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

March 12, 2013

Cockpit Displays – Recorded Flight Data

Specialist's Factual Report
By Bill Tuccio

1. EVENT SUMMARY

Location: Lakeside, California
Date: December 29, 2012
Aircraft: Lancair IV-P
Registration: N5M
Operator: Private
NTSB Number: WPR13FA076

On December 29, 2012, at about 1014 Pacific standard time (PST), a McKenzie, Lancair IV-P turbine, N5M, was substantially damaged following impact with terrain near Lakeside, California. The private pilot and his two passengers were fatally injured. The pilot/owner was operating the airplane under the provisions of 14 *Code of Federal Regulations* Part 91. Instrument meteorological conditions prevailed for the personal cross-country flight, which had originated from Montgomery Field, San Diego, California, approximately 9 minutes before the accident. A flight plan had not been filed.

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF INVESTIGATION

The Safety Board's Vehicle Recorder Division received the following electronic displays and related devices:

Recorder Manufacturer/Model: **Sierra Flight Systems Integrated Display Unit**
Recorder Serial Number: **201**

Recorder Manufacturer/Model: **Sierra Flight Systems Integrated Display Unit**
Recorder Serial Number: **210**

Recorder Manufacturer/Model: **Sierra Flight Systems Engine AirData Computer**
Recorder Serial Number: **203**

Recorder Manufacturer/Model: **SmartMedia Memory Cards – Quantity of 3**
Recorder Serial Number: **Unknown**

3.1. Device Descriptions

The following sections contain descriptions of the devices received.

3.1.1. Sierra Flight Systems Integrated Display Unit

The Sierra Flight Systems Integrated Display Unit (IDU) (Sierra Flight Systems part number IUAOAI/P-SI) is an Electronic Flight Information System (EFIS). The unit has a 5" wide by 4" tall display, with four buttons on each side, and two knobs at each lower corner. The instrument integrates multiple primary flight instruments including airspeed, altitude, electronic compass, turn rate, bank angle, pitch angle, vertical speed, and an optional slip/skid ball. The unit can also function as a navigation and engine display. The unit may integrate with external components, including a GPS/Air Data/Attitude Heading Reference System (AHRS). Units are typically installed in pairs, providing primary flight display (PFD) and multifunction flight display (MFD) capabilities.

The unit is capable of recording a log of aircraft parameters at a rate of 1 sample per second to an internal PCMCIA card. The parameters recorded depend upon installation and include primary flight instrument data, GPS position data, AHRS data, and engine data. The PCMCIA card is formatted in MSDOS[1] file system format, and parameters are recorded in engineering units, as plain text, to sequential log files.

Additionally, a screen capture of the display is stored each time the pilot pushes the FPL (flight plan) key at the upper left of the display. This feature is a diagnostic tool to assist in troubleshooting avionics issues.

Sierra Flight Systems was acquired by Chelton Flight Systems, which was subsequently acquired by Cobham plc.

3.1.1.1. Device Condition

Two Sierra Flight Systems IDUs were recovered from the accident aircraft. The units sustained minor impact damage, as shown in figure 1. An internal inspection revealed memory components of the both units were similarly dislodged, as shown in figure 2. The internal PCMCIA cards, as shown in figure 3, were removed from each unit and the contents downloaded without difficulty.

[1] MSDOS means Microsoft Disk Operating System.

Figure 1. Damaged exterior of Sierra Flight Systems IDU.

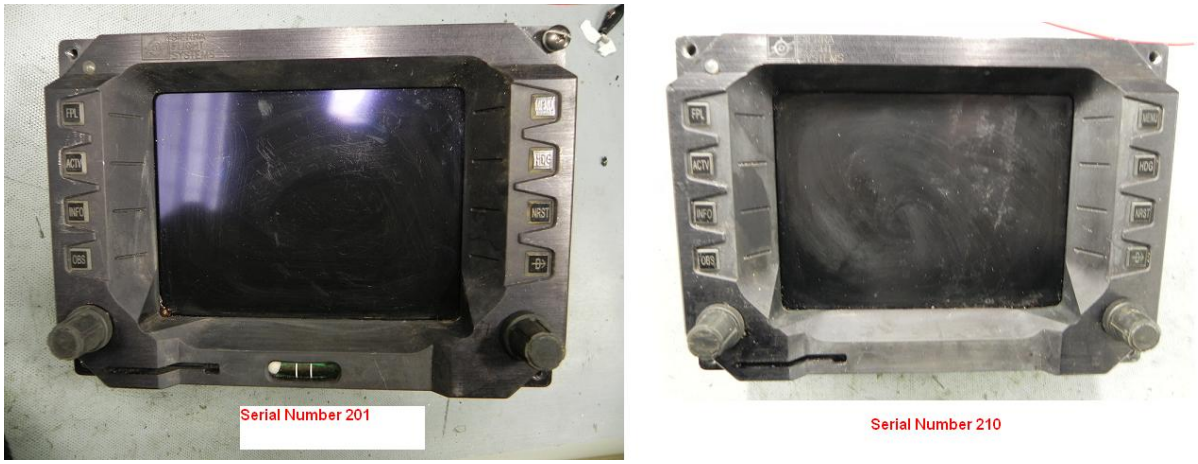


Figure 2. Dislodged internal component (from Sierra Flight Systems IDU Serial Number 201).

