

**NATIONAL TRANSPORTATION SAFETY BOARD**  
Office of Research and Engineering  
Washington, D.C. 20594

May 15, 2006

## **Flight Data Recorder**

### **Group Chairman's Factual Report by Dennis R. Grossi**

#### **A. ACCIDENT**

Location: Chicago Midway Airport  
Date: December 8, 2005  
Time: 1914 local time  
Aircraft: Southwest Airlines, Flight 1248, B737-700, N471WN  
NTSB Number: DCA06MA009

#### **B. GROUP**

N/A

#### **C. SUMMARY**

On December 8, 2005, at 1914 Central Standard Time, Southwest Airlines flight 1248, Boeing B-737-7H4 registered as N471WN, over ran runway 31C at Chicago Midway Airport in Chicago Illinois, during the landing roll out. The airplane departed the end of the runway, rolled through a blast fence, a perimeter fence, and onto the roadway. The airplane came to a stop after impacting one automobile. Instrument meteorological conditions prevailed at the time. The airplane was substantially damaged. The flight was conducted under 14 CFR Part 121 and had departed from the Baltimore Washington International Thurgood Marshal Airport Maryland.

The flight data recorder (FDR), a Honeywell Model SSFDR (s/n 10452), was removed from the aircraft following the accident and taken to the Safety Board's laboratory in Washington, D.C., for readout and evaluation. In addition the FDRs were pulled from the following 5-aircarrier aircraft that landing in the 25 minutes preceding the accident:

United Airline, Flight 1446, Airbus A320-232, N479UA, Landing time 18:49:00;.  
Southwest Flight 2920, Boeing 737-700, N795SW, Landing time 18:53:38;  
Southwest Flight 321, Boeing 737-700, N213WN, Landing time 19:00:38;  
Southwest Flight 2947, Boeing 737-700, N482WN, Landing time 19:02:28;  
Southwest Flight 1830, Boeing 737-700, N788SA, Landing time 19:04:07.

The following is a summary of selected flight recorder parameters recorded during the approach and landing roll of Flight 1248. All times reference local time, unless otherwise noted:

- Until approximately 13 seconds prior to touchdown, the glide slope and localizer data indicate a less than  $\frac{1}{2}$  - DOT<sup>1</sup> deviation from the instrument landing system (ILS) glide path. At this point in the approach the radio altitude had decreased to 141 feet and the glide slope deviation value reached approximately 1DOT (high or Fly Down), where it remained until just prior to touchdown. The localizer values did not deviate more than  $\frac{1}{2}$  DOT;
- When the main gear air ground parameter indicated the transition from air to ground or main gear touchdown the airspeed was 124 knots, the ground speed was 131 knots, heading 316° and the vertical acceleration reached 1.413 g's. The wind speed and direction at touchdown were 5.5 knots and 147.7°, respectively.
- The ground spoilers fully deployed and auto brakes were applied within 1.25 seconds after main gear touchdown as vertical acceleration registered a peak value of 1.74 g's. Once the auto brakes were activated the brake pressure rose steadily over the next 5-seconds to 2400psi (left. brake) and 2600psi (right. brake).
- The longitudinal acceleration values reached a peak deceleration of  $-0.26342$  g's approximately 6-seconds after main gear touchdown as the brake pressure reached the peak brake pressure commanded by the auto brakes. The ground speed decreased to 113 knots at the point of peak longitudinal deceleration.
- Approximately 10-seconds after touchdown engine fan speed (N1) decreased from 32% at touchdown to approximately 20% where it remained for approximately 8 seconds.
- The auto brakes were selected off approximately 12-seconds after touchdown and the brake pressure increased to 3000psi.
- The first indication of thrust reverse activity occurred 15-seconds after main gear touchdown. The thrust reversers were fully deployed 18-seconds after touchdown, and N1 reached 80% 9-seconds later or 27-seconds after touchdown as ground speed decreased to 62 knots.
- The data are consistent with the nose gear departing the paved surface of the overrun and overriding the blast fence 33.8 seconds after main gear touchdown. This was evident in the sharply increased activity of the acceleration parameters and pitch attitude, which spiked from  $-1.9^\circ$  to  $2.6^\circ$  in less than a second. At this point in

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<sup>1</sup> The FDR records ILS deviation as "Difference in Depth of Modulation" (DDM); where  $0.0875$  DDM=1DOT of Glide slope deviation and  $0.0775$  DDM=1DOT of Localizer deviation. The glide path deviation is displayed to the cockpit crew; as DOTs; where  $1\text{DOT} = 0.35^\circ$  Glide slope deviation with a full-scale deflection of  $\pm 0.7^\circ$  and  $1\text{DOT} = 0.9998$  of Localizer deviation  $^\circ$ .

the landing roll the ground speed had decreased to 39.5 knots, while the thrust reversers remained fully deployed and the brake pressure remained at 3000psi.

- The data are consistent with the aircraft coming to rest 8 seconds after departing the paved surface of the overrun with a collapsed nose gear on a heading of 336°

The following table provides a comparison of selected FDR parametric data for Flight 1248 and the five other air carrier aircraft that landed within the 25 minutes preceding the accident.

| Flt. No. | Aircraft Model | Conditions at Touchdown |              |          |           |           | Elapsed Sec. After T/D to |              |                   |
|----------|----------------|-------------------------|--------------|----------|-----------|-----------|---------------------------|--------------|-------------------|
|          |                | Time Hr:Min             | Ground Speed | Airspeed | Vert. "G" | Gross Wt. | 1 <sup>st</sup> Brake Use | T/R Deployed | 40 Knots Grnd Spd |
| 1446     | A320           | 18:49                   | 128          | 123      | 1.33      | 114040    | 3.5 auto                  | 6            | 18                |
| 2920     | B737           | 18:52                   | 140          | 132      | N/A       | 114480    | 0.5 crew                  | 4            | 21                |
| 321      | B737           | 19:01                   | 121          | 113      | 1.5       | 103320    | 6.0 crew                  | 4            | 25                |
| 2947     | B737           | 19:02                   | 132          | 122      | 1.95      | 110320    | 8.0 crew                  | 4            | 26                |
| 1830     | B737           | 19:04                   | 126          | 117      | 1.35      | 105520    | 2.0 crew                  | 4            | 24                |
| 1248     | B737           | 19:13                   | 131          | 124      | 1.41      | 118280    | 3.3 auto                  | 18           | 33                |

Additionally, Flight 1446 disengaged Auto Brakes (Medium Mode) approximately 11 seconds after main gear touchdown with the application of manual braking that increased brake pressure. Flight 2920 was the only flight to manually engage maximum brake pressure (3000psi) directly (within 6-seconds) after touchdown. Flight 1830 also used maximum brake pressure but not until 19-seconds after touchdown as reverse thrust was decreasing. Brake pressure did not exceed 700 psi for Flight 321 until 20-seconds after touchdown and 14-seconds after Flight 2947 touched down when differential braking was used.

## D. DETAILS OF INVESTIGATION

### 1. Description of Data

This model FDR recorded the ARINC 717 standard 256 words per second 12-bit serial data stream output from the digital flight data acquisition unit (DFDAU). The recorder uses solid-state memory devices to retain 25-hour of data. The oldest data are overwritten by the newest.

### 2. Examination of Recorder

The flight recorder was not damaged, and showed no evidence of excessive wear.

### 3. Readout and Evaluation

#### a. Readout

The data from the accident aircraft were recovered from the FDR using the recorder manufacturer's standard download software. Data from the prior flight listed above were downloaded by the respective operators and provided to the Safety Board as raw binary files.

The data were reduced from the raw recorded decimal values (0 to 4095) to engineering units (e.g., feet, degrees, knots, etc. ) using the data map and conversion logic contained in Boeing Data Frame document 737-3B rev. E, which list 1,150 parameters in a 256, 12-bit word per second data frame as stated above. This documentation, provided by the operator in an electronic file, was loaded directly into the Board's FDR presentation and analysis software. The same documentation file was used to process the FDR data from the 4 B737s that landed prior to the accident flight. The A320 data were converted to engineering units and discrete values using documentation "SFIM FDIU P/N ED43A1D5 (MOD 25591)", which lists 298 parameters in a 128, 12-bit word data frame.

**b. Evaluation**

An examination of the recovered data sets indicated that the recorder systems operated normally except for the following sensor problems:

Accident aircraft – Parameter Ground Speed indicates a residual value of 3-knots after the aircraft comes to rest during the accident flight. The ground speed values on prior flights go to zero knots when the airplane is stopped.

Aircraft N795SW – All three acceleration parameters recorded invalid data.

