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

June 5, 2014

Electronic Devices Factual Report

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

1. EVENT

Location:	Tribune, Kansas
Date:	February 22, 2014
Aircraft:	Vans Aircraft RV-9
Registration:	N7872
Operator:	Private
NTSB Number:	CEN14LA148

On February 22, 2014, at 1802 mountain standard time, a Vans RV-9A, N7872, was found in a field about 11 miles west of Tribune, Kansas. The airplane sustained substantial damage. The private pilot was fatally injured. The airplane was owned and operated by the pilot under 14 *Code of Federal Regulations* Part 91 as a personal flight that was not operating on a flight plan. Visual meteorological conditions prevailed on the day of the accident. The flight originated from Tribune, Kansas, at time unknown.

2. DETAILS OF DEVICE INVESTIGATION

The Safety Board's Vehicle Recorder Division received the following devices:

Device 1:	Advanced Flight Systems Inc. AF-4500sEEp
Device 1 Serial Number:	61571

Device 1:	Advanced Flight Systems Inc. AF-3400EFA V5
Device 1 Serial Number:	60331

2.1. Advanced Flight Systems Inc. AF-4500/3400 Series Description

The Advanced Flight Systems Inc. AF-4500 and AF-3400 series are multifunction, liquid crystal displays (LCD) capable of displaying aircraft attitude, altitude, heading, navigation, moving map, engine information, and airway and approach databases, depending on options and installation. The units can record dynamic flight information

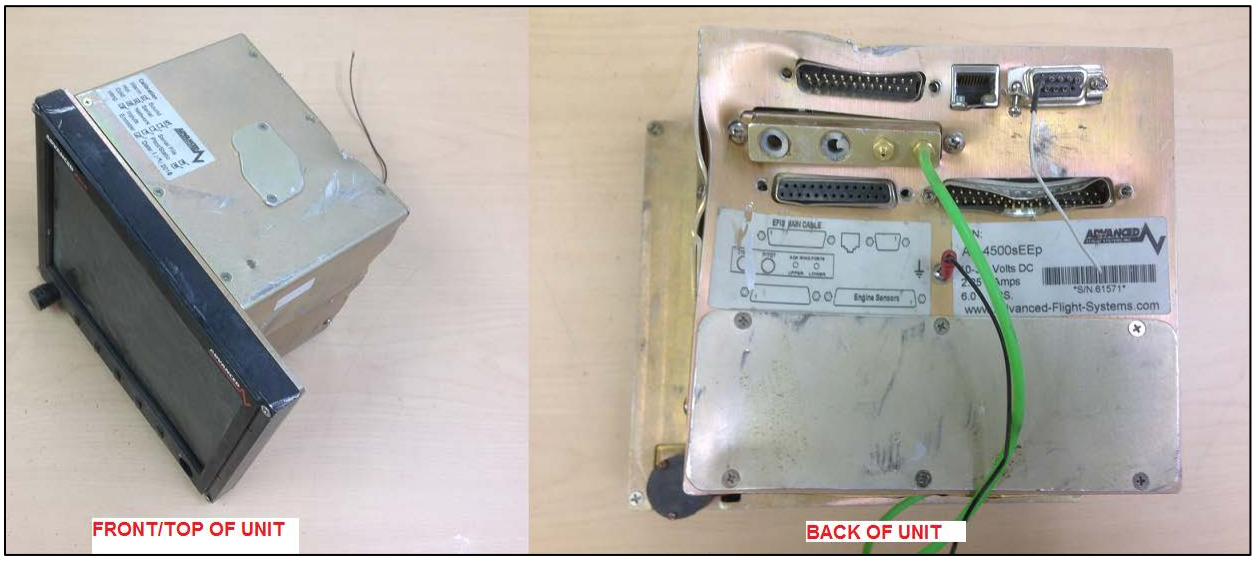
on internal flash non-volatile memory[1] at a pilot selectable interval. The unit records approximately 50 discrete data parameters to the internal non-volatile memory.

