

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division

Washington, D.C. 20594

March 21, 2014

Flight Data Recorder - 10

Specialist's Factual Report

By Cassandra Johnson

1. EVENT SUMMARY

Location: Milwaukee, Wisconsin
Date: June 06, 2011
Aircraft: Bombardier CL-600-2B19
Registration: N866AS
Operator: Skywest Airlines
NTSB Number: CEN111A379

On June 6, 2011, about 9:32 p.m. central daylight time (CDT), N866AS, a Bombardier CL-600-2B19, operated as Skywest Airlines flight 4443, landed with the right main landing gear retracted on runway 19R at the General Mitchell International Airport (MKE), Milwaukee, Wisconsin. The 2 pilots, 1 flight attendant, and 41 passengers reported no injuries. All of the airplane occupants evacuated the airplane via the main cabin door. The scheduled domestic passenger flight was conducted under the provisions of Title 14 *Code of Federal Regulations* Part 121. Visual meteorological conditions prevailed and an activated instrument flight rules flight plan was on file.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR Carriage Requirements

The event aircraft, N866AS, was manufactured in 2001 and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 57 parameters, as cited in Title 14 CFR Part 121.344(e).

4. DETAILS OF FLIGHT DATA RECORDER INVESTIGATION

The Safety Board's Vehicle Recorder Division received the following FDR:

Recorder Manufacturer/Model: **L-3/Fairchild FA2100**
Recorder Serial Number: **000174026**

4.1. L-3/Fairchild 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 (for example, pressure altitude, magnetic heading, computed airspeed) has a specifically assigned word number within the subframe. The FA2100 is designed to meet the crash-survivability requirements of TSO-C124a.

4.1.1. Recorder Condition

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

4.1.2. Recording Description

The FDR recording contained approximately 119.4 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 1 hour and 42 minutes. The parameters evaluated for the purpose of this report appeared to be in accordance with the federal FDR carriage requirements.

4.1.3. Engineering Units Conversions

The engineering units 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 state abbreviations used in this report.

4.2. Time Correlation

Correlation of the FDR data from SRN to the event local time, CDT, was established by using the recorded GMT² hours, GMT Minutes, and GMT Seconds and then applying an additional 5 hours offset to change GMT to CDT.

Accordingly, the time offset for the event flight data from SRN to local CDT is the following: $CDT = SRN - 352,195$. Therefore, for the rest of this report, all times for the event flight are referenced as CDT, not SRN. However, the previous flight is referenced as SRN, not local time.

4.3. FDR Plots and Corresponding Tabular Data

Figures 1 to 5 contain FDR data recorded during the June 06, 2011 event. Figures 6 to 9 contain FDR data recorded during the previous flight. All the parameters listed in table A-1 are plotted except GMT Hours, GMT Minutes, and GMT Seconds. Figures 1 and 6 contain

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).

the basic parameters. Figures 2, 3 and 7 contain landing gear parameters plus some hydraulic parameters. Lastly, figures 4, 5, 8, and 9 contain select parameters.

Figures 1 and 2 cover the entire event flight from 19:45:00 CDT to 21:35:00 CDT. Figure 3 covers the last 42 minutes of data from 20:52:00 CDT to the end of the recording at 21:34:00 CDT (the x-axis ends at 21:35:00 CDT). Figure 4 covers 29 minutes of data from 20:51:45 CDT to 21:20:45 CDT. Lastly, figure 5 covers 5 minutes of data from 20:51:45 CDT to 21:56:45 CDT when the landing gear disagree warning first transitioned from “Not Active” to “Active”.

Figures 6 and 7 cover the entire previous flight from 420,600 SRN to 423,240 SRN. Figure 8 covers the previous takeoff from 420,735 SRN to 420,790 SRN. Lastly, figure 9 covers the previous landing from 422,850 SRN to 422,900 SRN.

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.

