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

November 4, 2015

Multiple Electronic Devices

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

1. EVENT

Location:	Bristol, Wisconsin
Date:	July 25, 2015
Aircraft:	Sanford Zenith CH 601XL
Registration:	N9601
Operator:	Private
NTSB Number:	CEN15FA315

On July 25, 2015, about 1117 central daylight time, a Sanford Zenith CH 601XL experimental amateur-built airplane, N9601, impacted terrain when it descended from cruise near the Binzel Airport (WI95), near Bristol, Wisconsin. The private pilot and one passenger were fatally injured. The airplane sustained substantial damage. The airplane was registered to and operated by the pilot under the provisions of 14 *Code of Federal Regulations* Part 91 as a personal flight. Day visual flight rules conditions prevailed for the flight, which did not operate on a flight plan. The flight originated from the Porter County Regional Airport (VPZ), near Valparaiso, Indiana, about 1030 and was destined for Oshkosh, Wisconsin.

2. DETAILS OF INVESTIGATION

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

Device 1:	Garmin GPSMAP 396
Device 1 Serial Number:	28207803
Device 2:	Dynon FlightDEK D180
Device 2 Serial Number:	001606

2.1. Garmin GPSMAP 396 Device Description

The Garmin GPSMAP 396 is a battery-powered portable 12-channel GPS receiver with a 256-color TFT LCD display screen. The unit includes a built-in Jeppesen database and is capable of receiving XM satellite radio for flight information including NEXRAD radar, lightning, METARs, TAFs, and TFRs. The unit stores date, route-of-flight, and flight-time information for up to 50 flights. A flight record is triggered when groundspeed exceeds 30 knots and altitude exceeds 500 feet, and ends when groundspeed drops

below 30 knots for 10 minutes or more. A detailed tracklog—including latitude, longitude, date, time, and GPS altitude information—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 memory.[1] 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. 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.

2.1.1. Garmin GPSMAP 396 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. The screen was replaced and the unit powered on normally. Screens were photo-documented and information was downloaded using the manufacturer's software.

Figure 1. Garmin GPSMAP 396 as received.

2.1.2. Garmin GPSMAP 396 Data Description

The "Active Goto" screen is shown in figure 2. The destination, KFLD, was Fond du Lac County Airport, Fond du Lac, Wisconsin.

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

Figure 2. Active Goto screen.

The downloaded data included 76 recording sessions (10,000 total data points) from August 23, 2014,[2] through July 25, 2015. The accident flight was the last session, recorded starting at 15:11:35 UTC and ending at 16:17:32 UTC on July 25, 2015 (381 total data points).

2.1.3. Garmin GPSMAP 396 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: Garmin GPSMAP 396 Data Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (UTC) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
GPS Alt	Recorded GPS Altitude (feet (ft), MSL)
Groundspeed	Average groundspeed (knots (kts))
Track	Average true course (degrees)

Note: MSL means altitude above mean sea level

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

2.1.4. Garmin GPSMAP 396 Overlays and Corresponding Tabular Data

Overlays were created with Google Earth. Weather shown in the overlays is not necessarily indicative of weather conditions at the time of the accident.

Figure 3 shows the accident flight recording. The recording began at 15:11:35 UTC at the VPZ airport. The aircraft departed and flew at about 2,000 feet through the Gary/Chicago International (GYY) Class D airspace, along the west coast of Lake Michigan, through the Waukegan Regional Airport (UGN) Class D airspace, and then through the Kenosha Regional Airport (ENW) Class D airspace. The recording ended at 16:17:32 UTC, near the WI95 private airport (not charted on the FAA aviation sectional).

Figure 4 shows the start of the recording at the VPZ airport. After the recording began, the aircraft taxied east by about 15:14:29 UTC, and then turned north towards runway 27. By 15:16:00 UTC, the aircraft turned around on runway 27 and began to head south again towards the taxiway. The aircraft then taxied on the taxiway across runway 36, and then took off from an intersection on runway 27 at about 15:17:38 UTC.

Figure 5 and 6 show the end of the recording. At about 16:51:31 UTC, the aircraft turned left and then by 16:16:18 UTC, the aircraft turned right. At about 16:17:20 UTC, the aircraft calculated groundspeed began to slow and the aircraft began to descend from 1,722 feet MSL to a last recorded datapoint of 1,152 feet MSL (terrain in the area was about 700 feet MSL). From 16:17:20 UTC until the end of the recording at 16:17:32 UTC, the aircraft lateral position changed by about 600 feet.

