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

April 5, 2018

Flight Data Recorder

Specialist's Factual Report
By Cassandra Johnson

1. EVENT SUMMARY

Location: Ypsilanti, Michigan
Date: March 8, 2017
Aircraft: Boeing MD-83
Registration: N786TW
Operator: Ameristar Air Cargo, Inc.
NTSB Number: DCA17FA076

On March 8, 2017, about 1452 eastern standard time (EST), Ameristar Air Cargo, Inc. dba Ameristar Charters flight 9363, a Boeing MD-83, N786TW, ran off the end of runway 23L after executing a rejected takeoff at Willow Run Airport (YIP), Ypsilanti, Michigan. (The MD-83 was manufactured by McDonnell Douglas, which merged with Boeing in August 1997.) All 110 passengers and 6 crewmembers evacuated the airplane. One passenger was reported to have received a minor injury. The airplane sustained substantial damage (no post-crash fire occurred). The airplane was operating under the provisions of Title 14 *Code of Federal Regulations* (CFR) Part 121 as an on-demand charter flight and was destined for Washington Dulles International Airport (IAD), Dulles, Virginia. Daytime visual meteorological conditions prevailed at the time of the accident.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR Carriage Requirements

The event aircraft, N786TW, was manufactured in 1992, and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 34 parameters, as cited in 14 CFR Part 121.344(d).

4. DETAILS OF FDR INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following FDR:

Recorder Manufacturer/Model: **L-3/Fairchild FA2100**
Recorder Serial Number: **000357063**

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 64 12-bit words of digital information (raw binary data) 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.

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 368 hours of data. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The event data was found near the end of the recording. The parameters evaluated for this report appeared to be in accordance with federal FDR carriage requirements.

4.1.3. FDR Conversion Documentation

FDR data frame documentation is essential for decoding FDR data (for example, changing the raw binary data into engineering units). It is the operator’s responsibility to maintain the FDR data frame documentation for decoding the FDR.

Ameristar Air Cargo, Inc. was unable to provide the complete FDR data frame documentation. The documentation provided contained the word and bit locations but not the conversions. Therefore, NTSB had to rely on archived conversion documentation for the parameters except there were no archived conversions available for control column position, control wheel position, and rudder pedal position. Therefore, conversions were derived for these three parameters based on the minimum and maximum decimal counts recorded during the flight control ground checks for the entire FDR recording. Ameristar Air Cargo, Inc. was notified of this lack of documentation.

Based on the FDR data frame documentation and archived documentation, month, day, and year were not recorded. However, Time GMT[1] Hours and Time GMT Minutes are recorded, but Time GMT Seconds is not recorded. Both Time GMT Hours and Time GMT Minutes are recorded every 4 seconds.

[1] GMT is Greenwich Mean Time which is also known as Coordinated Universal Time (UTC).

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=+).[2]

Table A-1 lists the FDR parameters verified and provided in this report and provides the plot/table labels, descriptions, and units. Additionally, table A-2 describes the unit and discrete abbreviations used in this report.

4.2. FDR Power Cycles

According to the aircraft manufacturer, the FDR starts recording when either engine fuel switch is on and the parking brake is off. Every time the parking brake is applied, the FDR stops recording. Additionally, the FDR will record if the nose gear weight on wheels (WOW) switch indicates flight (air) regardless of the fuel switch positions or the parking brake.

Review of the FDR data after the previous landing to the end of the FDR data indicated the FDR stopped recording 6 times as shown in Table 1. Table 1 provides the SRN (elapsed seconds) in whole seconds, the recorded GMT time in hours and minutes, and EST (recorded GMT time - 5 hours) in hours and minutes.

