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

August 18, 2020

Electronic Devices

Specialist's Factual Report
by Gerald Kawamoto

1. EVENT

Location:	Yorba Linda, California
Date:	February 3, 2019
Aircraft:	Cessna 414A
Registration:	N414RS
Operator:	Private
NTSB Number:	WPR19FA079

On February 3, 2019, at 1345 Pacific standard time, a Cessna 414, N414RS, experienced an in-flight breakup over Yorba Linda, California, about 11 miles west of the departure airport, Fullerton Municipal Airport (FUL), Fullerton, California. The pilot and four individuals on the ground sustained fatal injuries, two individuals on the ground sustained serious injuries and the airplane was destroyed. The airplane was registered to and operated by the private pilot as a Title 14 *Code of Federal Regulations* (CFR) Part 91 cross-country personal flight. Visual meteorological conditions (VMC) prevailed over the accident location, and no flight plan was filed. The flight departed at 1339, with a planned destination of Minden-Tahoe Airport (MEV), Minden, Nevada.

2. DETAILS OF INVESTIGATION

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

Device 1:	**Appareo Stratus 2S**
Device 1 Serial Number:	**017335**
Device 2:	**JPI EDM-760**
Device2 Serial Number:	**36944**
Device 3:	**Shadin Digiflo-L**
Device 3 Serial Number:	**5247**
Device 4:	**Apple iPad Pro**
Device 4 Serial Number:	**DLXT71YWGMLM**

2.1. Appareo Stratus 2S Device Description

The Appareo Status 2S device is a self-contained battery powered unit that contains an internal AHRS,[1] GPS/WAAS receiver,[2] and ADS-B[3] receiver in one compact unit. The unit communicates wirelessly with compatible devices to display all the acquired information. In addition to communicating with compatible devices, the Stratus device records GPS position and AHRS information internally on a non-volatile flash[4] memory chip. Internal memory has the space to store over 13 hours of flight data that is sampled at approximately 5 data records per second (5 Hz).

2.1.1. Appareo Stratus 2S Data Recovery

The device was undamaged upon arrival at the Vehicle Recorder Laboratory, as shown in Figure 1. The device powered on normally and data was extracted using laboratory tools.

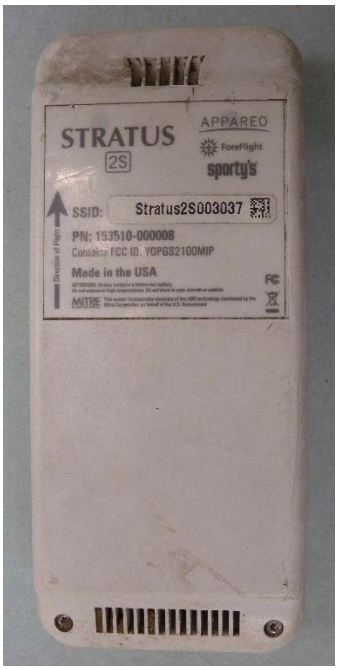

Figure 1. Appareo Stratus 2S as received.

[1] The Attitude Heading Reference System consists of a set of 3-axis gyroscope, accelerometers and heading reference sensors that enable the unit to compute pitch, roll, and yaw motions.
[2] The Wide Area Augmentation System (WAAS) is an air navigation aid to augment the Global Positioning System (GPS), by improving its accuracy, integrity, and availability.
[3] Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance technology deployed throughout the national airspace system. The ADS-B system is composed of aircraft avionics and a ground infrastructure. Onboard avionics determine the position of the aircraft by using the GPS and transmit its position along with additional information about the aircraft to ground stations for use by air traffic control (ATC) and other ADS-B services. This information is transmitted at a rate of approximately once per second. Operators equipped with ADS-B realize additional benefits from ADS-B broadcast services: Traffic Information Service - Broadcast (TIS-B) (traffic information) and Flight Information Service - Broadcast (FIS-B) (weather information).
[4] Non-volatile memory (NVM) is semiconductor memory that does not require external power for data retention.

2.1.2. Appareo Stratus 2S Data Description

The data extracted included sessions from January 18, 2019, through February 3, 2019 Coordinated Universal Time (UTC). The last session recorded on the device was related to the accident event and is included in this report.

2.1.3. Appareo Stratus 2S Parameters Provided

Table 1 describes data parameters recorded and derived by the device.