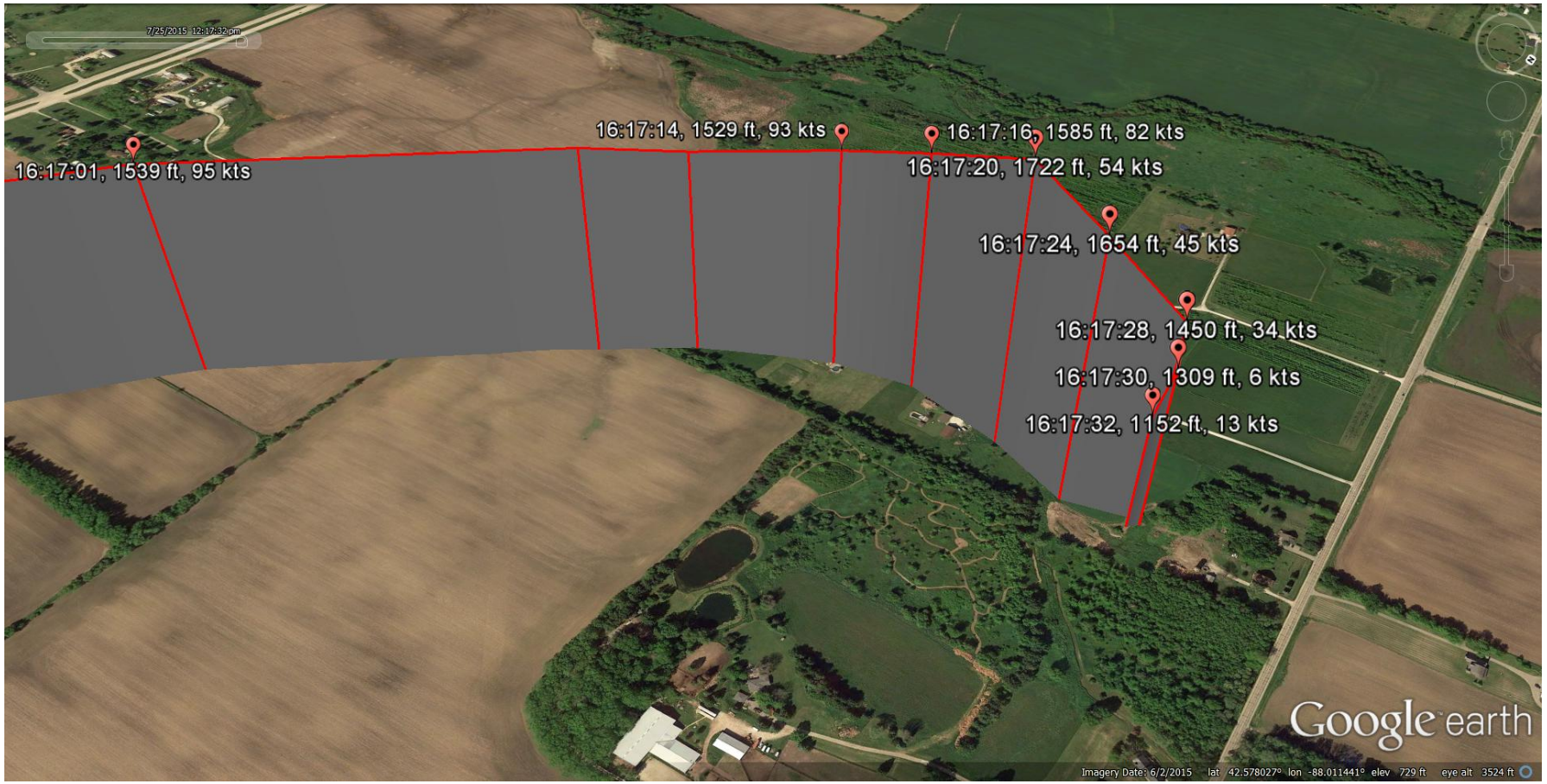
Tabular data used to generate figures 3 through 6 are included as attachment 1 in electronic comma-delimited (.CSV) format.

