

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

November 17, 2020

Engine Data Monitor (EDM)

Specialist's Factual Report
By Sean Payne

1. EVENT SUMMARY

Location: Moosic, PA
Date: September 20, 2020
Aircraft: Piper PA-28R-180
Registration: N3790T
Operator: Private
NTSB Number: ERA20LA322

On September 20, 2020, about 2047 eastern daylight time (EDT), a Piper PA-28R-180, N3790T, was substantially damaged when it was involved in an accident near Moosic, Pennsylvania. The commercial pilot sustained a serious injury while the pilot rated passenger sustained minor injuries. The airplane was operated as a Title *14 Code of Federal Regulations* part 91 personal flight.

2. ENGINE DATA MONITOR GROUP

An Engine Data Monitor group was not convened.

3. DETAILS OF INVESTIGATION

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

Recorder Manufacturer/Model: **Electronics International CGR-30P**
Recorder Serial Number: **239076**

3.1. Electronics International CGR-30P Description

The Electronics International CGR-30P is a panel mounted instrument that can monitor and record up to 66 parameters related to engine operations. Depending on the installation engine parameters monitored can include:

- Exhaust Gas Temperature (EGT)
- Cylinder Head Temperature (CHT)
- Oil Pressure and Temperature
- Manifold Pressure
- Outside Air Temperature
- Engine Revolutions per Minute
- Fuel Pressure
- Battery Voltage

- Battery Amperage

The unit can also optionally be connected to an external GPS system to provide real time calculation of range and endurance. Additionally, when connected to an external GPS source, the device can calculate additional fuel management parameters such as Gallons Remaining to Destination and other estimations of fuel usage.

The unit contains an internal non-volatile¹ micro SD² card for data storage of the parameters recorded and calculated. The data are stored at a rate of 3 samples per second. The amount of data stored is dependant on the size of the micro SD card installed on the device's internal board. Additionally, the recording feature will only begin to overwrite older flight files when it has stored 1,500 flights. For a non-damaged unit, the data can be downloaded by the operator using a USB flash drive and following the instructions on the unit when accessed from the "USB and Data Recording Screen."

3.1.1. Data Recovery

The recorder was in good condition and the data were extracted normally from the recorder. Figure 1 is a photo of the device.



Figure 1. Photo of EDM.

3.1.2. Data Description

The EDM recording contained recordings from August 8, 2019, to the time of the accident flight on September 20, 2020. There were a additional data files recorded after the accident flight as a result of power cycles of the EDM.

The accident flight recording began on September 20, 2020, at 18:22:30 and lasted until 20:47:00

3.1.3. Engineering Units Conversions

The engineering units conversions used for the data contained in this report are based on documentation from the manufacturer of the EDM.

¹ Non-volatile – electronic memory that does not require power to retain data.

² Micro SD – Secure Digital – a non-volatile memory card format.

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

3.2. Time Correlation

The EDM records time with the first data sample based on the unit's internal clock. This clock is set and updated by the operator.

The correlation of the EDM data to the event local time, eastern daylight time (EDT), was established by comparing the EDM's recorded time to ADS-B data for the accident aircraft. Using the recorded time of the EDM and then applying an additional 8,912 second offset to convert to EDT. Therefore, for the rest of this report, all times are referenced as EDT and not recorded time.

When comparing the above event, the corrected time correlation for this device is as follows:

$$\text{EDT} = \text{GCR-30P Time} + 8,912 \text{ seconds}$$

3.3. Plots and Corresponding Tabular Data

The following five figures contain EDM data recorded during the flights previous to the accident and the accident flight. These flights all occurred on September 20, 2020.

Figure 2 is a plot of select engine parameters for a recorded session two flights previous to the accident flight. Data shows the cylinder head temperature (CHT) values for cylinder 2 remained higher than recorded values for cylinders 1, 3 and 4. This difference approached approximately 92 degrees Fahrenheit during the flight. The time in this plot is given in the format HH:MM:SS and has not been aligned to local time.

Figure 3 is a plot of select engine parameters for a recorded session one flight previous to the accident flight. Data shows the cylinder head temperature (CHT) values for cylinder 2 remained higher than recorded values for cylinders 1, 3 and 4. This difference approached approximately 97 degrees Fahrenheit during the flight. The time in this plot is given in the format HH:MM:SS and has not been aligned to local time.

