Docket No. SA-531

Exhibit No. 10-A

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

Flight Data Recorder Group Chairman
Factual Report

(29 Pages)

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

April 16, 2009

Flight Data Recorder – 10

Group Chairman's Factual Report
By Cassandra Johnson

1. EVENT SUMMARY

Location: Clarence City, New York
Date: February 12, 2009
Aircraft: Dash8-400Q, Registration: N200WQ
Operator: Colgan, Flight 3407
NTSB Number: DCA09MA027

On February 12, 2009, about 2217 eastern standard time (EST), a Colgan Air Inc., Bombardier Dash 8-Q400, N200WQ, d.b.a. Continental Connection flight 3407, crashed during an instrument approach to runway 23 at the Buffalo-Niagara International Airport (BUF), Buffalo, New York. The crash site was approximately 5 nautical miles northeast of the airport in Clarence Center, New York, and mostly confined to one residential house. The four flight crew and 45 passengers were fatally injured and the aircraft was destroyed by impact forces and post crash fire. There was one ground fatality. Night visual meteorological conditions prevailed at the time of the accident. The flight was a Code of Federal Regulations (CFR) Part 121 scheduled passenger flight from Liberty International Airport (EWR), Newark, New Jersey to BUF.

2. FLIGHT DATA RECORDER GROUP

A flight data recorder (FDR) group was convened on February 15, 2009.

Chairman:	Cassandra Johnson Mechanical Engineer National Transportation Safety Board
Member:	Anna Cushman Flight Data Analyst Federal Aviation Agency
Member:	Robert Henriksen Engineering Colgan Air, Inc.
Member:	Allan Paige Engineering Manager Bombardier
Member:	John White Staff Engineer Air Line Pilots Association, Int'l

3. DETAILS OF FLIGHT DATA RECORDER INVESTIGATION

On February 13, 2009, the Safety Board's Vehicle Recorder Division received the following FDR:

Recorder Manufacturer/Model: **Honeywell SSFDR, Model 980-4700, 128 Word**
Recorder Serial Number: **14241**

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

3.1. Recorder Description

The Honeywell Solid State Flight Data Recorder (SSFDR) records airplane flight information in a digital format using solid-state flash memory as the recording medium. The SSFDR can receive data in the ARINC 573/717/747 configurations and can record a minimum of 25 hours of flight data. This recorder 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, heading, airspeed) has a specifically assigned word number within the subframe. The SSFDR is designed to meet the crash-survivability requirements of TSO–C124.

3.2. FDR Carriage Requirements

Federal regulations regarding the carriage requirements of FDRs on aircraft can be found in the following regulations: 14 CFR 121.343, 14 CFR 121.344, 14 CFR 121.344a and 14 CFR 135.152. In general, for turbine-powered transport category aircraft manufactured on or before October 11, 1991, an FDR must be installed on board that records a minimum of 18 parameters, and for those turbine-powered aircraft that seat between 10 and 19 passengers, the minimum is 22 parameters. Newly manufactured aircraft are required to be equipped with an FDR that records a minimum of 88 parameters. Specifically, the accident aircraft, N200WQ, was operating such that it was required to be equipped with an FDR that recorded 88 parameters, as cited in 14 CFR 121.343.

3.3. Recording Description

The FDR recording contained approximately 26.5 hours of data. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The accident flight was the last flight of the recording and its duration was approximately 58 minutes.

3.4. Time Correlation

Correlation of the FDR data from SRN to the accident local time, eastern standard time (EST), was established with an offset provided by the Aircraft Performance Group Chairman in the Aircraft Performance Study. Accordingly, the time offset for the accident flight FDR data from SRN to local time is the following: EST = SRN – 15,355.0695. Therefore, for the rest of this report, all times are referenced as EST, not SRN.

3.5. Engineering Units Conversions

The engineering units conversions used for the data contained in this report are based on documentation from the aircraft manufacturer, Bombardier. Where applicable, the conversions have been changed to ensure that the parameters conform to the Safety Board's standard sign convention that climbing right turns are positive (CRT=+).[1]

3.5.1. Parameters Provided and Verified

The following table lists the FDR parameters provided and verified in this report.

Table 1. Verified and provided FDR parameters.

Parameter Name	Parameter Description
1. Accel Lat (g)	Lateral Acceleration (g)
2. Accel Long (g)	Longitudinal Acceleration (g)
3. Accel Vert (g)	Vertical Acceleration (g)
4. Aileron Trim Pos (deg)	Aileron Trim Position (degrees)
5. Aileron-R (deg)	Aileron-Right (degrees)
6. Airspeed Cal-L (kts)	Calibrated Airspeed-Left (knots)
7. Airspeed Cal-R (kts)	Calibrated Airspeed-Right (knots)
8. ALT Hold Mode	Altitude Hold Mode (discrete)[2]
9. ALT Select Mode	Altitude Select Mode (discrete)
10. Altitude Press-L (ft)	Pressure Altitude-Left (feet)
11. Altitude Press-R (ft)	Pressure Altitude-Right (feet)
12. Altitude Radio (ft)	Altitude Radio (feet)
13. AOA-L (deg)	Angle of Attack-Left (degrees)
14. AOA-R (deg)	Angle of Attack-Right (degrees)
15. Auto Pilot	Auto Pilot (discrete)
16. Ctrl Col Force Transducer1 (lbs)	Control Column Force Transducer 1 (pounds)
17. Ctrl Col Force Transducer2 (lbs)	Control Column Force Transducer 2 (pounds)
18. Ctrl Col Pos-L (deg)	Control Column Position-Left (degrees)
19. Ctrl Col Pos-R (deg)	Control Column Position-Right (degrees)
20. Ctrl Whl Force Aileron Transducer (lbs)	Control Wheel Force Aileron Transducer (pounds)
21. Ctrl Whl Force Spoiler Transducer (lbs)	Control Wheel Force Spoiler Transducer (pounds)
22. Ctrl Whl Pos-L (deg)	Control Wheel Position-Left (degrees)
23. Ctrl Whl Pos-R (deg)	Control Wheel Position-Right (degrees)
24. Deice Airframe	Deice Airframe (discrete)
25. Deice Pitot	Deice Pitot (discrete)
26. Deice Propeller	Deice Propeller (discrete)
27. Drift Angle (deg)	Drift Angle (degrees)
28. Elevator-L (deg)	Elevator-Left (degrees)
29. Elevator-R (deg)	Elevator-Right (degrees)
30. Eng1 Condition Lvr (deg)	Engine 1 Condition Lever (degrees)
31. Eng1 Fuel Flow (pph)	Engine 1 Fuel Flow (pounds per hour)

[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 = +, Left Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +.

[2] A discrete is typically a 1-bit parameter that is either a 0 state or 1 state where each state is uniquely defined for each parameter. For example, for the Altitude Hold Mode FDR parameter, a 0 state equals "Not Active" and a 1 state equals "Active".

Table 1. Verified and provided FDR parameters.	
Parameter Name	**Parameter Description**
32. Eng1 InterTurbine Temp (degC)	Engine 1 Internal Turbine Temperature (degrees Celsius)
33. Eng1 NH (%)	Engine 1 High Pressure Rotor Speed (percent)
34. Eng1 NL (%)	Engine 1 Low Pressure Rotor Speed (percent)
35. Eng1 NP (RPM)	Engine 1 Propeller Speed (RPM)
36. Eng1 Oil Press	Engine 1 Oil Pressure (discrete)
37. Eng1 Prop Beta	Engine 1 Propeller Beta (discrete)
38. Eng1 Pwr Lvr (deg)	Engine 1 Power Lever (degrees)
39. Eng1 Torque (%)	Engine 1 Torque (percent)
40. Eng1 Torque Cmd (%)	Engine 1 Torque Command (percent)
41. Eng2 Condition Lvr (deg)	Engine 2 Condition Lever (degrees)
42. Eng2 Fuel Flow (pph)	Engine 2 Fuel Flow (pounds per hour)
43. Eng2 InterTurbine Temp (degC)	Engine 2 Internal Turbine Temperature (degrees Celsius)
44. Eng2 NH (%)	Engine 2 High Pressure Rotor Speed (percent)
45. Eng2 NL (%)	Engine 2 Low Pressure Rotor Speed (percent)
46. Eng2 NP (RPM)	Engine 2 Propeller Speed (RPM)
47. Eng2 Oil Press	Engine 2 Oil Pressure (discrete)
48. Eng2 Prop Beta	Engine 2 Propeller Beta (discrete)
49. Eng2 Pwr Lvr (deg)	Engine 2 Power Lever (degrees)
50. Eng2 Torque (%)	Engine 2 Torque (percent)
51. Eng2 Torque Cmd (%)	Engine 2 Torque Command (percent)
52. Flap Ctrl Sel (deg)	Flap Control Select (degrees)
53. Flap TE (deg)	Trailing Edge Flap Position (degrees)
54. GA Mode	Go-Around Mode (discrete)
55. Gear Dn+Lock-Main	Gear Down and Locked-Main (discrete)
56. Gear Dn+Lock-N	Gear Down and Locked-Nose (discrete)
57. Gear Ldg Hdle Pos	Landing Gear Handle Position (discrete)
58. Gear Up+Lock-Main	Gear Up and Locked-Main (discrete)
59. Gear Up+Lock-N	Gear Up and Locked-Nose (discrete)
60. Gear WOW-Main	Weight on Wheels Main Gear (discrete)
61. Gear WOW-Nose	Weight on Wheels Nose Gear (discrete)
62. Ground Spd (kts)	Ground Speed (knots)
63. GS Mode	Glideslope Mode (discrete)
64. Heading Mag (deg)	Magnetic Heading (degrees)
65. Heading Mode	Heading Mode (discrete)
66. IAS Mode	Indicated Airspeed Mode (discrete)
67. Ice Detected	Ice Detected (discrete)
68. ILS GS Dev-1 (dot)	Instrument Landing System Glideslope Deviation-1 (dot)
69. ILS GS Dev-2 (dot)	Instrument Landing System Glideslope Deviation-2 (dot)
70. ILS Loc Dev-1 (dot)	Instrument Landing System Localizer Deviation-1 (dot)
71. ILS Loc Dev-2 (dot)	Instrument Landing System Localizer Deviation-2 (dot)
72. Latitude (deg)	Latitude (degrees)
73. LOC Mode	Localizer Mode (discrete)
74. Longitude (deg)	Longitude (degrees)
75. Master Caution	Master Caution (discrete)
76. Master Warning	Master Warning (discrete)
77. Pitch (deg)	Pitch (degrees)
78. Pitch Trim Nose Dn CoPilot 1	Pitch Trim Nose Down Copilot 1 (discrete)
79. Pitch Trim Nose Dn CoPilot 2	Pitch Trim Nose Down Copilot 2 (discrete)

Table 1. Verified and provided FDR parameters.	
Parameter Name	**Parameter Description**
80. Pitch Trim Nose Dn Pilot 1	Pitch Trim Nose Down Pilot 1 (discrete)
81. Pitch Trim Nose Dn Pilot 2	Pitch Trim Nose Down Pilot 2 (discrete)
82. Pitch Trim Nose Up CoPilot 1	Pitch Trim Nose Up Copilot 1 (discrete)
83. Pitch Trim Nose Up CoPilot 2	Pitch Trim Nose Up Copilot 2 (discrete)
84. Pitch Trim Nose Up Pilot 1	Pitch Trim Nose Up Pilot 1 (discrete)
85. Pitch Trim Nose Up Pilot 2	Pitch Trim Nose Up Pilot 2 (discrete)
86. Pitch Trim Pos-L (deg)	Pitch Trim Position-Left (degrees)
87. Pitch Trim Pos-R (deg)	Pitch Trim Position-Right (degrees)
88. Roll (deg)	Roll (degrees)
89. Rudder Ped Pos (deg)	Rudder Pedal Position (degrees)
90. Rudder Pedal Force Left - Copilot (lbs)	Rudder Pedal Force Left - Copilot (pounds)
91. Rudder Pedal Force Left - Pilot (lbs)	Rudder Pedal Force Left - Pilot (pounds)
92. Rudder Pedal Force Right- Copilot (lbs)	Rudder Pedal Force Right- Copilot (pounds)
93. Rudder Pedal Force Right- Pilot (lbs)	Rudder Pedal Force Right- Pilot (pounds)
94. Rudder Pos (deg)	Rudder Position (degrees)
95. Rudder Trim Enable	Rudder Trim Enable (discrete)
96. Rudder Trim Extend	Rudder Trim Extend (discrete)
97. Rudder Trim Pos (deg)	Rudder Trim Position (degrees)
98. SAT-L (degC)	SAT-Left (degrees Celsius)
99. SAT-R (degC)	SAT-Right (degrees Celsius)
100. Sel Baro Setting(Hg)-L (inHg)	Selected Barometric Setting(Hg)-Left (inches of Mercury)
101. Sel Baro Setting(Hg)-R (inHg)	Selected Barometric Setting(Hg)-Right (inches of Mercury)
102. Selected Airspeed (kts)	Selected Airspeed (knots)
103. Selected Altitude (ft)	Selected Altitude (feet)
104. Selected Course (deg)	Selected Course (degrees)
105. Selected Heading (deg)	Selected Heading (degrees)
106. Selected VS (ft/min)	Selected Vertical Speed (feet per minute)
107. Spoiler Inbd-L (deg)	Spoiler Inboard-Left (degrees)
108. Spoiler Inbd-R (deg)	Spoiler Inboard-Right (degrees)
109. Spoiler Outbd-L (deg)	Spoiler Outboard-Left (degrees)
110. Spoiler Outbd-R (deg)	Spoiler Outboard-Right (degrees)
111. Stick Pusher	Stick Pusher (discrete)
112. Stick Shaker L	Stick Shaker Left (discrete)
113. Stick Shaker R	Stick Shaker Right (discrete)
114. VHF1	VHF1 (discrete)
115. VHF2	VHF2 (discrete)
116. VHF3	VHF3 (discrete)
117. WCP FADEC L Fail	WCP FADEC Left Fail (discrete)
118. WCP FADEC R Fail	WCP FADEC Right Fail (discrete)
119. Wind direction (deg)	Wind direction (degrees)
120. Wind Speed (kts)	Wind Speed (knots)
121. Yaw Damper	Yaw Damper (discrete)

3.5.2. Altitude Pressure

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 have not been corrected for the local altimeter setting at the time of the event.