Figure 3. Accident flight recording overlaid on aviation sectional chart.

Figure 4. Start of recording at VPZ.

Figure 5. End of accident flight recording.

Figure 6. Last recorded points.



2.2. Dynon FlightDEK D180 Device Description

The Dynon FlightDEK D180 is a 7” wide screen display mounted in the cockpit of non-type certificated aircraft. The instrument integrates multiple flight instruments including airspeed, altitude, gyro-stabilized magnetic compass, turn rate, slip/skid ball, bank angle, pitch angle and vertical speed. The unit also has other functions that include a clock/timer, g-meter, voltmeter and a density altitude/true airspeed calculator. The unit contains an Air Data, Attitude and Heading Reference System (ADAHRS) to provide air data, attitude and heading information to the display. Depending on the installation in the operator’s aircraft, certain parameters might not be displayed, for example, angle-of-attack.

The instrument also integrates up to 16 engine related instruments including manifold pressure, temperatures, RPM and fuel system information. Depending on the type of engine installed in the aircraft and pilot preferences, not all display options may be available.

Depending on the firmware version on the unit, the ability to log data to internal memory exists. According to the manufacturer, firmware versions 3.0 and later contain the ability to log certain engine parameters and firmware versions 5.0 and later contain the ability to log certain EFIS, engine, and GPS parameters. The data logging must be configured by the operator to enable logging and set the data log interval. The unit can also be configured to start logging data automatically at boot-up. The data logging interval can be set to store at 1, 3, 5, 10, 30, or 60 second intervals. The internal memory can store at least 30 minutes of cumulative data at a 1 second recording interval or at least 30 hours at a 60 second data recording interval. When the recording limit in the internal memory is reached, the oldest record is dropped and a new record is added.

2.2.1. Dynon FlightDEK D180 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage and information was extracted using the manufacturer’s software normally, without difficulty.

2.2.2. Dynon FlightDEK D180 Data Description

The Dynon device was running software version 5.5.0.249 and was configured to record data every 10 seconds. A total of 2,948 datapoints were recovered; however, the device was not configured with a GPS input and the clock periodically reset to “00:00:00,” coincident with each new recording. The accident flight was identified as the last recording and contained 398 datapoints.

2.2.3. Dynon FlightDEK D180 Parameters Provided

Table 2 describes data parameters from the Dynon device verified and used in this report. Table 3 shows unit abbreviations.

Table 2: Dynon FlightDEK D180 Data Parameters

Parameter Name	Parameter Description
airspeed (kts)	Indicated Airspeed
altitude (ft)	Pressure Altitude
amps (amps)	Bus or Battery Amperage
cht # (degF)	Cylinder Head Temperature #
egt # (degF)	Exhaust Gas Temperature #
gz (g)	Vertical Acceleration
heading (deg)	Magnetic Heading
man pres (inHg)	Manifold Pressure
oil pres (psi)	Oil Pressure
oil temp (degF)	Oil Temperature
pitch (deg)	Pitch Angle
roll (deg)	Roll Angle
rpm (rpm)	Engine RPM
volts (Volts)	Bus or Battery Voltage

Note: # is an integer from 1 to 6, representing the cylinder being measured.

Table 3: Unit Abbreviations.

Unit Abbreviation	Description
amps	Amperes
deg	Degrees
degF	Degrees Fahrenheit
ft	Feet
g	Acceleration
inHg	Inches of Mercury
kts	Knots
psi	Pounds per Square Inch
Volts	Volts

2.2.4. Dynon FlightDEK D180 Time Correlation

Dynon FlightDEK 180 data were recorded in elapsed time from the start of the recording. Dynon altitude, airspeed, and heading were graphically aligned with Garmin GPSMAP 396 altitude, groundspeed, and track. The offset of each recording was adjusted until the best-fit graphical alignment shown in figure 7 was achieved. The alignment shown in figure 7 was achieved, such that Dynon elapsed time of 440 seconds aligned with 15:18:42 Garmin UTC. Accordingly, 54,682 seconds was added to Dynon elapsed time to convert to UTC.