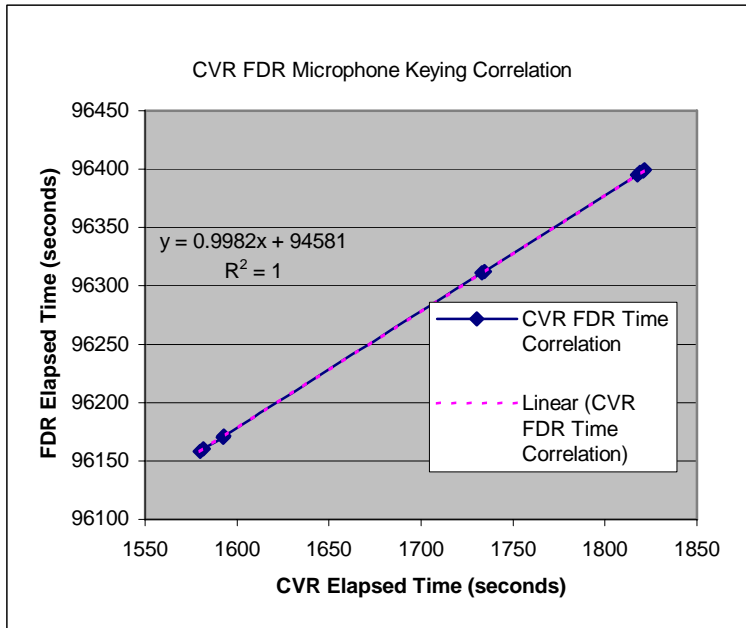
*Note: only the parameters referenced in this report were evaluated.*

**c. Time Correlation of CVR and FDR**

The last five microphone keying events recorded by the FDR and the radio transmission recorded by the CVR were used to establish a common time base for the two recordings. A regression analysis of the time interval between the start and stop of each radio transmission as recorded by the FDR and CVR indicated a linear relationship with a coefficient of determination ( $R^2$ ) of 1, where 1 represents the best possible fit (see Figure 1). The Aircraft Performance Group established the following local time correlation (see Group Chairman's Factual Report for details):

**Correlation Anchor Point (Local = CVR = FDR)**

| Local Time     |           | CVR Elapsed Time |         | FDR Elapsed Time |
|----------------|-----------|------------------|---------|------------------|
| Hr: Min: Sec.  | Seconds   | Hr: Min: Sec.    | Seconds | Seconds          |
| 19: 13: 52.558 | 69232.558 | 00: 30: 18.76    | 1818.76 | 96396.901        |



| CVR Trans. | FDR Mic Key |
|------------|-------------|
| 1580.005   | 96157.816   |
| 1581.604   | 96159.816   |
| 1592.554   | 96169.816   |
| 1592.932   | 96170.816   |
| 1732.953   | 96310.816   |
| 1734.396   | 96311.816   |
| 1817.746   | 96394.816   |
| 1818.916   | 96396.816   |
| 1820.61    | 96397.816   |
| 1821.501   | 96398.816   |

Figure 1

**E. Data Plot**

Plots of selected parameters for the accident flight and the prior flights listed above are attached. The plots cover the period from short final through the landing roll and runway departure. For comparison, the longitudinal acceleration and ground speed traces from the accident flight are overlaid on the corresponding traces of the prior flights. The time correlation between the accident flight and prior flights was established at main gear touchdown as determined by main gear air/ground parameter.

**F. Tabular Listing**

Tabular listing of the FDR parameters contained in the aforementioned plots are available in an electronic format in the Public Docket.

