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

February 7, 2013

Cockpit Displays Factual Report

Specialist's Factual Report
by Bill Tuccio

A. EVENT

Location:	Birmingham, Alabama
Date:	October 6, 2012
Aircraft:	Cirrus SR22
Registration:	N80KW
Operator:	Private
NTSB Number:	ERA13LA012

B. GROUP - No Group

C. SUMMARY

On October 6, 2012, about 1215 central daylight time (CDT), a Cirrus SR22, N80KW, operated by a private individual, was substantially damaged during deployment of the Cirrus Airplane Parachute System (CAPS), following a loss of control during a missed approach at Birmingham International Airport (BHM), Birmingham, Alabama. The private pilot incurred minor injuries and the passenger was seriously injured. The personal flight was conducted under the provisions of 14 Code of Federal Regulations Part 91. Instrument meteorological conditions prevailed and an instrument flight rules flight plan was filed for the flight that departed Charles B Wheeler Downtown Airport (MKC), Kansas City, Missouri; destined for BHM.

D. DETAILS OF INVESTIGATION

The NTSB Vehicle Recorder Laboratory received the following device:

GPS Manufacturer/Model:	Avidyne Primary Flight Display (PFD)
Serial Number:	20590445

Avidyne PFD Device Description

The Avidyne PFD unit includes a solid state Air Data and Attitude Heading Reference System (ADAHRS) and displays aircraft parameter data including altitude, airspeed, attitude, vertical speed, and heading. The PFD unit has external pitot/static inputs for altitude, airspeed, and vertical speed information. Each PFD contains two flash memory devices mounted on a riser card. The flash memory stores information the PFD unit uses to generate the various PFD displays. Additionally, the PFD has a data logging function, which is used by the manufacturer for maintenance and diagnostics. Maintenance and diagnostic information recording consists of system information, event data and flight data.

The PFD samples and stores several data streams in a sequential fashion; when the recording limit of the PFD is reached, the oldest record is dropped and a new record is added. Data from the ADAHRS is recorded at a rate of 5 Hz. Air data information such as pressure altitude, indicated airspeed, and vertical speed are recorded at 1 Hz. Global Positioning System (GPS) and navigation display and setting data are recorded at a rate of 0.25 Hz, and information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.

Avidyne PFD Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage as shown in Figure 1. Power was applied to the accident unit and recorded data was successfully downloaded.

Figure 1. Photo of Avidyne PFD from accident aircraft.

Avidyne PFD Recorder Contents

The PFD contained approximately 16 hours of recorded data, including the accident flight. The oldest recorded data was from September 25, 2012. The software version was 530-00214-002_REV03.

Engineering Units Conversions

Where applicable, the conversions have been changed to ensure that the parameters conform to the NTSB's standard sign convention that climbing right turns are positive (CRT=+)[1]. Appendix A lists the PFD parameters verified and provided in this report.

Time Correlation

A GPS position and Coordinated Universal Time (UTC) record is recorded in the PFD data every 4 seconds, however the time data is updated on the aircraft only every 6 seconds resulting in repeated time data. As a consequence, the data may be up to 6 seconds off from true UTC. For this report, the time the aircraft was descending through 4,880.0 feet pressure altitude was assumed to be 1702:56 UTC. In order to convert to CDT, 5 hours was subtracted, making the assumed time at 4,880.0 feet pressure altitude, 1202:56 CDT.

PFD Recorded Data Plots and Corresponding Tabular Data

Figure 2 shows a plot of basic parameters for the entire flight. The aircraft departed at about 0917 CDT and climbed to about 8,700 feet pressure altitude. At about 0954 CDT, the aircraft descended to about 6,700 feet pressure altitude and remained at that altitude for about 2 hours. At about 1158 CDT, the aircraft began a descent into the Birmingham terminal area. Figure 3 shows a Google Earth overlay of the entire flight.

Figure 4 shows a plot of basic parameters for the approach into Birmingham until the end of the recording. The plot overlays the Birmingham ILS 6 58 degree final approach course for reference on the plot of magnetic heading. At 1208:45 CDT, the aircraft was level at 2,866 feet pressure altitude on a heading of 150 degrees. The aircraft remained on this heading until 1212:29 CDT, when it turned left to a heading of 83 degrees. At about 1212:41 CDT, the vertical deviation indicator (VDI) began to indicate less than 100% of an up deflection value. At about 1213:11 CDT, the horizontal deviation indicator (HDI) began to indicate less than 100% of a right deflection value, and the pressure altitude also began to decrease. At about 1213:30 CDT, the HDI passed through a centered position towards a left deflection. At about 1213:41 CDT, the aircraft began a left turn. At about 1214:06 CDT, the VDI passed through center towards a down deflection. By about 1214:50 CDT, the VDI was

[1] 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 = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

deflected at least 100% down, the HDI was approximately centered, and the heading was about 56 degrees.

At about 1215:55 CDT, the aircraft began a right turn towards the southeast while at a pressure altitude of about 2,185 feet pressure altitude and an indicated airspeed of about 83 knots. At about 1216:11 CDT, the aircraft began to climb from a pressure altitude of 2,019 feet pressure altitude, while the airspeed decreased to a minimum value of 60 knots at 1216:28 CDT. At 1216:38 CDT, the airspeed had increased to 124 knots and the altitude had decreased to 1,834 feet pressure altitude. During the period 1216:28 CDT to 1216:38 CDT, the roll reached a maximum value of 76 degrees left, and the pitch reached 30 degrees nose down.

From 1216:38 CDT until about 1217:00 CDT, the airspeed, altitude, and pitch varied. At about 1217:00 CDT, the longitudinal deceleration increased, reaching a maximum value of -1.6 gs; thereafter the heading varied while the altitude decreased continuously.

Figure 5 shows a Google Earth overlay of the approach towards the Birmingham airport. The extended centerline of runway six is annotated on the overlay, and select pressure altitudes of the flight path are also annotated.

Figure 6 shows an overlay of the Birmingham ILS 6 approach chart and the lateral aircraft path. Figure 7 shows a three-dimensional overlay of the aircraft path on the Birmingham ILS 6 approach chart.