Table 1. FDR recording status after previous landing

SRN (seconds)	FDR Status	Recorded GMT (HH:MM)	EST (HH:MM)
178,423	Stopped Recording (after previous landing)	06:04	01:04
178,432	Start Recording	06:25	01:25
178,933	Stopped Recording	06:33	01:33
178,940	Start Recording	12:10	07:10
179,059	Stopped Recording	12:12	07:12
179,068	Start Recording	17:36	12:36
179,129	Stopped Recording	17:37	12:37
179,140	Start Recording	17:42	12:42
179,569	Stopped Recording	17:49	12:49
179,580	Start Recording	19:35	14:35
179,755	Stopped Recording	19:38	14:38
179,764	Start Recording	19:49	14:49
179,924	End of FDR Recording	19:52	14:52

[2] 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 = +.

4.3. Time Correlation

Correlation of the FDR data from SRN to the local time, EST, from 179,764 SRN to the end of the recording was established by using the recorded Time GMT Hours and Time GMT Minutes and then applying an additional 5 hours offset to change GMT to EST. Since Time GMT Minutes is recorded every 4 seconds, the recorded GMT time has an accuracy of +/- 2 seconds.

Accordingly, the time offset for the event data from SRN to EST is the following: EST = SRN – 126,381 with a +/- 2 second accuracy for SRNs after 179,764 SRN. Times prior to 179,764 SRN are referenced as SRN with select recorded times provided in EST. [3]

4.4. FDR Plots and Corresponding Tabular Data

Figures 1 to 4 contain FDR data recorded during the rejected takeoff event on March 8, 2017. All the parameters listed in table A-1 are plotted except Time GMT Hours, Time GMT Minutes, and pressure altitude. Figure 5 contains FDR data that covers the previous landing to the end of the FDR recording.

Figures 1 and 2 cover the entire movement from 14:49:43 EST to the end of the FDR recording at 14:52:23 EST (the x-axis scale is from 14:49:40 EST to 14:52:25 EST). Figures 3 and 4 have expanded scales from 14:51:25 EST to the end of the FDR recording at 14:52:23 EST (the x-axis ends at 14:52:25 EST).

Figure 5 covers the previous landing until the end of the FDR recording and contains select parameters including pressure altitude. After the previous landing, the FDR stopped recording 6 times before the aircraft began taxiing to the departure runway at 14:49:43 EST. Therefore, the x-axis scale was left in SRN and is from 178,060 SRN to 179,980 SRN. The local times (recorded GMT time converted to EST) are annotated on figure 5 for each time the FDR stopped recording and started recording.

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 FDR data indicated during the previous landing that both the left and right elevators consistently moved together. After landing when the parking brake was applied, the FDR stopped recording at 1:04 EST (178,423 SRN).[4] At about 1:25 EST (178,432 SRN), the FDR started recording until 1:33 EST (178,933 SRN). During this time, the right elevator fluctuated between approximately -4 degrees (deg) and 7.5 degrees while the left elevator fluctuated between approximately -6 deg and -1 deg. The FDR started recording again at about 7:10 EST (178,940 SRN) until about 7:12 EST (179,059 SRN). During this time, the right elevator position was about 13 degrees (deg) and the left elevator was about -1.7 deg. Between 12:36 EST (179,068 SRN), when the FDR started recording again, until 14:38 EST (179,755 SRN), the FDR started recording and stopped recording two more times. During this time, the right elevator position was approximately -16.5 deg and the left

[3] The provided EST prior to 179,764 SRN are the recorded Time GMT Hours and Time GMT Minutes with a 5 hour offset applied.
[4] Month and day were not recorded.

elevator position fluctuated between -17 deg and 29 deg. At about 14:49 EST (179,764 SRN), the last time the FDR started recording before the rejected takeoff, until the end of the FDR data at 14:52:23 EST (179,924 SRN), the right elevator position remained at about -16.5 deg, moving to about -13.5 deg during the attempted rotation, while the left elevator position varied between -17 deg and 28 deg over the entire time period.