Dennis R. Grossi  
National Resource Specialist Flight Data Recorders

Attachment

# **ATTACHMENT**

Data Plots



## **Flight 1248**

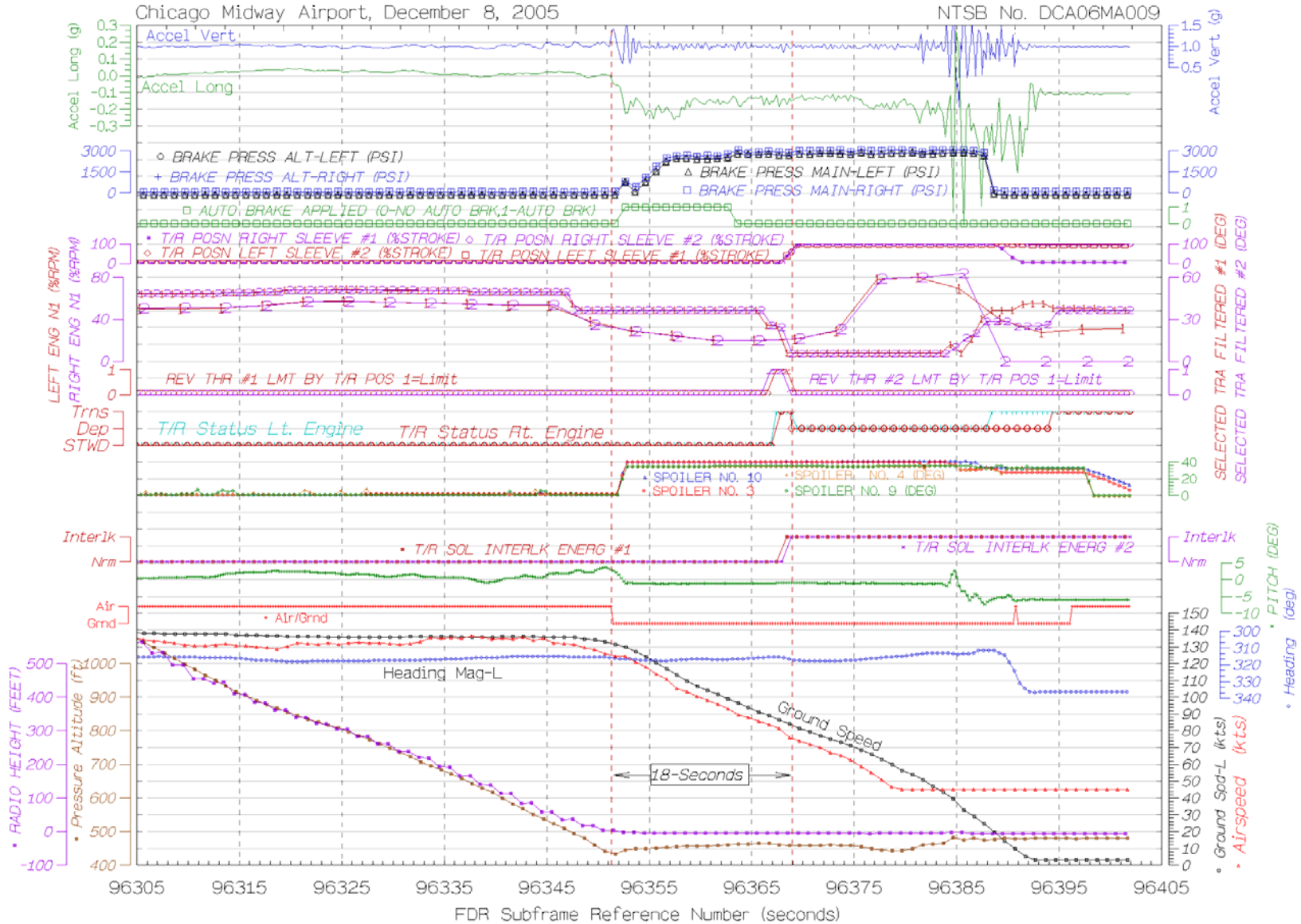
Data Plots



# Southwest Airlines, B737-7H4 Flight #1248, N471WN

Chicago Midway Airport, December 8, 2005

NTSB No. DCA06MA009



Revised: May 11, 2006

Plot 1

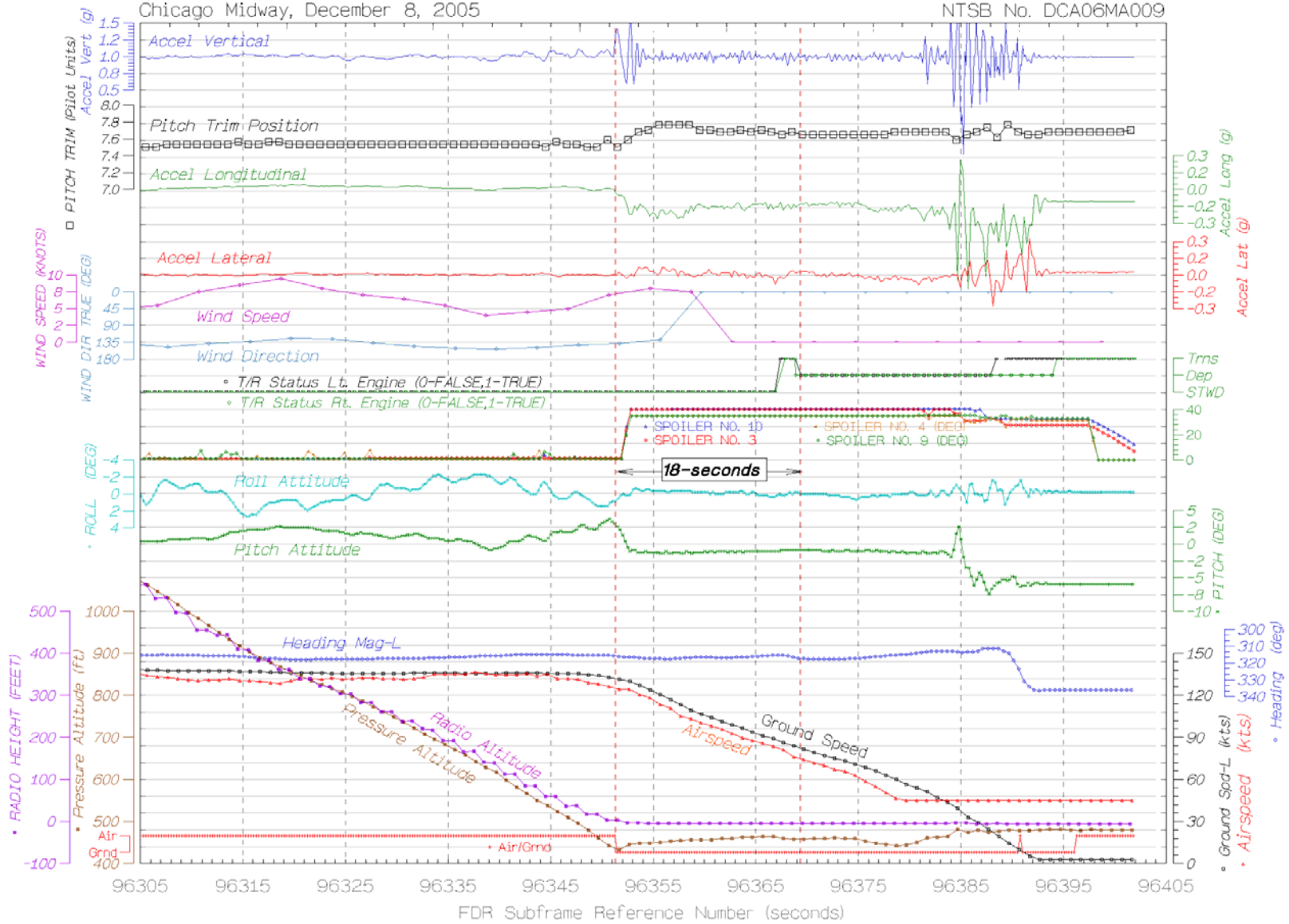
National Transportation Safety Board

DCA06MA009

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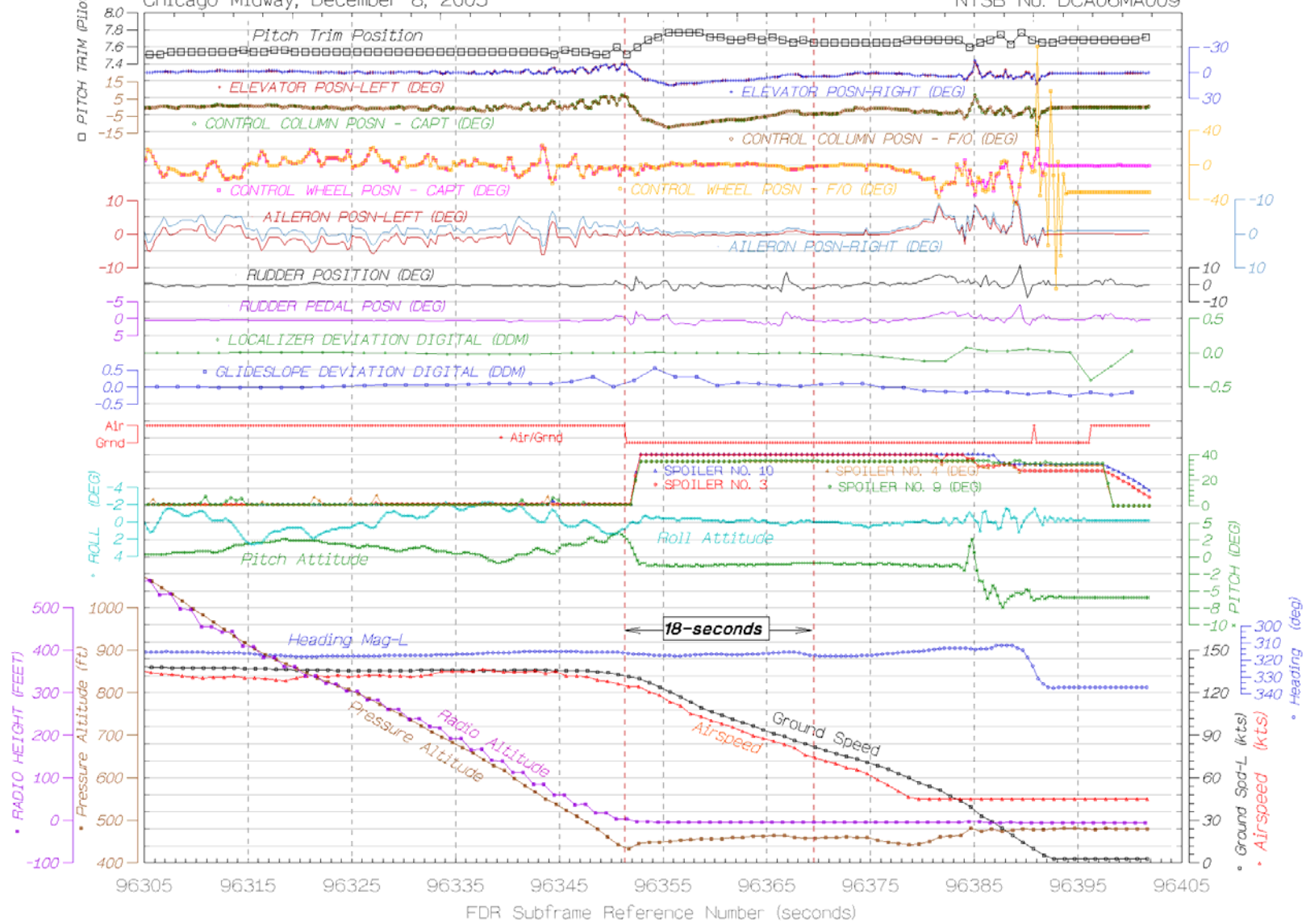
Plot 2

National Transportation Safety Board

# Southwest Airlines, B737-7H4 Flight #1248, N471WN

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



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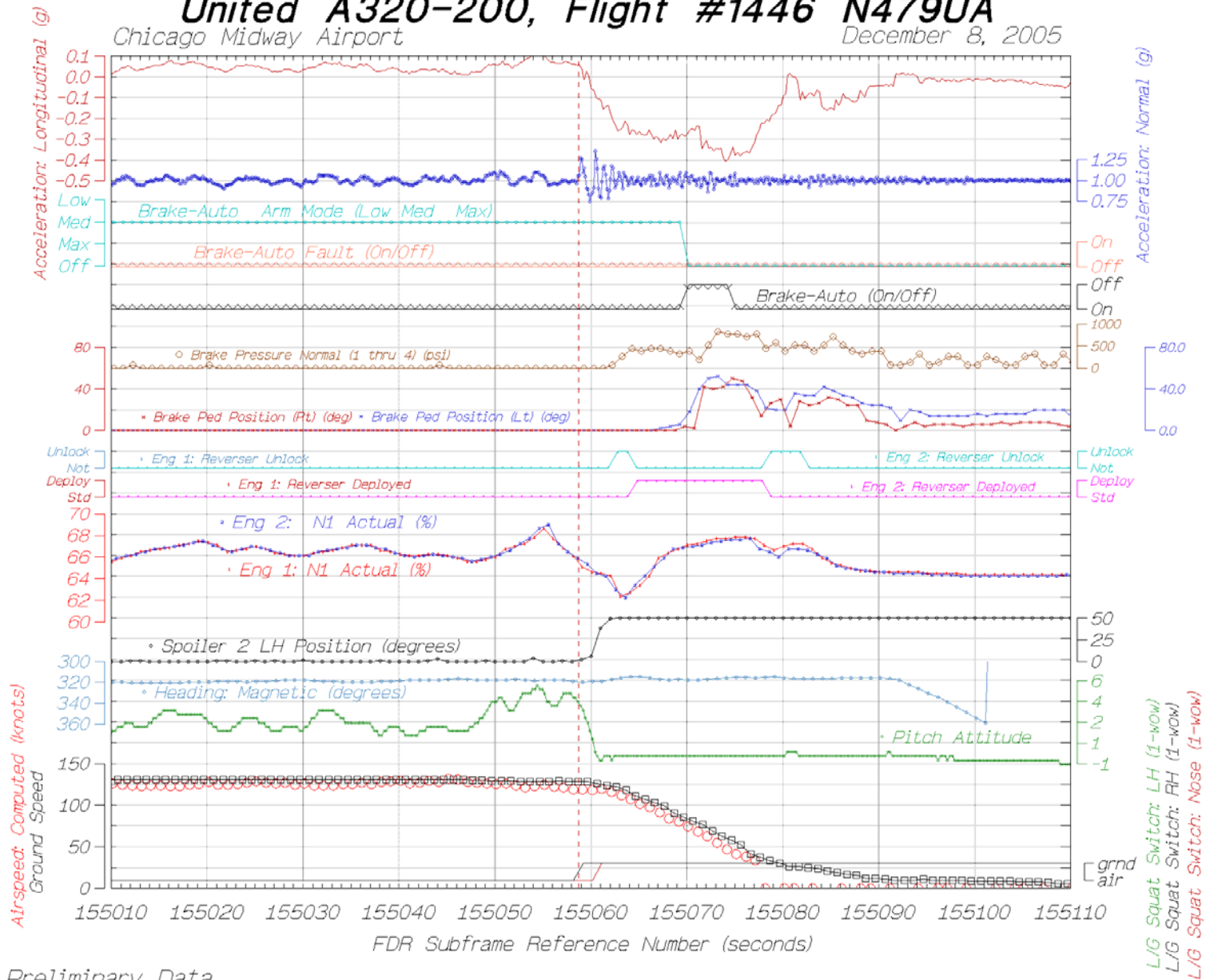
Plot 3