Figure 3. Internal PCMCIA card from Sierra Flight Systems IDU Serial Number 201.

3.1.1.2. Recording Description

The file “LOG00.DAT,” the current log file, was retrieved from the download of each Sierra Flight Systems IDU unit. There were about 24 additional log files of prior flights, only one of which was examined for this investigation. None of the screen capture files were pertinent to the investigation. The LOG00.DAT file from the unit with serial number 201 contained recorded data on December 29, 2012 between 18:04:42 UTC and 18:15:29

UTC. The file recorded primary flight instrument data, GPS position data, AHRS data, and engine data.

The “LOG00.DAT” file from the unit with serial number 210 contained data similar to the serial number 201 unit. The vertical acceleration parameter of the serial number 210 unit fluctuated between discrete values of 0 and 1, and as such was considered unreliable. The serial number 201 unit recorded all parameters.

The data in this report is from the serial number 201 unit. The data contains the accident flight recording and a prior flight recording on December 27, 2012.

3.1.1.3. Engineering Units Conversions

The logged data is recorded by the Sierra Flight Systems IDU in engineering units.

Where applicable, changes to the conversions have been made to ensure the parameters conform to the Safety Board’s standard sign convention that climbing right turns are positive (CRT=+).[2]

APPENDIX A lists the Sierra Flight Systems IDU parameters verified and provided in this report from the Sierra Flight Systems IDU serial number 201.

3.1.2. Additional Items: Sierra Flight Systems Engine AirData Computer and SmartMedia Memory Cards

The Sierra Flight Systems Engine AirData Computer (figure 4) and the three SmartMedia memory cards (figure 5) were not analyzed for this report. The Sierra Flight Systems Engine AirData Computer did not record any data; instead it supplied its data to the Sierra Flight Systems IDUs.

The SmartMedia cards are normally used to transfer database information to or from the various Sierra Flight Systems units. Rather than using the SmartMedia cards for data download, the internal PCMCIA cards from the Sierra Flight Systems IDUs were directly downloaded to retrieve the recorded information as described in section 3.1.1.1.

[2] CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Left Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +.

Figure 4. Sierra Flight Systems Engine AirData Computer.

Figure 5. Smartmedia memory cards.

3.2. Time Correlation

The Sierra Flight Systems IDU has an internal clock that is automatically set to GPS time when a valid GPS time signal is first received. After the internal clock is set to GPS time, the internal clock then increments time until power is removed from the IDU.

The time in this report uses the time as recorded by the Sierra Flight Systems IDU serial number 201 unit. In order to convert from UTC to PST, 8 hours was subtracted to convert from UTC to PST. Therefore, for the rest of this report, all times are referenced as PST.

3.3. Overlays, Plots and Corresponding Tabular Data

The following six figures contain data recorded during the December 29, 2012 event and a prior flight on December 27, 2012. All times are PST and all altitudes are pressure altitude. Figures 6 and 7 are Google Earth overlays of the accident flight, figures 8 through 10 are plots of the accident flight, and figures 11 and 12 are plots of a prior flight on December 27, 2012 flight.

Figure 6 is a Google Earth overlay of the accident flight, with select points annotated. The recording began at 1004:42 PST, and the aircraft departed about 1009:28 PST. The aircraft climbed northwesterly, and at about 3,100 feet pressure altitude, began a turn

towards the northeast. The aircraft initially climbed to a maximum recorded pressure altitude of 5,238 feet and then descended to 3,868 feet pressure altitude by 1013:35 PST. The aircraft then climbed to a maximum recorded pressure altitude of 6,858 feet.

Figure 7 is a Google Earth overlay of the end of the accident flight recording, with select points annotated. After reaching a maximum pressure altitude of 6,858 feet at 1014:51 PST, the aircraft descended to a last recorded pressure altitude of 1,428 feet at 1015:29 PST.

Figure 8 is a plot of the entire accident flight recording. After take-off, engine N1 was about 95% and remained so until about 1012:24 PST, when the aircraft began to descend out of about 5,000 feet pressure altitude. After 1009:33 PST, prior to 1014:41 PST when the aircraft began a rapid descent, the vertical acceleration fluctuated between about +1.4 g and +0.3 g.

Figure 9 is a plot of the accident flight from 1012:00 PST until the end of the recording. By about 1012:38 PST, N1 decreased to about 79%, the aircraft was descending, and indicated airspeed was decreasing through 201 knots. At about 1013:40 PST, N1 increased to 94%, as the aircraft began to climb out of 3,968 feet pressure altitude, and the indicated airspeed decreased through 189 knots. During the time period from 1013:40 PST until 1014:41 PST, the pitch attitude increased from 5 degrees to 26 degrees, the airspeed decreased, the altitude increased, the roll angle was less than 5 degrees, and the aircraft was heading northeasterly.

Figure 10 is a plot of the accident flight from 1014:30 PST until the end of the recording. At 1014:35 PST, the pitch attitude continued to increase to a maximum recorded value of 44.5 degrees; this pitch attitude was reached when the airspeed was 76 knots. At 1014:46 PST, the aircraft began to roll left 38 degrees, then reduced to 8 degrees left, and then increased to a maximum recorded value of 93 degrees left by 1014:53 PST.

