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

November 4, 2013

Engine Monitor Report

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

A. EVENT

Location:	Fallon, Nevada
Date:	July 10, 2013
Aircraft:	Raytheon A36
Registration:	N517DJ
Operator:	Silver Sage Aviation
NTSB Number:	WPR13LA321

B. GROUP - No Group

C. SUMMARY

On July 10, 2013, about 0445 Pacific daylight time (PDT), a Raytheon Aircraft Company, A36, N517DJ, during initial climbout experienced a catastrophic engine failure, resulting in an off airport landing near Fallon Municipal Airport (FLX), Fallon, Nevada. Silver Sage Aviation, was operating the airplane under the provisions of 14 *Code of Federal Regulations* Part 135. The commercial pilot and three passengers sustained minor injuries; the airplane sustained substantial damage. The cross country business flight was departing Fallon, Nevada, about 0445, with a planned destination of Dixie Valley, Nevada. Night visual meteorological conditions prevailed, and a visual flight rules (VFR) flight plan had been filed.

D. DETAILS OF INVESTIGATION

The NTSB Vehicle Recorder Laboratory received the following device:

GPS Manufacturer/Model:	JPI EDM-800
Serial Number:	20903

JPI EDM-800 Device Description

The J.P. Instruments (JPI) EDM-800 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 (MAP), outside air temperature, turbine inlet temperature (TIT), propeller revolutions per minute (RPM), compressor discharge temperature, fuel flow, carburetor temperature, and battery voltage.

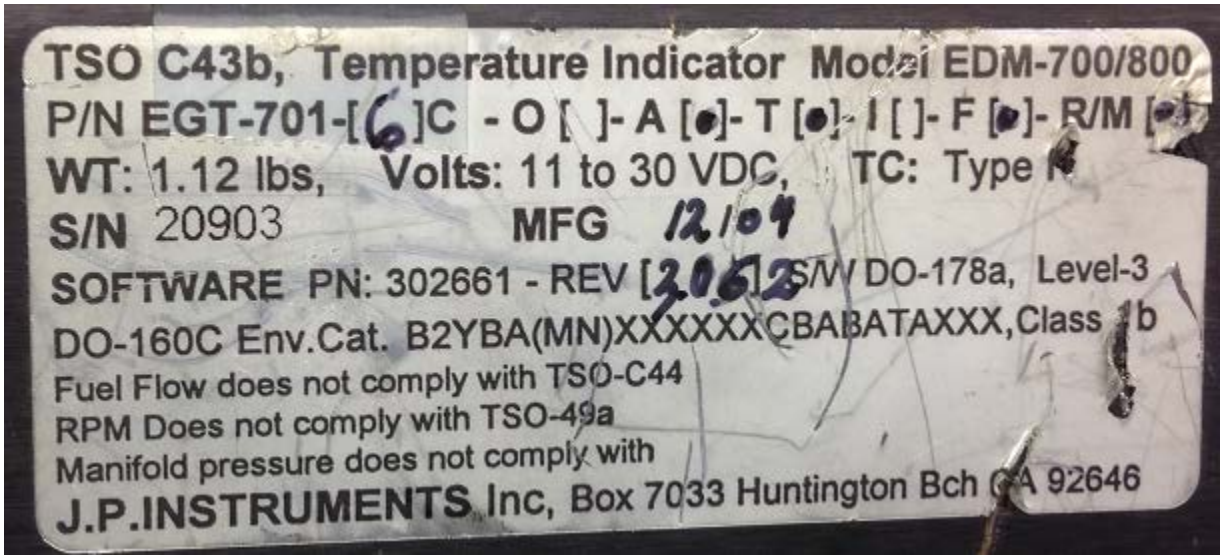
The unit can also calculate, in real-time, horsepower, fuel used, shock cooling rate and EGT differentials between the highest and lowest cylinder temperatures. The calculations are also based on the aircraft installation.

The unit contains non-volatile memory[1] 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.

Data Recovery

The unit was in good condition and the data were extracted normally. Figure 1 shows a picture of the unit data plate, indicating the firmware revision of 3.062, the number "6" inscribed next to the letter "C," and a dot next to the letters "A," "T," "F," and "R/M." There were no entries on the data plate adjacent to the letters "O" and "I." The number inscribed adjacent to "MFG" was "12/04".