National Transportation Safety Board

**Flight 1446**  
Data Plots

# United A320-200, Flight #1446 N479UA

Chicago Midway Airport December 8, 2005



Preliminary Data  
Revised: May 12, 2006

National Transportation Safety Board

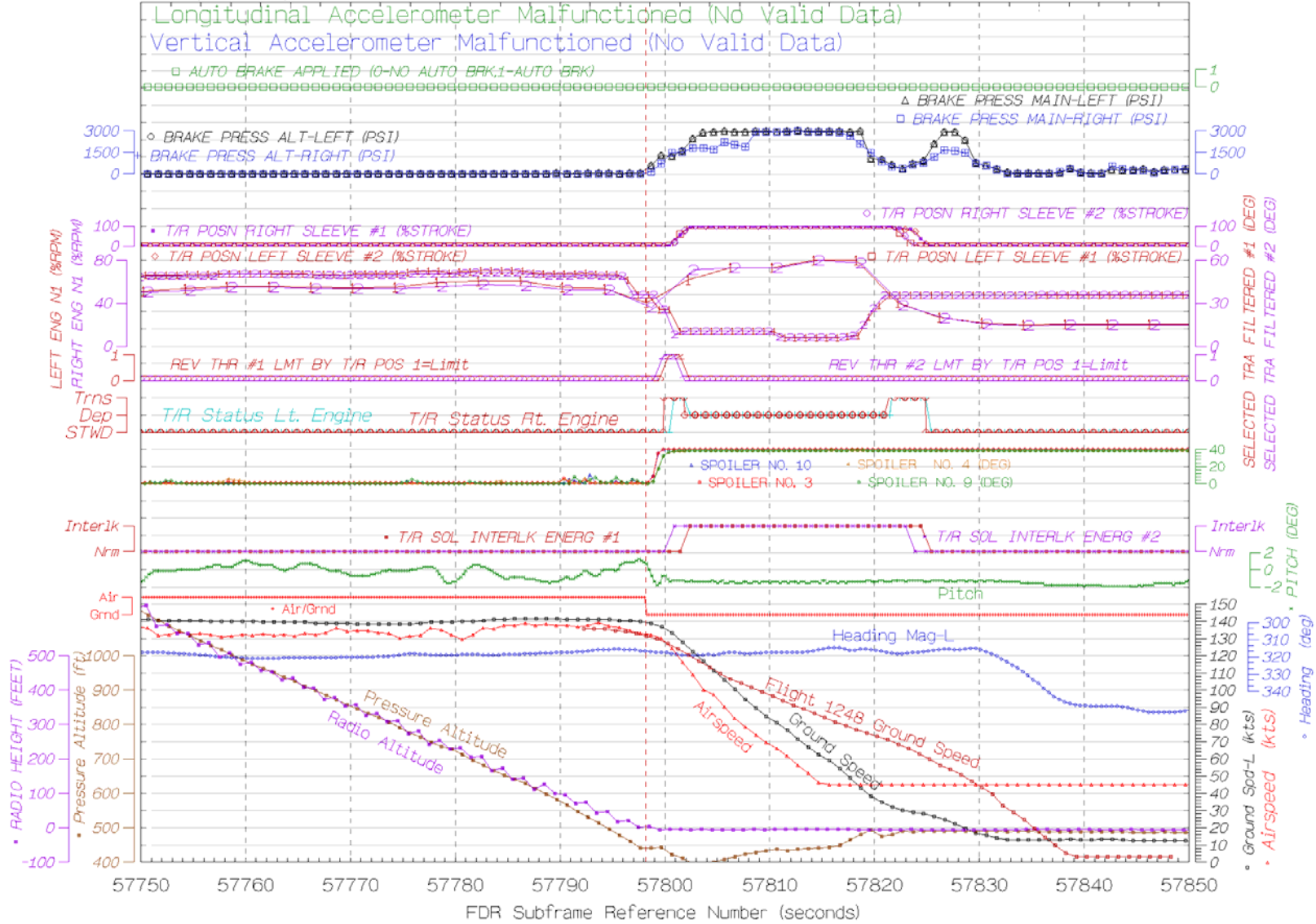
## **Flight 2920**

Data Plots

# Southwest Airlines, B737-7H4 Flight #2920, N795SW

Chicago Midway Airport, December 8, 2005

NTSB No. DCA06MA009



Revised: May 12, 2006

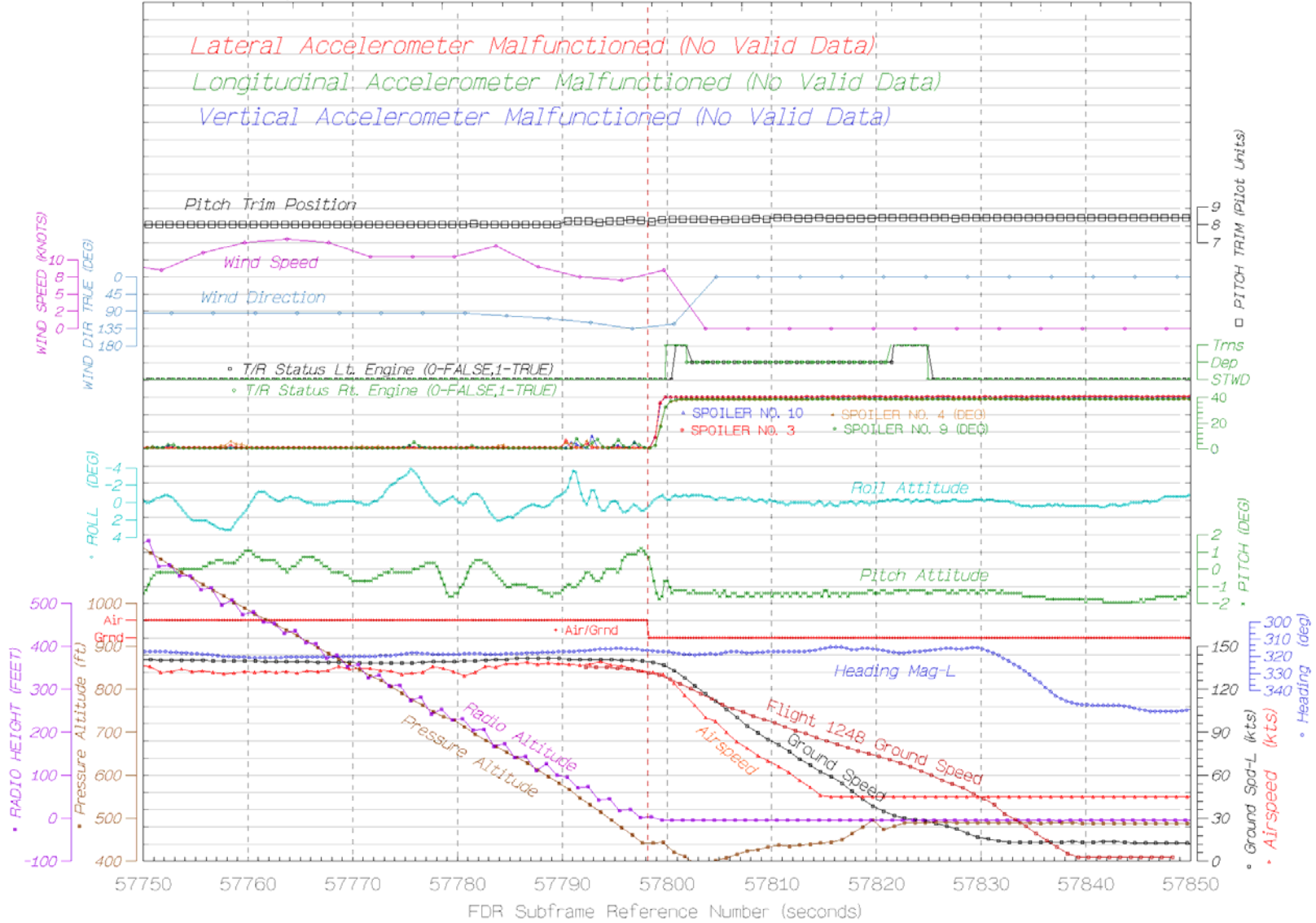
Plot 1

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# Southwest Airlines, B737-7H4 Flight #2920, N795SW

