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

October 2, 2017

Cockpit Display – Recorded Flight Data

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

1. EVENT SUMMARY

Location: Marengo, Illinois
Date: December 9, 2016
Aircraft: Aircraft Manufacturing & Design LLC CH601XL
Registration: N4218
Operator: Private
NTSB Number: CEN17FA053

On December 9, 2016, about 1819 central standard time, an Aircraft Manufacturing & Design LLC, CH601XL SLSA,[1] N4218, impacted the terrain following a loss of control in Marengo, Illinois. The sport pilot was fatally injured. The airplane was destroyed. The airplane was registered to and operated by a private individual under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91 as a personal flight. Visual meteorological conditions prevailed for the flight, which was not operated on a flight plan. The flight originated from the Poplar Grove Airport (C77), Poplar Grove, Illinois, about 1812, with an intended destination of the Schaumburg Regional Airport (06C), Schaumburg, Illinois.

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF INVESTIGATION

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

      Recorder Manufacturer/Model: **Dynon EMS-D120**
      Recorder Serial Number: **002109**

3.1. Dynon EMS-D120 Description

The Dynon EMS-D120 (EMS is an acronym for Engine Monitoring System) is a 7" wide screen display mounted in the cockpit of non-type certificated aircraft. The instrument integrates up to 16 engine related instruments including manifold pressure, temperatures, RPM, fuel system information, and external Global Positioning System (GPS) information.

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[1] SLSA means Special Light-Sport Aircraft, see 14 CFR 21.190.

Depending on the type of engine installed in the aircraft and pilot preferences, not all display options are available.

Depending on the firmware version on the unit, the ability to log data to internal, non-volatile memory[2] exists. According to the manufacturer, firmware versions 3.0 and later contain the ability to log certain engine 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. Data logging can be set to store at 1, 3, 5, 10, 30, and 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 recording interval. When the recording limit in the internal memory is reached, the oldest record is dropped and a new record is added (that is, the data wraps around and begins overwriting older data).

3.1.1. Dynon EMS-D120 Data Recovery

The device incurred significant impact damage, as shown in figure 1. Figure 2 shows the device after disassembly, with an inset showing three semiconductor chips that were recovered. By comparing the chips to other EMS-D120 recoveries, it was determined the "SST 39VF3201" chip, shown in figure 3, was the chip containing non-volatile memory. Most of the 48-pin connectors were damaged and some were missing. Bent connectors were straightened and missing connectors were replaced by mechanically removing the chip packaging and soldering new connectors in place. Figure 4 shows missing connectors with packaging mechanically removed, and figure 5 shows the connectors replaced. Figure 6 shows the chip with all 48-pin connectors repaired.

The repaired chip was successfully read using a Xeltec EEPROM programmer. The resulting binary chip image was processed to extract recorded history.

Figure 1. Front and back of device, as received.

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

CEN17FA053
Cockpit Display – Recorded Flight Data Factual Report - Page 2

Figure 2. Recovered semiconductor chips.

Figure 3. Non-volatile memory.

