2.2 CAUTION AND WARNING SYSTEM (C/W)

CONTENTS

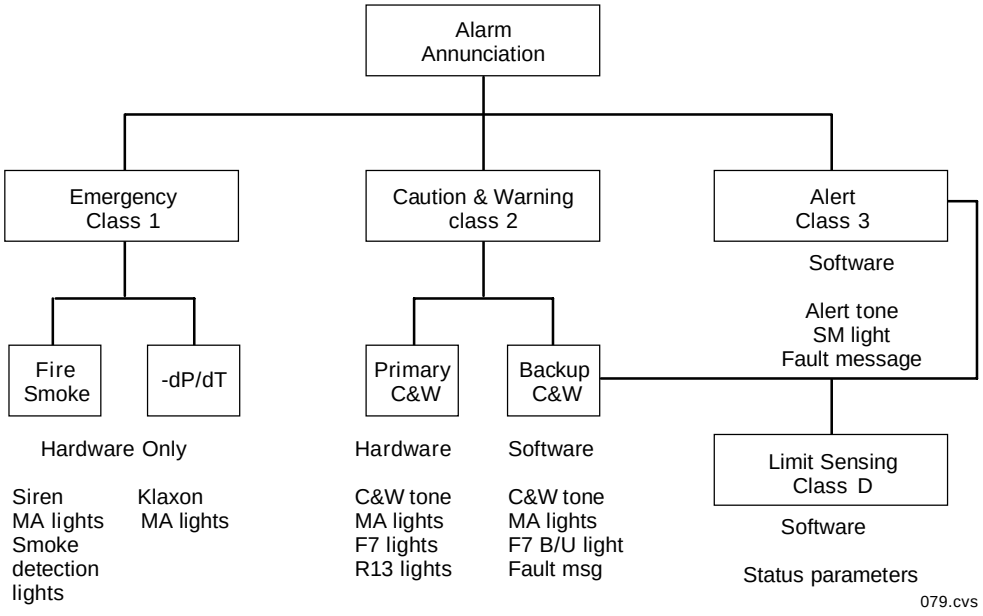
Description

The caution and warning system warns the crew of conditions that may create a hazard to orbiter operation and/or crew. Under certain circumstances, the system also alerts the crew to situations that require time-critical (under 5 minutes) procedures to correct them. The system uses data such as temperature, pressure, flow rates, and switch positions to determine whether an alarm situation exists. The system consists of software and electronics that provide the crew with visual and aural cues when a system exceeds predefined operating limits. Visual cues consist of four red MASTER ALARM lights, a 40-light array on panel F7, a 120-light array on panel R13U, and CRT messages. The aural cue is sent to the communications system for distribution to flight crew headsets or speaker boxes.

The crew interfaces with the C/W system through panel R13U, panel C3, CRT displays, panel F7, panel L1, and the four red MASTER ALARM pushbutton indicators on panels F2, F4, A7, and MO52J.

The C/W system interfaces with the auxiliary power units, data processing system, environmental control and life support system, electrical power system, flight control system, guidance and navigation, hydraulics, main propulsion system, reaction control system, orbital maneuvering system, and payloads.

Inputs enter the software C/W logic circuitry from the onboard computers through multiplexers/demultiplexers (MDMs) to activate alarm tones and the BACKUP C/W ALARM. Some of these are used to turn on the BACKUP C/W ALARM light on panel F7 while crew input resets the MASTER ALARM lights and tones.



Caution and Warning Diagram

Alarms

Four alarm classes constitute the C/W system.

Class 1 - Emergency

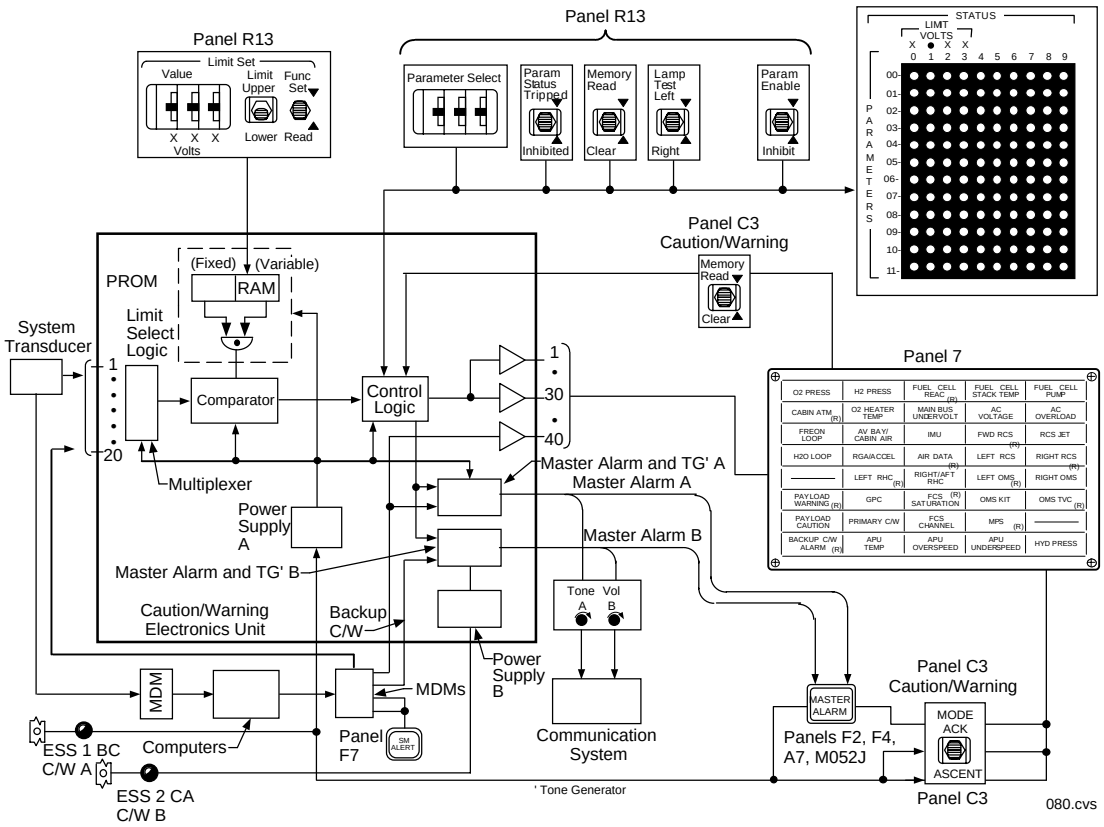
There are two alarms in this class: (1) smoke detection/fire suppression and (2) rapid cabin depressurization. (These systems are discussed in more detail later in this section.) Class 1 is a hardware system only; its input is not processed by any MDMs or software. The system uses hardware, such as hard-wired sensors, to monitor parameters and to issue alarms. Because of the nature of the class 1 alarms, they always receive the highest priority for resolution.

The emergency (class 1) aural alarms consist of a siren (activated by the smoke detection system) and a klaxon (activated by the delta pressure/delta time sensor that recognizes a rapid loss of cabin pressure), and they are annunciated by hardware. The siren's frequency varies from 666 to 1,470 hertz and returns at a five-second-per-cycle rate. The klaxon is a 2,500-hertz signal with an on/off cycle of 2.1 milliseconds on and 1.6 milliseconds off, mixed with a 270-hertz signal with a cycle of 215 milliseconds on and 70 milliseconds off.

The emergency alarm visual cues consist of illumination of the four MASTER ALARM pushbutton indicators on panels F2, F4, A7, and MO52J. The smoke detection system also illuminates SMOKE DETECTION lights on panel L1, displays information on the SM SYS SUMM 1 display (SMOKE), and issues a backup C/W "smoke alarm" message. Similarly, cabin pressure information can be seen on the SM SYS SUMM 1 display (CABIN).

Class 2 - C/W

This class also consists of two subclasses: primary C/W, which is a hardware system, and backup (B/U) C/W, which is a software system.



Caution and Warning System Overview

The primary C/W system has the capacity to monitor 120 inputs, which are received from transducers through either signal conditioners or flight forward MDMs. Baselined limit values are stored in the C/W electronics unit located in avionics bay 3. These values can be changed by the crew, after the parameters' engineering units are converted to a standard voltage value, through switches on panel R13U; however, if power is lost, the limits will return to their original values. The majority of the original stored values are identical to the backup C/W (software) values. Thirty-nine lights on the panel F7 annunciator matrix are dedicated to the primary C/W; the exception is the BACKUP C/W ALARM.

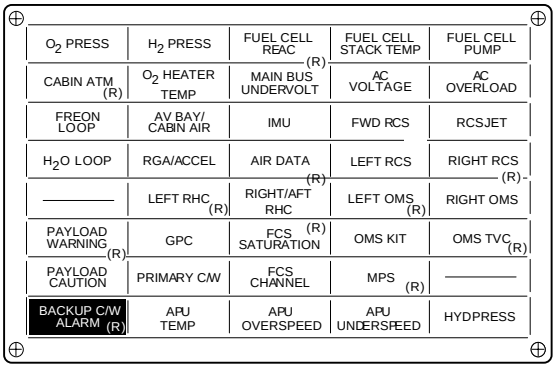
When a primary C/W alarm is issued, the appropriate lamp on the panel F7 annunciator matrix is illuminated, all four MASTER ALARM indicators are illuminated, the C/W tone sounds, and the appropriate lamp on the panel R13U parameter status light matrix is illuminated. No CRT fault message is generated by the primary C/W.

The primary C/W system receives power from power supply A from the C/W A circuit breaker powered by ESS 1BC on panel 013, and power supply B from C/W B circuit breaker powered by ESS 2CA on panel 013.

A loss of power supply A will cause all panel F7 lights except BACKUP C/W ALARM to illuminate. It will also cause a loss of panel R13U status lights and function, smoke detection via circuit test A, the CAUTION/ WARNING MEMORY READ switch, lower bulbs of the MASTER ALARM light (except for lamp test), primary C/W limit sensing, and tones to the middeck.

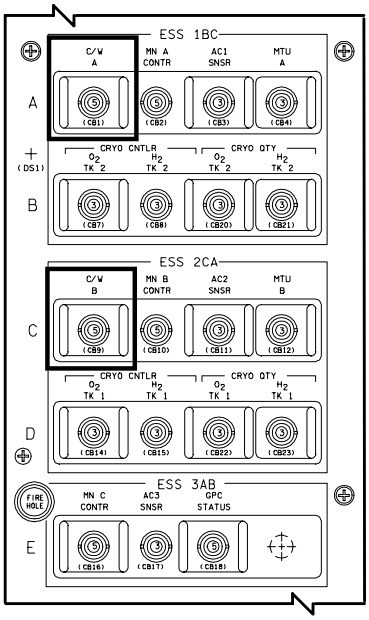
A loss of power supply B causes the BACKUP C/W ALARM light to come on in addition to the primary C/W light, a loss of smoke detection via circuit test B, upper bulbs of the MASTER ALARM lights (except during a lamp test), and sleep station headset tones.

The backup C/W (class 2) system is part of the systems management fault detection and annunciation (FDA), GNC, and backup flight system software programs. Only the 69 backup C/W alarms that are produced by FDA (software that monitors parameters and initiates alarms) have limits that can be changed and displayed in engineering units accessed through the SM TABLE MAINTENANCE specialist function display (SPEC 60). The remaining backup C/W alarms that are produced by the guidance and navigation program are accessed through general-purpose computer read/write procedures. A backup C/W out-of-tolerance condition will trigger illumination of the four MASTER ALARM lights, illuminate the red BACKUP C/W ALARM light on panel F7, and display a message on the fault message line and fault summary page.



Caution and Warning Annunciator Matrix on Panel F7

(The 39 lights shown are dedicated to the primary C/W System. The BACKUP C/W ALARM light is dedicated to the entire backup C/W system. (R) signifies a red warning light. Red lights take precedence over yellow).



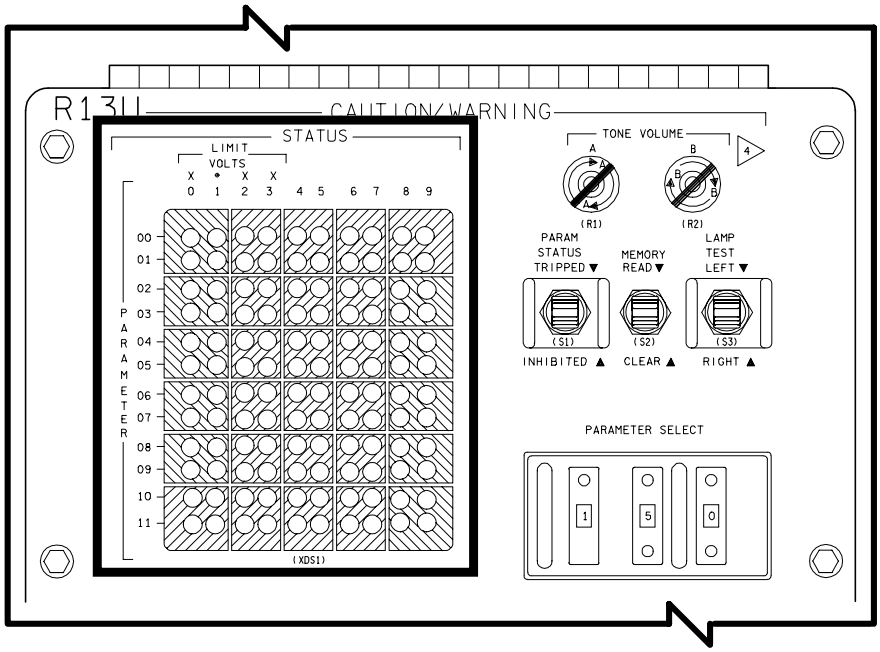
C/W Circuit Breaker on Panel 013

The class 2 (C/W) aural master alarm is activated by the primary (hardware) system, the backup (software) system, or both. The C/W tone is an alternating 375 hertz and 1,000 hertz at a 2.5 hertz rate. The alternating C/W alarm tone is generated when the hardware system detects an out-of-limit condition on any of the 120 parameters it monitors or when the software (backup) system detects a parameter that is out of limits.

Class 2 primary and backup C/W visual cues include a 40-light annunciator matrix on panel F7. This matrix annunciates various system or functional failures. Each light is driven by one or more parameters. With the exception of the BACKUP C/W ALARM light, once a lamp has been illuminated, it will not be extinguished until all parameters driving that light are back within limits. THE BACKUP C/W ALARM light is extinguished once a MSG RESET key is pushed.

