

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

November 20, 2017

Cockpit Display – Recorded Flight Data

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

1. EVENT SUMMARY

Location: Firebaugh, California
Date: May 15, 2017
Aircraft: Evolution Aircraft, Lancair Evolution
Registration: N846PM
Operator: Private
NTSB Number: WPR17LA104

On May 15, 2017, about 1644 Pacific daylight time (PDT), an Evolution Aircraft, Lancair Evolution, N846PM, was substantially damaged during a forced landing attempt at Firebaugh Airport (F34), Firebaugh, California. The private pilot and one rear seat passenger did not sustain any injuries. A front seat passenger and two rear seat passengers received minor injuries. The airplane was owned and operated by a private individual and operated by the pilot under the provisions of Title 14 *Code of Federal Regulations* Part 91. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed for the cross-country flight that departed Livermore Municipal Airport (LVK), Livermore, California. The personal flight was destined for Marana Regional Airport (AVQ), Marana, Arizona.

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 three SD cards from a Garmin G1000 installed in N846PM. Two of the cards contained subscription aviation data and were not pertinent; the remaining card contained recorded aircraft history and is the subject of this report.

3.1. Garmin G1000 System Description

The Garmin G1000 Integrated Flight Deck is a collection of multiple avionics units which include flight displays, air data computers, attitude/heading reference system (AHRS), communications and other systems. A typical installation includes a primary flight display (PFD) and a multi-function display (MFD). Each display includes two SD card slots, an upper and a lower slot. The lower SD card slot is used by the system for software updates and various databases.¹

¹ Databases can include terrain data, obstacle data, SafeTaxi charts, flight charts and airport terrain databases

Depending on the display unit software, the aircraft can include a data logging feature. The data logging feature must be enabled by the aircraft operator. If the data logging feature is available and enabled, a SD card must be installed in the upper slot of the MFD. Depending on the airframe and engine combination as many as 64 parameters can be stored at a rate of one sample per second (1Hz). According to the manufacturer of the display unit, one flight hour can be stored in approximately 2 MB. The SD card typically used is 2 GB in size and can store over 1,000 flight hours.

3.1.1. SD Card Data Recovery

The 2GB SD card was in good condition and the data were extracted normally.

3.1.2. SD Card Data Description

The G1000 SD card stores flight data in individual flight logs. The SD card contained 34 log files. The accident flight recording was the last flight and was approximately 1 hour and 10 minutes.

3.1.3. Engineering Units Conversions

The flight log data were converted to engineering units by the display unit.

Appendix A lists provided and verified parameters as well as any abbreviations used in this report.

3.2. Time Correlation

The G1000 records time with the first data sample based on the unit's internal clock. This clock is set and updated by the unit and is based off GPS time. The internal logic of the G1000 converted GPS time to PDT; therefore, this report uses PDT time as recorded on the SD card.

3.3. Plots and Corresponding Tabular Data

The following figures contain data recorded during the event on May 15, 2017. These figures are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page. Figures 1 through 8 provide a quick reference summary of basic and engine parameters most relevant to the event.

Figures 9 through 18 provide geographical and cartographic overlays of the position information created using Google Earth, with select annotations of parametric data. Some of the overlays include annotations of flight management system waypoints shown by parameter "AtvWpt" in figure 22. Weather and lighting conditions depicted in the overlays are not necessarily representative of conditions at the time of the recording. In some cases, overlapping tracks are displayed in different colors to add clarity.

Figures 19 through 28 provide detailed basic, engine, navigation, and miscellaneous parameters for various time ranges.

Collectively these figures (most notably figures 1 through 18) show the following as it relates to the accident flight:²

- The recording began at 15:43:42 PDT.
- At 16:06:23 PDT, the airplane began its takeoff roll from LVK.
- By 16:24:28 PDT, the airplane had climbed to flight level 250.³
- At 16:31:03 PDT, basic parameters (altitude, roll, pitch) first changed from their prior steady state, coincident with changes in engine parameters (NG, NP, Torque). At this time, the airplane was about 7 nautical miles west of the F34 airport, and about 25 nautical miles west of the Madera Municipal Airport (MAE).
- By 16:31:05 PDT, Barometric Corrected Altitude (AltB) increased about 700 feet, while Pressure Altitude (AltMSL) decreased about 40 feet.
- By 16:31:20 PDT, altitude had decreased about 1,000 feet, NG was decreasing through 78%, and NP decreased to 248 RPM.
- At 16:31:38 PDT, NP decreased to 0 RPM, and volt1 and volt2 decreased by about half a Volt (from 28.1 to 27.5 Volts). NP remained at 0 for the rest of the recording.
- By 16:33:37 PDT, the airplane had descended to about 12,500 feet; between about 16:33:37 and 16:34:32 PDT, while essentially level at this altitude, the indicated airspeed (IAS) decreased from about 200 knots to 120 knots.
- At 16:34:49 PDT, NG was at 0% and the aircraft was descending through 12,100 feet. By this time, the airplane was in the vicinity of the F34 airport. For the remainder of the flight, the aircraft descended while turning near the F34 airport.
- By 16:43:54 PDT, the aircraft was passing through about 1,500 feet, flying relatively straight southeast towards F34, consistent with a final approach to runway 12. While on final approach, the groundspeed was about 5-10 knots higher than the true airspeed (TAS).
- Between 16:44:38 and 16:44:58 PDT, the indicated airspeed decreased from about 120 knots to 0.

The corresponding tabular data used to create these figures are provided in electronic (*.csv⁴) format as attachment 1 to this report.

² For a description of parameters, units, and abbreviations see tables A-1, A-2, and A-3 in the appendix.

³ Based on AltB (Barometric Corrected Altitude); AltMSL (Pressure Altitude) was about 1,000 feet higher, even though the recorded altimeter setting was 29.92 inHg which should have caused AltB to equal AltMSL.

⁴ Comma Separated Value format.

Figure 1. Basic and engine parameters - flight portion.

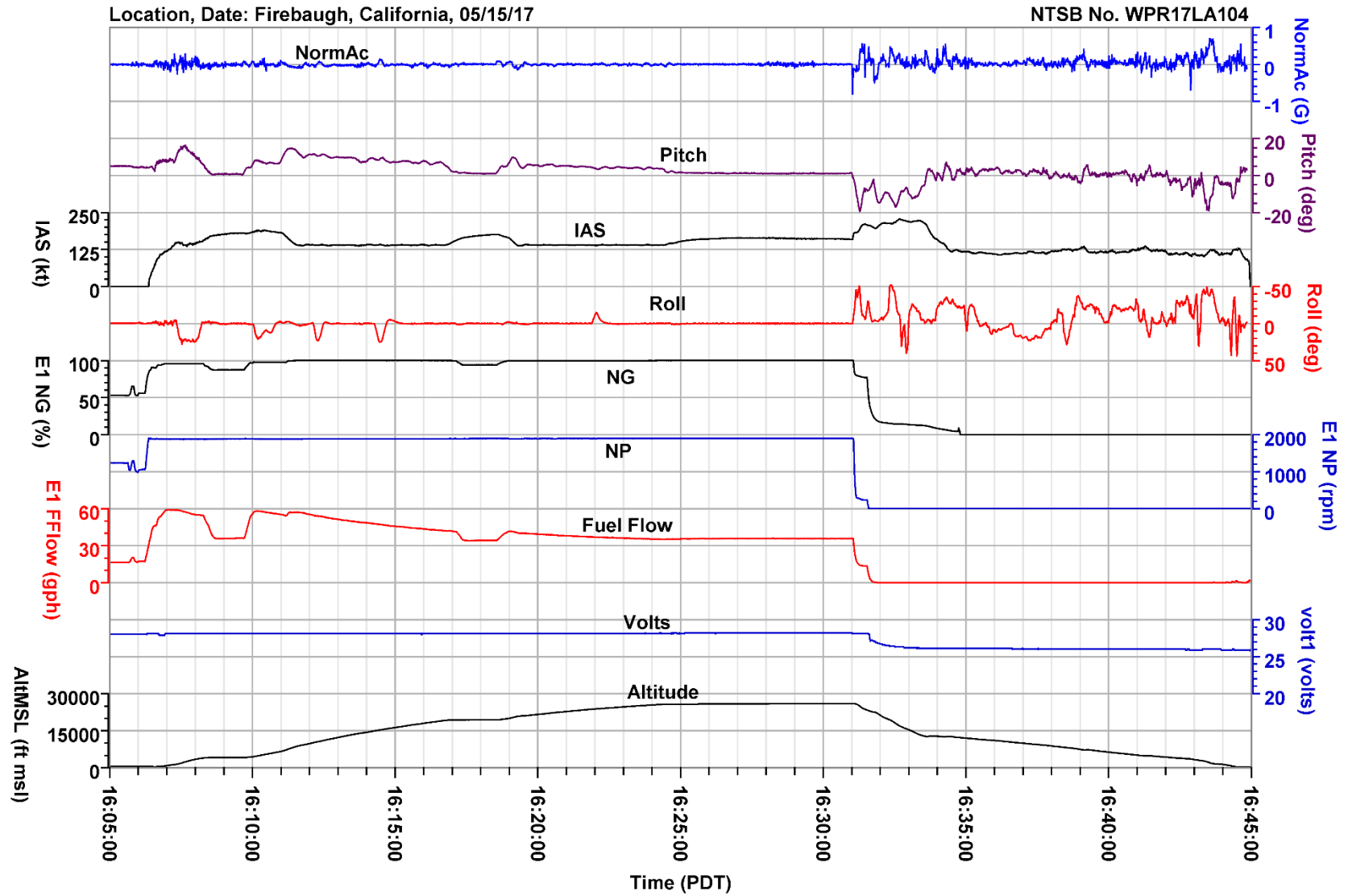


Figure 2. Basic and engine parameters - before upset.

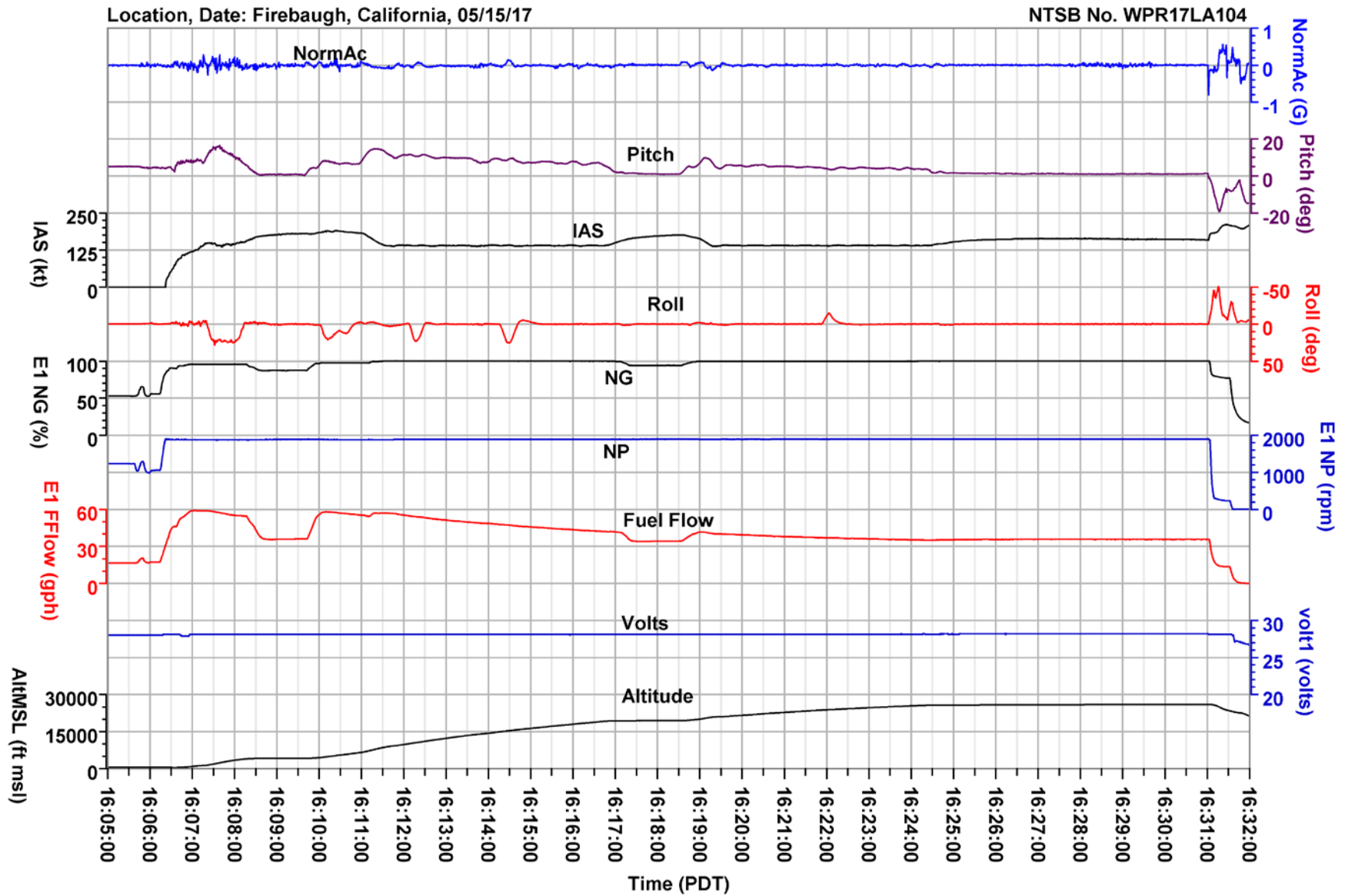


Figure 3. Basic and engine parameters - after upset.