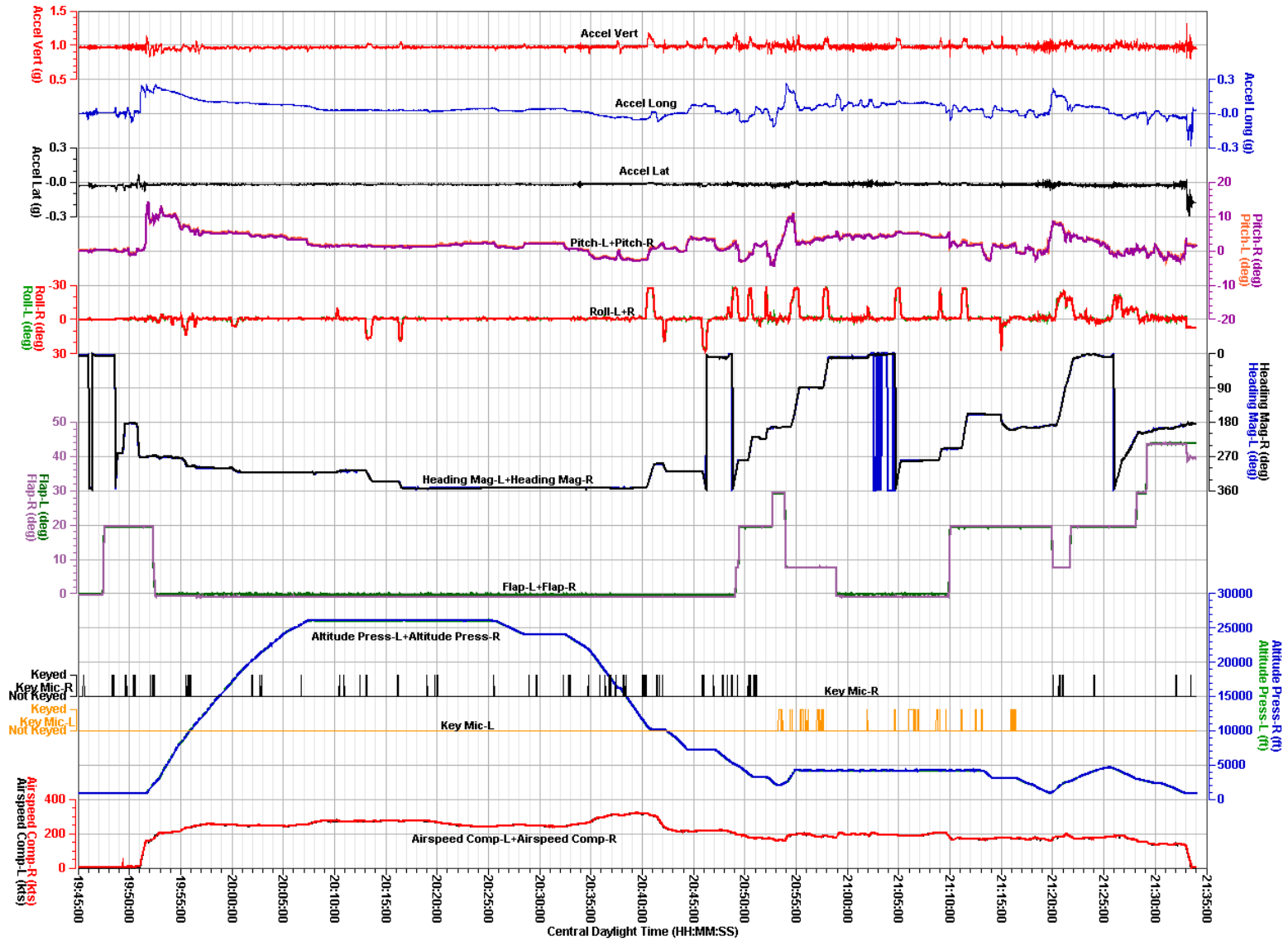
In brief, the FDR data indicated the following for the event flight:

- About 1 hour after takeoff at 20:52:36 CDT while descending through a pressure altitude of approximately 2,745 feet (ft), the left landing gear transitioned from “Not Down and Locked” to “Down and Locked”.
- At 20:52:40 CDT, the nose landing gear transitioned from “Not Down and Locked” to “Down and Locked”. At this time, the pressure altitude decreased to approximately 2,618 ft.
- At 20:52:58 CDT, the landing gear disagree warning transitioned from “Not Active” to “Active”. At this time, the pressure altitude decreased to approximately 2,217 ft.
- At 20:54:20 CDT, the right landing gear transitioned from “Not Down and Locked” to “Down and Locked”. At this time, the pressure altitude increased to approximately 2,869 ft. A second later at 20:54:21 CDT, the landing gear disagree warning transitioned back to “Not Active”.
- At 20:54:57 CDT, the right landing gear transitioned back to “Not Down and Locked”. By 20:55:00 CDT, both the left and nose landing gear transitioned back to “Not Down and Locked”.
- Over approximately the next 10 minutes until 21:04:57 CDT, the nose landing gear transitioned six times from “Not Down and Locked” to “Down and Locked” then remained at “Down and Locked” until touchdown. Additionally during this time from 21:00:36 CDT to 21:01:06 CDT, the right landing gear transitioned to “Down and Locked” and back to “Not Down and Locked”. During this time, the pressure altitude was steady at about 4,150 ft.
- About 43 seconds later at 21:05:40 CDT, the Hydraulic Pressure #3 decreased from approximately 2,720 pounds per square inch (psi) to 14 psi. At this time, the pressure altitude remained at about 4,150 ft.
- Over the approximately the next 7.5 minutes until 21:13:14 CDT, the Hydraulic Pressure #3 increased to about 2,720 psi, decreased to about 10 psi, increased to about 2,700 psi, decreased to about 14 psi, and then increased to about 2,680 psi where it remained until touchdown. During this time, the pressure altitude remained at about 4,150 ft.

- Six minutes and 36 seconds later at 21:19:50 CDT, the left landing gear transitioned from “Not Down and Locked” to “Down and Locked” and remained at “Down and Locked” until touchdown. At this time, the pressure altitude had decreased to about 900 ft.
- About 13 minutes and 14 seconds later at 21:33:04 CDT, the left landing gear weight on wheels transitioned from “Air” to “Ground”. One second later at 21:33:05 CDT, the nose landing gear transitioned from “Air” to “Ground”.

The corresponding tabular data used to create figures 1 to 5 including GMT Hours, GMT Minutes, and GMT Seconds are provided in electronic comma separated value (*.csv) format as attachment 1 to this report. Additionally, the corresponding tabular data used to create figures 6 to 9 are provided in electronic comma separated value (*.csv) format as attachment 2 to this report.

Figure 1. Basic parameters for entire event flight.