C/W CH	PARAMETER NAME	C/W CH	PARAMETER NAME	C/W CH	PARAMETER NAME	C/W CH	PARAMETER NAME	C/W CH	PARAMETER NAME
0	CRYO O2 P TK1	25	GPC 3	50	CRYO H2 P TK1	*75		100	L RHC
1	CRYO O2 HTR1 TK1	26	RCS LEAK/TK P - F	51	CRYO O2HTR 2 TK3	76	RCS TK P FU- R	101	FCS SATURATION
2	TC1 REAC O2	27	OMS ENG - L	52	FC3 REAC H2	*77		102	FC2 COOL PUMP
3	DC VOLT MAIN A	28	APU 3 EGT	53	AC3 VOLT (ϕA, B, C)	78	APU 2 OVERSPEED	103	IMU
4	CAB PRESS	29	MPS HE TK P - R	54	CAB N2 FLOW 1	79	MPS MANF P LH2	104	AV BAY 3 TEMP
5	GPC 1	30	CRYO O2 P TK 4/5	*55		80	CRYO H2 P TK 4/5	105	H2O LOOP 1 PUMP OUT P
6	RCS TK P OX - F	31	CRYO O2 HTR 2 TK2	56	RCS LEAK/TK P - L	*81		106	FREON LOOP 1 FREON FLOW
7	OMS TK P OX - L	32	FC2 REAC H2	57	OMS ENG - R	82	FC3 STACK T	107	FREON LOOP 1 EVAP OUT T
8	APU 1 EGT	33	AC1 VOLT (ϕA, B, C)	58	APU 3 OIL T	83	AC3 OVLD	108	APU 2 UNDERSPEED
9	MPS HE TK P - C	34	CAB PPO2 A	59	MS HE REG P - R	84	AV BAY 1 TEMP	109	HYD 2 P
10	CRYO O2 P TK2	35	GPC 4	60	CRYO H2 P TK2	*85		110	R/AFT RHC
11	CRYO O2 HTR 2 TK1	36	RCS TK P OX - L	61	CRYO O2 HTR 1 TK4	86	RCS LEAK/TK P - R	111	FCS CH BYPASS
12	FC1 REAC H2	37	OMS TK P OX - R	62	FC1 STACK T	*87		112	FC3 COOL PUMP
13	DC VOLT MAIN B	38	APU 1 OIL T	63	AC1 OVLD	88	APU 3 OVERSPEED	*113	
14	CAB O2 FLOW 1	39	MPS HE REG P - C	64	CAB N2 FLOW 2	*89		114	CAB HX OUT T
15	GPC 2	*40		*65		*90		115	HWO LOOP 2 PUMP OUT P
16	RCS TK P FU - F	41	CRYO O2 HTR 1 TK3	66	RCS TK P OX - R	91	ADTA	116	FREON LOOP 2 FREON FLOW
17	OMS TK P FU - L	42	FC3 REAC O2	67	OMS TVC	92	FC1 COOL PUMP	117	FREON LOOP 2 EVAP OUT T
18	APU 2 EGT	43	AC2 VOLT (ϕA, B, C)	68	APU 1 OVERSPEED	93	RGA/AA	118	APU 3 UNDERSPEED
19	MPS HE TK P - L	44	CAB PPO2 B	69	MPS MANF PL O2	94	AV BAY 2 TEMP	119	HYD 3 P
20	CRYO O2 P TK34	45	GPC 5	70	CRYO H2 P TK3	95	PL WARNING		
21	CRYO O2 HTR 1 TK2	46	RCS TK P FU - L	71	CRYO O2 HTR 2 TK4	96	RCS JET		
22	FC2 REAC O2	47	OMS TK P FU - R	72	FC2 STACK T	97	PL CAUTION		
23	DC VO MAIN C	48	APU 2 OIL T	73	AC2 OVLD	98	APU 1 UNDERSPEED		
24	CAB O2 FLOW 2	49	MPS HE REG P - L	74	CAB FAN ΔP	99	HYD 1 P		

Hardware Caution and Warning Table



Parameter Status Light Matrix on Panel R13U

Panel R13U is the crew's interface with the primary C/W system. It includes a parameter status light matrix that is used to check the status of a parameter and also to check parameter limits. When used to check the status of parameters, the numbers on the left side of the matrix are read first to obtain the first two numbers of the parameter (row), then the number on the top is read to obtain the third number of the parameter. The matrix can display all 120 parameters (numbered from 000 to 119) of the primary C/W system.

Class 3 - Alert

This class is a software system operated by the SM software. It would generally receive lower priority than a class 1 or 2 alarm. Class 3 alert is designed to inform the flight crew of a situation leading up to a class 2 alarm or one that may require a long procedure (over 5 minutes) in order to rectify the problem. When an alert parameter exceeds its limits, the blue SM ALERT light on panel F7 is illuminated, a discrete is sent to the primary C/W system to turn on the alert tone, and the software displays a fault message on the fault message line and fault summary page.

Both guidance, navigation, and control (GNC) and systems management (SM) software sense out-of-limit conditions. These software systems also serve some less critical parameters and annunciate the systems management alert tone. The SM alert tone is a steady tone of 512 hertz of predefined duration generated in the C/W electronics when activated by inputs from the onboard computers.

Class 0 - Limit Sensing

Class 0 is a software system consisting of up and down arrows on the CRT displays next to a parameter. It provides no aural annunciation.

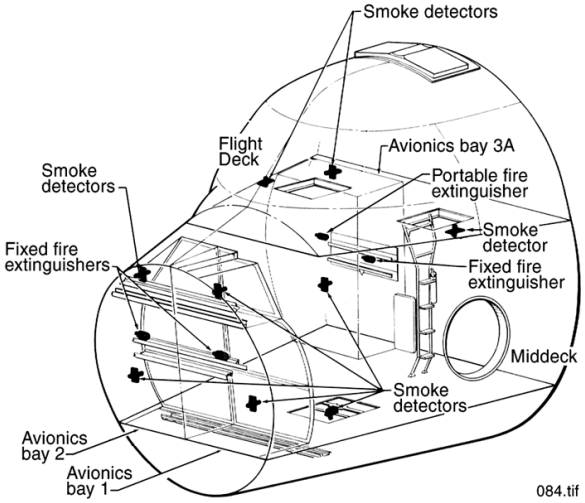
A down arrow displayed next to a parameter would indicate that the low limit for that parameter had been met or violated. In addition, the down arrow is used to indicate a state that does not agree with the nominal state; for example, a fan that is nominally on (e.g., HUM SEP fan) is off.

An up arrow displayed next to a parameter would indicate that the upper limit for that parameter has been exceeded.

Smoke Detection and Fire Suppression

This emergency class 1 alarm is hardware driven. The crew is alerted to emergency situations by use of visual and audio alarms.

Smoke detection and fire suppression capabilities are provided in the crew cabin avionics bays, the crew cabin, and the Spacelab pressurized module. Ionization detection elements, which sense levels of smoke concentrations or rate of concentration change, trigger alarms and provide information on smoke concentration levels to the performance-monitoring CRT system and an array of red SMOKE DETECTION lights on panel L1.



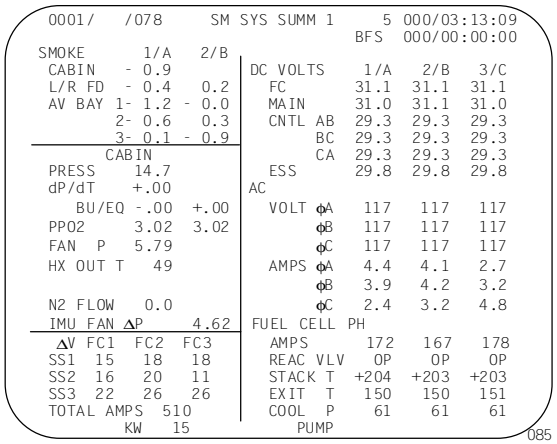
Smoke Detection and Fire Suppression System

The ionization detection system is divided into two groups: group A and group B. Group A ionization detection elements are located in the environmental control and life support system cabin fan plenum outlet beneath the crew cabin middeck floor and in the left return air duct on the crew cabin flight deck, and one element is located in each of the three forward avionics bays (1, 2, and 3A). Group B ionization detection elements are located in the right return air duct on the crew cabin flight deck and in avionics bays 1, 2, and 3A. On Spacelab missions, ionization detection elements are located in the Spacelab module.

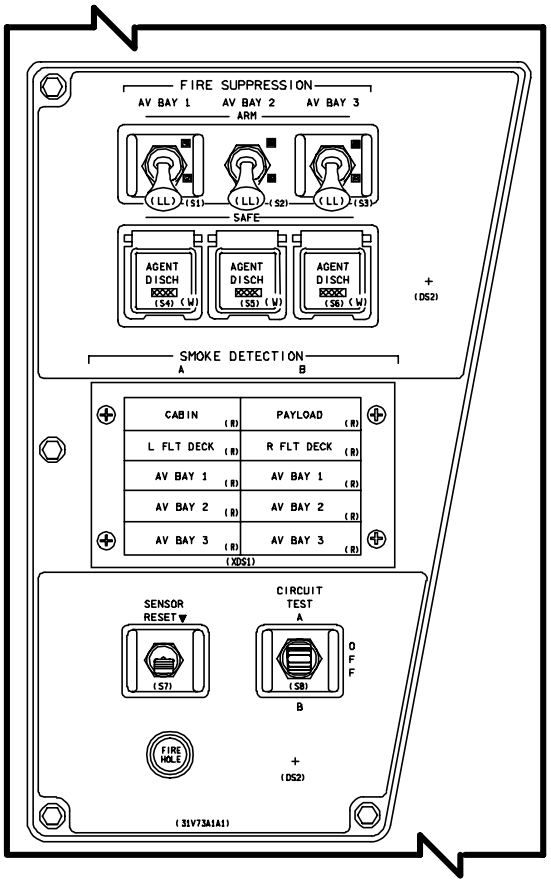
If an ionization detection element senses a smoke particle concentration of 2,000 (±200) micrograms per cubic meter for at least 5 seconds and/or a rate of smoke increase of 22 micrograms per cubic meter per second for eight consecutive counts in 20 seconds, a trip signal illuminates the applicable red SMOKE DETECTION light on panel L1, illuminates the four red MASTER ALARM lights on panels F2, F4, A7, and MO52J, and sounds the siren in the crew cabin. The normal reading on the SM SYS SUMM 1 display for the smoke detection elements is 0.3 to 0.4 milligram per cubic meter. A reading on the CRT of 2.0, plus or minus 0.2, corresponds to 2,000 (±200) micrograms per cubic meter.

After an alarm and a reset of the detector, the following conditions may be observed:

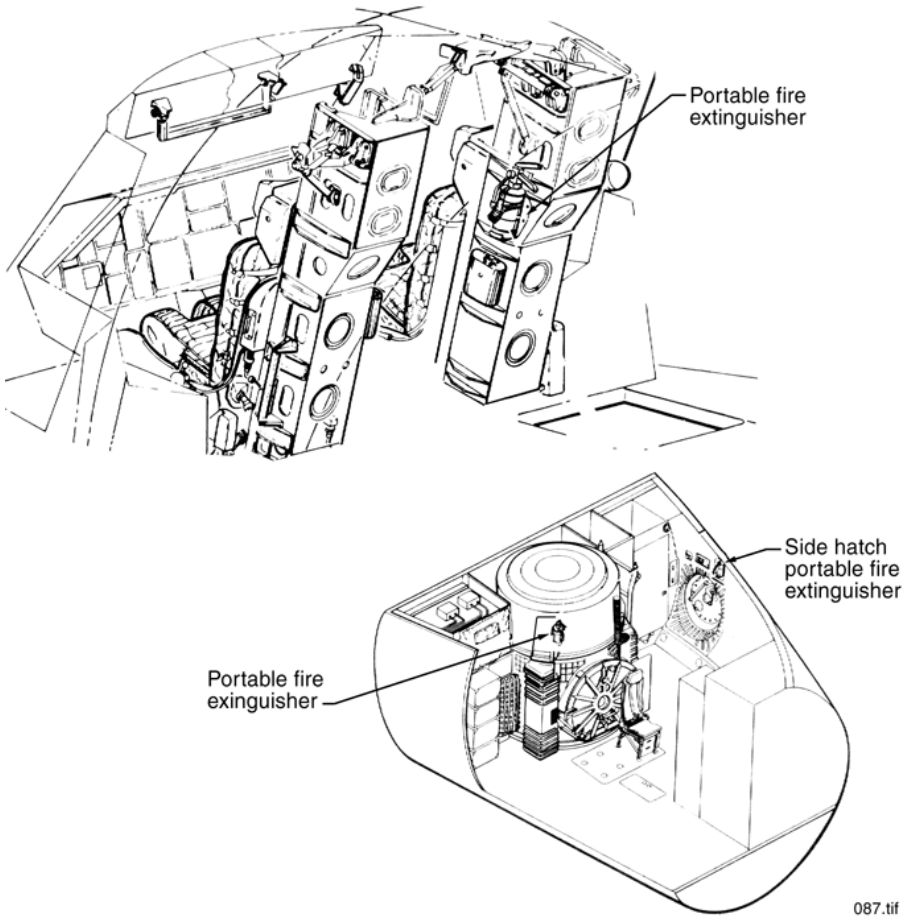
- If the alarm returns in 5 seconds, it is due to the concentration exceeding 2,000 ± 200 micrograms per cubic meter for 5 seconds.
- If the alarm returns in 20 seconds, it is due to the concentration increasing at a rate greater than or equal to 22 micrograms per cubic meter per second for eight consecutive counts in 20 seconds.
- If the alarm returns immediately, the detector would be suspect, and a self test should be performed. If available, the concentration readout should be observed on SM SYS SUMM 1.
- If the alarm does not return, perform self test. If available, check concentration on SM SYS SUMM 1.



SM SYS SUMM 1 (DISP 78)



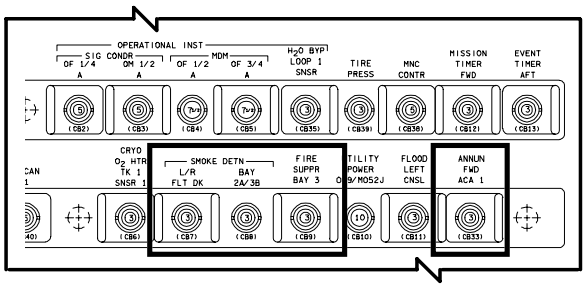
FIRE SUPPRESSION Switches and Push Buttons and SMOKE DETECTION Lights on Panel L1



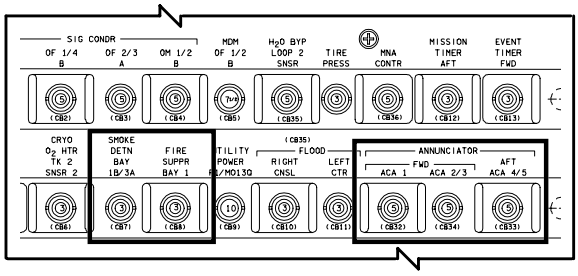
Fire Extinguisher Locations

Fire suppression in the crew cabin avionics bays is provided by three Halon extinguisher bottles permanently mounted in avionics bays 1, 2, and 3A. Each bottle contains 3.74 to 3.8 pounds of Halon in a pressure vessel that is 8 inches long and 4.25 inches in diameter. To activate the applicable bottle in an avionics bay, the corresponding *FIRE SUPPRESSION* switch on panel L1 is positioned to *ARM*, and the corresponding *AGENT DISCH* pushbutton indicator on panel L1 is depressed for at least 2 seconds. The *AGENT DISCH* pushbutton indicator activates the corresponding pyro initiator controller, which initiates a pyrotechnic valve on the bottle to discharge the Halon into the avionics bay. The discharge of Halon will produce a noise of approximately 130 decibels in the avionics bay. The discharge will give a Halon concentration in the avionics bay of 7.5 to 9.5 percent. A 4 to 5 percent concentration is required to suppress a fire. This concentration will provide protection for approximately 72 hours. When the bottle is fully discharged, the pushbutton indicator white light will be illuminated. The white light will be illuminated if the pressure in an avionics bottle falls below 60 ± 10 psig.

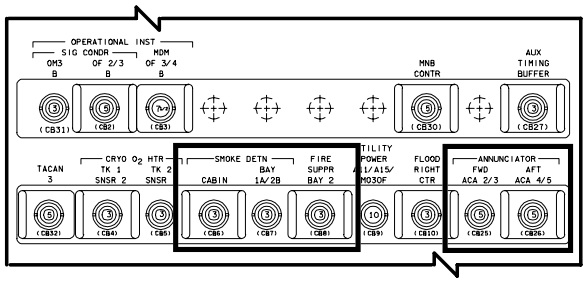
Red *SMOKE DETECTION* lights on panel L1 are illuminated by the following: the CABIN light is illuminated by a smoke detection ionization element in the ECLSS cabin fan plenum, the *L FLT DECK* light is illuminated by the crew cabin left flight deck return air duct smoke ionization element, the *R FLT DECK* light is illuminated by the crew cabin right flight deck return air duct smoke ionization element, and the *PAYLOAD* light is illuminated by the smoke detection ionization elements in the Spacelab pressurized module. The applicable smoke detection ionization element illuminates the applicable red *AV BAY* light on panel L1, activates the *C/W MASTER ALARM* red light, and sounds the siren in the crew cabin.



Fire and Smoke Subsystem Control Circuit Breakers on Panel 014



Fire and Smoke Subsystem Control Circuit Breakers on Panel 015



Fire and Smoke Subsystem Control Circuit Breakers on Panel 016

The circuit breakers that control the fire and smoke subsystem are located on panels 014, 015, and 016. Panel 014 contains the *MN A SMOKE DETN L/R FLT DK* and *BAY 2A/3B*, *FIRE SUPPR BAY 3*, and *ANNUN FWD ACA 1* circuit breakers. Panel 015 contains *MN B SMOKE DETN BAY 1B/3A*, *FIRE SUPPR BAY* 1 and annunciator *FWD ACA 1* and *ACA 2/3* and *AFT ACA 4/5* circuit breakers. Panel 016 contains *MN C SMOKE DETN CABIN* and *BAY 1A/2B, FIRE SUPPR BAY 2*, and *ANNUNCIATOR FWD ACA 2/3* and *AFT ACA 4/5*.

