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

June 5, 2008

Flight Data Recorder - 10

Specialist's Factual Report
By Cassandra Johnson

1. EVENT SUMMARY

Location: St Louis, Missouri
Date: September 28, 2007
Aircraft: MD-82, N454AA
Operator: American Airlines, Flight 1400
NTSB Number: DCA07MA310

On September 28, 2007, at 1316 central daylight time (CDT), a McDonnell Douglas DC-9-82 (MD-82), N454AA, operated by American Airlines as flight 1400, executed an emergency landing at Lambert-St Louis International Airport (STL), St. Louis, Missouri, after the flight crew received a left engine fire warning during departure climb from the airport. The airplane sustained substantial damage. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed for the 14 CFR Part 121 scheduled domestic flight. After landing, the 2 flight crewmembers, 3 flight attendants, and 138 passengers deplaned via air stairs and no occupant injuries were reported. The intended destination of the flight was Chicago O'Hare International Airport (ORD), Chicago, Illinois.

2. FLIGHT DATA RECORDER GROUP

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

3. DETAILS OF FLIGHT DATA RECORDER INVESTIGATION

On October 2, 2007, the Safety Board's Vehicle Recorder Division received the following FDR:

Recorder Manufacturer/Model: **L-3 Communications Fairchild Model FA2100**
Recorder Serial Number: **012015**

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

3.1. Recorder Description

This solid-state FDR (SSFDR) 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. This recorder is configured to record 64 12-bit words of digital information every second. Each grouping of 64 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 64-word intervals. Each data parameter (for example, altitude, heading, airspeed) has a specifically assigned word number within the subframe. The FA2100 is designed to meet the crash-survivability requirements of TSO–C124a.

3.2. Recording Description

The FDR recording contained approximately 103 hours of data. Timing of the FDR data is measured as a 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 20 minutes.

3.3. Time Correlation

Correlation of the FDR data from SRN to the incident local time, Central Daylight Time (CDT), was established with an offset provided by the CVR Group Chairman in the Factual Report of Investigation, Cockpit Voice Recorder. Accordingly, the time offset from SRN to local time is the following: local time = SRN - 320,834.9 seconds.[1] Therefore, for the rest of this report, all times are referenced as local time, not SRN.

3.4. FDR Power Logic

When the aircraft is on the ground with weight on the wheels, four conditions must be met for the FDR to be powered:

1. 115 volt power is provided.
2. Either fuel lever is on.
3. FDR circuit breaker is not pulled.
4. Parking brake is released.

Similarly, when the aircraft is airborne (for example, without weight on the wheels), three conditions must be met for the FDR to continue to be powered:

1. 115 volt power is provided.
2. Either fuel lever is on.
3. FDR circuit breaker is not pulled.

3.5. FDR Data Sequence of Power Loss

After the FDR was powered and recording data for the event flight, the FDR lost power and stopped recording twice. Since the timing of the FDR is elapsed time and not real time, the FDR stops recording when it loses power and does not keep track of how much real time is missing. Therefore, the time that elapsed during the gaps in the FDR timing was calculated by aligning the CVR microphone keying to the FDR recorded microphone keying (Key VHF-1 and Key VHF-2), and by using the FDR's recorded GMT Hrs and GMT Min parameters. The following table highlights the FDR recording and the gaps in data.

[1] This offset was confirmed by comparing the SRN to the FDR parameters Time GMT Hrs and Time GMT Min. "GMT" stands for Greenwich Mean Time and, at the time of the accident, GMT Hrs was 5 hours ahead of the incident local time (CDT).

Event	Local Time	Elapsed Time From Event 1 (HH:MM:SS)	Elapsed Time Between Events (HH:MM:SS)
1. FDR powered and recording data for the event flight	13:07:13.0	00:00:00.0	Not Applicable
2. Gear WOW transitioned from "Grnd[2]" to "Air"	13:12:22.4	00:05:09.4	00:05:09.4 (Event 1 to Event 2)
3. Eng1 Fire Warn transitioned from "Off" to "On"	13:13:54.7	00:06:41.7	00:01:32.3 (Event 2 to Event 3)
4. FDR not powered	13:16:59.0	00:09:46.0	00:03:04.3 (Event 3 to Event 4)
5. FDR powered and recording data	13:17:21.0	00:10:08.0	00:00:22 (Event 4 to Event 5)
6. FDR not powered	13:17:24.5	00:10:11.5	00:00:03.5 (Event 5 to Event 6)
7. FDR powered and recording data	13:29:37.0	00:22:24.0	00:12:12.5 (Event 6 to Event 7)
8. Gear WOW Transitioned From "Air" to "Grnd"	13:32:19.4	00:25:06.4	00:02:42.4 (Event 7 to Event 8)
9. End of FDR data	14:01:39.6	00:54:26.6	00:29:20.2 (Event 8 to Event 9)

3.6. Engineering Unit Conversions

The engineering unit conversions used for the data contained in this report are based on documentation from American Airlines. 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=+).[3]

3.6.1. Parameters Provided and Verified

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

Table 1. Verified and provided FDR parameters.

Plot Parameter	FDR Description
1. Accel Lat (g)	Lateral Acceleration (g)
2. Accel Long (g)	Longitudinal Acceleration (g)
3. Accel Vert (g)	Vertical Acceleration (g)
4. Aileron-L (deg)	Left Aileron Position (degrees)
5. Aileron-R (deg)	Right Aileron Position (degrees)
6. Airspeed (kts)	Airspeed (knots)
7. Altitude Press (ft)	Pressure Altitude (feet)
8. AP	Auto Pilot status (discrete)
9. AP Throttle Mode	Auto Pilot Throttle Mode (discrete)
10. Brake Ped Pos-L (deg)	Left Brake Pedal Position (degrees)
11. Brake Ped Pos-R (deg)	Right Brake Pedal Position (degrees)

[2] Grnd stands for Ground.

[3] 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 that 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 = +.