Table 1. Appareo Stratus 2S Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time for recorded data point (HH:MM:SS.0)
Latitude (deg)	Recorded Latitude (degrees)
Longitude (deg)	Recorded Longitude (degrees)
MSL Altitude (ft)	Recorded MSL Altitude (feet)
Ground Speed (kts)	Averaged derived ground speed (knots)
Heading (deg)	Magnetic Heading (degrees)
Pitch (deg)	Pitch Angle (degrees)
Bank (deg)	Bank Angle (degrees)

2.2. 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 memory 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.

2.2.1. JPI EDM-760 Data Recovery

The device exhibited minor impact damage upon arrival at the Vehicle Recorder Division. An internal examination showed the electronic components were undamaged and data was extracted normally using laboratory tools.

Figure 2. JPI EDM-760 as received.

2.2.2. JPI EDM-760 Data Description

The data extracted included 12 sessions from January 20, 2019, through February 3, 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. The user set date was determined to be accurate and corresponded to the current date when the device powered on. The time recorded on the device was correlated to UTC time by aligning the application of takeoff power to GPS position data recorded on the Appareo Stratus 2.

2.2.3. JPI EDM-760 Parameters Provided

Table 2 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 2. JPI EDM-760 Data Parameters

Parameter Name	Parameter Description
Time	Correlated PST time for recorded data point (HH:MM:SS)
LEGT 1-6 (degF)	Left Engine Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)
LCHT 1-6 (degF)	Left Engine Cylinder Head Temperature Cylinder # (degrees Fahrenheit)
LTIT (degF)	Left Engine Turbine Inlet Temperature (degrees Fahrenheit)
LCLD (degF/min)	Left Engine Shock Cooling Rate (degrees Fahrenheit per minute)
REGT 1-6 (degF)	Right Engine Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)
RCHT 1-6 (degF)	Right Engine Cylinder Head Temperature Cylinder # (degrees Fahrenheit)
RCLD (degF/min)	Right Engine Shock Cooling Rate (degrees Fahrenheit per minute)

2.3. Shadin Digiflo-L Device Description

The Shadin Fuel Flow Indicator is a digital fuel management system designed to provide fuel management information under real-time flight conditions to the flight crew. The unit is connected to the engine fuel flow transducers. The unit is capable of transmitting fuel information to certain GPS receivers for additional calculations and display of fuel management data. The unit does not interface with an aircraft's fuel quantity indicating system. The unit requires the flight crew to enter the initial fuel on board the aircraft. All calculations and data provided by the unit are based on fuel flow. Between power cycles the unit retains the last fuel used and fuel remaining.

2.3.1. Shadin Digiflo-L Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had sustained minor impact damage as shown in Figure 3. The device powered on normally.

Figure 3. Shadin Digiflo-L as received.

2.3.2. Shadin Digiflo-L Data Description

After power up, photos of the display were taken and shown in Figure 4:

- **Left.** Gallons used: 5939 gallons displayed
- **Right.** Gallons remaining: 0.0 gallons displayed.

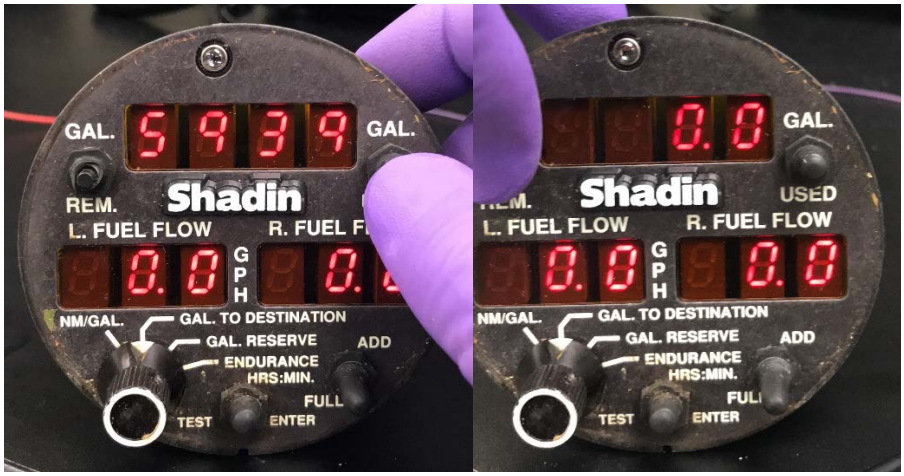

Figure 4. Shadin Digiflo-L showing the gallons used (left) and gallons remaining (right).

