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

February 25, 2013

Flight Data Recorder - 10

Group Chairman's Factual Report
By Greg Smith

1. EVENT SUMMARY

Location: Boston, Massachusetts
Date: January 07, 2013
Aircraft: Boeing 787
Registration: JA829J
Operator: Japan Airlines
NTSB Number: DCA13IA037

On January 7, 2013, about 1021 eastern standard time, smoke was discovered by cleaning personnel in the aft cabin of a Japan Airlines (JAL) Boeing 787, JA829J, that was parked at a gate at Logan International Airport, Boston, Massachusetts. About the same time, a maintenance manager in the cockpit observed that the auxiliary power unit (APU) had automatically shut down. Shortly afterward, a mechanic opened the aft electronic equipment (EE) bay and found smoke and flames coming from the APU battery. No passengers or crewmembers were aboard the airplane at the time, and none of the maintenance or cleaning personnel aboard the airplane was injured. Aircraft rescue and firefighting responded to the battery fire, and one firefighter received minor injuries. The airplane had arrived from Narita International Airport, Narita, Japan, as a regularly scheduled passenger flight operated as JAL flight 008 and conducted under the provisions of 14 Code of Federal Regulations Part 129.

2. FLIGHT DATA RECORDER GROUP

A flight data recorder (FDR) group was convened on January 11, 2013.

Chairman: Greg Smith
             Aerospace Engineer / FDR Specialist
             National Transportation Safety Board

Member: Simon Lie
             Associate Technical Fellow / Air Safety Investigation
             Boeing Commercial Airplanes

Member: Anna Cushman
             Aerospace Engineer / Flight Data Lab Manager
             Federal Aviation Administration / AVP-100

Member: Nathan Rohrbaugh
Flight Data Analyst
Federal Aviation Administration / AVP-100

Member: Greg Moran
Design Engineer / Avionics – Recording Systems
Boeing Commercial Airplanes

Member: Florent Duru
Safety Investigator
Bureau d'Enquêtes et d'Analyses

Member: Satoru Yamauchi
Senior Aircraft Accident Investigator – Recorder Group
Japan Transport Safety Board

3. FDR CARRIAGE REQUIREMENTS

The event aircraft, JA829J, was manufactured in December 2012, and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 88 parameters, as cited in 14 CFR Part 121.344, by reference from 14 CFR Part 129.20.

4. DETAILS OF FLIGHT DATA RECORDER INVESTIGATION

The Safety Board's Vehicle Recorder Division received the following FDRs:

Recorder Manufacturer/Model: **GE EAFR-2100**
Recorder Serial Number (S/N): **16PL73**

Recorder Manufacturer/Model: **GE EAFR-2100**
Recorder S/N: **16PLDM**

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

4.1. GE EAFR-2100 Description

The EAFR-2100 is a multifunction recorder which records flight data, audio data, and communication, navigation, surveillance air traffic management (CNSATM) messages designed to meet the characteristics of *ARINC Characteristic 767, Enhanced Airborne Flight Recorder* (EAFR). Two EAFRs are installed on Boeing 787 aircraft, one forward and one aft (S/Ns 16PL73 and 16PLDM, respectively, for the incident aircraft). The forward and aft recorders are powered by the left and right 28V DC buses respectively. The forward recorder is equipped with a recorder independent power supply (RIPS) to provide backup power to the recorder for approximately 10 minutes once left DC bus power is lost. Both recorders record the same set of flight data independent of each other.

4.1.1. Recording Description

The forward and aft EAFR recordings contained approximately 57.6 hours of flight data each, in ARINC 767 format. ARINC 767 data contains intrinsic timing information measured in milliseconds from the start of each recording session. The event recording

sessions were the last sessions of each respective recording. Their durations were approximately 13 hours 22 minutes and 13 hours 12 minutes on the forward and aft recordings, respectively. Due to the RIPS, the forward EAFR continued to record for approximately 9 minutes and 58 seconds after the end of the aft EAFR's recording.

4.1.2. Parameter Source and Stale Data Issues

The EAFR has an integral flight data acquisition function (FDAF). The FDAF receives data from various data sources then transmits that data to the FDR function for storage into the crash protected memory. The FDAF sends data to the FDR function according to a periodic schedule. If no new value has been received since the last time a parameter's value was sent to the FDR function, the FDAF continues to transmit the last value received from the source. This data is referred to as "stale data".

For some parameters, the FDAF has multiple prioritized data sources available from which it receives parameter values. For these parameters, a separate source index parameter is generated by the FDAF and recorded. The source index parameter indicates the source being used for a parameter[1] (or group of parameters) or if no sources are available. These source index parameters have names which end in "_SI". For parameters with a source index, stale data is indicated by the source index being set to zero indicating "no source available". During post-event processing of the FDR data, instances of stale data indicated by a "no source available" value of a parameter's source index have been omitted from the plots and tabular data.

However, parameters which have only a single source do not have a source index parameter and consequently do not have a recorded indication that the data may be stale. Such parameters have been given a "#" suffix to indicate that repeated values may actually represent stale data and that a more detailed understanding of the various aircraft systems and data path is required to fully analyze the data.

4.1.3. Engineering Units Conversions

The engineering units conversions used for the data contained in this report are based on the Flight Recorder Electronic Documentation (FRED) file which was stored on each EAFR. The FRED files are based on *ARINC Specification 647A-1, Flight Recorder Electronic Documentation (FRED)*. In some cases, parameter conversions were augmented based on additional 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=+).[2]

The EAFR's FRED file indicates that more than 2000 parameters are recorded by the EAFR. Of those, 363 were evaluated as part of the investigation to date. Appendix A lists the FDR parameters verified and provided in this report.

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[1] Table A-1 in Appendix A includes a column with the source index parameter name for each parameter if applicable.
[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 = +.

4.2. Time Correlation

An elapsed time since start of recording was generated by summing the elapsed time for a recording session with the durations of the sessions preceding it. This time is referred to as the FDR elapsed time. Correlation of the FDR elapsed time of each recording (forward and aft) to the event local time, eastern standard time (EST), was established from the recorded Time_UTC_Hr_NAV, Time_UTC_Min_Nav, and Time_UTC_Sec_Nav parameters and then applying an additional -5 hour offset to change UTC to EST.

On board the aircraft there are multiple independent UTC sources that are synchronized to within 2 seconds of the GPS UTC time. The source of the EAFR time parameters can acquire time from several of these UTC sources and can change sources when one becomes invalid. However, this secondary UTC source is not reported to the EAFR and several shifts in recorded UTC time were seen during the post flight power down of the aircraft. Therefore, the correlation to UTC time was established using the recorded UTC time at touchdown.

Accordingly, the time offset for the event flight data from the forward EAFR's FDR elapsed time to local EST is the following: EST = Fwd FDR Elapsed Time – 209979.462. Similarly, the time offset for the event flight data from the aft EAFR's FDR elapsed time to local EST is the following: EST = Aft FDR Elapsed Time – 209245.526. Therefore, for the rest of this report, all times are referenced as EST, not FDR elapsed time.

4.3. Timeline of Events

Table 1 is a timeline of events identified in the FDR recordings truncated to 1 second time resolution.

Table 1. Timeline of FDR events.

Time (EST)	Event	FDR Indication
10:00:24	*Aircraft touches down.	On_Ground parameter records "Ground"
10:04:10	*APU Started.	APU_Pri_Fuel_Vlv_A# parameter records "Open"
10:06:15	Aircraft finished turning into parking location.[3]	Heading_Mag_Nav parameter within 2 degrees of final heading and rate of change less than 0.5 degrees/second
10:06:48	Parking Brake Set	All Parking_Brake_Set parameters record "Set"
10:06:52	Engine 1 shut down	Eng1_Fuel_Cutoff parameter records "Cutoff"
10:06:54	*Engine 2 shut down	Eng2_Fuel_Cutoff parameter records "Cutoff"
10:21:01	Initial drop in APU battery bus voltage	DCBus_APU_Battery_Volts parameter drops from 32 to 31 volts
10:21:04	APU battery current increases indicating current into the battery for 4 seconds	DCBus_APU_Battery_Current parameter increases to 44 – 45 amps until returning to -3 amps at 10:21:08
10:21:07	APU battery bus voltage drops again	DCBus_APU_Battery_Volts drops to 30 volts

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[3] This event was used to synchronize the FDR data and security camera video recordings documented in the Airport Emergency Response Group Chairman's Factual Report.

Time (EST)	Event	FDR Indication
10:21:09	APU battery bus voltage drops again	DCBus_APU_Battery_Volts drops to 29 volts
10:21:10	APU battery bus voltage increases	DCBus_APU_Battery_Volts increases to 31 volts
10:21:15	APU battery failed EICAS[4] message indicated	ELEC_APU_BATTERY parameter records "Failure"
10:21:27	APU battery bus voltage drops over next 3 seconds	DCBUS_APU_Battery_Volts decreases 1 volt/second until reaching 28 volts
10:21:37	APU battery bus voltage and APU battery current begin to step between zero and non-zero values	DCBus_APU_Battery_Volts drops to 0 volts then steps back to 28 volts three times DCBus_APU_Battery_Current increases to 0 amps then steps back to -5 amps three times.
	*APU controller goes offline and APU shuts down	All parameters whose source is the APU controller (APUC)[5] record 0 values.
	*Aft EAFR flight data recording ends	Last recorded data from aft EAFR flight data recording
10:21:40	Left and Right 1 and 2 AC buses unpowered EICAS messages indicated	All ELEC_AC_BUS parameters record "Unpowered"
10:21:41	APU battery failed EICAS message no longer indicated	ELEC_APU_BATTERY parameter records "No Message"
10:22:00	Main battery discharging EICAS message indicated	MAIN_BATTERY_DISCH parameter records "Discharging"
10:22:10	APU controller comes back online	Parameters whose source is the APUC begin recording non-zero values again
10:22:53	Main battery power switched off EICAS message indicated	ELEC_BATTERY_OFF parameter records "Switch Off"
10:23:16	*Aircraft systems providing data to the EAFR have shut down	From this point to the end of the forward recording all source index parameters record "NoSrc"
10:31:35	*Forward EAFR flight data recording ends	Last recorded data from the forward EAFR flight data recording

Note: Events marked with an asterisk (*) are annotated on the plots in Appendices B and C.

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[4] Engine Indication and Crew Alerting System
[5] The APUC is the source of 31 recorded parameters including APU_Shaft_Speed_A#, and APU_Batt_VDC_A#. The majority of the parameters plotted in figures B-3, B-4, C-3 and C-4 are provided to the EAFR by the APUC.

4.4. FDR Plots and Corresponding Tabular Data

The following two figures contain FDR data recorded during the 01/07/2013 event.

Figure 1 is a plot of parameters which indicate the incident aircraft's motion from approximately two minutes prior to touchdown through parking and engine shutdown. Parameters included in Figure 1 are: lateral, longitudinal and normal accelerations; engine 1 and 2 N1 speeds; engine 1 and 2 fuel cutoff discretes; APU shaft speed; magnetic heading; parking brake set discretes; airspeed; pressure and radio altitudes; and air/ground indication.

Figure 2 is a plot of parameters which show the APU battery failure and subsequent shut down of the APU and various airplane systems. Parameters included in Figure 2 are: APU shaft speed; APU battery voltage sensed by the APU controller; APU battery voltage and current sensed through the battery charger; the bus power control unit source index, which indicates the source of the parameters sensed through the battery charger; APU battery failure EICAS message discrete; AC electrical bus EICAS message discretes; main battery discharging EICAS message discrete and battery off EICAS message discrete.

Many other electrical, cooling, ventilation, and aircraft system parameters were reviewed and evaluated from both the forward and aft EAFR flight data recordings. Appendix B contains plots of the forward EAFR recording of these parameters for a 33 minute timeframe beginning approximately two minutes before touchdown. Appendix C contains plots of the aft EAFR recording of these parameters for the same timeframe.

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 these 48 plots are provided in compressed electronic format[6] as Attachments 1 and 2 to this report. Attachment 1 contains data from the forward EAFR recording and Attachment 2 contains data from the aft EAFR recording.

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[6] Attachments 1 and 2 are zip archives containing comma separated value (csv) files.

Figure 1. Forward EAFR recording of airplane motion.
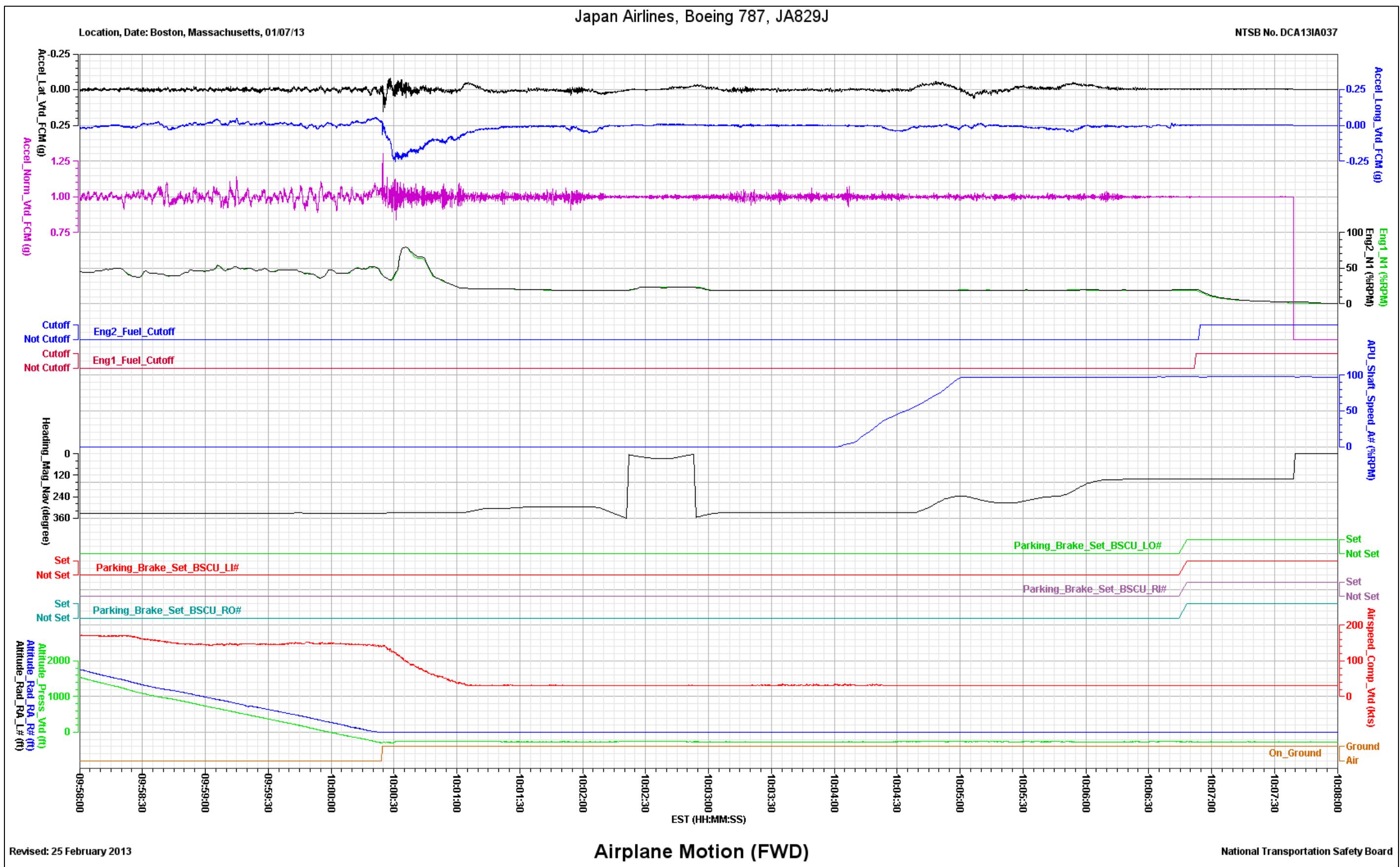
Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Airplane Motion (FWD)

Revised: 25 February 2013

National Transportation Safety Board

Figure 2. Forward EAFR recording of battery failure.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Battery Failure / APU Shutdown (FWD)

Revised: 25 February 2013

National Transportation Safety Board
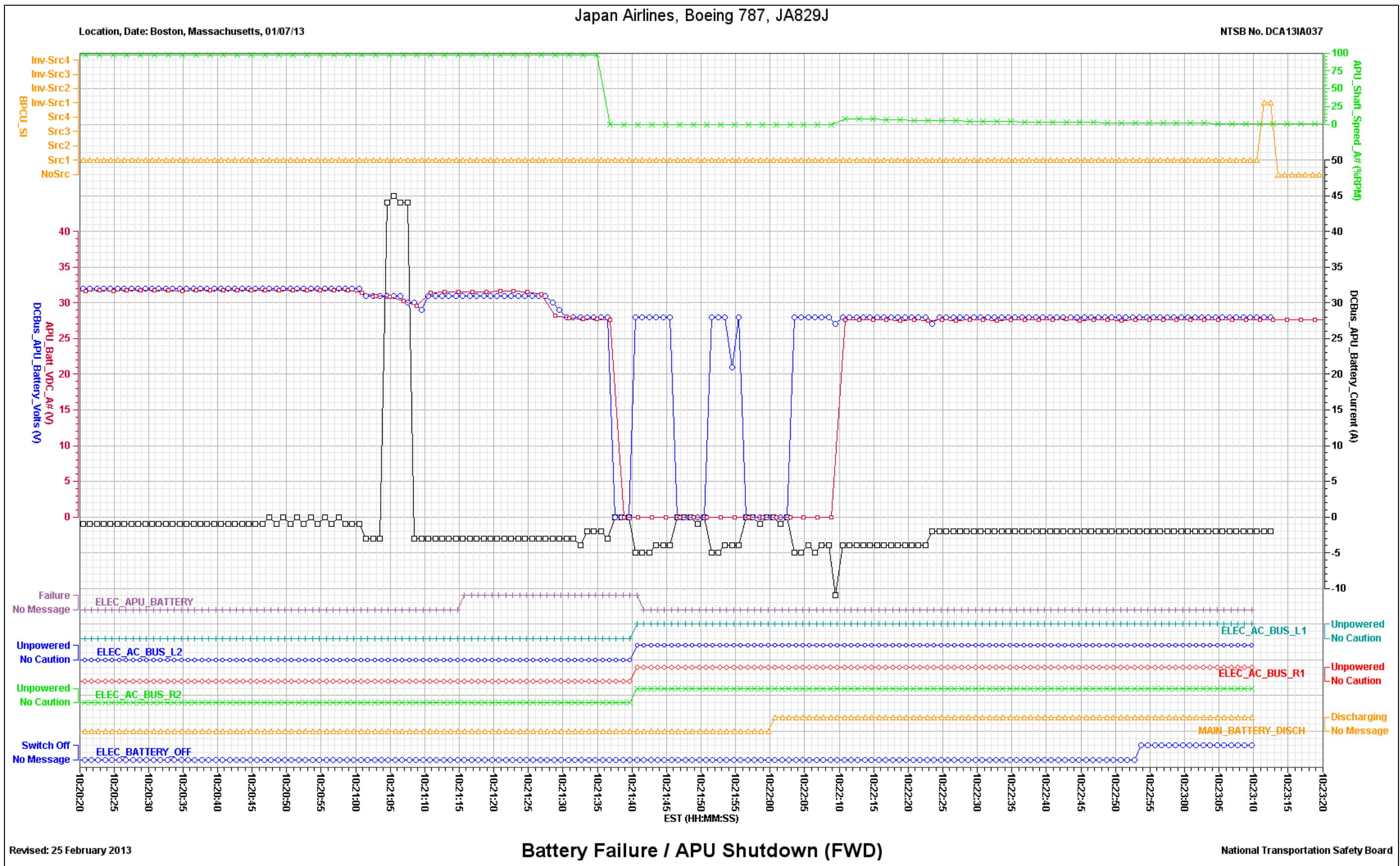
APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameters and table A-2 describes the unit abbreviations used in this report.

Table A-1. Verified and provided FDR parameters.

Parameter Name (units)	Description	Source Index	Figure Number(s)
28_VDC_Inst_Bus_L_Voltage (V)	Captain's Instrument Bus Voltage	BPCU_SI	B-12, C-12
28_VDC_Inst_Bus_R_Voltage (V)	First Officer's Instrument Bus Voltage	BPCU_SI	B-12, C-12
28VDC_Bus_L_Voltage (V)	Left DC Bus Voltage	BPCU_SI	B-12, C-12
28VDC_Bus_R_Voltage (V)	Right DC Bus Voltage	BPCU_SI	B-12, C-12
AC_Feed_RPDU_21_Load_Cur (A)	Remote Power Distribution Unit (RPDU) 21 AC Load Current	BPCU_SI	B-14, C-14
AC_Feed_RPDU_22_Load_Cur (A)	RPDU 22 AC Load Current	BPCU_SI	B-14, C-14
AC_Feed_RPDU_31_Load_Cur (A)	RPDU 31 AC Load Current	BPCU_SI	B-14, C-14
AC_Feed_RPDU_32_Load_Cur (A)	RPDU 32 AC Load Current	BPCU_SI	B-14, C-14
AC_Feed_RPDU_41_Load_Cur (A)	RPDU 41 AC Load Current	BPCU_SI	B-15, C-15
AC_Feed_RPDU_42_Load_Cur (A)	RPDU 42 AC Load Current	BPCU_SI	B-15, C-15
AC_Feed_RPDU_71_Load_Cur (A)	RPDU 71 AC Load Current	BPCU_SI	B-15, C-15
AC_Feed_RPDU_72_Load_Cur (A)	RPDU 72 AC Load Current	BPCU_SI	B-16, C-16
AC_Feed_RPDU_73_Load_Cur (A)	RPDU 73 AC Load Current	BPCU_SI	B-16, C-16
AC_Feed_RPDU_74_Load_Cur (A)	RPDU 74 AC Load Current	BPCU_SI	B-16, C-16
AC_Feed_RPDU_75_Load_Cur (A)	RPDU 75 AC Load Current	BPCU_SI	B-17, C-17
AC_Feed_RPDU_76_Load_Cur (A)	RPDU 76 AC Load Current	BPCU_SI	B-17, C-17
AC_Feed_RPDU_83_Load_Cur (A)	RPDU 83 AC Load Current	BPCU_SI	B-18, C-18
AC_Feed_RPDU_84_Load_Cur (A)	RPDU 84 AC Load Current	BPCU_SI	B-18, C-18
AC_Feed_RPDU_92_Load_Cur (A)	RPDU 92 AC Load Current	BPCU_SI	B-18, C-18
Accel_Lat_Body_Vtd_FCM (g)	Body Lateral Acceleration	ISM_1_SI	B-1, C-1
Accel_Lat_Vtd_FCM (g)	Center of Gravity (CG) Lateral Acceleration	ISM_2_SI	1, B-1, C-1
Accel_Long_Body_Vtd_FCM (g)	Body Longitudinal Acceleration	ISM_1_SI	B-1, C-1
Accel_Long_Vtd_FCM (g)	CG Longitudinal Acceleration	ISM_2_SI	1, B-1, C-1
Accel_Norm_Body_Vtd_FCM (g)	Body Normal Acceleration	ISM_1_SI	B-1, C-1
Accel_Norm_Vtd_FCM (g)	CG Normal Acceleration	ISM_2_SI	1, B-1, C-1
ADRF_SI	Air Data Reference Function (ADRF) Parameters Source Index	EAFR	B-2, C-2
Aft_EE_Overboard_Exht_Vlv_EE	Aft EE Overboard Exhaust Vent	EECool_SI	B-7, C-7
Air_Cycle_Machine_Spd_PCU_L1# (RPM)	Cabin Air Condition and Temperature Control System (CACTCS) Air Cycle Machine Speed from Pack Control Unit (PCU) L1		B-19, C-19

Parameter Name (units)	Description	Source Index	Figure Number(s)
Air_Cycle_Machine_Spd_PCU_L2# (RPM)	CACTCS Air Cycle Machine Speed from PCU L2		B-19, C-19
Air_Cycle_Machine_Spd_PCU_R1# (RPM)	CACTCS Air Cycle Machine Speed from PCU R1		B-19, C-19
Air_Cycle_Machine_Spd_PCU_R2# (RPM)	CACTCS Air Cycle Machine Speed from PCU R2		B-19, C-19
Airspeed_Comp_Vtd (kts)	Computed Airspeed	ADRF_SI	1, B-2, C-2
Altitude_Press_Vtd (ft)	Pressure Altitude	ADRF_SI	1, B-2, C-2
Altitude_Rad_RA_L# (ft)	Left Radio Altitude		1, B-2, C-2
Altitude_Rad_RA_R# (ft)	Right Radio Altitude		1, B-2, C-2
Anti_Ice_Wing_State	Wing Ice Protection Control Unit (WIPCU) Zone Controller Condition	WIPS_SI	
APU_Batt_VDC_A# (V)	APU Battery Bus Voltage from APU Controller (APUC)		2, B-3, C-3
APU_Calc_WF_Fuel_Flow_A# (lbs/hr)	Calculated APU Fuel Flow		B-3, C-3
APU_Current_Avail_A# (A)	APU Battery Bus Current from APUC		B-3, C-3
APU_Differential_Oil_Press_A# (PSID)	APU Differential Oil Pressure		B-3, C-3
APU_EGT_1_A# (degree C)	APU Exhaust Gas Temperature (EGT) 1		B-3, C-3
APU_EGT_2_A# (degree C)	APU EGT 2		B-3, C-3
APU_EGT_A# (degree C)	APU EGT		B-3, C-3
APU_Fire_Switch_1	APU Fire Switch 1 Position	FD_SI	B-4, C-4
APU_Fire_Switch_2[7]	APU Fire Switch 2 Position	FD_SI	B-4, C-4
APU_Fuel_Pump_Cmd_A# (RPM)	Commanded APU Fuel Flow		B-3, C-3
APU_Gen_1_Oil_Press_P3_A# (PSIA)	Left APU Generator Oil Pressure		B-3, C-3
APU_Gen_2_Oil_Press_P4_A# (PSIA)	Right APU Generator Oil Pressure		B-3, C-3
APU_Ignition_A_Exciter_A#	APU Ignition Channel A Control Command		B-3, C-3
APU_Ignition_B_Exciter_A#	APU Ignition Channel B Control Command		B-3, C-3
APU_Inlet_Air_Press_P1_A# (PSIA)	APU Inlet Air Pressure		B-3, C-3
APU_Inlet_Door_Cmd_Open_A#	APU Inlet Door Open Command		B-3, C-3
APU_Inlet_Door_Pos_A#	APU Inlet Door Position		B-3, C-3
APU_Inlet_Temp_T1_A# (degree C)	APU Inlet Temperature		B-3, C-3
APU_Oil_Deprime_Vlv_A#	APU Oil Deprime Valve Command		B-3, C-3
APU_Oil_Press_P1_A# (PSIA)	APU Oil Pressure 1		B-3, C-3
APU_Oil_Press_P2_A# (PSIA)	APU Oil Pressure 2		B-3, C-3
APU_Oil_Qty_A# (Qt US)	APU Oil Quantity		B-3, C-3
APU_Oil_Temp_A# (degree C)	APU Oil Temperature		B-3, C-3
APU_Pri_Fuel_Pr_A# (PSIA)	APU Fuel Pressure		B-3, C-3
APU_Pri_Fuel_Vlv_A#	APU Primary Fuel Valve Command		B-4, C-4
APU_Sec_Fuel_Vlv_A#	APU Secondary Fuel Valve Command		B-4, C-4
APU_Shaft_Speed_A# (%RPM)	APU Shaft Speed		1, 2, B-4, C-4

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[7] This parameter is a reserved parameter and will not change.