After 1014:52 PST, the aircraft began to descend, and the recorded heading cyclically rotated to the left, making nearly seven, 360 degree turns between 1014:51 PST and the end of the recording at 1015:29 PST. During the descent, the indicated airspeed reached a maximum value of about 95 knots, and the roll angle varied between about 20 degrees left and right. After the first 360 degree heading change, at 1014:57 PST, N1 began to decrease, reaching a minimum value of about 64% at 1015:05 PST.

At 1015:18 PST, as the aircraft passed through about 3,200 feet pressure altitude, N1 began to increase. By 1015:22 PST, N1 had increased to 96% and remained at about 96% until the end of the recording.

Figure 11 is a plot of the entire recording of a prior flight on December 27, 2012. The plot shows a maximum pitch angle of about 15 degrees during takeoff, and thereafter pitch angles between +/- 10 degrees. The roll angles for the entire flight were between +/- 15 degrees. After takeoff, N1 remained above 87% until the aircraft descended below about 12,500 feet pressure altitude.

Figure 12 is a plot of the last 10 minutes of a prior flight on December 27, 2012. On the prior flight, as the aircraft descended through 2,895 feet pressure altitude at 1414:18 PST, the indicated airspeed was 176 knots and N1 was about 75%. The indicated airspeed remained above 150 knots until about 1416:15 PST, when N1 reduced to about 67%. After the indicated airspeed began recording a value of 0 knots, N1 reduced to about 60% and remained at about 60% until the end of the recording.

The corresponding tabular data used to create the six figures are provided in electronic command separated value (*.csv) format in two attachments to this report. Attachment 1 contains data for the accident flight. Attachment 2 contains data for the prior flight on December 27, 2012.

Figure 6. Google Earth overlay of accident recording.