Figure 8 shows a plot of autopilot parameters for the entire flight. The autopilot was engaged shortly after take-off and remained on throughout the flight in GPSS mode until about 1158 CDT, when the aircraft began to descend. Figure 9 shows the autopilot states during the approach until the end of the recording. The autopilot approach mode became active at about 1213:37 CDT. The autopilot “soft mode” became active at about 1214:53 CDT. All autopilot modes switched to off at about 1215:19 CDT, at which point the autopilot ready mode became active. The aircraft experienced the large longitudinal deceleration 1 minute and 39 seconds after the autopilot modes switched to off. The autopilot glideslope and trim parameters recorded off during the entire accident flight recording.

Figure 10 shows a plot of engine parameters for the entire flight. The manifold pressure, RPM, and fuel flow increased coincident with airspeed at about 0917 CDT. At about 1158 CDT, the manifold pressure decreased as the aircraft descended out of 6,700 feet pressure altitude.

Figure 11 shows a plot of engine parameters for the approach until the end of the recording. Between about 1209 CDT and 1216 CDT, the manifold pressure decreased from about 19 inHg to 14 inHg. At about 1216:12 CDT, as the heading turned towards the southeast, the manifold pressure increased, reaching 27 inHg by 1216:36 CDT; at which time the RPM reached a maximum value of about 2,660 RPM. At 1217:00 CDT,

the period of maximum longitudinal deceleration, the oil pressure decreased. The RPM remained at about 2,660 RPM until about 1217:12 CDT, when it decreased along with fuel flow and power.

Tabular data used to generate figures 2 through 11 are included as Attachment 1. This attachment is provided in electronic comma-delimited (.CSV) format.

Figure 2. Plot of basic parameters for entire accident flight.

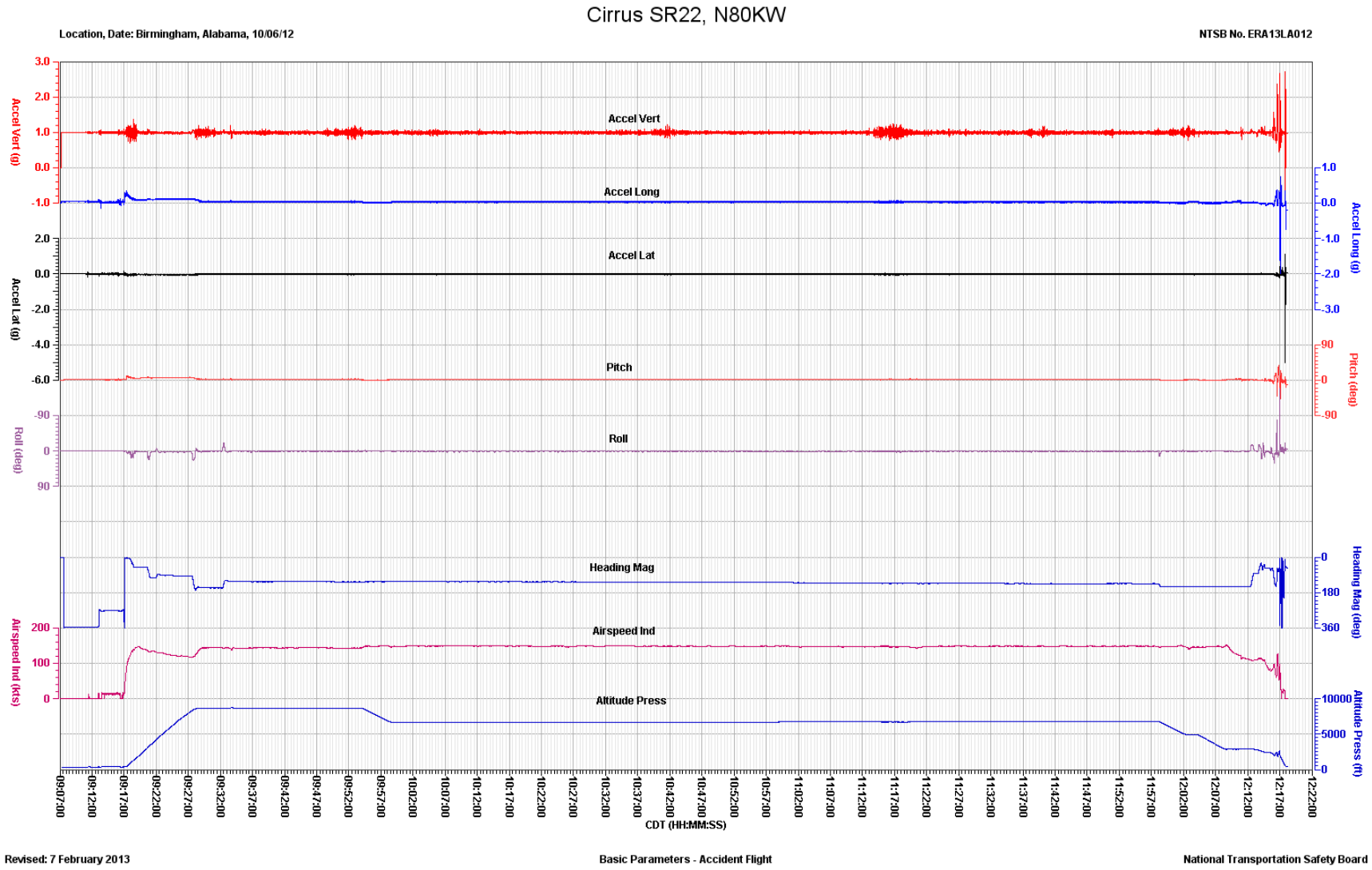


Figure 3. Google Earth overlay showing entire accident flight.

