

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, D.C. 20594

August 15, 2016

Flight Data Recorder

Specialist's Factual Report By George Haralampopoulos

1. EVENT SUMMARY

Location: Memphis, Tennessee
Date: February 5, 2014
Aircraft: Embraer EMB-145
Registration: N802HK
Operator: Trans States Airlines
NTSB Number: DCA14FA058

On February 5, 2014, about 0015 central standard time (CST), Trans States Airlines flight 3395, and Embraer 145, registration N802HK, landed hard on runway 36R in Memphis, Tennessee, incurring substantial damage. The flight was being operated under the provisions of 14 *Code of Federal Regulations* Part 121 as a scheduled domestic passenger flight from Houston, Texas, to Memphis, Tennessee. There were no injuries to the 3 flight crew members or 50 passengers aboard.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR CARRIAGE REQUIREMENTS

The event aircraft, N802HK, was manufactured in 2002 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 FDR INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received an electronic file containing the FDR data from the N802HK aircraft. The aircraft was equipped with a Honeywell Solid State FDR (P/N: 980-4700-042).

4.1. Honeywell FDR Device Description

The FDR data in the electronic file was configured such that 128 12-bit words of digital information were recorded 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, pitch angle, roll angle, and magnetic heading) has a specifically assigned word number within the subframe.

4.1.1. FDR Recording Description

The FDR recording contained approximately 54 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 55 minutes. The parameters evaluated for the purpose of this report appeared to be in accordance with the federal FDR carriage requirements, except the aircraft's control surface position parameters; left and right aileron, left and right elevator, and rudder.

4.1.1.1. Functional Test of Control Surface Sensors

A functional test of the left side elevator, right side aileron, and rudder control surface sensors, installed on the accident aircraft was performed by the sensor manufacturer. The test reported that all three units exhibited some amount of external corrosion and had a failed primary circuit board.

The NTSB reported the findings to the aircraft manufacturer and a follow up test was coordinated with the sensor manufacturer for control surface sensors installed on a different EMB-145 reporting similar problems. The test attempted to duplicate the erroneous values exhibited by the sensors in aircraft operating conditions with a lower limit of -55 deg Celsius and an upper limit of 85 deg Celsius. The test showed the sensor failed at temperatures -18 degrees Celsius and lower and the root cause of failure was determined to be moisture ingress.

4.1.2. 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 abbreviations used in this report.

4.2. Time Correlation

Correlation of the FDR data from SRN to the event local time, CST, was established by using the recorded Time GMT² hours, Time GMT Minutes, and then applying an additional 6 hours offset to change GMT to CST.

Accordingly, the time offset for the event flight data from SRN to local CST is the following: CST = SRN – 193838. Therefore, for the rest of this report, all times are referenced as CST, not SRN. However, previous landings are referenced as SRN, not local time.

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

The following 6 figures contain FDR data recorded during the February 5, 2014, event. Times shown before midnight reference the prior day of February 4, 2014. Appendix A lists the FDR parameters verified and provided in this report.

Figure 1 shows a basic overview of the accident event from 22:30:00 through 00:20:00 CST, and contains aircraft air data, accelerations, attitudes, and discrete information.

Figure 2 is a segment of figure 1 and highlights the landing portion of the event from 00:11:00 to 00:16:00 CST. A dashed line is shown when weight on wheels (WOW) becomes active at 00:15:03 CST.

Figure 3 shows an overview of the aircraft controls and localizer deviation during the descent into landing from 22:30:00 through 00:20:00 CST. A blue box is shown where the localizer mode is engaged on the flight director (FD) during the flight.

Figure 4 is a segment of figure 3 and highlights the landing portion of the event from 00:11:00 to 00:16:00 CST. Dashed lines are shown at 00:14:35 CST 00:15:03 CST, for when autopilot becomes disengaged and weight on wheels (WOW) becomes active.

Figure's 5 and 6 show the recorded anti-ice parameters for the event flight and the prior flight. Figure 6 shows recorded anti-ice parameter signatures during the prior flight that are consistent with a functional check of the anti-ice system occurring at 75313 to 76213 SRN.