The time in the units is set by the operator and maintained by an internal lithium-ion battery between power cycles. Displayed and recorded times are from the internal clock on each unit. However, when power is applied and the unit is connected to a GPS, the internal clock will automatically be set to GPS time. Thereafter the clock will advance based on the internal microprocessor. When connected to another Advanced Flight Systems Inc. device, discrete data parameters are shared and recorded (except time).

2.1.1. Advanced Flight Systems Inc. AF-4500sEEp Data Recovery

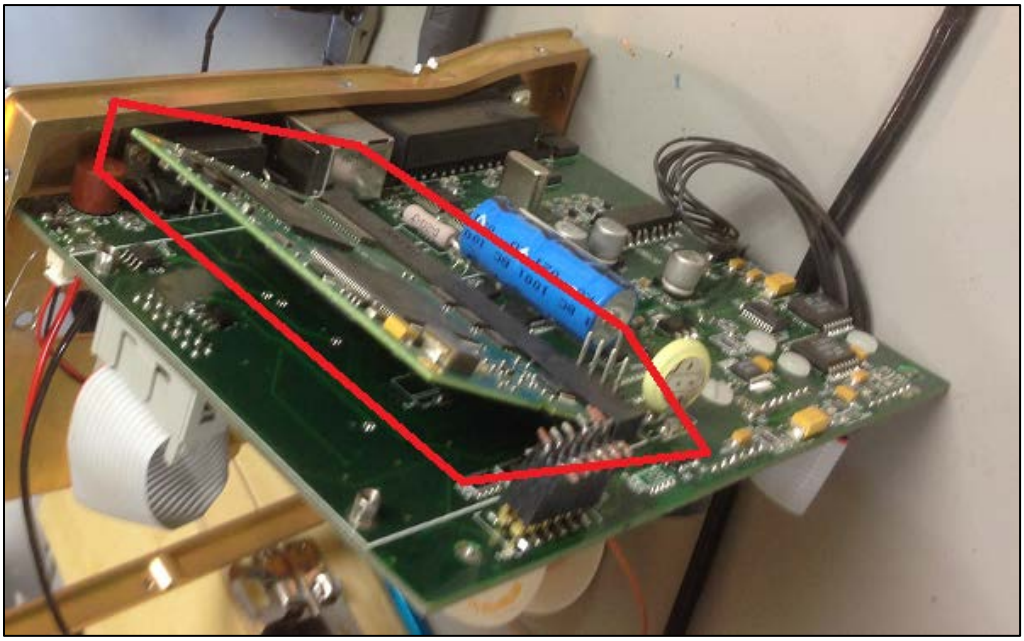
Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had sustained significant impact damage, as shown in figure 1. The internal memory board was removed from the unit, as shown in figure 2, and brought to the manufacturer. NTSB personnel witnessed the manufacturer download data from the memory board using a surrogate unit.

Figure 1. AF-4500sEEp as received.



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

Figure 2. Internal memory board (outlined) partially removed from AF-4500sEEp.



