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

December 8, 2020

Flight Data Recorder

Specialist's Factual Report
By Charles Cates

1. EVENT SUMMARY

Location: Dutch Harbor, Alaska
Date: October 17, 2019
Aircraft: Saab 2000
Registration: N686PA
Operator: Peninsula Aviation Services Inc.
NTSB Number: DCA20MA002

On October 17, 2019, about 1740 Alaska daylight time, Peninsula Aviation Services Inc. d.b.a. PenAir flight 3296, a Saab 2000, N686PA, was landing at Unalaska Airport (DUT), Unalaska, Alaska, when the airplane overran the end of the runway, passed through the airport perimeter fence, crossed a road, and pitched down over shoreline rocks with its nosewheel in Dutch Harbor. Two flight crewmembers, one flight attendant, and 39 passengers were aboard the airplane; 1 passenger sustained fatal injuries. The airplane was substantially damaged. The airplane was operating as a regularly scheduled passenger flight under the provisions of Title 14 *Code of Federal Regulations* (CFR) Part 121. Visual meteorological conditions prevailed at the time of the accident. The flight had departed from Ted Stevens Anchorage International Airport (ANC), Anchorage, Alaska, at 1523.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR CARRIAGE REQUIREMENTS

The event aircraft, N686PA, was manufactured in 1995, and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 34 parameters, as cited in Title 14 CFR Part 121.344.

4. DETAILS OF FDR INVESTIGATION

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

Recorder Manufacturer/Model: **L3/Fairchild F1000, p/n S800-3000-00**
Recorder Serial Number: **00691**

4.1. L3/Fairchild F1000 Description

This model FDR records airplane flight information in a digital format using solid-state flash memory as the recording medium. The F1000 can receive data in the ARINC 573/717/747/542a 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 F1000 is designed to meet the crash-survivability requirements of TSO-C124.

4.1.1. Recorder Condition

The recorder was in good condition and the data were extracted normally from the recorder.

Figure 1. Exterior of flight recorder

4.1.2. Recording Description

The FDR recording contained approximately 43 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 and its duration was approximately 2 hours and 20 minutes. The parameters evaluated for the purpose of this report were in accordance with 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=+).[1]

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. Spikes in Pressure Altitude

In order to capture altitude at a high enough resolution over the entire range required, the pressure altitude parameter was stored as two components in different locations in the dataframe. The most significant part (MSP) is stored only once every four seconds while the least significant part (LSP) is stored every second. To determine the combined total pressure altitude, the MSP and LSP of the parameter are concatenated and converted to engineering units. Because the MSP was stored at a lower rate than the LSP, the resultant combined parameter data often had spikes of one to three samples of around 500 feet as the parameter value passed through a point where the LSP wrapped. These spikes have not been corrected in the plotted or tabular data.

4.1.5. 1 Hz variations in Altitude and Speed Parameters

Small variations in pressure altitude, radio altitude, airspeed, ground speed, and vertical speed are seen at a 1 Hz interval. These variations are because the FDR alternately sources these parameters from their left and right redundant systems. The variations are due to the variations between the left and right aircraft systems.

4.2. Time Correlation

Correlation of the FDR data from SRN to the event local time, Alaska daylight time (AKDT), was established by using the recorded Time GMT[2] hours, Time GMT Minutes, and Time GMT Seconds and then applying an additional 8 hours offset to change GMT to AKDT.

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

AKDT = SRN – 93,369

Therefore, for the rest of this report, all times are referenced as AKDT, not SRN.

[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 = +.

[2] GMT is Greenwich Mean Time which is also known as Coordinated Universal Time (UTC).

4.3. FDR Plots and Corresponding Tabular Data

Figures 2 to 12 contain FDR data recorded during the event on October 17, 2019. All the parameters listed in table A-1 are plotted except Time GMT Hours, Time GMT Minutes, and Time GMT Seconds.

Figures 2, 3, 4, and 6 contain aircraft basic parameters. Figure 2 covers the full flight duration, figure 3 covers the first approach to DUT and a go around, figure 4 covers the second approach and landing at DUT, and figure 6 covers a zoom view of the final approach portion, landing, and accident sequence.

Figure 5 contains autoflight control system parameters from the first approach until the end of the recording.

Figures 7, 8, 11, and 12 cover a period of the touchdown and accident sequence. Figure 7 contains parameters representing the deceleration forces present during landing and rollout, figure 8 contains flight controls, figure 11 contains hydraulic system discretes, and figure 12 contains landing gear related discretes.

Figures 9 and 10 cover a period of the second approach and landing at DUT. These figures contain parameters from the left and right engines. Of note, the engine control index defines how the electronic engine controller (EEC) is controlling the engine. When the control index is beyond the scale it is indicative of the control in an engine start mode.

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. The FDR data showed that N686PA departed from ANC at 1523 AKDT. The aircraft climbed to a pressure altitude of 30,000 feet (ft) and cruised on a southwesterly heading for about 1 hour and 26 minutes. The aircraft descended steadily for about 21 minutes. The autopilot was in use from shortly after takeoff until the first approach into DUT.

At 1733:00 AKDT, the autopilot was disconnected and it remained disconnected for the remainder of the flight. At 1733:30 AKDT, the aircraft began a descent from 950 ft above ground level (AGL). Wind speeds were recorded as being 28 knots (kts) at 260 degrees to 270 degrees. Wind speeds decreased as the aircraft descended from 28 kts to 17 kts while wind direction remained consistent. At 425 ft AGL the aircraft rolled 30 degrees left, rolling out at 172 ft AGL on a heading of 117 degrees, consistent with final approach to the runway One second later, at 1735:30 AKDT, maneuvers consistent with a go around were performed.

Following the go around, the aircraft climbed to 1150 ft AGL and began to descend again while performing a 300 degree left turn. While descending through about 350 ft AGL, the aircraft rolled 30 degrees left, rolling out on the runway heading at about 100 ft AGL. As the aircraft rolled out from 100 ft to 50 ft AGL, a Sink Rate warning was recorded from the aircraft ground proximity warning system (GPWS). Vertical speed recorded a peak of -1292 feet per minute (fpm) during this portion of the final descent. The aircraft roll angle oscillated +/- 5 degrees as it pitched up consistent with a landing flare. At the beginning of the flare, indicated airspeed was about 135 kts and ground speed was about 149 kts. IAS reference

speed[3] was recorded as 136 kts. Winds recorded by the FDR[4] during the final approach were about 270 degrees at 9 kts and the aircraft's magnetic heading was 122 degrees.

Accelerations consistent with main gear touchdown occurred at 1739:54 AKDT, followed by the nose gear at 1739:55 AKDT, and the 1 Hz Gear Weight on Wheels signal became true at 1739:56. Indicated airspeed at main gear touchdown was about 125 kts and ground speed was about 141 kts. Rate of deceleration increased over the three seconds following main gear touchdown to a peak of -0.48 g. During this time, the flaps retracted by 5 degrees and both propellers transitioned to beta mode with the engines controlling to ground idle propeller speed (Np).

At 1739:59 AKDT, longitudinal deceleration changed from a smooth deceleration to a slightly oscillatory profile, with variations of approximately 0.03 g at each 0.25 second sample of longitudinal acceleration and an overall trend toward less deceleration. Also during this time, an Anti-Skid Inboard Fault Caution became active. This oscillatory and decreasing deceleration behavior continued for the next 11.5 seconds, when the longitudinal acceleration had reached -0.17 g and ground speed was 54 kts. The decreased deceleration behavior was despite the engines transitioning from ground idle beta to max reverse power at 1740:03 AKDT.