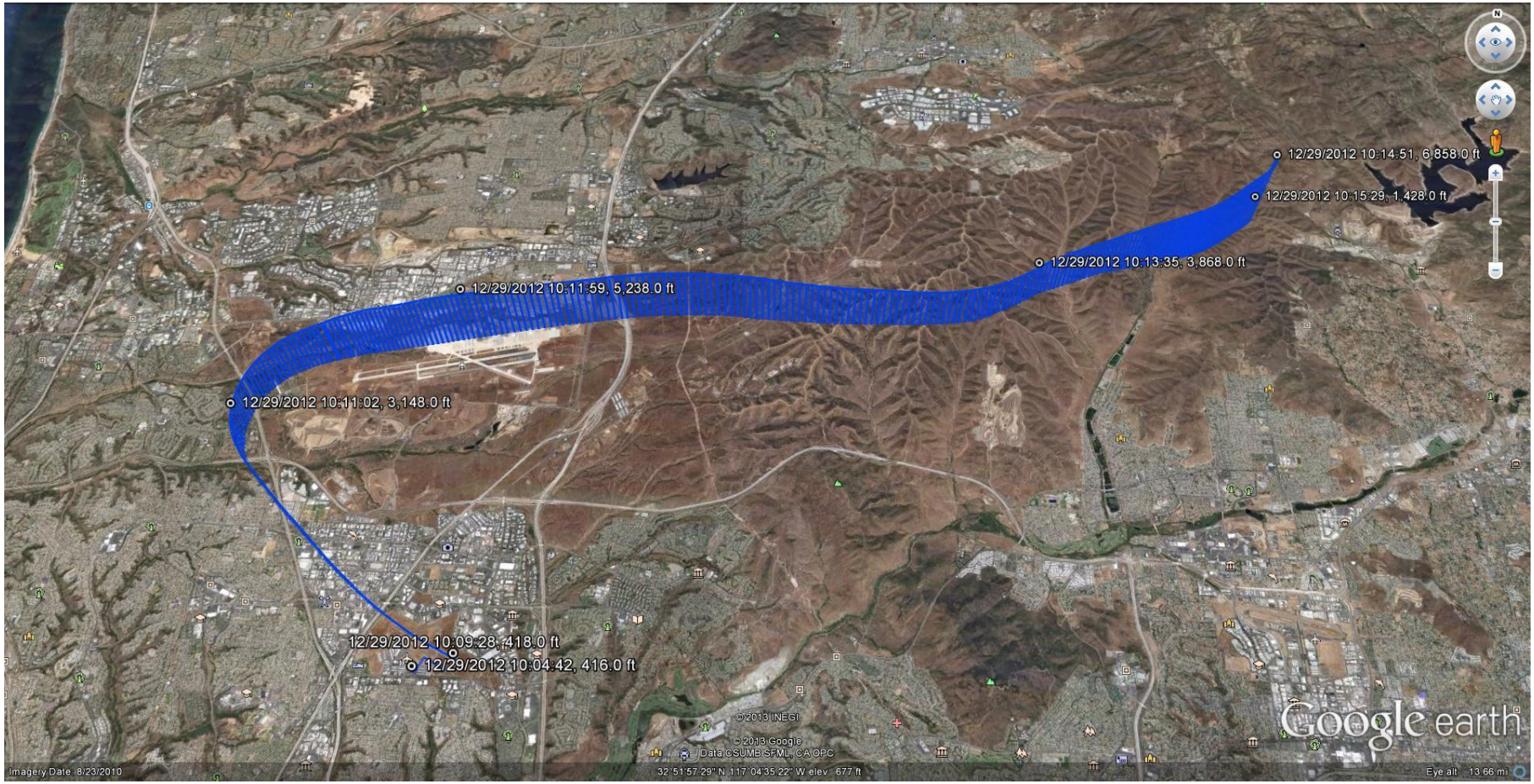


Figure 7. Google Earth overlay of end of accident recording

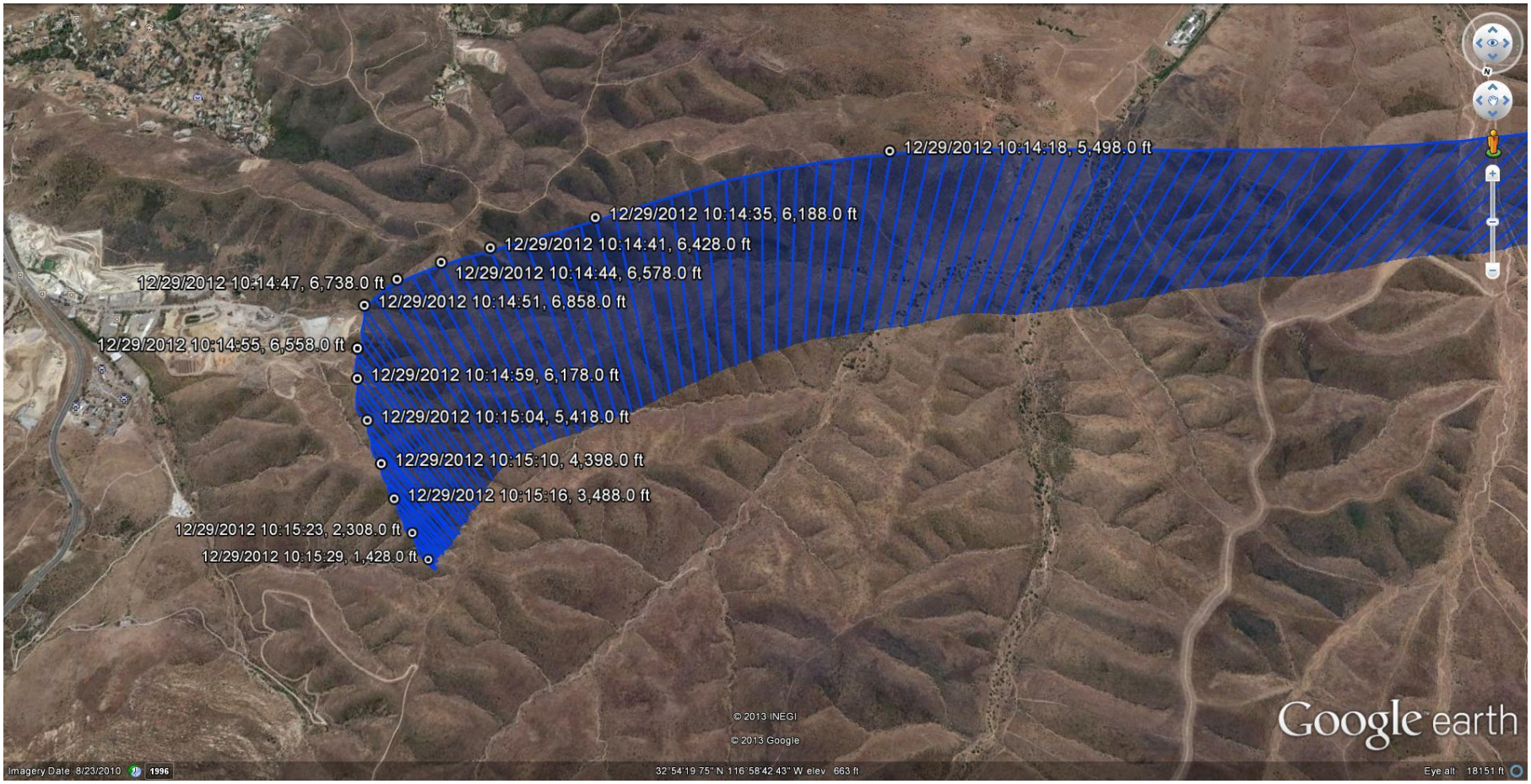


Figure 8. Plot of accident flight recording.