2.1.1.1. Advanced Flight Systems Inc. AF-4500sEEp Data Description

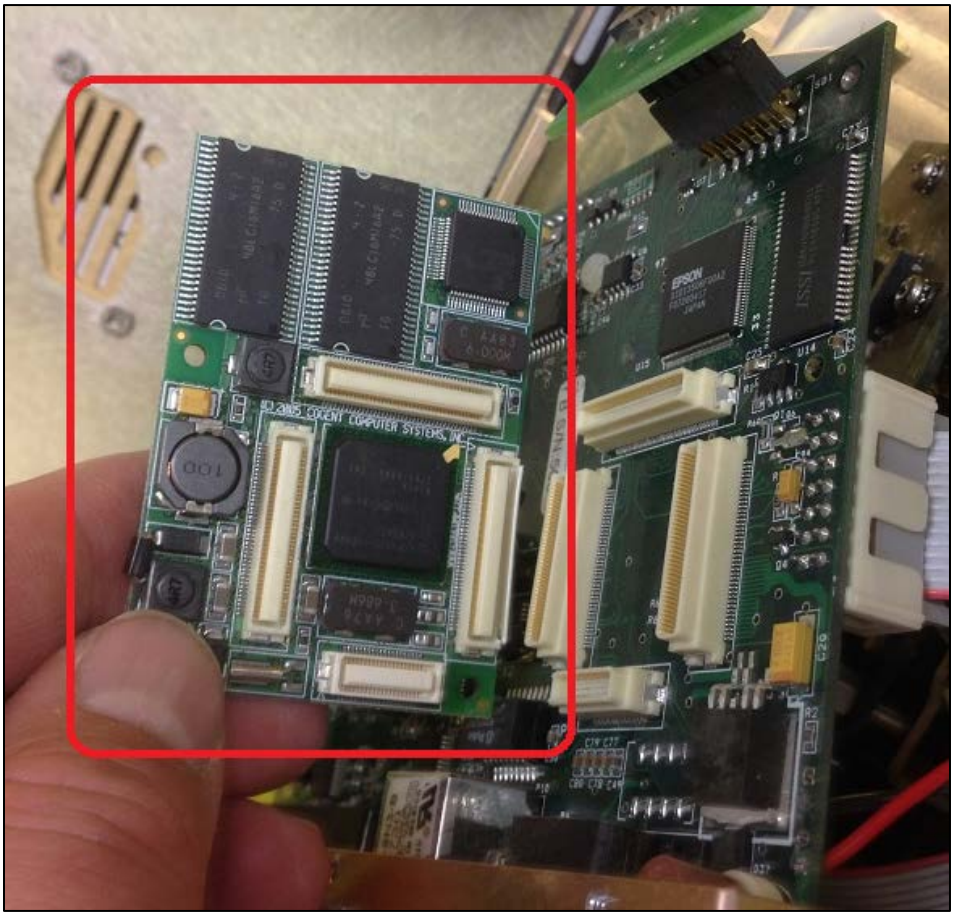
Data from March 18, 2013 through February 22, 2014 was extracted from the AF-4500sEEp. Data was sampled once every 10 seconds.

2.1.2. Advanced Flight Systems Inc. AF-3400EFA Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had sustained significant impact damage, as shown in figure 3. The internal memory board was removed from the unit, as shown in figure 4, and brought to the manufacturer. NTSB personnel witnessed the manufacturer download data from the memory board using a surrogate unit.

Figure 3. AF-3400EFA as received.

Figure 4. Internal memory board (outlined) partially removed from AF-3400EF.



2.1.2.1. Advanced Flight Systems Inc. AF-3400EFA Data Description

Data from August 19, 2013 through February 22, 2014 was extracted from the AF-3400EFA. Data was sampled once every 5 seconds.

2.2. Data Source and Timing

The data extracted from both units were examined. Based on this examination, only the data from the AF-3400EFA on February 22, 2014 was used for this report. A review of the parameters indicated the recorded angle of attack (degrees) was not valid.

According to the Advanced Flight Systems Inc. User Guide and Installation Manual (AF-3400/AF-3500/AF-4500, Version 7.4), the offset from UTC to local time is set by the user; this offset could not be verified. As such, times used in this report are “AFS 3400 Time.”

Appendix A lists the parameters verified and provided in this report.