2.2.5. Dynon FlightDEK D180 Plots and Tabular Data

Figures 8 through 11 show plots of data recorded by the Dynon FlightDEK D180 on the accident flight. Collectively the plots show:

- After departure, the aircraft initially climbed to about 3,000 feet pressure altitude and then descended to about 2,000 feet pressure altitude for most of the flight.

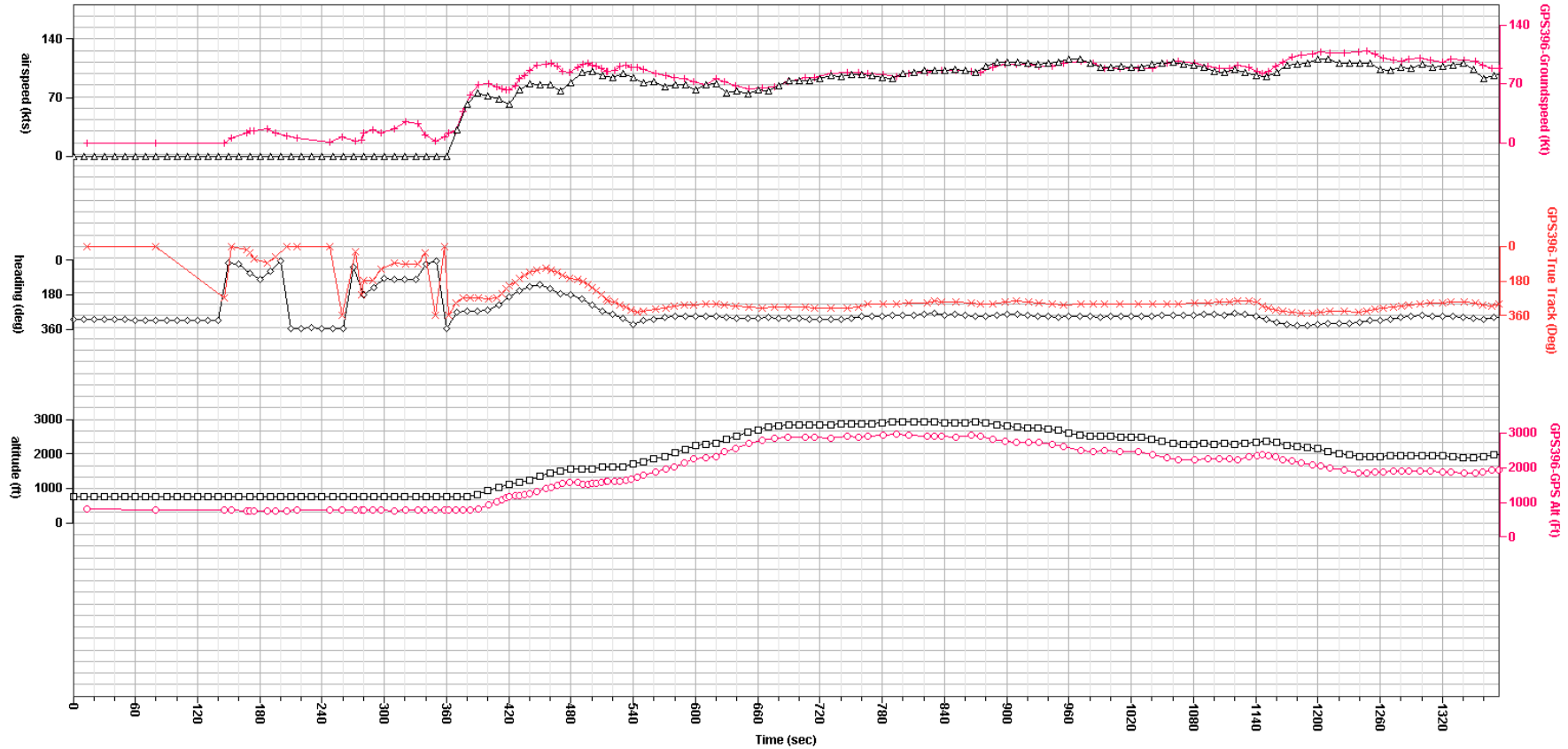
- Other than the middle (about 15:40:02 UTC) and end of the recording, engine parameters remained fairly steady throughout the flight.

