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

September 8, 2014

Electronic Devices Factual Report

Specialist's Factual Report
by Bill Tuccio, Ph.D.

1. EVENT

Location:	Fall City, Washington
Date:	July 8, 2014
Aircraft:	Cessna 182
Registration:	N5816B
Operator:	Private
NTSB Number:	WPR14FA286

On July 8, 2014, about 0800 Pacific daylight time, a Cessna 182, N5816B, was substantially damaged following impact with terrain at a golf course near Fall City, Washington. The certified private pilot, the owner and sole occupant of the airplane, sustained fatal injuries. The local flight was being operated in accordance with 14 *Code of Federal Regulations* Part 91, and a flight plan was not filed. Instrument meteorological conditions prevailed in the area of the accident at the time of the event. The flight had departed the Fall City Airport (1WA6), about 5 minutes prior to the accident, with its destination being Harvey Field (S43), Snohomish, Washington.

2. DETAILS OF DEVICE INVESTIGATION

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

Device 1:	Garmin GPSMAP 296
Device 1 Serial Number:	67023899
Device 2:	JPI Engine Monitor EDM-700
Device 2 Serial Number:	23520

2.1. Garmin GPSMAP 296 Device Description

The Garmin GPSMAP 296 is a hand-portable GPS unit equipped with a detachable antenna, a 256 color TFT LCD display, built in base map and an internal Jeppesen aviation database. The unit employs a parallel 12 channel receiver and can be operated using external power, or alternatively by using an internal Li-Ion rechargeable battery. The GPSMAP 296 is capable of storing date, route of flight, and flight time

information for up to 50 individual flights in the form of a flight log. Flight logging begins when the GPS unit senses a speed increase to greater than 30 knots together with an altitude gain of greater than 500 feet. The record is saved when the speed is sensed to decrease to below 30 knots, and a new log will be started if more than 10 minutes passes from this time. A detailed tracklog – including latitude, longitude, date, time, and GPS altitude information for an unspecified number of points – is stored within the unit whenever the receiver has a lock on the GPS navigation signal. Position is updated within the tracklog as a function of time or distance moved, depending on how the unit has been configured. Once the current tracklog memory becomes full, new information either overwrites the oldest information or recording stops, depending on how the unit is configured. The current tracklog can be saved to long-term memory and 15 saved tracklogs can be maintained in addition to the current tracklog. Tracklog storage may be activated or de-activated at user discretion. All recorded data is stored in non-volatile[1] 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 using the NMEA 0183 version 2.0 protocol. 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.

2.1.1. Garmin GPSMAP 296 Data Recovery

Upon arrival at the NTSB's Vehicle Recorder Laboratory, an exterior examination revealed the device had sustained minor impact damage, as shown in figure 1. Power was applied to the device and information was downloaded normally, without difficulty.

Figure 1. Garmin GPSMAP 296 as received.

2.1.2. Garmin GPSMAP 296 Data Description

The data extracted included 56 recording sessions (10,000 data points) from July 28, 2013, through July 8, 2014. The accident flight was the last flight recorded, starting at 14:52:51 Universal Coordinated Time (UTC) and ending at 15:07:02 UTC on July 8, 2014.

[1] Non-volatile memory is semiconductor memory that does not require external power for data retention.

2.1.3. Garmin GPSMAP 296 Parameters Provided

Table 1 describes data parameters provided by the GPS device. Date, Time, Latitude, Longitude, and GPS Altitude are recorded by the device. Groundspeed and Track are derived from the recorded parameters.

Table 1: GPS Data Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (EDT) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
GPS Alt	Recorded GPS Altitude (feet, MSL[2])
Groundspeed	Average groundspeed between current and previous data point (knots)
Track	Average true course between current and previous data point (degrees)

2.1.4. Garmin GPSMAP 296 Overlays and Corresponding Tabular Data

Figures 2 through 6 were generated using data extracted from the Garmin GPSMAP 296 and overlaid using Google Earth. The weather depicted in Google Earth is not necessarily representative of the weather conditions experienced when the recordings were made.

Figures 2 and 3 compare the accident flight to 16 prior takeoffs at 1WA6 between July 30, 2013 and June 14, 2014. The accident flight began a turn to the north before the end of the runway, while 15 of the 16 other flights began a turn to the north about 0.3 miles beyond the departure end of runway "W[3]."