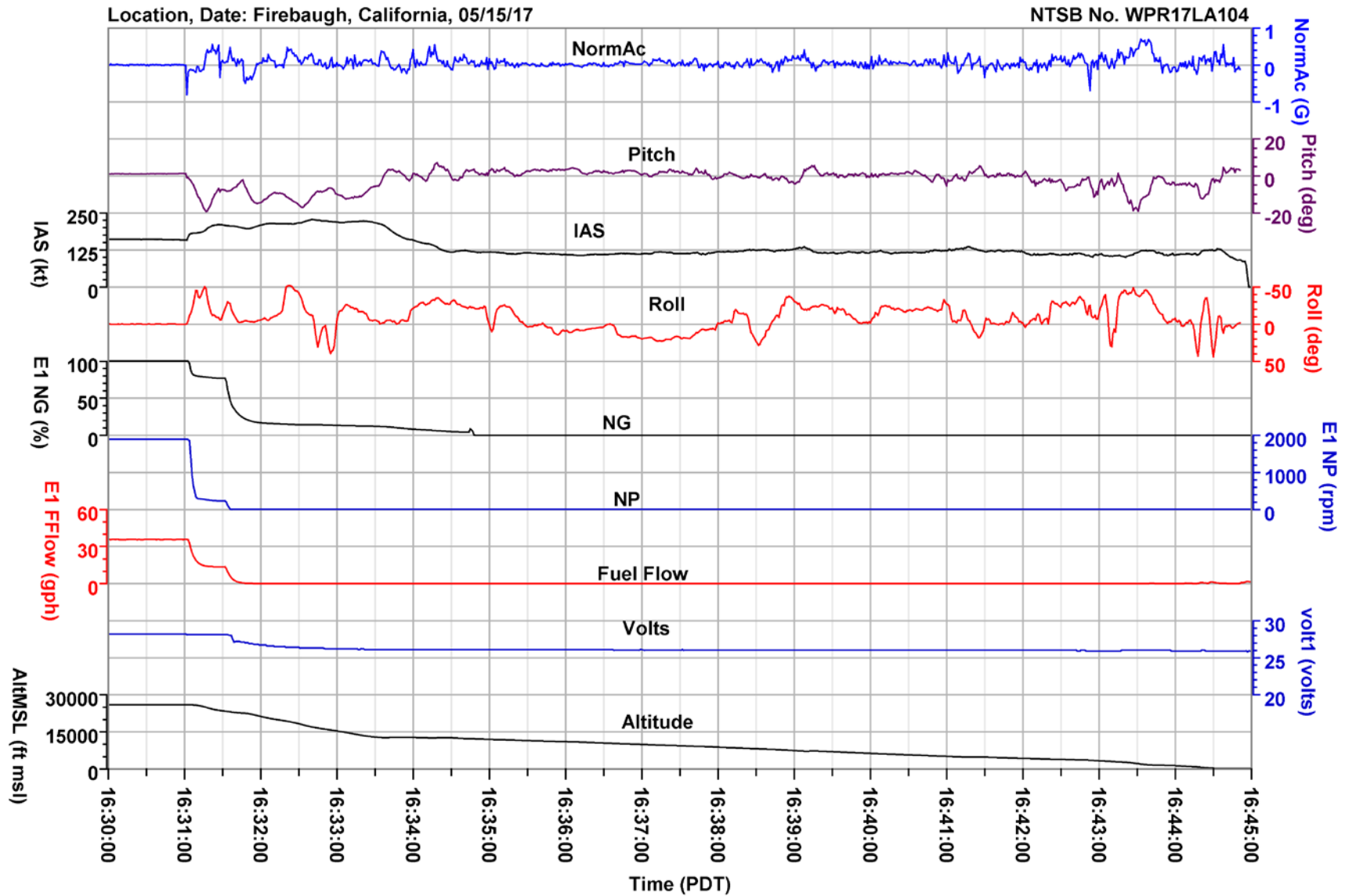


Figure 4. Basic and engine parameters - start of upset.

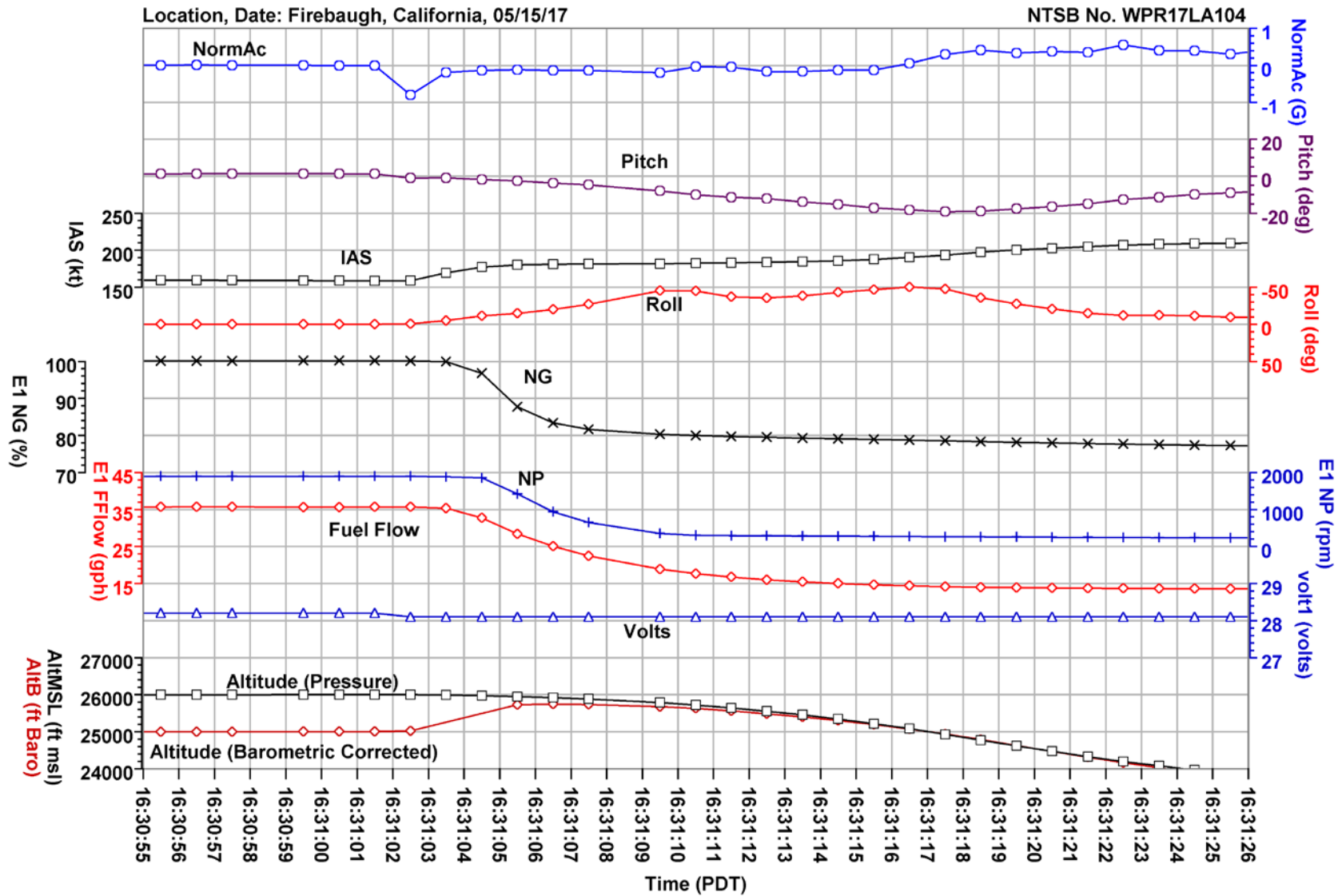


Figure 5. Basic and engine parameters - Np to 0.

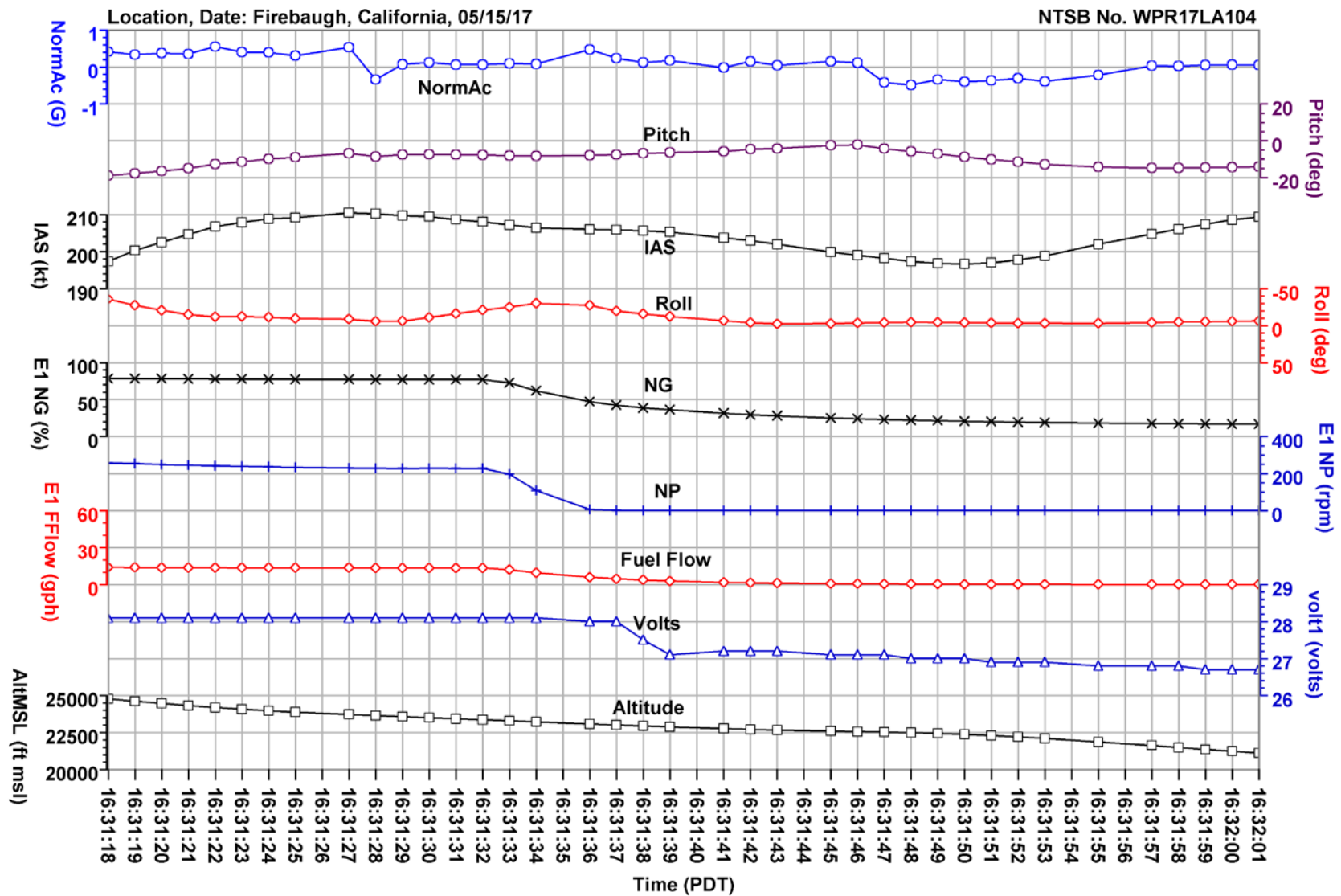


Figure 6. Basic and engine parameters - IAS decrease.

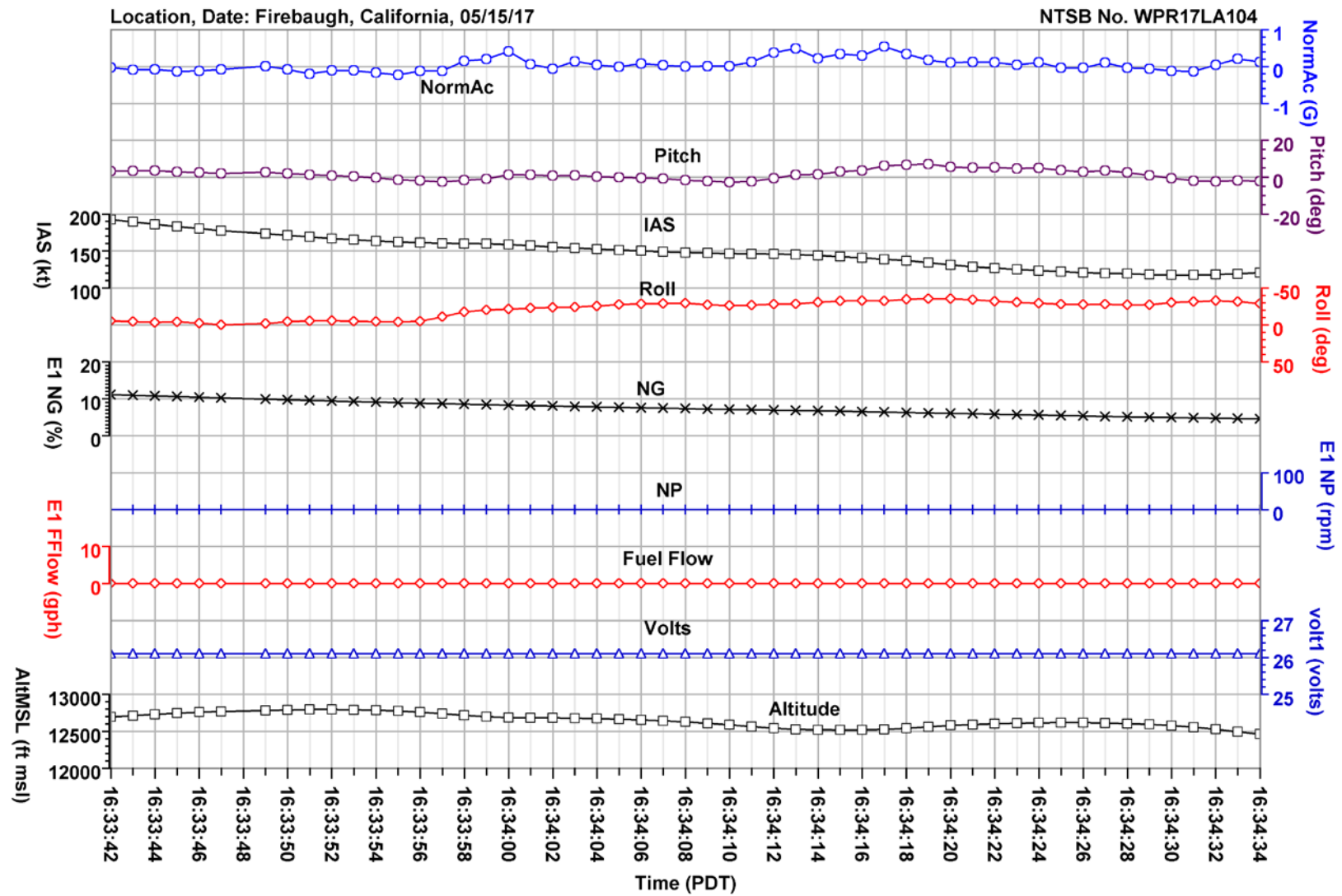


Figure 7. Basic and engine parameters - Ng to 0.

