

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR22LA284

FLIGHT DATA RECORDER

Specialist's Factual Report

May 31, 2023

A. ACCIDENT

Location: San Francisco, California
Date: July 27, 2022
Time: 12:40 Pacific daylight time (PDT)
19:40 coordinated universal time (UTC)
Airplane: Bombardier BD-100-1A10 (Challenger 300), XO Jet, N557XJ

B. FLIGHT DATA RECORDER SPECIALIST

Specialist: Steven Smith
Mechanical Engineer (Recorder Specialist)
National Transportation Safety Board (NTSB)

C. FEDERAL CARRIAGE REQUIREMENTS

The event aircraft, N557XJ, was operating as Title 14 *Code of Federal Regulations* Part 91 such that it was not required to be equipped with a flight data recorder (FDR).

D. DETAILS OF THE INVESTIGATION

An FDR group was not convened. NTSB Vehicle Recorder Division received the following FDR:

Recorder Manufacturer/Model: L-3/Fairchild FA2100
Part Number: 2100-2043-00
Recorder Serial Number: 000293110

1.0 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 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, airspeed) has a specifically assigned word number within the subframe. The FA2100 is designed to meet the crash-survivability requirements of TSO-C124a.

1.1 Recorder Condition

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

1.2 Recording Description

The FDR recording contained approximately 74 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 36 minutes.

1.2.1 Engineering Unit 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 1 lists the FDR parameters verified and provided in this report. Additionally, table 2 describes the unit and discrete state abbreviations used in this report.

1.3 Time Correlation

Correlation of the FDR data from SRN to the event local time, PDT, was established by using the recorded UTC Hours, UTC Minutes, and UTC Seconds and then applying an additional 7 hours offset to change UTC to PDT.

Accordingly, the time offset for the event flight data from SRN to local PDT is the following: $PDT = SRN - 206051$. Therefore, for the rest of this report, all times are referenced as PDT, not SRN.

E. FIGURES AND TABULAR DATA

Figures 1 to 10 contain FDR data recorded during the event on July 27, 2022. All the parameters listed in table 1 are plotted except UTC Hours, UTC Minutes, UTC Seconds, Latitude, Longitude, Key VHF-1, and Key VHF-2.

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 = +, Right Rudder = +.

Figures 1 to 3 present all the same basic aircraft parameter time history plots for the entire flight, nine-minute window leading up to the accident, and a two-minute window encompassing the accident, respectively.

Figures 4 to 6 present all the same engine data time history plots for the entire flight, nine-minute window leading up to the accident, and a two-minute window encompassing the accident, respectively.

Figures 7 and 8 present time history plots for pilot control actions for the entire flight and a 15-minute window surrounding the accident, respectively.

Figure 9 is a three minute and 15 second time history plot of the flight control surfaces during the accident portion of the flight.

Figure 10 is a graphical overlay generated using Google Earth showing the entire flight. Weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the 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 accident aircraft departed runway 28R at San Francisco International Airport (SFO) at 12:30:51 PDT. As the aircraft climbed, the magnetic heading changed from 282 degrees to 54 degrees (right turn). At 12:32:19 the autopilot was engaged while the aircraft was at 4,265 ft pressure altitude, 220 knots (kts) indicated airspeed (244 kts ground speed), and a magnetic heading of 54 degrees. At 12:32:24, six seconds after the autopilot was engaged, the master caution activated (for 5 seconds). The autopilot remained engaged, and master caution was active again at 12:32:38 (for 6 seconds). At 12:36:39, both the Master Disconnect parameter and the Automatic Flight Control System (AFCS) Abnormal Disconnect parameter changed from "Not Disconnected" to "Disconnected." At this time, vertical acceleration increased from 0.985 g's to 2.221 g's in less than a second. At 12:36:40, the autopilot was disengaged. Vertical acceleration (sampled 8 times a second) reached -0.426 g's during this second. At 12:36:41, vertical acceleration was 2.096 g's and reduced within the second to 0.176 g's. The autopilot remained off for the remainder of the flight. At 12:36:48, the pilot and copilot manual trim enabled was active seven times within the minute. For each occurrence where the pilot manual trim enabled was active, a respective pitch trim command nose down flag was active. At each occurrence, the stabilizer trimmed nose down.