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



Revised: May 12, 2006

Plot 2

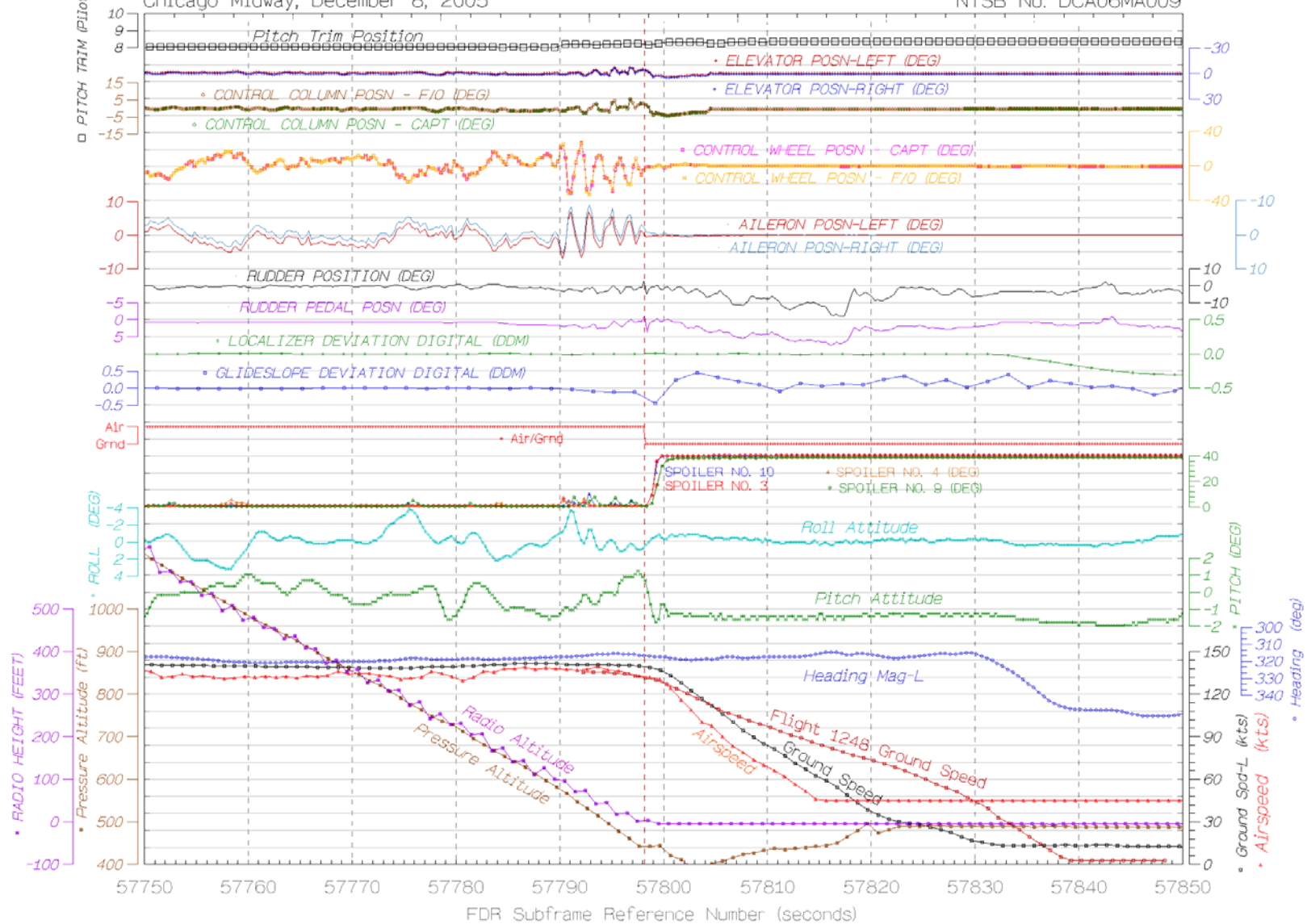
National Transportation Safety Board



# Southwest Airlines, B737-7H4 Flight #2920, N795SW

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



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Plot 3

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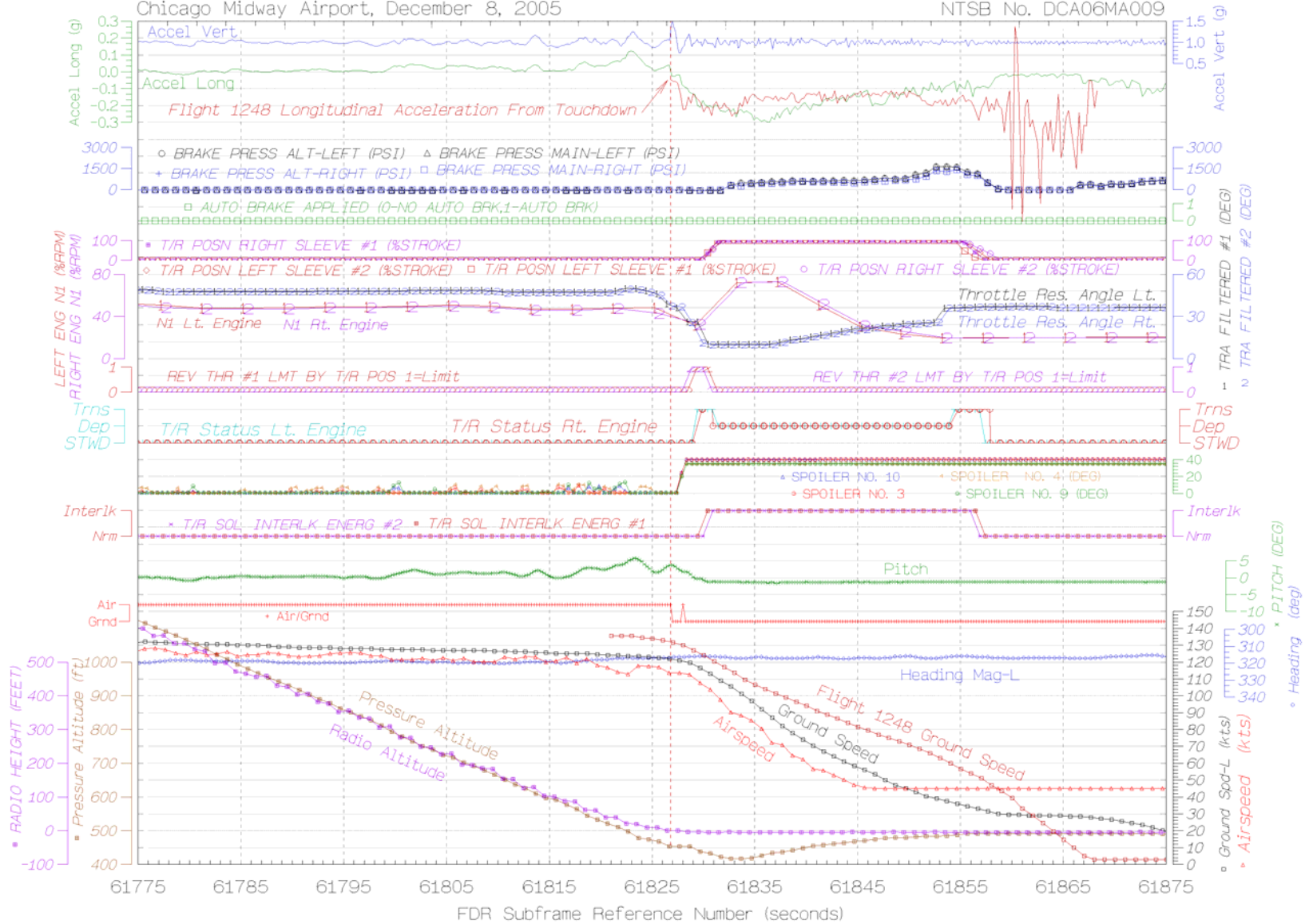
## **Flight 321**