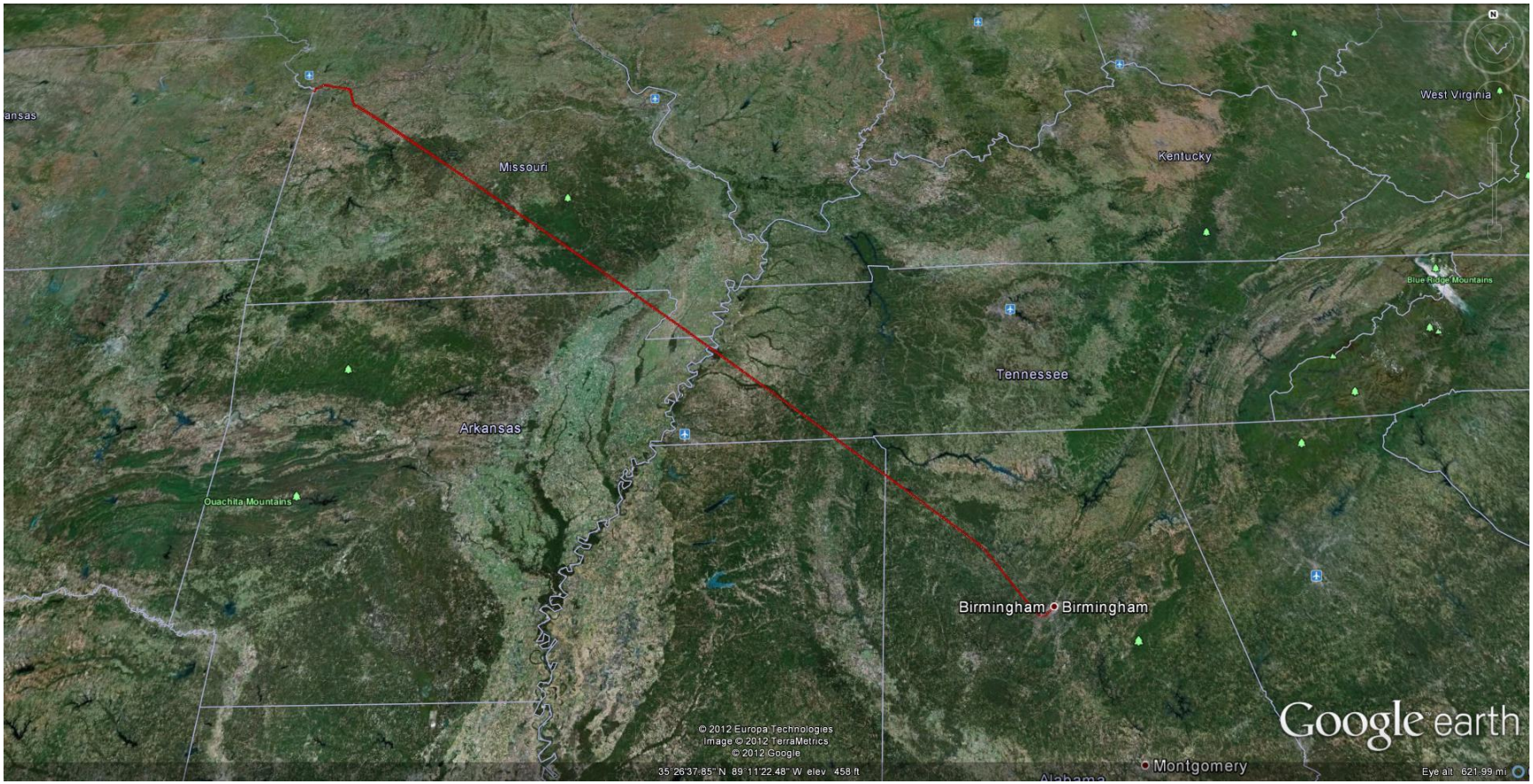


Figure 4. Plot of basic parameters for approach until end of recording.

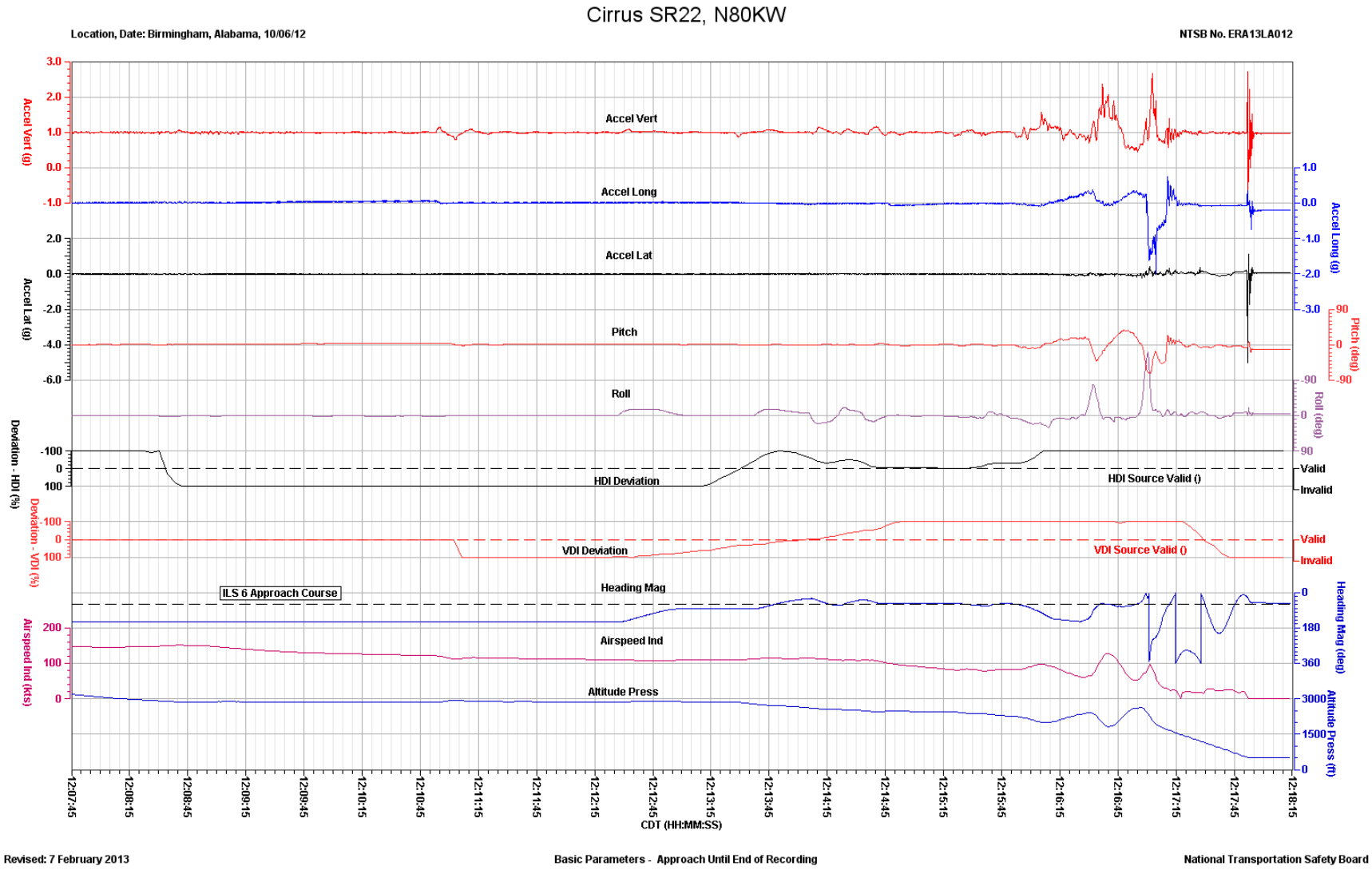


Figure 5. Google Earth overlay showing approach until end of recording.