Figure 4. Chip packaging mechanically removed.
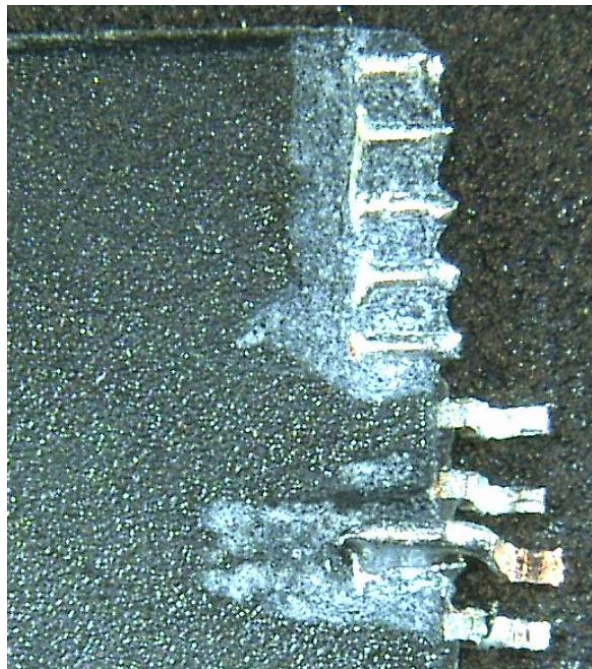
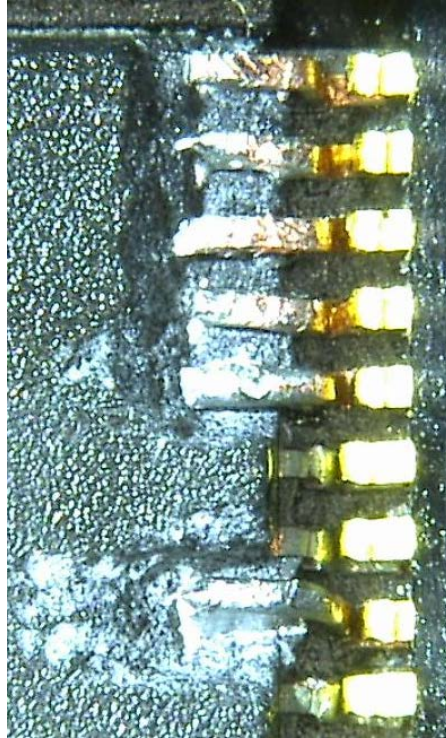**Figure 5. Chip with connectors replaced.**

Figure 6. Chip with all connectors repaired.

3.1.2. Dynon EMS-D120 Data Description

The recording contained approximately 16 recording sessions. Neither the date/time of the recordings or the recording interval was determined.[3] Because the recording interval was

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[3] A continuous stream of data was recovered with no markers of when a recording stopped/started. Furthermore, some streams that appeared contiguous by a review of parameters contained a few records of missing data. Based on these factors, the number of recording sessions is an estimate (thus the qualifier, "approximately").

not determined, any references to duration refer to data counts; one count being one data point.

Data shown in appendix A was recovered as recorded on the device, without further conversion.

3.2.   Plots and Corresponding Tabular Data

Geographical overlays were created using Google Earth. Weather and lighting conditions are not representative of conditions at the time of the recordings.

Figure 7 shows all recorded geographic data recovered from the Dynon EMS-D120, with the C77 Airport (Poplar Grove) and the accident location annotated. There was no recorded data at C77 or the accident location.

In order to further understand why the accident was not recorded and to determine the wrap-around point of the recorded data, recorded engine data was examined.

Figures 8 and 9 show select engine parameters, plotted for the entire recording duration and the first 10,000 counts of data, respectively. The discontinuity in data at 8,019 counts is consistent with the wrap-around point of data overwriting, as described in section 3.1. The maximum Hobbs recorded was 318.0 hours and the minimum was 309.8 hours. The maximum Tach recorded was 236.0 hours and the minimum was 229.4 hours.

Recorded latitude, longitude, and groundspeed were examined around the wrap-around point identified in figures 8 and 9. Figure 10 shows a geographic overlay with annotations for three separate recording sessions: 1, 2, and 3. Recording 1 was from Dupage Airport (DPA) to Chicago Executive Airport (PWK), with groundspeeds consistent with a routine flight. Recording 2, shown in detail in figure 11, shows points on the ramp at PWK, with groundspeeds similar to taxi speeds.[4] Recording 3 shows a recording that starts at a groundspeed of 98 knots, consistent with a recording beginning during a routine flight. Combined with the plots in figures 8 and 9, recording 3 was the oldest recording (ending at 8,019 counts), recording 2 the most recent recording, and recording 1 was recorded just prior to recording 2.

In summary, the accident flight was not recorded and the last recorded data was on the ground at PWK.

The corresponding tabular data used to create these five figures are provided in electronic (*.csv[5]) format as attachment 1 to this report.

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[4] Recording 2 contained some discontinuities, possibly indicative of power cycles to the Dynon EDM-D120.
[5] Comma Separated Value format.