At 1740:10 AKDT, the longitudinal deceleration profile became smooth for 5.5 seconds and the Anti-Skid Inboard Fault Caution transitioned to inactive. Engine power lever angles (PLAs) stayed at about 1 degree, consistent with commanding maximum reverse power, and deceleration rate remained steady between -0.16 g and -0.2 g. At 1740:16 AKDT, the oscillations in longitudinal acceleration resumed and the Anti-Skid Inboard Fault Caution reactivated with ground speed at 34 kts.

Two seconds later, at 1740:18 AKDT, the engine PLA began to increase from about 1 degree to about 35 degrees, consistent with idle power, over 3 seconds. The engines and propellers transitioned to idle power and beta mode, respectively. At 1740:19 AKDT, changes in pitch, roll, and vertical and longitudinal accelerations were consistent with a departure of the runway surface. Ground speed at this time was 23 kts.

One second after runway departure, the weight on wheels and left main gear down and locked signals became false, consistent with damage to the left main gear. About one second after that the left engine gas generator speed dropped to 0%, consistent with damage to the left engine.

The recording stopped at 1740:31 AKDT and the data is consistent with a sudden power interruption to the recorder. The final three seconds of recorded data are unreliable, as evidenced by invalid data during this time including the aircraft attitude and ground speed.

The corresponding tabular data used to create figures 2 to 12, including Time GMT Hours, Time GMT Minutes, and Time GMT Seconds, are provided in electronic comma separated value (*.csv) format as attachment 1 to this report. An additional three landings at DUT were

[3] IAS reference speed is the speed bug set on the flight control panel by the flight crew.
[4] Per the manufacturer, the wind information recorded by the FDR is sourced from the FMS and is not considered to be accurate during the approach phase, especially not after having flown a traffic pattern.

recorded on the FDR and are discussed in the Aircraft Performance Factual Report. The corresponding tabular data from these three landings are provided as attachment 2, attachment 3, and attachment 4 to this report. Previous landings are presented in the original FDR timing, Subframe Reference Number (SRN), not local time.