Figure 4 is a plot of various engine parameters for the entire accident flight. The trend for cylinder 2 CHT values was initially similar to the recorded data for previous flights (cylinder 2 was running hotter). At around 19:05:30, cylinder 2 CHT values dropped in line with the other cylinders, something that was not seen in recorded data for previous flights. Around 20:00:30, CHT values for cylinder 2 decreased sharply. At this time, EGT values for cylinder 2 also dropped. The EGT and CHT values for the remaining 3 cylinders were at normal values. Recorded data continued until the accident occurred.

Figure 5 is a simplified plot of the entire accident flight using only selected engine parameters. Times 19:05:30 and 20:00:30 have been demarcated on the plot.

Figure 6 is a simplified plot of a portion of the accident flight between 19:55 and 20:05. The plot focuses on EGT and CHT values for all cylinders, and highlights the behavior of cylinder 2.

A review of all recorded data showed, dating back to when the unit was installed³, showed that CHT values for cylinder 2 were routinely higher than all other cylinders. The order of magnitude of this difference varied throughout the data history and would have been affected by factors such as the aircraft's flight regime, the aircraft's performance profile, and environmental factors.

A review of all recorded data indicated that a maximum CHT value difference of 102 degrees Fahrenheit between CHT values for cylinder 2 and the coldest recorded cylinder. This occurred on a recording made on February 22, 2020.

The corresponding tabular data used to create the first two plots (figures 2 and 3) for the previous flight are provided in electronic (*.csv⁴) format as Attachment 1 to this report. Attachment 1 contains all data downloaded from the EDM. Attachment 1 does not contain a time correction to EDT.

The corresponding tabular data used to create figures 3, 4 and 5 for the accident flight are provided in electronic (*.csv) format as Attachment 2 to this report. Attachment 2 contains data from the EDM for the accident flight only. Attachment 2 contains a time correction to EDT.

³ The unit was installed on December 5, 2019.

⁴ Comma Separated Value format.