Three hand-held fire extinguishers are available in the crew cabin. Two are located in the crew cabin middeck, and one is on the flight deck. Each fire extinguisher nozzle is tapered to fit fire hole ports located in several display and control panels. The holes are of two types: a ½-inch diameter hole covered with a marked label, and an unmarked ½- to ¼-inch diameter tapered hole. These holes give access to the volume immediately behind the individual panel. To suppress a fire behind a panel or within an avionics bay, the extinguisher nozzle should be inserted into the fire hole and the actuating mechanism depressed for 15 seconds. This will ensure a complete discharge. The extinguishing agent is Halon-1301 (monobromo-trifluoromethane). Halon-1301 minimizes the major hazards of a conflagration: smoke, heat, oxygen depletion, and formation of pyrolysis products such as carbon monoxide. The fire extinguishers are 13 inches long. The portable fire extinguishers can also be used as a backup for extinguishers in the avionics bays. Consideration should be given to the reactive force on the crewmember when discharging the extinguishers on orbit.

Halon 1301

Halon 1301 is used as the extinguishing agent for all fire suppression devices. It is colorless and odorless. Discharge of the agent may create a light mist in the vicinity of the discharge nozzle. Therefore, visibility is not adversely affected. Once the Halon is discharged into an enclosure, it is difficult to detect its presence through normal human senses.

Exposure to Halon in the 5 to 7 percent range produces little, if any, noticeable effect. At levels between 7 and 10 percent, mild central nervous system effects such as dizziness and tingling in the extremities have been reported. Above 10 percent, some subjects report a feeling of impending unconsciousness after a few minutes, although test subjects exposed to up to 14 percent for 5 minutes have not actually lost consciousness. These types of effects were completely reversible upon removal from exposure.

It is considered good practice to avoid all unnecessary exposure to Halon 1301 and to limit exposures to the following times:

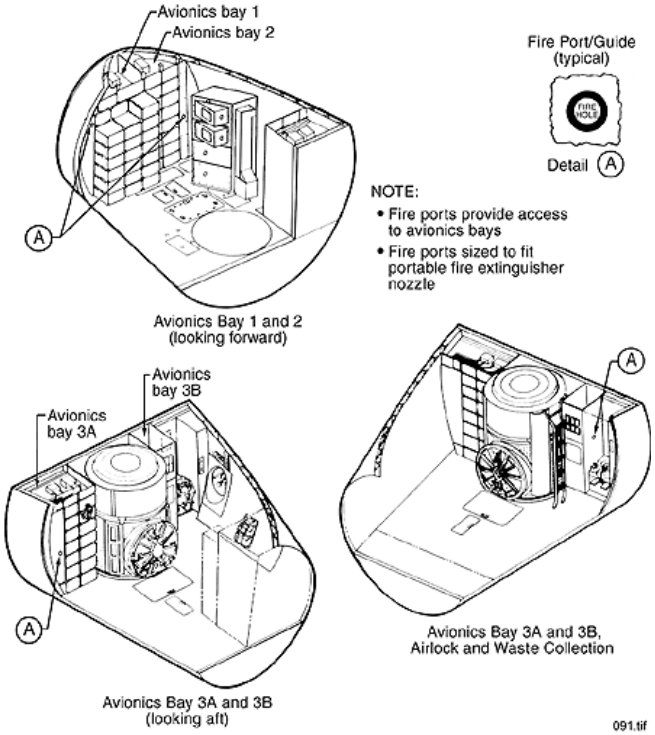
- 7 percent and below: 15 minutes
- 7 to 10 percent: 1 minute
- 10 to 15 percent: 30 seconds
- Above 15 percent: prevent exposure.

Anyone suffering from toxic effects of Halon 1301 should immediately move or be moved to fresh air. In treating persons suffering toxic effects, the use of epinephrine (adrenaline) and similar drugs must be avoided. These drugs may produce cardiac arrhythmias, including ventricular fibrillation.

Although Halon 1301 has a low toxicity, its decomposition can be hazardous. These products have a characteristically sharp acrid odor, even in minute concentrations of only a few parts per million. This smell provides a warning system but at the same time creates a noxious, irritating atmosphere.

The accepted theory is that Halon must decompose before it is effective in suppressing fire. The decomposition takes place on exposure to a flame or to a hot surface of approximately 900° F.

Depending on the severity of the fire, length of time Halon is exposed to flame, and concentration of Halon, the decomposition products may be extensive or minimal.



Fire Port Locations

The *SMOKE DETECTION CIRCUIT TEST* switch on panel L1 tests the smoke detection system, lights, and alarm circuitry. When the switch is positioned to *A* or *B*, electrical power is applied to the ACA channels controlling the *AGENT DISCH* lights, and the white lights are illuminated. Two tests are completed for both the A and the B circuits to test the complete logic circuitry of the smoke detection system. In the first test, after approximately a 20-second delay, the *SMOKE DETECTION* A or B lights are illuminated, and the siren is triggered. In the second test, the *SMOKE DETECTION CIRCUIT TEST* switch is turned off in 5 to 10 seconds, bypassing the 20-second time delay and immediately annunciating a siren and a *SMOKE DETECTION* light (A or B).

Once the alarm system has been triggered, it remains latched until the *SMOKE DETECTION SENSOR* switch on panel L1 is positioned to RESET. When the system is latched, the emergency alarm system will not activate an alarm in case of another fire in the same or any other avionics bay.

Various parameters of the smoke detection system and remote fire extinguishing agent system are provided to telemetry.

Rapid Cabin Depressurization

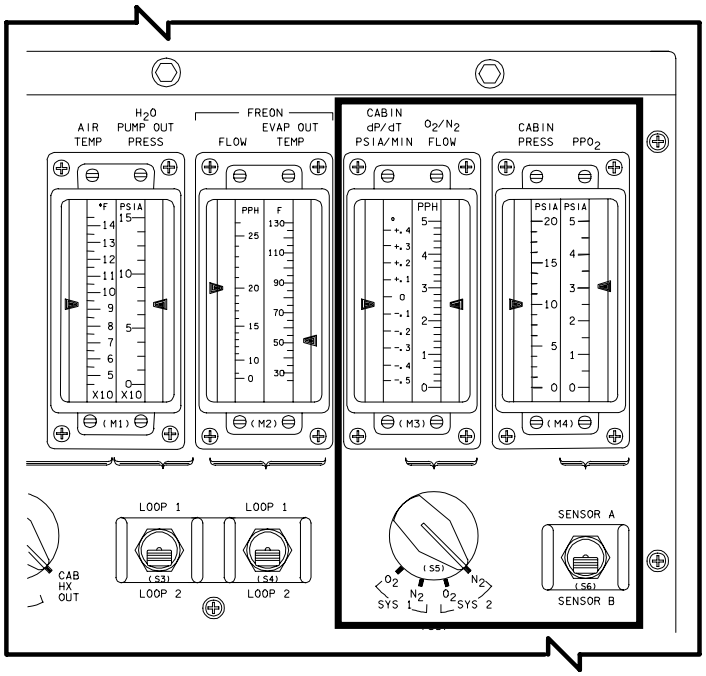
The cabin pressurization rate, dP/dT, senses the rate at which atmospheric pressure is changing in the orbiter (in psi/min). There will be an alarm issued only for a rapid cabin depressurization. If a dP/dT alarm was issued, it would indicate that air was leaking at a rate much higher than normal. The system alerts the crew to a rapid pressure change with respect to time by annunciation of the four MASTER ALARM pushbutton indicators and sounding of the klaxon (class 1 alarm).

A dP/dT alarm will be issued if the change in pressure versus change in time decreases at a rate of 0.08 psi per minute or greater. The normal cabin dP/dT is zero psi per minute (±0.01 psi for all normal operations.

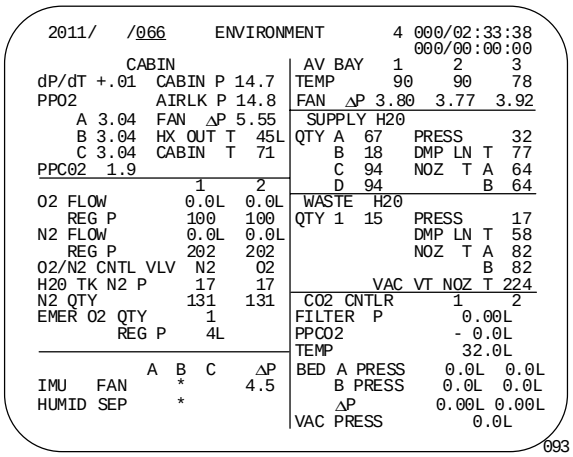
In addition, a class 3 alarm will annunciate for a decrease in pressure greater than or equal to 0.12 psi per minute, based on equivalent dP/dT or backup dP/dT.

Values for dP/dT can be monitored on the SM SYS SUMM 1 (dP/dT, dP/dT-EQ, dP/dT-BU), and the dedicated display on panel O1 (dP/dT).

The rapid dP/dT detector is powered by the MN B PPO2 C CABIN DP/DT circuit breaker on panel 015.



Cabin Pressure Meters and Switches on Panel 01



ENVIRONMENT Display (DISP 66)

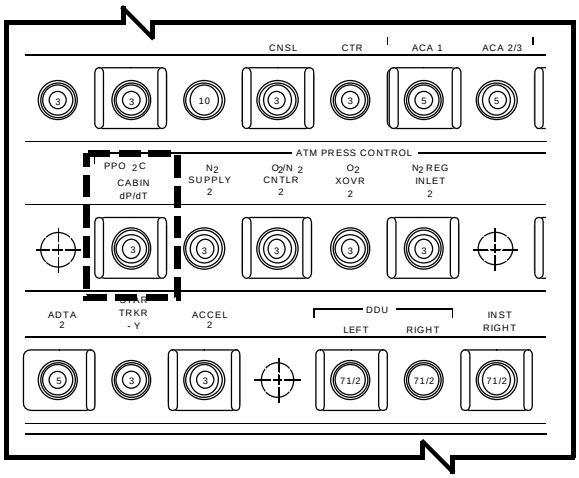
Operations

Primary C/W System

The primary C/W system has three modes of operation: ascent, normal, and acknowledge. These modes are controlled by the *CAUTION/ WARNING MODE* switch on panel C3. The switch has three settings: *ASCENT*, *NORM*, and *ACK*. The normal mode is discussed first.

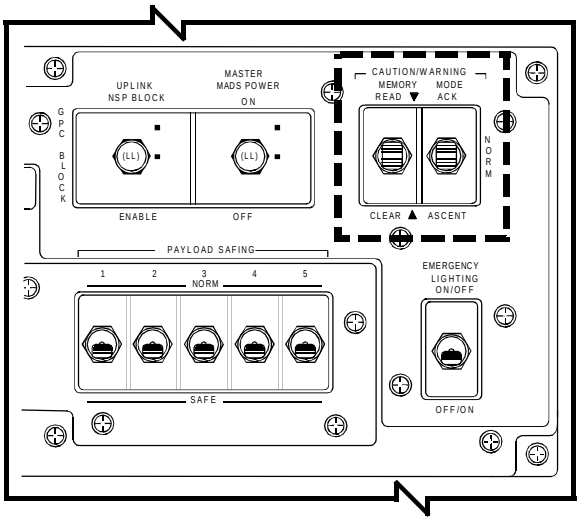
The primary C/W system receives 120 inputs directly from transducers through signal conditioners, or from the flight forward multiplexer/ demultiplexers, and are fed into a multiplexing system. Of these 120 inputs, 95 come directly from transducers, five are from input/output processors, 18 are provided through multiplexer/demultiplexer software, and two are spares. These inputs can be either analog or bilevel. The analog signals are zero to 5 volts dc; the discretes are either zero, 5, or 28 volts dc. All of these inputs are designed to provide upper or lower limit detection. If the parameter has exceeded its limits, it will turn on the C/W tone, light the appropriate light on panel F7, illuminate the four red *MASTER ALARM* pushbutton indicators, and store the parameter in memory.

The C/W tone can be silenced and the *MASTER ALARM* red light extinguished by depressing any one of the *MASTER ALARM* pushbutton indicators; however, the C/W light on panel F7 will remain illuminated until the out-of-tolerance condition is corrected. Any one of the *MASTER ALARM* pushbutton indicators will reset all tones, including the systems management tone.



MN B PPO_2 C CABIN DP/DT Circuit Breaker on Panel 015

The C/W ascent mode is the same as the normal mode, except that the commander's red *MASTER ALARM* pushbutton indicator will not be illuminated.



CAUTION/WARNING MEMORY and MODE Switches on Panel C3

The C/W acknowledge mode is also the same as the normal mode, except that the 40 annunciator lights on panel F7 will not be illuminated unless one of the red *MASTER ALARM* pushbutton indicators (on panel F2 for the commander or panel F4 for the pilot) is depressed.

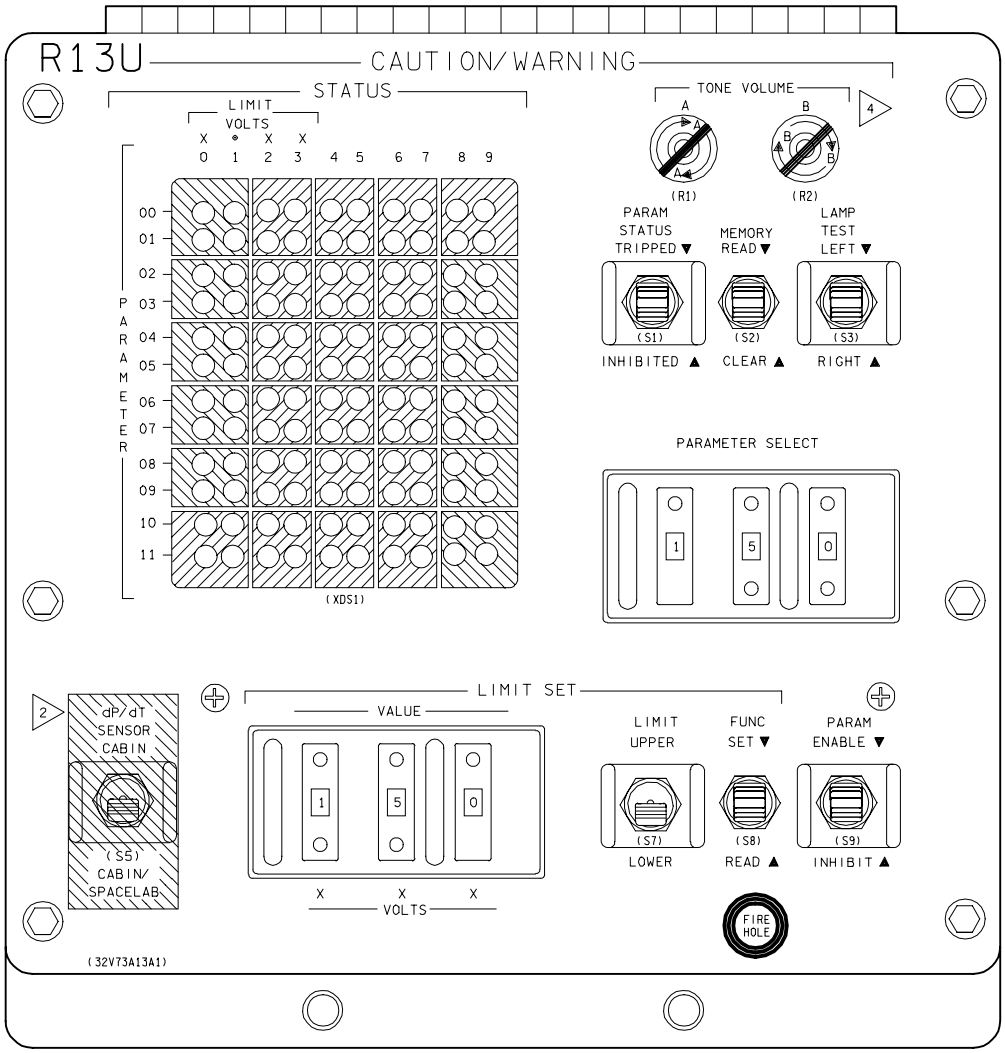
Panel R13U

Each of the 120 status C/W red parameter lights on panel R13U receives an input from a specific parameter. A primary C/W parameter matrix cue card identifies the 120 input channels and correlates them to the panel F7 C/W annunciator light matrix. If an out-of-limit condition exists on a specific parameter that is set on panel R13U, it illuminates the corresponding light on panel F7. If the *CAUTION/WARNING PARAM STATUS* switch on panel R13U is held in the *TRIPPED* position when an out-of-limit parameter light on panel F7 is illuminated, the corresponding light on panel R13U will also be illuminated.