Table 1. Verified and provided FDR parameters.	
Plot Parameter	**FDR Description**
12. Brake Press-L (psi)	Left Brake Pressure (pounds per square inch)
13. Brake Press-R (psi)	Right Brake Pressure (pounds per square inch)
14. Ctrl Col Pos (deg)	Control Column Position (degrees)
15. Ctrl Whl Pos (deg)	Control Wheel Position (degrees)
16. Elevator-L (deg)	Left Elevator Position (degrees)
17. Elevator-R (deg)	Right Elevator Position (degrees)
18. Eng1 EGT (degC)	Engine 1 Exhaust Gas Temperature (degrees Celsius)
19. Eng1 EPR	Engine 1 Engine Pressure Ratio (discrete)
20. Eng1 Fire Warn	Engine 1 Fire Warning status (discrete)
21. Eng1 Fuel Flow (pph)	Engine 1 Fuel Flow (pounds per hour)
22. Eng1 N1 (%RPM)	Engine 1 N1 (%RPM)
23. Eng1 N2 (%RPM)	Engine 1 N2 (%RPM)
24. Eng1 Rvrsr Deploy	Engine 1 Reverser Deploy status (discrete)
25. Eng1 Rvrsr Lock	Engine 1 Reverser Lock status (discrete)
26. Eng2 EGT (degC)	Engine 2 Exhaust Gas Temperature (degrees Celsius)
27. Eng2 EPR	Engine 2 Engine Pressure Ratio (discrete)
28. Eng2 Fire Warn	Engine 2 Fire Warning status (discrete)
29. Eng2 Fuel Flow (pph)	Engine 2 Fuel Flow (pounds per hour)
30. Eng2 N1 (%RPM)	Engine 2 N1 (%RPM)
31. Eng2 N2 (%RPM)	Engine 2 N2 (%RPM)
32. Eng2 Rvrsr Deploy	Engine 2 Reverser Deploy status (discrete)
33. Eng2 Rvrsr Lock	Engine 2 Reverser Lock status (discrete)
34. Flap (deg)	Flap Position (degrees)
35. Gear Status-R	Right Gear Status (discrete)
36. Gear WOW	Weight on Wheels Gear (discrete)
37. Heading (deg)	Magnetic Heading (degrees)
38. Hyd Press Low-L	Left Hydraulic Pressure Low (discrete)
39. Hyd Press Low-R	Right Hydraulic Pressure Low (discrete)
40. Hyd Temp Hi-L	Left Hydraulic Temperature Hi status (discrete)
41. Hyd Temp Hi-R	Right Hydraulic Temperature Hi status (discrete)
42. Key VHF-1	Microphone Key VHF-1 (discrete)
43. Key VHF-2	Microphone Key VHF-2 (discrete)
44. Pitch (deg)	Pitch Attitude (degrees)
45. Roll (deg)	Roll Attitude (degrees)
46. Rudder (deg)	Rudder Position (degrees)
47. Rudder Ped Pos (deg)	Rudder Pedal Position (degrees)
48. Slat Disagree	Slat Disagree status (discrete)
49. Slat Retract	Slat Retract status (discrete)
50. Slat-L	Left Slat Position (discrete)
51. Slat-R	Right Slat Position (discrete)
52. Spoiler ROB (deg)	Right Outboard Spoiler Position (degrees)
53. Time GMT Hrs (hr)	Greenwich Mean Time Hours (hours)
54. Time GMT Min (min)	Greenwich Mean Time Minutes (minutes)
55. Warn Master	Master Warning status (discrete)

3.6.2. Pressure Altitude Parameter

The FA2100 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.

3.6.3. Time GMT Hrs and Time GMT Min Parameters

The source of the FDR parameters Time GMT Hrs and Time GMT Min is the first officer's electronic clock. As noted in footnote 1, GMT stands for Greenwich Mean Time. GMT is is equivalent to Coordinated Universal Time (UTC).

3.6.4. Flap Positions for Takeoffs and Landings

For the event flight, the flap positions at takeoff and landing were 8.4 degrees and 6.0 degrees, respectively. After landing, the flap position continued to increase for another 56 seconds until it stopped at 27.1 degrees and remained at 27.1 degrees until the end of the recording.

Excluding the event flight, the FDR recorded 44 flights (1 flight = 1 take-off and 1 landing). Of those flights, flap position at takeoff ranged from 6.7 degrees to 11 degrees and flap position at landing ranged from 28 degrees to 40 degrees. Table 2 lists all the flap positions during the previous takeoffs and landings, starting from the first previous flight (#1) to the 44th previous flight (the oldest flight recorded).

Table 2: Flap Positions for Previous Flights

Previous Flight Number	Takeoff Flap Position	Landing Flap Position
1.	10.9	27.8
2.	8.4	40.1
3.	10.6	28.5
4.	10.6	27.8
5.	10.9	39.7
6.	8.4	40.1
7.	10.9	40.1
8.	7.0	40.1
9.	6.7	28.1
10.	8.4	40.1
11.	10.9	40.4
12.	10.9	40.1
13.	10.9	40.4
14.	10.9	40.4
15.	10.5	28.1

Table 2: Flap Positions for Previous Flights

Previous Flight Number	Takeoff Flap Position	Landing Flap Position
16.	7.0	40.1
17.	10.9	27.8
18.	6.7	40.4
19.	10.9	28.1
20.	10.9	28.1
21.	7.0	28.1
22.	10.9	40.4
23.	10.9	40.4
24.	8.4	40.4
25.	7.0	40.4
26.	7.0	28.1
27.	7.0	27.8
28.	6.7	40.4
29.	7.0	28.1
30.	6.7	28.1

Table 2: Flap Positions for Previous Flights

Previous Flight Number	Takeoff Flap Position	Landing Flap Position
31.	8.4	28.1
32.	10.9	28.5
33.	10.5	28.1
34.	10.9	40.1
35.	10.9	40.4
36.	10.5	40.4
37.	10.9	28.1
38.	7.0	40.4
39.	10.9	28.1
40.	10.9	40.8
41.	10.9	28.5
42.	8.8	40.1
43.	10.9	40.1
44.	10.9	40.4

3.6.5. Eng1 N1 and Eng1 N2 Parameters

After the second power loss (13:29:37.0 local time), the recorded raw decimal values for Eng1 N1 and Eng1 N2 FDR parameters were outside the normal operating range of 638 to 4095 decimal counts. Therefore, the engineering values were also outside the normal operating range and were set to a value of 999 %RPM.