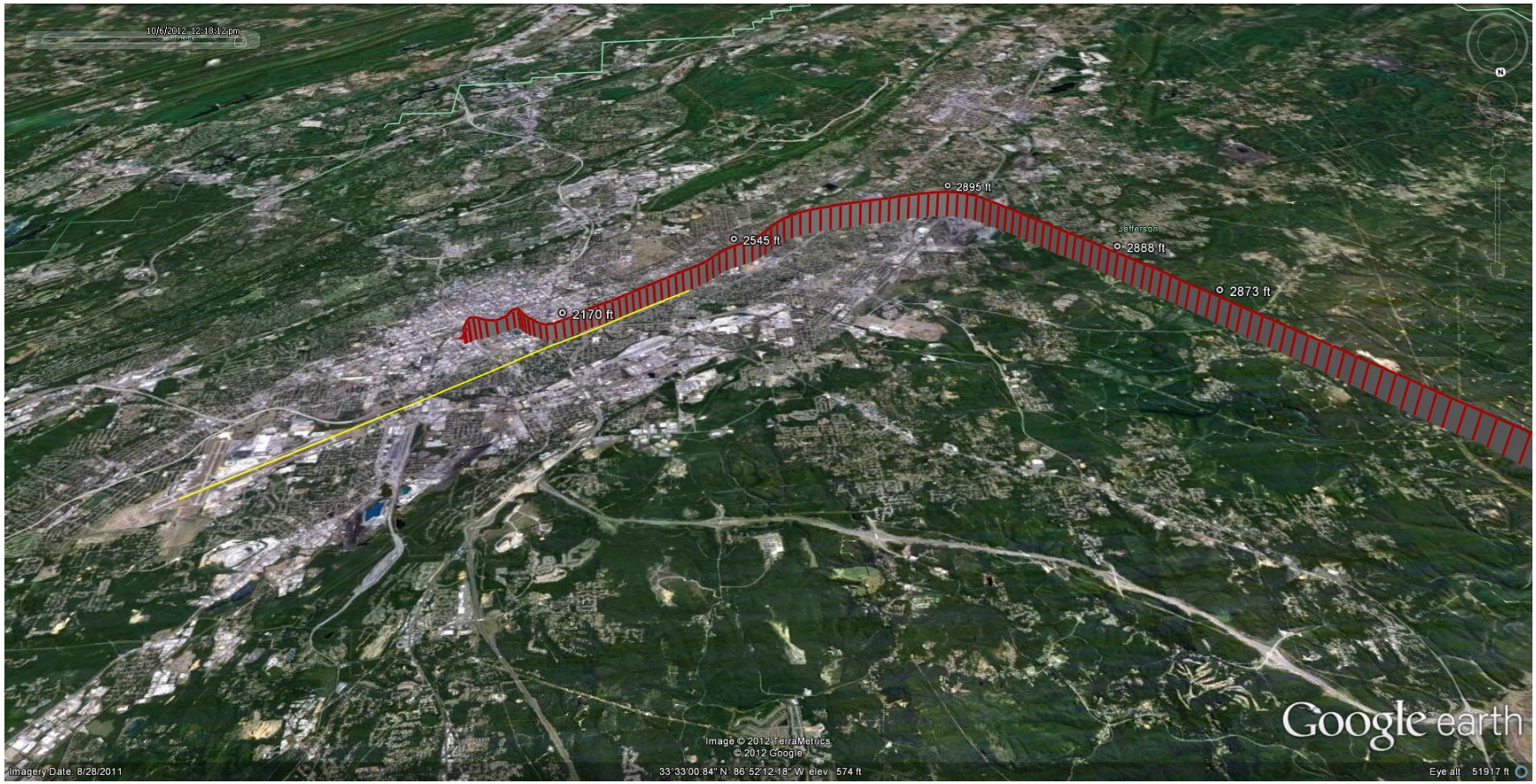


Figure 6. 2-dimensional overlay of Birmingham ILS Runway 6 approach and aircraft flight path.