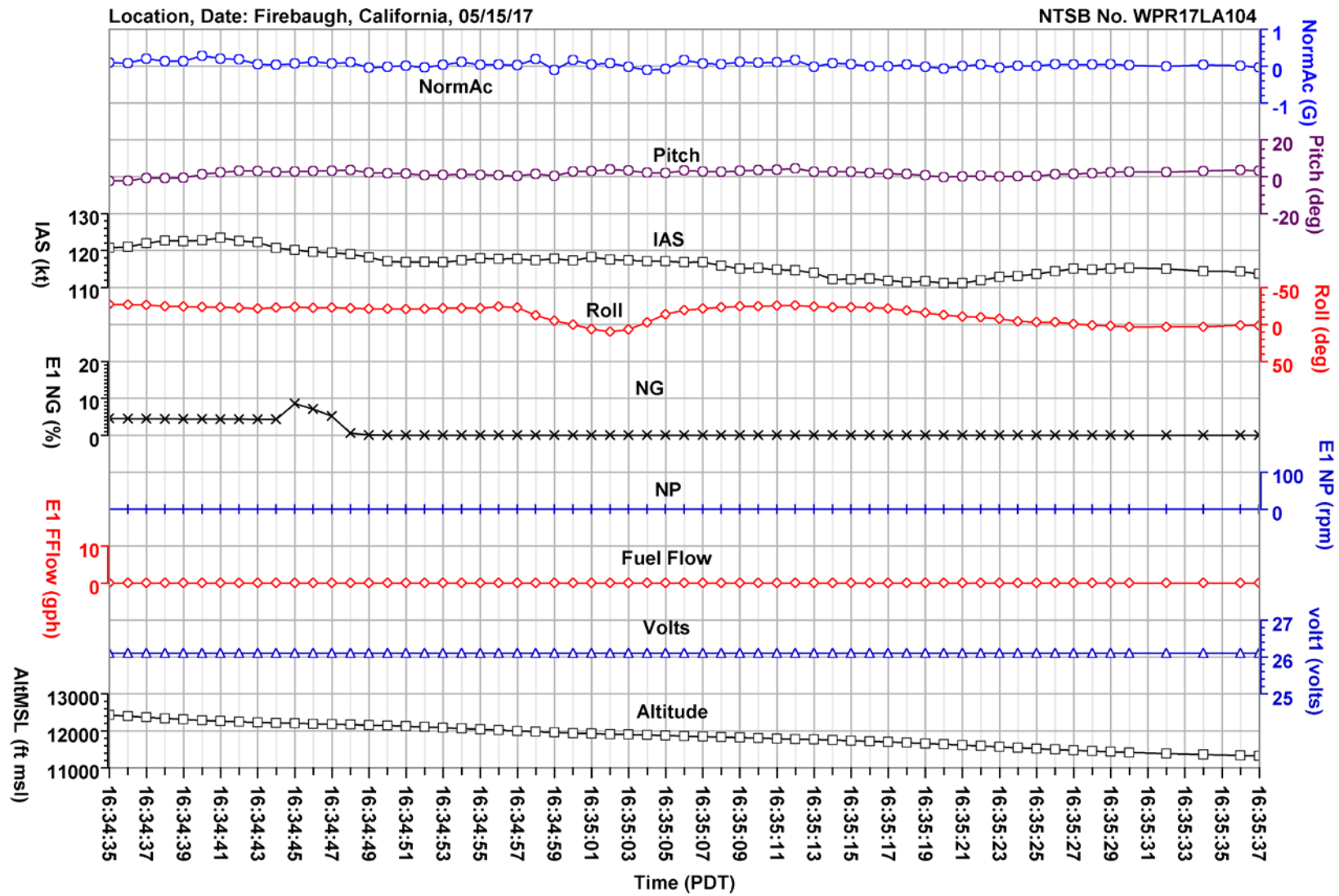


Figure 8. Basic and engine parameters - end of recording.

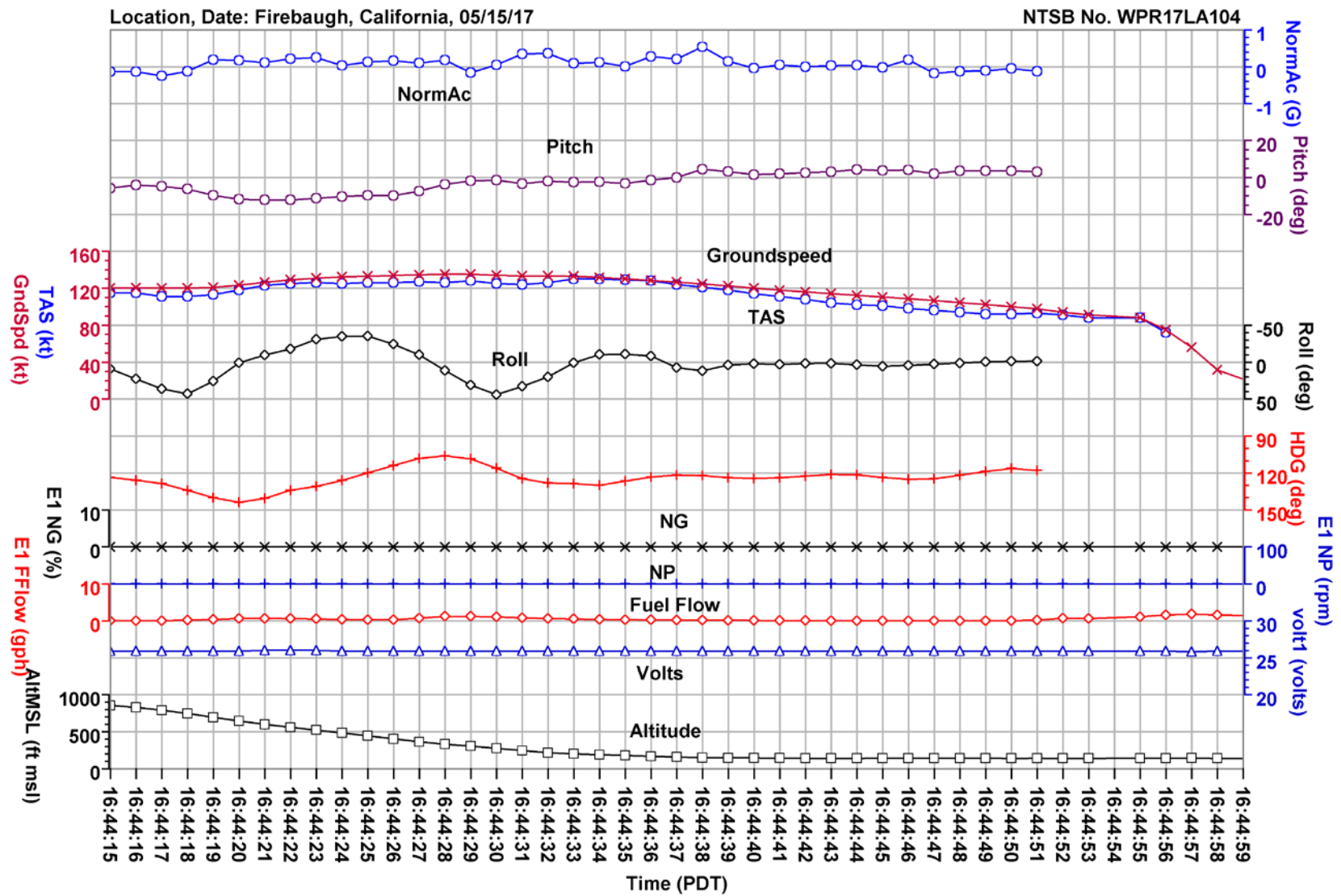


Figure 9. Overview of accident flight - IFR Low Altitude Enroute Chart overlay.

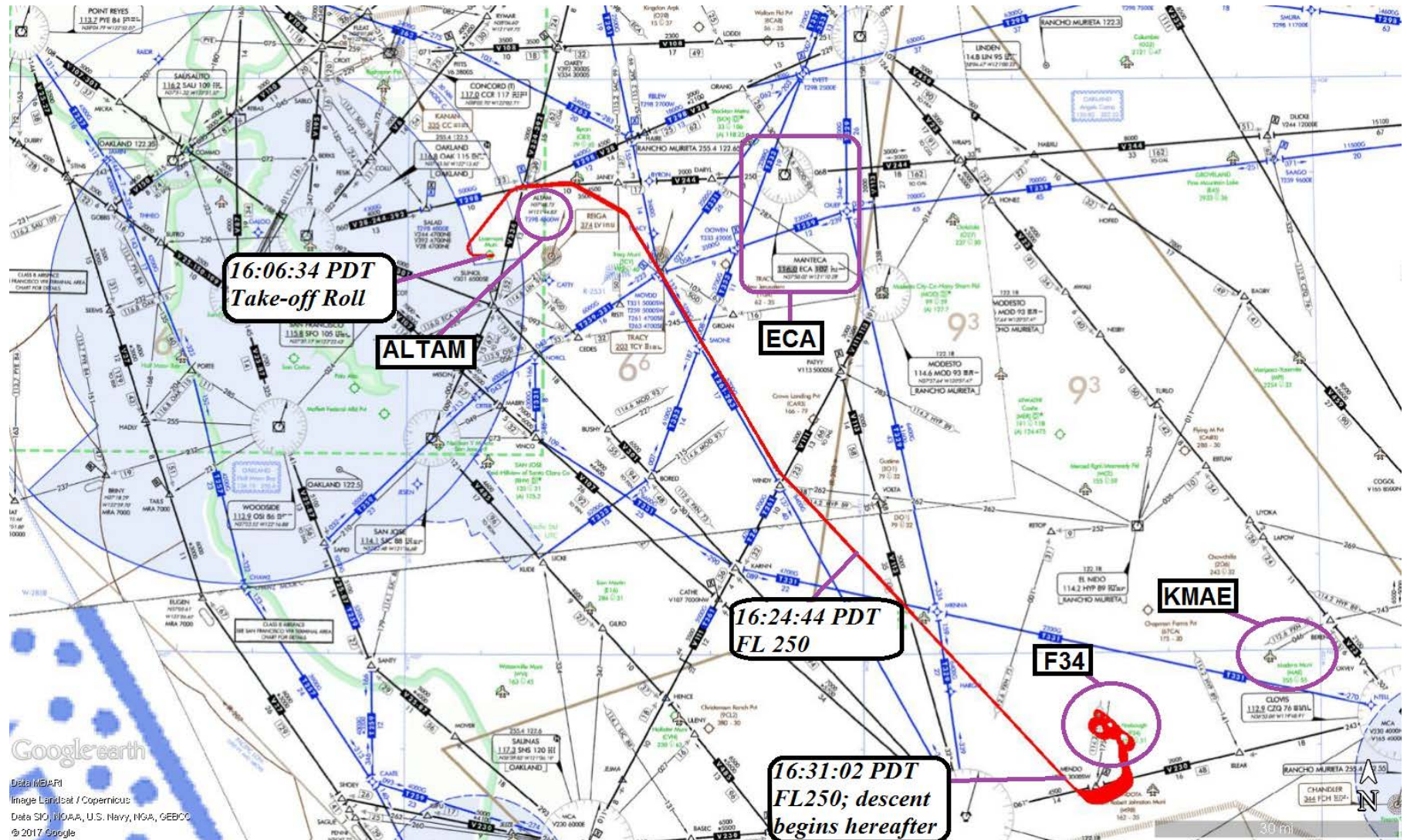


Figure 10. Overview of accident flight - satellite overlay.