The corresponding tabular data used to create figures 1 to 4, including Time GMT Hours and Time GMT Minutes, are provided in electronic comma separated value *.csv format as attachment 1 to this report. Additionally, the corresponding tabular data used to create figure 5, including Time GMT Hours and Time GMT Minutes, are provided in electronic comma separated value *.csv format as attachment 2 to this report.

Figure 1. Plot of parameters during rejected takeoff (2 minute 45 second scale).

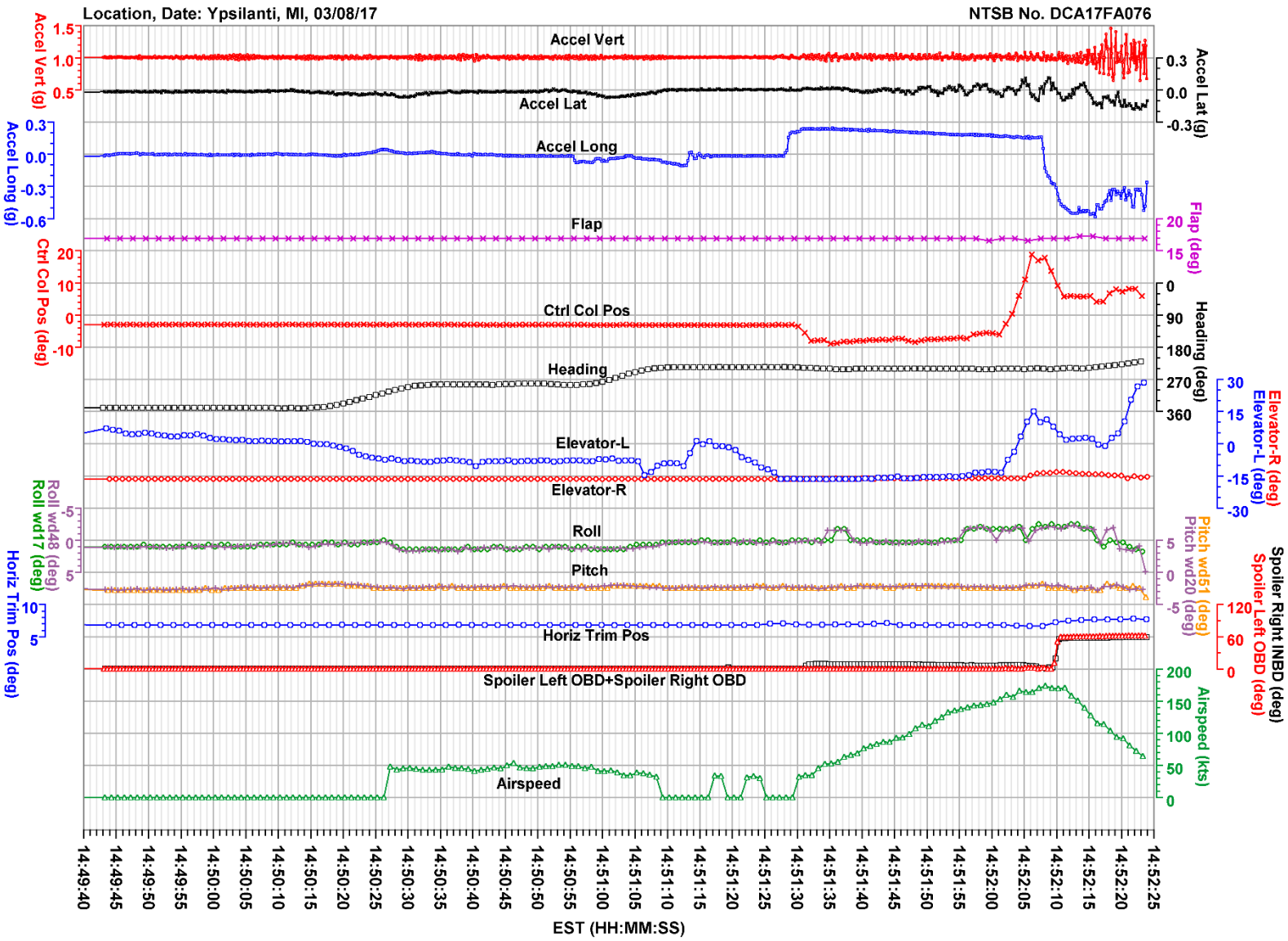


Figure 2. Plot of additional parameters during rejected takeoff (2 minute 45 second scale).