Parameter Name (units)	Description	Source Index	Figure Number(s)
APU_Shaft_Speed_Sensor_1_A# (%RPM)	APU Shaft Speed Sensor 1		B-4, C-4
APU_Shaft_Speed_Sensor_2_A# (%RPM)	APU Shaft Speed Sensor 2		B-4, C-4
APU_Shut_Off_Valve_Open_Ind#	APU Shut Off Valve Position		B-4, C-4
APU_Speed_Target_A# (%RPM)	APU Target Shaft Speed		B-4, C-4
APU_Starter_CMD_A# (%Max Amps)	APU Starter Speed Commanded		B-4, C-4
APU_Starter_Enable_A#	APU Starter Enabled		B-4, C-4
APU_WF_Fuel_Flow_Cmd_A# (lbs/hr)	APU Commanded Fuel Flow		B-4, C-4
BOTTLE_DISCH_APU	APU Fire Bottle Discharged	DCACAMT_SI	B-6, C-6
BOTTLE_DISCH_CARGO	Cargo Fire Bottles Discharged	DCACAMT_SI	B-6, C-6
BPCU_SI	Bus Power Control Unit (BPCU) Parameters Source Index	EAFR	2, B-12, C-12, B-13, C-13, B-14, C-14, B-15, C-15, B-16, C-16, B-17, C-17, B-18, C-18, B-22, C-22
Cabin_Air_Comp_1_OLet_Tmp_PCU_L1# (degree F)	CACTCS Cabin Air Compressor 1 Outlet Temperature from PCU L1		B-19, C-19
Cabin_Air_Comp_1_OLet_Tmp_PCU_L2# (degree F)	CACTCS Cabin Air Compressor 1 Outlet Temperature from PCU L2		B-19, C-19
Cabin_Air_Comp_1_OLet_Tmp_PCU_R1# (degree F)	CACTCS Cabin Air Compressor 1 Outlet Temperature from PCU R1		B-19, C-19
Cabin_Air_Comp_1_OLet_Tmp_PCU_R2# (degree F)	CACTCS Cabin Air Compressor 1 Outlet Temperature from PCU R2		B-19, C-19
Cabin_Air_Comp_1_Spd_PCU_L1# (RPM)	CACTCS Cabin Air Compressor 1 Speed from PCU L1		B-19, C-19
Cabin_Air_Comp_1_Spd_PCU_L2# (RPM)	CACTCS Cabin Air Compressor 1 Speed from PCU L2		B-19, C-19
Cabin_Air_Comp_1_Spd_PCU_R1# (RPM)	CACTCS Cabin Air Compressor 1 Speed from PCU R1		B-19, C-19
Cabin_Air_Comp_1_Spd_PCU_R2# (RPM)	CACTCS Cabin Air Compressor 1 Speed from PCU R2		B-19, C-19
Cabin_Air_Comp_2_OLet_Tmp_PCU_L1# (degree F)	CACTCS Cabin Air Compressor 2 Outlet Temperature from PCU L1		B-19, C-19
Cabin_Air_Comp_2_OLet_Tmp_PCU_L2# (degree F)	CACTCS Cabin Air Compressor 2 Outlet Temperature from PCU L2		B-19, C-19
Cabin_Air_Comp_2_OLet_Tmp_PCU_R1# (degree F)	CACTCS Cabin Air Compressor 2 Outlet Temperature from PCU R1		B-19, C-19
Cabin_Air_Comp_2_OLet_Tmp_PCU_R2# (degree F)	CACTCS Cabin Air Compressor 2 Outlet Temperature from PCU R2		B-19, C-19

Parameter Name (units)	Description	Source Index	Figure Number(s)
Cabin_Air_Comp_2_Spd_PCU_L1# (RPM)	CACTCS Cabin Air Compressor 2 Speed from PCU L1		B-19, C-19
Cabin_Air_Comp_2_Spd_PCU_L2# (RPM)	CACTCS Cabin Air Compressor 2 Speed from PCU L2		B-19, C-19
Cabin_Air_Comp_2_Spd_PCU_R1# (RPM)	CACTCS Cabin Air Compressor 2 Speed from PCU R1		B-19, C-19
Cabin_Air_Comp_2_Spd_PCU_R2# (RPM)	CACTCS Cabin Air Compressor 2 Speed from PCU R2		B-19, C-19
CCR_CABINET_L	Common Computing Resource (CCR) Left Cabinet Failed	DCACAMT_SI	B-5, C-5
CCR_CABINET_R	CCR Right Cabinet Failed	DCACAMT_SI	B-5, C-5
CCR_FIBER_OPTIC_XLTR	CCR Fiber Optic Translator Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_1L	CCR General Processing Module (GPM) 1L Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_1R	CCR GPM 1R Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_2L	CCR GPM 2L Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_2R	CCR GPM 2R Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_3L	CCR GPM 3L Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_3R	CCR GPM 3R Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_4L	CCR GPM 4L Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_4R	CCR GPM 4R Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_5L	CCR GPM 5L Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_5R	CCR GPM 5R Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_6L	CCR GPM 6L Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_6R	CCR GPM 6R Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_7L	CCR GPM 7L Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_7R	CCR GPM 7R Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_8L	CCR GPM 8L Failed	DCACAMT_SI	B-5, C-5
CCR_GPM_8R	CCR GPM 8R Failed	DCACAMT_SI	B-5, C-5
CCR_GRAPHICS_GENERATOR	CCR Graphics Generator Module Failed	DCACAMT_SI	B-5, C-5
CCR_NETWORK_SWITCH	Any CCR Network Switch Failed	DCACAMT_SI	B-5, C-5
CCR_POWER_CONTROL_MODULE	Any CCR Power Control Module Failed	DCACAMT_SI	B-5, C-5
CCS_NETWORK_SWITCH_3	Common Computing System (CCS) Network Switch 3 Failed	DCACAMT_SI	B-5, C-5
CCS_NETWORK_SWITCH_4	CCS Network Switch 4 Failed	DCACAMT_SI	B-5, C-5
CCS_NETWORK_SWITCH_5	CCS Network Switch 5 Failed	DCACAMT_SI	B-5, C-5
CCS_NETWORK_SWITCH_6	CCS Network Switch 6 Failed	DCACAMT_SI	B-5, C-5
CCS_NETWORK_SWITCH_7	CCS Network Switch 7 Failed	DCACAMT_SI	B-5, C-5
CCS_NETWORK_SWITCH_8	CCS Network Switch 8 Failed	DCACAMT_SI	B-5, C-5
CCS_RDC_1_FWD_EE_BAY	CCS Remote Data Concentrator (RDC) 1 Failed	DCACAMT_SI	B-6, C-6

Parameter Name (units)	Description	Source Index	Figure Number(s)
CCS_RDC_2_FWD_EE_BAY	CCS RDC 2 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_3_FWD_EE_BAY	CCS RDC 3 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_4_FWD_EE_BAY	CCS RDC 4 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_5_DOOR_3L	CCS RDC 5 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_6_DOOR_3R	CCS RDC 6 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_7_AFT_EE_BAY	CCS RDC 7 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_8_AFT_EE_BAY	CCS RDC 8 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_9_AFT_EE_UPPER	CCS RDC 9 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_10_AFT_EE_UPPER	CCS RDC 10 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_11_FLIGHT_DECK_L	CCS RDC 11 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_12_FLIGHT_DECK_R	CCS RDC 12 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_13_DOOR_1L	CCS RDC 13 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_14_DOOR_1R	CCS RDC 14 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_15_DOOR_2L	CCS RDC 15 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_16_DOOR_2R	CCS RDC 16 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_17_DOOR_4L	CCS RDC 17 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_18_DOOR_4R	CCS RDC 18 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_19_AFT_EE_BAY	CCS RDC 19 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_21_FWD_EE_UPPER	CCS RDC 21 Failed	DCACAMT_SI	B-6, C-6
CCS_RDC_23_DOOR_4R	CCS RDC 23 Failed	DCACAMT_SI	B-6, C-6
Cmd_State_APU_Fuel_SO_Act	APU Shut Off Valve Command State	FQMS_SI	B-4, C-4
Cooling_Aft_Main_State_EE	Aft EE Cooling State	EECool_SI	B-7, C-7
Cooling_FD_Main_State_EE	Flight Deck (FD) EE Cooling State	EECool_SI	B-7, C-7
Cooling_Loop_Avail_L_PECS_CACTCS	Left Power Electronics Cooling System (PECS) CACTCS Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_CenHyd	Left PECS Center Hydraulics Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_DmndOrCenHYDIF	Left PECS Hydraulics Demand or Center Off Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_ICS	Left PECS Integrated Cooling System (ICS) Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_MinCACTCS	Left PECS Minimum CACTCS Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_NGS	Left PECS Nitrogen Generation System (NGS) Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_NotAvail	Left PECS Not Available	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_OJ	Left PECS Overboard Jettison Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_RAF	Left PECS Ram Air Fan (RAF) Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_L_PECS_XctrlRAF	Left PECS RAF Cross Control Available	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_CACTCS	Right PECS CACTCS Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_CenHyd	Right PECS Center Hydraulics Load Shed Request	PECS_SI	B-8, C-8

Parameter Name (units)	Description	Source Index	Figure Number(s)
Cooling_Loop_Avail_R_PECS_DmndOrCenHYDIF	Right PECS Hydraulics Demand or Center Off Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_ICS	Right PECS ICS Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_MinCACTCS	Right PECS Minimum CACTCS Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_NGS	Right PECS NGS Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_NotAvail	Right PECS Not Available	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_OJ	Right PECS Overboard Jettison Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_RAF	Right PECS Ram Air Fan (RAF) Load Shed Request	PECS_SI	B-8, C-8
Cooling_Loop_Avail_R_PECS_XctrlRAF	Right PECS RAF Cross Control Available	PECS_SI	B-8, C-8
Cooling_Sensor_1_Fwd_Flow_EE (lbs/min)	EE Cooling Sensor 1 Flow	EECool_SI	B-7, C-7
Cooling_Sensor_1_Fwd_Temp_EE (degree F)	EE Cooling Sensor 1 Temperature	EECool_SI	B-7, C-7
Cooling_Sensor_2_Aft_Flow_EE (lbs/min)	EE Cooling Sensor 2 Flow	EECool_SI	B-7, C-7
Cooling_Sensor_2_Aft_Temp_EE (degree F)	EE Cooling Sensor 2 Temperature	EECool_SI	B-7, C-7
DC_Bus_270V_GCU_L1_Off_BPCU	L1 270V DC Bus Status	BPCU_SI	B-13, C-13
DC_Bus_270V_GCU_L2_Off_BPCU	L2 270V DC Bus Status	BPCU_SI	B-13, C-13
DC_Bus_270V_GCU_R1_Off_BPCU	R1 270V DC Bus Status	BPCU_SI	B-13, C-13
DC_Bus_270V_GCU_R2_Off_BPCU	R2 270V DC Bus Status	BPCU_SI	B-13, C-13
DC_Feed_RPDU_21_Load_Cur (A)	RPDU 21 DC Load Current	BPCU_SI	B-14, C-14
DC_Feed_RPDU_22_Load_Cur (A)	RPDU 22 DC Load Current	BPCU_SI	B-14, C-14
DC_Feed_RPDU_31_Load_Cur (A)	RPDU 31 DC Load Current	BPCU_SI	B-14, C-14
DC_Feed_RPDU_32_Load_Cur (A)	RPDU 32 DC Load Current	BPCU_SI	B-14, C-14
DC_Feed_RPDU_41_Load_Cur (A)	RPDU 41 DC Load Current	BPCU_SI	B-15, C-15
DC_Feed_RPDU_42_Load_Cur (A)	RPDU 42 DC Load Current	BPCU_SI	B-15, C-15
DC_Feed_RPDU_71_Load_Cur (A)	RPDU 71 DC Load Current	BPCU_SI	B-15, C-15
DC_Feed_RPDU_72_Load_Cur (A)	RPDU 72 DC Load Current	BPCU_SI	B-16, C-16
DC_Feed_RPDU_73_Load_Cur (A)	RPDU 73 DC Load Current	BPCU_SI	B-16, C-16
DC_Feed_RPDU_74_Load_Cur (A)	RPDU 74 DC Load Current	BPCU_SI	B-16, C-16
DC_Feed_RPDU_75_Load_Cur (A)	RPDU 75 DC Load Current	BPCU_SI	B-17, C-17
DC_Feed_RPDU_76_Load_Cur (A)	RPDU 76 DC Load Current	BPCU_SI	B-17, C-17
DC_Feed_RPDU_81_Load_Cur (A)	RPDU 81 DC Load Current	BPCU_SI	B-17, C-17
DC_Feed_RPDU_82_Load_Cur (A)	RPDU 82 DC Load Current	BPCU_SI	B-17, C-17
DC_Feed_RPDU_83_Load_Cur (A)	RPDU 83 DC Load Current	BPCU_SI	B-18, C-18
DC_Feed_RPDU_84_Load_Cur (A)	RPDU 84 DC Load Current	BPCU_SI	B-18, C-18
DC_Feed_RPDU_92_Load_Cur (A)	RPDU 92 DC Load Current	BPCU_SI	B-18, C-18
DCACAHSM_SI	Display and Crew Alerting (DCA) Crew Alert High Speed Miscellaneous (CAHSM) Parameters Source Index	EAFR	B-11, C-11

Parameter Name (units)	Description	Source Index	Figure Number(s)
DCACAMT_SI	DCA Crew Alert Messaging Tool (CAMT) Parameters Source Index	EAFR	B-4, C-4, B-5, C-5, B-6, C-6, B-9, C-9, B-11, C-11, B-21, C-21, B-23, C-23
DCAEICFCL_SI	DCA EICAS Fuel Cutoff (FC) Left Parameters Source Index	EAFR	B-10, C-10
DCAEICFCR_SI	DCA EICAS FC Right Parameters Source Index	EAFR	B-10, C-10
DCAEICN1L_SI	DCA EICAS N1 Left Parameters Source Index	EAFR	B-10, C-10
DCAEICN1R_SI	DCA EICAS N2R Parameters Source Index	EAFR	B-10, C-10
DCAFCENDC_SI	DCA Flight Control Electronics (FCE) Navigation Display (ND) Captain Parameters Source Index	EAFR	B-2, C-2
DCAFCENDF_SI	DCA FCE ND First Officer Parameters Source Index	EAFR	B-2, C-2
DCAMAINT_SI	DCA Maintenance Parameters Source Index	EAFR	B-11, C-11
DCBus_APU_Battery_Current (A)	APU Battery Current	BPCU_SI	2, B-12, C-12
DCBus_APU_Battery_Volts (V)	APU Battery Output Voltage	BPCU_SI	2, B-12, C-12
EE_Cooling_Fan_LPS	EE Cooling Fan Status	LPS_SI	B-7, C-7
EECool_SI	EE Cooling Parameters Source Index	EAFR	B-7, C-7
ELEC_115V_AC_BUS_L	Left 115V AC Bus Status Message	DCACAMT_SI	B-9, C-9
ELEC_115V_AC_BUS_R	Right 115V AC Bus Status Message	DCACAMT_SI	B-9, C-9
ELEC_28V_DC_BUS_L	Left 28V DC Bus Status Message	DCACAMT_SI	B-9, C-9
ELEC_28V_DC_BUS_R	Right 28V DC Bus Status Message	DCACAMT_SI	B-9, C-9
ELEC_AC_BUS_L1	L1 AC Bus Status Message	DCACAMT_SI	2, B-9, C-9
ELEC_AC_BUS_L2	L2 AC Bus Status Message	DCACAMT_SI	2, B-9, C-9
ELEC_AC_BUS_R1	R1 AC Bus Status Message	DCACAMT_SI	2, B-9, C-9
ELEC_AC_BUS_R2	R2 AC Bus Status Message	DCACAMT_SI	2, B-9, C-9
ELEC_APU_BATTERY	APU Battery Status Message	DCACAMT_SI	2, B-9, C-9
ELEC_BACKUP_BUS	Backup Bus Status Message	DCACAMT_SI	B-9, C-9
ELEC_BATTERY_OFF	Main Battery Switch Status Message	DCACAMT_SI	2, B-9, C-9
ELEC_CABIN-UTIL_OFF	Cabin/Utility Switch Status Message	DCACAMT_SI	B-9, C-9
ELEC_FLT_INST_BUS_ FO	First Officer's Flight Instrument Bus Status Message	DCACAMT_SI	B-9, C-9
ELEC_FLT_INST_BUS_CAPT	Captain's Flight Instrument Bus Status Message	DCACAMT_SI	B-9, C-9
ELEC_HOT_BATTERY_BUS	Hot Battery Bus Status Message	DCACAMT_SI	B-9, C-9
ELEC_IFE-SEATS_OFF	In-Flight Entertainment/Passenger Seat Power Switch Status Message	DCACAMT_SI	B-9, C-9
ELEC_MAIN_BATTERY	Main Battery Status Message	DCACAMT_SI	B-9, C-9
ELEC_STANDBY_SYS	Standby System Status Message	DCACAMT_SI	B-9, C-9
ELEC_TRU_C1	C1 Transformer Rectifier Unit (TRU) Status Message	DCACAMT_SI	B-9, C-9
ELEC_TRU_C2	C2 TRU Status Message	DCACAMT_SI	B-9, C-9

Parameter Name (units)	Description	Source Index	Figure Number(s)
ELEC_TRU_L	Left TRU Status Message	DCACAMT_SI	B-9, C-9
ELEC_TRU_R	Right TRU Status Message	DCACAMT_SI	B-9, C-9
Eng1_Fuel_Cutoff	Engine 1 Fuel Cutoff Switch Position	DCAEICFCL_SI	1, B-10, C-10
Eng1_N1 (%RPM)	Engine 1 N1 Speed	DCAEICN1L_SI	1, B-10, C-10
Eng2_Fuel_Cutoff	Engine 2 Fuel Cutoff Switch Position	DCAEICFCR_SI	1, B-10, C-10
Eng2_N1 (%RPM)	Engine 2 N1 Speed	DCAEICN1R_SI	1, B-10, C-10
FD_SI	FD Parameters Source Index	EAFR	B-4, C-4, B-22, C-22, B-23, C-23
FIRE_APU	APU Fire Warning	DCACAMT_SI	B-4, C-4, B-6, C-6
FIRE_CARGO_AFT	Forward Cargo Fire Warning	DCACAMT_SI	B-6, C-6
FIRE_CARGO_FWD	Aft Cargo Fire Warning	DCACAMT_SI	B-6, C-6
FIRE_TEST_FAIL	Fire Detection System Test Failed Message	DCACAMT_SI	B-6, C-6
FIRE_TEST_IN_PROG	Fire Detection System Test In Progress Message	DCACAMT_SI	B-6, C-6
FIRE_TEST_PASS	Fire Detection System Test Passed Message	DCACAMT_SI	B-6, C-6
FIRE_WHEEL_WELL	Wheel Well Fire Warning	DCACAMT_SI	B-6, C-6
FQMS_SI	Fuel Quantity Management System Parameters Source Index	EAFR	B-4, C-4
GCU_L1_ATRU_Failed	L1 Generator Control Unit (GCU) Auto Transformer Rectifier Unit (ATRU) Failed	BPCU_SI	B-13, C-13
GCU_L2_ATRU_Failed	L2 GCU ATRU Failed	BPCU_SI	B-13, C-13
GCU_R1_ATRU_Failed	R1 GCU ATRU Failed	BPCU_SI	B-13, C-13
GCU_R2_ATRU_Failed	R2 GCU ATRU Failed	BPCU_SI	B-13, C-13
GCUL1_ATRU_270DC_Volt_Neg (V)	L1 GCU ATRU Negative Output Voltage	BPCU_SI	B-13, C-13
GCUL1_ATRU_270DC_Volt_Pos (V)	L1 GCU ATRU Positive Output Voltage	BPCU_SI	B-13, C-13
GCUL2_ATRU_270DC_Volt_Neg (V)	L2 GCU ATRU Negative Output Voltage	BPCU_SI	B-13, C-13
GCUL2_ATRU_270DC_Volt_Pos (V)	L2 GCU ATRU Positive Output Voltage	BPCU_SI	B-13, C-13
GCUR1_ATRU_270DC_Volt_Neg (V)	R1 GCU ATRU Negative Output Voltage	BPCU_SI	B-13, C-13
GCUR1_ATRU_270DC_Volt_Pos (V)	R1 GCU ATRU Positive Output Voltage	BPCU_SI	B-13, C-13
GCUR2_ATRU_270DC_Volt_Neg (V)	R2 GCU ATRU Negative Output Voltage	BPCU_SI	B-13, C-13
GCUR2_ATRU_270DC_Volt_Pos (V)	R2 GCU ATRU Positive Output Voltage	BPCU_SI	B-13, C-13
Heading_Mag_Nav (degree)	Magnetic Heading	NAV_SI	1, B-2, C-2
Heading_ND_L (degree)	Left ND Heading	DCAFCENDC_SI	B-2, C-2
Heading_ND_R (degree)	Right ND Heading	DCAFCENDF_SI	B-2, C-2
Heading_True_Nav (degree)	True Heading	NAV_SI	B-2, C-2
HLF_SI	High Lift Function Parameters Source Index	EAFR	B-10, C-10
HPC_SI	Hydraulic Pressure Center Parameters Source Index	EAFR	B-11, C-11
Hyd_Press_C_HYDIF (PSIA)	Center Hydraulic System Pressure	HPC_SI	B-11, C-11
Hyd_Press_L_HYDIF_L# (PSIA)	Left Hydraulic System Pressure		B-11, C-11

Parameter Name (units)	Description	Source Index	Figure Number(s)
Hyd_Press_R_HYDIF_R# (PSIA)	Right Hydraulic System Pressure		B-11, C-11
HYD_PRESS_SYS_C	Center Hydraulic System Low Pressure Caution	DCACAMT_SI	B-11, C-11
HYD_PRESS_SYS_L	Left Hydraulic System Low Pressure Caution	DCACAMT_SI	B-11, C-11
HYD_PRESS_SYS_R	Right Hydraulic System Low Pressure Caution	DCACAMT_SI	B-11, C-11
ISM_1_SI	Instruments and Sensors Module (ISM) 1 Parameters Source Index	EAFR	B-1,C-1
ISM_2_SI	ISM 2 Parameters Source Index	EAFR	B-1,C-1
Key_VHF_C_Capt#	Center VHF Radio Keyed By Captain		B-11, C-11
Key_VHF_C_FO#	Center VHF Radio Keyed By First Officer		B-11, C-11
Key_VHF_C_Obs#	Center VHF Radio Keyed By Observer		B-11, C-11
Key_VHF_L_Capt#	Left VHF Radio Keyed By Captain		B-11, C-11
Key_VHF_L_FO#	Left VHF Radio Keyed By First Officer		B-11, C-11
Key_VHF_L_Obs#	Left VHF Radio Keyed By Observer		B-11, C-11
Key_VHF_R_Capt#	Right VHF Radio Keyed By Captain		B-11, C-11
Key_VHF_R_FO#	Right VHF Radio Keyed By First Officer		B-11, C-11
Key_VHF_R_Obs#	Right VHF Radio Keyed By Observer		B-11, C-11
L1_GCU_Gen_Load (% open)	L1 Generator Load	BPCU_SI	B-12, C-12
L2_GCU_Gen_Load (% open)	L2 Generator Load	BPCU_SI	B-12, C-12
LPS_SI	Low Pressure System Parameters Source Index	EAFR	B-7, C-7
MAIN_BATTERY_DISCH	Main Battery Discharging Message	DCACAMT_SI	2, B-9, C-9
Main_Battery_Voltage (V)	Main Battery Voltage	BPCU_SI	B-12, C-12
Maint_Event	Maintenance Event Button Pushed	DCAMAINT_SI	B-11, C-11
Maint_Ind	Maintenance Display On MFD	DCAMAINT_SI	B-11, C-11
Master_Caut_Act	Master Caution Light Activated	DCACAHSM_SI	B-11, C-11
Master_Warn_Act	Master Warning Light Activated	DCACAHSM_SI	B-11, C-11
NAV_SI	Navigation Parameters Source Index	EAFR	B-2, C-2
On_Ground	Aircraft On Ground	ONGND_SI	1, B-2, C-2
On_Ground_System_Invalid	On Ground System Status	ONGND_SI	B-2, C-2
ONGND_SI	On Ground Parameters Source Index	EAFR	B-2, C-2
Pack_Comp_Outlet_Temp_PCU_L1# (degree F)	L1 PCU CACTCS Pack Compressor Outlet Temperature		B-20, C-20
Pack_Comp_Outlet_Temp_PCU_L2# (degree F)	L2 PCU CACTCS Pack Compressor Outlet Temperature		B-20, C-20
Pack_Comp_Outlet_Temp_PCU_R1# (degree F)	R1 PCU CACTCS Pack Compressor Outlet Temperature		B-20, C-20
Pack_Comp_Outlet_Temp_PCU_R2# (degree F)	R2 PCU CACTCS Pack Compressor Outlet Temperature		B-20, C-20
Pack_Outlet_Temp_PCU_L1# (degree F)	L1 PCU CACTCS Pack Outlet Temperature		B-20, C-20
Pack_Outlet_Temp_PCU_L2# (degree F)	L2 PCU CACTCS Pack Outlet Temperature		B-20, C-20

Parameter Name (units)	Description	Source Index	Figure Number(s)
Pack_Outlet_Temp_PCU_R1# (degree F)	R1 PCU CACTCS Pack Outlet Temperature		B-20, C-20
Pack_Outlet_Temp_PCU_R2# (degree F)	R2 PCU CACTCS Pack Outlet Temperature		B-20, C-20
Parking_Brake_Set_BSCU_LI#	Left Inboard Parking Brake Set		1, B-10, C-10
Parking_Brake_Set_BSCU_LO#	Left Outboard Parking Brake Set		1, B-10, C-10
Parking_Brake_Set_BSCU_RI#	Right Inboard Parking Brake Set		1, B-10, C-10
Parking_Brake_Set_BSCU_RO#	Right Outboard Parking Brake Set		1, B-10, C-10
PCM_C1_Fail_FCM	C1 Power Control Module (PCM) Failed	PFCF_2_SI	B-9, C-9
PCM_C2_Fail_FCM	C2 PCM Failed	PFCF_2_SI	B-9, C-9
PCM_L_Fail_FCM	Left PCM Failed	PFCF_2_SI	B-9, C-9
PCM_R_Fail_FCM	Right PCM Failed	PFCF_2_SI	B-9, C-9
PCU_Channel_In_Control_PCU_L1#	L1 PCU Channel In Control		B-20, C-20
PCU_Channel_In_Control_PCU_L2#	L2 PCU Channel In Control		B-20, C-20
PCU_Channel_In_Control_PCU_R1#	R1 PCU Channel In Control		B-20, C-20
PCU_Channel_In_Control_PCU_R2#	R2 PCU Channel In Control		B-20, C-20
PECS_SI	PECS Parameters Source Index	EAFR	B-8, C-8
PFCF_2_SI	PFCF2 Parameters Source Index	EAFR	B-9, C-9
R1_GCU_Gen_Load (% open)	R1 Generator Load	BPCU_SI	B-12, C-12
R2_GCU_Gen_Load (% open)	R2 Generator Load	BPCU_SI	B-12, C-12
Ram_Air_Fan_Spd_PCU_L1# (RPM)	L1 PCU CACTCS Ram Air Fan Speed		B-20, C-20
Ram_Air_Fan_Spd_PCU_L2# (RPM)	L2 PCU CACTCS Ram Air Fan Speed		B-20, C-20
Ram_Air_Fan_Spd_PCU_R1# (RPM)	R1 PCU CACTCS Ram Air Fan Speed		B-20, C-20
Ram_Air_Fan_Spd_PCU_R2# (RPM)	R2 PCU CACTCS Ram Air Fan Speed		B-20, C-20
Secondary_Hx_Outlet_Temp_PCU_L1# (degree F)	L1 PCU CACTCS Secondary Heat Exchanger Outlet Temperature		B-20, C-20
Secondary_Hx_Outlet_Temp_PCU_L2# (degree F)	L2 PCU CACTCS Secondary Heat Exchanger Outlet Temperature		B-20, C-20
Secondary_Hx_Outlet_Temp_PCU_R1# (degree F)	R1 PCU CACTCS Secondary Heat Exchanger Outlet Temperature		B-20, C-20
Secondary_Hx_Outlet_Temp_PCU_R2# (degree F)	R2 PCU CACTCS Secondary Heat Exchanger Outlet Temperature		B-20, C-20
SMOKE_EQUIP_CLG_AFT	Aft EE Bay Smoke Detected	DCACAMT_SI	B-21, C-21
SMOKE_EQUIP_CLG_FWD	Forward EE Bay or Flight Deck Smoke Detected	DCACAMT_SI	B-21, C-21
SMOKE_EQUIP_CLG_MISC	Cabin Electrical Cabinet Smoke Detected	DCACAMT_SI	B-21, C-21
SMOKE_LAVATORY	Lavatory Smoke Detected	DCACAMT_SI	B-21, C-21
SMOKE_REST_UPR_DR_1	Upper Crew Rest Door 1 Smoke Detected	DCACAMT_SI	B-21, C-21
SMOKE_REST_UPR_DR_4	Upper Crew Rest Door 1 Smoke Detected	DCACAMT_SI	B-21, C-21
StbyDC_Feed_RPDU_71_LdCur (A)	RPDU 71 Standby DC Load Current	BPCU_SI	B-15, C-15
StbyDC_Feed_RPDU_72_LdCur (A)	RPDU 72 Standby DC Load Current	BPCU_SI	B-16, C-16
StbyDC_Feed_RPDU_73_LdCur (A)	RPDU 73 Standby DC Load Current	BPCU_SI	B-16, C-16