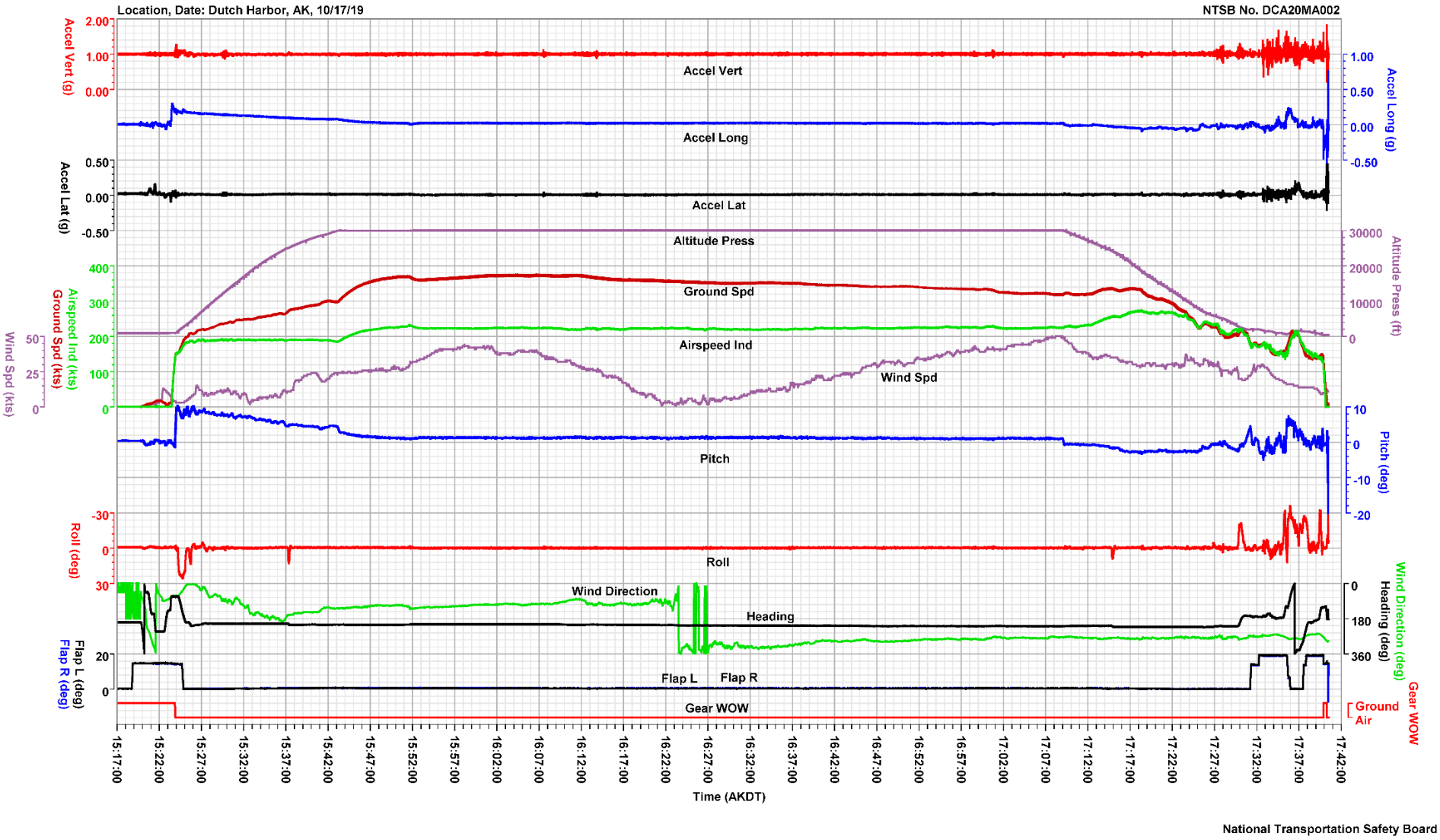

Figure 2. Plot of aircraft basic parameters during entire flight

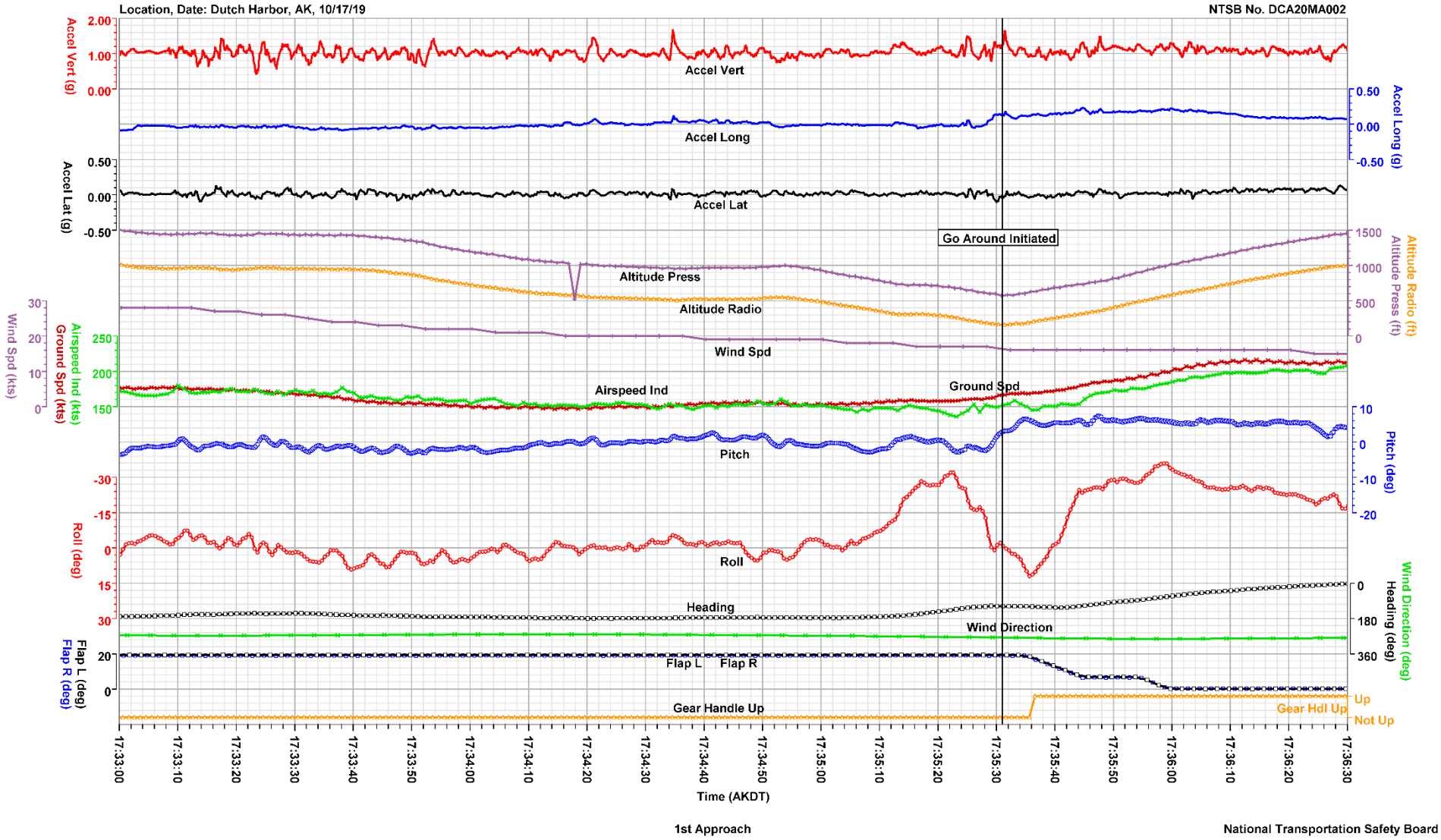

Figure 3. Plot of aircraft basic parameters during time of first approach to DUT and go around.

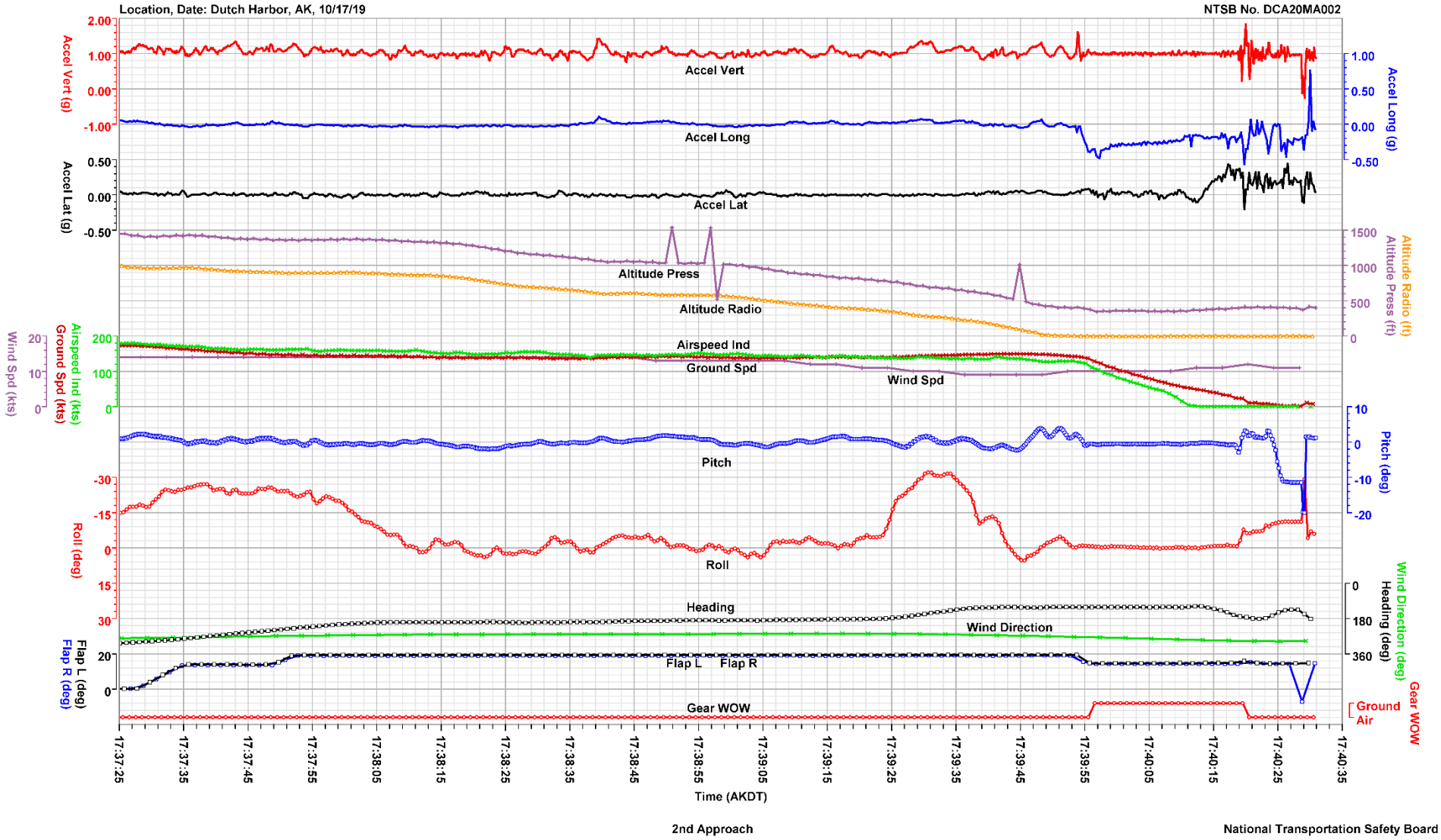

Figure 4. Plot of aircraft basic parameters during 2nd approach to DUT and landing.