Some limits, and the list of parameters monitored, change with flight phase. The crew uses the *PARAM ENABLE/INHIBIT* and *LIMIT* switches on panel R13U to tailor the C/W system for their current configuration.

The three *CAUTION/WARNING PARAMETER SELECT* thumbwheels on panel R13U provide signals to the C/W electronics unit and define the specific parameter for enabling and inhibiting the parameter and setting and reading the parameter's limits.

The *CAUTION/WARNING LIMIT SET* switch grouping on panel R13U is used to change limits or to read a parameter's limits. The three *VALUE* thumbwheels provide the signals to the C/W unit, defining the voltage value setting of a parameter's upper or lower limit, X.XX.



Panel R13U

The *UPPER* setting of the *CAUTION/ WARNING LIMIT SET LIMIT* switch on panel R13U provides a signal to the C/W electronics unit, which modes the electronics to set or read the upper limit of a parameter specified by the settings on the *PARAMETER SELECT* thumbwheels for that parameter. The *CAUTION/ WARNING LIMIT SET FUNC* switch is cycled to set or read the upper limit of that parameter. The LOWER setting functions in the same manner, except for the lower limit for a parameter.

The *CAUTION/WARNING LIMIT SET FUNC SET* switch position on panel R13U provides a signal to the C/W electronics unit, which sets the value specified by the *LIMIT SET VALUE* thumbwheels into the parameter as specified by the PARAMETER SELECT thumbwheels and LIMIT SET LIMIT switch. The LIMIT SET FUNC READ switch position on panel R13U provides a signal to the C/W electronics unit, which illuminates the lights under the STATUS LIMIT VOLTS X.XX columns on panel R13U that correspond to the voltage parameter limit specified by the

PARAMETER SELECT thumbwheels and the LIMIT SET LIMIT switch. The value read corresponds to the parameter's full-scale range on a scale of zero to 5 volts dc. The LIMIT SET FUNC switch center position disables the set and read functions.

The *ENABLE* position of the *CAUTION/ WARNING PARAM* switch on panel R13U provides a signal to the C/W electronics unit to enable the parameter indicated on the *PARAMETER SELECT* thumbwheels, which allows the parameter to trigger the primary C/W alarm when out of limits. The *INHIBIT* position operates the same as *ENABLE*, except it inhibits the parameter from triggering the primary C/W alarm. The center position of the switch disables the enable and inhibit functions.

The *TRIPPED* position of the *CAUTION/ WARNING PARAM STATUS* switch on panel R13U provides a signal to the C/W electronics unit, which illuminates the C/W status lights that correspond to the parameters that are presently out of limits, including those that are inhibited. The *INHIBITED* position illuminates those C/W lights on panel R13U that have been inhibited. The center position disables the tripped and inhibited functions.

The *CAUTION/WARNING MEMORY READ* switch position on panel R13U provides a signal to the C/W electronics unit, which illuminates the C/W status lights on panel R13U that correspond to the parameters that are currently out of limits and that have been out of limits since the last positioning of this switch or the *CAUTION/WARNING MEMORY* switch on panel C3 to *CLEAR*. The *CLEAR* position on panel R13U or panel C3 provides a signal to the C/W electronics unit that clears from the memory any parameters that are presently within limits, but any parameters that are out of limits during this action remain in memory. The center position of the switch on panel R13U or panel C3 disables the clear and read functions.

The *CAUTION/WARNING TONE VOLUME* A knob on panel R13U, when adjusted clockwise, increases the system A siren, klaxon, C/W, and SM tone generator output signals to the audio central control unit. The B switch functions the same as the A switch for system B tone generators.

The *CAUTION/WARNING LAMP TEST* switch on panel R13U, when positioned to *LEFT*, provides a signal to the C/W electronics unit, which illuminates the left five columns of the C/W status matrix lights on panel R13U. The *RIGHT* position functions the same as the *LEFT*, except for the right five columns of lights. This allows the verification of all 120 lights, making sure that none have burned out.

Software (Backup) Caution and Warning

When the software caution and warning system detects an out of limits condition, it sounds an aural tone or master alarm, lights the *MASTER ALARM* or *SM ALERT* light, and issues a fault message that is displayed flashing on the CRT fault message line. The master alarm light and tones are reset by depressing a *MASTER ALARM* light pushbutton. The fault message will flash until acknowledged by a depression of the ACK key or until the MSG RESET key is depressed to erase the message. The MSG RESET key will also extinguish the *SM ALERT* light.

The displayed fault message is used to diagnose system failures and frequently is used as the title of the flight data file procedure to be worked by the crew in response to the failure. The text of the fault message identifies the system where limits are being exceeded. A list of individual fault messages is presented in the summary at the end of this section.

For some general classes of fault messages, the first part of the text contains the SPEC number to be consulted to determine the specific parameter that is out of limits. The GPCs declaring the fault are enumerated after the message text. In parentheses at the end of the fault message, software will display the number of other fault messages generated while the current message was being displayed. To view these messages and the time at which they were annunciated, the crew must look at the fault summary page, or scroll through them using the *ACK* key.

After reset of the displayed fault message, the message line will be blank until another new message is generated by the software. To avoid missing messages in a multi-failure scenario, crews should occasionally review all messages on the fault summary page and try to reset messages on the fault line as quickly as possible after reviewing them.

Fault messages for some parameters are issued every time the software completes the required number of data counts with the parameter out of limits. This can result in a steady stream of fault messages and *MASTER ALARMS* that may obscure other important fault messages. If this situation is encountered, the crew or Mission Control can inhibit the affected parameter to prevent nuisance messages and alarms in OPS 2 or OPS 4. In OPS 1, 6, or 3, the crew generally has to tolerate the extra alarms/fault messages and pay extra close attention to the fault summary display.

In order to clear messages from the fault summary page, the crew enters a SPEC 99 PRO on the keyboard. If the fault summary (DISP 99) is called up using a SPEC 99 PRO instead of the FAULT SUMM key, the fault summary page will appear, and then immediately clear itself.

Software caution and warning limits for some parameters change depending on the phase of flight. These changes can be entered by the crew via the SPEC 60 TABLE MAINTENANCE display or uplinked from the ground. The ground uplink for limits changes is called a Table Maintenance Block Uplink (TMBU).

SPEC 60, SM Table Maintenance

The primary avionics software system (PASS) includes three types of applications software, called major functions. The first, systems management (SM), is the function that is active on orbit. The second, guidance, navigation, and control (GNC), is active during all flight phases. The third, payload software, provides operations support to payloads. The backup flight system (BFS), normally used only during ascent and entry, also contains both SM and GNC software.

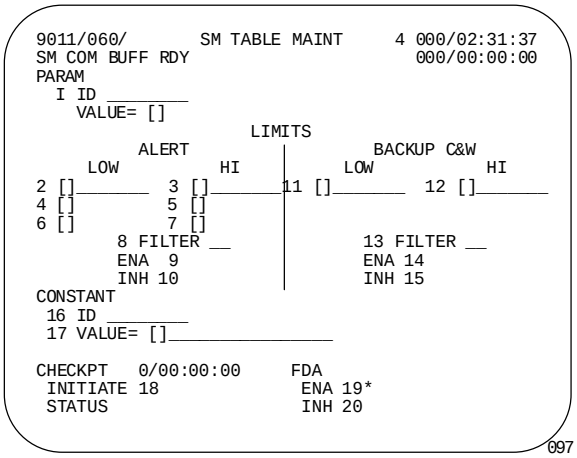
Modules within both SM and GNC software monitor parameters and initiate alarms. To change the characteristics of the PASS GNC, BFS GNC, and BFS SM parameters, the crew would have to perform a GPC memory read/write procedure. (This procedure is described in the DPS HW/SW 2102 Training Manual.)

However, PASS SM parameters <u>can</u> be accessed directly by the crew. Within PASS SM is a module called fault detection and annunciation. This module monitors the backup C/W and alert parameters and initiates alarms.

SPEC 60 SM TABLE MAINT is the crew interface with the PASS SM parameters. Using SPEC 60, the crew can read and change the following for each PASS SM backup C/W or alert parameters: (1) lower and upper limits, (2) noise filter value, and (3) enable/inhibit status. Additionally, the crew can read and change SM program constants, initiate a checkpoint, and enable or inhibit the entire fault detection and annunciation software module.

SPEC 60, which is a PASS SM SPEC, is available during SM OPS 2 and SM OPS 4. When the SM TABLE MAINT display is called up by its SPEC number (SPEC 60 PRO), each field will be blank except CHECKPT time and FDA ENA.

When SPEC 60 is called by pressing RESUME, the fields that were previously in use will retain their data. When a legal item entry is made, the new data will be displayed in the appropriate field and will overwrite any previous data.



SM TABLE MAINT CRT (SPEC 60)

Any backup C/W parameter may be accessed by entering its software ID number (see page 2.2-4) in item 1 of the SM TABLE MAINT display. The limits, noise filter value, and enable/inhibit status of alert parameters may be changed with items 2 through 10. The same characteristics of backup C/W parameters are available through items 11 through 15. These CRT parameters are discussed in more detail below.

PARAM ID (Item 1) and PARAM Value

The software ID number for the desired fault detection and annunciation (FDA) parameters is entered in item 1. The software IDs are located in the C/W and FDF TABLE of the Flight Data File Reference Data Book.

When a valid ID is entered, the ID number will be displayed in the PARAM ID space, and the current value of the parameter will be displayed in the PARAM VALUE field. The status of the parameter is indicated by the presence or absence of an up or down arrow. The appropriate ALERT or BACKUP C/W data will appear in the LIMITS portion (items 2 through 10 or items 11 through 15 respectively). If the parameter is monitored by both the Alert and B/U C/W systems, then both sections will contain the proper data. Otherwise, one of the LIMITS sections will be blank.

If the PARAM ID is not valid, all associated data fields will be blank, and an ILLEGAL ENTRY message will be displayed.

Limits Alert Low and Hi (Items 2 through 7)

These fields contain the upper and lower alert limits of the FDA parameter identified in item 1. The limit values are displayed in engineering units and can be changed by entering the desired data in the appropriate items.

Alert parameters that are preconditioned may have two or three limits sets. All other alert parameters have only one limit set. The SM software selects which set of limits is currently active and places an asterisk next to that set (before item 2, 4, or 6). (There is no item entry that allows the crew to move the asterisk to directly select which set of limits is active. This is done exclusively by software.) If only one set of limits exists for the parameter, this set will be displayed in the first limit set location, and the asterisk will be placed by item 2. If a value is entered in a limit set that does not exist for the selected parameter, an illegal entry message will be displayed.

Limits Backup C/W Low and Hi (Items 11 and 12)

The backup C/W system limits for the FDA parameter identified in item 1 are displayed in these fields. The limit values, which are in engineering units, can be changed by entering the new data in the desired item.

Backup C/W parameters have one set of limits. An asterisk next to item 11 indicates that there exists a backup C/W limit set for the parameter.

Limits Alert Filter (Item 8)

The Alert parameter noise filter value can be read or changed through item 8. It is the number of consecutive times the parameter has to be sensed out of limits before an alarm annunciates. The reverse is true for returning back into limits. The range of valid values is 1 through 15.

Limits Backup C/W Filter (Item 13)

The backup C/W filter functions similarly to the Alert filter (item 8).

Limits Alert ENA or INH (Items 9 and 10)

The annunciation of an out-of-limits Alert parameter may be either enabled or inhibited by executing the respective item. The items are mutually exclusive, and an asterisk indicates the current annunciation status by appearing after the more recently selected item.

The class 0 status indicators (up and down arrows) and transducer data symbols (H, L, M, ?) are not affected by this item.

Limits Backup C/W ENA or INH (Items 14 and 15)

These backup C/W items operate similarly to the Alert items 9 and 10.

FDA ENA or INH (Items 19 and 20)

The PASS FDA software can be either inhibited or enabled by executing the respective item. The items are mutually exclusive, and an asterisk denotes the current state. The display is initialized with FDA enabled.

When FDA is inhibited, the following FDA functions are disabled:

- FDA alarm annunciation. This includes backup C/W (class 2), Alert (class 3), and limit sensing up or down arrows (class 0).
- Limit sensing (class 0). The last value of each out-of-limits parameters status indicator is displayed.
- Precondition steering.
- False alarm avoidance noise filters.

Other parameter status indicators (H, L, M, ?) are not affected because they are not generated by the FDA software.

Constants

SM constants may be accessed through items 16 and 17. These constants are primarily involved in SM special processes such as water loop pump cycling, alert preconditioning, and payload deployment.

Constant ID (Item 16)

When a constant ID number is entered in item 16, both the CONSTANT ID and VALUE fields are filled. If the ID was illegal, both data fields are blanked.

The constant IDs and values are not typically carried onboard the orbiter, although various malfunction procedures contain occasional constants. If a constant must be changed, Mission Control will either provide the crew with the data or directly change the constant through a TMB Uplink. (See TMBU description in this section.)

Constant Value (Item 17)

This field contains the current value of the constant identified in item 16. The constant value can be changed by entering the new data in item 17.

TMBU

TMBU is the type of uplink that Mission Control uses to change the following data:

- Parameter limit values
- Parameter noise filter values
- Parameter annunciation enable/inhibit status
- SM constant values.

The use of TMBUs decreases the crew's workload because the changes that are uplinked do not have to be entered on SPEC 60.

SPEC 60 operations and TMBUs are interlocked such that TMBU loads are rejected if SPEC 60 is active. If a TMBU is in progress when SPEC 60 is called, the flashing words UPLINK and UL will be displayed on the display, and all item entries will be prohibited by an ILLEGAL ENTRY message.

Uplink

The flashing word UPLINK is displayed in the top center of SPEC 60 to indicate that a TMBU is in progress.

UL

When any two-stage command (including a TMBU) is uplinked, a flashing UL is displayed in the upper right corner of all CRTs associated with the GPC(s) that are being commanded.

Checkpoints

When a checkpoint is performed, the following information is saved in a mass memory unit:

- Parameter limit values
- Parameter noise filter values
- Parameter annunciation enable/inhibit status
- SM constant values
- Checkpoint timetags.

The checkpoint capability is valuable because changes made through item entries on SPEC 60 affect only the SM GPC software and not the mass memory unit software. If these changes are not saved in a mass memory unit, and the SM GPC fails, flight software will lose the changes that have been made. The changes would then have to be reentered.

When checkpoint retrieval is enabled, the software loaded into an SM GPC from a mass memory unit will contain the most recent version of changes saved during checkpoint.

Checkpoint Initiate (Item 18), Checkpoint Status, and Time

When item 18 is executed, the STATUS field will go blank. While the checkpoint is being performed, a flashing BSY will be displayed next to SM COMM BUFF at the top left of SPEC 60. This indicates that the SM communications buffer is in use. When the checkpoint is completed, the CHECK PT STATUS field will contain GOOD. If the SM common buffer was not available, CHECK PT STATUS will be FAIL, and item 18 should be executed again.

The mission elapsed time (MET) of the most recent successful checkpoint will be displayed as DD/HH:MM:SS, in the checkpoint time field.

SM COMM BUFF - BSY, or RDY

Either a flashing BSY or a status RDY is displayed after SM COMM BUFF to indicate the status of the SM Common Buffer. BSY (busy) indicates that the SM COMM BUFF is being used; RDY (ready) means the buffer is available.

Keypad entries are rejected if BSY is flashing.

CKPT RETRV ENA (SPEC 1, Item 12)

Executing this item will alternately select or deselect CKPT RETRV ENA. An asterisk appears next to item 12 when checkpoint retrieval is enabled.