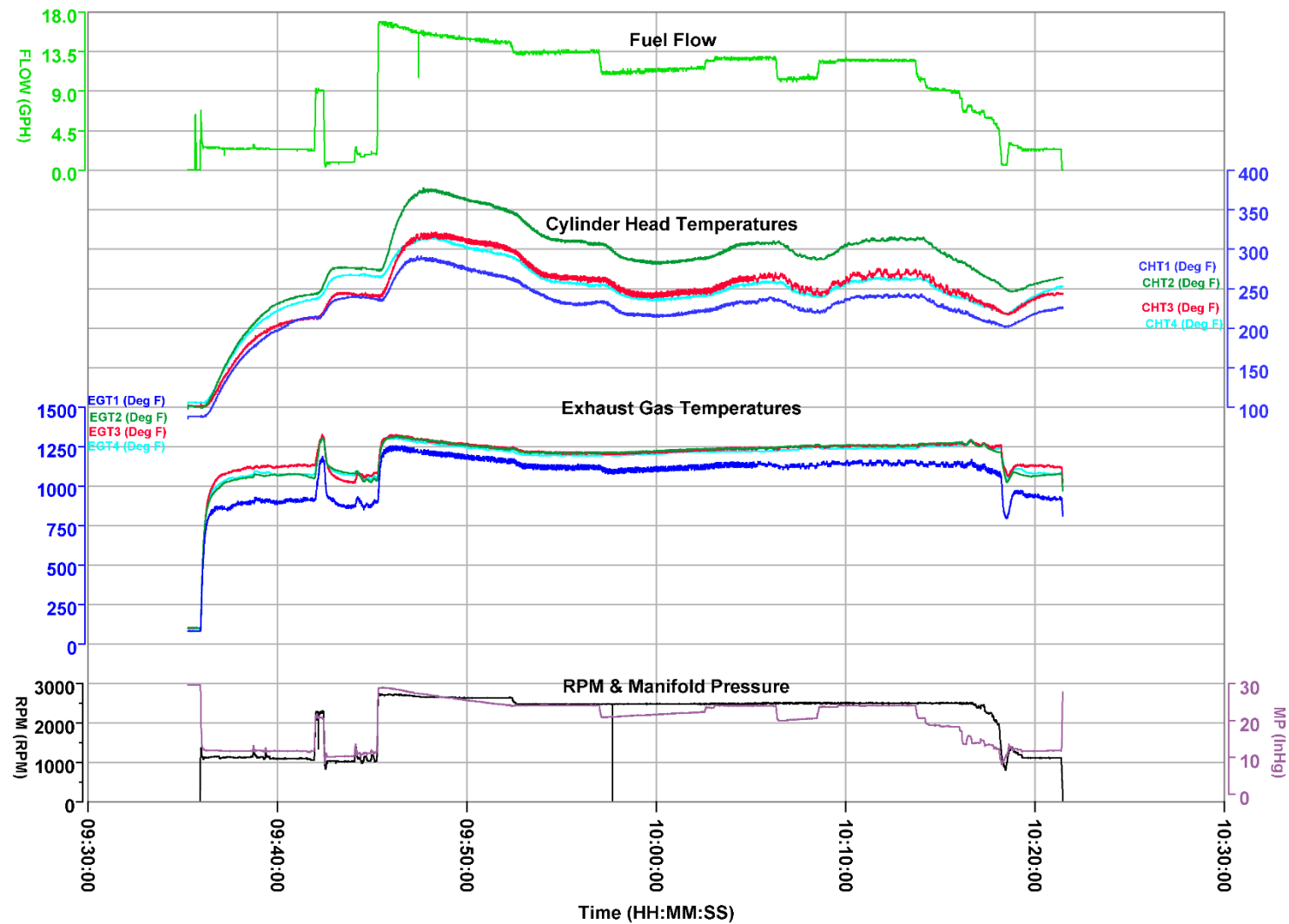


Figure 2. Plot of select engine parameters for a recording made two flights previous to the accident.

