

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division

June 9, 2022

Flight Data Recorder

Specialist's Factual Report
By Kyle Garner

1. EVENT

Location: Truckee, CA
Date: July 26, 2021
Aircraft: Bombardier Inc. CL-600-2B16
Registration: N605TR
NTSB Number: WPR21FA286

2. FLIGHT DATA RECORDER GROUP

A flight data recorder (FDR) group was not convened.

3. FDR CARRIAGE REQUIREMENTS

The event aircraft, N605TR, was manufactured in 2007 and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 18 parameters, as cited in Title 14 *Code of Federal Regulations* Part 91.609(c) Appendix E.

4. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following FDR:

Recorder Manufacturer/Model: L-3/Fairchild FA2100, 128 wps
Recorder Serial Number: Unknown¹

4.1. FA2100 Description

This model FDR records airplane flight information in a digital format using solid-state flash memory as the recording medium. The FA2100 can receive data in the ARINC 573/717/747 configurations and can record a minimum of 25 hours of flight data. It is configured to record 128 12-bit words of digital information every second. Each grouping of 128 words (each second) is called a subframe. Each subframe has a unique 12-bit synchronization (sync) word identifying it as subframe 1, 2, 3, or 4. The sync word is the first word in each subframe. The data stream is "in sync" when successive sync words appear at proper 128-word intervals. Each data parameter (e.g., altitude, heading, airspeed) has a specifically assigned word number within the subframe. The FA2100 is designed to meet the crash-survivability requirements of TSO-C124b.

¹ The serial number of the FDR was not readable, due to severe heat and structural damage from the event. See section 4.1.1 for recorder condition details.

4.1.1. Recorder Condition

Upon arrival at the laboratory, it was evident that the FDR had sustained severe heat and structural damage, as shown in Figure 1.



Figure 1. FDR, as received.

The outer case was removed, and the interior crash-protected case did not appear to have any heat or structural damage. The memory board within the crash-protected case was checked for heat and structural damage and none was found. The data were successfully downloaded from the non-volatile memory² (NVM) using instructions from the manufacturer and NTSB lab equipment.

4.1.2. Recording Description

The FDR recording contained approximately 409 hours of data. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The event flight was the last flight of the recording.

The parameters evaluated for this report appeared to be per federal FDR carriage requirements.

4.1.3. Engineering Unit Conversions

The engineering unit conversions used for the data contained in this report are based on documentation from the aircraft manufacturer. 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=+).³

² Non-volatile memory is a semiconductor memory that does not require external power for data retention.

³ CRT=+ means that for parameters recorded that indicate 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 = +.

The lateral acceleration parameter had a bias of about -0.035g for the entirety of the recording. After the raw data was converted to engineering units, an offset of +0.035g was added to the lateral acceleration parameter. The figures in section 4.3 were generated with the offset for lateral acceleration applied.

Table A-1 lists the FDR parameters verified and provided in this report. Additionally, Table A-2 describes the unit and discrete abbreviations used in this report.

4.1.4. Pressure Altitude

This FDR records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The pressure altitude information presented in the FDR plots and the electronic data has not been corrected for the local altimeter setting at the time of the event.

4.2. Time Correlation

Correlation of the FDR data from SRN to Coordinated Universal Time (UTC), was established by using the recorded GMT Hours, GMT Minutes, and GMT Seconds parameters. Then, conversion from UTC to Pacific daylight time (PDT) was established by subtracting 7 hours.

Accordingly, the time offset for the event flight data from SRN to PDT is the following:

$$\text{PDT} = \text{SRN} - 1423782$$

Therefore, for the rest of this report, all times are referenced as PDT.

4.3. FDR Plots and Corresponding Tabular Data

Figures 2 to 18 contain FDR data recorded during the event on July 26, 2021. Parameters from the event flight are plotted for three different time ranges:

- Full Flight – the complete event flight, takeoff to impact, from 1145 to approximately 1318
- Descent – the event flight's descent into Truckee-Tahoe Airport until impact, from 1309 to approximately 1318
- Final 2 Minutes – the final two minutes of the event flight's recording, from 1316 to approximately 1318

Figures 2 to 4 are plots of basic parameters, figures 5 to 7 are plots of pitch-related parameters, figures 8 to 10 are plots of roll-related parameters, figures 11 to 13 are plots of autopilot and miscellaneous parameters, and figures 14 to 16 are plots of engine-related parameters for the event flight.

Figures 17 and 18 are Google Earth overlays of the event flight path using latitude, longitude, and pressure altitude recorded by the FDR. Note that the weather and lighting conditions shown in Google Earth are not necessarily representative of the weather and lighting conditions at the time of the event.

The data show the aircraft departed Coeur d'Alene Airport (KCOE), in Kootenai County, Idaho at 11:45:37 and climbed to a cruising altitude of 37,000 feet MSL on a southwesterly heading. The aircraft continued in cruise for about an hour before it began a descent at approximately 1248 for Truckee-Tahoe Airport. 12 seconds before the recording ended, the aircraft entered a left bank

and the flight spoilers extended. While still in a left bank, about 7 seconds later, the stick pusher and stick shaker activated. The recording ended shortly thereafter, at 13:18:11.

The corresponding tabular data used to create Figures 2 to 18 are provided in electronic comma-separated value (*.csv) format as attachment 1 to this report.

Basic Parameters - Full Flight

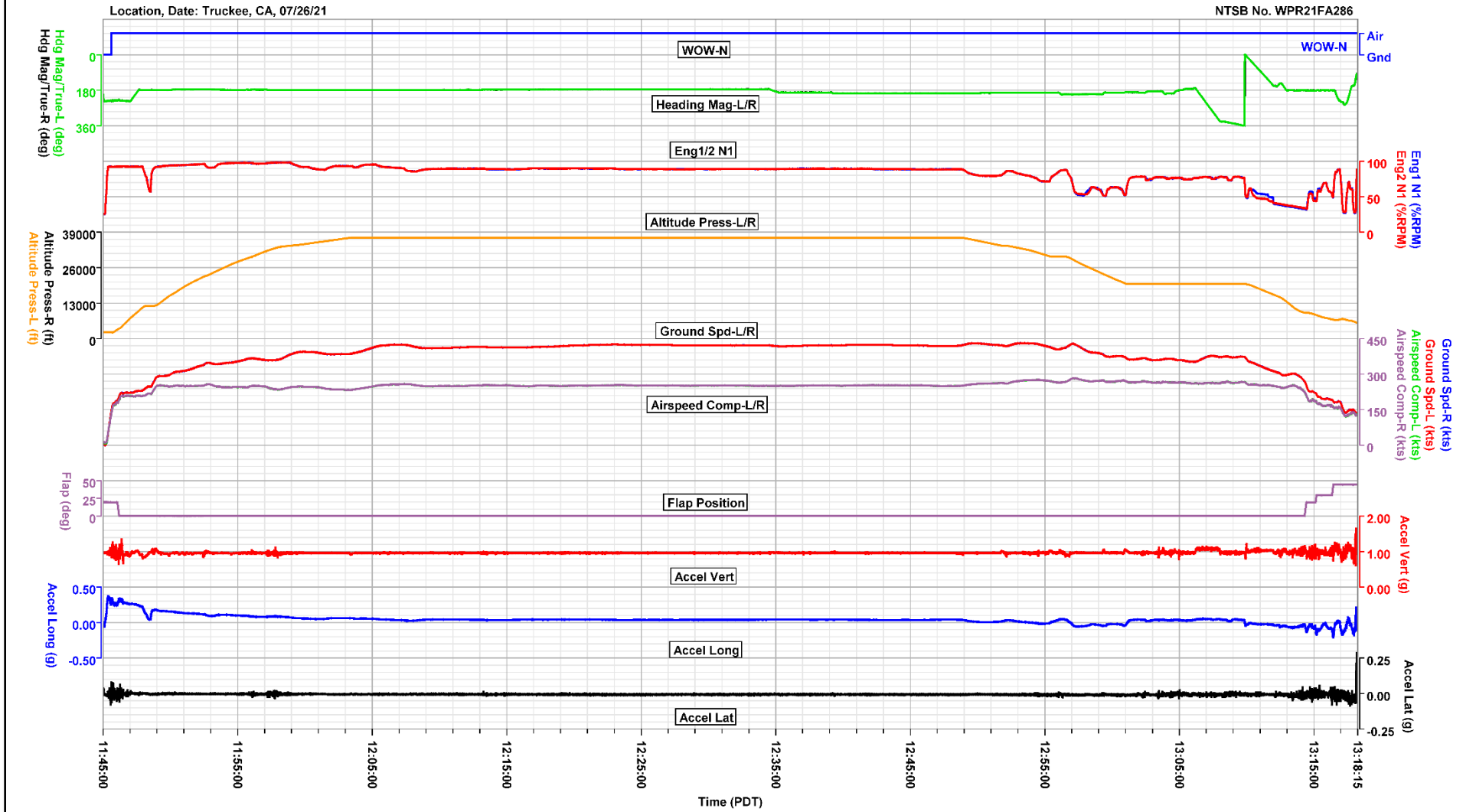


Figure 2. Plot of basic parameters – full event flight.