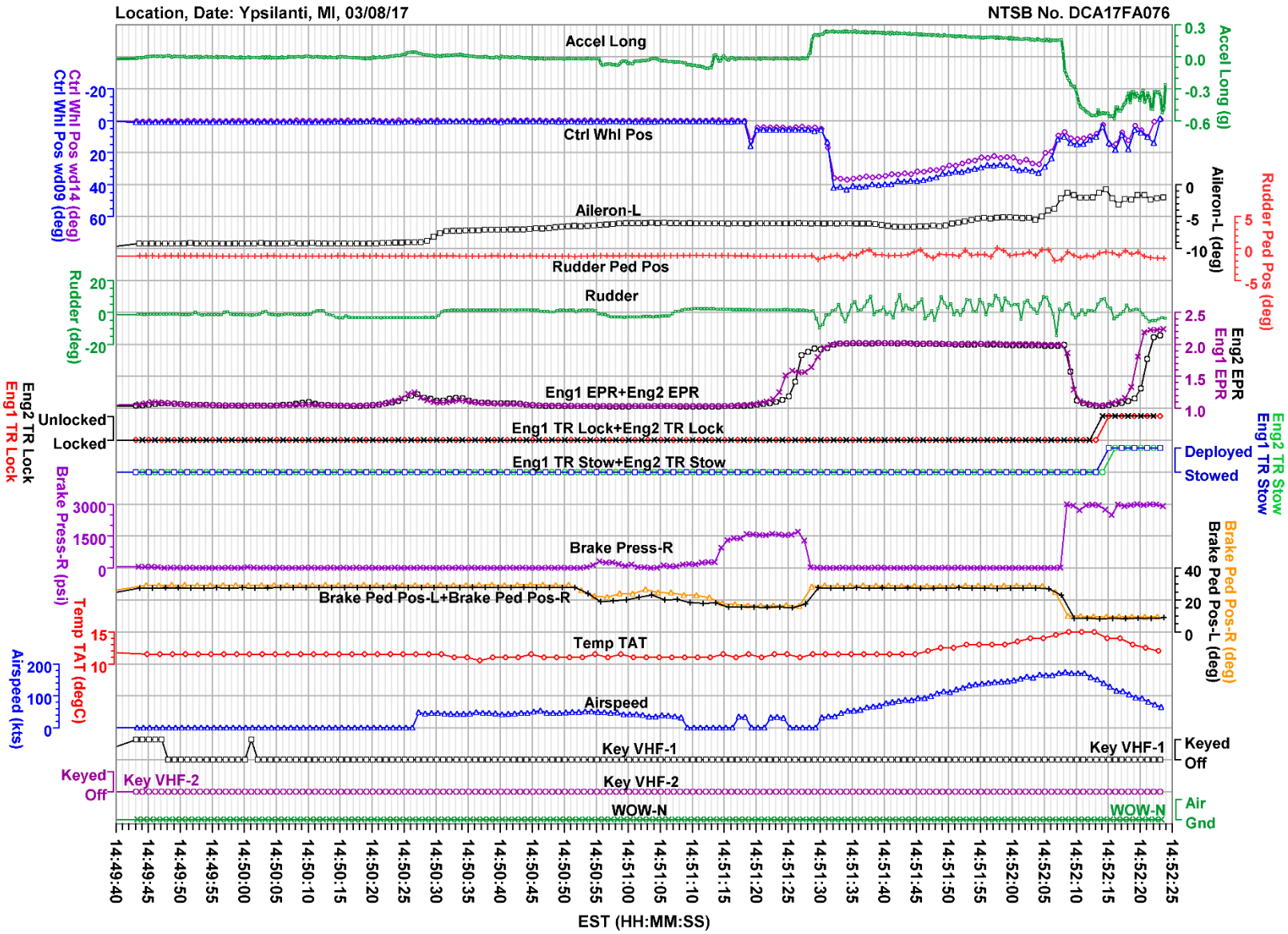


Figure 3. Plot of parameters during rejected takeoff (expanded scale).