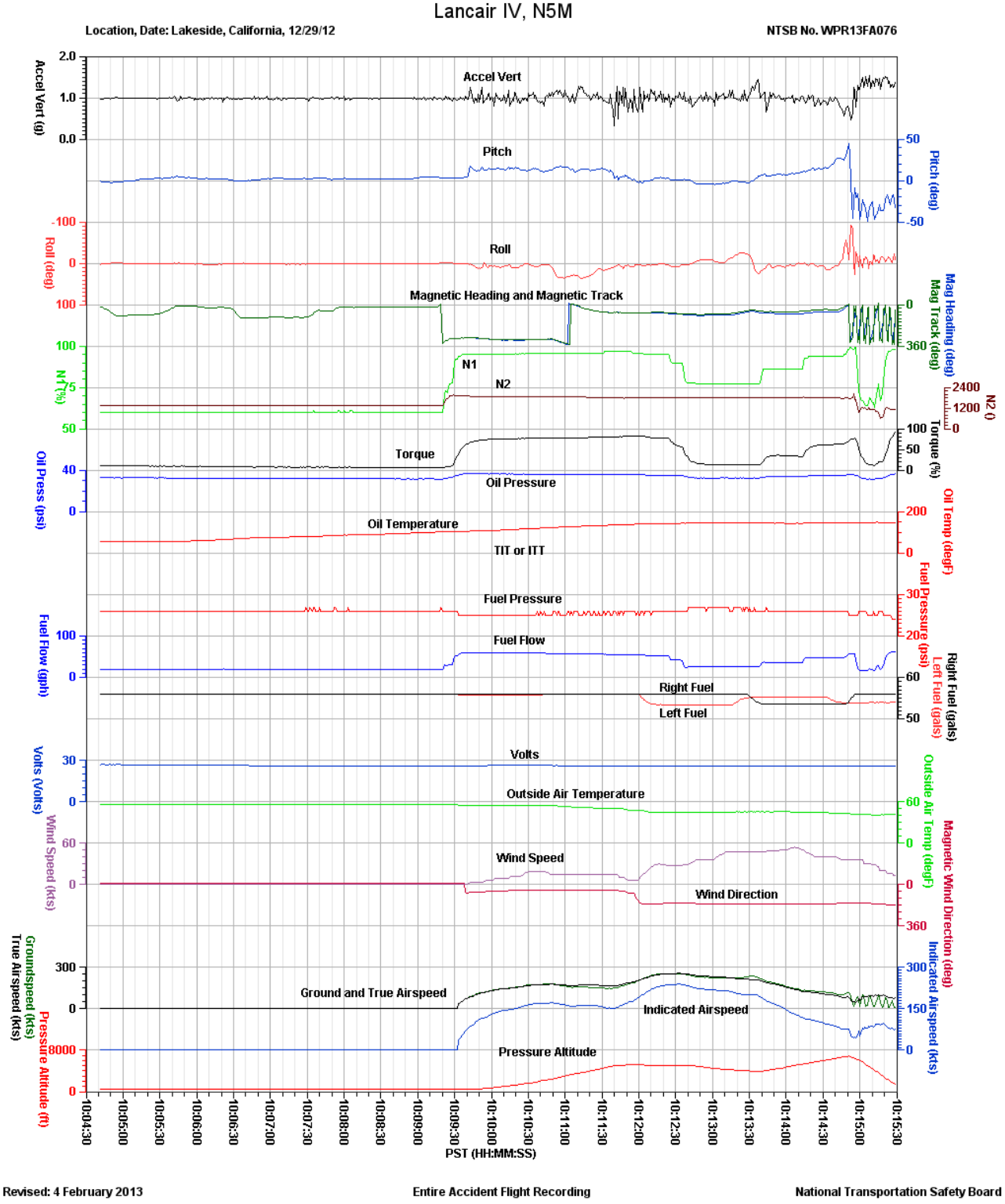


Figure 9. Plot of accident flight initial level off until end of recording.