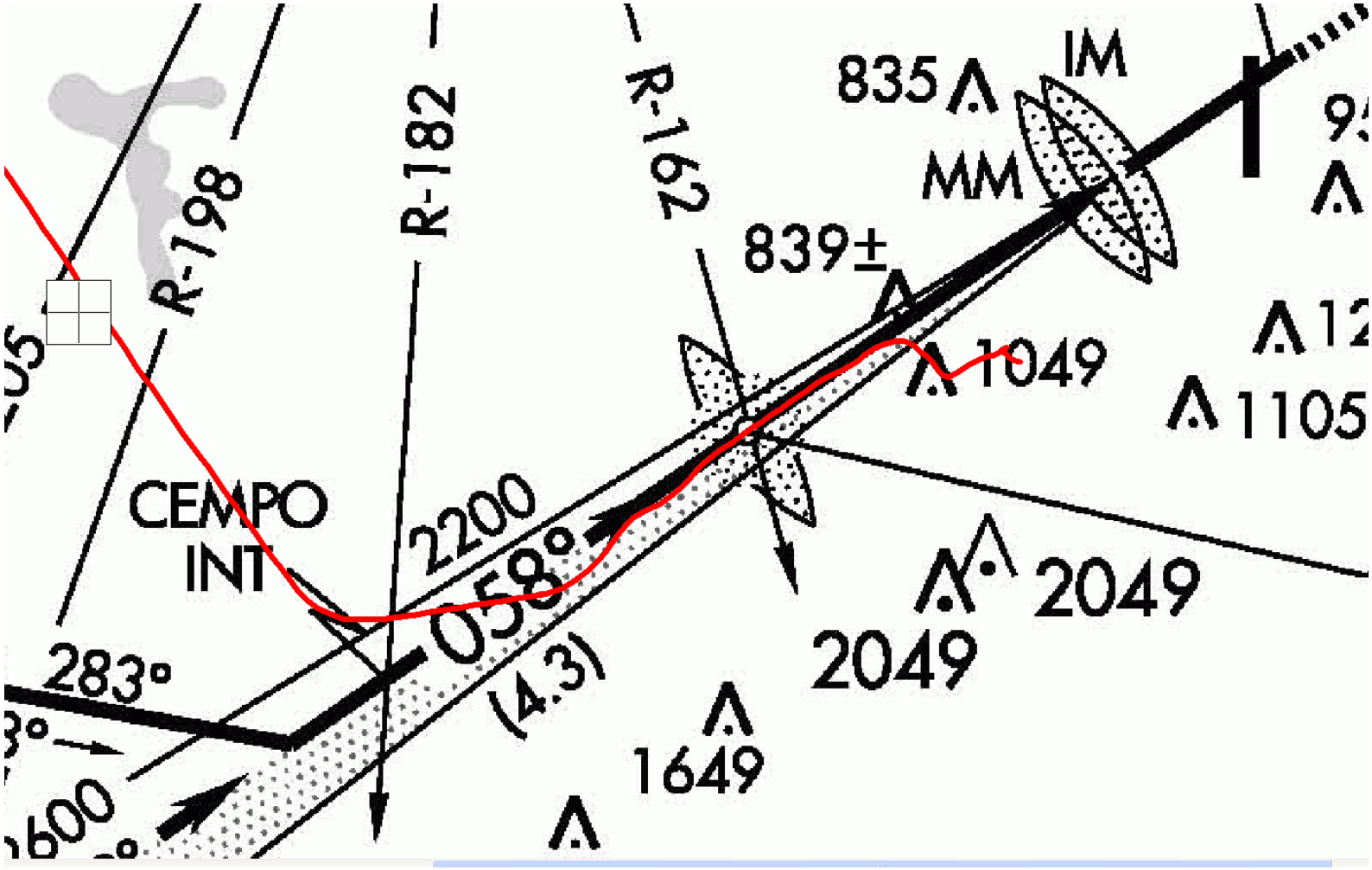


Figure 7. 3-dimensional overlay of Birmingham ILS Runway 6 approach and aircraft flight path.

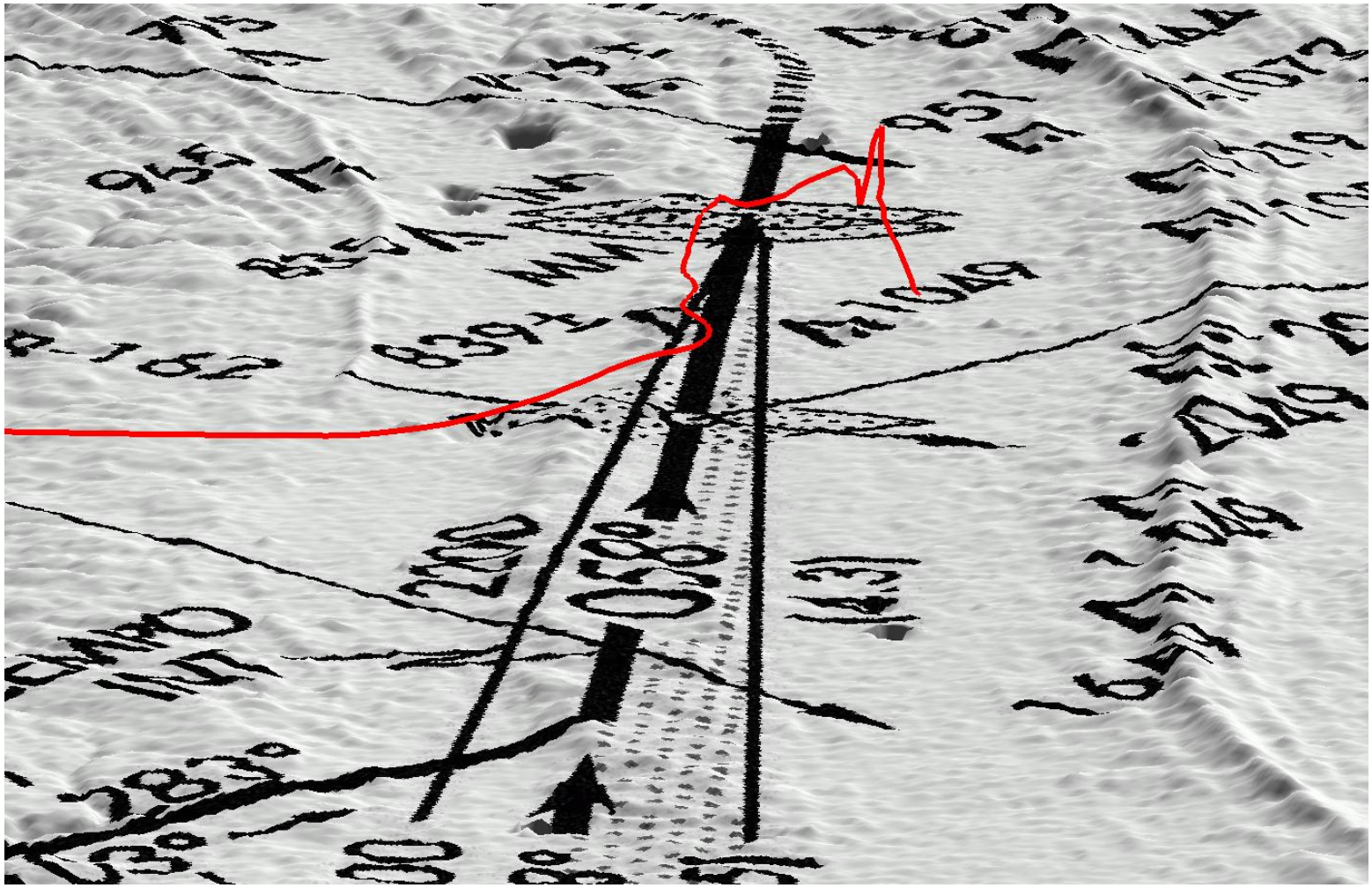


Figure 8. Plot of autopilot parameters for entire accident flight.