MMU Assignment (DPS Utility - SPEC 1, Items 3 and 4)

A checkpoint saves the changes in the mass memory unit assigned to the SM software by item 3 or 4. In order to save the checkpoint in both, two checkpoints must be performed.

C/W Summary Data

- The C/W system consists of four alarm classes: emergency (class 1), C/W (class 2), alert (class 3), and limit sensing (class 0).
- Emergency alarms cover two situations: smoke detection/fire suppression and cabin pressure.
- Smoke detection and fire suppression capabilities are provided in the crew cabin avionics bays, the crew cabin, and the Spacelab pressurized module.
- Increased smoke particle concentration will illuminate *SMOKE DETECTION* lights on panel L1, illuminate four red *MASTER ALARM* lights on panels F2, F4, A7, and MO52J, and sound the siren in the crew cabin.
- Fire suppression in the crew cabin avionics bay is provided by one permanent Halon extinguisher bottle in avionics bays 1, 2, and 3A. The bottle is operated by switches on panel L1.
- Three portable hand-held extinguishers in the crew cabin are operated by inserting them into fire holes located in several display and control panels.
- A class 1 alarm (four *MASTER ALARM* pushbutton indicators and the sounding of the klaxon) is triggered when there is a rapid change in cabin pressure with respect to time.
- Class 2 alarms include primary (hardware) and backup (software) systems. The crew interfaces with the system primarily through the 40-light annunciator matrix on panel F7 and a 120-parameter monitor on panel R13U.
- Class 3 alerts warn the crew of a situation leading up to a class 2 alarm or of one that may require a long procedure.
- Class 0, a software system, consists of up and down arrows displayed on the CRT displays next to a parameter.
- The SPEC 60 TABLE MAINT display allows the crew to change limits, noise filter values, and status of backup C/W or alert system parameters.
- C/W information can be seen on the SM SYS SUMM 1 (DISP 78), and ENVIRONMENT (DISP 66) displays.
- Pressing the *MASTER ALARM* light will silence the alarm and reset the light.
- Pressing the ACK key will stop the fault messages from flashing. Subsequent pressing of ACK key will scroll through fault messages.
- Pressing the MSG RESET key will erase fault messages and extinguish the *SM ALERT* light.

C/W Rules of Thumb

- The *SENSOR RESET* switch on panel L1 should be pressed when smoke concentration goes below 1.8. This prevents masking of alarms.
- When panel R13U is not in use, the *PARAMETER SELECT* thumbwheels should be set to a value greater than 119.
- Crewmembers should reset fault messages as quickly as possible after review to avoid covering other messages
- The fault summary should be reviewed regularly to avoid missed fault messages.

F7 Light Summary

NOTE

A Class 2 audible tone and *MASTER ALARM* lights accompany the appropriate C/W light. Most lights are hardware-driven, but many parameters are also software-sensed by the PASS or BFS GPCs. The software provides a CRT message and illuminates the *BACKUP C/W ALARM* light. The hardware channels listed below are the same as the channels on the C/W STATUS light matrix on panel R13U. The color of each light is indicated by (R) for red and (Y) for yellow.

O2 PRESS (Y): Indicates an O2 tank 1, 2, 3, or 4 pressure or the O2 kit (Tank 5) pressure out of limits. The hardware channels are 0, 10, 20, 30, and 40 for Tanks 1, 2, 3, 4, and 5, respectively.

H2 PRESS (Y): Indicates either an H2 Tank 1, 2, 3, or 4 pressure or the H2 kit (Tank 5) pressure out of limits. The hardware channels are 50, 60, 70, 80, and 90 for Tanks 1, 2, 3, 4, and 5, respectively.

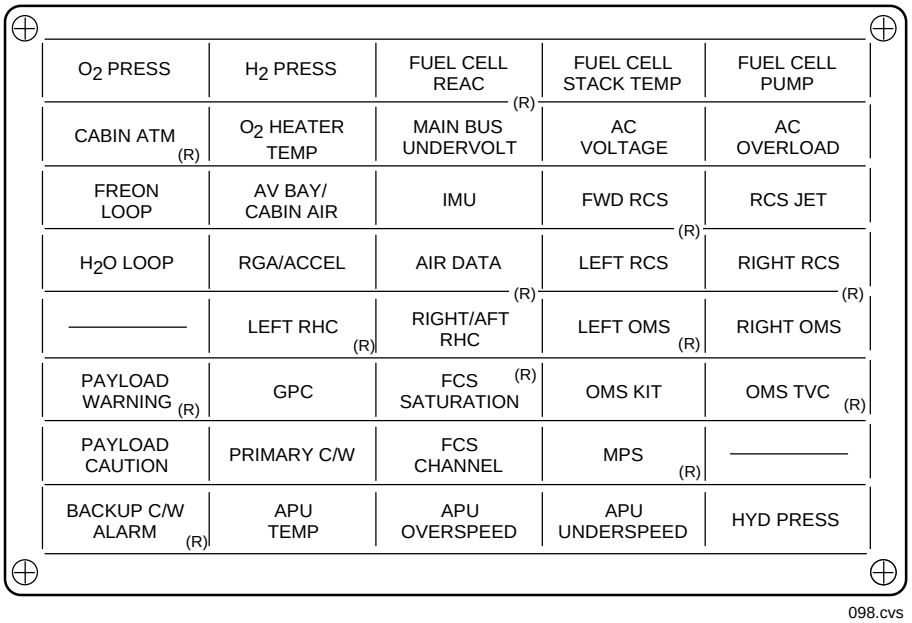
FUEL CELL REAC (R): Indicates an O2 or H2 Fuel Cell 1, 2, or 3 reactant valve is closed. The hardware channels are 2, 22, 32, 42, and 52 for FC 1, 2, and 3 O2 and H2 respectively.

FUEL CELL STACK TEMP (Y): Indicates a Fuel Cell 1, 2, or 3 stack temperature out of limits. The hardware channels are 62, 72, and 82 for FC 1, 2, and 3, respectively.

FUEL CELL PUMP (Y): Indicates a Fuel Cell 1, 2, or 3 pump ÐP out of limits. The hardware channels are 92, 102, and 112 for FC 1, 2, and 3 respectively.

CABIN ATM (R): Indicates either cabin pressure, PPO2, O2 flow rate, or N2 flow rate out of limits. The hardware channels are 4, 14, 24, 34, 44, 54, and 64 for cabin press, O2 SYS 1 and 2 flow rate, PPO2 A and B, and N2 SYS 1 and 2 flow rate respectively.

O2 HEATER TEMP (Y): Indicates an O2 Tank 1, 2, 3, or 4 heater temp or O2 kit (Tank 5) heater temp out of limits. The hardware channels are 1, 11, 21, 31, 41, 51, 61, 71, and 81 for O2 Tank 1 HTR 1 and 2, Tank 2 HTR 1 and 2, Tank 3 HTR 1 and 2, Tank 4 HTR 1 and 2, and Tank 5 respectively.



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Caution and Warning Light Matrix on Panel F7

F7 Light Summary (continued)

MAIN BUS UNDERVOLT (R): Indicates main bus A, B, or C voltage low. The hardware channels are 3, 13, and 23 for main bus A, B, and C respectively.

AC VOLTAGE (Y): Indicates AC bus 1, 2, or 3 phase A, B, or C out of limits. The hardware channels are 33, 43, and 53 for AC bus 1, 2, and 3 respectively.

AC OVERLOAD (Y): Indicates an inverter 1, 2, or 3 phase A, B, or C output of 225 percent overload for 20 sec or 300 percent for 4 to 6 sec. The hardware channels are 63, 73, and 83 for inverter 1, 2, and 3 respectively.

FREON LOOP (R): Indicates a low Freon loop 1 or 2 flow rate or a temperature out of limits. The hardware channels are 106, 116, 107, and 117 for loop 1 and 2 flow rate, and loop 1 and 2 temp respectively.

AV BAY/CABIN AIR (Y): Indicates out of limits condition on cabin fan ĐP, AV Bay 1, 2, or 3 air out temp, or cabin heat exchanger air temp. The hardware channels are 74, 84, 94, 104, and 114 for cabin fan ĐP, AV Bay 1, 2, or 3 Temp, and CAB HX temp respectively.

IMU (Y): Indicates detection of an inertial measurement unit (IMU) failure or dilemma. The hardware channel is 103 and is a discrete driven from the GNC software.

FWD RCS (R): Indicates detection of an out of limits condition on a forward RCS oxidizer tank ullage pressure, fuel tank ullage pressure, or forward oxidizer or fuel leak. The hardware channels are 6, 16, and 26 for oxidizer tank press, fuel tank press, and leak respectively.

RCS JET (Y): Indicates detection of an RCS jet failed on, failed off, or leaking. The hardware channel is 96 and is a discrete driven from the GNC software.

H2O LOOP (Y): Indicates an out of limits condition on H_2O loop 1 or 2 pump out pressure. The hardware channels are 105 and 115 for loop 1 and 2 respectively.

RGA/ACCEL (Y): Indicates detection of a rate gyro assembly (RGA) 1, 2, 3, or 4 failure, or an accelerometer 1, 2, 3, or 4 failure. The hardware channel is 93 and is a discrete driven from the GNC software.

AIR DATA (R): Indicates detection of an air data transducer assembly (ADTA) dilemma. The hardware channel is 91 and is a discrete driven from the GNC software.

LEFT RCS (R): Indicates detection of a left RCS oxidizer, fuel tank ullage pressure out of limits, or left oxidizer or fuel leak. The hardware channels are 36, 46, and 56 for oxidizer tank press, fuel tank press, and leak respectively.

RIGHT RCS (R): Indicates detection of a right RCS oxidizer, fuel tank ullage pressure out of limits, or right oxidizer or fuel tank leak. The hardware channels are 66, 76, and 86 for oxidizer tank press, fuel tank press, and leak respectively.

SPARE: Available for future warning parameter growth.

LEFT RHC (R): Indicates detection of a left rotational hand controller (RHC) pitch, roll, and yaw disagree. The hardware channel is 100 and is a discrete driven from the GNC software.

RIGHT/AFT RHC (R): Indicates detection of a right or aft RHC pitch, roll, or yaw disagree. The hardware channel is 110 and is a discrete driven from the GNC software.

LEFT OMS (R): Indicates detection of a left OMS pod oxidizer, fuel tank ullage pressure out of limits, or an engine abnormal (OMS engine fail to cutoff, fail to ignite, or early shutdown) condition. The hardware channels are 37, 47, and 57 for the oxidizer, fuel tank press, and engine abnormal respectively. The hardware channels are 7, 17, and 27 for the oxidizer, fuel tank press, and engine abnormal respectively.

RIGHT OMS (R): Indicates detection of a right OMS pod fuel tank ullage pressure out of limits, or an engine abnormal (OMS engine fail to ignite, or early shutdown) condition.

F7 Light Summary (continued)

PAYLOAD WARNING (R): Indicates detection of up to five payload parameter inputs out of limits. The hardware channels are 55, 65, 75, 85, and 95.

GPC (Y): Indicates GPC 1, 2, 3, 4, or 5 has determined itself failed and issued a self-fail discrete. The hardware channels are 5, 15, 25, 35, and 45 for GPC 1, 2, 3, 4, and 5 respectively.

FCS SATURATION (Y): Indicates detection of elevon position or hinge moment saturation. The channel is 101 and is a discrete driven from the GNC software.

OMS KIT (Y): Indicates detection of an OMS kit oxidizer or fuel tank ullage pressure out of limits. The hardware channels are 77 and 87 for oxidizer and fuel respectively.

OMS TVC (R): Indicates detection of an OMS pitch or yaw gimbal failure. The hardware channel is 67. An OMS TVC failure may also result in a LEFT or RIGHT OMS light.

PAYLOAD CAUTION (Y): Indicates detection of a payload parameter input out of limits. The hardware channel is 97 and is not presently implemented.

PRIMARY C/W (Y): Indicates detection of a C/W system self-test failure internal to the C/W EU. The failures include the loss of power supply A or B, loss of A or B timing, or the inability of a C/W self-test parameter to pass limit check. No channel number. The parameter is internal to the C/W unit hardware itself. The light also illuminates each time the ESS 1BC C/W A circuit breaker is closed after being opened and extinguishes when the MASTER ALARM pushbutton indicator is depressed.

FCS CHANNEL (Y): Indicates detection of an elevon, rudder, or speedbrake actuator failure, SRB rock or tilt actuator failure, or MPS engine pitch and yaw actuator failure. The hardware channel is 111 and is a discrete driven from the GNC software.

MPS (R): Indicates detection of an MPS engine He tank press, He regulator out press, LO2 manifold press, or LH2 manifold press out of limits. The hardware channels are 9, 19, 29, 39, 49, 59, 69, and 79 for Engine 1, 2, and 3 He TK, He reg, and LO2 and LH2 pressure respectively.

SPARE (R): Available for future warning parameter growth.

BACKUP C/W ALARM (R): Indicates detection of a C/W alarm via SM, GNC, or BFS software monitoring. In OPS 2 SM parameter limits can be accessed, changed, enabled, and inhibited through the Table Maintenance display.

APU TEMP (Y): Indicates an APU 1, 2, or 3 exhaust gas temp or lube oil temp out of limits. The hardware channels are 8, 18, 28, 38, 48, and 58 for APU 1, 2, and 3 EGT and lube oil temp respectively.

APU OVERSPEED (Y): Indicates an APU 1, 2, or 3 speed greater than a specified percentage of the designed speed. The hardware channels are 68, 78, and 88 for APU 1, 2, and 3 respectively.

APU UNDERSPEED (Y): Indicates an APU 1, 2, or 3 speed less than a specified percentage of the designed speed. The hardware channels are 98, 108, and 118 for APU 1, 2, and 3 respectively.

HYD PRESS (Y): Indicates a hydraulics system 1, 2, or 3 supply pressure out of limits. The hardware channels are 99, 109, and 119 for APU 1, 2, and 3 respectively.