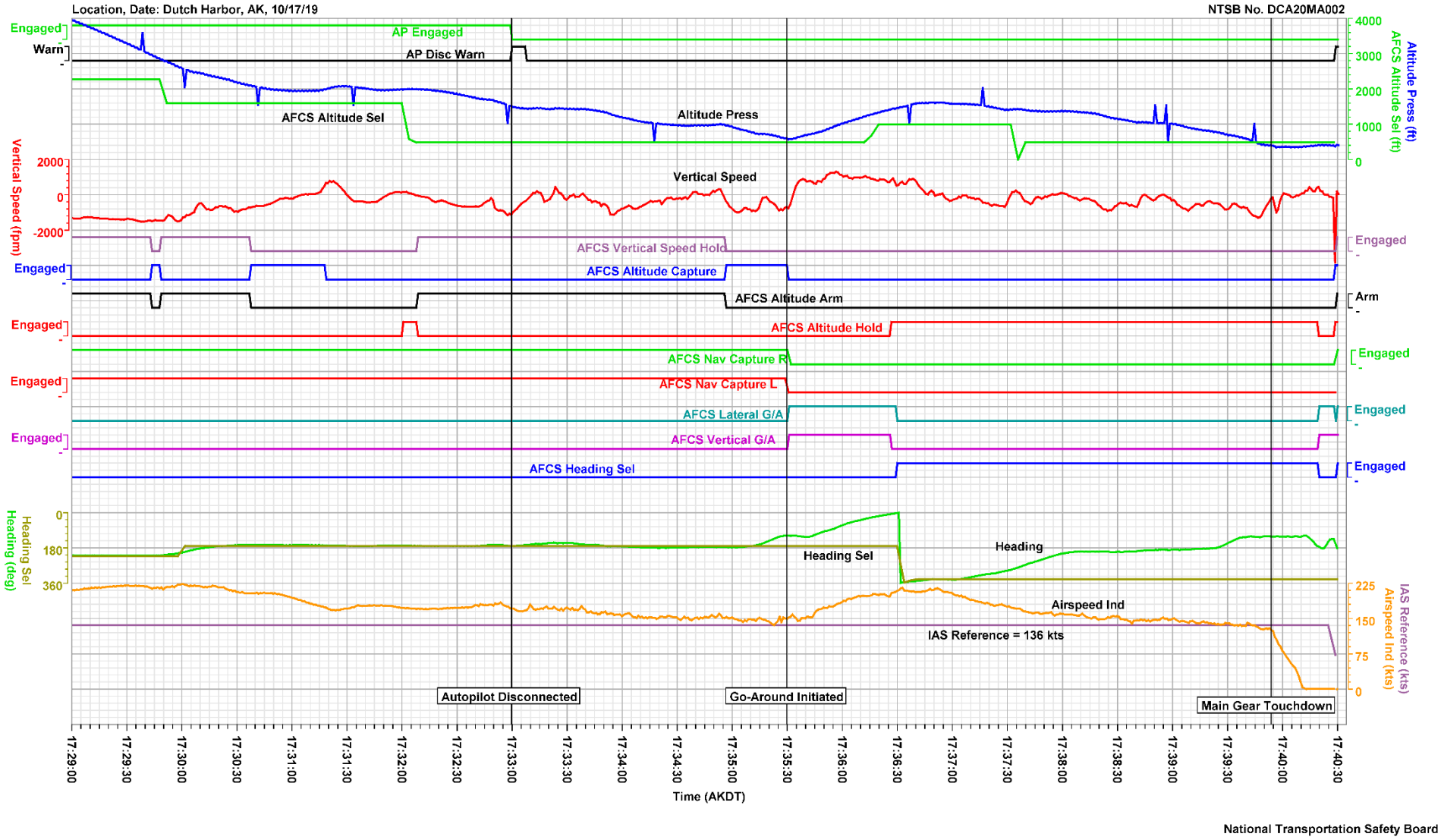

Figure 5. Plot of autoflight control system parameters from the first approach to the end of the recording.

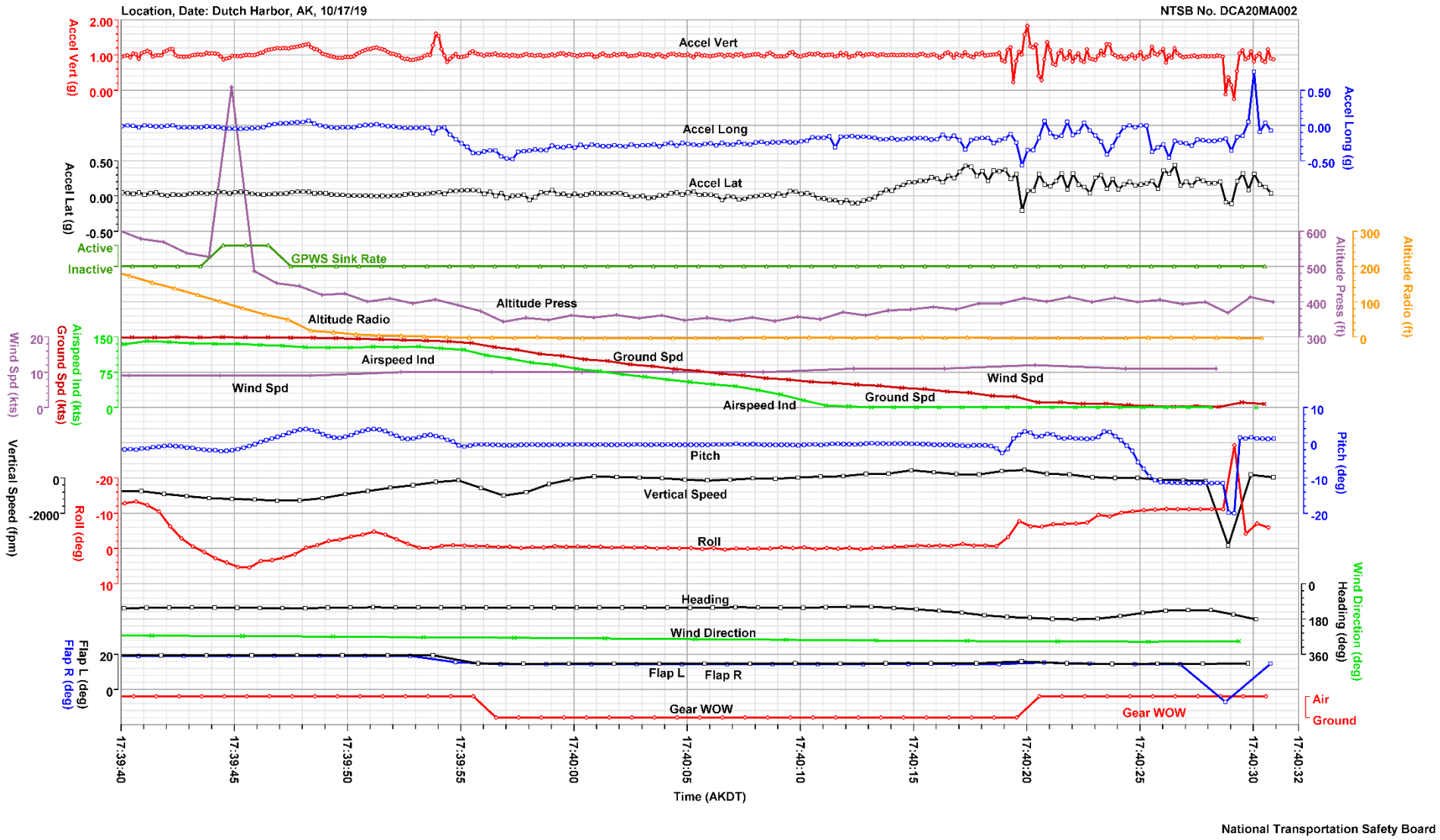

Figure 6. Plot of basic parameters detailing the touchdown and accident sequence until the end of the recording.