Parameter Name (units)	Description	Source Index	Figure Number(s)
StbyDC_Feed_RPDU_74_LdCur (A)	RPDU 74 Standby DC Load Current	BPCU_SI	B-16, C-16
StbyDC_Feed_RPDU_81_LdCur (A)	RPDU 81 Standby DC Load Current	BPCU_SI	B-17, C-17
StbyDC_Feed_RPDU_82_LdCur (A)	RPDU 82 Standby DC Load Current	BPCU_SI	B-17, C-17
Time_UTC_Hr_Nav (hour)	UTC Hours	NAV_SI	
Time_UTC_Min_Nav (min)	UTC Minutes	NAV_SI	
Time_UTC_Sec_Nav (sec)	UTC Seconds	NAV_SI	
VCTU_Pwr_Removal_Failed	Variable Camber Trim Unit (VCTU)Power Removal Failed	HLF_SI	B-10, C-10
Window_Heat_L_Fwd_Bckup_Switch	Left Forward Backup Window Heat Switch Position	FD_SI	B-22, C-22
Window_Heat_L_Fwd_Switch	Left Forward Window Heat Switch Position	FD_SI	B-22, C-22
Window_Heat_L_Side_Switch	Left Side Window Heat Switch Position	FD_SI	B-22, C-22
Window_Heat_R_Fwd_Bckup_Switch	Right Forward Backup Window Head Switch Position	FD_SI	B-22, C-22
Window_Heat_R_Fwd_Switch	Right Forward Window Heat Switch Position	FD_SI	B-22, C-22
Window_Heat_R_Side_Switch	Right Side Window Heat Switch Position	FD_SI	B-22, C-22
WindowHt_L1_BU_Load_Cur (A)	L1 Backup Window Heat Current	BPCU_SI	B-22, C-22
WindowHt_L1_PHA_Load_Cur (A)	L1 Window Heat Phase A Current	BPCU_SI	B-22, C-22
WindowHt_L1_PHB_Load_Cur (A)	L1 Window Heat Phase B Current	BPCU_SI	B-22, C-22
WindowHt_L2_Load_Cur (A)	L2 Window Heat Current	BPCU_SI	B-22, C-22
WindowHt_R1_BU_Load_Cur (A)	R1 Backup Window Heat Current	BPCU_SI	B-22, C-22
WindowHt_R1_PHA_Load_Cur (A)	R1 Window Heat Phase A Current	BPCU_SI	B-22, C-22
WindowHt_R1_PHB_Load_Cur (A)	R1 Window Heat Phase B Current	BPCU_SI	B-22, C-22
WindowHt_R2_Load_Cur (A)	R2 Window Heat Current	BPCU_SI	B-22, C-22
Wing_Anti-Ice_Switch_Pos	Wing Anti-Ice Switch Position	FD_SI	B-23, C-23
WING_ANTI-ICE_SYS	Wing Ice Protection System (WIPS) Failed Message	DCACAMT_SI	B-23, C-23
WIPS_AC1_Pwr_Use (kVA)	WIPS AC1 Power Draw	WIPS_SI	B-23, C-23
WIPS_AC2_Pwr_Use (kVA)	WIPS AC2 Power Draw	WIPS_SI	B-23, C-23
WIPS_ELCF_State1	WIPS ELCF State 1 Maintenance Page	WIPS_SI	B-23, C-23
WIPS_ELCF_State2	WIPS ELCF State 2 Maintenance Page	WIPS_SI	B-23, C-23
WIPS_ELCF_State3	WIPS ELCF State 3 Maintenance Page	WIPS_SI	B-23, C-23
WIPS_ELCF_State4	WIPS ELCF State 4 Maintenance Page	WIPS_SI	B-23, C-23
WIPS_SI	WIPS Parameters Source Index	EAFR	B-23, C-23
WIPS_VDC1_On	WIPS VDC1 Maintenance Page	WIPS_SI	B-23, C-23
WIPS_VDC2_On	WIPS VDC2 Maintenance Page	WIPS_SI	B-23, C-23
Zone_A1_Duct_Temp_CACTCS_1# (degree F)	CACTCS Zone A1 Duct Temperature		B-21, C-21
Zone_A2_Duct_Temp_CACTCS_1# (degree F)	CACTCS Zone A1 Duct Temperature		B-21, C-21
Zone_B1_Duct_Temp_CACTCS_1# (degree F)	CACTCS Zone B1 Duct Temperature		B-21, C-21
Zone_B2_Duct_Temp_CACTCS_1# (degree F)	CACTCS Zone B2 Duct Temperature		B-21, C-21
Zone_C1_Duct_Temp_CACTCS_1# (degree F)	CACTCS Zone C1 Duct Temperature		B-21, C-21

Parameter Name (units)	Description	Source Index	Figure Number(s)
Zone_C2_Duct_Temp_CACTCS_1# (degree F)	CACTCS Zone C2 Duct Temperature		B-21, C-21
Zone_D1_Duct_Temp_CACTCS_1# (degree F)	CACTCS Zone D1 Duct Temperature		B-21, C-21
Zone_D2_Duct_Temp_CACTCS_1# (degree F)	CACTCS Zone D2 Duct Temperature		B-21, C-21

Table A-1 Notes:

1) 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.

2) Parameters with a source index of EAFR are parameters generated within the EAFR for documentation of the recorded data.

3) Parameters without a source index are only available from a single source as described in Section 4.1.2

4) Parameters which do not have a units value in parentheses after the name are discrete parameters which have no units associated with them. A discrete parameter 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 abbreviations.

Units Abbreviation	Description
kts	knots
g	g
in	inches
ft	feet
min	minutes
sec	seconds
RPM	revolutions per minute
%RPM	percent revolutions per minute
%open	percent open (max electrical load)
V	volts
A	amps
kVA	kilovolt-amp
lbs/hr	pounds per hour
lbs/min	pounds per minute
PSID	pounds per square inch differential
PSIA	pounds per square inch absolute
Qt US	US quarts

APPENDIX B

This appendix contains plots of data from the flight data recording of the forward EAFR. Figures B-1 through B-23 show selected parameters for the 9:58 EST to 10:32 EST time period, which begins approximately two minutes prior to touchdown in Boston. Selected events from the timeline of FDR events (Table 1) are annotated on the plots for reference. When a plot includes a parameter that is available from multiple sources, the related source index parameter is also included in the plot. Table A-1 of Appendix A includes a column indicating source index parameter for each parameter where applicable.

Figure B-1. Acceleration parameters.
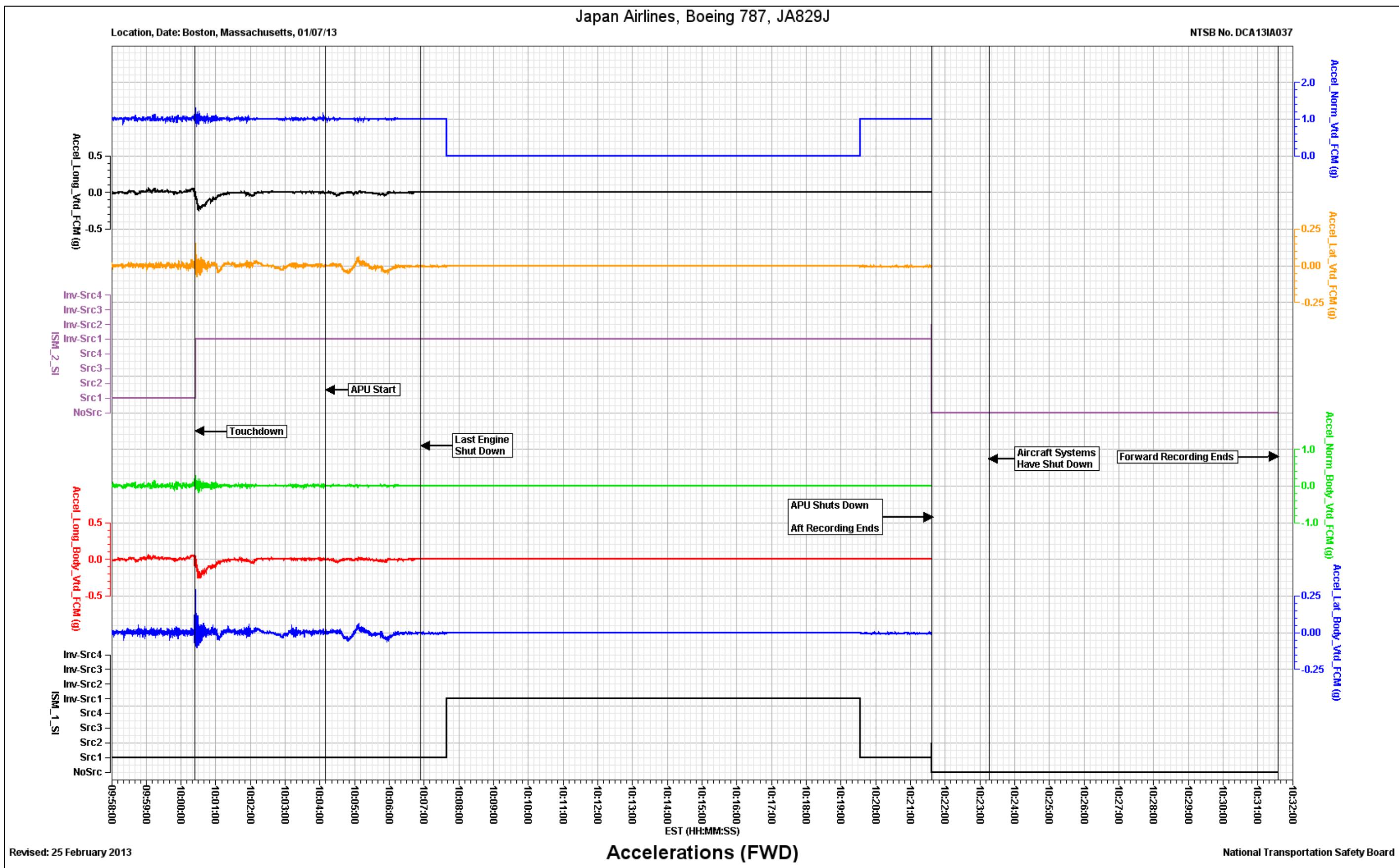
Figure B-2. Position parameters.
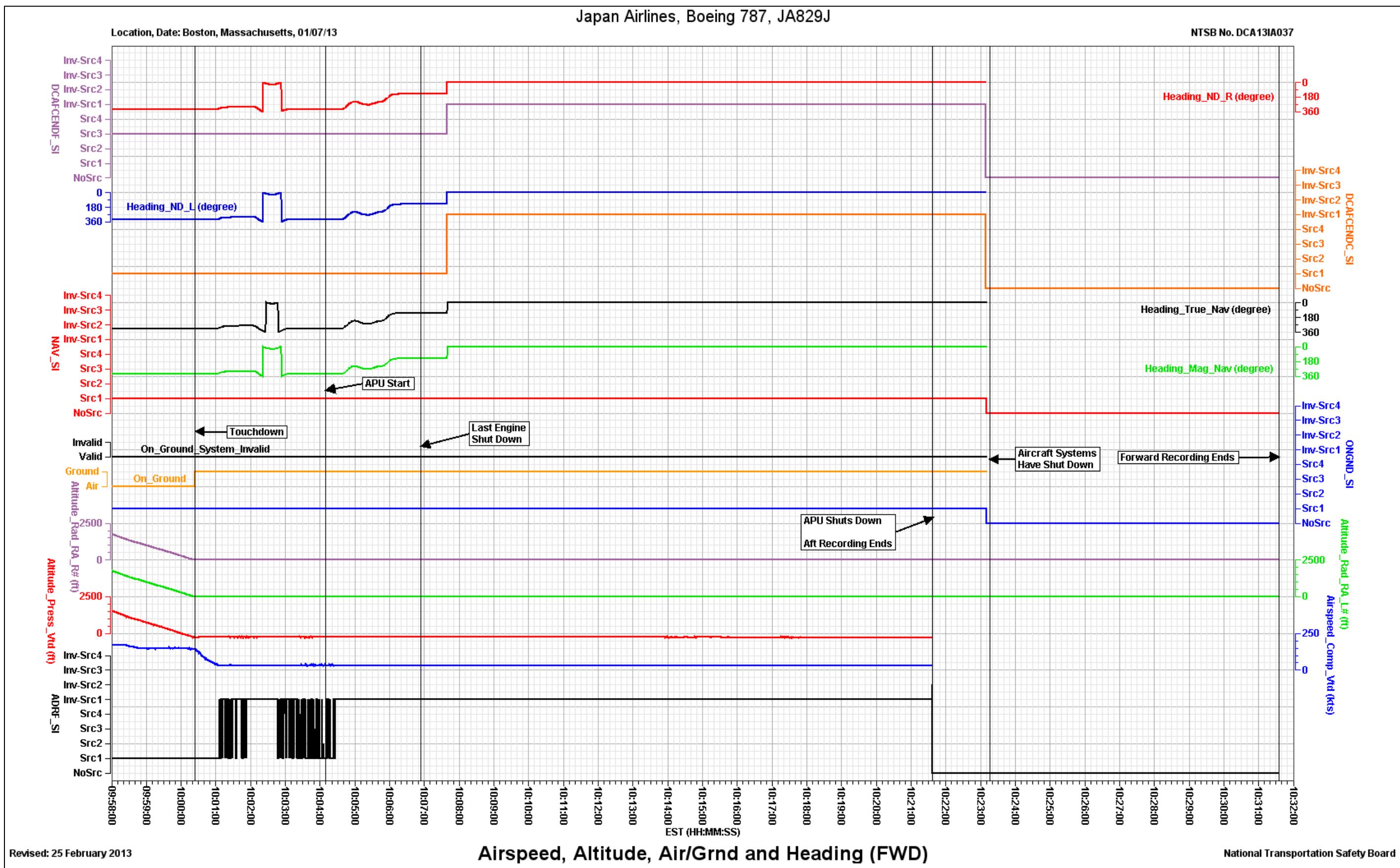
Figure B-3. First set of APU related parameters.
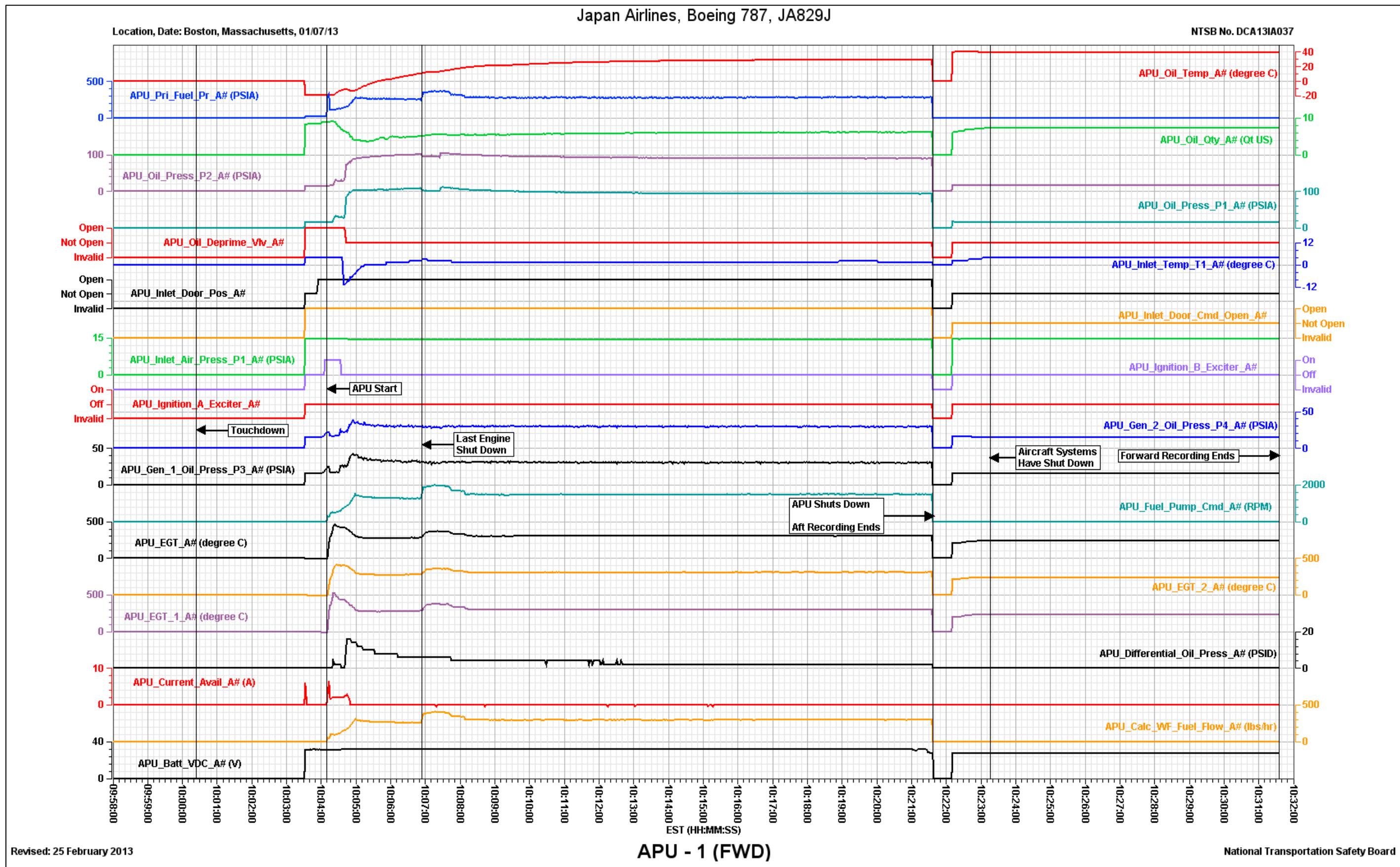
Figure B-4. Second set of APU related parameters.
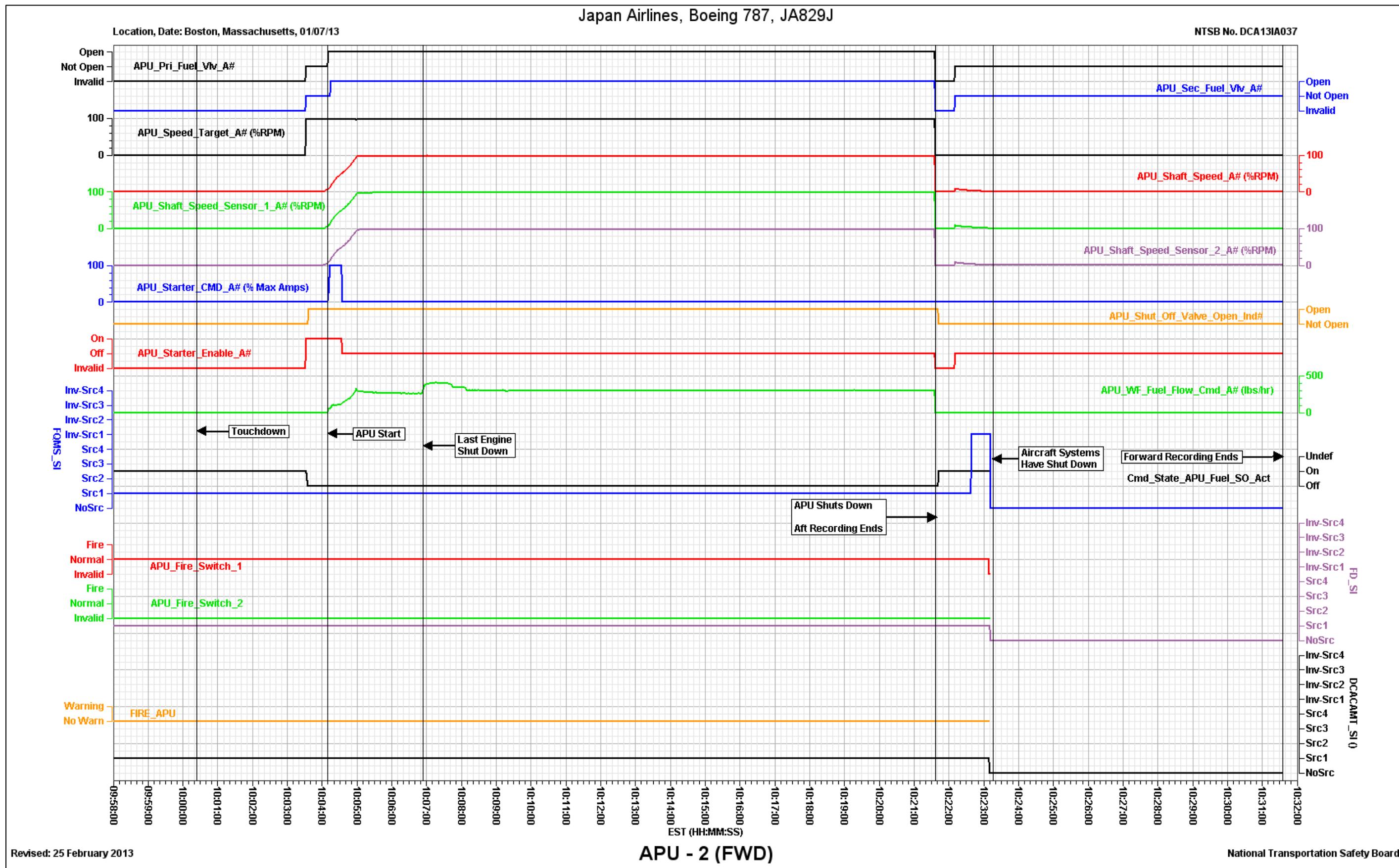
Figure B-5. First set of parameters indicating the state of the data network.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Data Network EICAS Messages - 1 (FWD)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board

DCA13IA037
FDR Factual Report, page 10B-6
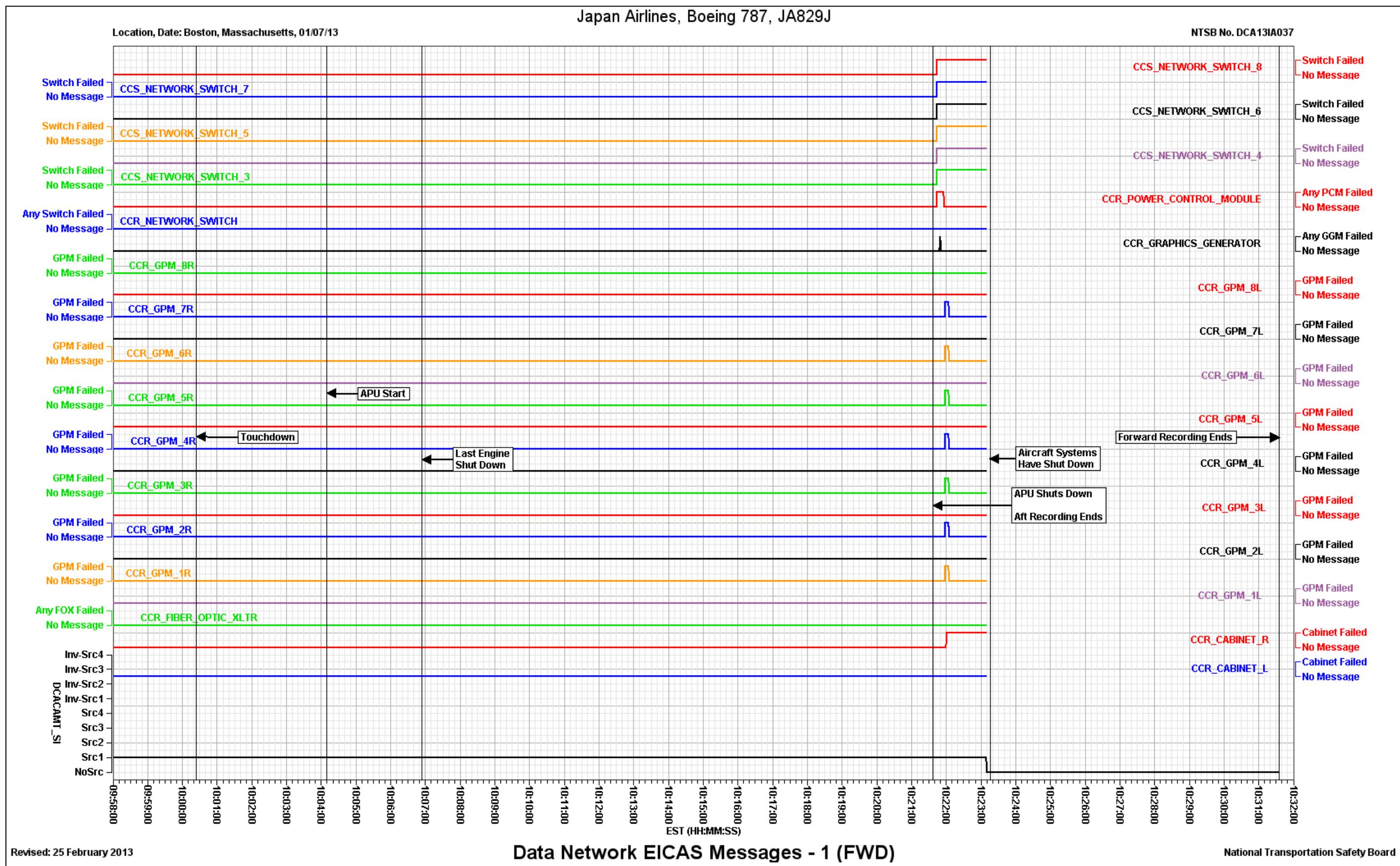
Figure B-6. Second set of parameters indicating the state of the data network.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Data Network and Fire EICAS Msgs - 2 (FWD)