Basic Parameters - Descent

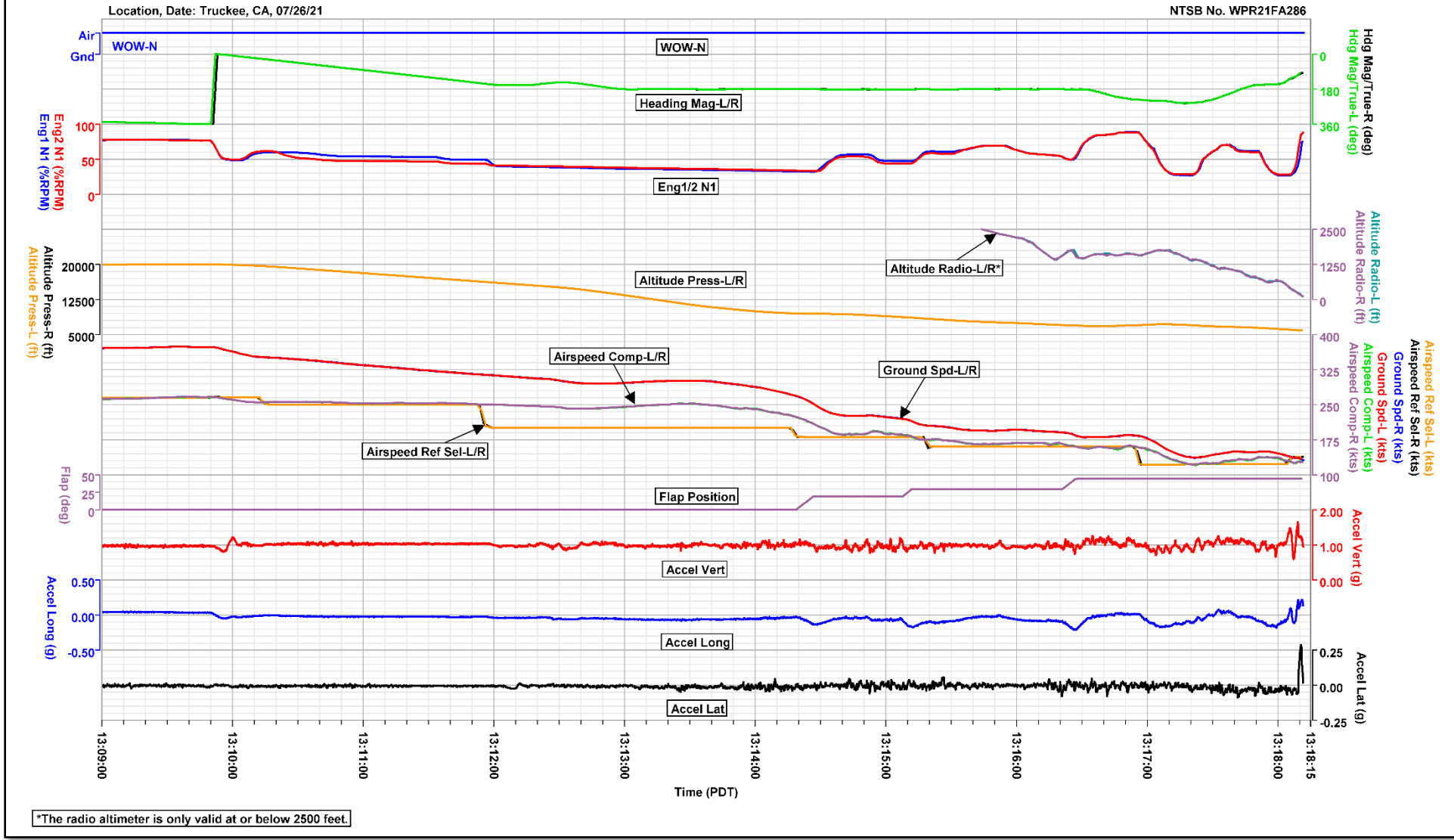


Figure 3. Plot of basic parameters – event flight descent.

Basic Parameters - Final 2 Minutes

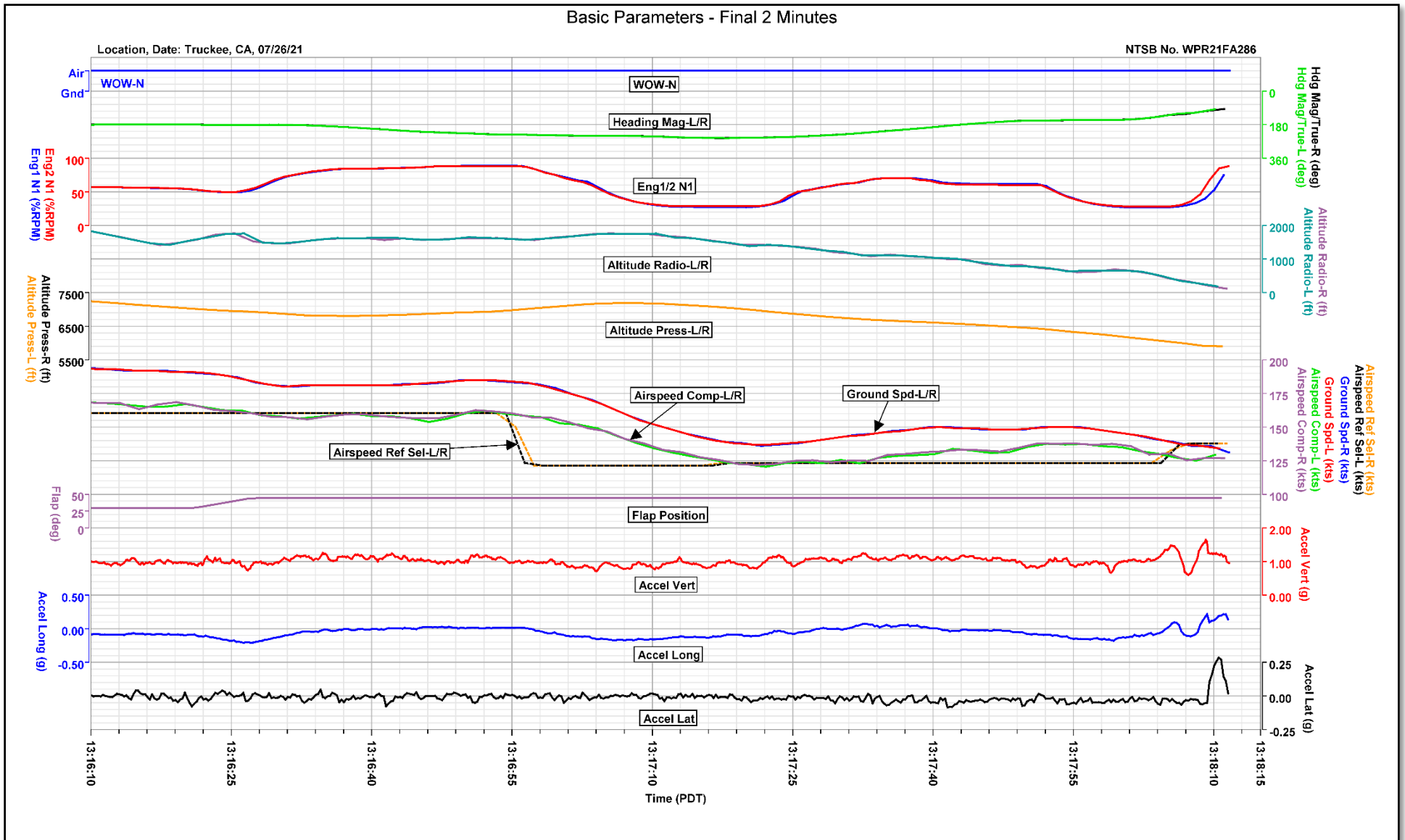


Figure 4. Plot of basic parameters – final two minutes of event flight.

Pitch Parameters - Full Flight

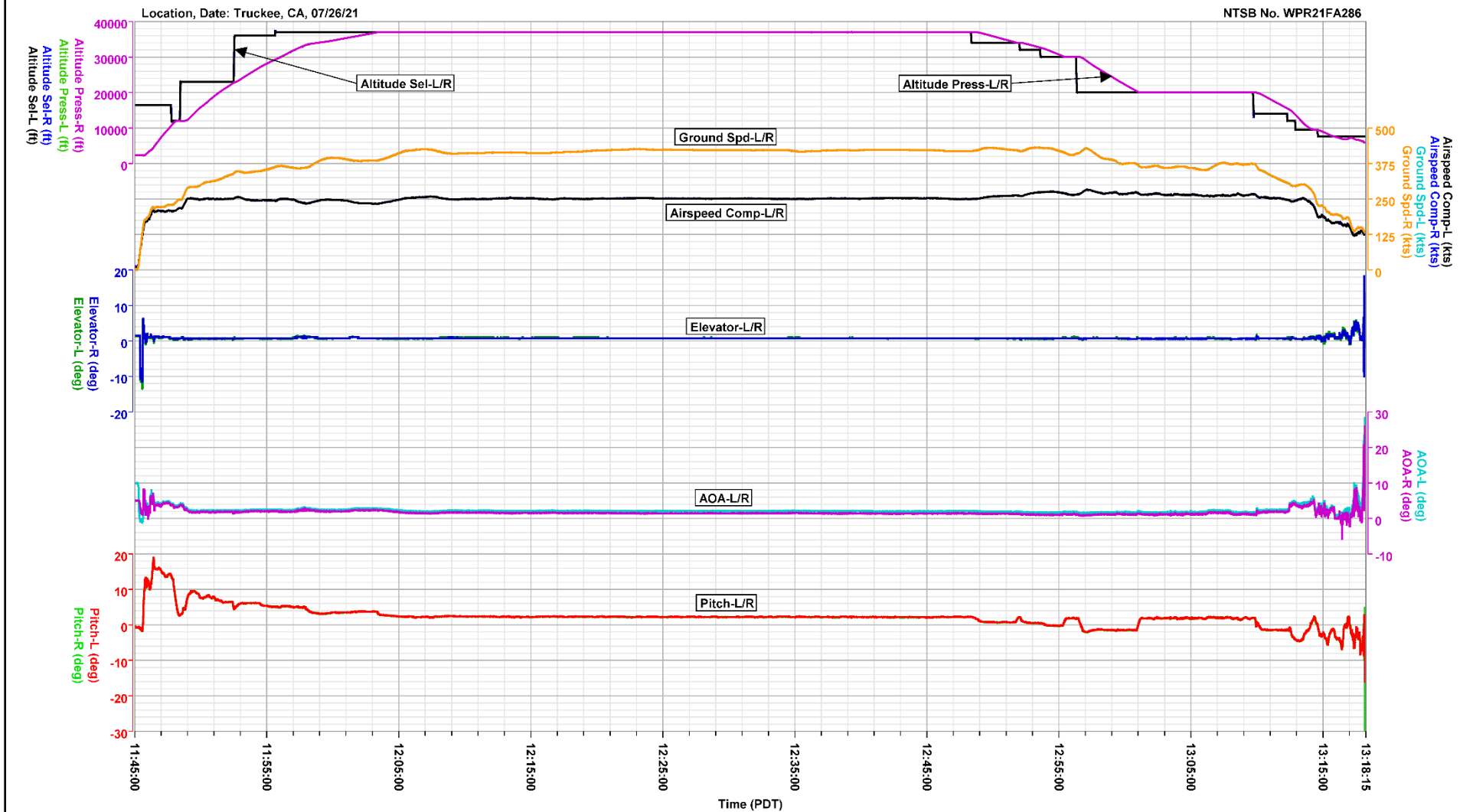


Figure 5. Plot of pitch-related parameters – full event flight.