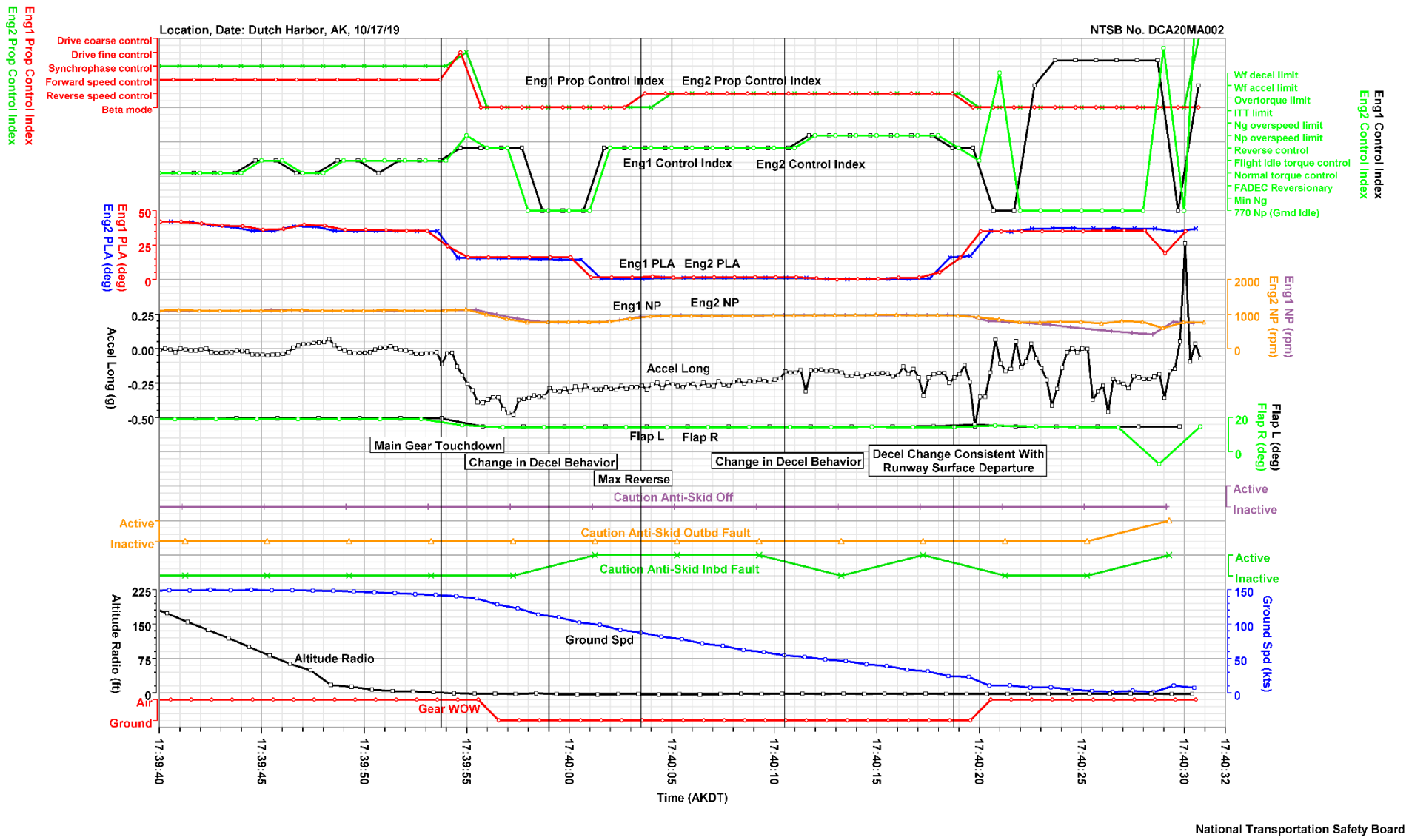

Figure 7. Plot of parameters relating to aircraft deceleration during the touchdown and accident sequence.

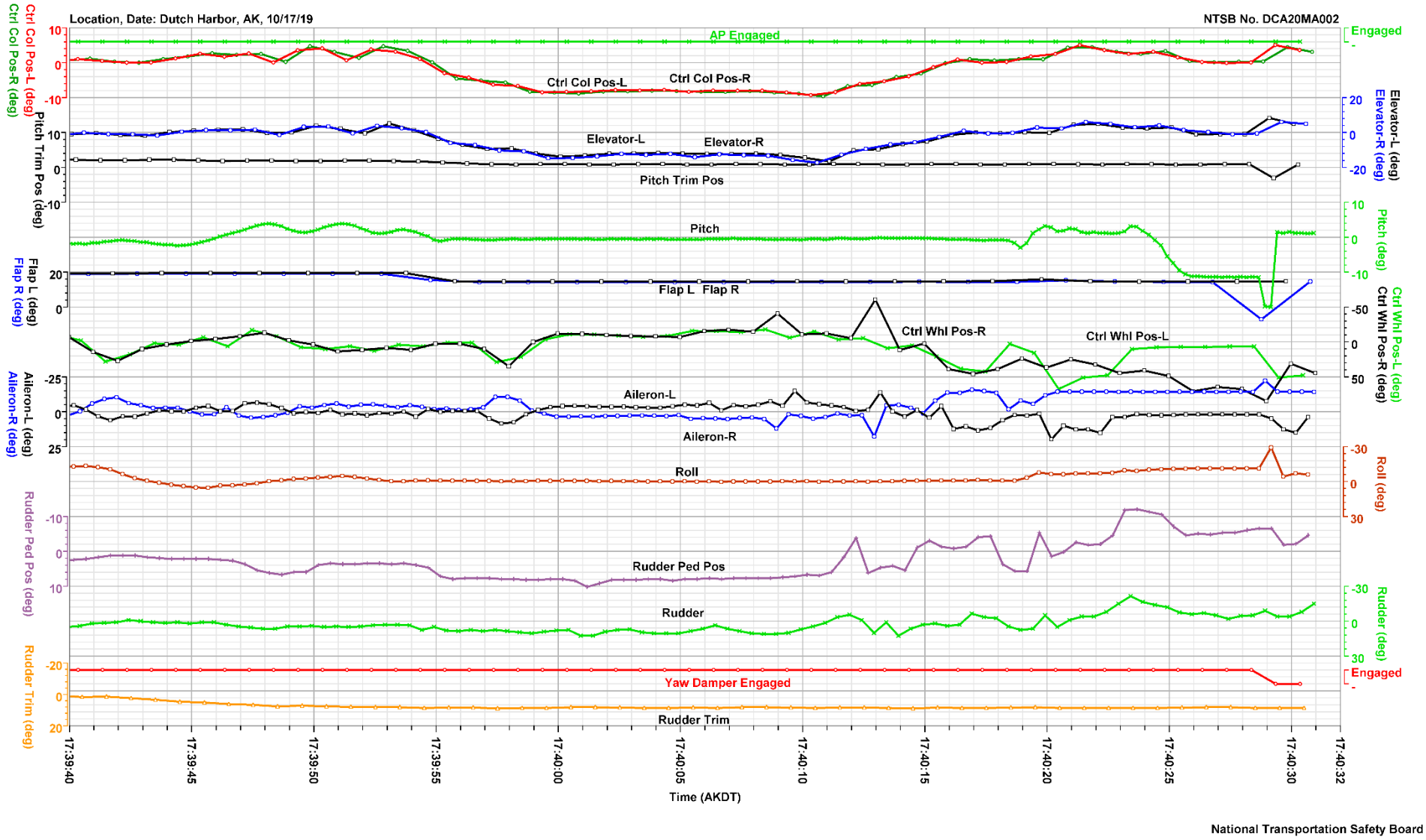

Figure 8. Plot of flight controls parameters during the touchdown and accident sequence.