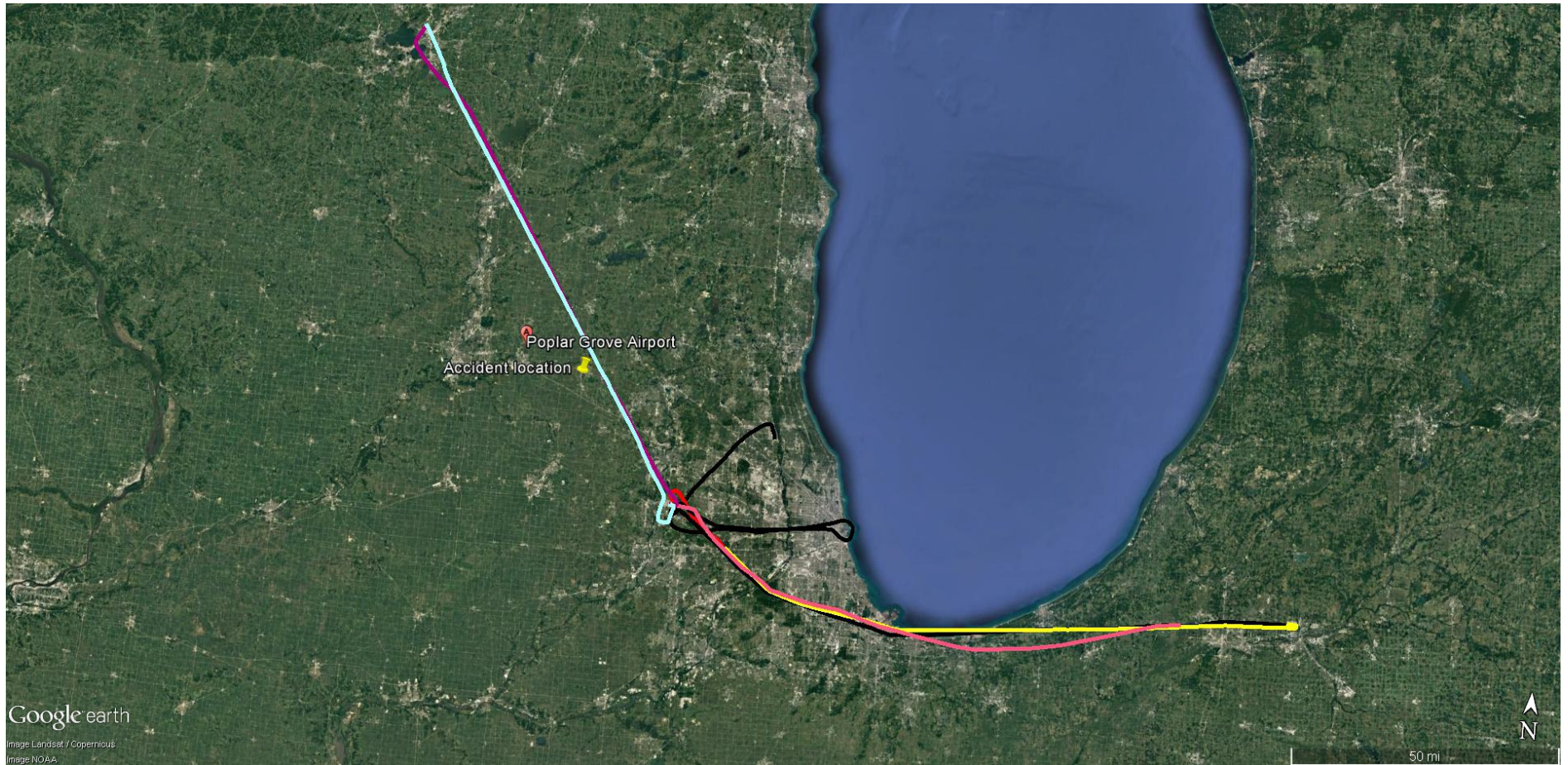**Figure 7. Satellite overlay of all recorded data.**