Fault Message Summary

MESSAGE		OPS AVAIL PASS	OPS AVAIL BFS	CAUSE	COMMENTS
S86 APU FUEL	1(2,3)	S2,4		• APU FUEL QTY ↓ • APU FUEL TK P ↑↓	
S86 APU GBX P	1(2,3)	S2,4		• GBX P ↓ • OIL OUT P ↑↓	
T	1(2,3)	S2,4		• OIL OUT T ↑↓ • GBX BRG T ↑	
S88 APU H2O T	1(2,3)	S2,4		• APU H2O LN INT T ↑↓	
SM2 APU SPD HI 1(2,3)			SM	• TURBINE OVERSPEED	• NO MAL
SM2 APU SPD LO 1(2,3)			SM	• TURBINE UNDERSPEED	• NO MAL
S86 APU TEMP	1(2,3)	S2,4		• BACKUP EGT ↑	
SM2 APU TEMP			SM	• OIL TEMP ↑↓	
S88 APU TK T	1(2,3)	S2,4		• APU TK SURF T ↓ • APU TK SKIN T ↑↓	
S66 AV BAY 1(2,3)	FAN	S2,4		• AV BAY 1(2,3) FAN ΔP ↑↓	
SM2 AV BAY FAN			SM		
BCE BYP	FLEX	S2,4		• BCE BYPASS ON FLEX/FLEX PAIR	
BCE BYP	KU	S2,4		• PL 1 KU COMM/RADAR S10 FAIL	• RADAR: GPC MODE NOT VALID UNLESS TRACKING, AUTO-TRACK MODE IS VALID • NO MAL
BCE BYP	MCIU	S2,4		• GPC DETECTED I/O LOSS WITH MCIU	

MESSAGE		OPS AVAIL PASS	OPS AVAIL BFS	CAUSE	COMMENTS
S62 BCE BYP OA		S2,4		• OA1, OA2, OR OA3 MDM OR MDM CARD FAIL	
OFA		S2,4		• OF1 OR OF2 MDM OR MDM CARD FAIL	
OFB		S2,4		• OF3 OR OF4 MDM OR MDM CARD FAIL	
PDI		S2,4		• PDI INTERFACE TO SM GPC FAIL	• MSG OCCURS AT SM OPS TRANSITION IF PDI POWER OFF
PL		S2,4		• PDI SSC OR EXC INTERFACE TO PCMMU FAIL	• MSG OCCURS AT SM OPS TRANSITION IF PDI POWER OFF OR IF SPACELAB AND SSC OR EXC POWER OFF
PSP 1(2)		S2,4		• PSP 1(2) TO PL 1(2) MDM SERIAL I/O FAIL	
BCE BYP	PL1(2)	S2,4		• BCE BYPASS ON PL BUSES	
BCE BYP	SCA	S2,4		• BCE BYPASS ON SCA	• NO MAL
BCE STRG 1	A	G1,2,3,6,8	G0,1,2,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT OF STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE
	ADTA	G1,3,6,8	G0,1,3,6		
	B	G1,2,3,6,8	G0,1,3,6		
	C	G1,2,3,6,8	G0,1,3,6		

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
BCE STRG 1	D	G1,2,3,6,8	G0,1,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT O STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE
	IMU	G1,2,3,6,8	G0,1,3,6		
	MLS	G1,3,6,8			
	MTU	G1,2,3,6,8,0	G0,1,3,6		
	NSP	G1,2,3,6,8,0	G0,1,3,6		
	STKR	G2,3,8			
	TAC	G1,3,6,8	G0,1,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT OF STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE • RADAR ALTIMETER DATA ALSO LOST
	PASS		G0,1,3,6	• BFS FAIL TO TRACK STRING 1	• NO MAL • I/O RESET MAY RESTORE PASS/BFS COMM
BCE STRG 2	A	G1,2,3,6,8	G0,1,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT OF STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE
	ADTA	G1,3,6,8	G0,1,3,6		

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
BCE STRG2 (Cont)	B	G1,2,3,6,8	G0,1,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT O STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE
	C	G1,2,3,6,8	G0,1,3,6		
	D	G1,2,3,6,8	G0,1,3,6		
	IMU	G1,2,3,6,8	G0,1,3,6		
	MLS	G1,3,6,8			
	MTU	G1,2,3,6,8,0	G0,1,3,6		
	TAC	G1,3,6,8	G0,1,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT OF STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE • RADAR ALTIMETER DATA ALSO LOST
	PASS		G0,1,3,6	• BFS FAIL TO TRACK STRING 1	• NO MAL • I/O RESET MAY RESTORE PASS/BFS COMM
BCE STRG 3	A	G1,2,3,6,8	G0,1,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT OF STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE
	ADTA	G1,3,6,8	G0,1,3,6		

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
BCE STRG3	B	G1,2,3,6,8	G0,1,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT O STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE
	C	G1,2,3,6,8	G0,1,3,6		
	D	G1,2,3,6,8	G0,1,3,6		
	IMU	G1,2,3,6,8	G0,1,3,6		
	MLS	G1,3,6,8			
	MTU	G1,2,3,6,8,0	G0,1,3,6		
	NSP	G1,2,3,6,8,0	G0,1,3,6		
	STKR	G2,3,8			
	TAC	G1,3,6,8	G0,1,3,6		
	PASS		G0,1,3,6	• BFS FAIL TO TRACK STRING 3	• NO MAL • I/O RESET MAY RESTORE PASS/BFS COMM

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
BCE STRG 4	A	G1,2,3,6,8	G0,1,2,3,6	• ALL GPCs DETECTED PROBLEM RECEIVING DATA FROM INDICATED BCE ELEMENT OF STRING 1 AND HAVE BYPASSED THAT ELEMENT	• BFS PRE-ENGAGE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE
	ADTA	G1,3,6,8	G0,1,3,6		
	B	G1,2,3,6,8	G0,1,3,6		
	C	G1,2,3,6,8	G0,1,3,6		
	D	G1,2,3,6,8	G0,1,3,6		
	PASS		G0,1,3,6	• BFS FAIL TO TRACK STRING 4	• NO MAL • I/O RESET MAY RESTORE PASS/BFS COMM
BDY FLP SW	L(R)	G3,6		• BODY FLAP DN(UP) SW DISAGREE	• NO MAL • DEFAULT TO NO OUTPUT
BODY FLAP	CYCL	G1,3,6		• BODY FLAP LIMIT CYCLING BUT USABLE	• NO MAL
	FAIL	G1,3,6		• BODY FLAP STALLED OR RUNAWAY	
	HOLD	G1,3,6		• BODY FLAP ONE CH FAILED BUT USABLE	
SM0 BRAKE P 1/3			G0,1,3,6	• PRESSURE >180 PSI IN BRAKES DRIVEN BY HYDRAULIC SYSTEM 1/3	
2/3			G0,1,3,6	• PRESSURE >180 PSI IN BRAKES DRIVEN BY HYDRAULIC SYSTEM 2/3	

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
S66 CAB AIRLK	PRES	S2,4		• AIRLOCK P ↑↓	• AP AIRLOCK TO AMB (PL)
S66 CAB HX OUT	TEMP	S2,4		• CAB HX OUT T	• NO MAL (NO LIMITS)
S66 CAB H2O N2	P1(2)	S2,4		• H2O TK N2 P ↓	
S66 CAB N2 FLO	1(2)	S2,4		• NW FLOW ↑	
SM1 CABIN N2			SM		
S66 CAB N2 QTY	1(2)	S2,4		• N2 SPLY QTY ↓	
S66 CAB N2 REG	P1(2)	S2,4		• N2 REG P ↑↓	
S66 CAB O2 EMR	SPLY	S2,4		• EMER O2 QTY AND REG P	• EMER O2 MSG ONLY WHEN EMER O2 TK MANIFESTED
S66 CAB O2 FLO	1(2)	S2,4		• O2 FLOW ↑	
SM 1 CABIN O2			SM		
S66 CAB O2 REG	P1(2)	S2,4		• O2 REG P ↑	
S66 CAB PPCO2		S2,4		• PPCO2 ↑	
S78 CABIN	DP/DT	S2,4		• CABIN PRESS RATE OF CHANGE ↓	
S66 CABIN	FAN	S2,4		• CABIN FAN ΔP ↑↓	
SM1 CABIN FAN			SM		
S66 CABIN	PRESS	S2,4		• CAB P ↑↓	
SM1 CABIN FAN			SM		
S66 CABIN	TEMP	S2,4		• CAB T ↑	
S78 CABIN O2	CONC	S2,4		• O2 CONC ↑	• NO MAL

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
S66 CABIN PPO2	A(B,C)	S2,4		• PPO2 ↑ ↓	• NO MAL
SM1 CABIN PPO2			SM		
SM1 CABIN DP/DT	BU		SM	• S/W CAB P RATE OF CHANGE COMP ↓	• NOT IN PRELAUNCH OPS 0
S78 CABN DP/DT	EQ	S2,4		• EQ CABIN PRESS RATE OF CHANGE ↓	
SM1 CABN DP/DT EQ			SM		
S60 CHECKPT FAIL		S2,4		• SM CHECKPOINT FAILED ON WRITE OR RESTORE DUE TO AN I/O FAILURE BETWEEN THE GPC AND MMU, OR MMU WAS OFF/BUSY	• ATTEMPT RECOVERY USING MMU MALS
CIRC PUMP		S2,4		• CIR PUMP FAILS TO TURN OFF	• INHIBITS CONTINUATION OF PUMP CYCLING SEQ
S87 CIRC PMP P	1(2,3)	S2,4		• CIRC PUMP P ↑↓	
S67 CNTL BUS	V	S2,4		• DC CNTL VOLT ↓	
RPC		S2,4		• DC CNTL BUS RPC = OFF	
CM BUF BSY	CRT1(2,3,4)	S2,4		• DEU IPL REQUEST WHEN THE SM COMMON BUFFER IS CURRENTLY BUSY	• NO MAL • WAIT FOR CONTENDING OPERATION TO COMPLETE, THEN RETRY THE SM DEU IPL
SM1 CNTL/ESS V			SM	• DC VOLT CNTL ↓ • DC VOLT ESS ↓	
S66 CO2 RL SYS	MALF	S2,4		• EDO CO2 CNTLR 1(2) MALFUNCTION	(OV102 ONLY) MALFUNCTION SIGNAL DURATION IS 6 SEC; RESULTING SPEC 66 '↓' WILL ONLY APPEAR FOR 6 SEC (PNL MO51F CONTROLLER FAIL LIGHT WILL REMAIN LATCHED)
S66 CABIN	FAN	S2,4		• CABIN FAN ΔP ↑↓	
SM1 CABIN FAN			SM	•	
S66 CABIN	PRESS	S2,4		• CAB P ↑↓	
SM1 CABIN FAN			SM	•	
S66 CABIN	TEMP	S2,4		• CAB T ↑	
S78 CABIN O2	CONC	S2,4		• O2 CONC ↑	• NO MAL

MESSAGE	OPS AVAIL		CAUSE	COMMENTS
	PASS	BFS		
S66 CO2 RL SYS PCO2	S2,4		• EDO CO2 RCRS CO2 PARTIAL PRESS ↑	• OV102 ONLY
S66 CO2 RL SYS VACP	S2,4			• (OV102 ONLY) CURRENTLY NO FDA ANNUNCIATION
S66 CO2 RL SYS FAN	S2,4			
S76 COMM CAM TEMP	S2,4		• TV CAMERA OVERTEMP - YES ↓	• CAM TEMP MSG VALID ONLY WHEN CCTV IN SYNC MODE
PA1 TEMP	S2,4		• POWER AMP 1 TEMP ↑	
PA2 TEMP	S2,4		• POWER AMP 2 TEMP ↑	
S76 COMSEC 1 BITE	S2,4		• COMSEC XMIT AND/OR RCV FAILED	
S76 COMSEC 2 BITE	S2,4		• COMSEC XMIT AND/OR RCV FAILED	
CRT BITE 1(2,3,4)	ALL	ALL	• A BITE ERROR DETECTED IN INDICATED DEU	
SM2 CRYO H2 MANF		SM	• MANF P ↓	
PRESS		SM	• TK CNTLP ↑↓	
SM2 CRYO O2 HTR		SM	• TK HTR ↑	
MANF		SM	• MANF P ↓	
PRESS		SM	• TK CNTL P ↑↓	
DAP RECONF	G2,8		• DESELECTION OF ONE OR MORE DOWNFIRING VERNIER JETS	• NO MAL • IF USING PRI RCS, MSG INDICATES FAILURE OF DOWNFIRING VERN JET W/O DOWNMODING • IF USING VERN RCS, OR UPON TRANS FROM PRI TO VERN RCS, DAP WILL DOWNMODE TO FREE DRIFT

MESSAGE	OPS AVAIL		CAUSE	COMMENTS
	PASS	BFS		
SM1 DC VOLT FC 1(2,3)		SM	• FC VOLT ↑↓	
S69 DELTA AMPS 1(2,3)	S2,4		• FC Δ AMPS ↑↓	
>3 DEU	ALL		• TOO MANY DEUs in COMMON SET	• NO MAL
DISPLAY SW A	G2,8		• AFT ADI ERROR/RATE SW • AFT ADI ATT SEL SW	• NO MAL • MAY BE TRIGGERED BY COMM FAULT OR I/O RESET • MOVE APPROPRIATE SW TO GREEN DOT DEFAULT POS • AIR DATA/RADAR ALT SW NOT READ IN OPS 1,2 OR 8 FOR PASS
L	G1,2,3, 6,8		• LH ADI ERROR/RATE SW • LH ADI ATT SEL SW • LH AIR DATA SW • LH HSI MODE/SOURCE/TRAN SW • LH RADAR ALT SW	
R	G1,2,3, 6,8		• RH ADI ERROR/RATE SW • RH ADI ATT SEL SW • RH AIR DATA SW • RH HSI MODE/SOURCE/TRAN SW • RH RADAR ALT SW	
DK XMTR 1(2,3,4)		ALL	• BFS DK TRANSMITTER FAILED HIGH ON A PASS CONTROLLED CRT	• NO MAL • BFS WILL DOWNMODE AFFECTED DK BUS - NO COMMAND/LISTEN CAPABILITY ON THAT BUS • ASSIGN BFS TO AFFECTED CRT TO RECOVER BFS COMMAND/LISTEN CAPABILITY • BFS IS STILL ENGAGEABLE WITH FULL CAPABILITY
S67 ESS BUS V 1BC(2CA,3AB)	S2,4		• DC VOLT ESS ↓	

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
ET SEP	AUTO	G6		• ET SEP MODE SW FAIL	• NO MAL • SW DEFAULTS TO AUTO IN G6
	INH	G1,6	G1,6	• AUTO SEP INH G1 = BODY RATES & FDLN DISC VLVS G6 = BODY RATES, α AND β	• NO MAL • USE CUE CARDS FOR DISC VLVS
	MAN	G1		• ET SEP SW FAIL (RM)	• NO MAL • USE SPEC 51 OVERRIDE
S77 EVA-MMU T	PORT STBD	S2,4		• MMU/FSS TEMP OUT OF LIMITS	
S88 EVAP FDLN	TA(B)	S2,4		• FDLN FWD,MID,AFT,TOOPPING,ACCUM LINE A(B) AND HI LOAD LINE A(B) T ↑↓	• FES FEEDLINE TEMPS
S88 EVAP HI LD	TEMP	S2,4		• FES HI LOAD NOZ AND DUCT T ↑↓	• HI LOAD IB/OB DUCT T AND NOZ T
S88 EVAP OUT T	1(2)	S2,4		• OUT T ↑↓	
SM2 EVAP OUT T			SM		
S88 EVAP TOP	TEMP	S2,4		• FES TOPPING NOZ AND DUCT T ↓↑	• TOPPING EVAP L(R) FWD(AFT) DUCT T AND L(4) NOZ T
167 EXT A/L	PRES	S2,4		• EXT AIRLOCK P ↑↓	• EXTERNAL AIRLOCK ONLY
F RCS	JET		G1,3,6	• F JET MANF 1(2,3,4) FAIL ON/OFF	• NO FAIL LK DETECTION IN BFS
	DJET	G1,2,3,6,8		• F DOWN JET 1(2,3,4) FAIL ON/OFF/LK	• FAIL OFF DETECTION NOT PERFORMED IN MM101 & 012 FOR PASS
	FJET	G1,2,3,6,8		• F FWD JET 1(2,3) FAIL ON/OFF/LK	
	LJET	G1,2,3,6,8		• FLEFT JET 1(3,5) FAIL ON/OFF/LK	

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
F RCS	RJET	G1,2,3,6,8		• F RIGHT JET 2(4,5) FAIL ON/OFF/LK	• FAIL OFF DETECTION NOT PERFORMED IN MM101 & 102 FOR PASS
	UJET	G1,2,3,6,8		• F UP JET 1(2,3) FAIL ON/OFF/LK	• FAIL OFF DETECTION NOT PERFORMED IN MM101 & 012 FOR PASS
	He P	G2,8	G,1,3,6	• F He (FU OR OX) TK P 2 LOW	• PKT C/L - RCS LEAK ISOL
	LEAK	G,2,3,8	G1,3,6	• PROP/He LEAK	• OX/FU Δ QTY > 9.5%
	PVT	G2,3,8		• LOSS OF P OR T DATA FRO RCS QTY CALC	• NO MAL • QTY CALC SUSPENDED
	TK P	G2,8	G1,3,6	• FWD RCS (FU OR OX) TK ULL PRESS HI/LOW	• QTY CALC SUSPENDED
S69 FC AMPS	1(2,3)	S2,4		• FC AMPS ↑↓	
SM1 FC AMPS 1(2,3)			SM		
S69 FC COOL P	1(2,3)	S2,4		• FC COOL P ↑↓	
SM1 FC COOL P 1(2,3)			SM		
S69 FC DELTA V	1(2,3)	S2,4		• FC SUBSTACK Δv > 150 MV	
SM1 FC DELTA V 1(2,3)			SM		
S69 FC EXIT T	1(2,3)	S2,4		• FC EXIT T ↑↓	
SM1 FC EXIT T 1(2,3)			SM		
S69 FC H2 FLOW	1(2,3)	S2,4		• FC H2 FLOW ↑	
S69 FC H2 PUMP	1(2,3)	S2,4		• FC H2 PUMP STATUS ↑↓	