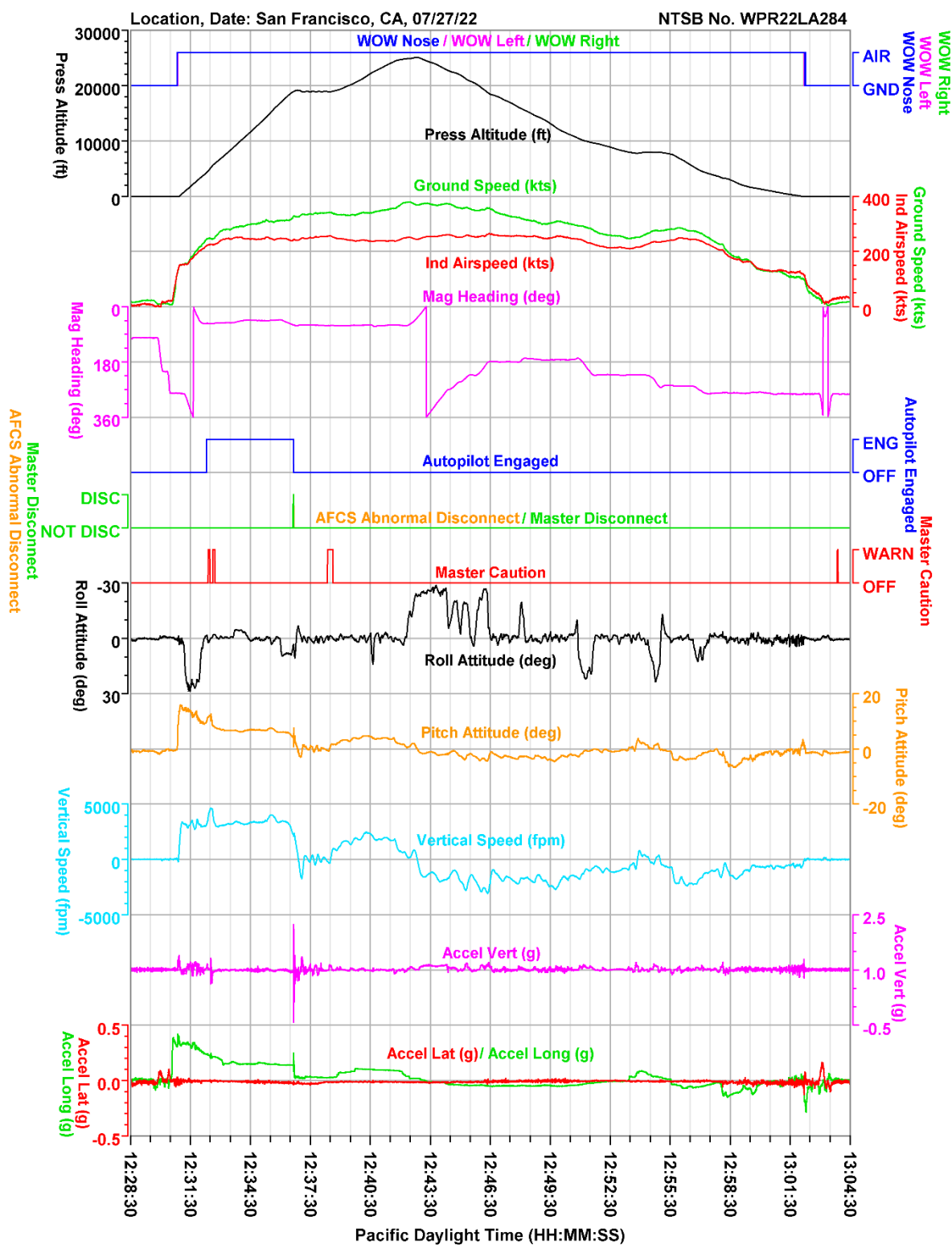
At 12:38:21 PDT, the right primary flight display (PFD) flag showed it failed (for 3 seconds). At 12:38:22, the master caution activated for 16 seconds. At 12:39:08, the right multi-function display (MFD) flag showed it failed for 14 seconds. At 12:42:50, the left MFD flag showed it had failed and remained in this state for the rest of the

flight. At this time, the aircraft began altering its heading to return to SFO airport. The remainder of the flight was uneventful. At 13:02:12 the weight on wheels on the left and right main landing gear registered a change from "AIR" to "GND." The aircraft landed on runway 28R without incident and taxied normally off the runway.

The corresponding tabular data used to create figures 1 to 10, including UTC Hours, UTC Minutes, UTC Seconds, Latitude, Longitude, Key VHF-1, and Key VHF-2, are provided in electronic comma separated value (CSV) format as attachment 1 to this report.

Submitted by:

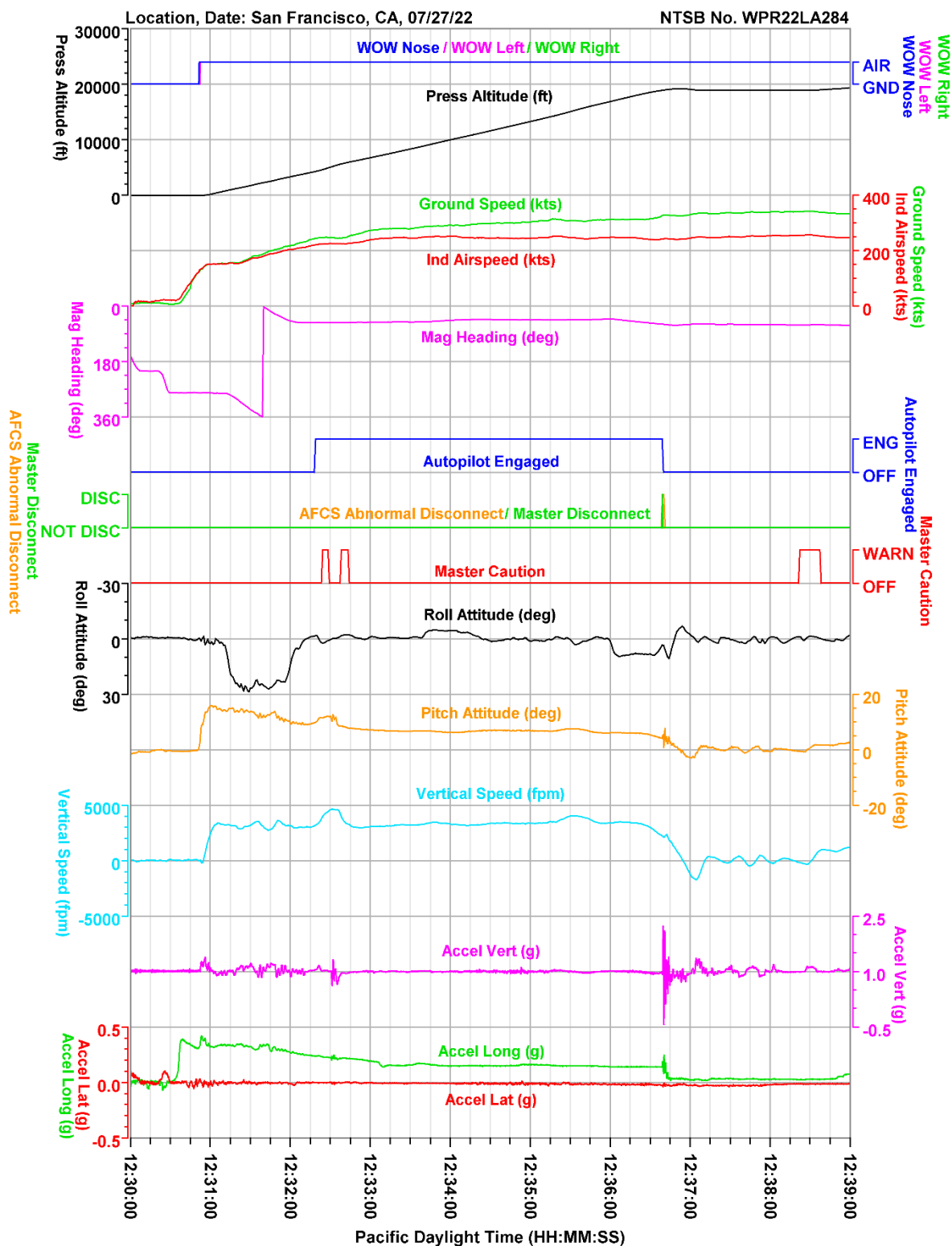
Steven Smith
Mechanical Engineer (Recorder Specialist)