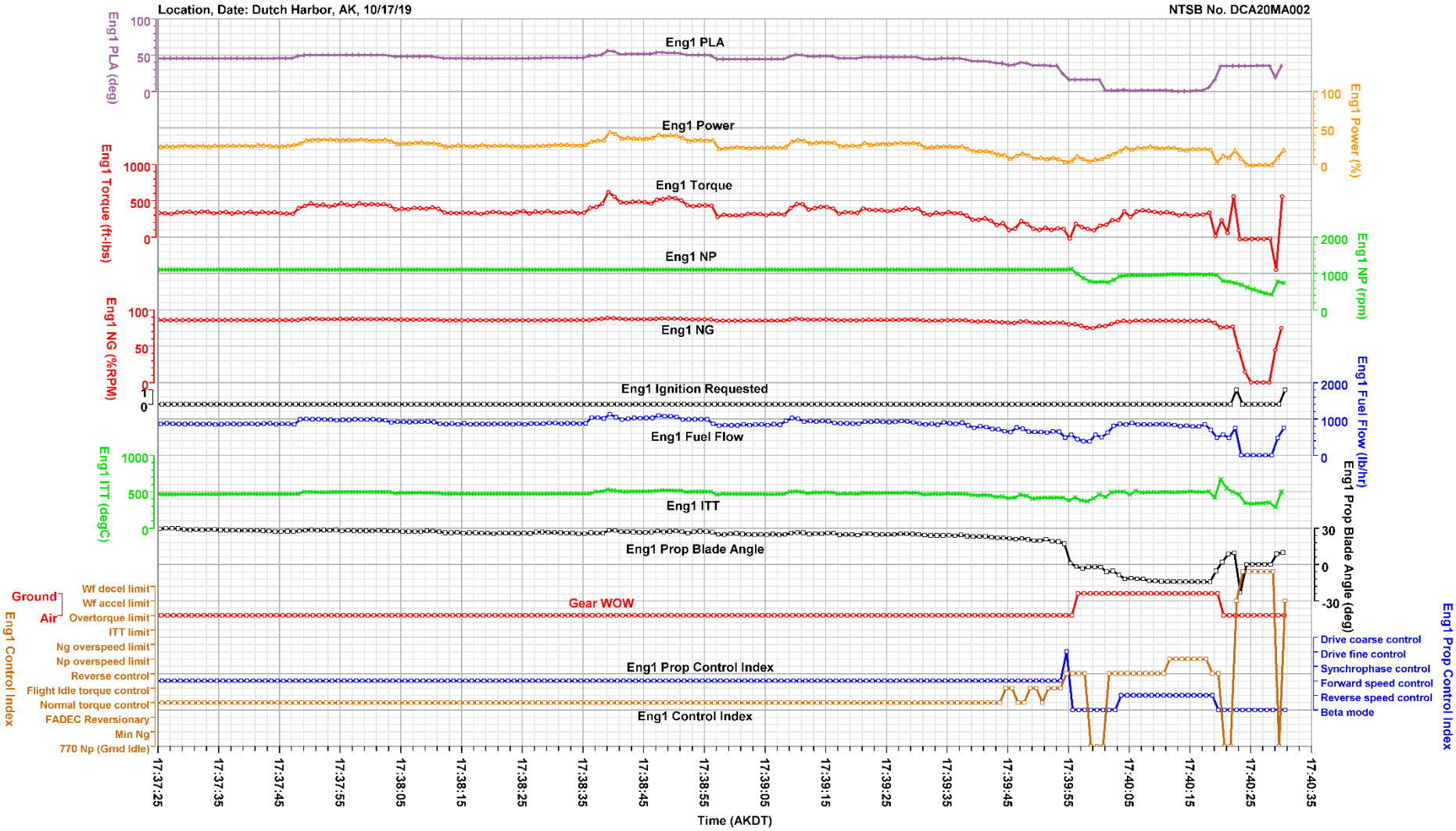

Figure 9. Plot of parameters from engine 1 from second approach through the end of the recording.

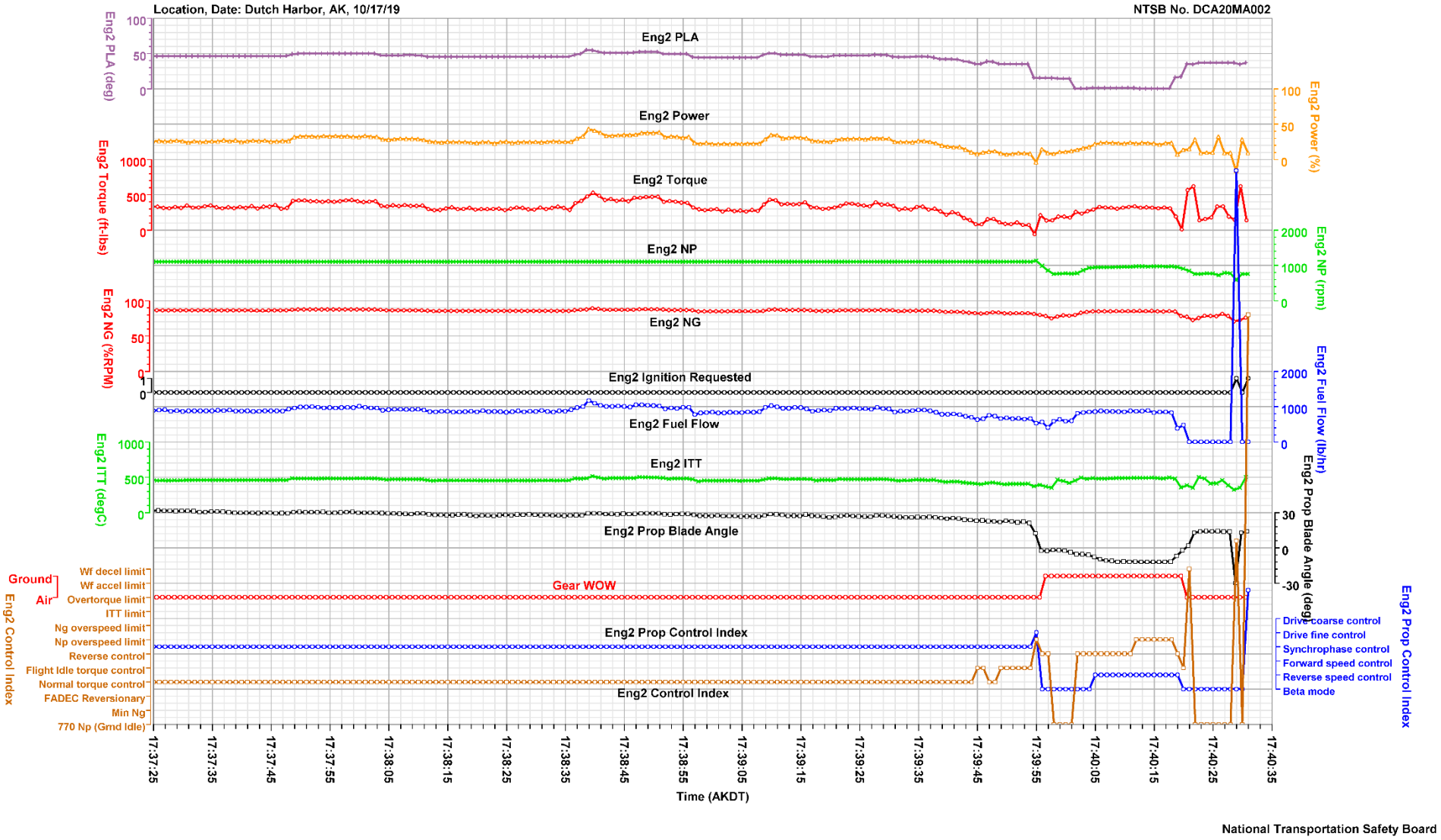

Figure 10. Plot of parameters from engine 2 from second approach through the end of the recording.

