

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

February 19, 2020

Engine Data Monitor (EDM)

Specialist's Factual Report
By Gerald Kawamoto

1. EVENT SUMMARY

Location: Kerrville, Texas
Date: April 22, 2019
Aircraft: Beech 58
Registration: N501CE
Operator: Private
NTSB Number: CEN19FA124

On April 22, 2019, at 0851 central daylight time, a Beech 58 airplane, N501CE, impacted terrain during approach to Kerrville Municipal Airport (ERV), Kerrville, Texas. The pilot and five passengers were fatally injured, and the airplane was substantially damaged. The airplane was registered to and operated by the pilot under the provisions of Title 14 *Code of Federal Regulations* Part 91 as a business flight. Day instrument meteorological conditions prevailed for the flight, which departed on an instrument flight rules flight plan from West Houston Airport (IWS), West Houston, Texas, at 0730.

2. ENGINE DATA MONITOR GROUP

An Engine Data Monitor (EDM) group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following EDM:

Recorder Manufacturer/Model: **JPI EDM-760**
Recorder Serial Number: **2233**

3.1. JPI EDM-760 Description

The J. P. Instruments EDM-760 is a panel mounted gauge that the operator can monitor and record up to 24 parameters related to twin engine operations. Depending on the installation engine parameters monitored, for both engines, can include: Exhaust Gas Temperature (EGT), Cylinder Head Temperature (CHT), Oil Pressure and Temperature, Manifold Pressure, Outside Air Temperature, Turbine inlet Temperature, Engine Revolutions per Minute, Compressor Discharge Temperature, Fuel Flow, Carburetor Temperature, and Battery Voltage.

The unit can also calculate, in real-time, horsepower, fuel used, shock cooling rate and EGT differentials between the highest and lowest cylinder temperatures. The calculations are also based on the aircraft installation.

The unit contains non-volatile memory¹ for data storage of the parameters recorded and calculated. The rate at which the data is stored is selectable by the operator from 2 to 500 seconds per sample. The memory can store up to 20 hours of data at a 6 second sample rate. The data can then be downloaded by the operator using the J.P. Instruments software.

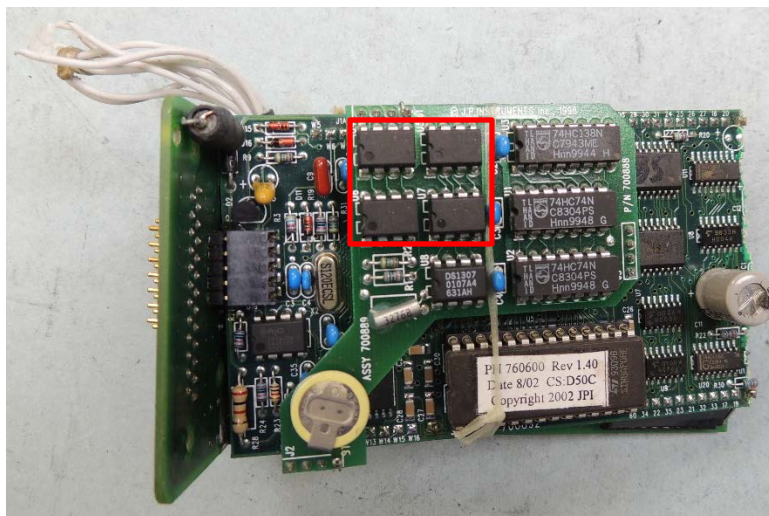
3.2. Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the unit had sustained impact damage, as shown in Figure 1. The non-volatile memory chips, as shown in Figure 2, were removed and a binary image was created using laboratory tools.

Figure 1. JPI EDM-760 as received.



Figure 2. JPI EDM-760 NVM chips on circuit board.



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

3.3. Data Description

The data extracted included 10 sessions from April 7, 2019 through April 22, 2019. The recorded time is based on the unit's internal clock, which is set and updated by the user. The device begins recording data when power is applied and stops when power is disconnected. Due to the condition of the device, the user set time was unable to be verified and is referred to as JPI Time in this report. The last recorded session was determined to be related to the accident and is included in this report. The data was recorded at a 6 second-per-sample rate.