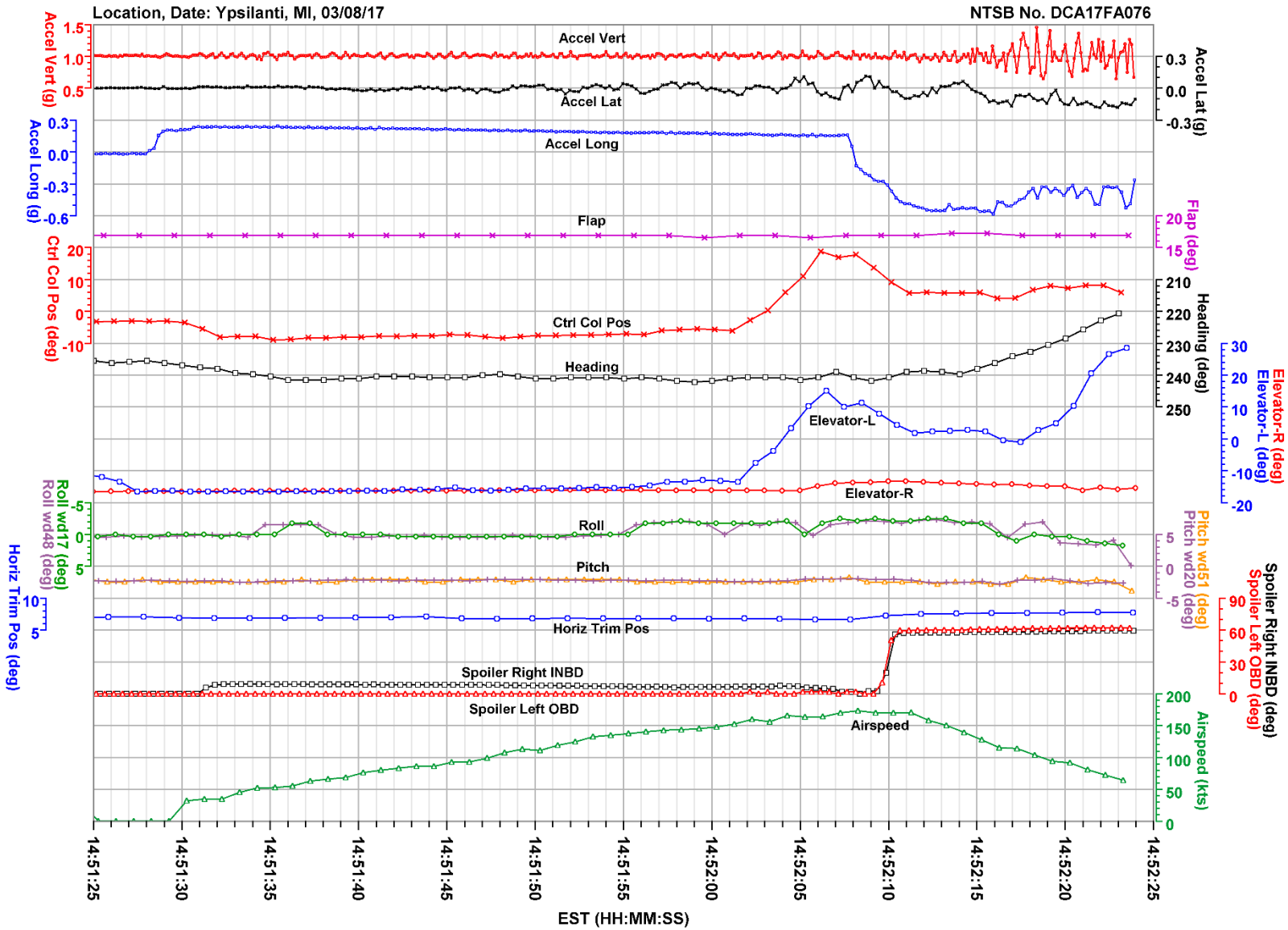


Figure 4. Plot of additional parameters during rejected takeoff (expanded scale).

