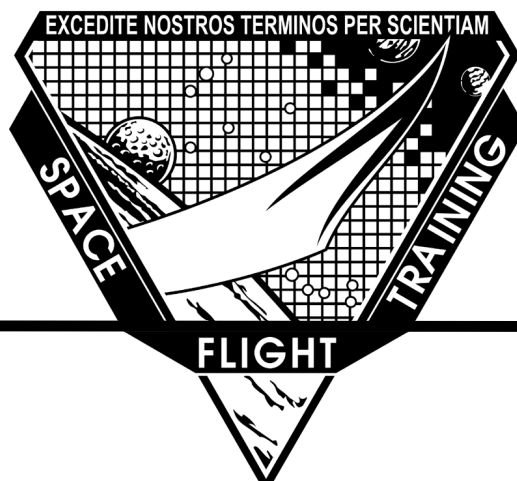


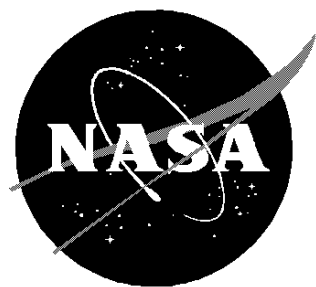
Caution and Warning

C&W 21002



**Mission Operations Directorate
Space Flight Training & Facility Operations
Shuttle Systems Training Branch**

**Revision B
July 1999**



National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
Houston, Texas

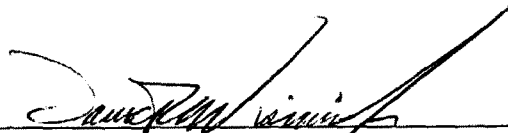
Caution and Warning Training Manual

C&W 21002

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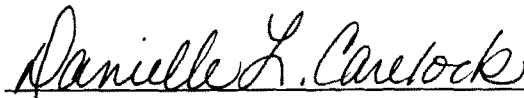


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Foreword

The content of this document was provided by the Shuttle Systems Group, Systems Training Branch, Space Flight Training & Facility Operations Division, Mission Operations Directorate (MOD), Lyndon B. Johnson Space Center (JSC), National Aeronautics and Space Administration (NASA). Technical documentation support was provided by Integrated Documentation Support (IDS), Hernandez Engineering, Inc. Any technical questions concerning this training manual or any recommendations should be directed to the training manual book manager, John Kennard/ USH-433T at 281-244-2334; all other questions should be directed to the document controller, Shelia Wagner/USH-433T at 281-244-7537.

This material is for training purposes only and should not be used as a source of operational data. All numerical data, displays, and checklist references are intended as examples. To determine any prerequisites before using this document, consult the applicable Certification Plan. For shuttle manuals, consult the Flight Operations Support Personnel Training Guide (Blue Book) or the Crew Training Catalog. For Space Station manuals, consult the appropriate Space Station Certification Training Guide or Training Administration Management System (TAMS). The applicable training package should be studied before attending any classroom session or lesson for which this is a prerequisite.

A Training Materials Evaluation is included at the end of this document. Inputs on this sheet will be used to evaluate the lesson material. You do not need to sign the sheet.

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Section 1

Introduction

This book is organized into sections. You should proceed through the sections in the order they are presented. Within the sections, however, you control your own progress. You should begin each section by reading the objectives and the learning material. The learning material is broken into both general and specific information. The first time you read a section you should read only the paragraphs in regular type.

Paragraphs in an italic typeface contain additional and specific information. This detailed information should be read during subsequent readings of a section because the information is not intended for all readers; it is designed to benefit all those who are required to possess a more detailed knowledge of the orbiter Caution and Warning (C&W) system.

In the sections that have review questions, the questions are separated from their answers so that you can flip the page over to compare your answer with the correct answer. It is not mandatory that you answer these questions; however, they are designed to help you check your own knowledge of the material that has been presented and to reinforce important information.

If current Flight Data File (FDF) procedures are desired, you can obtain copies of the Reference Data Book, Orbit Operations Checklist, and cue cards from the 4S, DA750 technical library and verify the SFOC Electronic Library System (SELS) for currency. The FDF procedures printed in this training manual are examples only and should not be used as a source of operational data.

The acronyms, abbreviations, and symbols used in this manual are listed in appendix A. The acronyms are defined when they are first used in the manual.

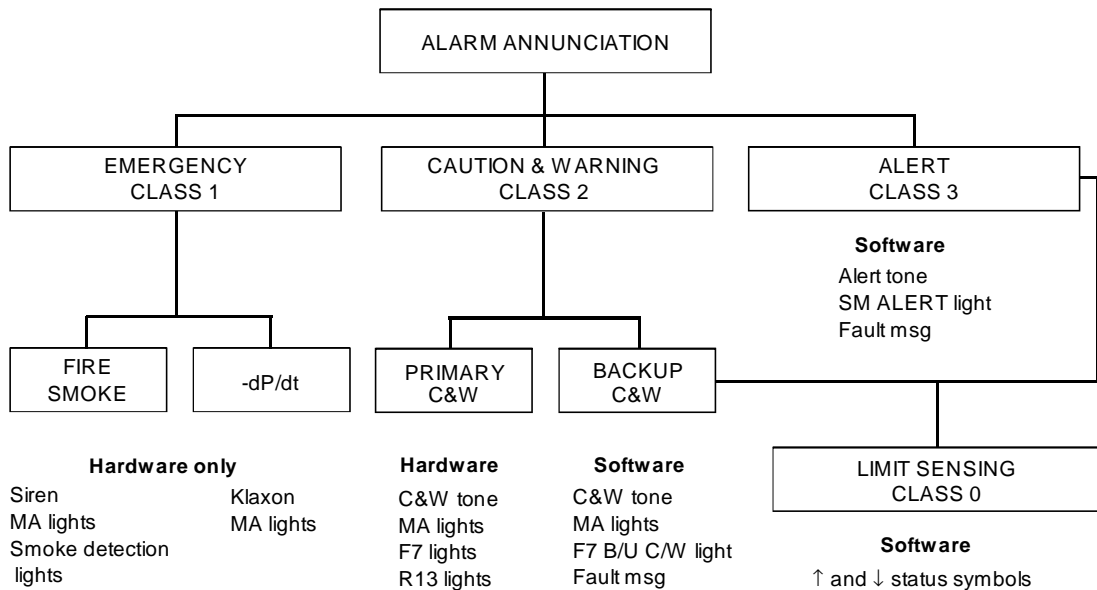
Section 2 Alarm Classes

Objectives

After reading this section, the student should be able to

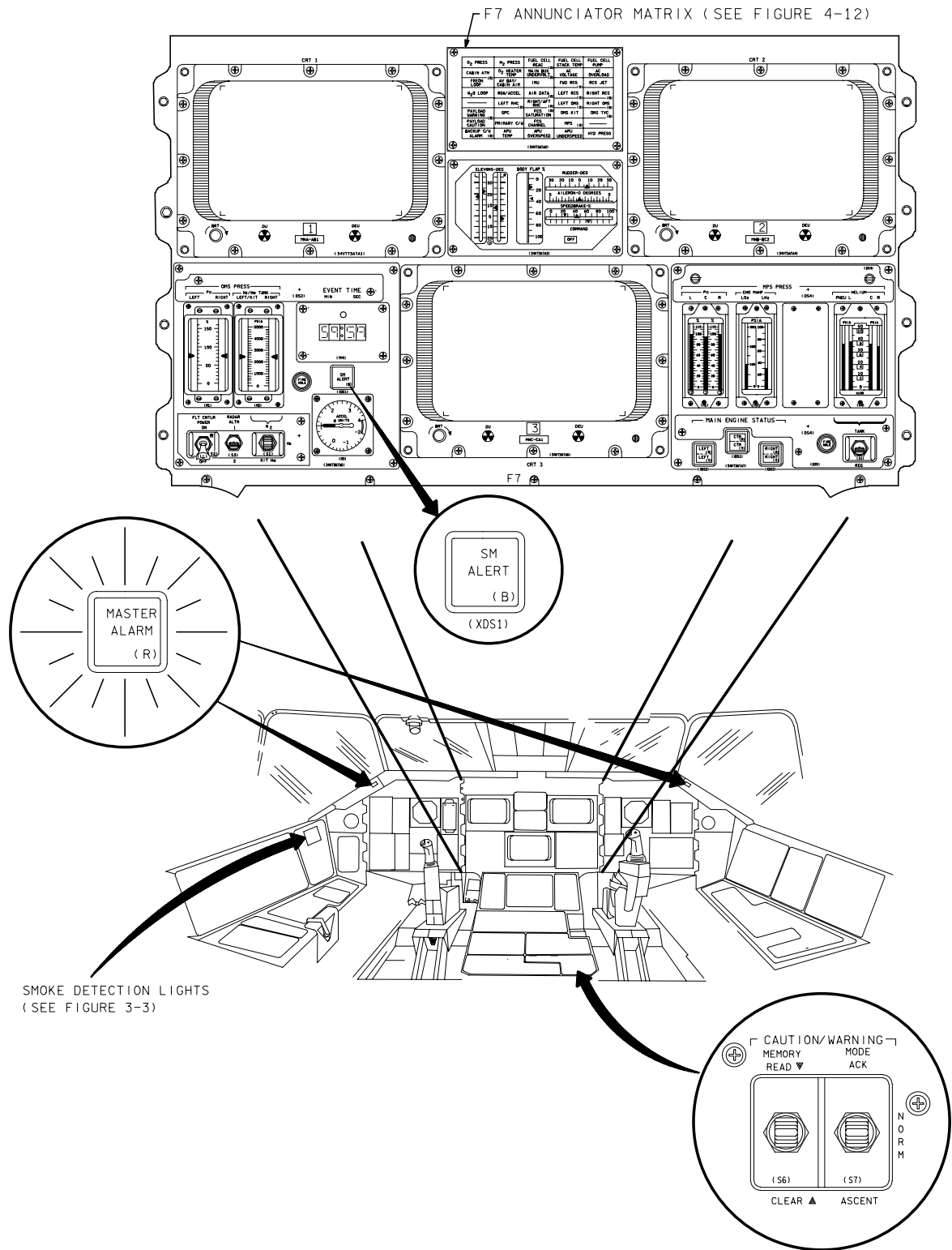
- Identify the different alarm classes
- Identify which systems are software systems
- Identify which systems are hardware systems
- Define some common terms used in discussions about the C&W system

Figure 2-1 is a diagram of the four alarm classes that make up the C&W system. Figure 2-2 illustrates the crew interfaces with the alarm systems. Table 2-1 describes the alarm tones. Refer to Figure 2-1 to see how the tones correspond to the various alarm classes.



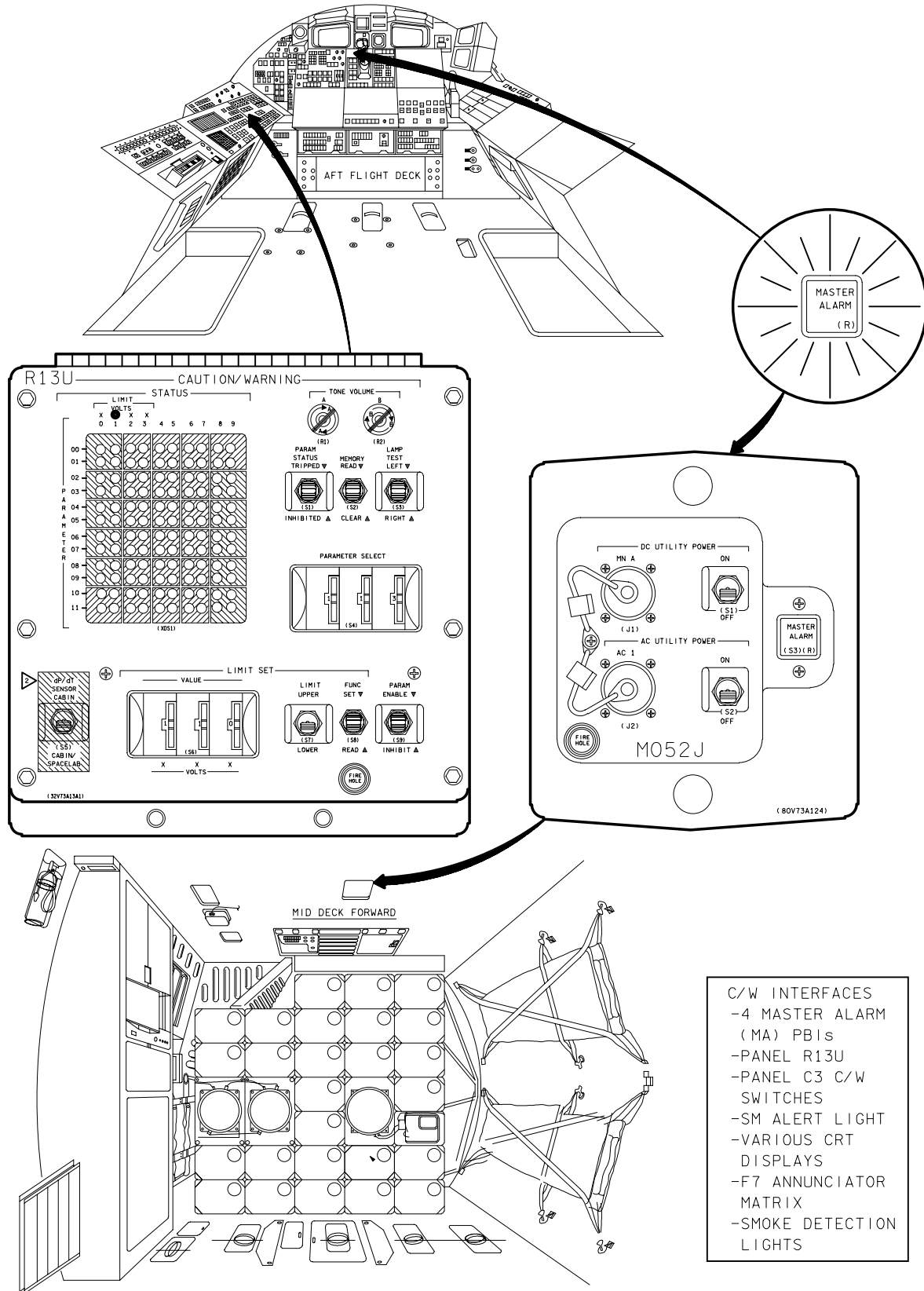
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Figure 2-1. C&W diagram



TD402A202, PNL 5

Figure 2-2. Alarm interfaces



- C/W INTERFACES
- 4 MASTER ALARM (MA) PBIs
 - PANEL R13U
 - PANEL C3 C/W SWITCHES
 - SM ALERT LIGHT
 - VARIOUS CRT DISPLAYS
 - F7 ANNUNCIATOR MATRIX
 - SMOKE DETECTION LIGHTS

TD402A203, PNL 4

Figure 2-2. Concluded

Overview

The C&W system alerts crewmembers to situations that could create a hazard to the orbiter and/or crew. Under certain circumstances, the system also is used to alert the crew to situations that will require time-critical procedures (under 5 minutes) to correct the situation. The C&W system uses data such as temperature, pressure, and flow rates to determine whether an alarm situation exists.

The crew interfaces with the C&W system through panel R13U, the C/W switches on panel C3, Cathode Ray Tube (CRT) displays, panel F7 annunciator matrix, the Master Alarm (MA) pushbutton indicators (pbi's) (panels F2, F4, A7, and M052J), the SM Alert light, and the smoke detection lights (panel L1). (See Figure 2-2.)

The C&W system uses audio and visual alerts to inform the crew of out-of-limits conditions, emergency situations, and events.

The C&W system discussion in this document includes the primary C&W hardware system, the backup (B/U) C&W software system, the Systems Management (SM) alert system, the fire and smoke emergency system, and the rapid delta pressure emergency system.

The C&W system has the responsibility of alerting the crew to out-of-limits conditions or improperly configured systems. When one of these conditions is detected, the C&W system alerts the crew with an alarm or group of alarms.

The visual cues consist of the following:

- Master alarm lights
- Parameter status lights
- C&W system annunciation lights
- Backup C&W light
- SM alert light
- Smoke detection lights
- Fault messages on CRTs
- Status symbols (↓ or ↑) on CRTs

The audio alarms consist of

- C&W tone
- Klaxon
- Siren
- SM alert tone

Alarm annunciation to inform the crew of out-of-limits conditions in the orbiter is provided by the following systems:

- Emergency systems sense smoke in the pressurized volumes and rapid loss of cabin pressure and set off emergency alarms.
- A hardware system and separate General Purpose Computer (GPC) software, working independently, provide C&W alarms. In many cases, the hardware system and the software system sense the same parameter and both systems trigger alarms for out-of-limits conditions. Other parameters are sensed only in the hardware system or only in the software system. Software sensing for C&W limit violations is accomplished by the SM software and in some cases by the Guidance, Navigation, and Control (GN&C) software.
- SM and GN&C software also sense some less critical parameters and trigger an alert for out-of-limits conditions.

The C&W system interfaces with and monitors the following systems:

- Auxiliary Power Unit (APU) pressures, temperatures, discretes, and events
- Data Processing System (DPS) input voltage to the GPCs
- Environmental Control and Life Support System (ECLSS) pressures, temperatures, quantities and flow rates
- Electrical Power System (EPS) bus currents and voltages, cryo temperatures and pressures, fuel cell temperatures, valve positions, and cell performance monitor
- Flight Control System (FCS) discrete events from the controlling computers
- Guidance and Navigation (G&N) Inertial Measurement Unit (IMU) discrete output by the GNC computers
- Hydraulic (HYD) pressures, temperatures, and quantities
- Main Propulsion System (MPS) pressures
- Reaction Control System (RCS) pressures and temperatures as well as fail discretes
- Orbital Maneuvering System (OMS) temperatures, pressures, and discretes
- Payload input channels for six discretes

At this point it is useful to define some commonly used terms.

Limits A set of limits (upper and lower) defines a normal/acceptable operating range. When a parameter has gone “out of limits,” it is outside its normal/acceptable operating range.

Inhibited A parameter that is inhibited no longer annunciates an alarm if it has gone out of limits.

Tripped	A tripped parameter is one that has gone out of limits; in other words, exceeded its limit range.
Hardware system	Pertaining to our context, a hardware system is one that uses hardware, such as switches, to work with parameters. It has its own hardware electronics unit that monitors parameters and issues alarms.
Software system	A software system relies on software to issue an alarm, to monitor parameters, and to work with parameters.

Four alarm classes make up the C&W system (Figure 2-1).

Class 1 - Emergency

Class 1 - Emergency has two types of alarms, smoke detection/fire suppression and rapid cabin depressurization. Class 1 is a hardware system only.

Smoke detectors are located throughout the crew compartment. Alarm signals and smoke particle concentration readings are provided to the crew. Once the crew confirms a fire, they can extinguish the fire by actuating the permanently mounted fire bottles if the fire is in an avionics bay or by using a handheld extinguisher if the fire is on the flight deck or middeck.

The cabin pressurization rate, also called delta pressure/delta time (dP/dt), senses the rate at which atmospheric pressure in the orbiter is changing with respect to time (in psi/min). An alarm is issued only for a rapid cabin depressurization (in other words, for negative dP/dt).

Because of the nature of the class 1 alarms, they receive the highest priority for resolution.

Class 2 - C&W

This class also consists of two subclasses, Primary C&W, which is a hardware system, and B/U C&W, which is a software system.

Primary C&W uses panel R13U and the C/W switches on panel C3 to access the system.

B/U C&W is accessed through Systems Management (SM) SPEC 60, SM TABLE MAINT, which can be displayed on a selected CRT.

Class 3 - Alert

This class is also a software system.

This system is also accessed through SM SPEC 60, SM TABLE MAINT, which can be displayed on a selected CRT.

Class 0 - Limit Sensing

Class 0 is a software system and consists of up and down arrows (\uparrow , \downarrow) displayed on the CRT next to a parameter.

A down arrow (↓) displayed next to a parameter indicates that the low limit for that parameter has been violated. In addition, the down arrow is used to indicate a state which does not agree with the nominal state. For example, a down arrow would be displayed next to a fan that is off and is nominally on (for example, humidity separator fan).

An up arrow (↑) displayed next to a parameter indicates that the upper limit for that parameter has been exceeded.

Limit sensing uses either the Backup C&W limits or the Alert limits. For cases where a parameter is monitored by both systems, the Alert limits drive the arrows.

Table 2-1. Alarm tone description

Tone	Actual and SPEC	Description
Siren	ACTUAL:	Varying frequency from 666 Hz to 1470 Hz and return with a period of 5 seconds
	SPEC:	Varying frequency from 666 ± 66 Hz to 1470 ± 147 Hz and return with a period of a 5 ± 0.5 seconds
Klaxon	ACTUAL:	2560 Hz with a period of 2.1 ms ON and 1.6 ms OFF mixed with a 256 Hz tone with a period of 215 ms ON and 70 ms OFF
	SPEC:	2500 ± 250 Hz with a period 2.1 ± 0.2 ms on and 1.6 ± 0.2 ms OFF mixed with a 270 ± 27 Hz tone with a period of 215 ± 21 ms ON and 70 ± 7 ms OFF
C&W tone	ACTUAL:	Alternating signal of 400 Hz and 1024 Hz at a 2.5 Hz rate. (In other words, it is 400 Hz for 0.4 seconds, then 1024 Hz for 0.4 seconds)
	SPEC:	Alternating signal of 375 ± 37.5 Hz and 1000 ± 100 Hz at a 2.5 ± 0.25 Hz rate
Alert tone	ACTUAL:	Continuous tone of 512 Hz
	SPEC:	Continuous tone of 550 ± 55 Hz

Questions

1. List the C&W alarm classes and their titles.
2. Which alarm class generally receives the highest priority? Why?
3. Define the phrase “out of limits.”
4. How many of the classes contain software systems? Name the classes.

Answers

1. The C&W alarm classes are Class 1 - Emergency, Class 2 - Caution and Warning, Class 3 - Alert, and Class 0 - Limit Sensing.
2. Class 1 - Emergency generally receives the highest priority because the situations that issue an alarm in this alarm class may seriously affect crew safety. Immediate action is required.
3. “Out of limits” means a parameter has violated a predetermined limit.
4. Three classes contain software systems: Class 2 - C&W, Class 3 - Alert, and Class 0 - Limit Sensing. Remember that Class 2 C&W has two subclasses, Primary C&W (hardware system) and B/U C&W (software system).

Section 3

Class 1 Emergency

Objectives

After reading the material about the fire and smoke subsystem, the student should be able to

- State the alarm annunciation, both audio and visual
- Identify the location of each smoke detector fire bottle, and portable fire extinguisher
- Describe how the smoke detectors and fire bottles operate
- Identify relevant data on CRT display SM SYS SUMM 1
- Identify and describe the function of relevant switches and circuit breakers (cb's) on panels L1, O14, O15, and O16
- Explain the purpose of the fire ports
- Summarize facts about Halon 1301

After reading the material about the cabin dP/dt subsystem, the student should

- State alarm annunciation, both aural and visual
- Identify the relevant meter on panel O1
- Identify the relevant data on CRT displays SM SYS SUMM 1 and SPEC 66
- Describe the normal cabin dP/dt for ascent, orbit, and entry
- Explain the difference between +dP/dt and -dP/dt

Overview

The Class 1 Emergency alarm system is a hardware system. It consists of two subsystems, fire and smoke subsystem and -dP/dt subsystem (Figure 3-1). The fire and smoke subsystem includes fire detection and suppression. The cabin dP/dt subsystem monitors cabin depressurization. These subsystems alert the crew by use of visual and audio alarms.

The fire detection capability is provided by smoke detectors. They are located in the cabin, flight deck, and middeck areas and in the three avionics bays.

The fire suppression is accomplished with three handheld extinguishers in the cabin. The three avionics bay extinguishers are remotely controlled through panel L1. Three portable handheld fire extinguishers located throughout the cabin are considered backups to the three avionics bay extinguishers. All extinguishers are charged with Halon 1301.

The cabin rapid dP/dt indication is provided by one dP/dt sensor located in the orbiter. The Class 1 Emergency alarm is triggered only for a decrease in pressure (-dP/dt) and is not triggered for an increase in cabin pressure (+ dP/dt).

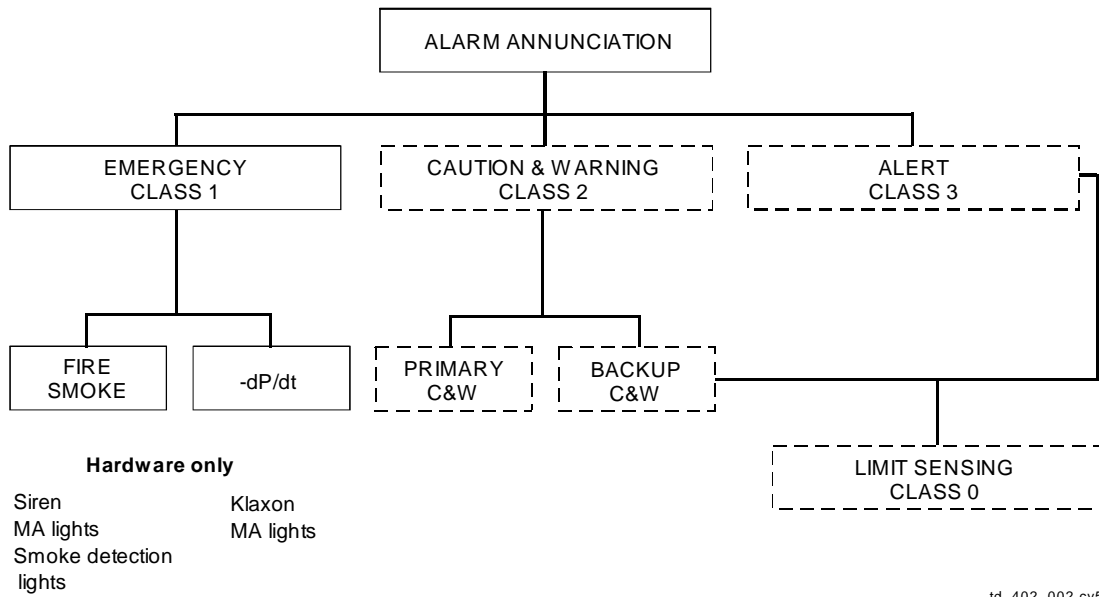


Figure 3-1. Class 1 alarm diagram

Fire and Smoke Subsystem

Annunciation

The fire and smoke subsystem uses audio and visual signals to alert the crew. These cues include

- Visual cues
 - MA lights on panel is F2, F4, A7, and MO52J (Figure2-2)
 - Panel L1 - Smoke detection light matrix (Figure 3-3)
- Audio cue
 - Siren tone - Varying frequency from 666 to 1470 Hz and return at a 5-sec/cycle rate. The siren can be silenced by depressing a MA pbi.

The B/U C&W system (see Section 4) will also annunciate an alarm for high smoke concentration.

Fire Detection

Smoke detector locations

Nine smoke detectors are monitored by the emergency system and are located throughout the cabin and avionics bays (Figure 3-2). The detectors are divided into two groups, A and B.

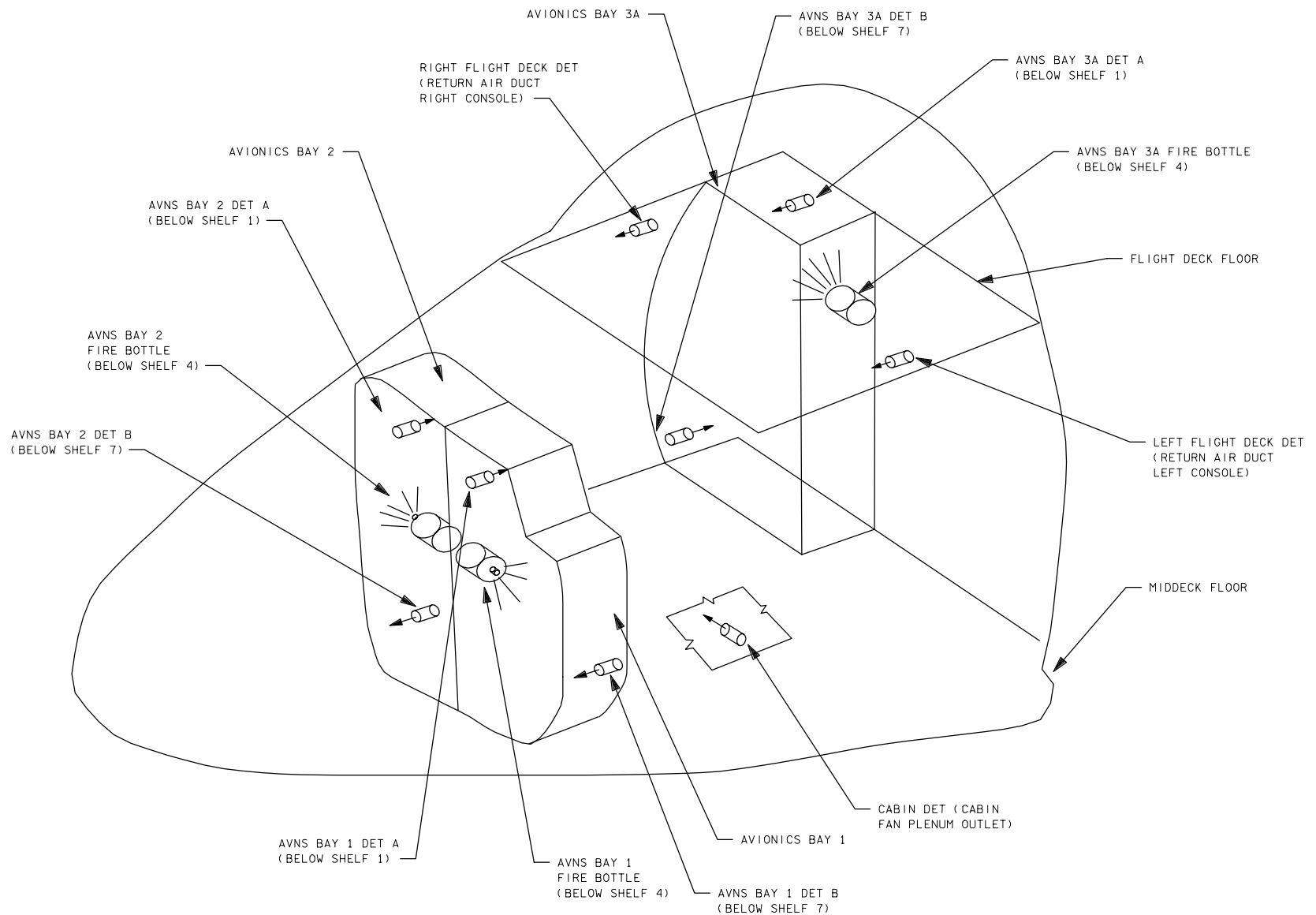
- Group A detectors include
 - One on the cabin fan outlet
 - One on the left return air duct of the flight deck
 - One in each of the three avionics bays
- Group B detectors include
 - One on the right return air duct of the flight deck
 - One in each of the three avionics bays
 - Payload smoke detection system input (if required)

Smoke detection

Each smoke detector will issue an alarm if either of the following two cases is violated:

- Smoke particle concentration of $2000 \pm 200 \mu\text{g}/\text{m}^3$ (for two consecutive counts; counts are 2.5 seconds apart)
- Rate of increase in concentration of $22 \mu\text{g}/\text{m}^3$ per second for eight consecutive counts (which takes 20 seconds)

If a fire occurs in an avionics bay, both smoke detectors in that bay should detect the fire. Each smoke detector illuminates a corresponding smoke detection light on panel L1. Refer to the Annunciation section for a complete description of the alarm annunciation.