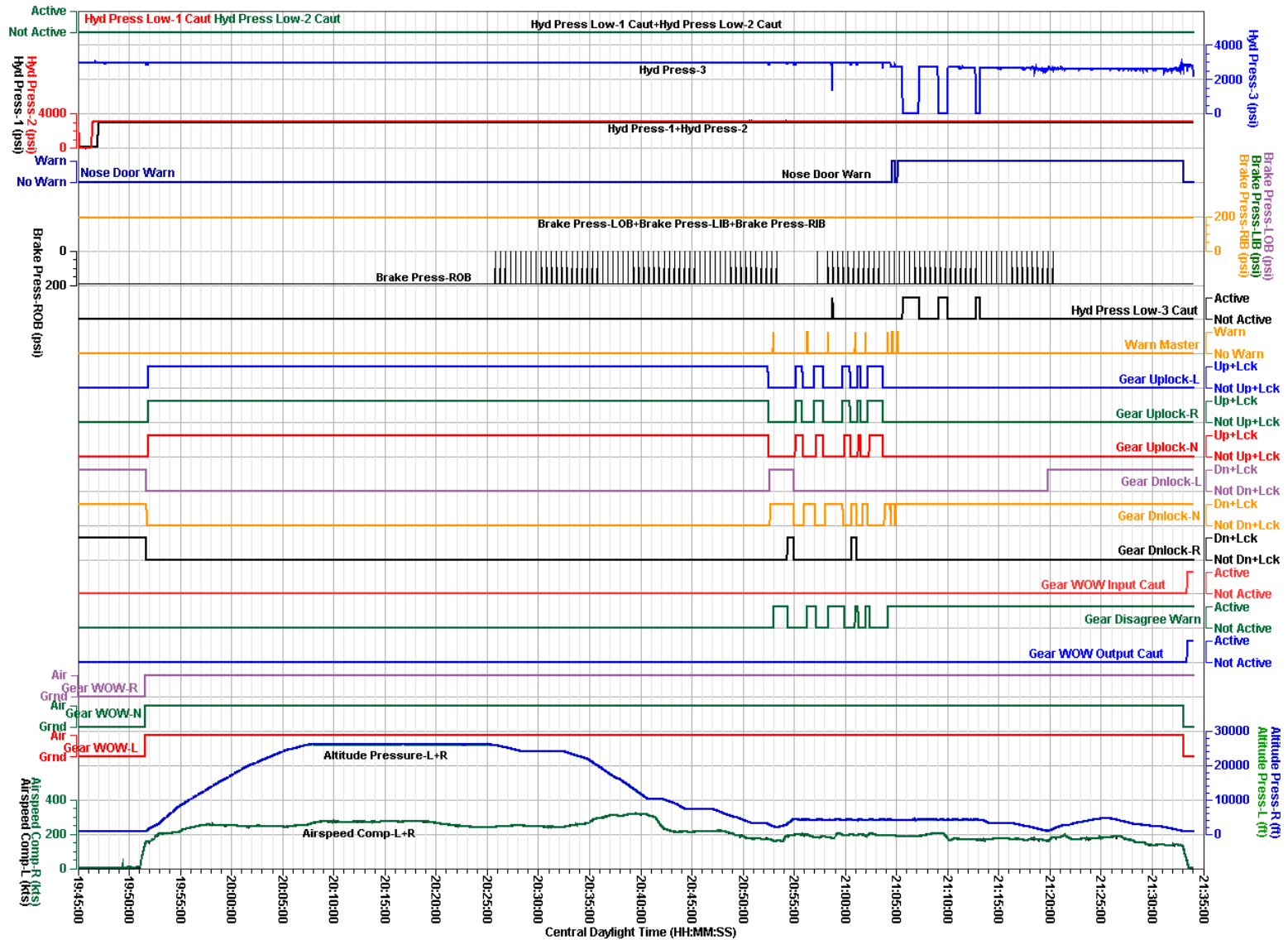


Revised: 14 February 2014

Basic Parameters - Entire Flight

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Figure 2. Landing gear and some hydraulic parameters for entire event flight.