MESSAGE			OPS AVAIL		CAUSE	COMMENTS
			PASS	BFS		
S69 FC H2O	ALT	1(2,3)	S2,4		• FC ALT H2O LN T ↑↓	
	PRI	1(2,3)	S2,4		• FC H2O LN T ↑↓	
	RLF	1(2,3)	S2,4		• FC HWO RLF VLV T ↑↓	
		HTR	S2,4		• FC H2O RLF HTR STATUS A,B ↑↓	• BOTH HTRS OFF OR BOTH HTRS INDICATING AUTO WILL ANNUNCIATE ALARM
		LINE	S2,4		• FC H2O RLF LN T ↑↓	
		NOZ	S2,4		• FC H2O RLF NOZ T A(B) ↑↓	
S69 FC O2 FLOW		1(2,3)	S2,4		• FC O2 FLOW ↑	
S69 FC PH		1(2,3)	S2,4		• FC PH - PH ↓	• PH > BILEVEL
SM1 FC PH 1(2,3)				SM	• FC PH HIGH	
S69 FC PRG LN		H2	S2,4		• FC H2 PURGE LN T 1(2) ↑	
		O2	S2,4		• FC O2 PURGE LN T ↑	
S69 FC PUMP		1(2,3)	S2,4		• FC COOL PUMP ΔP ↓	
SM1 FC PUMP 1(2,3)				SM		
FC PURGE		1(2,3)	S2,4		• FAILS FLOW CHECK AT PURGES AT END OF PURGE	• USE MAN FC PURGE PROC
		SEQ	S2,4		• LOSS OF PWR TO PURGE LN HTRS AFTER AUTO SEQ INIT OR LOSS OF SWITCH FUNCTION	• USE MAN FC PURGE PROC • SEQ FAIL FLAG TERMINATES AUTO PURGE SEQ
		TEMP	S2,4		• FC PURGE LINE TEMP TOO LOW TO PERFORM AUTO PURGE	• TERMINATES AUTO PURGE • USE MAN FC PURGE PROC
S69 FC REAC		1(2,3)	S2,4		• FC REAC ↓	FC REAC VLV - CL
SM1 FC REAC 1(2,3)				SM		
S69 FC READY		1(2,3)	S2,4		• FC READY ↓	

MESSAGE			OPS AVAIL		CAUSE	COMMENTS
			PASS	BFS		
S69 FC STACK T		1(2,3)	S2,4		• FC STACK T ↑↓	
SM1 FC STACK T 1(2,3)				SM		
S69 FC VOLTS		1(2,3)	S2,4		• FC VOLT ↑↓	
FCS CH		1(2,3,4)	G1	G1	• SRB CHANNEL BYPASS	• NO MAL • ROCK & TILT ACT A(B,C,D) CH FAIL
			G1,3,6	G1,6	• MPS CHANNEL BYPASS	• NO MAL • MPS ENG PITCH(YAW) CH FAIL
			G1,3,6	G1,3,6	• AERO CHANNEL BYPASS	• NO MAL • ELEV (RUD,S/B) ACT CH FAIL
FCS SAT		POS	G3,6	G3,6	• L/R IB/OB ELEVON POSITION SATURATION	• NO MAL • ELEVON SAT (>+12 OR <-15 DEG)
		MOM	G3,6	G3,6	• L/R IB/OB PRI DELTA PRESS	• NO MAL • IN RTLS EXPECT HINGE MOM >2400 PSI (80% SYS MAX)
S67 FPC/FLC		1(2,3)	S2,4		• FWD PCA V ↓	
S88 FREON FLOW		1(2)	S2,4		• FLOW ↓	FCL ICH FLOW
SM2 FREON FLOW				SM		
S88 FREON QTY		1(2)	S2,4		• ACCUM QTY ↓	• FREON LOOP ACCUM QTY
S88 FREON RAD		T1(2)	S2,4		• CNTL OUT T 1(2) ↓	• RAD CONTROLLER OUT TEMP
S88 FRN AFT CP		1(2)	S2,4		• AFT CP FREON FLOW ↓	• AFT CP FLOW
S88 FRN PL HX		1(2)	S2,4		• PL HX FREON FLOW ↓	• PL HX FLOW
S86 FU TK VLV		1(2,3)	S2,4		• APU FUEL TANK VLV TEMP ↑↓	•
SM2 FU TK VLV APU				SM		

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
S76 GCIL	FAIL	S2,4		• GCIL CONFIG FAILED TO PNL	
S86 GG/FU PMP	1(2,3)	S2,4		• APU GG BED T ↑↓	
GPC	BITE	ALL	ALL	• S/W FORCED CLOSED PROCESS DUE TO GPC H/W (S/W) FAULT	• IN PASS
				• BFS RESTART INDICATION	• IN BFS
	CONF	ALL		• NBAT TGT GPCs NOT IN RUN OR NOT SPECIFIED	• NO MAL • PROCEDURAL ERROR OR SWITCH ERROR
	SUM		ALL	• BFS GPC FAIL CHECKSUM	
	1	ALL		• INDICATED GPC HAS FAILED	
	2	ALL			
	3	ALL			
	4	ALL			
	5	ALL		• GPC 5 HAS FAILED	• NO MAL
GPC PWR			ALL	• PWR TRANSITIONS TO BFS GPC	• NO MAL • BFS WILL DISENGAGE • S/W DOES AUTO RESTART
S68 H2 CNTL P	1(2,3,4,5)	S2,4		• CNTL P ↑↓	
HTR T	1(2,3,4,5)	S2,4		• HTR T ↑	
MANF	PRES	S2,4		• MANF P ↓	
	VLV	S2,4		• MANF VLV = CL	
TK P	1(2,3,4,5)	S2,4		• TK P ↑↓	

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
168 HW CNTL P	6(7,8,9)	S2,4		• CNTL P ↑↓	
HTR T	6(7,8,9)	S2,4		• HTR T ↑	
TK P	6(7,8,9)	S2,4		• TK P ↑↓	
S69 H2O LN PH		S2,4		• H2O LINE PH ↓	• PH > 9 BILEVEL
S88 H2O LOOP 1(2)	FLOW	S2,4		• ICH FLOW	• ACTIVE LOOP ONLY
	QTY	S2,4		• ACCUM QTY ↓↑	
	TEMP	S2,4		• PUMP OUT T ↑↓ • CAB HX IN T ↓ • ICH OUT T ↓	• H2O LOOP TEMPS
S88 H2O PUMP P	1(2)	S2,4		• P 1(2) ↑↓ OR ΔP 1(2) ↑↓	• ΔP HIGH ONLY FOR INACTIVE LOOP
SM2 H2O PUMP P			SM		• ΔP HIGH OR LOW FOR ACTIVE LOOP
HIGH G		G3,6		• HIGH G	• NO MAL
S66 HUMID SEP	A(B)	S2,4		• HUM SEP SPEED ↓	
SM2 HYD ACUMP P 1(2,3)			SM	• ACCUM P ↓	
S86 HYD PRESS	1(2,3)	S2,4		• HYD SYS SPLY P ↑↓	• NO MAL
SM2 HYD PRESS			SM		
SM2 HYD QTY 1(2,3)			SM	• RSVR QTY ↑↓	
S86 HYD RSVR Q	1(2,3)	S2,4		• RSVR QTY ↑↓	
S86 HYD RSVR T	1(2,3)	S2,4		• RSVR T ↓↑	
SM2 HYD RSVR T 1(2,3)			SM		

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
ILLEGAL ENTRY		ALL	ALL	• ILLEGAL KYBD ENTRY WITH RESPECT TO OPS SELECT/TRANSITION, DATA LOAD, INITIALIZATION, MEM RECONFIG, GPC ASSIGN, KYBD SYNTAX, FREEZE DRY LOAD, ETC	NO MAL IF APPROPRIATE, KYBD INPUT SHOULD BE REENTERED
S66 IMU FAN	DP	S2,4		• IMU FAN ΔP ↑↓	
SM1 CABIN IMU			SM		
S66 IMU FN SPD	A(B,C)	S2,4		• IMU FAN SPEED ↓	
I/O ERROR	CRT1	ALL	ALL	• ERROR IN DEU 1(2,3,4) MSG (I/O OR CHECKSUM)	
	CRT2	ALL	ALL		
	CRT 3	ALL	ALL		
	CRT 4	ALL	ALL		
	D/L	ALL		• I/O ERROR ON DOWNLIST INTERFACE WITH PCMMU	
	FA1	G1,2,3,6,8	G0,1,3,6	• INPUT/OUTPUT ERROR ON INDICATED UNIT HAS BEEN DETECTED	BFS PRE-ENGAE MUST BE IN SYNC WITH (TRACKING) PASS TO ANNUNCIATE
	F2	G1,2,3,6,8	G0,1,3,6		
	F3	G1,2,3,6,8	G0,1,3,6		
	F4	G1,2,3,6,8	G0,1,3,6		

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
ITEM RJCT PSP		S2,4		• PCP CC CMD REJECTED DUE TO PSP CMD DATA TRANSMISSION IN PROGRESS	• NO MAL
S76 KU-GMBL A	TEMP	S2,4		• KU GMBL A TEMP ↑	
GMBL B	TEMP	S2,4		• KU GMBL B TEMP ↑	
GYRO	TEMP	S2,4		• KU BYRO TEMP ↑	
XMTR	TEMP	S2,4		• KU XMTR TEMP ↑	
L OMS	GMBL	G1,2,3	G1,3	• PITCH (YAW) CMD/FEEDBACK Δ2° FOR 3.8 SEC	• NO MAL
	PC	G1,2,3,6	G1,3,6	• ENG CHAMBER PRESS LOW	
	QTY	G1,2,3,6,8		• ENG FU OR OX TK LEVEL LOW	
	TEMP		G1,3	• ENG FU INJ T HI	
	TK P	G2,8	G1,3	• FU OR OX TK ULLAGE P HI/LOW	
			G1,3,6	• He OR N2 TK P LOW • N2 REG P HI/LOW	
	VLV	G2		• He P/VAP ISOL VLV MISMATCH	• NO MAL
S89 L OMS	TEMP	S2,4		• ENG FU INJ T HI/LOW	• NO MAL

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
L RCS	JET		G1,3,6	• LEFT JET MANF 1(2,3,4) FAIL ON/OFF	• NO FAIL LK DETECTION IN BFS
	AJET	G1,2,3, 6,8		• L AFT JET 1(3) FAIL ON/OFF/LK	• FAIL OFF DETECTION NOT PERFORMED IN MM101 & 102 FOR PASS
	DJET	G1,2,3, 6,8		• L DOWN JET 2(3,4,5) FAIL ON/OFF/LK	
	LJET	G1,2,3, 6,8		• L LEFT JET 1(2,3,4,5) FAIL ON/OFF/LK	
	UJET	G1,2,3, 6,8		• L UP JET 1(2,4) FAIL ON/OFF/LK	
	He P	G2,8	G1,3,6	• L RCS AFT He (FU OR OX) TK PRESS - 2 LOW	• PKT CL - RCS LEAK ISOL
	LEAK	G2,3,8	G1,3,6	• PROP/He LEAK	• OX/FU ΔQTY > 9.5%
	PVT	G2,3,8		• LOSS OF P OR T DATA FOR RCS QTY CALC	• NO MAL • QTY CALC SUSPENDED
	TK P	G2,8	G1,2,3, 6	• L RCS AFT (FU OX OX) TK ULL PRESS HI/LOW	
	XFEED	G1,3,6		• L RCS PROP TANK LOW PRESS	• FAILURE ON LEFT SIDE, AUTO XFEED FROM RIGHT
S67 MAIN BUS V	A(B,C)	S2,4		• MN VOLTS ↑↓	
SM1 MAIN BUS V A(B,C)			SM		

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
MPS DATA	C(L,R)	G1,6	G1,6	• DATA PATH FAIL	• NO MAL • REF AESP CUE CARDS
MPS ELEC	C(L,R)	G1,6	G1,6	• ELECTRONIC LOCKUP MODE FAIL	• NO MAL • REF AESP CUE CARDS
MPS H2 OUT P C(L,R)			G1,6	• PREMATURE SSME SHUTDOWN • MPS GH2 OUT P ↓	• NO MAL • REF AESP CUE CARDS
MPS HYD	C(L,R)	G1,6	G1,6	• HYD LOCKUP MODE FAIL	• NO MAL • REF AESP CUE CARDS
MPS He P C(L,R)			G1,6	• MPS He TK P HI/LOW • HI LEAK RATE dP/dT	• NO MAL • REF AESP, APCL
			G1,3,6	• INDICATED REG P HI/LOW	• NO MAL • REF AESP, APCL, EPCL
MPS LH2/O2 MANF			G1,6	• MPS LH2 ENG MANF P HI • MPS LOX ENG MANF P HI	• NO MAL • REF AESP CUE CARDS
ULL			G1,6	• ET ULL P HI/LO	•
MPS O2 OUT T C(L,R)			G1,6	• PREMATURE SSME SHUTDOWN • MPS OG2 OUT T ↓	• NO MAL • REF AESP CUE CARDS
MPS PNEU ACUM			G1,6	• MPS PNEU ACUM PRESS LOW	• NO MAL • REF AESP CUE CARDS
REG			G1,3,6	• MPS PNEU REG PRESS HI/LOW	• NO MAL • REF AESP, APCL, EPCL
TK			G1,6	• MPS PNEU TANK PRESS LOW	• NO MAL • REF AESP CUE CARDS
NAV EDIT		G2		• RNDZ NAV EDIT	• NO MAL
			G3,6	• DRAG H, ADTA, OR TACAN NAV EDIT	• BFS DOES NOT SUPPORT MLS • NO MAL

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
NAV EDIT (Cont)	ALT	G3,6		• ADTA ALT DATA NOT PROCESSING < M2.5 • DRAG H DATA NOT PROCESSING 85.2K FT < H < 140K FT	• NO MAL • MLS NAV EDIT MESSAGE (MLSNV) SEEN ONLY ON HUD
	TAC	G3,6		• TACAN DATA NOT PROCESSING <140K FT	• NO MAL
S76 NSP 1	BITE	S2,4		• NSP A/G 1 OR 2 XMIT AND/OR RCV VOICE MUX FAILED	
S76 NSP 2	BITE	S2,4		• NSP A/G 1 OR 2 XMIT AND/OR RCV VOICE MUX FAILED	
S68 O2 CNTL P	1(2,3,4,5)	S2,4		• CNTL P ↑↓	
HTR T	1(2,3,4,5)	S2,4		• HTR T ↑	
TRP	1(2,3,4,5)	S2,4		• HTR CUR SNSR = TRIP	
MANF	PRESS	S2,4		• MANF P ↓	
	VLV	S2,4		• MANF VLV = CL	
TK P	1(2,3,4,5)	S2,4		• TK P ↑↓	
168 O2 CNTL P	6(7,8,9)	S2,4		• CNTL P ↑↓	
HTR T	6(7,8,9)	S2,4		• HTR T ↑	
TRTP	6(7,8,9)	S2,4		• TKP ↑↓	
TK P	6(7,8,9)	S2,4		• TK P ↑↓	
OFF/BUSY MMU	1(2)	ALL		• AN MMU TRANSACTION IS REQUESTED WHEN THE MMU IS OFF/BUSY, FAILED OFF, OR SELECTED FOR IPL	

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
G23 OMS/RCS	QTY	G2		• L(R) OMS TO RCS PROP TRANSFER EXCEEDS LIMIT	• NO MAL
OTT ST IN		G3,6	G3,6	• INDICATED E/W LVL LESS THAN LVL REQD FOR OVHD APPROACH	• NO MAL • MSG TERMINATES < 45 NM FROM LDG OR E/W LVL AGAIN MATCHES PROFILE
S76 PA1 OUTPUT	LOW	S2,4		• PWR AMP OUTPUT ↓	
S76 PA2 OUTPUT	LOW	S2,4		• PWR AMP OUTPUT ↓	
168 PALLET H2 PRESS			S3,6	• H2 TK 6 (7,8,9) CNTL P ↑↓	
TK P			S3,6	• H2 TK 6 (7,8,9) TK P ↑↓	
O2 HTR			S3,6	• O2 TK 6 (7,8,9) HTR T ↑	
PRESS			S3,6	• O2 TK 6 (7,8,9) CNTL P ↑	
TK P			S3,6	• O2 TK 6 (7,8,9) TK P ↑	
T		S2,4		• PALLET T ↑↓	
V	A	S2,4		• PALLET V A ↓	
	B	S2,4		• PALLET V B ↓	
PDB CONFIG		S2,4		• PLBD OUT-OF-SEQUENCE CONFIG	• CAUSES TERMINATION OF AUTO SEQUENCE
S63 PDB CONFIG			SM		
PBD CONFIG		S2,4		• PLBD AUTO SEQ FAIL	• CAUSES TERMINATION OF AUTO SEQUENCE
S63 PDB CONFIG			SM	•	