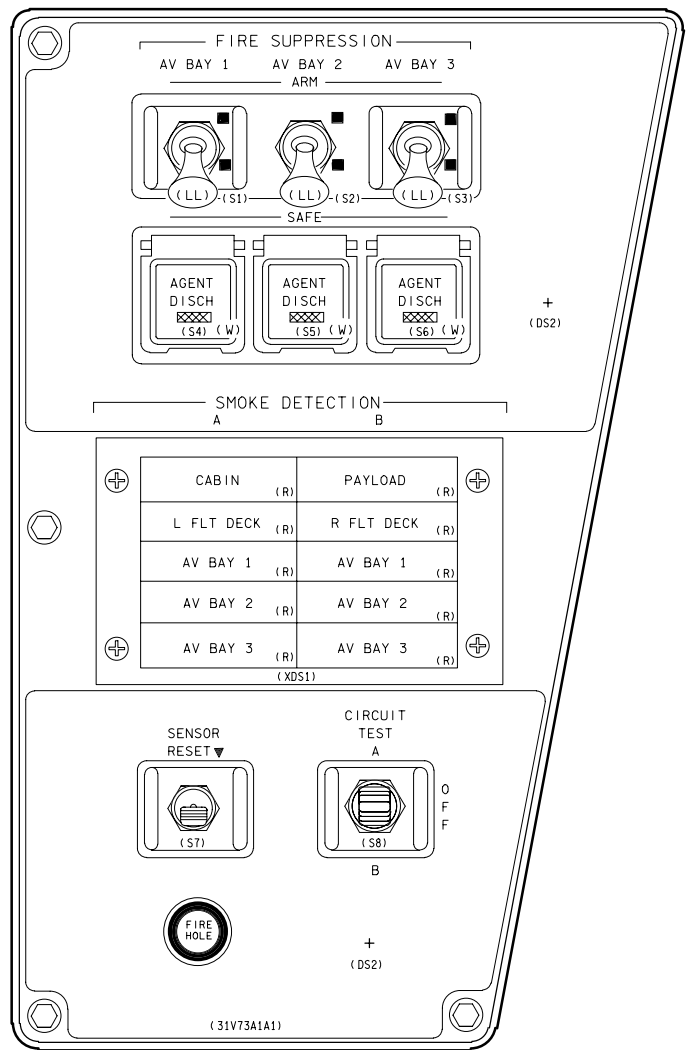
TD4020302. ART 2

Figure 3-2. Smoke detector and fire bottle locations

Once the alarm system has been triggered, it remains latched until a reset signal is input to the detector from panel L1 (see Figure 3-3). When the system is latched, the emergency alarm system does not activate an alarm in case of another fire in the same or any other avionics bay. However, the system illuminates the panel L1 smoke detection light, and the smoke concentration on SM SYS SUMM 1 shows an increase. The B/U C&W also is triggered.

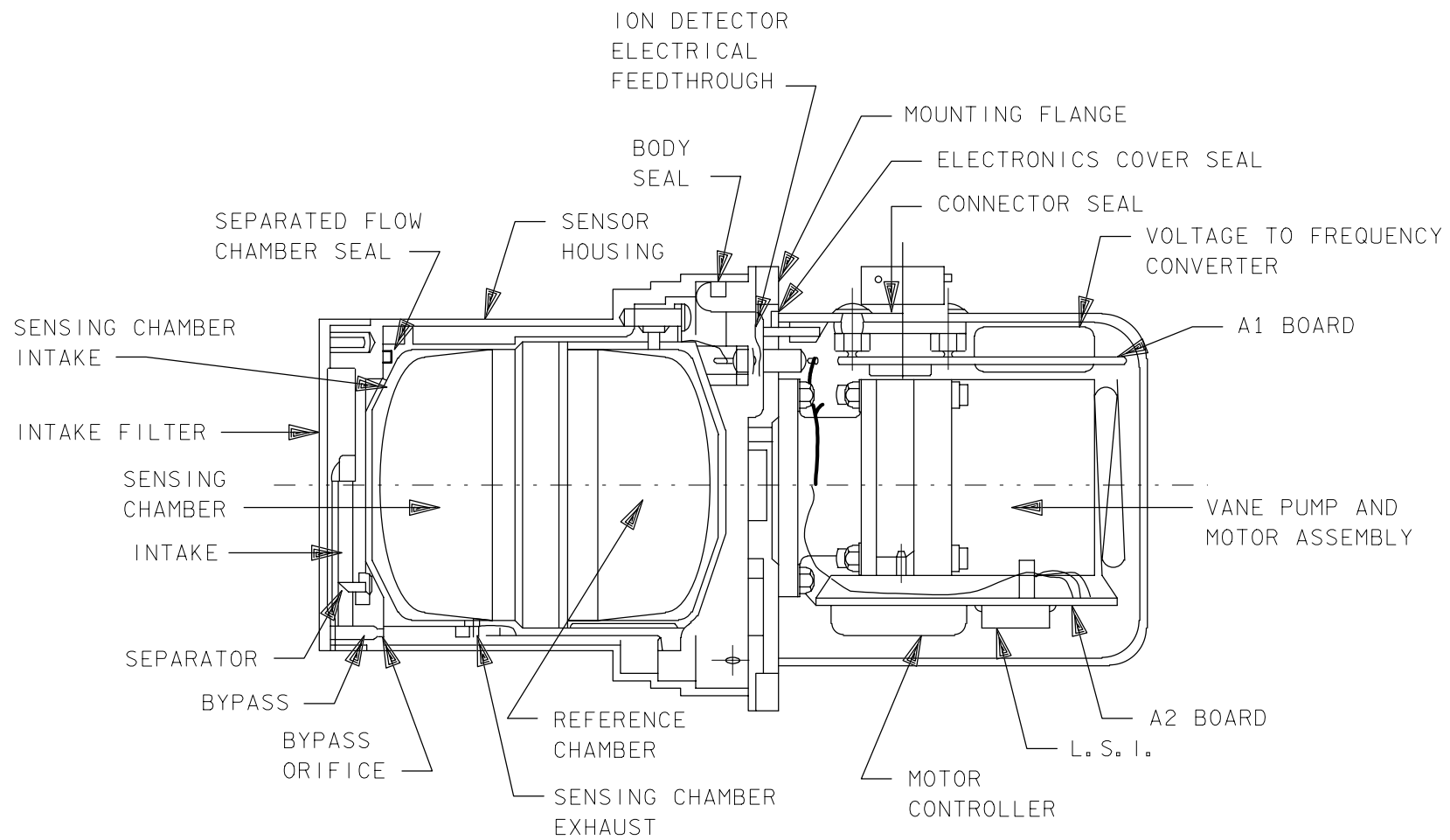
The smoke detectors are sensitive to submicron particles and will therefore announce an alarm for a presmoke state of a potential fire condition. These particles are emitted from materials that have been subject to abnormal energy, such as wire bundle heating due to excessive current.

Figure 3-4 shows the smoke detector used by the orbiter. The detector uses a positive displacement pump (fan) to draw a continuous air sample into the inlet filter. The inlet filters out particles larger than 40 microns. The flow, once through the intake, is turned to pass the separator inlet.



TD4020303. ART: 1

Figure 3-3. Panel L1



TD4020304, ART 1

Figure 3-4. Smoke detector

The separator allows particles of 2 microns or less to enter. This is accomplished by flowing the air sample across the separator inlet. The kinetic energy of the air flow is great enough that the larger particles continue past the separator inlet and exit from the detector. The smaller particles, 2 microns or less are drawn into the separator and enter the sensing chamber. The reference chamber is filled with a constant sample of static air and is not recharged unless a pressure differential occurs in the surrounding atmosphere. Thus the sensing chamber is constantly recycled, whereas the reference chamber is not.

The sensing and reference chambers are separated by Americium 241. The Americium is a radiation source that discharges alpha particles into both chambers. The air molecules become ionized by the radiation field and are attracted to the outer cover of the chamber. The cover acts as an electrode, thus creating current flow. The submicron particles present in the sensing chamber are attracted by and become attached to the ionized air molecules. This reduces their mobility and causes a drop in current flow. The difference in current flow between the sensing and the reference chamber (which does not see the submicron particles) is processed to provide the alarm and analog concentration outputs. The air then exits the sensing chamber and mixes with the bypassed flow. The mixture then exits the detector through the fan.

Smoke detection circuit test

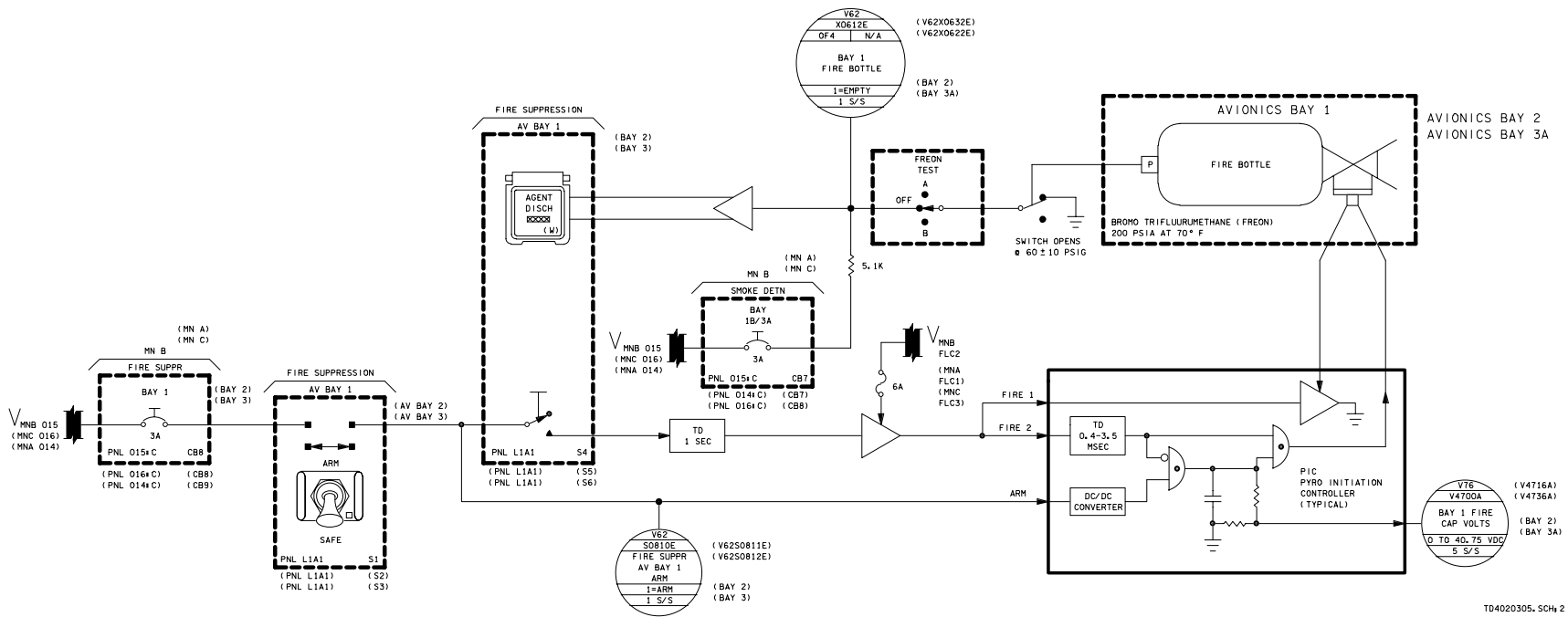
The smoke detection system includes a test circuit that tests the light and alarm circuitry. Figure 3-5 shows a functional diagram of the avionics bay fire suppression and circuit test system.

When the test switch on panel L1 is placed in the A (or B) position, power is applied to the Annunciation Control Assembly (ACA) channels. The agent discharge lights illuminate immediately. Approximately 20 seconds later, the smoke detection A (or B) lights (except PAYLOAD) illuminate and the siren is triggered. Following this indication, when the circuit test switch is taken to OFF, the agent discharge lights are extinguished.

If the circuit test switch is taken to OFF between 5 and 10 seconds after being placed in A (or B), the agent discharge lights go out, the smoke detection A (or B) lights (except PAYLOAD) illuminate, and the siren is triggered.

The siren can be interrupted by pressing a Master Alarm. The smoke detection A and B lights are extinguished by taking the sensor switch to reset and releasing the switch.

The circuit test procedure is found in the Environmental Control and Life Support System (ECLSS) section of the Orbit Operations Checklist (ORB OPS C/L). Refer to a copy of this C/L for the current procedure. The procedure is normally performed during the first day in orbit.



TD4020305, SCH 2

Figure 3-5. Avionics bay fire suppression and circuit test system

Performance monitoring

The smoke concentration is monitored by SM SYS SUMM 1 (SPEC 78) in Backup Flight System (BFS) for OPS 1 and 3 and Primary Avionics Software System (PASS) for OPS 2 (Figure 3-6). The values displayed are sent from the respective smoke detectors.

The normal reading from the detectors on the CRT display is -0.5 to $+0.5 \mu\text{g}/\text{m}^3$. A reading of 2.0 triggers the B/U C&W alarm annunciation.

Troubleshooting false alarms

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

- If the alarm returns immediately, the concentration readouts should be observed on SM SYS SUMM 1 in the affected location. If concentrations are normal, the alarm is false.
- If the alarm does not return, perform self-test. If available, check concentration on SM SYS SUMM 1.

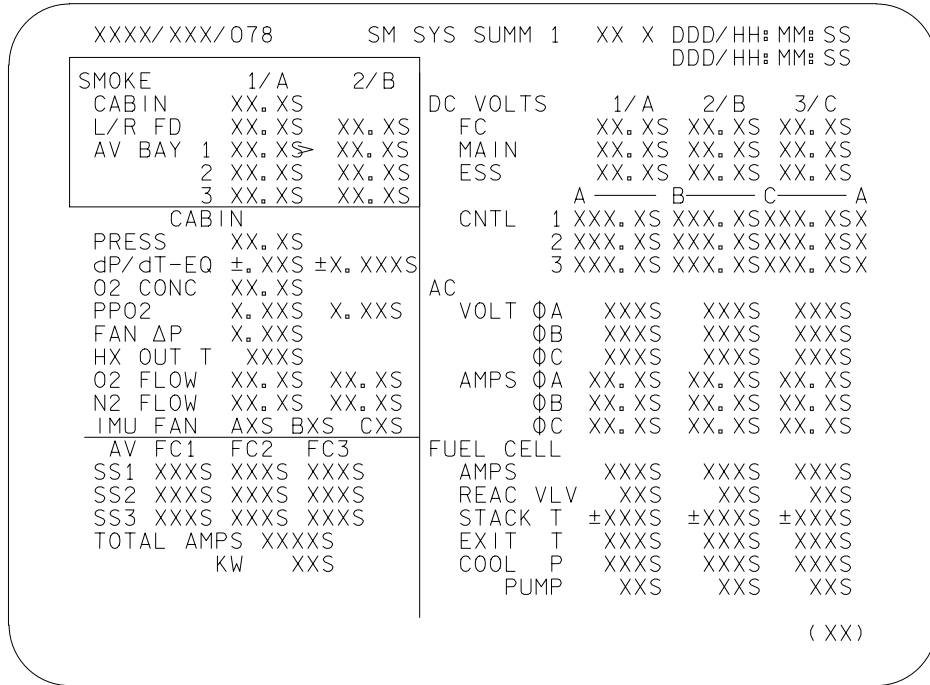
XXXX/XXX/078			SM SYS SUMM 1	XX X	DDD/HH: MM: SS	
				BFS	DDD/HH: MM: SS	
SMOKE	1/A	2/B	DC VOLTS	1/A	2/B	3/C
CABIN	XX.XS		FC	XX.XS	XX.XS	XX.XS
L/R FD	XX.XS	XX.XS	MAIN	XX.XS	XX.XS	XX.XS
AV BAY 1	XX.XS	XX.XS	CNTL AB	XX.XS	XX.XS	XX.XS
2	XX.XS	XX.XS	BC	XX.XS	XX.XS	XX.XS
3	XX.XS	XX.XS	CA	XX.XS	XX.XS	XX.XS
CABIN			ESS	XX.XS	XX.XS	XX.XS
PRESS	XX.XS		AC			
dP/dT	±.XXS		VOLT ΦA	XXXX	XXXX	XXXX
BU/EQ	±.XXS	±.XXS	ΦB	XXXX	XXXX	XXXX
PP02	±.XXS	±.XXS	ΦC	XXXX	XXXX	XXXX
FAN ΔP	X.XXS		AMPS ΦA	XX.XS	XX.XS	XX.XS
HX OUT T	XXXX		ΦB	XX.XS	XX.XS	XX.XS
O2 FLOW	X.XS	X.XS	ΦC	XX.XS	XX.XS	XX.XS
N2 FLOW	X.XS	X.XS	FUEL CELL PH	XXS	XXS	XXS
IMU FAN ΔP	X.XXS		AMPS	XXXX	XXXX	XXXX
ΔV FC1	FC2	FC3	REAC VLV	XXS	XXS	XXS
SS1	XXXX	XXXX	STACK T	±XXXX	±XXXX	±XXXX
SS2	XXXX	XXXX	EXIT T	XXXX	XXXX	XXXX
SS3	XXXX	XXXX	COOL P	XXXX	XXXX	XXXX
TOTAL AMPS	XXXXS		PUMP	XXS	XXS	XXS
KW	XXS					

(XX)

TD402A315.CRT: 2

(a) BFS

Figure 3-6. SMS SYS SUMM 1 (SPEC 78)



TD402A316. CRT# 1

(b) PASS

Figure 3-6. Concluded

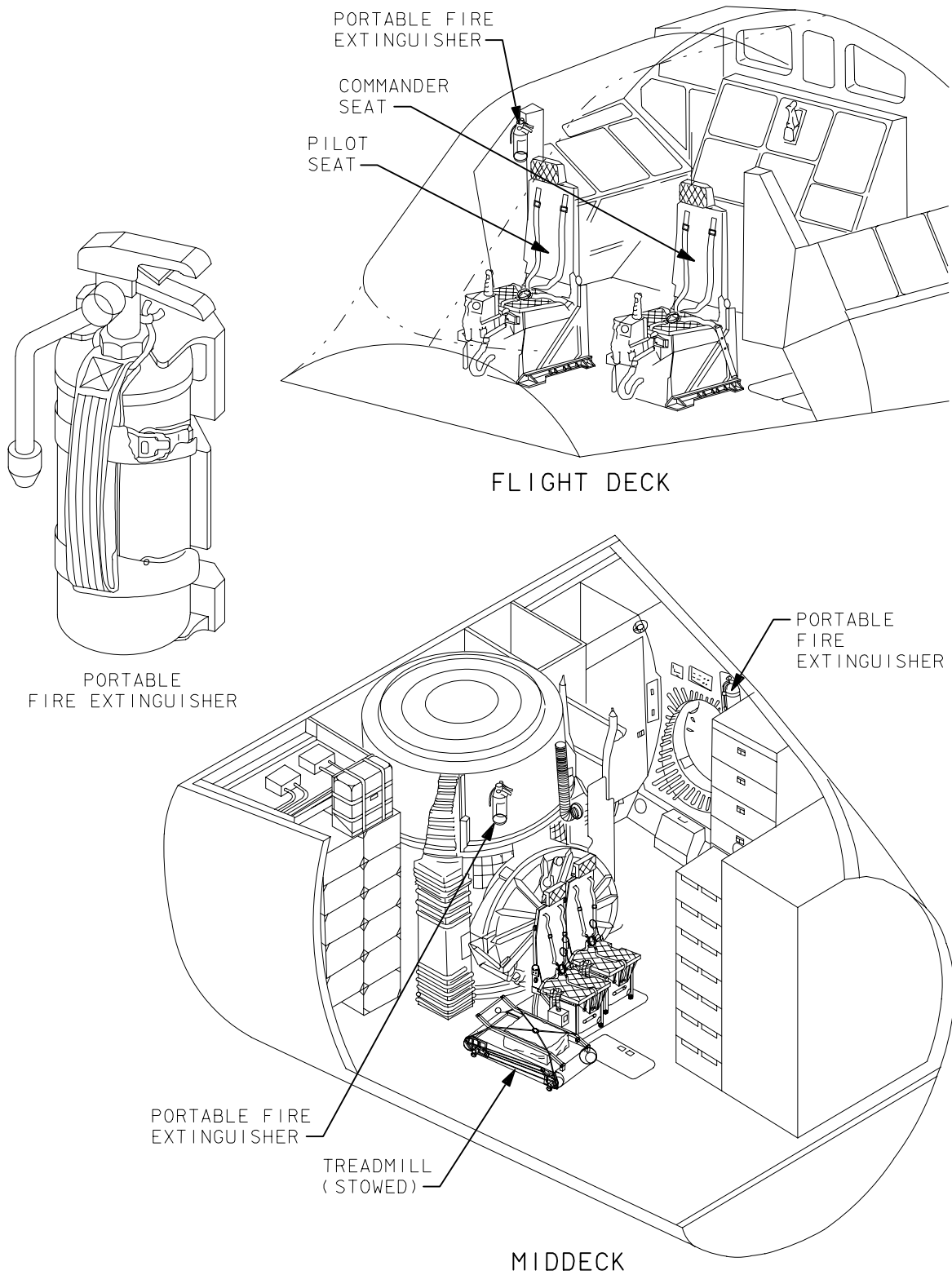
Fire Suppression

Fire bottle and portable fire extinguisher locations. The fire suppression system consists of three permanent fire suppressant (Halon) bottles and three fire extinguishers. The fire bottles are mounted in avionics bays 1, 2, and 3A (Figure 3-2). The fire extinguishers are located in the flight deck and middeck (Figure 3-7).

Portable fire extinguishers and fire port locations. The fire extinguishers can be used to suppress fires in open areas as well as closed areas. One extinguisher is on the flight deck and two are on the middeck.

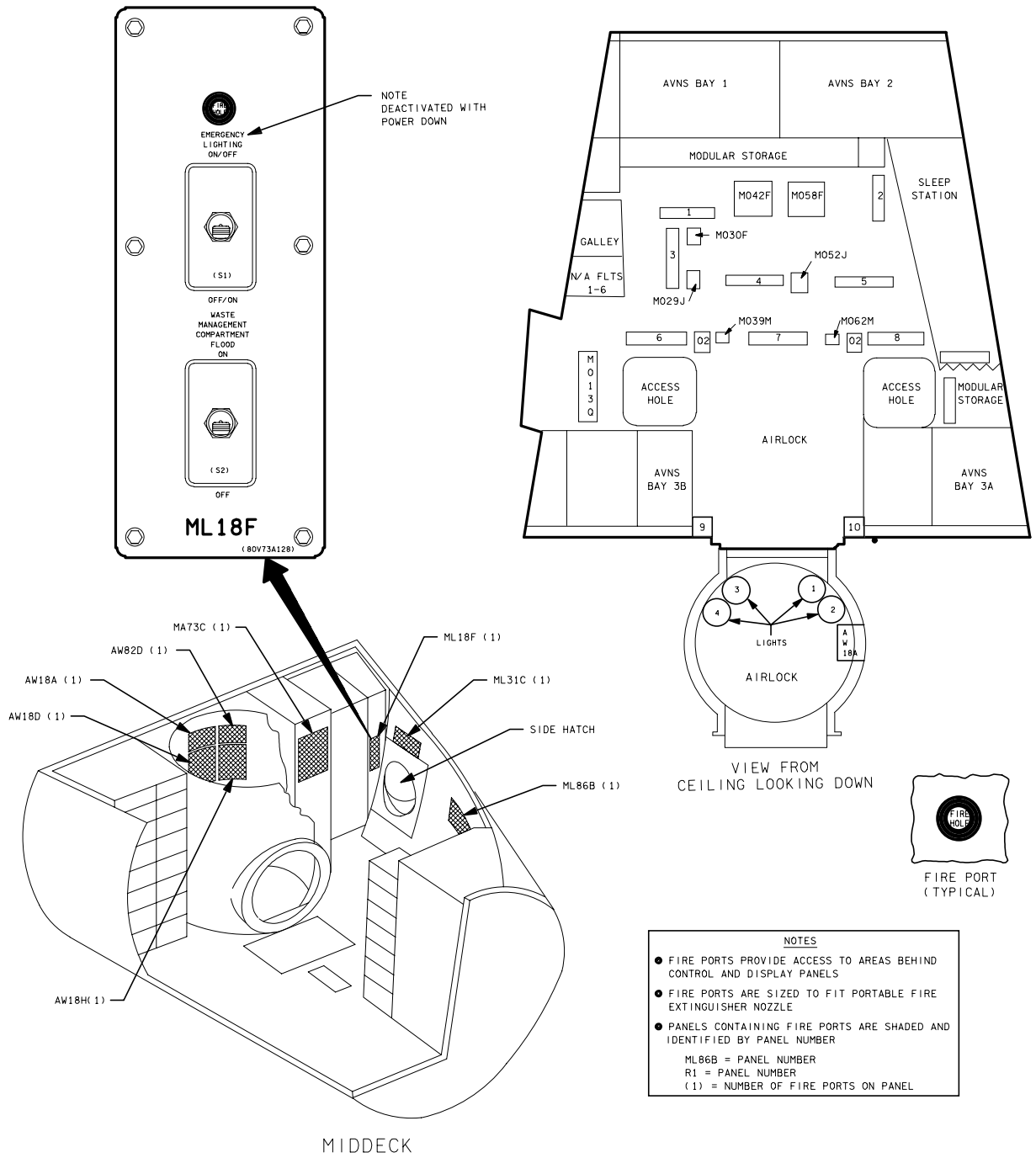
The portable extinguishers are pressurized to 200 psi. They maintain a fairly constant discharge rate for 10 seconds.

Fire ports, sized to fit the extinguisher nozzles, are present throughout the flight deck and middeck (Figure 3-8). To suppress a fire behind a panel or within an avionics bay, the extinguisher nozzle is inserted into the fire port and the actuating mechanism is depressed for 15 seconds. This ensures a complete discharge.



TD402A317. ART 1

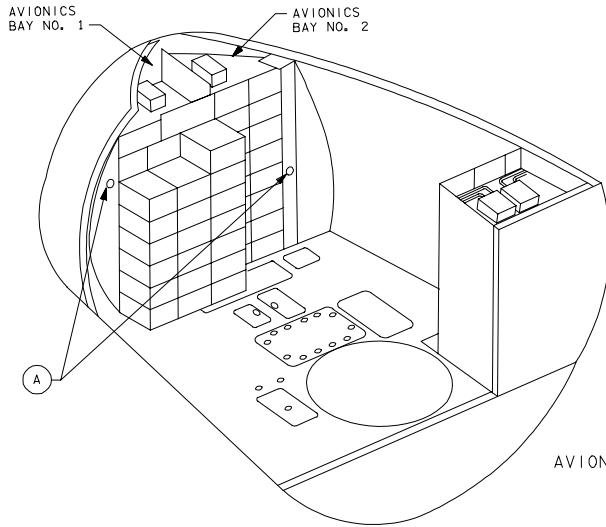
Figure 3-7. Portable fire extinguisher locations



TD402308B, ART. 1

(b) Middeck

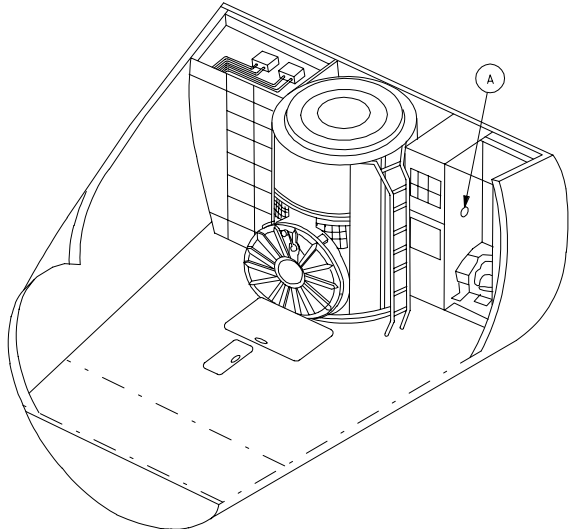
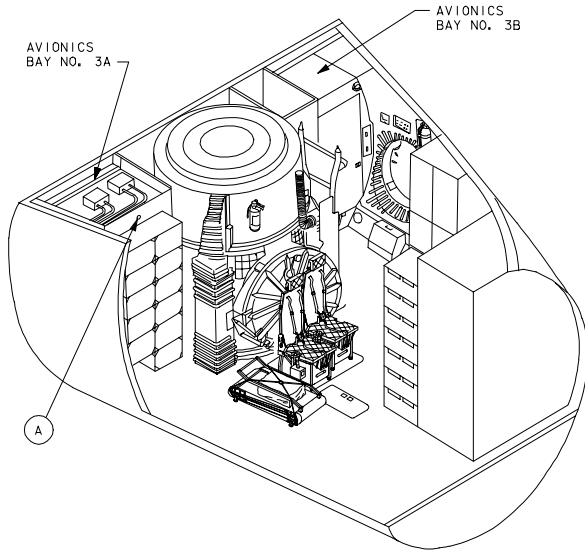
Figure 3-8. Continued



- NOTES**
- FIRE PORTS PROVIDE ACCESS TO AVIONICS BAYS
 - FIRE PORTS ARE SIZED TO FIT PORTABLE FIRE EXTINGUISHER NOZZLE

AVIONICS BAYS 1 AND 2

NOTE: (A) FIRE PORT/GUIDE (TYPICAL)



AVIONICS BAYS 3A AND 3B

TD402308C, ART. 1

(c) Avionics bays

Figure 3-8. Concluded

Fire bottle discharge procedure

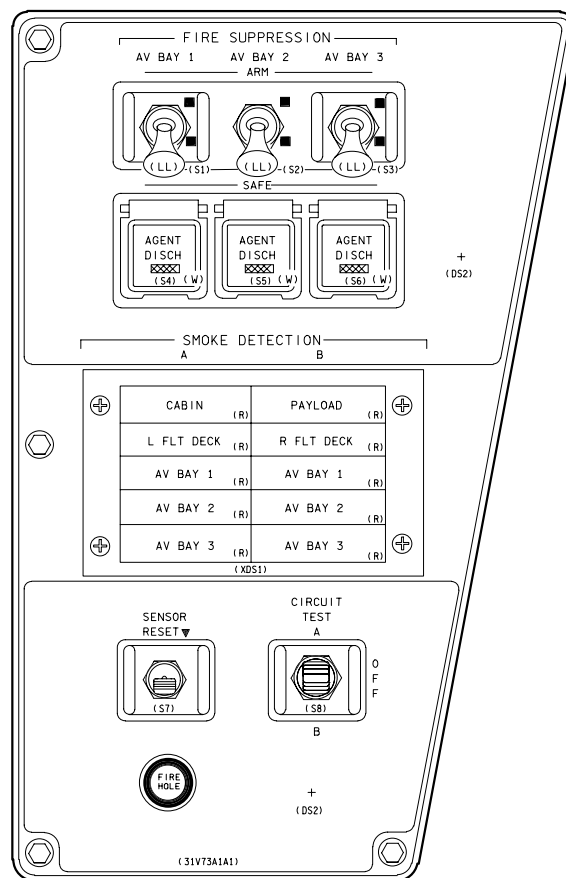
The fire bottles in the avionics bays 1, 2, and 3A are electronically discharged by performing the following actions on panel L1 (Figure 3-9):

FIRE SUPPRESSION - ARM
 FIRE SUPPRESSION pb - DISCH (push until lit)

Placing the switch in the ARM position provides power to the AGENT DISCHARGE pbi. Once the AGENT DISCHARGE cover has been lifted and the pbi depressed, power is applied to a 1-second time delay to prevent accidental discharge. The time delay then routes main electrical power to the Pyro Initiation Controller (PIC). The PIC opens the valve on the fire suppression bottle. When the pressure in the bottle drops to about 60 (± 10) pounds per square inch gauge (psig), the AGENT DISCHARGE light illuminates.

The discharge of the bottle in the avionics bay gives a Halon concentration of 7.5 to 9.5 percent. A 4- to 5- percent concentration is required to suppress a fire.

The FIRE/SMOKE cue card contains the fire suppression procedures for ascent, orbit, and entry. The cue card is mounted to the left of the FIRE SUPPRESSION switches.



TD4020303, ART 1

Figure 3-9. Panel L1

Fire bottle operation

The fire bottle consists of nozzle assembly, pressure switch, and pressure vessel (Figures 3-10 and 3-11).

The nozzle assembly consists of a 1.5-inch nozzle, a PIC, a spring, and a hollow cylindrical knife. The PIC provides an explosion when the agent discharge button on panel L1 is depressed. This explosion compresses the spring which drives the knife into the pressure vessel diaphragm. The diaphragm ruptures and releases the Halon. When the pressure drops to 60 ± 10 psig, the pressure switch sends a signal to panel L1 and illuminates the agent discharge light.