3.5.3. Angle of Attack (AOA)

Angle of Attack (for both left and right) is the raw angle of attack. More specifically, the raw angle of attack is the angle of the AOA vane relative to the fuselage longitudinal axis (seat rails).

3.5.4. Control Column Forces

According to Bombardier, the control column forces are recorded separately using a transducer at the base of the pilot's control column and the copilot's control column. With the system operating normally (for example, disconnect not pulled), there is no way to determine if pilot, copilot or both are flying. Therefore, the original names from the Bombardier documentation were changed from "control column force pilot" and "control column force copilot" to "control column force transducer 1" and "control column force transducer 2", to accurately represent the information being recorded.

With autopilot engaged, and hands off the column, the transducers should indicate opposite forces as the autopilot moves the elevators. In normal situations with control columns connected and only one pilot having hands on the column, both forces should be similar.

With autopilot not engaged and no stick pusher activation, the force measured by the transducer on the pilot side consists of the force from the left feel unit plus mechanical friction force; unless the elevator stop is reached at which time the force will include the force applied against the stop. Similarly, the force measured by the transducer on the copilot side consists of the force from the right feel unit plus mechanical friction force; unless the elevator stop is reached at which time the force will include the force applied against the stop. The total force being applied by the pilot and/or copilot is the sum of the forces measured by the two transducers.

In the event of a stick pusher activation, the copilot and pilot forces will be split due to the force of the stick pusher so that the pilot (or copilot) force input is the average of the two control column forces. If either pilot resists the stick pusher, the difference will be the full capability of the stick pusher. If neither pilot offers any resistance to the stick pusher, the difference will be zero.

3.5.5. Control Wheel Forces

According to Bombardier, the control wheel force on the pilot side and the control wheel force on the copilot side are recorded separately using individual transducers. The force measured by the transducer on the pilot side of the system is a resultant of the force in the spoiler circuit. Since there is no feel unit or aerodynamic load in this circuit, the measurement is mechanical friction force; unless the spoiler stop is reached at which time the force will include the force applied against the stop. Therefore, the parameter was renamed from "control wheel pilot force" to "control wheel force spoiler transducer", to accurately represent the information being recorded.

The force measured by the transducer on the copilot side of the system is a resultant of the force in the aileron circuit, which includes aerodynamic load, mechanical friction force and a spring centering force. Therefore, the parameter was renamed from “control wheel copilot force” to “control wheel force aileron transducer”, to accurately represent the information being recorded.

The total force being applied by the pilot and/or copilot is the sum of the forces measured by the two transducers. If the aileron stop is reached, the force will include the force applied against the stop. With the system operating normally (for example, disconnect is not pulled), there is no way to determine if pilot, copilot or both are flying. In addition, with autopilot engaged, the aileron servo force is not expected to be seen by either transducer due to the lack of a feel unit in the spoiler circuit.

3.5.6. Flap TE

The source of the trailing edge flap position is from the torque tube on the right flap.

3.5.7. Ice Detected

The ice detected discrete is based on either the left ice probe detecting ice or the right ice probe detecting ice.

3.5.8. Rudder Pedal Forces

According to Bombardier, each rudder pedal has its own transducer. For both the pilot and copilot, pushing on the right pedal is indicated by a positive force and pushing on the left pedal is indicated by a negative force. The net force on the rudder control system from either the pilot or copilot is the sum of the two forces. In normal situations with only one pilot having his feet on the pedals, the other system will read zero.

3.6. FDR Plots and Corresponding Tabular Data

The following 21 plots contain FDR data recorded during the February 12, 2009 event. All of the FDR parameters listed in table 1 are plotted except for latitude and longitude. Plots 1 through 7 cover the last 110 seconds of flight data (22:15:05 EST to 22:16:55 EST), plots 8 through 14 cover the last 10 minutes of the flight data (22:06:55 EST to 22:16:55 EST), and, lastly, plots 15 through 21 cover the entire flight (21:17:15 EST to 22:17:15 EST).

Near the end of the FDR data between 22:16:35.30 EST and 22:16:49.30 EST, the radio altitude continually indicated 0 feet although both the left and right pressure altitude parameters indicated that the aircraft was still airborne. In general, the radio altimeter is a device mounted under the aircraft that measures the altitude (called radio altitude) above the terrain beneath the aircraft. During the times the aircraft was in a 105 degrees right roll attitude, the radio altitude recorded 0 feet because the terrain was no longer below the aircraft.

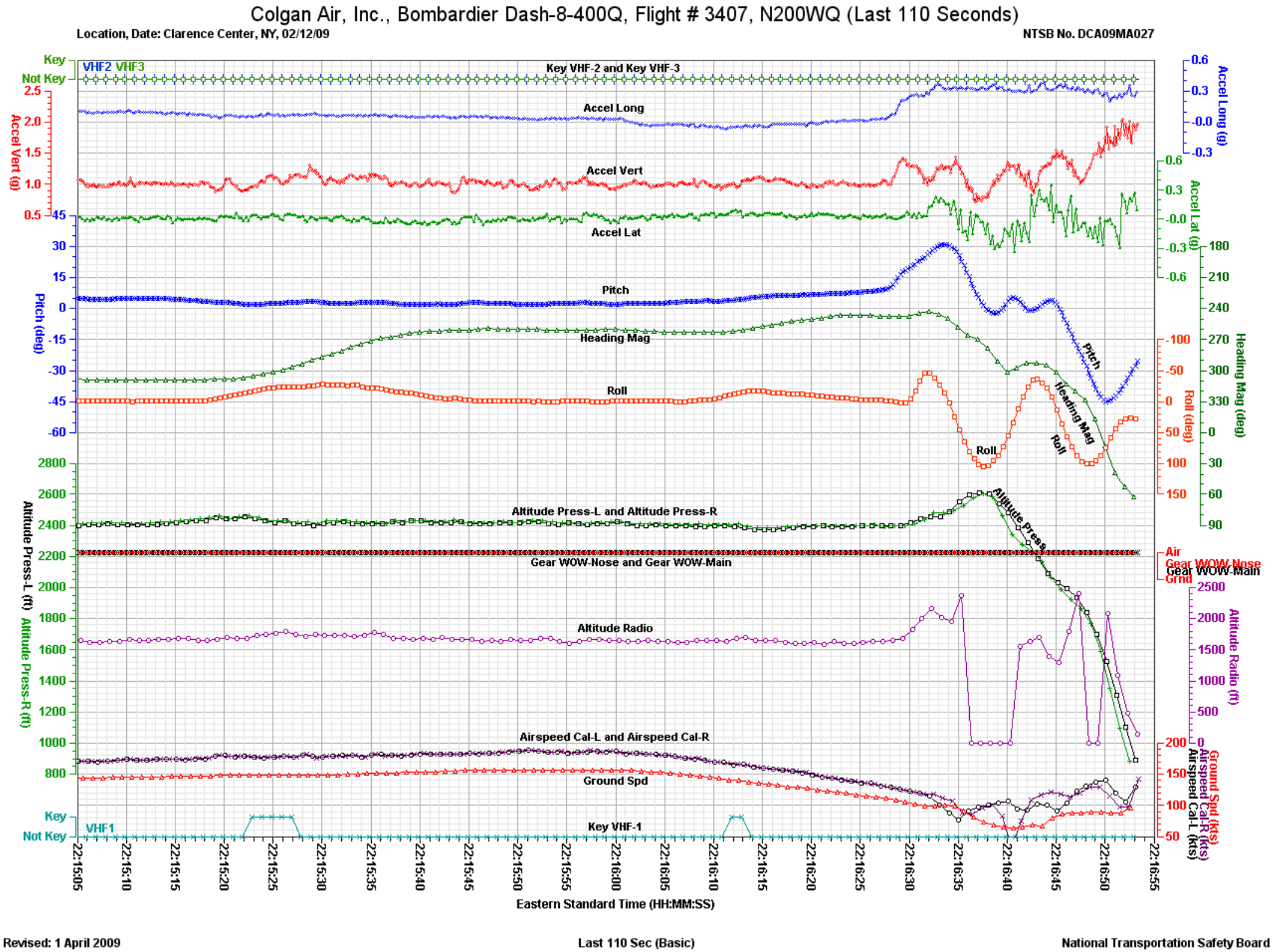
Additionally, near the end of the FDR data, at 22:16:40.44 EST, the right calibrated airspeed parameter indicated 32 knots, which did not follow the trend of the left calibrated airspeed data. In general, calibrated airspeed is derived from the difference between the ram air pressure from the pitot tube (pitot probes are mounted on the outside of the aircraft facing forward) and the static pressure (static pressure is frequently detected at static ports

on one or both sides of the aircraft). The static pressure measurement is subject to error due to the inability to place the static ports at positions where the pressure is actual static pressure at all airspeeds and at all attitudes. When the right calibrated airspeed was 32 knots, the aircraft was rolling left 33 degrees when just 2.94 seconds earlier (at 22:16:37.60 EST) the aircraft had rolled right to 105 degrees. This unusual attitude affected the static pressure measurement and, therefore, provided an inaccurate right calibrated airspeed of 32 knots.

These plots 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.

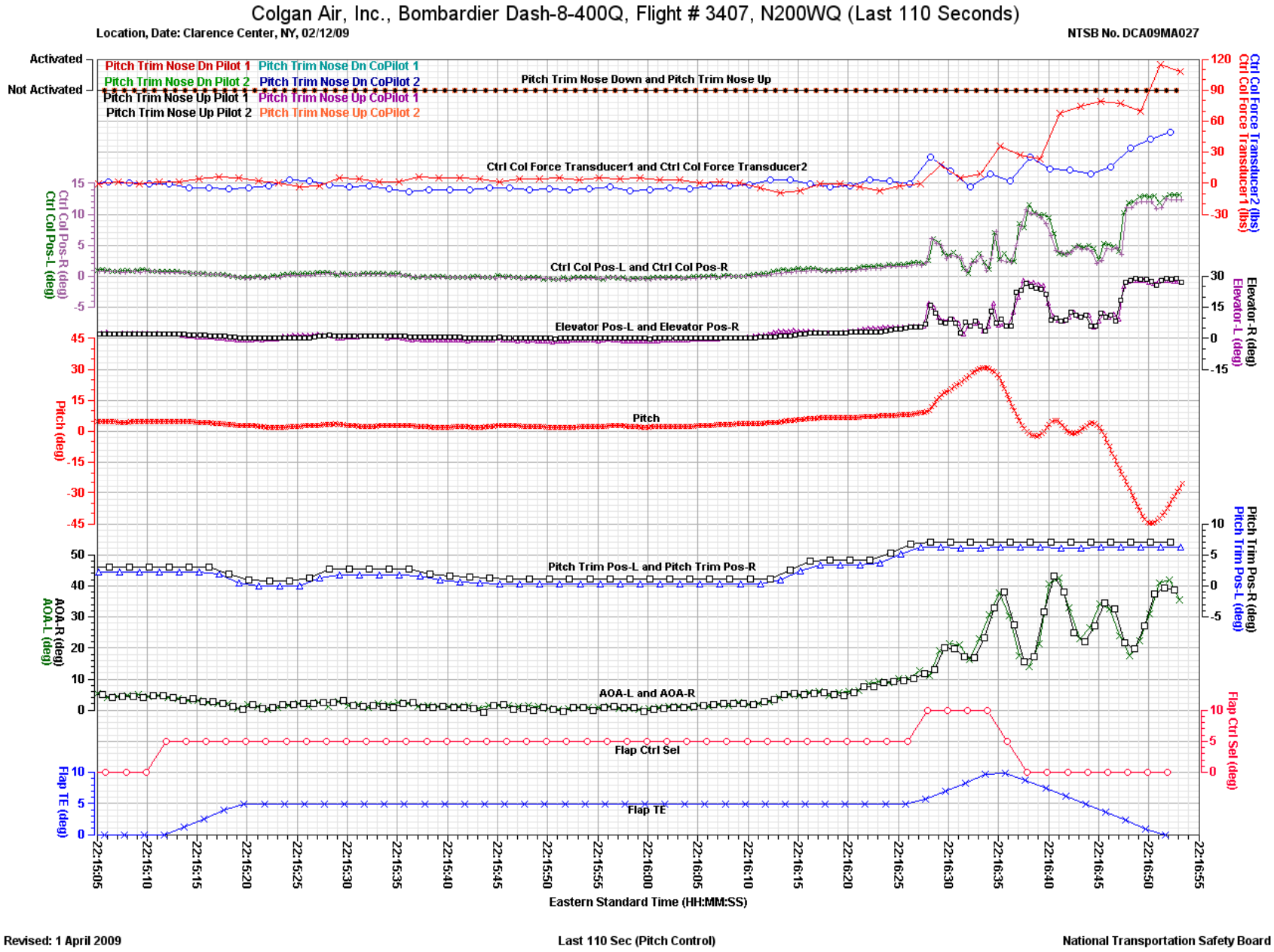
The corresponding tabular data used to create these 21 plots plus latitude and longitude are provided in electronic (.CSV) format as Attachment 1 to this report.