3.7. FDR Plots and Corresponding Tabular Data

The following eight plots contain FDR data recorded during the September 28, 2007, event. All of the parameters listed Table 1 are included in these plots except for Time GMT Hrs and Time GMT Min parameters. Plots 1 through 4 cover the entire FDR recording from the time that the FDR was powered and recording before the event takeoff until the time that the FDR turned off after the aircraft landed (from 13:07:05 local time to 13:02:05 local time). Plots 5 through 8 have a smaller time scale corresponding to 37.4 seconds before takeoff until the first time the FDR loses power (from 13:11:45 local time to 13:17:05 local time). Plots 5 through 8 contain the same parameters as Plots 1 through 4, respectively.

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.

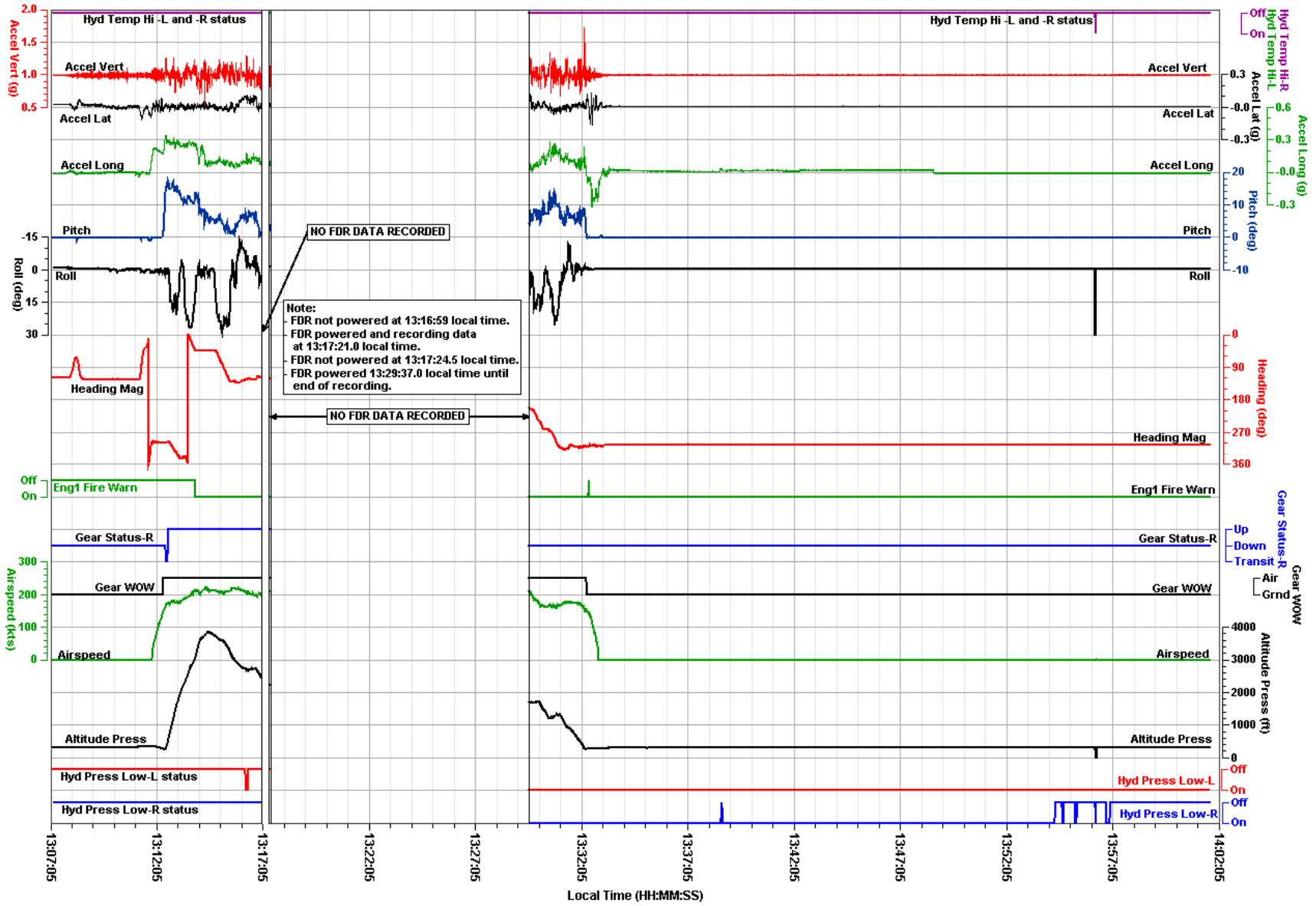
The corresponding tabular data used to create these eight plots, plus the FDR parameters Time GMT Hrs and Time GMT Min, are provided in electronic (.CSV) format as Attachment 1 to this report.

Plot 1

American Airline, McDonnell Douglas MD-82, Flight# 1400, N454AA, Entire FDR Recording On Day of Event

Location, Date: St. Louis, MO, 09/28/07

NTSB No. DCA07MA310



Revised: 5 June 2008

Final Plot1 Basics (Entire Recording on Day of Event)