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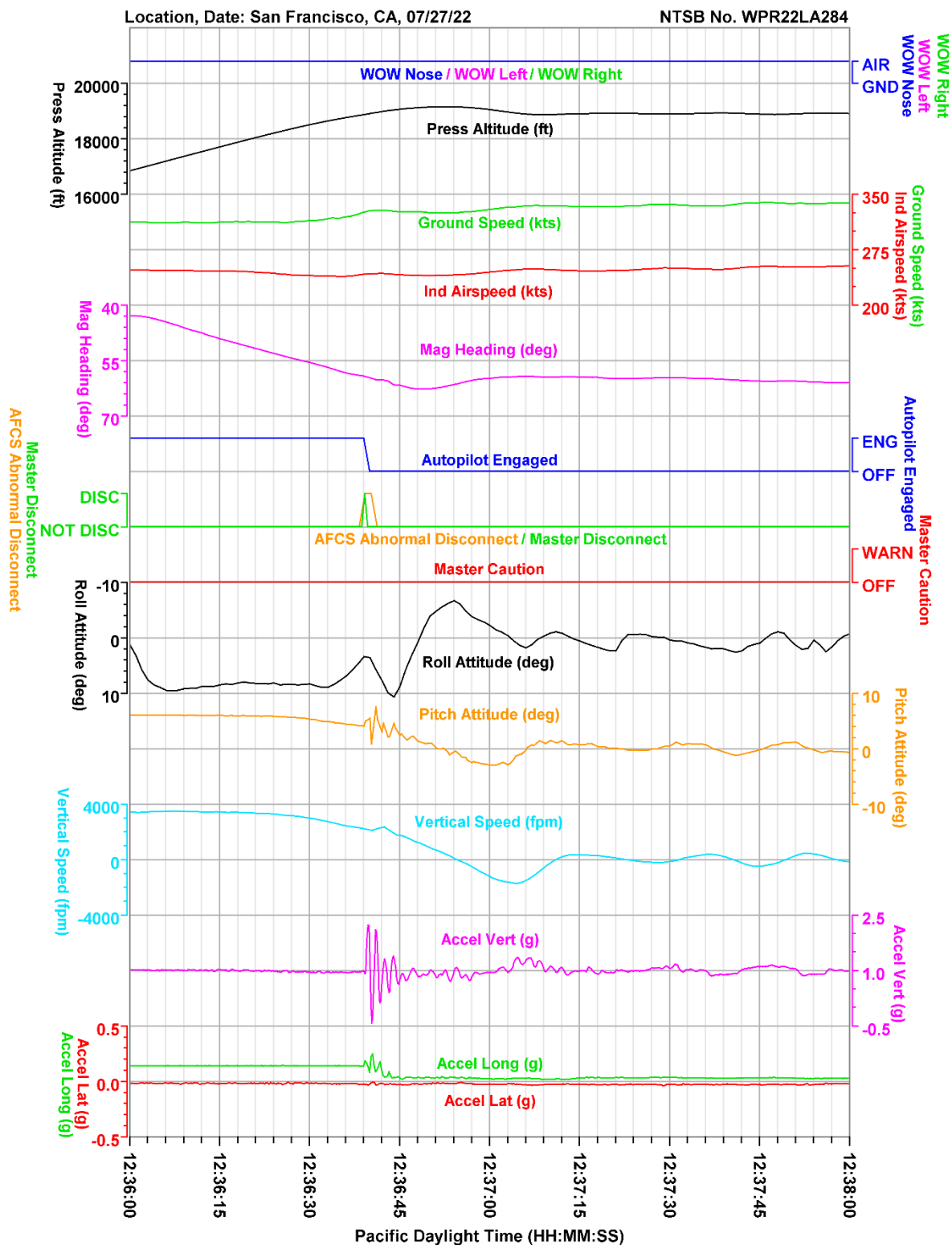
Figure 1. Time history plot of the entire flight with basic aircraft parameters.