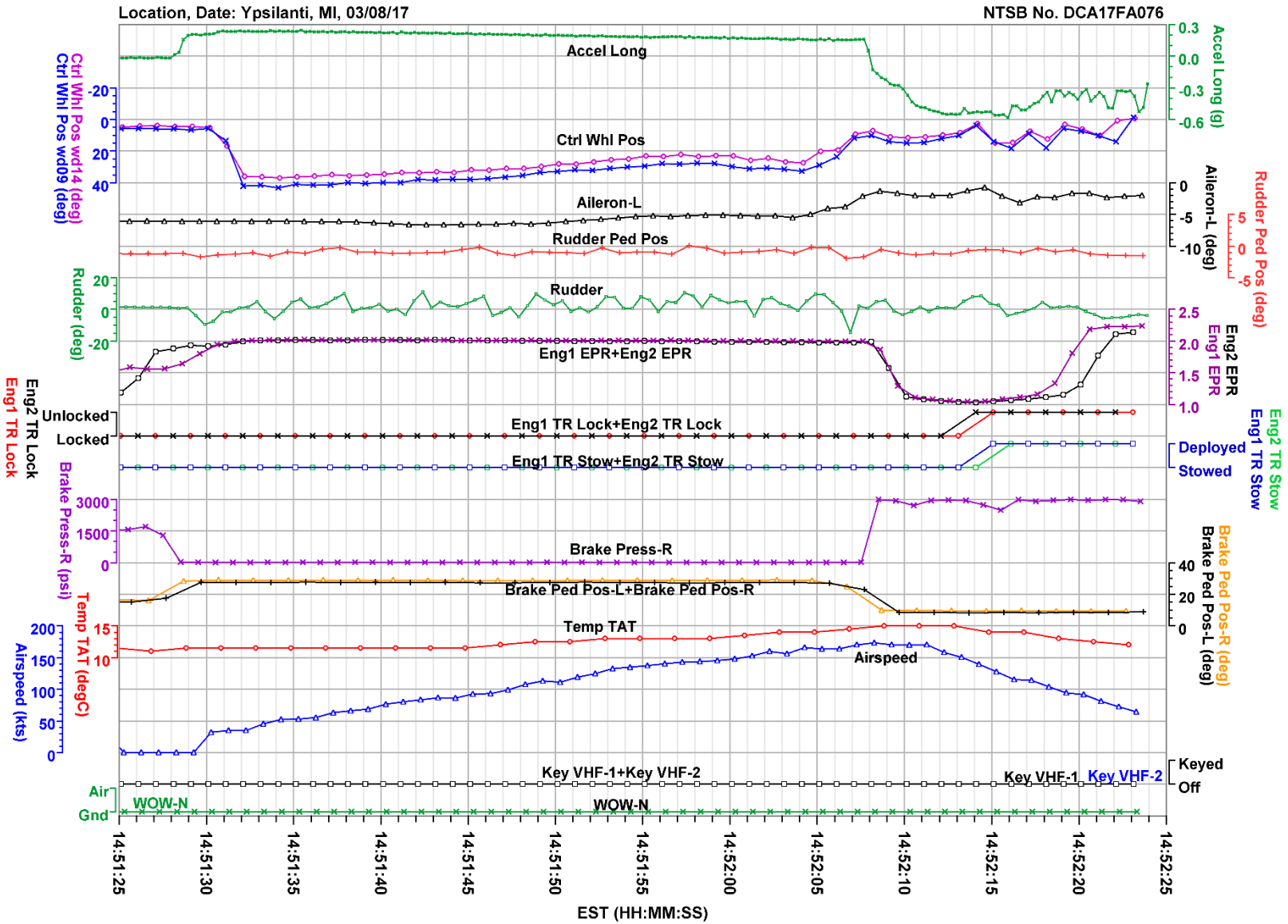