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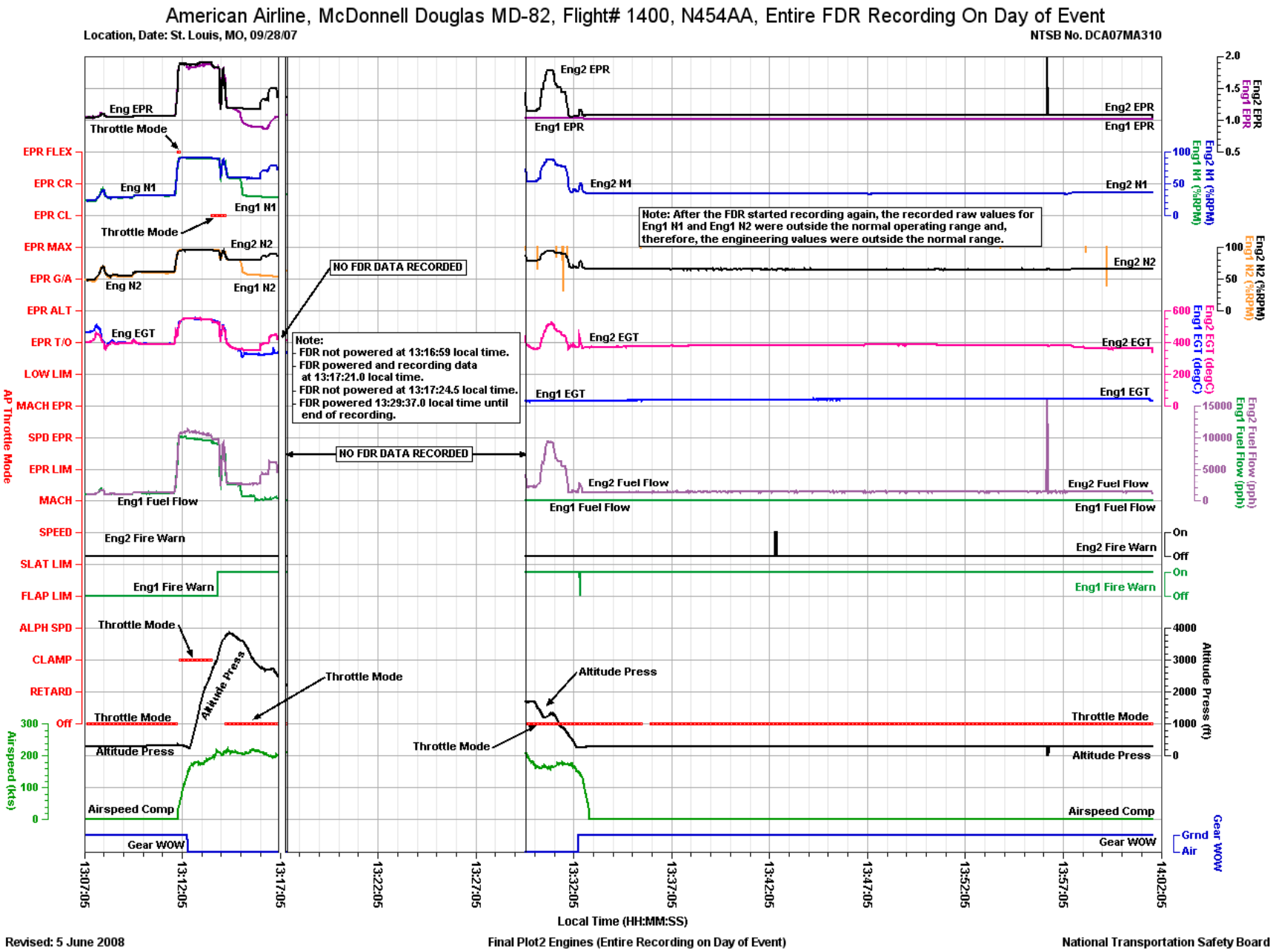
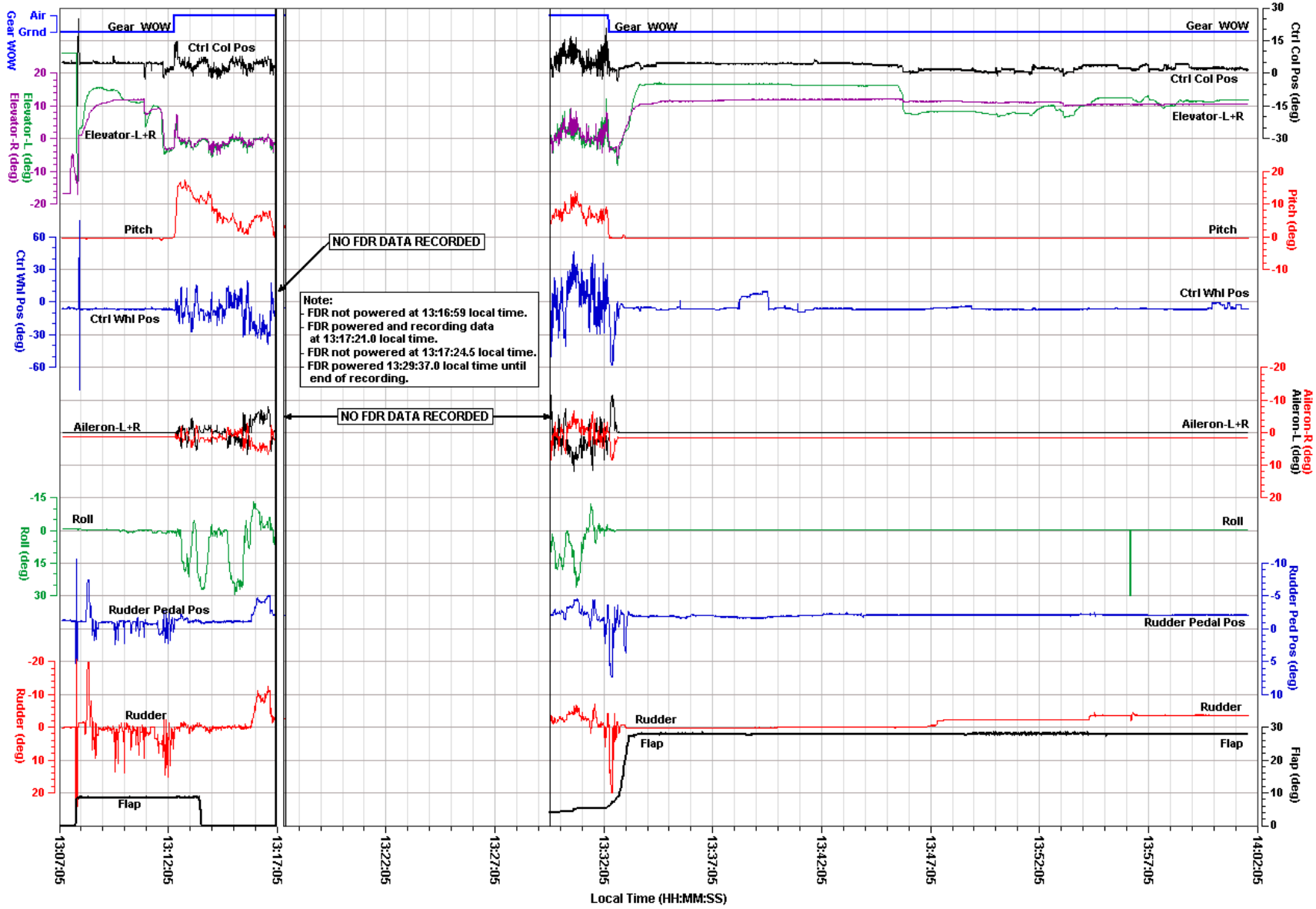
Plot 2