Data Plots

# Southwest Airlines, B737-7H4 Flight #321, N213WN

Chicago Midway Airport, December 8, 2005

NTSB No. DCA06MA009



Revised: May 11, 2006

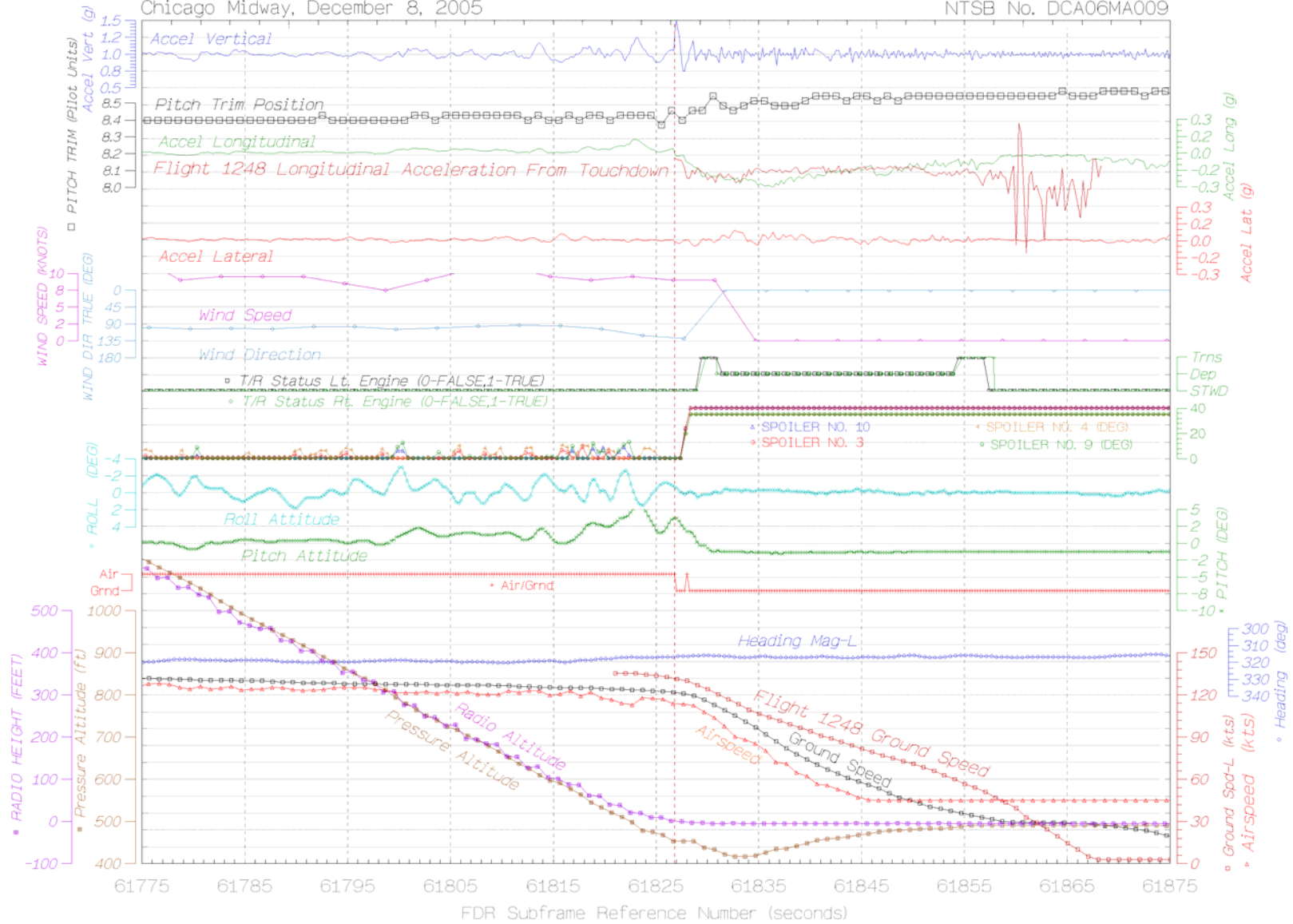
Plot 1

National Transportation Safety Board

# Southwest Airlines, B737-7H4 Flight #321, N213NW

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



Revised: May 11, 2006

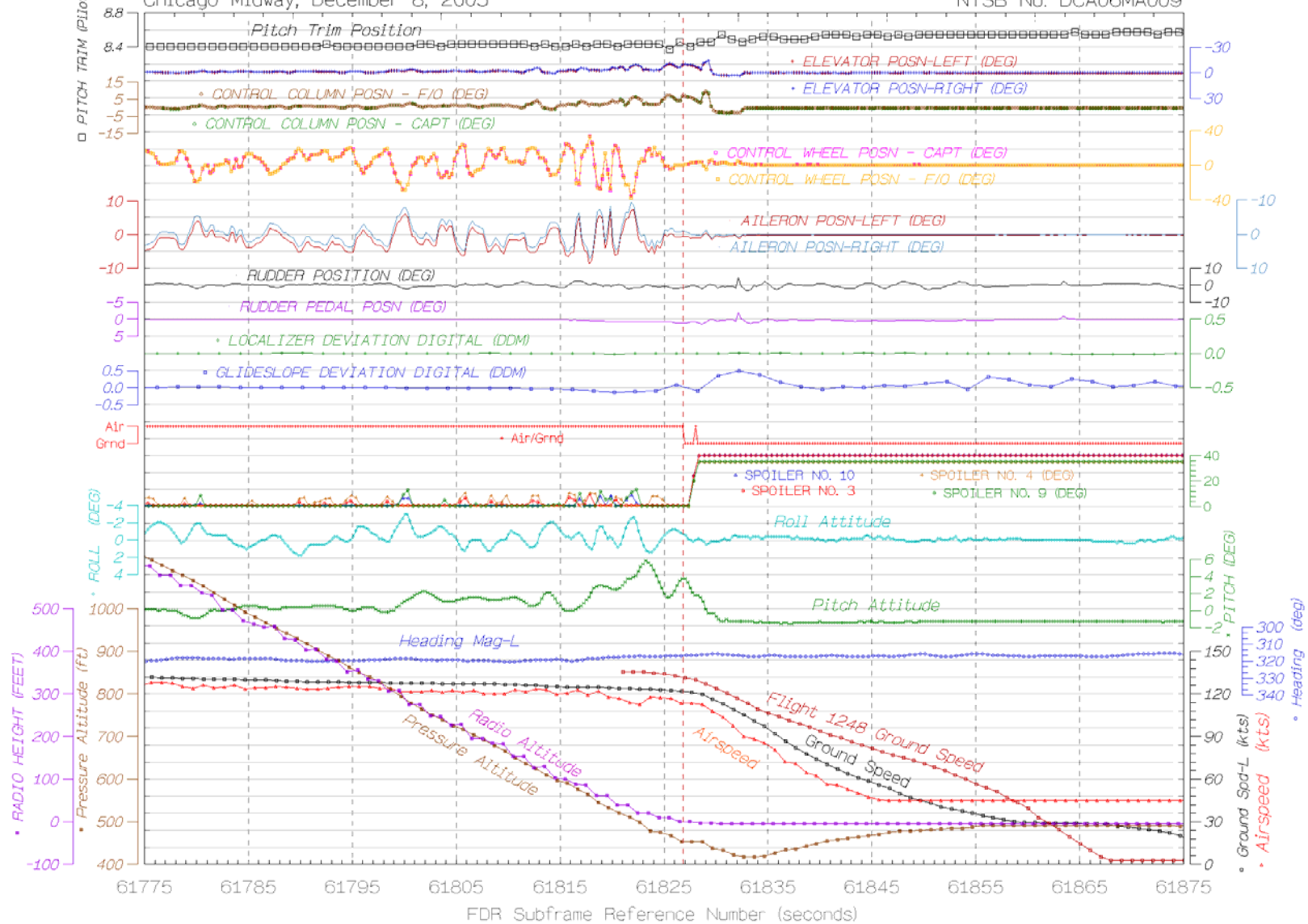
Plot 2

National Transportation Safety Board

# Southwest Airlines, B737-7H4 Flight #321, N213WN

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



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Plot 3

National Transportation Safety Board

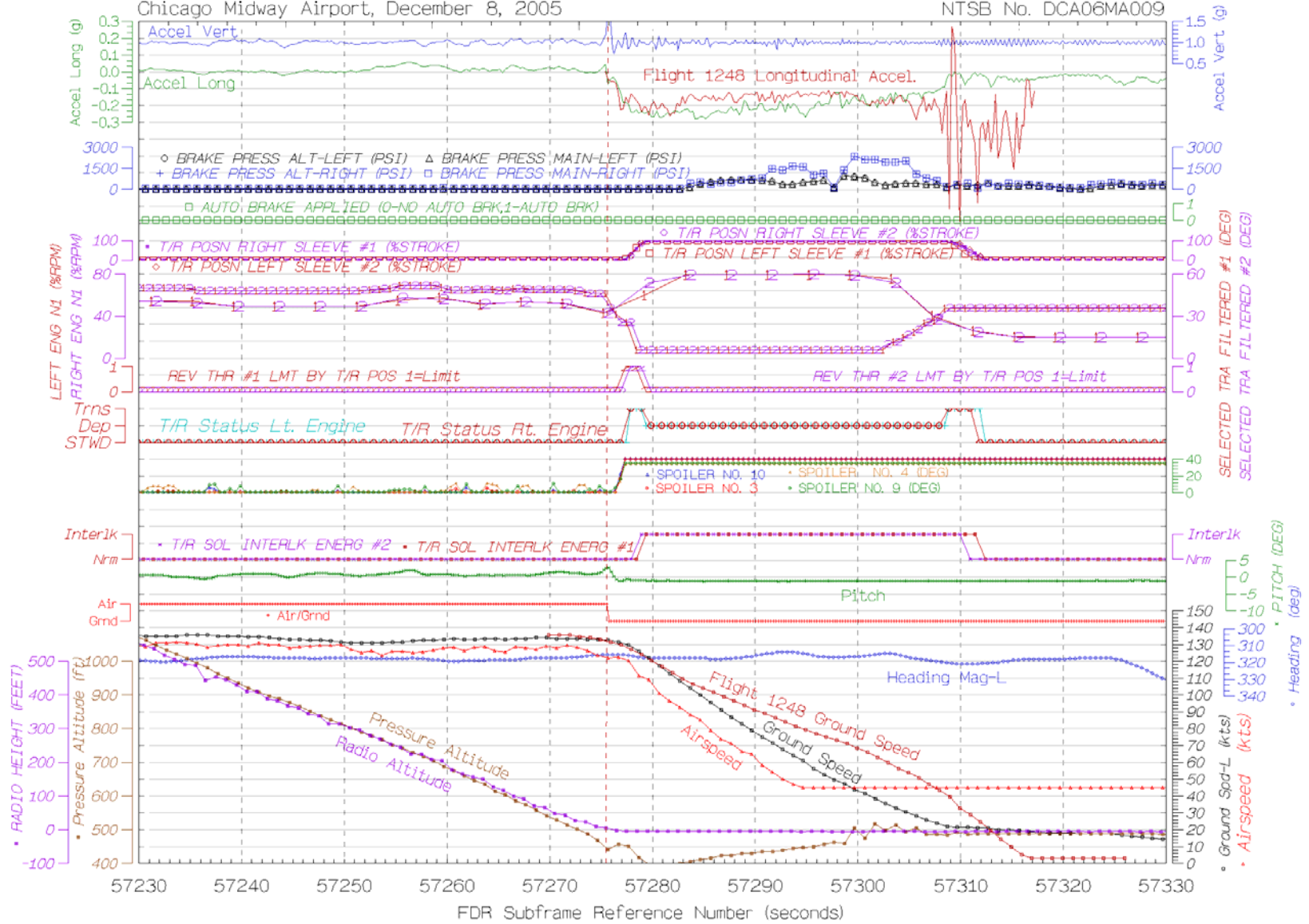