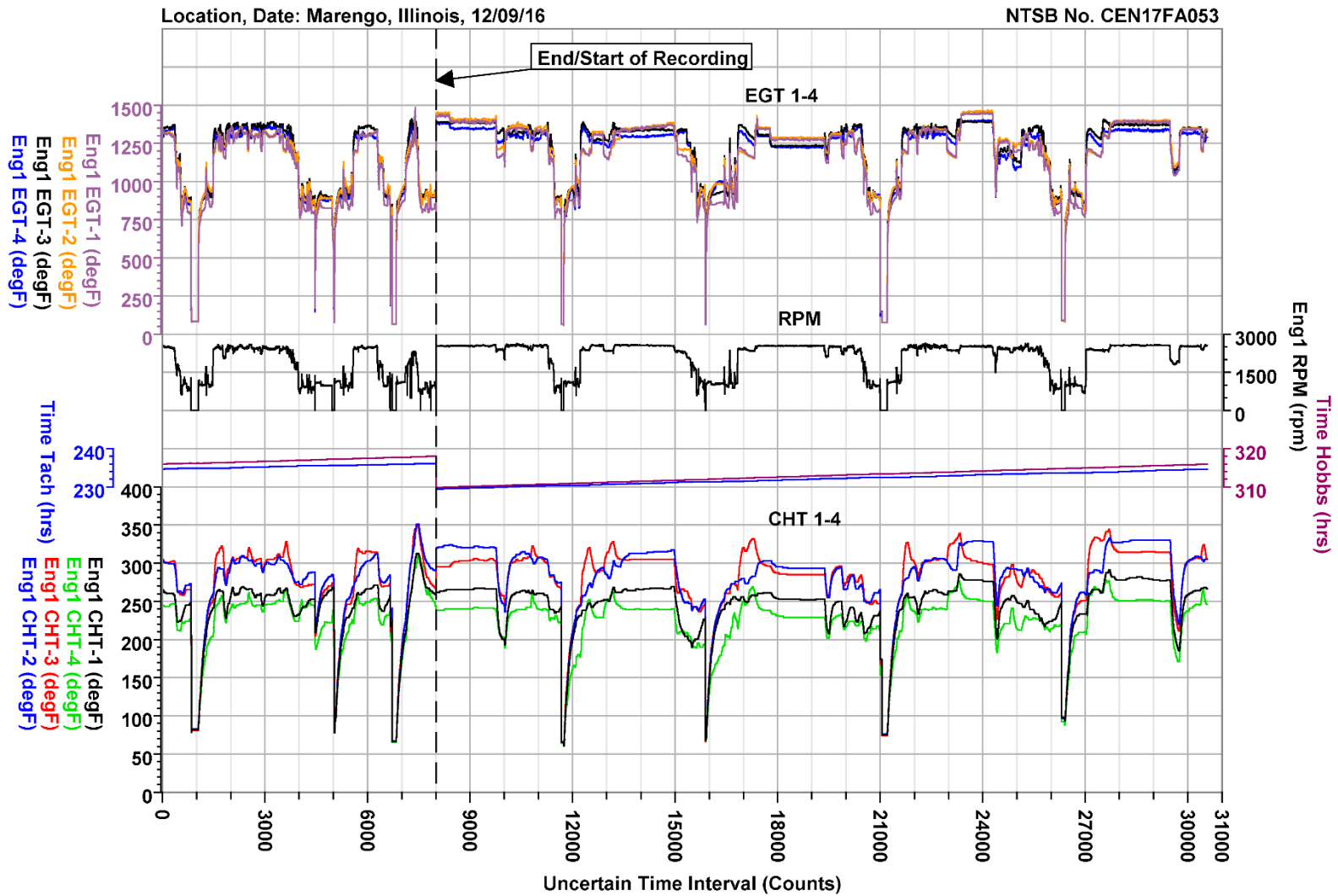**Figure 8. Plot of select parameters, entire recording duration.**