2.4. Personal Electronic Device (PED) Description

PEDs are a category of devices comprised primarily of portable computing devices and mobile phones. Portable computing devices are typically capable of internet access, email, messaging services, and can run user-installed applications to perform specific tasks. PED user and system data is typically stored on non-volatile memory and can be accessed through manufacturer-provided interfaces.

2.4.1. Apple iPad Pro Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the iPad Pro had sustained impact damage as shown in Figure 5, rendering the device inoperable. The logic board was removed and examined. The extent of the damage precluded normal recovery procedures and additional attempts were unsuccessful in yielding usable data, thus no data were recovered.

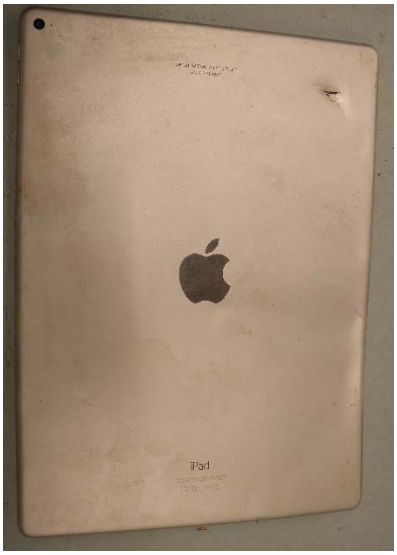

Figure 5. iPad Pro as received.

3. Plots and Corresponding Tabular Data

Figures 6 and 7 are graphical overlays generated in Google Earth using data from the Appareo Stratus 2S. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Figure 6 shows the entire accident flight.

Figure 7 shows the last 25 seconds of the accident flight.

Figure 8 is a plot of parameters from the Appareo Stratus 2S for the entire accident flight. The time interval displayed is 13:31:00 to 13:46:00 PST. Application of takeoff power was at approximately 13:38:17 PST.

Figure 9 is a plot of parameters from the Appareo Stratus 2S at the end of the accident flight. The time interval displayed is 13:44:00 to 13:45:15 PST. Between 13:45:05.3 and 13:45:08.9 PST no data points were recorded.

Figure 10 is a plot of parameters from the JPI EDM-760 for the entire accident flight. The time interval displayed is 13:32:00 to 13:46:00 PST. LEGT 2 was erratic for the accident recording. Examination of past data for this parameter revealed similar behavior.

Figure 11 is a plot of parameters from the JPI EDM-760 at the end of the accident flight. The time interval displayed is 13:44:00 to 13:45:20 PST.

The corresponding tabular data used to create Figures 6 through 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 electronic .CSV format as Attachment 2 to this report.