Figure 1. Unit data plate.



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

Data Description

The unit contained recorded data over 13 power cycles, recorded at a sample rate of once every 6 seconds. The recorded data spanned dates of July 8, 2013 through the accident flight on July 10, 2013, as recorded by the unit internal clock. The parameters recorded were EGT, CHT, TIT, voltage, fuel flow, MAP, RPM, oil pressure, and oil temperature. Additionally, the calculated shock cooling rate and maximum difference between EGT sensors were also recorded. No other parameters were recorded by the unit.

When the unit was powered on, it displayed 71.6 gallons of fuel remaining and 2.4 gallons of fuel used. Both of these values are affected by pilot inputs usually made when the unit initially receives power. The fuel flow calibration "K-factor" was set to 88.50.

This report examined the last flight on the recording on July 10, 2013 and portions of two prior flights on July 8, 2013 and July 9, 2013.

Engineering Units Conversion

The engineering units conversions used for the data contained in this report are based on documentation from the manufacturer of the EDM-800, J.P. Instruments.

Appendix A lists the EDM-800 parameters verified and provided in this report.

Time Correlation

The EDM-800 records time with the first data sample based on the unit's internal clock. This clock is set and updated by the operator. Examination of the recorded data, and comparison with the reported accident time provided by the IIC, indicated the EDM-800 internal clock was set to Coordinated Universal Time (UTC), but was 18 minutes ahead of actual UTC. As such, 18 minutes was subtracted from all EDM-800 recorded times to correct for the error.

Correlation of the EDM-800 data to the event local time, PDT, was established by using the corrected UTC recorded time and then subtracting a 7 hour offset to change UTC to PDT. Therefore, for the rest of this report, all times are referenced as PDT, not recorded time.

Plots and Corresponding Tabular Data

Figure 2 shows a plot of the entire accident flight recording. The fuel flow, MAP, and RPM increased at about 0447:55 PDT. From 0448:48 PDT through 0449:54 PDT, the oil pressure decreased from 90 psi to 80 psi, while the MAP decreased 1 inHg and the oil temperature increased from 150 degF to 165 degF. Between the samples at 0449:54 PDT and 0450:00 PDT, the oil pressure, fuel flow, and MAP began to decrease; during this same period, the RPM fluctuated and some of the EGTs began to decrease. By 0450:54 PDT, the oil pressure had reduced to 0 psi.

Figure 3 shows accident flight CHTs and EGTs around the time these parameters began to decrease. By 0450:12 PDT, EGTs 3,4,5, and 6 had decreased by 300 degF from their values 18 seconds prior, and continued to decrease to below 375 degF by the end of the recording. EGTs 1 and 2 increased slightly at 0450:06 PDT, and then decreased by about 150 degF by the end of the recording.

Accident flight CHTs 1,4,5, and 6, shown in figure 3, began to decrease by 0450:24 PDT. After 0450:12 PDT, CHTs 2 and 3 increased by about 10 degF by the end of the recording, while CHTs 1,4,5 and 6 decreased by at least 100 degF by the end of the recording.

Figures 4 and 5 show the takeoff portions of prior flights on July 9, 2013 and July 8, 2013, respectively. These flights do not record a decrease or trend difference in CHT or EGT parameters during operational phases similar to the accident flight.

The corresponding tabular data used to create figures 2 and 3 are provided in electronic (*.csv[2]) format as Attachment 1 to this report. The tabular data used to create figure 4 are provided in electronic (*.csv) format as Attachment 2 to this report. The tabular data used to create figure 5 are provided in electronic (*.csv) format as Attachment 3 to this report.

[2] Comma Separated Value format.

Figure 2. Plot of all parameters for entire accident flight recording.

