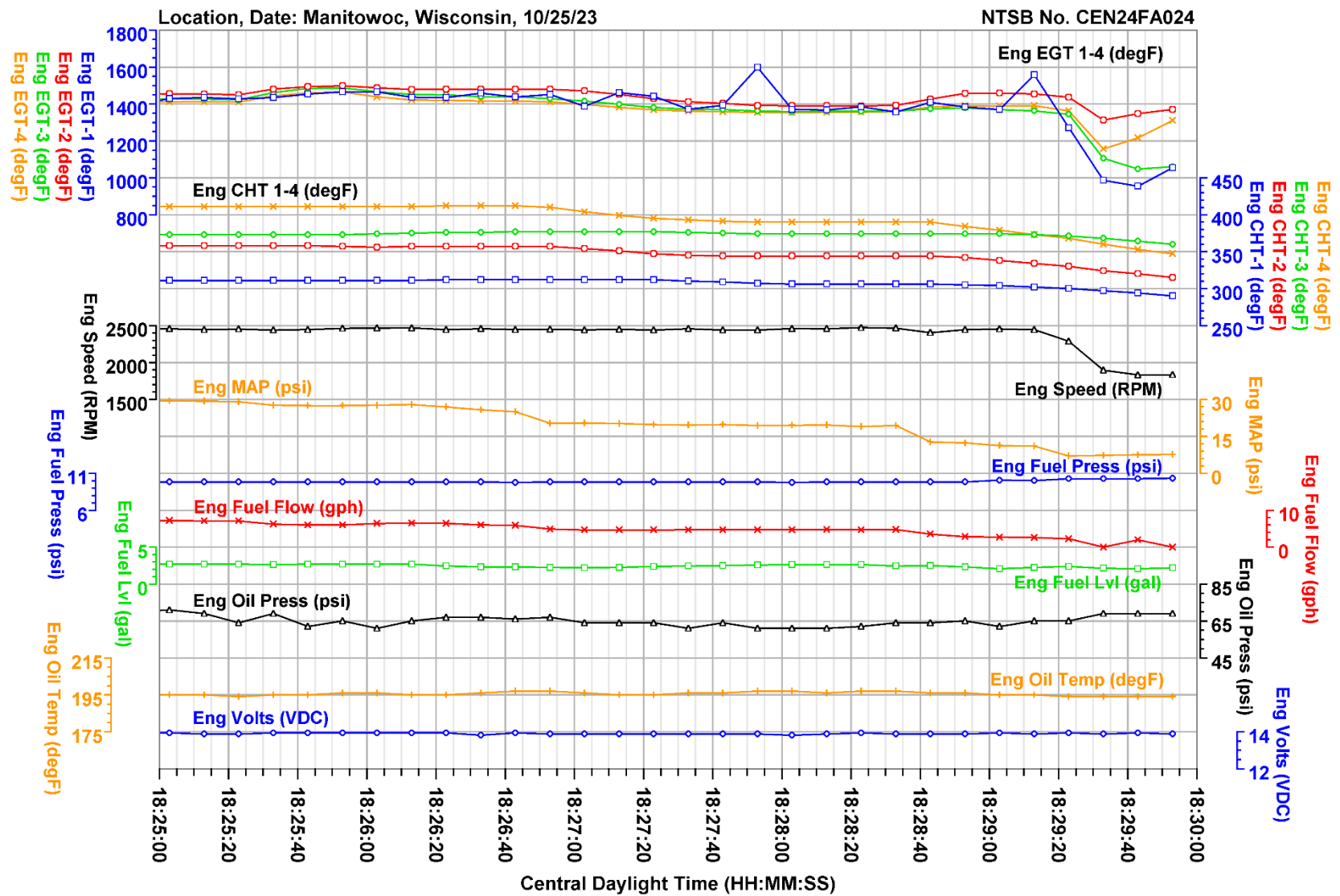
The corresponding tabular data used to create figures 10 and 11 are provided in CSV format as attachment 2 to this report. Note, the altitude parameter used from the ADS-B data is geometric altitude and was left uncorrected for the geoid.