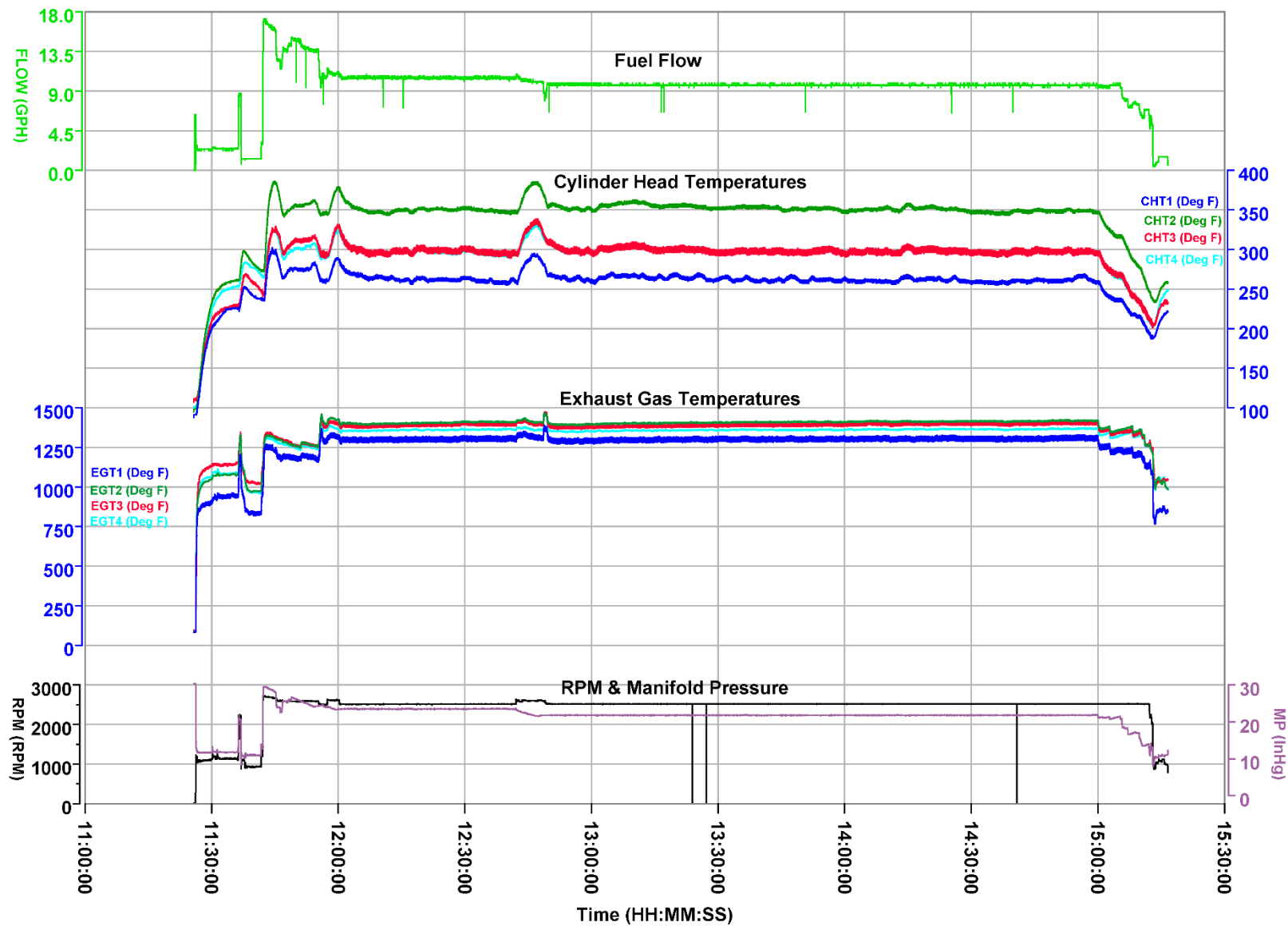


Figure 3. Plot of select engine parameters for a recording made one flight previous to the accident.