Figures 4 through 6 show the entire accident flight. The recording began at 14:52:51 UTC. By 14:53:53 UTC, the aircraft was taxiing towards runway "W." By 14:54:39 UTC, the aircraft was at the runup area for runway "W."

At about 15:05:50 UTC, the aircraft began its takeoff roll on runway "W." Between 15:06:01 UTC and 15:06:08 UTC, the aircraft track began to turn towards the north.

At about 15:06:26 UTC, the track began to turn towards the west. At 15:06:34 UTC, the initial takeoff climb reached a maximum recorded GPS altitude of 515 feet. At 15:06:42 UTC, the aircraft was travelling south and the recorded GPS altitude reached a minimum of 217 feet at 127 knots groundspeed. The aircraft then climbed to a final maximum altitude of 577 feet before a final descent. The last recorded point was at 15:07:02 UTC at 135 feet on a southwesterly track.

[2] Altitude above mean sea level.
[3] According to the AirNav.com, the west runway was called runway "W."

Tabular data used to generate figures 4 through 6 are included as attachment 1 in electronic comma-delimited (.CSV) format.

Figure 2. Accident flight compared to 16 prior takeoffs from 1WA6 (3-dimesional).

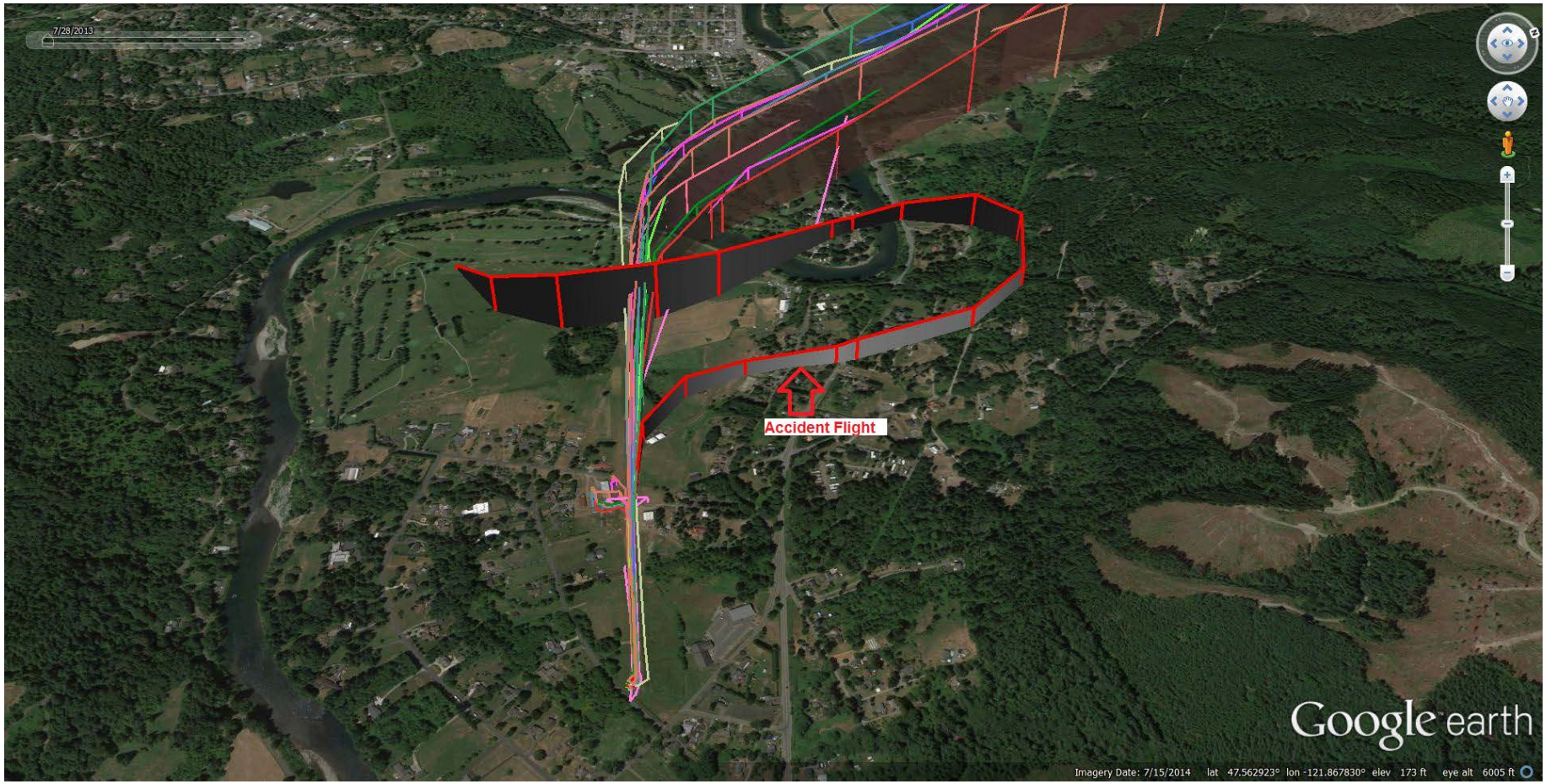


Figure 3. Accident flight compared to 16 prior takeoffs from 1WA6 (overhead).