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
S62 PDI DECOM FAIL		S2,4		• DECOM 1 FMT ↑ • DECOM 2 FMT ↑ • DECOM 3 FMT ↑ • DECOM 4 FMT ↑	• MSG OCCURS IF DECOM FDA ENA AND PL TLM FAIL FOR PDI DECOM FAILS • MSG ALSO OCCURS IF PL DEPLOYED, PI FAIL, OR PSP FAIL
S96 PDRS ABE	COMM	S2,4		• ABE/MCIU MISCOMPARE	
	JPC1	S2,4		• SHOULDER JPC FAIL	
	JPC2	S2,4		• WRIST JPC FAIL	
	SY SP EP WP WY WR	S2,4		• SPA PWR (COMMUTATOR, MDA) FAIL • TACH/PHASE LOCK LOOP FAIL	• AUTO BRAKES APPLIED
	EE	S2,4		• EE CMDS ↓, EE FLAG ↓, EEEU FAIL ↓	
	T CK	S2,4		• MCIU TEMP MONITOR CIRCUIT FAIL	
	FS	S2,4		• MCIU EXTERNAL FRAME SYNC BITE OR BITE VERIFICATION FAILURE	
	HC	S2,4		• RHC (THC) HARDOVER (ANY AXIS) • MCIU HC ↓ (MULTIPLEXER MISMATCH)	• S/W DOWNMODE TO IDLE IF IN MANUAL (TEST)

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
PDRS TEST	BRK C/W NMI FS LOSS	S2,4		• MCIU BITE VERIFICATION TEST FAILURE	
PDRS CNTL	SY SP EP WP WY WR	S2,4		• CONSISTENCY CK - JOINT RUNAWAY • TACH DATA FAIL	• AUTO BRAKES APPLIED
PDRS DERIG		S2,4		• UNCOMMANDED DERIGIDIZE	• POSSIBLE EE STRUCT FAIL
S94 PDRS GPC		S2,4		• MCIU-DETECTED GPC COMM FAIL	• MCIU SAFING COMMANDED • S/W DNMODE TO 'SUSPEND'
S96 PDRS MCIU	MADC	S2,4		• MADC REF VOLT TEST FAIL	• AUTO BRAKES APPLIED
	MCPC	S2,4		• MCPC REF VOLT TEST FAIL	• AUTO BRAKES APPLIED
	ICF	S2,4		• ICF FAIL	• AUTO BRAKES APPLIED (MAY NOT BE IND)
PDRS RCH	SY SP EP WP WY WR	S2,4		• JOINT EXCEEDS POS OR NEG RCH LIMIT	• APPROX 2° PRIOR TO S/W STOP • APPROX 4° PRIOR TO HARDSTOP
PDRS REL		S2,4		• UNCOMMANDED P/L RELEASE	• POSSIBLE EE STRUCT FAIL

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
PDRS SING	SY	S2,4		• SY/WY WITHIN 3 FT OR COALIGNMENT	• LOSE ±Y DEG OF FREEDOMAT SINGULARITY
	EP	S2,4		• EP > -7.6°	• LOSE -X DEG OF FREEDOM AT SINGULARITY
	WY	S2,4		• WY WITHIN ±15° OF ±90° SING	• LOSE ROLL DEG OF FREEDOM AT SINGULARITY
PDRS CNTL	SY SP EP WP WY WR ALL	S2,4		• JOINT SLIPPAGE WITH THE BRAKES ON AND NOT IN DIRECT MODE	• SLIPPAGE GREATER THAN 0.5° PER JOINT OR SUM OF 2.0° FOR ALL JOINTS
PDRS TEMP	PORT STBD	S2,4		• JOINT/EE TEMP OUT OF LIMITS	
S94 PDRS WR R		S2,4		• PDRS WRIST ROLL RANGE CHECK FAILURE	
206 PL CL2			SM	• AV FAN ΔP ↑↓ • H2O PUMPS ΔP STAT ↓	• SEE ASCENT/ENTRY SYSTEMS PROCEDURES (SPACELAB MODULE CONFIGURATION ONLY)
PL CL3			SM	• AUX BUS A/B U/V ↓ • SS INV IN AMPS ↑ • SS TEMP ↑ • EXPINV IN APMPS ↑ • EXP TEMP ↑ • SS AC ΦA(B,C) V ↑↓ • MAIN BUS V	• SEE ASCENT/ENTRY SYSTEMS PROCEDURES

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
PNL TRIM	L(R)	G3,6		• LH(RH) +/- P/R/Y TRIM SW DISAGREE	• NO MAL
PROBES		G3,6		• EITHER ADTA PROBE NOT DEPLOYED DURING 1 < M < 2.5	• NO MAL
S89 PRPLT THRM	OMS	S2,4		• OX(FU) LN STRUCT T HI/LOW	
	POD	S2,4		• PROP AND STRUCT T HI/LOW	
	RCS	S2,4		• FWD AND L/R RCS STRUCT T HI/LOW	
L OMS	GMBL	G1,2,3	G1,3	• PITCH (YAW) CMD/FEEDBACK Δ2° FOR 3.8 SEC	• NO MAL
	PC	G1,2,3,6	G1,3,6	• ENG CHAMBER PRESS LOW	
	QTY	G1,2,3,6,8		• FU FU OR OX TK LEVEL LOW	
	TEMP		G1,3	• ENG FU INJ T HI	
	TK P	G2,8	G1,3	• FU OR OX TK ULLAGE P HI/LOW	
			G1,3,6	• He OR N2 TK P LOW • N2 REG P HI/LOW	
	VLV	G2		• OMS R POD He/P VAP ISOL VLV MISMATCH	• NO MAL
S89 L OMS	TEMP	S2,4		• ENG FU INJ T HI/LOW	• NO MAL

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
L RCS	JET		G1,3,6	• RIGHT JET MANF 1(2,3,4) FAIL ON/OFF	• NO FAIL LK DETECTION IN BFS
	AJET	G1,2,3, 6,8		• R AFT JET 1(3) FAIL ON/OFF/LK	• FAIL OFF DETECTION NOT PERFORMED IN MM101 & 102 FOR PASS
	DJET	G1,2,3, 6,8		• R DOWN JET 2(3,4,5) FAIL ON/OFF/LK	
	RJET	G1,2,3, 6,8		• R RIGHT JET 1(2,3,4,5) FAIL ON/OFF/LK	
	UJET	G1,2,3, 6,8		• R UP JET 1(2,4) FAIL ON/OFF/LK	
	He P	G2,8	G1,3,6	• R RCS AFT He (FU OR OX) TK PRESS - 2 LOW	• PKT CL - RCS LEAK ISOL
	LEAK	G2,3,8	G1,3,6	• PROP/He LEAK	• OX/FU ΔQTY > 9.5%
	PVT	G2,3,8		• LOSS OF P OR T DATA FOR RCS QTY CALC	• NO MAL • QTY CALC SUSPENDED
	TK P	G2,8	G1,2,3, 6	• R RCS AFT (FU OX OX) TK ULL PRESS HI/LOW	
	XFEED	G1,3,6		• R RCS PROP TANK LOW PRESS	• FAILURE ON RIGHT SIDE, AUTO XFEED FROM LEFT
G23 RCS SYSTEM	F(L,R)	G2,8		• F(L,R) RCS FU OR OX TK TEMP	
		G2,8		• F(L,R) RCS FU OR OX TK OUT PRESS	
RCS PWR	FAIL	G,1,2,3, 6,8		• LOSS OF VLV LOGIC PWR TO MANF ISOL VLVs	OMS/RCS VLVs WITH tb - bp STUCK IN CURRENT POSITION

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
RM FAIL	ACC	G1,3,6		• FAIL	• NO MAL • DES/SEL AVAILABLE
	ADTA	G3,6	G3,6	• FAIL	• NO MAL • DES/SEL AVAILABLE
	IMU	G1,2,3, 6,8	G1,3,6	• FAIL • COMM FAULT CAUSES BFS RM FAIL	• NO MAL • DES/SEL AVAILABLE
	MLS	G3,6		• FAIL	• NO MAL • DES/SEL AVAILABLE OPS 8 ONLY • NO CRT DAT OPS 3
	RGA	G1,3,6		• FAIL	• NO MAL • DES/SEL AVAILABLE
	TAC	G3,6		• FAIL	• NO MAL • DES/SEL AVAILABLE
	XFER		G1,3,6	• BFS NOT RECEIVE STATE VECTOR OR REFSMAT	• NO MAL
G33 RNDZ RADAR		G2		• KU-BAND BREAKS TRACK WITH RADAR TARGET (GPC ANT STEERING MODE ONLY)	• NO MAL
ROLL REF		G3	G3	• REF ROLL STATUS FAIL	• NO MAL
S86 RSVR/ACC P	1(2,3)	S2,4		• RSVR P ↓ • ACCUM P ↓	
SBTC/THC	A	G2,8		• AFT THC POS/NEG X/Y/Z OUTPUT A/B/C FAIL • AFT THC POS/NEG X/Y/Z OUTPUT DISAGREE	• NO MAL
	L	G3,6		• L SBTC CMD A(B,C) FAIL • L SBTC CMD A(B,C) DISAGREE	

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
SBTC/THC	L	G2,3,8		• FWD THC POS/NEG X/Y/Z OUTPUT A/B/C FAIL • FWD THC POS/NEG X/Y/Z OUTPUT DISAGREE	• NO MAL
	R	G3,6		• R SBTC CMD A(B,C) FAIL • R SBTC CMD A(B,C) DISAGREE	
SEL AUTO		G2		• UNIV PTG MNVR T-30 & NOT AUTO	• NO MAL
SENSE SW		G2		• AFT SENSE SW DEFAULT	• NO MAL • DEFAULT POS IS '-Z'
212 SL LINK ERR		S2,4		• ANY OF THE FOLLOWING MDM SERIAL I/O LINK ERROR CONDITIONS OCCURRED FOR SSC OR EXC: NO SL RESP ↓ GPC NO MATCH ↓ SL LENGTH ↓ AR NO MATCH ↓ SR NO MATCH ↓ MSG RJECT (ITEM OR GNC) ↓ MSG LINK BUSY ↓ MSG LINK DSBL ↓	• SL MAL, CDMS, MDM/MTU/PCMMU
212 SL LINK TERM		S2,4		MDM SERIAL I/O LINK TO SPACELAB TERMINATED. CAUSED BY ANY OF THE FOLLOWING FOR SSC OR EXC: NOP IND ↓ COMM ↓ LINK INTRPT ↓	• SL MAL, CDMS, MDM/MTU/PCMMU
SM1 SMOKE ALRM			SM	ANY SMOKE CONC ↑	

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
SM1 SMOKE BAY	1A	S2,4		• AV BAY 1 SENSOR A CONC ↑	• NO MAL
	1B	S2,4		• AV BAY 1 SENSOR B CONC ↑	
	2A	S2,4		• AV BAY 2 SENSOR A CONC ↑	
	2B	S2,4		• AV BAY 2 SENSOR B CONC ↑	
	3A	S2,4		• AV BAY 3 SENSOR A CONC ↑	
	3B	S2,4		• AV BAY 3 SENSOR B CONC ↑	
SM1 SMOKE CAB	LFD	S2,4		• LEFT FLT DECK SMOKE CONC ↑	• NO MAL
	RFD	S2,4		• RIGHT FLT DECK SMOKE CONC ↑	
	HX	S2,4		• RETURN AIR CAB HX SMOKE CONC ↑	
SPD BRK		G3,6		• SPEED BRAKE POSITION > 20% FROM AUTO SCHEDULE DURING 0.95 < M <9.8	• NO MAL
S66 SPLY H2O	PRES	S2,4		• SUPPLY H2O IN P ↓↑	
	QTY	S2,4		• SUPPLY QTY TK A(B,C,D) ↓ C(D) ↑	
	TEMP	S2,4		• SPLY DUMP LINE T ↑↓ • SPLY NOZ T A(B) ↑	
SSME FAIL	C(L,R)	G1,6	G1,6	• PREMATURE ME SHUTDOWN	• IN MM101, MSG ANNUNCIATED BY BFS ONLY
SSME REPOS FAIL		G3	G3	• MORE THAN ONE MPS/TVC ISOL VLV FAILED TO INDICATE OPEN • LESS THAN TWO APU/HYD SYSTEMS INDICATED GOOD	• NO MAL • SSME REPOSITIONING FOR DRAG CHUTE DEPLOY IS NOT COMPLETE • MM304 AND 3.5 < MACH < 8

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
SUMWORD ICC	1(2,3,4,5)	ALL		• SUMWORD MISCOMPARE IN DATA FROM INDICATED GPC	
SW TO MEP		G3,6	G3	• MEP ALERT	• NO MAL
TFL LOAD FAIL		S2,4	ALL	• READ COMPARE ERROR • UNSUCCESSFUL LOAD	• NO MAL • MAY BE RESULT OF GROUND UPLINK
TGT ΔT		G2		• REQUESTED TRANSFER TIME CAUSED SINGULARITY IN TARGETING ALGORITHM	
TGT EL ANG		G2		• EXCEEDED MAX NUMBER OF ITERATIONS ON TPI TIG FOR GIVEN ELEVATION ANGLE	• NO MAL
TGT ITER		G2		• LAMBERT TGT TRANSFER ANGLE NEAR SINGULARITY POINT • PARABOLIC TRANSFER • MAX NUMBER OF ITERATIONS	
S87 THERMAL	HYD	S2,4		• HX OUT T ↓	
S87 THERMAL CNTL	1(2,3)	S2,4		• LN T ELEV RD/SPBK/BDY FLP ↑↓	• HYD CIRC PUMP NOT MAINTAINING HYD THERMAL ENVIR
SM0 THRM	APU		SM	• GG BED ↓, APU INJ T ↓	• APCL, EPCL - THERM HTR
	APU		SM	• APU FU FEED LN T ↑↓, PUMP IN T ↑↓, PUMP OUT T ↑↓, FU TEST LN T ↑↓, FU SERVICE LN T ↑↓, PUMP DRN LN T ↑↓, PUMP BYP LN T ↑↓, GGVM SPLY LN T ↓↑, H2O LN INJ ↑↓	
	EVAP		a	• FES NOZ, DUCT OR FDLN T ↑↓	• ONLY SELECTED DUCTS AND FDLN Ts ARE SENSED FOR STATUS

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
SM0 THRM (Cont)	FRN		SM	• ACCUM QTY ↓ • RAD OUT T ↑↓	• NO ASC/ENT PKT C/L
	H2O		a	• H2O SPLY IN P ↑↓	
	HYD		a	• H2O BLR T ↑↓	• NO MAL • ACL, EPCL - THERM HTR
	PRPLT		a	• OMS FU/OX BLD/DRAIN LN T • OMS POD RCS HOUSING • OMS RCS STRUCT T • OX ENG IN OR ENG FU FDLN T	
TIME	MTU	ALL		• AUTOMATIC TIME SOURCE CHANGE	
	TONE	ALL		• TIME MGT TIME TONE	• NO MAL
SM0 TIRE PRESS			G3,6	• NOSE GEAR/MLG TIRE PRESS ↓	
S66 VAC VNT NZ	TEMP	S2,4		• VACUUM VENT NOZ T	• NO MAL (NO LIMITS)
SM2 W/B QTY 1(2,3)			SM	• HYD SYS H2O BOILER FLUID QTY 40%	
S66 WASTE H2O	PRES	S2,4		• WASTE LIQ P ↑↓	
	QTY	S2,4		• WASTE QTY ↑↓	• NO MAL FOR QTY HIGH
	TEMP	S2,4		• WASTE NOZ T ↑↓ • DUMPLINE T ↑↓	
S86 WSB P	1(2,3)	S2,4		• REG P ↑↓ • N2 P ↓	
Q	1(2,3)	S2,4		• H2O QTY ↓	
T	1(2,3)	S2,4		• TK T ↓ • BLR T ↑↓	