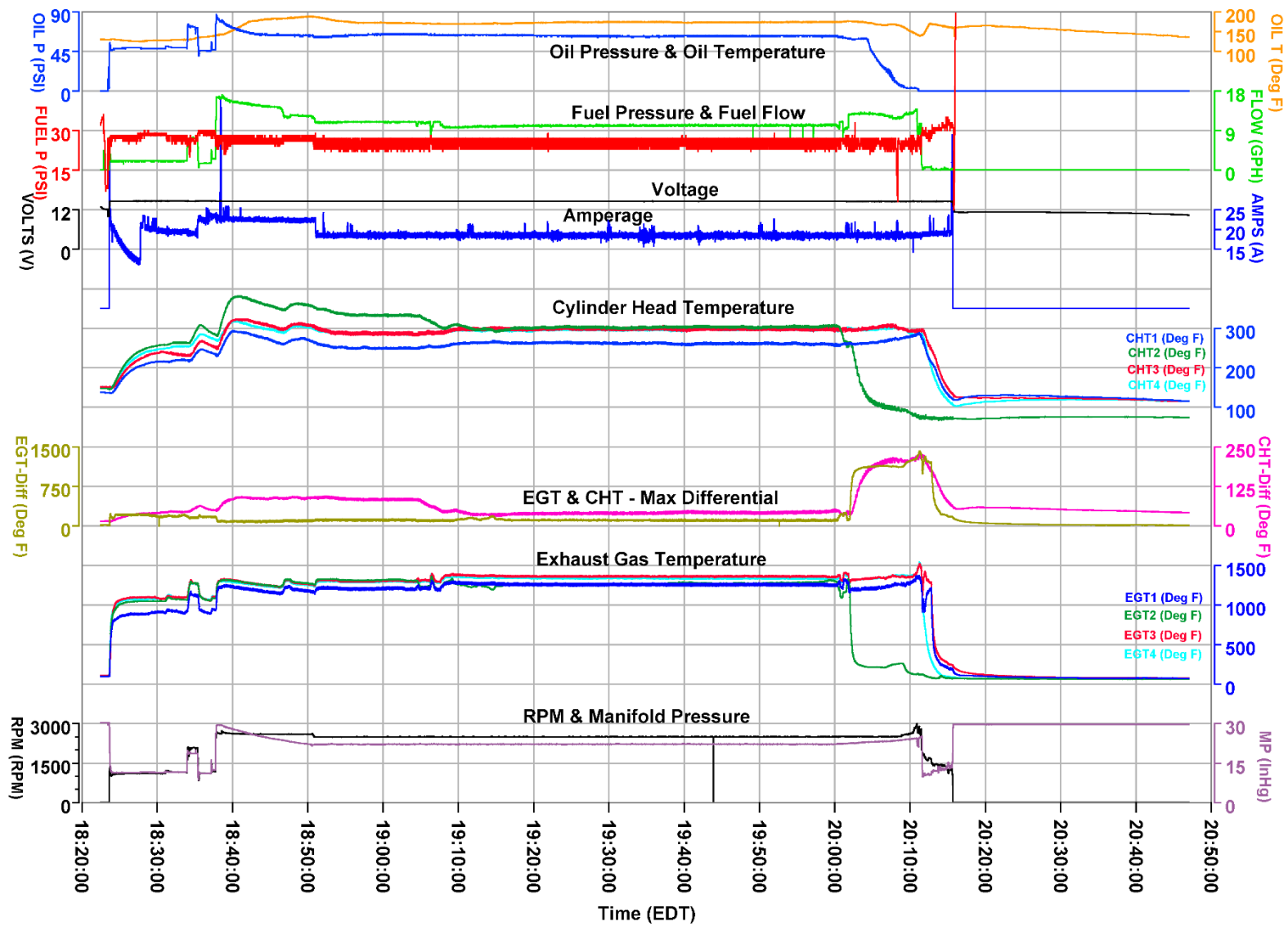


Figure 4. Plot of various engine parameters for the entire accident flight.