3. OVERLAYS AND TABULAR DATA

Figures 5 through 8 show graphical overlays, generated using Google Earth, of the GPS latitude, longitude, and indicated altitude for the entire flight. The recording began at 1747:14 at the Tribune Municipal Airport and ended at 1805:44. The aircraft departed runway 17 at Tribune about 4 minutes after the recording began. After climbing about 500 feet, the aircraft made a right turn and proceeded west-northwest. At about 1800, the aircraft made a right turn and proceeded towards the east-southeast. Between about 1800:49 and 1803:06, the recorded track included two, left-hand 360 degree turns. In the last 21 seconds of the recording, the track turned left as the altitude decreased from 4,140 feet to a final recorded altitude of 3,920 feet.

Figure 9 shows a plot of basic flight parameters recorded during the accident flight and figure 10 focuses on the last five minutes. During ground operations the GPS altitude was about 3,640 feet and the highest recorded altitude during the flight was 4,830 feet. At about 1801:14, the pitch attitude fluctuated and the vertical acceleration recorded a value of +2.10 g. At about 1802:35, the vertical acceleration recorded a value of +2.80 g and a roll angle of about 60 degrees. As the aircraft descended through 4,010 feet near the end of the recording, the pitch once again fluctuated, the roll increased to about 75 degrees, and the vertical acceleration recorded a maximum value of +3.20 g.

Figure 11 shows a plot of engine parameters recorded during the accident flight and figure 12 focuses on the last five minutes. From the period after take-off until the end of the recording, the engine parameters indicated little change.

Tabular data used to generate figures 5 through 12 are included as Attachment 1. Attachment 1 includes all latitude and longitude values. These attachments are provided in electronic comma-delimited (.CSV) format.

Figure 5. Graphical overlay of ground track from accident flight.

Figure 6. Graphical overlay from start of accident recording, ground taxi, and take-off.

Figure 7. Graphical overlay of two 360 degree changes in track.

Figure 8. Graphical overlay of end of recording.

Figure 9. Plot of basic parameters for accident flight.

Figure 10. Plot of basic parameters for end of accident flight recording.