Submitted by:

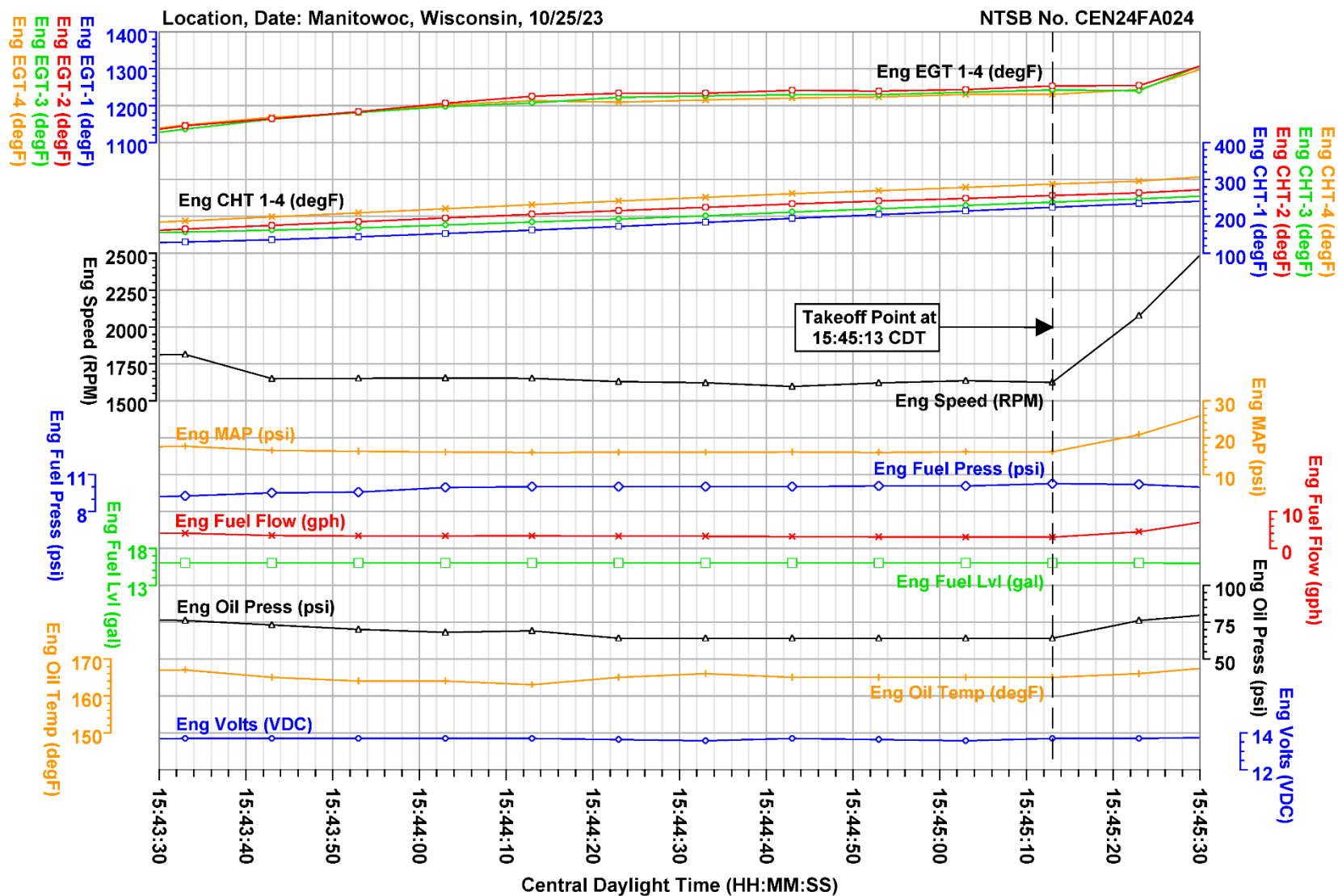
Steven Smith  
Mechanical Engineer (Recorder Specialist)