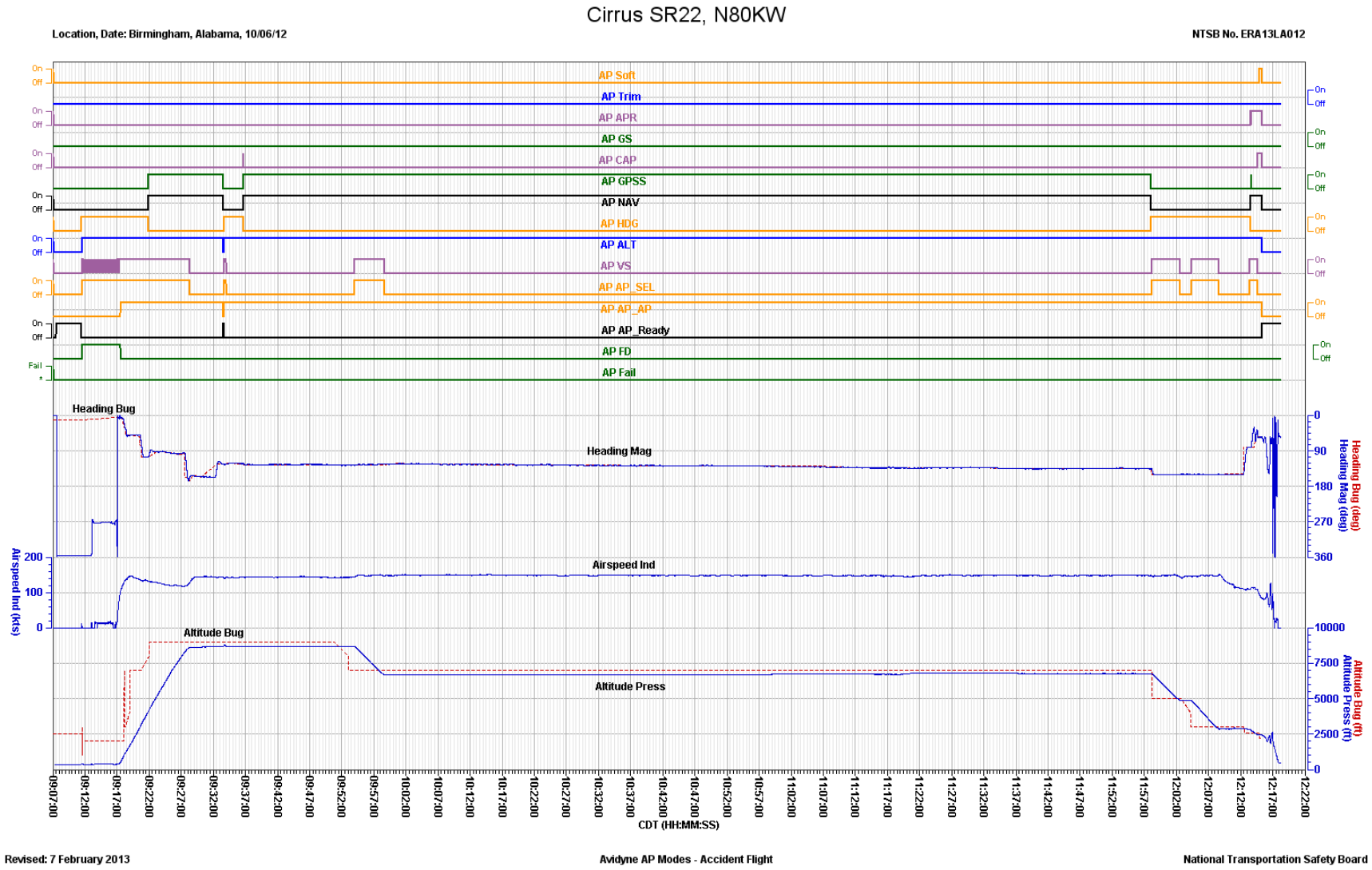


Figure 9. Plot of autopilot parameters for approach until end of recording.