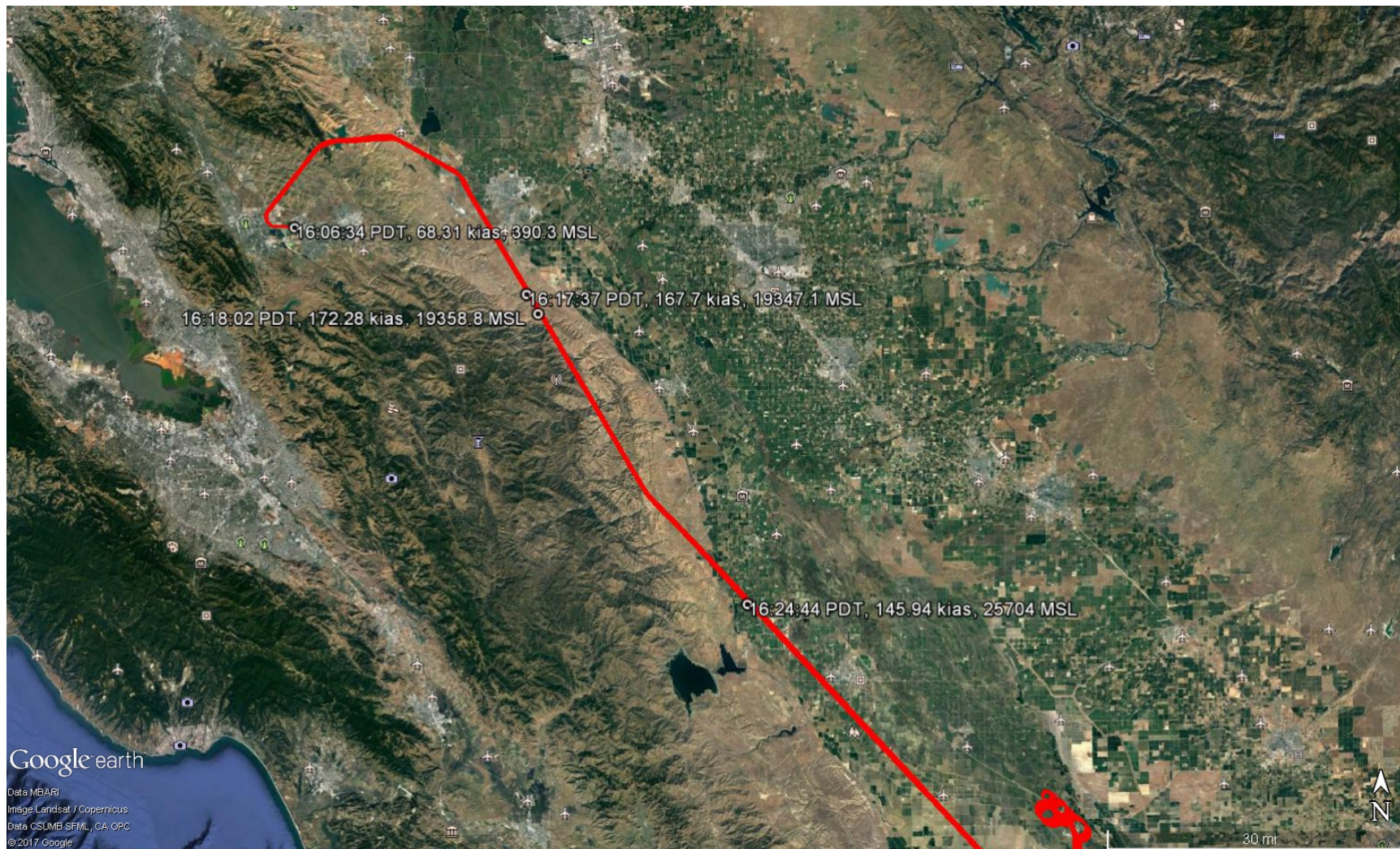


Figure 11. Start of recording - satellite overlay.

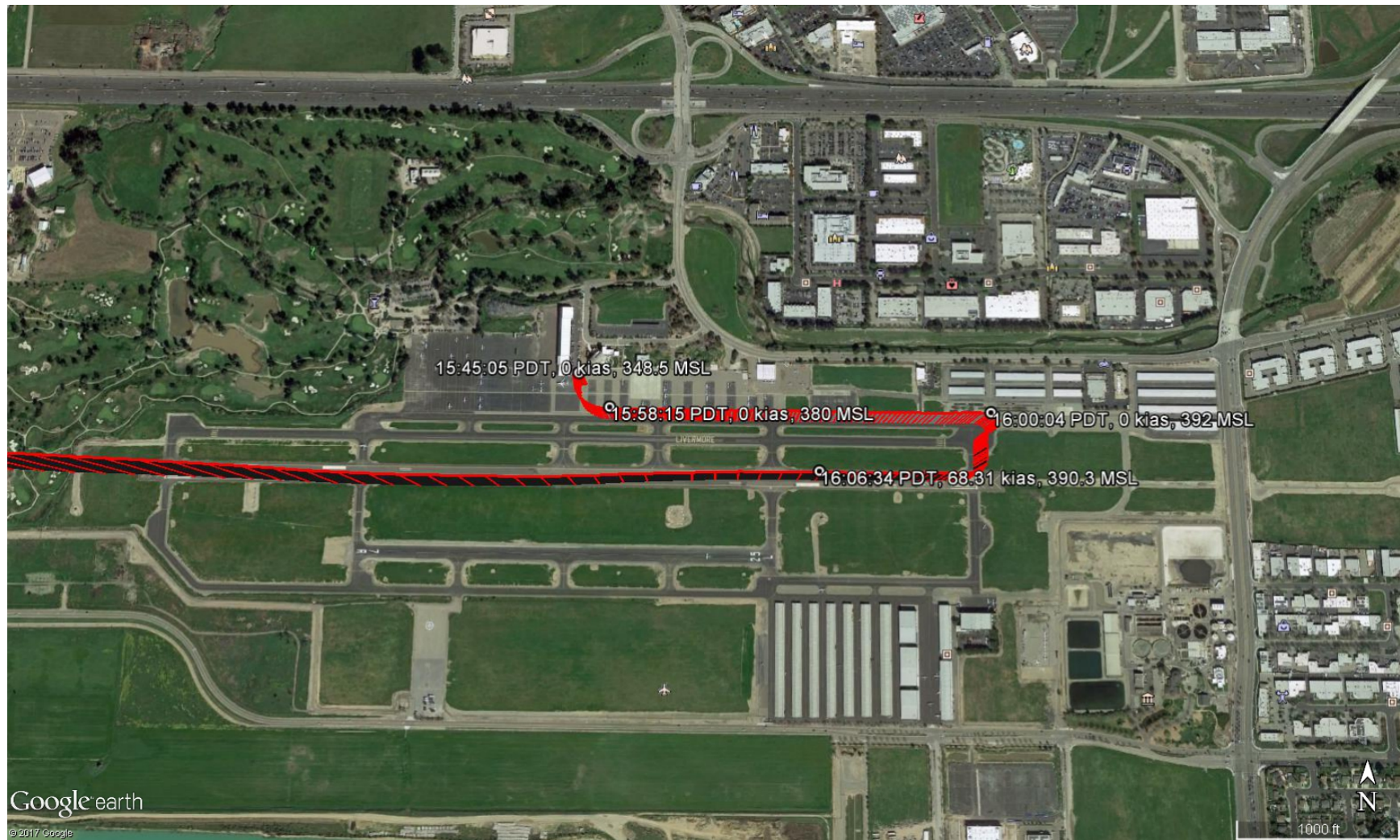


Figure 12. Initial climb - Low Altitude Enroute Chart overlay.

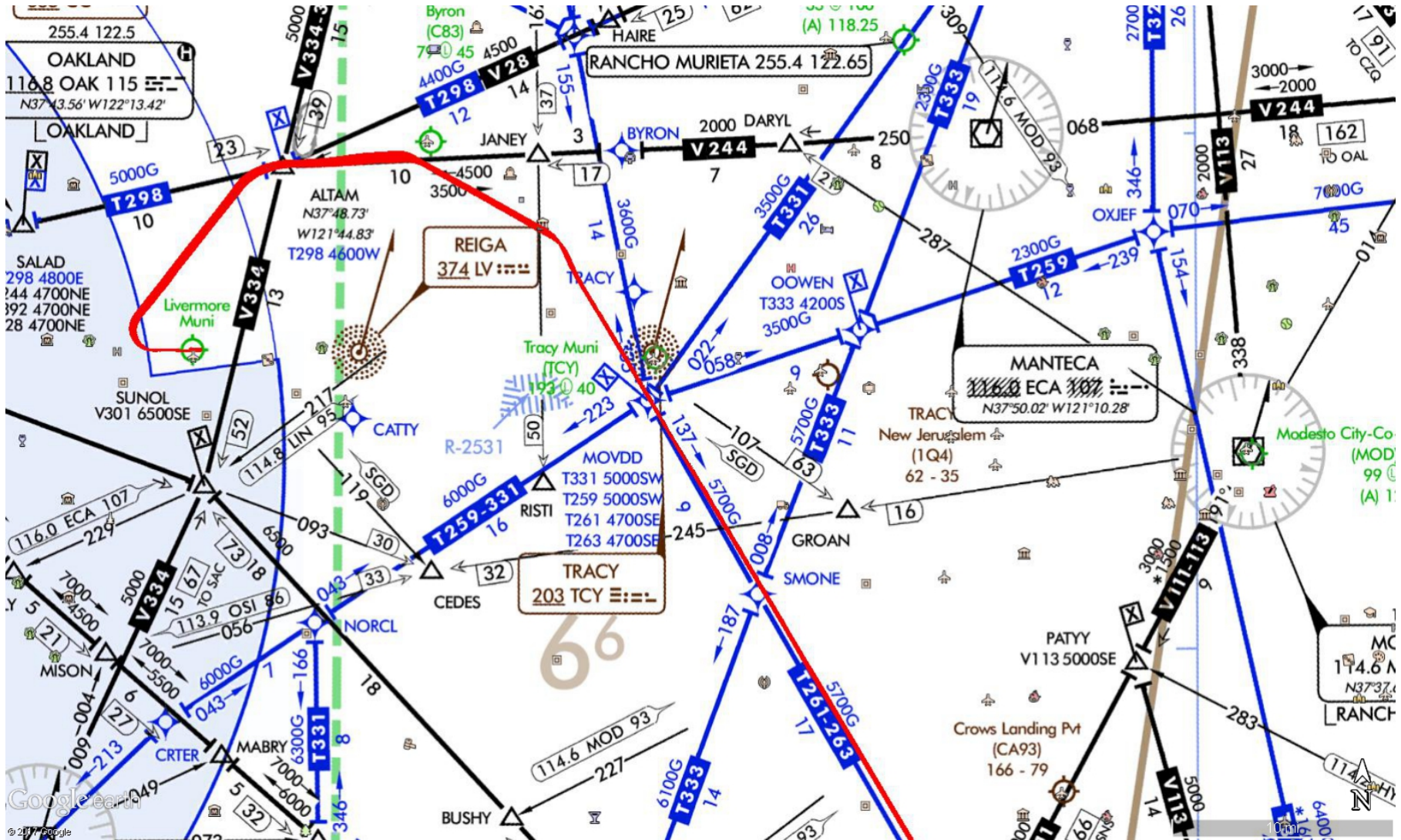


Figure 13. End of recording - High Altitude Enroute Chart overlay.

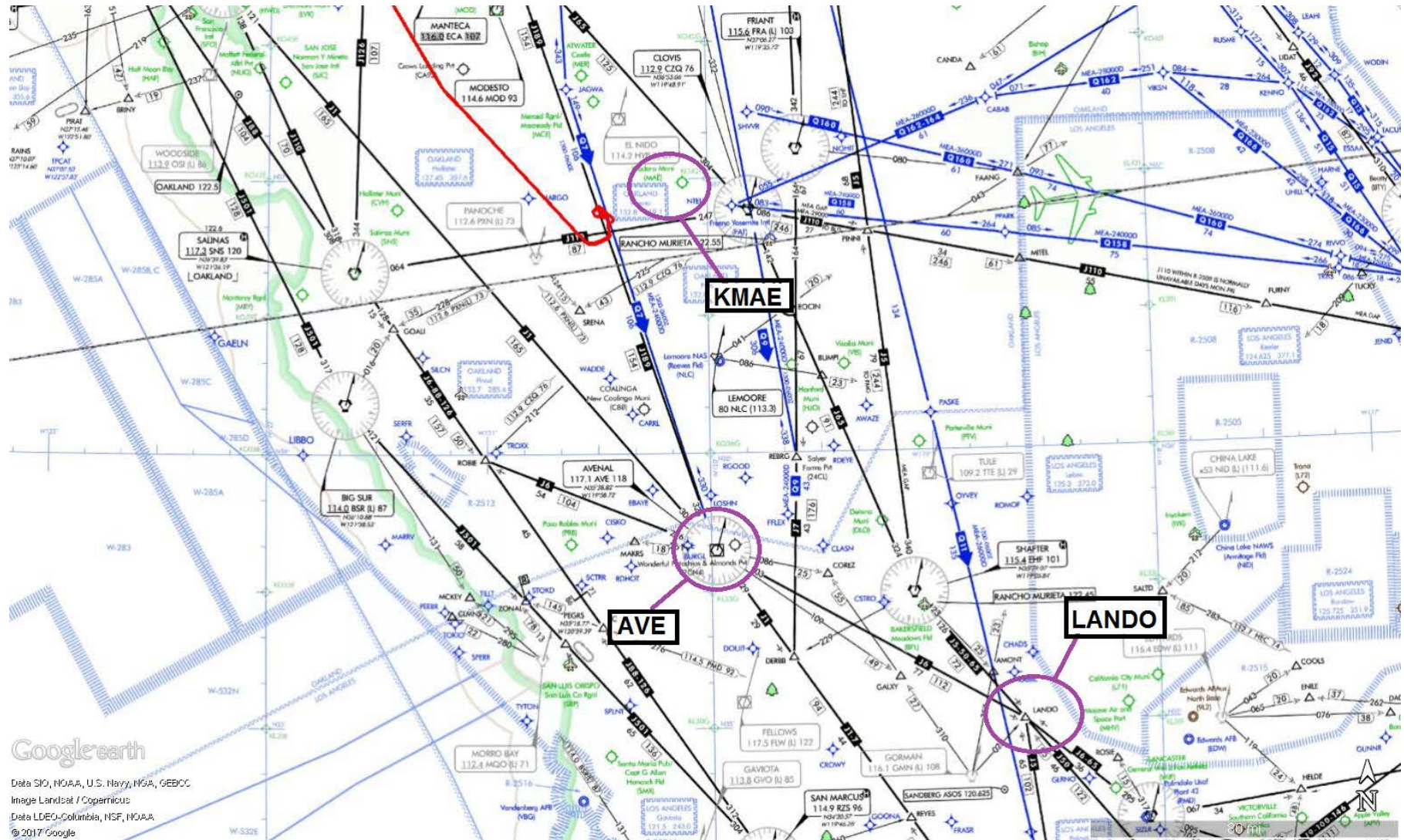


Figure 14. Satellite overlay of end of recording.