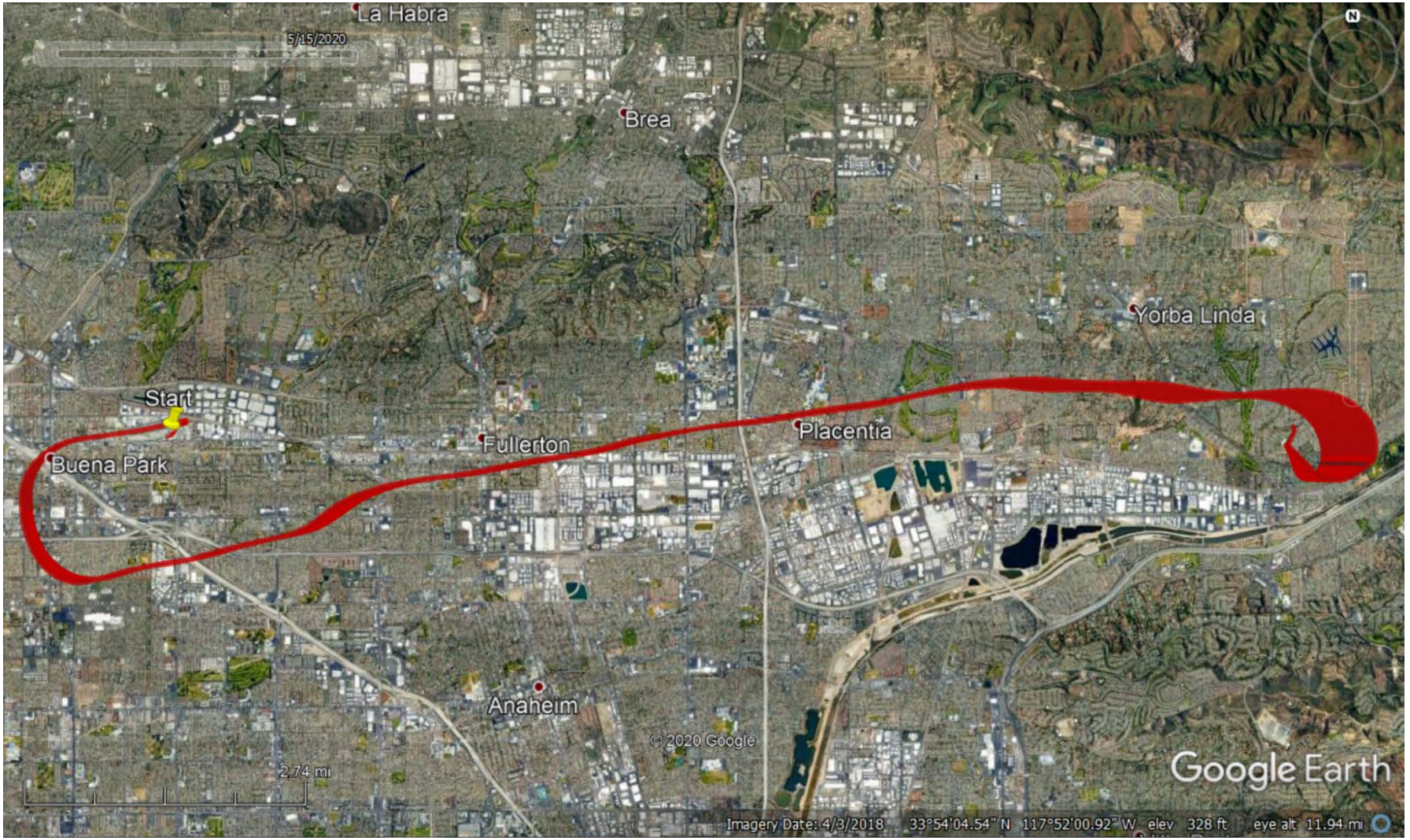

Figure 6. Google Earth overlay of the entire accident flight recorded on the Appareo Stratus 2S.