Revised: 25 February 2013

National Transportation Safety Board
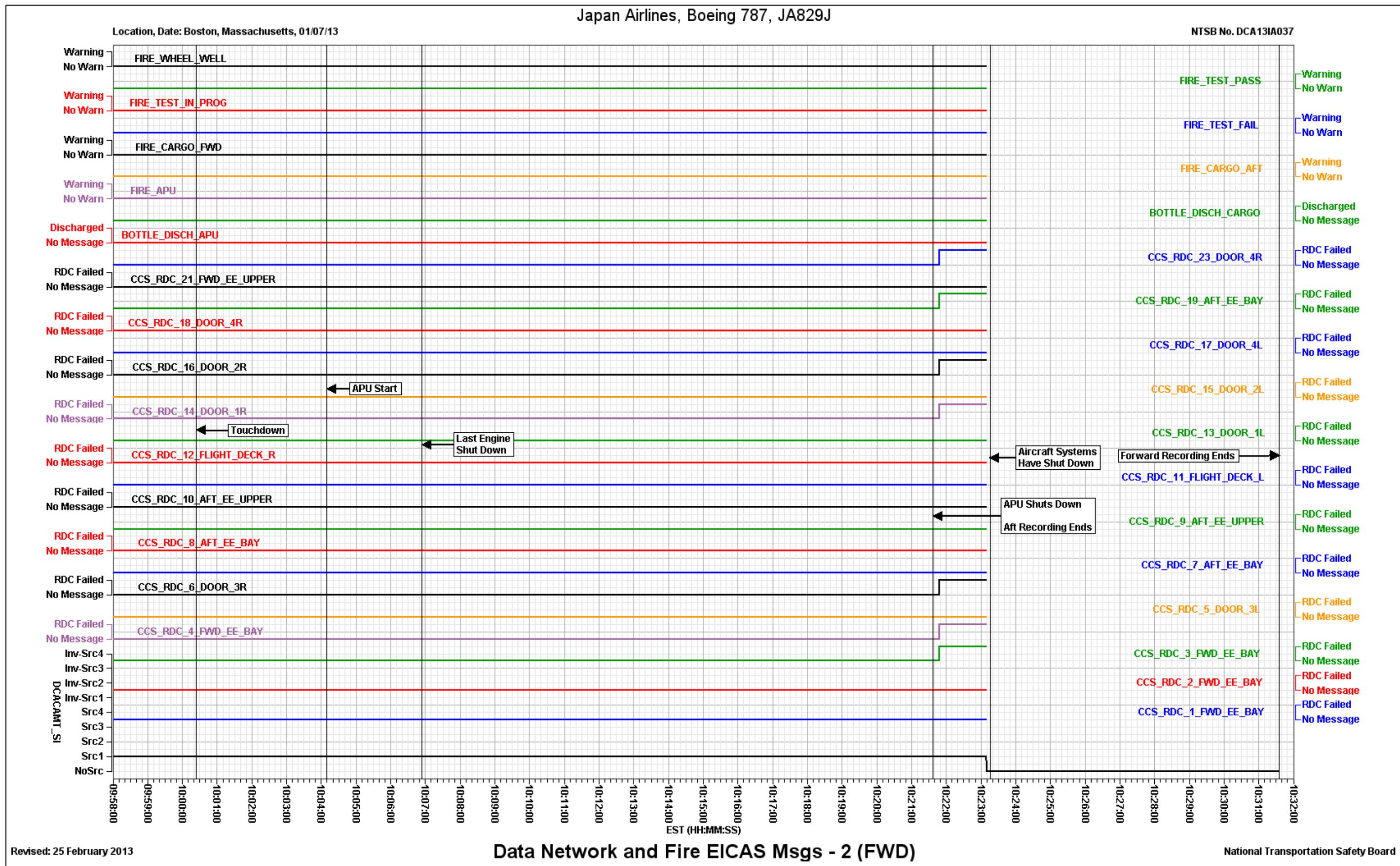
Figure B-7. First set of parameters related to electronic equipment cooling.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Electronics Cooling - 1 (FWD)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board
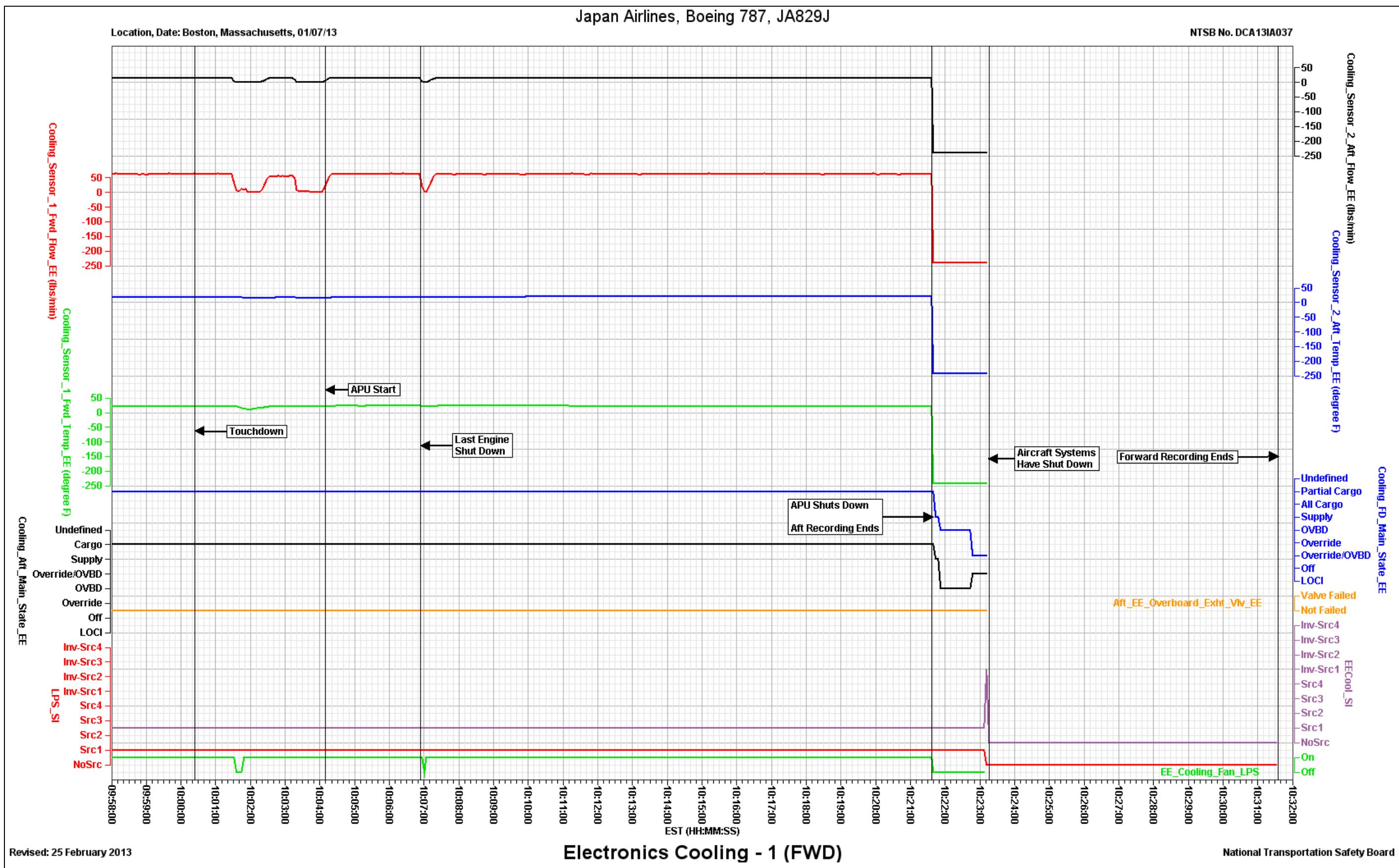
Figure B-8. Second set of parameters related to electronic equipment cooling.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Electronics Cooling - 2 (FWD)

Revised: 25 February 2013

National Transportation Safety Board
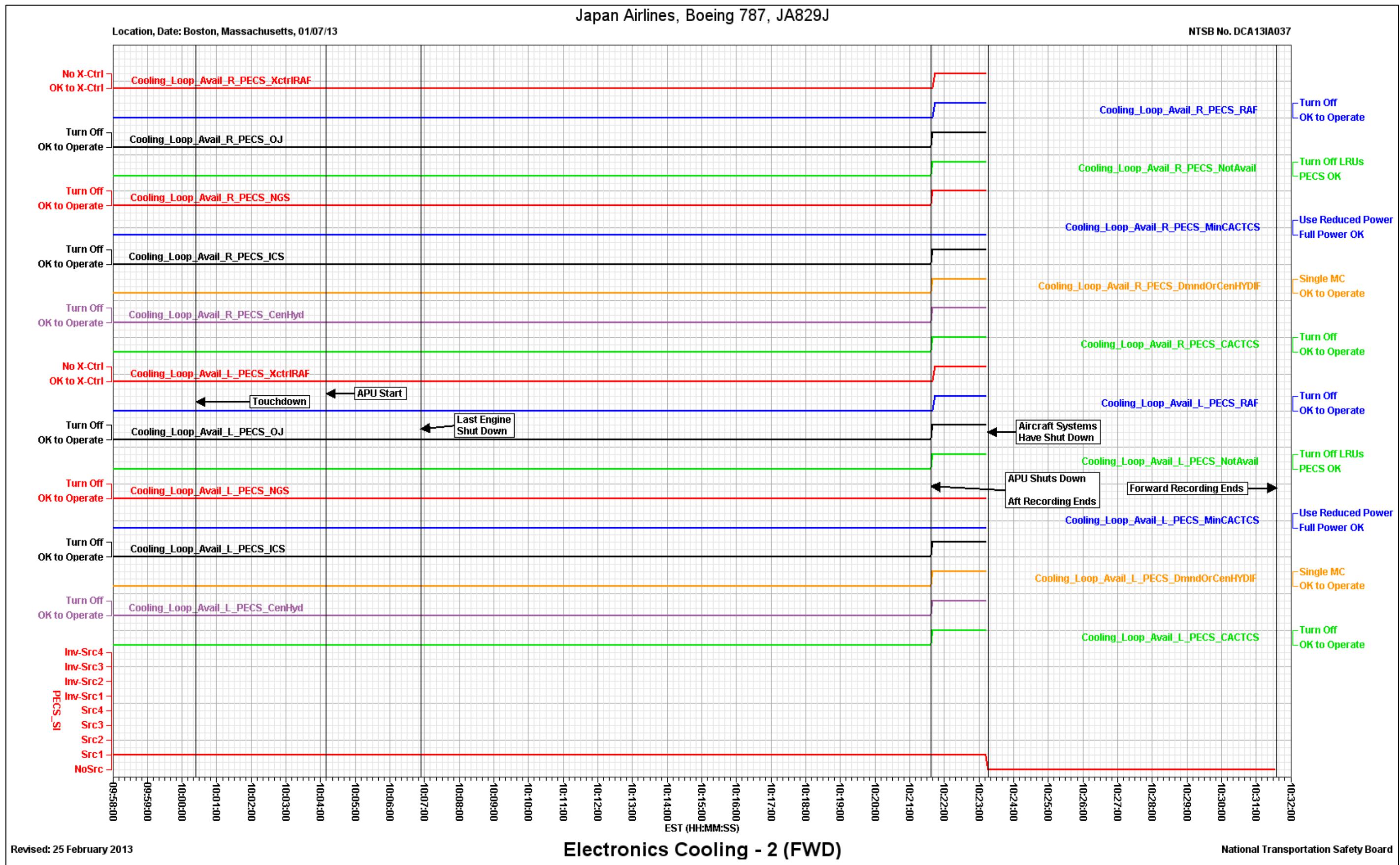
Figure B-9. Electrical EICAS message and power control module discrete parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Electrical EICAS and Misc Discretes (FWD)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board
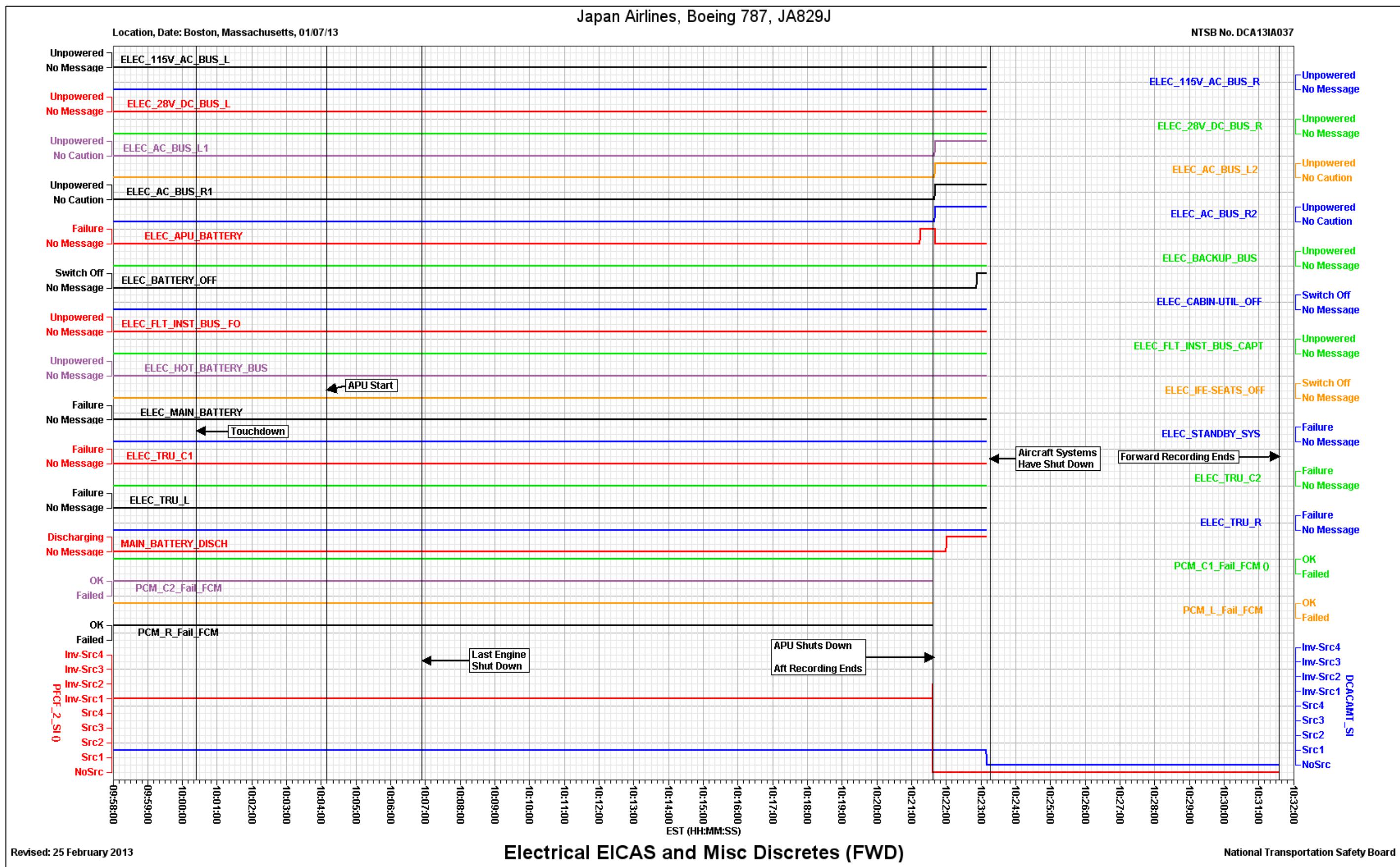
Figure B-10. Parameters indicating engine shut down and setting of parking brake.

Japan Airlines, Boeing 787, JA829J

Engines, Parking Brake and VCTU Power (FWD)
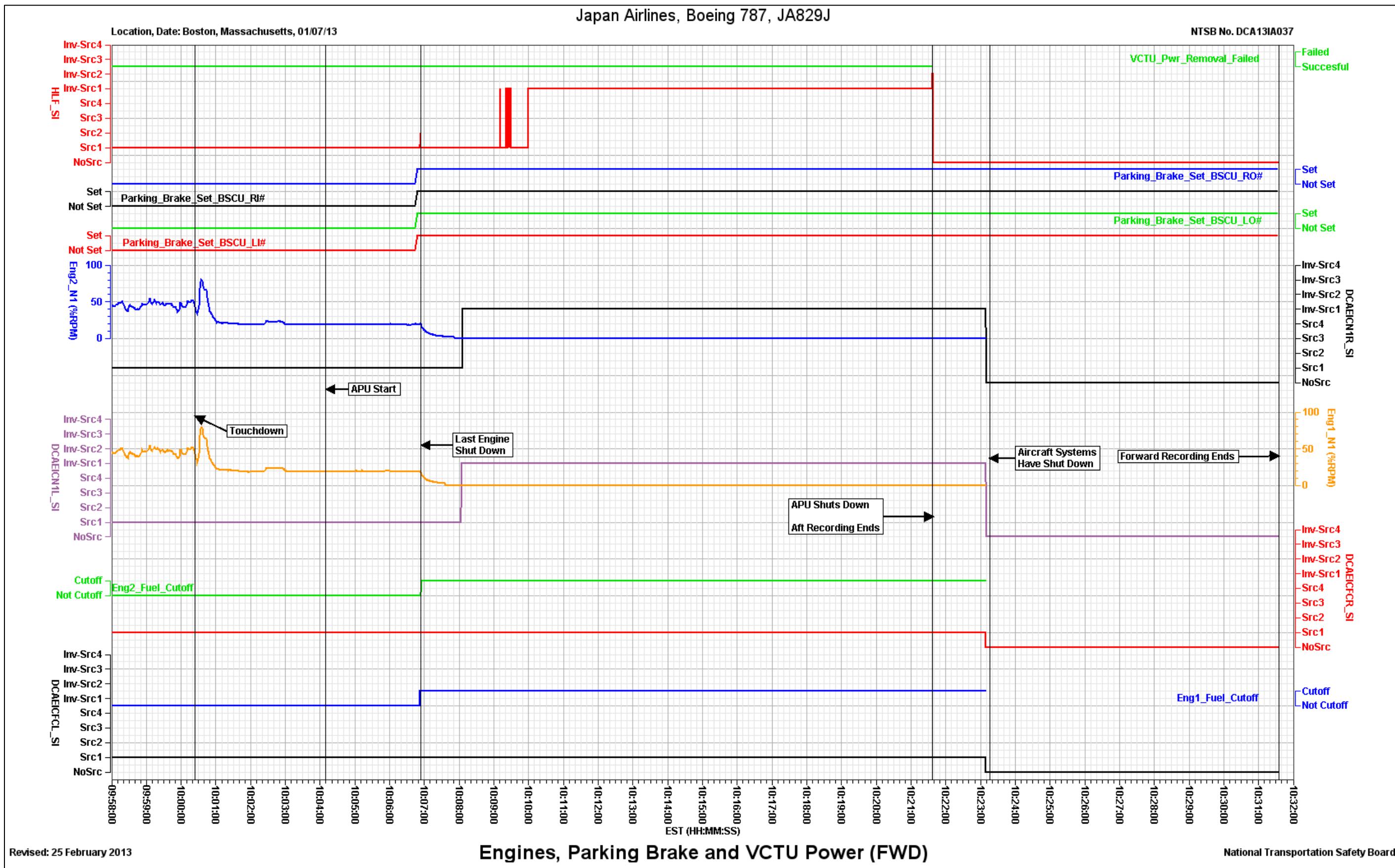
Figure B-11. Hydraulic systems, master warning and caution, and radio keying parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Hydraulics, Mstr Warn/Caut and Radios (FWD)

Revised: 25 February 2013

National Transportation Safety Board
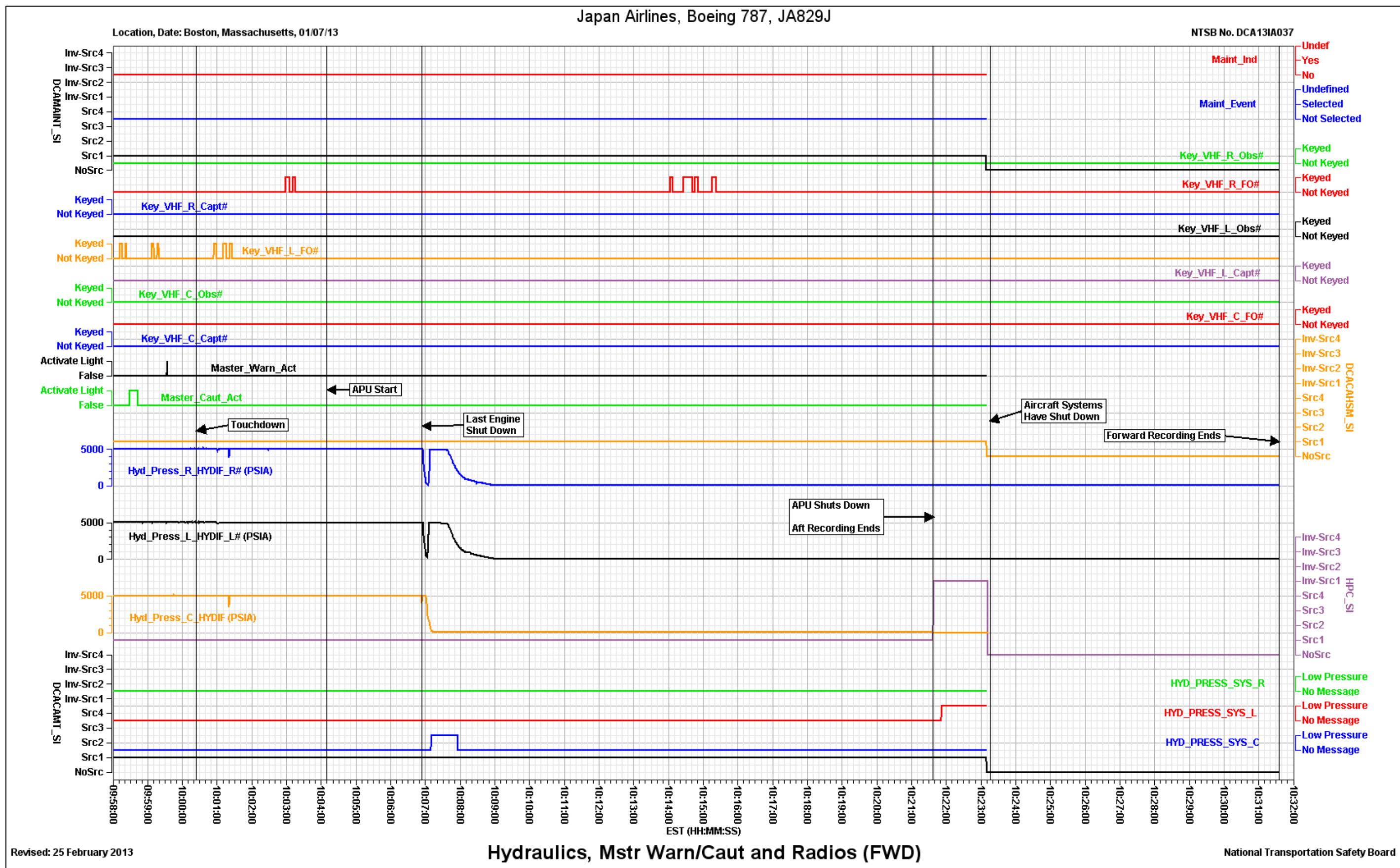
Figure B-12. First set of power generation and distribution parameters.
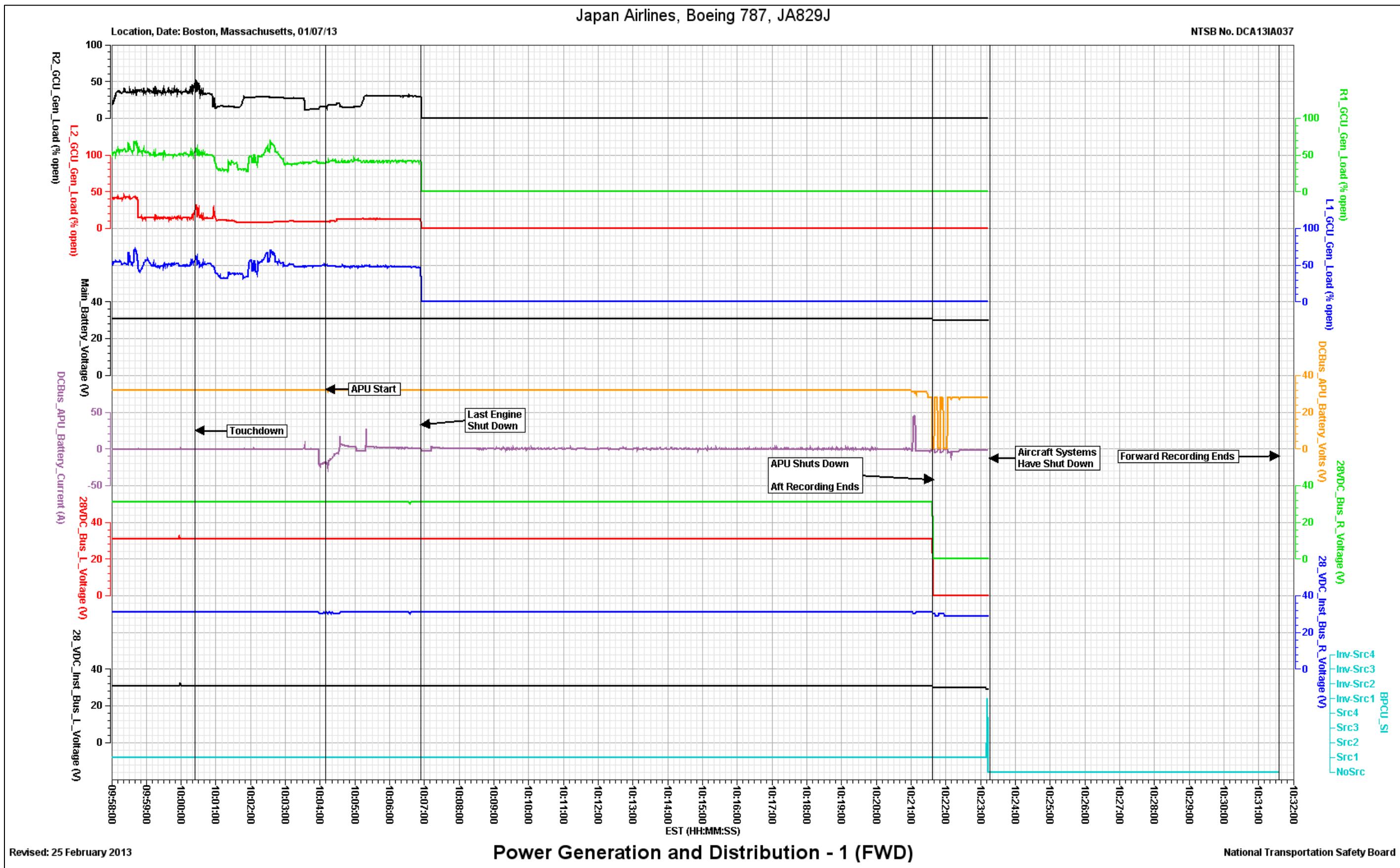
Figure B-13. Second set of power generation and distribution parameters.