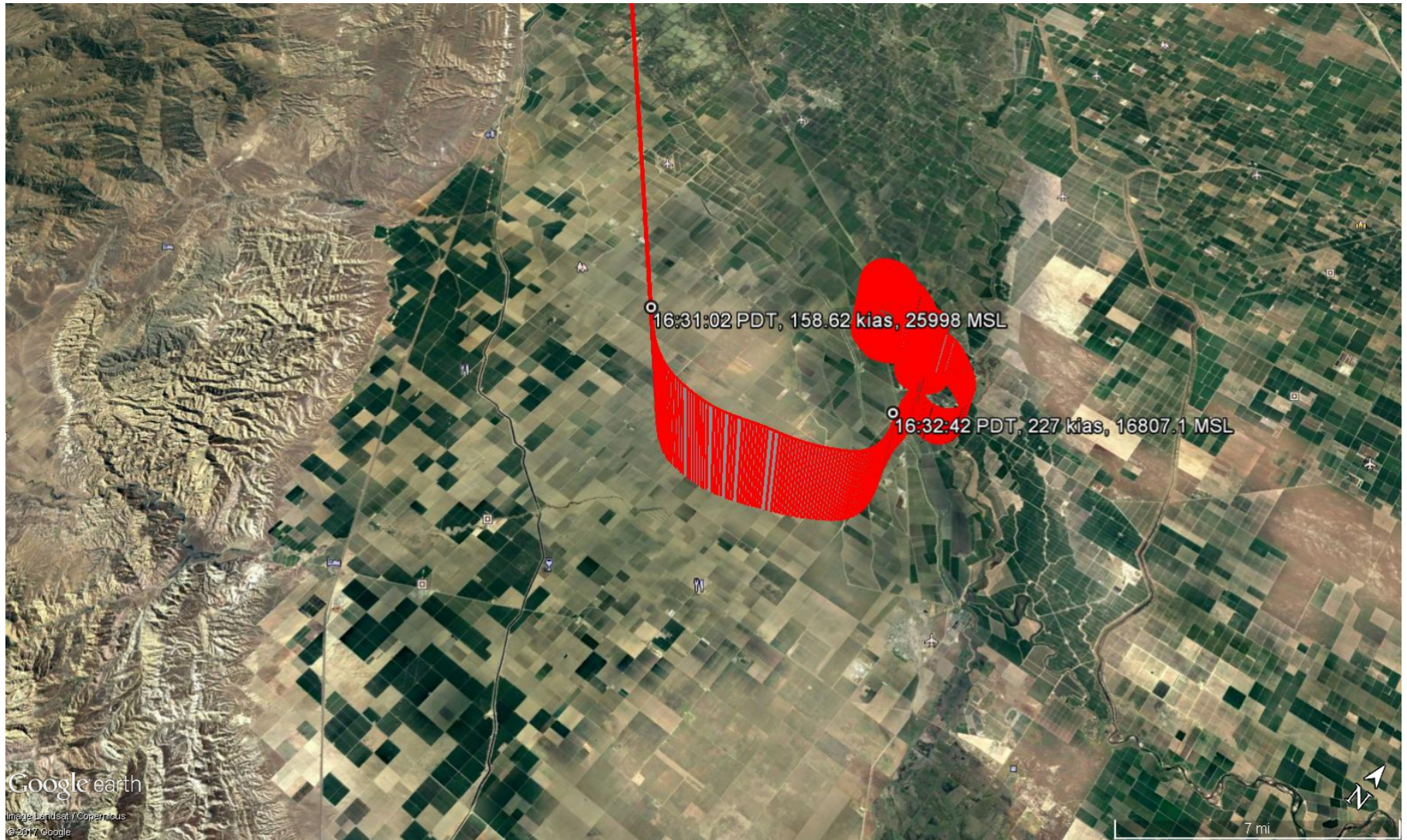


Figure 15. Satellite overlay of descent from 18,000 feet to 10,000 feet (partial track).



Figure 16. Satellite overlay of descent from 10,000 feet to 8,000 feet (partial track).

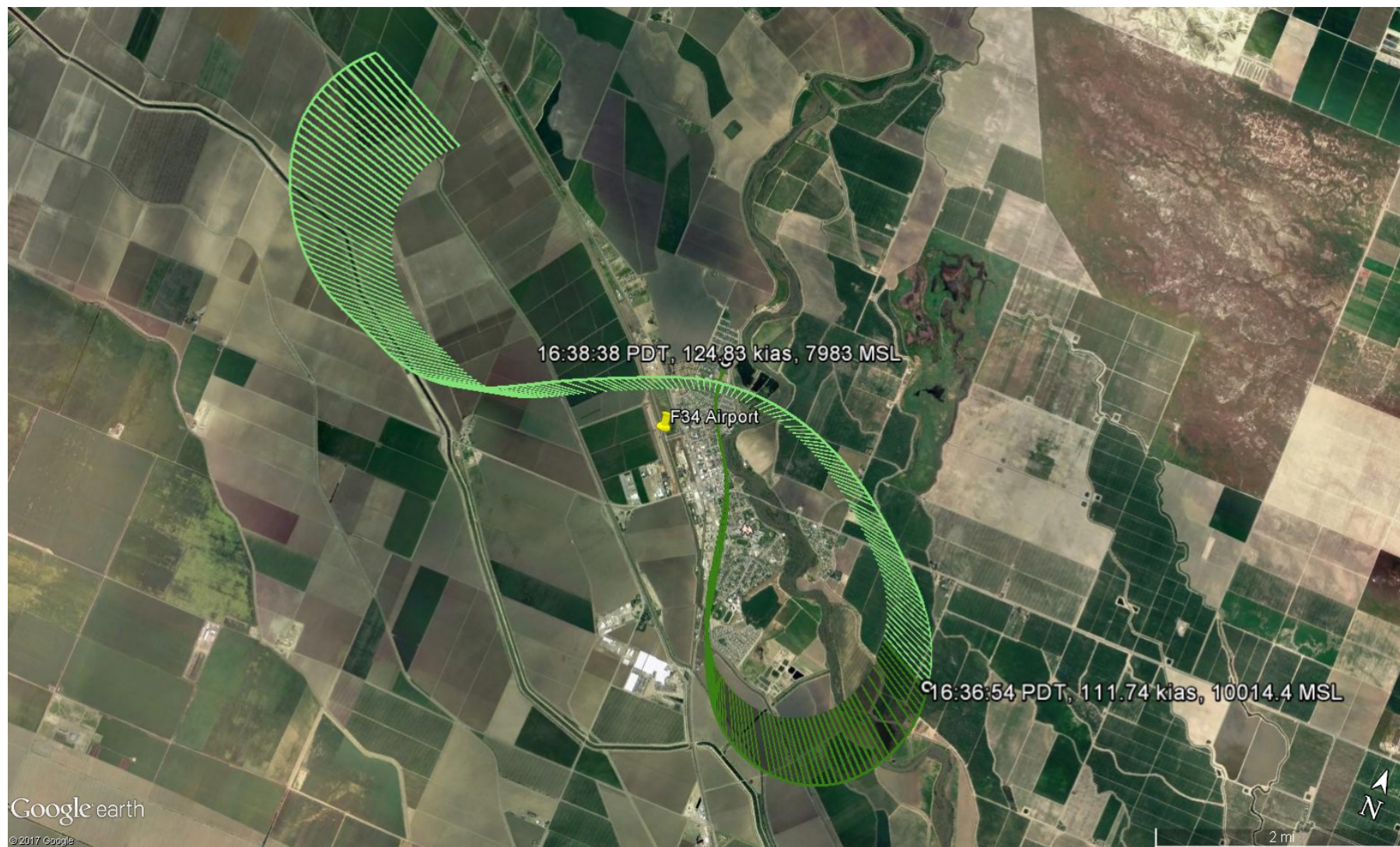


Figure 17. Satellite overlay of descent from 10,000 feet to 4,000 feet (partial track).

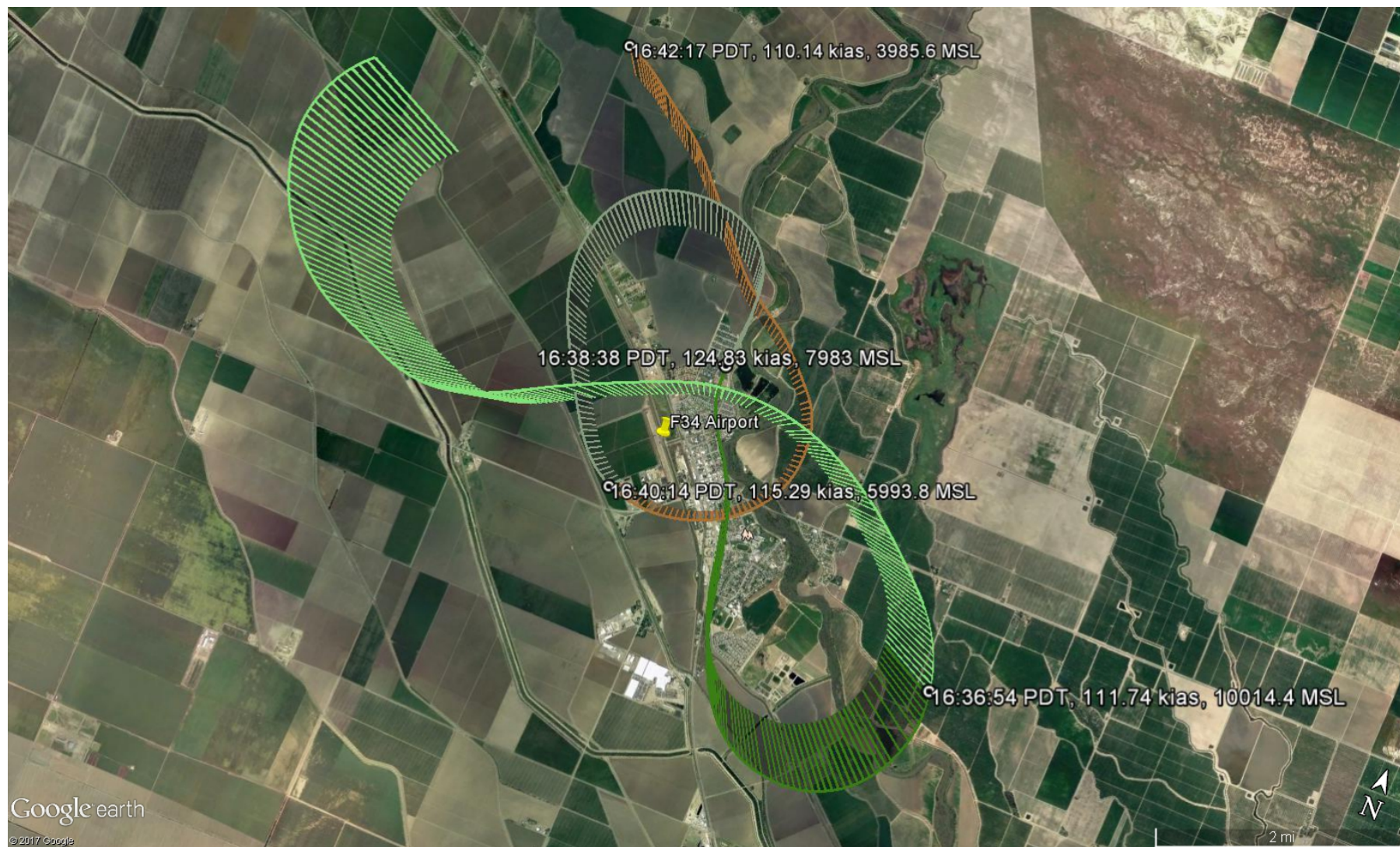


Figure 18. Satellite overlay of descent from 6,000 feet to end of recording (partial track).

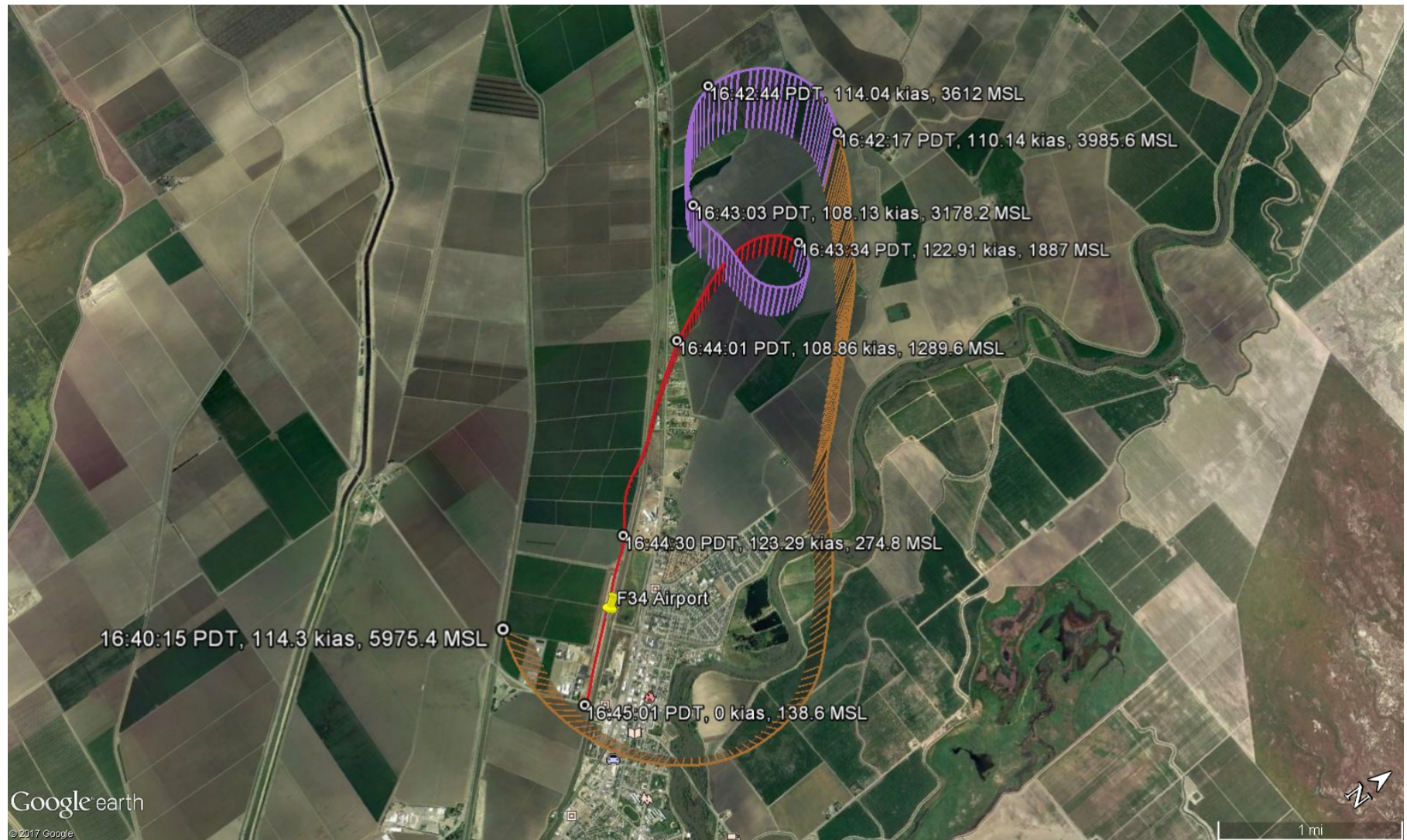


Figure 19. Basic parameters - entire recording.