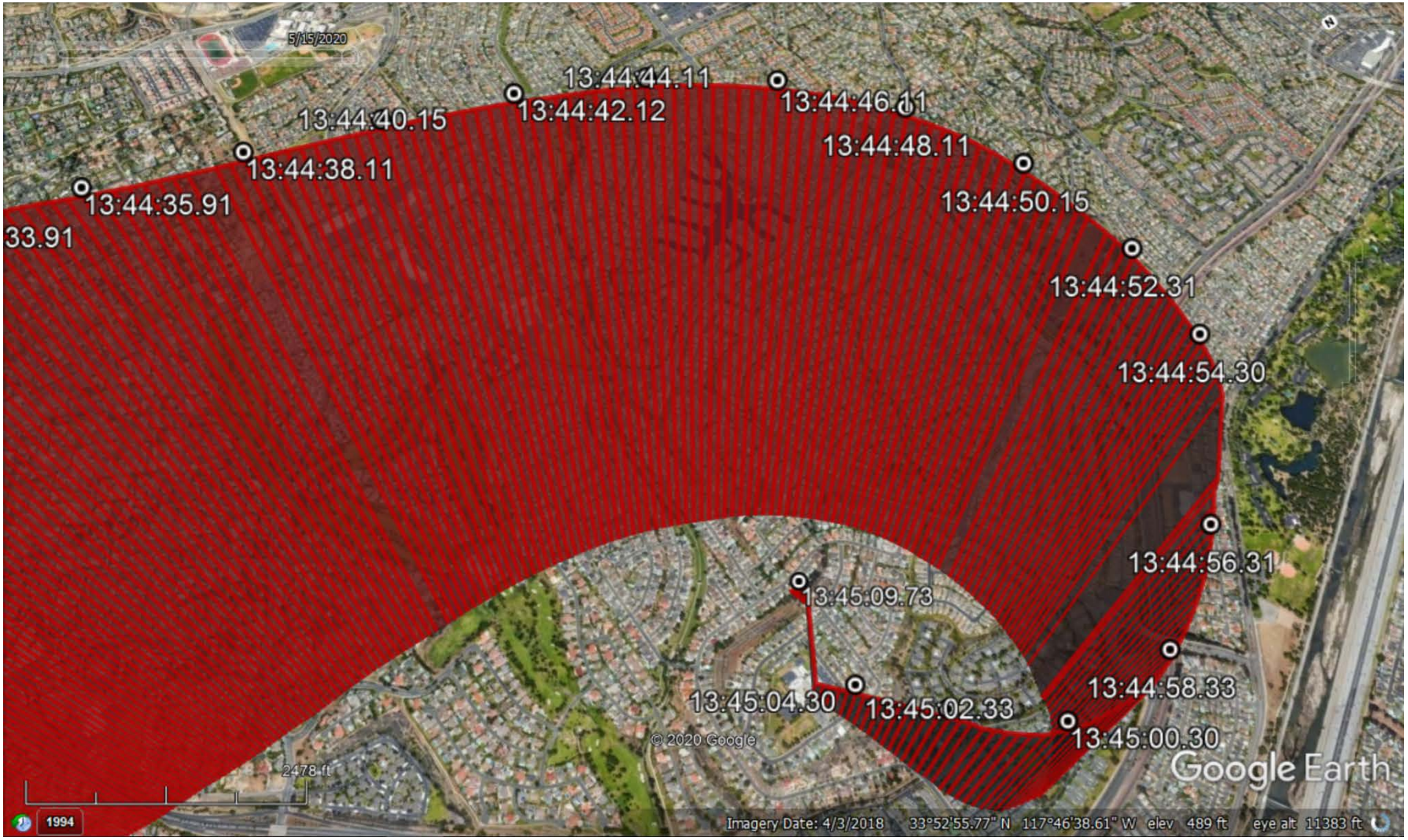

Figure 7. Google Earth overlay of the end of the accident flight recorded on the Appareo Stratus 2S.