Figure B-14. Remote power distribution units 21, 22, 31, and 32 current parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

APU Start

Touchdown

Last Engine
Shut Down

Aircraft Systems
Have Shut Down

Forward Recording Ends

APU Shuts Down

Aft Recording Ends

RPDU 21, 22, 31, 32 Currents (FWD)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board

Figure B-15. Remote power distribution units 41, 42, and 71 current parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Touchdown

APU Start

Last Engine Shut Down

APU Shuts Down

Aft Recording Ends

Aircraft Systems Have Shut Down

Forward Recording Ends

RPDU 41, 42, 71 Currents (FWD)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board

DCA13IA037
FDR Factual Report, page 10B-16
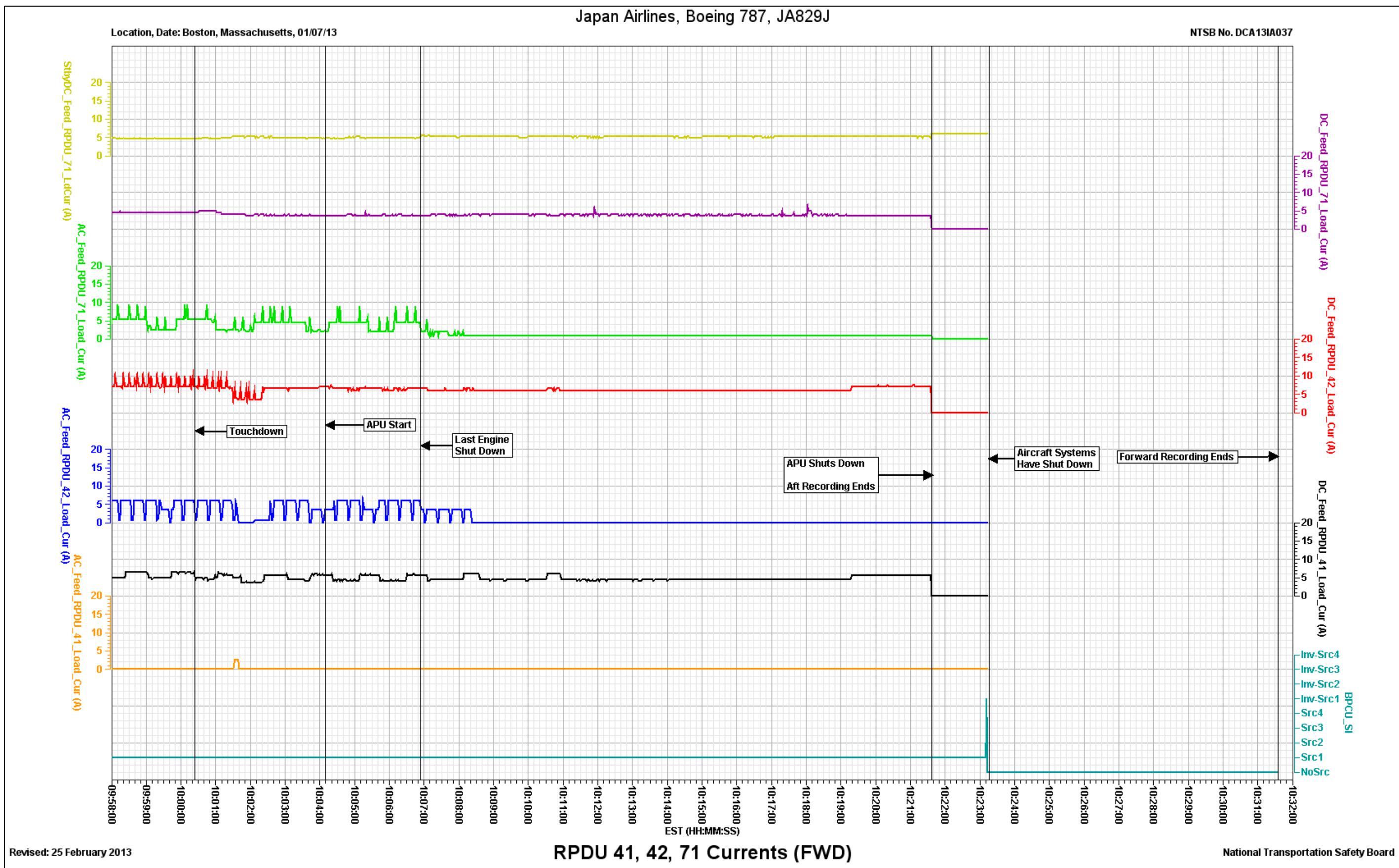
Figure B-16. Remote power distribution units 72, 73, and 74 current parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

APU Start

Touchdown

Last Engine
Shut Down

Aircraft Systems
Have Shut Down

Forward Recording Ends

APU Shuts Down

Aft Recording Ends

EST (HH:MM:SS)

RPDU 72, 73, 74 Currents (FWD)

Revised: 25 February 2013

National Transportation Safety Board

DCA13IA037
FDR Factual Report, page 10B-17
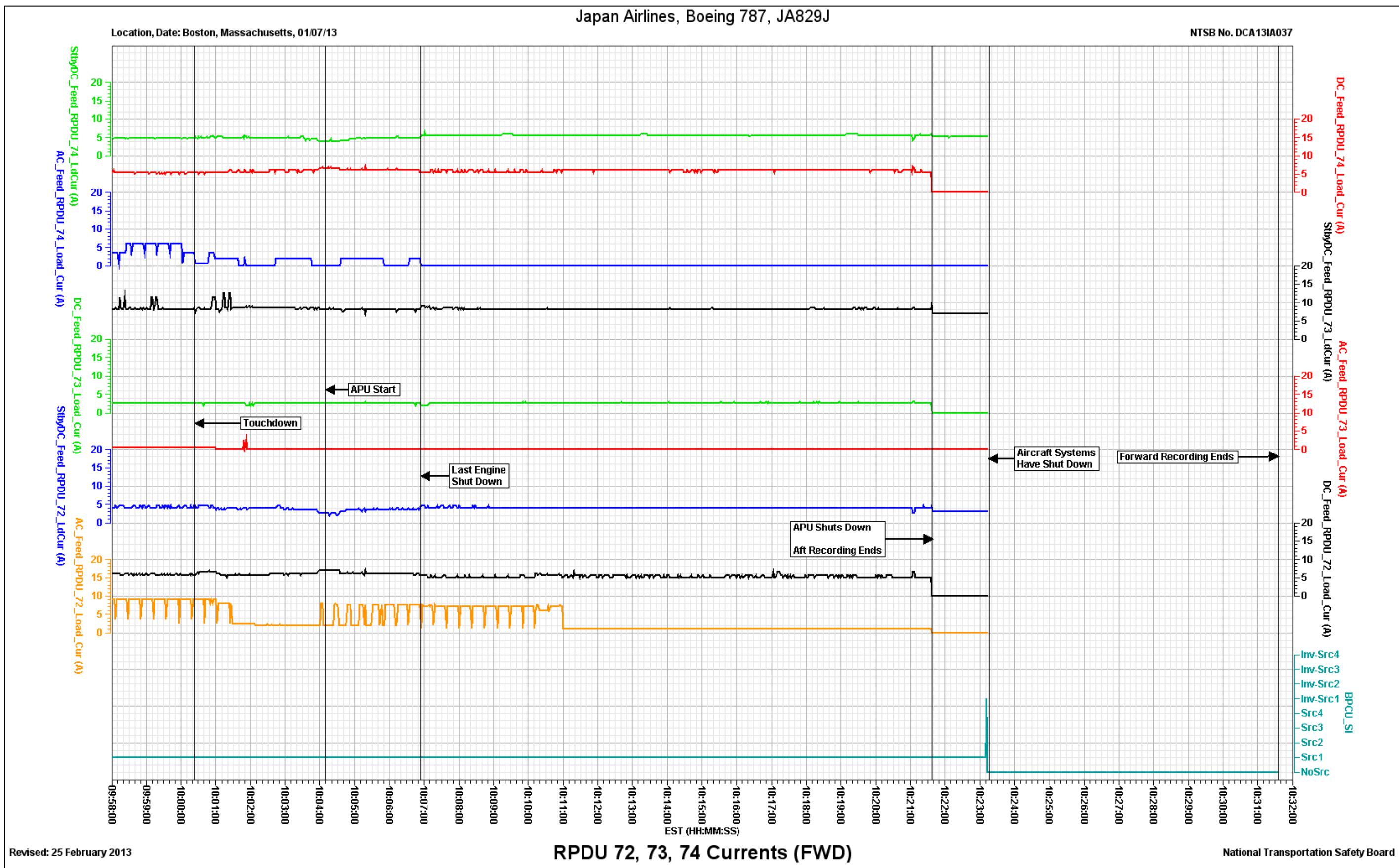
Figure B-17. Remote power distribution units 75, 76, 81, and 82 current parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

APU Start

Touchdown

Last Engine Shut Down

Aircraft Systems Have Shut Down

Forward Recording Ends

APU Shuts Down

Aft Recording Ends

EST (HH:MM:SS)

Revised: 25 February 2013

RPDU 75, 76, 81, 82 Currents (FWD)

National Transportation Safety Board

DCA13IA037
FDR Factual Report, page 10B-18
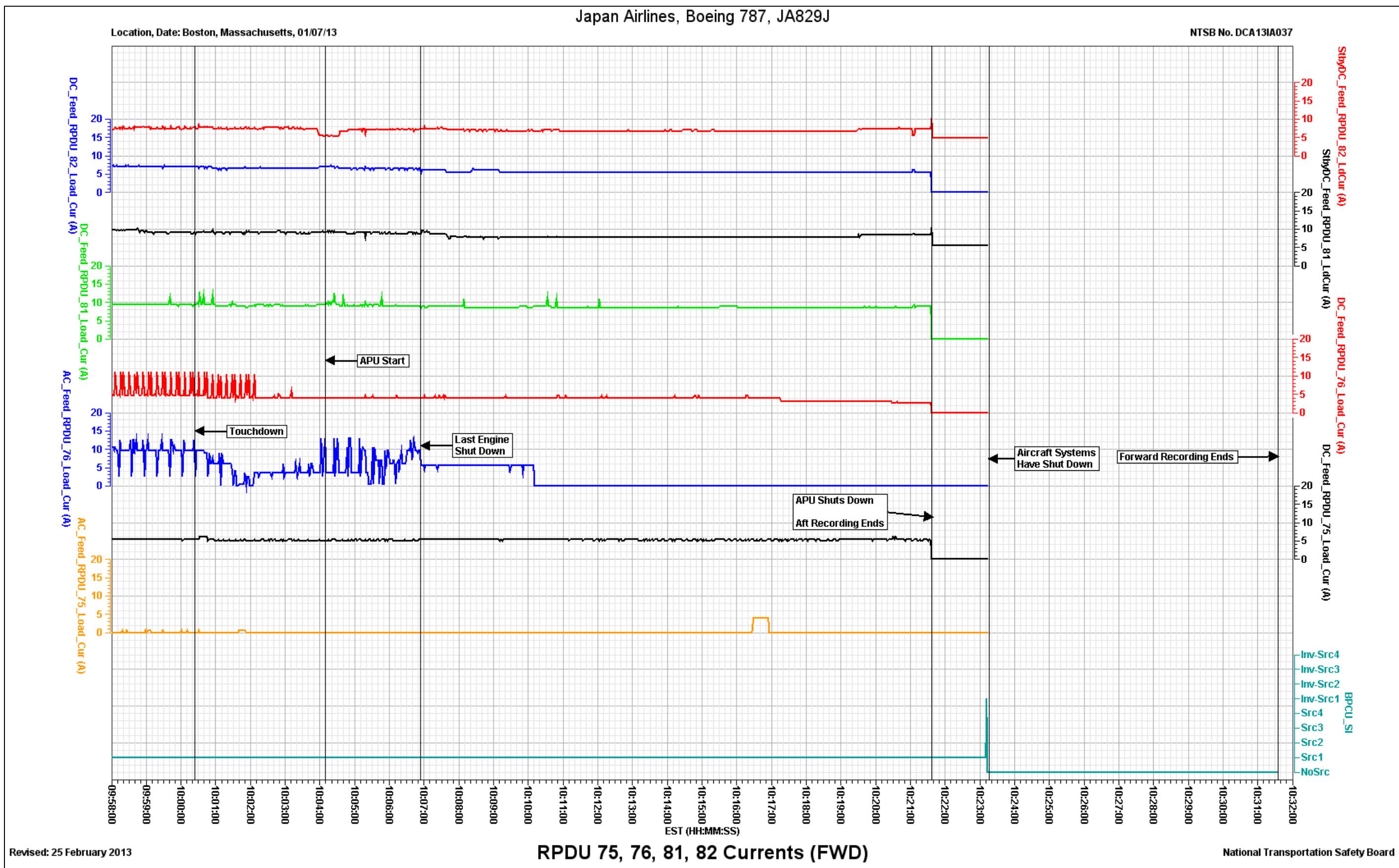
Figure B-18. Remote power distribution units 83, 84, and 92 current parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

APU Start

Touchdown

Last Engine Shut Down

Aircraft Systems Have Shut Down

Forward Recording Ends

APU Shuts Down

Aft Recording Ends

RPDU 83, 84, 92 Currents (FWD)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board

DCA13IA037
FDR Factual Report, page 10B-19
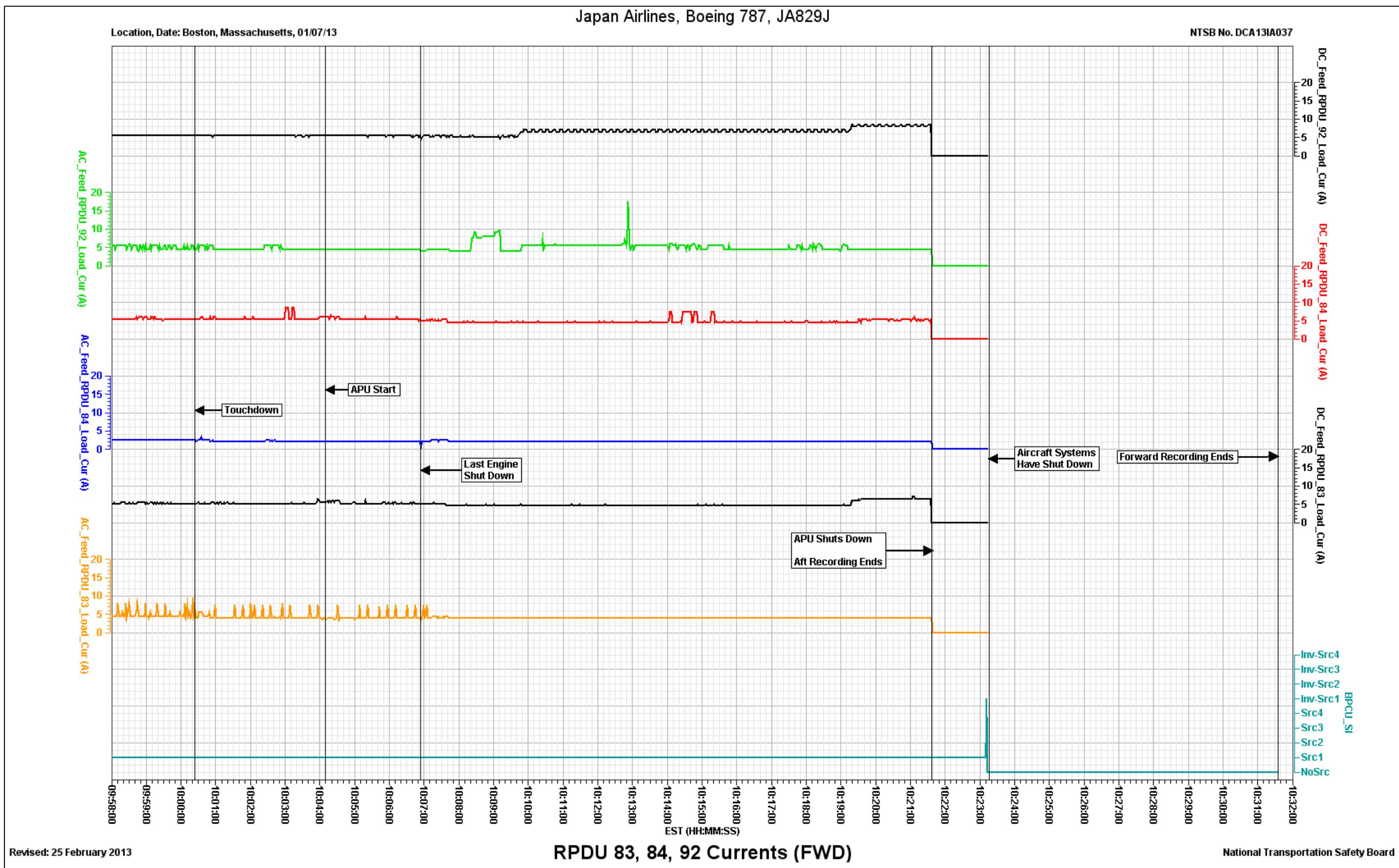
Figure B-19. First set of ventilation systems parameters.
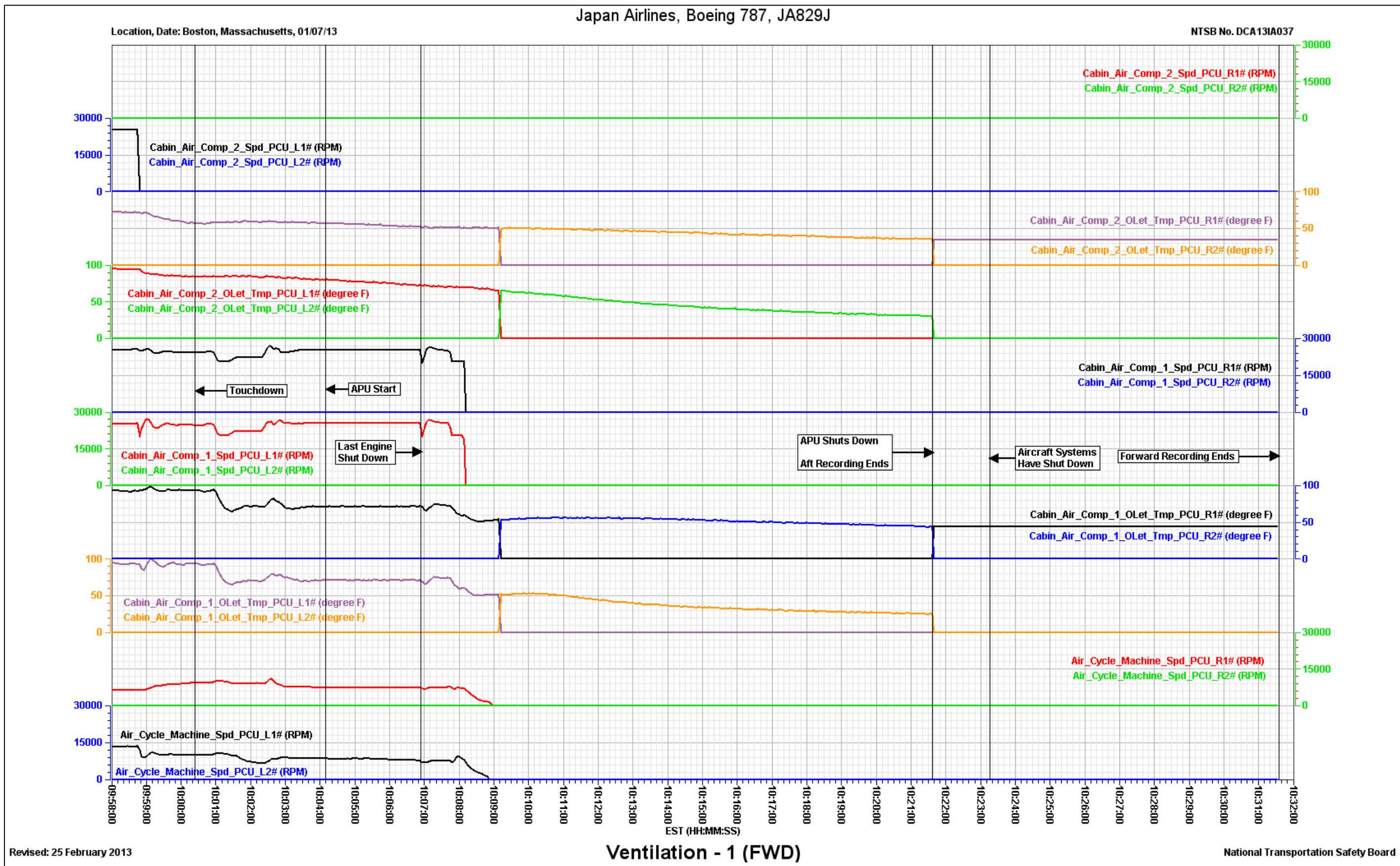
Figure B-20. Second set of ventilation systems parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Ventilation - 2 (FWD)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board

Figure B-21. Third set of ventilation systems parameters.
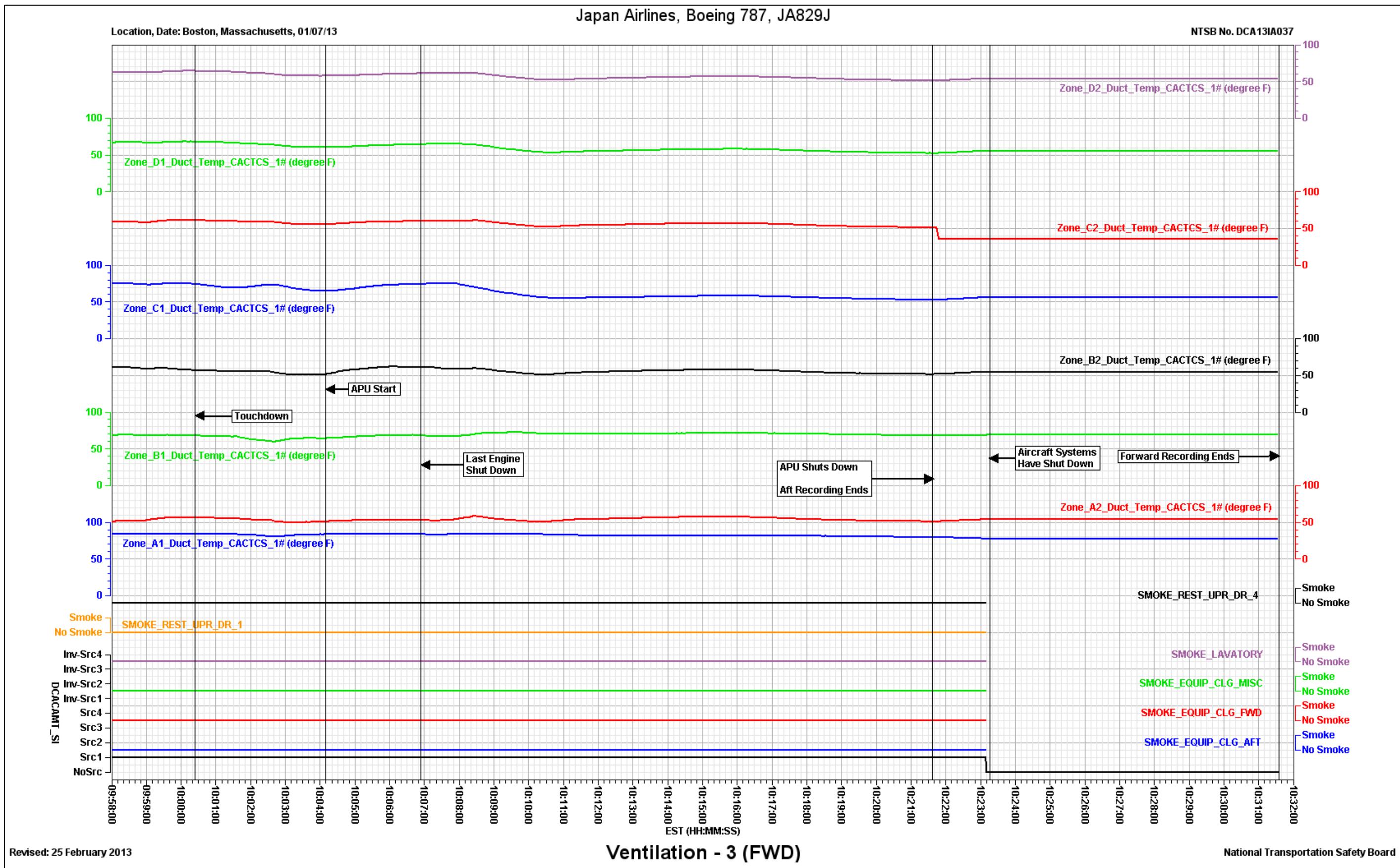
Figure B-22. Window heat parameters.
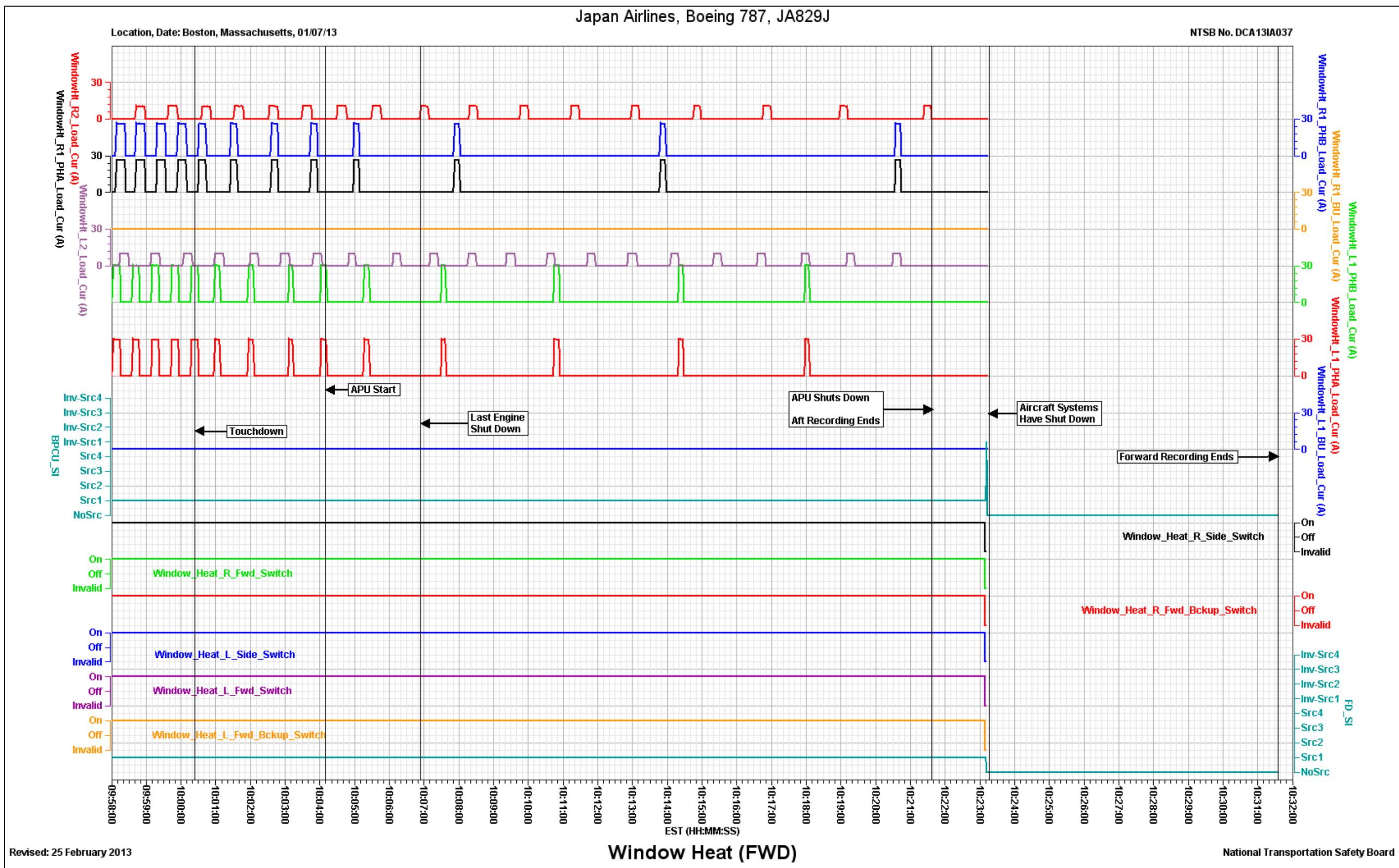
Figure B-23. Wing ice protection system parameters.
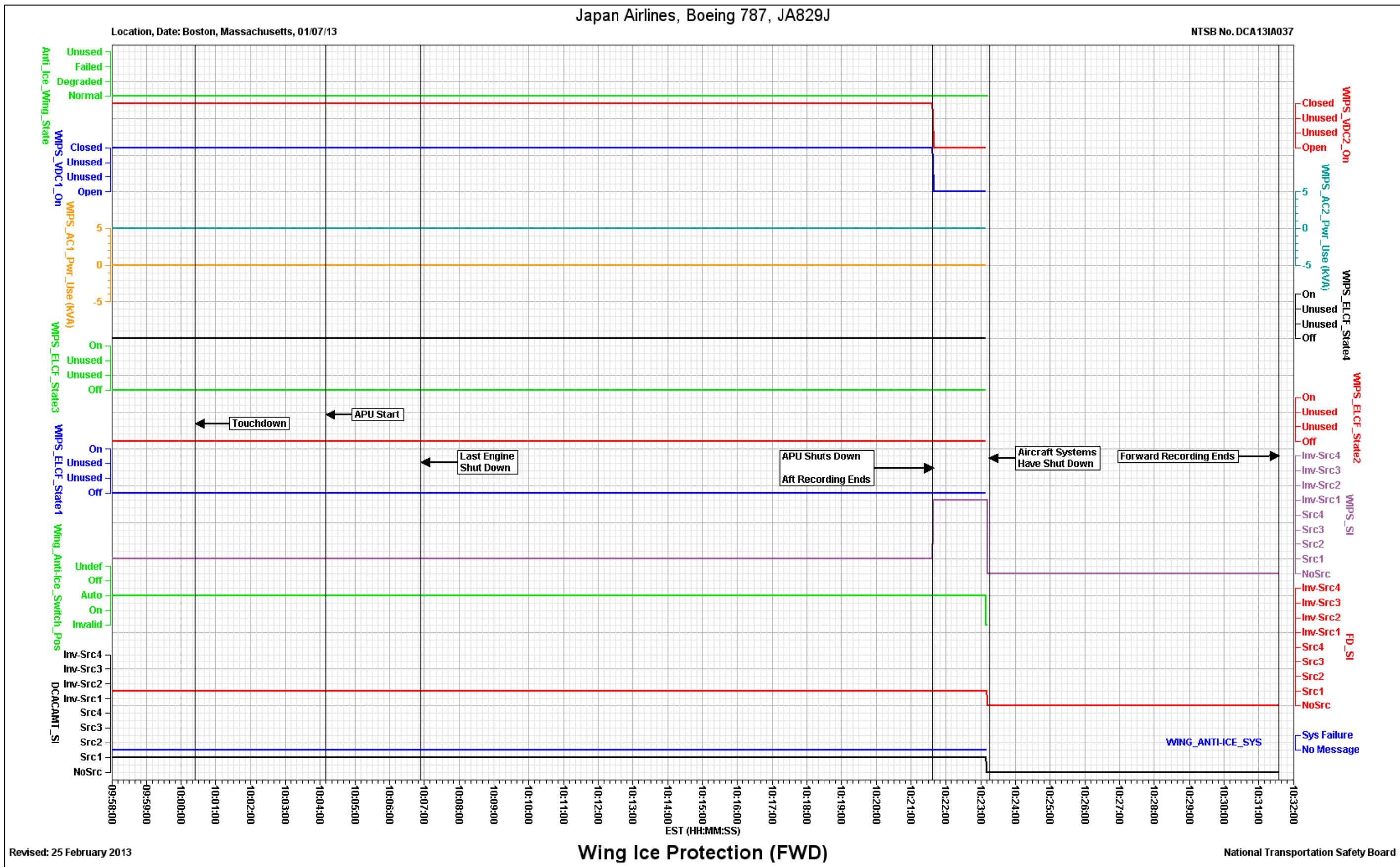
APPENDIX C

This appendix contains plots of data from the flight data recording of the aft EAFR. Figures C-1 through C-23 show selected parameters for the 9:58 EST to 10:32 EST time period, which begins approximately two minutes prior to touchdown in Boston. Selected events from the timeline of FDR events (Table 1) are annotated on the plots for reference. When a plot includes a parameter that is available from multiple sources, the related source index parameter is also included in the plot. Table A-1 of Appendix A includes a column indicating source index parameter for each parameter where applicable.