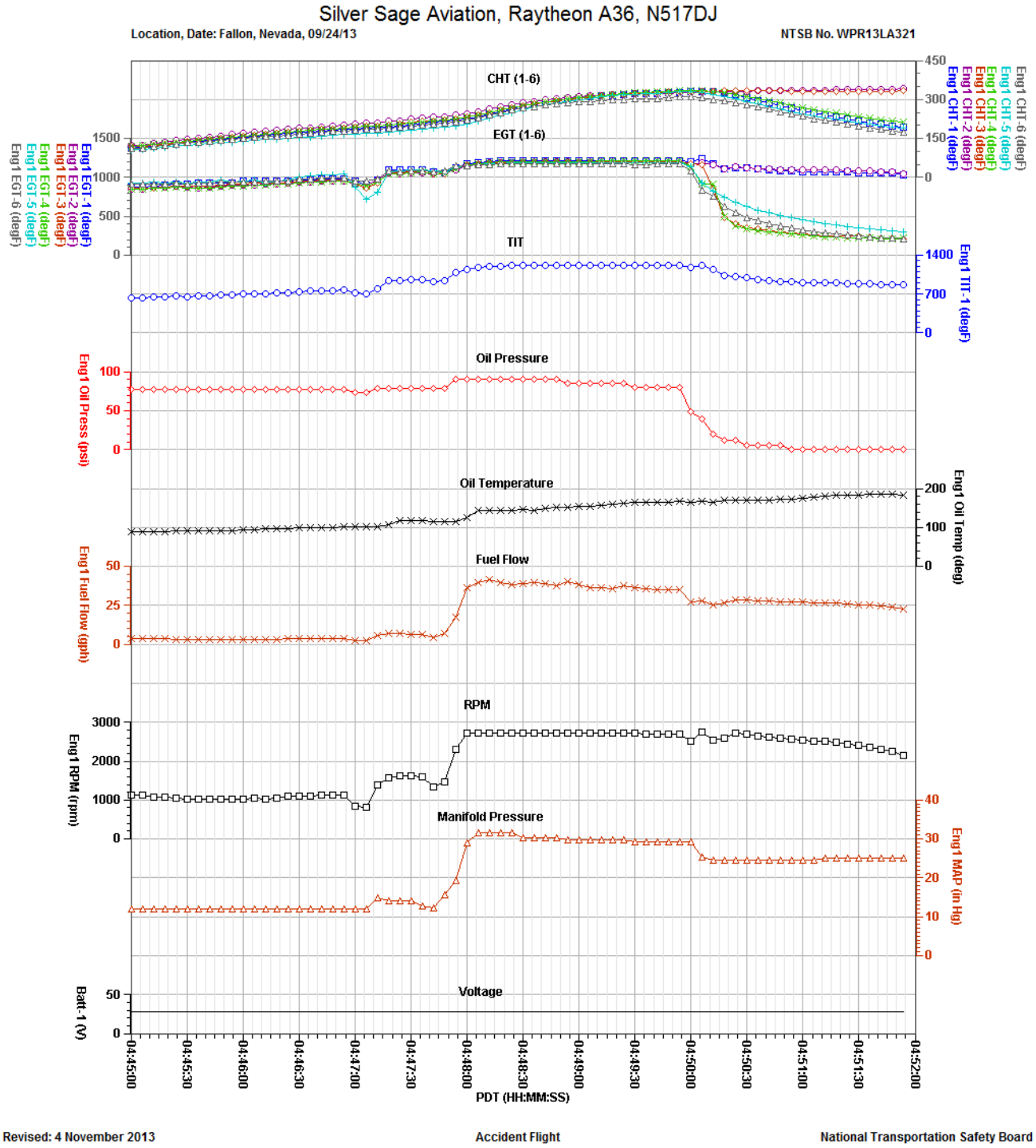
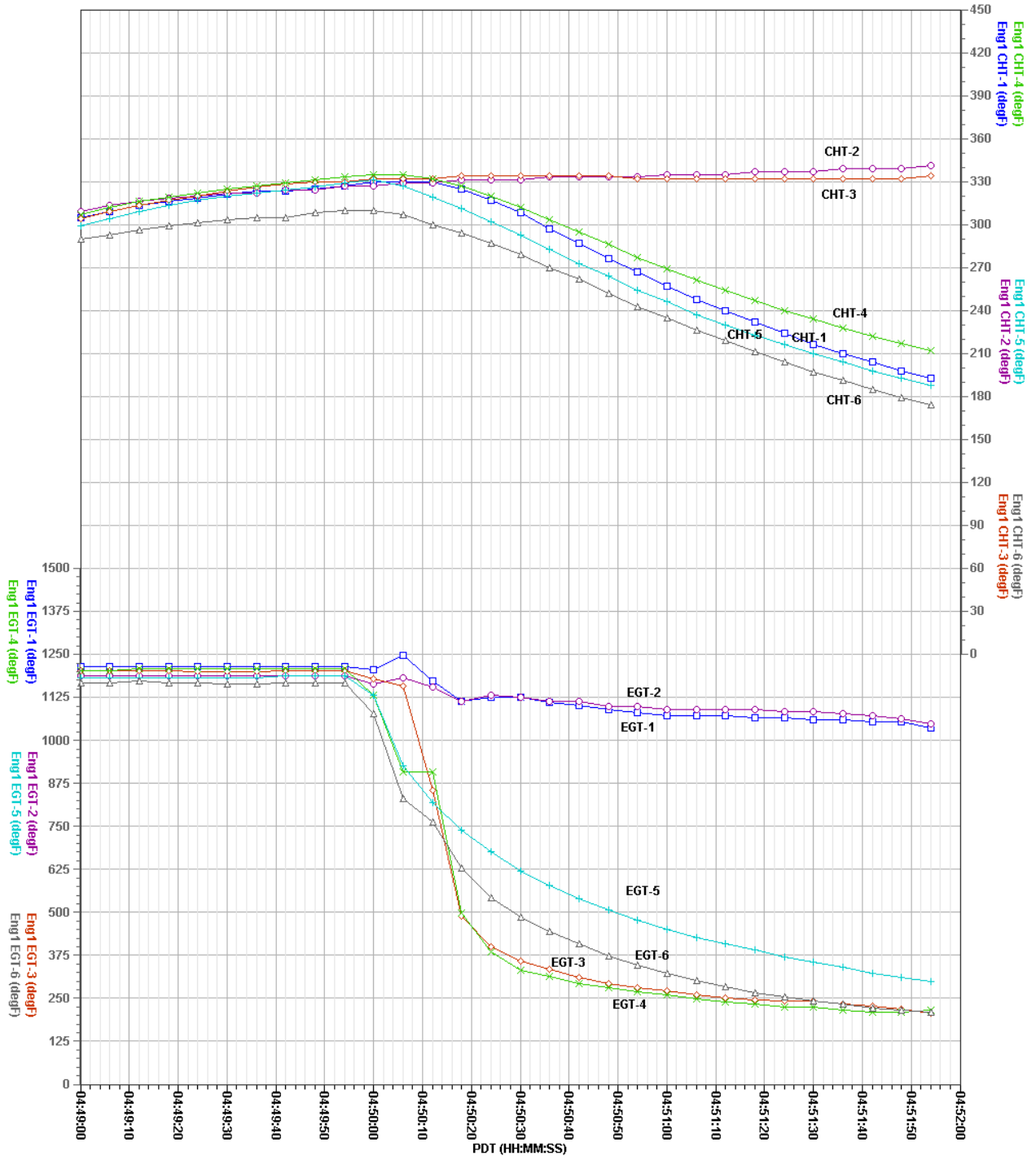