Location, Date: Marengo, Illinois, 12/09/16   NTSB No. CEN17FA053

Figure 9. Plot of select parameters, showing wrap-around point of recording.
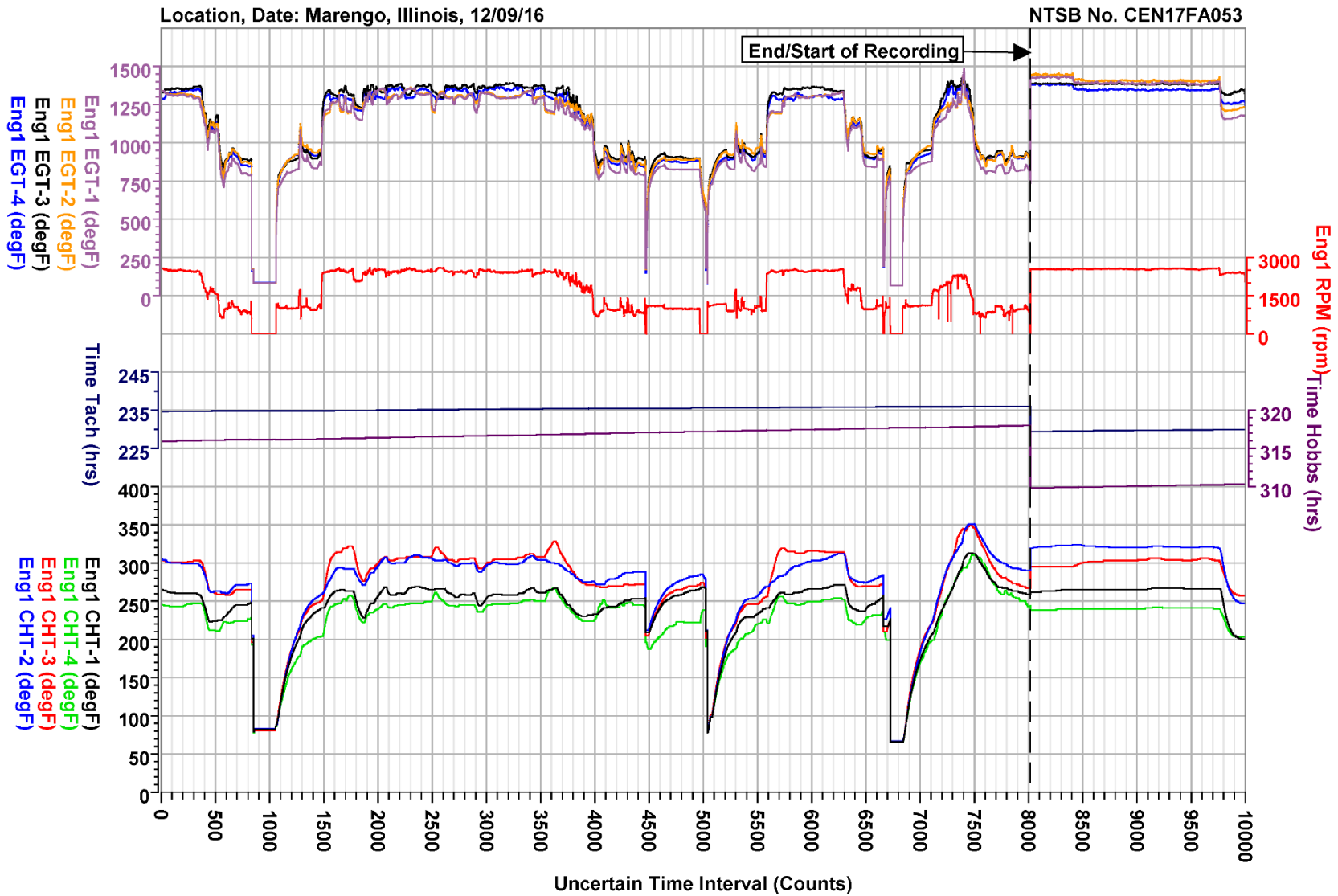
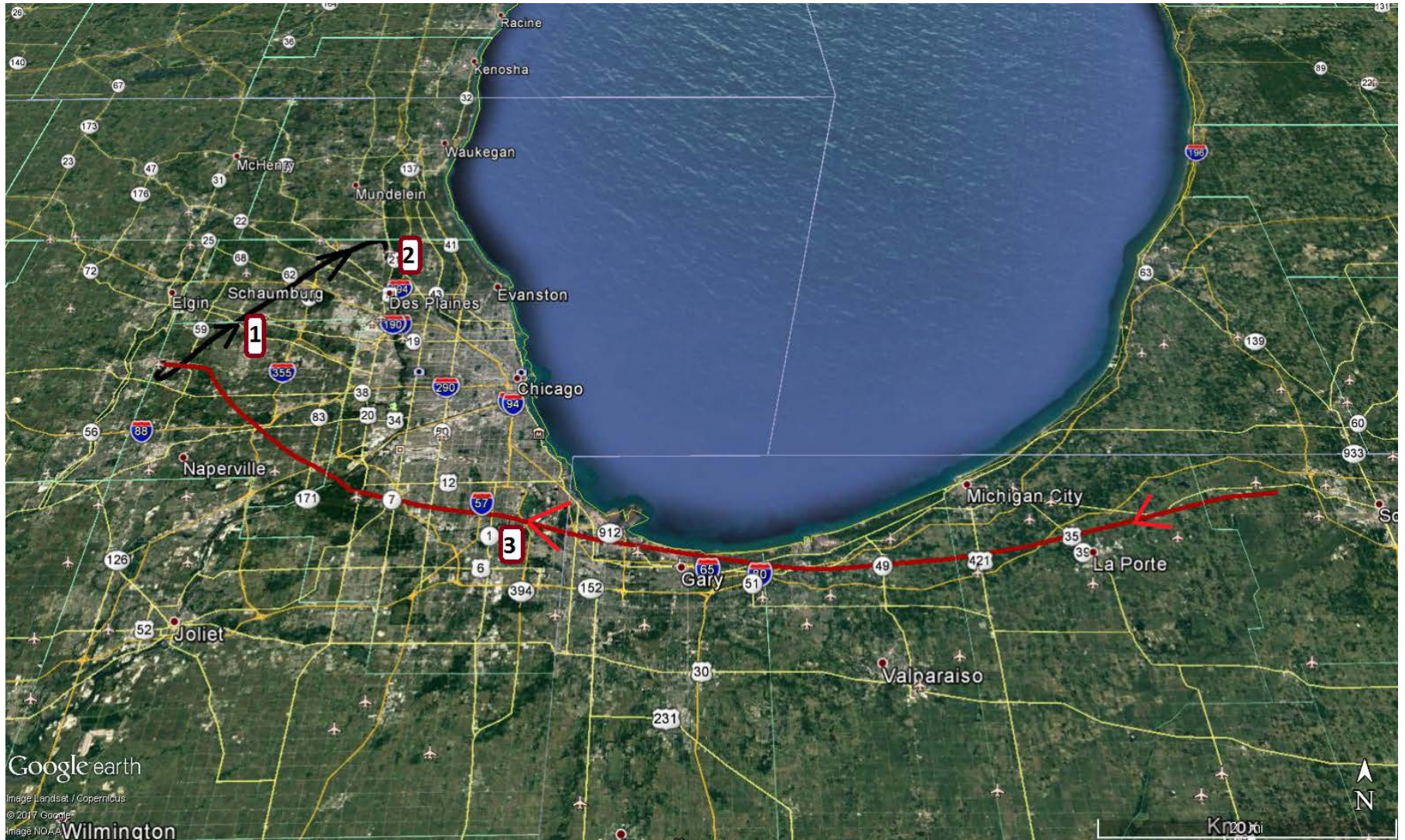**Figure 10. Recordings surrounding wrap-around.**

