

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

February 21, 2020

Flight Data Recorder

Specialist's Factual Report
By Charles Cates

1. EVENT SUMMARY

Location: Burbank, California
Date: December 06, 2018
Aircraft: Boeing 737-700
Registration: N752SW
Operator: Southwest Airlines
NTSB Number: DCA19IA036

On December 6, 2018, about 0905 pacific standard time, Southwest Airlines flight 278, a Boeing 737-7H4, N752SW, overran runway 08 during the landing roll at Bob Hope Airport (KBUR), Burbank, California, and came to rest in the engineered materials arresting system (EMAS) at the departure end of the runway. None of the 117 passengers and crew onboard were injured and the airplane sustained minor damage. The regularly scheduled passenger flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 from Metropolitan Oakland International Airport (KOAK), Oakland, California to KBUR.

2. FLIGHT DATA RECORDER GROUP

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

3. FDR CARRIAGE REQUIREMENTS

The event aircraft, N752SW, was manufactured in November 1999, 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.

4. DETAILS OF FDR INVESTIGATION

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

Recorder Manufacturer/Model: **Honeywell 4700 256 wps**
Recorder Serial Number: **4546**

4.1. Honeywell 4700 256 wps 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. It is configured to record 256 12-bit words of digital information every second. Each grouping of 256 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 256-word intervals. Each data parameter (for example, altitude, heading, and airspeed) has a specifically assigned word number within the subframe. The SSFDR 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 using the manufacturer's standard procedures for data recovery.

4.1.2. Recording Description

The FDR recording contained approximately 27 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 52 minutes. The parameters evaluated for the purpose of this report appeared to be in accordance with federal FDR carriage requirements.

4.1.3. Engineering Units Conversions

The engineering unit 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, pacific standard time (PST), was established by using the recorded Time GMT² hours, Time GMT Minutes, and Time GMT Seconds and then applying an additional -8 hours offset to change GMT to PST.

Accordingly, the time offset for the event flight data from SRN to local PST is the following: $PST = SRN - 65,414.70625$. Therefore, for the rest of this report, all times are referenced as PST, not SRN.

4.3. FDR Plots and Corresponding Tabular Data

Figures 1 to 5 contain FDR data recorded during the event on December 6, 2018. All the parameters listed in table A-1 are plotted except Time GMT Hours, Time GMT Minutes, and Time GMT Seconds.

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).

Figure 1 is a plot of aircraft basic parameters from the full duration of the flight.

Figure 2 is a plot of aircraft basic parameters from the time that the aircraft captured the glideslope until the end of the recording.

Figure 3 is a plot of flight controls parameters from the time that the aircraft captured the glideslope until the end of the recording.

Figure 4 is a plot of parameters related to the deceleration of the aircraft from the time that the aircraft was 300 ft above ground level (AGL) until the end of the recording.

Figure 5 is a plot of aircraft and wind speeds and directions from the time that the aircraft was 300 ft AGL until the end of the recording.

The data show that the aircraft departed at about 8:10 PST for an approximately 52 minute flight on a southeasterly heading. The cruise portion of the flight was at 33,000 ft and about 269 knots computed airspeed for about 16 minutes.

During the descent accelerations consistent with light to moderate turbulence were recorded below 7,000 ft. At about 8:58 PST the aircraft turned on to its final heading and captured the glideslope and localizer. The aircraft began to descend, maintaining the glideslope. Final flaps were selected at 8:59 PST and the airspeed decelerated to 133-136 knots, while groundspeed was at 144-145 knots. FMC calculated Vref speed was 126 knots. With final flaps selected, pitch varied from +3.3 deg to -1.7 deg and roll varied by +/-3.3 deg.

The aircraft touched down at 9:02:35 PST at an airspeed of 126 knots and a groundspeed of 149 knots. Winds at touchdown were reported by the FMC to be 20 knots at 285 degrees. At touchdown, autobrakes, auto speedbrakes, and ground spoilers were all activated. Both thrust reversers transitioned and were fully deployed within 3 seconds of touchdown and engines spooled up with the thrust reversers deployed. Brake pressure reached its max of 3,000 psi in 7 seconds.