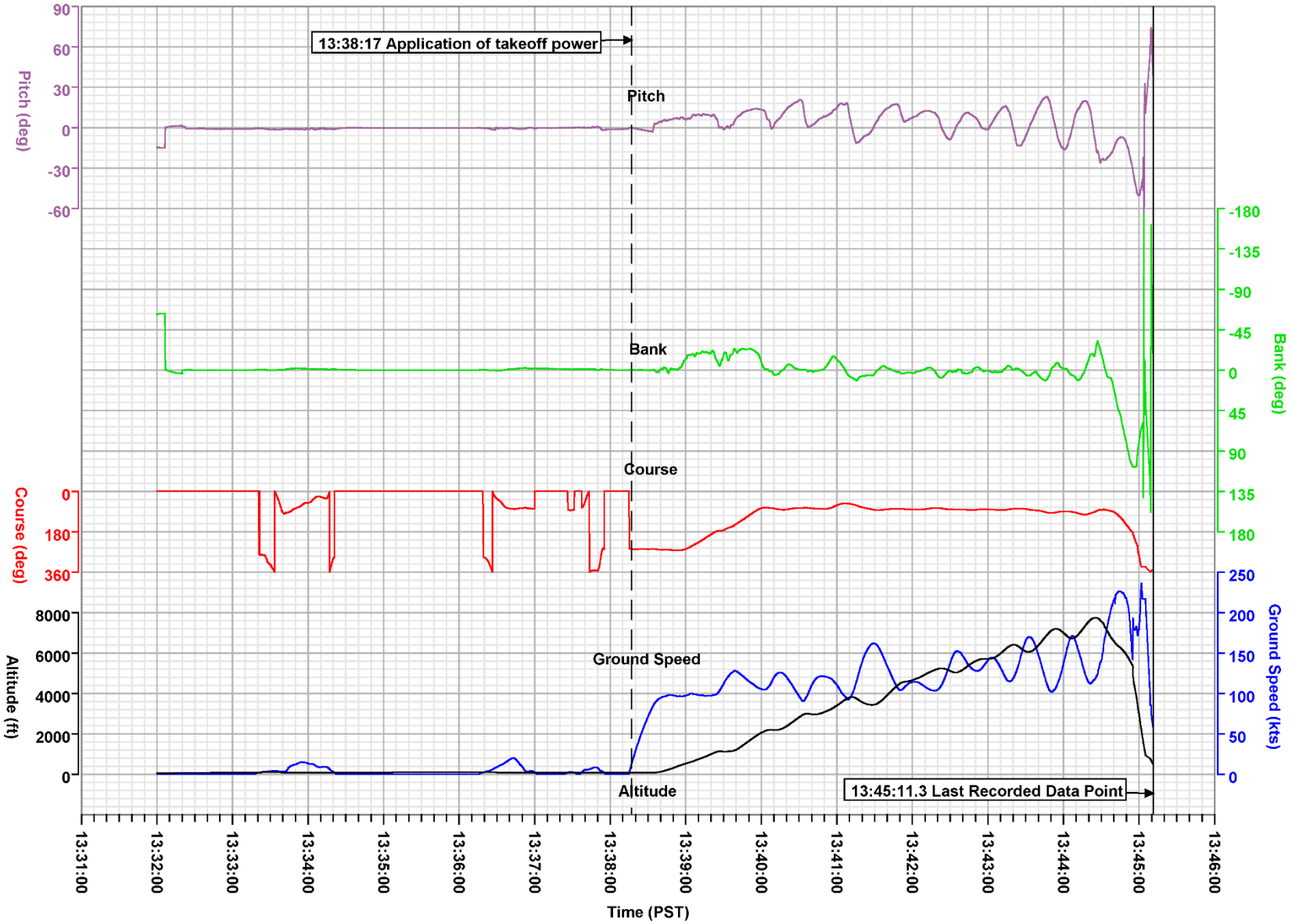

Figure 8. Plot of parameters from the Appareo Stratus 2S for the entire accident flight.