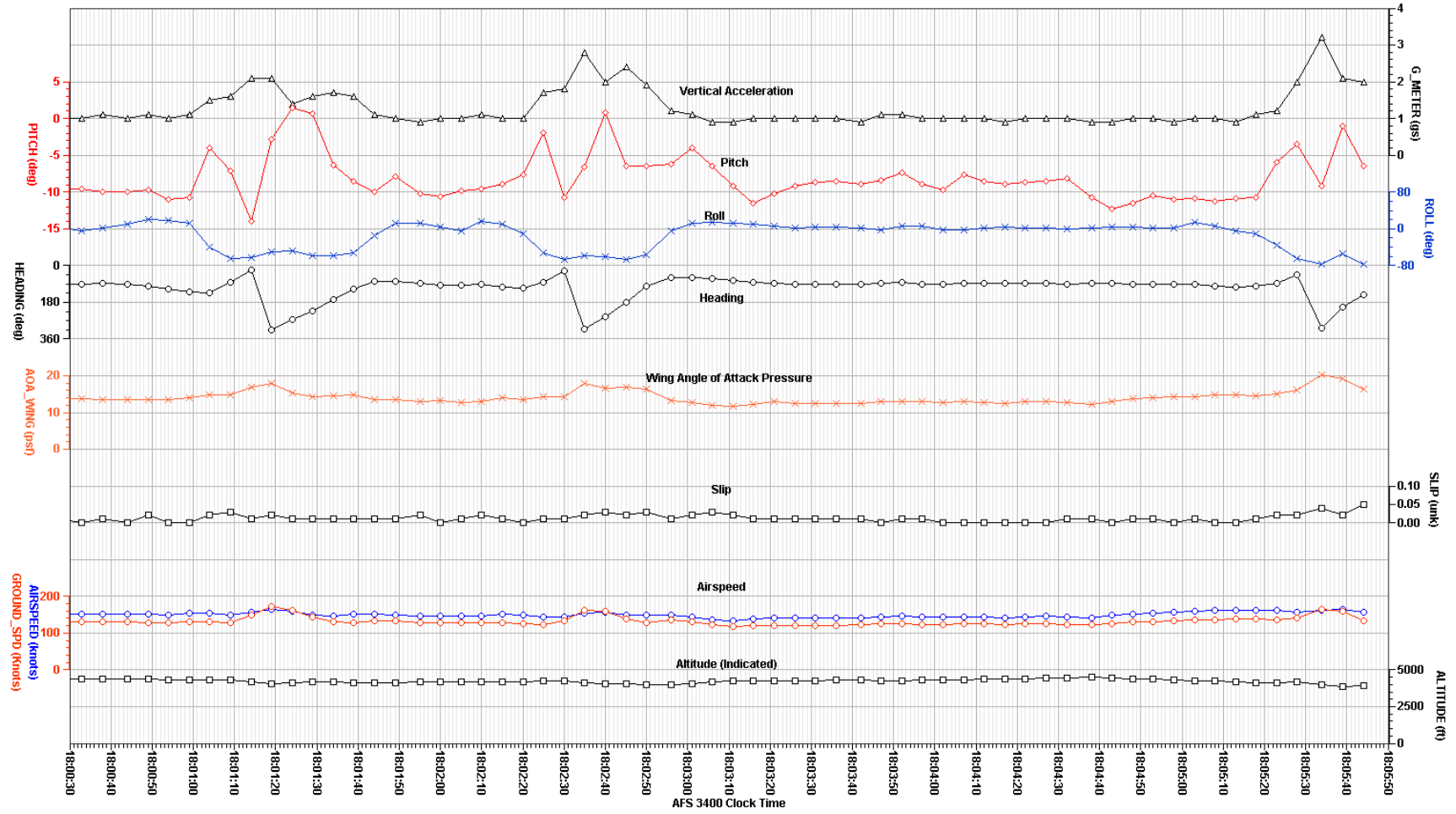


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Figure 11. Plot of engine parameters for accident flight.