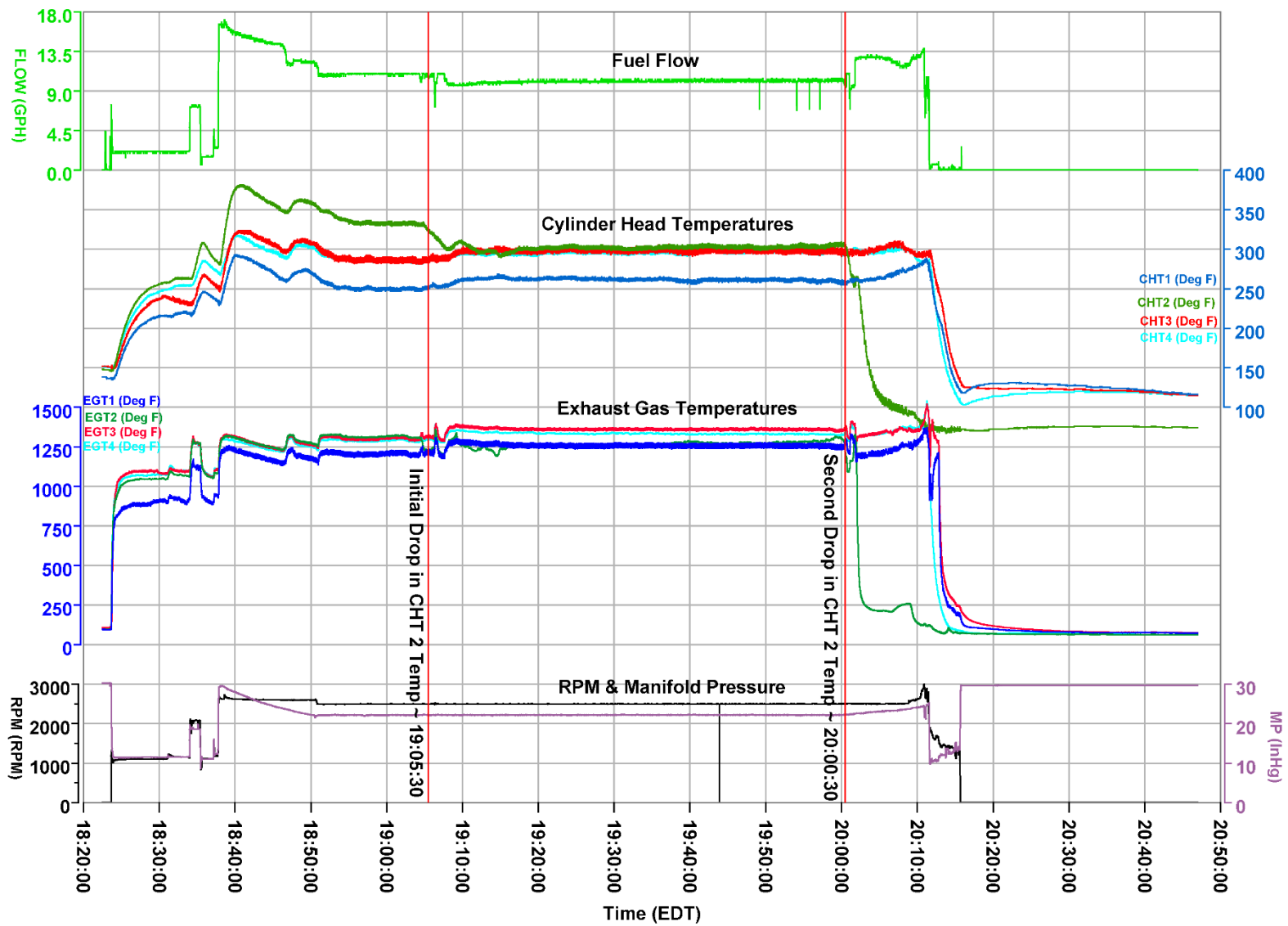


Figure 5. Plot of select engine parameters for the entire accident flight.