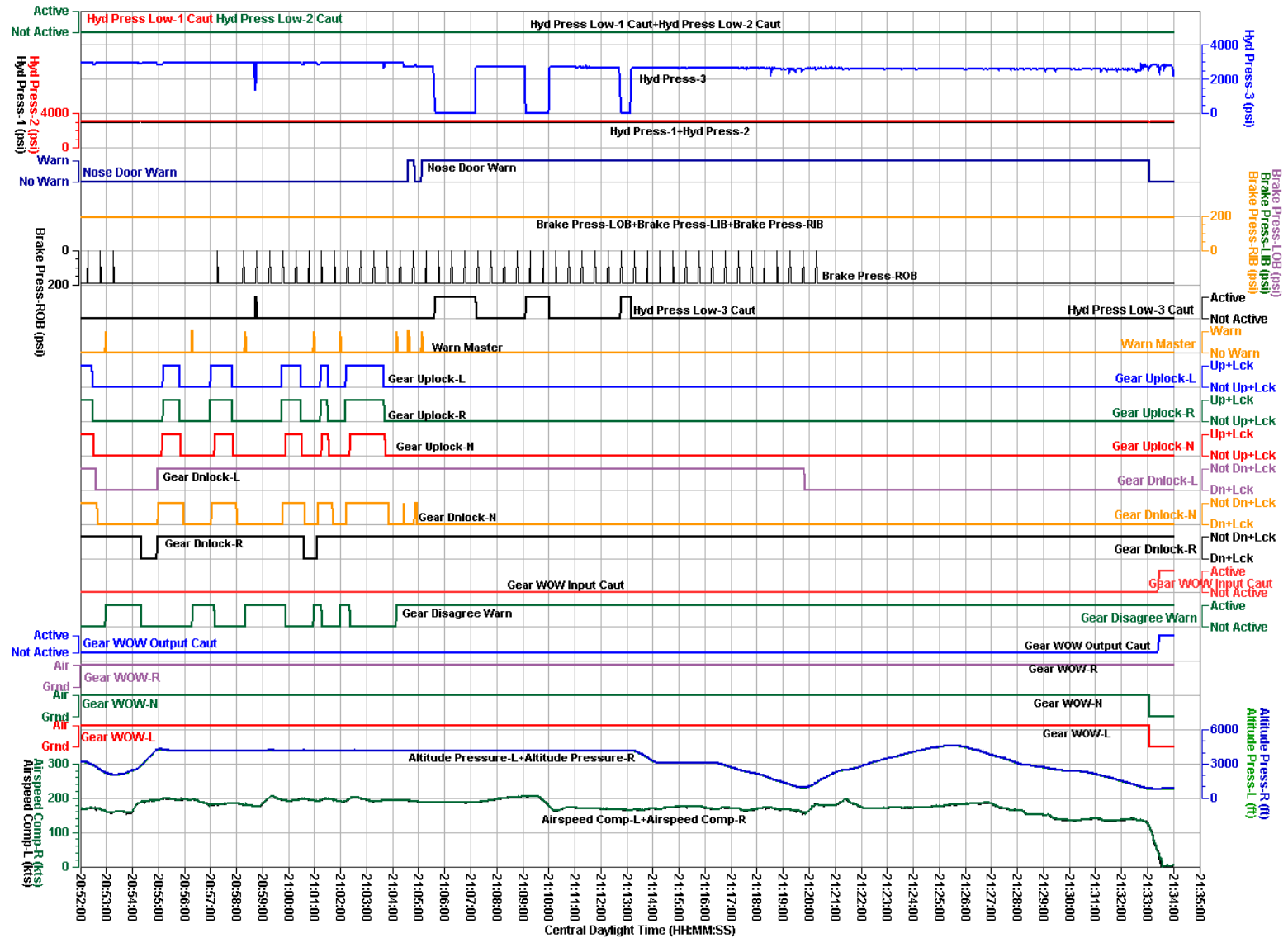


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More Parameters - Entire Flight

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Figure 3. Landing gear and some hydraulic parameters during last 42 minutes of the event flight.