Plot 1 (Last 110 Seconds)

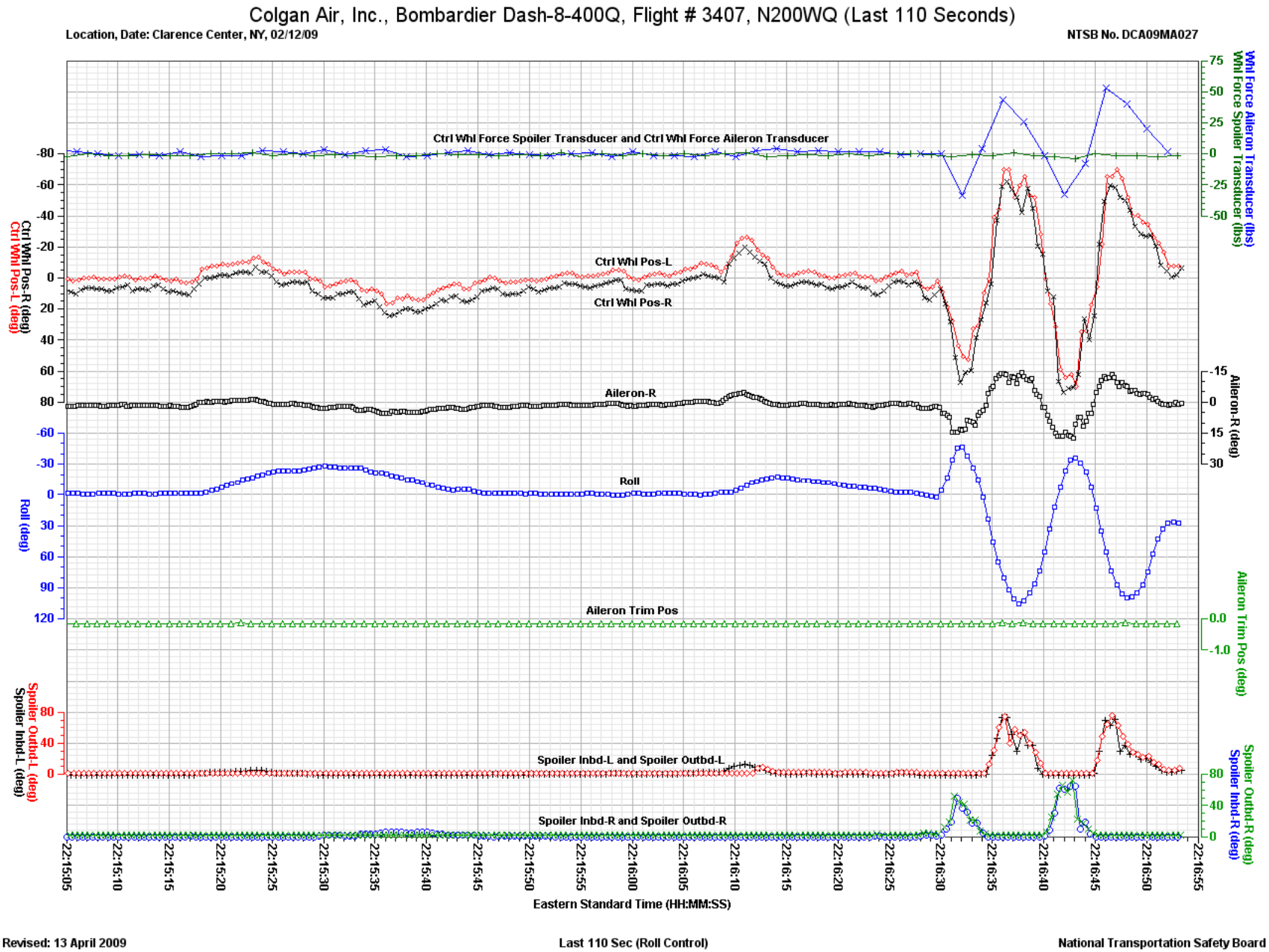


Revised: 1 April 2009 Last 110 Sec (Basic) National Transportation Safety Board

Plot 2 (Last 110 Seconds)



Plot 3 (Last 110 Seconds)



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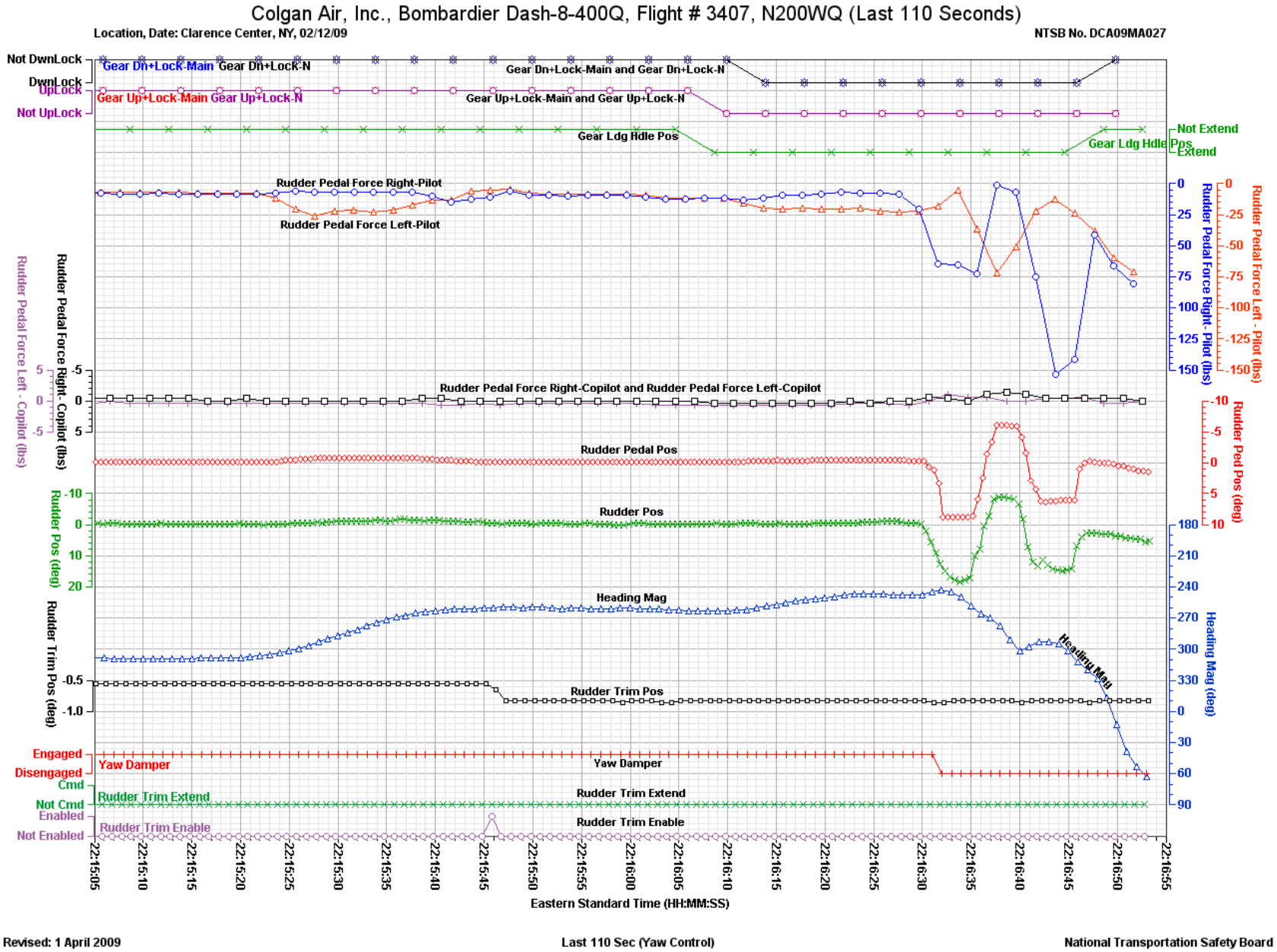
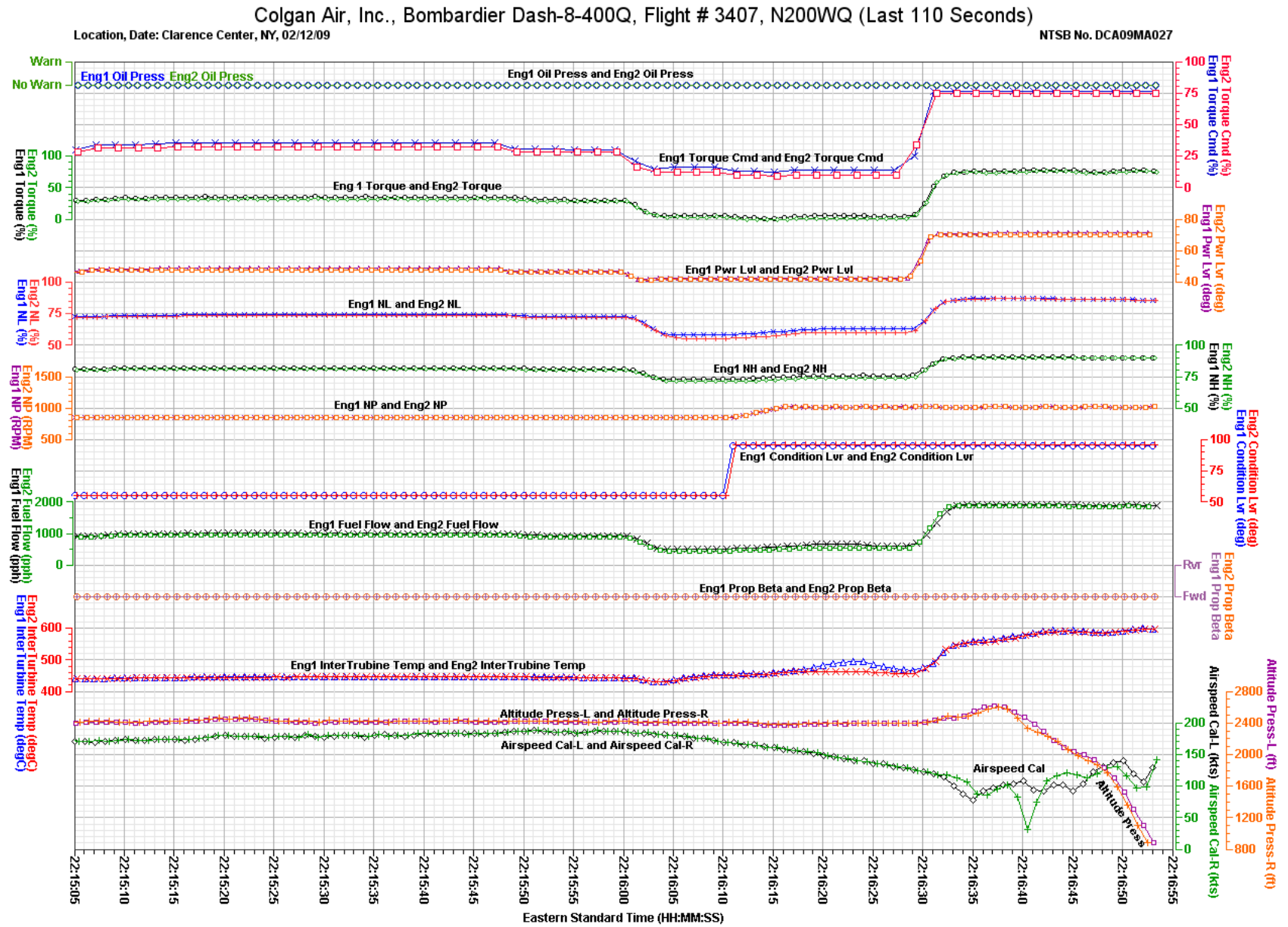
Last 110 Sec (Roll Control)