Pitch Parameters - Descent

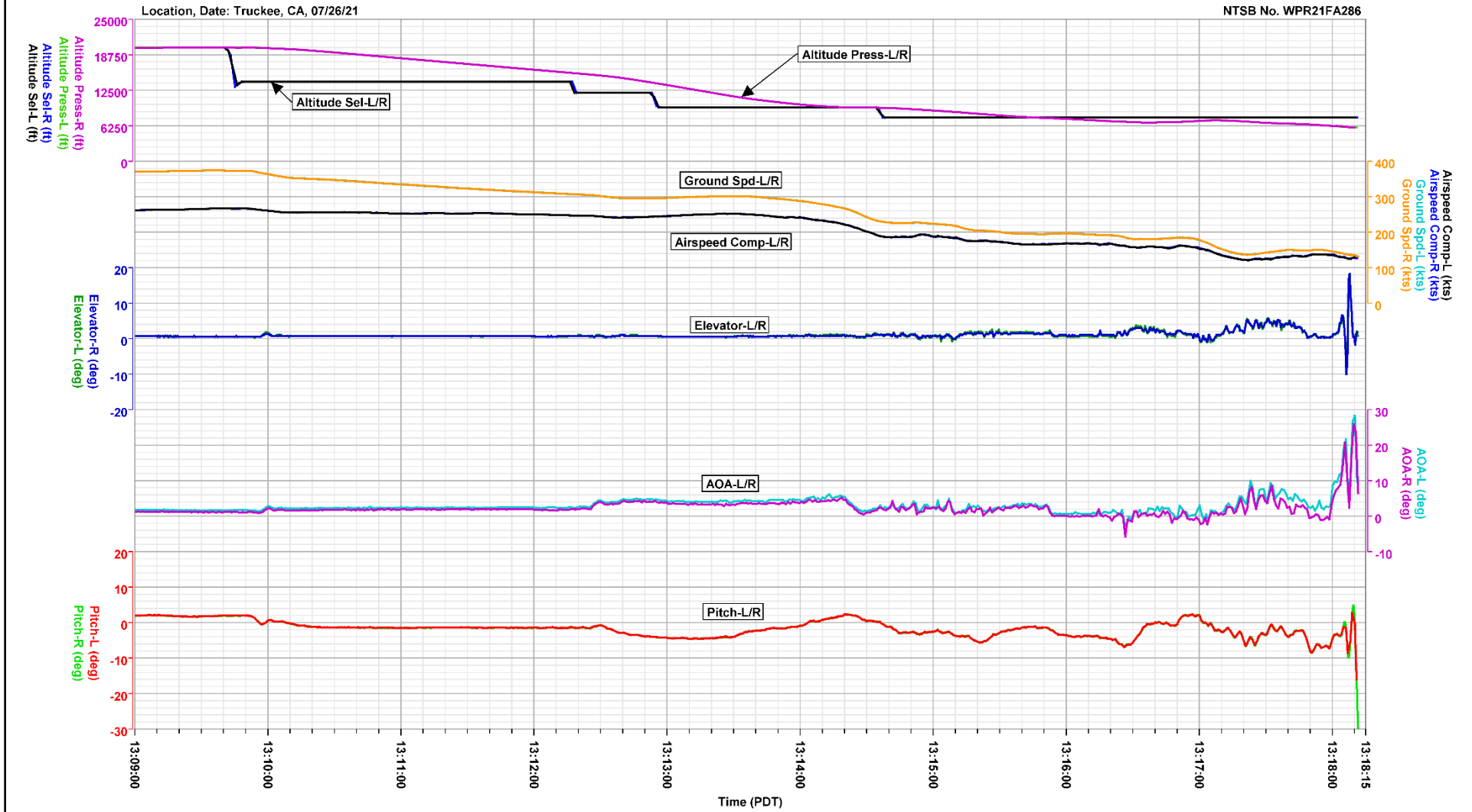


Figure 6. Plot of pitch-related parameters – event flight descent.

Pitch Parameters - Final 2 Minutes

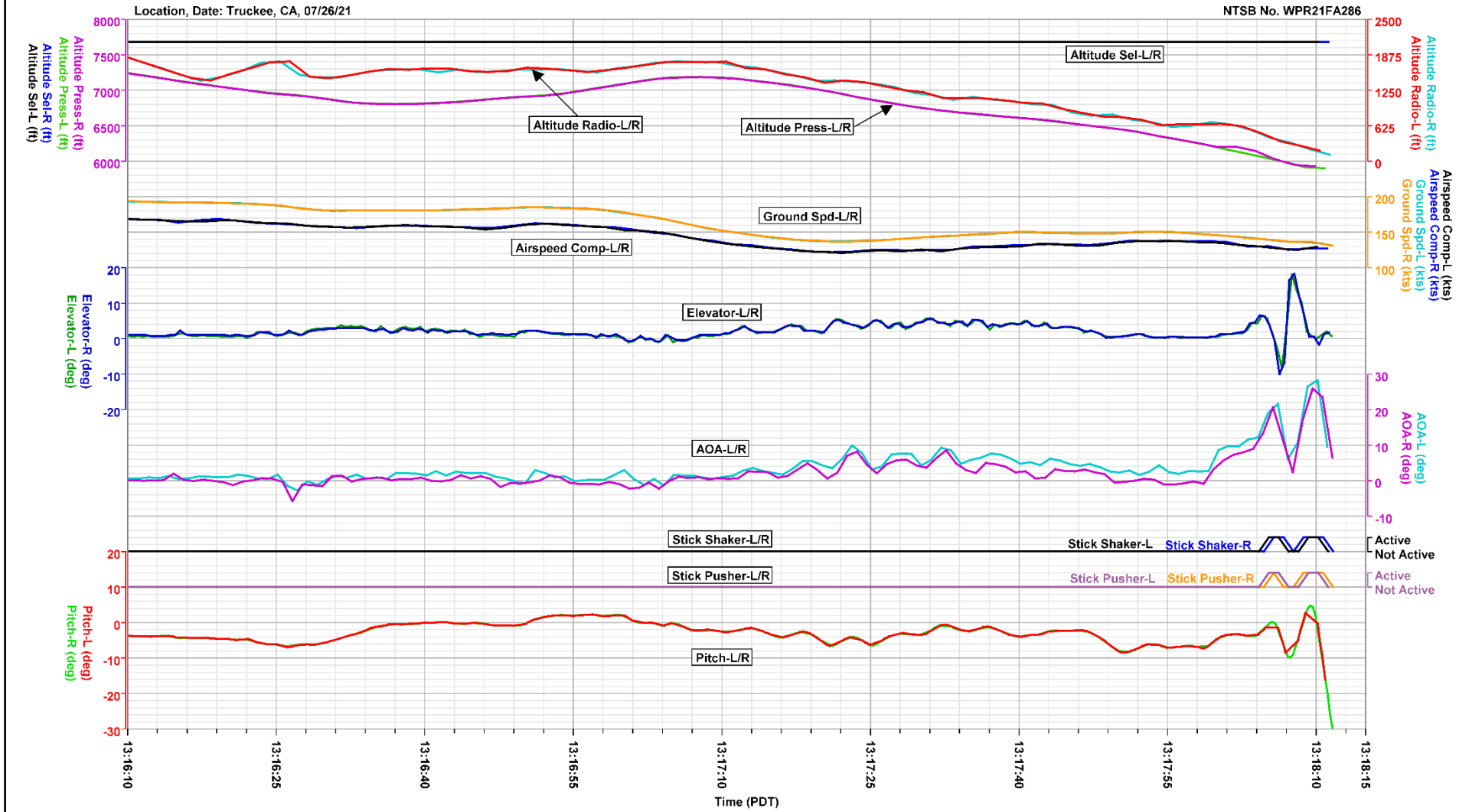


Figure 7. Plot of pitch-related parameters – final two minutes of event flight.