3.4. Parameters Provided

Table 1 describes data parameters recorded by the device. The engineering units conversions used for the data contained in this report are based on documentation from the manufacturer of the EDM.

Table 1: JPI EDM-760 Data Parameters

Parameter Name	Parameter Description
JPI Time	Device time for recorded data point (HH:MM:SS)
Eng1 EGT 1-6 (degF)	Left Engine Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)
Eng1 CHT 1-6 (degF)	Left Engine Cylinder Head Temperature Cylinder # (degrees Fahrenheit)
Eng1 CLD (degF/min)	Left Engine Shock Cooling Rate (degrees Fahrenheit per minute)
Eng1 Fuel Flow (gph)	Left Engine Fuel Flow (gallons per hour)
Eng1 Fuel Used (gal)	Left Engine Fuel Used (gallons)
Eng2 EGT 1-6 (degF)	Right Engine Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)
Eng2 CHT 1-6 (degF)	Right Engine Cylinder Head Temperature Cylinder # (degrees Fahrenheit)
Eng2 CLD (degF/min)	Right Engine Shock Cooling Rate (degrees Fahrenheit per minute)
Eng2 Fuel Flow (gph)	Right Engine Fuel Flow (gallons per hour)
Eng2 Fuel Used (gal)	Right Engine Fuel Used (gallons)
Voltage (V)	Battery Voltage (Volts)

3.5. Plots and Corresponding Tabular Data

The following four figures contain EDM data recorded during the April 22, 2019, event.

Figure 3 is a plot of Engine 1 parameters from the accident flight recorded on the device for the entire flight. The time interval is 13:40:00 to 15:15:00 JPI Time.

Figure 4 is a plot of Engine 1 parameters from the accident flight recorded on the device at the end of the flight. The time interval is 15:05:45 to 15:12:15 JPI Time.

Between 15:06 and 15:07, EGT and CHT values for all cylinders decrease. EGT values decrease over 500 degrees Fahrenheit during that span. Between 15:07 and 15:07:45 the temperatures return to similar values prior to the drop. Between 15:07:45 and 15:08:15, EGT values increases and decrease in a back and forth fashion. From 15:08:15 until the end of the recording, EGT and CHT values for cylinder 6 begin to diverge from the other cylinder temperatures.

Figure 5 is a plot of Engine 2 parameters from the accident flight recorded on the device for the entire flight. The time interval is 13:40:00 to 15:15:00 JPI Time. For the duration of the flight, EGT and CHT values for cylinder 6 diverged from the other cylinder values. Previous sessions revealed that EGT and CHT values for cylinder 6 had a history of diverging.

At about 14:58, EGT and CHT values began to decrease for all cylinders. The values level out until about 15:06 before decreasing sharply until the end of the recording.

Figure 6 is a plot of Engine 2 parameters from the accident flight recorded on the device at the end of the flight. The time interval is 15:05:45 to 15:12:15 JPI Time.

Figure 7 is a plot of Engine 1 and Engine 2 fuel parameters for the last six sessions recorded. The x-axis depicts the total seconds elapsed from the first session recorded to the JPI EDM-760's non-volatile memory. The dates and times of the sessions are summarized in Table 2.

Table 2. Summary of last six sessions.

Session (elapsed seconds)	Start Date and Time	End Date and Time	Duration
4 (55812)	April 15, 2019 12:43:30	April 15, 2019 15:02:42	02:19:12
5 (64164)	April 15, 2019 15:50:34	April 15, 2019 17:27:58	01:37:24
6 (70008)	April 15, 2019 18:03:24	April 15, 2019 19:54:06	01:50:42
7 (76650)	April 17, 2019 20:41:54	April 17, 2019 21:01:30	00:19:36
8 (77826)	April 17, 2019 22:50:58	April 17, 2019 23:16:34	00:25:36
9 (79362)	April 22, 2019 13:42:32	April 22, 2019 15:12:08	01:29:36

Between 15:06:15 and 15:06:30, the values for EGT and CHT increase, then immediately decrease rapidly until about 15:08. EGT values decrease over 500 degrees Fahrenheit during that span. Between 15:08 and 15:08:15, EGT values increase rapidly before decreasing steadily until the end of the flight.