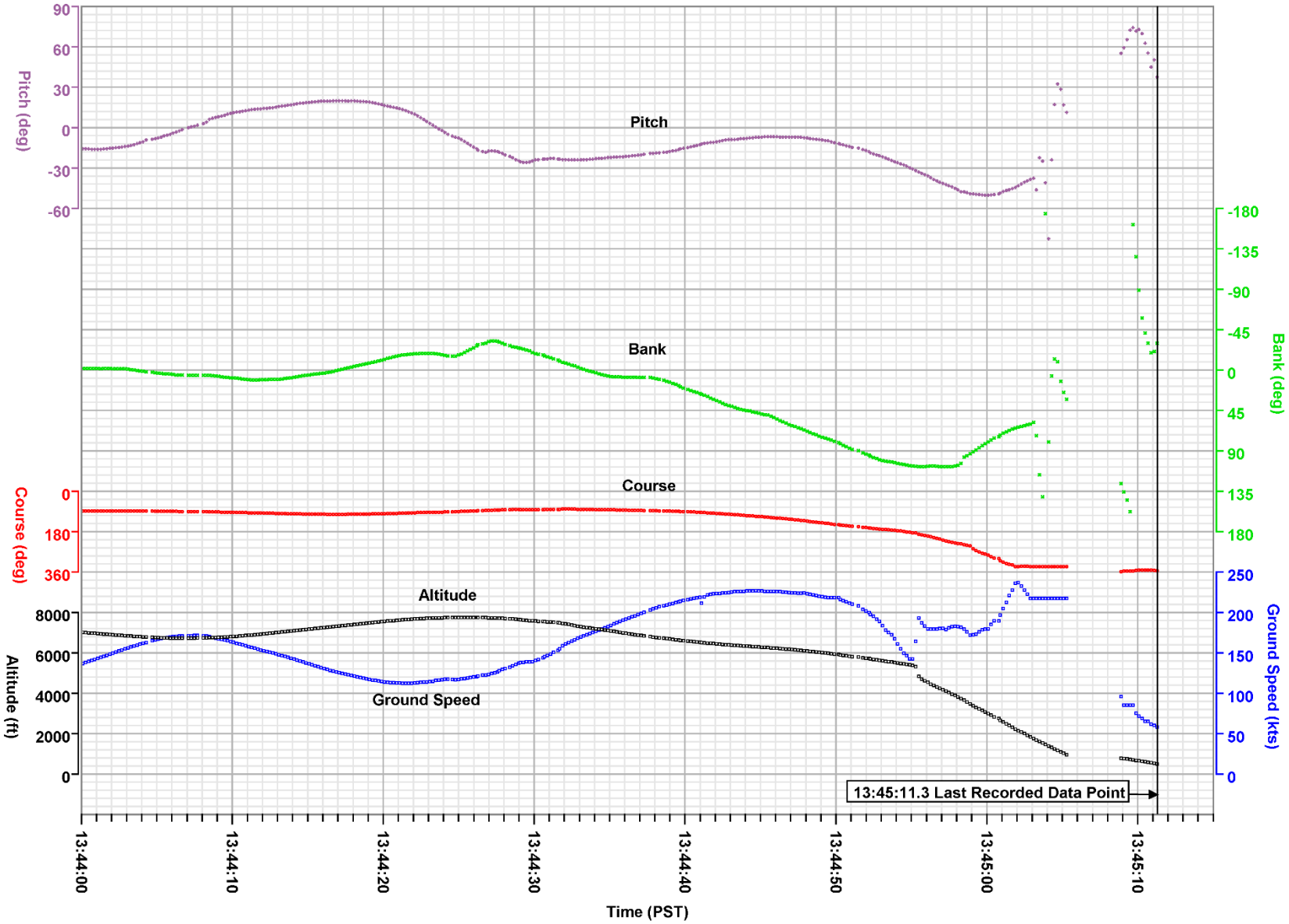

Figure 9. Plot of parameters from the Appareo Stratus 2S at the end of the accident flight.

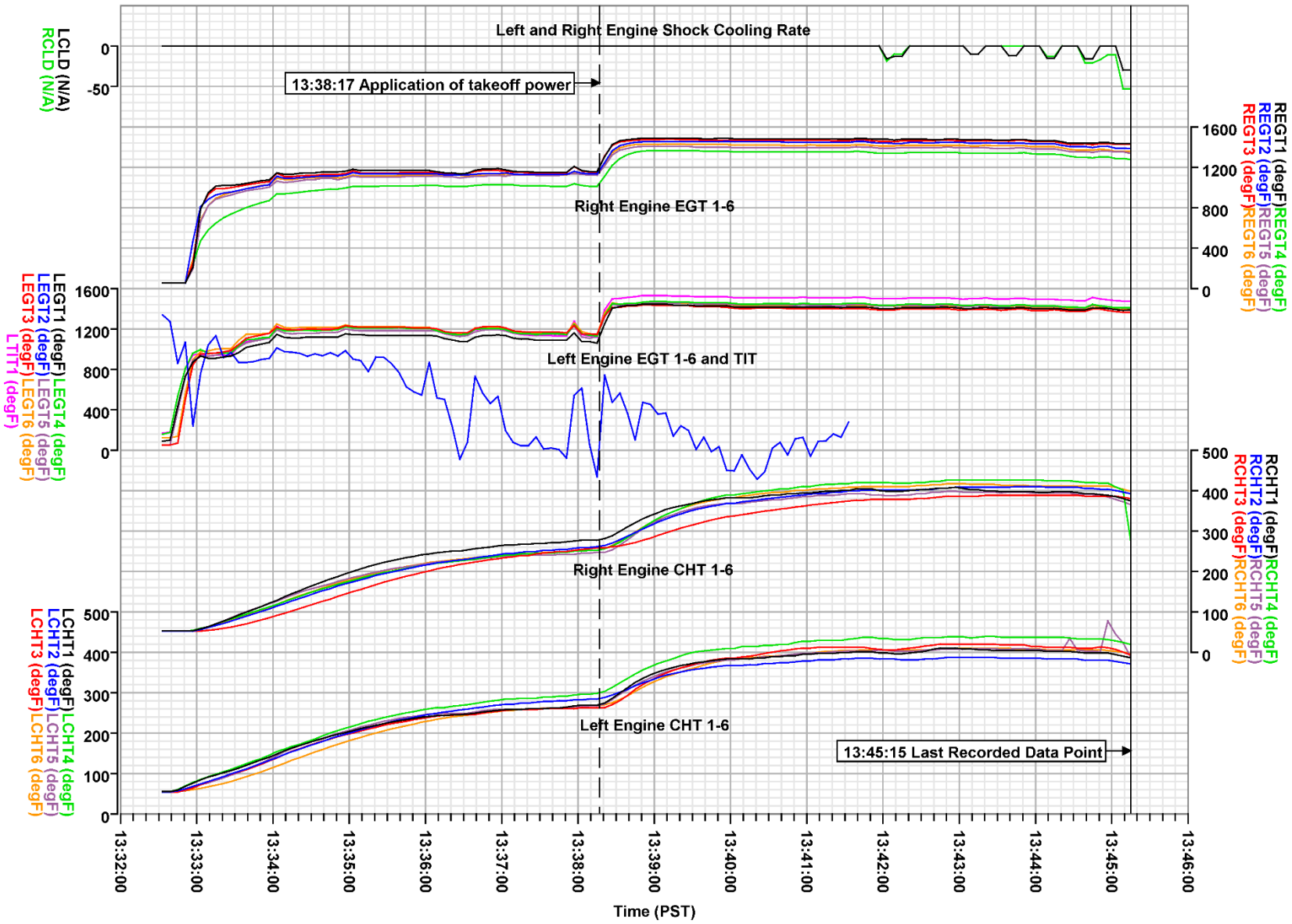

Figure 10. Plot of parameters from the JPI EDM-760 for the entire accident flight.