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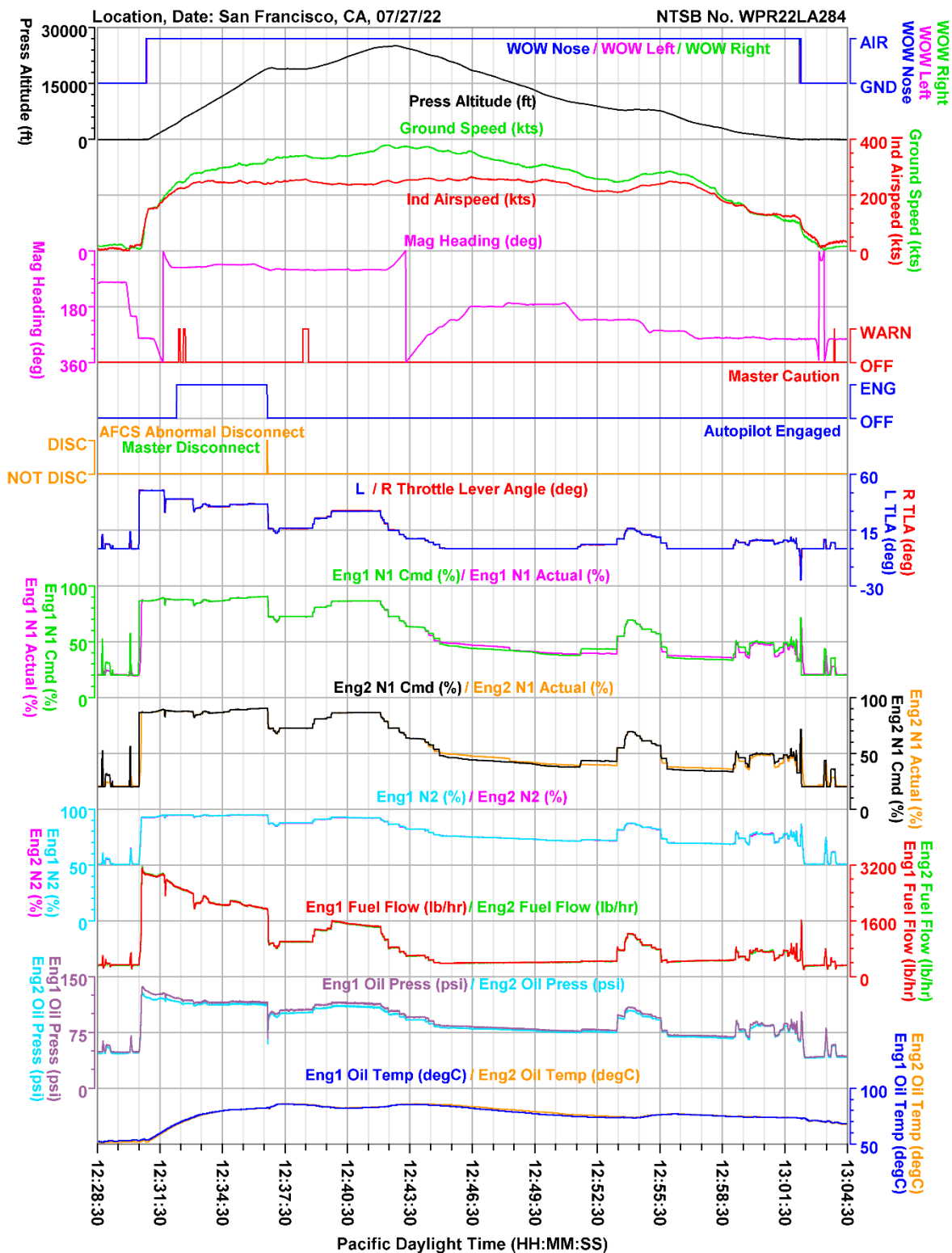
Figure 2. Nine-minute time history plot surrounding the accident with basic aircraft parameters.



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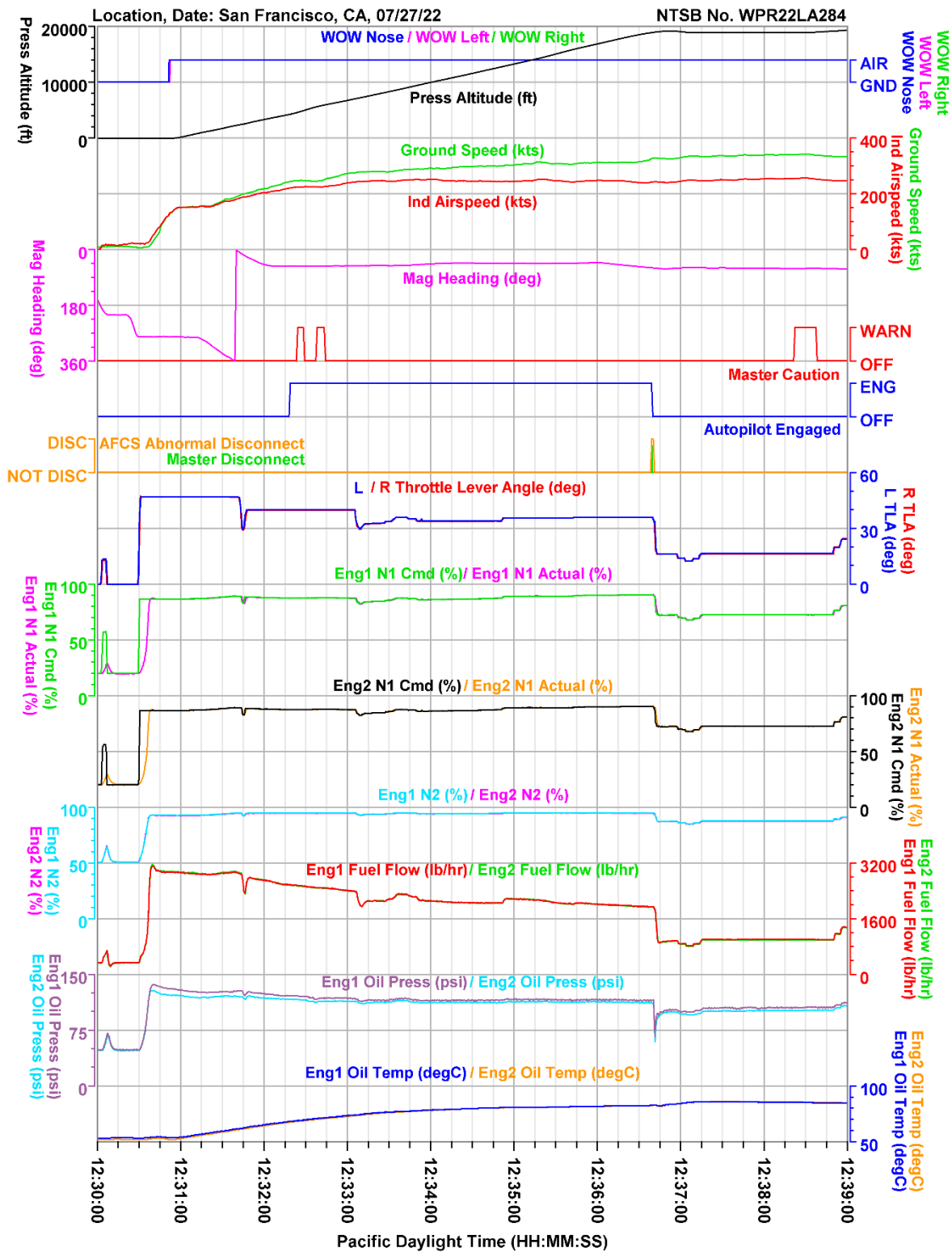
Figure 3. Two-minute time history plot surrounding the accident with basic aircraft parameters.