Figure C-1. Acceleration parameters.
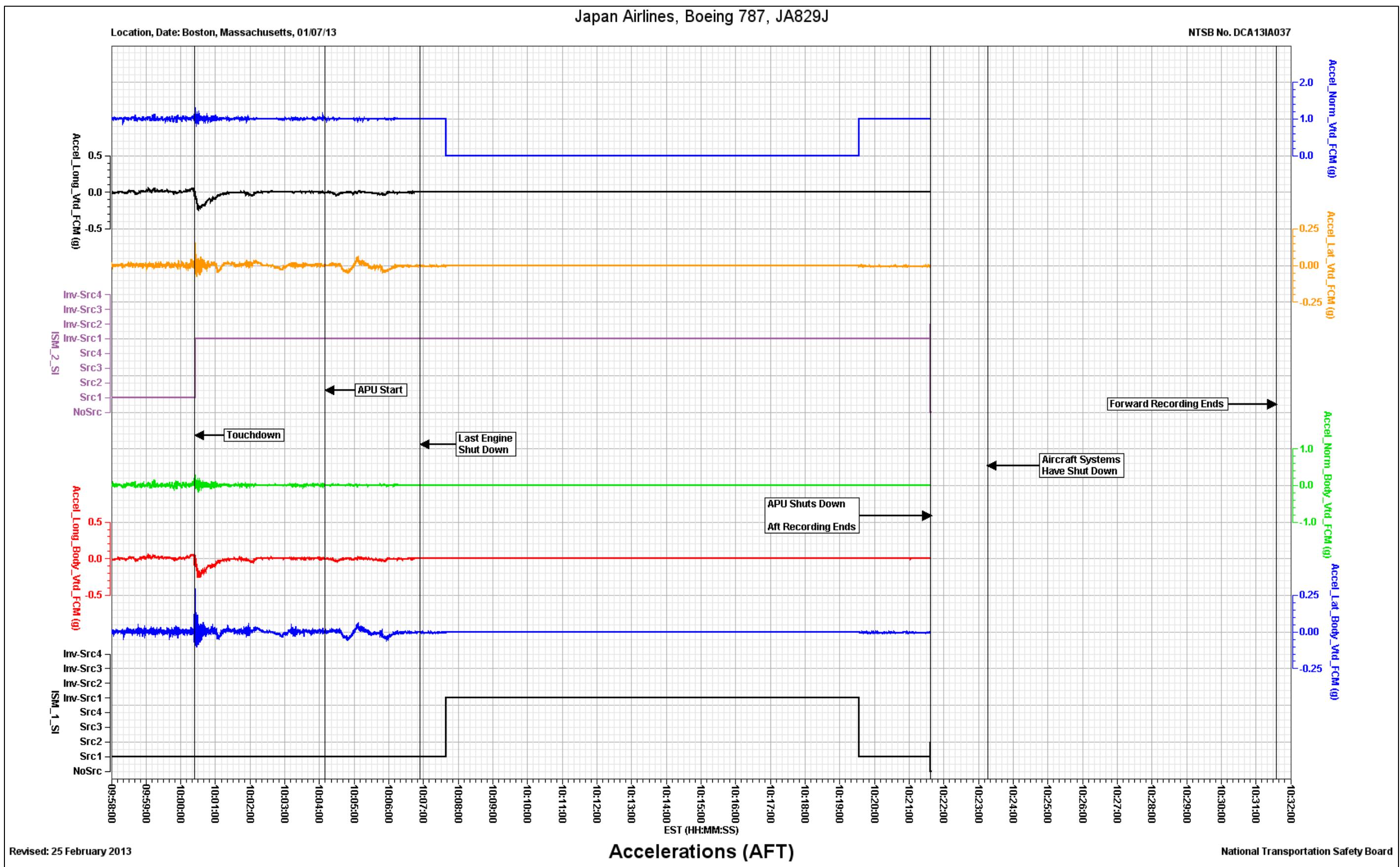
Figure C-2. Position parameters.
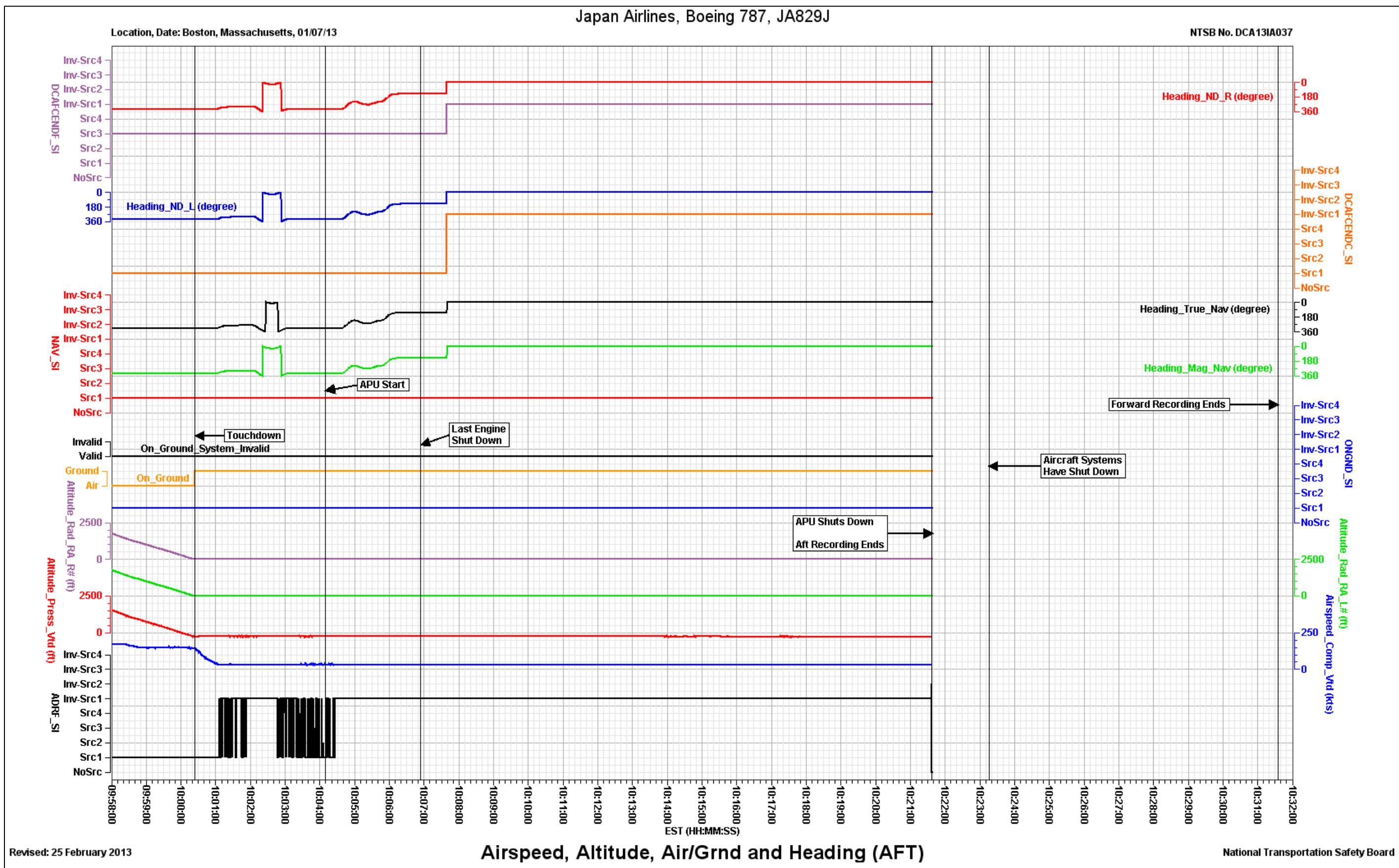
Figure C-3. First set of APU related parameters.
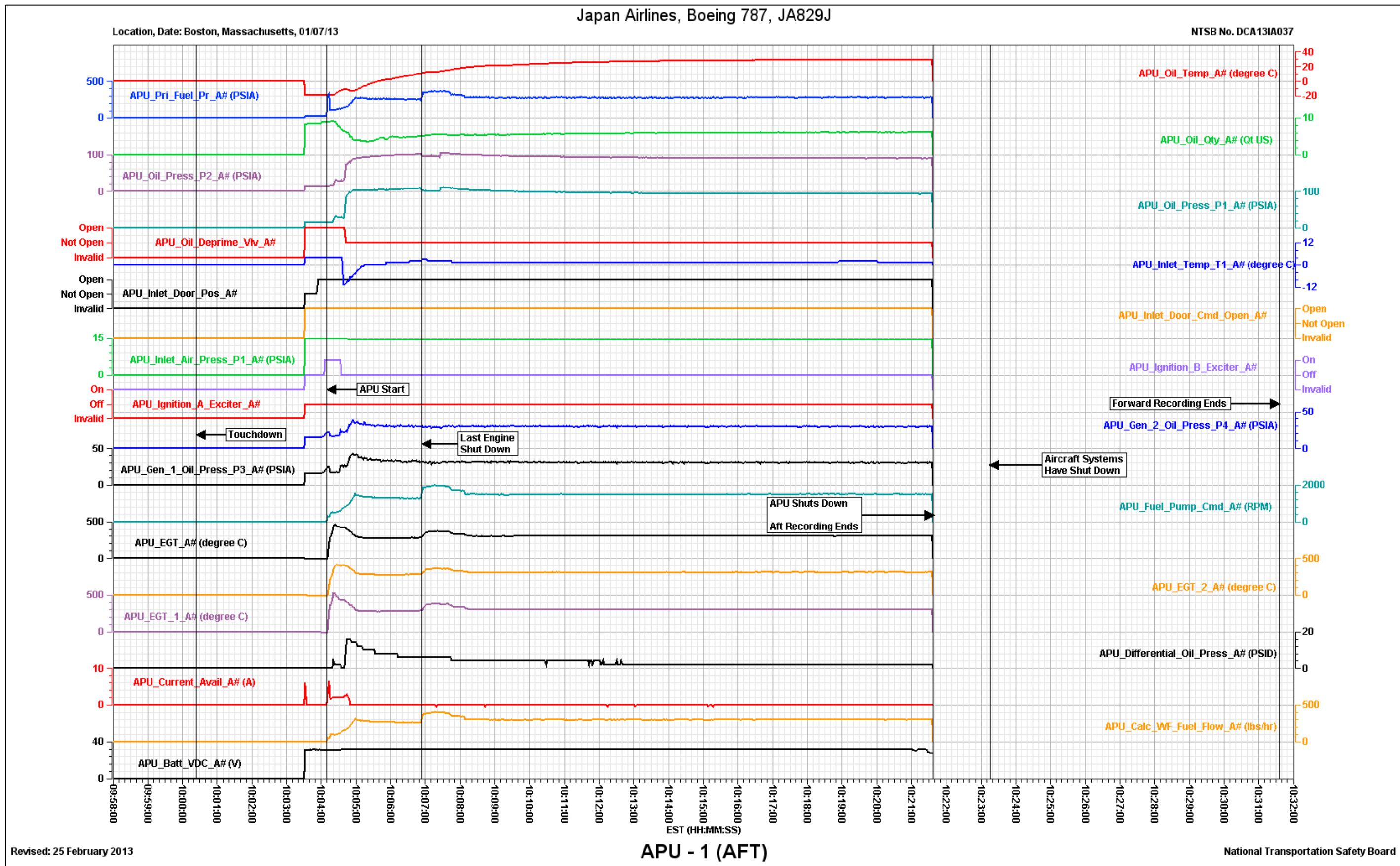
Figure C-4. Second set of APU related parameters.
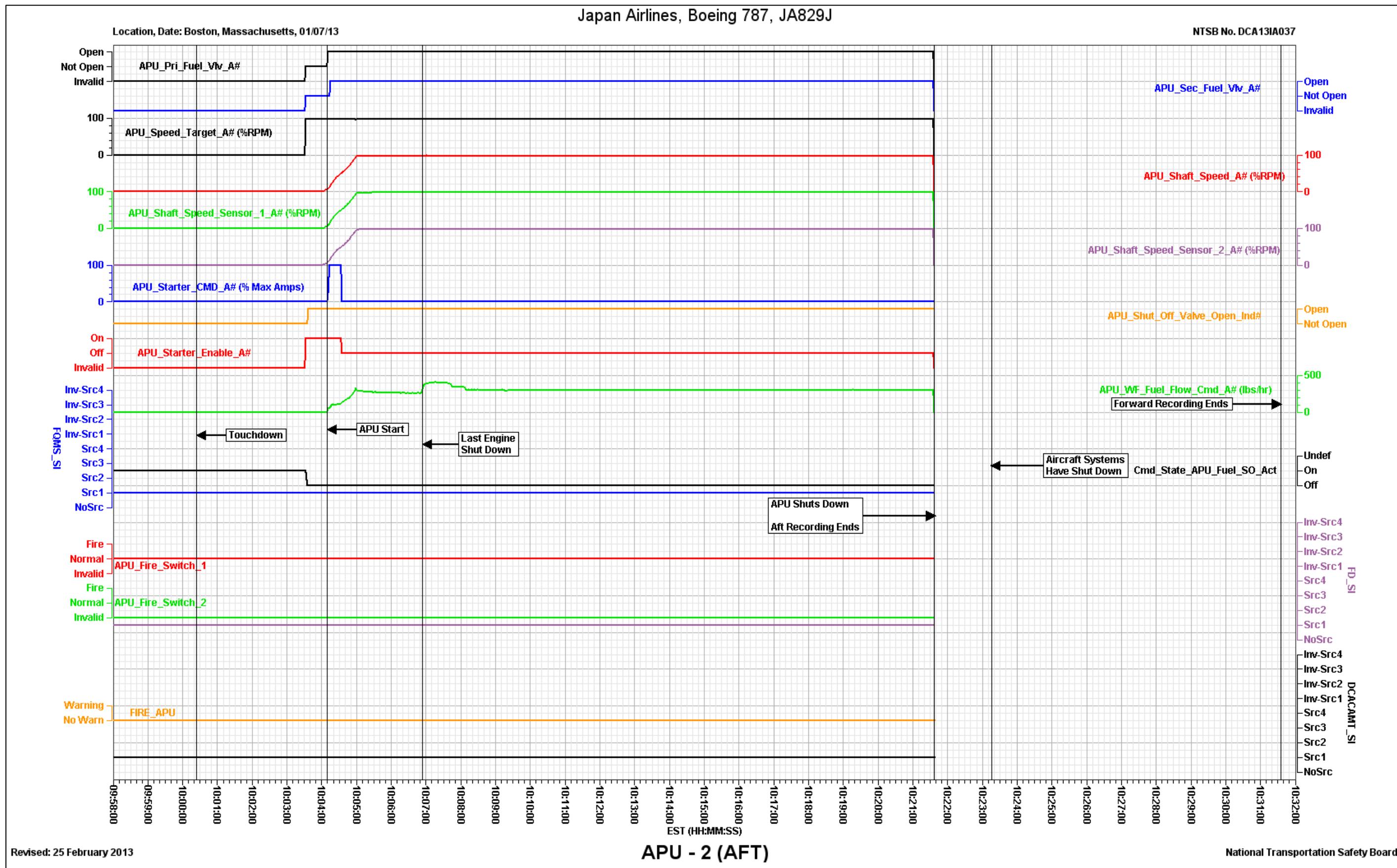
Figure C-5. First set of parameters indicating the state of the data network.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Revised: 25 February 2013

Data Network EICAS Messages - 1 (AFT)

EST (HH:MM:SS)

National Transportation Safety Board
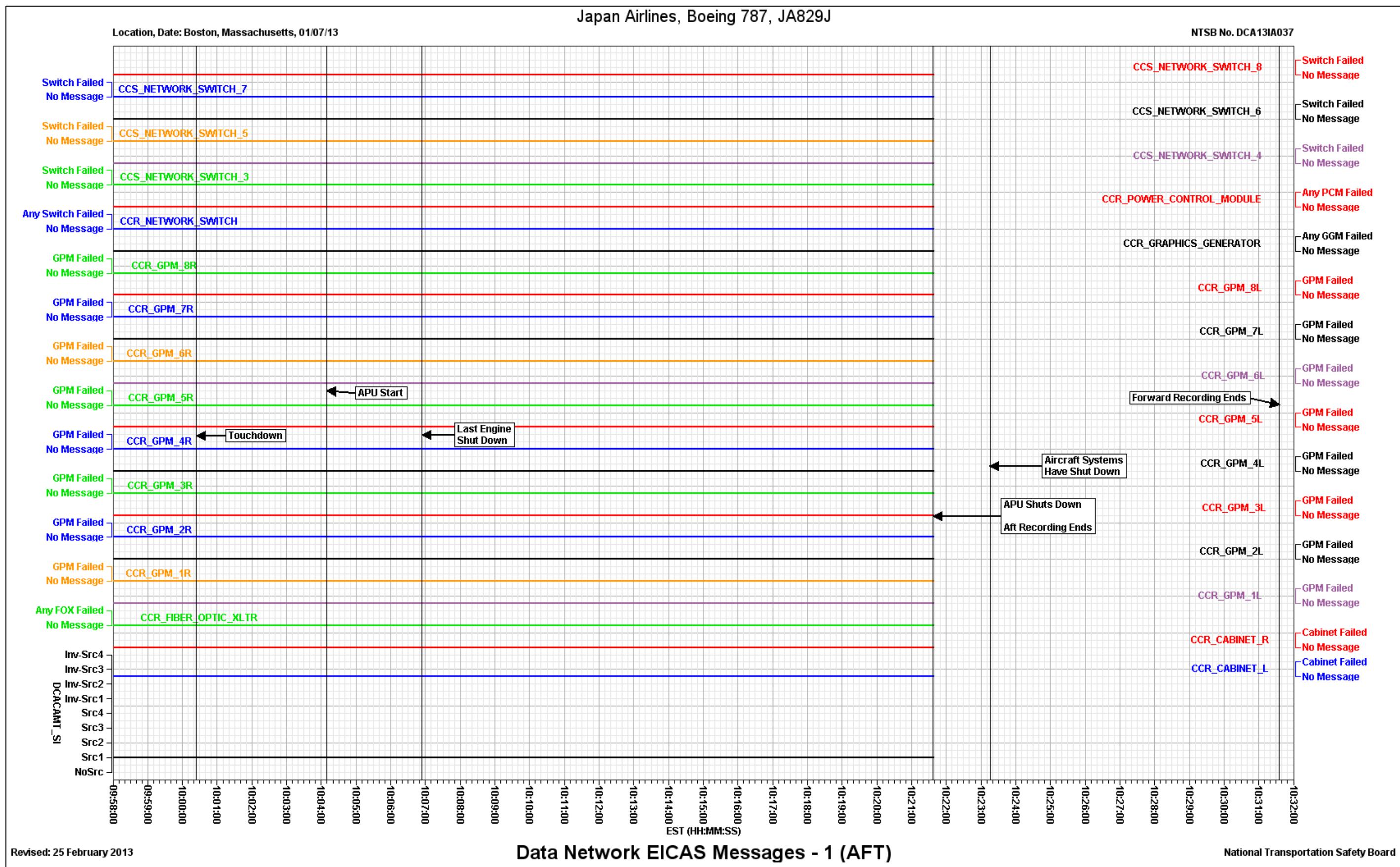
Figure C-6. Second set of parameters indicating the state of the data network.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Data Network and Fire EICAS Msgs - 2 (AFT)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board
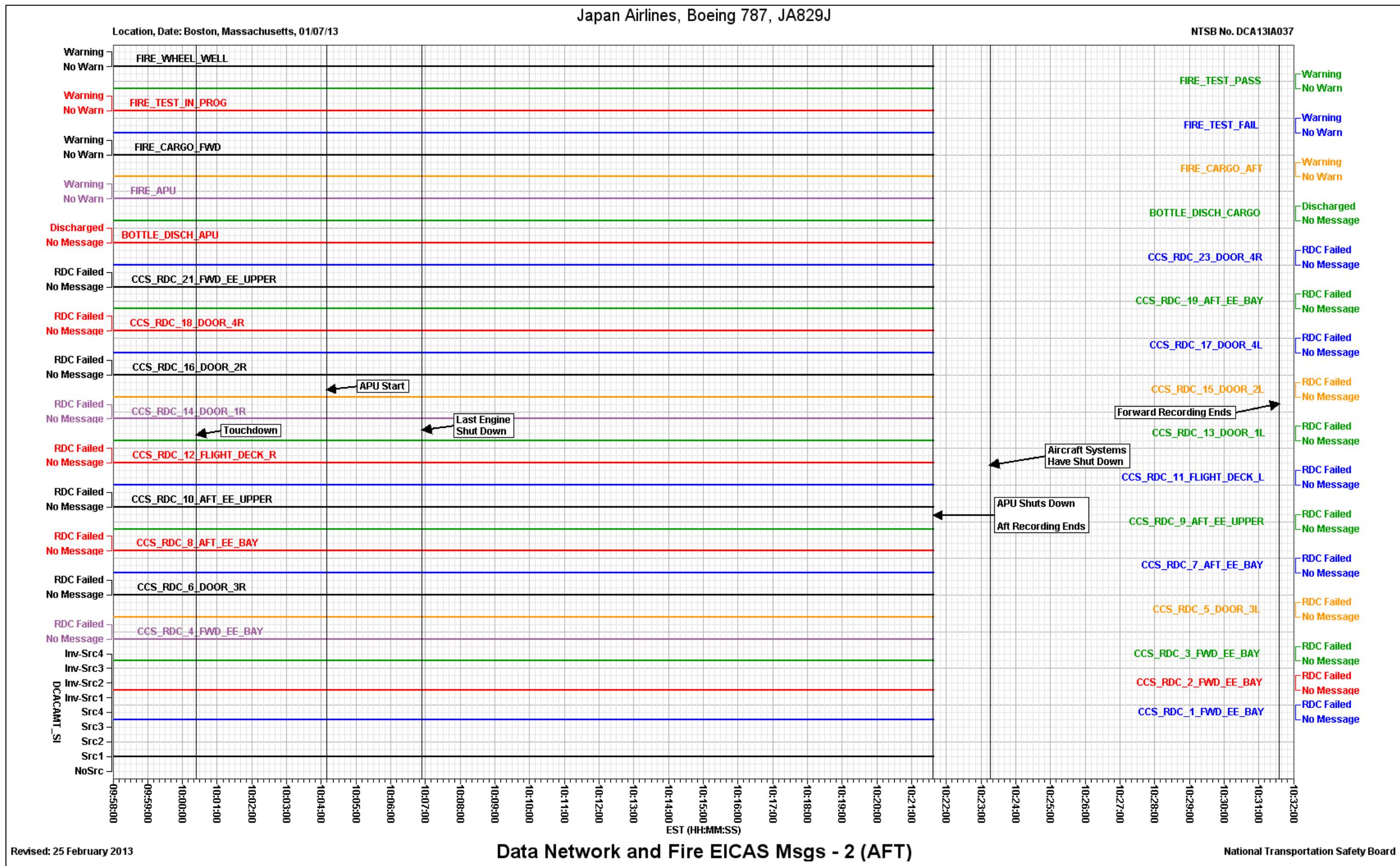
Figure C-7. First set of parameters related to electronic equipment cooling.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Electronics Cooling - 1 (AFT)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board
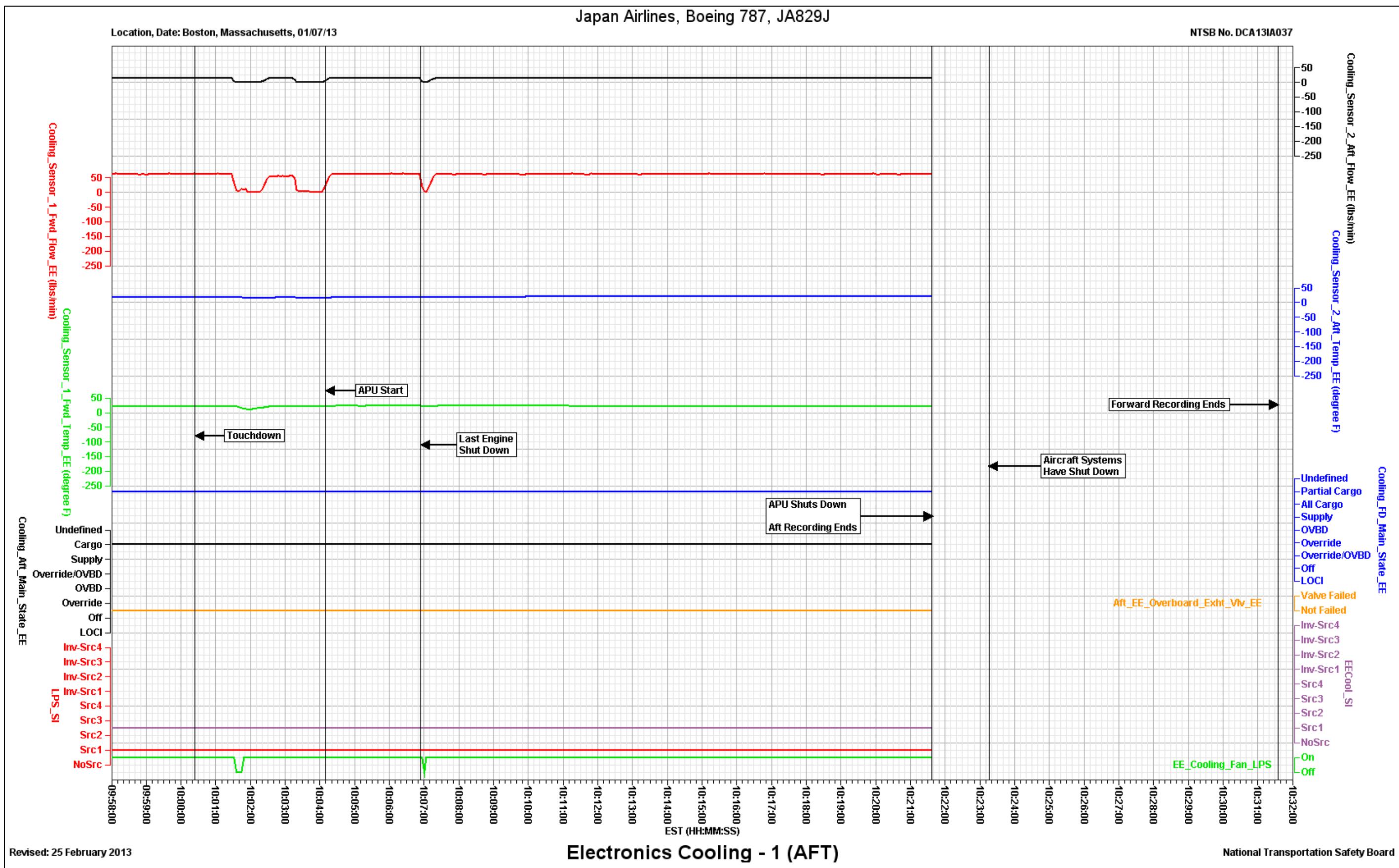
Figure C-8. Second set of parameters related to electronic equipment cooling.