The data recorded during the event flight was non-eventful until the approach phase of the flight starting at 23:40:00 CST at a pressure altitude of about 8000 feet (ft). The aircraft continued to descend and prepare for an attempted landing from about 4000 ft at about 23:45:00 CST, the aircraft's lateral FD mode changed to localizer at 23:51:05 CST and the autopilot was disengaged at 23:51:59 CST.

At 23:52:54 CST, the localizer FD mode changed to heading hold and the aircraft began a climb as airspeed and altitude began to increase. The aircraft leveled off at about 3000 ft at 23:53:54 CST, and maintained that altitude for a duration of about 6 minutes and 30 seconds. At 23:56:10 CST, the AP was reengaged.

At 00:01:19 CST, the aircraft descended to about 2000 ft and held that altitude for 11 minutes and 19 seconds, when the aircraft descended consistent with landing. During that time the lateral FD mode changed to localizer at 00:10:18 CST.

The aircraft WOW became active at 00:15:03 CST. A second before the activation, the stick shaker became active at a recorded angle of attack of 15 degrees. A peak vertical acceleration of 2.6 g's was recorded at this time. The aircraft continued the rollout uneventfully.

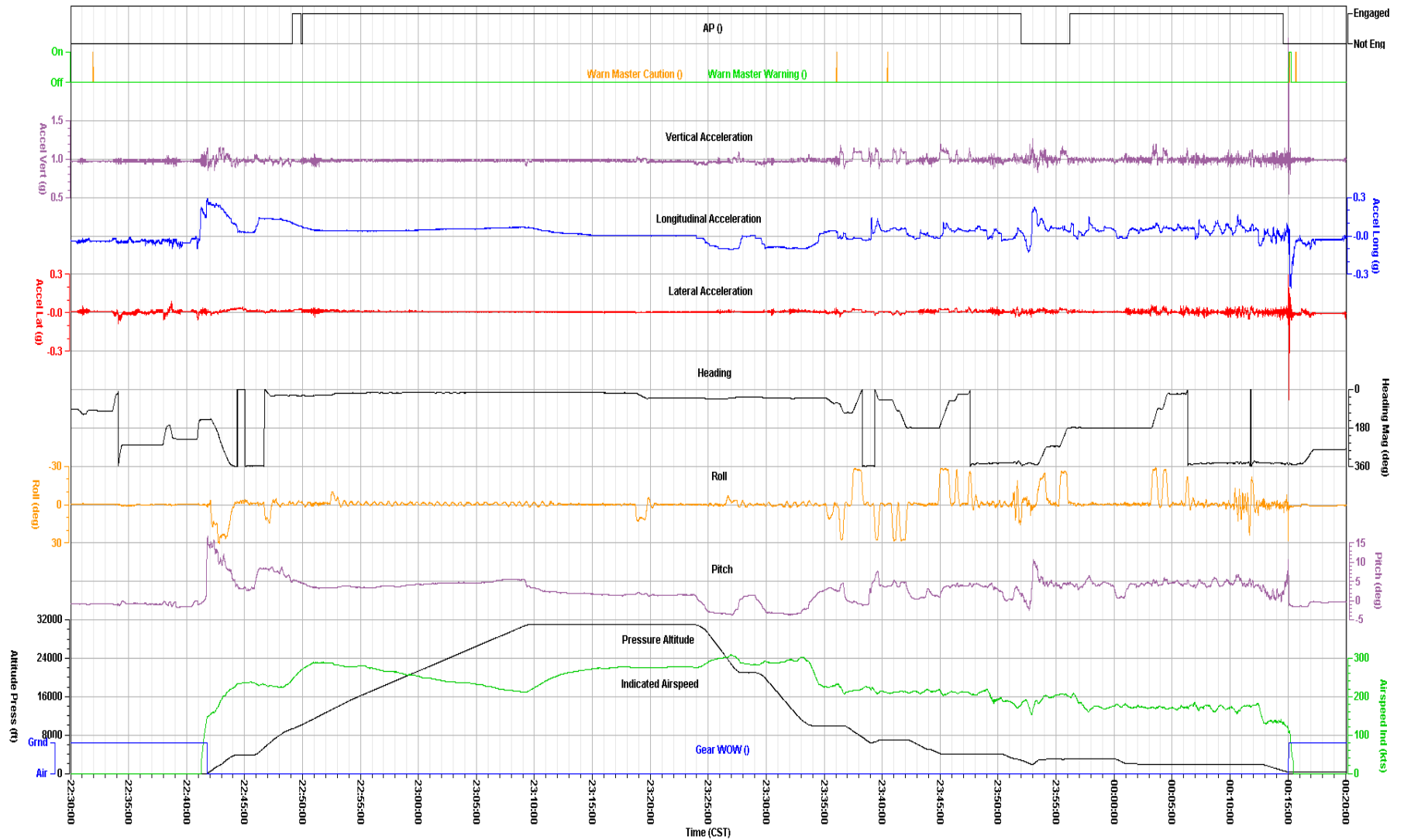
These figures are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