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More Parameters - Last 42 Minutes

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Figure 4. Select parameters during last 29 minutes of the event flight.

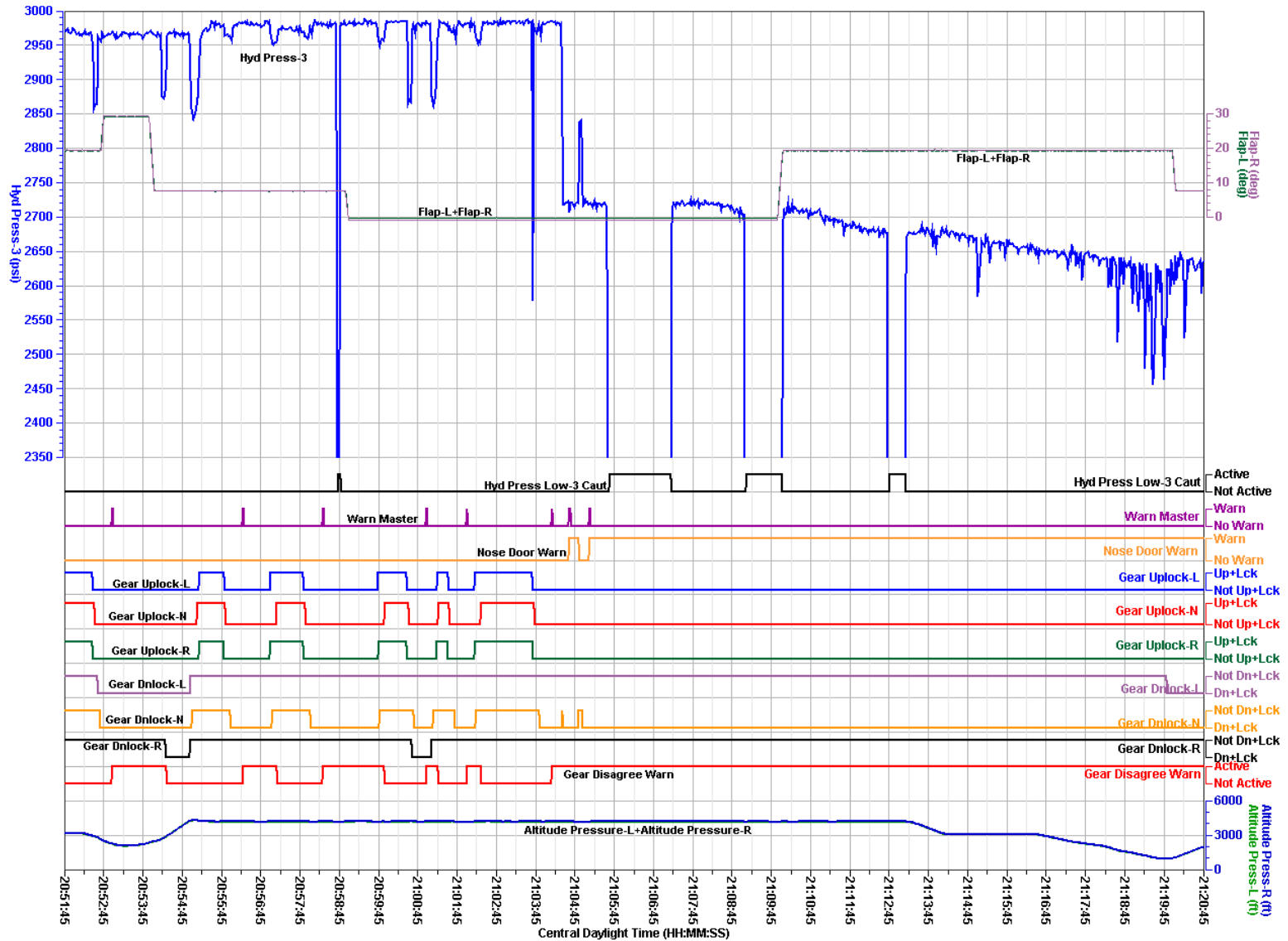
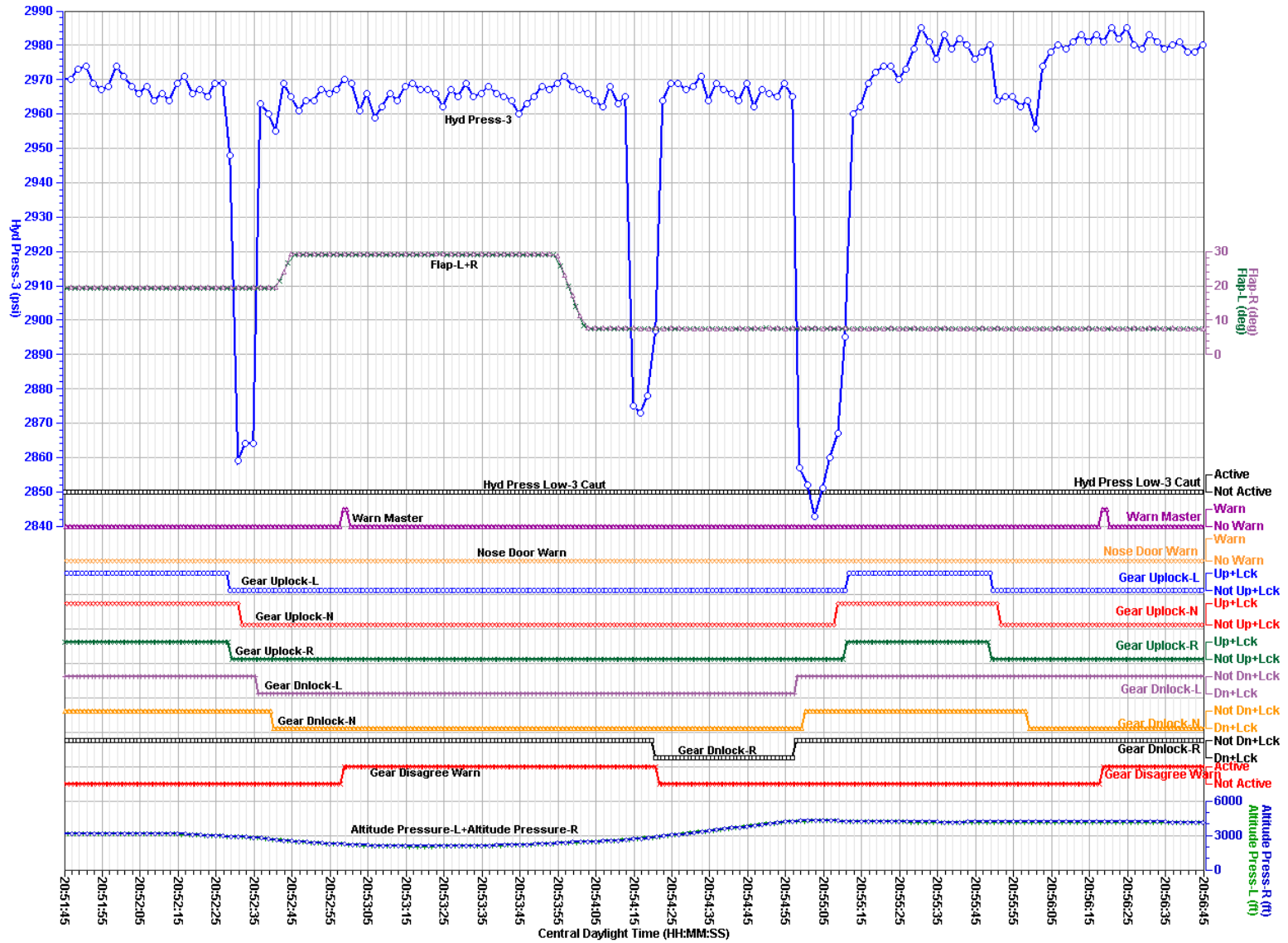