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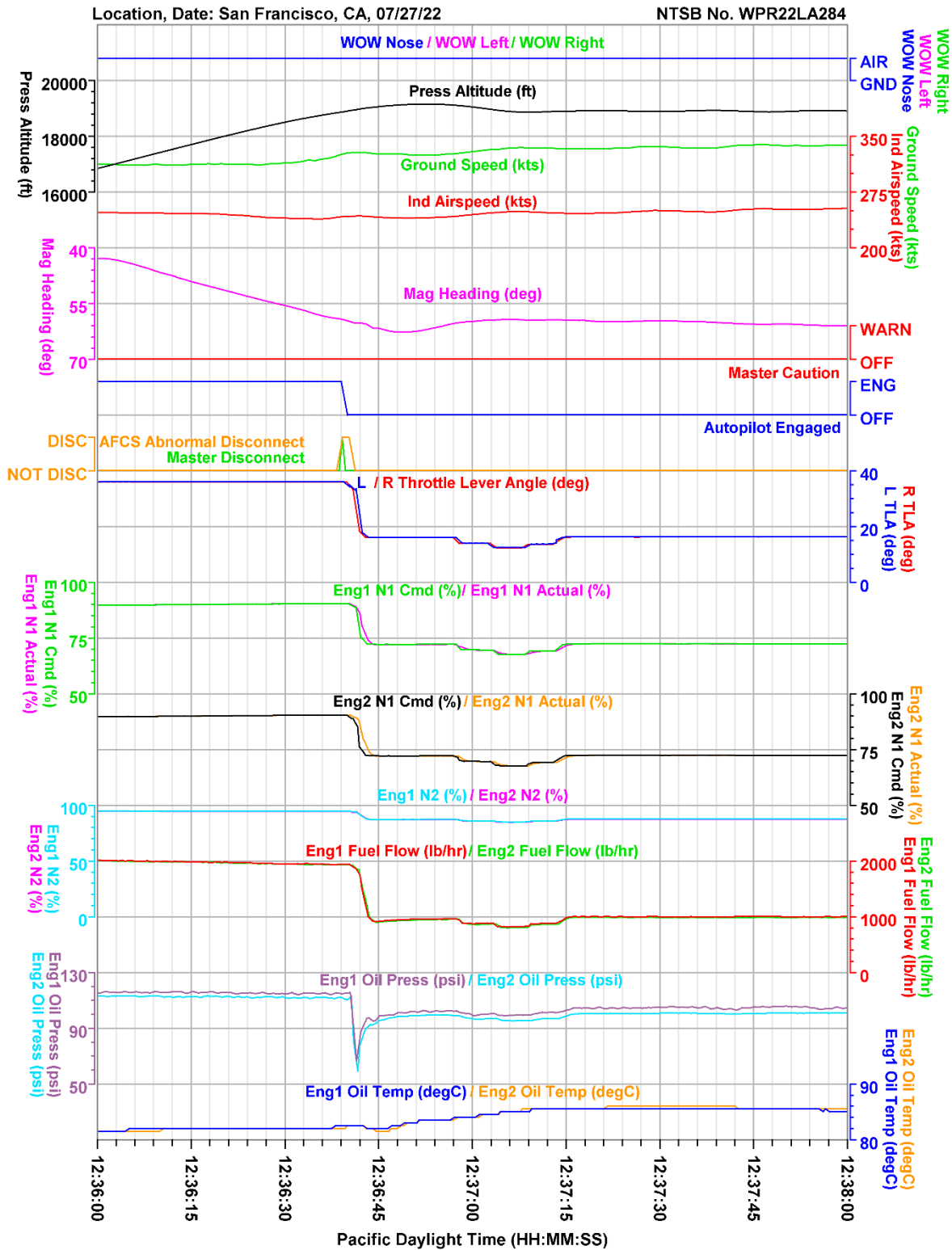
Figure 4. Time history plot of the entire flight with engine parameters.