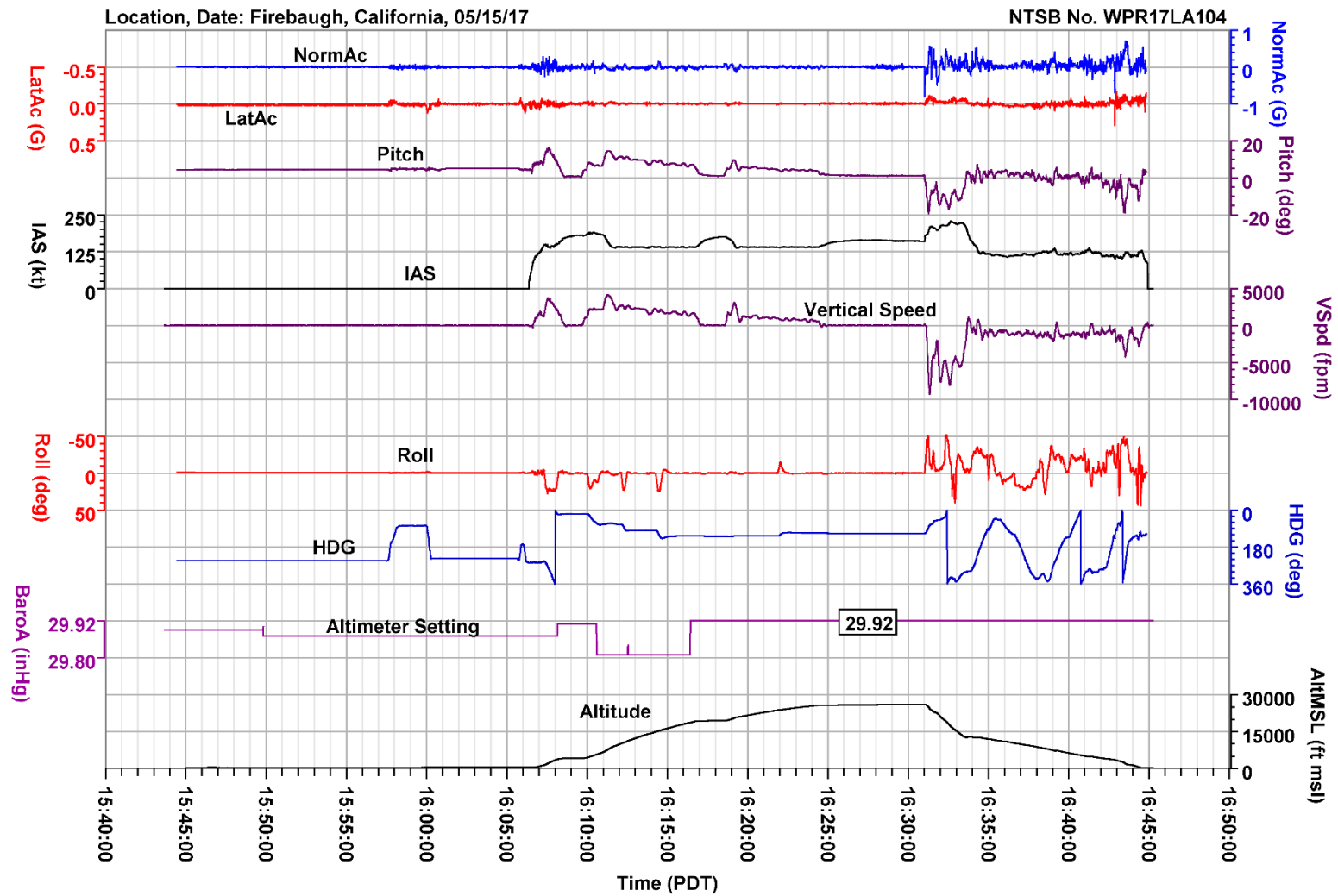


Figure 20. Engine parameters - entire recording.

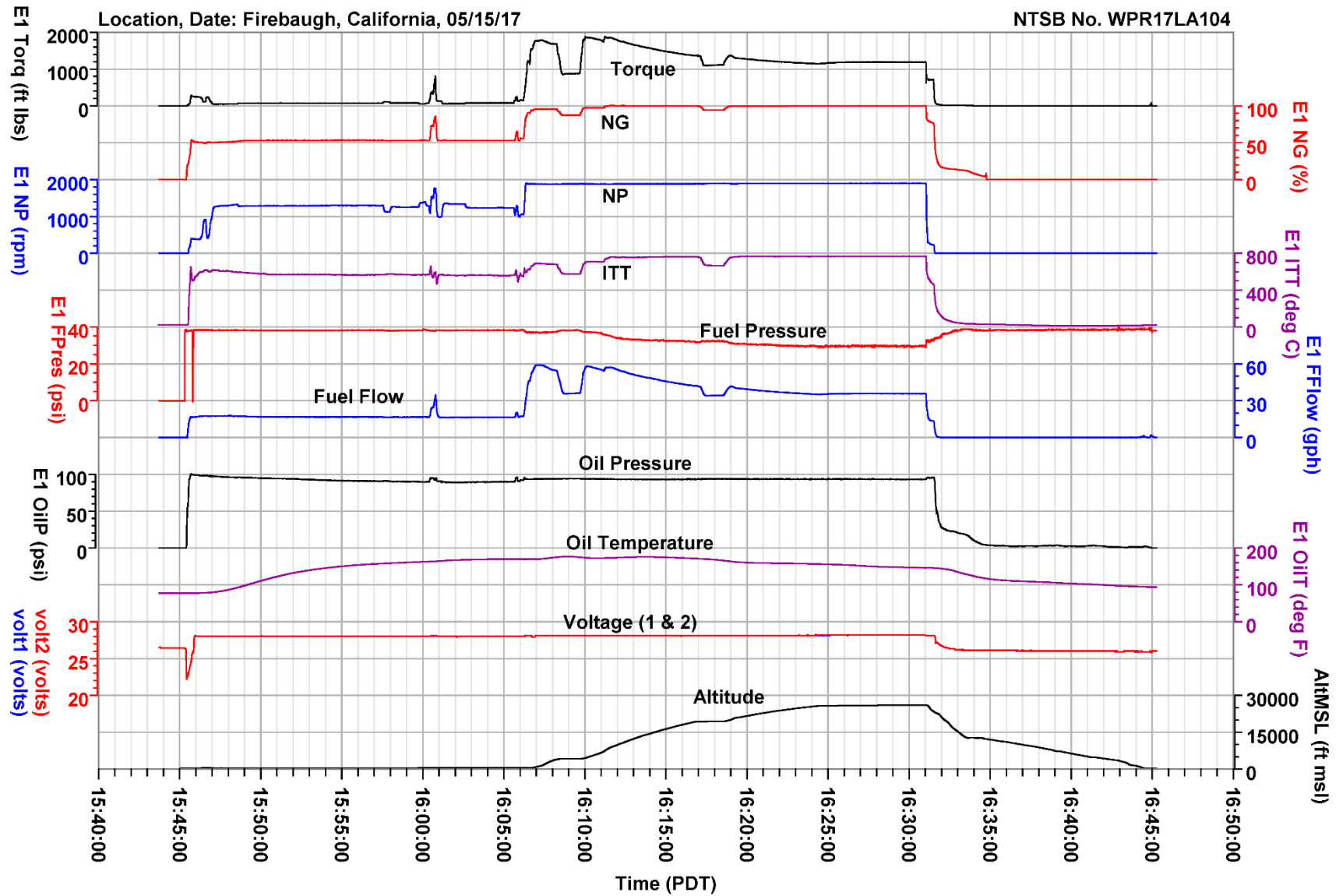


Figure 21. Navigation-related parameters - entire recording.

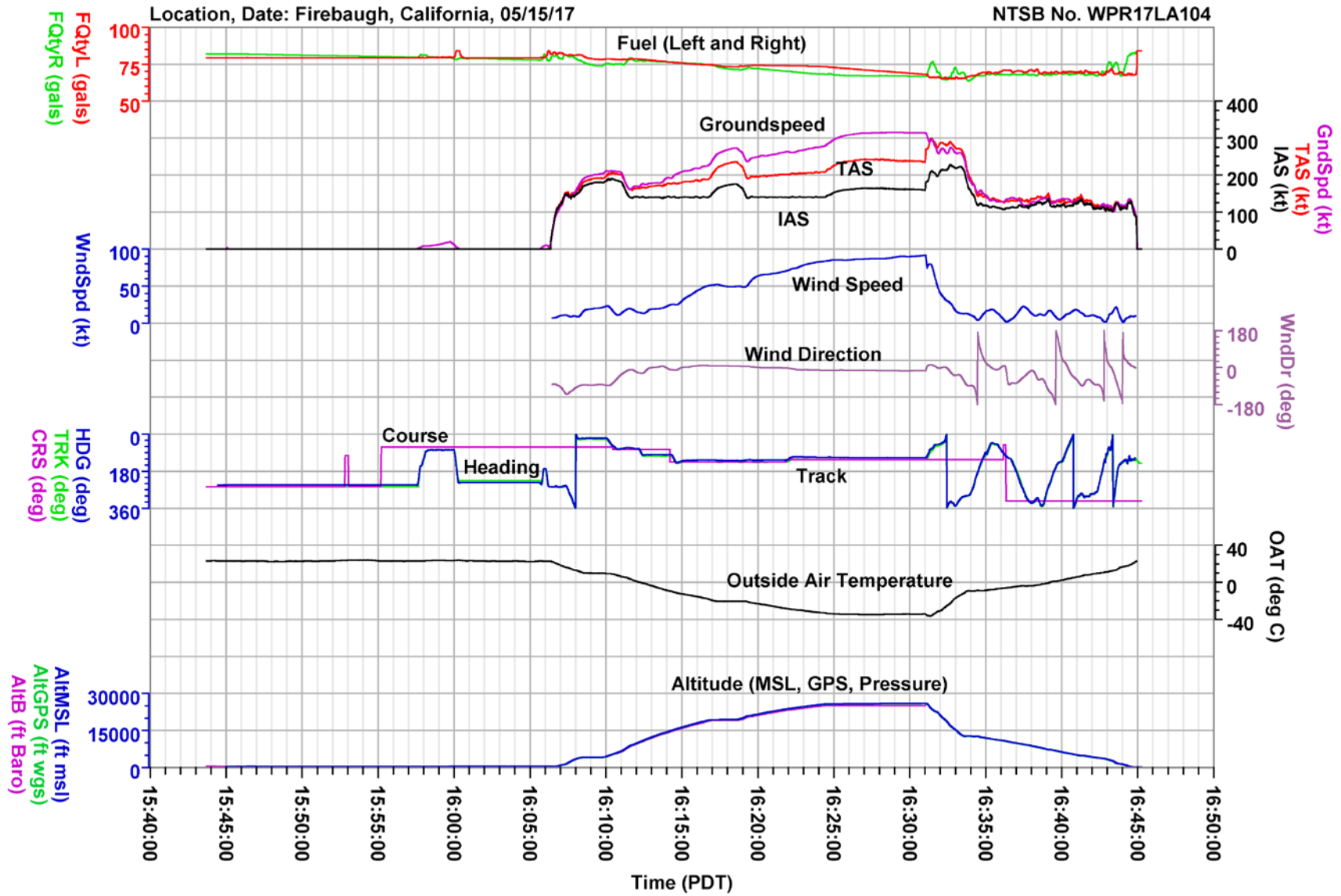


Figure 22. Miscellaneous parameters - entire recording.