The corresponding tabular data used to create figure's 1 through 5 are provided in electronic comma separated value (*.csv) format as attachment 1 to this report. The

tabular data used to create figure 6 is provided in (.csv) format as attachment 2 to this report.

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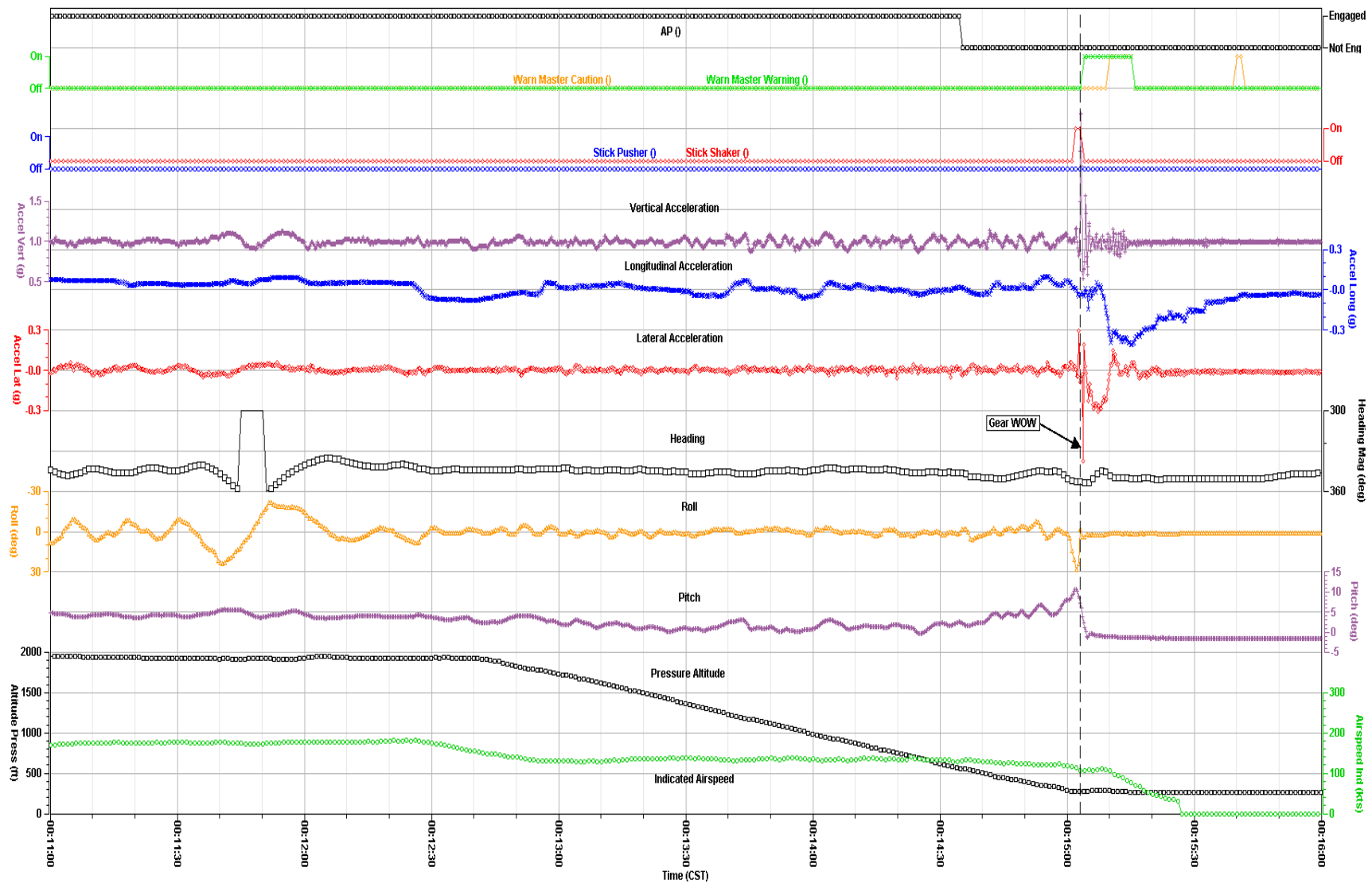
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Figure 1. Plot of basic parameters during entire flight.