- The last two datapoints after 16:17:02 UTC (16:17:12 and 16:17:22 UTC) showed fluctuating altitude, decreasing oil pressure, decreasing RPM, decreasing EGT, increasing CHT, increase in pitch to 14 degrees (followed by a decrease in pitch), and decreasing indicated airspeed.

Given the limitations of the Dynon sample rate and the limitation of the time alignment between the Dynon and the Garmin 396, both devices appeared to stop recording at the same time (the last expected sample for the Dynon would have been 16:37:32 UTC, which was the last recorded time by the Garmin 396).

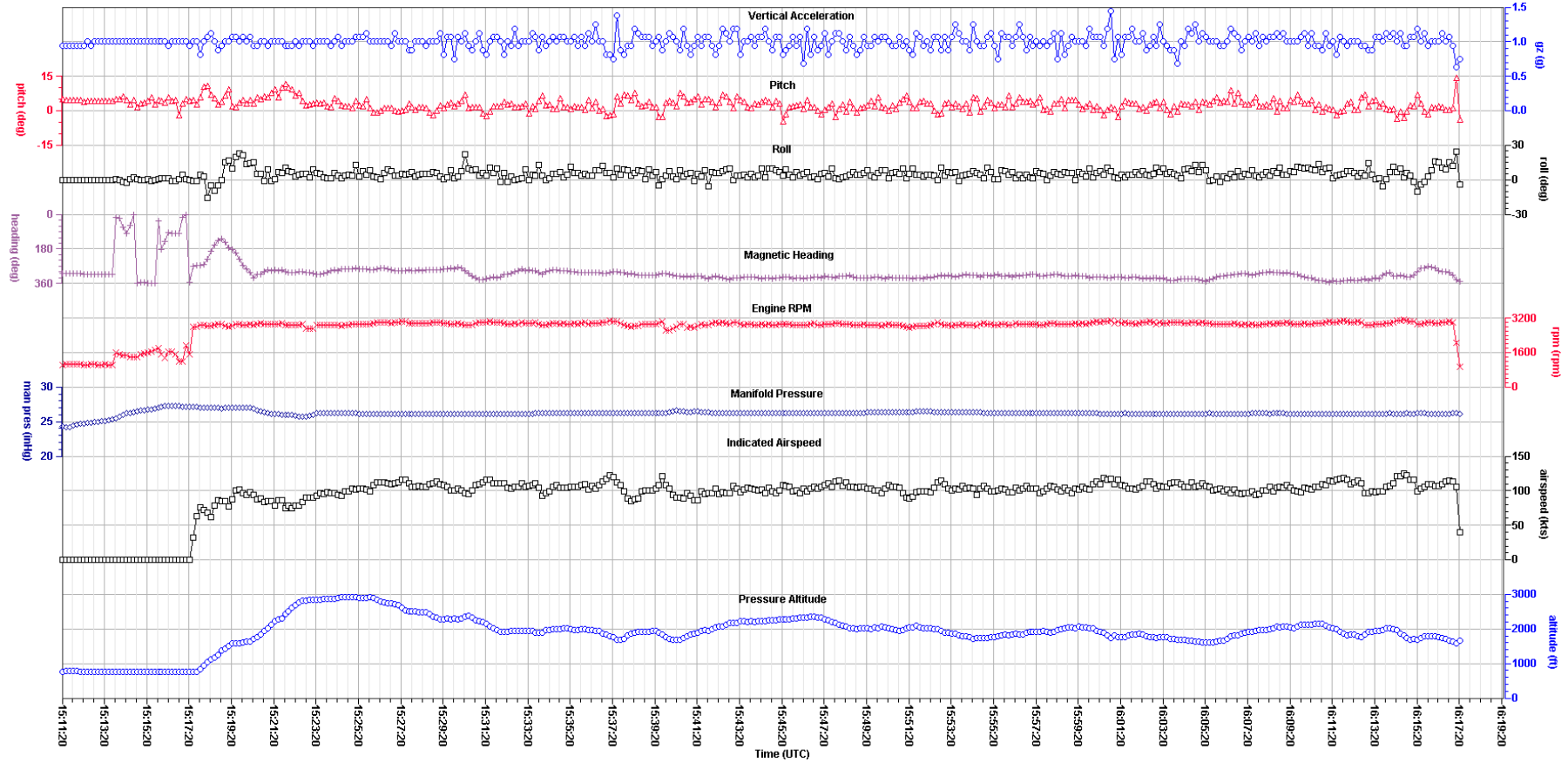
Tabular data used to generate figures 7 through 11 are included as attachment 2 in electronic comma-delimited (.CSV) format.