The tabular data associated with Figures 3 through 6 from the accident flight recorded by the JPI EDM-760 device is included as Attachment 1. The tabular data associated with Figure 7 is included as Attachment 2. These attachments are provided in electronic comma-delimited (.csv) format.

Figure 3. Plot of Engine 1 parameters during the entire flight.

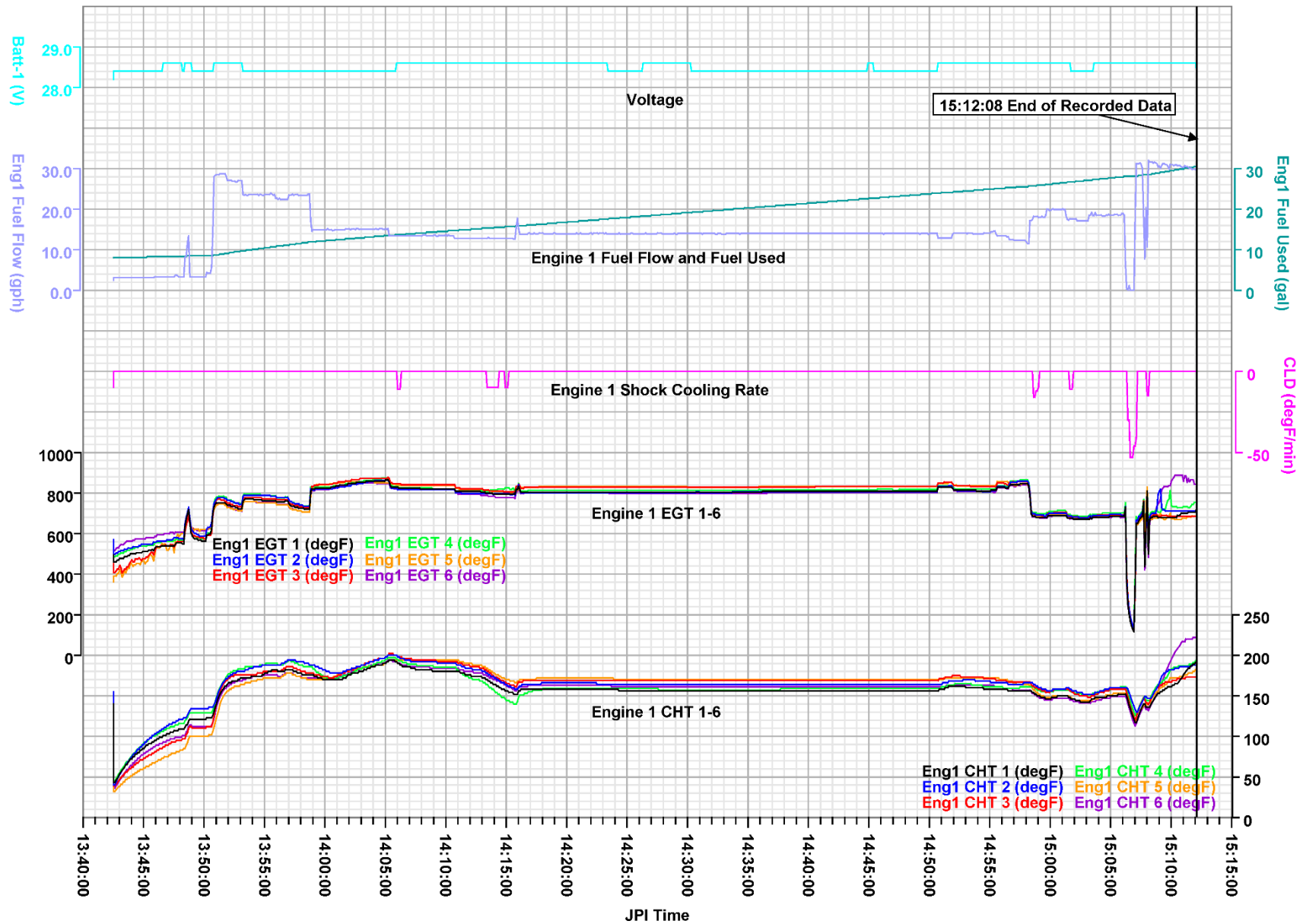


Figure 4. Plot of Engine 1 parameters at the end of the flight.