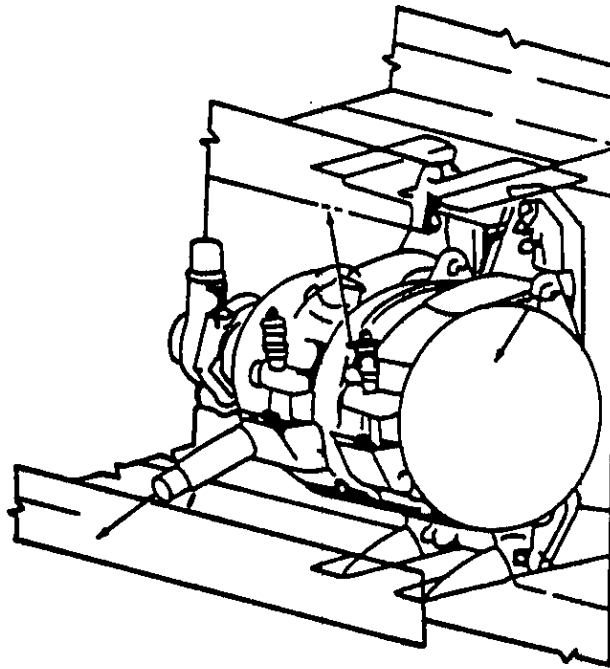
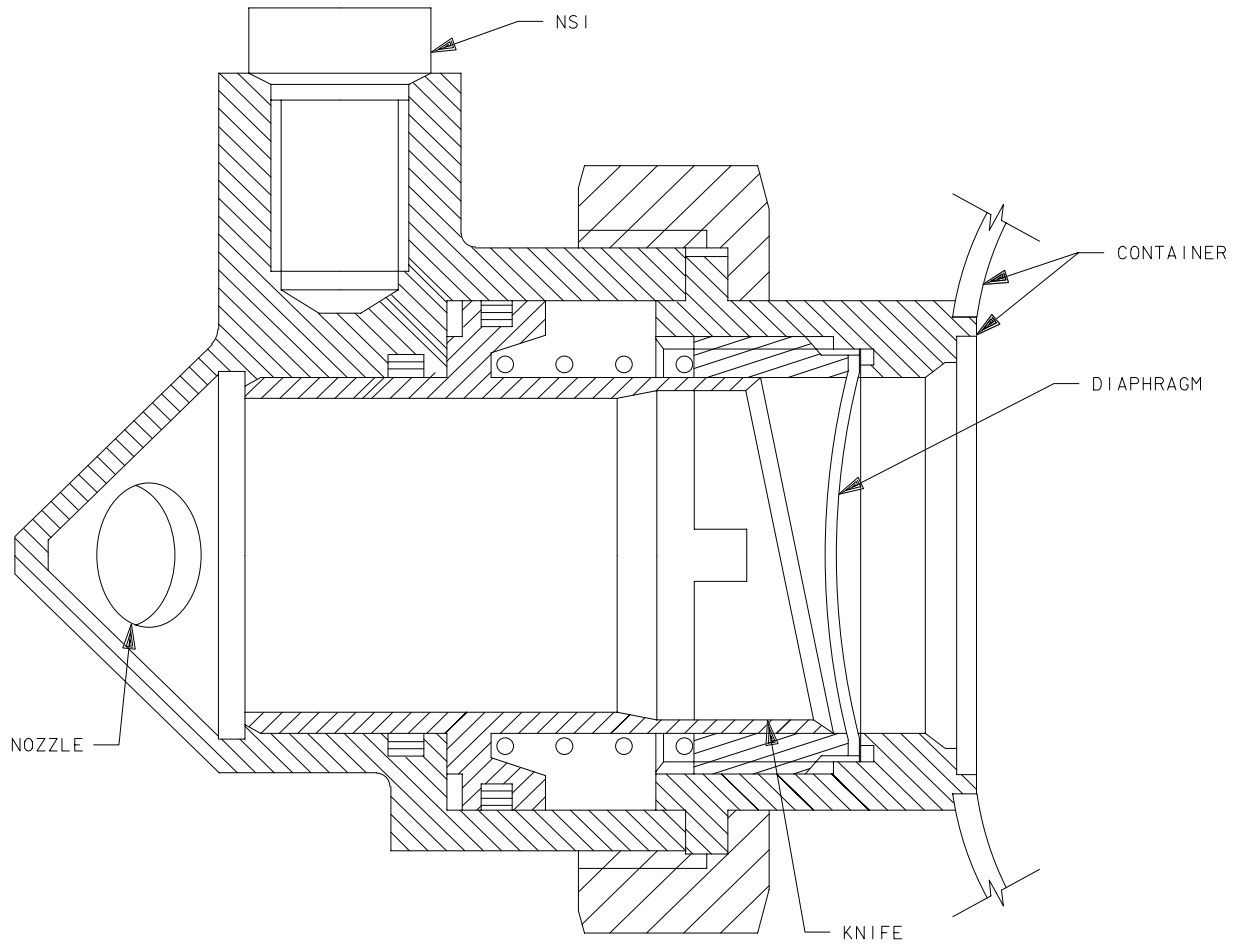


Figure 3-10. Fire bottle and mount



TD4020312. ART. 2

Figure 3-11. Fixed fire extinguisher nozzle assembly

Performance Monitoring

Once the fire bottle in an avionics bay has been discharged, the smoke concentration caused by the fire will stabilize. However, the smoke detectors will see a concentration spike of about 6000 $\mu\text{g}/\text{m}^3$ (handheld extinguisher) or about 7500 $\mu\text{g}/\text{m}^3$ (avionics bay fire bottle) when the Halon is discharged. Within about 90 to 120 seconds, the smoke concentration value on SM SYS SUMM 1 will have more or less returned to the stable smoke particle concentration remaining from the fire. (See SSSH 5.1-1.)

The Halon is effective in the cabin while the cabin fan is turned off (maximum of 20 minutes). The Halon is effective in an avionics bay for 50 hours (avionics bay fan can be operating).

Controls

The cb's that control the fire and smoke subsystem are located on O14, O15, and O16.

Panel O14:C (Figure 3-12)

cb MNA SMOKE DETN L/R FLT DK - Applies power to the left and right flight deck smoke detectors.

cb MNA SMOKE DETN BAY 2A/3B - Applies power to the avionics bay 2 sensor A and bay 3 sensor B smoke detectors and provides power for the sensor reset function.

cb MNA FIRE SUPPR BAY 3 - Supplies power to the avionics bay 3A fire suppressant bottle PIC.

cb MNA ANNUN FWD ACA 1 - Supplies power to the ACA 1 electronics and annunciator lights, including the brightness control and test function.

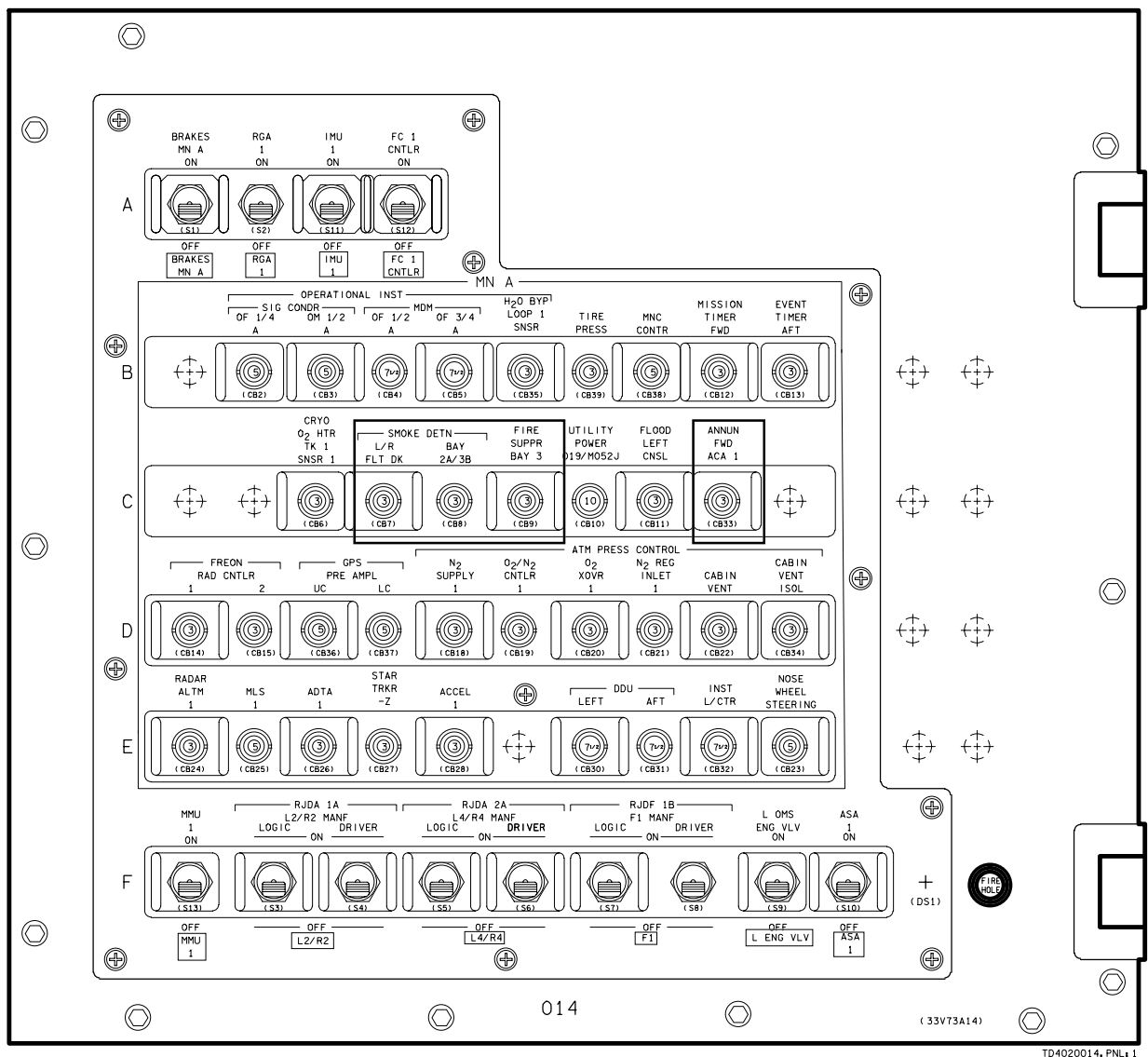


Figure 3-12. Panel O14

Panel O15:C (Figure 3-13)

cb MNB SMOKE DETN BAY 1B/3A - Applies power to the avionics bay sensor B and bay 3 sensor A smoke detectors. Provides power for the sensor reset function.

cb MNB FIRE SUPPR BAY 1 - Supplies power to the avionics bay 1 fire suppressant fire bottle PIC.

cb MNB ANNUN FWD ACA 1 - Supplies power to the ACA 1 electronics and annunciation lights, including the brightness control and test function.

cb MNB ANNUN FWD ACA 2/3 - Supplies power to ACA 2 and 3 electronics and annunciation lights, including the brightness control and test function.

cb MNB ANNUN AFT ACA 4/5 - Supplies power to the ACA 4 and 5 electronics and annunciation lights, including the brightness control and test function.

cb MNB PP0₂C CABIN DP/DT - Provides power for the PP0₂C and cabin DP/DT sensors.

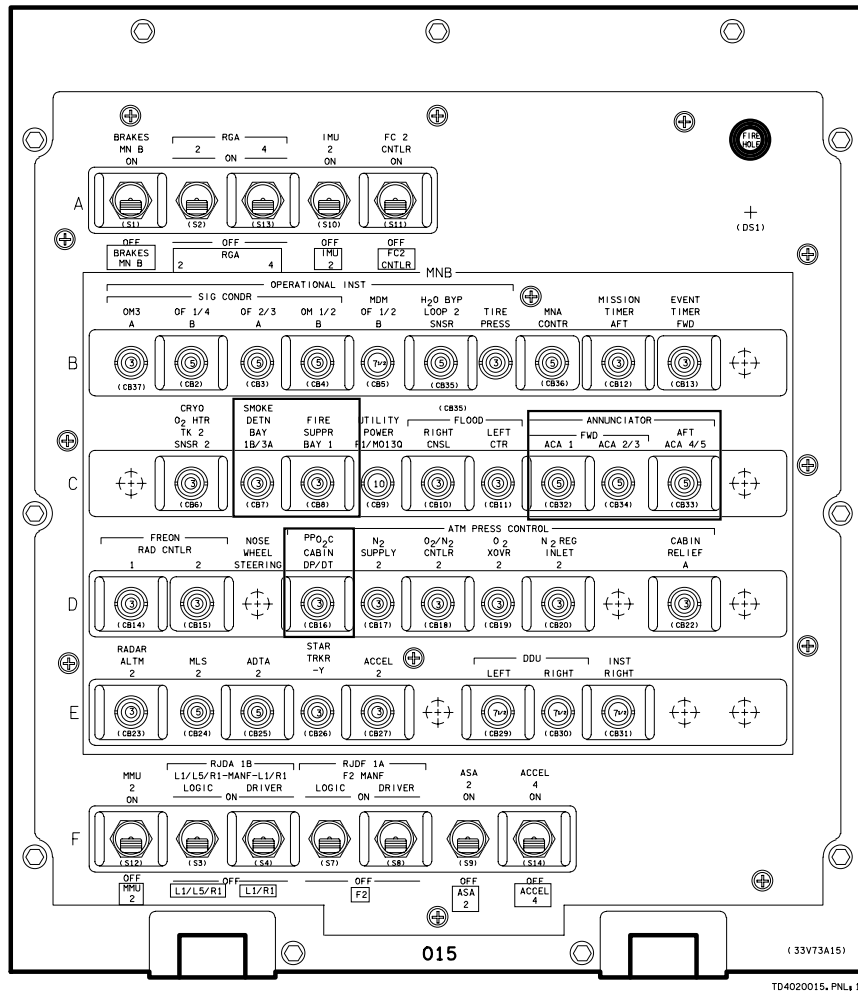


Figure 3-13. Panel O15

Panel O16 (Figure 3-14)

cb MNC SMOKE DETN CAB - Applies power to the CABIN smoke detector, enabling the sensor.

cb MNC SMOKE DERN BAY 1A/2B - Applies power to the avionics bay 1 sensor A and bay 2 sensor B smoke detectors. Provides power for the sensor reset function.

Cb MNC FIRE SUPPR BAY 2 - Supplies power to the avionics bay 2 fire suppressant bottle PIC.

cb MNC ANNUN FWD ACA 2/3 - Supplies power to the ACA 2 and 3 electronics and annunciation lights, including the brightness control and test function.

cb MNC ANNUN AFT ACA 4/5 - Supplies power to the ACA 4 and 5 electronics and annunciation lights, including the brightness control and test function.

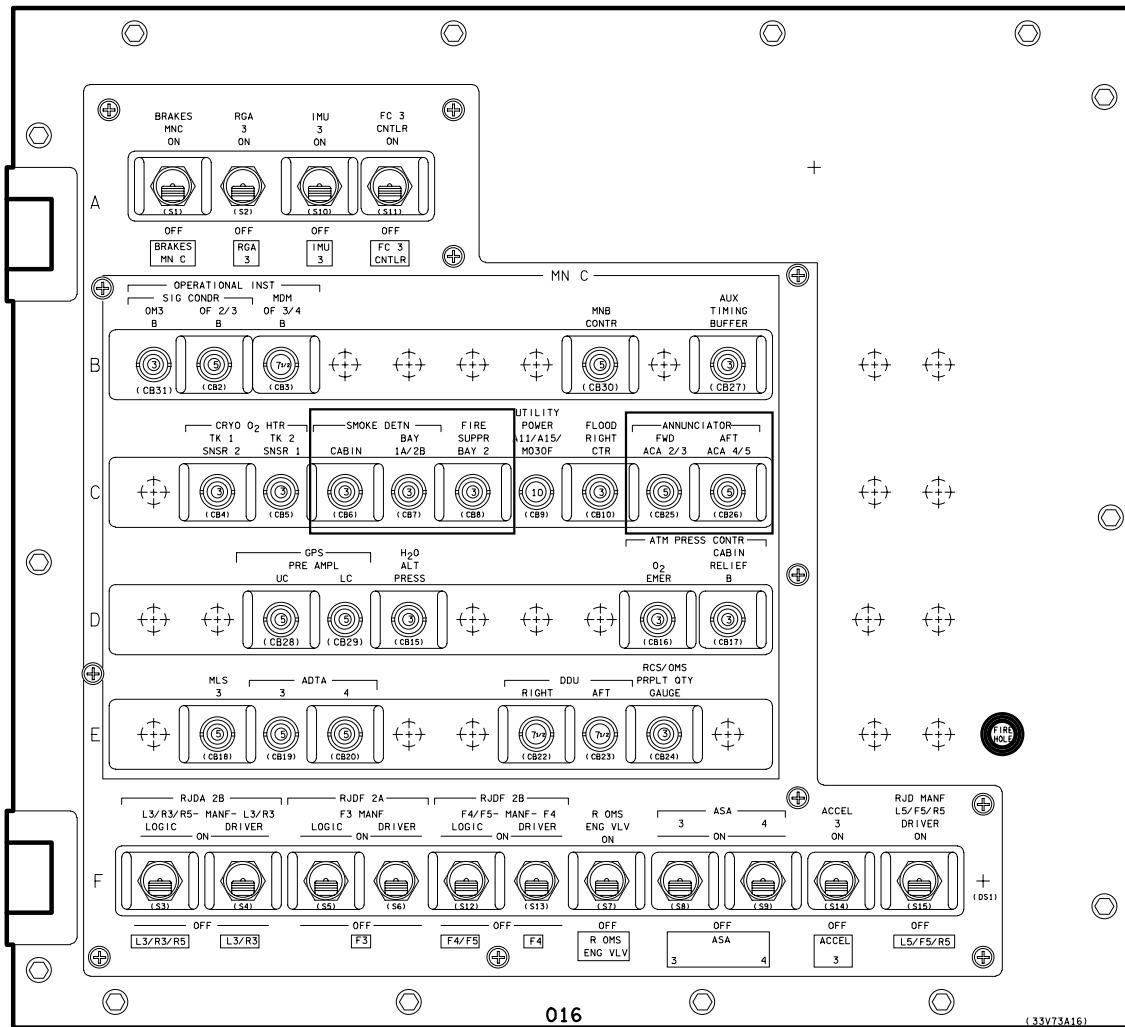


Figure 3-14. Panel O16

Panel	Type	Nomenclature/ position	Function	Remarks
L1	2-Pos lever lock	FIRE SUPPRESSION AV BAY 1 (2,3) SAFE/ARM	Controls power from main electrical bus B (MNB) (C,A) to the Avionics Bay (AV BAY) 1 (2,3) AGENT DISCH PBI and fire bottle PIC arm circuit	3 switches. Figure 3-10
L1	Pushbutton indicator	FIRE SUPPRESSION AV BAY 1 (2,3) AGENT DISCH	Connects dc power from the main bus to the PIC to activate the fire bottle discharge pyros. Also, illuminates when the fire bottle has discharged to 60 ± 10 psig	3 switches
L1	5 by 2 light display	SMOKE DETECTION A/B	Illuminates when the smoke detector connected to that light detects $2000 \mu\text{g}/\text{m}^3$ of smoke particles	Figure 3-10
L1	2-Pos momentary	SENSOR RESET	Resets the circuitry that turns on the smoke-detection lights and causes the lights to extinguish. Also, sets the smoke detector output FFs back to 0	
L1	3-Pos toggle	CIRCUIT TEST A/B	Applies 28 V power to the A or B smoke detectors to test the lights and 20-second time delay. Also, breaks the ground circuit to the AGENT DISCH light allowing the lights to illuminate	

Halon 1301

Halon 1301 is used as the extinguishing agent for all fire suppression devices. Halon 1301 is colorless and odorless. Discharge of the agent may create a light mist in the vicinity of the discharge nozzle, but 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 physiological effect. At levels between 7 and 10 percent, mild Central Nervous System (CNS) 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 as much as 14 percent for 5 minutes have not lost consciousness. These types of CNS effects are 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.

Post-Fire Contaminants

One 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. 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. 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.

After a fire, the Combustion Products Analyzer (CPA) can be used to determine the levels of four of the contaminants in the cabin air (Table 3-1).

Table 3-1. Combustion products analyzer measurements (ppm)

Contaminant	7-day SMAC¹	TLV²	IDLH³	CPA⁴range
Carbon monoxide (CO)	25	50	1500	1-1000
Hydrogen cyanide (HCH)	1	10	60	1-100
Hydrogen chloride (HCl)	1	5	100	1-100
Hydrogen fluoride (HF)	0.1	3	20	1-100

¹SMAC - Spacecraft Maximum Allowable Concentrations.

²TLV - Threshold Limit Value* (8-hr limit).

³IDLH - Immediate Danger to Life and Health.

⁴CPA - Combustion Products Analyzer.

Operational Summary and Notes

- The cabin and left and right FLT DK detectors are located in the cabin return air ducts.
- The avionics bay detectors are located near the top and bottom of each bay, with the Freon (Halon) bottle located near the middle.
- When testing a detector, the circuit test switch selects either all “A” or all “B” detectors.
- All detectors are reset with the sensor reset switch.
- All detectors exhibit a background concentration level of -0.5 to + 0.5 mg/m³ on SM SYS SUMM 1 display.
- To discharge the Halon from the bottle in the avionics bays, the system must be armed and the AGENT DISCHARGE pbi pushed and held for approximately 2 seconds. This ensures the timeout of time delays in the circuitry (see Space Shuttle Systems Handbook (SSSH) drawing 5.1).
- Avionics bay bottle discharge time is less than 1 second.
- Avionics bottle discharge in a bay results in 7.5- to 9.5-percent Halon concentration. A 4- to 5-percent concentration is required for effective suppression.
- Halon concentration in the cabin and avionics bays decreases with time.
- The Halon is effective for 50 hours in the avionics bays.
- Avionics bay fans should be turned off to prevent O₂ from mixing with the flame. The Halon bottle distribution system works independently from the avionics fan.

- The cabin fan should be turned off (maximum of 20 min) to localize toxic byproducts, to ensure Halon is not dispersed before suppressing the fire, and to minimize any O₂ introduction to the fire. Once the cabin fan is turned back on, the concentration of Halon is dispersed evenly throughout the cabin and is not sufficient to suppress fires. If another fire occurs, another handheld fire bottle discharge is required to suppress the fire.
- Portable bottles are considered backups to the avionics bay bottles for avionics bay fires. If a portable bottle is discharged into an avionics bay, the resultant Halon concentration is 6 to 7 percent.
- Numerous fire holes are throughout the orbiter for use with the portable bottles. The holes are of two types, a 1/2-inch-diameter hole covered with a marked label or a 1/2- to 1/4-inch diameter tapered hole. The tapered type has no marked label. These holes give access to the volume immediately behind the individual panel.
- *During normal self-test or reset of a detector, if a detector is stuck on one of these conditions (for example, the result of a switch failure), the analog concentration output still responds to changes in smoke level.*
- *Self-test checks for pump motor running and proper function of rate alarm and concentration alarm processing circuits. These three tests must be satisfied before the detector outputs the alarm signal, indicating a good self-test.*
- *The second self-test signal must be continuous for at least 25 seconds to allow for a complete self-test sequence. The first self-test signal must be more than 5 but less than 10 seconds.*
- *Smoke detector power requires approximately 6.5 watts each.*
- *Bottle discharge may be heard by the crew. Tests have shown that the overall sound pressure level may reach 143 dB.*
- *Avionics bay bottles have a low pressure switch that closes at approximately 60 psig to indicate bottle depletion.*
- *The pressure within an avionics bay momentarily rises approximately 1 psia when the avionics bottle is discharged.*
- *Avionics bay bottle pressure at 65 °F 185 psig.*
- *Time required to fully discharge the portable bottles is approximately 15 seconds.*
- *The cabin fan should be turned off before discharging a portable extinguisher behind the flight deck panels.*

Cabin dP/dt Subsystem

dP/dt Annunciation

The cabin dP/dt system is designed to alert the crew to a rapid cabin depressurization.

Cabin dP/dt is measured by a sensor (Figure 3-15). The value of this sensor is read in the dP/dt field of the CRT displays and the panel O1 meter. This sensor generates the Class 1 Emergency Alarm when a value of -0.08 psi/min is exceeded.

- Visual cue

MA lights on panels F2, F4, A7, and MO52J (Figure 2-2)

- Aural cue

Klaxon - 2560 Hz tone with a period of 2.1 ms ON and 1.6 ms OFF mixed with a 256 Hz tone with a period of 215 ms ON and 70 ms OFF. The Klaxon can be silenced by depressing an MA pbi.

The cabin dP/dt is presented on two CRT displays and on a meter located on panel O1. The CRT displays are SPEC 66 ENVIRONMENT and SPEC 78 SYS SUMM 1. The SM SYS SUMM 1 display is available in both PASS and BFS.

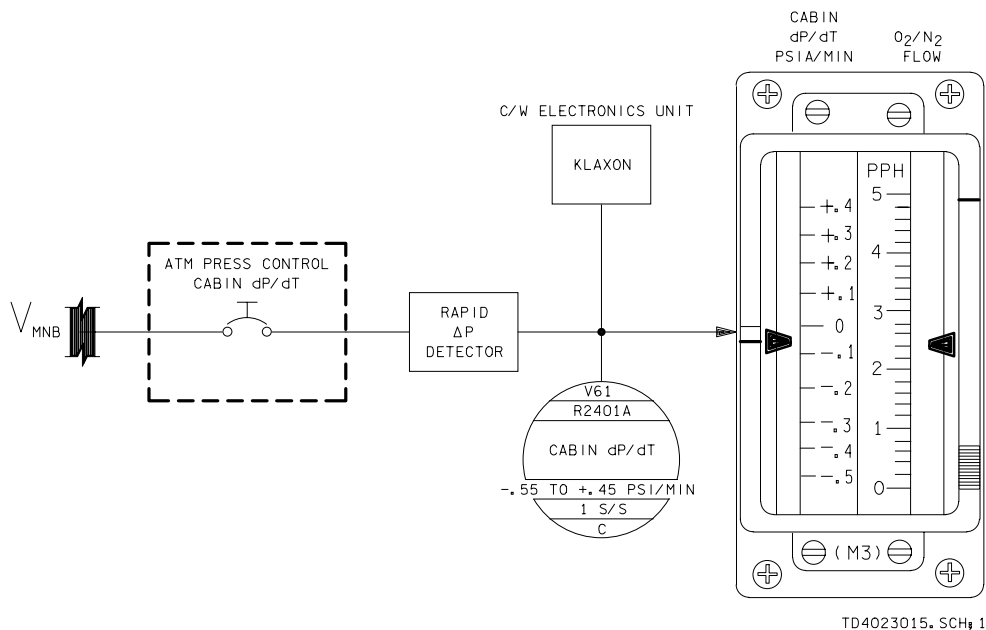


Figure 3-15. Cabin rapid ΔP

Other Cabin Leak Annunciation

Two calculated parameters, B/U dP/dt (BFS) and EQ dP/dt (PASS and BFS), can generate Class 3 Alerts. These parameters are not part of the Class 1 Emergency alarm system.

B/U dP/dt is calculated from changes in cabin pressure. P_0 is cabin pressure at time equals zero while P_{30} is the cabin pressure 30 seconds later. The pressures and computation are updated every 5 seconds by the BFS. The software filters the final value to avoid large changes in B/U dP/dt due to cabin pressure bit flips.

$$B / U \, dP / dt = 2(P_{30} - P_0)$$

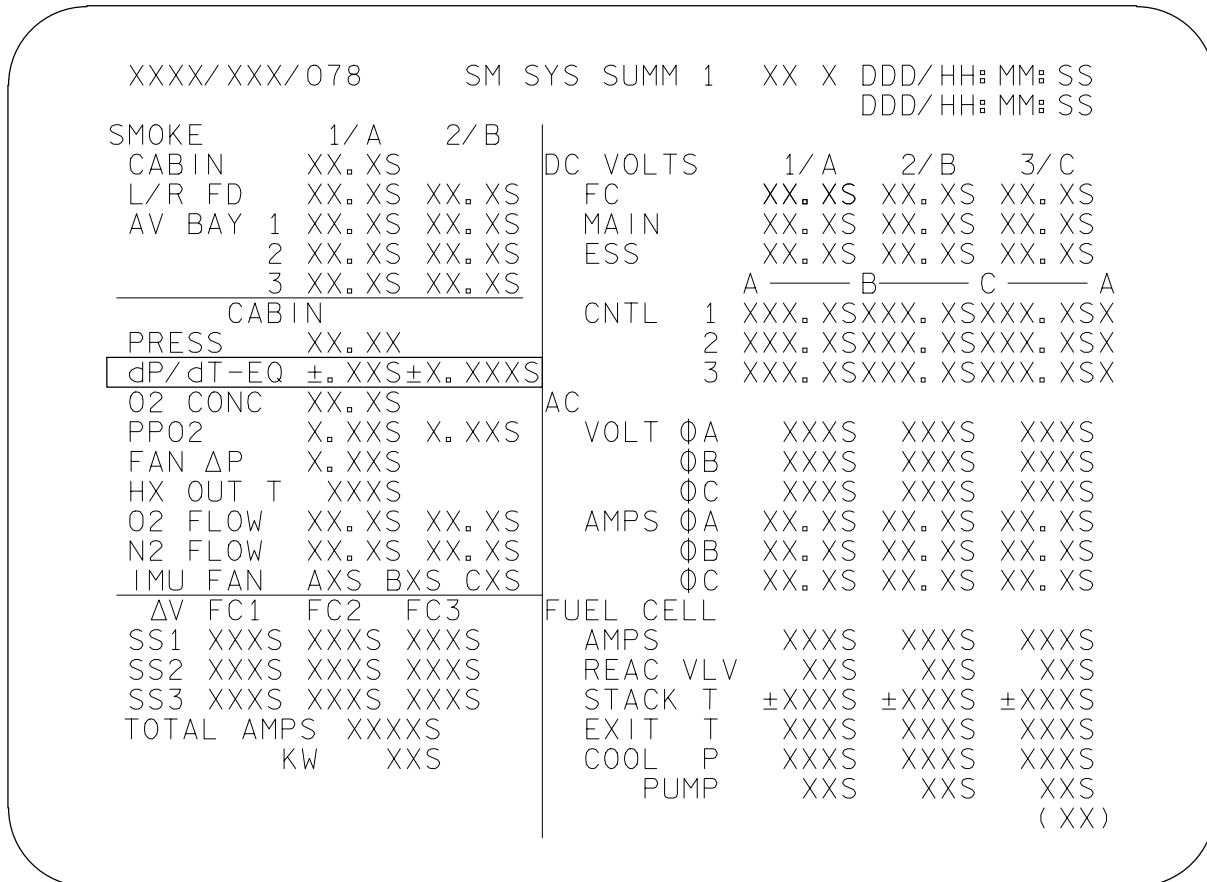
Equivalent (EQ) dP/dt takes the current dP/dt and cabin pressure and normalizes the dP/dt to a 14.7 psia cabin pressure.

$$EQ \, dP . dt = 14.7 \left(\frac{dp / dt}{Cabin \, P} \right)$$

If a cabin leak occurs, various Class 2 C& W and Class 3 Alert alarms may be annunciated. Thus alarms may include EQ DP/DT, B/U DP/DT, CABIN PRESS (when lower limit is violated), N_2 flow, and O_2 flow (if flowing to maintain cabin pressure). There also may be alarms when the lower limits of various fans are exceeded.

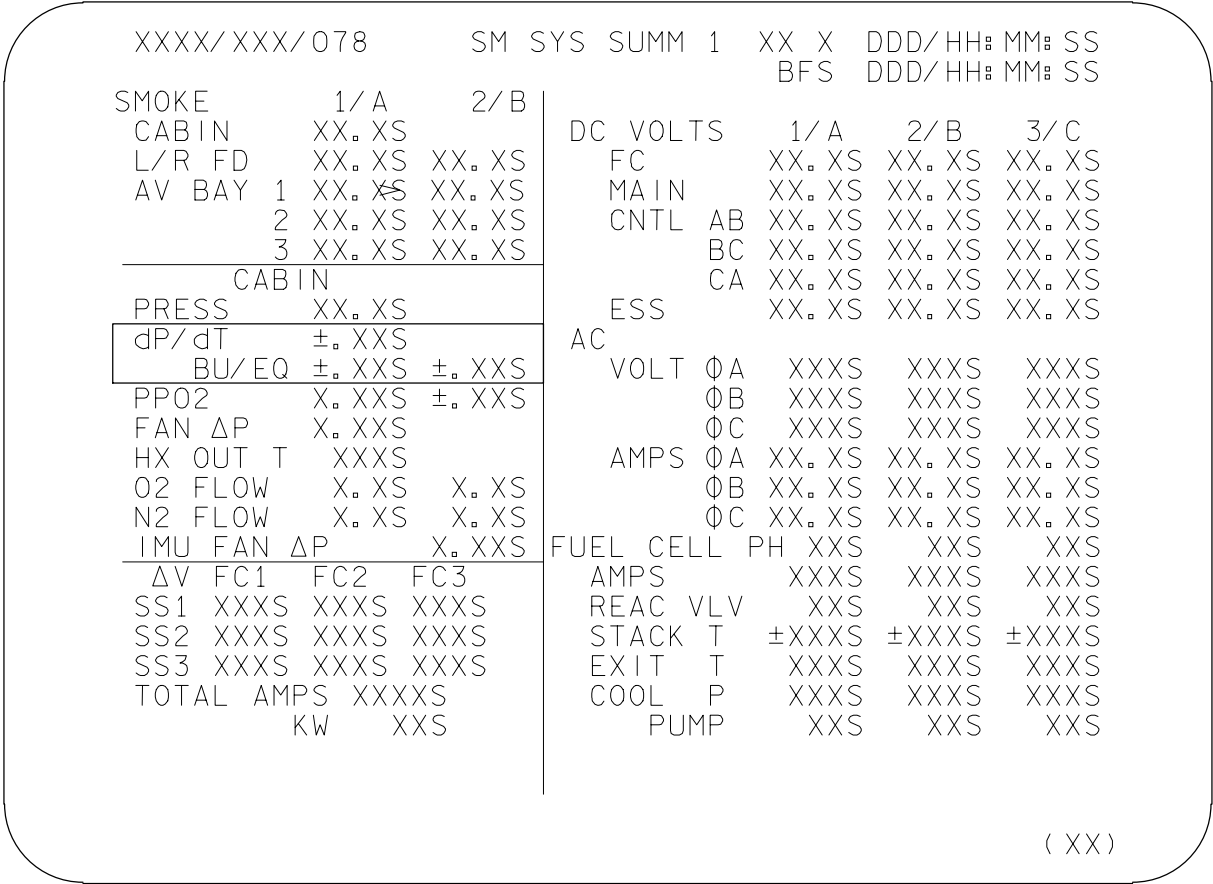
Performance Monitoring

The value of cabin dP/dt is displayed on a meter on panel O1. It also is displayed, along with EQ DP/DT and B/U DP/DT, on the following CRT displays: PASS and BFS SM SYS SUMM 1 and PASS SPEC 66. See Figure 3-16, Figure 3-17, and Figure 3-18.