American Airline, McDonnell Douglas MD-82, Flight# 1400, N454AA, Entire FDR Recording On Day of Event
Location, Date: St. Louis, MO, 09/28/07
NTSB No. DCA07MA310
AP Throttle Mode
EPR FLEX
EPR CR
EPR CL
EPR MAX
EPR G/A
EPR ALT
EPR T/O
LOW LIM
MACH EPR
SPD EPR
EPR LIM
MACH
SPEED
SLAT LIM
FLAP LIM
ALPH SPD
CLAMP
RETARD
Airspeed (kts)
Eng EPR
Eng2 EPR
Eng1 EPR
Throttle Mode
Eng N1
Eng1 N1
Eng2 N1
Eng N2
Eng1 N2
Eng2 N2
Eng EGT
Eng2 EGT
Eng1 EGT
Eng1 Fuel Flow
Eng2 Fuel Flow
Eng2 Fire Warn
Eng1 Fire Warn
Altitude Press
Airspeed Comp
Gear WOW
Eng2 N1 (%RPM)
Eng1 N1 (%RPM)
Eng2 N2 (%RPM)
Eng1 N2 (%RPM)
Eng2 EGT (deg C)
Eng1 EGT (deg C)
Eng2 Fuel Flow (pph)
Eng1 Fuel Flow (pph)
Altitude Press (ft)
On
Off
Grnd
Air
NO FDR DATA RECORDED
Note:
- FDR not powered at 13:16:59 local time.
- FDR powered and recording data at 13:17:21.0 local time.
- FDR not powered at 13:17:24.5 local time.
- FDR powered 13:29:37.0 local time until end of recording.
Note: After the FDR started recording again, the recorded raw values for Eng1 N1 and Eng1 N2 were outside the normal operating range and, therefore, the engineering values were outside the normal range.
13:07:05
13:12:05
13:17:05
13:22:05
13:27:05
13:32:05
13:37:05
13:42:05
13:47:05
13:52:05
13:57:05
14:02:05
Local Time (HH:MM:SS)
Revised: 5 June 2008
Final Plot2 Engines (Entire Recording on Day of Event)
National Transportation Safety Board

Plot 3

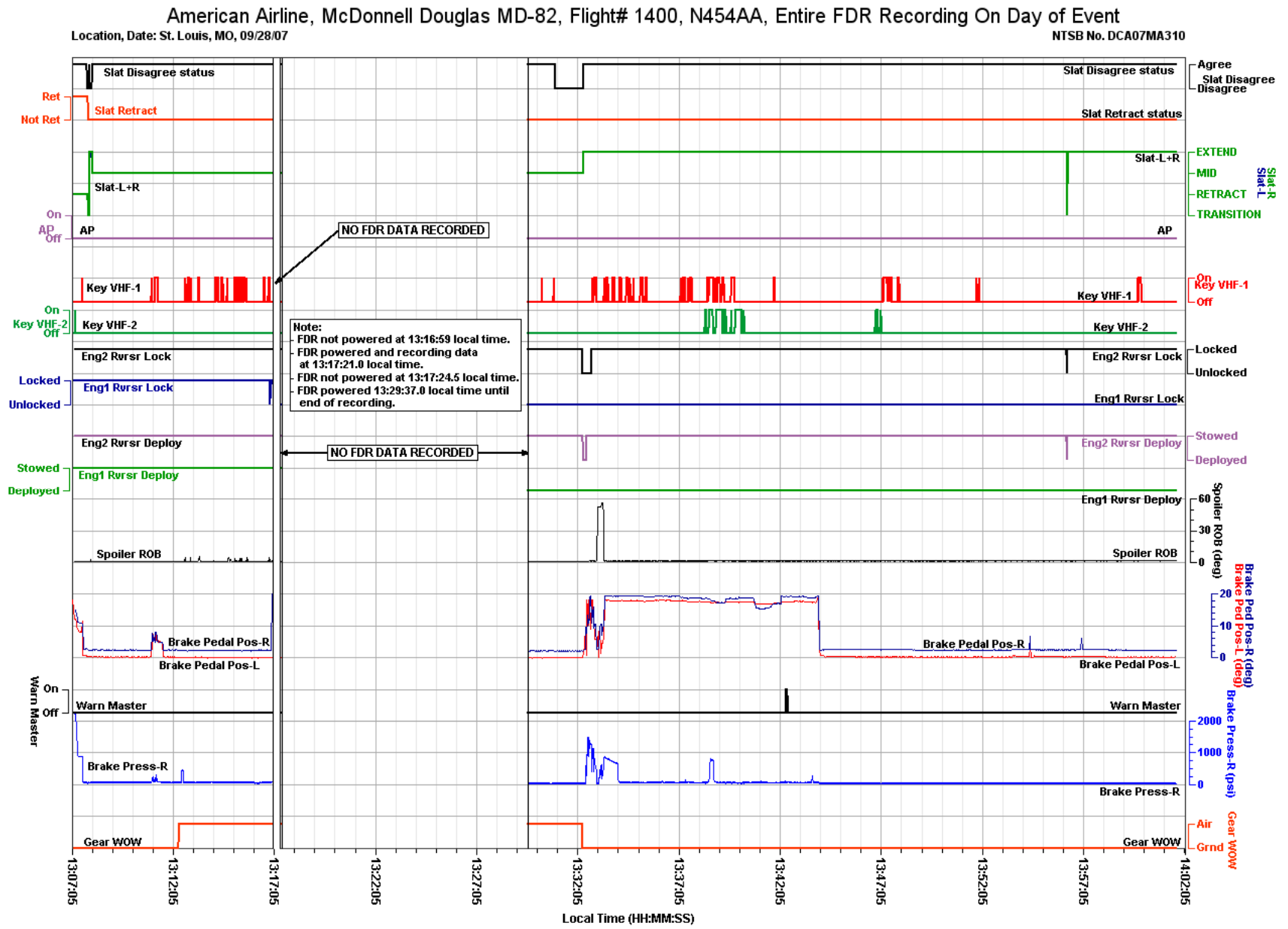
American Airline, McDonnell Douglas MD-82, Flight# 1400, N454AA, Entire FDR Recording On Day of Event