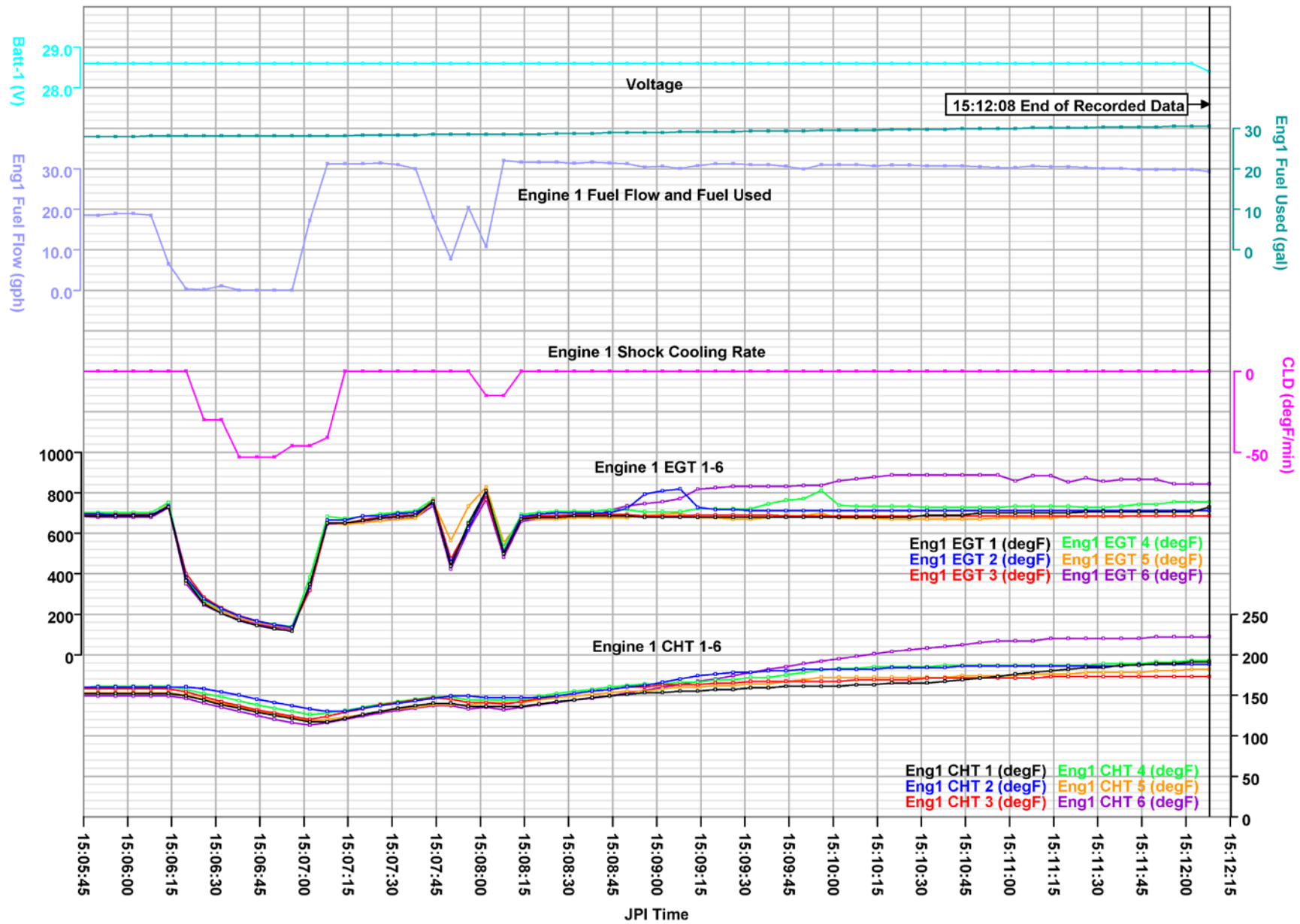


Figure 5. Plot of Engine 2 parameters during the entire flight.