TD4020316. CRT; 1

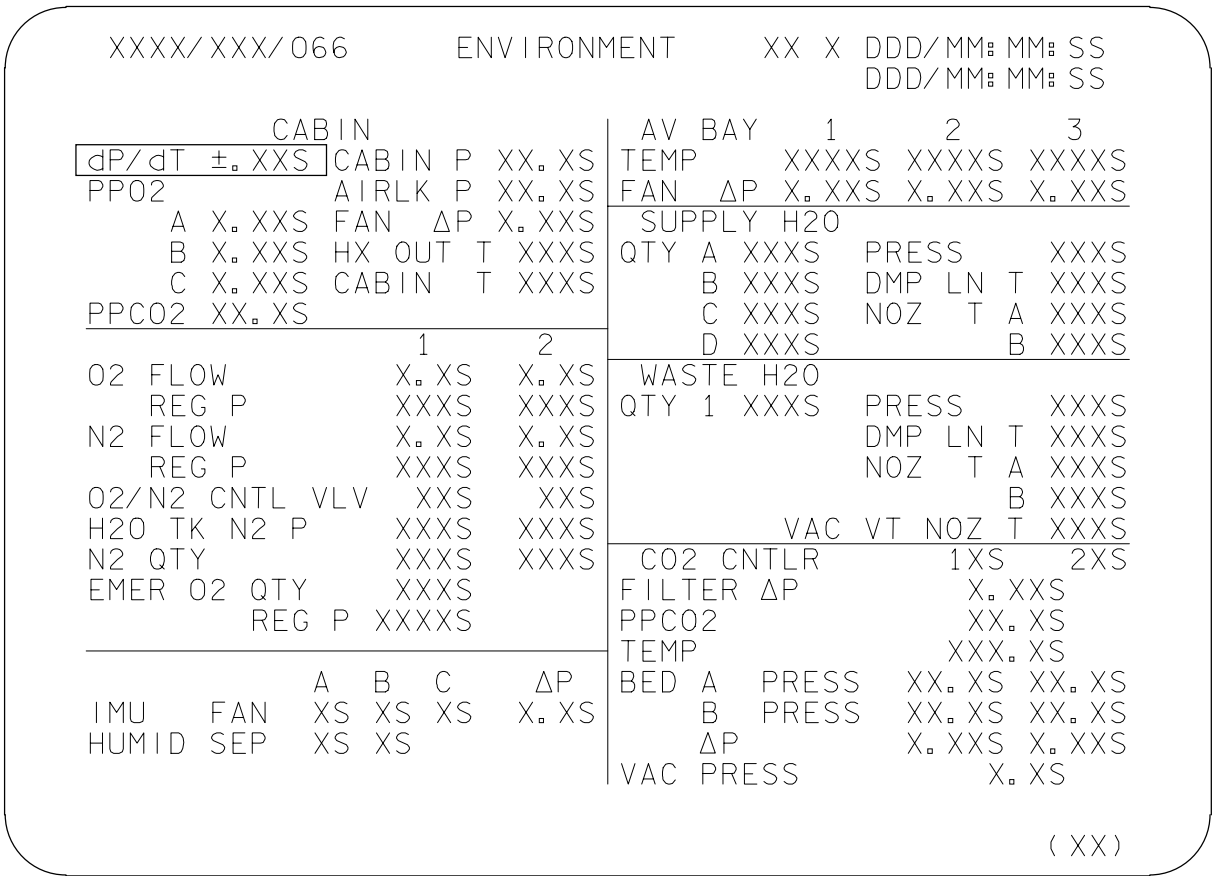
Figure 3-16. SM SYS SUMM 1 (PASS)



(XX)

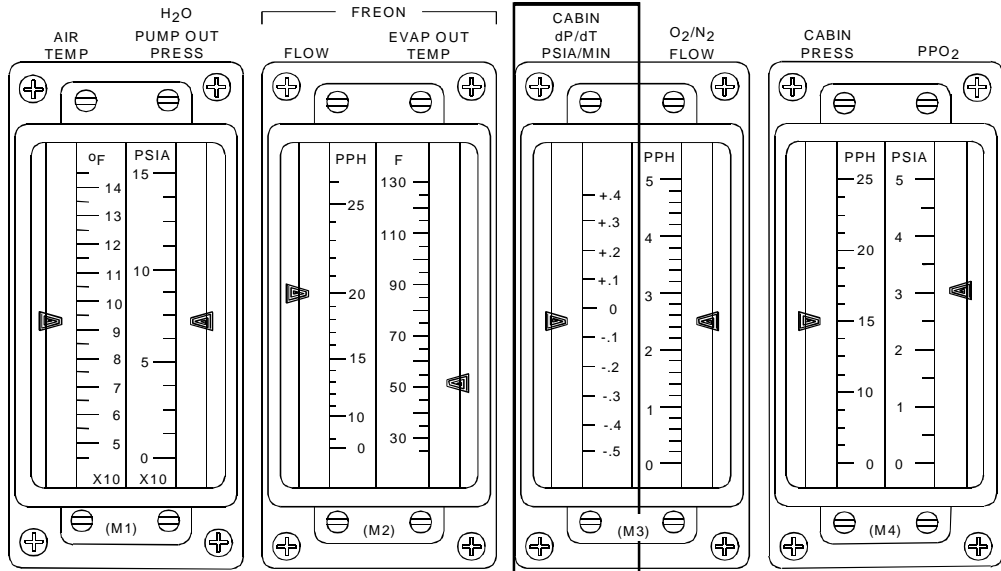
TD4020317. CRT 1

Figure 3-17. SM SYS SUMM 1 (BFS)



TD4020318. CRT 2

Figure 3-18. SM SPEC 66



td402_013.cv5

Figure 3-19. Panel O1 meters

The nominal dP/dt on orbit and entry is 0 ± 0.01 psi/min. During the first 2 minutes of ascent (launch to Solid Rocket Booster (SRB) Separation (SEP), the dP/dt can be as high as -0.07 psi/min because of cabin stretch. The Class 1 Emergency annunciates when the dP/dt ≥ -0.08 psi/min. The system trips only when the cabin is losing pressure (-dP/dt).

Controls

Panel O15: D (see Figure 3-13)

The PPO₂C CABIN DP/DT cb provides power from main B to the dP/dt sensor. This cb also provides power to the PPO₂C sensor.

Questions

1. Which CRT display shows concentration of smoke in the avionics bays?
 - a. SPEC 66
 - b. SM SYS SUMM 1
 - c. SM SYS SUMM 2
 - d. GNC SYS SUMM 1
2. If the emergency smoke alarm system is latched (sensor reset has not been performed) and a fire occurs in another location, which of the following indications will NOT occur?
 - a. Illumination of corresponding panel L1 smoke detection light(s)
 - b. Increase in corresponding SM SYS SUMM 1 smoke concentration(s)
 - c. Siren
3. The smoke detectors check for concentrations and rate increase of concentrations; which of the following is true?
 - a. $2000 \pm 200 \mu\text{g}/\text{m}^3$ for 5 seconds and/or $22 \mu\text{g}/\text{m}^3$ per second for eight consecutive counts in 70 seconds
 - b. $2000 \pm 200 \mu\text{g}/\text{m}^3$ for eight consecutive counts in 20 seconds and/or $22 \mu\text{g}/\text{m}^3$ per second for 5 seconds
 - c. $2000 \pm 200 \mu\text{g}/\text{m}^3$ for 5 seconds and/or $22 \mu\text{g}/\text{m}^3$ per second for eight consecutive counts in 20 seconds
4. What procedure is used to discharge a fire bottle in to an avionics bay?
5. True or false. For avionics bay fires, portable extinguishers are considered backups to the avionics bay bottles.
6. The Class 1 Emergency annunciation for a cabin rapid dP/dt consists of
 - a. MA lights, siren, and panel L1 light
 - b. MA lights, Klaxon, and panel L1 light
 - c. MA lights and siren
 - d. MA lights and Klaxon

7. The alarm system will sound when the dP/dt equals or exceeds
 - a. -0.07 psi/min
 - b. -0.02 psi/sec
 - c. -0.08 psi/min
 - d. -0.07 psi/sec
8. The nominal dP/dt during orbit is
 - a. ± 0.07 psi/sec
 - b. ± 0.07 psi/min
 - c. ± 0.01 psi/min
 - d. ± 0.01 psi/sec
9. The cabin pressure and dP/dt can be referenced on which of the following:
 - a. Panel L1, panel O1, and SPEC 66
 - b. Panel O1, SPEC 66, and SM SYS SUMM 1
 - c. Panel O1, SPEC 55, and SM SYS SUMM 1
 - d. Panel L1, panel O1, and SM SYS SUMM 1
10. Where are the fire extinguishers located?
 - a. One on middeck and two on the flight deck
 - b. Two on middeck and two on the flight deck
 - c. Two on middeck and one on the flight deck
 - d. One on middeck and one on the flight deck

Additional questions over detailed information

11. True or false. Both the sensing and reference chambers in the smoke detectors are constantly recycled.
12. True or false. The separator of the smoke detector allows only particles 2 microns or less to enter the sensing chamber.
13. True or false. The radiation source used by the smoke detectors is Americium 241.
14. True or false. The fire bottles use a PIC to provide an explosion in the nozzle assembly.
15. The nozzle assembly consists of the following:
 - a. A 1/2-inch nozzle, a PIC, a valve, and a chain

- b. A 1/4-inch nozzle, a valve, and a hollow cylindrical knife
 - c. A 1/2-inch nozzle, a valve, and a hollow cylindrical knife
 - d. A 1/2-inch nozzle, a PIC, a spring, and a hollow cylindrical knife
16. True or false. The diaphragm of the fire bottle is ruptured by use of a knife.
17. True or false. The pressure switch on the fire bottle sends a signal to panel L1 to illuminate the AGENT DISCH light when the pressure in the bottle drops to 60 ± 10 psi.
18. How many smoke detectors are in each avionics bay?
- a. One
 - b. Two
 - c. Three
 - d. Four
19. True or false. Once the alarm system is triggered by a smoke detector, the entire system remains latched until reset by panel L1.
20. When performing a circuit test on panel L1, how long is it until the siren sounds after the test switch is placed in A or B position?
- a. Approximately 5 seconds
 - b. Approximately 10 seconds
 - c. Approximately 15 seconds
 - d. Approximately 20 seconds
21. How long is the Halon effective as a fire suppressant after discharge in to an avionics bay?
- a. 24 hours
 - b. 72 hours
 - c. 24 hours
 - d. 50 hours
22. True or false. All detectors are reset with the sensor reset switch on panel L1.
23. True or false. All fire ports are located on the flight deck.
24. True or false. The fire bottles in the avionics bays are empty when the AGENT DISCH light goes off.
25. True or false. The emergency alarm system annunciates for either +dP/dt or -dP/dt.

Answers

1. b. SM SYS SUMM 1 shows concentration of smoke in the avionics bays.
2. c. If the emergency smoke alarm system is latched and a fire occurs in another location, there will be no siren.
3. c. The smoke detector inspects for smoke particle concentration of $2000 \pm 200 \mu\text{g}/\text{m}^3$ for a period of at least 5 seconds and/or a rate increase of $22 \mu\text{g}/\text{m}^3 \text{ sec}$ for eight consecutive counts in 20 seconds.
4. To discharge a fire bottle into an avionics bay, place the FIRE SUPPRESSION ARM/SAFE switch in the ARM position, lift the cover, and press the AGENT DISCHARGE pbi.
5. True. Portable extinguishers are considered backups to the avionics bay bottles for avionics bay fires.
6. d. The Class 1 Emergency annunciation for a cabin rapid dP/dt consists of MA lights and the Klaxon.
7. c. The alarm system sounds when the dP/dt equals or exceeds $-0.08 \text{ psi}/\text{min}$.
8. c. The nominal dP/dt during orbit is $\pm 0.01 \text{ psi}/\text{min}$.
9. b. The cabin pressure and dP/dt can be referenced on panel O1, SPEC 66, and SM SYS SUMM 1.
10. c. Two fire extinguishers are located on the middeck; one is located on the flight deck.
11. False. Only the sensing chamber is recycled.
12. True. The separator of the smoke detector allows only particles 2 microns or less to enter the sensing chamber.
13. True. The radiation source used by smoke detectors is Americium 241.
14. True. The fire bottles use a PIC to provide an explosion in the nozzle assembly.
15. d. The nozzle assembly consist of a 1/2-inch nozzle, a PIC, a spring, and a hollow cylindrical knife.
16. True. The diaphragm of the fire bottle is ruptured by use of a knife.
17. True. The pressure switch on the fire bottle sends a signal to panel L1 to illuminate the AGENT DISCH light when the pressure in the bottle drops to $60 \pm 10 \text{ psi}$.
18. b. Two smoke detectors are in each avionics bay.
19. True. Once the alarm system is triggered by a smoke detector, the entire system remains latched until reset by panel L1.

20. d. The siren sounds in approximately 20 seconds after the test switch is placed in A or B position when performing a circuit test on panel L1.
21. d. After discharge into an avionics bay, Halon is effective as a fire suppressant for 50 hours.
22. True. All detectors are reset with the sensor reset switch on panel L1.
23. False. Fire ports are provided throughout the flight deck and middeck.
24. False. The fire bottles in the avionics bays are not empty when the AGENT DISCH light goes off.
25. False. The emergency alarm system annunciates only for a $-dP/dt$.

Section 4

Class 2 Caution and Warning

Objectives

After reading this section, the student should be able to

- Differentiate between Primary C&W and B/U C&W
- Specify which software supports B/U C&W
- State the aural and visual indications for
 - Primary C&W
 - B/U C&W
- Describe the crew response to Primary and B/U C&W annunciation
- Explain the purpose of the following:
 - Upper and lower limits
 - Enable/inhibit status
 - Noise filter value (B/U C&W)
- Describe the capabilities of panel R13U
- Correctly answer the questions at the end of the section

Overview

The C&W system (Figure 4-1) monitors parameters associated with many orbiter systems. The C&W system consists of two subsystems, Primary C&W (a hardware system) and Backup (B/U) C&W (a software system).

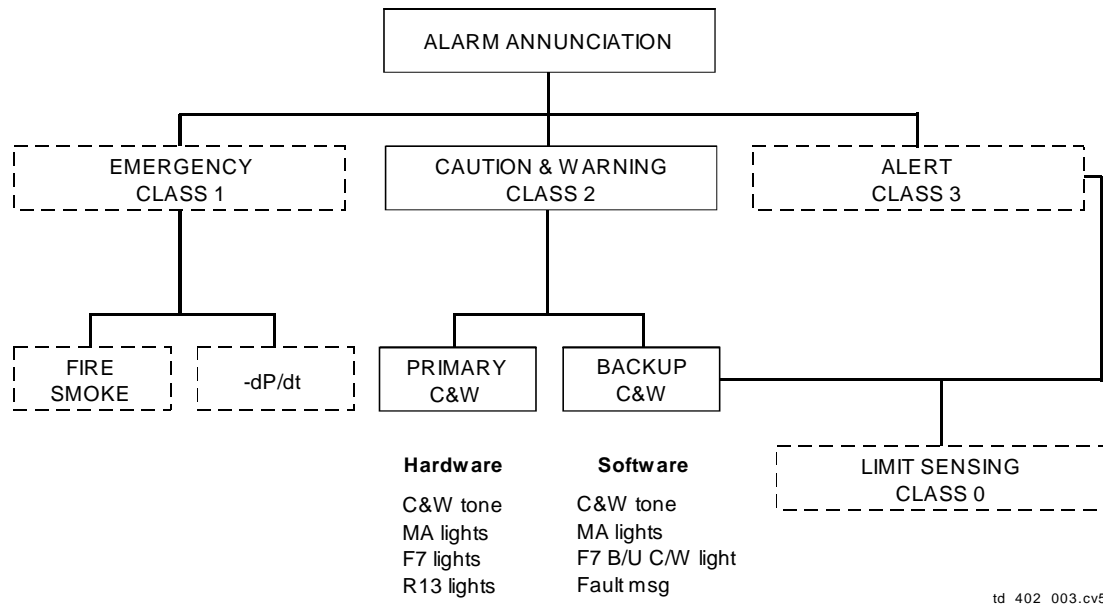


Figure 4-1. Class 2 C&W diagram

Primary C&W

The Primary C&W system is a hardware system. The system has the capacity to monitor 120 inputs, most of which are received from transducers through signal conditioners. A few inputs are received from GPCs through Flight Forward (FF) Multiplexer/Demultiplexers (MDMs). The Primary C&W system is sometimes referred to as the Hardware C&W system.

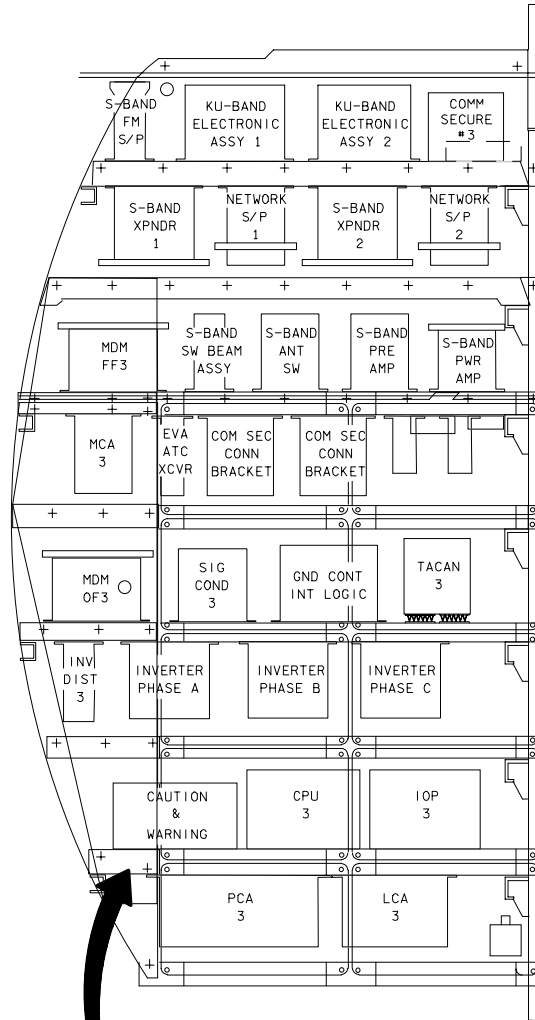
The primary C&W system receives 120 inputs directly from transducers, through signal conditioners, or from the FF MDMs and they are fed into a multiplexing system. Of these 120 inputs, 95 are directly from transducers, 5 are from GPC input/output processors, 18 are software provided through MDMs, and 2 are spares. These inputs can be either analogs or discrettes. The analog signals are 0 to 5 volts dc; the discrettes can be either 0, 5, or 28 volts dc. All the inputs are designed to provide high, low, or both high and low limit detection. An additional eight signals are added to the multiplexing system by the C&W electronics for self-testing purposes. Each input is then tested against its limit values. If the parameter limits have been exceeded eight consecutive times (or is out of limits for 100 ms), the C&W tone will sound, the appropriate indicator on the annunciator panel will light, and the parameter number will be stored in memory. If the parameter status switch is held in the TRIPPED position, the out-of-limits parameters will also illuminate the corresponding light on the status parameter matrix on panel R13.

The additional eight parameters mentioned above, which are tested against limits, are generated within the C&W electronics and used as a self-test check. Should the self-test fail, the primary C&W light will illuminate on the panel F7 annunciator light array.

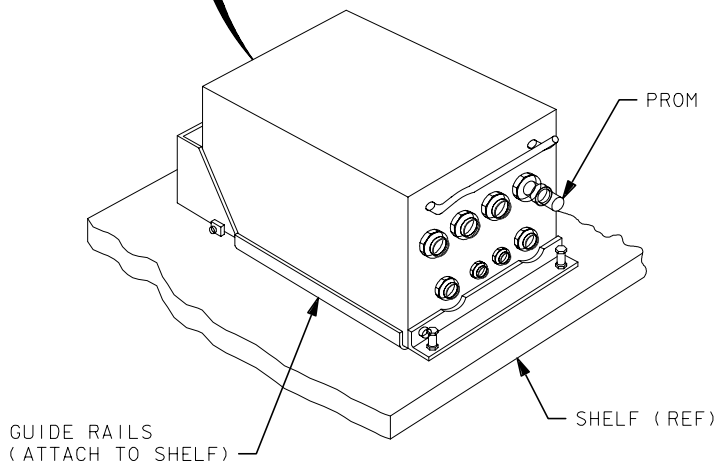
Twelve discrete inputs come directly into the C&W master alarm tone logic circuitry from the computers through the MDMs for the purpose of activating alarm tones for the backup C&W alarm. Six of these discretes are used to turn the SM alert tone on and off. The other six are used to turn the backup C&W light on panel F7 on and off. One additional discrete sent into the master alarm tone logic is to reset the master alarm lights and tone. This discrete comes through the Launch Forward (LF) MDM and will be used prior to launch only.

The C&W electronics unit (Figure 4-2) is located in avionics bay 3A (middeck). It contains the electronics necessary to perform limit comparisons, alarm annunciation, and other Primary C&W functions.

A Programmable Read-Only Memory (PROM), which is connected to the C&W electronics unit, contains preset (default) limits. If values other than those on the PROM are desired by the crew, changes can be made through panel RIU. However, if power is lost to the C&W electronics, the system reverts (defaults) to the PROM values upon reapplication of power, and the desired values have to be reentered manually (Figure 4-2). Unlike the Backup C&W and Alert systems, MCC cannot uplink changes to the Primary C&W system limits.



COMPONENT LOCATIONS - BAY 3A



TD4020402. ART# 3

Figure 4-2. Primary C&W electronics unit

Annunciator Light Matrix

A 40-light annunciator matrix is located on panel F7 (Figure 4-3).

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 or inhibited. The intensity of the lights is adjustable by the crew by using the bright/variable switch and the variable intensity knob on panel O6 (Figure 4-4). Each lamp assembly has two bulbs, wired in parallel, for redundancy. Each lamp assembly can be individually removed from the annunciator matrix so that lamp replacement does not require removing the annunciator matrix from the console. Power for the annunciator light matrix is routed through the ESS 1 BC C/W A cb on panel O13:A (Figure 4-9).

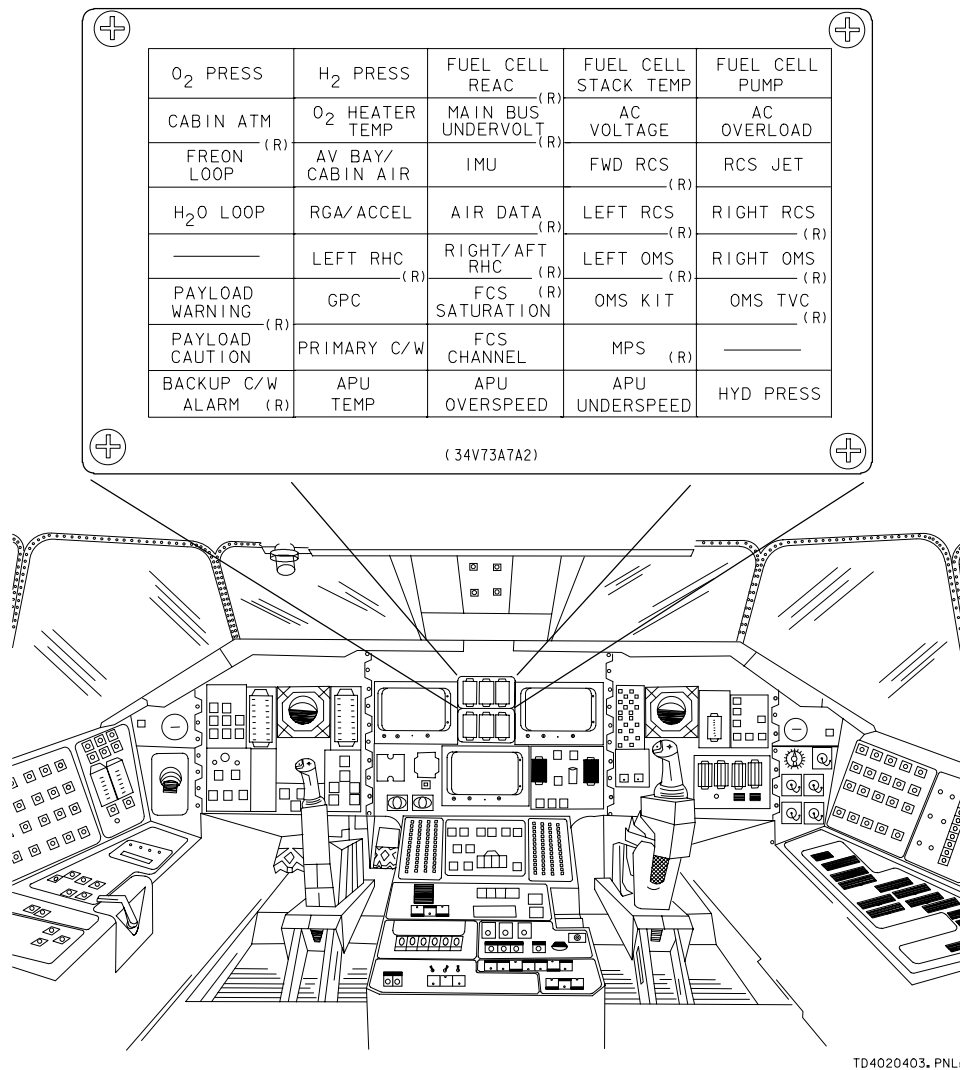
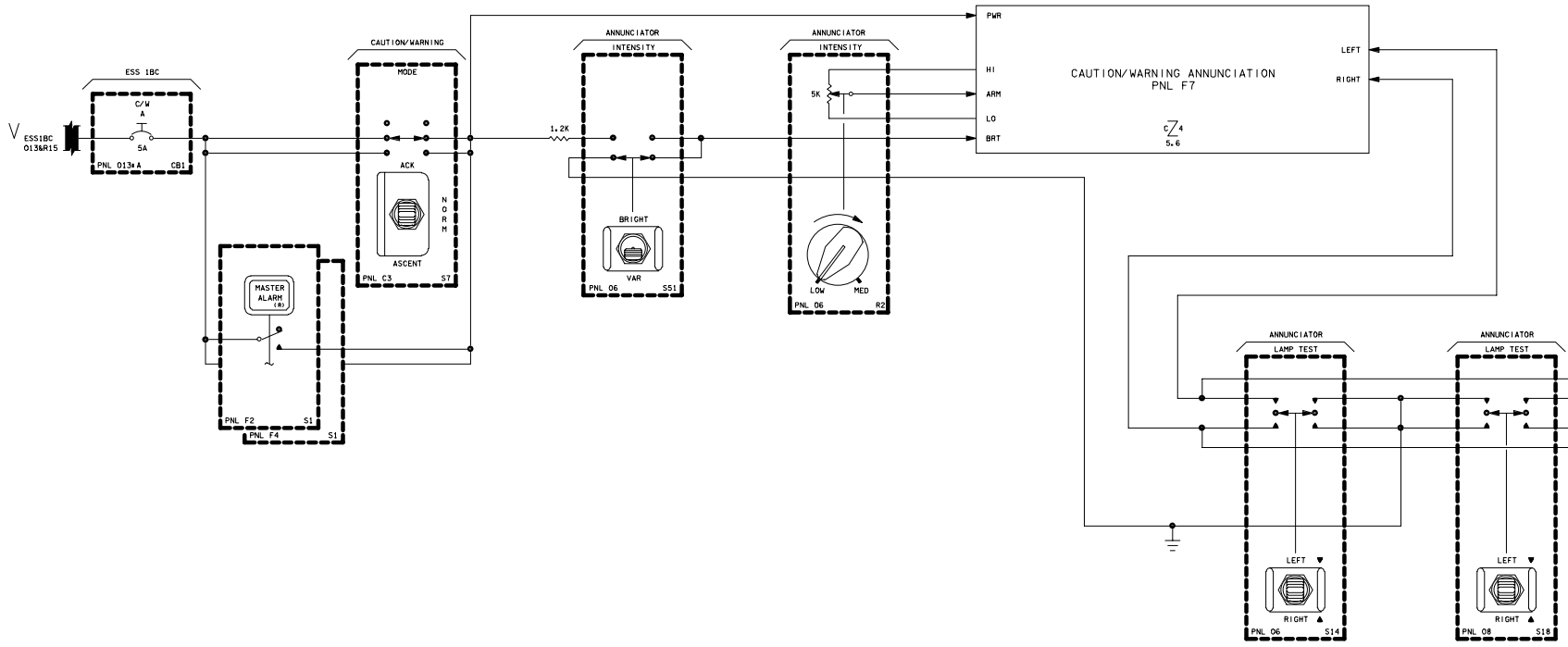


Figure 4-3. Annunciator light matrix



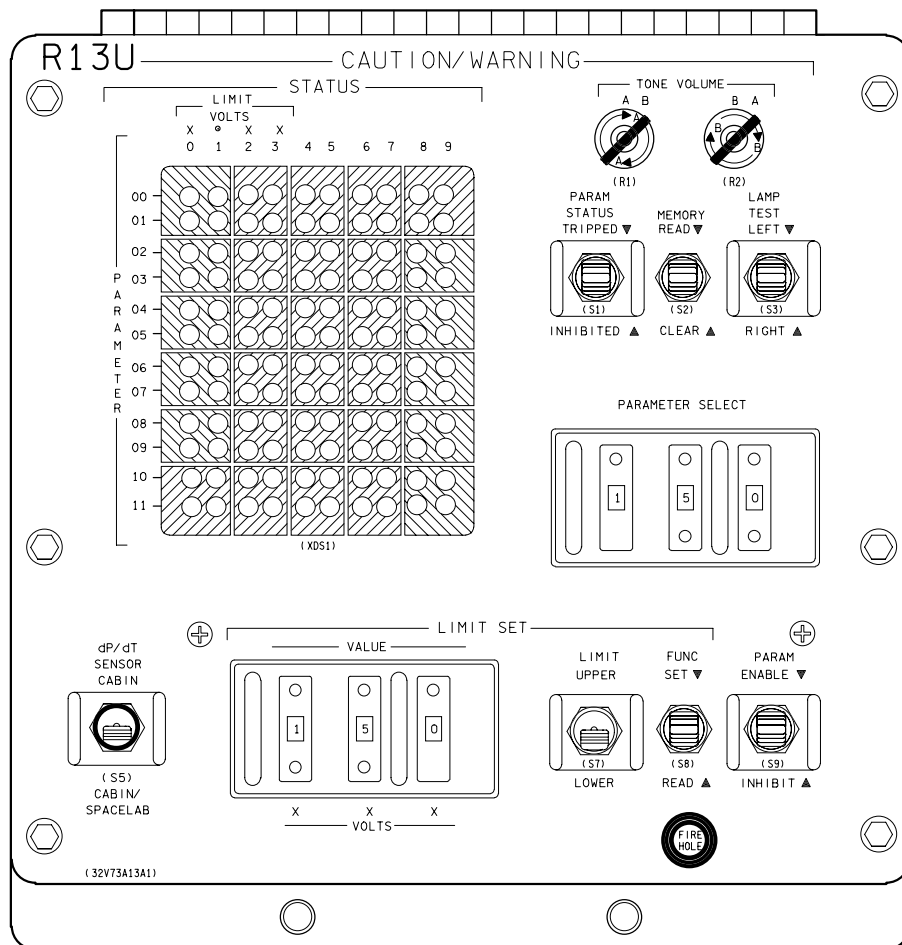
TD4020404.SCH.1

Figure 4-4. Annunciator light schematic

Panel R13U

Panel R13U is the crew interface with the Primary C&W system. Controls on this panel allow the crew to verify and change Primary C&W limits, inhibit and enable Primary C&W parameters, check the tripped or inhibited status of Primary C&W parameters, and access the Primary C&W memory (Figure 4-5).