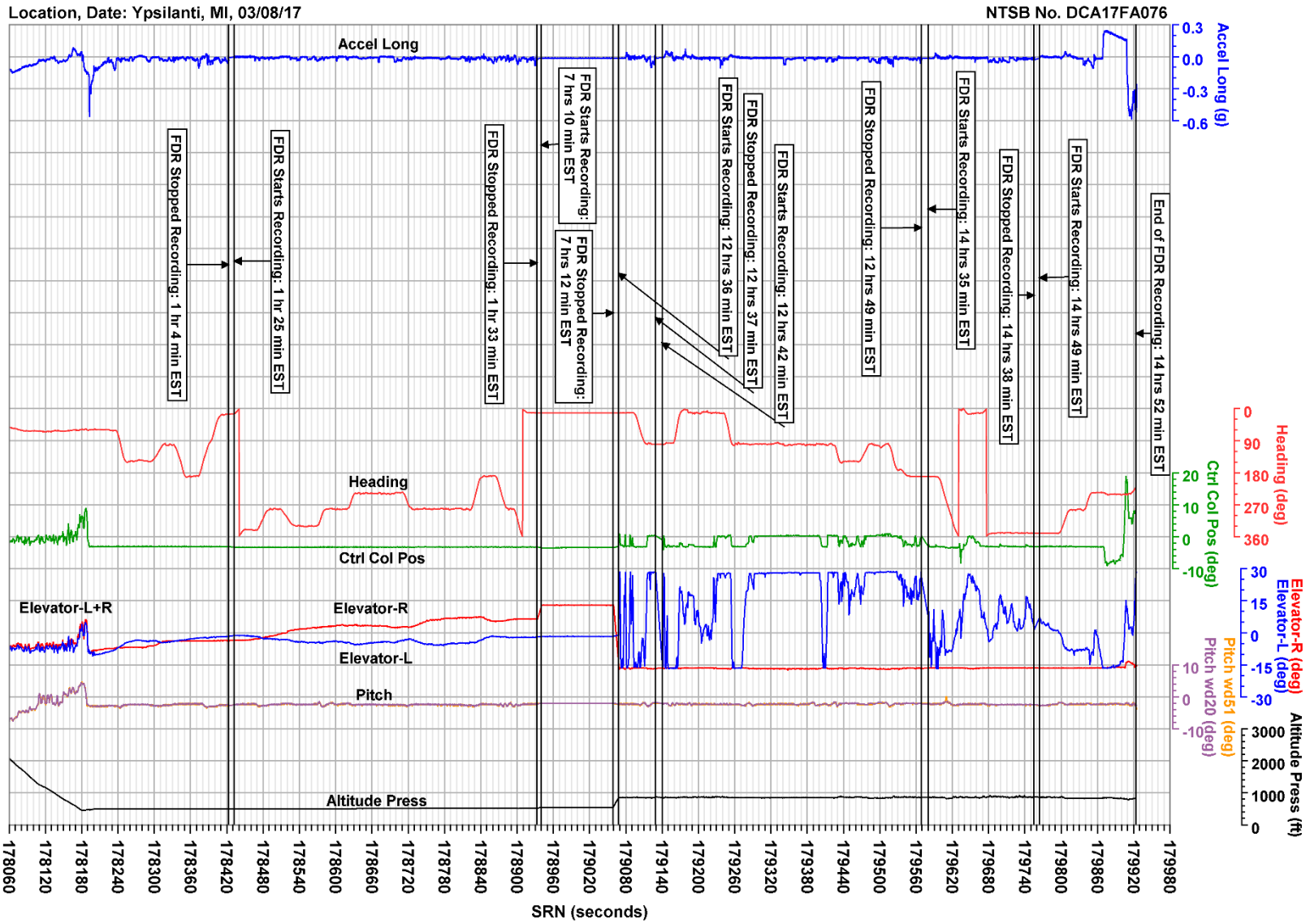