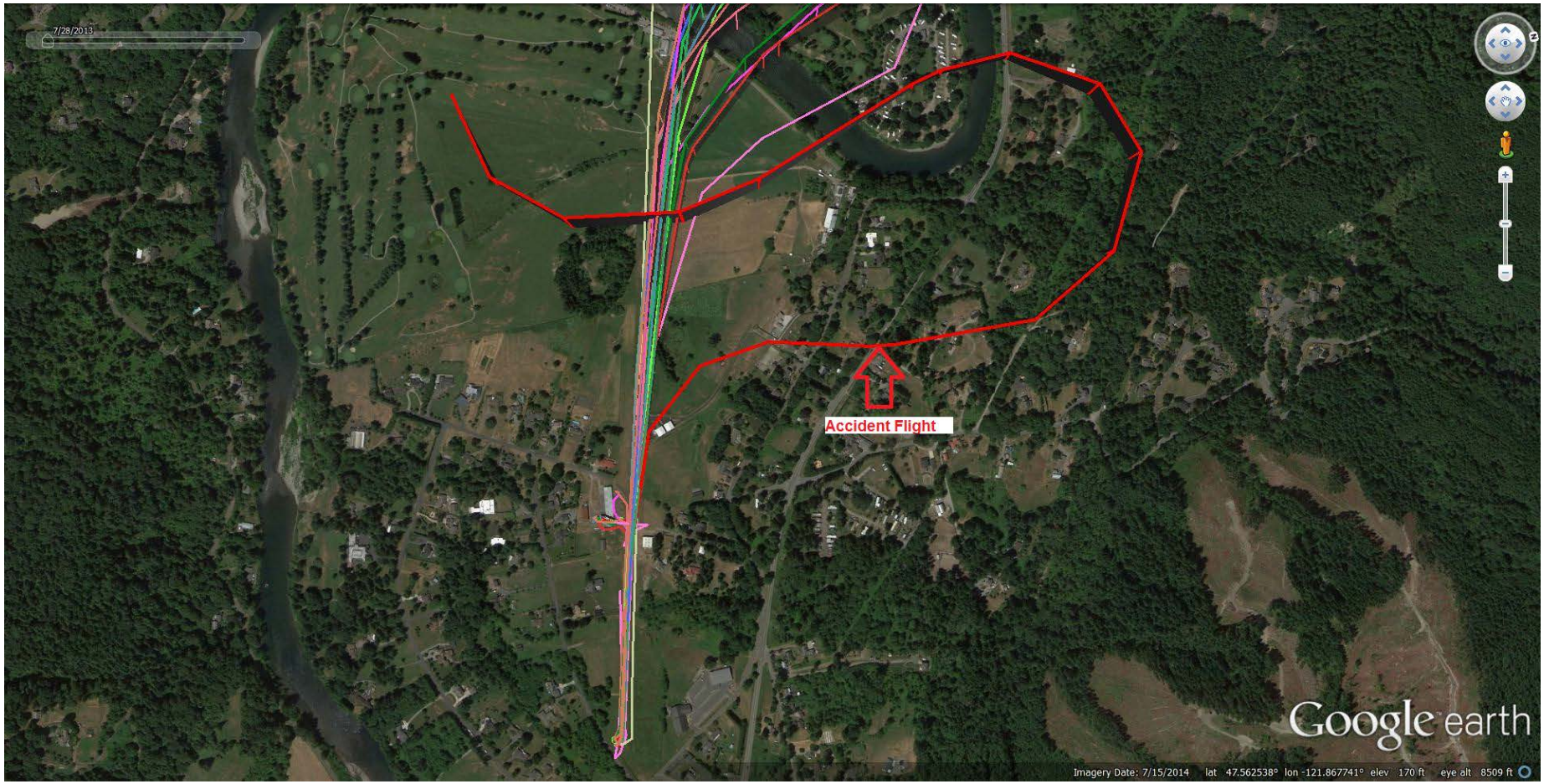


Figure 4. Start of recording and taxi out.

Figure 5. Takeoff run.