National Transportation Safety Board

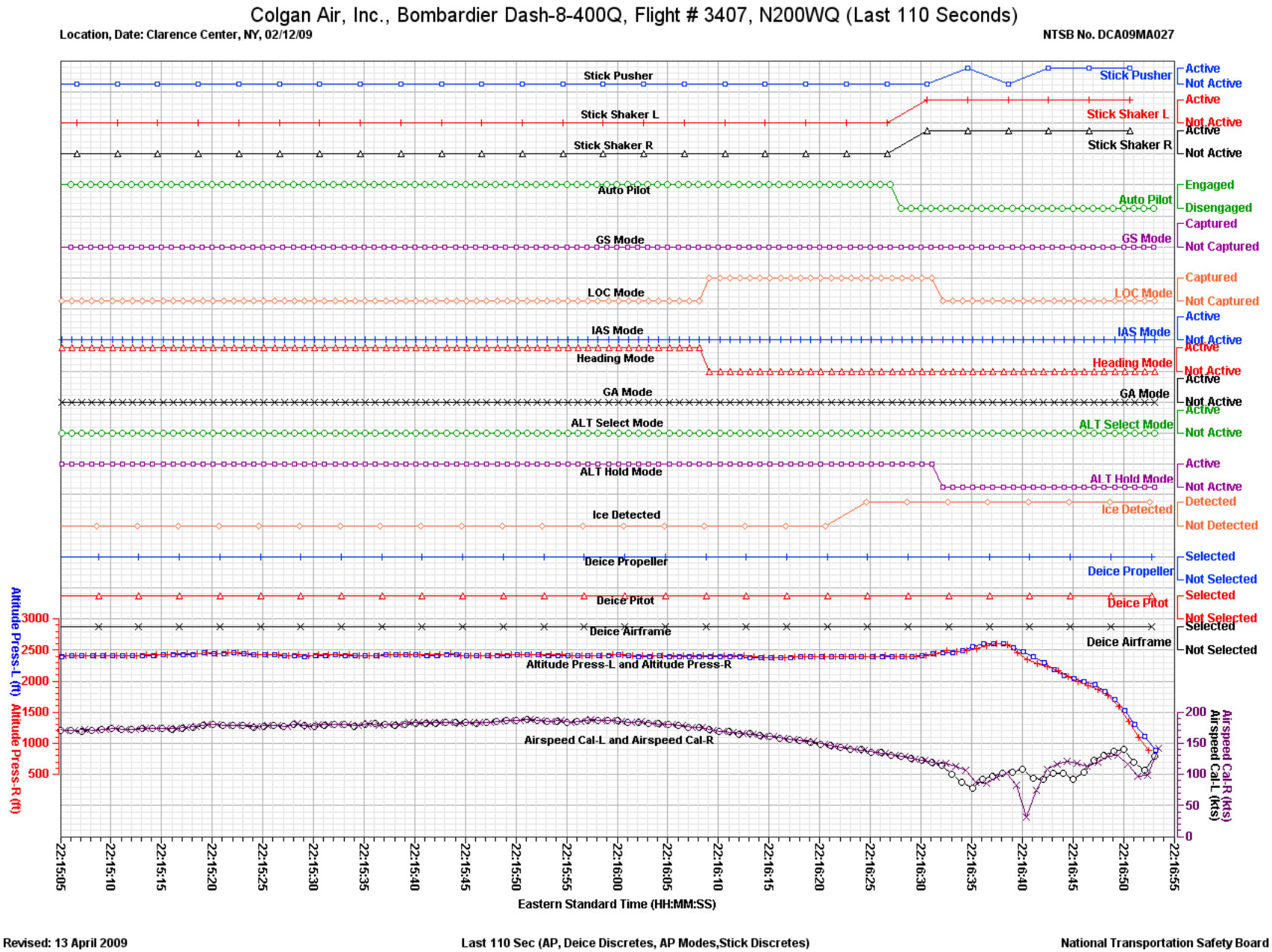
Plot 4 (Last 110 Seconds)



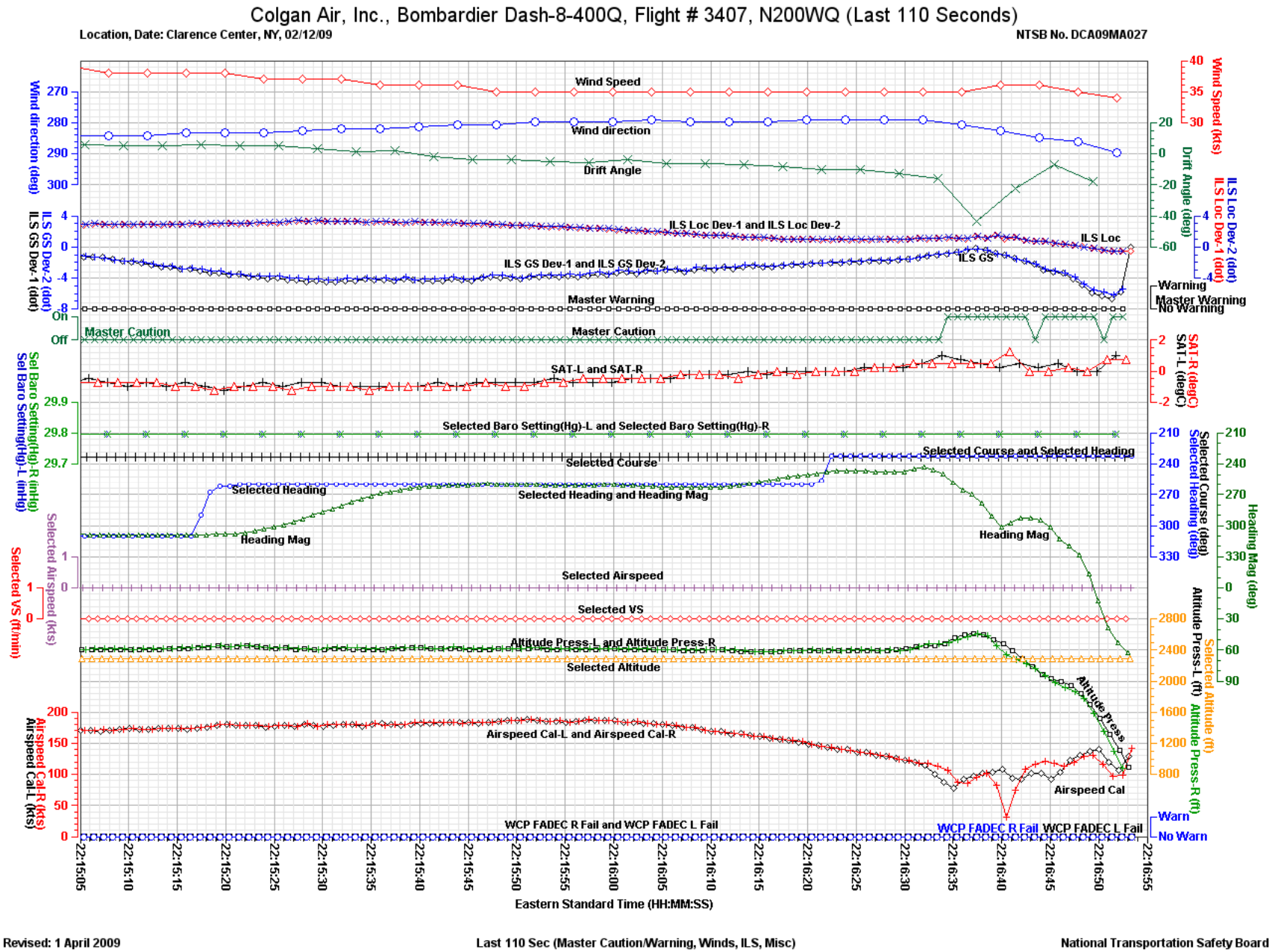
Plot 5 (Last 110 Seconds)



Plot 6 (Last 110 Seconds)



Plot 7 (Last 110 Seconds)



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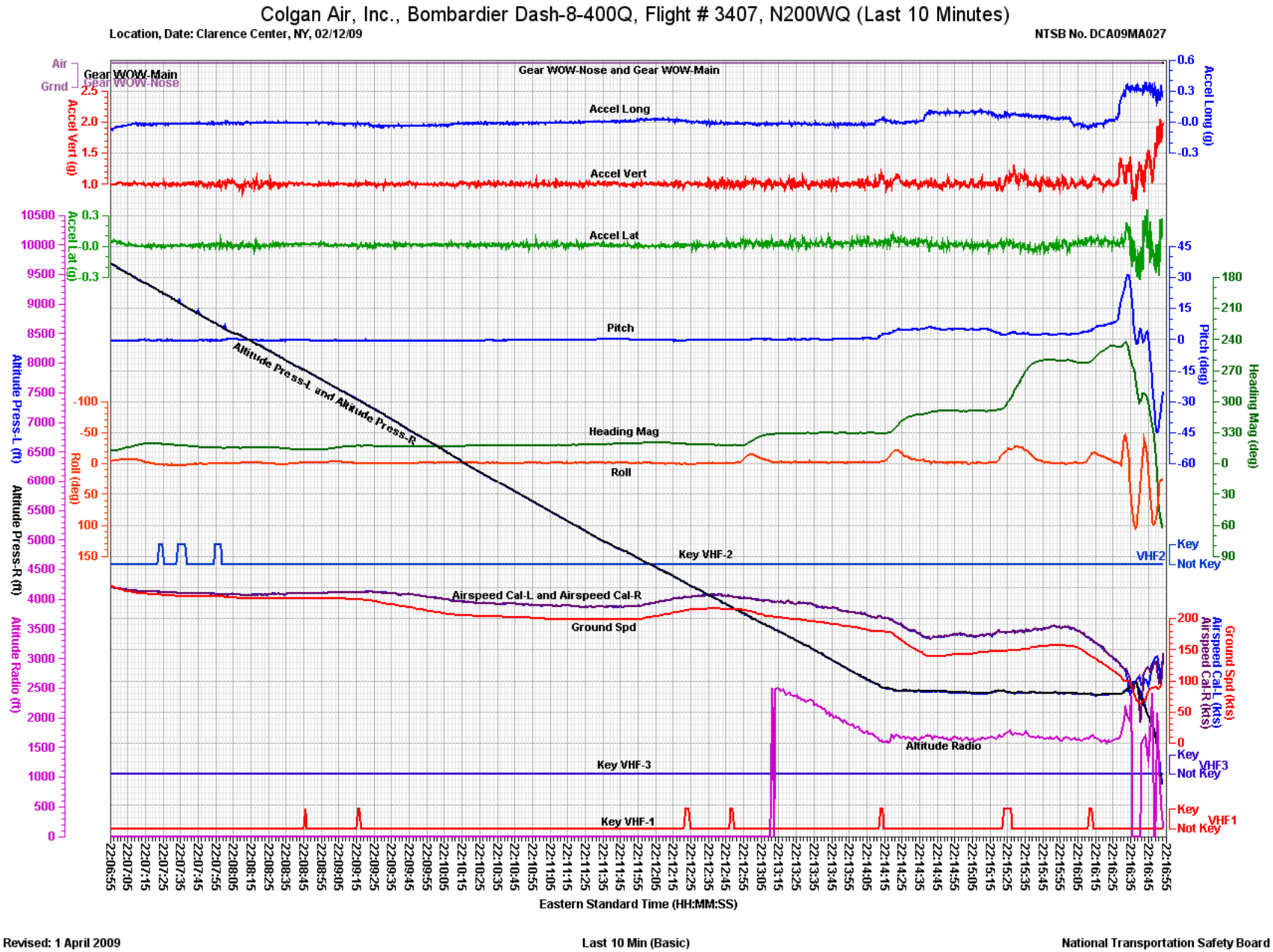
Last 110 Sec (Master Caution/Warning, Winds, ILS, Misc)

National Transportation Safety Board

Plot 8 (Last 10 Minutes)