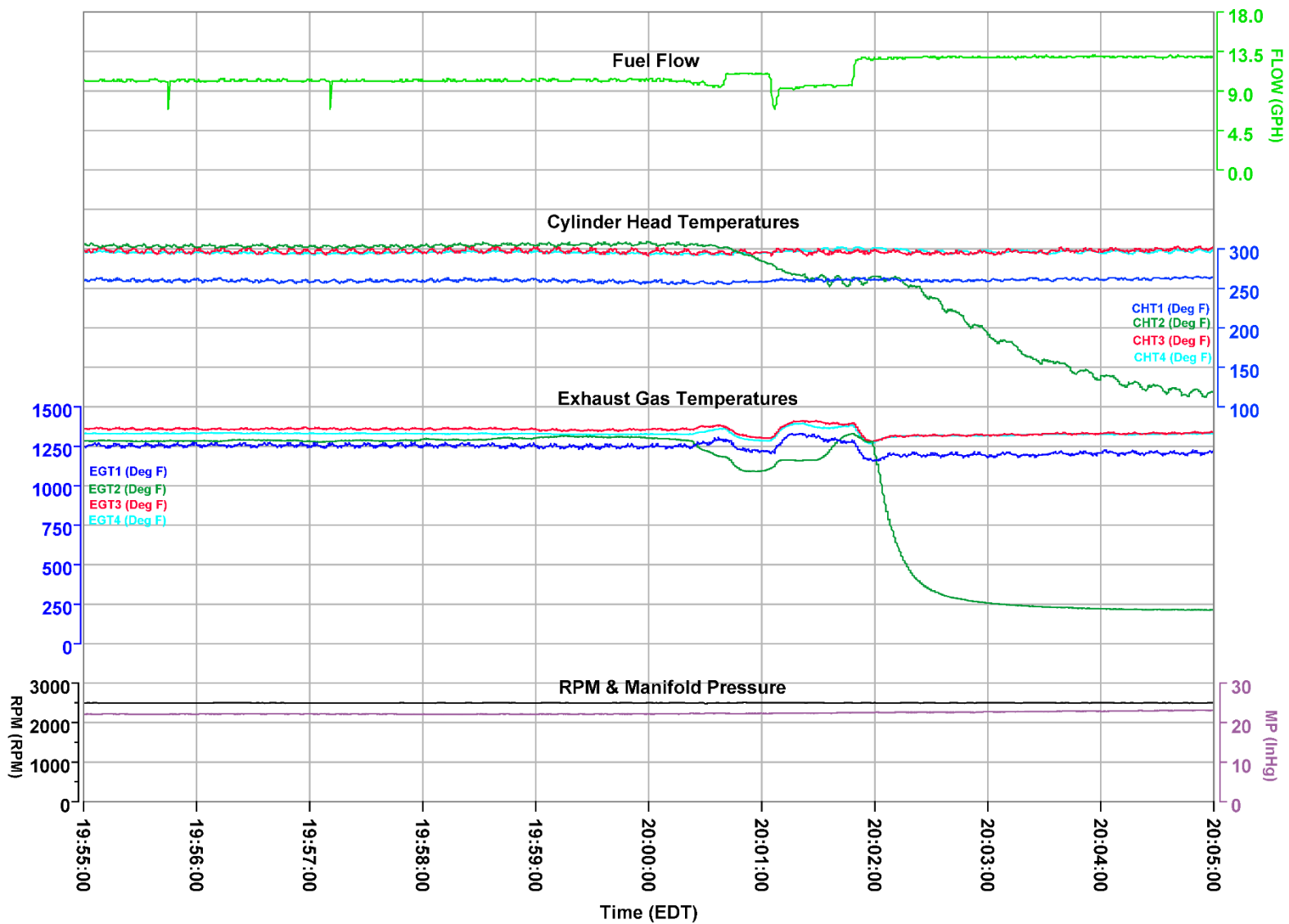


Figure 6. Plot of select engine parameters for the accident flight between 19:55 and 20:05 EDT.

APPENDIX A

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

Table A-1. Verified and provided parameters.

Parameter Name (Units)	Parameter Definition
SEL TANK QTY (Tank #)	Selected Tank Number
RPMLEFT (rpm)	Left Magneto Sensed RPM
RPMRIGHT (rpm)	Right magneto Sensed RPM
RPM (rpm)	Engine RPM
MP (in.Hg)	Manifold Pressure
TEMP COMP (deg. F)	Ambient Temp at Engine Data Converter
VOLTS (V)	Battery System Voltage
AMPS (A)	Battery System Amperage
FLOW (gph)	Fuel Flow
FLOW ANN (gph)	Annunciated Value for Fuel Flow
EGT-# (deg. F)	Exhaust Gas Temper Cylinder #
EGT (deg. F.)	Display Data from Selected Cylinder for EGT
EGT-Diff (deg. F)	EGT Max Differential highest and lowest cylinder
EGT-Hot (deg. F)	Hottest Cylinder EGT Value
CHT-# (deg. F)	Cylinder Head Temperature Cylinder #
CHT (deg. F)	Display Data from Selected Cylinder for EGT
CHT-Diff (deg. F)	CHT Max Differential Highest and Lowest Cylinder
CHT-Hot (deg. F)	Hottest Cylinder CHT Value
FUEL P (psi)	Fuel Pressure
FUEL P ANN (psi)	Annunciated Value for Fuel Pressure
OIL P (psi)	Oil Pressure
OIL P ANN (psi)	Annunciated Value for Oil Pressure
OIL T (deg. F)	Oil Temperature
OIL T ANN (deg. F)	Annunciated Value for Oil Temperature
FLT (hrs)	Flight Timer
TACH (hrs)	Tach Time
EST TOTAL (gal)	Calculated Total Fuel Remaining
RANGE (nm)	Calculated Range
TO DEST (nm)	Calculated Nautical Miles to Destination
AT DEST (nm)	Calculated Range Beyond Destination
REMAIN (gal)	Calculated Amount of Fuel Remaining
TO DEST (gal)	Calculated Fuel Required to Destination
AT DEST (gal)	Calculated Fuel Reserve at Destination
TO EMPTY (HH:SS)	Calculated Flight Time Until Empty
TO DEST (HH:SS)	Calculated Time to Destination
AT DEST (HH:SS)	Calculated Endurance Beyond Destination
TIME (HH:MM)	Calculated Endurance Remaining after Arrival based on Calculated Fuel Remaining

Parameter Name (Units)	Parameter Definition
QUANTITY (gal)	Calculated Fuel Available at Destination
FLIGHT (gal)	Fuel Burned Since Start of Flight Timer
SINCE ADD (gal)	Fuel burned since the last time the unit was 'topped off'.
ECONOMY (nmpg)	Calculated Fuel Economy
ENGINE (gph)	Total Fuel Flow
SWITCH IN (N/A)	Triggers Switch Annunciator
SWTCH ANN (N/A)	Fuel Tank Switch Annunciator
FUEL ANN (N/A)	Triggers Fuel Annunciator

Table A-2. Unit abbreviations.

Units Abbreviation	Description
rpm	revolutions per minute
deg. F	Degrees Fahrenheit
gal	gallons
gph	gallons per hour
hrs	hours
HH:MM	hours and minutes
psi	pounds per square inch
V	Volts DC
A	Amperes
InHg	inches of mercury
nm	nautical miles
nmpg	Nautical miles per gallon
tank #	fuel tank number
N/A	Not available

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.