Roll Parameters - Full Flight

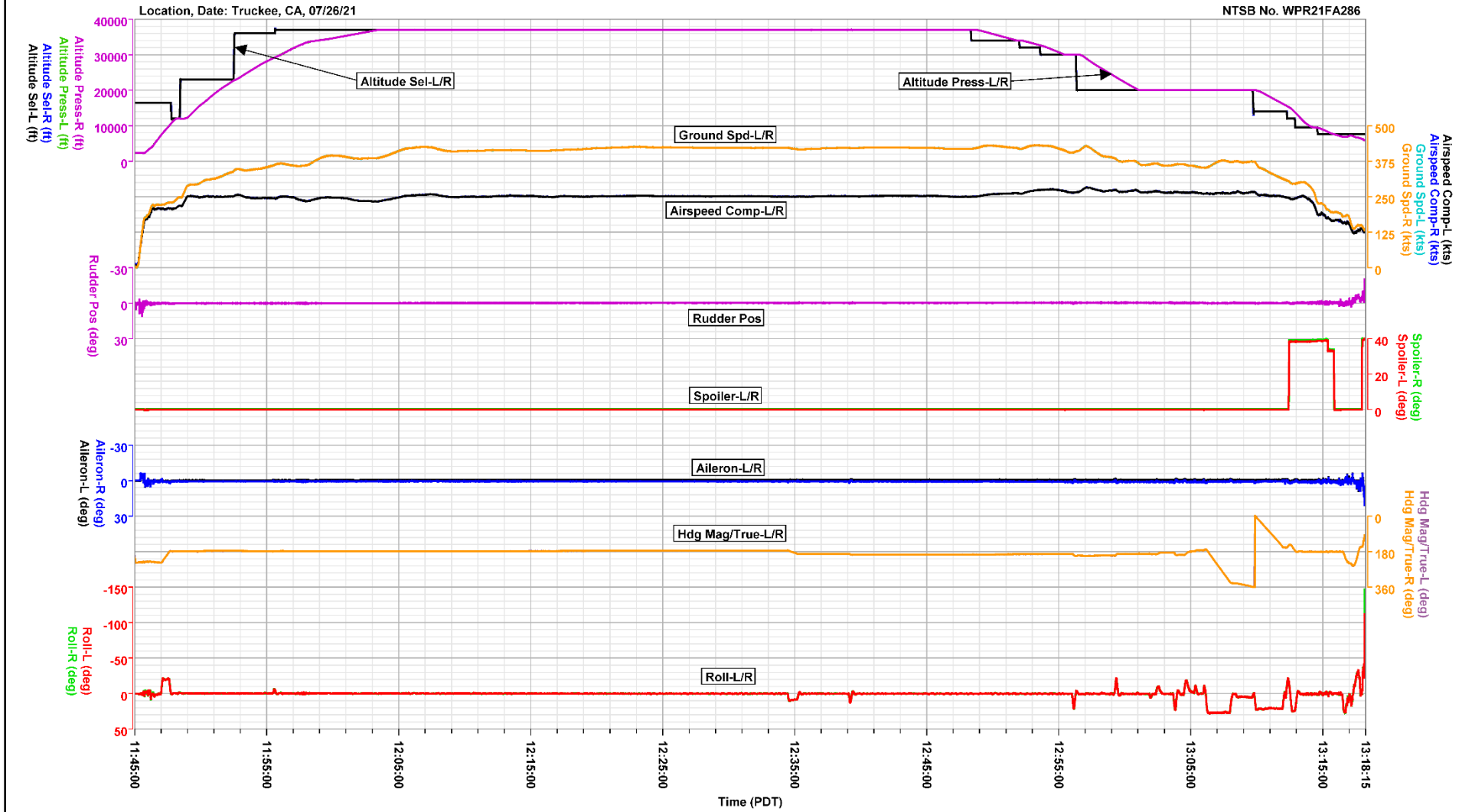


Figure 8. Plot of roll-related parameters – full event flight.

Roll Parameters - Descent

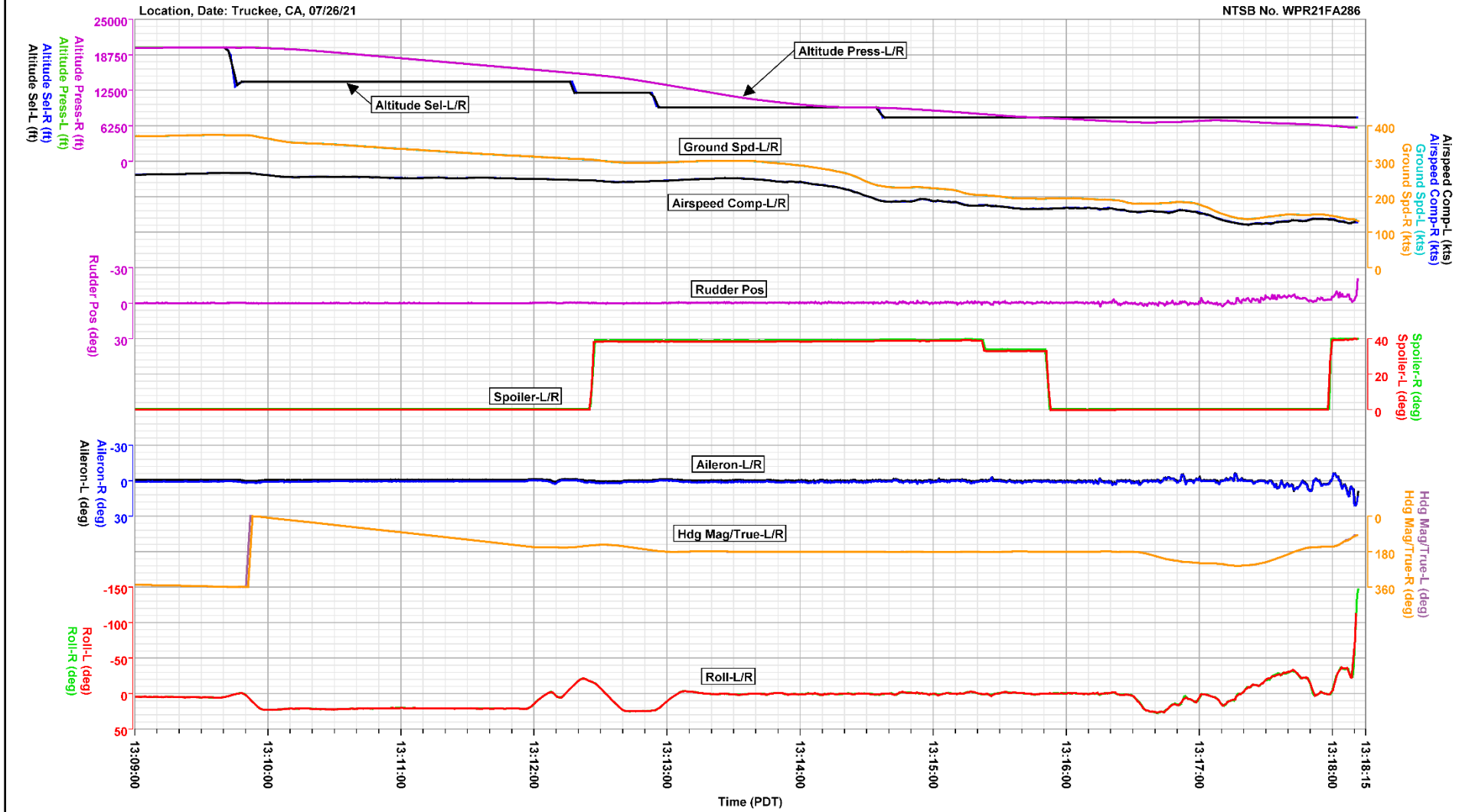


Figure 9. Plot of roll-related parameters – event flight descent.

Roll Parameters - Final 2 Minutes

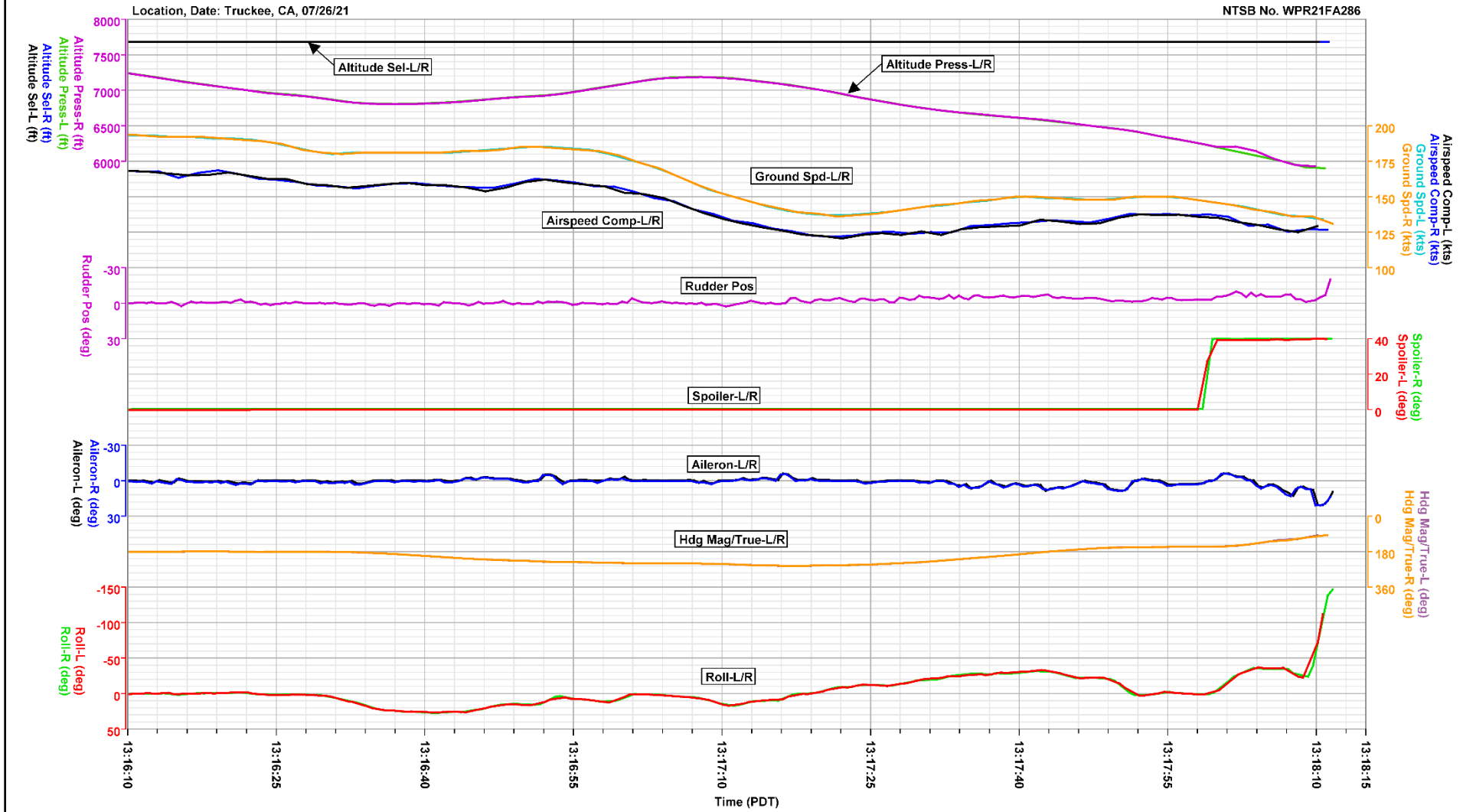


Figure 10. Plot of roll-related parameters – final two minutes of event flight.