Location, Date: St. Louis, MO, 09/28/07 NTSB No. DCA07MA310



Revised: 5 June 2008 Final Plot3 Flight Controls (Entire Recording on Day of Event) National Transportation Safety Board

Plot 4



Revised: 5 June 2008

Final Plot4 More (Entire Recording on Day of Event)

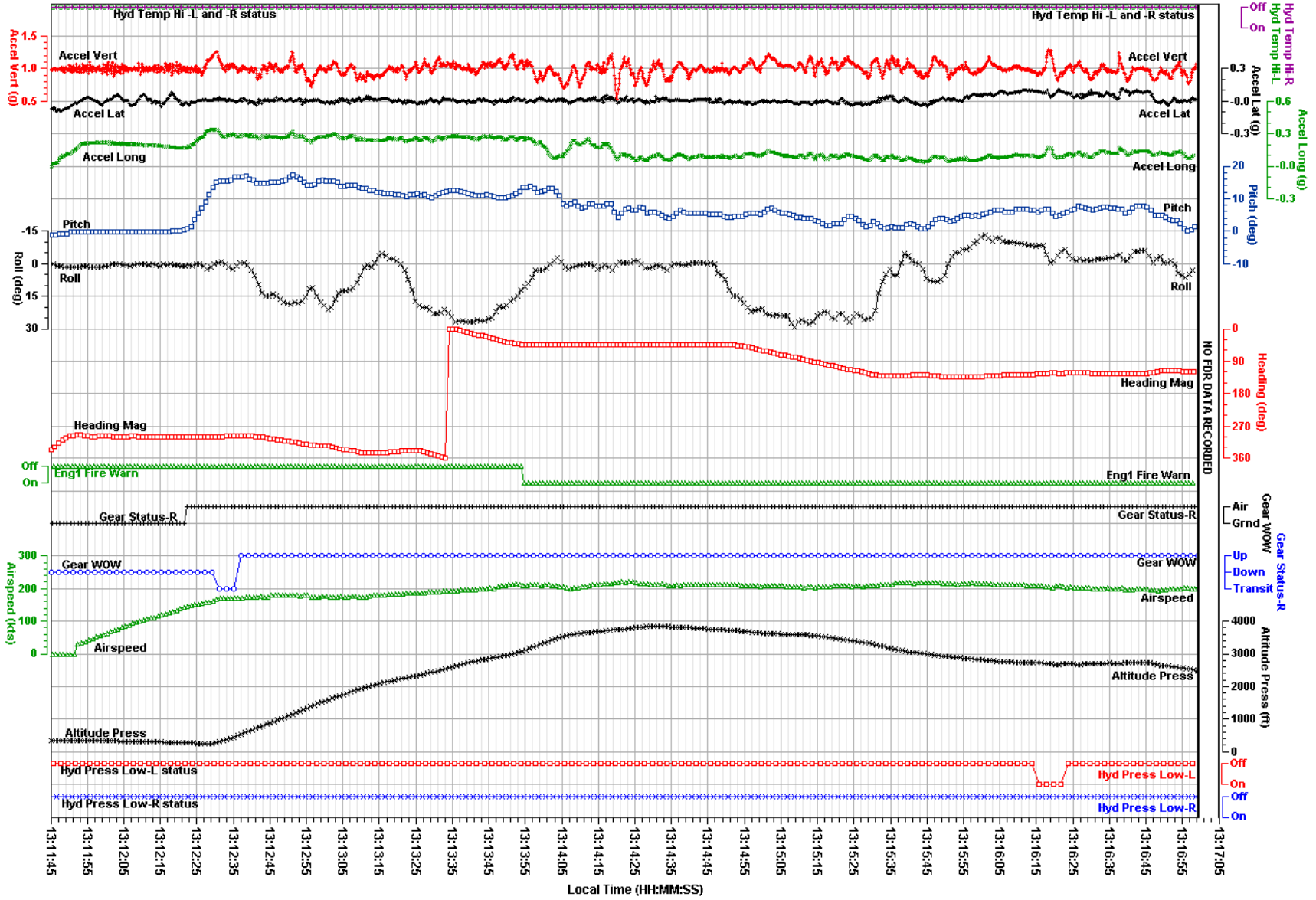
National Transportation Safety Board

Plot 5

American Airline, McDonnell Douglas MD-82, Flight# 1400, N454AA, Event Zoom

Location, Date: St. Louis, MO, 09/28/07

NTSB No. DCA07MA310



Revised: 5 June 2008

Final Plot1 Basics (Event Zoom)