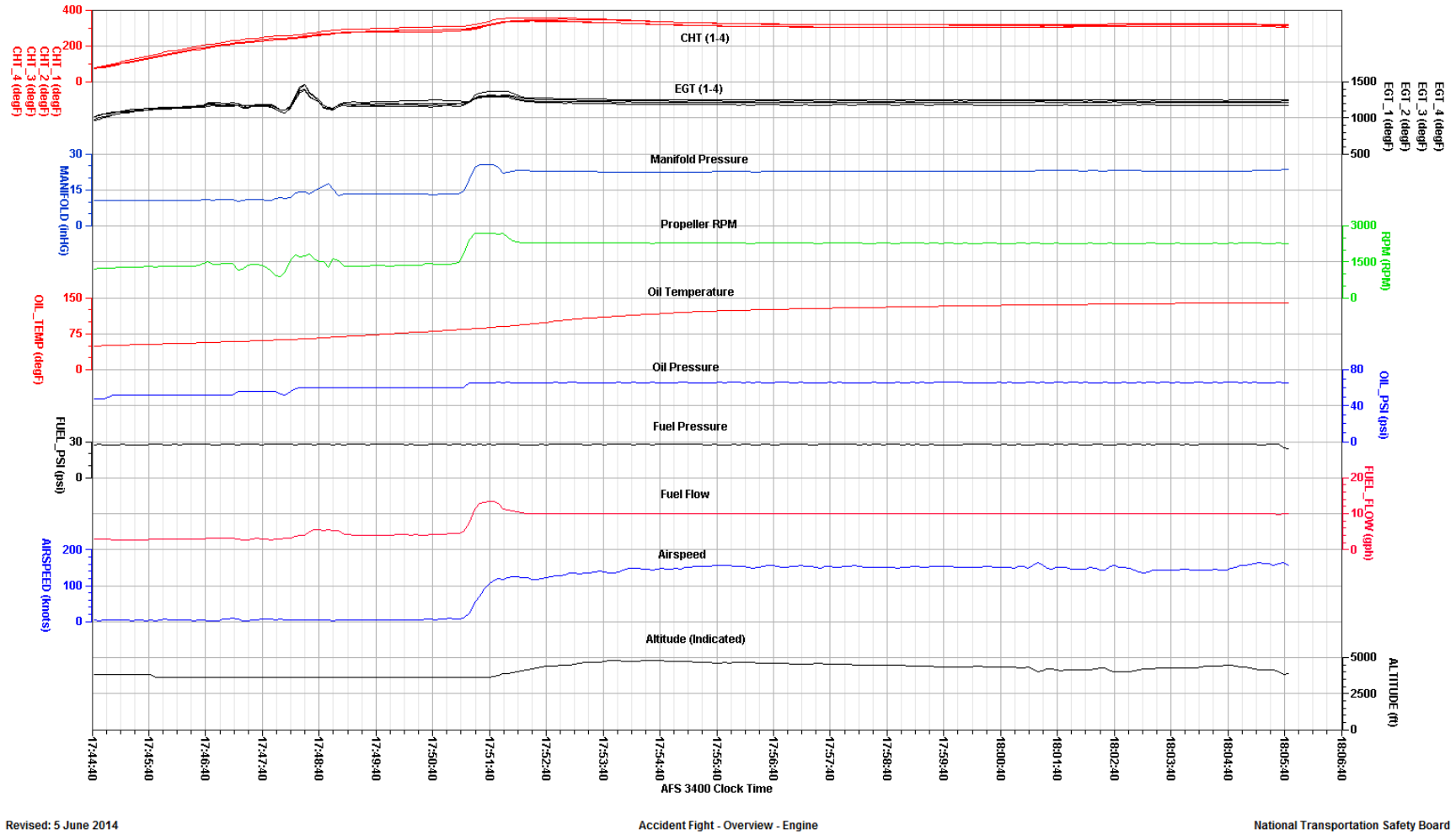

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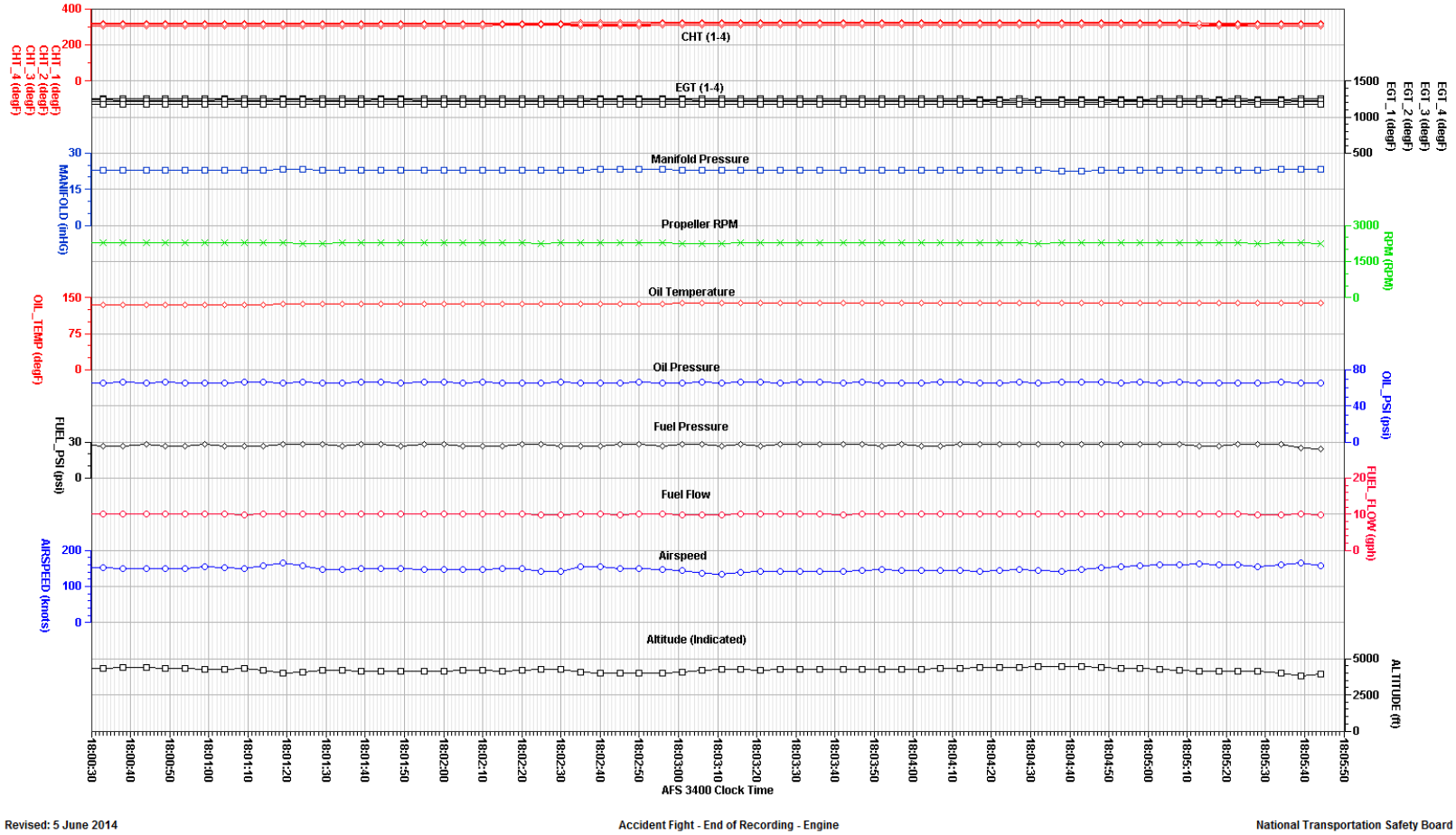
Figure 12. Plot of engine parameters for end of accident flight recording.



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APPENDIX A

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

Table A-1. Verified and provided parameters.

Parameter Name	Parameter Description
AIRSPEED (kts)	Indicated Airspeed
ALTITUDE (ft)	Indicated Altitude
AOA_WING (psf)	Wing Angle of Attack Pressure
CHT_1 (degF)	Cylinder Head Temperature 1
CHT_2 (degF)	Cylinder Head Temperature 2
CHT_3 (degF)	Cylinder Head Temperature 3
CHT_4 (degF)	Cylinder Head Temperature 4
EGT_1 (degF)	Exhaust Gas Temperature 1
EGT_2 (degF)	Exhaust Gas Temperature 2
EGT_3 (degF)	Exhaust Gas Temperature 3
EGT_4 (degF)	Exhaust Gas Temperature 4
FUEL_FLOW (gph)	Fuel Flow
FUEL_PSI (psi)	Fuel Pressure
G_METER (g)	Vertical Acceleration
GROUND_SPD (kts)	GPS Ground speed
HEADING (deg)	Magnetic Heading
LATITUDE (deg)	GPS Latitude
LONGITUDE (deg)	GPS Longitude
MANIFOLD (inHg)	Manifold Pressure
OIL_PSI (psi)	Oil Pressure
OIL_TEMP (degF)	Oil Temperature
PITCH (deg)	Pitch Angle
ROLL (deg)	Roll Angle
RPM (rpm)	Propeller Revolutions per Minute
SLIP (unk)	Slip Angle

Table A-2. Unit abbreviations.

Units Abbreviation	Description
deg	degrees
degF	degrees Fahrenheit
ft	feet
g	g
gph	gallons per hour
inHg	inches of Mercury
kts	knots
psi	pounds per square inch
psf	pounds per square foot
unk	units could not be determined