Autopilot Parameters - Full Flight

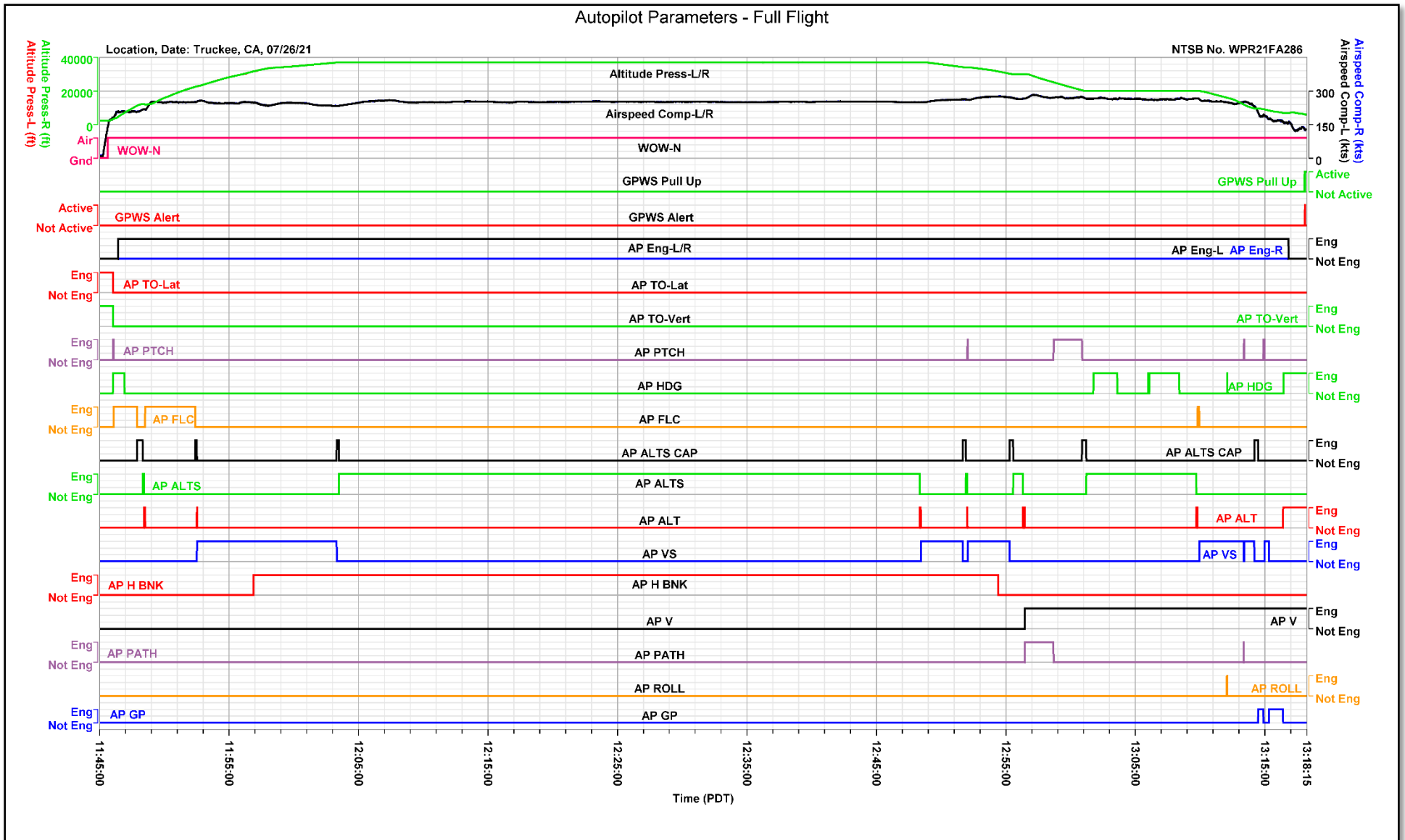


Figure 11. Plot of autopilot and miscellaneous parameters – full event flight.

Autopilot Parameters - Descent

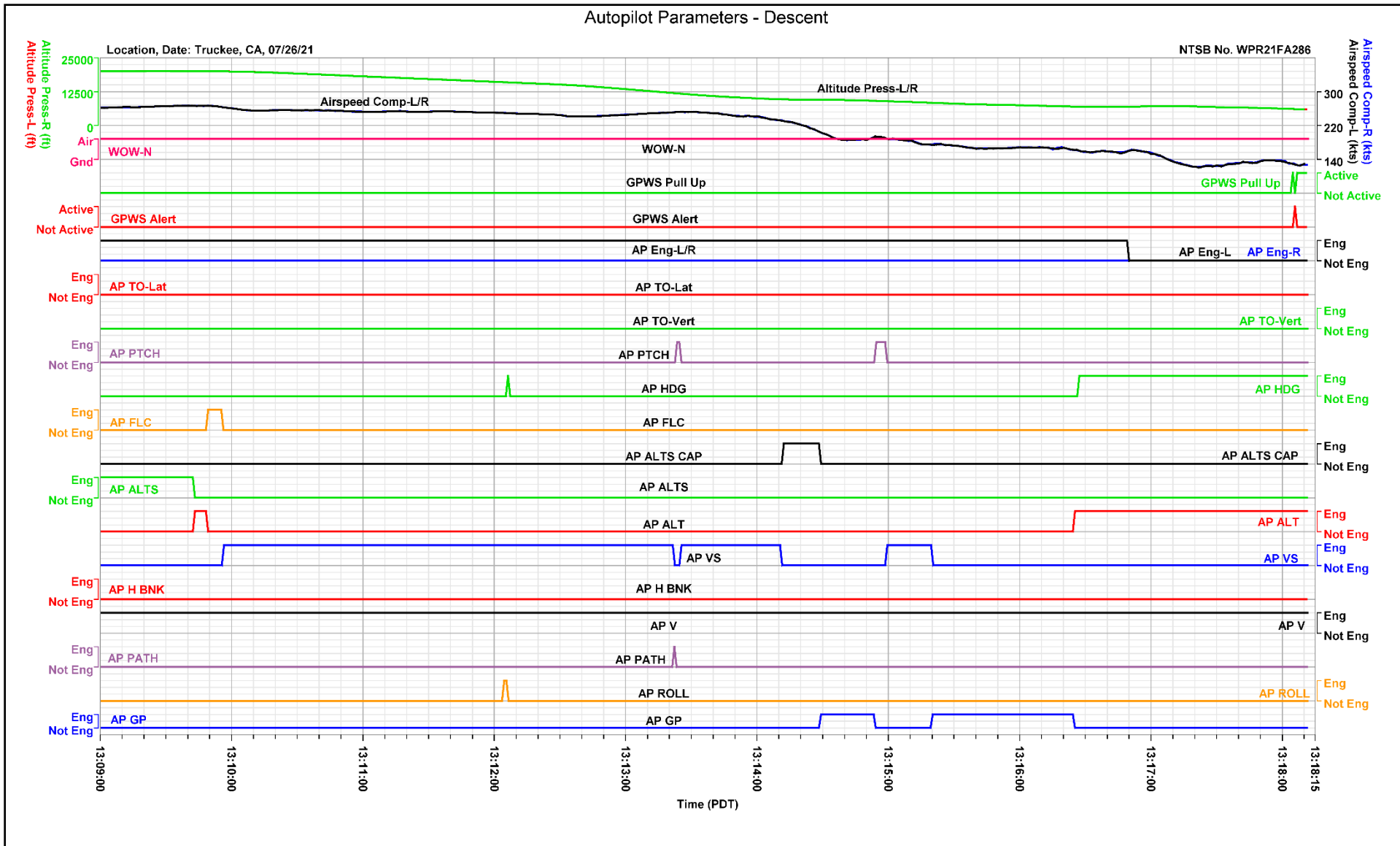


Figure 12. Plot of autopilot and miscellaneous parameters – event flight descent.