Japan Airlines, Boeing 787, JA829J

NTSB No. DCA13IA037

Electronics Cooling - 2 (AFT)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board
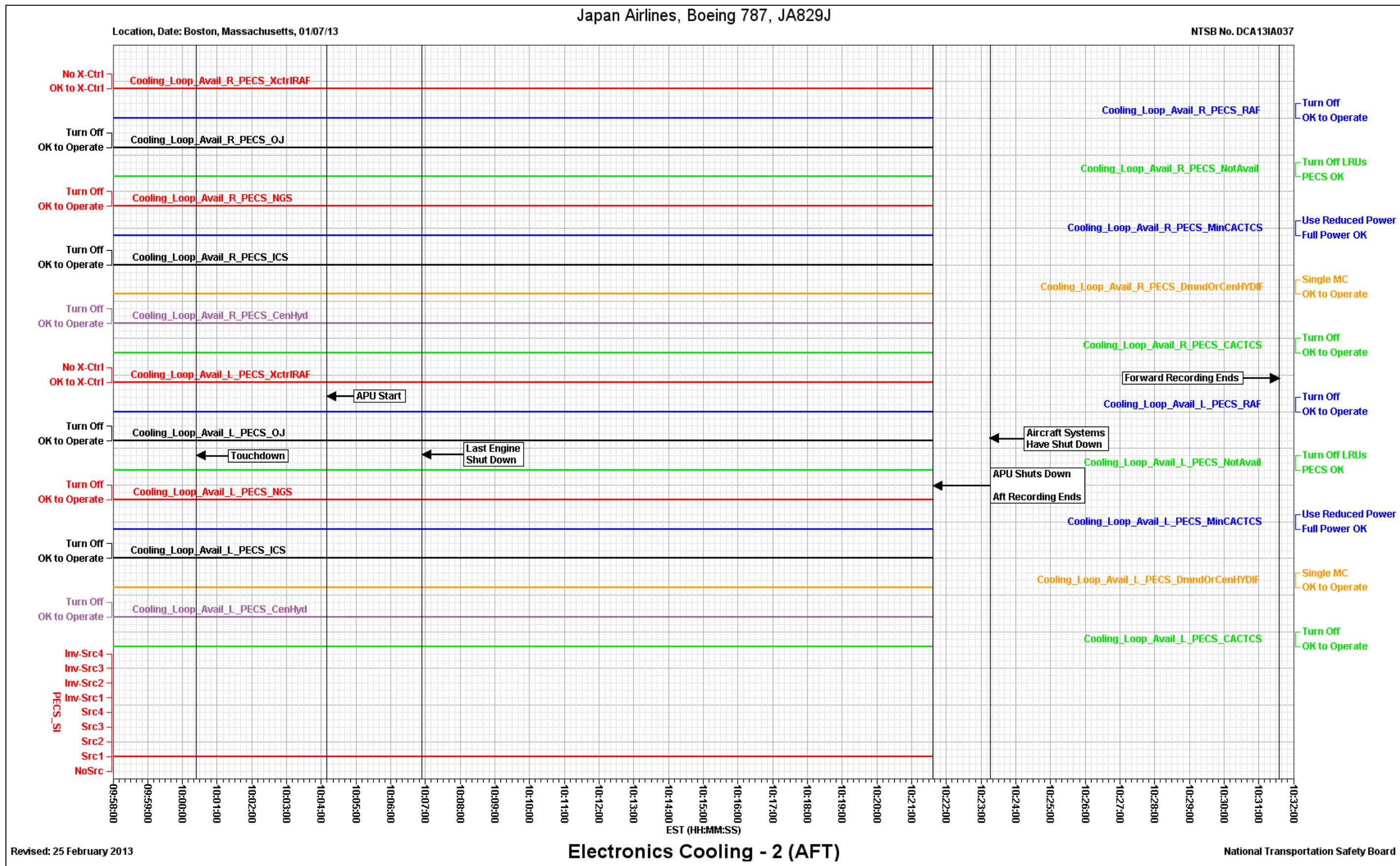
Figure C-9. Electrical EICAS message and power control module discrete parameters.
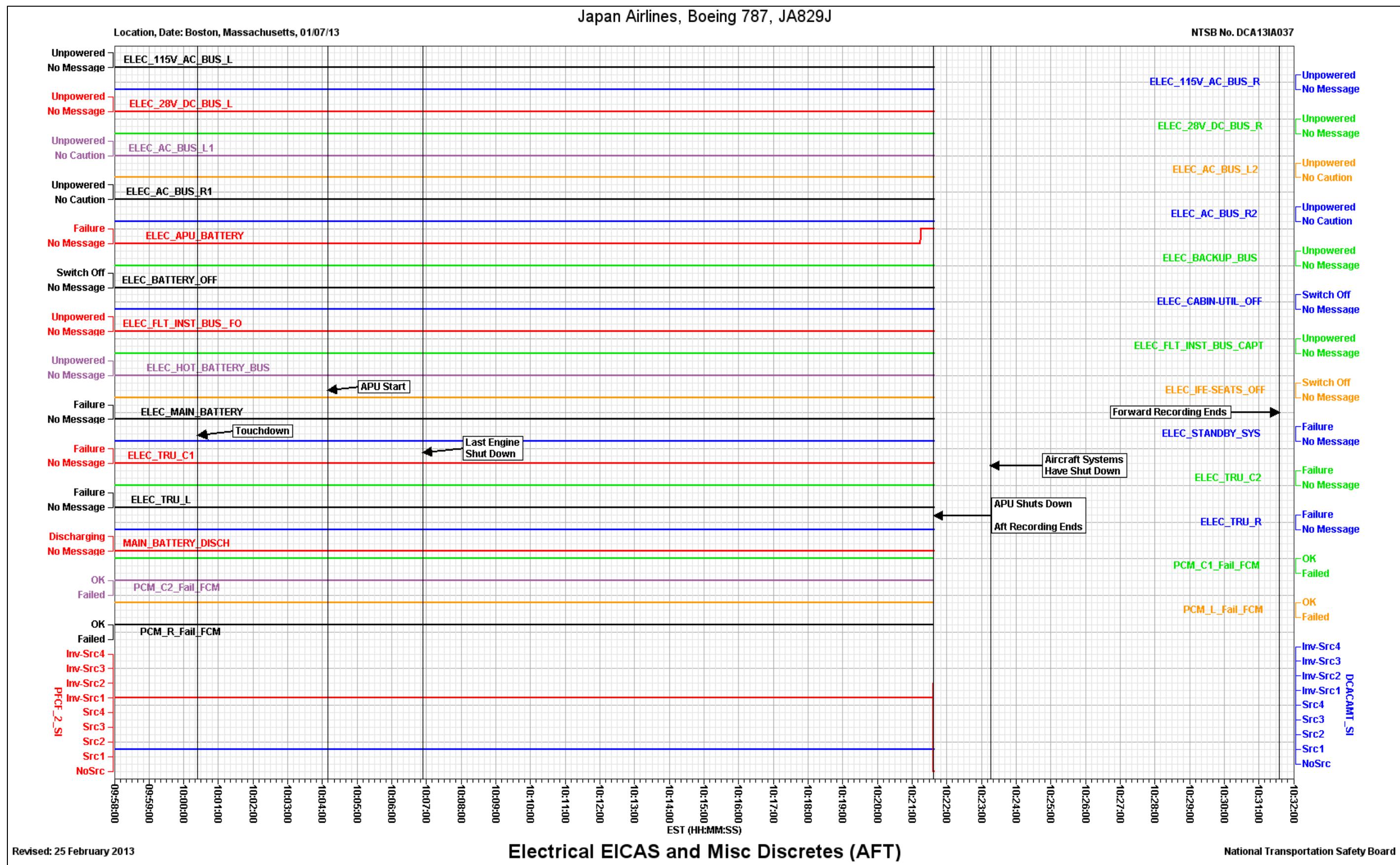
Figure C-10. Parameters indicating engine shut down and setting of parking brake.


Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Engines, Parking Brake and VCTU Power (AFT)

Revised: 25 February 2013

National Transportation Safety Board
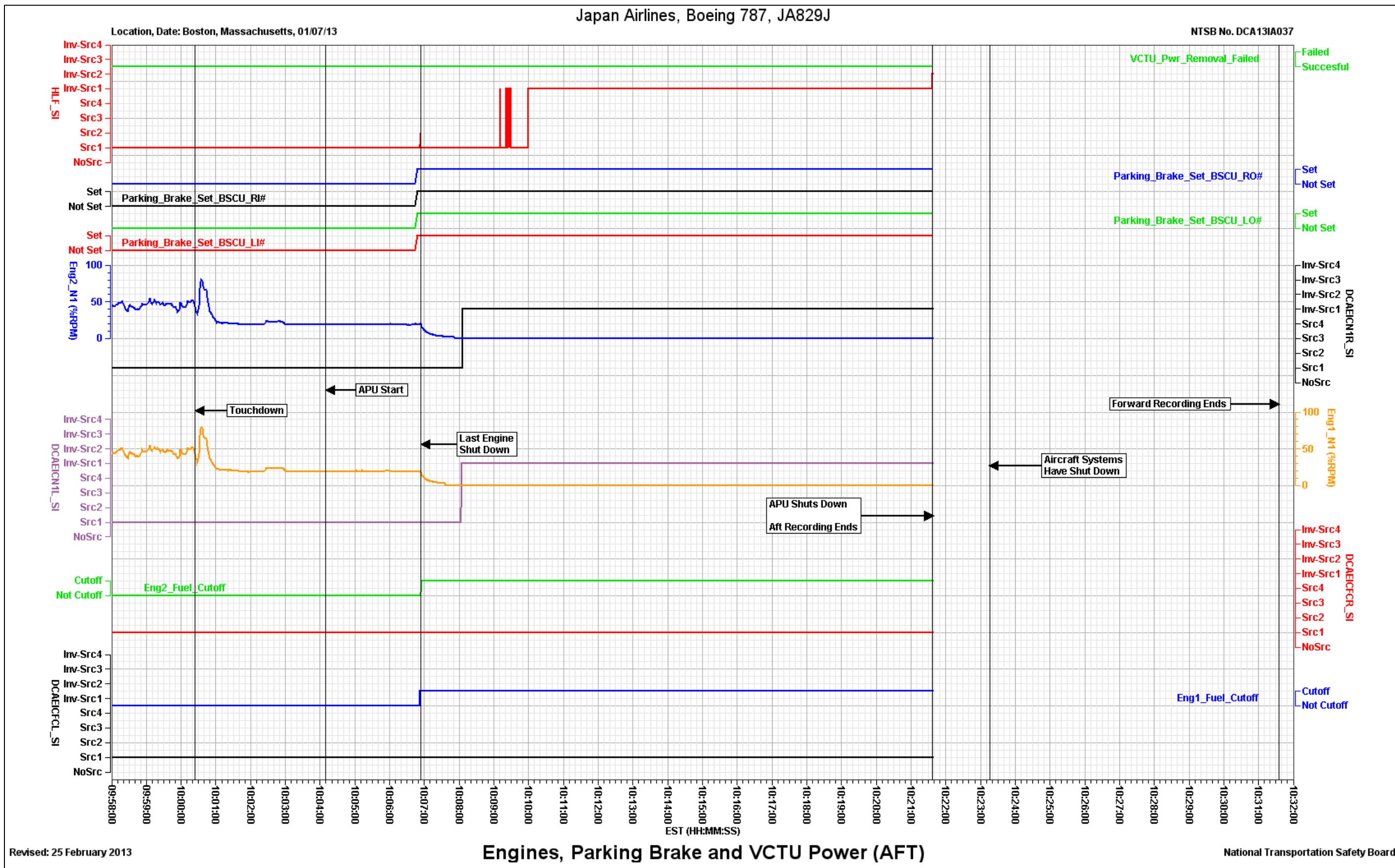
Figure C-11. Hydraulic systems, master warning and caution, and radio keying parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Hydraulics, Mstr Warn/Caut and Radios (AFT)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board

DCA13IA037
FDR Factual Report, page 10C-12
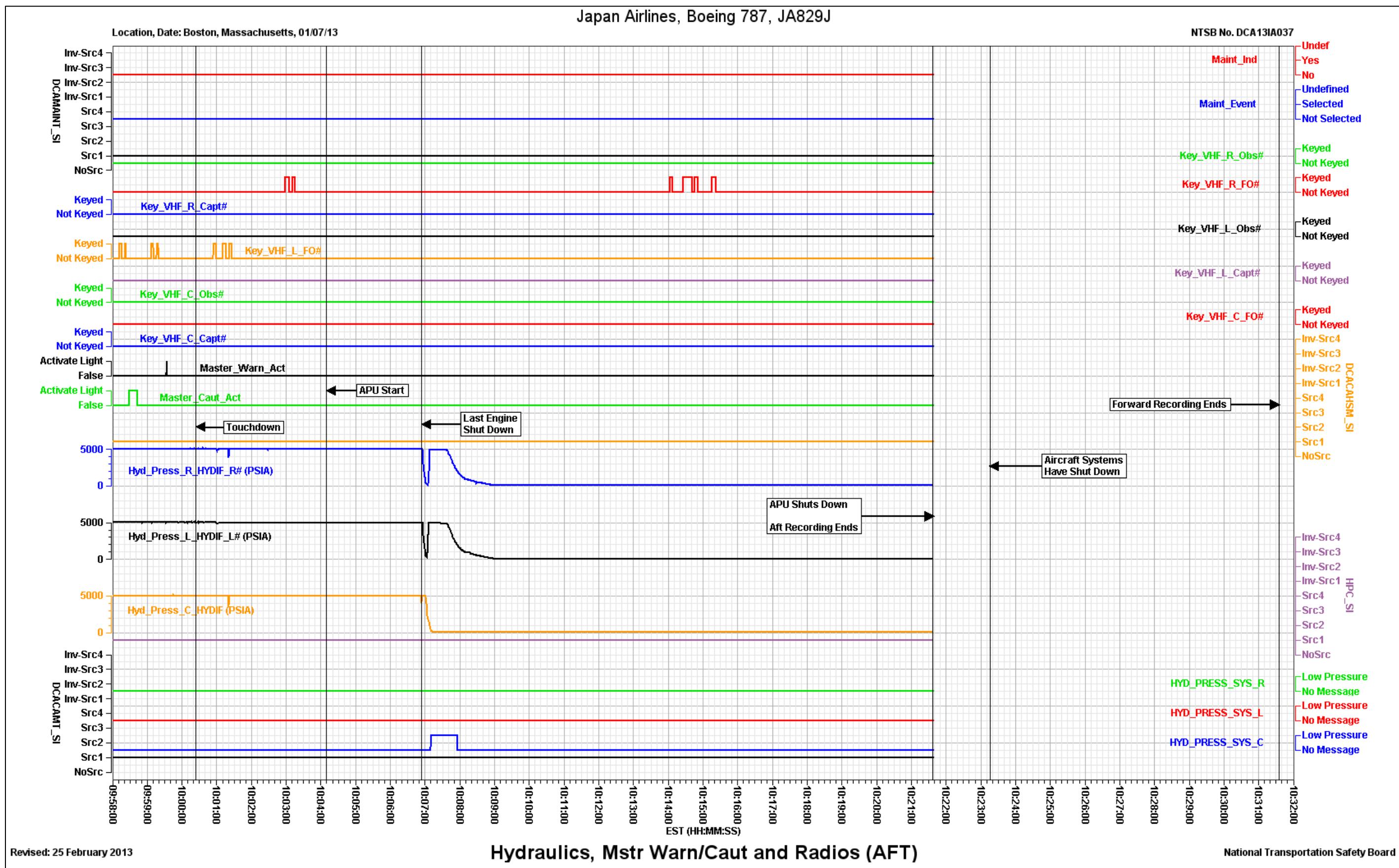
Figure C-12. First set of power generation and distribution parameters.
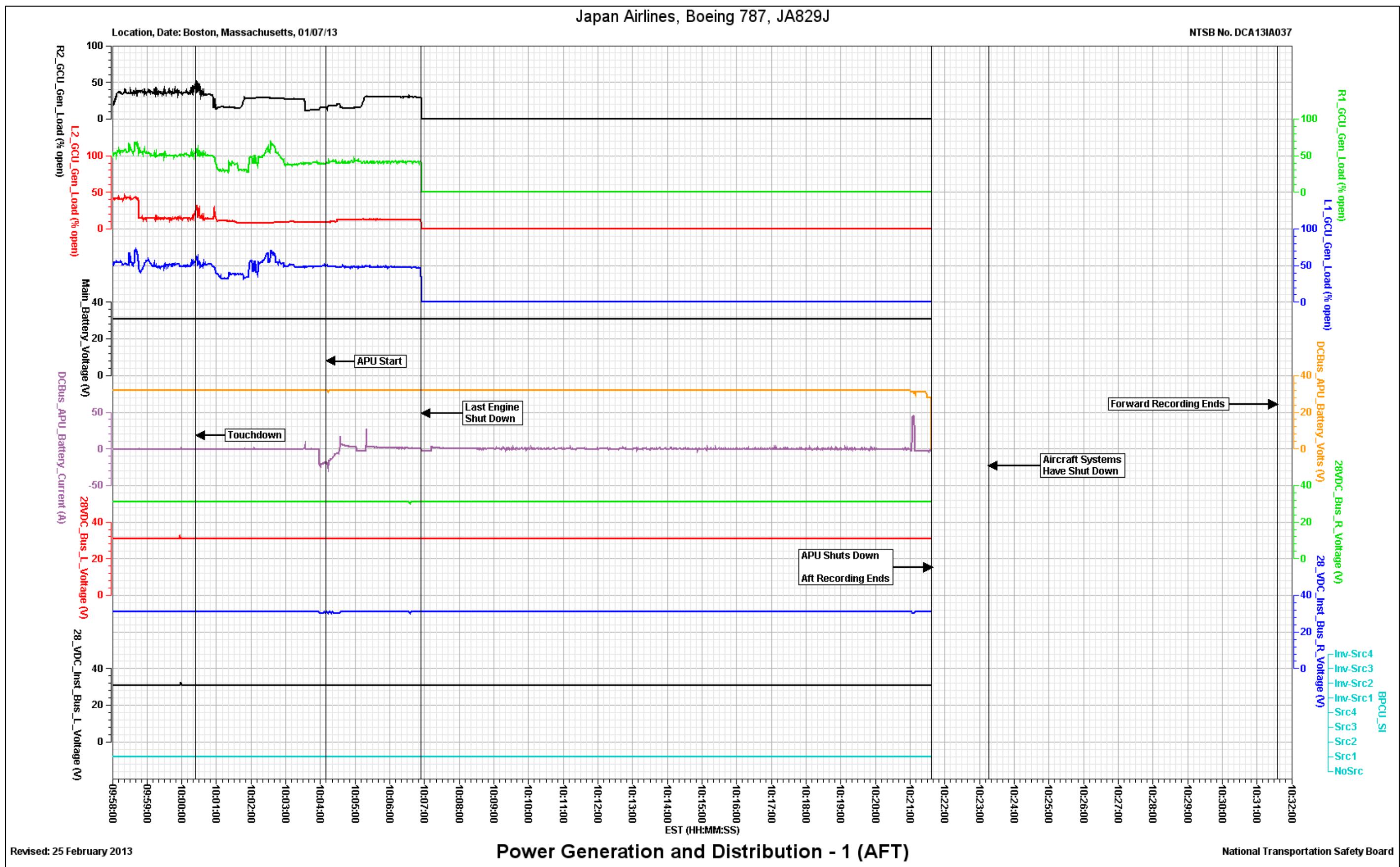
Figure C-13. Second set of power generation and distribution parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Power Generation and Distribution - 2 (AFT)

EST (HH:MM:SS)

Revised: 25 February 2013

National Transportation Safety Board
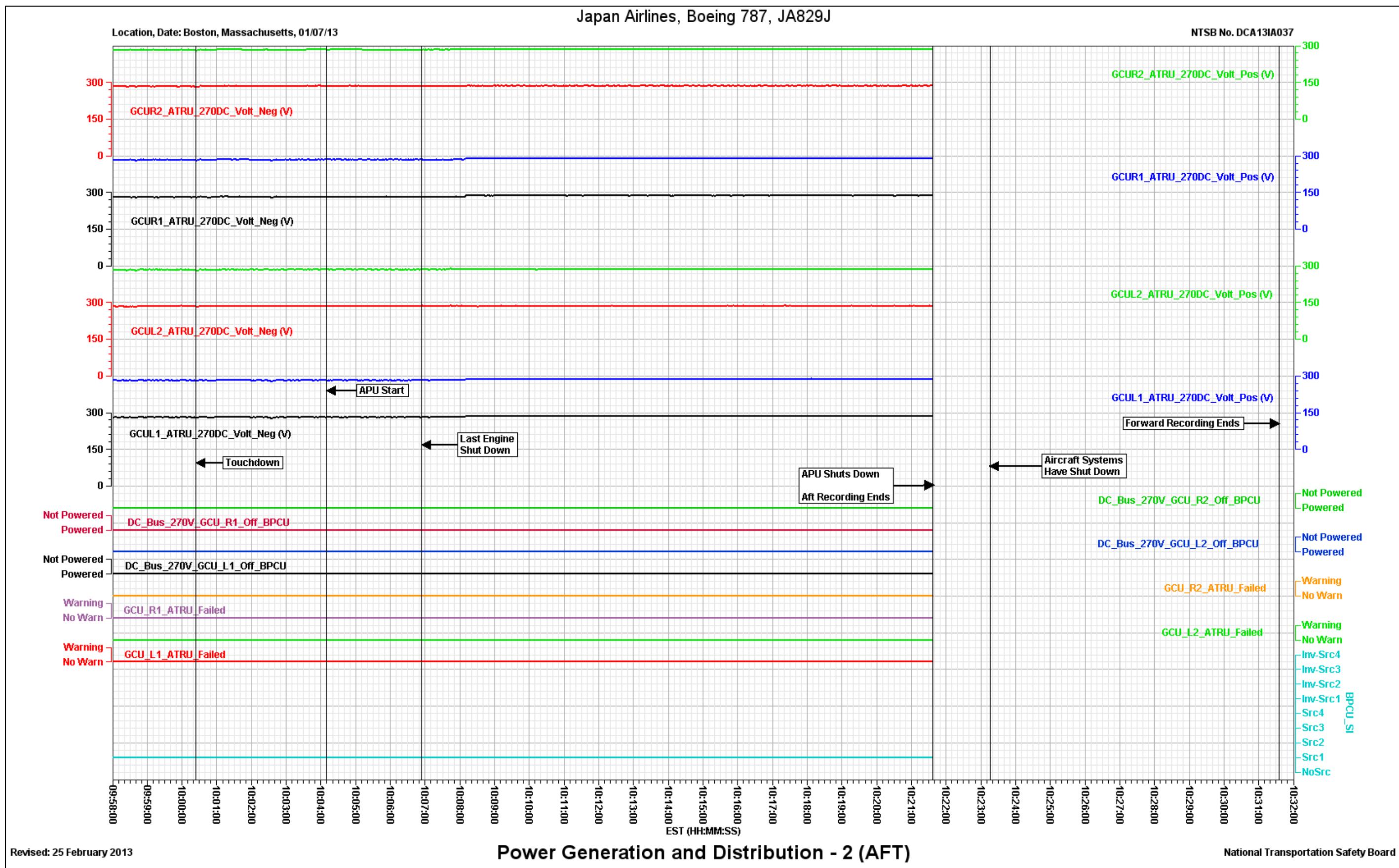
Figure C-14. Remote power distribution units 21, 22, 31, and 32 current parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

APU Start

Forward Recording Ends

Touchdown

Last Engine Shut Down

APU Shuts Down

Aft Recording Ends

Aircraft Systems Have Shut Down

EST (HH:MM:SS)

Revised: 25 February 2013

RPDU 21, 22, 31, 32 Currents (AFT)

National Transportation Safety Board
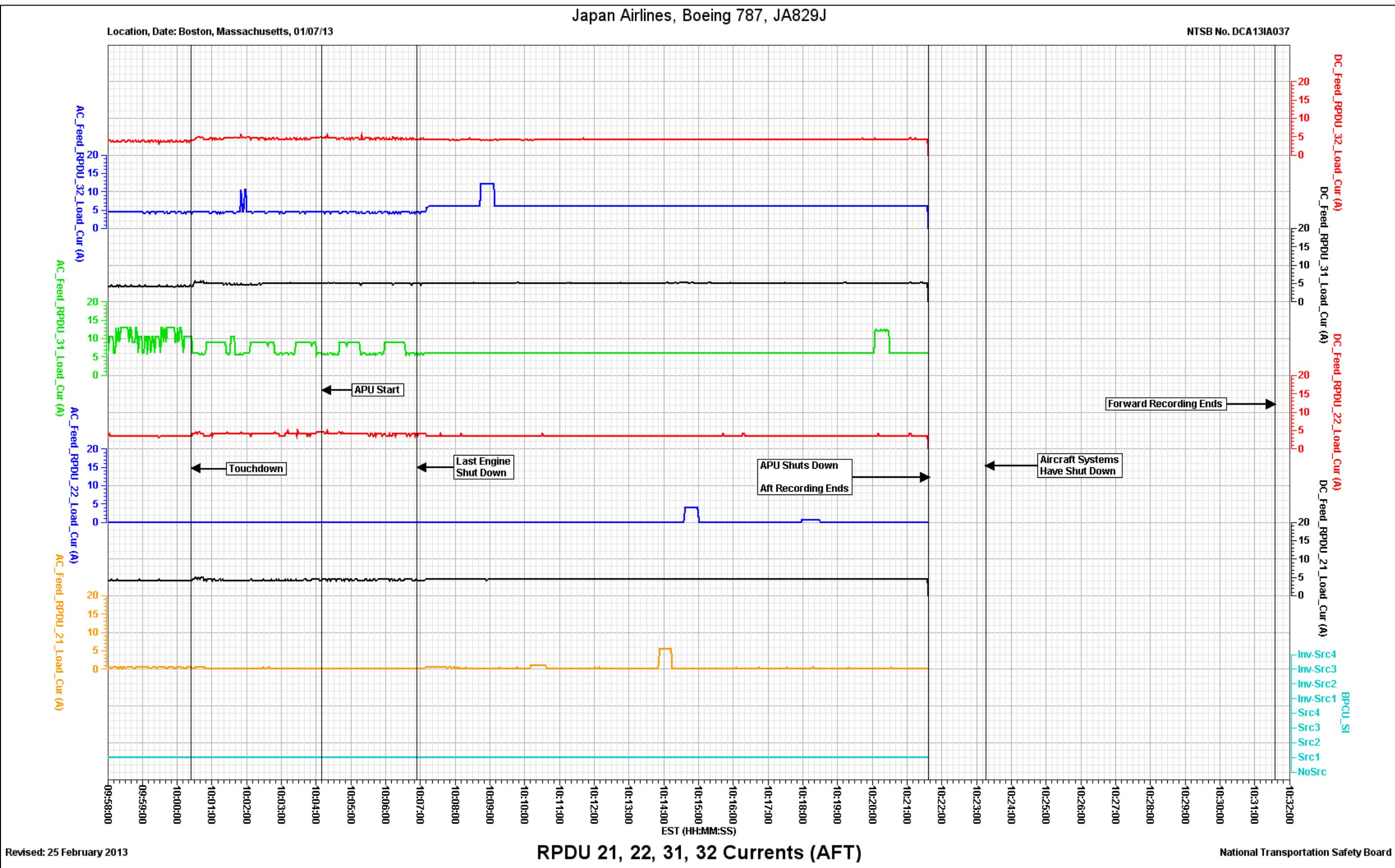
Figure C-15. Remote power distribution units 41, 42, and 71 current parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

APU Start

Touchdown

Last Engine Shut Down

APU Shuts Down

Aft Recording Ends

Aircraft Systems Have Shut Down

Forward Recording Ends

EST (HH:MM:SS)

RPDU 41, 42, 71 Currents (AFT)