Figure 5. Select parameters with expanded 5 minute scale from the event flight.

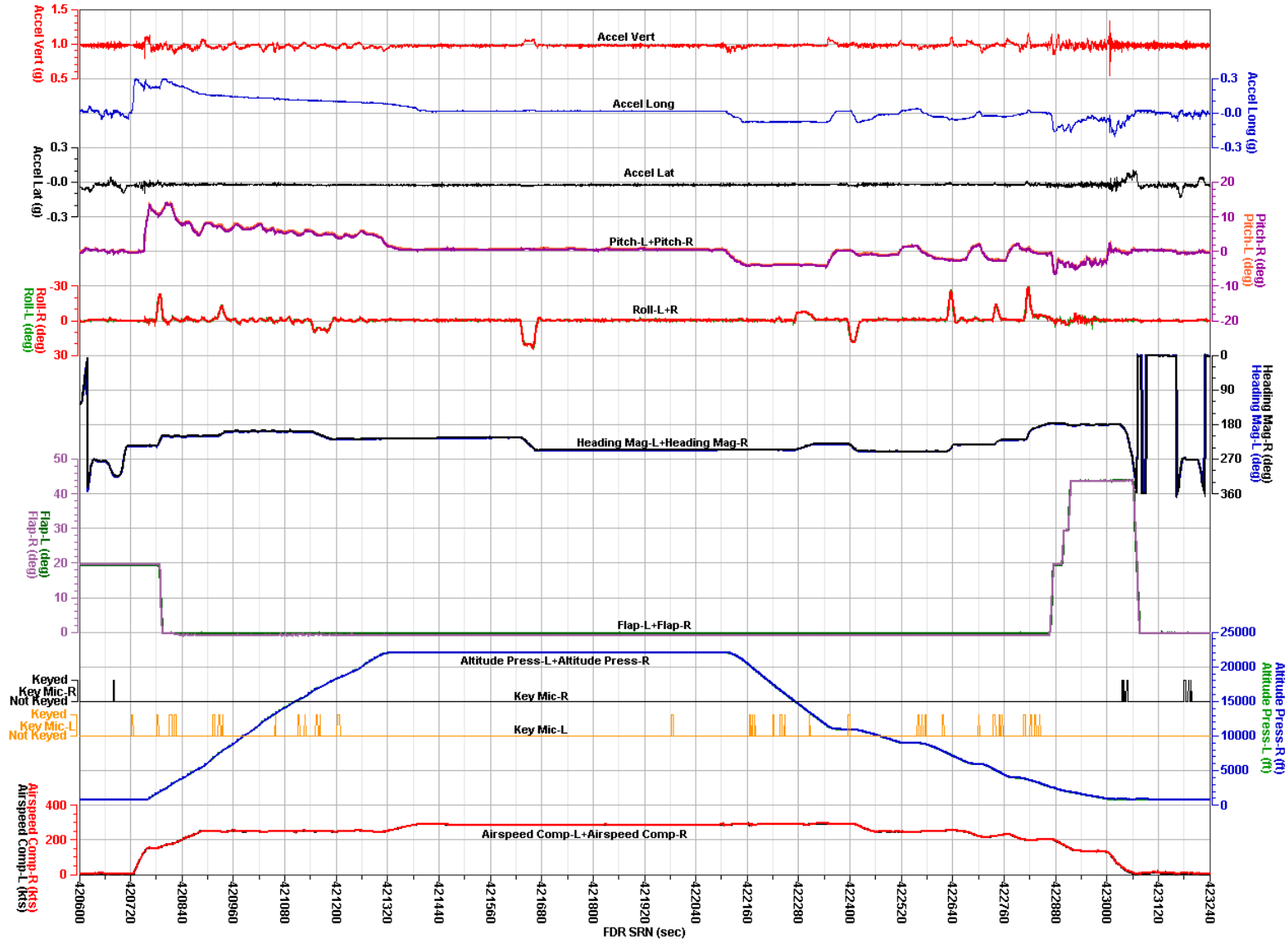


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Selected Parameters - 5 Minutes

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Figure 6. Basic parameters for entire previous flight.

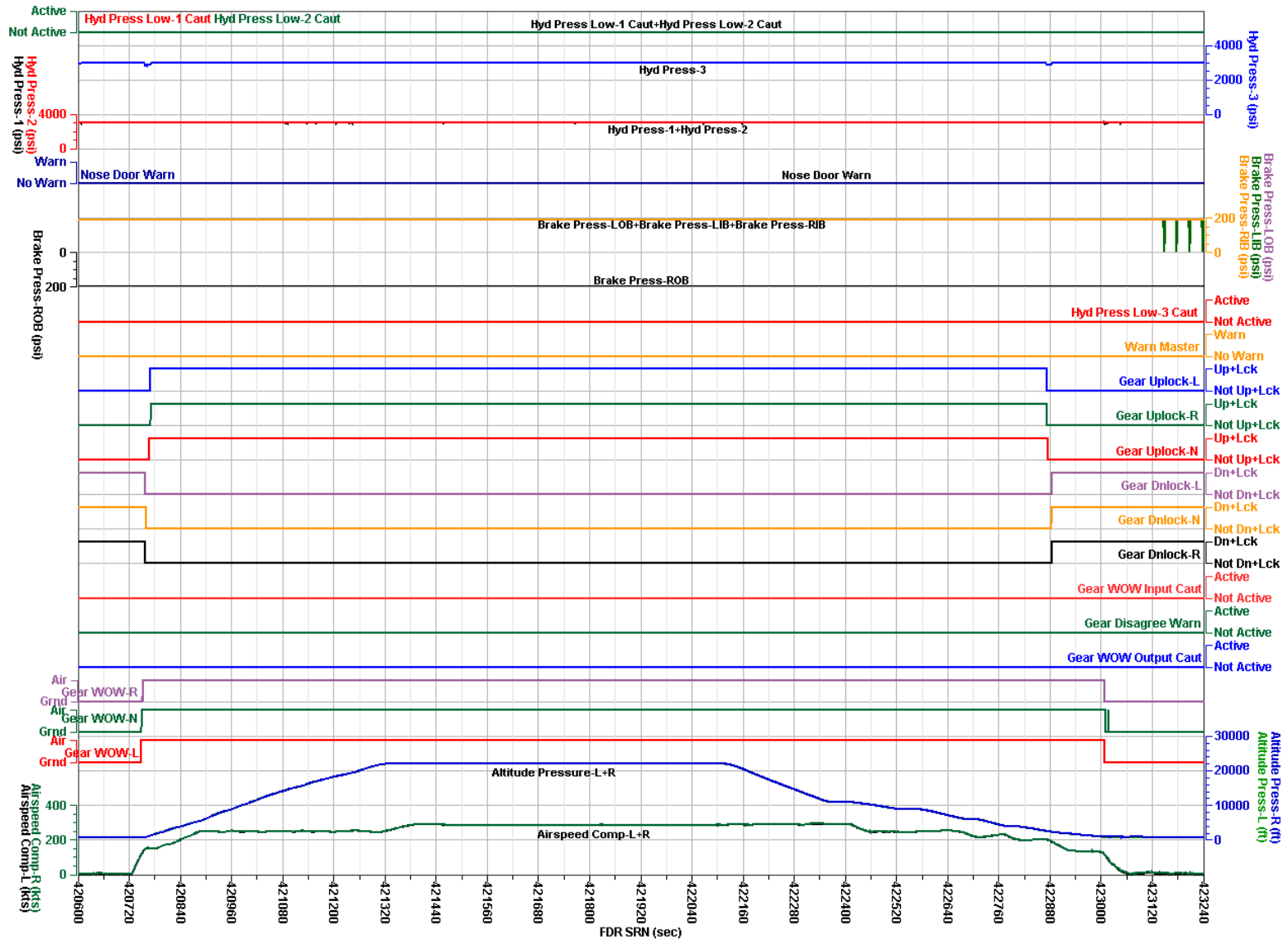


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Basic Parameters - Entire Previous Flight

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Figure 7. Landing gear and some hydraulic parameters for entire previous flight.