Figure 3. Plot of accident flight EGTs and CHTs near time of engine event.



Revised: 24 September 2013 End of Accident Flight - EGT & CHT Parameters National Transportation Safety Board

Figure 4. Plot of takeoff portion of July 9, 2013 flight.

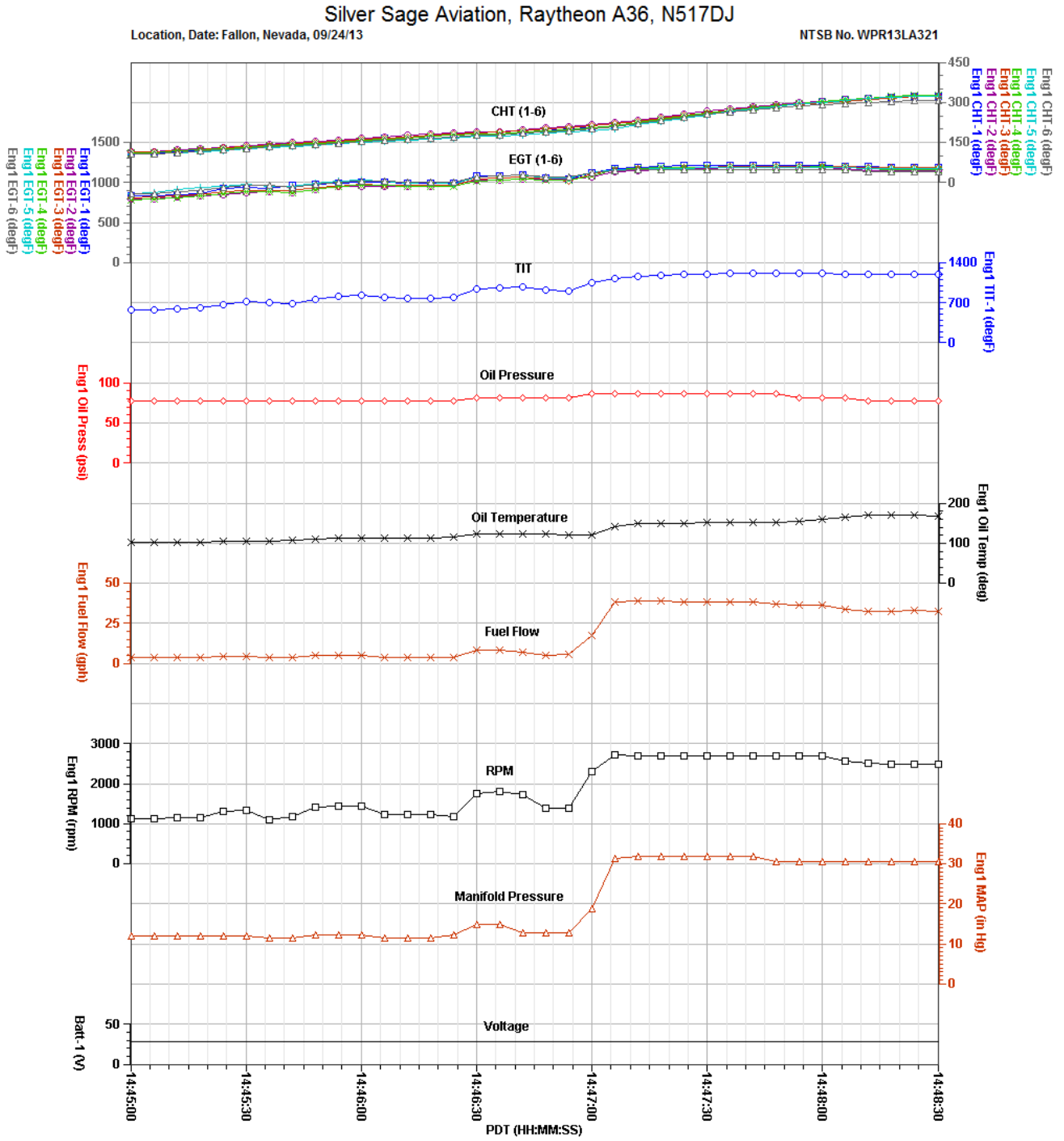
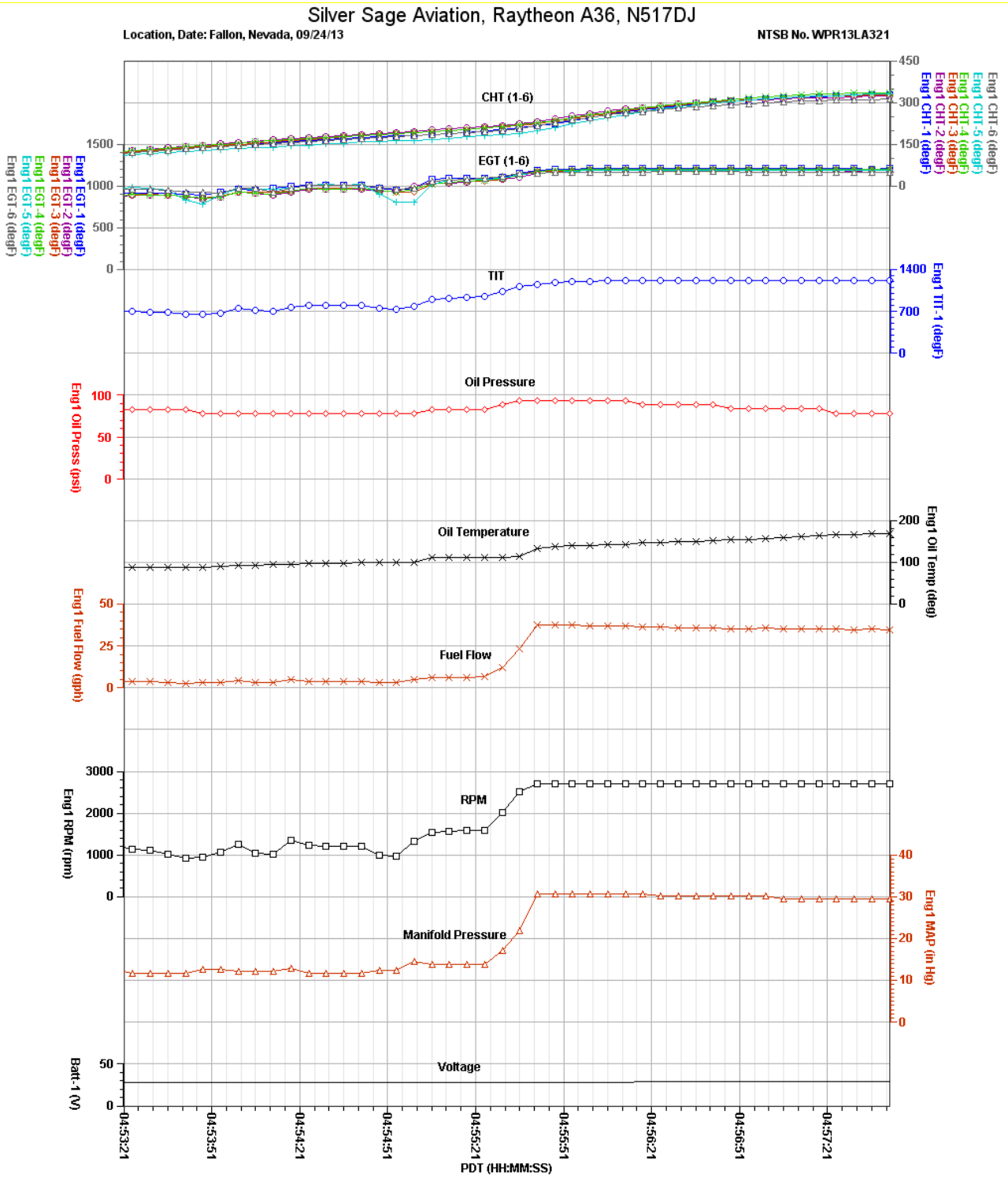