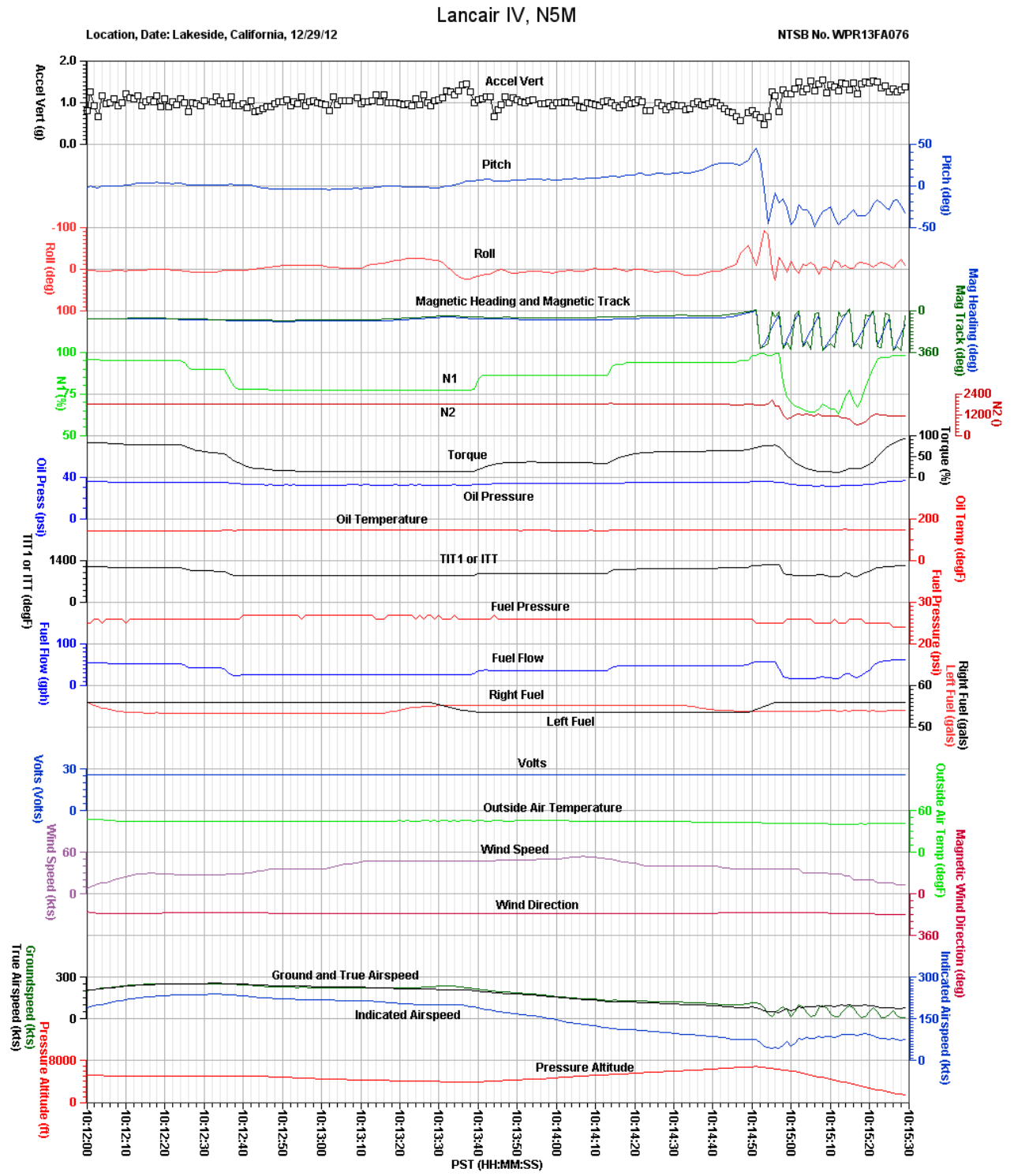


Figure 10. Plot of accident flight upset until end of recording.

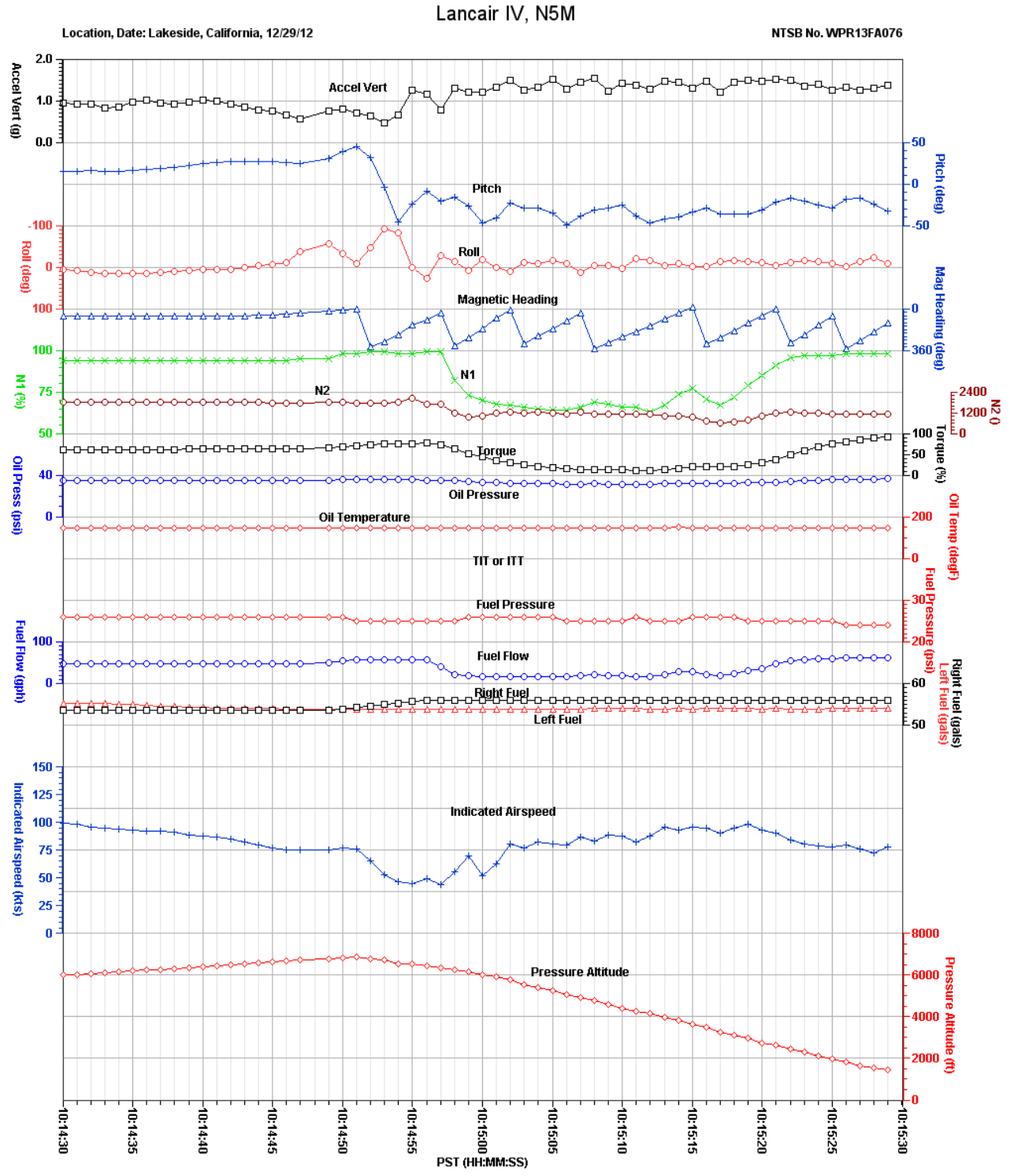


Figure 11. Plot of entire recording of prior flight.