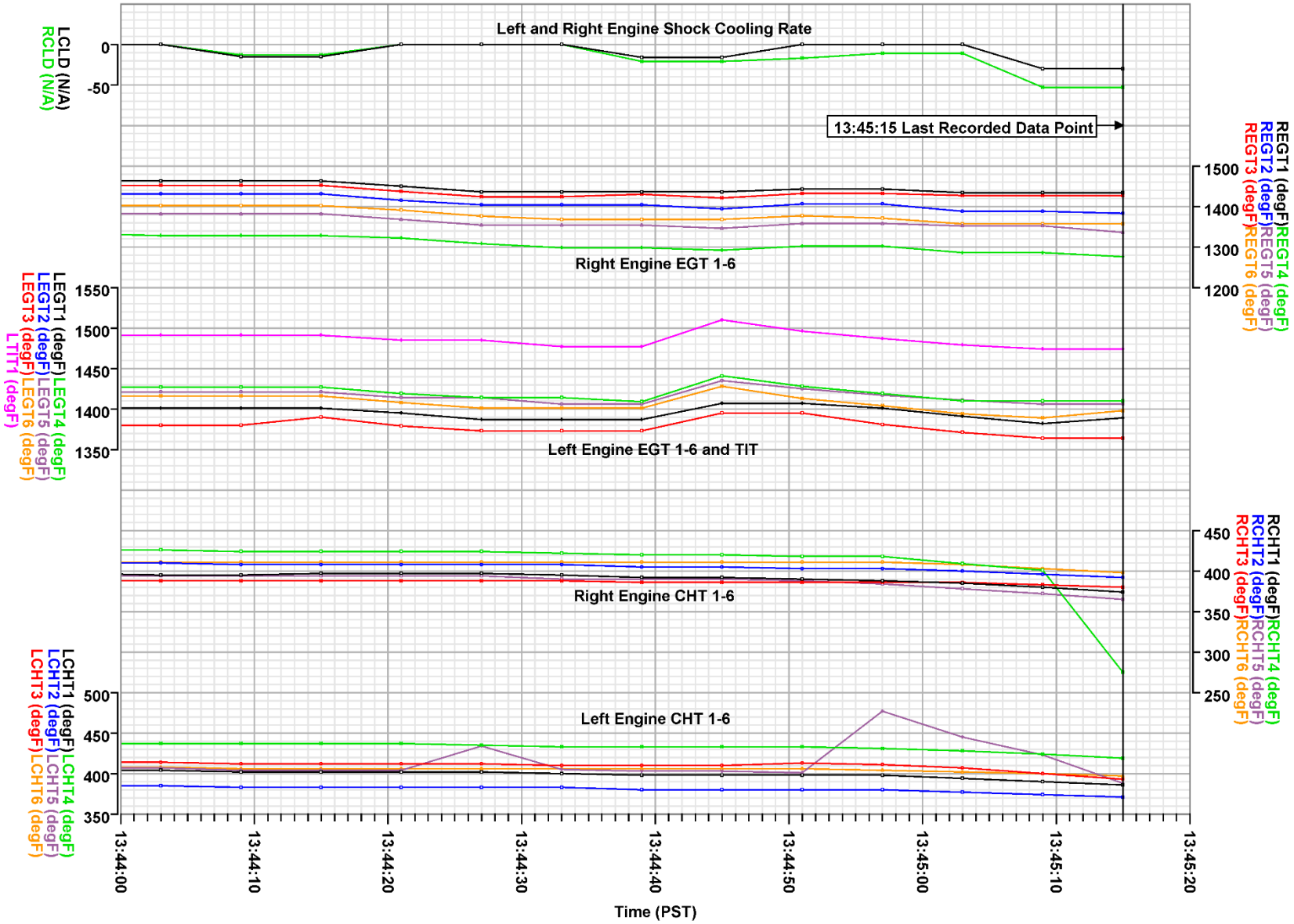

Figure 11. Plot of parameters from the JPI EDM-760 at the end of the accident flight.