Autopilot Parameters - Final 2 Minutes

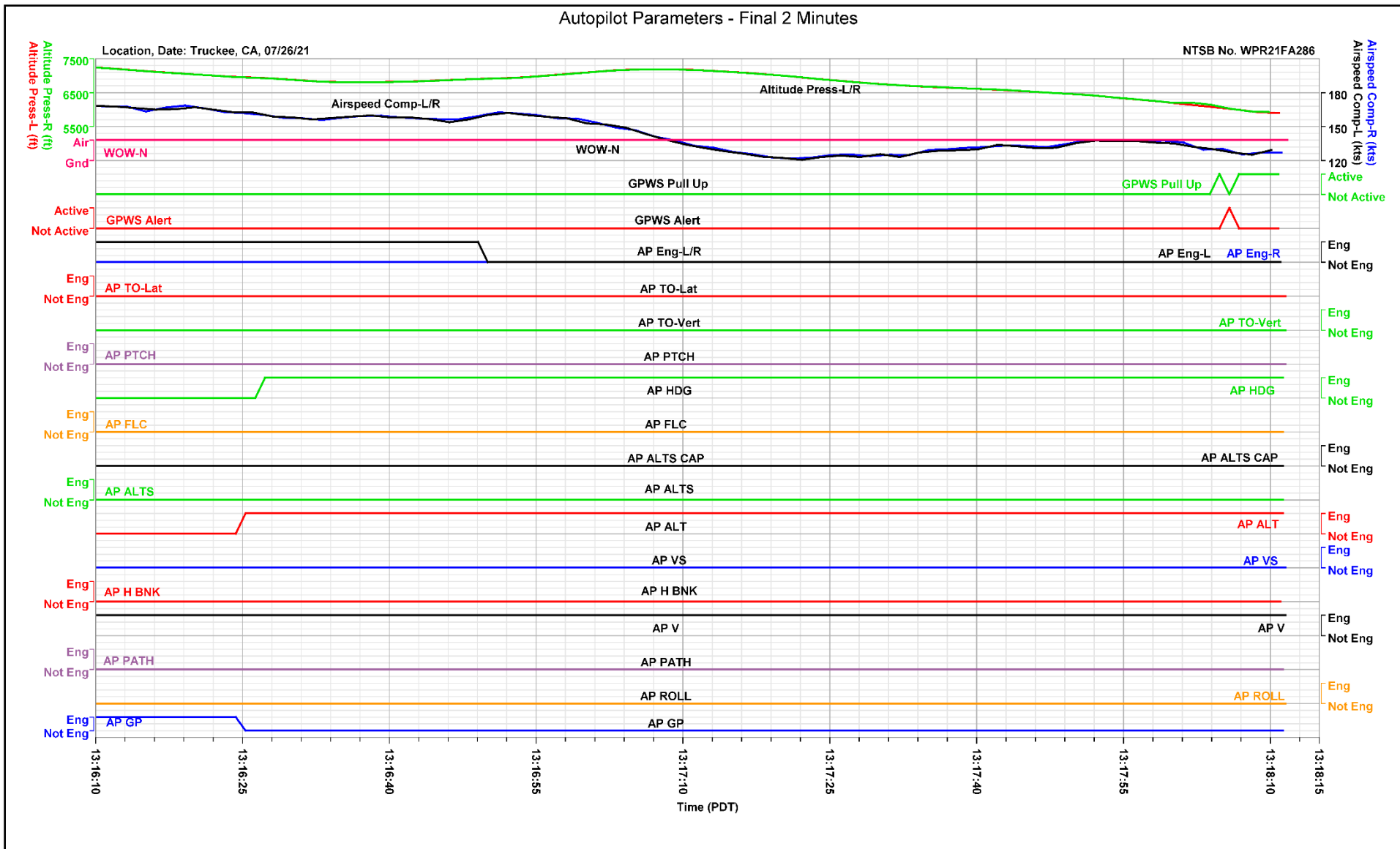


Figure 13. Plot of autopilot and miscellaneous parameters – final two minutes of event flight.

Engine Parameters - Full Flight

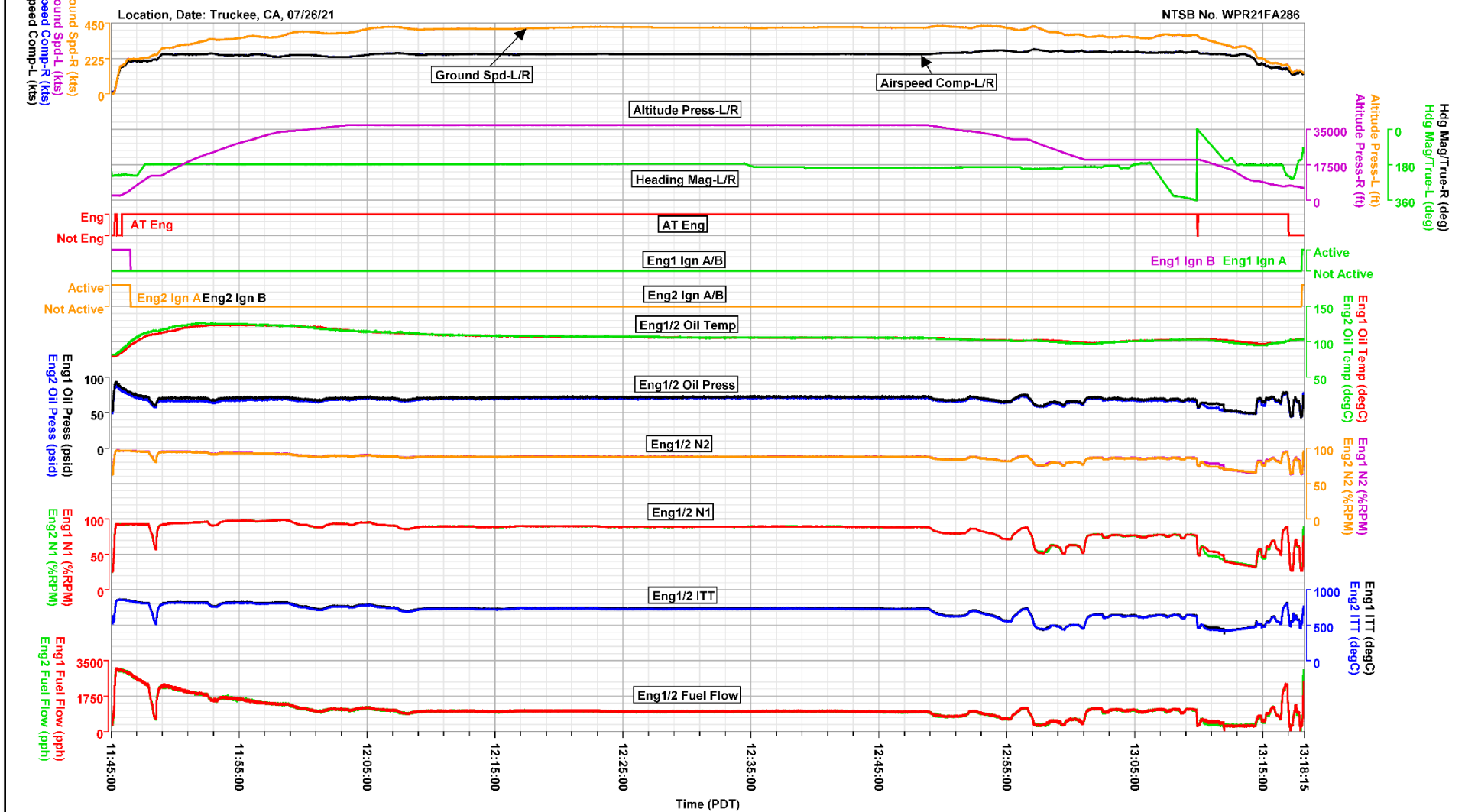


Figure 14. Plot of engine parameters - full event flight.

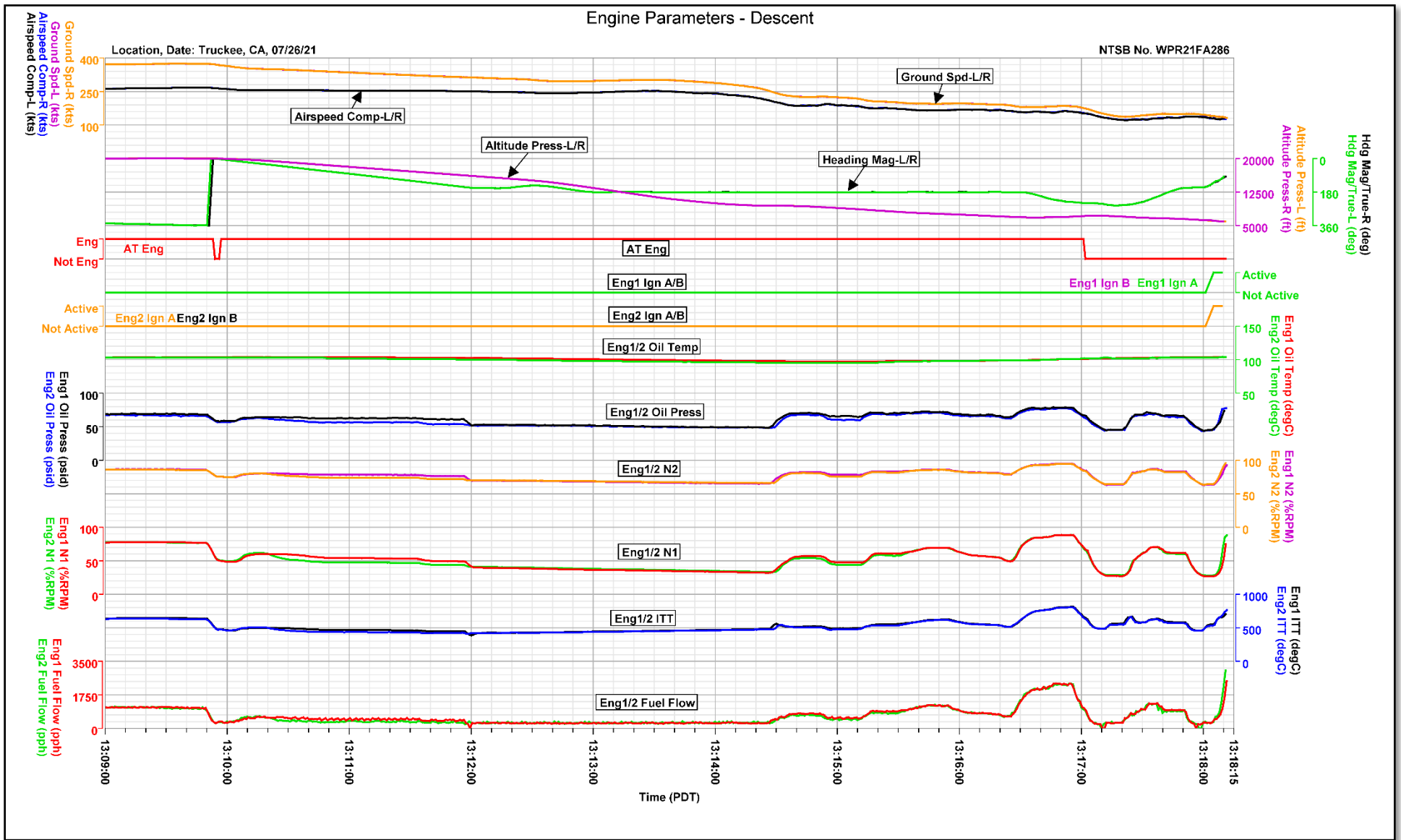


Figure 15. Plot of engine parameters – event flight descent.