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More Parameters - Entire Previous Flight

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Figure 8. Select parameters during previous takeoff.

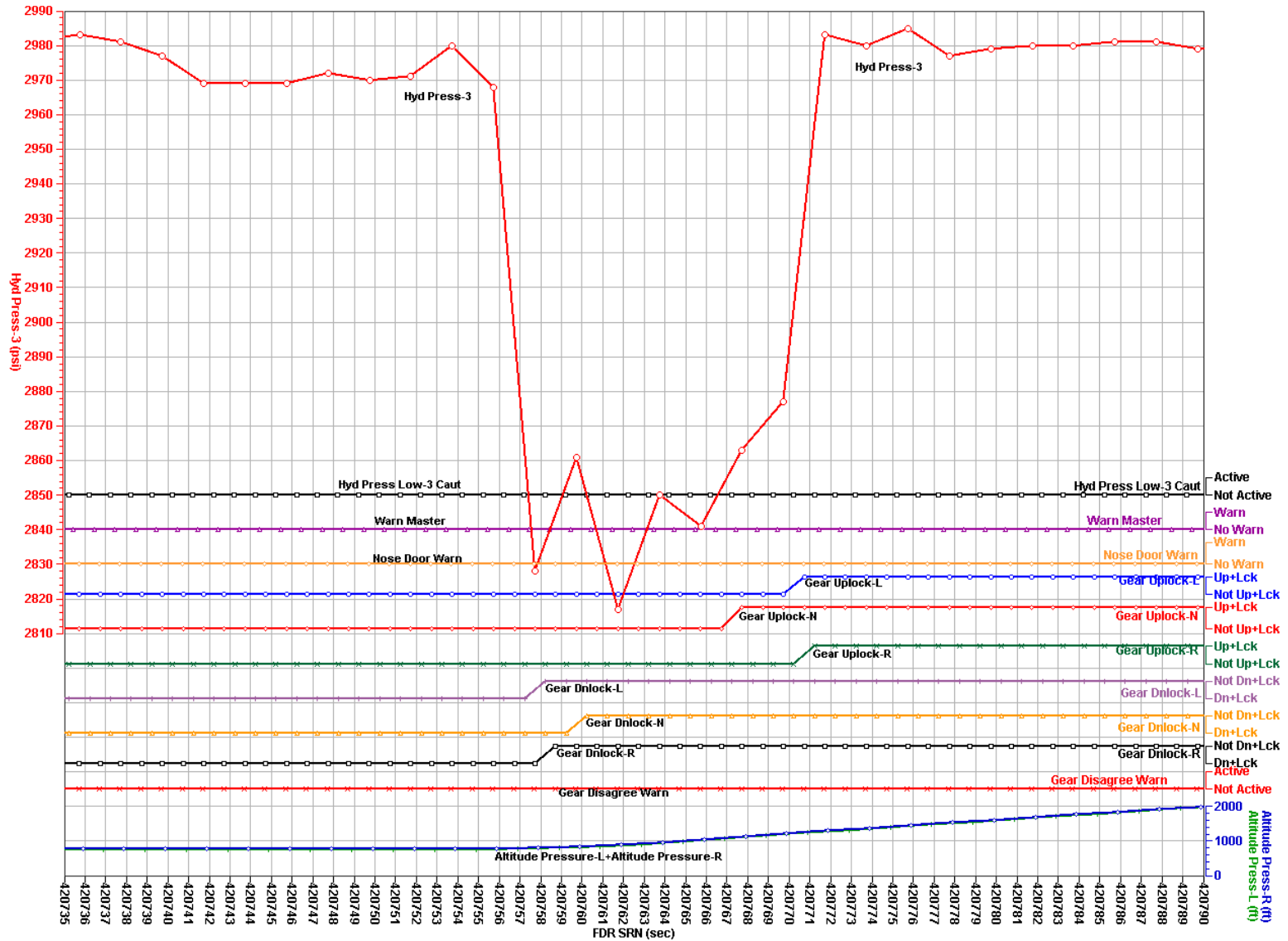
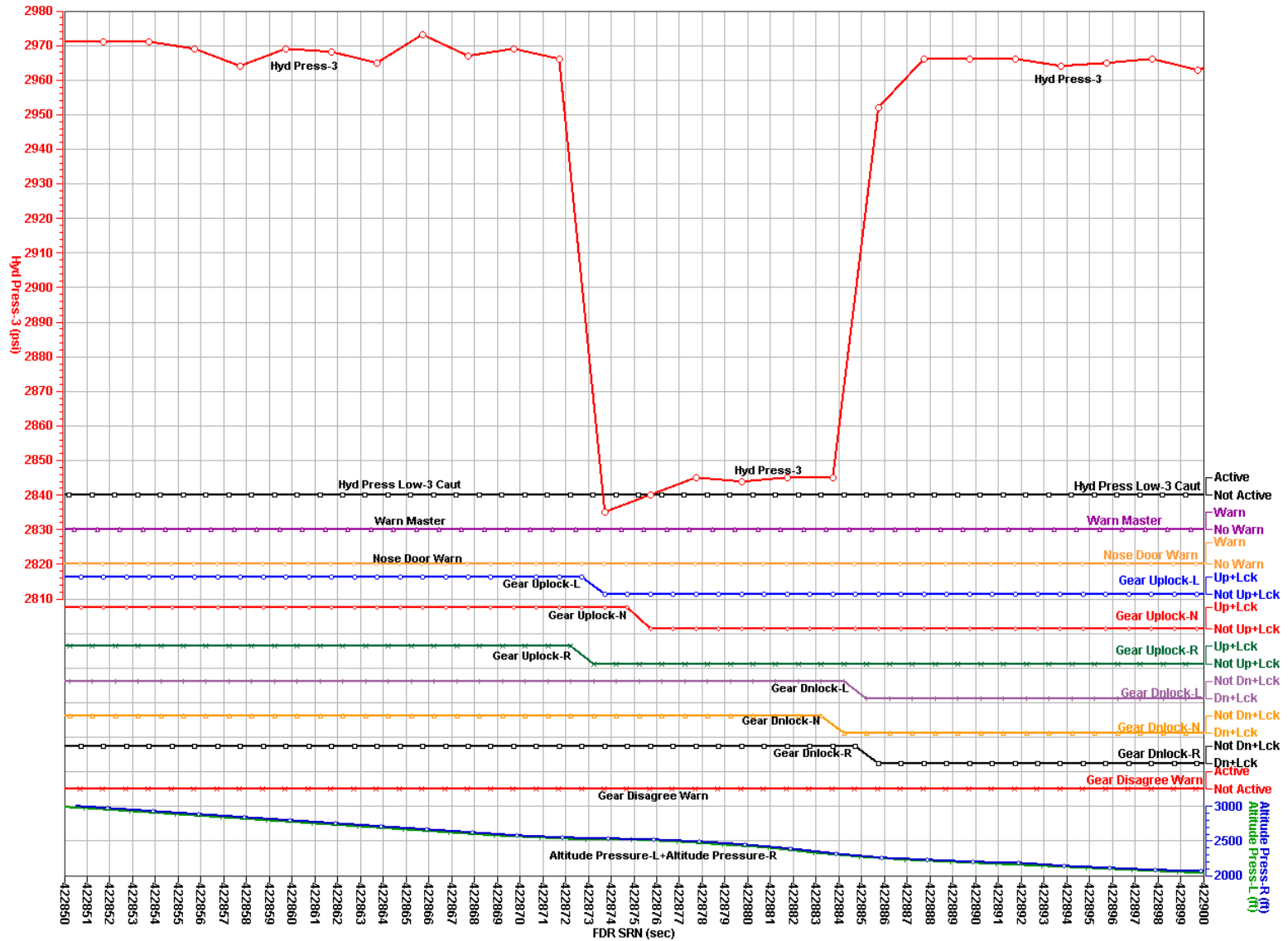