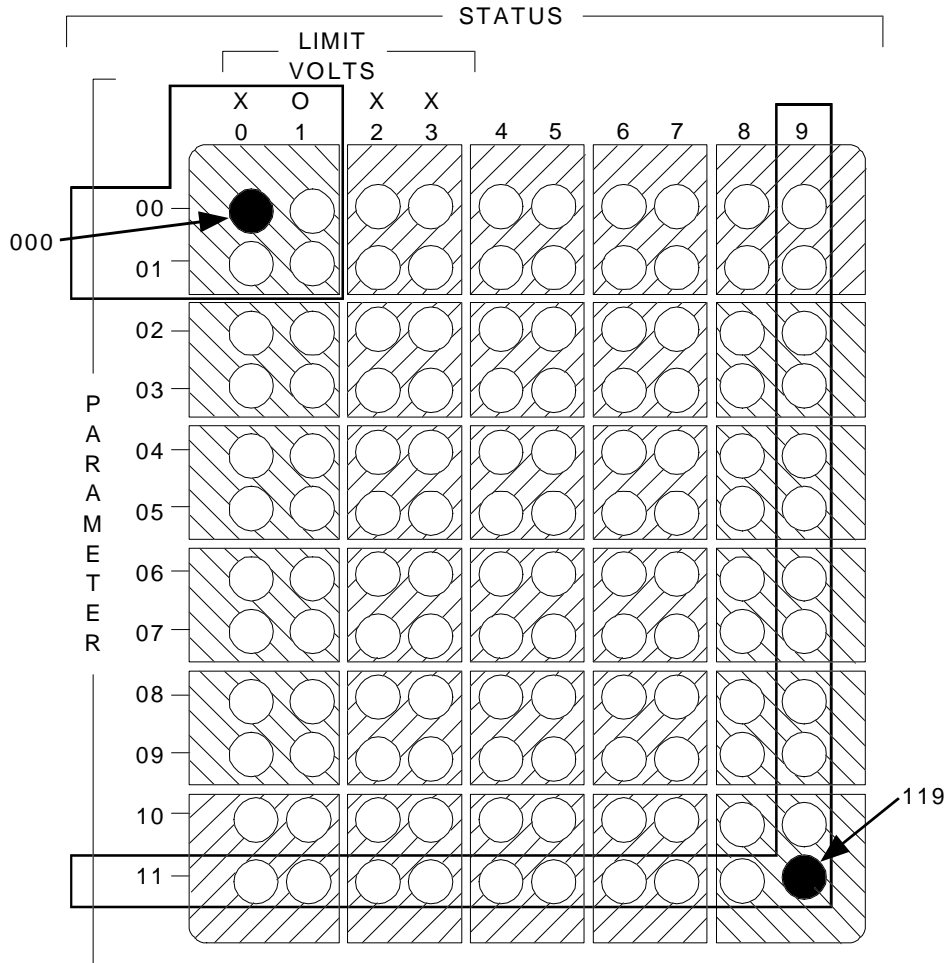
Starting at the upper right-hand corner of panel R13U, there are two TONE VOLUME control potentiometers. When turned clockwise, the potentiometer increases the volume of the siren, Klaxon, C&W tone, and Alert tone. There is one potentiometer for each of the two tone generators. Audio annunciation control is discussed further in Section 9.



TD4020405, PNL 1

Figure 4-5. Panel R13U

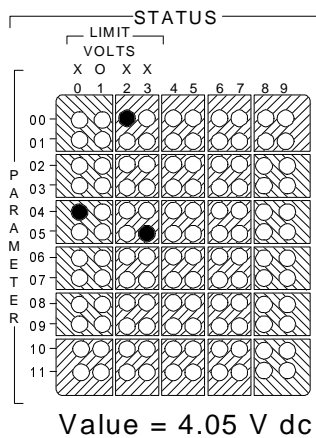
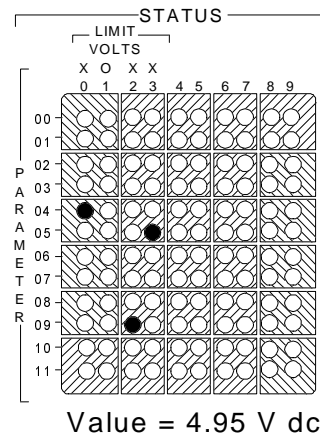
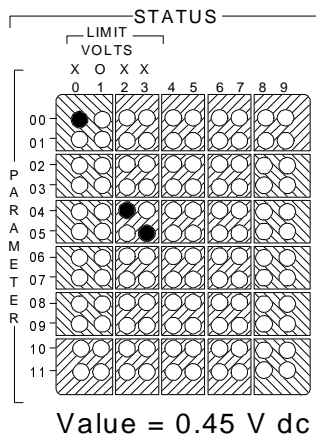
To the left of these controls is the STATUS light matrix. This matrix is used to check the status of a parameter and also to check the limits for a particular parameter. When used to check the status of parameters, the numbers down the left side are read first to obtain the first two numbers of the parameter (row), then the number on the top is read to obtain the third number of the parameter (column). The matrix has the capability to display all the 120 parameters available to the Primary C&W system. The 120 parameters are numbered from 000 to 119 (Figure 4-6).



td402_011.cv5

Figure 4-6. STATUS matrix

The STATUS light matrix also is used to read limits (Figure 4-7). Because the 120 parameters measure different things such as temperature, pressure, and flow rates, it is necessary to have one engineering measurement that can be used for all the parameters. Previous programs have used transducers with signals from 0 to 5 V dc; therefore, the voltage was chosen with a range of 0 to 5 V dc. Because of this, all 120 hardware (primary) parameters have their limits in voltage, even though the parameter being measured may not be voltage. The Reference Data Book, which is discussed in Section 7, is used to convert voltage to the appropriate engineering unit or to convert an engineering unit to voltage; for example, voltage to pressure or pressure to voltage. The key at the top of the matrix shows how the first four columns of the parameter status light matrix are used to read the voltage for a particular limit. The second column is always blank when reading limits; it is the decimal place of X.XX volts.



td402_012.cv5

Figure 4-7. Limit values

The LAMP TEST switch is used to test the continuity of the 120 lamps on the STATUS light matrix. The left position illuminates the left 60 lamps, and the right position illuminates the right 60 lamps.

The MEMORY test switch accesses the C&W memory. When placed in the READ position, the parameters that have gone out of limits since the last time the memory was cleared and the parameters that are presently out of limits will be illuminated on the STATUS light matrix. When the switch is taken to the CLEAR position, the C&W memory is cleared and the only parameters that remain in the memory are the ones that are presently out of limits. Because this switch position (CLEAR) does not give any indication that the action has been performed, a prudent course of action is to take the switch to the READ position to verify that the C&W memory was cleared.

The parameter (PARAM) STATUS switch, when taken to the TRIPPED position, illuminates on the light matrix those parameters that are presently tripped. The INHIBITED position illuminates those parameters that are presently inhibited.

The PARAMETER SELECT thumbwheels (pushbuttons) are used to select the number of the desired parameter. This parameter will then be affected by the PARAM and LIMIT SET switches.

The PARAM switch, when moved to the INHIBIT position, inhibits the selected parameter. The ENABLE position enables the selected parameter if it was previously inhibited.

The LIMIT SET switches work together either to read or to set a limit of the selected parameter.

The VALUE thumbwheels (pushbuttons) are used for entering the value, in volts, for the limit of the selected parameter. The valid voltage range is 0.00 to 5.00 in increments of 0.05.

The LIMIT switch is used to choose either the upper or the lower limit for a selected parameter.

When placed in the READ position, the function (FUNC) switch displays on the STATUS light matrix the voltage value of the selected limit for the selected parameter. The SET position sets the selected limit for the selected parameter to the voltage value that is entered on the VALUE thumbwheels (pushbuttons). Because the set position does not illuminate the value on the STATUS light matrix, it is prudent to verify that the desired value has been entered by moving the switch to the READ position after setting a limit.

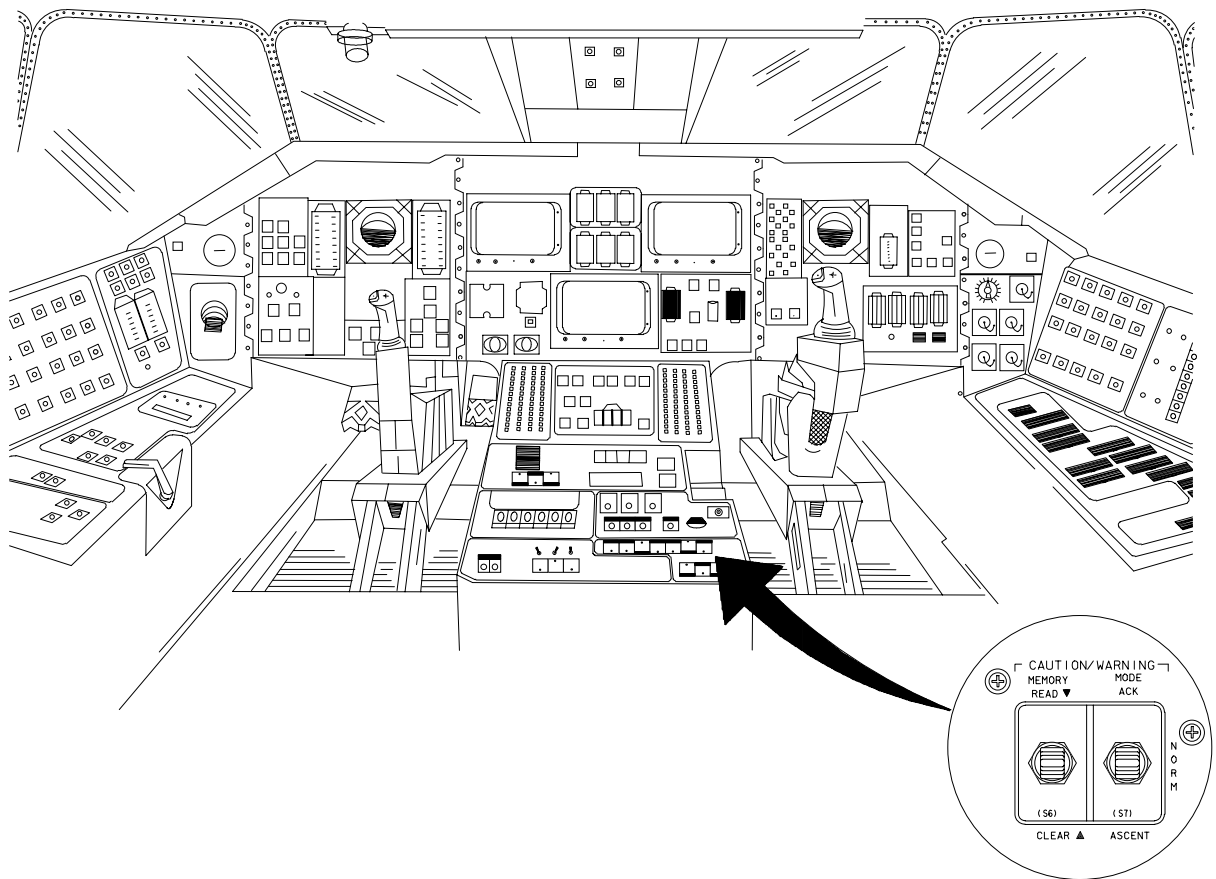
When not in use, the PARAMETER SELECT thumbwheels (pushbuttons) should be left at a value higher than 119 to prevent inadvertent inhibits, enables, and limit changes.

When setting either the PARAMETER SELECT number or the LIMIT SET VALUE (or any similar pushbuttons on the shuttle), care should be taken to avoid pushing the increment and decrement pushbuttons at the same time. Pressing both simultaneously may jam the mechanism. It may be possible to correct a jam by pulling out on the pushbuttons, but the prudent action is to take care to avoid a jam in the first place.

Additionally, one should not change the direction (increment to decrement or vice versa) too quickly because the previous pushbutton may be sticking a little. If (when changing direction) the pushbutton will not go in, pull out on the other pushbutton then try again.

Panel C3

The MEMORY switch located on panel C3 (Figure 4-8) accesses the same memory and operates the same as the MEMORY switch on panel R13U. The clear position clears the C&W memory, just as the MEMORY switch on panel R13U does. However, the READ position illuminates the parameters on the panel F7 annunciator matrix, not the R13U parameter status light matrix. The lights that are illuminated on panel F7 are the parameters that are presently tripped and the parameters that have been tripped since the last time the memory was cleared.



TD4020410, PNL 1

Figure 4-8. MEMORY switch on panel C3

The MODE switch has three positions. This allows the crew to select various modes of annunciation for the C&W system. The positions are Acknowledge (ACK), Normal (NORM), and ASCENT. The MODE switch is usually placed in the NORM position throughout the entire flight.

The normal position allows for all normal annunciation of the C&W system.

The acknowledge position removes power from the panel F7 C&W annunciator light matrix, thereby preventing the lights from illuminating when an alarm is issued. The lights are illuminated by pressing and holding the MA pbi on either panel F2 (CDR) or F4 (PLT). This action applies power to the panel F7 C&W light matrix by way of the MA pbi. This position is used when the crew does not want the annunciator lights to suddenly come on, possibly distracting them or causing excessive glare. For example, this position can be used for night landings.

The ASCENT position removes power to the bulbs in the MA pbi on panel F2 (CDR); however, the switch still functions properly when depressed. The ASCENT position was intended to keep the commander (CDR) from confusing the MA light with the abort light when the abort light was located next to the MA pbi on panel F2. The abort light is now located on panel F6, so this is no longer a concern and the ASCENT position is not used.

Primary C&W Alarm Annunciations

When a primary C&W parameter violates either its upper limit or lower limit, a primary C&W alarm will be issued if the parameter is enabled. The normal annunciations received when a Primary C&W alarm is issued are

- Aural
 - C&W tone - This is an alternating signal of 400 Hz and 1024 Hz at a 2.5-Hz rate (400 Hz for 0.4 seconds then 1024 Hz for 0.4 sec). The same tone is generated for Backup C&W alarms. The C&W tone can be silenced by depressing an MA pbi.
- Visual
 - Lamp illuminated on the panel F7 annunciator matrix. This light corresponds to the parameter that is out of limits. (The BACKUP C/W ALARM lamp will not be lit for this purpose.)
 - MA pbi's illuminated on panels MO52J, A7, F4, and F2.
 - Lamp illuminated on panel R13U PARAMETER STATUS light matrix when the STATUS switch is in the TRIPPED position.

Refer to Figure 2-2 for the locations of the C&W interfaces.

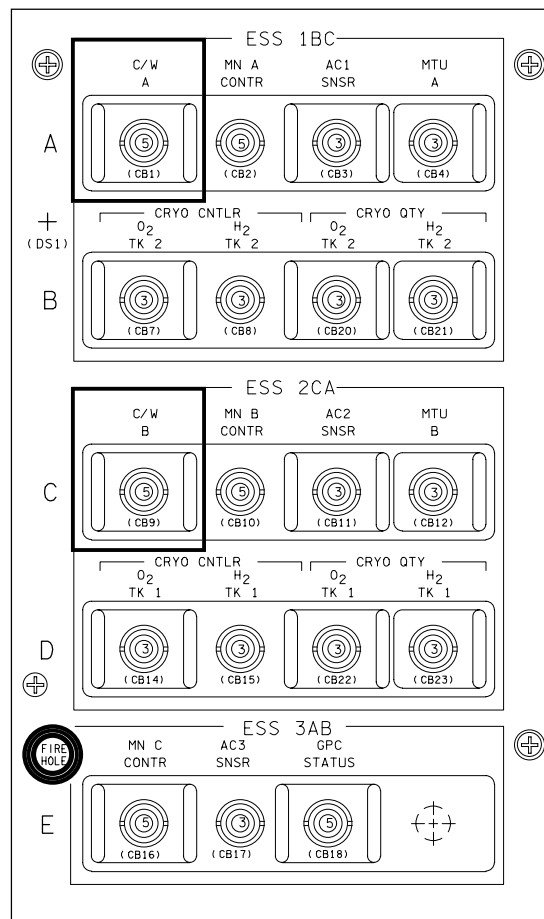
Power Supply

The Primary C&W system receives power from two power supplies. They are power supply A (from cb powered by Essential (ESS) bus 1BC on panel O13) and power supply B (from cb powered by ESS 2CA on panel O13). These power supplies give power to all logic memory circuits in addition to the status display panel (R13) for power supply A and tones for each power supply. (See Figure 4-9 and Section 9, Audio Annunciation Control.)

A loss of power supply A causes the loss of primary C&W. All lights will illuminate on panel F7 except for the backup C&W light. It also causes a loss of panel R13 status lights and function; siren for “A” smoke detectors, C&W MEMORY READ switch, two of four bulbs of the MA light (except for lamp test); primary C&W limit sensing; and tones to the middeck.

A loss of power supply B causes the B/U C&W light on panel F7 to come on in addition to the primary C&W light. It also causes a loss of the siren for the “B” smoke detectors, two of four bulbs of the MA lights (except during a lamp test), and sleep station headset tones.

— PNL 013 —



TD4030013, PNL 2

Figure 4-9. Panel O13

The effects of loss of power from the ESS buses to the power supplies versus a failure of the power supply are similar, except that power is removed from the annunciator lights on panel F7 for ESS 1BC loss. With this failure, the entire F7 light matrix is unpowered.

If either the power to the A power supply (ESS 1BC) or power supply A is lost and then regained, some out-of-limits conditions may occur. This is because parameters that were inhibited become enabled, and any parameter whose limits have been changed default back to PROM values (reference SSSH, Table 5-1).

If a power supply fails, an In-Flight Maintenance (IFM) procedure is available to regain the loss or restore C&W system redundancy to recognize the loss of the associated ESS bus of the remaining C&W system (see IFM C/L, C&W Electronics Unit Contingency Power).

C/W POWER SUPPLY FAILURE	
PRIMARY C/W light ON plus:	
<u>SYS A PWR SPLY</u>	<u>SYS B PWR SPLY</u>
All F7 annun lts ON except BACKUP C/W lt	BACKUP C/W light ON (no reset)
Loss of:	Loss of:
C/W status pnl lts and function (R13U)	Smoke detection
Smoke detection	Siren test CKT B
Siren test CKT A	Upper bulbs Master
C/W memory read	Alarm light except for lamp test
Lower bulbs Master Alarm light except for lamp test	Sleep station headset tones
Primary C/W limit sensing	
ACCU Bypass tones to MIDDK SMU	

Figure 4-10. C&W power supply loss matrix

Self-Test

Eight self-test parameters are numbered 120 through 127 and cannot be accessed or have their limits changed by crewmembers.

The self-test parameters have upper and lower limits that are “out of limits.” Their output from the timing unit is inhibited to the primary caution working trigger so that there is not an MA every time a parameter is checked.

Parameter numbers 120 through 123 are low limit tested, while 124 through 127 are high limit tested (set by the PROM). When a parameter fails the self-test, a PRI C&W light is annunciated on panel F7, and you get an MA light and C&W tone. Many things can cause a self-test fail; for

example, a timing unit failure, a limit shift such that the logic thinks that the upper limit and lower limit values are within limits (limit shift), or a power failure.

The self-test parameters are just a way of making sure that limits are always being read properly.

Backup C&W

System Description

The B/U C&W system is a software system. Software contained in the General Purpose Computers (GPCs) monitors parameters, detects out-of-limits conditions, and initiates B/U C&W annunciation.

Only those C&W alarms that are produced by Fault Detection and Annunciation (FDA) have limits that can be changed and displayed in engineering units; these limits are accessed through the SM TABLE MAINTENANCE display. The remaining Backup C&W alarms that are produced by the GNC software are accessed through GPC Memory Read/Write procedures. The Backup C&W alarm is operated by the Primary C&W system but triggered by the GPCs through FF MDMs. The Fault Messages produced by the SM Backup C&W program are found in the FDF REF DATA book. SPEC 60 does not exist in the Backup Flight Software (BFS). Backup C&W parameters in the BFS are also accessed by a Memory Read/Write.

The B/U C&W system is sometimes referred to as the Software (S/W) C&W system.

B/U C&W and Alert Software Support

The B/U C&W system and the Alert system are supported by the Systems Management (SM) and Guidance, Navigation, and Control (GNC) major functions of both the PASS and the BFS software. All orbiter software except the payload major function is included.

The Data Processing System (DPS) software that is used by the GPCs consists of these two systems.

Primary Avionics Software System. The PASS has the following three types of applications software, called major functions.

1. SM - This major function is active on orbit. The software module within SM that monitors parameters and initiates alarms is called Fault Detection and Annunciation (FDA).
2. GNC - This major function is active during all flight phases. When GNC software detects an out-of-limits condition, a signal is sent to the Guidance, Navigation, And Control Annunciation Interface (GAX). The GAX software determines the appropriate response and initiates an alarm, if required.
3. Payload (PL) - This major function does not contain alarm annunciation software.

Backup Flight Software. The BFS contains both GNC and SM major functions. The BFS is normally used only during ascent and entry.

When the BFS is in RUN, the BFS alarm annunciation depends on the BFS engage status.

- Preengaged = SM C&W, SM Alerts
- Engaged = SM C&W, SM Alerts, GNC C&W, GNC Alerts

When the BFS is in STANDBY, alarm annunciation consists of only CRT fault messages and status indicators. No lights or tones are annunciated because the BFS does not have control of the payload buses in STANDBY.

Crew and Mission Control Center (MCC) Software Interface.

- PASS SM parameters - SPEC 60, SM Table Maintenance (Section 8 - SPEC 60), provides a crew interface with the PASS SM parameters so that their limits, noise filter value, and enable/inhibit status may be read or changed. MCC may also make these changes through an uplinked TMBU (Section 8). Information about these parameters and the procedures for using SPEC 60 are located in the FDF Reference Data Book and in the SM Flight Software Requirements (FSR) document.
- PASS GNC, BFS GNC, and BFS SM parameters - To change the way these parameters are monitored, a memory read/write procedure must be performed by the crew or uplinked from MCC. The Display and Control (D&C) FSR contains information about these parameters.

Further information about the DPS, DPS software, and memory read/write procedures can be found in the Crew Software Interface (CSI) 2102, DPS OV 2102, DPS PRINC 2102, and DPS Hardware/Software 2102 training manuals.

Requirements for B/U C&W Annunciation

Limits

Each B/U C&W parameter has either an upper limit, a lower limit, or both. For each parameter, the GPC software compares the present value with the limit set. If either the upper or lower limit is violated, the parameter is out of limits.

For parameters that are monitored by both B/U C&W and Primary C&W, the limits for each system are set at the same value (Flight Rule 9.1.4-10). This will result in simultaneous Primary and B/U C&W annunciation for these parameters.

The preflight limits for all SM parameters and a few GNC parameters are contained in the C&W section of the Reference Data Book, which is carried onboard the orbiter as part of the FDF (see Section 7 of this training manual).

Noise Filter Value

For an alarm to be annunciated, the parameter must be out of limits for a certain number of consecutive samples. This number, “n,” is the parameter noise filter value. It has a range of 1 through 15. A parameter cannot annunciate a subsequent alarm until it has been back within limits for at least “n” consecutive samples and once again out of limits for “n” consecutive samples.

A noise filter value of greater than 1 provides a certain amount of false alarm avoidance by reducing the possibility of nuisance alarms caused by a transient signal or a signal that is fluctuating around a limit value.

Thus, by altering the noise filter value, it is possible to control how quickly an out-of-limits condition will be annunciated to the crew. The smaller the noise filter value, the sooner the crew alert. However, the smaller the noise filter value, the greater the potential for nuisance annunciation. *The B/U C&W noise filter value is typically set at 2 to provide rapid annunciation of Class 2 B/U C&W alarms. (Alert values are typically 15, 7, or 2.) All BFS parameters have a noise filter value of 2.*

Typical SM GPC data acquisition rates for FDA parameters are 1.04 Hz (essentially once a second) and 0.52 Hz (essentially once every other second). *Most B/U C&W parameters have GPC acquisition rates of 1.04. (Values of either 1.04 or 0.52 are typical for Alert parameters.)*

Example 1. A parameter is sampled once every second (1.04 Hz) and has a filter value of 2. It must be out of limits for 2 seconds before annunciating an alarm. It would then have to be back within limits for at least 2 seconds and out of limits again for 2 seconds before a subsequent alarm would be annunciated for the parameter. *(This is typical for B/U C&W parameters.)*

Example 2. A parameter is sampled once every 2 seconds (0.52 Hz) and has a filter value of 15. It must be out of limits for 30 seconds before annunciating an alarm. It would then have to be back within limits for at least 30 seconds and out of limits again for 30 seconds before a subsequent alarm would be annunciated for the parameter. *(This is common for Alert parameters.)*

Noise filter values and GPC data acquisition rates are specified in the SM FSR and are not carried onboard the shuttle.

B/U C&W Parameter Annunciation Enable/Inhibit Status

For each parameter, alarm annunciation is either enabled or inhibited. A parameter must be enabled in order for annunciation to occur. An inhibited parameter that goes out of limits does not generate B/U C&W annunciation. The Class 0 Limit Sensing remains active for inhibited parameters.

B/U C&W Annunciation

Annunciation occurs when an enabled parameter that is out of limits has satisfied its noise filter value requirement. Regardless of the type of software that initiated the alarm, B/U C&W annunciation consists of the following indications (Figure 2-2, Figure 4-11, and Figure 4-12):

- Aural

Generation of the C&W tone - *This is an alternating signal of 400 Hz and 1024 Hz at a 2.5-Hz rate (400 Hz for 0.4 seconds then 1024 Hz for 0.4 seconds). The same tone is generated for primary C&W alarms.*

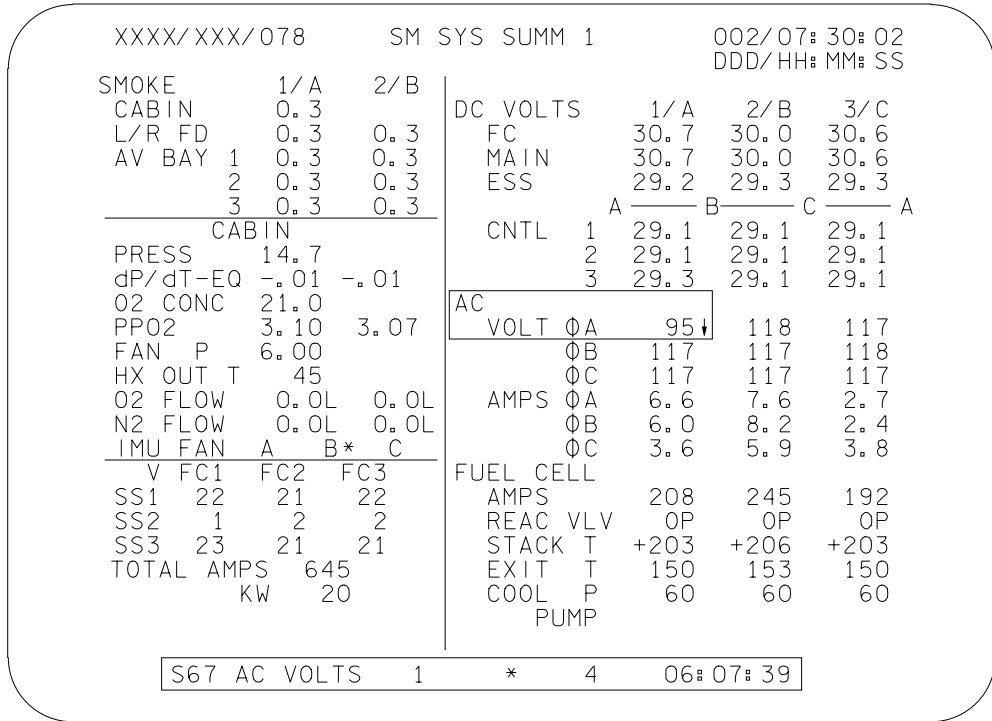
- Visual

- Illumination of the red MA lights on panels MO52J, A7, F4, F2 (Figure 2-2).
- Illumination of the red BACKUP C/W ALARM light in the lower left corner of the panel F7 C&W annunciator matrix (Figure 4-12).
- Display of the appropriate fault message on
 - CRT fault message line (Figure 4-11) - If the fault message line already contains a message, the queue number at the right of the message is incremented.
 - Fault summary (SPEC 99) - Maintains a chronological record of fault messages (Section 9, Fault Summary).

Note: The fault messages are defined in the Fault Message section of the FDF Reference Data Book (see Section 7 of this training manual).

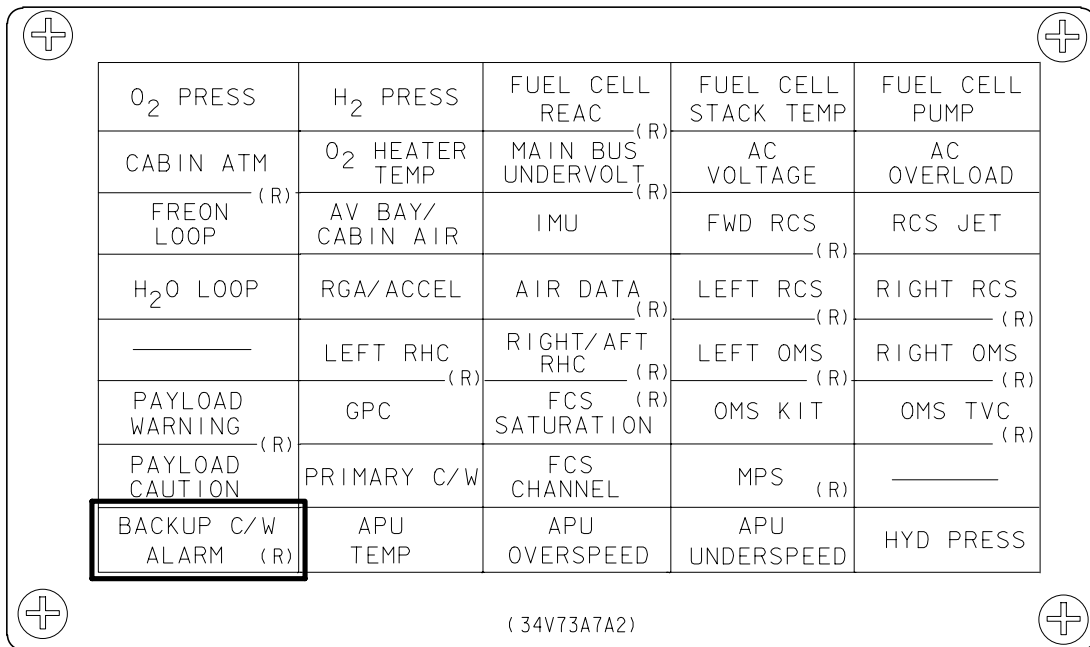
- An up or down arrow, which is generated by Class 0 Limit Sensing, is displayed beside the parameter on each SPEC that contains the parameter (Figure 4-11) (Section 6, Class 0). If a parameter is concurrently monitored by the B/U C&W and Alert systems, the Class 0 limit sensing arrows appear when the Alert limits are violated.

The C&W tone, the MA lights, and the BACKUP C/W ALARM light are generated by the primary C&W electronics unit but are driven by a discrete from the B/U C&W system.



TD4020410. CRT: 3

Figure 4-11. B/U C&W fault message example



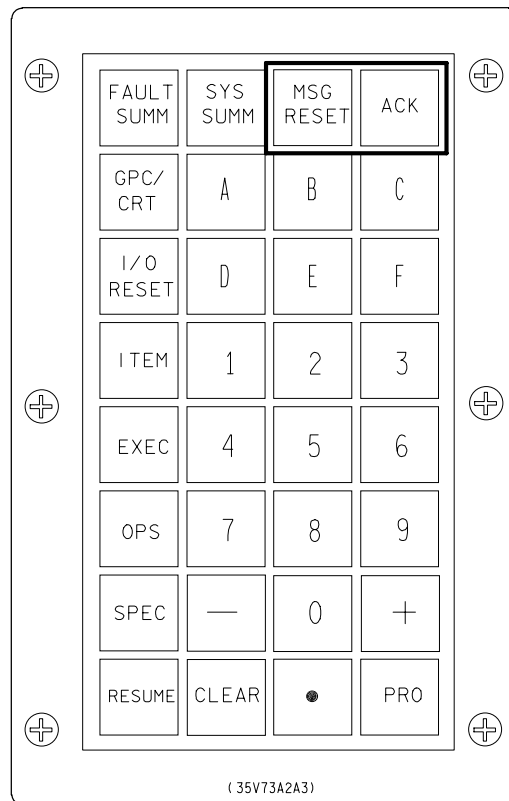
TD4020414. PNL: 2

Figure 4-12. BACKUP C/W ALARM light

Crew Response to B/U C&W Annunciation

The crew response to a B/U C&W alarm may include the following actions:

- Depress the MASTER ALARM pbi - This extinguishes the MA light and silences the C&W tone.
- Depress the ACK key on the keypad (Figure 4-13) - Fault message stops flashing and becomes stationary. This stop is unnecessary if the crewmember can examine the message while it is flashing.
- Read fault message on fault message line of CRT - If subsequent messages have occurred, as noted by a queue number on the CRT, look at the fault summary display (Section 9) or scroll through them using the ACK key.
- Depress the MSG RESET key on the keypad (Figure 4-13) - This clears the fault message line and extinguishes the BACKUP C/W ALARM light on panel F7. (The light is extinguished regardless of the status of the parameter that caused the annunciation. This differs from the Primary C&W panel F7 systems lights that remain lit until the parameter is either within limits or inhibited.)
- Consult appropriate FDF procedure for actions to be performed.