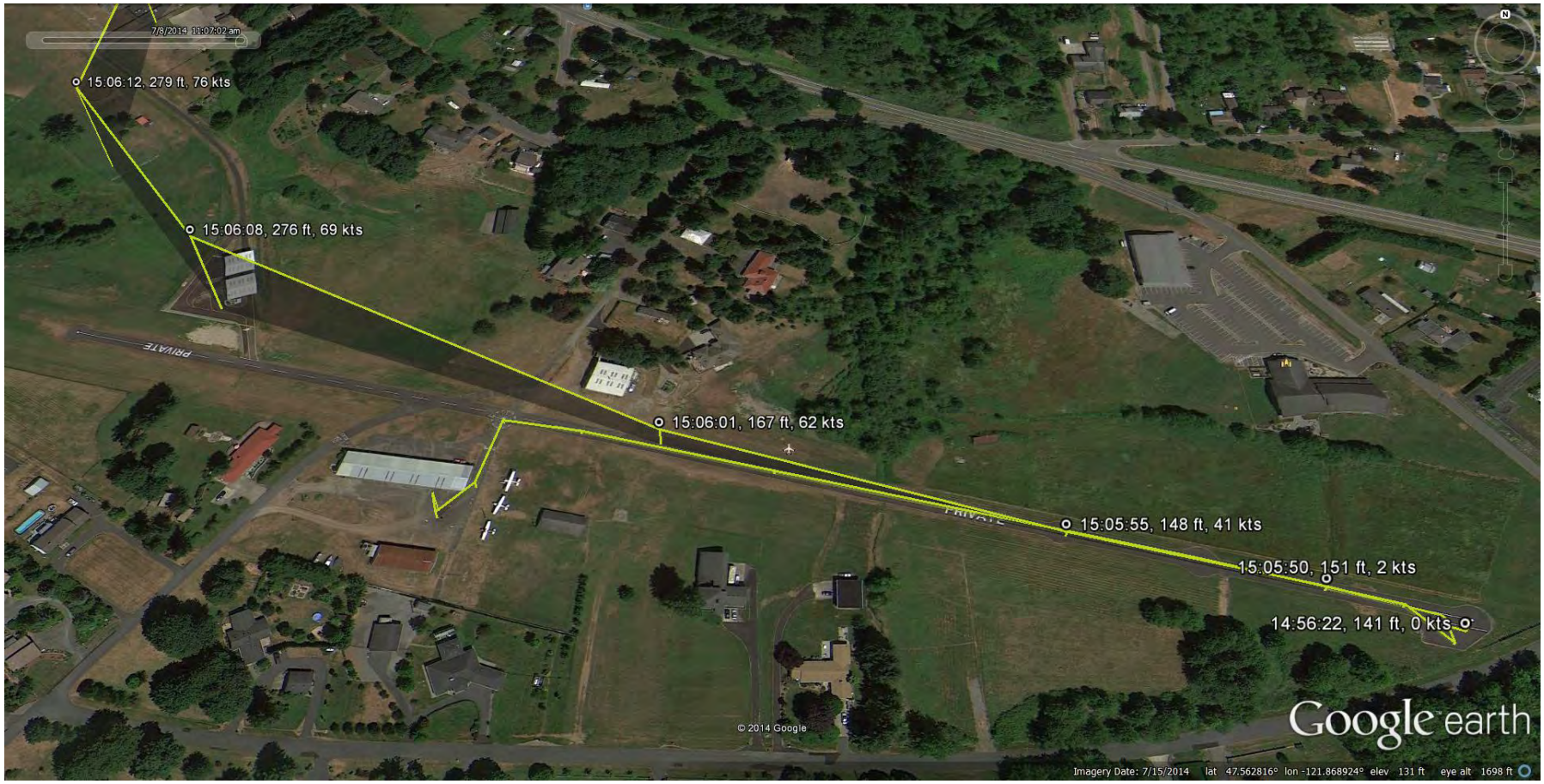
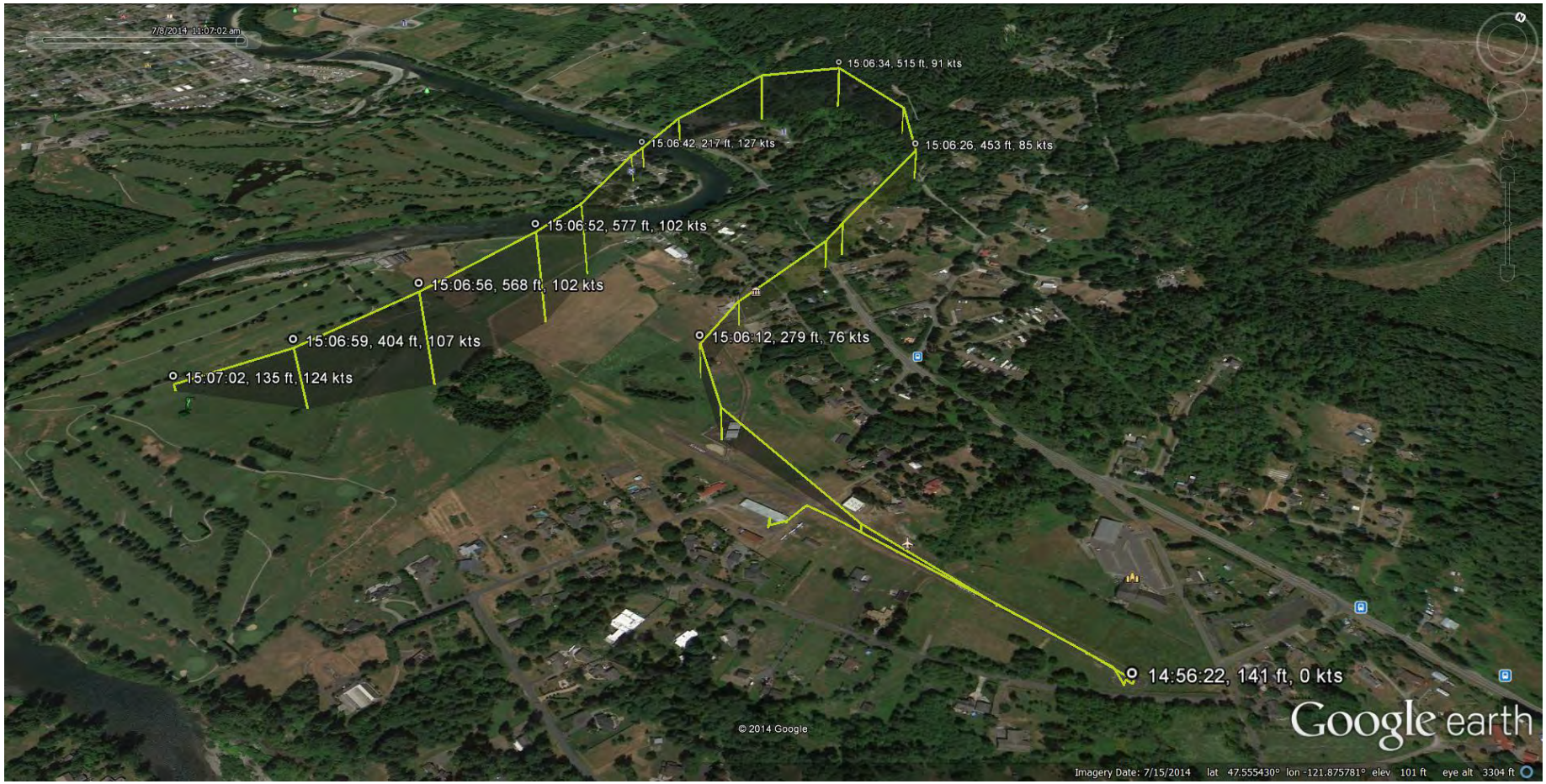


Figure 6. After takeoff run until end of recording.