Revised: 25 February 2013

National Transportation Safety Board
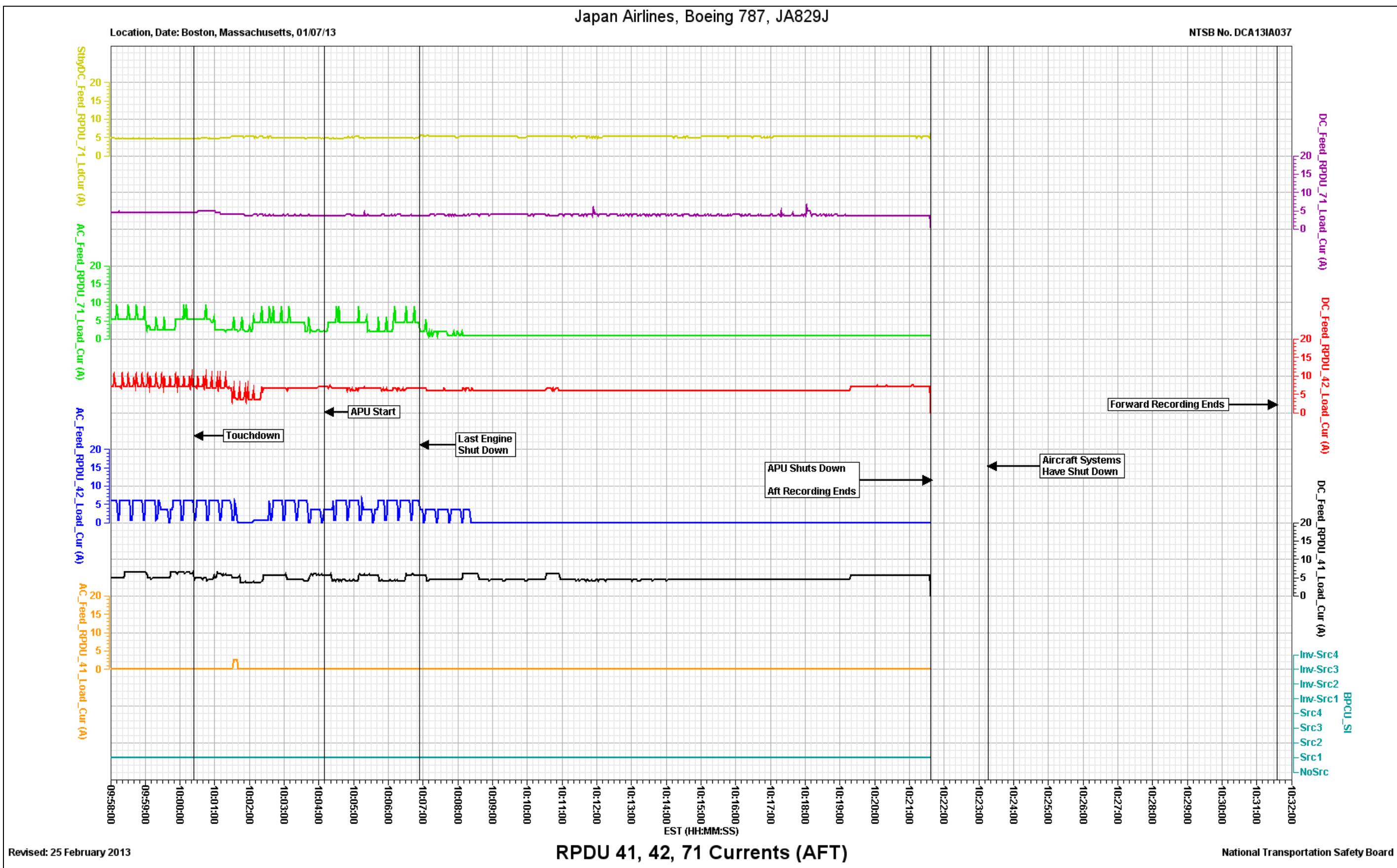
Figure C-16. Remote power distribution units 72, 73, and 74 current parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

APU Start

Touchdown

Last Engine Shut Down

Forward Recording Ends

Aircraft Systems Have Shut Down

APU Shuts Down

Aft Recording Ends

EST (HH:MM:SS)

Revised: 25 February 2013

RPDU 72, 73, 74 Currents (AFT)

National Transportation Safety Board
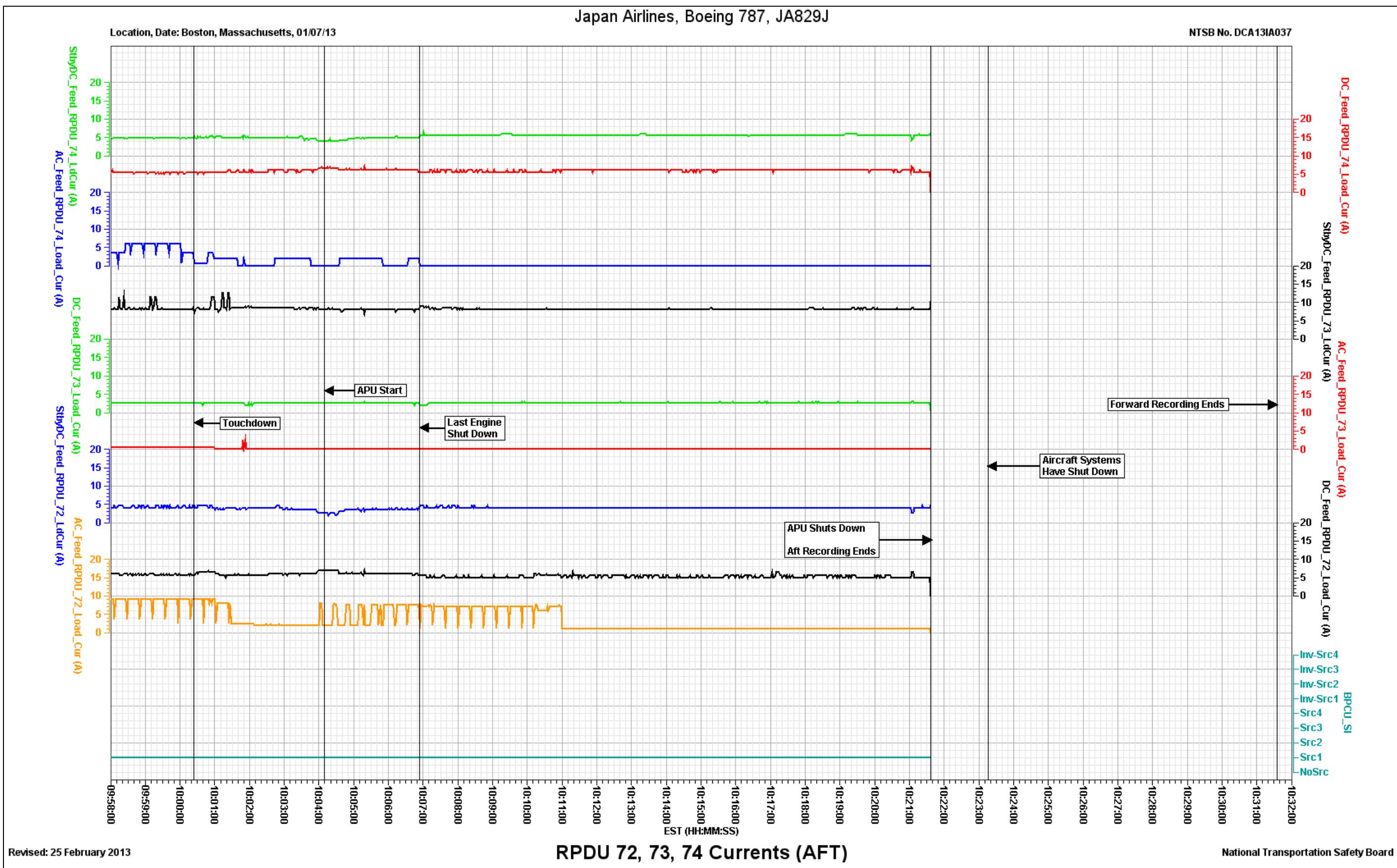
Figure C-17. Remote power distribution units 75, 76, 81, and 82 current parameters.

Japan Airlines, Boeing 787, JA829J
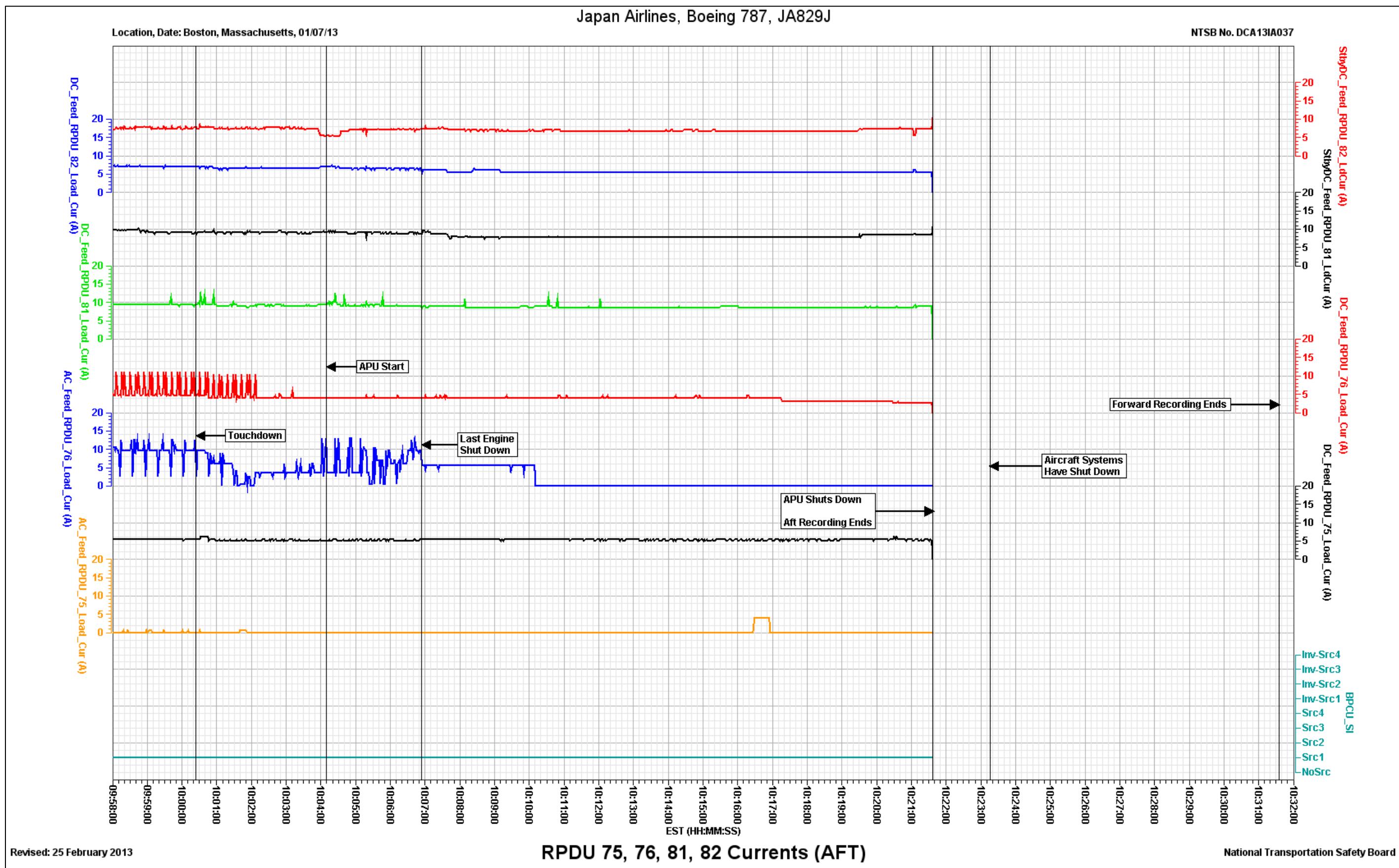
Figure C-18. Remote power distribution units 83, 84, and 92 current parameters.
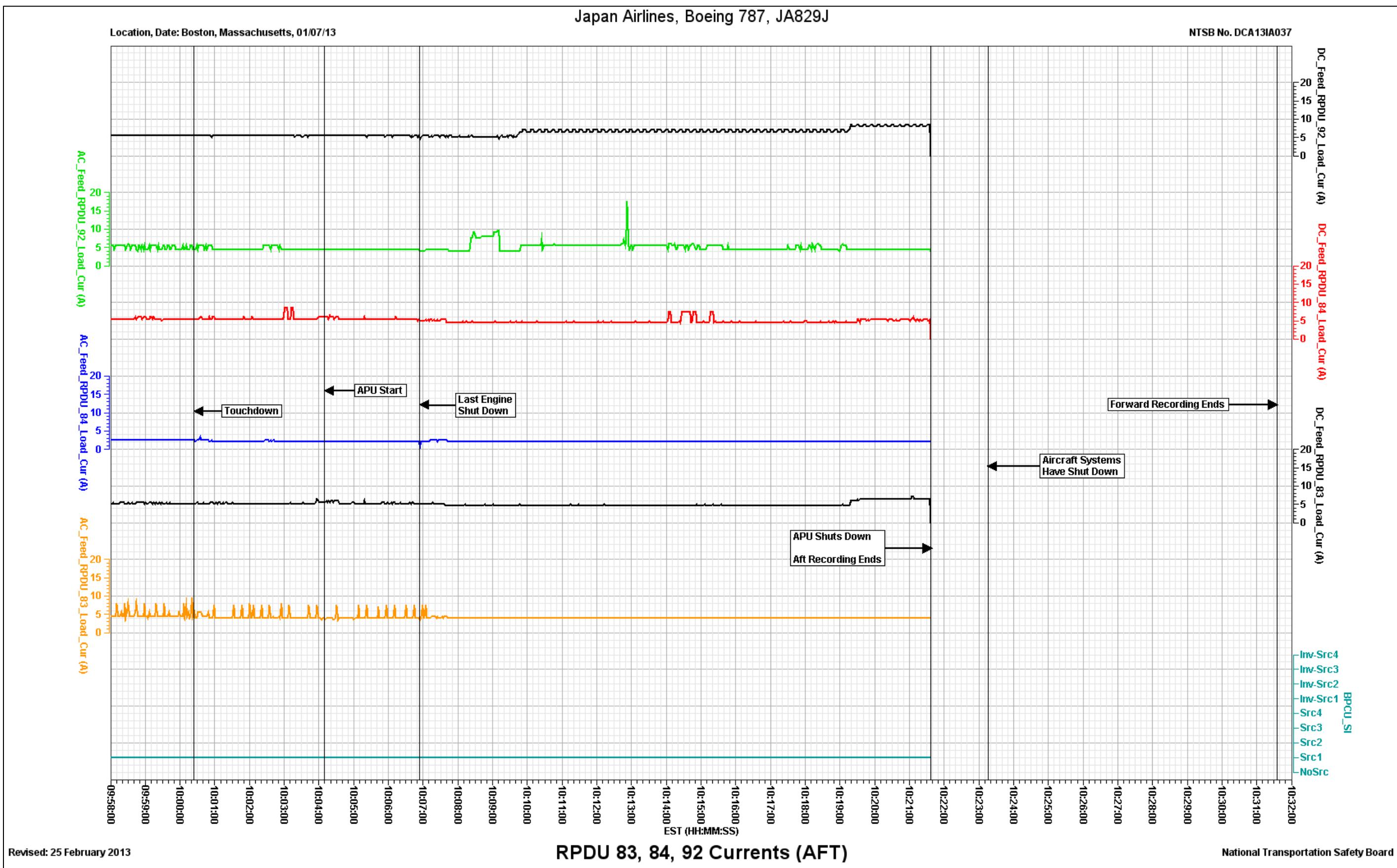
Figure C-19. First set of ventilation systems parameters.

Japan Airlines, Boeing 787, JA829J
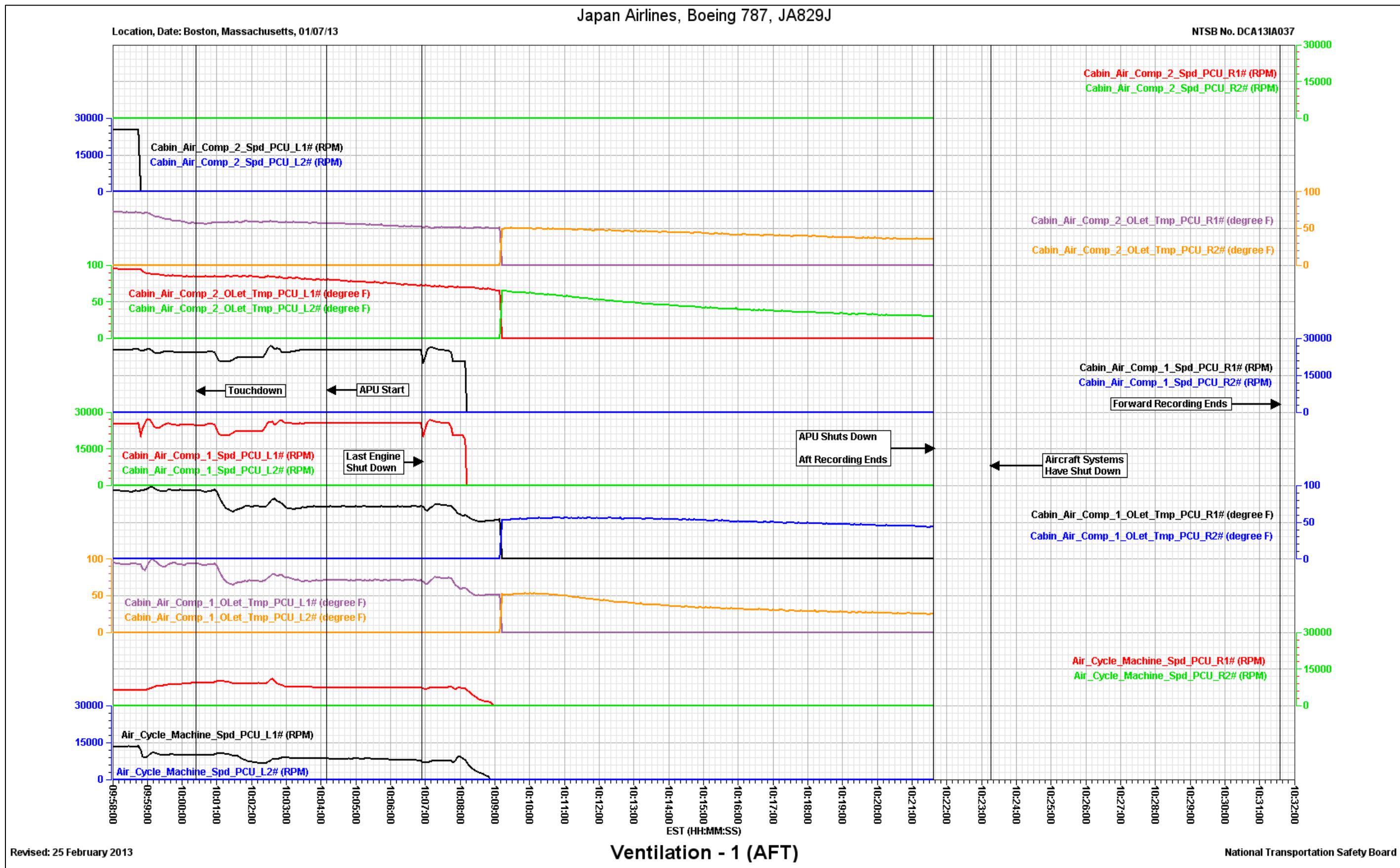
Figure C-20. Second set of ventilation systems parameters.

Japan Airlines, Boeing 787, JA829J
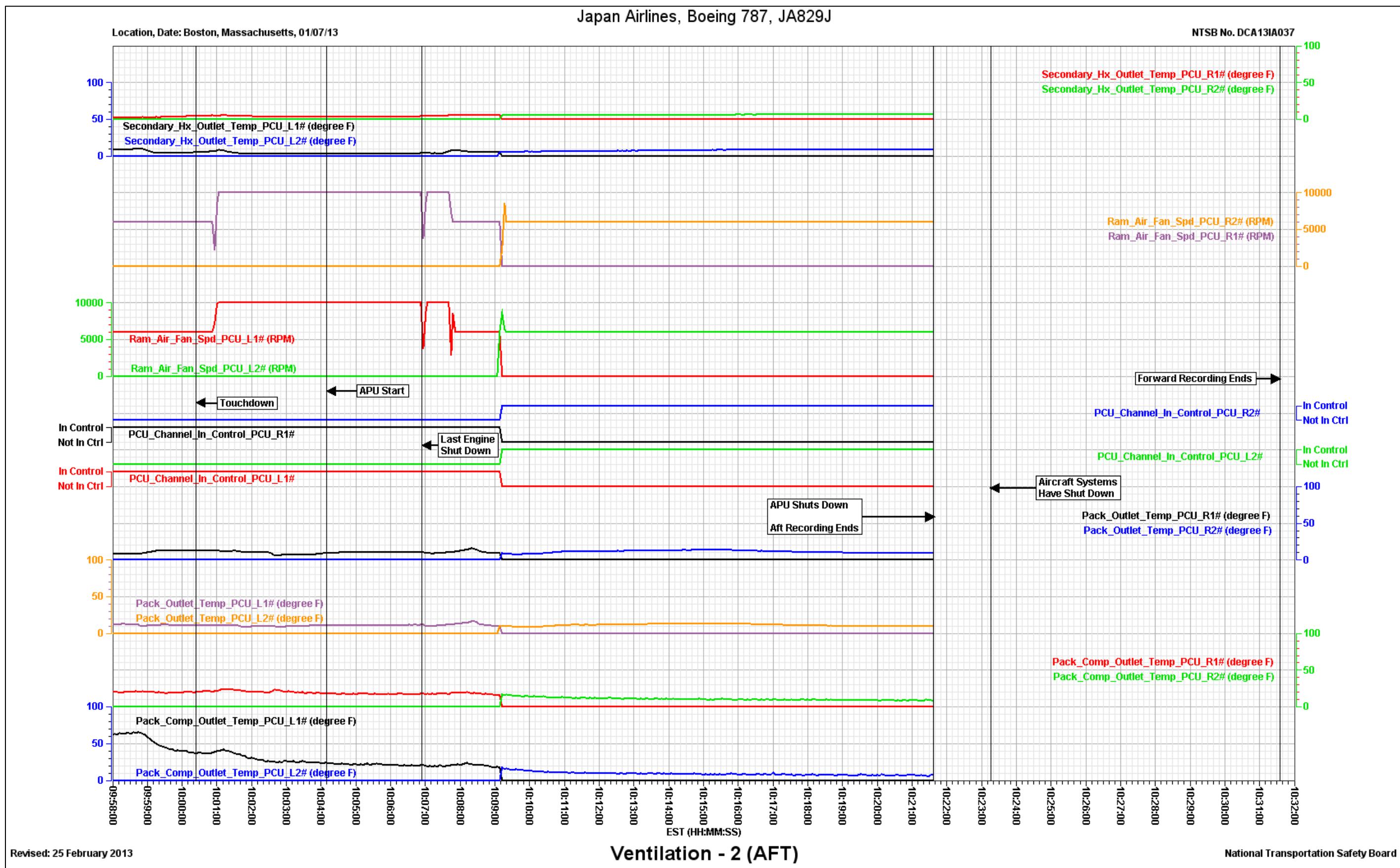
Figure C-21. Third set of ventilation systems parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Zone_D2_Duct_Temp_CACTCS_1# (degree F)

Zone_D1_Duct_Temp_CACTCS_1# (degree F)

Zone_C2_Duct_Temp_CACTCS_1# (degree F)

Zone_C1_Duct_Temp_CACTCS_1# (degree F)

Zone_B2_Duct_Temp_CACTCS_1# (degree F)

APU Start

Forward Recording Ends

Touchdown

Zone_B1_Duct_Temp_CACTCS_1# (degree F)

Last Engine Shut Down

Aircraft Systems Have Shut Down

APU Shuts Down

Aft Recording Ends

Zone_A2_Duct_Temp_CACTCS_1# (degree F)

Zone_A1_Duct_Temp_CACTCS_1# (degree F)

SMOKE_REST_UPR_DR_4

Smoke
No Smoke

Smoke
No Smoke

SMOKE_REST_UPR_DR_1

Inv-Src4
Inv-Src3
Inv-Src2
Inv-Src1
Src4
Src3
Src2
Src1
NoSrc

SMOKE_LAVATORY

Smoke
No Smoke

SMOKE_EQUIP_CLG_MISC

Smoke
No Smoke

SMOKE_EQUIP_CLG_FWD

Smoke
No Smoke

SMOKE_EQUIP_CLG_AFT

Smoke
No Smoke

DCACAMT_SI

EST (HH:MM:SS)

Ventilation - 3 (AFT)

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Figure C-22. Window heat parameters.
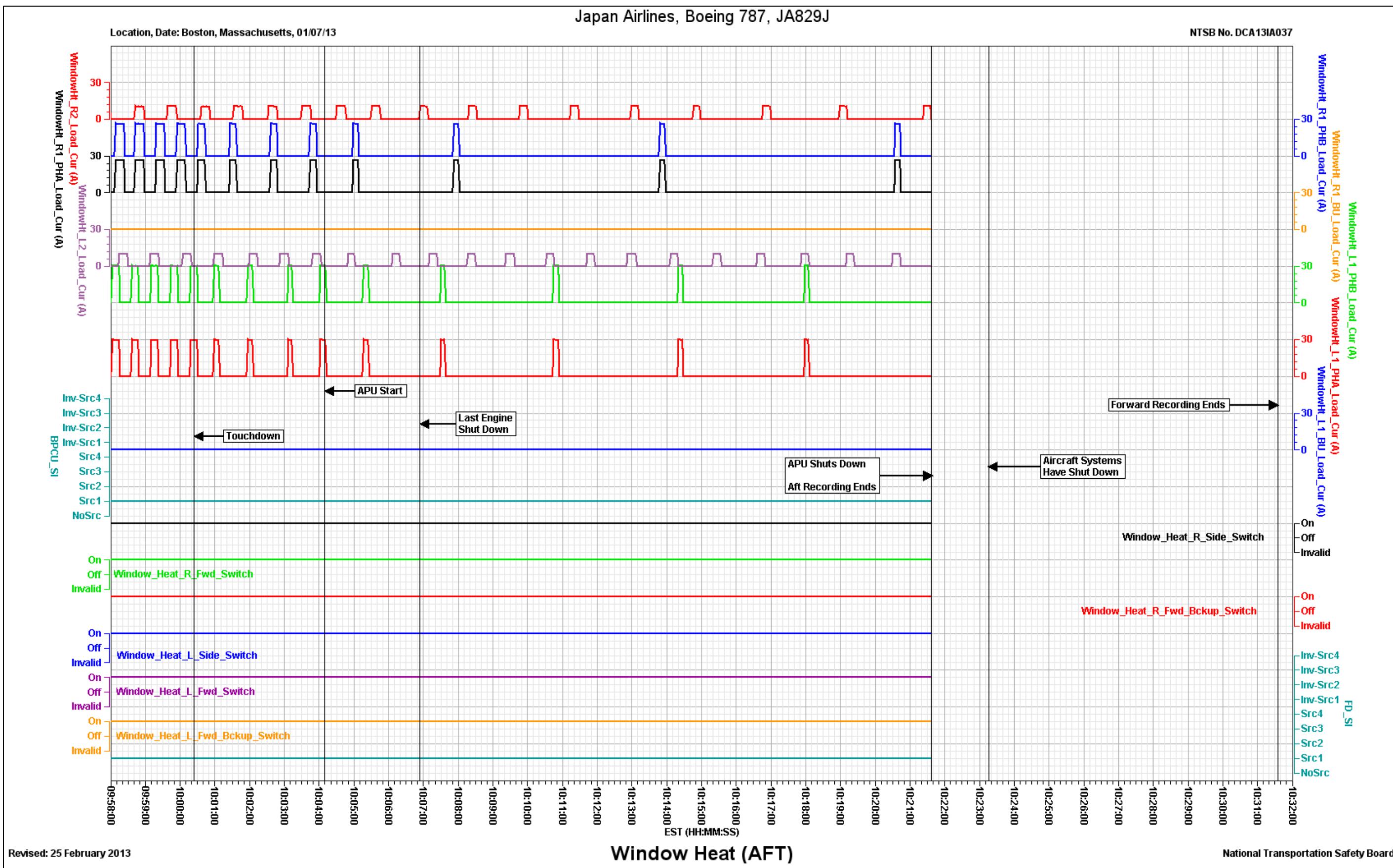
Figure C-23. Wing ice protection system parameters.

Japan Airlines, Boeing 787, JA829J

Location, Date: Boston, Massachusetts, 01/07/13

NTSB No. DCA13IA037

Wing Ice Protection (AFT)

Revised: 25 February 2013

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