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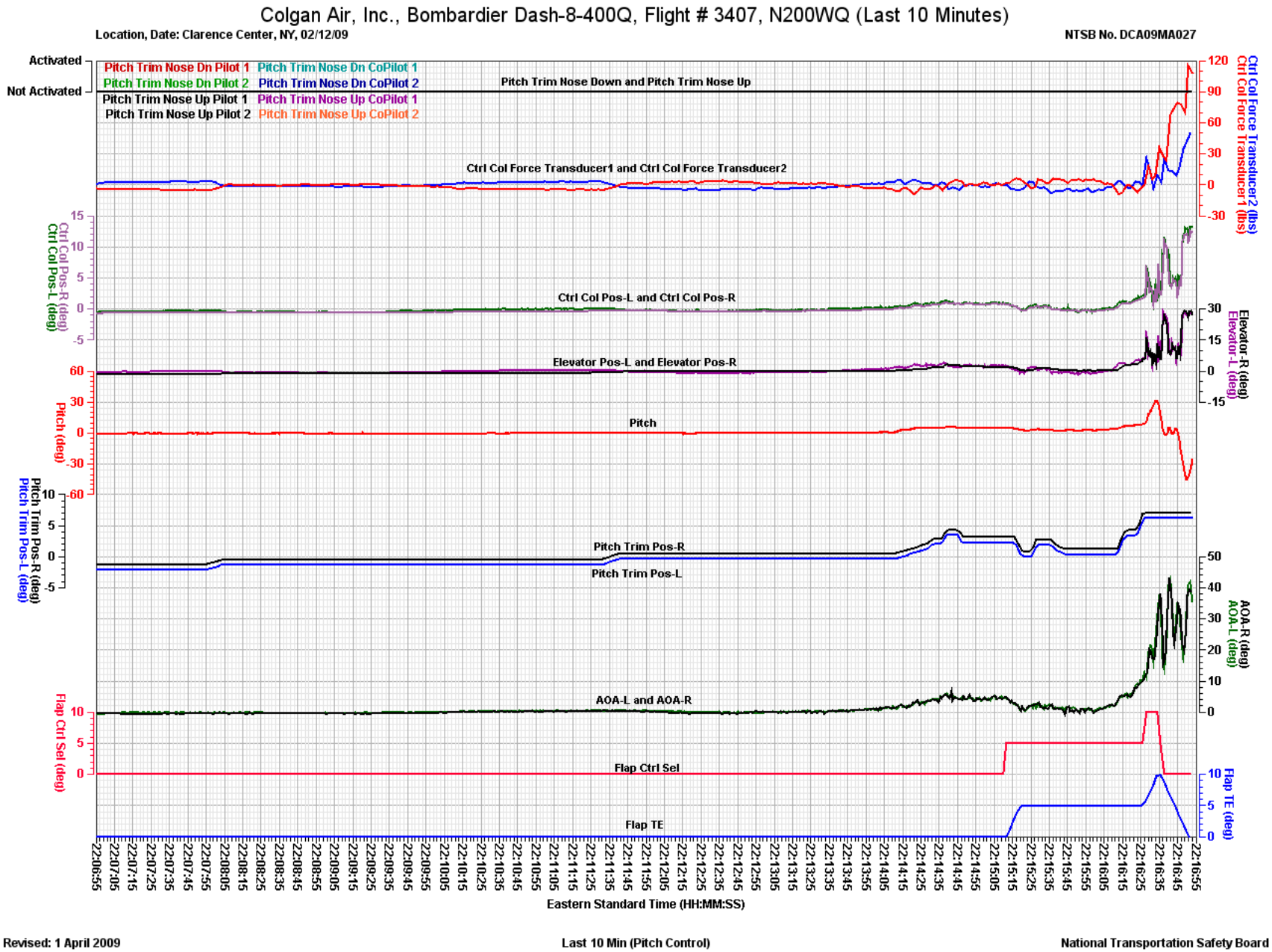
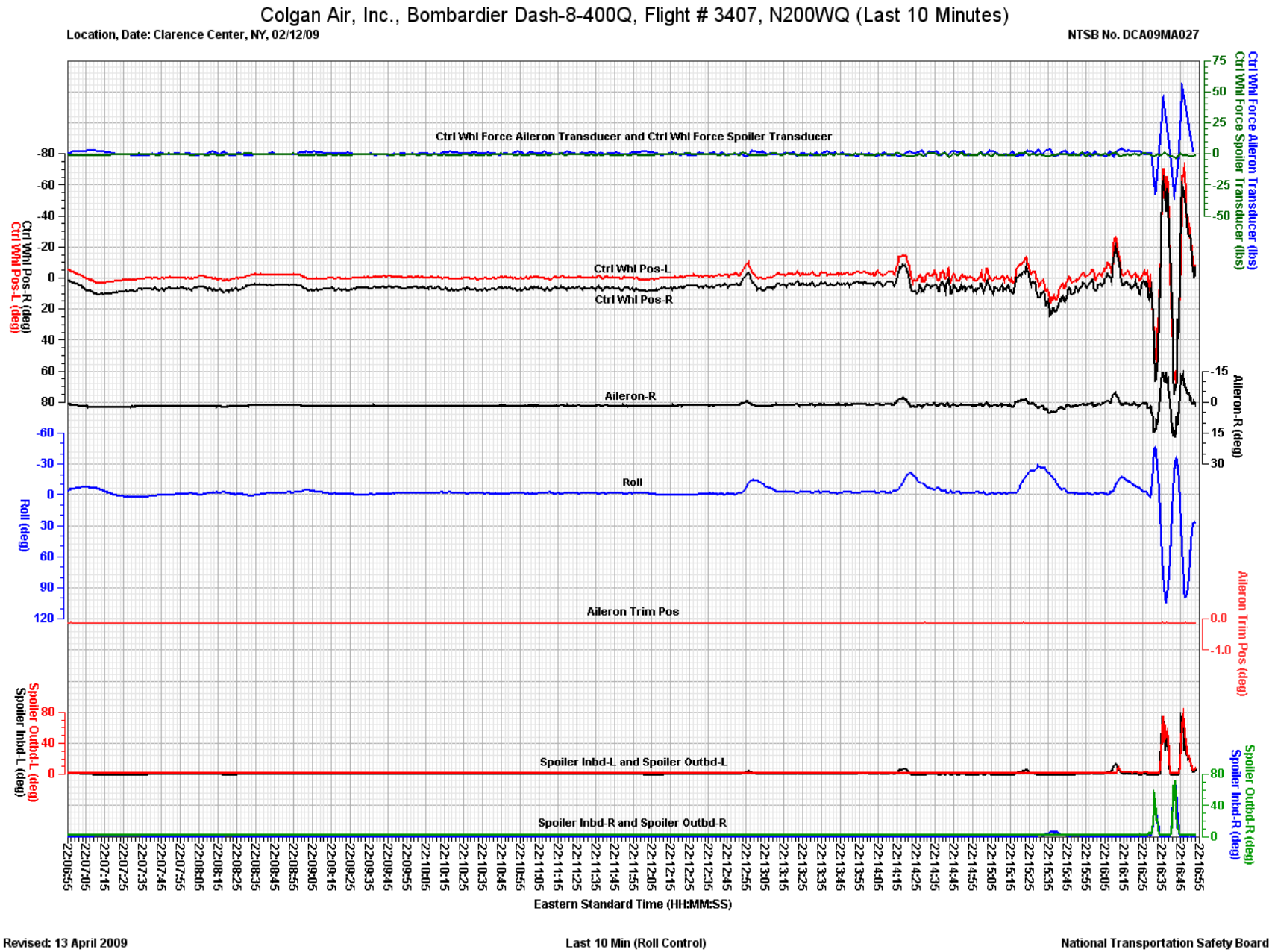
Plot 9 (Last 10 Minutes)



Plot 10 (Last 10 Minutes)

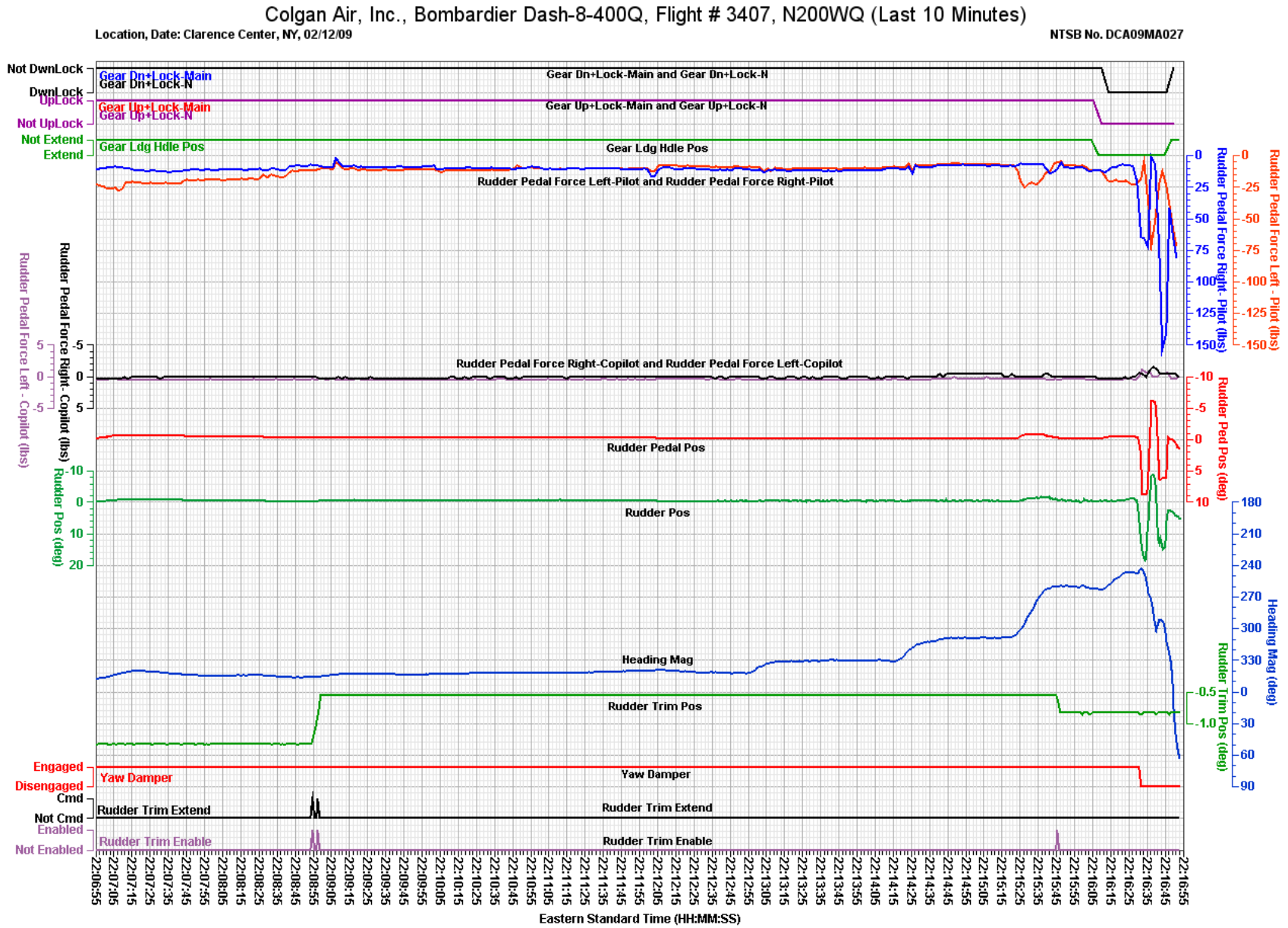


Revised: 13 April 2009

Last 10 Min (Roll Control)

National Transportation Safety Board

Plot 11 (Last 10 Minutes)



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Last 10 Min (Yaw Control)

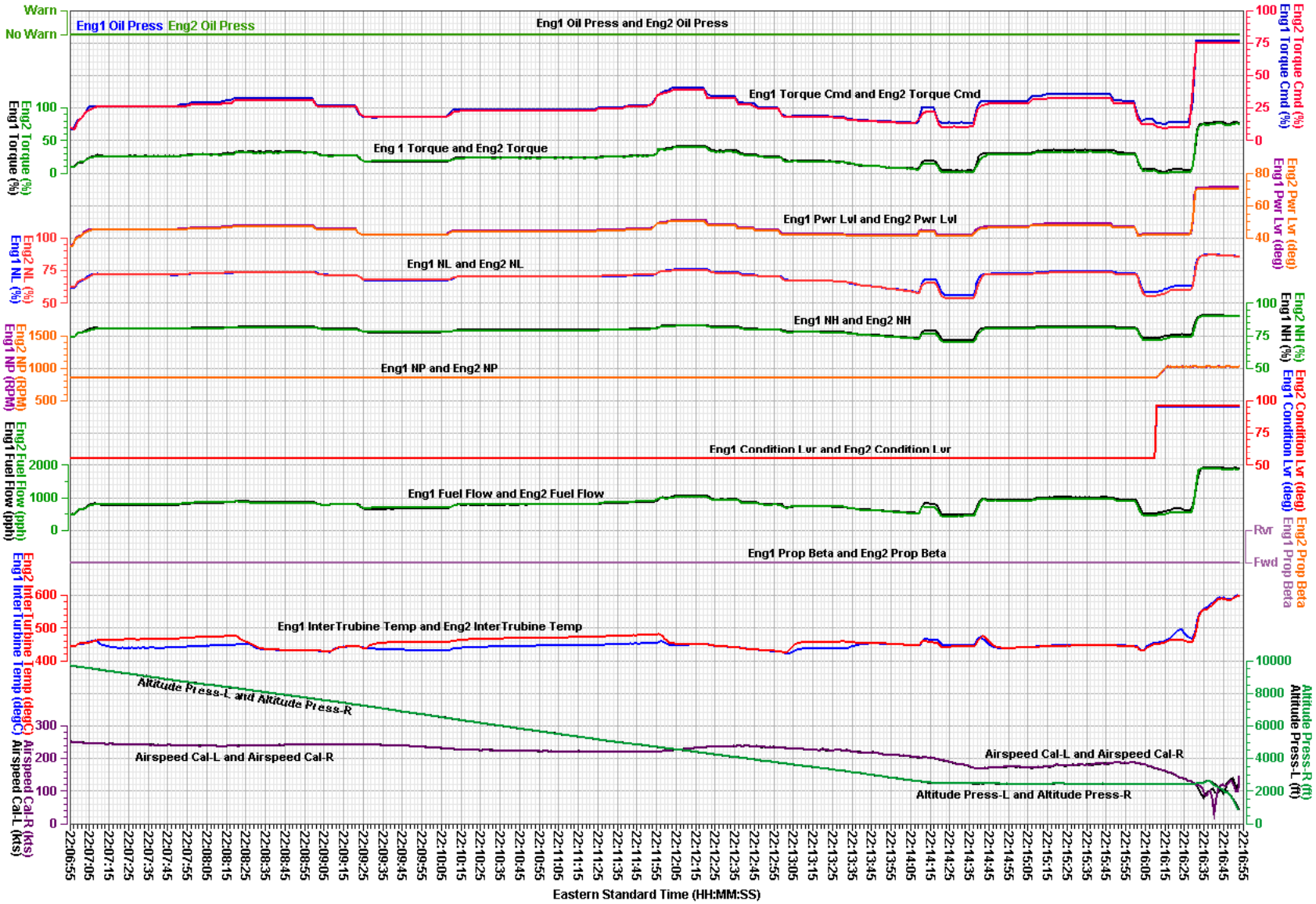
National Transportation Safety Board

Plot 12 (Last 10 Minutes)