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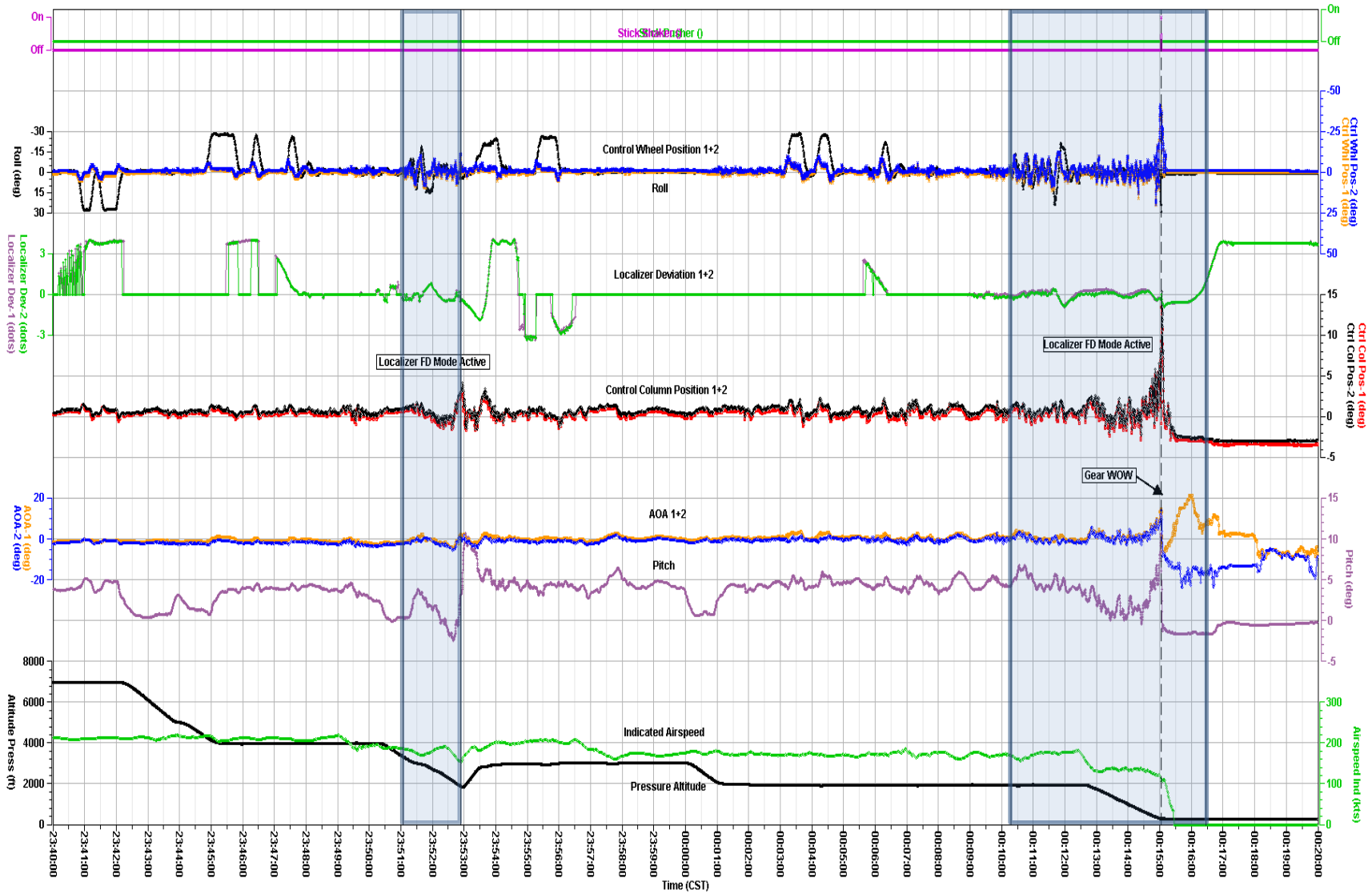
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Figure 2. Plot of basic parameters highlighting gear WOW.