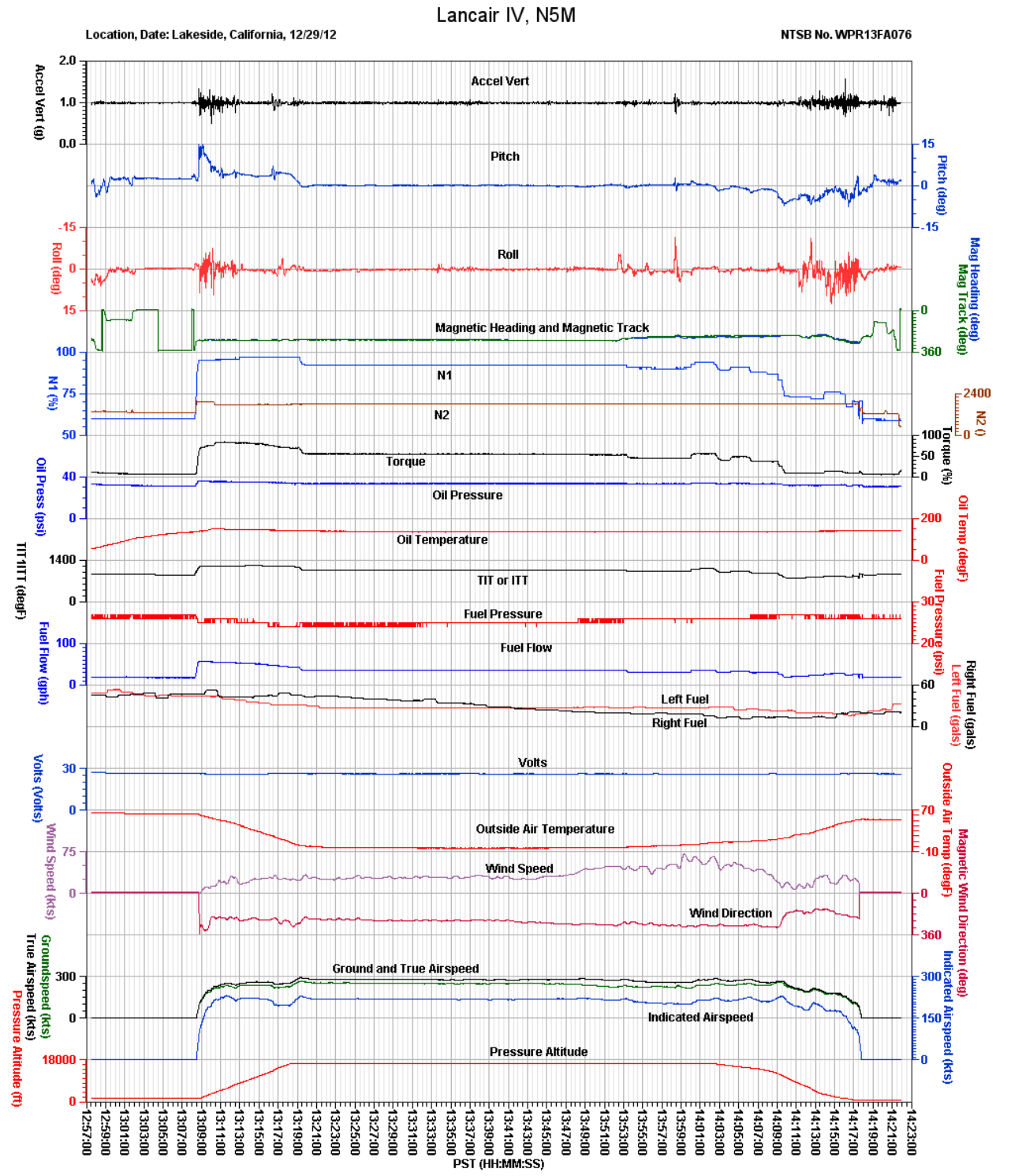
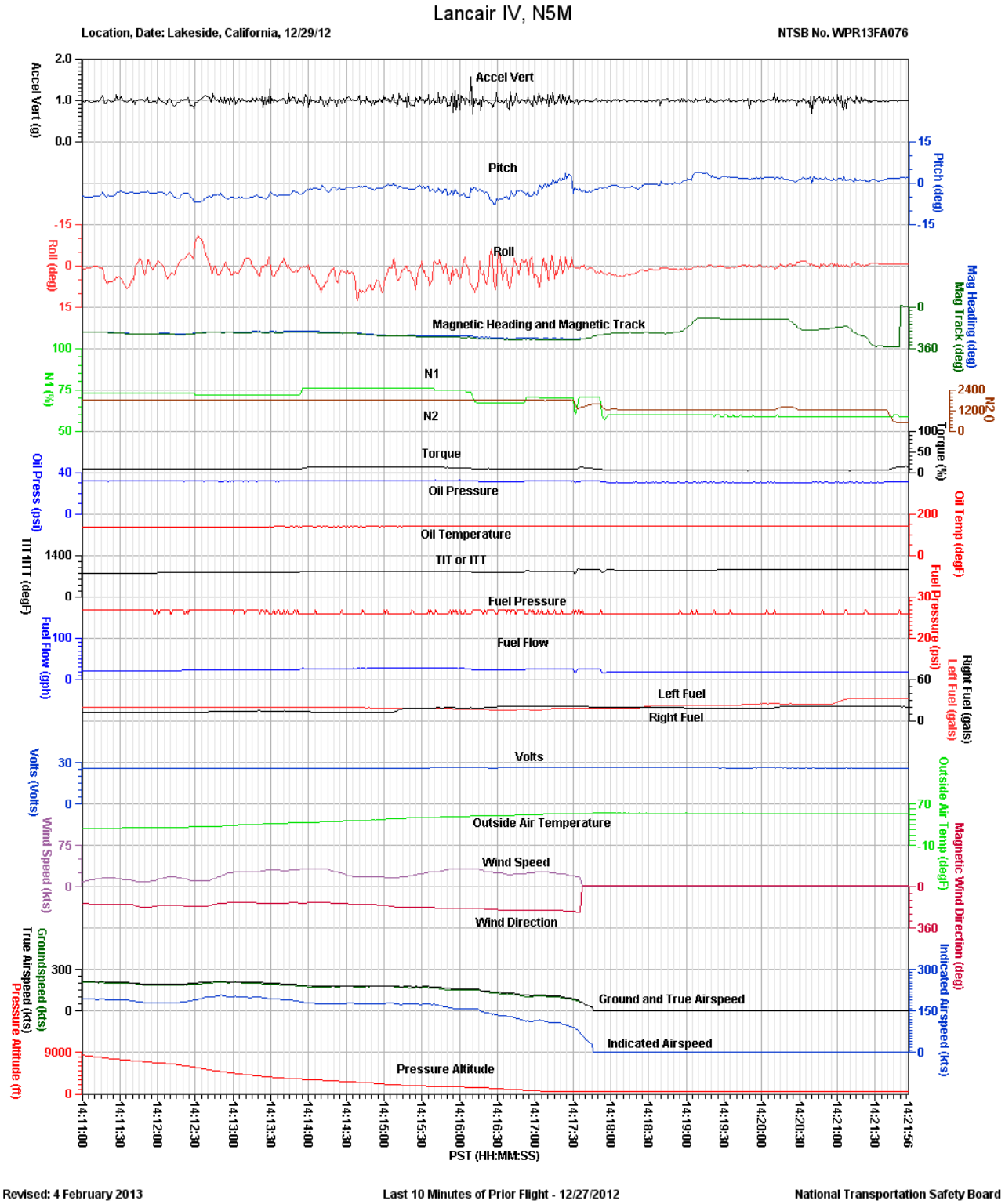