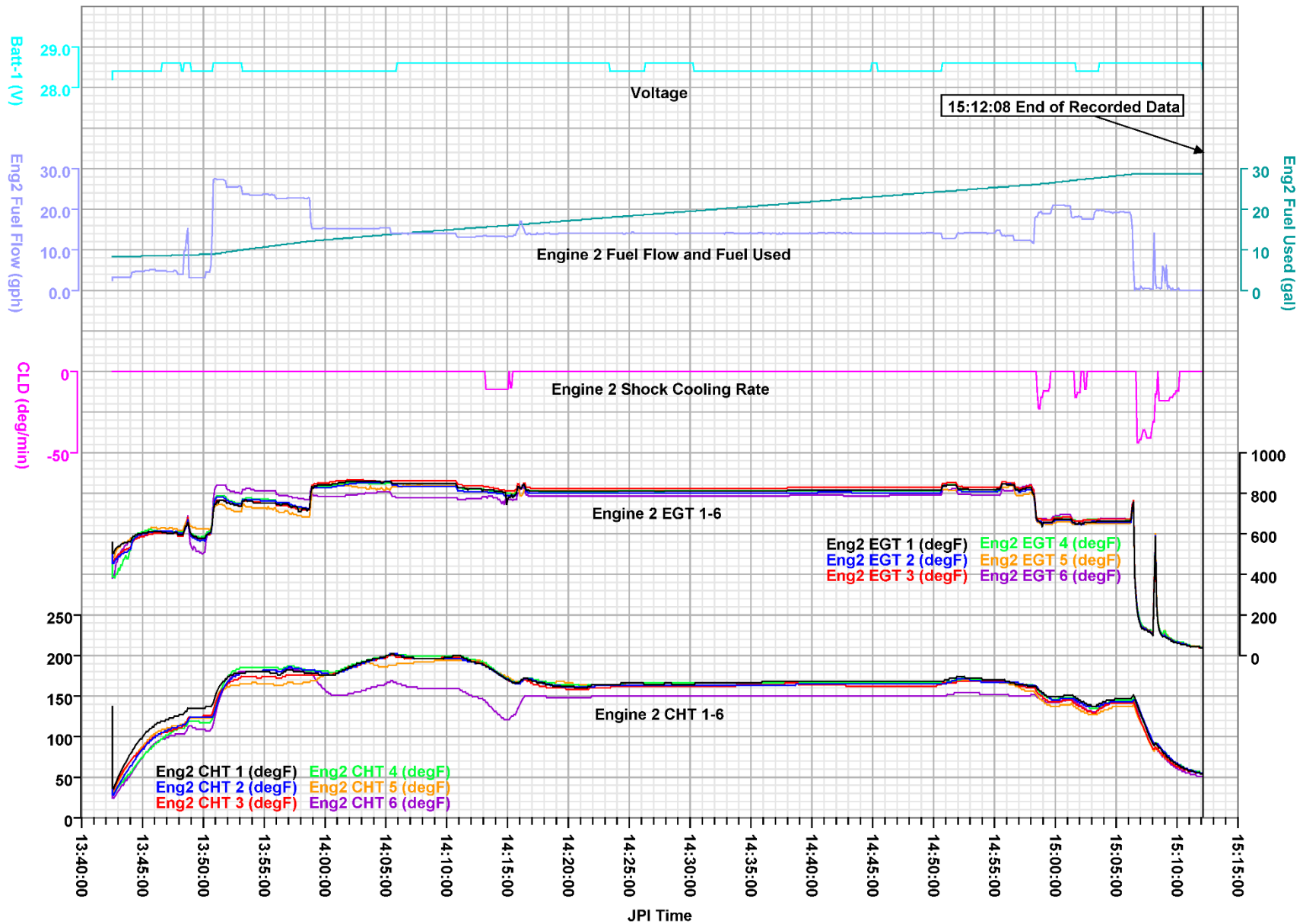


Figure 6. Plot of Engine 2 parameters at the end of the flight.