Engine Parameters - Final 2 Minutes

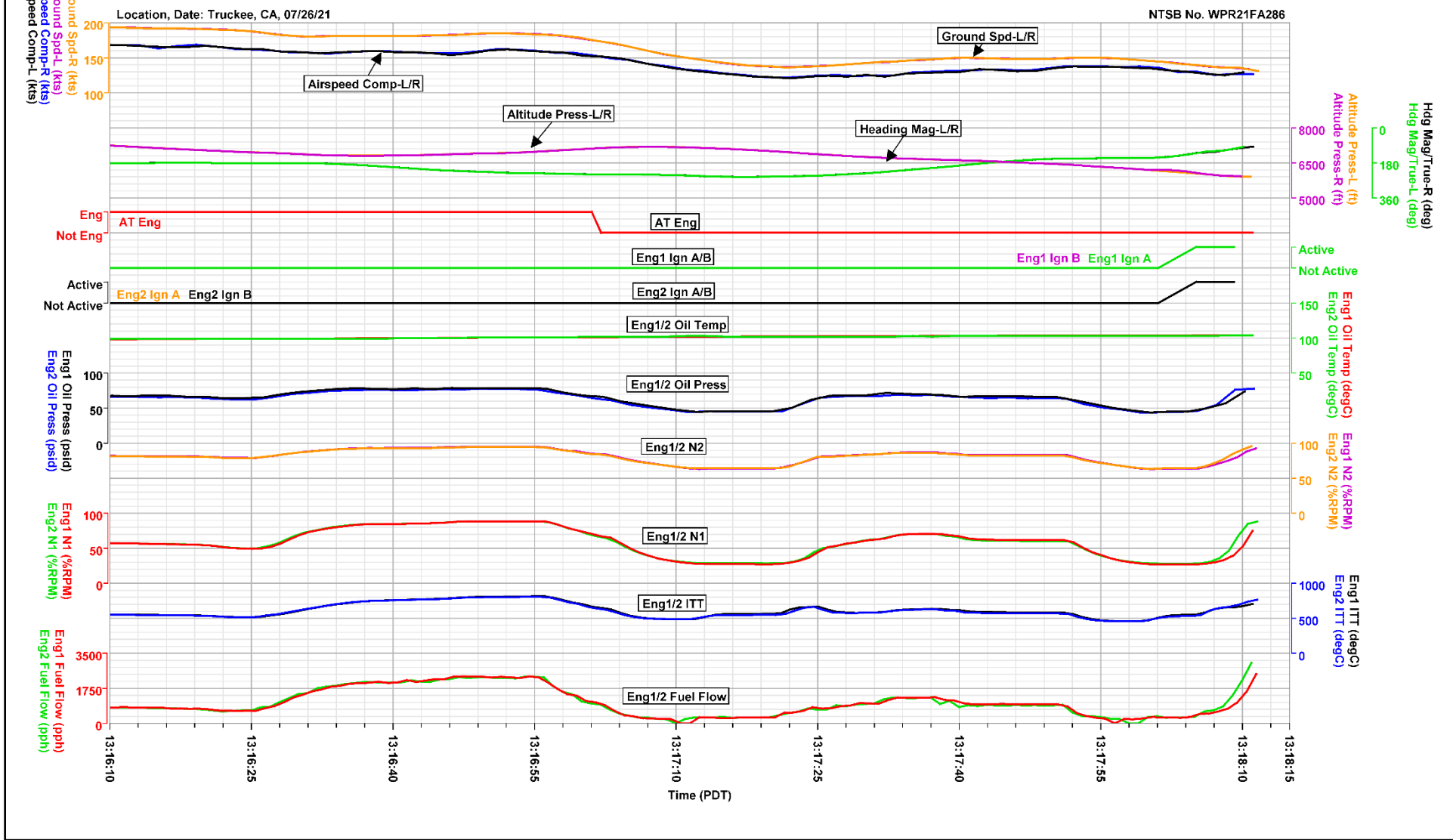


Figure 16. Plot of engine parameters - final two minutes of event flight.

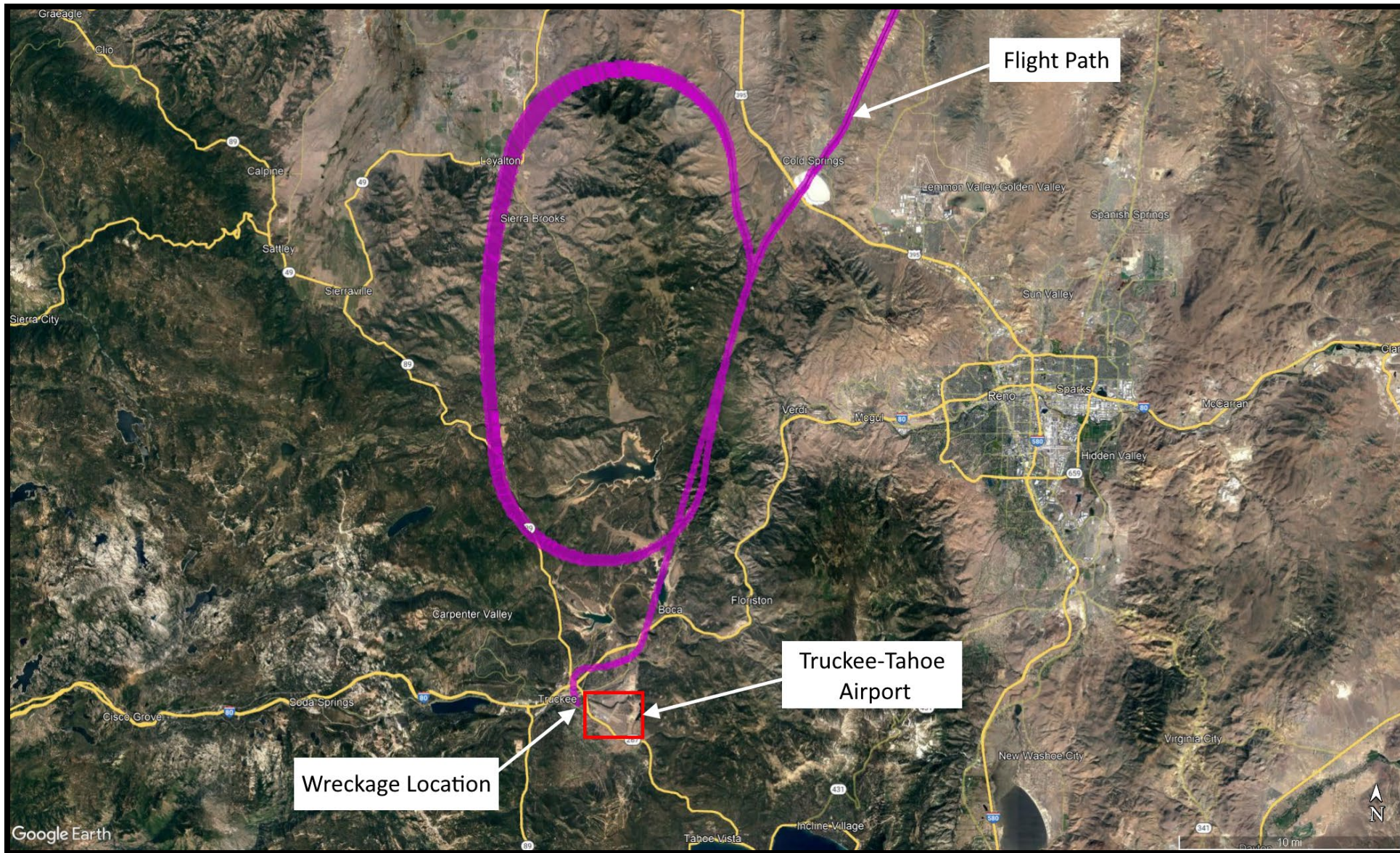


Figure 17. Flight path of event flight - Google Earth overlay.