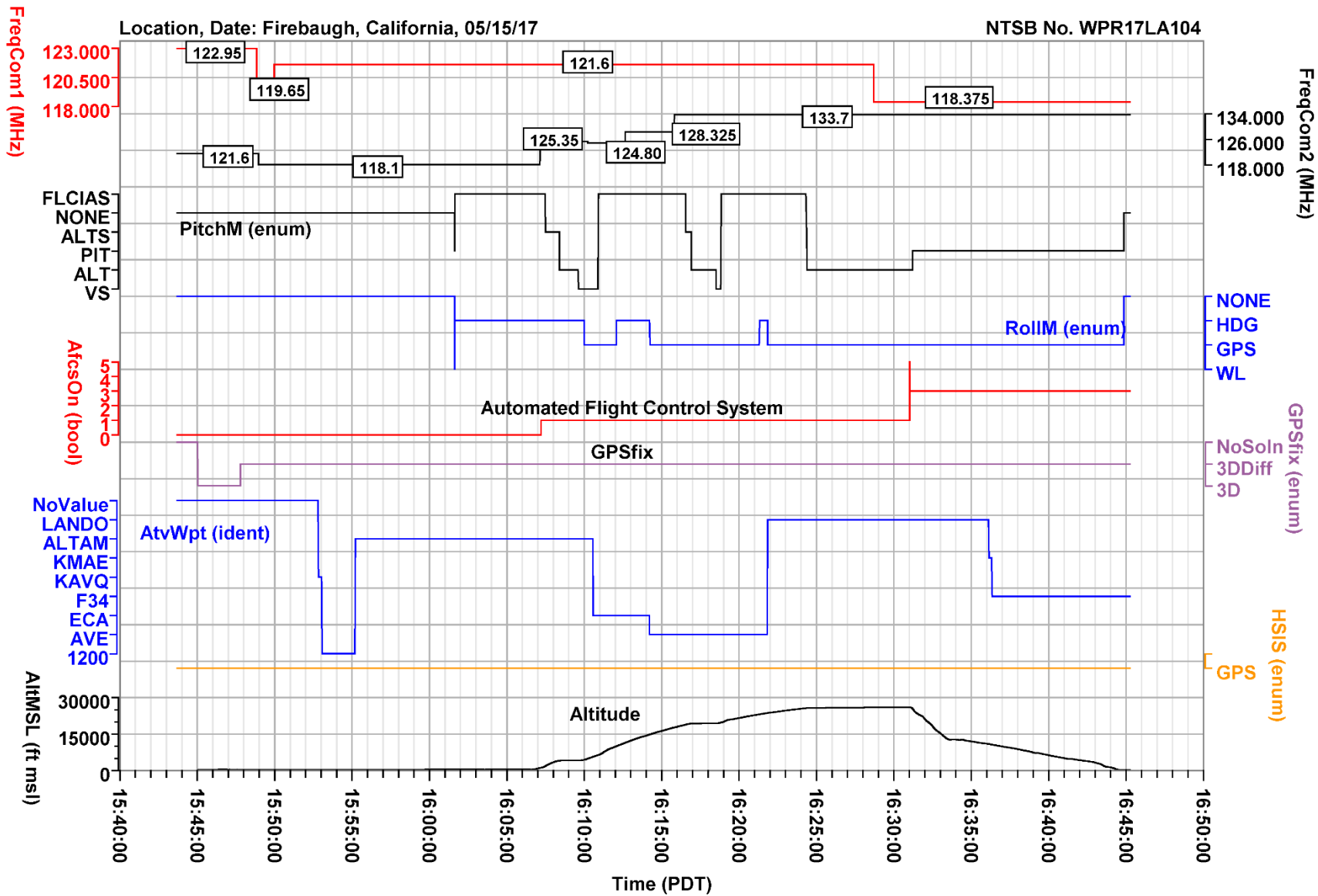


Figure 23. Basic parameters – flight portion.

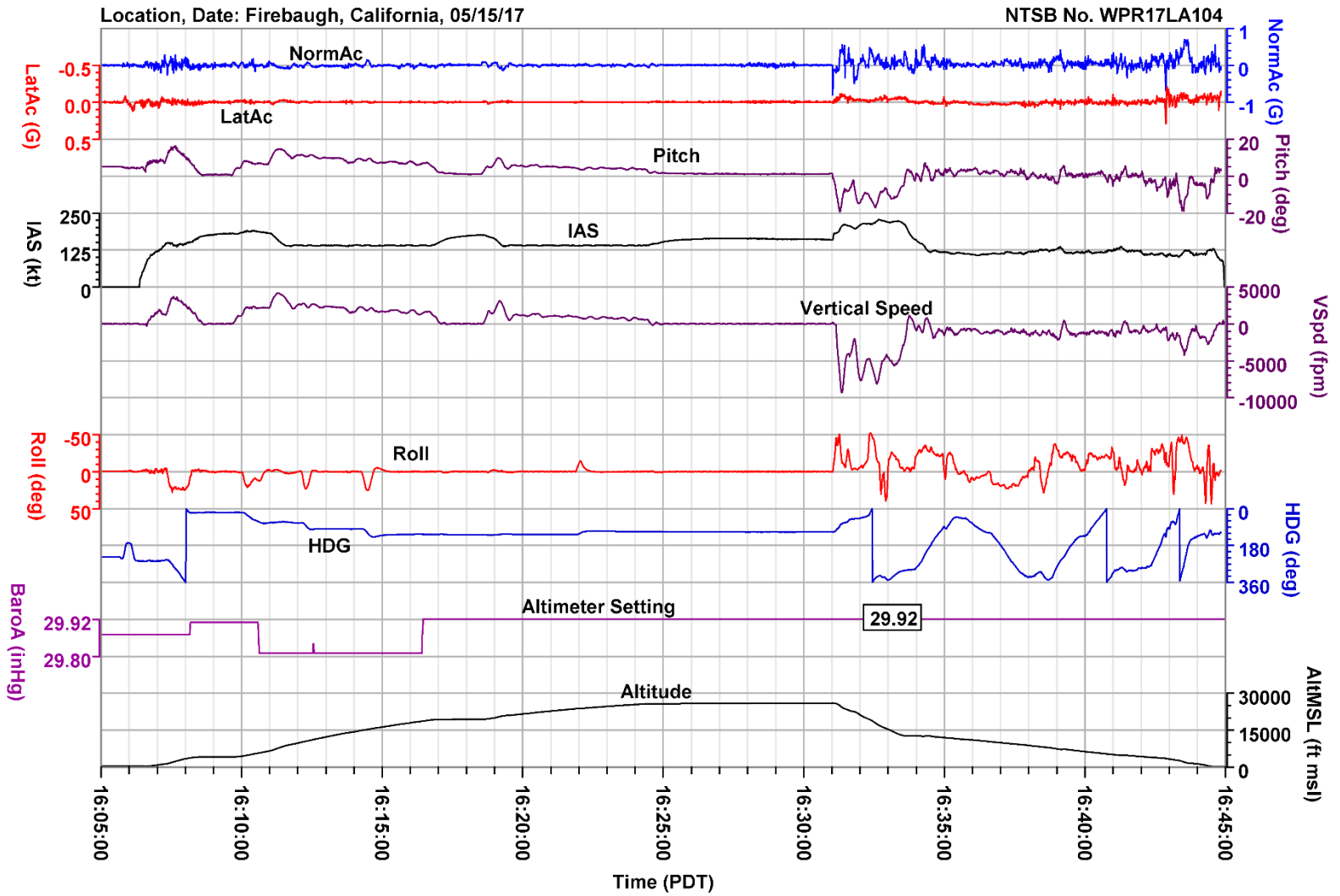


Figure 24. Engine parameters - flight portion.

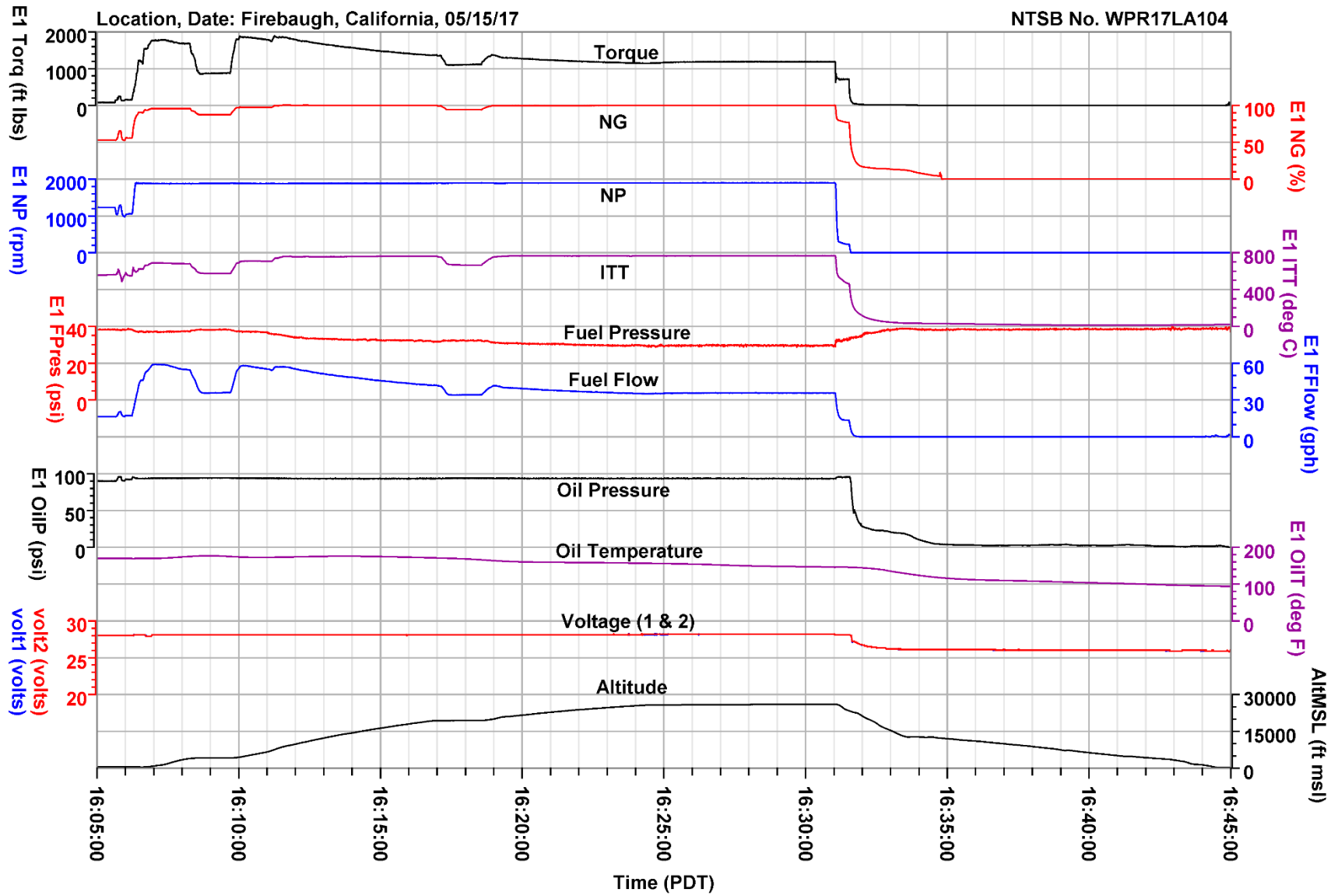


Figure 25. Basic parameters – leading up to upset.

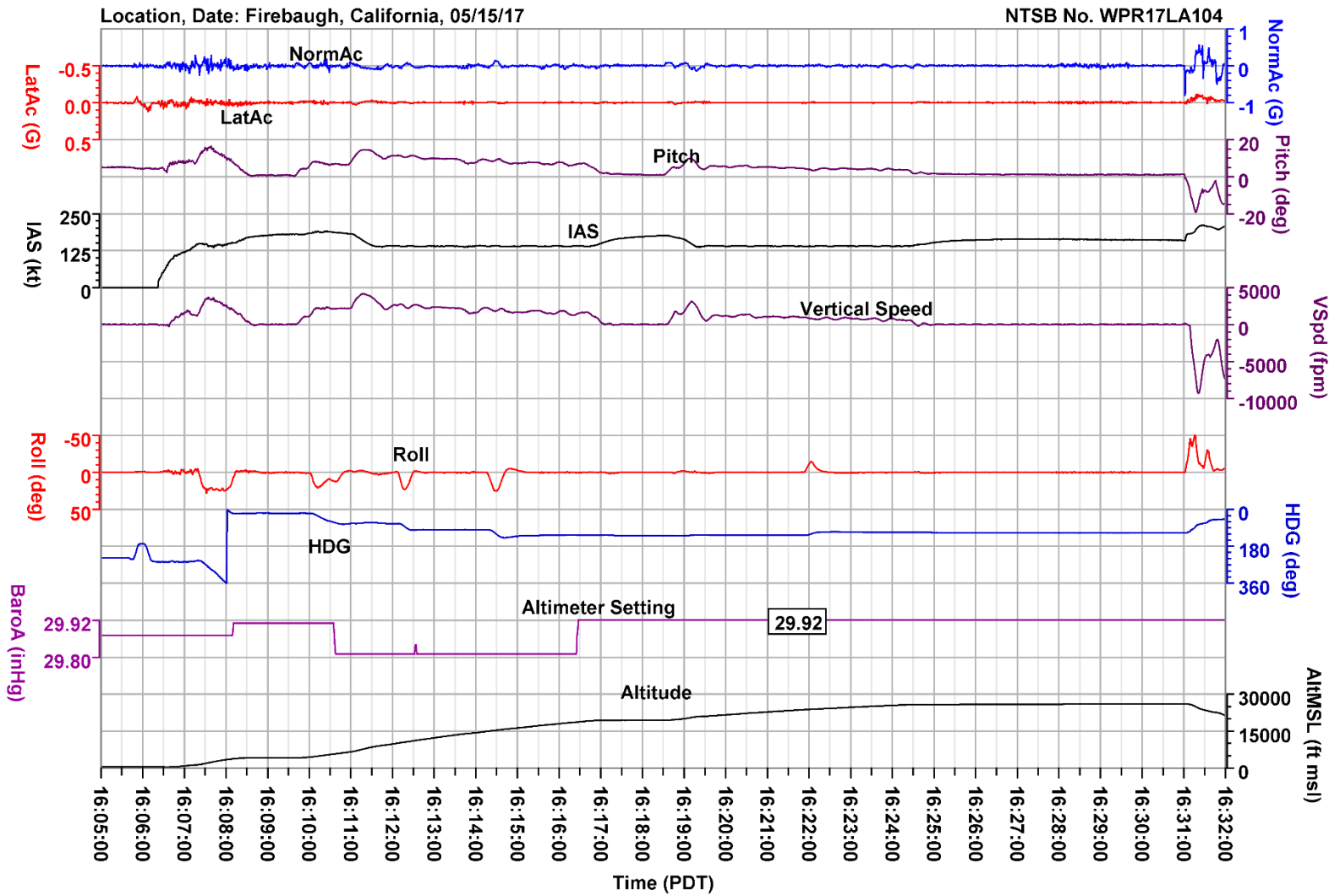


Figure 26. Engine parameters – leading up to upset.