TD4020415, PNL 2

Figure 4-13. Keypad

Questions

Answer the following questions by either filling in the blank or selecting the appropriate answer.

1. The Primary C&W system is Class _____; the B/U C&W system is Class _____.
2. True or false. Both Primary C&W and B/U C&W are software systems.
3. True or false. Both PASS and BFS support B/U C&W.
4. Which of the following major functions support B/U C&W?
 - a. GNC
 - b. SM
 - c. Both GNC and SM
5. True or false. Flight rules do not require that the B/U C&W and Primary C&W limits be the same.
6. Limits for the following systems are in which units?

____ Primary C&W	a. Volts dc
	b. Engineering units
____ B/U C&W	c. Imaginary units
7. Preflight limit values are available to the crew in the _____ section of the FDF _____ Book.
8. The R13 C/W panel allows the crewmember to interact with the _____ system(s).
 - a. Primary C&W
 - b. B/U C&W
 - c. a and b
9. Panel RI 3 is used to _____ for the Primary C&W system.
 - a. Read and change parameter limits
 - b. Enable and inhibit parameters
 - c. Change parameter filter values
 - d. a and b
 - e. a, b, and c

10. The panel R13 light matrix is used to
- a. Determine which parameters are tripped
 - b. Determine which parameters are inhibited
 - c. Read the upper or lower limit of a parameter
 - d. a and b
 - e. a, b, and c
11. True or false. The panel R13 and panel C3 MEMORY switches access the same C&W memory.
12. The panel F7 annunciator matrix contains
- a. Primary C&W system lights
 - b. The BACKUP C/W ALARM light
 - c. a and b
13. The fault summary maintains a record of _____ fault messages
- a. Primary C&W
 - b. B/U C&W
 - c. a and b

14. C&W annunciation - Place an "X" in the appropriate positions to indicate the annunciation for the enabled and inhibited states of both Primary and B/U C&W.

	Primary C&W		Backup C&W	
	Enabled	Inhibited	Enabled	Inhibited
MA lights illuminated				
Panel F7 BACKUP C/W ALARM light illuminated				
Panel F7 system light illuminated				
Panel R13 status light illuminated while the PAFTAM STATUS switch is in the TRIPPED position				
Panel R13 status light illuminated while the PARAM STATUS switch is in the INHIBITED position				
C&W tone				
Fault message on CRT				
Class 0 Limit Sensing up and down arrows on CRT displays				

15. Crew response to annunciation - Place an "X" in the appropriate positions to indicate the crew response to the various types of Primary and B/U C&W annunciation.

	Press MA bi	Press ACK	Press MSG RESET	Not possible by any of these actions
Extinguish MA lights				
Extinguish panel F7 BACKUP C/W ALARM light				
Extinguish panel F7 system lights				
Extinguish panel R13 parameter light				
Make CRT fault message stationary				
Erase CRT fault message				
Interrupt C&W tone				

Answers

1. The Primary C&W system is Class 2; the B/U C&W system is Class 2.
2. False. Primary C&W is a hardware system.
3. True. Both PASS and BFS support B/U C&W.
4. c. Both GNC and SM support SIU C&W.
5. False. Flight rules do require that the B/U C&W and Primary C&W limits be the same.
6. a and b. For the Primary C&W system, the limits are designated in volts dc. For the B/U C&W system, the limits are in engineering units.
7. Preflight limit values are available to the crew in the C&W section of the FDF Reference Data Book.
8. a. The R13 C/W panel allows the crewmember to interact with the Primary C&W system.
9. d. Panel R13 is used to read and change parameter limits and enable and inhibit parameters for the Primary C&W system.
10. e. The panel R13 light matrix is used to determine which parameters are tripped, determine which parameters are inhibited, and read the upper or lower limit of a parameter.
11. True. The panel R13 and panel C3 MEMORY switches access the same C&W memory.
12. c. The panel F7 annunciator matrix contains Primary C&W system lights and the BACKUP C/W ALARM light.
13. b. The fault summary maintains a record of B/U C&W fault messages.

14. C&W annunciation.

	Primary C&W		Backup C&W	
	Enabled	Inhibited	Enabled	Inhibited
MA lights illuminated	X		X	
Panel F7 BACKUP C/W ALARM light illuminated			X	
Panel F7 system light Illuminated	X			
Panel R13 status light illuminated while the PAFTAM STATUS switch is in the TRIPPED position	X			
Panel R13 status light illuminated while the PARAM STATUS switch is in the INHIBITED position		X		
C&W tone	X		X	
Fault message on CRT			X	
Class 0 Limit Sensing up and down arrows on CRT displays			X	X

15. Crew response to annunciation.

	Press MA bi	Press ACK	Press MSG RESET	Not possible by any of these actions
Extinguish MA lights	X			
Extinguish panel F7 BACKUP C/W ALARM light			X	
Extinguish panel F7 system lights				X
Extinguish panel R13 parameter light				X
Make CRT fault message stationary		X		
Erase CRT fault message			X	
Interrupt C&W tone	X			

Section 5

Class 3 Alert

Objectives

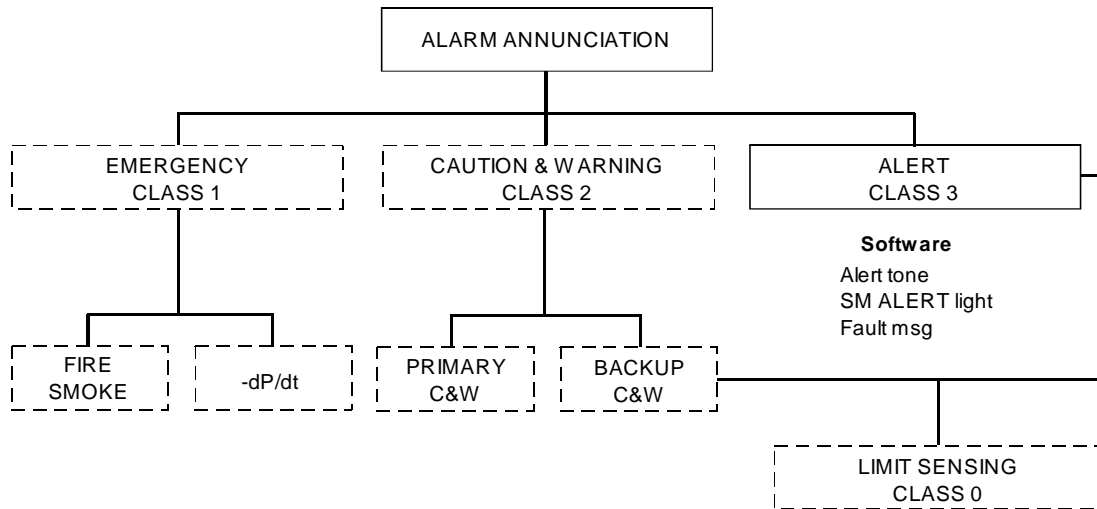
After reading this section, the student should be able to

- Specify which software supports Alerts
- State the aural and visual indications of Alert annunciation
- Describe the crew response to Alert annunciation
- Explain the purpose of
 - Upper and lower limits
 - Enable/inhibit status
 - Noise filter value
 - Preconditioning
- Correctly answer the questions at the end of the section

System Description

The Alert system is a software system (Figure 5-1). Software contained in the GPC monitors parameters, detects out-of-limits conditions, and initiates Alert annunciation.

The Alert system monitors parameters associated with many orbiter systems. Some of the parameters also are monitored by the C&W system. When a parameter is monitored by both systems, the Alert limits tend to be tighter than the C&W limits.



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Figure 5-1. Class 3 Alert diagram

Alert Software Support

The Alert system is supported by the same software as the B/U C&W system. This includes the SM and GNC major functions of both the PASS and the BFS software. Refer to Section 4, B/U C&W and Alert Software Support, for details about the Alert software support.

SPEC 60, SM Table Maintenance (Section 8, SPEC 60), provides a crew interface with the PASS SM parameters so that their limits, noise filter values, and annunciation enable/inhibit status may be read or changed. To change the way a PASS GNC or a BFS parameter is monitored, a memory read/write procedure must be performed (see the DPS Hardware/Software 2102 Training Manual for details).

Requirements for Alert Annunciation

Limits

Each Alert parameter has either one, two, or three sets of limits. Each set of limits may consist of an upper limit, a lower limit, or both. The GPCs sample the present value of each parameter and compare it to the parameter limits to determine whether an upper or lower limit is violated.

The C&W section of the FDF Reference Data Book contains the preflight limits for all SM parameters and a few GNC parameters (see Section 7 of this training manual).

Preconditioning

Even though Alert parameters may have two or three sets of limits, only one of the sets is active at any one time. Alert parameters with two or three sets of limits have precondition steering, or preconditioning, which is used to determine the set of limits that is active.

Each set of limits has a corresponding set of conditions. The GPC software determines which set of conditions is satisfied and selects the respective set of limits. This selection is typically based on the operating level or the switch configuration of an orbiter system. The H₂O loop 2 pump out pressure parameter provides an example of preconditioning that is based on system configuration (Figure 5-2). The limits vary depending on whether the pump is on (will detect a failed pump) or off (will detect a leak). The fuel cell stack temperature preconditioning is based on the fuel cell operating level (Figure 5-2). Preconditions are listed in the FDF REF Data Book (Section 7 of this training manual).

Each limit set has a corresponding logic statement consisting of from one to four discretized or limit-sensed analogs. The logic statement defines the conditions for which the limit set is used. If no logic statement is satisfied, the first set of limits is selected as the default set. The preconditioning logic statements for Alerts generated by the SM major function are located in the SM FSR.

The crew cannot directly select which set of limits is active. If the crew alters the system configuration (turns on a pump, for example) or changes the system performance (decreases the loads on the fuel cell, thereby changing its power output, for example), the GPC may select a different limit set since a different precondition may be met. The crew or MCC can change the value of constants (Section 8, SPEC 60) that are used in the preconditioning process (for example, changing the values of the fuel cell output power associated with each limit set), but this is rarely done.

H₂O Loop 2 Pump Out Pressure

<u>Alert limits</u>		Precondition*
Low	High	
50.0	75.0	ON or GPC with “pump ON” command issued
20.0	None	OFF or GPC with “pump ON” command not present

*The precondition is loop 2 pump switch position (ON, OFF, or GPC).

Fuel Cell Stack Temp

<u>Alert limits</u>		Precondition*
Low	High	
180	212	<3.5 kW
190	222	3.5-7.5 kW
198	238	>7.5 kW

*The precondition is fuel cell power output.

Figure 5-2. Preconditioning

Some Alert parameters have a time delay which is invoked when the GPC software selects a new limit set. The time delay must expire before fault detection can occur. For example, a temperature parameter may have a time delay that will cause the software to wait a certain number of minutes (or seconds) after an associated heater is turned on. *The time delay values are listed in the SM FSR and are not carried onboard*

Noise Filter Value

The Alert noise filter provides false alarm avoidance in the same manner as the backup C&W noise filter. Refer to the noise filter value portion of Section 4, B/U C&W, for details regarding noise filter operation.

Typical values for the Alert noise filter are 15, 7, and 2. All BFS parameters have a noise filter value of 2. Alert parameters are sampled every second or every other second. It is common for Alert parameters to have a filter value of 15 and be sampled every 2 seconds. For such parameters, annunciation will occur no earlier than 30 seconds after the parameter initially violates a limit.

Alert Parameter Annunciation Enable/Inhibit Status

For each parameter, alarm annunciation is either enabled or inhibited. An enabled parameter which goes out of limits can annunciate an Alert; an inhibited parameter cannot. The Class 0 Limit Sensing remains active for inhibited parameters.

Alert Annunciation

Annunciation occurs when an enabled parameter that is out of limits has satisfied its noise filter value requirement. Alert annunciation consists of the following indications (regardless of the type of software which initiated the Alert):

- Aural

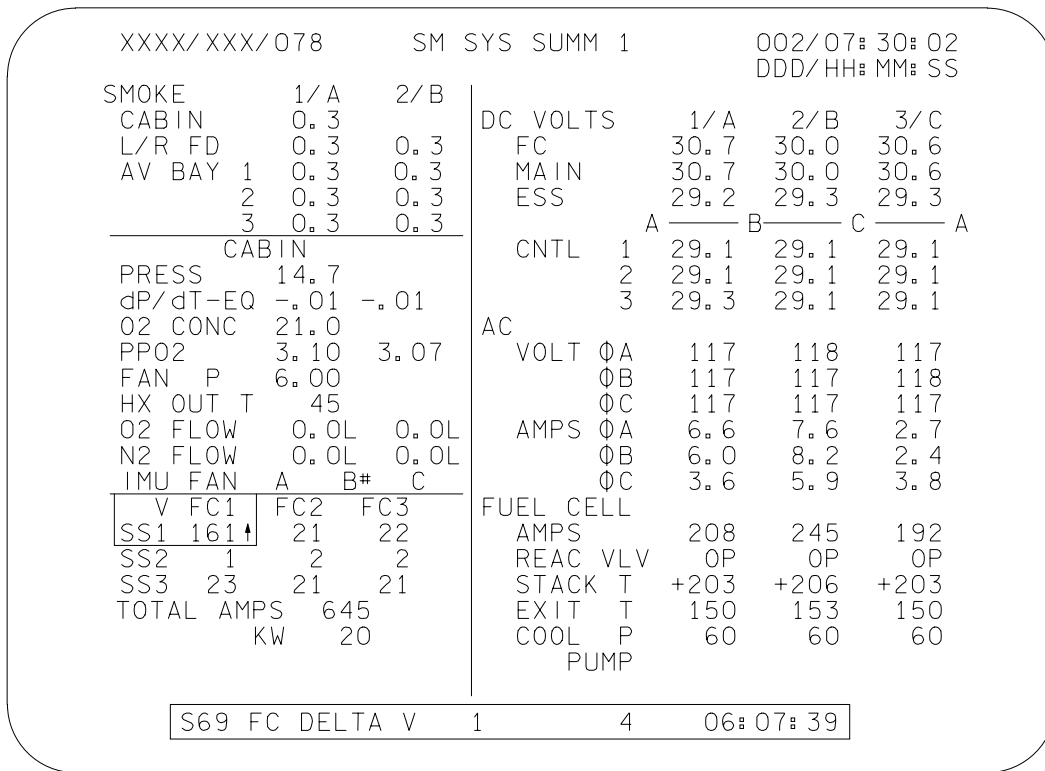
Generation of the Alert tone - *This is a continuous tone at 512 Hz. It is generated by the primary C&W electronics unit but is driven by a discrete from the Alert system.*

- Visual

- Illumination of the blue SM ALERT light on panel F7 (Figure2-2).
- Display of the appropriate fault message on
 - CRT fault message line (Figure 5-3) - If the fault message line already contains a message, the queue number at the right of the message is incremented.
 - Fault summary (SPEC 99) - Maintains a chronological record of fault messages (Section 9, Fault Summary).

Note: The fault messages are defined in the Fault Message section of the FDF Reference Data Book (Section 7 of this training manual).

- An up or down arrow, which is generated by Class 0 Limit Sensing, is displayed beside the parameter on each SPEC that contains the parameter (Figure 5-3) (Section 6, Class 0).



TD4020503. CRT: 3

Figure 5-3. Alert fault message example

The duration of the Alert tone is adjustable from 0 to 99 seconds. The crew can read and change the DURATION (item 23) on SM SPEC 2, TIME (Figure 5-4). A value of 1 is typical. Setting the duration to 0 will prevent the tone from annunciating (this is not typically done). The crew may change the duration presleep and postsleep to provide a longer tone during crew sleep periods. The tone is interruptible. If it is not interrupted, it will halt when the duration has been satisfied.

```

2011/002/          TIME          0

MISSION TIME          TONE
GMT 1                3  00=00=00 MSN T
MET 2X               6  00=00=00
CRT TIMER
9 SET [ ]00=00=00    20 [ ]00=00=00 CRT T
START 12 STOP 13
14 START AT 00=00=00 MSN T
17 COUNT TO 00=00=00 MSN T
23 DURATION  _1

-----
MTU
24 GMT [ ]000/00:00:00 000
28 MET [ ]000/00:00:00 000
UPDATE 32
MET RESET 33

-----
GPC TIME
MTU ACCUM 1 | GMT | TRY | GPC
2 | 187/23=29=01.000 | 34 | 1 A1
3 | 187/23=29=01.000 | 35 | 2 A1
GPC | 187/23=29=01.000 | 36 | 3
37 | 187/23=29=01.000 | 37 | 4 A1
5

TIME SYNC 38

```

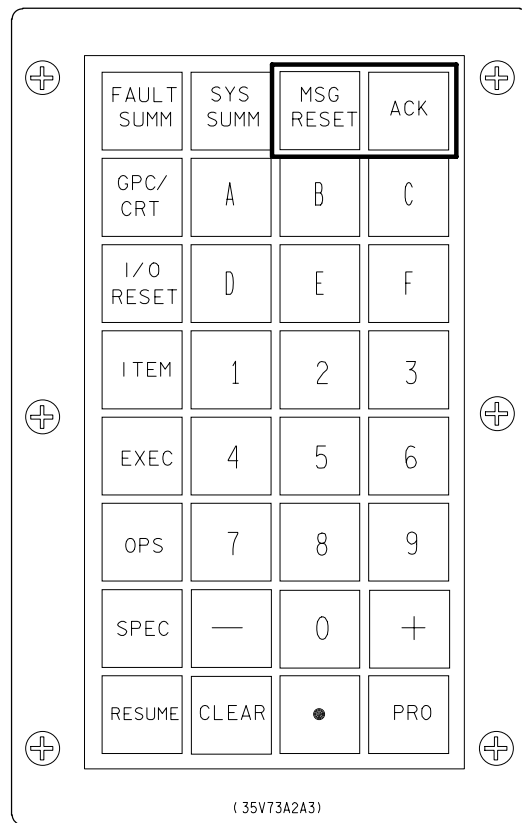
TD4020505. CRT 1

Figure 5-4. SPEC 2, TIME with Alert duration highlighted

Crew Response to Alerts

The crew response to an Alert may include the following actions:

- Optional: Depress the MASTER ALARM pbi - This interrupts the Alert tone if the duration has not already timed out.
- Depress the ACK key on the keypad (Figure 5-5) - Fault message stops flashing and becomes stationary. This also interrupts the Alert tone and extinguishes the blue SM ALERT light on panel F7. This step is unnecessary if the crewmember can examine the message while it is flashing and if the Alert tone duration has already timed out.
- Read fault message - If subsequent messages have occurred, as noted by a queue number on the CRT, look at the fault summary display (Section 9) or scroll through them using the ACK key.
- Depress the MSG RESET key on the keypad - This action clears the fault message line and extinguishes the blue SM ALERT light on panel F7. This also silences the Alert tone if the duration has not timed out.
- Consult the appropriate FDF procedure for actions to be performed.



TD4020520, PNL 1

Figure 5-5. Keypad

Questions

Answer the following questions by either filling in the blank or selecting the appropriate answer.

1. The Alert system is Class _____
2. True or false. Both PASS and BFS support Alerts.
3. Which of the following major functions support Alerts?
 - a. GNC
 - b. SM
 - c. Both GNC and SM
4. An Alert parameter may have up to _____ sets of limits.
5. Alert limits are in which of the following units?
 - a. V dc
 - b. Engineering units
6. The duration of the Alert tone may be adjusted by an item _____ entry on SPEC ____ .
7. True or false. When the Alert tone is activated and not interrupted, it will stop when it has timed out.
8. True or false. Alert parameters with one set of limits are preconditioned.
9. Preflight limit values are available to the crew in the _____ section of the _____ (FDF).

10. Alert annunciation - Place an “X” in the appropriate positions to indicate the annunciation for the enabled and inhibited states of Alerts.

	Alert	
	Enabled	Inhibited
SM ALERT light illuminated		
MA light illuminated		
Alert tone		
C&W tone		
Fault message on CRT		
Class 0 Limit Sensing (up and down arrows on CRT displays)		

11. Crew response to annunciation - Place an “X” in the appropriate positions to indicate the crew response to the various types of Alert annunciation.

	Press MA pbi	Press ACK	Press MSG RESET	Not possible by any of these actions
Extinguish SM Alert light				
Make CRT fault message stationary				
Erase CRT fault message				
Interrupt C&W tone				

*Alert tone will time out if no action is performed.

Answers

1. The Alert system is Class 3.
2. True. Both PASS and BFS support Alerts.
3. c. Both GNC and SM major functions support Alerts.
4. An Alert parameter may have up to three sets of limits.
5. b. Alert limits are in engineering units.
6. The duration of the Alert tone may be adjusted by an item 23 entry on SPEC 2.
7. True. When the Alert tone is activated and not interrupted, it will stop when it has timed out.
8. False. Alert parameters with two or three sets of limits are preconditioned.
9. Preflight limit values are available to the crew in the C&W section of the Reference Data Book.
10. Alert annunciation.

	Alert	
	Enabled	Inhibited
SM ALERT light illuminated	X	
MA light illuminated		
Alert tone	X	
C&W tone		
Fault message on CRT	X	
Class 0 Limit Sensing (up and down arrows on CRT displays)	X	X

11. Crew response to annunciation.

	Press MA pbi	Press ACK	Press MSG RESET	Not possible by any of these actions
Extinguish SM Alert light		X	X	
Make CRT fault message stationary		X		
Erase CRT fault message			X	
Interrupt C&W tone	X	X	X	

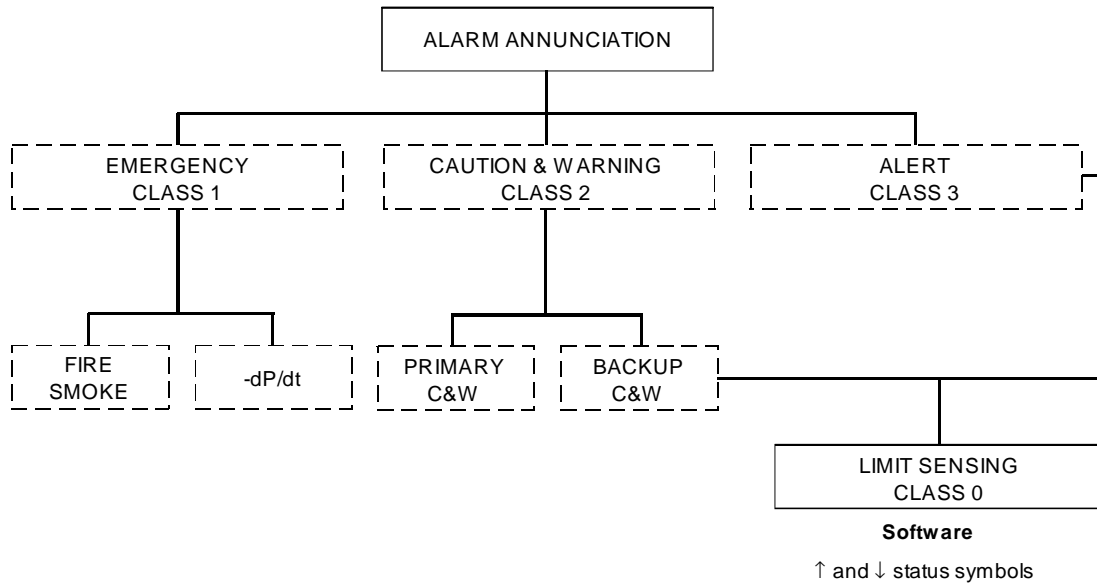
*Alert tone will time out if no one action is performed.

Section 6

Class 0 Limit Sensing

Objectives

After completing this section, the student should understand how limit sensing is annunciated and the interrelationship to the other software C&W systems (Figure 6-1).



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Figure 6-1. Class 0 Limit Sensing diagram

Introduction

Class 0 Limit Sensing is the least critical portion of the orbiter C&W system. It is a software system that, unlike the others, provides no aural annunciation, preconditioning, or special purpose limit-sensing capabilities. Its sole purpose is to provide crewmembers a quick way to identify out-of-limit parameters on often cluttered CRT displays. This is accomplished by displaying appropriate status symbols.

Status Symbols

The CSI training manual introduces six specially defined parameter status indicators. The indicators or symbols are listed below.

- **M** This symbol indicates missing data. The parameter value may be blanked or the last value received by the GPC may be displayed. If data are missing for a parameter that has no numerical value associated with it, then an M is used to indicate the parameter status.
- **H** This symbol indicates that a parameter is off-scale high. The transducer limit has been reached, and the scale is registering at its highest possible value. The actual parameter being measured may, in fact, be higher than the recorded data, but the instrument in use does not have the capacity to measure the value.
- **L** This symbol indicates off-scale low parameters. This means that the parameter value is the lowest possible reading due to transducer limitations. The actual value of the parameter may be lower than the displayed value, but the range of the hardware cannot accommodate this reading
- **?** This symbol indicates Redundancy Management (RM) dilemma. That is, if two hardware units measuring the same parameter disagree and the software cannot isolate which of the two is failed, a ? will be displayed in both places.
- **↑** This symbol indicates a parameter driven out-of-limits high.

The value displayed is a true reading but has equaled or exceeded the operational high limit established by the software.

When the parameter value exceeds both the transducer limit and the operational limit, the H symbol overrides the ↑ symbol.

- **↓** This symbol is the counterpart to the ↑ symbol. It indicates that a parameter value is equal to or less than the operational lower limit established by software. The value displayed is a true reading.

When the parameter value exceeds both the transducer limit and the operational limit, the L symbol overrides the ↓ symbol.

In addition, the ↓ symbol is used to indicate a discrete state which does not agree with the nominal state. For example, a cryogenic oxygen valve feeding the fuel cells is normally open; if it closes, a ↓ is displayed next to the parameter.

The ↓ also is used to indicate that a hardware unit has been declared failed by a GPC.

Status symbols are displayed in “overbright” intensity directly to the right of the affected parameter (Figure 5-3).

Limit-Sensing Indications

The Class 0 alarm generates two of six status symbols. The symbols are

↑ and ↓

The remaining four status symbols are not generated by this alarm class. *They are provided by subroutines separate from the (FDA) software.*

SM FDA is a subroutine which monitors the operational low and high limits of all parameters listed in the FDA limit table. The limit table contains operational limits for B/U C&W (Class 2), Alert (Class 3), and limit sensing (Class 0) systems.

When a limit is violated, the appropriate ↑ or ↓ status symbol is shown next to the parameter on all CRT displays on which the parameter is listed. No fault message, tone, or light is associated with this alarm class.

If a parameter is monitored by both B/U C&W (Class 2) and Alert (Class 3), Class 0 Limit Sensing uses the Alert limits and NOT the B/U C&W limits.

Class 0 Limit Sensing remains active for a parameter even if B/U C&W and/or Alert annunciation is inhibited for that parameter.

The GNC software provides a similar function for GNC parameters.

Section 7

FDF Reference Data Book

Objectives

After completing this section, the student should be able to identify and use the information available in the fault message table and the three C&W tables in the FDF Reference Data Book.

Introduction

- This section discusses the following tables from the FDF Reference Data Book:
- Fault message table
- C&W and FDA table
- Hardware C&W table
- Primary-to-backup C&W analog parameter calibration table

Fault Message Table

The fault message table provides a reference to crewmembers on all software-generated fault messages.

Figure 7-1 is an example of a typical fault message table. The following is a list of the information contained in the table:

Message	The message column notes the exact message announced on a CRT display.
OPS availability	This column is broken into two subcolumns: PASS and BFS. Under each subcolumn is a list of GPC Operational Sequences (OPS) in which a particular message can be received.
Cause	This column lists the operational causes that drive the associated messages.

Comments

The comments column provides crewmembers with clarification notes.

One way of accomplishing this purpose is to expand on exactly what condition must be present for a message to be annunciated. For example, an FRCS LEAK message will be generated for an OX/FUΔ QTY > 9.5 percent, which is indicated by a bilevel discrete.

A second use is to identify which conditions have no corresponding long form malfunction procedure (in other words, NO MAL).

A third use is to identify what action to take or what PKT C/L to use. This is done only in those cases where the general procedure titles contained in the PKT C/L are too generic for proper identification and use. For example, the RCS LEAK ISOL PKT C/L procedure should be used for an F RCS He P msg.

A fourth use is to note the effects of the failure on the system. Examples include “quantity calculation suspended” and “cause termination of auto sequence.”

MESSAGE		OPS AVAIL		CAUSE	COMMENTS
		PASS	BFS		
FRCS (Cont)	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	
	He P	G2,8	G1,3,6	• F He (FU OR OX) TK P 2 LOW	• PKT C/L - RCS LEAK ISOL
	LEAK	G2,3,8	G1,3,6	• PROP/He LEAK	• OX/FU Δ QTY > 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	G1,3,6	• FWD RCS (FU OR OX) TK ULL PRESS HI/LOW	• QTY CALC SUSPENDED
S69 FC AMPS SM1 FC AMPS 1(2,3)	1(2,3)	S2,4		• FC AMPS $\uparrow \downarrow$	
			SM		
S69 FC COOL P SM1 FC COOL P 1(2,3)	1(2,3)	S2,4		• FC COOL P $\uparrow \downarrow$	
			SM		
S69 FC DELTA V SM1 FC DELTA V 1(2,3)	1(2,3)	S2,4		• FC SUBSTACK $\Delta V > 150$ MV	
			SM		
S69 FC EXIT T SM1 FC EXIT T 1(2,3)	1(2,3)	S2,4		• FC EXIT T $\uparrow \downarrow$	
			SM		
S69 FC H2 FLOW	1(2,3)	S2,4		• FC H2 FLOW \uparrow	
S69 FC H2 PUMP	1(2,3)	S2,4		• FC H2 PUMP STATUS $\uparrow \downarrow$	

Figure 7-1. Typical fault message table

C&W and FDA Table

The C&W and FDA table provides a comprehensive alphabetical listing of limit-sensed parameters and their respective annunciation limits for the hardware Primary C&W and SM software B/U C&W and the SM the Alert systems. Only a few GNC parameters are listed. The table also provides information that can be used by the crew to alter limits and to eliminate nuisance alarms.

Figure 7-2 is an example of one page out of the C&W and FDA table. The table columns are organized as follows:

Parameter name	<i>The parameter name is consistent with the parameter title on the CRT display as much as possible; these names are alphabetically arranged. PASS, BFS, and/or GNC are specified when multiple entries are necessary. Footnotes attached to the parameter name typically indicate the OPS, Major Mode (MM), major function (GNC or SM), and/or flight system (PASS or BFS) for parameters that are not limit sensed at all times in both PASS and BFS.</i>
C/W CH	<i>The C/W channel column gives the parameter number (from 000 to 119) to be used on panel R13U for the PARAMETER SELECT thumbwheels (pushbuttons) and the STATUS MATRIX. This channel number corresponds only to the primary C&W system (Class 2).</i>
H/W C/W	<i>The H/W C/W column presents the high and low Primary C&W limits (Class 2) in V dc. In the cases where hardware limits are not backed up by identical software limits, the value in engineering units is printed in parentheses below the value in V dc.</i>
SOFTWARE ID	<i>This column gives the parameter Identification (ID) to be used when altering parameter fault detection via PASS Table Maintenance, SM SPEC 60. Software IDs for BFS SM limits also are given, although at the present time there is no BFS equivalent to the Table Maintenance SPEC. GNC limit-sensed parameters cannot be changed except by memory read/write; I-load identification numbers are provided for selected parameters.</i>
PASS SPEC	<i>This column lists the specific SPEC or DISP number on which the parameter appears.</i>

SM ALERT

The SM Alert column contains the low and high Alert limits (Class 3) in engineering units. The column title is misleading because some GNC parameter limits are included as well as limits for SM parameters.

BACKUPC&W

The BACKUP C&W column provides crewmembers with the high and low B/U C&W (Class 2) limits in engineering units.

Precondition and/
or bilevel state

The last column identifies precondition characteristics when applicable.

It also describes the circumstances that generate the bilevel change of state and subsequent alarm. Bilevel means two possible states exist for a given parameter (for example, an APU has either experienced an underspeed or it has not). Bilevel comments give the state which triggers alarm annunciation.

Also listed in this column are default values for the primary C& W system. Refer to Section 2 for a discussion of defaults.

In addition, a few notes describe unusual cases.