Figure 11. Recording at PWK airport; end of recording 1 and all of recording 2.

Note: different colors on recording 2 represent a discontinuity in the recorded data for this session.

APPENDIX A – Dynon EMS-D120 Parameters

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

Table A-1 - Verified and provided parameters.

Parameter Name	Parameter Description
Eng1 CHT-# (degF)	Cylinder Head Temperature #
Eng1 EGT-# (degF)	Exhaust Gas Temperature #
Eng1 Fuel Flow (gal/hr)	Fuel Flow
Eng1 Fuel Press (psi)	Fuel Pressure
Eng1 Oil Pressure (psi)	Oil Pressure
Eng1 Oil Temp (degF)	Oil Temperature
Eng1 RPM (rpm)	Engine (or Propeller) Revolutions per Minute
Eng1 Volts (Vdc)	Volts
Ground Spd (kts)	Ground Speed
Latitude (deg)	Latitude
Longitude (deg)	Longitude
Time Hobbs (hrs)	Hobbs Time
Time Tach (hrs)	Tachometer Time

is a placeholder for the corresponding cylinder, 1 through 4

Table A-2 - Unit abbreviations.

Units Abbreviation	Description
deg	degrees
degF	degrees Fahrenheit
gal/hr	gallons per hour
kts	knots
psi	pounds per square inch
rpm	revolutions per minute
Vdc	Volts DC
hrs	hours