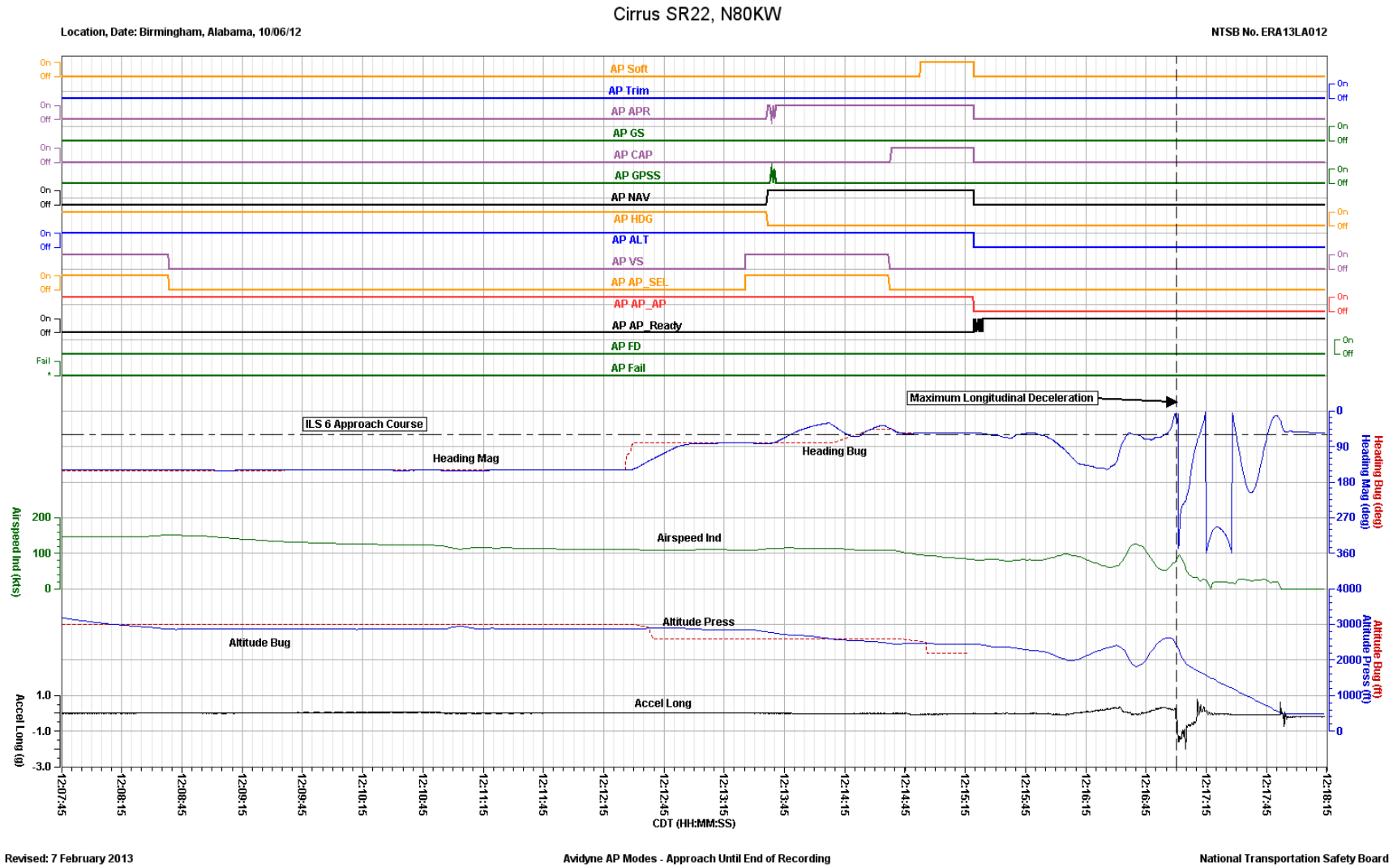


Figure 10. Plot of engine parameters for entire flight.

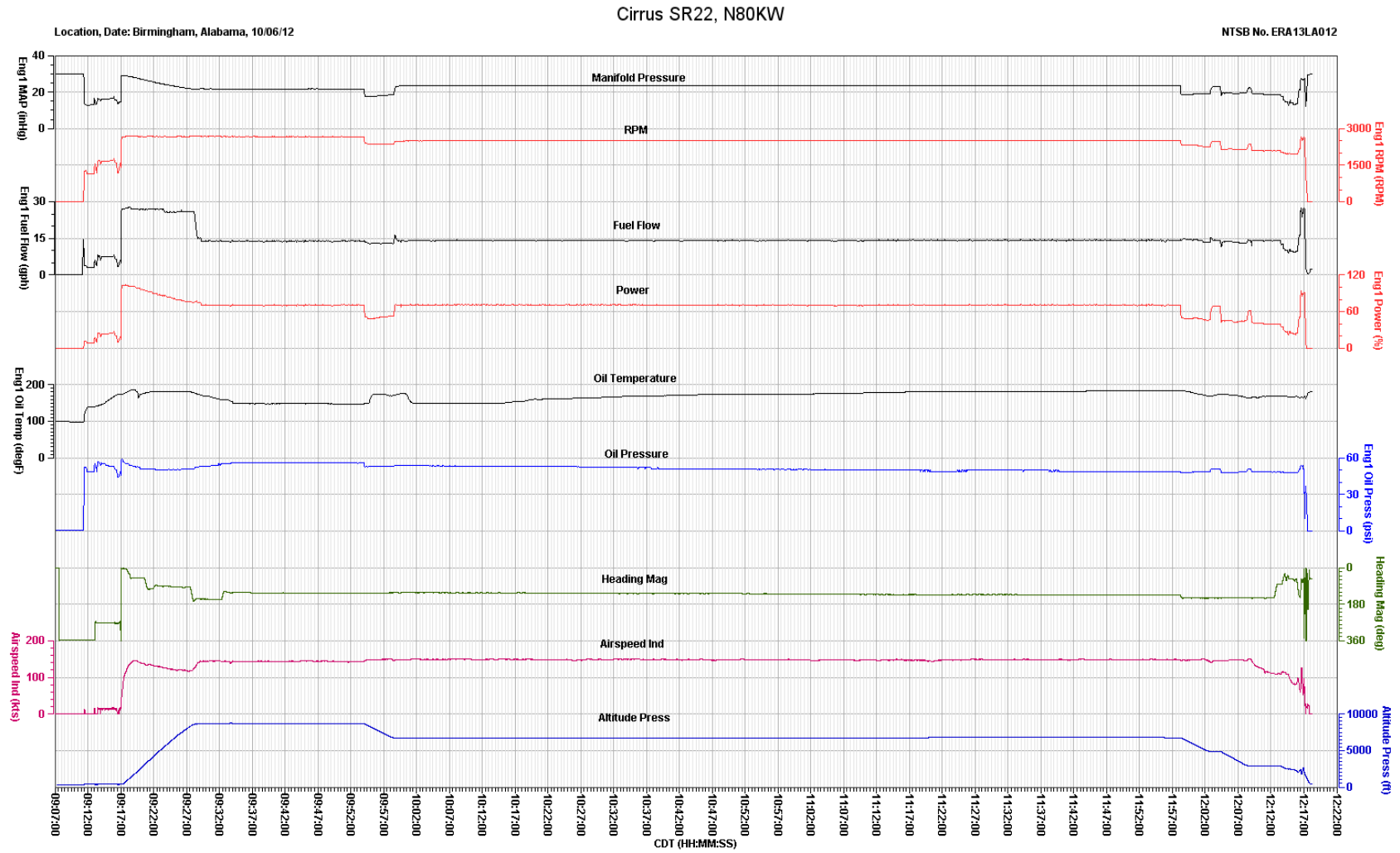
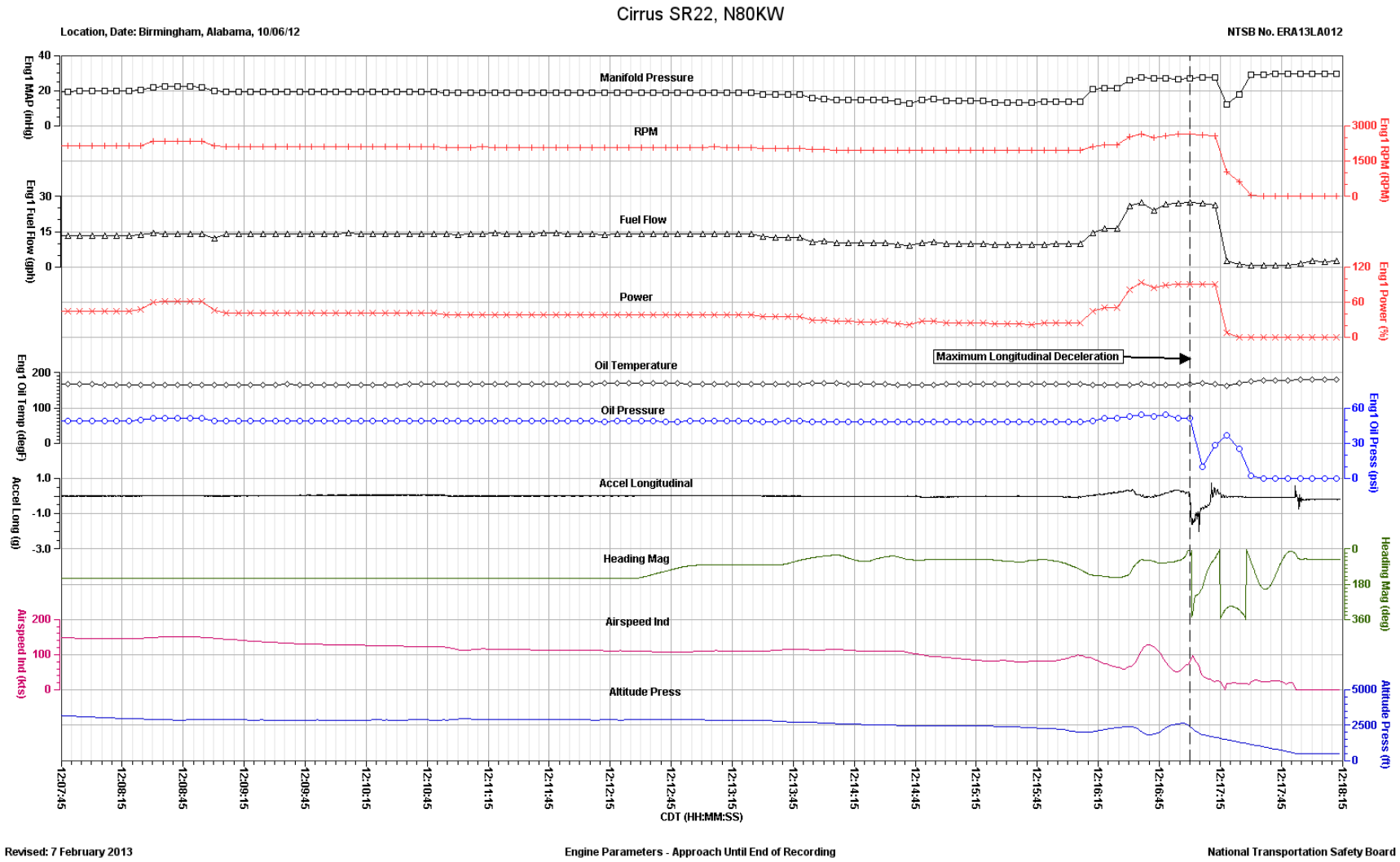