Figure 12. Plot of last 10 minutes of a prior flight recording.



APPENDIX A – Sierra Flight Systems Parameters

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
1. Accel Vert (g)	Vertical Acceleration
2. Fuel Flow (gph)	Fuel Flow
3. Fuel Pressure (psi)	Fuel Pressure
4. Groundspeed (kts)	Ground Speed
5. Indicated Airspeed (kts)	Indicated Airspeed
6. Latitude (deg)	Latitude
7. Left Fuel (gal)	Left Fuel Level
8. Longitude (deg)	Longitude
9. Mag Heading (deg)	Magnetic Heading
10. Mag Track (deg)	Magnetic Track
11. Magnetic Wind Direction (deg)	Magnetic Wind Direction
12. N1 (%)	N1
13. N2 (unknown) [3]	N2
14. Oil Press (psi)	Oil Pressure
15. Oil Temp (degF)	Oil Temperature
16. Outside Air Temp (degF)	Outside Air Temperature
17. Pitch (deg)	Pitch
18. Pressure Altitude (ft)	Pressure Altitude
19. Right Fuel (gal)	Right Fuel Level
20. Roll (deg)	Roll
21. Time UTC	Time UTC
22. TIT1ITT (degF)	Turbine Inlet Temperature or Inter Turbine Temperature[4]
23. Torque (%)	Torque
24. True Airspeed (kts)	True Airspeed
25. Volts (Volts)	Volts
26. Wind Speed (kts)	Wind Speed

Table A-2 - Unit abbreviations.

Units Abbreviation	Description
%	percent
deg	degrees
degF	degrees Fahrenheit
ft	feet
g	g

[3] Sierra Flight Systems documentation identifies the parameter as “N2” but does not provide any units; the parameter meaning and units were not determined for this report.
[4] The value recorded depends on aircraft configuration and could not be determined for this report.

Units Abbreviation	Description
gal	gallons
gph	gallons per hour
kts	knots
psi	pounds per square inch
V	Volts DC