Colgan Air, Inc., Bombardier Dash-8-400Q, Flight # 3407, N200WQ (Last 10 Minutes)

Location, Date: Clarence Center, NY, 02/12/09

NTSB No. DCA09MA027



Revised: 1 April 2009

Last 10 Min (Engines)

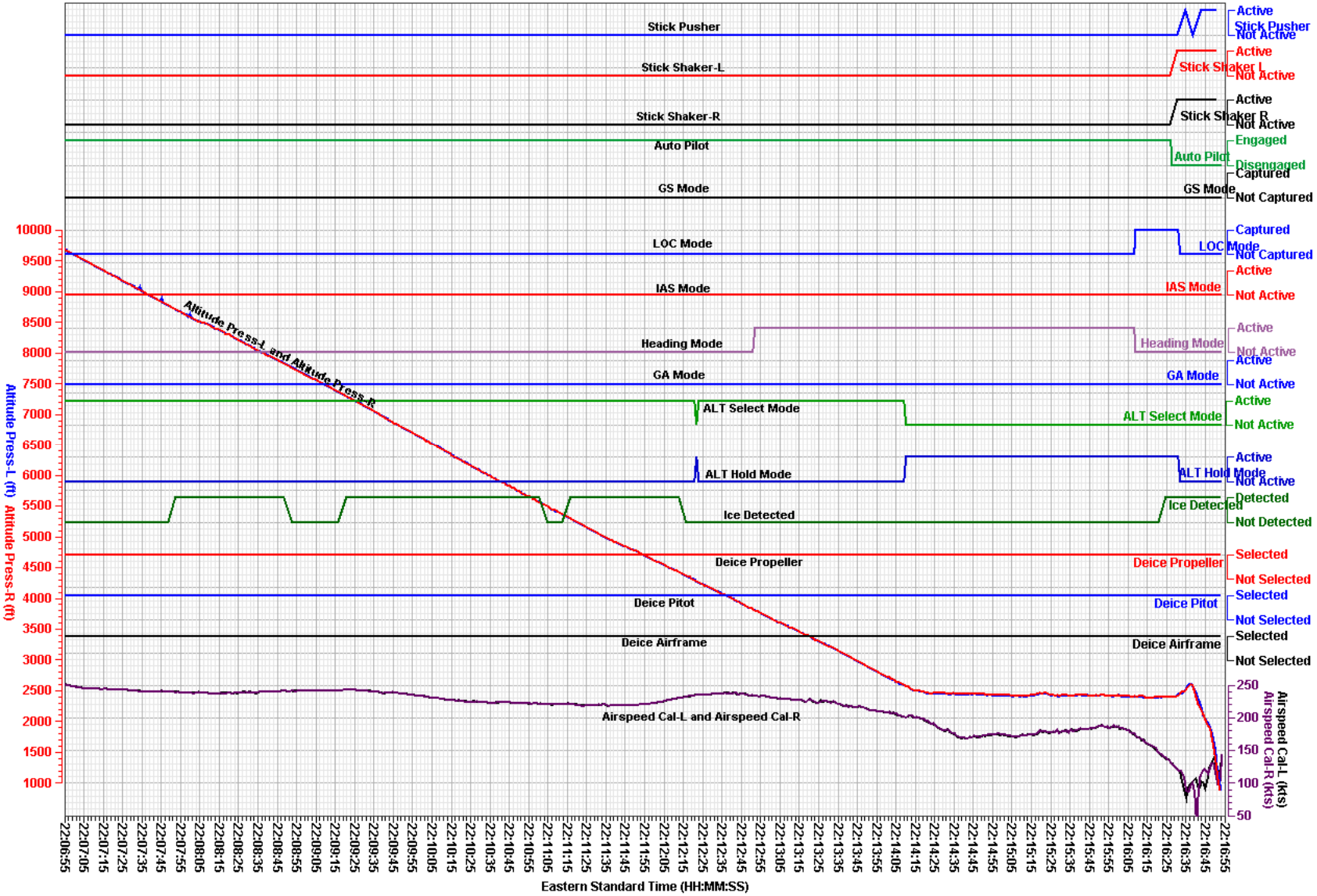
National Transportation Safety Board

Plot 13 (Last 10 Minutes)

Colgan Air, Inc., Bombardier Dash-8-400Q, Flight # 3407, N200WQ (Last 10 Minutes)

Location, Date: Clarence Center, NY, 02/12/09

NTSB No. DCA09MA027



Revised: 1 April 2009

Last 10 Min (AP, Deice Discretes, AP Modes,Stick Discretes)

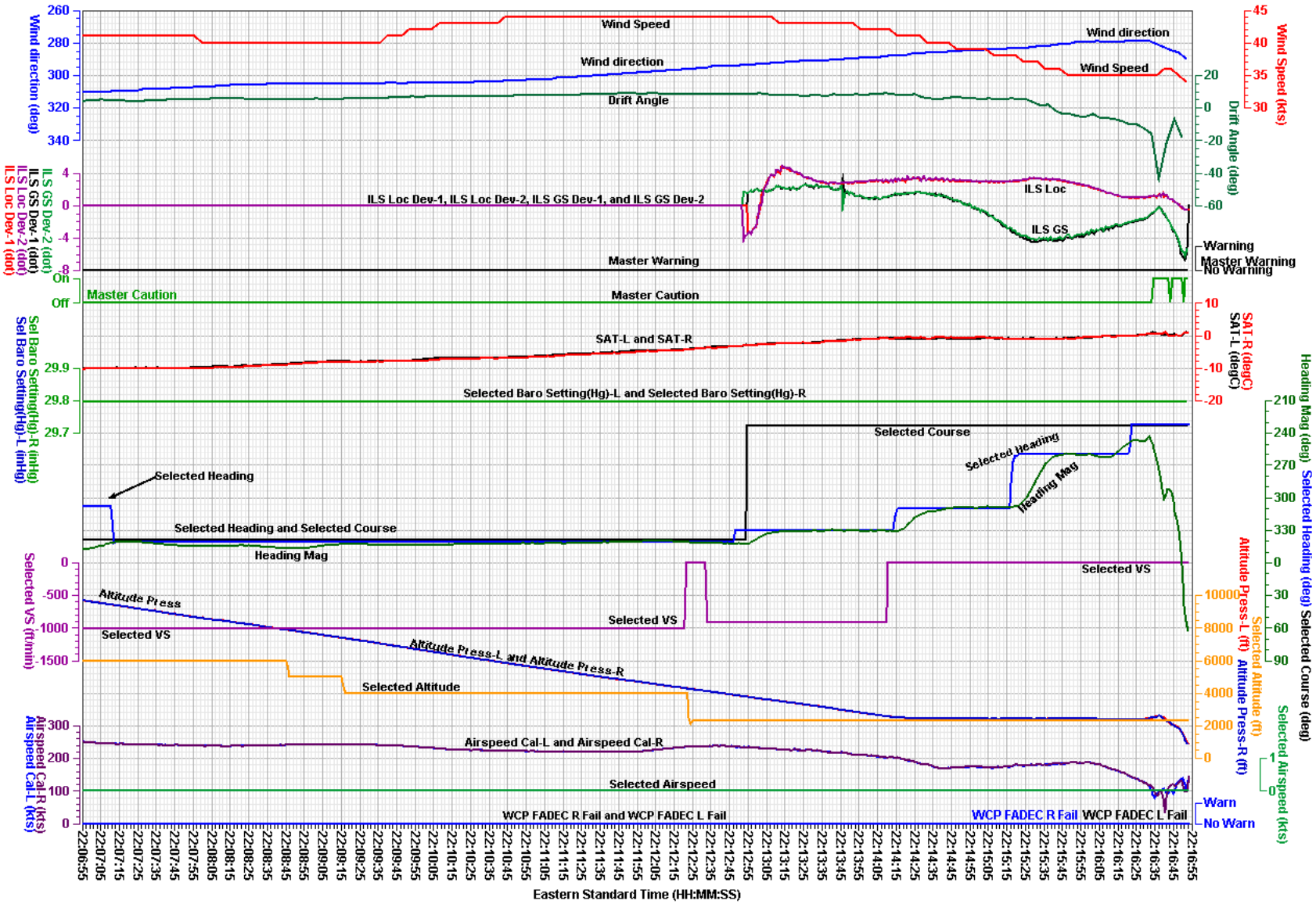
National Transportation Safety Board

Plot 14 (Last 10 Minutes)

Colgan Air, Inc., Bombardier Dash-8-400Q, Flight # 3407, N200WQ (Last 10 minutes)

Location, Date: Clarence Center, NY, 02/12/09

NTSB No. DCA09MA027



Revised: 1 April 2009

Last 10 Min (Master Caution/Warning, Winds, ILS, Misc)

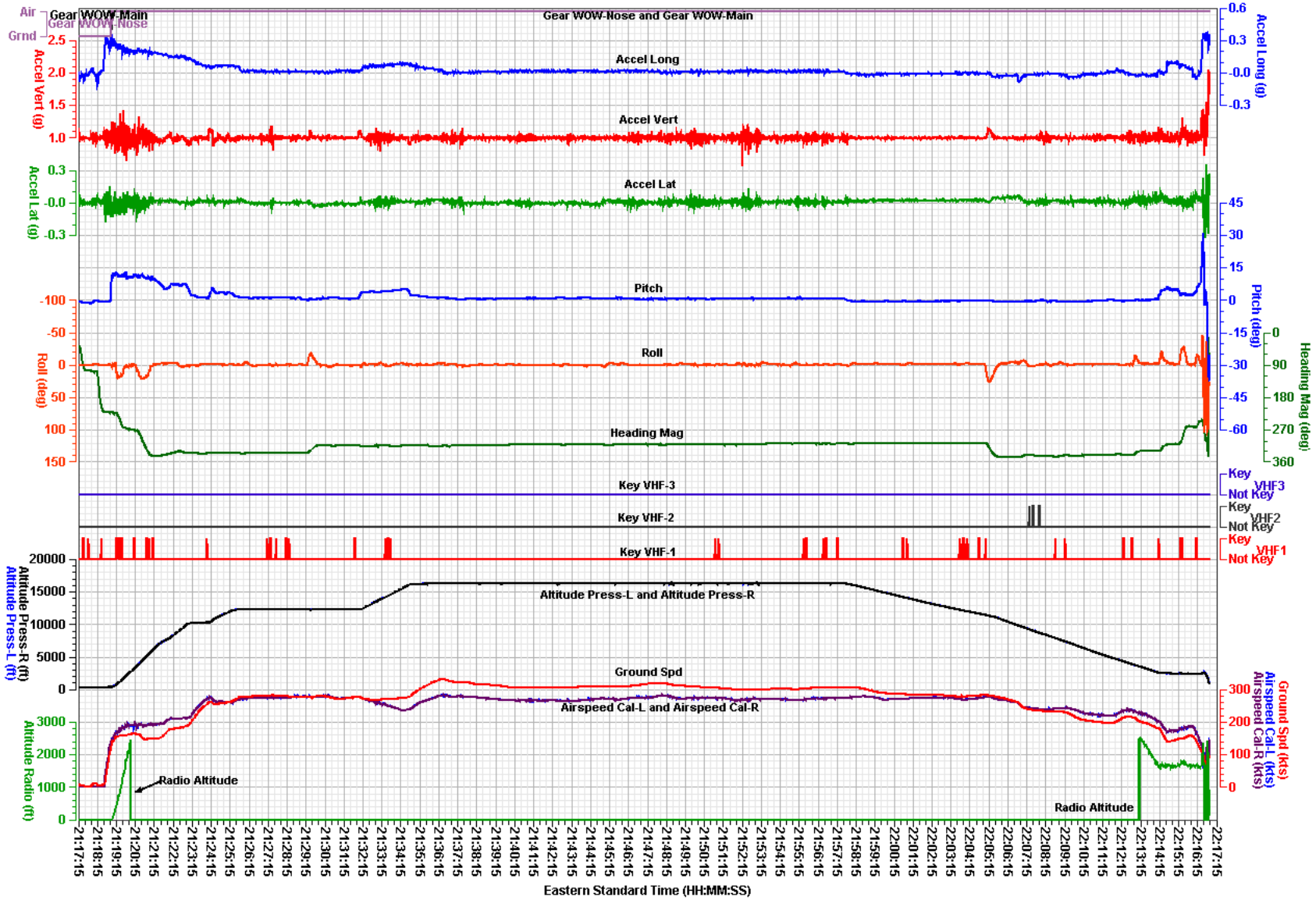
National Transportation Safety Board

Plot 15 (Entire Flight)