Figure 5. Plot of takeoff portion of July 8, 2013 flight.



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 JPI parameters.

Parameter Name	Parameter Description
1. Eng1 CHT-1 (degF)	Cylinder Head Temperature Cylinder 1
2. Eng1 CHT-2 (degF)	Cylinder Head Temperature Cylinder 2
3. Eng1 CHT-3 (degF)	Cylinder Head Temperature Cylinder 3
4. Eng1 CHT-4 (degF)	Cylinder Head Temperature Cylinder 4
5. Eng1 CHT-5 (degF)	Cylinder Head Temperature Cylinder 5
6. Eng1 CHT-6 (degF)	Cylinder Head Temperature Cylinder 6
7. Eng1 EGT-1 (degF)	Exhaust Gas Temperature Cylinder 1
8. Eng1 EGT-2 (degF)	Exhaust Gas Temperature Cylinder 2
9. Eng1 EGT-3 (degF)	Exhaust Gas Temperature Cylinder 3
10. Eng1 EGT-4 (degF)	Exhaust Gas Temperature Cylinder 4
11. Eng1 EGT-5 (degF)	Exhaust Gas Temperature Cylinder 5
12. Eng1 EGT-6 (degF)	Exhaust Gas Temperature Cylinder 6
13. Eng1 Fuel Flow (gph)	Fuel Flow
14. Eng1 MAP (inHg)	Engine Manifold Pressure
15. Eng1 RPM (rpm)	Propeller Revolutions per Minute
16. Oil Pressure (psi)	Oil Pressure
17. Oil Temperature (degF)	Oil Temperature
18. TIT (degF)	Turbine Inlet Temperature

Table A-2. Unit abbreviations.

Units Abbreviation	Description
degF	degrees Fahrenheit
gph	gallons per hour
inHg	inches of Mercury
psi	pounds per square inch
rpm	revolutions per minute