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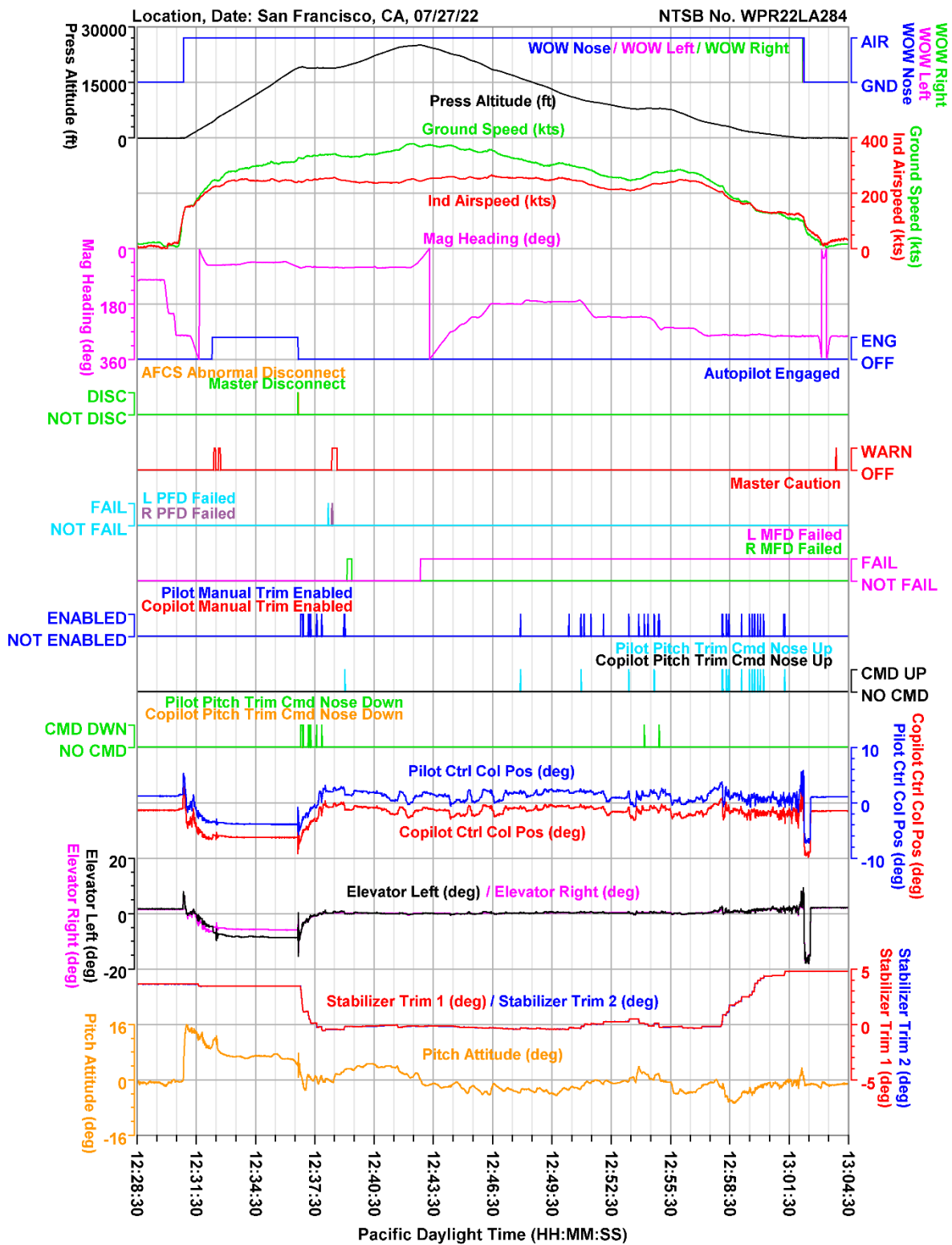
Figure 5. Nine-minute time history plot surrounding the accident with engine parameters.



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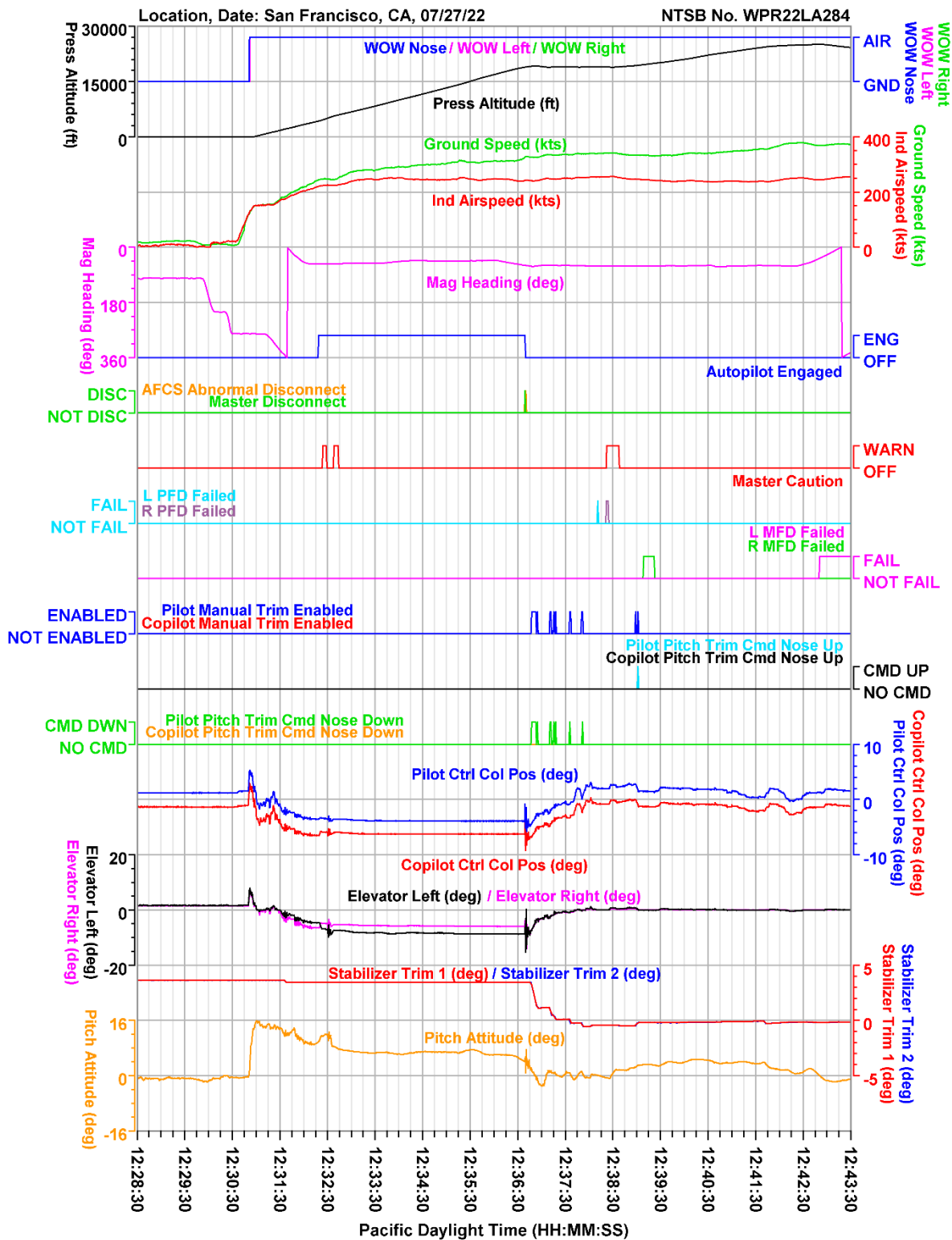
Figure 6. Two-minute time history plot surrounding the accident with engine parameters.