## **Flight 2947**

Data Plots

# Southwest Airlines, B737-7H4 Flight #2947, N482WN

Chicago Midway Airport, December 8, 2005

NTSB No. DCA06MA009



Revised: May 12, 2006

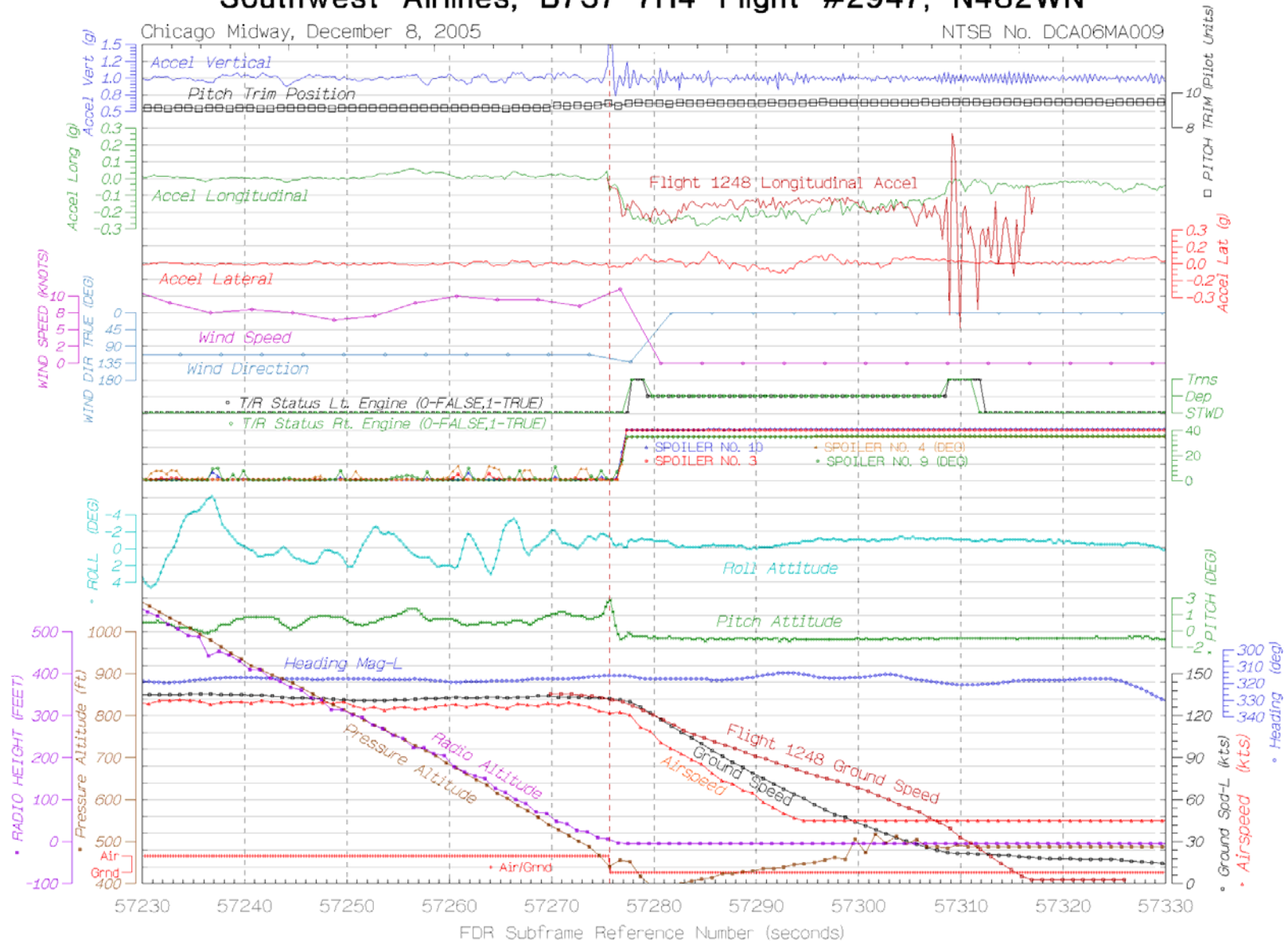
Plot 1

National Transportation Safety Board

# Southwest Airlines, B737-7H4 Flight #2947, N482WN

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



Revised: May 12, 2006

Plot 2

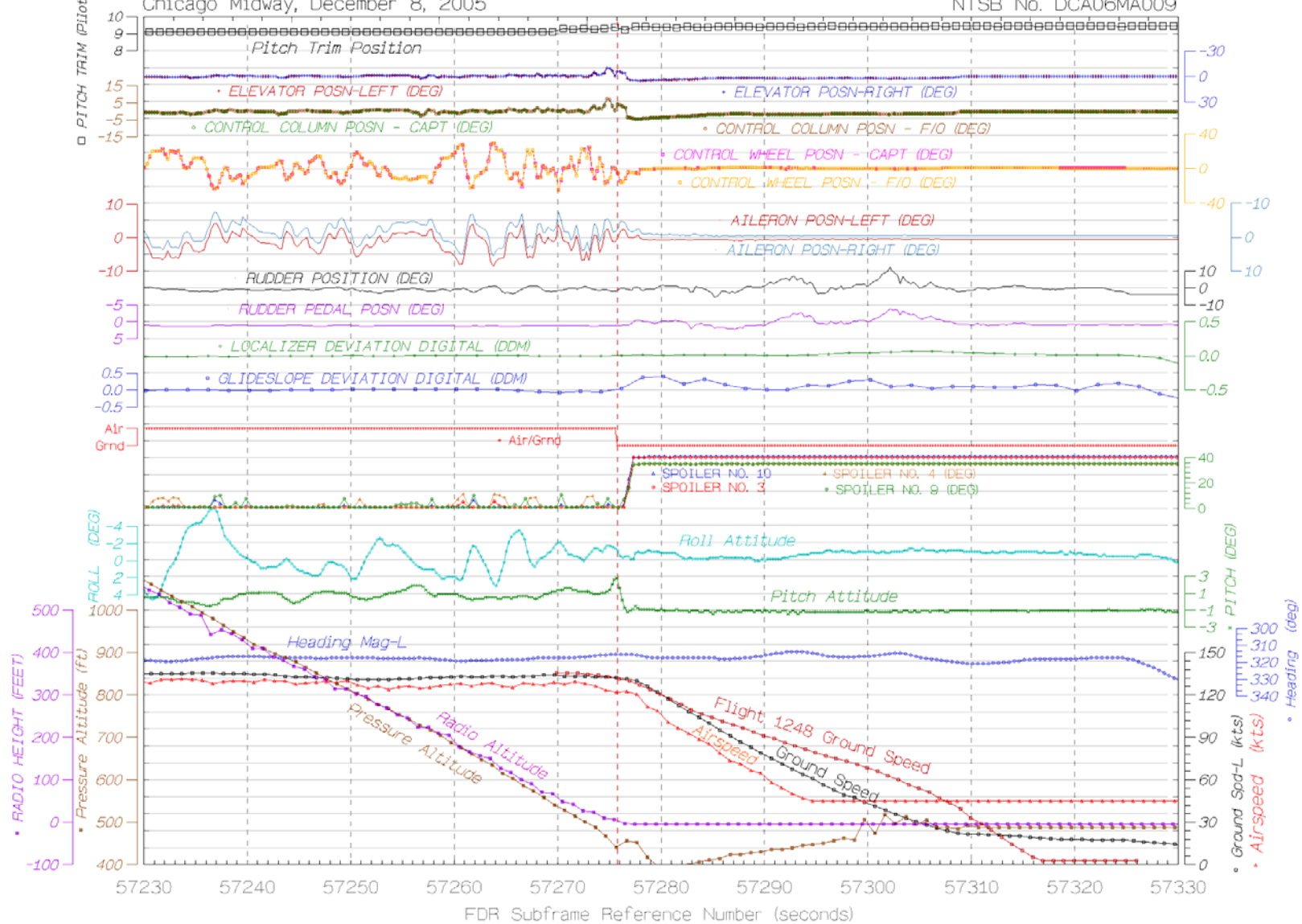
National Transportation Safety Board



# Southwest Airlines, B737-7H4 Flight #2947, N482WN

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



Revised: May 12, 2006

Plot 3

National Transportation Safety Board