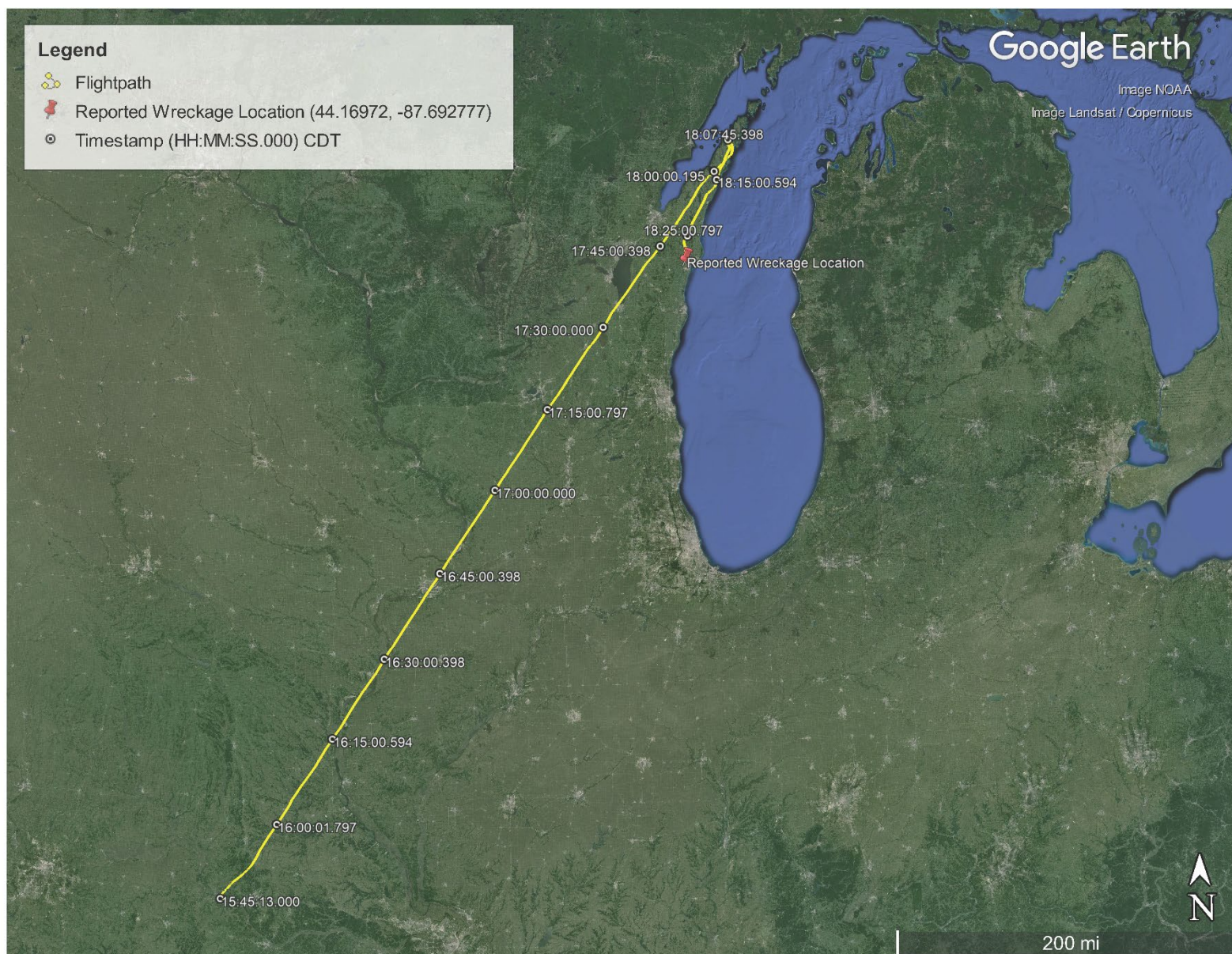
**Figure 7.** Time history plot of the Dynon EMS-D120 engine parameters for the entire flight.