Figure 7. Dynon / Garmin time alignment plot.



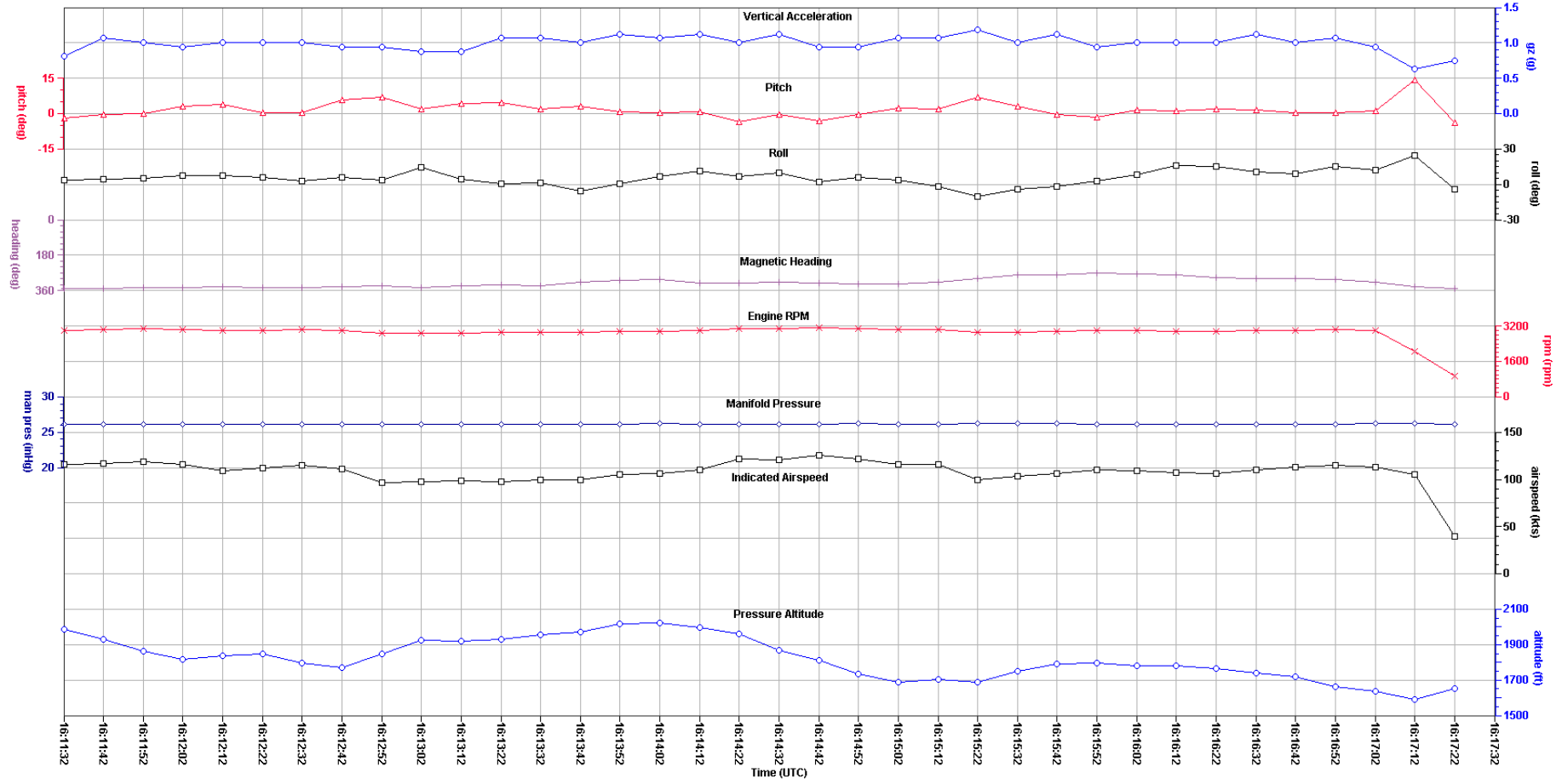
Revised: 20 October 2015 Alignment Plot National Transportation Safety Board

Figure 8. Dynon accident flight recording - basic parameters.



