

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

April 5, 2019

Electronic Devices

Specialist's Factual Report by Gerald Kawamoto

1. EVENT

Location: Starke, Florida
Date: November 23, 2017
Aircraft: Mooney M20C
Registration: N6894N
Operator: Private
NTSB Number: ERA18FA030

On November 23, 2017, about 1515 eastern standard time, a Mooney M20C, N6894N, impacted terrain near Starke, Florida. Instrument meteorological conditions prevailed at the time and an instrument flight rules flight plan was filed for the 14 *Code of Federal Regulations* (CFR) Part 91 personal flight from Ocala International Airport-Jim Taylor Field (OCF), Ocala, Florida to Cecil Airport (VQQ), Jacksonville, Florida. The airplane was destroyed by impact forces. The private pilot was fatally injured. The flight originated about 1500 eastern standard time from OCF.

2. DETAILS OF INVESTIGATION

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

Device 1: JPI EDM-700
Device 1 Serial Number: 19906
Device 2: Garmin GPSMAP 696
Device 2 Serial Number: 1H6001707

2.1. JPI EDM-700 Device Description

The JPI EDM-700 is a panel-mounted gauge that allows the operator to monitor and record up to 24 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, Turbine Inlet Temperature, Engine Revolutions Per Minute (RPM), Compressor Discharge Temperature, Fuel Flow, Carburetor Temperature, and Battery Voltage.

The unit can also calculate in real time, percent of maximum horsepower, fuel used, shock cooling rate, and EGT differentials between 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-per-sample rate. The data can then be downloaded by the operator using the J.P. Instruments software.

2.1.1. JPI EDM-700 Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the unit had sustained minor impact damage, as shown in Figure 1, resulting in the display becoming inoperable. The damaged display was removed and a functioning display was connected to the circuit boards. Information was extracted normally using the manufacturer's software.

Figure 1. JPI EDM-700 as received.



2.1.2. JPI EDM-700 Data Description

The data extracted included 19 sessions from July 26, 2017², through November 23, 2017. 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.

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

² All dates and times are referenced to Coordinated Universal Time (UTC).

2.1.3. JPI EDM-700 Parameters Provided

Table 1 describes data parameters recorded by the device. The recorded time is based on the unit's internal clock, which is set and updated by the user.

Table 1: JPI EDM-700 Data Parameters

Parameter Name	Parameter Description
Time	Time (UTC) for recorded data point (HH:MM:SS)
EGT 1-4 (degF)	Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)
CHT 1-4 (degF)	Cylinder Head Temperature Cylinder # (degrees Fahrenheit)
CLD (degF/min)	Shock Cooling Rate (degrees Fahrenheit per minute)
Voltage (V)	Battery Voltage (Volts)

2.1.4. JPI EDM-700 Data Time Correlation

The date and time on the device is manually adjusted by the operator. The device begins recording data when power is applied and stops when power is disconnected. Time displayed on the device was determined to be 8 hours and 28 minutes ahead of a reference clock. The device display only provided time to the nearest minute. All times included in this report have been adjusted to reflect this offset.

2.2. Garmin GPSMAP 696

The Garmin GPSMAP 696 is a portable GPS receiver capable of storing date, route-of-flight, and flight-time information for up to 50 flights. A detailed tracklog – including latitude, longitude, date, time, and groundspeed information – is stored within the unit whenever the receiver has a lock on the GPS navigation signal. 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 PC via a built-in serial port. The unit can also communicate with external devices such as a computer using a built in USB 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.

2.2.1. Garmin GPSMAP 696 Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the unit had sustained impact damage, as shown in Figure 2, rendering it inoperable. The non-volatile memory chip was removed and attempted to be read out using the appropriate chip readers. The chip had no apparent visible damage when viewed under a microscope and an x-ray examination did not reveal any damage to the wire bonds as shown in Figure 3, however, the chip was unresponsive to various readout methods. The chip was sent to the Integrated Electronics Engineering Center (IEEC) at Binghamton University in Binghamton, New York. The IEEC laboratory evaluated the chip with an acoustic microscope that uses soundwaves to produce an image of the silicon chip. The evaluation revealed cracks in the die, as shown in Figure 4. Due to the damage to the die, the IEEC determined it was not possible to retrieve any data from the chip. The IEEC's report is provided as Attachment 1 to this report.

Figure 2. Garmin GPSMAP 696 as received.



Figure 3. X-ray image of the GPSMAP 696 NVM chip.

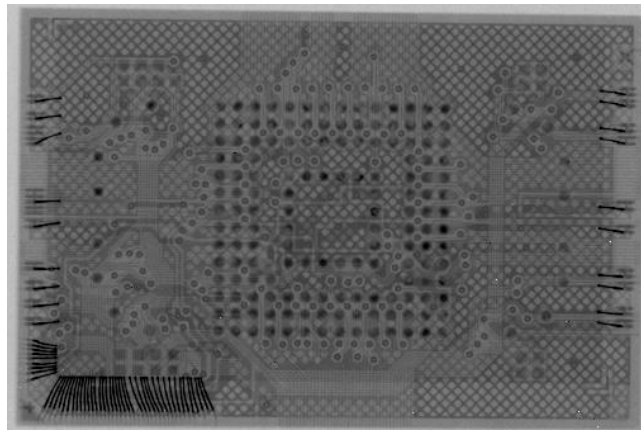


Figure 4. C-SAM image revealing damage to the die in the GPSMAP 696 NVM chip.