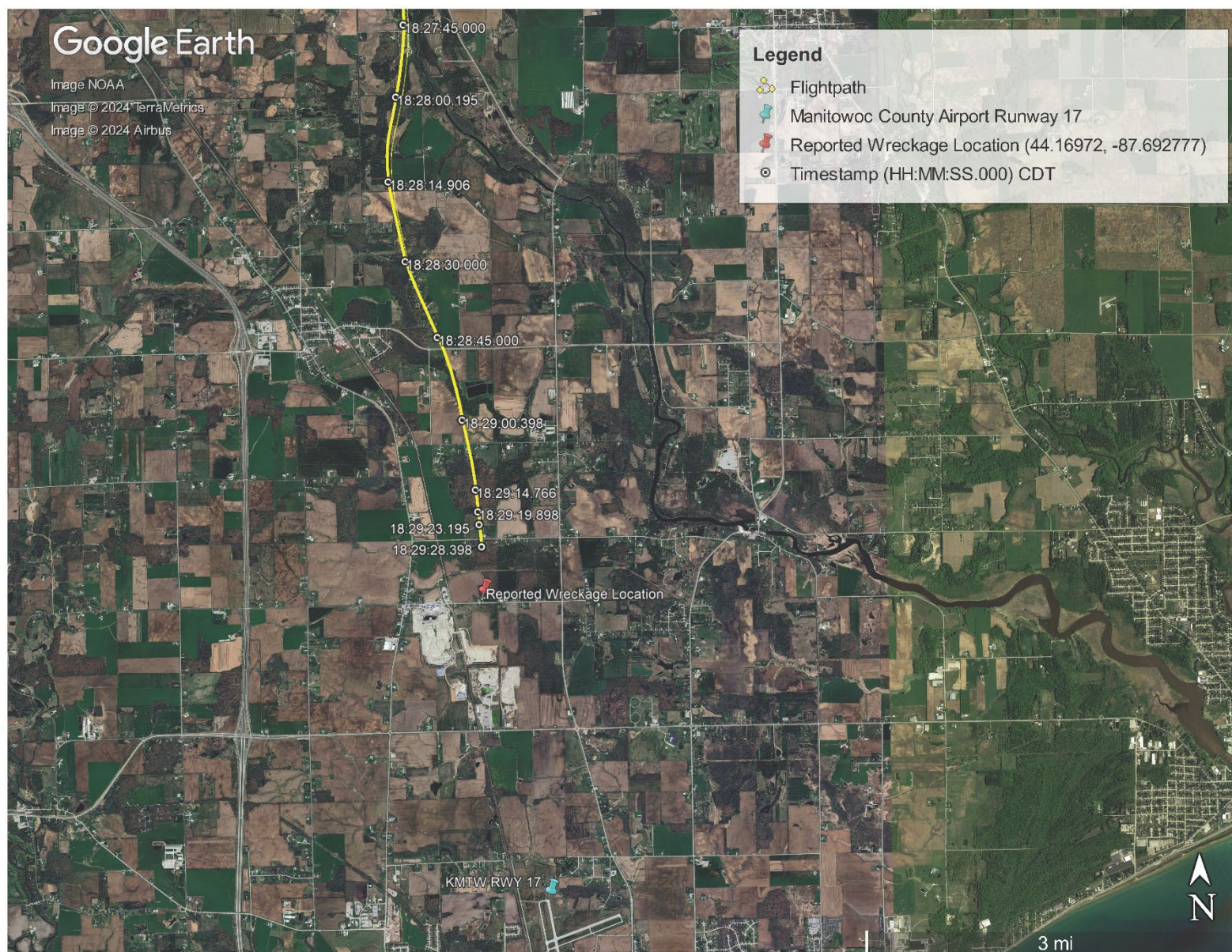
**Figure 8.** Time history plot of the Dynon EMS-D120 engine parameters for the final 5 minutes of the recording.



**Figure 9.** Time history plot of the Dynon EMS-D120 takeoff for time correlation with ADS-B data.



**Figure 10.** Google Earth overlay of entire flight using ADS-B data.



**Figure 11.** Google Earth overlay of the final portion of the recorded ADS-B data.