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Figure 3. Plot of aircraft controls and localizer deviation during descent.

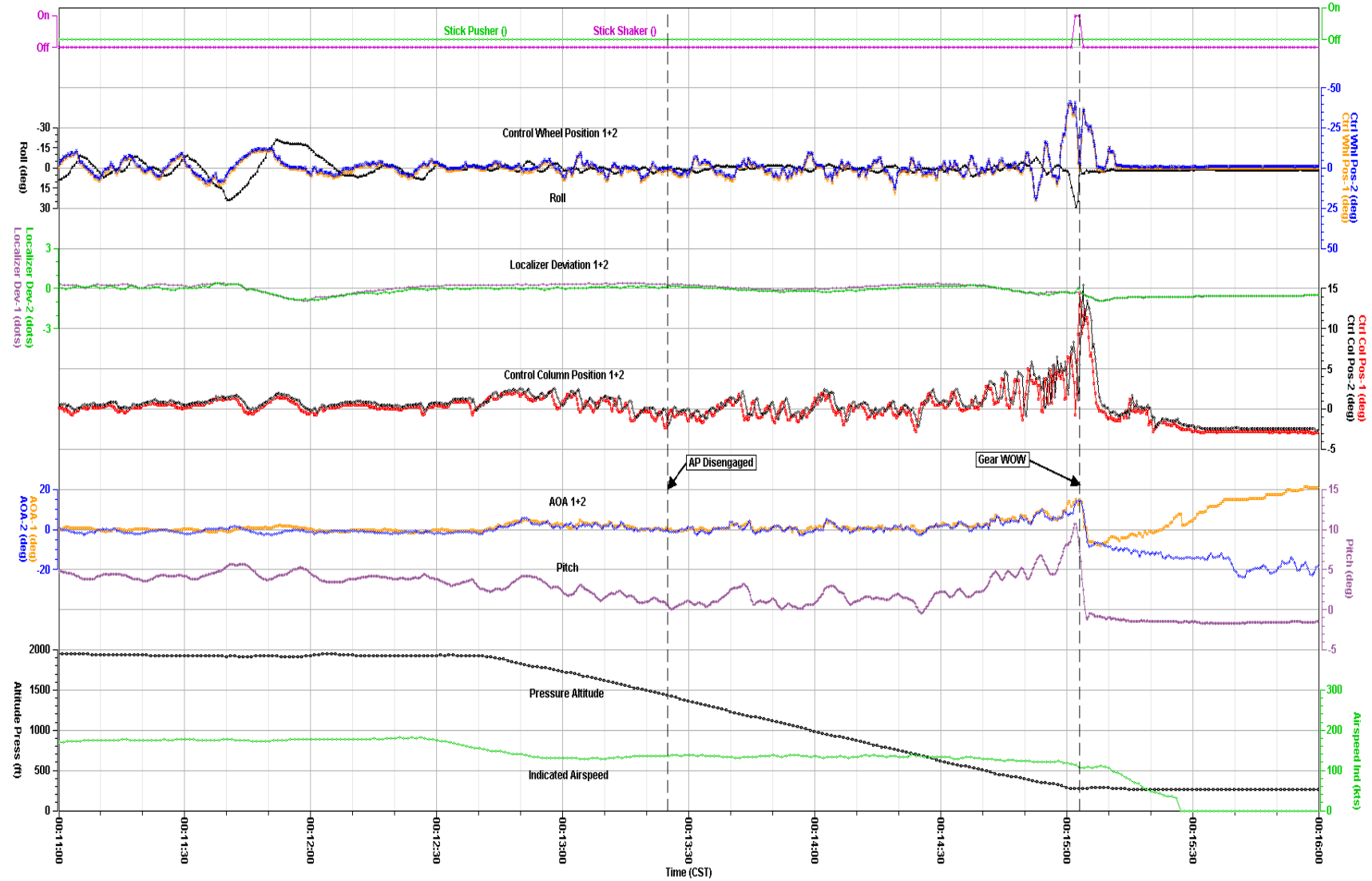
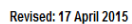