Figure 11. Plot of engine parameters for approach until end of recording.



APPENDIX A – Avidyne PFD 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 Lat (g)	Lateral Acceleration
2. Accel Long (g)	Longitudinal Acceleration
3. Accel Vert (g)	Vertical Acceleration
4. Airspeed Ind (kts)	Indicated Airspeed
5. Altitude Bug (ft)	Altitude Bug
6. Altitude Press (ft)	Pressure Altitude
7. AP ALT (discrete)	Autopilot Altitude Mode
8. AP AP_AP (discrete)	Autopilot On and Engaged
9. AP AP_Ready (discrete)	Autopilot Ready Mode
10. AP AP_SEL (discrete)	Autopilot PFD Vertical Speed Signal Active
11. AP APR (discrete)	Autopilot Approach Mode
12. AP CAP (discrete)	Autopilot Capture
13. AP Fail (discrete)	Autopilot Fail
14. AP FD (discrete)	Flight Director Only Mode
15. AP GPSS (discrete)	Autopilot GPSS Mode
16. AP GS (discrete)	Autopilot Glideslope
17. AP HDG (discrete)	Autopilot Heading Mode
18. AP NAV (discrete)	Autopilot Nav Mode
19. AP Soft (discrete)	Autopilot Soft Nav Capture Mode
20. AP Trim (discrete)	Autopilot Trim Control Active
21. AP VS (discrete)	Autopilot Vertical Speed Mode
22. Deviation – HDI (%)	Horizontal Deviation Indicator
23. Deviation – VDI (%)	Vertical Deviation Indicator
24. Eng1 Fuel Flow (gph)	Engine Fuel Flow
25. Eng1 MAP (inHg)	Engine Manifold Pressure
26. Eng1 Oil Press (psi)	Engine Oil Pressure
27. Eng1 Oil Temp (degF)	Engine Oil Temperature
28. Eng1 Power (%)	Engine Power
29. Eng1 RPM (rpm)	Propeller RPM
30. HDI Source Valid (discrete)	Horizontal Deviation Indicator Valid
31. Heading Bug (deg)	Heading Bug
32. Heading Mag (deg)	Magnetic Heading
33. Latitude (deg)	Latitude
34. Longitude (deg)	Longitude
35. Pitch (deg)	Pitch
36. Roll (deg)	Roll
37. Time - Day (day)	UTC Time - Day
38. Time - Month (month)	UTC Time - Month
39. Time - Year (year)	UTC Time – Year

Parameter Name	Parameter Description
40. Time UTC Hrs (hr)	Time UTC Hours
41. Time UTC Min (min)	Time UTC Minutes
42. Time UTC Sec (sec)	Time UTC Seconds
43. VDI Source Valid (discrete)	Vertical Deviation Indicator Valid

Table A-2 - Unit abbreviations.

Units Abbreviation	Description
%	percent
g	g
rpm	revolutions per minute
deg	degrees
degF	degrees Fahrenheit
discrete	discrete
ft	feet
hr	hour
kts	knots
psi	pounds per square inch
sec	Seconds
gph	Gallons per Hour
inHg	Inches of Mercury

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.