For the first 17 seconds following touchdown, the aircraft reached and maintained a deceleration rate of about 0.3 – 0.4 g. Groundspeed reached 44 knots in this time. For the next 5 seconds deceleration rate decreased to 0.15 to 0.2 g, slowing to a groundspeed of about 33 knots. Following this change the deceleration rate increased to its maximum of about 0.6 g until the aircraft stopped. The high rate was consistent with the aircraft decelerating in the EMAS.

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 figures 1 to 5, including Time GMT Hours, Time GMT Minutes, and Time GMT Seconds, are provided in electronic comma separated value (*.csv) format as attachment 1 to this report.

Figure 1. Plot of basic parameters during entire flight.

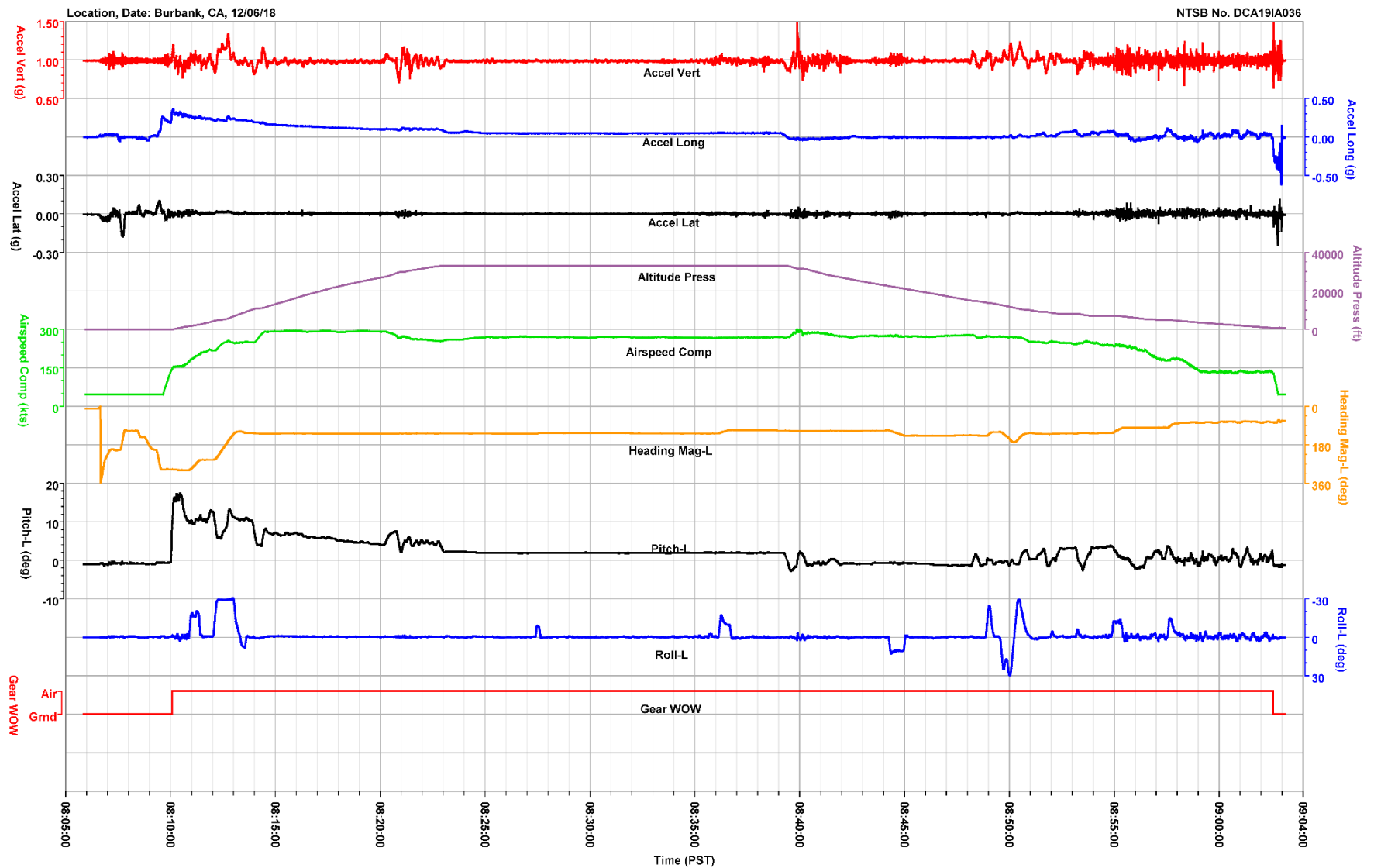
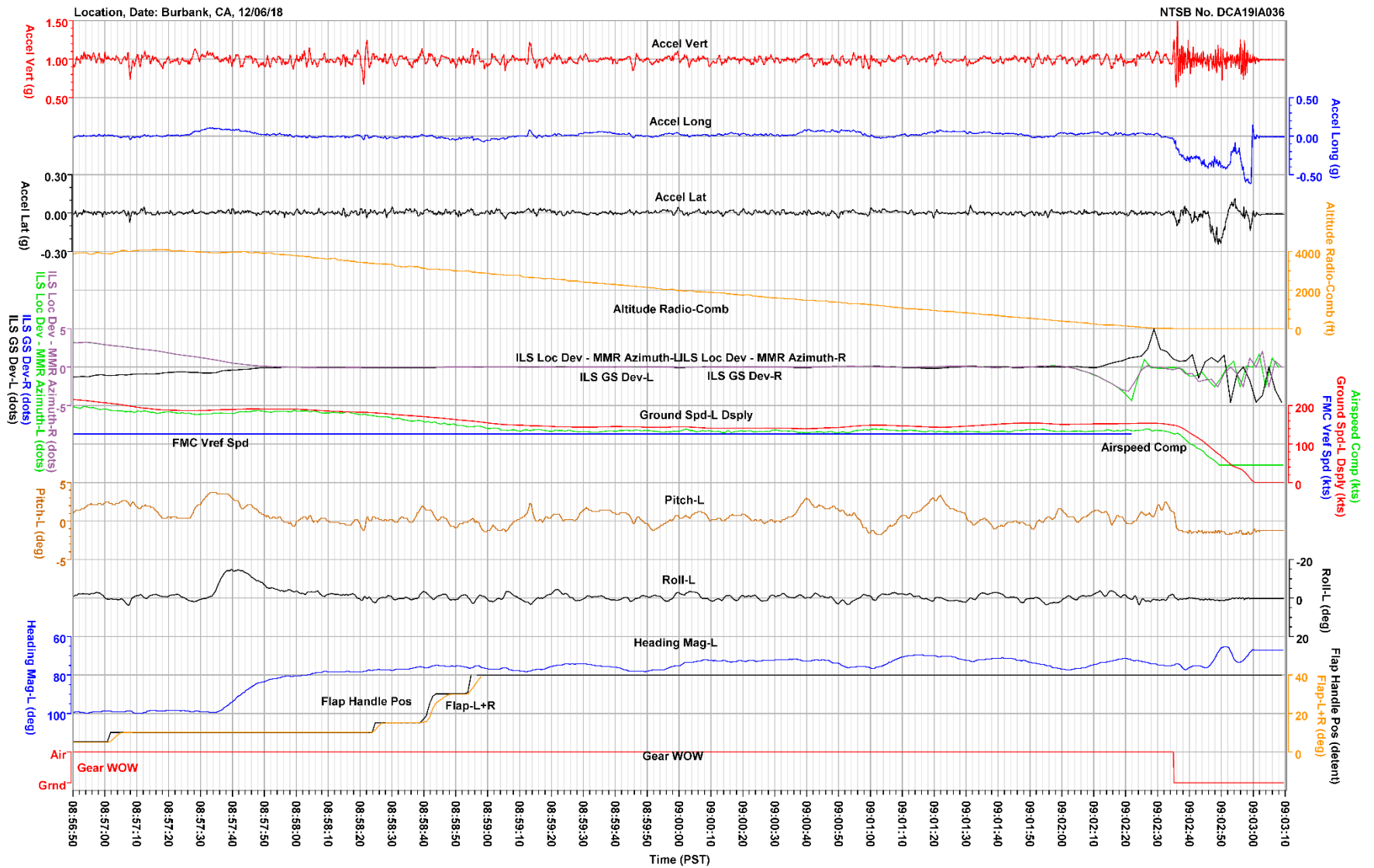


Figure 2. Basic parameters from glideslope capture until the end of the recording.