Figure 4. Plot of aircraft controls and localizer deviation during gear WOW.



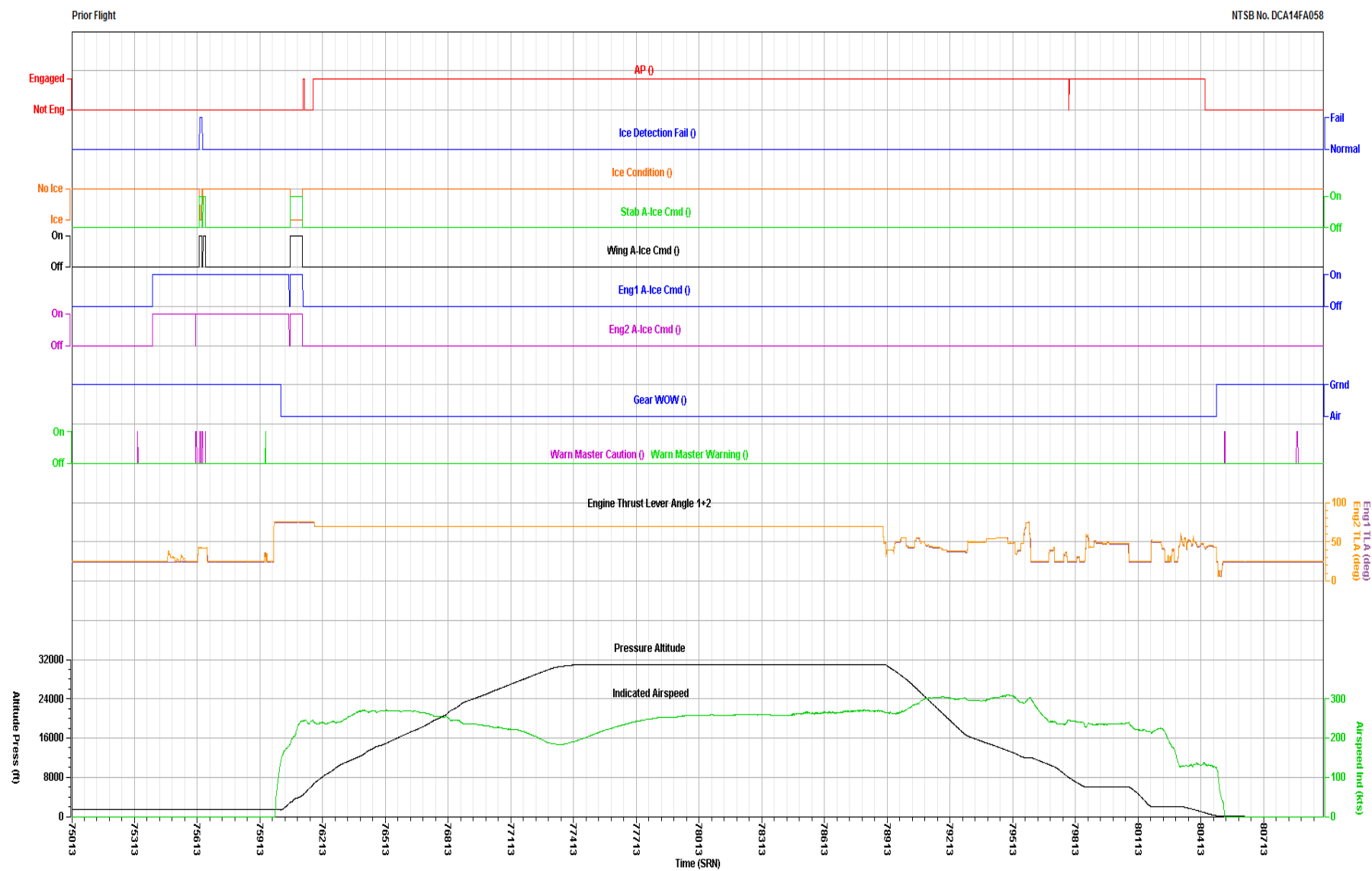


Figure 6. Plot of anti-ice parameters during prior flight.

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 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 Ind (kts)	Indicated Airspeed
5. Altitude Press ^a (ft)	Pressure Altitude
6. Ctrl Col Pos-1 (deg)	Left Control Column Position
7. Ctrl Col Pos-2 (deg)	Right Control Column Position
8. Ctrl Whl Pos-1 (deg)	Left Control Wheel Position
9. Ctrl Whl Pos-2	Right Control Wheel Position
10. Heading Mag (deg)	Magnetic Heading
11. Pitch (deg)	Pitch Angle
12. Roll (deg)	Roll Angle
13. Gear WOW (discrete)	Gear Weight On Wheels
14. Stick Shaker (discrete)	Stick Shaker
15. Stick Pusher (discrete)	Stick Pusher
16. Warn Master Caution (discrete)	Master Caution On/Off
17. Warn Master Warning (discrete)	Master Warning On/Off
18. AP (discrete)	Autopilot Engaged/Disengaged
19. AOA-1 (deg)	AOA Source 1
20. AOA-2 (deg)	AOA Source 2
21. Localizer Dev-1 (dots)	Localizer Deviation Source 1
22. Localizer Dev-2 (dots)	Localizer Deviation Source 2
23. Ice Detection Fail (discrete)	Ice Detection Fail