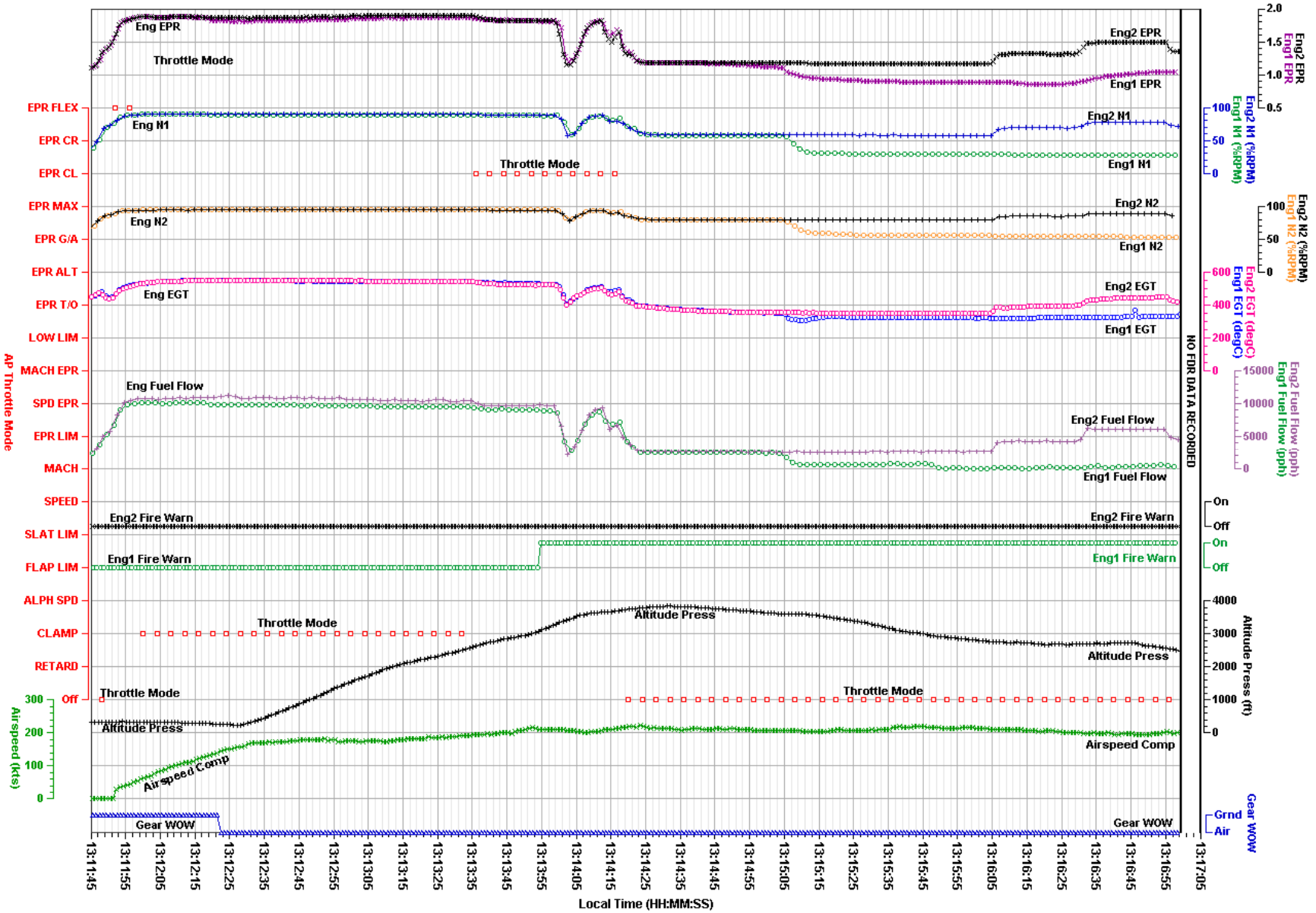
National Transportation Safety Board

Plot 6

American Airline, McDonnell Douglas MD-82, Flight# 1400, N454AA, Event Zoom

Location, Date: St. Louis, MO, 09/28/07

NTSB No. DCA07MA310



Revised: 5 June 2008

Final Plot2 Engines (Event Zoom)