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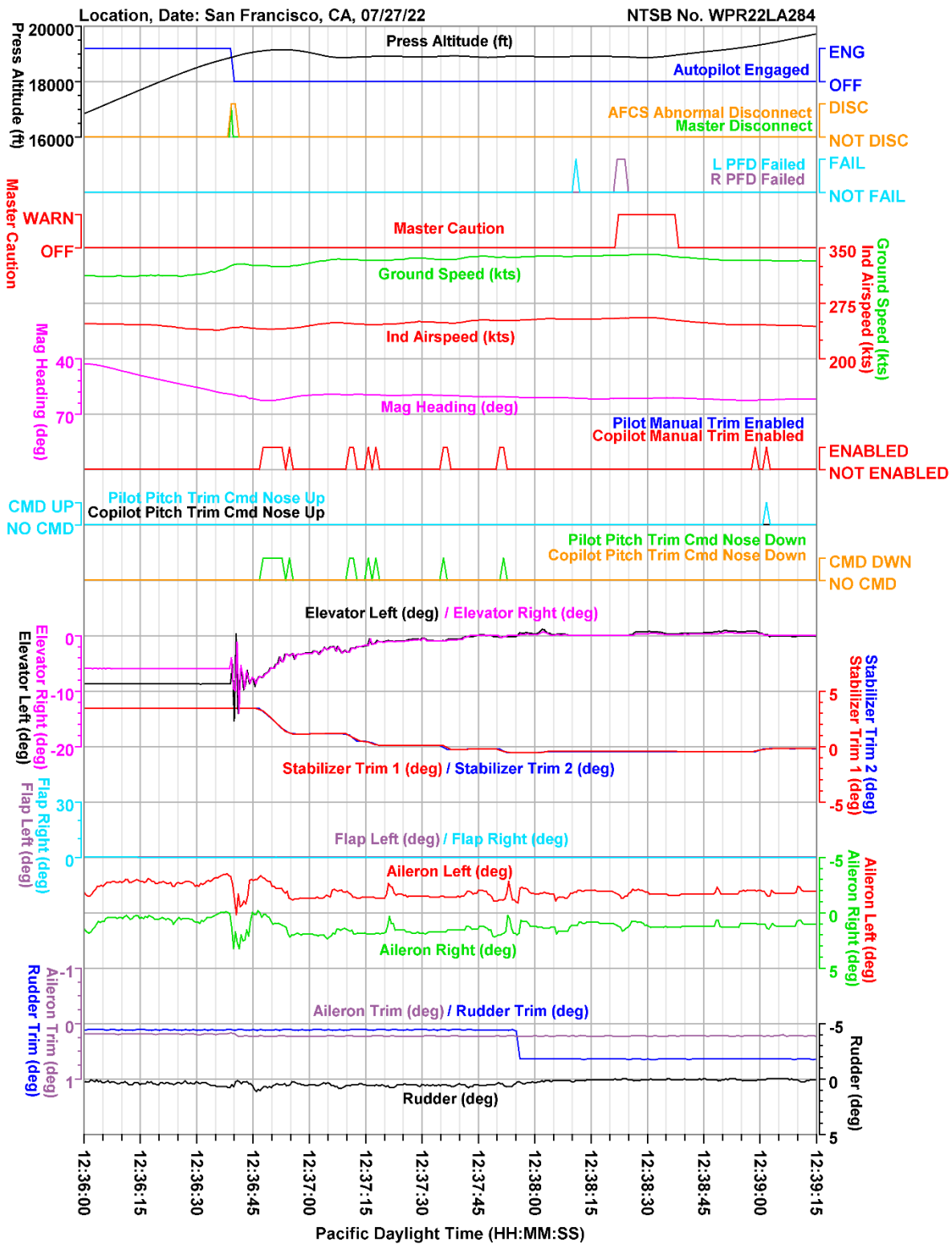
Figure 7. Time history plot of the entire flight with Pilot and Copilot controls.



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Figure 8. Fifteen-minute time history plot of zoomed portion of the Pilot and Copilot controls.



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Figure 9. Three minute 15 second time history plot of flight controls and various pitch trim commands.