3. OVERLAYS AND TABULAR DATA

Figure 5 is a plot of parameters from the accident flight recorded on the JPI EDM-700 device for the entire flight. The time interval is 18:53:00 to 20:03:00 UTC.

Figure 6 is a plot of parameters from the accident flight recorded on the JPI EDM-700 device at the end of the flight. The time interval is 19:38:00 to 19:58:00 UTC.

The tabular data from the accident flight recorded by the JPI EDM-700 device is included as Attachment 2. This attachment is provided in electronic comma separated value (csv) format.

Figure 5. Plot of data from the JPI EDM-700 for the entire accident flight.

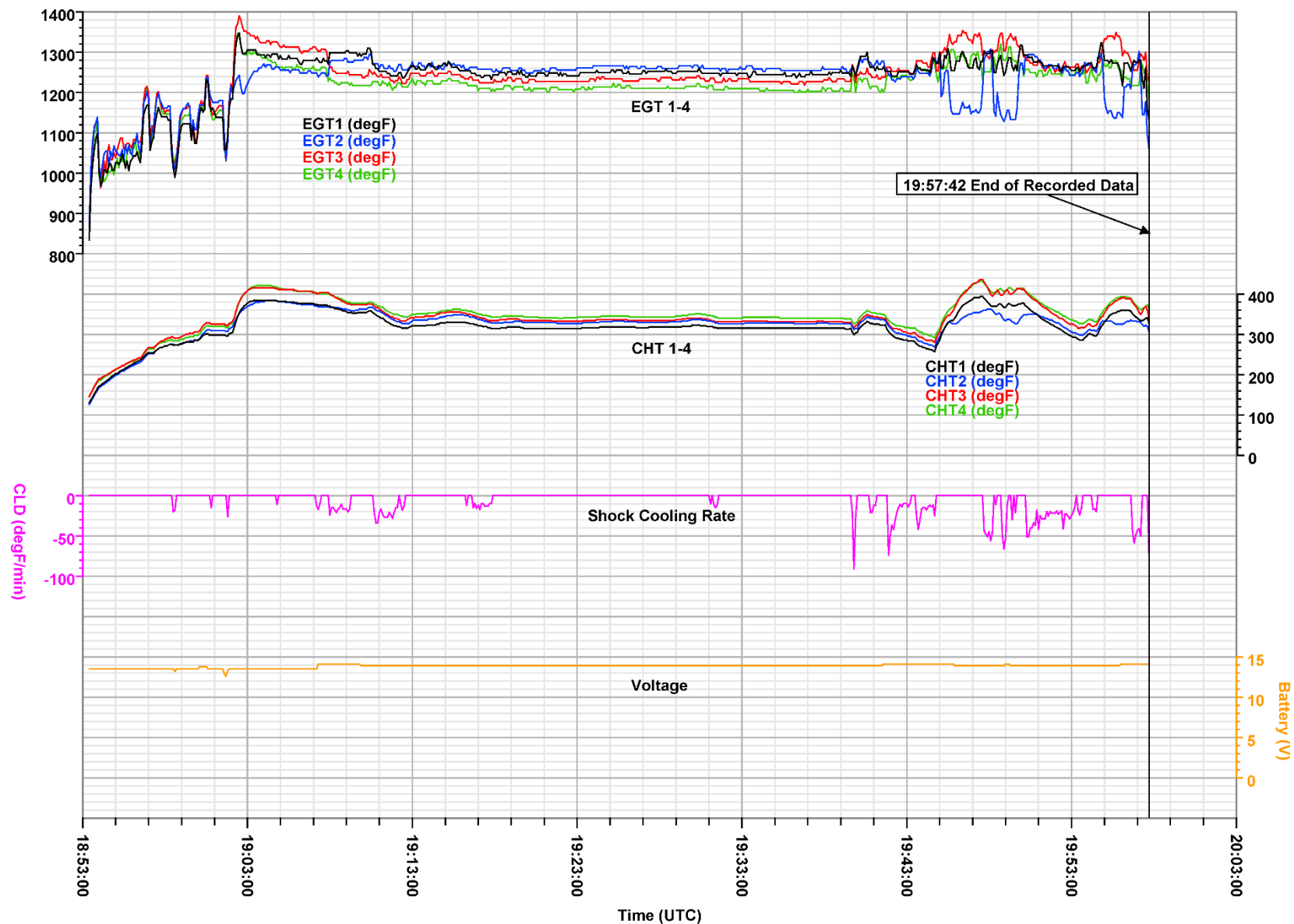


Figure 6. Plot of data from the JPI EDM-700 at the end of the accident flight.