Figure 5. Plot of select parameters from previous landing until end of FDR recording.



APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the plot/table labels, descriptions, and units. Additionally, table A-2 describes the unit and discrete abbreviations used in this report.

Table A-1. Verified and provided FDR parameters.

Plot/Table Labels	Descriptions	Units
Accel Lat	Lateral Acceleration	g
Accel Long	Longitudinal Acceleration	g
Accel Vert	Vertical Acceleration	g
Aileron-L	Left Aileron Position	deg
Airspeed	Computed Airspeed	kts
Altitude Press	Pressure Altitude	ft
Brake Ped Pos-L	Left Brake Pedal Position	deg
Brake Ped Pos-R	Right Brake Pedal Position	deg
Brake Press-R	Left Brake Pressure	psi
Ctrl Col Pos	Control Column Position	deg
Ctrl Whl Pos wd09	Control Wheel Position	deg
Ctrl Whl Pos wd14	Control Wheel Position	deg
Elevator-L	Left Elevator Position	deg
Elevator-R	Right Elevator Position	deg
Eng1 EPR	Engine 1 Engine Pressure Ratio	
Eng1 TR Lock	Engine 1 Thrust Reversers Lock Status	
Eng1 TR Stow	Engine 1 Thrust Reversers Stowed Status	
Eng2 EPR	Engine 2 Engine Pressure Ratio	
Eng2 TR Lock	Engine 2 Thrust Reversers Lock Status	
Eng2 TR Stow	Engine 2 Thrust Reversers Stowed Status	
Flap	Flap Position	deg
Heading	Magnetic Heading	deg
Horiz Trim Pos	Horizontal Trim Position	deg
Key VHF-1	Microphone Keying-1	
Key VHF-2	Microphone Keying-2	
Pitch wd20	Pitch Angle	deg
Pitch wd51	Pitch Angle	deg
Roll wd17	Roll Angle	deg
Roll wd48	Roll Angle	deg
Rudder	Rudder Position	deg
Rudder Ped Pos	Rudder Pedal Position	deg
Spoiler Left OBD	Left Outboard Spoiler Position	deg
Spoiler Right INBD	Right Inboard Spoiler Position	deg
Temp TAT	Total Air Temperature	degC
Time GMT Hrs	Greenwich Mean Time Hours	hrs
Time GMT Min	Greenwich Mean Time Minutes	min
WOW-N	Nose Gear Weight on Wheels	

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 figure 5 and in the electronic data has not been corrected for the local altimeter setting at the time of the event.

NOTE: Except for engine pressure ratio (EPR), parameters with a blank unit description in table A-1 are discretes. 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.

NOTE: Wd stands for word location. Parameters designated with word locations are sampled twice a second. Normally, these parameters would be combined but the bit lengths are different; therefore, each parameter has a different conversion and the parameters are presented separately.

Table A-2. Unit and discrete abbreviations.

Unit and discrete Abbreviations	Descriptions
deg	degrees
degC	degrees Celsius
ft	feet
g	g
Gnd	ground
hrs	hours
kts	knots
min	minutes
psi	pounds per square inch