PARAMETER NAME	C/W CH	H/W C/W		SOFTWARE ID	PASS SPEC	SM ALERT		B/U C/W		PRECONDITION (P) AND/OR BILEVEL STATE (BL)
		LOW	HIGH			LOW	HIGH	LOW	HIGH	
APU SPEED % 2 (PASS) APU SPEED % 2 (BFS)				0460235	86	40.0	112.0	80.0	122.0	<ul style="list-style-type: none"> • APU 2 ON & NOT IN HIGH SPD MODE (P) • APU 2 ON & IN HIGH SPD MODE (P)
APU SPEED % 3 (PASS) APU SPEED % 3 (BFS)				0460335	86	40.0	112.0	80.0	122.0	
APU TEMP EGT 1 ^a	8		4.20	0460142						<ul style="list-style-type: none"> • < 80% (BL)
APU TEMP EGT 2 ^a	18		4.20	0460242						
APU TEMP EGT 3 ^a	28		4.20	0460342						
APU UNDERSPEED 1	98		5.00							
APU UNDERSPEED 2	108		5.00							
APU UNDERSPEED 3	118		5.00							
AV BAY FAN ΔP 1				0612642	66	2.5	4.3			
AV BAY FAN ΔP 2				0612647	66	2.5	4.3			
AV BAY FAN ΔP 3				0612658	66	2.5	4.3			
AV BAY TEMP 1	84		4.25	0612645	66				130.0	
AV BAY TEMP 2	94		4.25	0612650	66				130.0	
AV BAY TEMP 3	104		4.25	0612661	66				130.0	

Figure 7-2. C&W FDA table

Hardware C&W Table

The hardware C&W table provides crewmembers with a quick way to associate primary C&W channel numbers with their respective parameter names (Figure 7-3).

HARDWARE C/W TABLE									
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 (A, 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 (A, 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 (A, B, C)	68	APU 1 OVERSPEED	93	RGAA/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		

* Channel not used

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Figure 7-3. Hardware C&W table

Primary-to-Backup C&W Analog Parameter Calibration Table

This calibration table is used in conjunction with the Primary C&W system. Because the Primary C&W system uses voltage for limits, a conversion from engineering units to voltage and voltage to engineering units is necessary. (See Figure 7-4.)

The first operation in using this table is to locate the name and bubble number of a parameter. As an example, if the parameter for Auxiliary Power Unit (APU) exhaust gas temperature is being worked with, then the associated bubble is bubble 11. If there is a multiplying factor or vehicle identifier, it will be listed by the parameter name.

After identifying an associated bubble for the parameter, read across the top of the table until reaching the column that matches the parameter bubble. The next step is to proceed down the column until the desired value, in engineering units, is located. Next, read across (row) to the left to the first column. The value that appears in the first column is the corresponding voltage to the engineering value that has been selected (column 1 also is used for parameters that have a 1 to 1 or power of 10 correspondence with the voltage).

If a limit value had been read for a particular parameter using the Primary C&W system, and it is desired to convert this voltage to its corresponding engineering unit, the same table is used. By locating the voltage value in the first column, then reading across to the appropriate column, the engineering unit is identified.

As an example, refer to Figure 7-5. If we want to set an upper limit of 15.5 psia for the cabin pressure on Columbia, OV-102, the first step is to locate the correct bubble. In this case, it is bubble 5a. Proceed down column 5a until the value 15.5 is located. You will notice that there is no value corresponding exactly to 15.5, so the value of 15.36 is substituted.

Moving to the left to the first column, we see that the corresponding voltage value is 3.85. This is the value that is used in the Primary C&W system.

Conversely, if we read the primary C&W lower limit for cabin pressure and find it to be 3.65 V, the corresponding pressure can be found. First, we identify which column corresponds to cabin pressure (column 5a). Then, we locate 3.65 in column 1, the C&W limit volts column. Next, we move to the right to column 5a. The value found in column 5a, 14.56, is the engineering unit (psia) that corresponds to 3.65 V.

① 0.00 TO 5.00	② -417 TO 468	③ -76.7 TO 298.1	④ -3.1 TO 496.8	⑤ ^a 0.11 TO 19.91	⑤ ^b 0.00 TO 20.00	⑤ ^c 0.05 TO 19.85	⑤ ^d 0.10 TO 19.92	⑥ 0 TO 8	⑦ 0 TO 40	⑧ 0 TO 100	⑨ 0 TO 150	⑩ 0 TO 300	⑪ 8 TO 1520	⑫ 24.9 TO 129.9	⑬ 45 TO 145	⑭ 145 TO 305	⑮ 515 TO 1015	⑯ 732 TO 2684
3.65	229	196.9	361.8	14.56	14.60	14.51	14.50	5.84	29.2	73	109.5	219	1112	101.5	118	261.8	880	2304
3.70	238	200.6	366.8	14.76	14.80	14.70	14.70	5.92	29.6	74	111.0	222	1127	102.6	119	263.4	885	2319
3.75	246	204.4	371.8	14.96	15.00	14.90	14.90	6.00	30.0	75	112.5	225	1142	103.6	120	265.0	890	2334
3.80	255	208.1	376.8	15.16	15.20	15.10	15.10	6.08	30.4	76	114.0	228	1157	104.7	121	266.6	895	2348
3.85	264	211.9	381.8	15.36	15.40	15.30	15.29	6.16	30.8	77	115.5	231	1172	105.7	122	268.2	900	2363
3.90	273	215.6	386.8	15.55	15.60	15.50	15.49	6.24	31.2	78	117.0	234	1187	106.8	123	269.8	905	2378
3.95	282	219.4	391.8	15.75	15.80	15.69	15.69	6.32	31.6	79	118.5	237	1202	107.8	124	271.4	910	2392
4.00	291	223.1	396.8	15.95	16.00	15.89	15.89	6.40	32.0	80	120.0	240	1217	108.9	125	273.0	915	2407
4.05	299	226.9	401.8	16.15	16.20	16.09	16.09	6.48	32.4	81	121.5	243	1233	109.9	126	274.6	920	2421
4.10	308	230.6	406.8	16.35	16.40	16.29	16.29	6.56	32.8	82	123.0	246	1248	111.0	127	276.2	925	2435
4.15	317	234.4	411.8	16.54	16.60	16.49	16.48	6.64	33.2	83	124.5	249	1263	112.0	128	277.8	930	2450
4.20	326	238.1	416.8	16.74	16.80	16.68	16.68	6.72	33.6	84	126.0	252	1278	113.1	129	279.4	935	2464
4.25	335	241.9	421.8	16.94	17.00	16.88	16.88	6.80	34.0	85	127.5	255	1293	114.1	130	281.0	940	2478
4.30	344	245.6	426.8	17.14	17.20	17.08	17.08	6.88	34.4	86	129.0	258	1308	115.2	131	282.6	945	2492
4.35	353	249.4	431.8	17.34	17.40	17.28	17.28	6.96	34.8	87	130.5	261	1323	116.2	132	284.2	950	2506
4.40	361	253.1	436.8	17.53	17.60	17.48	17.48	7.04	35.2	88	132.0	264	1338	117.3	133	285.8	955	2520
4.45	370	256.9	441.8	17.73	17.80	17.67	17.67	7.12	35.6	89	133.5	267	1354	118.3	134	287.4	960	2534
4.50	379	260.6	446.8	17.93	18.00	17.87	17.87	7.20	36.0	90	135.0	270	1369	119.4	135	289.0	965	2548
4.55	388	264.4	451.8	18.13	18.20	18.07	18.07	7.28	36.4	91	136.5	273	1384	120.4	136	290.6	970	2561
4.60	397	268.1	456.8	18.33	18.40	18.27	18.27	7.36	36.8	92	138.0	276	1399	121.5	137	292.2	975	2575
4.65	406	271.8	461.8	18.52	18.60	18.47	18.47	7.44	37.2	93	139.5	279	1414	122.5	138	293.8	980	2589
4.70	414	275.6	466.8	18.72	18.80	18.66	18.67	7.52	37.6	94	141.0	282	1429	123.6	139	295.4	985	2602
4.75	423	279.3	471.8	18.92	19.00	18.86	18.87	7.60	38.0	95	142.5	285	1444	124.6	140	297.0	990	2616
4.80	432	283.1	476.8	19.12	19.20	19.06	19.06	7.68	38.4	96	144.0	288	1459	125.7	141	298.6	995	2630
4.85	441	286.8	481.8	19.32	19.40	19.26	19.26	7.76	38.8	97	145.5	291	1475	126.7	142	300.2	1000	2643
4.90	450	290.6	486.8	19.51	19.60	19.46	19.46	7.84	39.2	98	147.0	294	1490	127.8	143	301.8	1005	2657
4.95	459	294.3	491.8	19.71	19.80	19.65	19.66	7.92	39.6	99	148.5	297	1505	128.8	144	303.4	1010	2670
5.00	468	298.1	496.8	19.91	20.00	19.85	19.86	8.00	40.0	100	150.0	300	1520	129.9	145	305.0	1015	2684

- ① C/W LIMIT
O2 PP
GN2 FLOW
CAB O2 FLO
X1000 = He TK P
- ② O2 TK HTR T
- ③ FCP STK T
- ④ APU LUBE OIL T
- ⑤ CABIN P
^aOV102
^bOV103
^cOV104
^dOV105
- ⑥ CAB FAN DP
- ⑦ MAIN BUS VOL
X10=OMS
TK ULL P
X10=RCS
TK ULL P
X100=HYD SYS P
- ⑧ MPS LHZ MANF P
x10= MPS
HE REGP
- ⑨ H2O LP PUMP P
- ⑩ MPS LO2 MANF P
- ⑪ APU EST
- ⑫ FCL EVAP
OUT T
- ⑬ AV BAY 7
CAB MX AIR OUT T
- ⑭ CRYO N2 PRESS

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Figure 7-4. Primary-to-backup C&W analog parameter calibration table

3.65 V ⇒ 14.56

1 3.00 TO 5.00	2 -417 TO 468	3 -76.7 TO 298.1	4 -3.1 TO 496.8	5 ^a 0.11 TO 19.91	5 ^b 0.00 TO 20.00	5 ^c 0.05 TO 19.85	5 ^d 0.10 TO 19.92	6 0 TO 8	7 0 TO 40	8 0 TO 100	9 0 TO 150	10 0 TO 300	11 8 TO 1520	12 24.9 TO 129.9	13 45 TO 145	14 145 TO 305	15 515 TO 1015	16 732 TO 2684
3.65	229	196.9	361.8	14.56	14.60	14.51	14.50	5.84	29.2	73	109.5	219	1112	101.5	118	261.8	880	2304
3.70	238	200.6	366.8	14.76	14.80	14.70	14.70	5.92	29.6	74	111.0	222	1127	102.6	119	263.4	885	2319
3.75	246	204.4	371.8	14.96	15.00	14.90	14.90	6.00	30.0	75	112.5	225	1142	103.6	120	265.0	890	2334
3.80	255	208.1	376.8	15.16	15.20	15.10	15.10	6.08	30.4	76	114.0	228	1157	104.7	121	266.6	895	2348
3.85	264	211.9	381.8	15.36	15.40	15.30	15.29	6.16	30.8	77	115.5	231	1172	105.7	122	268.2	900	2363
3.90	273	215.6	386.8	15.55	15.60	15.50	15.49	6.24	31.2	78	117.0	234	1187	106.8	123	269.8	905	2378
3.95	282	219.4	391.8	15.75	15.80	15.69	15.69	6.32	31.6	79	118.5	237	1202	107.8	124	271.4	910	2392
4.00	291	223.1	396.8	15.95	16.00	15.89	15.89	6.40	32.0	80	120.0	240	1217	108.9	125	273.0	915	2407
4.05	299	226.9	401.8	16.15	16.20	16.09	16.09	6.48	32.4	81	121.5	243	1233	109.9	126	274.6	920	2421
4.10	308	230.6	406.8	16.35	16.40	16.29	16.29	6.56	32.8	82	123.0	246	1248	111.0	127	276.2	925	2435
4.15	317	234.4	411.8	16.54	16.60	16.49	16.48	6.64	33.2	83	124.5	249	1263	112.0	128	277.8	930	2450
4.20	326	238.1	416.8	16.74	16.80	16.68	16.68	6.72	33.6	84	126.0	252	1278	113.1	129	279.4	935	2464
4.25	335	241.9	421.8	16.94	17.00	16.88	16.88	6.80	34.0	85	127.5	255	1293	114.1	130	281.0	940	2478
4.30	344	245.6	426.8	17.14	17.20	17.08	17.08	6.88	34.4	86	129.0	258	1308	115.2	131	282.6	945	2492
4.35	353	249.4	431.8	17.34	17.40	17.28	17.28	6.96	34.8	87	130.5	261	1323	116.2	132	284.2	950	2506
4.40	361	253.1	436.8	17.53	17.60	17.48	17.48	7.04	35.2	88	132.0	264	1338	117.3	133	285.8	955	2520
4.45	370	256.9	441.8	17.73	17.80	17.67	17.67	7.12	35.6	89	133.5	267	1354	118.3	134	287.4	960	2534
4.50	379	260.6	446.8	17.93	18.00	17.87	17.87	7.20	36.0	90	135.0	270	1369	119.4	135	289.0	965	2548
4.55	388	264.4	451.8	18.13	18.20	18.07	18.07	7.28	36.4	91	136.5	273	1384	120.4	136	290.6	970	2561
4.60	397	268.1	456.8	18.33	18.40	18.27	18.27	7.36	36.8	92	138.0	276	1399	121.5	137	292.2	975	2575
4.65	406	271.8	461.8	18.52	18.60	18.47	18.47	7.44	37.2	93	139.5	279	1414	122.5	138	293.8	980	2589
4.70	414	275.6	466.8	18.72	18.80	18.66	18.67	7.52	37.6	94	141.0	282	1429	123.6	139	295.4	985	2602
4.75	423	279.3	471.8	18.92	19.00	18.86	18.87	7.60	38.0	95	142.5	285	1444	124.6	140	297.0	990	2616
4.80	432	283.1	476.8	19.12	19.20	19.06	19.06	7.68	38.4	96	144.0	288	1459	125.7	141	298.6	995	2630
4.85	441	286.8	481.8	19.32	19.40	19.26	19.26	7.76	38.8	97	145.5	291	1475	126.7	142	300.2	1000	2643
4.90	450	290.6	486.8	19.51	19.60	19.46	19.46	7.84	39.2	98	147.0	294	1490	127.8	143	301.8	1005	2657
4.95	459	294.3	491.8	19.71	19.80	19.65	19.66	7.92	39.6	99	148.5	297	1505	128.8	144	303.4	1010	2670
5.00	468	298.1	496.8	19.91	20.00	19.85	19.86	8.00	40.0	100	150.0	300	1520	129.9	145	305.0	1015	2684

- ① C/W LIMIT
O2 PP
GN2 FLOW
CAB O2 FLO
X1000 = He TK P
- ② O2 TK HTR T
- ③ FCP STK T
- ④ APU LUBE OIL T
- ⑤ CABIN P
^aOV102
^bOV103
^cOV104
^dOV105
- ⑥ CAB FAN DP
- ⑦ MAIN BUS VOL
X10=OMS
TK ULL P
X10=RCS
TK ULL P
X100=HYD SYS P
- ⑧ MPS LHZ MANF P
x10= MPS
HE REGP
- ⑨ H2O LP PUMP P
- ⑩ MPS LO2 MANF P
- ⑪ APU EST
- ⑫ FCL EVAP
OUT T
- ⑬ AV BAY 7
CABMX AIR OUT T
- ⑭ CRYO N2 PRESS

Figure 7-5. Example using calibration table

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Section 8

SPEC 60, SM Table Maintenance

Objectives

After reading this section, the student will be able to

- Specify which software contains SPEC 60
- Specify which alarm classes are associated with SPEC 60
- Read or change each of the following for a B/U C&W or Alert parameter:
 - Upper and lower limits
 - Noise filter value
 - Enable/inhibit status
- Explain the function of each item on SPEC 60
- Locate the reference material and procedures for using SPEC 60
- Correctly answer the questions at the end of the section

Overview

The crew uses SPEC 60, SM Table Maintenance (Figure 8-1) to interact with the B/U C&W and Alert parameters monitored by the PASS SM software.

While B/U C&W and Alert parameters are supported by the GNC and SM major functions of both PASS and BFS, only the PASS SM parameters can be accessed through SPEC 60. To change the characteristics of PASS GNC, BFS GNC, and BFS SM parameters, the crew or MCC (via uplink) has to perform a GPC memory read/write procedure. (This procedure is described in the DPS Hardware/Software 2102 Training Manual.) The remainder of this section will address PASS SM parameters only.

```
2011/060/          SM TABLE MAINT          /  :  :
SM COM BUFF          /  :  :
PARAM
  1 ID -----
  VALUE=
      ALERT          LIMITS          BACKUP C W
      LOW           HI           LOW           HI
2 [ ]----- 3 [ ]----- 11 [ ]----- 12 [ ]-----
4 [ ]          5 [ ]
6 [ ]          7 [ ]
      8 FILTER --           13 FILTER --
      ENA 9           ENA 14
      INH 10          INH 15

CONSTANT
  16 ID -----
  17 VALUE= [ ]-----

CHECKPT 000/00:00:00  FDA
INITIATE 18          ENA 19*
STATUS              INH 20

TD4020801.CRT; 1
```

Figure 8-1. SPEC 60

Using SPEC 60, the crew can read and change the following for each PASS SM B/U C&W or Alert parameter:

- Lower and upper limits
- Noise filter value
- Enable/inhibit status

Additionally, the crew can read and change SM program constants, initiate a checkpoint, and enable or inhibit the entire FDA software module. FDA is the PASS SM software module that monitors the B/U C&W and Alert parameters and initiates alarms. FDA also drives the arrows for Class 0 Limit Sensing.

The FDF DPS Dictionary provides the crew with a description of SPEC 60. The C&W section of the FDF Reference Data Book (Section 7 of this training manual) provides the crew with procedures for using SPEC 60, software IDs, preflight limit values, and other reference information.

SPEC 60 Operations

SPEC 60 is available during SM OPS 2 and SM OPS 4. When the SM Table Maintenance display is called up by its SPEC number (SPEC 60 PRO), each field is blank except CHECKPT time and FDA ENA. When SPEC 60 is recalled by pressing RESUME, the fields that were previously in use retain their data. When a legal item entry is made, the new data are displayed in the appropriate fields and overwrite any previous data.

Backup C&W and Alert Parameters

Any (PASS SM) B/U C&W or Alert parameter may be accessed by entering its software ID number in item 1. The limits, noise filter value, and enable/inhibit status of Alert parameters may be accessed with items 2 through 10 (Figure 8-2). The same characteristics of B/U C&W parameters are available through items 11 through 15 (Figure 8-3). Refer to Sections 4 and 5 for details regarding the functions of noise filter values, enables, inhibits, limits, etc.


```

2011/060/          SM TABLE MAINT          /  :  :
SM COM BUFF          /  :  :
PARAM
  1 ID -----
    VALUE=

                                LIMITS
  2 [ ]-----  3 [ ]-----  11 [ ]-----  12 [ ]-----
    ALERT LOW          HI          BACKUP C W          HI
  4 [ ]-----  5 [ ]-----
  6 [ ]-----  7 [ ]-----
                                8 FILTER --          13 FILTER --
                                ENA 9          ENA 14
                                INH 10         INH 15

CONSTANT
  16 ID -----
  17 VALUE= [ ]-----

CHECKPT 000/00: 00: 00  FDA
INITIATE 18          ENA 19*
STATUS              INH 20

```

TD4020802. CRT: 1

Figure 8-2. SPEC 60 with Alert items highlighted

```

2011/060/          SM TABLE MAINT          /  :  :
SM COM BUFF          /  :  :
PARAM
  1 ID -----
    VALUE=

                                LIMITS
  2 [ ]-----  3 [ ]-----  11 [ ]-----  12 [ ]-----
    ALERT LOW          HI          BACKUP C W          HI
  4 [ ]-----  5 [ ]-----
  6 [ ]-----  7 [ ]-----
                                8 FILTER --          13 FILTER --
                                ENA 9          ENA 14
                                INH 10         INH 15

CONSTANT
  16 ID -----
  17 VALUE= [ ]-----

CHECKPT 000/00: 00: 00  FDA
INITIATE 18          ENA 19*
STATUS              INH 20

```

TD4020803. CRT: 1

Figure 8-3. SPEC 60 with B/U C&W items highlighted

PARAM ID (Item 1) and PARAM VALUE

The software ID number for the desired FDA parameter is entered in item 1.

The software IDs and preflight limit values are located in the C&W and FDA table of the FDF Reference Data Book (Section 7 of this training manual).

The software ID is built from the parameter MSID by changing the V to a 0 and dropping the other letters. For example, the MSID for AV BAY 1 TEMP is V612645 and its software ID is 0612645. When entering the ID in item 1, leading zeroes may be omitted.

When a valid ID is entered, the ID number is displayed in the PARAM ID space and the current value of the parameter is 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 appear in the LIMITS portion of the SPEC (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 contain the proper data (Figure 8-4). Otherwise, one of the LIMITS sections is blank (Figure 8-5). Additionally, the ALERT side will display either one, two, or three sets of limits depending on the parameter.

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

```

2011/060/          SM TABLE MAINT          /  :  :
SM COM BUFF          /  :  :
PARAM
  1 ID 0450120
    VALUE= + 202.00

      ALERT                LIMITS                BACKUP C W
      LOW                  HI                    LOW                  HI
2 [+]180.00 3 [+]212.00 11 *172.50 12 [+]243.70
4 *190.00 5 [+]222.00
6 [+]198.00 7 [+]238.00
      8 FILTER _7                13 FILTER _2
      ENA 9*                ENA 14*
      INH 10                INH 15

CONSTANT
16 ID
17 VALUE= [ ]

CHECKPT 000/00:00:00  FDA
INITIATE 18          ENA 19*
STATUS              INH 20

```

TD4020804. CRT; 2

Figure 8-4. SPEC 60 with FC stack T ID

```

2011/060/          SM TABLE MAINT          /  :  :
SM COM BUFF          /  :  :
PARAM
  1 ID 0450101
    VALUE= 189.00

      ALERT                LIMITS                BACKUP C W
      LOW                  HI                    LOW                  HI
2 *54.00 3 [ ] 360.00 11 [ ] 12 [ ]
4 [ ] 5 [ ]
6 [ ] 7 [ ]
      8 FILTER _2                13 FILTER --
      ENA 9                ENA 14
      INH 10                INH 15

CONSTANT
16 ID
17 VALUE= [ ]

CHECKPT 000/00:00:00  FDA
INITIATE 18          ENA 19*
STATUS              INH 20

```

TD4020805. CRT; 1

Figure 8-5. SPEC 60 with FC amps ID

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 (Section 5) may have two or three limit sets. All other Alert parameters have only one limit set. Based on the preconditions, 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 is displayed in the first limit set location and the asterisk is 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 is displayed. Refer to Section 5 to review details about preconditioning.

LIMITS BACKUP C&W LOW and HI (Items 11 and 12)

The B/U C&W limits for the Fault Detection And Annunciation (FDA) parameter identified in item 1 are displayed in these fields. The limit values, in engineering units, can be changed by entering the new data in the desired item.

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

LIMITS ALERT FILTER (Item 8)

The Alert parameter noise filter value can be read or changed through item 8. The range of valid values is 1 through 15.

LIMITS BACKUP C&W FILTER (Item 13)

The B/U C&W noise filter function is similar to the Alert filter (item 8) function. The major difference, in fact, is that the noise filter value is almost always preinitialized by the flight software with a value of 2. This ensures rapid annunciation of a Class 2 C&W out-of-limits condition.

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 item 9 or 10. 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.

Selection of the ENA item for a previously inhibited parameter that is currently out-of-limits will not result in a fault message annunciation (such annunciation may be thought of as a “one shot” occurrence and would have occurred only at the time of the original fault detection, had annunciation not been inhibited). Should the parameter go back within limits (and fulfill the noise filter value count) and then later go out-of-limits again (and fulfill the noise filter value count), then the message will be annunciated (provided the parameter remains enabled).

LIMITS BACKUP C&W ENA or INH (Items 14 and 15)

The operation of these B/U C&W items is similar to the operation of Alert items 9 and 10.

FDA Status, Enabled, or Inhibited

The (PASS SM) FDA software module that monitors parameters and initiates alarms is called FDA software.

FDA ENA or NH (Items 19 and 20)

All of the (PASS SM) FDA software can be either inhibited or enabled by executing the respective item (Figure 8-6). 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 (PASS SM) FDA functions are disabled:

- FDA alarm annunciation - Includes B/U C&W (class 2), Alert (Class 3), and limit sensing up or down arrows (Class 0)
- Limit sensing (Class 0) - Last value displayed for each out-of-limits parameter status indicator
- 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 (refer to Section 6, Class 0 Limit Sensing). Also, PASS GNC alarm annunciation is not affected by these (or any other) item entries on SPEC 60.

The FDA INH, item 20, would not normally be utilized in flight, except under extraordinary circumstances, because the feature totally kills all of the PASS SM FDA functions until reenabled via item 19.

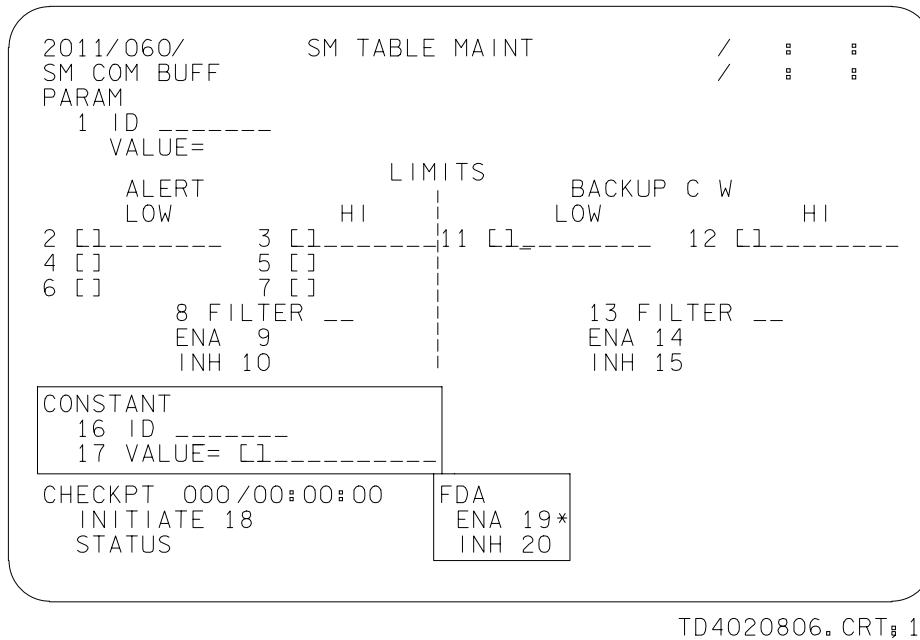


Figure 8-6. SPEC 60 with Constant FDA items highlighted

Constants

Many, but not all, SM constants may be accessed through items 16 and 17 (Figure 8-6). These constants are primarily involved in SM special processes such as water loop pump cycling, Alert preconditioning, and payload deployment (refer to SM FSR).

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 is illegal, both data fields are blanked.

A complete list of constant IDs and values is not carried onboard the shuttle typically, although various malfunction procedures contain constant IDs and values. If a constant must be changed, the MCC either provides the crew with the data or directly changes the constant through a TMBU (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.

Table Maintenance Block Update (TMBU)

A TMBU is the type of uplink that the MCC uses to change the following PASS SM 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 are displayed on the SPEC (Figure 8-7). All item entries are prohibited and result in an ILLEGAL ENTRY message.

(See the DPS PRINC 2102 and DPS HW/SW 2102 training manuals for additional information about uplinks.)

```
2011/060/          SM TABLE MAINT  UL  /  :  :
SM COM BUFF          UPLINK  /  :  :
PARAM
 1 ID -----
  VALUE=
      ALERT          LIMITS          BACKUP C W
      LOW           HI           LOW           HI
2 [ ]----- 3 [ ]----- 11 [ ]----- 12 [ ]-----
4 [ ]          5 [ ]
6 [ ]          7 [ ]
      8 FILTER --          13 FILTER --
      ENA 9           ENA 14
      INH 10          INH 15

CONSTANT
16 ID -----
17 VALUE= [ ]-----

CHECKPT 000/00: 00: 00  FDA
INITIATE 18           ENA 19*
STATUS              INH 20
```

TD4020807. CRT: 2

Figure 8-7. SPEC 60 uplink indicators

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 any GPCs that are being commanded.

Checkpoints

When an SM checkpoint is performed, the following information is saved on a Mass Memory Unit (MMU):

- 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 MMU software. If these changes are not saved on an MMU (via a checkpoint) and the SM GPC fails, the changes are lost and will have to be entered again (either via crew entry or uplink TMBU).

When checkpoint retrieve is enabled (Figure 8-9), the software loaded into an SM GPC from an MMU will contain the most recent checkpoint. (See the DPS HW/SW 2102 and DPS PRINC 2102 training manuals for additional information about SM checkpoints.)

CHECKPOINT INITIATE (Item 18), CHECKPOINT STATUS, and Time

When item 18 is executed, the STATUS field goes blank. While the checkpoint is being performed, a flashing BSY is displayed next to SM COM BUFF at the top left of SPEC 60. This indicates that the SM common buffer is in use. When the checkpoint is completed, the CHECKPT STATUS field contains GOOD. If the SM common buffer was not available, CHECKPT STATUS would be FAIL and item 18 should be executed again.

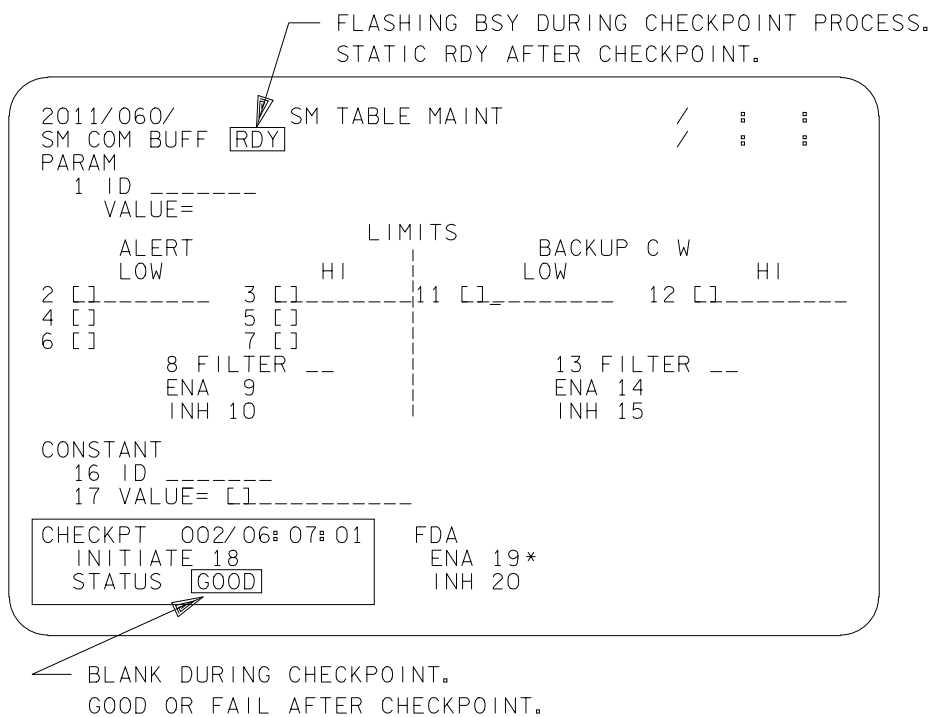
The Mission Elapsed Time (MET) of the most recent successful checkpoint is displayed as DD/HH:MM:SS in the checkpoint time field.

SM COM BUFF - BSY or RDY

Either a flashing BSY or a static RDY is displayed after SM COM BUFF (Figure 8-8) to indicate the status of the SM common buffer. BSY (busy) indicates that the SM COM BUFF is being used; RDY (ready) means the buffer is available.

Keypad entries on this SPEC are rejected if BSY is flashing.

Certain other mass memory related operations, besides SM checkpoint writes, also utilize the SM common buffer: SM checkpoint retrievals, Telemetry Format Loads, Decom Format Loads, and ground uplink MMU operations (MMU patch or crew text, both of which are rarely utilized in today's operational environment). See the communication system training manuals for further details. Note that SM roll-in SPECS do NOT utilize the SM common buffer.



TD4020808. CRT; 1

Figure 8-8. SPEC 60 after checkpoint

CKPT RETRV ENA (DPS UTILITY - SPEC 1, Item 12)

Executing this item (Figure 8-9) alternately selects or deselects CKPT RETRV ENA. An asterisk appears next to item 12 when checkpoint retrieve is enabled.