Figure 9. Select parameters during previous landing.



APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameters and table A-2 describes the unit and discrete state abbreviations used in this report.

Table A-1. Verified and provided FDR 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 Comp-L (kts)	Left Computed Airspeed
5. Airspeed Comp-R (kts)	Right Computed Airspeed
6. Altitude Press-L (ft)	Left Pressure Altitude
7. Altitude Press-R (ft)	Right Pressure Altitude
8. Brake Press-LIB (psi)	Left Inboard Brake Pressure
9. Brake Press-LOB (psi)	Left Outboard Brake Pressure
10. Brake Press-RIB (psi)	Right Inboard Brake Pressure
11. Brake Press-ROB (psi)	Right Outboard Brake Pressure
12. Flap-L (deg)	Left Flap Position
13. Flap-R (deg)	Right Flap Position
14. Gear Disagree Warn (discrete)	Landing Gear Disagree Warn
15. Gear Dnlock-L (discrete)	Left Landing Gear Down and Locked
16. Gear Dnlock-N (discrete)	Nose Landing Gear Down and Locked
17. Gear Dnlock-R (discrete)	Right Landing Gear Down and Locked
18. Gear Uplock-L (discrete)	Left Landing Gear Up and Locked
19. Gear Uplock-N (discrete)	Nose Landing Gear Up and Locked
20. Gear Uplock-R (discrete)	Right Landing Gear Up and Locked
21. Gear WOW Input Caut (discrete)	Weight on Wheels Gear Input Caution
22. Gear WOW Output Caut (discrete)	Weight on Wheels Gear Output Caution
23. Gear WOW-L (discrete)	Left Landing Gear Weight on Wheels
24. Gear WOW-N (discrete)	Nose Landing Gear Weight on Wheels
25. Gear WOW-R (discrete)	Right Landing Gear Weight on Wheels
26. Heading Mag-L (deg)	Left Magnetic Heading
27. Heading Mag-R (deg)	Right Magnetic Heading
28. Hyd Press Low-1 Caut (discrete)	Hydraulic Pressure Low-1 Caution
29. Hyd Press Low-2 Caut (discrete)	Hydraulic Pressure Low-2 Caution
30. Hyd Press Low-3 Caut (discrete)	Hydraulic Pressure Low-3 Caution
31. Hyd Press-1 (psi)	Hydraulic Pressure 1
32. Hyd Press-2 (psi)	Hydraulic Pressure 2
33. Hyd Press-3 (psi)	Hydraulic Pressure 3
34. Key Mic-L	Left Microphone Keyed
35. Key Mic-R	Right Microphone Keyed
36. Nose Door Warn (discrete)	Nose Door Warning
37. Pitch-L (deg)	Left Pitch Angle
38. Pitch-R (deg)	Right Pitch Angle

Parameter Name	Parameter Description
39. Roll-L (deg)	Left Roll Angle
40. Roll-R (deg)	Right Roll Angle
41. Time GMT Hrs (hrs)	Greenwich Mean Time Hours
42. Time GMT Min (min)	Greenwich Mean Time Minutes
43. Time GMT Sec (sec)	Greenwich Mean Time Seconds
44. Warn Master (discrete)	Master Warning

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.

Table A-2. Unit and discrete state abbreviations.

Unit and Discrete Abbreviation	Description
deg	degrees
discrete	discrete
Dn+Lck	Down and Locked
ft	feet
g	g
Grnd	Ground
hrs	hours
kts	knots
min	minutes
Not Dn+Lck	Not Down and Locked
Not Up+Lck	Not Up and Locked
psi	pounds per square inch
sec	seconds
Up+Lck	Up and Locked

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.