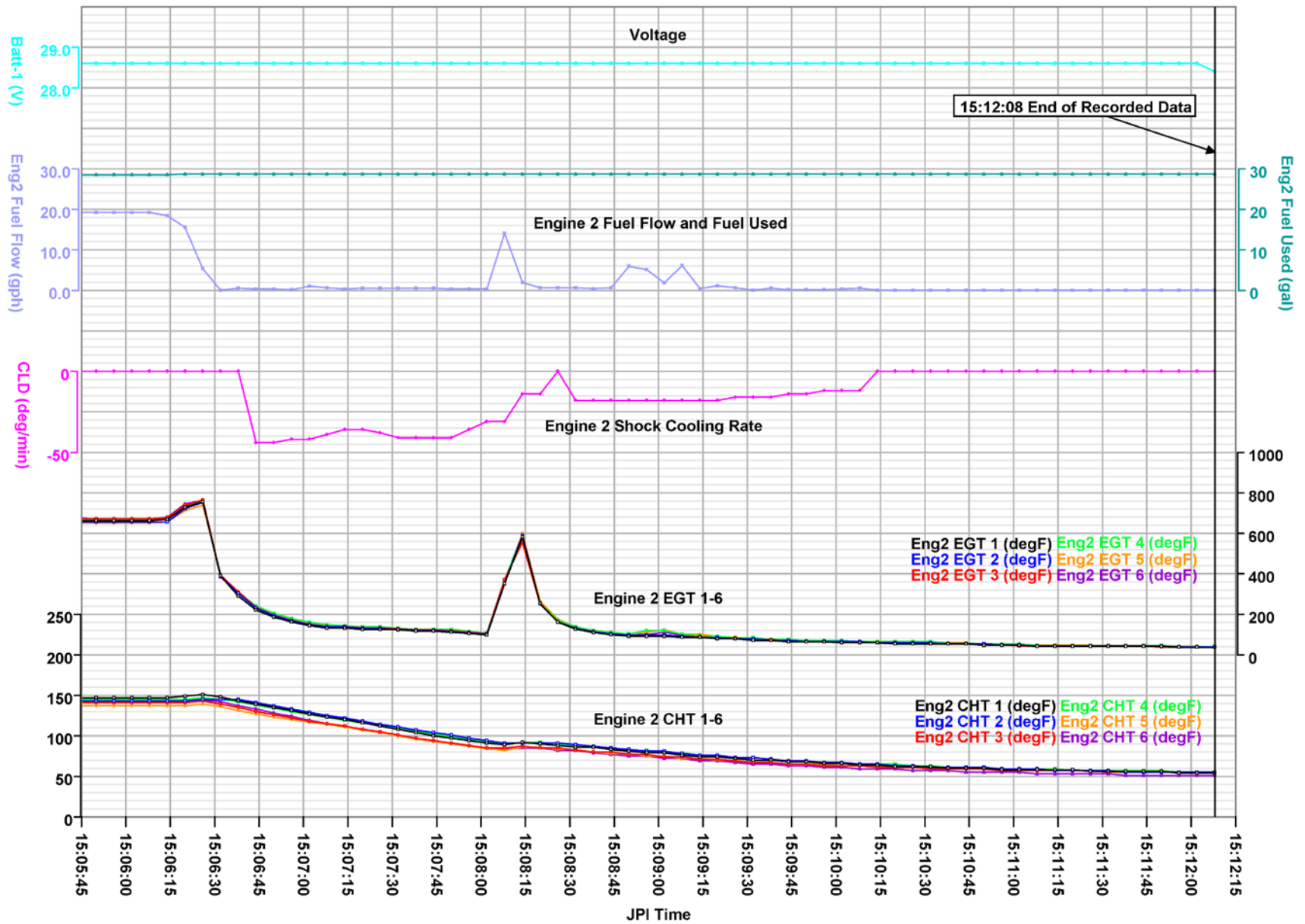


Figure 7. Plot of Engine 1 and Engine 2 fuel parameters for the last 6 sessions recorded.