24. Ice Condition (discrete)	Ice Condition
25. Stab A-Ice Cmd (discrete)	Stabilizer Anti-ice Command
26. Wing A-Ice Cmd (discrete)	Wing Anti-Ice Command
27. Eng1 A-Ice Cmd (discrete)	Engine 1 Anti-Ice Command
28. Eng2 A-Ice Cmd (discrete)	Engine 2 Anti-Ice Command
29. Eng1 TLA (deg)	Engine 1 Thrust Lever Angle
30. Eng2 TLA (deg)	Engine 2 Thrust Lever Angle
31. Rudder Ped Pos ^b (deg)	Rudder Pedal Position
32. Elevator-L ^b (deg)	Left Elevator Position
33. Elevator-R ^b (deg)	Right Elevator Position
34. Aileron-L ^b (deg)	Left Aileron Position
35. Aileron-R ^b (deg)	Right Aileron Position
36. Rudder ^b (deg)	Rudder Position
37. Flap ^b (deg)	Flap Position
38. Time GMT Hrs	Aircraft Clock Source GMT Hours
39. Time GMT Min	Aircraft Clock Source GMT Minutes

NOTE: ^a 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.

^b Data is not plotted however is included in the attached tabular data.

Table A-2. Unit and discrete abbreviations.

Units Abbreviation	Description
deg	degrees
kts	knots
g	g
discrete	discrete
ft	feet
hrs	hours
min	minutes
sec	seconds
dots	dots

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.