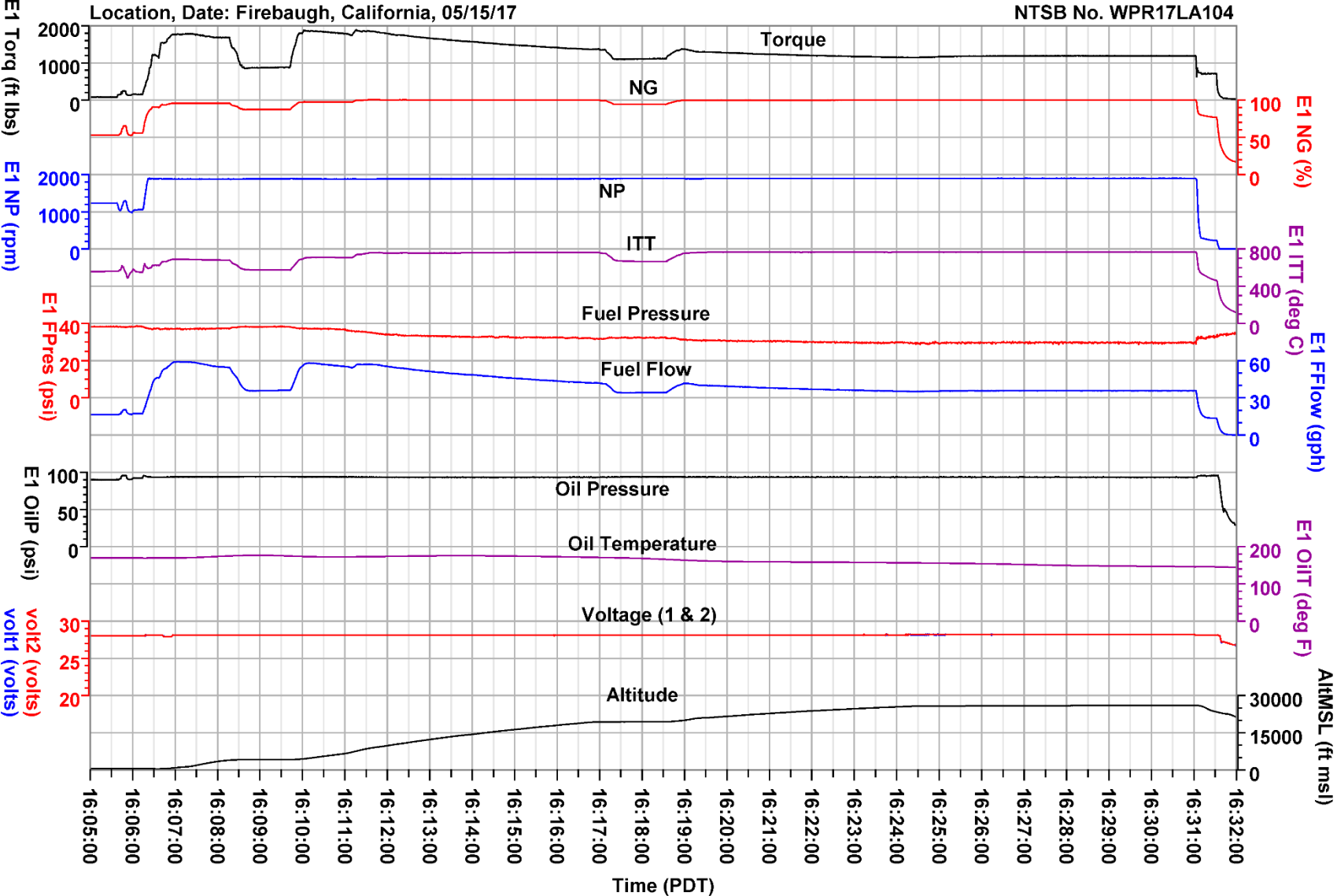


Figure 27. Basic parameters - after upset.

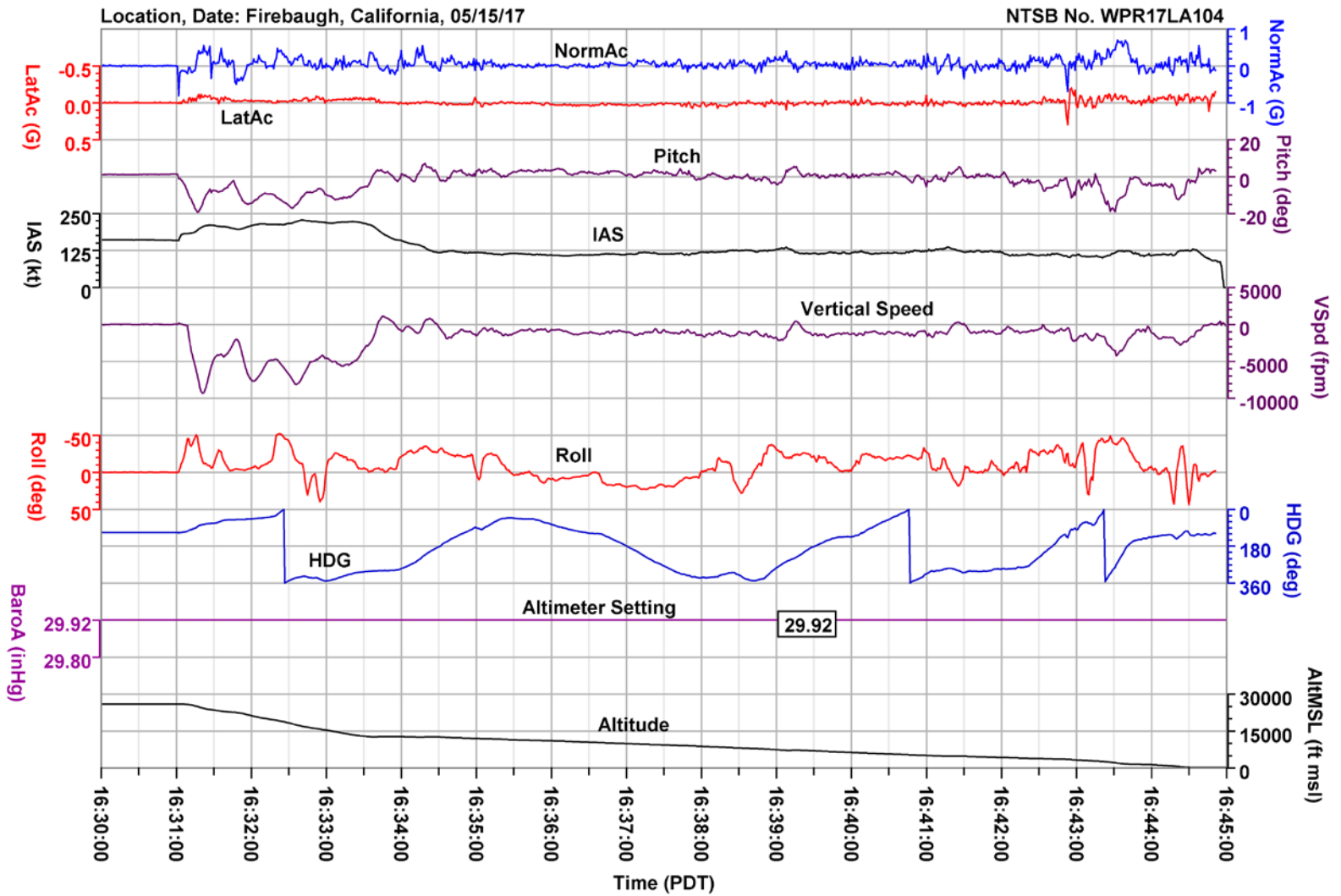
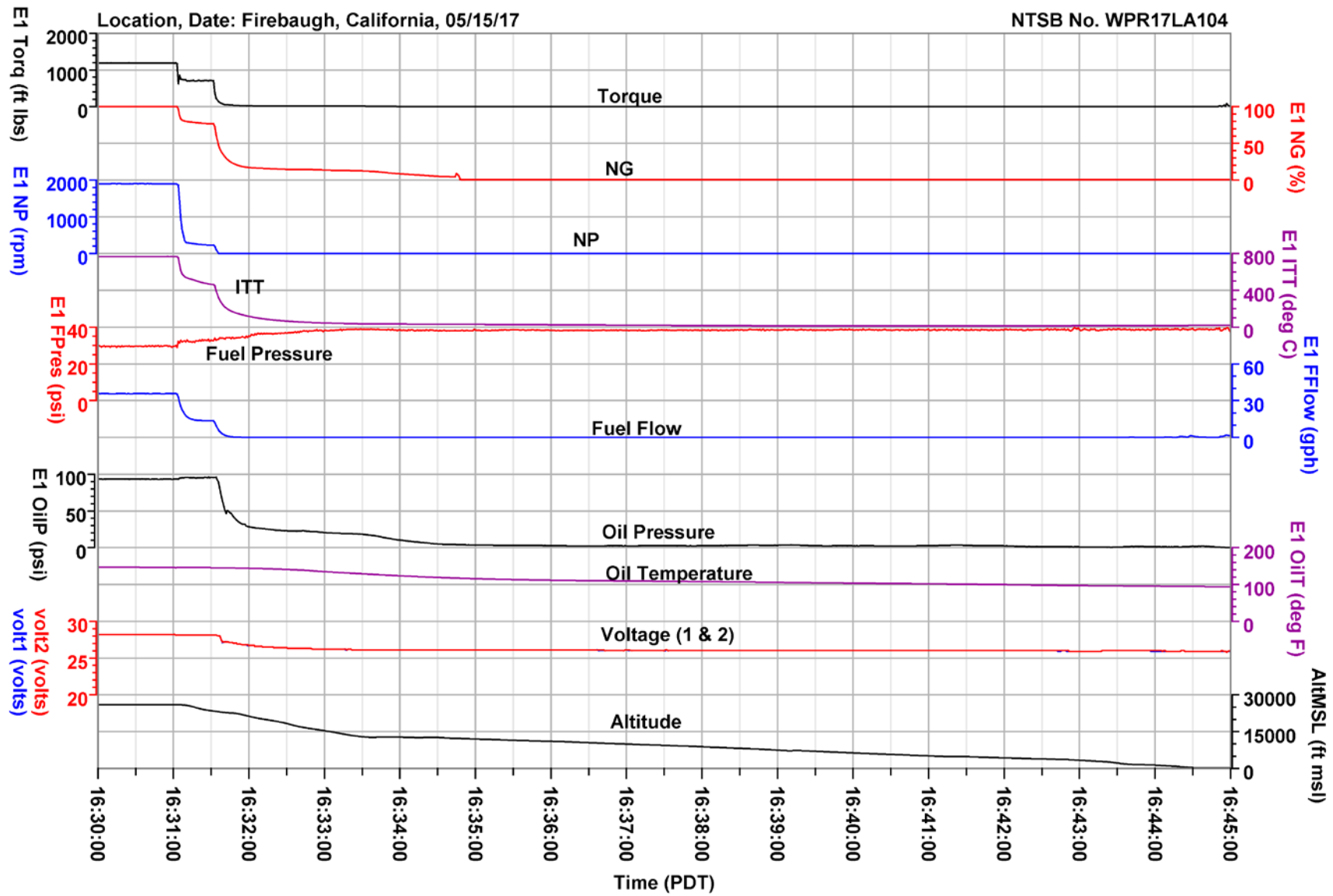


Figure 28. Engine parameters - after upset.



APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameters, table A-2 describes the unit abbreviations, and table A-3 describes any value abbreviations.

Table A-1. Verified and provided parameters.

Parameter Name	Parameter Description
1. AfcsOn (discrete)	Automatic Flight Control System On (Note 1)
2. AltB (ft)	Barometric Corrected Altitude
3. AltGPS (ft)	GPS Altitude
4. AltMSL (ft)	Pressure Altitude
5. AtvWpt (text)	Active Waypoint Identifier (text of identifier)
6. BaroA (inHg)	Barometric Correction Setting
7. CRS (deg)	Course
8. E1 FFlow (gph)	Fuel Flow
9. E1 FPres (psi)	Fuel Pressure
10. E1 ITT (degC)	Interturbine Temperature
11. E1 NG (%)	Engine Gas Generator Speed
12. E1 NP (rpm)	Engine Propeller Speed
13. E1 OilP (psi)	Engine Oil Pressure
14. E1 OilT (degF)	Engine Oil Temperature
15. E1 Torq (ft lbs)	Engine Torque
16. FQtyL (gal)	Left Fuel Quantity
17. FQtyR (gal)	Right Fuel Quantity
18. FreqCom1 (MHz)	VHF Radio 1 (Comm) Tuned Frequency
19. FreqCom2 (MHz)	VHF Radio 2 (Comm) Tuned Frequency
20. GPSFix (discrete)	GPS Fix Type
21. GrndSpd (kts)	Ground Speed
22. HDG (deg)	Magnetic Heading
23. HSIS (discrete)	Horizontal Situation Indicator Source
24. IAS (kts)	Indicated Airspeed
25. LatAc (g)	Lateral Acceleration
26. Latitude (deg)	Latitude
27. Longitude (deg)	Longitude
28. NormAc (g)	Vertical Acceleration
29. OAT (degC)	Outside Air Temperature
30. Pitch (deg)	Pitch
31. PitchM (text)	Auto Flight Control System Pitch Mode
32. Roll (deg)	Roll
33. RollM (text)	Auto Flight Control System Roll Mode
34. TAS (kts)	True Airspeed
35. Time Local (HH:MM:SS)	Recorded Time
36. TRK (deg)	Ground Track
37. volt1 (V)	Bus 1 Voltage
38. volt2 (V)	Bus 2 Voltage

Parameter Name	Parameter Description
39. VSpd (fpm)	Vertical Speed
40. WndDr (deg)	Wind Direction
41. WndSpd (kts)	Wind Speed

Note 1: For this report, the meaning of AfcsOn discrete states were not determined.

Table A-2. Unit abbreviations.

Units Abbreviation	Description
%	percent
deg	degrees
degC	degrees Celsius
degF	Degrees Fahrenheit
discrete	discrete
ft	feet
gal	gallons
gph	gallons per hour
in	inches
inHg	inches of Mercury
kts	knots
psi	pounds per square inch
SS	seconds
V	Volts DC
HH	hours
MM	minutes
ft lbs	foot pounds
text	human-readable text
g	G
MHz	megahertz

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.

Table A-3. Value abbreviations.

Units Abbreviation	Description
FLCIAS	indicated airspeed mode
ALTS	*
ALT	altitude hold mode
PIT	pitch mode
VS	vertical speed mode
HDG	heading mode
GPS	GPS mode
WL	*
NoSoln	no solution
3DDiff	differential GPS position solution
3D	GPS position solution

NOTE: "*" descriptions were not determined for this report.