Colgan Air, Inc., Bombardier Dash-8-400Q, Flight # 3407, N200WQ (Entire Flight)

Location, Date: Clarence Center, NY, 02/12/09

NTSB No. DCA09MA027

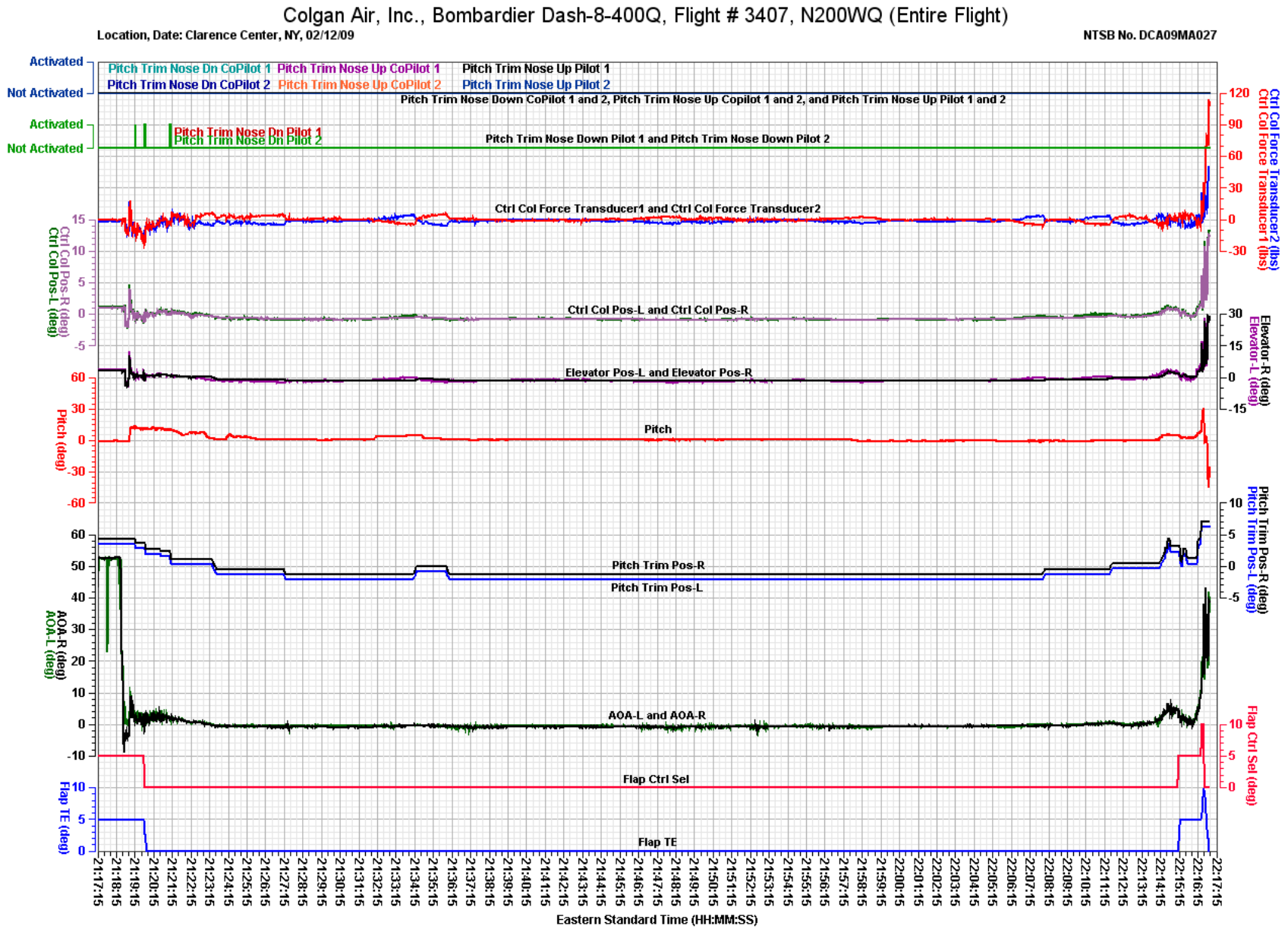


Revised: 1 April 2009

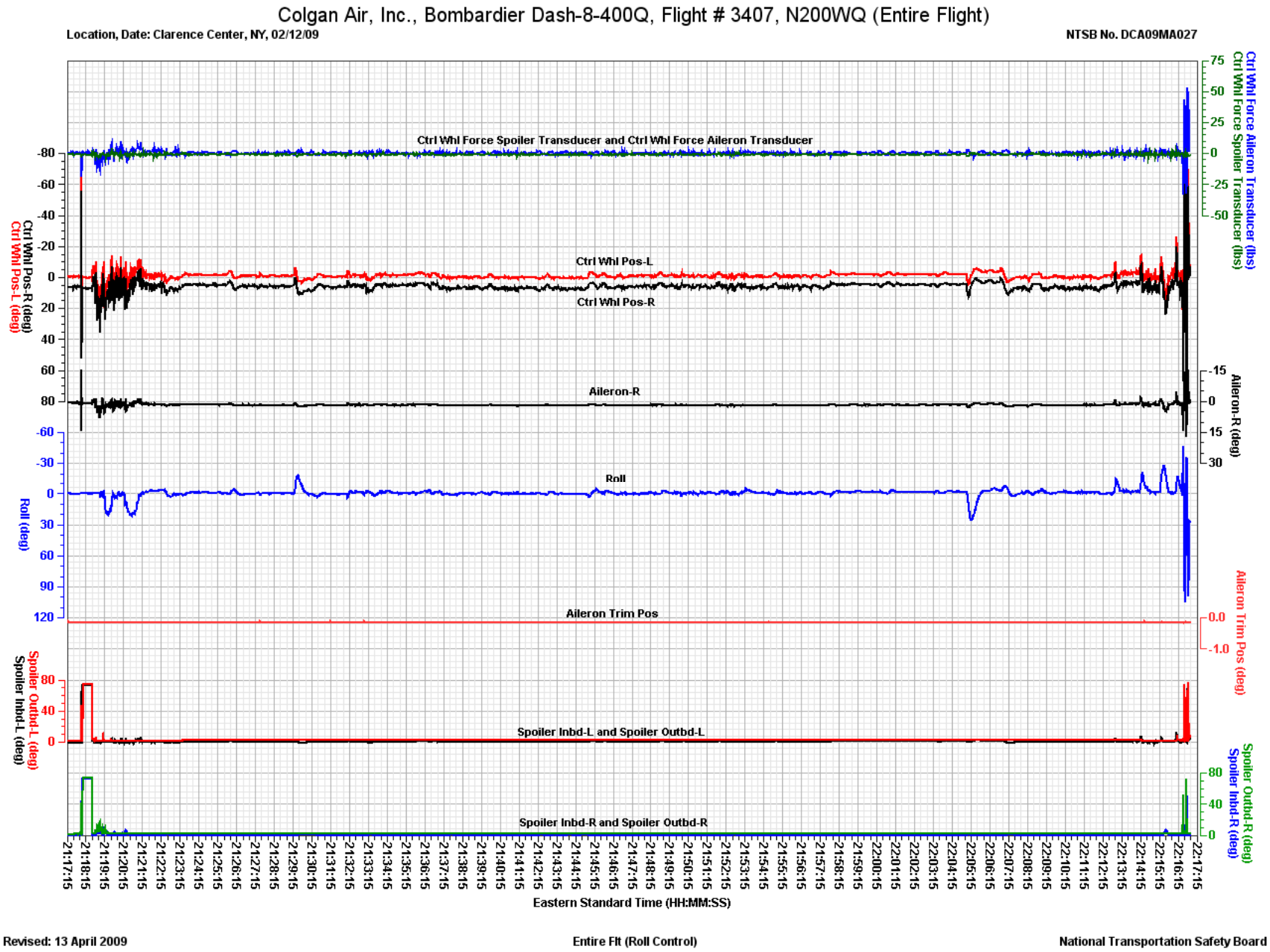
Entire Flt (Basic)

National Transportation Safety Board

Plot 16 (Entire Flight)



Plot 17 (Entire Flight)



Revised: 13 April 2009

Entire Flt (Roll Control)

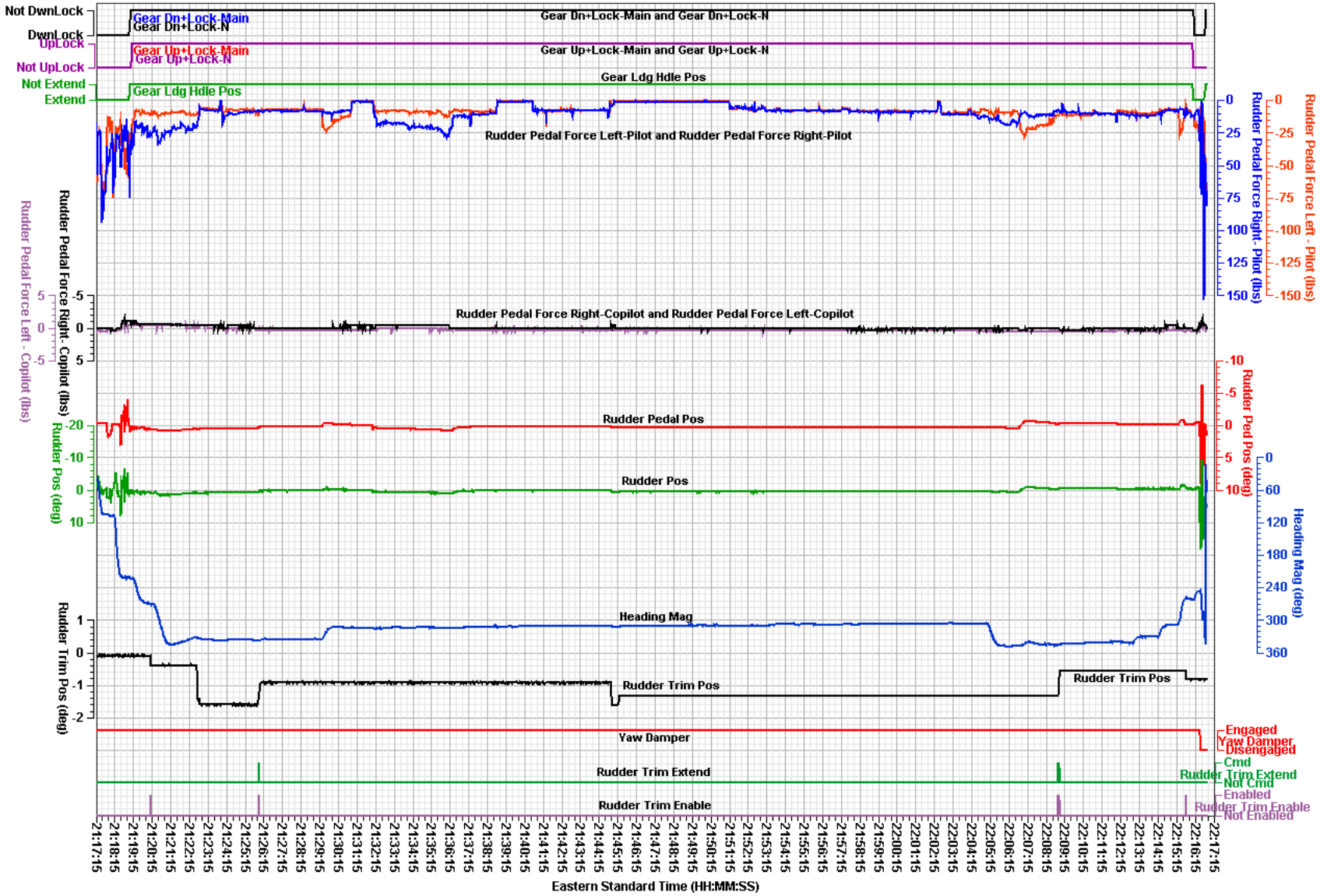
National Transportation Safety Board

Plot 18 (Entire Flight)