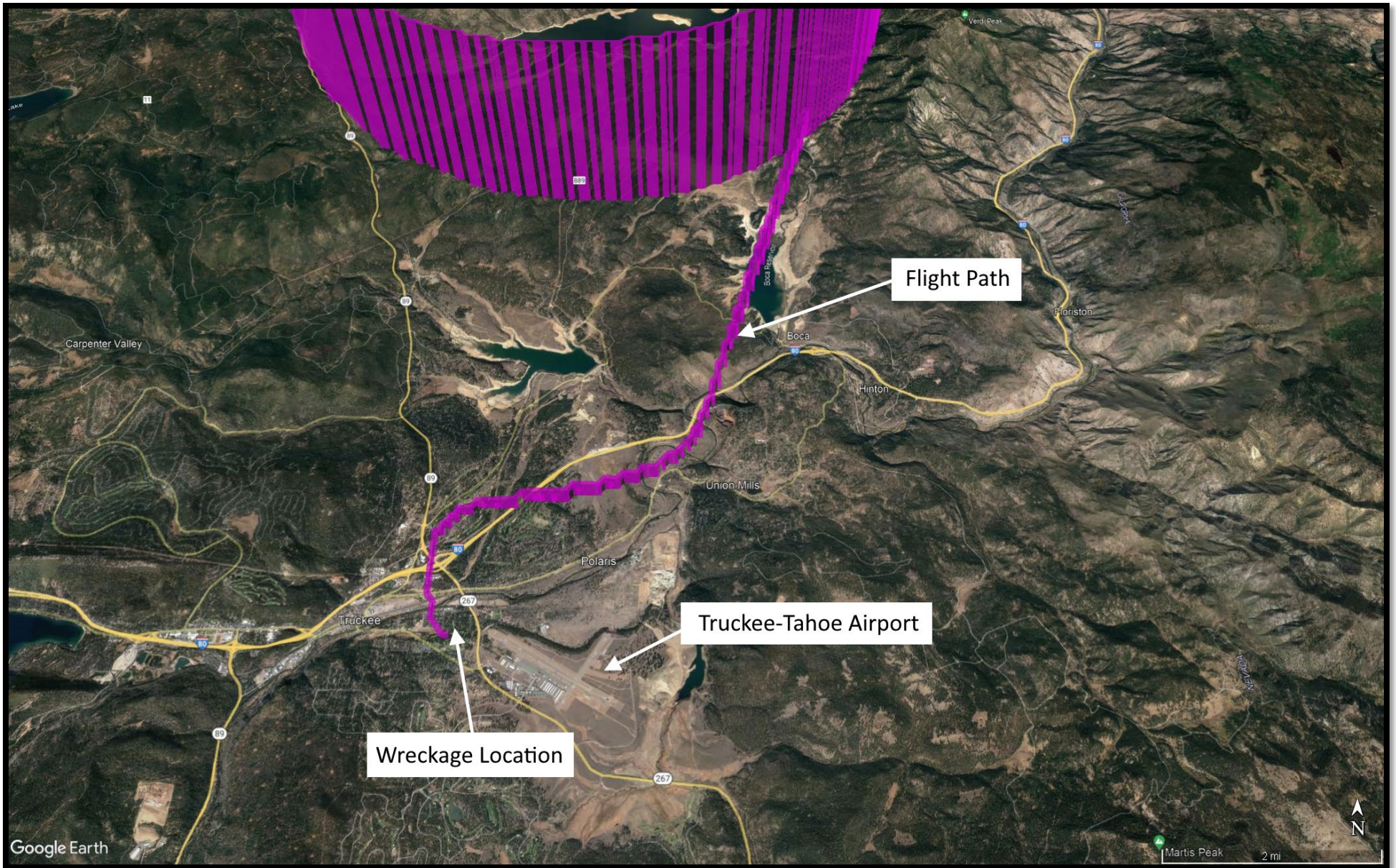


Figure 18. Flight path of event flight - Google Earth overlay - zoom.

APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the plot/table labels, parameter names, and units. Additionally, Table A-2 describes the unit and discrete abbreviations used in this report.

Table A-1. Verified and provided FDR parameters⁴.

| Plot/Table Label | Parameter Names | Units |
|-------------------------|--|--------------|
| Accel Lat | Lateral Acceleration | g |
| Accel Long | Longitudinal Acceleration | g |
| Accel Vert | Vertical Acceleration | g |
| Aileron-L | Aileron Position-Left | deg |
| Aileron-R | Aileron Position-Right | deg |
| Airspeed Comp-L/R | Computed Airspeed-Left/Right | kts |
| Airspeed Ref Sel-L/R | Selected Reference Airspeed-Left/Right | kts |
| Altitude Press-L/R | Pressure Altitude Left/Right | ft |
| Altitude Radio-L/R | Radio Altitude-Left/Right | ft |
| Altitude Sel-L/R | Altitude Select-Left/Right | ft |
| AOA-L/R | Angle of Attack-Left/Right | deg |
| AP ALT | ALT (ALT hold capture) | |
| AP ALTS | Altitude select mode | |
| AP ALTS CAP | Altitude select mode - capturing | |
| AP ALTV | Vertical navigation mode | |
| AP ALTV CAP | Vertical navigation mode - capturing | |
| AP Eng-L/R | AP Engaged-Left/Right | |
| AP FLC | FLC (Flight Level Change Mode) | |
| AP GA-Lat* | GA (Lateral Go-around) | |
| AP GA-Vert* | GA (Vertical Go-around) | |
| AP GP | GP (Glide path mode) | |
| AP GS* | GS (Glide slope mode) | |
| AP H BNK | 1/2 BNK (Half Bank mode) | |
| AP HDG | HDG (Heading select mode) | |
| AP NAV Cap Srce* | NAV Capture source | |
| AP PATH | PATH (Vertical navigation mode) | |
| AP PTCH | PTCH (Pitch mode) | |
| AP ROLL | ROLL (Roll mode) | |
| AP TO-Lat | TO (Lateral Takeoff mode) | |
| AP TO-Vert | TO (Vertical Takeoff mode) | |
| AP V | V (Vertical Navigation mode) | |
| AP VS | VS (Vertical Speed mode) | |
| AT Eng | Autothrottle Engaged | |
| Drift Angle* | Drift Angle | deg |
| Elevator-L/R | Elevator Position-Left/Right | deg |
| Eng1/2 Fuel Flow | Engine 1/2 Fuel Flow | pph |
| Eng1/2 ITT | Engine 1/2 Interturbine Temperature | degC |
| Eng1/2 N1 | Engine 1/2 N1 | %RPM |
| Eng1/2 N2 | Engine 1/2 N2 | %RPM |
| Eng1/2 Oil Press | Engine 1/2 Oil Pressure | psid |

⁴ Parameters verified and provided, but not plotted are designated with an asterisk after the Plot/Table Label.

APPENDIX A

| Plot/Table Label | Parameter Names | Units |
|--------------------------|---|-------|
| Eng1/2 Oil Temp | Engine 1/2 Oil Temperature | degC |
| Eng1/2 Rvrsr Arm* | Engine 1/2 Thrust Reverser Armed | |
| Eng1/2 Rvrsr Deploy* | Engine 1/2 Thrust Reverser Deployed | |
| Eng1/2 Rvrsr Unlk* | Engine 1/2 Thrust Reverser Unlocked | |
| Flap | Flap Position | deg |
| Flap Hdl-0* | Flap Handle at Position 0 | |
| Flap Hdl-20* | Flap Handle at Position 20 | |
| Flap Hdl-30* | Flap Handle at Position 30 | |
| Flap Hdl-45* | Flap Handle at Position 45 | |
| Fuel Qty-Aux* | Fuel Quantity-Aux | lb |
| Fuel Qty-L/R/Tail* | Fuel Quantity-Left/Right/Tail | lb |
| Gear Dwn+Lckd-L/N/R* | Landing Gear Down and Locked-Left/Nose/Right | |
| GMT-Hrs* | GMT-Hours | hrs |
| GMT-Min* | GMT-Minutes | min |
| GMT-Sec* | GMT-Seconds | sec |
| Gnd Spoiler-L/R* | Ground Spoiler-Left/Right | |
| GPWS Alert | Ground Proximity Warning System-Alert | |
| GPWS Pull Up | Ground Proximity Warning System-Pull Up | |
| GPWS Terr Caut* | Ground Proximity Warning System-Terrain Caution | |
| GPWS Terr Warn* | Ground Proximity Warning System-Terrain Warning | |
| Ground Spd-L/R | Ground Speed-Left/Right | kts |
| Hdg Mag/True Src-L/R* | Mag/True Heading Source-Left/Right | |
| Hdg Mag/True-L/R | Mag/True Heading-Left/Right | deg |
| Hdg Sel-L/R* | Heading Selected-Left/Right | deg |
| Latitude* | Latitude | deg |
| Longitude* | Longitude | deg |
| Master Warn* | Master Warning | |
| Pitch Trim* | Pitch Trim | deg |
| Pitch-L/R | Pitch-Left/Right | deg |
| Roll-L/R | Roll-Left/Right | deg |
| Rudder Pos | Rudder Position | deg |
| Spoiler Ctrl Auto Arm* | Spoiler Control-Auto Arm | |
| Spoiler Ctrl Pnl Arm* | Spoiler Control-Panel Arm | |
| Spoiler Ctrl Pnl Disarm* | Spoiler Control-Panel Disarm | |
| Spoiler-L/R | Spoiler Position-Left/Right | deg |
| Stick Pusher-L/R | Stick Pusher-Left/Right | |
| Stick Shaker-L/R | Stick Shaker-Left/Right | |
| Temp TAT-L/R* | Total Air Temperature-Left/Right | degC |
| VHF Key-L/R* | VHF Keying-Left/Right | |
| Wind Direction-Mag* | Wind Direction-Magnetic | deg |
| Wind Speed* | Wind Speed | kts |
| WOW-L/N/R | Landing Gear Weight-on-Wheels-Left/Nose/Right | |
| YD 1 Eng* | Yaw Damper Engaged-1 | |
| YD 2 Eng* | Yaw Damper Engaged-2 | |

NOTE: Parameters with a blank unit description in Table A-1 are discretes. 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.

APPENDIX A

Table A-2. Unit and discrete abbreviations.

| Abbreviation | Description |
|--------------|--------------------------------|
| %rpm | percent revolutions per minute |
| deg | degrees |
| degC | degrees Celsius |
| ft | feet |
| hrs | hours |
| kts | knots |
| lb | pounds |
| min | minutes |
| pph | pounds per hour |
| mb | millibars |
| psi | pounds per square inch |
| sec | seconds |