2.2. JPI EDM-700 Device Description

The J.P. Instruments (JPI) EDM-700 is a panel mounted instrument enabling 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 (TIT), 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-700 Data Recovery

Upon arrival at the NTSB's Vehicle Recorder Laboratory, an exterior examination revealed the device had sustained minor impact damage, as shown in figure 7. Figure 8 shows a picture of the unit data plate, indicating the firmware revision of 3.02, the number "6" inscribed next to the letter "C," and a dot next to the letter "F." There were no entries on the data plate adjacent to the letters "O," "A," "T", "I," or "R/M." The number inscribed adjacent to "MFG" was "4/06".

Figure 7. JPI EDM-700 dataplate.

Figure 8. JPI EDM-700 dataplate.

2.2.2. JPI EDM-700 Data Description

The unit contained recorded data over 8 power cycles recorded at a sample rate of once every 6 seconds. When powered on, the internal clock was 24 hours and 10 minutes behind UTC time; as such, 24 hours and 10 minutes were added to all recorded times to convert to UTC.

The recorded data included dates between May 15, 2014, through the accident flight on July 8, 2014 (after the UTC time was corrected). The parameters recorded were EGT, CHT, voltage, and fuel flow. Additionally, the calculated shock cooling rate and maximum difference between EGT sensors was also recorded. No other parameters were recorded by the unit.

While the GPS recorded information for about 14 minutes, the EDM-700 only recorded 30 seconds of information between an approximate time of 14:56:02 UTC and 14:56:32 UTC.

2.2.3. JPI EDM-700 Parameters Provided

The engineering units conversions used for the data contained in this report are based on documentation from the manufacturer of the EDM-700, JPI.

Table 2 describes data parameters provided by the EDM-700. Given tolerances of the EDM-700 internal clock and the limitation of only displaying time to the minute on the display, time in this report relative to GPS time may be off by up to 2 minutes.

Table 2: JPI EDM-700 Data Parameters

Parameter Name	Parameter Description
BAT (Volts)	Bus Voltage
C-1 (degF)	Cylinder Head Temperature Cylinder 1
C-2 (degF)	Cylinder Head Temperature Cylinder 2
C-3 (degF)	Cylinder Head Temperature Cylinder 3
C-4 (degF)	Cylinder Head Temperature Cylinder 4

Parameter Name	Parameter Description
C-5 (degF)	Cylinder Head Temperature Cylinder 5
C-6 (degF)	Cylinder Head Temperature Cylinder 6
E-1 (degF)	Exhaust Gas Temperature Cylinder 1
E-2 (degF)	Exhaust Gas Temperature Cylinder 2
E-3 (degF)	Exhaust Gas Temperature Cylinder 3
E-4 (degF)	Exhaust Gas Temperature Cylinder 4
E-5 (degF)	Exhaust Gas Temperature Cylinder 5
E-6 (degF)	Exhaust Gas Temperature Cylinder 6
FF (gph)	Fuel Flow
Time (hh:mm:ss)	Time of Data Sample
USD (gals)	Fuel Used

Note: degF is degrees Fahrenheit; gph is gallons per hour; gals is gallons.

2.2.4. JPI EDM-700 Plots and Corresponding Tabular Data

Figure 9 shows the entire accident flight recording consisting of six data samples. The values are fairly constant, with CHTs between 200º and 300ºC, EGTs between 900º and 1400ºC, fuel flow between 4 and 5 gph, and voltage between 13 and 14 Volts.

Tabular data used to generate figure 9 is included as attachment 2 in CSV format.

Figure 9. JPI EDM-700 plot of entire accident recording.