National Transportation Safety Board

Figure 3. Flight controls parameters from glideslope capture to the end of the recording.

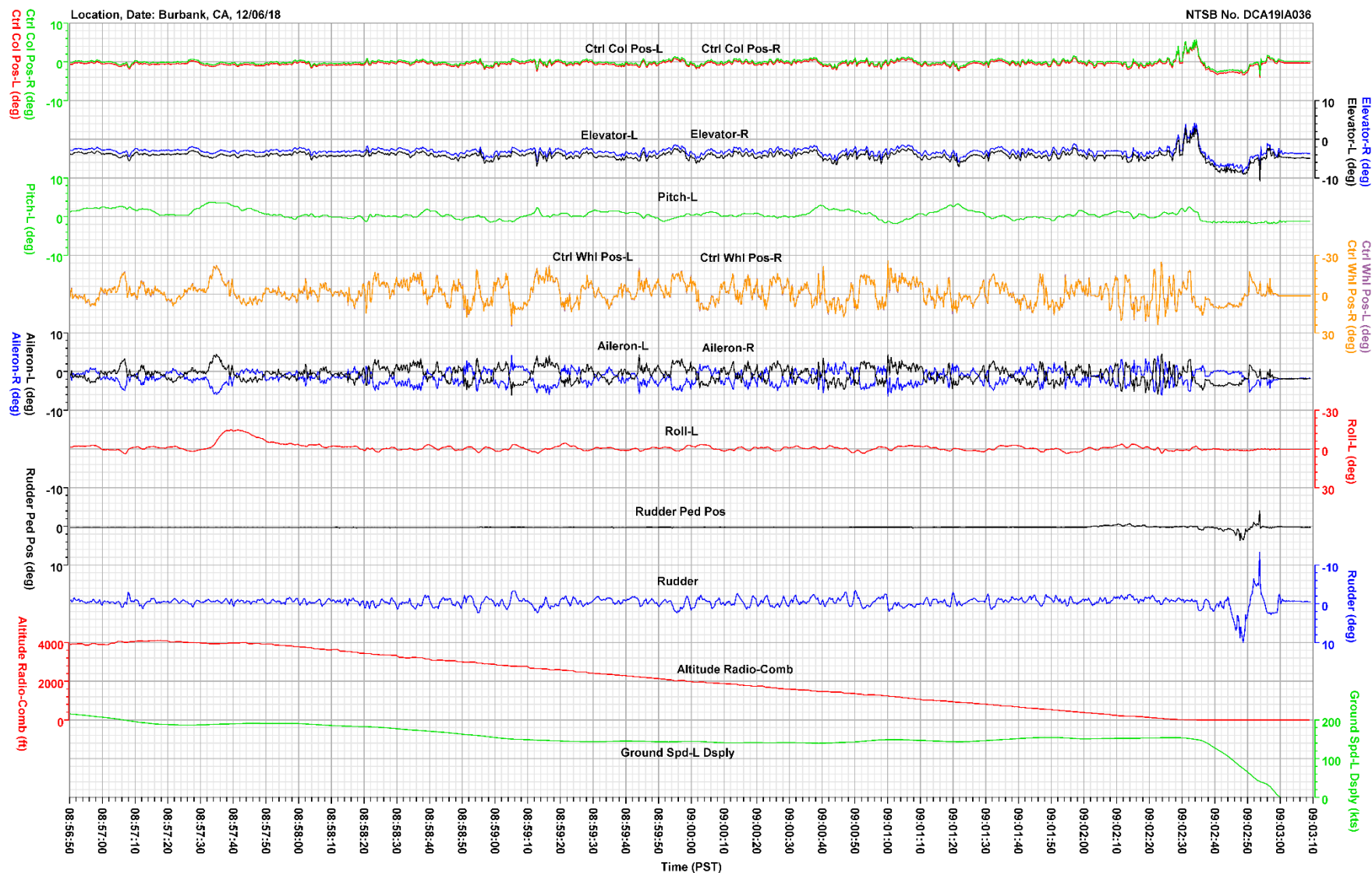