Revised: 4 November 2015 Basic Parameters - Entire Accident Flight Recording National Transportation Safety Board

Figure 9. Dynon end of accident flight recording - basic parameters.



Revised: 20 October 2015 | Basic Parameters - End of Accident Flight Recording | National Transportation Safety Board

Figure 10. Dynon accident flight recording - engine parameters.

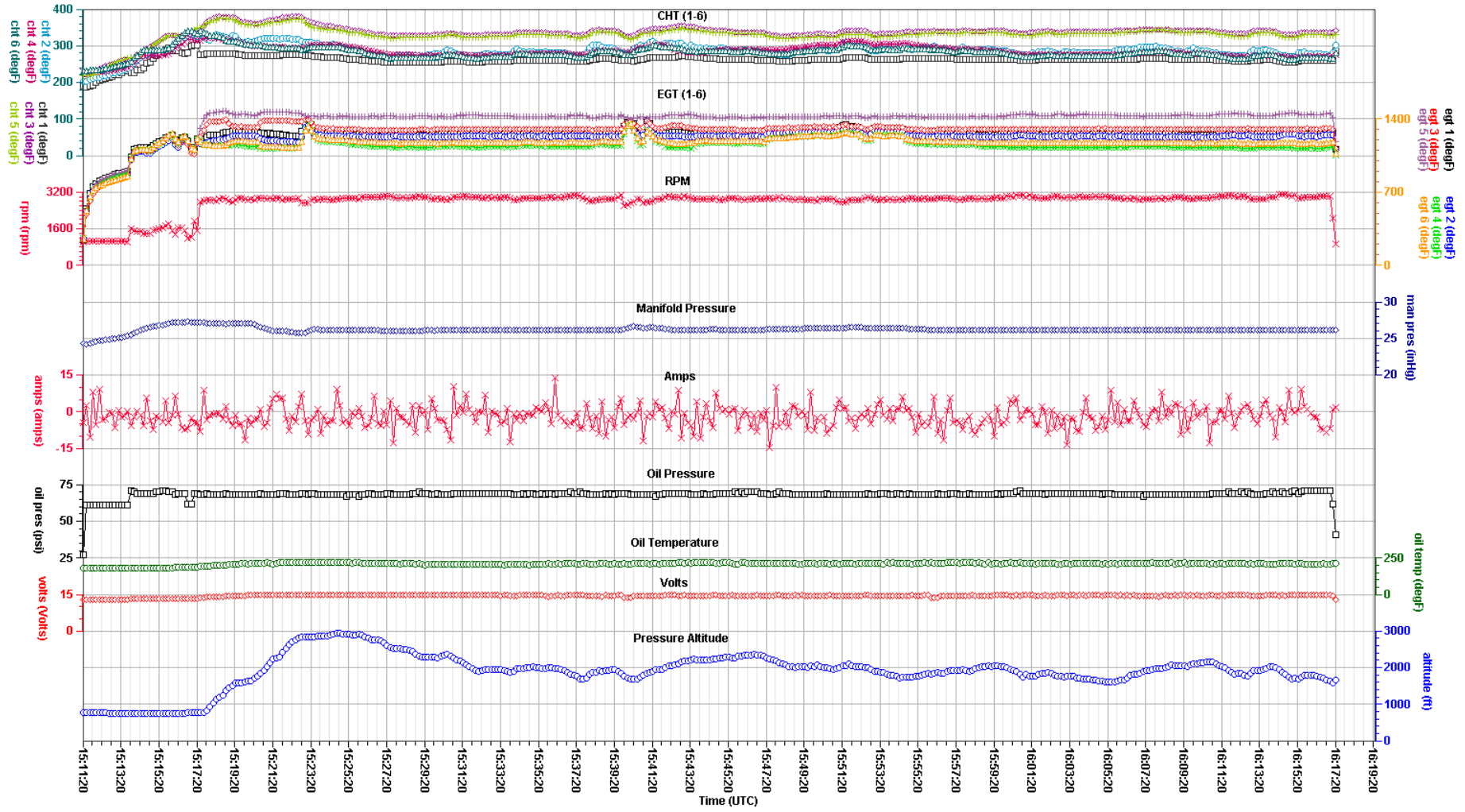


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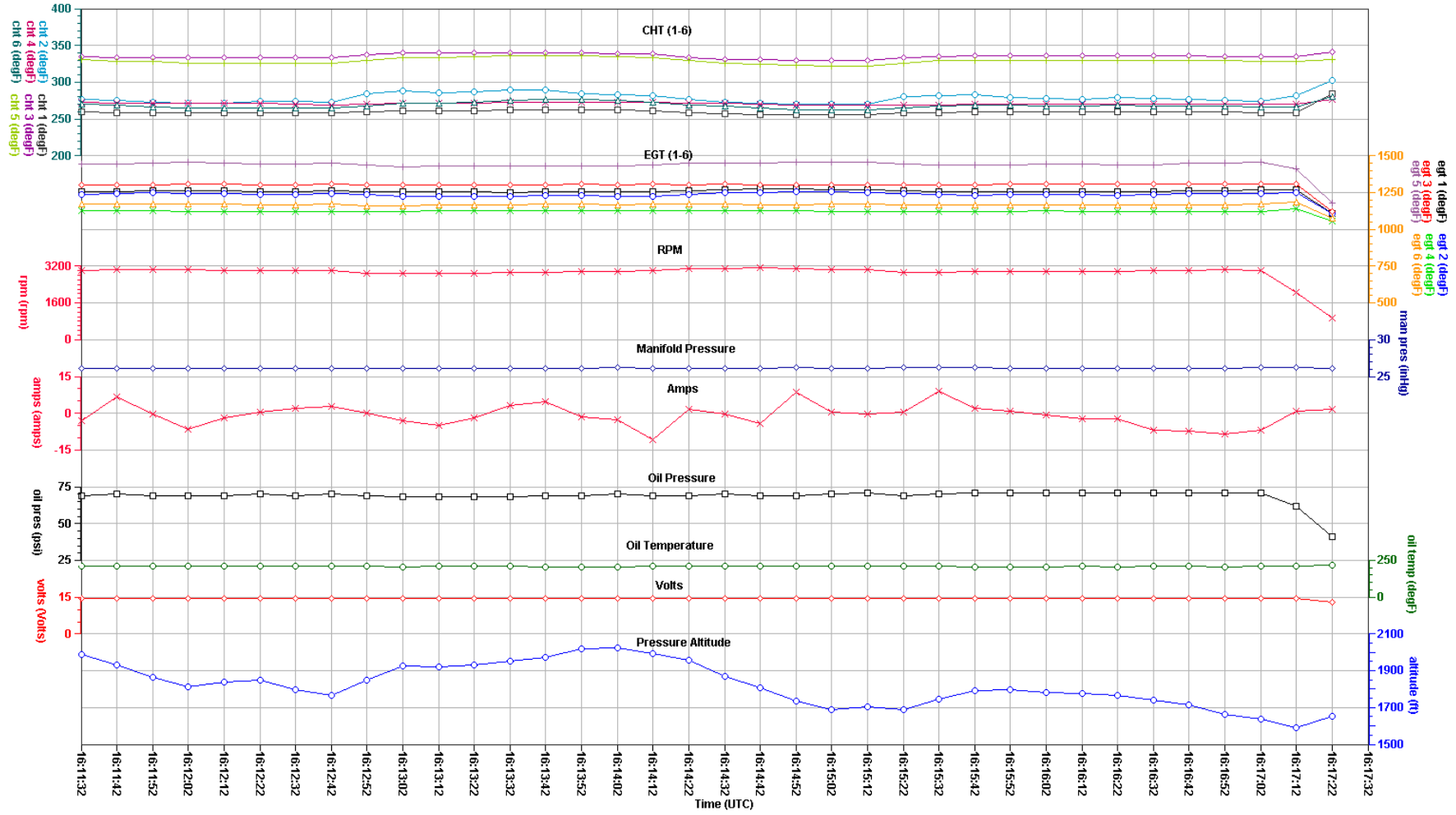
Figure 11. Dynon end of accident flight recording - engine parameters.



Revised: 20 October 2015 Engine Parameters - End of Accident Flight Recording National Transportation Safety Board