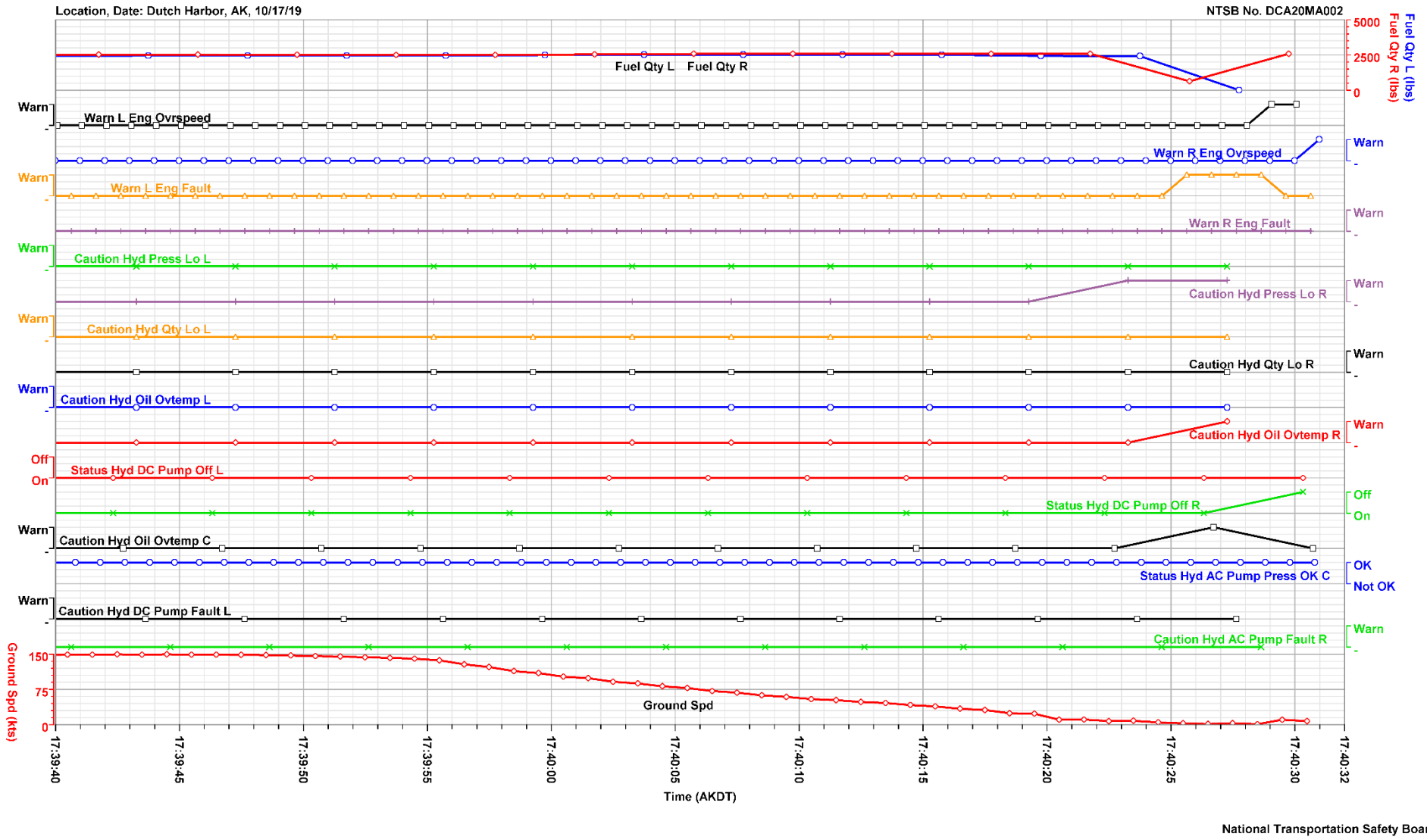

Figure 11. Plot of engine and hydraulic discretes and fuel quantity from touchdown through the end of the recording.

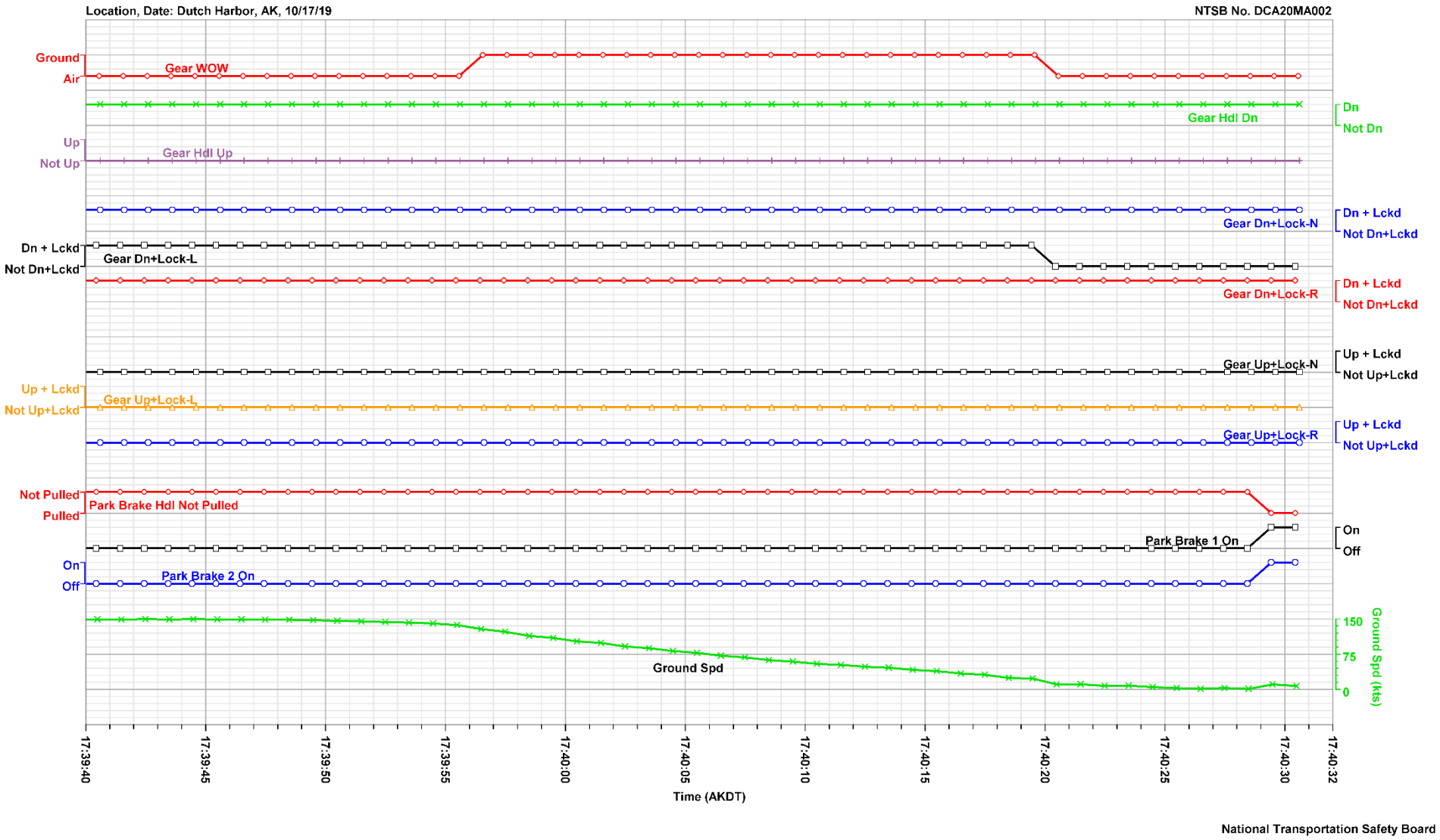

Figure 12. Plot of landing gear related discretes from touchdown through the end of the recording.

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 parameters.