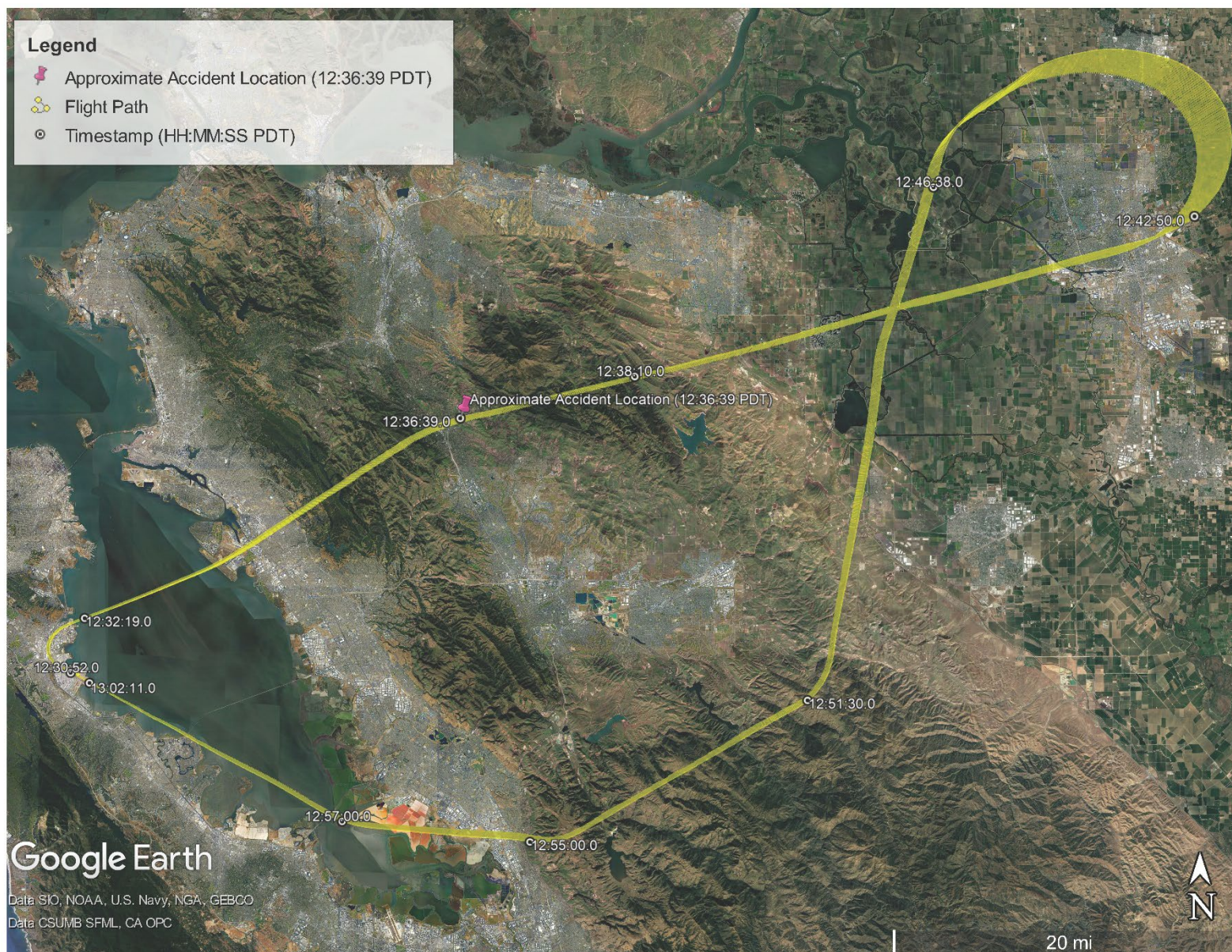


Figure 10. Google Earth overlay of the entire accident flight route.

APPENDIX A. VERIFIED AND PROVIDED PARAMETERS

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

Table 1. Verified and provided FDR parameters.

Plot/Table Labels	Parameter Names	Units
Accel Lat	Lateral Load Factor	g
Accel Long	Longitudinal Load Factor	g
Accel Vert	Vertical Load Factor	g
AFCs Abnormal Disconnect	Automatic Flight Control System Abnormal Disconnect	
Aileron Left	Left Aileron Surface Position	deg
Aileron Right	Right Aileron Surface Position	deg
Aileron Trim	Aileron Trim	deg
Autopilot Engaged	Autopilot Engaged	
Copilot Ctrl Col Pos	Copilot Control Column Position	deg
Copilot Manual Trim Enabled	Copilot Manual Trim Enabled	
Copilot Pitch Trim Cmd Nose Down	Copilot Commanding Pitch Trim Nose Down	
Copilot Pitch Trim Cmd Nose Up	Copilot Commanding Pitch Trim Nose Up	
Elevator Left	Left Elevator Surface Position	deg
Elevator Right	Right Elevator Surface Position	deg
Eng1 Fuel Flow	Engine 1 Fuel Flow	lb/hr
Eng1 N1 Actual	Engine 1 Fan Speed Actual	%
Eng1 N1 Cmd	Engine 1 Fan Speed Command	%
Eng1 N2	Engine 1 Core Speed	%
Eng1 Oil Press	Engine 1 Oil Pressure	psi
Eng1 Oil Temp	Engine 1 Oil Temperature	degC
Eng2 Fuel Flow	Engine 2 Fuel Flow	lb/hr
Eng2 N1 Cmd	Engine 2 Fan Speed Command	%
Eng2 N1 Actual	Engine 2 Fan Speed Actual	%
Eng2 N2	Engine 2 Core Speed	%
Eng2 Oil Press	Engine 2 Oil Pressure	psi
Eng2 Oil Temp	Engine 2 Oil Temperature	degC
Flap Left	Left Flap Surface Position	deg
Flap Right	Right Flap Surface Position	deg
Ground Speed	Ground Speed	kts
Ind Airspeed	Indicated Airspeed	kts
Key VHF-1	Microphone Keying-1	
Key VHF-2	Microphone Keying-2	
L MFD Fail	Left Multi-Function Display Failure	
L PFD Fail	Left Primary Flight Display Failure	
L TLA	Left Throttle Lever Angle	deg
Latitude	Latitude Coordinate	deg
Longitude	Longitude Coordinate	deg
Mag Heading	Magnetic Heading	deg
Master Caution	Master Caution	

Plot/Table Labels	Parameter Names	Units
Master Disconnect	Master Disconnect button on Control Wheel	
Pilot Ctrl Col Pos	Pilot Control Column Position	deg
Pilot Manual Trim Enabled	Pilot Manual Trim Enabled	
Pilot Pitch Trim Cmd Nose Down	Pilot Commanding Pitch Trim Nose Down	
Pilot Pitch Trim Cmd Nose Up	Pilot Commanding Pitch Trim Nose Up	
Pitch Attitude	Pitch Angle	deg
Press Altitude	Pressure Altitude	ft
R MFD Fail	Right Multi-Function Display Failure	
R PFD Fail	Right Primary Flight Display Failure	
R TLA	Right Throttle Lever Angle	deg
Roll Attitude	Roll Angle	deg
Rudder	Rudder Position	deg
Rudder Trim	Rudder Trim	deg
Stabilizer Trim 1	Stabilizer Trim Position 1	deg
Stabilizer Trim 2	Stabilizer Trim Position 2	deg
Time UTC-Hr	Coordinated Universal Time Hour	hrs
Time UTC-Min	Coordinated Universal Time Minutes	min
Time UTC-Sec	Coordinated Universal Time Seconds	sec
Vertical Speed	Vertical Speed	fpm
WOW Left	Left Main Landing Gear Weight on Wheels	
WOW Nose	Nose Gear Weight on Wheels	
WOW Right	Right Main Landing 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 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 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 2. Unit and discrete state abbreviations

Unit and Discrete State Abbreviations	Descriptions
%	percent
deg	degrees
degC	degrees Celsius
DISC	Disconnected
Eng	Engaged
fpm	feet per minute
ft	feet
g	unit of gravitation acceleration
hrs	hours
kts	knots
lb/hr	pounds per hour
min	minutes
psi	pounds per square inch
sec	seconds
WOW	Weight on Wheels