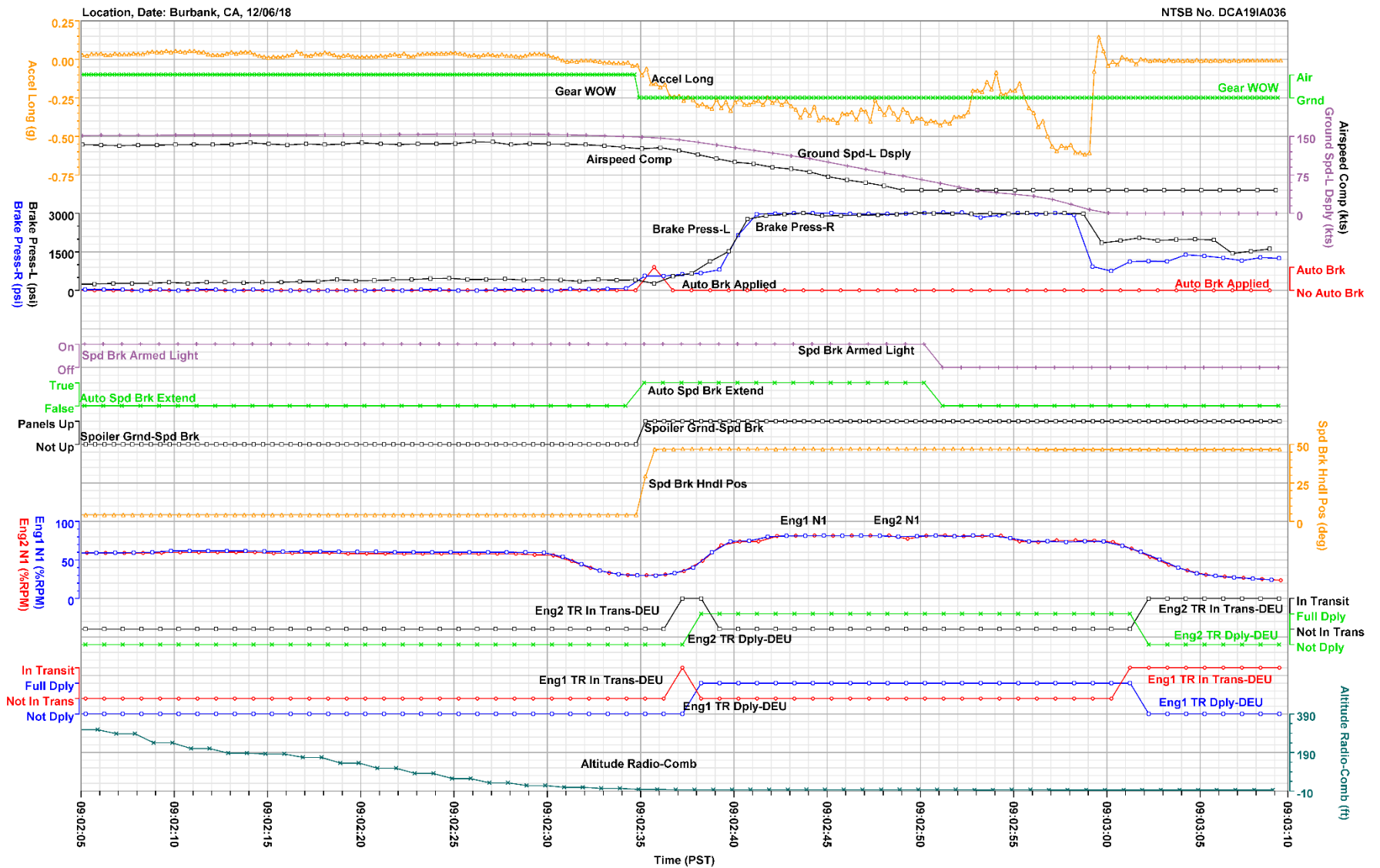
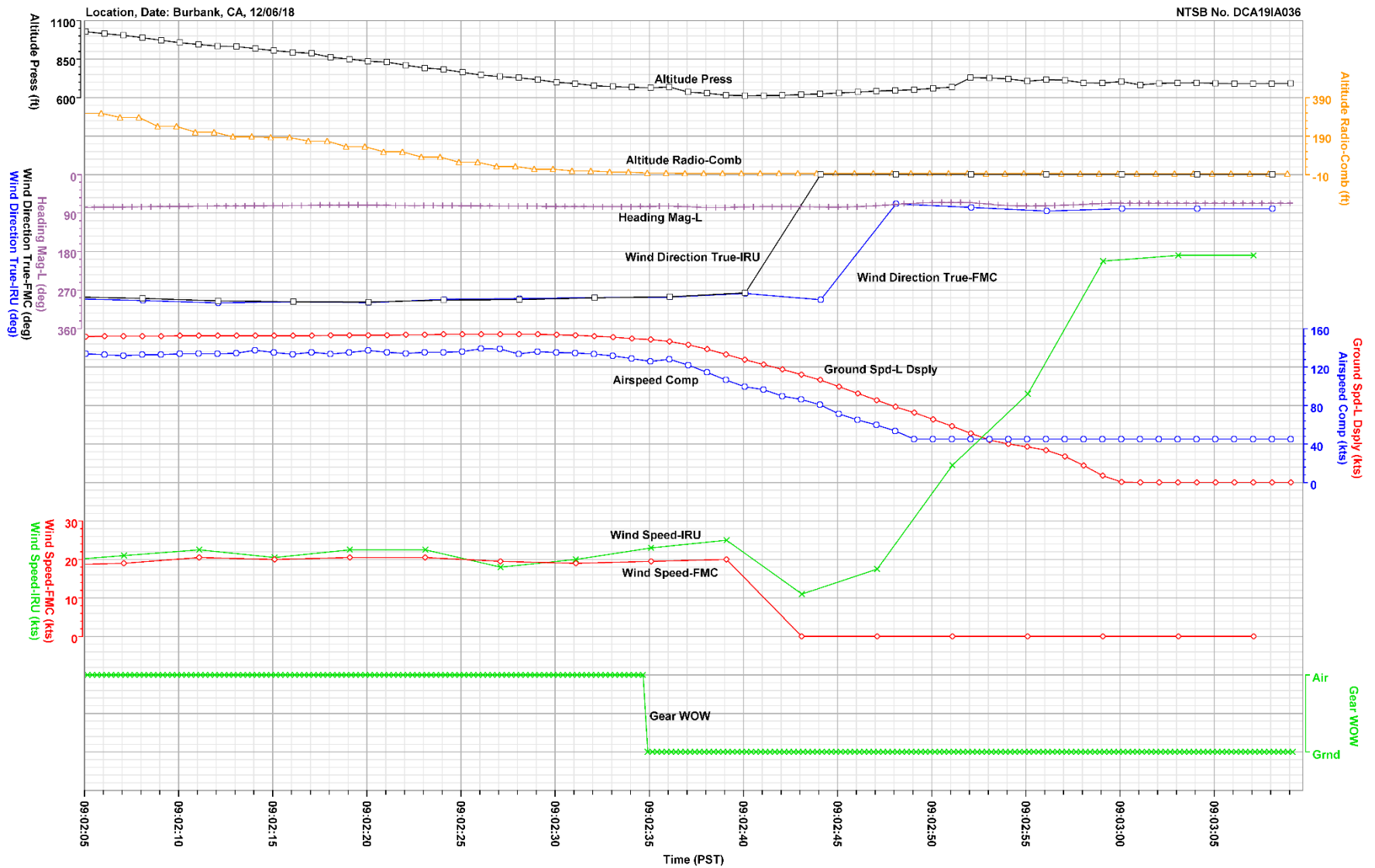