Plot/Table Labels	Parameter Names	Units
1. Accel Lat	Lateral Acceleration	g
2. Accel Long	Longitudinal Acceleration	g
3. Accel Vert	Vertical Acceleration	g
4. AFCS Altitude Arm	Autoflight Control System Altitude mode armed	
5. AFCS Altitude Capture	Autoflight Control System Altitude Captured	
6. AFCS Altitude Hold	Autoflight Control System Altitude Hold mode	
7. AFCS Altitude Sel	Autoflight Control System Altitude Selected	ft
8. AFCS Approach Arm	Autoflight Control System Approach mode armed	
9. AFCS Approach Capture	Autoflight Control System Approach Captured	
10. AFCS Glideslope Arm	Autoflight Control System Glideslope mode armed	
11. AFCS Glideslope Capture	Autoflight Control System Glideslope Captured	
12. AFCS Heading Sel	Autoflight Control System Heading Select mode	
13. AFCS Lateral G/A	Autoflight Control System Go Around Lateral mode	
14. AFCS Nav Arm L	Autoflight Control System Left Navigation mode armed	
15. AFCS Nav Arm R	Autoflight Control System Right Navigation mode armed	
16. AFCS Nav Capture L	Autoflight Control System Left Navigation Captured	
17. AFCS Nav Capture R	Autoflight Control System Right Navigation Captured	
18. AFCS Vertical G/A	Autoflight Control System Go Around Vertical mode	
19. AFCS Vertical Speed Hold	Autoflight Control System Vertical Speed mode	
20. Aileron-L	Left Aileron Position	deg
21. Aileron-R	Right Aileron Position	deg
22. Airspeed Ind	Indicated Airspeed	kts
23. Altitude Press	Pressure Altitude	ft
24. Altitude Radio	Radio Altitude	ft
25. AP Disc Warn	Autopilot Disconnect Warning	
26. AP Engaged	Autopilot Engaged	
27. Caution Anti-Skid Inbd Fault	Anti-Skid System Inboard Fault Detected	
28. Caution Anti-Skid Off	Anti-Skid System Off	
29. Caution Anti-Skid Outbd Fault	Anti-Skid System Outboard Fault Detected	
30. Caution Hyd Oil Ovtemp C	Center Hydraulic System Oil Overtemperature	
31. Caution Hyd Oil Ovtemp L	Left Hydraulic System Oil Overtemperature	
32. Caution Hyd Oil Ovtemp R	Right Hydraulic System Oil Overtemperature	
33. Caution Hyd Press Lo L	Left Hydraulic System Pressure Low	
34. Caution Hyd Press Lo R	Right Hydraulic System Pressure Low	
35. Caution Hyd Qty Lo C	Center Hydraulic System Quantity Low	
36. Caution Hyd Qty Lo L	Left Hydraulic System Quantity Low	
37. Caution Hyd Qty Lo R	Right Hydraulic System Quantity Low	

APPENDIX A

Plot/Table Labels	Parameter Names	Units
38. Ctrl Col Pos-L	Left Control Column Position	deg
39. Ctrl Col Pos-R	Right Control Column Position	deg
40. Ctrl Whl Pos-L	Left Control Wheel Position	deg
41. Ctrl Whl Pos-R	Right Control Wheel Position	deg
42. Drift Angle	Aircraft Drift Angle	deg
43. Elevator-L	Left Elevator Position	deg
44. Elevator-R	Right Elevator Position	deg
45. Eng1 Control Index	Left Engine Control Index	
46. Eng1 Fuel Flow	Left Engine Fuel Flow	lb/hr
47. Eng1 Ignition Requested	Left Engine Ignition Requested	
48. Eng1 ITT	Left Engine Interturbine Temperature	deg C
49. Eng1 NG	Left Engine Gas Generator Speed	%
50. Eng1 NP	Left Engine Propeller Speed	rpm
51. Eng1 PLA	Left Engine Power Lever Angle	deg
52. Eng1 Power	Left Engine Power	%
53. Eng1 Prop Blade Angle	Left Engine Propeller Blade Angle	deg
54. Eng1 Prop Control Index	Left Engine Propeller Control Index	
55. Eng1 Torque	Left Engine Torque	ft-lbs
56. Eng2 Control Index	Right Engine Control Index	
57. Eng2 Fuel Flow	Right Engine Fuel Flow	lb/hr
58. Eng2 Ignition Requested	Right Engine Ignition Requested	
59. Eng2 ITT	Right Engine Interturbine Temperature	deg C
60. Eng2 NG	Right Engine Gas Generator Speed	%
61. Eng2 NP	Right Engine Propeller Speed	rpm
62. Eng2 PLA	Right Engine Power Lever Angle	deg
63. Eng2 Power	Right Engine Power	%
64. Eng2 Prop Blade Angle	Right Engine Propeller Blade Angle	deg
65. Eng2 Prop Control Index	Right Engine Propeller Control Index	
66. Eng2 Torque	Right Engine Torque	ft-lbs
67. Flap L	Left Flap Position	deg
68. Flap R	Right Flap Position	deg
69. Fuel Qty L	Fuel Quantity - Left Tank	lbs
70. Fuel Qty R	Fuel Quantity - Right Tank	lbs
71. Gear Dn+Lock-L	Left Main Gear Down and Locked	
72. Gear Dn+Lock-N	Nose Gear Down and Locked	
73. Gear Dn+Lock-R	Right Main Gear Down and Locked	
74. Gear Hdl Dn	Gear Handle Down	
75. Gear Hdl Up	Gear Handle Up	
76. Gear Up+Lock-L	Left Main Gear Up and Locked	
77. Gear Up+Lock-N	Nose Gear Up and Locked	
78. Gear Up+Lock-R	Right Main Gear Up and Locked	
79. Gear WOW	Landing Gear Weight on Wheels	
80. GPWS Sink Rate	Ground Proximity Warning System Sink Rate Warning	

APPENDIX A

Plot/Table Labels	Parameter Names	Units
81. Ground Spd	Ground Speed	kts
82. Heading	Magnetic Heading	deg
83. Heading Sel	Heading Selected	deg
84. IAS Reference	Reference Airspeed set by the flight crew	kts
85. Park Brake 1 On	Parking Brake 1 On	
86. Park Brake 2 On	Parking Brake 2 On	
87. Park Brk Hdl Not Pulled	Parking Brake Handle Not Pulled	
88. Pitch	Pitch Angle	deg
89. Pitch Trim Pos	Pitch Trim Position	deg
90. Roll	Roll Angle	deg
91. Roll Trim Pos	Roll Trim Position	deg
92. Rudder	Rudder Position	deg
93. Rudder Ped Pos	Rudder Pedal Position	deg
94. Rudder Trim	Rudder Trim Position	deg
95. Status Hyd AC Pump Press OK C	Center AC Hydraulic Pump Pressure OK	
96. Status Hyd DC Pump Off L	Left DC Hydraulic Pump Off	
97. Status Hyd DC Pump Off R	Right DC Hydraulic Pump Off	
98. Time GMT Hrs	GMT Hours	hrs
99. Time GMT Min	GMT Minutes	min
100. Time GMT Sec	GMT Seconds	sec
101. Vertical Speed	Vertical Speed	ft/min
102. Wind Direction	Wind Direction	deg
103. Wind Spd	Wind Speed	kts
104. Yaw Damper Engaged	Yaw Damper Engaged	

NOTE: 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 in the electronic data has not been corrected for the local altimeter setting at the time of the event.

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.

Unit and Discrete Abbreviations	Descriptions
deg	degrees
deg C	degrees Celsius
FADEC	Full Authority Digital Engine Controller
ft	feet
ft-lbs	foot-pounds
hr	hour
kts	knots
lbs	pounds
min	minute
Ng	Gas Generator Speed
Np	Propeller Speed
rpm	revolutions per minute
sec	second
Wf	Fuel Flow