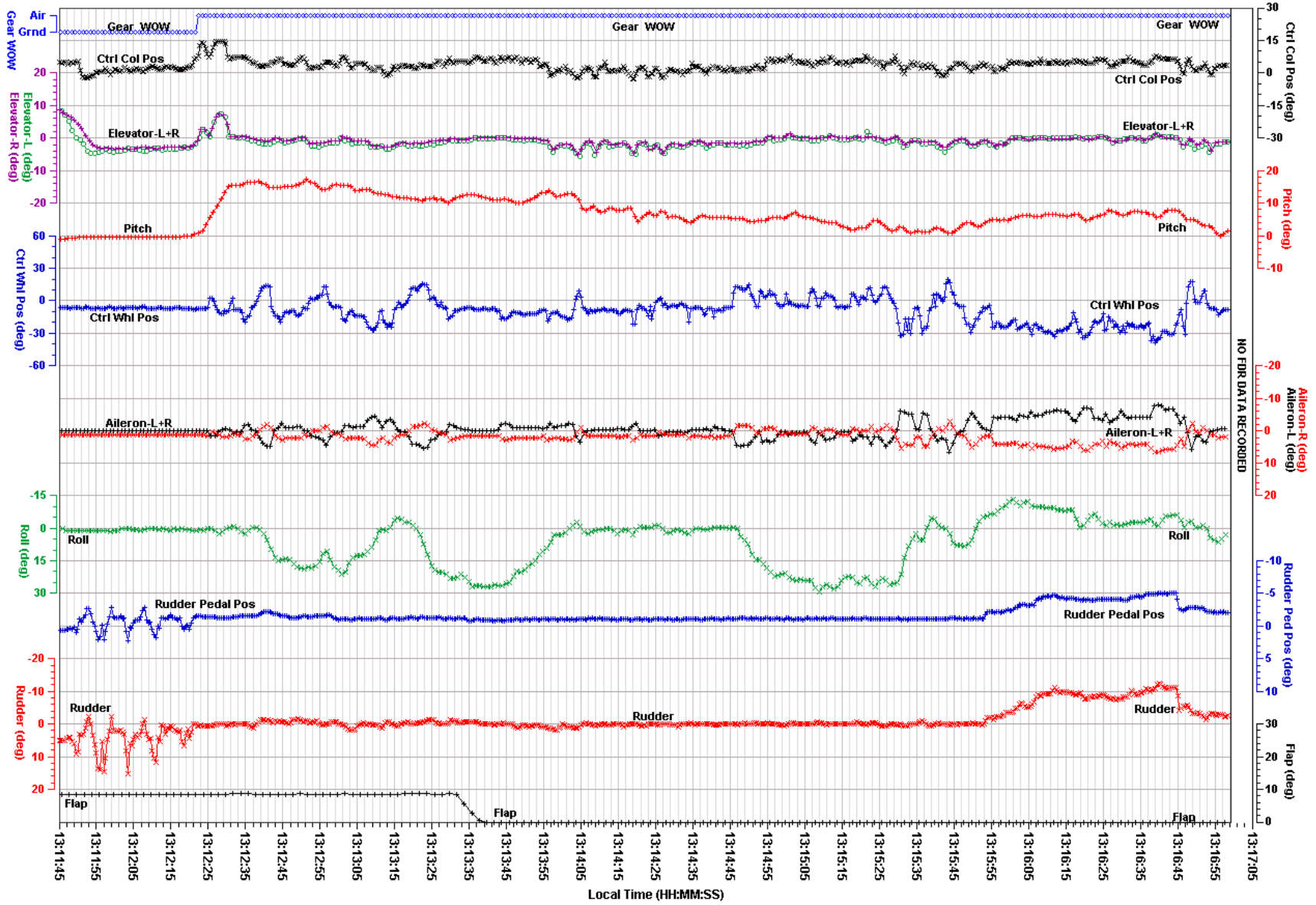
National Transportation Safety Board

Plot 7

American Airline, McDonnell Douglas MD-82, Flight# 1400, N454AA, Event Zoom

Location, Date: St. Louis, MO, 09/28/07

NTSB No. DCA07MA310



Revised: 5 June 2008

Final Plot3 Flight Controls (Event Zoom)

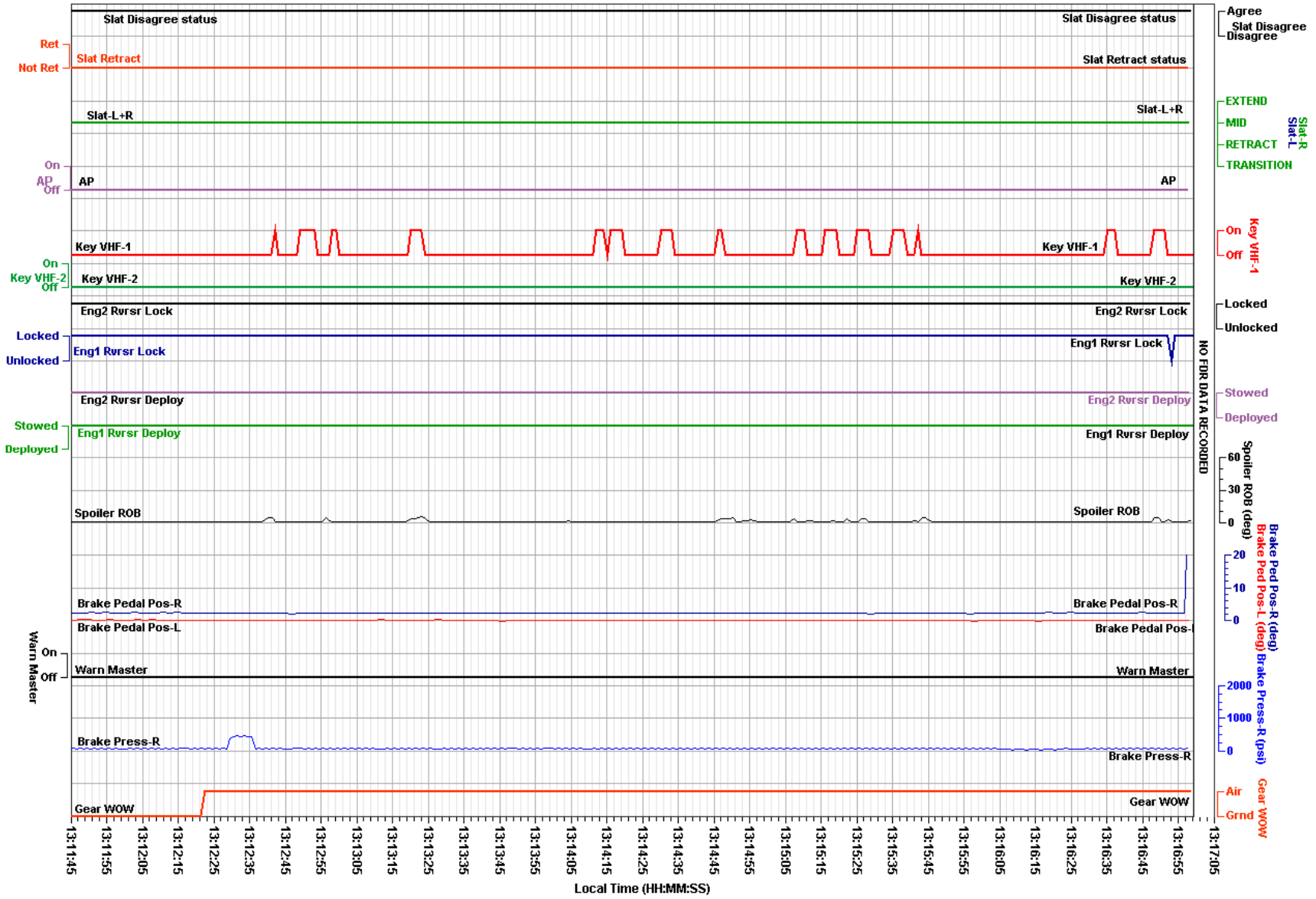
National Transportation Safety Board

Plot 8

American Airline, McDonnell Douglas MD-82, Flight# 1400, N454AA, Event Zoom

Location, Date: St. Louis, MO, 09/28/07

NTSB No. DCA07MA310



Revised: 5 June 2008

Final Plot4 More (Event Zoom)

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