Figure 4. Parameters related to aircraft deceleration during landing rollout.



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Figure 5. Plot of aircraft and wind speeds and directions during final approach and landing rollout.



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APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the plot/table labels, parameter names, 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	Description	Units
Accel Lat	Lateral Acceleration	g
Accel Long	Longitudinal Acceleration	g
Accel Vert	Vertical Acceleration	g
Aileron-L	Left Aileron Position	deg
Aileron-R	Right Aileron Position	deg
Airspeed Comp	Computed Airspeed	kts
Altitude Press	Pressure Altitude	ft
Altitude Radio-Comb	Radio Altitude - Combined Sources	ft
Auto Brk Applied	Autobrake applied	
Auto Spd Brk Extend	Auto Speedbrake Extended	
Brake Press-L	Left Brake Pressure	psi
Brake Press-R	Right Brake Pressure	psi
Ctrl Col Pos-L	Left Control Column Position	deg
Ctrl Col Pos-R	Right Control Column Position	deg
Ctrl Whl Pos-L	Left Control Wheel Position	deg
Ctrl Whl Pos-R	Right Control Wheel Position	deg
Elevator-L	Left Elevator Position	deg
Elevator-R	Right Elevator Position	deg
Eng1 N1	Left Engine Fan Speed	%rpm
Eng1 TR Dply-DEU	Left Engine Thrust Reverser Deployed	
Eng1 TR In Trans-DEU	Left Engine Thrust Reverser In Transit	
Eng2 N1	Right Engine Fan Speed	%rpm
Eng2 TR Dply-DEU	Right Engine Thrust Reverser Deployed	
Eng2 TR in Trans-DEU	Right Engine Thrust Reverser In Transit	
Flap Handle Pos	Flap Handle Position	deg
Flap-L+R	Left and Right Flap Position	deg
FMC Vref Spd	FMC Calculated Vref Speed	deg
Gear WOW	Landing Gear Weight on Wheels	
Ground Spd-L Dsply	Displayed Groundspeed	kts
Heading Mag-L	Magnetic Heading	deg
ILS GS Dev-L	Left Glideslope Deviation	dots
ILS GS Dev-R	Right Glideslope Deviation	dots
ILS Loc Dev - MMR Azimuth L	Left Localizer Deviation	dots
ILS Loc DEV - MMR Azimuth R	Right Localizer Deviation	dots
Pitch-L	Pitch Angle	deg
Roll-L	Roll Angle	deg

Plot/Table Labels	Description	Units
Rudder	Rudder Position	deg
Rudder Ped Pos	Rudder Pedal Position	deg
Spd Brk Armed Light	Speed Brake Armed Annunciator Light	
Spd Brk Hndl Pos	Speed Brake Handle Position	deg
Spoiler Grnd-Spd Brk	Ground Spoilers Extended	
Time GMT Hrs	Greenwich Mean Time Hours	hrs
Time GMT Min	Greenwich Mean Time Minutes	min
Time GMT Sec	Greenwich Mean Time Seconds	sec
Wind Direction True-FMC	FMC Calculated Wind Direction	deg
Wind Direction True-IRU	IRU Calculated Wind Direction	deg
Wind Speed-FMC	FMC Calculated Wind Speed	kts
Wind Speed-IRU	IRU Calculated Wind Speed	kts

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

NOTE: 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.

Table A-2. Unit and discrete abbreviations.

Units and Abbreviations	Description
deg	degrees
kts	knots
ft	feet
psi	pounds per square inch
rpm	revolutions per minute
hrs	hours
min	minutes
sec	seconds
FMC	Flight Management Computer
IRU	Intertial Reference Unit
Dsply	Displayed
Vref	Reference Speed
Dply	Deployed