Colgan Air, Inc., Bombardier Dash-8-400Q, Flight # 3407, N200WQ (Entire Flight)

Location, Date: Clarence Center, NY, 02/12/09

NTSB No. DCA09MA027



Revised: 1 April 2009

Entire Flt (Yaw Control)

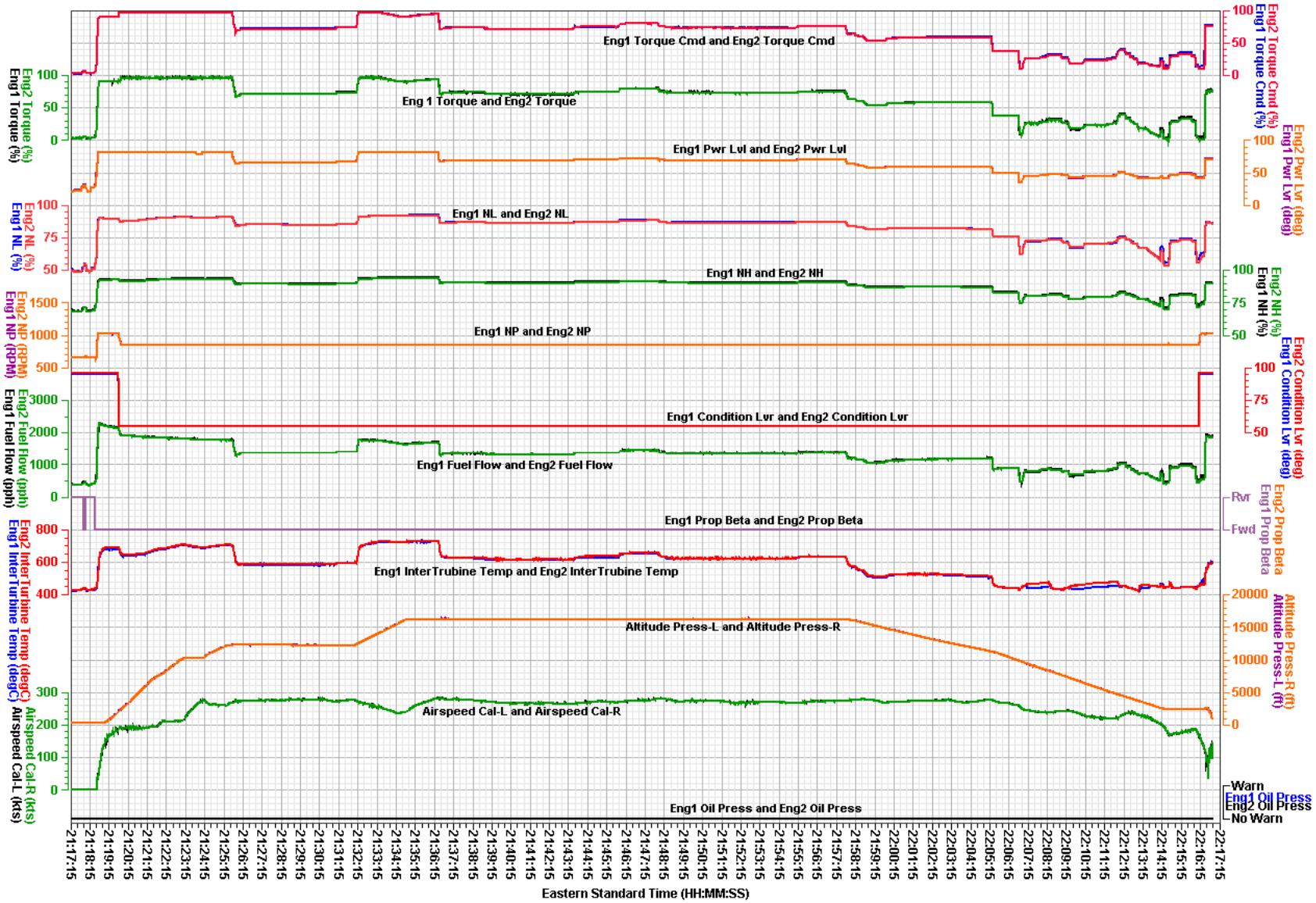
National Transportation Safety Board

Plot 19 (Entire Flight)

Colgan Air, Inc., Bombardier Dash-8-400Q, Flight # 3407, N200WQ (Entire Flight)

Location, Date: Clarence Center, NY, 02/12/09

NTSB No. DCA09MA027

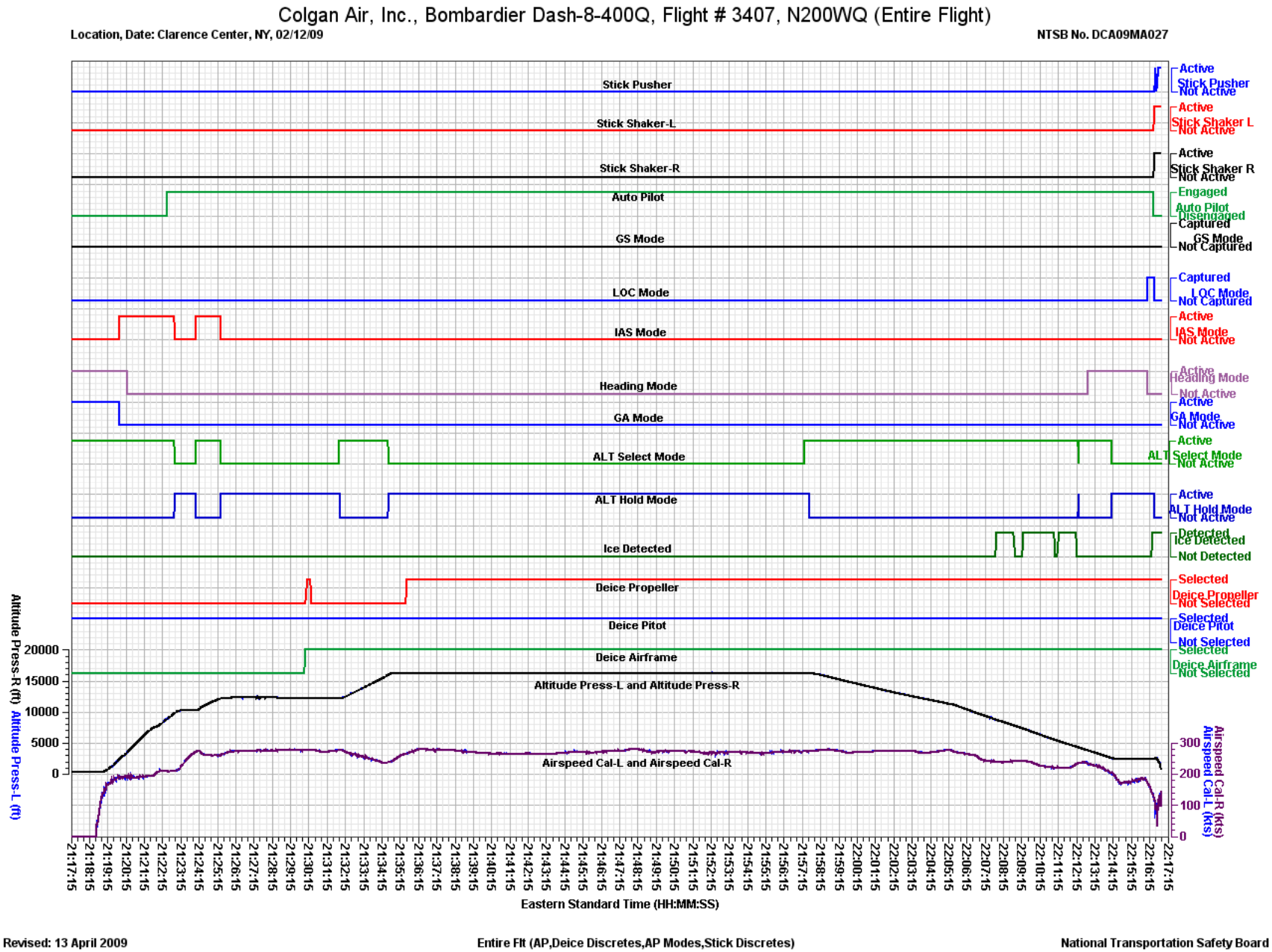


Revised: 1 April 2009

Entire Flt (Engines)

National Transportation Safety Board

Plot 20 (Entire Flight)

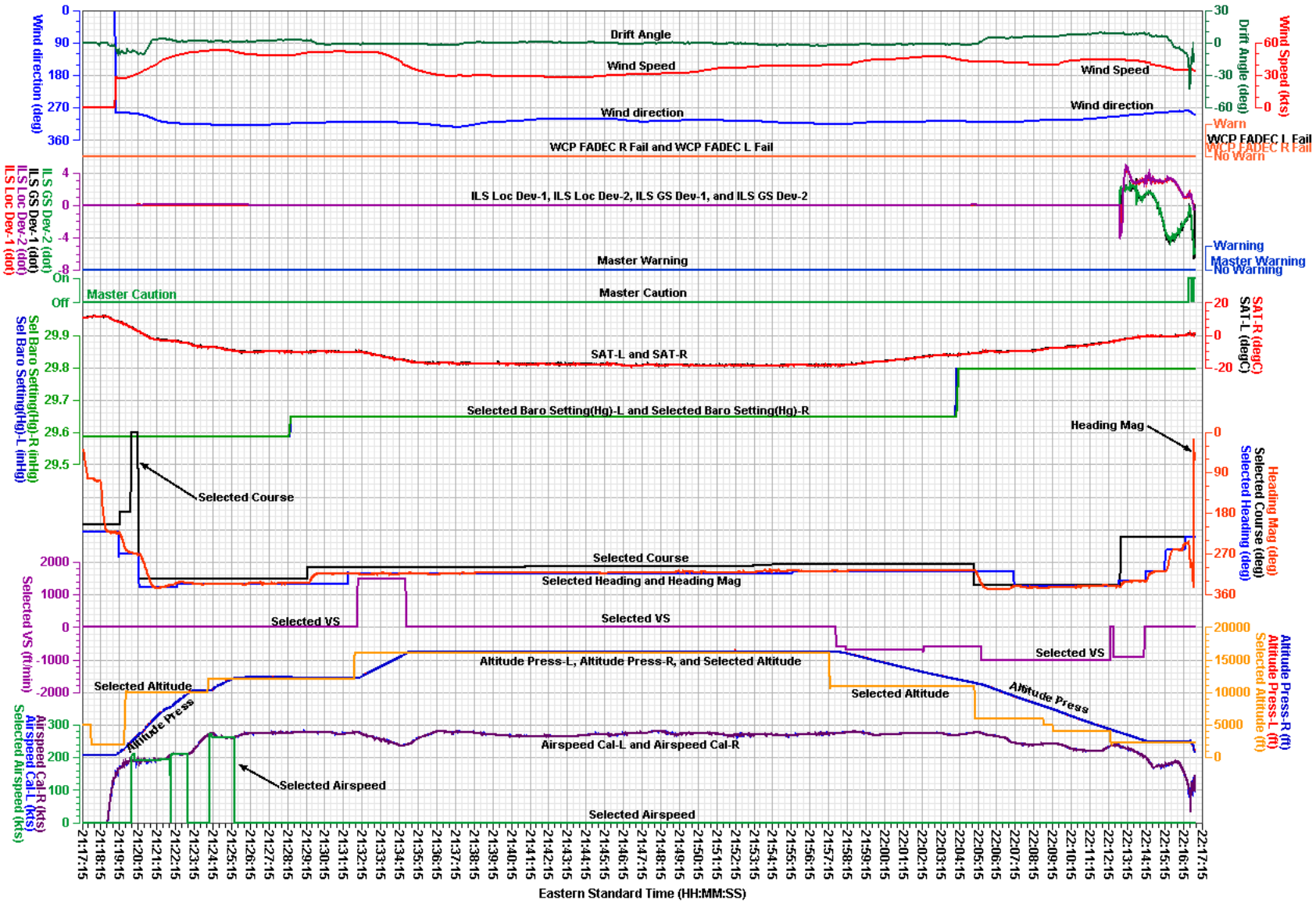


Plot 21 (Entire Flight)

Colgan Air, Inc., Bombardier Dash-8-400Q, Flight # 3407, N200WQ (Entire Flight)

Location, Date: Clarence Center, NY, 02/12/09

NTSB No. DCA09MA027



Revised: 13 April 2009

Entire Flt (Master Caution/Warning, Winds, ILS, Misc)

National Transportation Safety Board