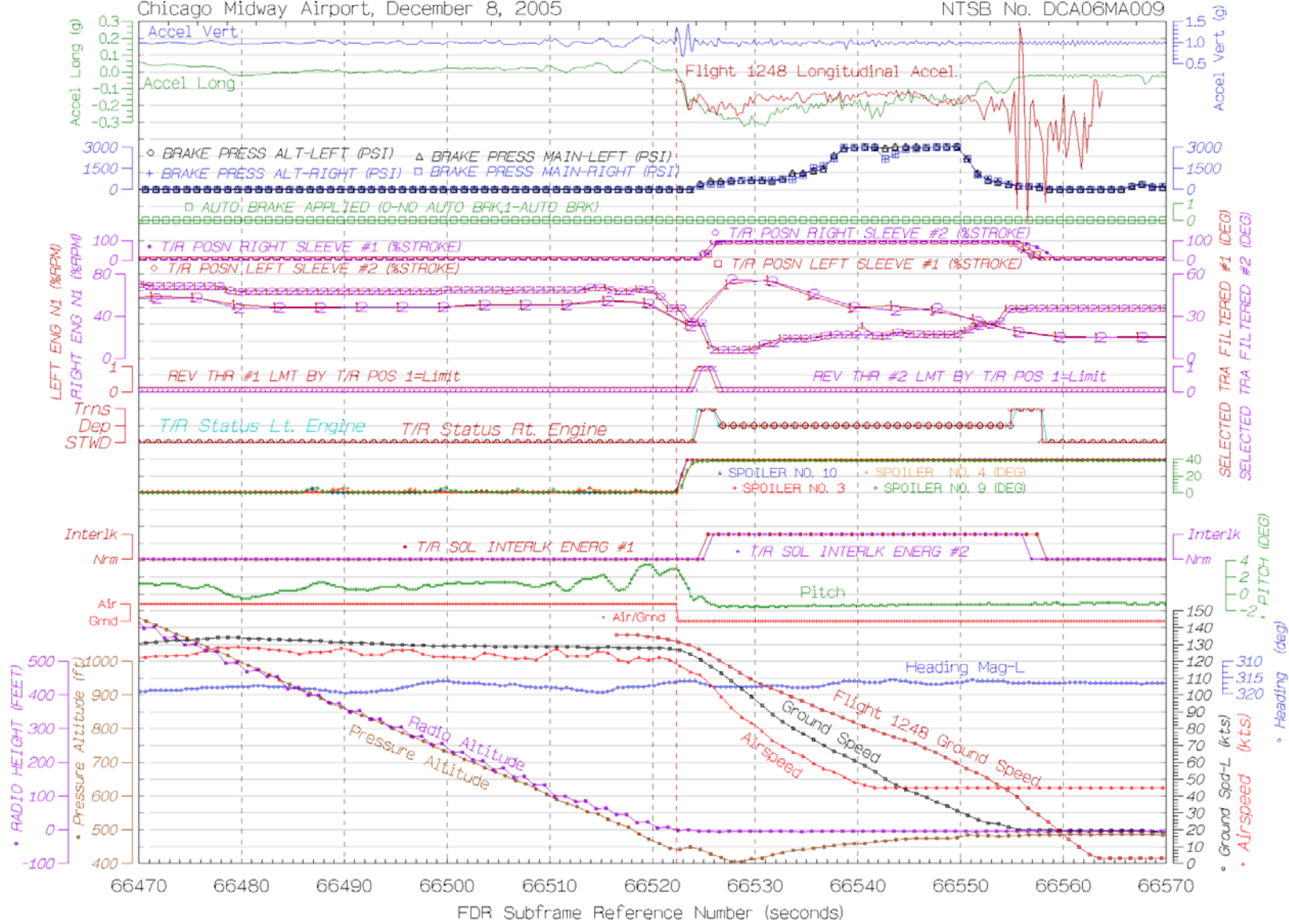
## **Flight 1830**

Data Plots

# Southwest Airlines, B737-7H4 Flight #1830, N788SA

Chicago Midway Airport, December 8, 2005

NTSB No. DCA06MA009



Revised: May 12, 2006

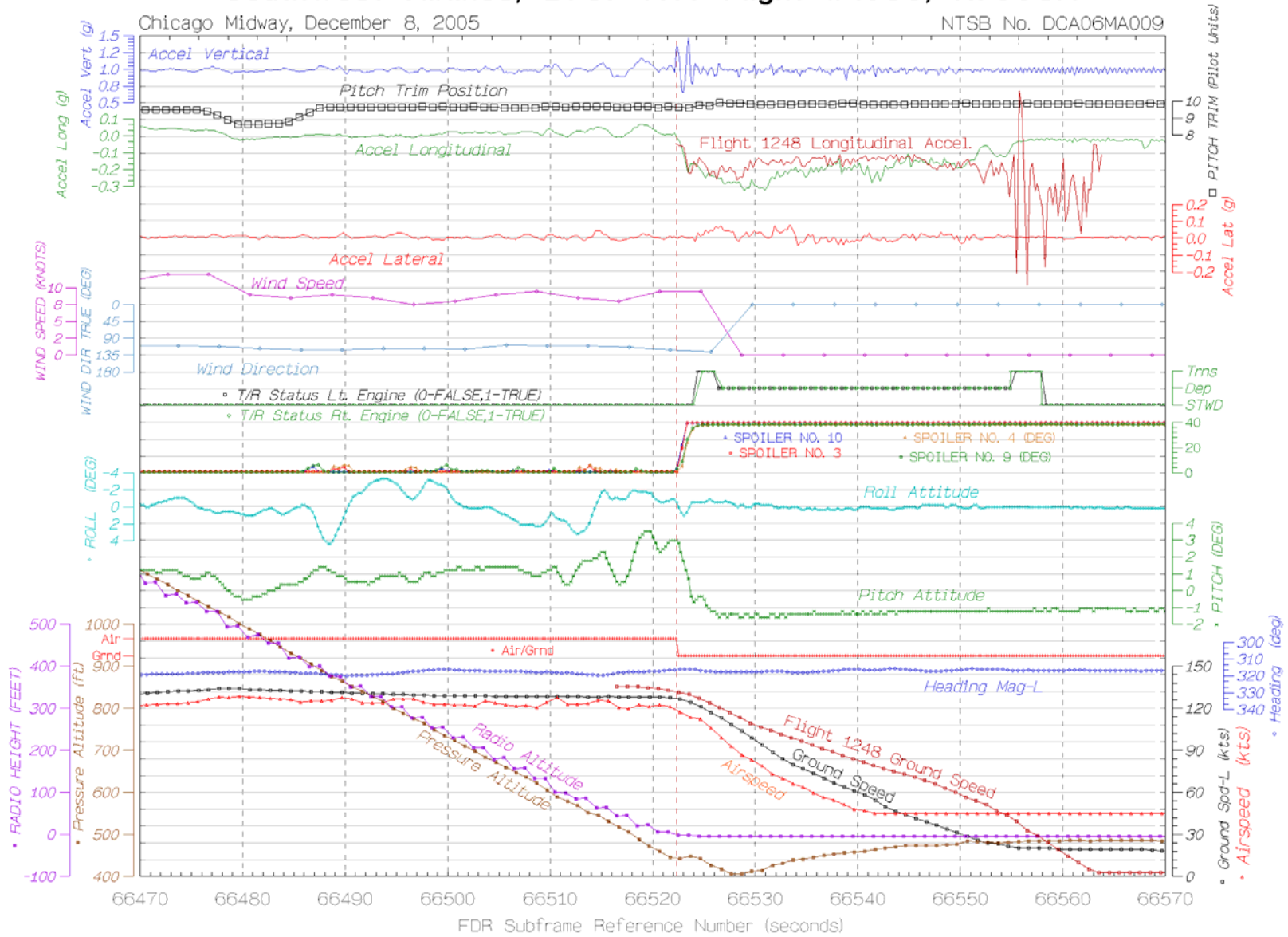
Plot 1

National Transportation Safety Board

# Southwest Airlines, B737-7H4 Flight #1830, N788SA

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



Revised: May 12, 2006

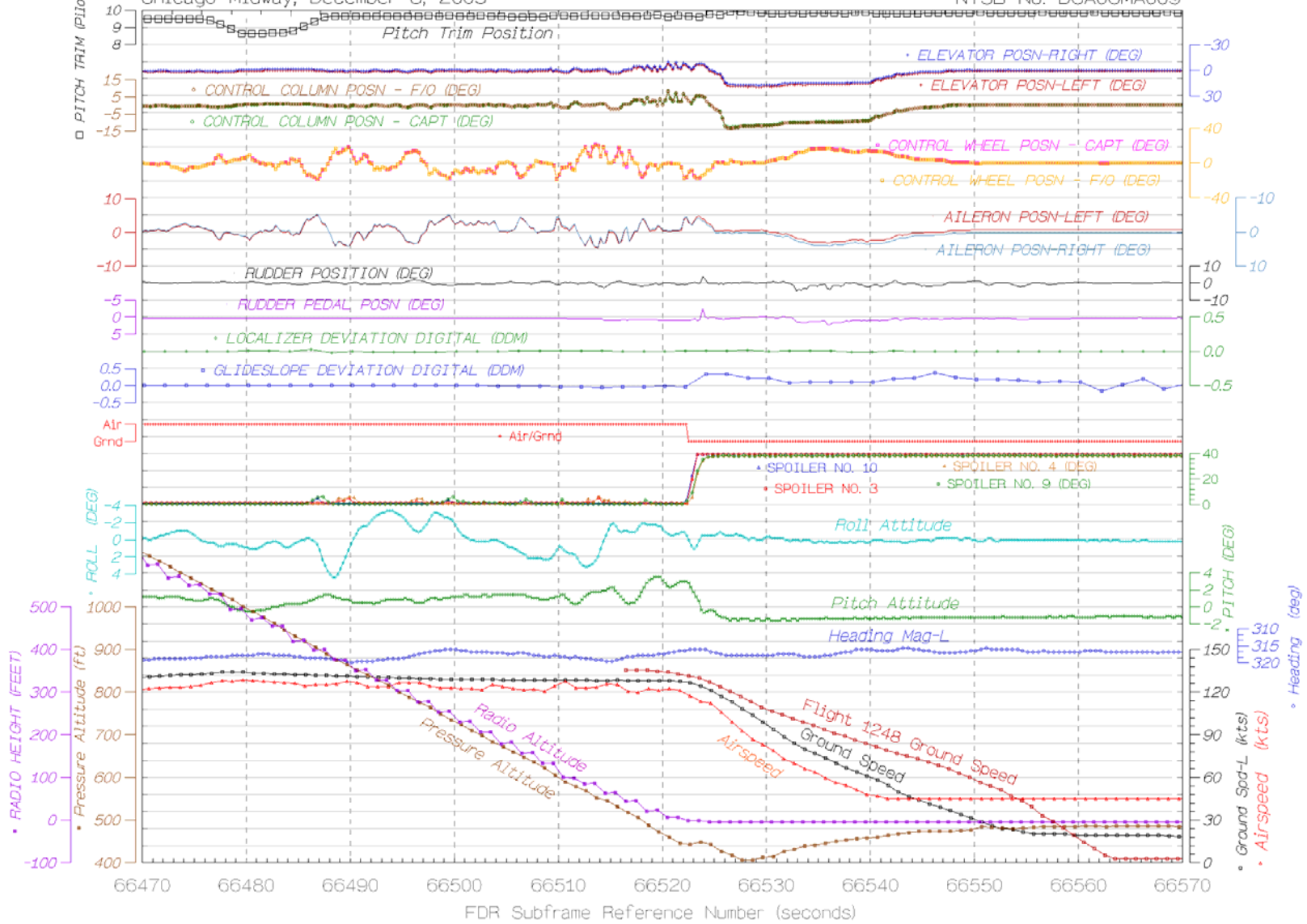
Plot 2

National Transportation Safety Board

# Southwest Airlines, B737-7H4 Flight #1830, N788SA

Chicago Midway, December 8, 2005

NTSB No. DCA06MA009



Revised: May 12, 2006

Plot 3

National Transportation Safety Board