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

A checkpoint saves the changes on the MMU that is assigned to the SM software by item 3 or 4 (Figure 8-9). To save the checkpoint on both MMUS, two checkpoints must be performed (one on each MMU).

```

XXXX/001/          DPS UTILITY          XX X DDD/HH:MM:SS
                                     DDD/HH:MM:SS

MMU ASSIGN          PORT ASSIGN
  1 2
  GNC 1X 2X        STRING 1 15X 16X  UL CNTL
  SM 3X 4X          2 17X 18X  AUTO 35X
  PL 5X 6X          3 19X 20X  ENA 36X
OPS 0 7X 8X        4 21X 22X  INH 37X
                                     PL 1/2 23X 24X  IPL SOURCE SW
MMU STATUS                                     MASK 38X
  1 XXX
  2 XXX

MMU SOURCE/BUS    VAR PARAM ID LIST
  GPC/MMU 9X      25 XXXX
  MMU/MMU 10X     26 XXXX
  GPC/LDB 11X     27 XXXX
                                     28 XXXX
                                     29 XXXX
                                     30 XXXX
                                     31 XXXX
                                     32 XXXX
                                     33 XXXX
                                     34 XXXX

CKPT RETRV          G3 ARCHIVE
  ENA 12X          LOAD 48X
                                     RETRIEVE 49X
                                     GROUND OPS
GSE POLL ENA 50X
SM GSE INH 51X
SM C/O ENA 52X
GNC C/O ENA 53X
BFC C/O ENA 54X
ALT PL9 TB 55X

RTC
  13 XXXX XXXX
  CMD 14

(XX)

```

TD4020810.CRT; 1

Figure 8-9. SPEC 1

Questions

Answer the following questions by either filling in the blank or selecting the appropriate answer. Refer to Figure 8-1 and Figure 8-9 as necessary.

1. SPEC 60, SM TABLE MAINT, is available in the _____ major function of OPS _____ and _____ .
2. Valid software IDs and preflight limit values are available to the crew in the C&W and FDA table of the _____ Book of the FDF.
3. List the SPEC 60 item number(s) used to perform the following functions:
Enter the software ID _____
Read or change: _____ B/U C&W lower limit
 _____ Alert lower limits
 _____ B/U C&W upper limit
 _____ Alert upper limits

Verify or change: _____ B/U C&W noise filter value
 _____ Alert noise filter value

Inhibit: _____ Alert parameter
 _____ FDA software
 _____ B/U C&W parameter

Enable: _____ Alert parameter
 _____ FDA software
 _____ B/U C&W parameter
4. True or false. After the software ID is entered, the VALUE field and the appropriate ALERT and B/U C&W fields will be filled.
5. True or false. A different set of Alert limits, from the set that is currently active, may be selected by executing an item on SPEC 60.
6. The present value of the parameter whose ID is entered in item 1 is displayed in the _____ field
7. Which of the following cannot be changed by item entries on SPEC 60?
 - a. PARAM ID
 - b. PARAM VALUE
 - c. BACKUP C/W LIMITS, LOW and HIGH
 - d. BACKUP C/W FILTER

8. An Alert parameter may have _____ set(s) of limits, and a B/U C&W parameter may have _____ set(s).
9. An asterisk appears next to item _____ if the second set of Alert limits is selected by preconditioning software. (This asterisk cannot be moved by a crew item entry.)
10. The flight controllers can make the same changes to the SM software that the crew makes using SPEC 60 by performing a _____ .
11. SM program constants can be changed by entering the constant ID in item _____ and entering the desired value in item _____ .
12. To save changes made to the SM software (via SPEC 60 or a TMBU) on an MMU, a _____ must be initiated by executing item _____ on SPEC 60.
13. In order for a checkpoint to be retrieved from an MMU, CKPT RETRV ENA (item _____ on SPEC _____) must be executed.

Answers

1. SPEC 60, SM TABLE MAINT, is available in the SM major function of OPS 2 and 4.
2. Valid software IDs and preflight limit values are available to the crew in the C&W and FDA table of the Reference Data Book of the FDF.
3. The specific item numbers are as follows:

Software ID	<u>Item 1</u>
Read or change:	<u>11</u> B/U C&W lower limit
	<u>2,4,6</u> Alert lower limits
	<u>12</u> B/U C&W upper limit
	<u>3,5,7</u> Alert upper limits
Verify or change:	<u>13</u> B/U C&W noise filter value
	<u>8</u> Alert noise filter value
Inhibit:	<u>10</u> Alert parameter
	<u>20</u> FDA software
	<u>15</u> B/U C&W parameter
Enable:	<u>9</u> Alert parameter
	<u>19</u> FDA software
	<u>14</u> B/U C&W parameter

4. True. After the software ID is entered, the VALUE field and the appropriate ALERT and B/U C&W fields will be filled.
5. False. A set of Alert limits that is different from the set that is currently active cannot be selected by executing an item on SPEC 60.
6. The present value of the parameter whose ID is entered in item 1 is displayed in the PARAM VALUE field.
7. b. PARAM VALUE cannot be changed by item entries on SPEC 60.
8. An Alert parameter may have from one to three sets of limits, and a B/U C&W parameter may have one set.
9. An asterisk appears next to item 4 if the second set of Alert limits is selected by preconditioning software. (This asterisk cannot be moved by a crew item entry.)
10. The flight controllers can make the same changes to the SM software that the crew makes using SPEC 60 by performing a TMBU.

11. SM program constants can be changed by entering the constant ID in item 16 and entering the desired value in item 17.
12. To save changes made to the SM software (via SPEC 60 or a TMBU) on an MMU, a checkpoint must be initiated by executing item 18 on SPEC 60.
13. In order for a checkpoint to be retrieved from an MMU, CKPT RETRV ENA (item 12 on SPEC 1) must be executed.

Section 9

Miscellaneous

Fault Summary

A historical summary of all Class 2 and Class 3 fault messages is provided through the FAULT display. The PASS fault summary display consists of 15 fault message lines and the BFS 20 (Figure 9-1). The message lines appear in reverse chronological order, with the oldest message displayed on the bottom line. When a new fault message is generated, it appears on the first line. The other messages are pushed down and the 15th or 20th (BFS) message disappears.

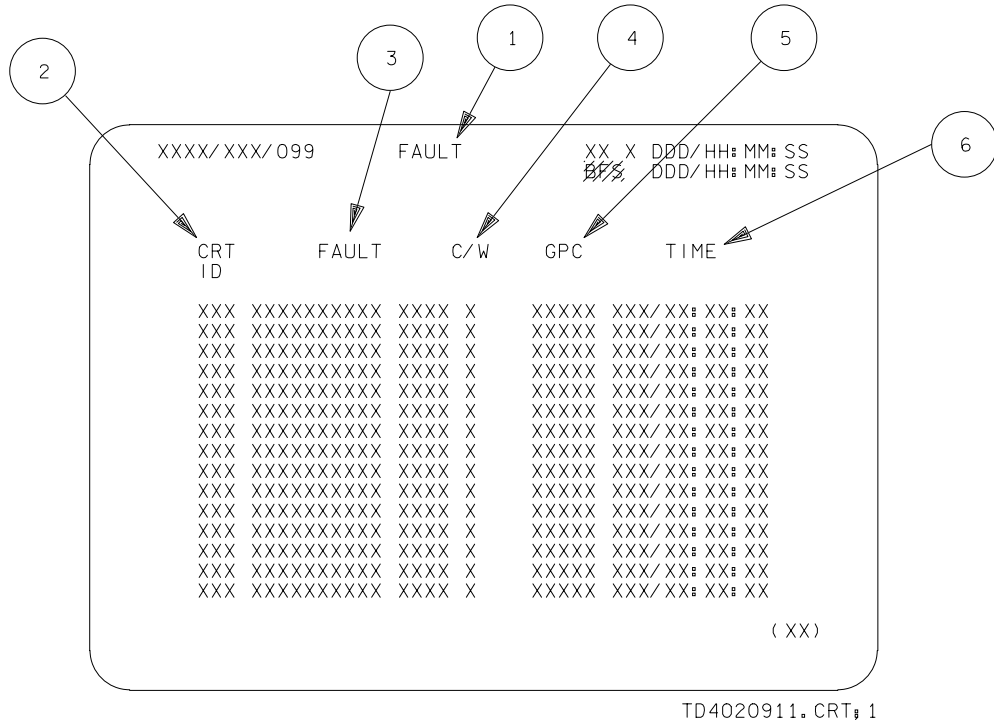
The only difference between the messages on the fault message line and the FAULT display is the TIME field. On the FAULT display, the TIME field includes days as well as hours, minutes, and seconds (DDD/HH:MM:SS).

The FAULT display is a DISP available in all OPS regardless of major function. It is selected for viewing by depression of the FAULT SUMM key or is selected by the keyboard entry SPEC 99 PRO. However, entering SPEC 99 PRO clears all fault messages from the FAULT display and the fault message lines. This capability is useful if and when the fault messages displayed are no longer significant (in other words, they are old or they have been dealt with).

Sometimes, a subsystem failure or malfunction results in the output of several fault messages, some of which may be identical. The FDA logic prevents the annunciation of identical fault messages. When a fault message is generated, its major and minor fields are compared to those of the top message of the display. If the fields are the same and if the new fault message has occurred within 4.8 seconds of the top message, the new message is inhibited.

The message displayed on the fault message line of any CRT is not necessarily the most recent fault message. Unless the fault message line was cleared with an MSG RESET, the crewmember will not see any new messages that came in on top of the flashing or frozen message. In that case, the crewmembers can see whether a new message has been annunciated by looking at a two-character field located in the last field on the far right of the fault message line. This field is called the buffer message indicator.

The buffer message indicator serves to indicate the number of messages in the fault buffer on the FAULT display since the last MSG RESET. The currently displayed message is not included in this counter. The number is enclosed by parentheses. If there are no fault messages in the stack, this field is blank. To view any of these messages, the crewmember must look at the FAULT SUMM display or scroll through the messages using the ACK key. An MSG RESET clears the fault message line and the buffer message indicator.



NOTE: // indicates parameters are driven and displayed on the BFS displays only.

Note: // indicates parameters are driven and displayed on the BFS displays only.

- (1) **FAULT** display. A system level display available in all OPS sequences. Includes up to 15 (20 for BFS) summary messages of faults (alerts of C&W) which have occurred. The message ordered so that the latest fault is at the top of the page. The display is called via a dedicated key (FAULT SUMM). If the display is called via SPEC 099 PRO, the messages are cleared.
- (2) **CRT ID**. A three-character field identifying the Cathode Ray Tube (CRT) page on which the fault is displayed. The first character represents the major function (G for Guidance, Navigation, and Control (GNC), S for Systems Management (SM), P for Payload (PL)), and the last two digits are the display number. However, the CRT Identification (ID) is not included in messages that are not referenced to a CRT display page.
- (3) **FAULT**. Text identifying the system experiencing the fault.
- (4) **C/W**. Use only with C/W messages. The field displays an indicator (*) if a lower or an upper limit was exceeded.
- (5) **GPC**. Identification of the General Purpose Computer (GPC) which detected and identified the fault. The BFS display has a single column for indicating the BFS GPC identification.
- (6) **TIME**. The mission time (in day/hr:min:sec) at which the fault was annunciated.

Figure 9-1. FAULT summary display

If messages have been accidentally erased or scrolled off the FAULT display, crewmembers can contact the ground for required information. The last five entries of the fault summary page are included in the downlist data. Downlisting occurs automatically every 5 seconds.

Annunciator Controls

The annunciator controls allow the crew to select the power source and adjust the intensity of annunciator lights. There is also a lamp test capability.

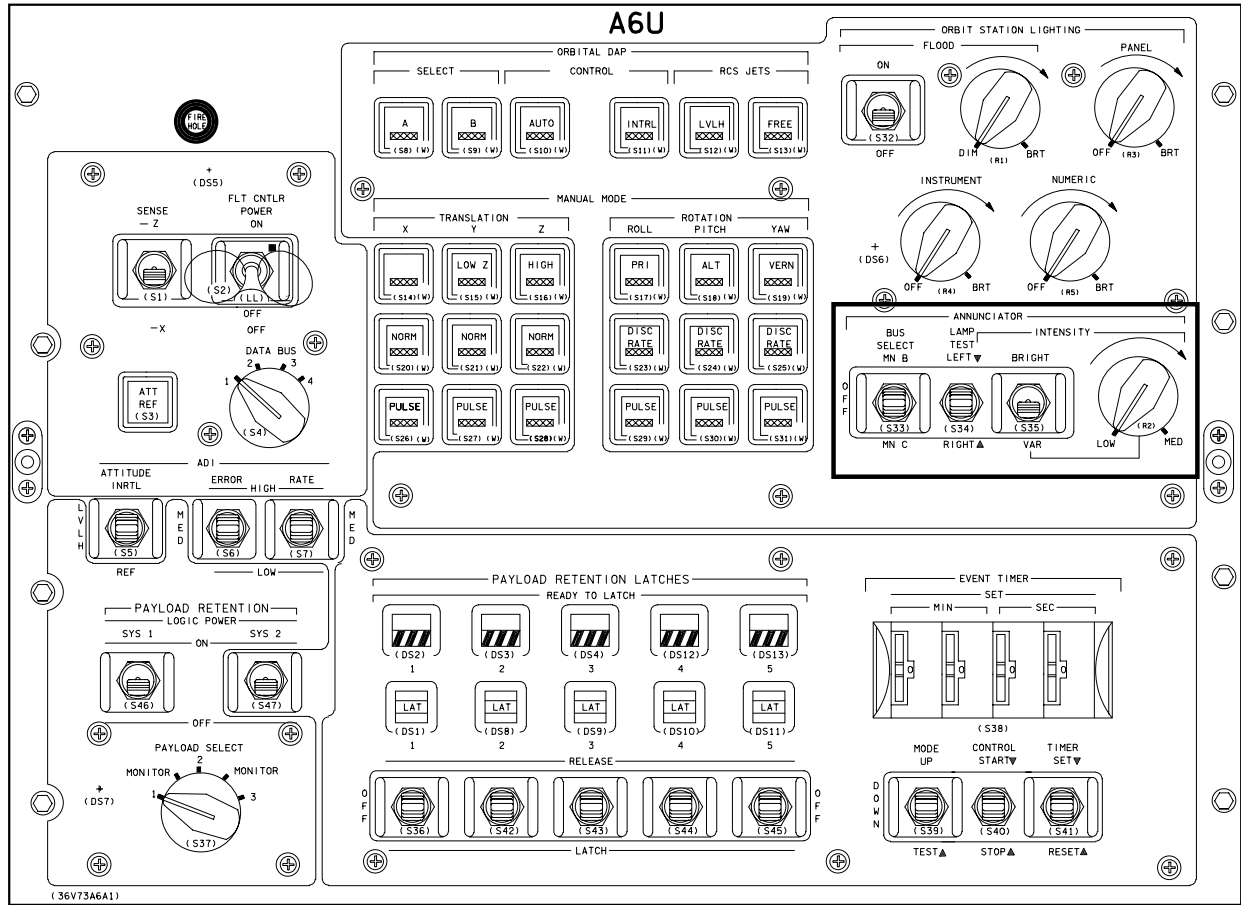
Annunciator Control Assemblies (ACAs) receive command signals that tell the ACA when to illuminate each light. The ACA illuminates appropriate lights to the intensity specified by the intensity controls. It uses the power source provided by the bus select switch. The panel F7 C&W Annunciation Matrix uses the forward annunciator controls but does not use an ACA (Figure 4-4). There are five ACAs on the orbiter. Look at SSSH Drawing 4.3-1 and Table 4.1 for details on what each ACA powers.

Lamp tests are always performed at full intensity, regardless of the position of the bright/variable switch.

Panel A6U

The annunciator controls on panel A6U are used to select the following (Figure 9-2):

- Bus select - Used to select either main bus B or C to power annunciation lights on aft panels.
- Lamp test left or right - Used to ensure that all lights are functional on aft panels.
- Bright/variable switch - Used to adjust intensity of the lights on aft panel; bright position illuminates lights at full intensity.
- Intensity dial - Used when bright/variable switch is in variable position; adjusts light intensity from low to medium.



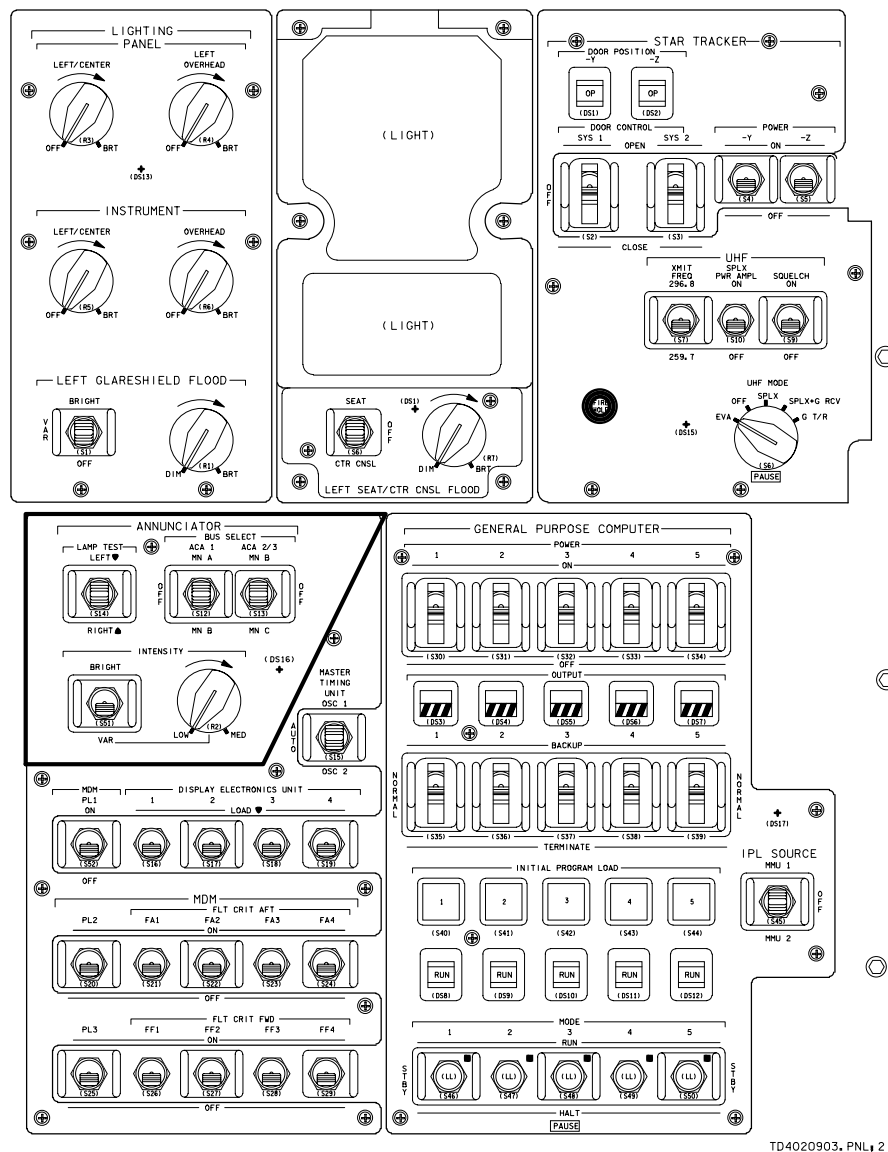
TD402902, PNL 2

Figure 9-2. Panel A6U

Panel O6

The annunciator controls on panel O6 (above the CDR's seat) are used to select the following (Figure 9-3):

- Bus select - Used to select the main bus to power annunciation lights on forward panels.
- Lamp test, left or right - Used to ensure that all lights are functional on forward panels.
- Bright/variable switch - Used exactly as the one on panel A6U, except it controls the forward panels.
- Intensity dial - Functions like the panel A6U dial.



TD4020903, PNL 2

Figure 9-3. Panel O6

Panel O8

Panel O8 (above the pilot's seat) has only the lamp test, which functions and controls exactly as the lamp test on panel O6 (Figure 9-4).

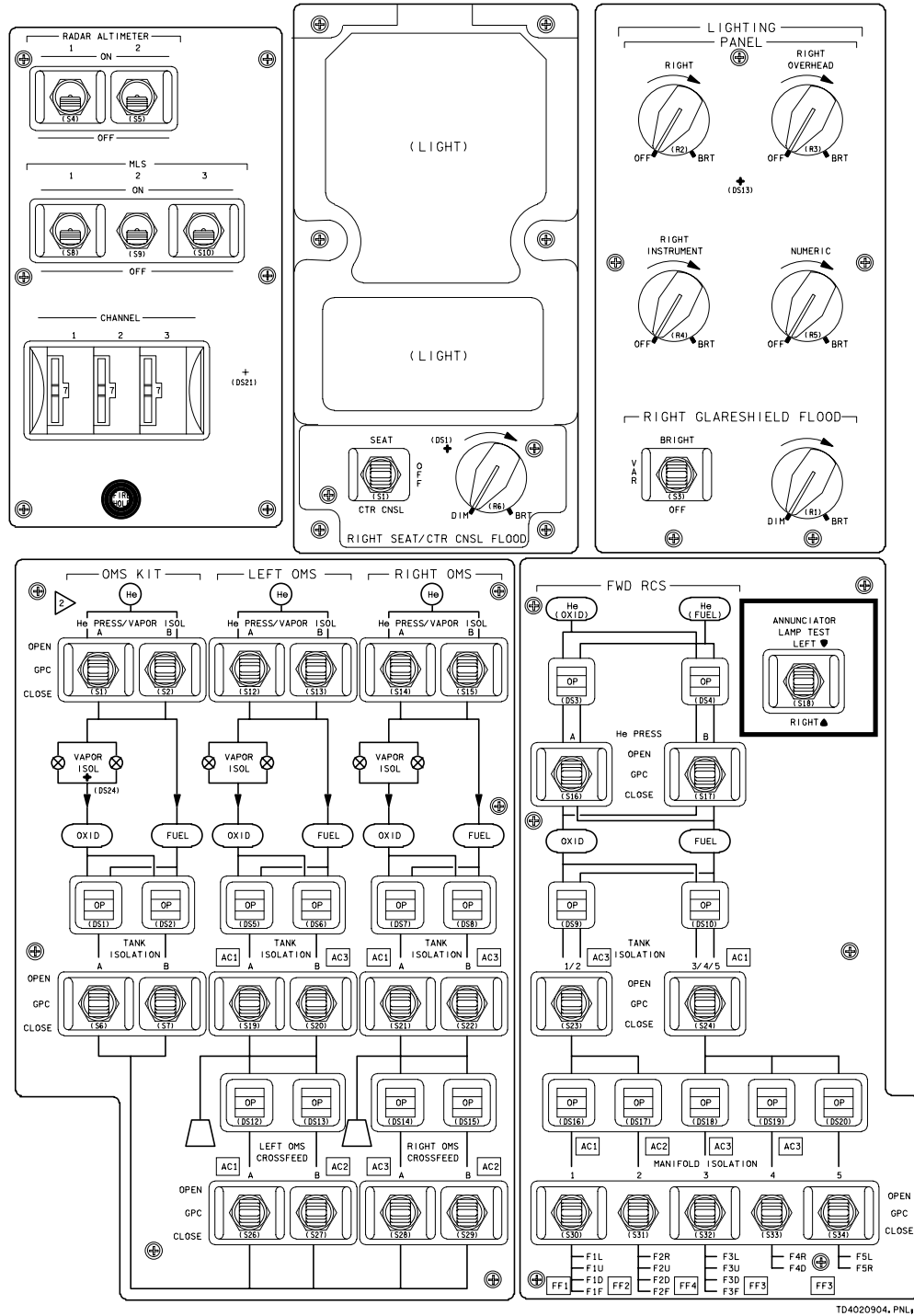


Figure 9-4. Panel O8

Displays and controls

Panel	Type	Nomenclature/ position	Function	Remarks
O13	Circuit breaker (Figure 3-3)	ESS 1BC C&W A	Power from Essential Bus 1BC (ESS) to the A power supply, the MASTER ALARM A bulbs, the C&W annunciator panel lights power supply, and the SM backup C&W A amplifier	Row A
O13	Circuit breaker	ESS 2CA C&W B	Power from ESS 2CA to the B power supply and the SM backup C&W B amplifier	Row C
O6 and O8	3-Pos momentary	Annunciator Lamp Test LEFT-OFF- RIGHT	Tests the "event" light bulbs on the left and right sides of the cockpit, including C&W and emergency lights	
F2 and F4	Pushbutton indicator	MASTER ALARM	Displays MASTER ALARM any time a C&W parameter exceeds its limits. It also acts as a switch which, when depressed, resets the master alarm tone and light logic, as well as provides an alternate source of power to the C&W annunciator power supply when the mode switch is in the ACK position	2 PBIs
C3	3-Pos momentary	Caution and Warning Memory READ-CLEAR	READ position illuminates lights on the C&W annunciator light matrix for all parameters that have been out of limits since the last memory clear command CLEAR position clears the recall memory in the electronics unit	
C3	3-Pos toggle	Caution and Warning Mode ACK-NORM- ASCENT	Acknowledge (ACK) - Allows the C&W annunciator lights to illuminate only when one of the two front cockpit master alarm PBIs are depressed NORM - When an out-of-limits parameter is detected, the system will initiate a master alarm light and audio tone, turn on the appropriate C&W annunciator light, and set the parameter number in the recall memory and primary C&W trigger memory	

Displays and controls

Panel	Type	Nomenclature/ position	Function	Remarks
			ASCENT - Keeps the panel F4 master alarm PBI from illuminating when an out-of-limits condition triggers a C&W alarm	
R-13	Lights (Figure 3-2)	Caution and Warning Status	A 120-light matrix with multiple functions. Each light represents a C&W input parameter. In addition, columns 0, 2, and 3 represent volt readings of parameter limits	
R-13	Screwdriver operated pot	Tone Volume A	Adjusts the volume of the C&W A tones that go into the Communications Audio Central Control Unit (COMM ACCU)	
R-13	Screwdriver operated pot	Tone Volume B	Adjusts the volume of the C&W B tones that go into the COMM ACCU	
R-13	3-Pos momentary	Parameter Status TRIPPED- INHIBITED	TRIPPED - Illuminates lights in the C&W status light matrix corresponding to the input parameters that are currently out-of-limits, regardless of whether or not they are inhibited INHIBITED - Illuminates lights in the C&W status light matrix corresponding to the parameters that have been inhibited	
R-13	3-Pos momentary	Memory READ-CLEAR	READ - Illuminates lights on the C&W status light matrix for all enabled parameters that have been out-of-limits since the last clear command	
R-13	3-Pos momentary	Lamp Test LEFT-RIGHT	Causes the lights in the left or right halves of the status matrix to illuminate	

Displays and controls

Panel	Type	Nomenclature/ position	Function	Remarks
R-13	3-Thumbwheels	Parameter Select	Identifies the parameters 000 through 119 that represent the 120 inputs to the primary C&W system	The left thumb-wheel has only the digits 0 and 1
R-13	3-Thumbwheels	Limit Set Value	A set of three switches used to set the upper or lower limit of a specific parameter	Will go from 0.00 to 5.95 in increments of 0.05
R-13	2-Pos toggle	Limit UPPER-LOWER	Specifies the parameter upper or lower limit for reading or changing	
R-13	2-Pos momentary	Function SET-READ	SET - Sets the limit specified in the value thumbwheels into the desired parameter READ - Causes the limit, as specified by the parameter thumbwheels and the limit switch, to be displayed in the LIMIT VOLTS columns of the status matrix	In columns 0, 2, and 3
O13	2-Pos momentary	PARAM ENABLE/INHIBIT	Enables and inhibits the out-of-limits alert portion of the parameter specified on the parameter thumbwheels	
F7	40-Light array	Annunciator array	A 40-light module of advisory lights driven by the C&W parameters in OR'd logic. These lights are grouped to display system or functional failures on the same light	See Figure 3-1
A7	Pushbutton indicator	MASTER ALARM	Displays MASTER ALARM any time a C&W parameter exceeds a limit. It also acts as a switch that resets the master alarm logic when depressed	1 of 4
MO52	Pushbutton indicator	MASTER ALARM	Same as the MASTER ALARM on panel A7	1 of 4

Audio Annunciation Control

Because of the importance of the audio annunciation for the C&W system, there is a certain amount of redundancy within the system. Two tone generators each output all four alarm tones. All four alarm tones are routed to both headsets and speakers throughout the orbiter. This routing is performed by the orbiter communication system (AUD/UHF 2102 Training Manual).

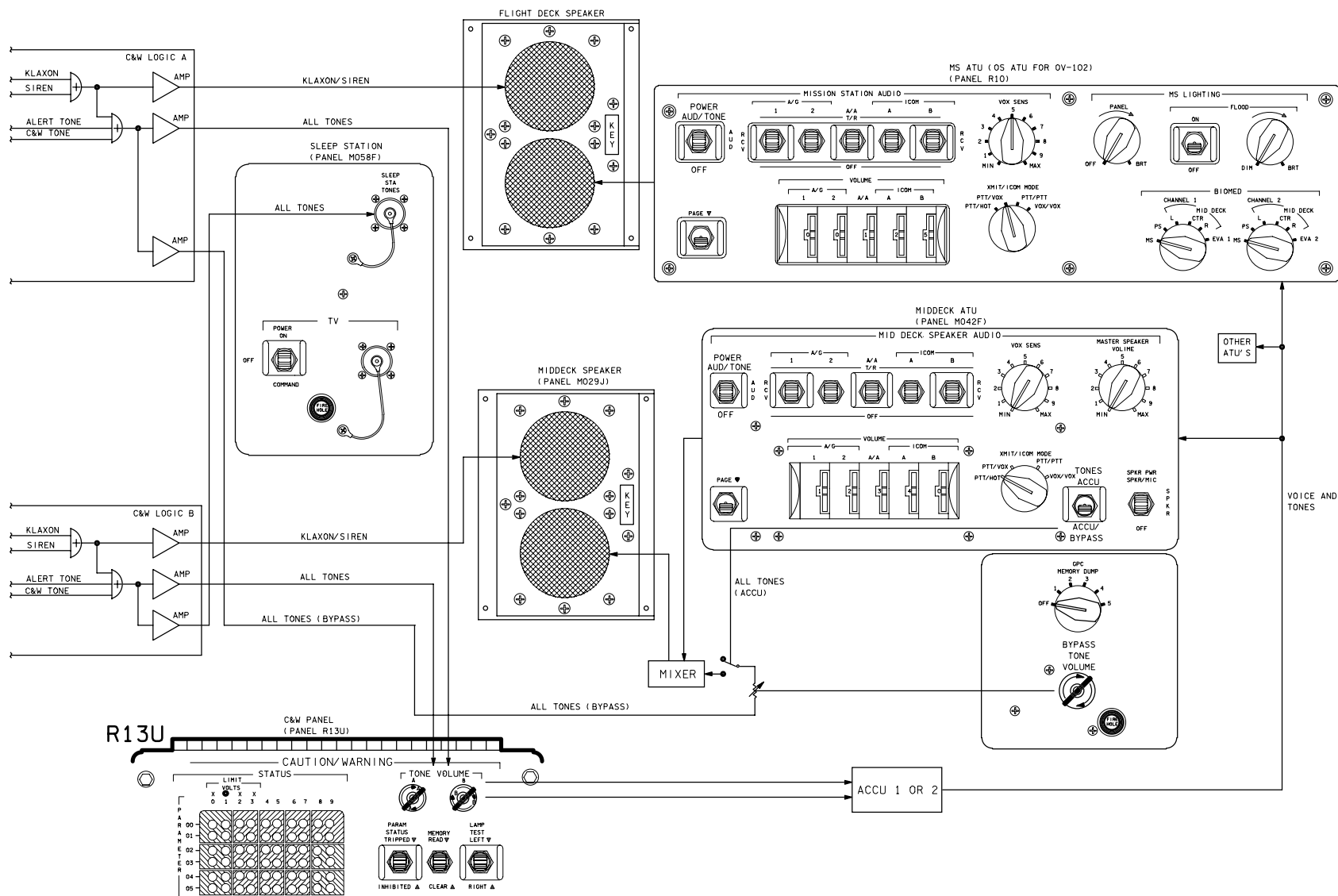
Within the Primary C&W system caution and warning electronics unit, there are two tone generators (A and B); each generates a Klaxon, a siren, an Alert tone, and a C&W tone. Each tone generator has three outputs (Figure 9-5).

One of the outputs from each of the tone generators sends all alarm tones through the panel R13 tone volume control potentiometers to the Audio Central Control Unit (ACCU), which distributes the audio alarms to the headsets, one speaker of the middeck speaker unit, and one speaker of the flight deck speaker unit (each speaker unit contains two speakers).

A second output from each of the two tone generators is used only for Klaxon and siren alarms. The A tone generator siren/Klaxon direct output drives the other speaker in the flight deck speaker unit. The B tone generator siren/Klaxon direct output drives the other speaker in the middeck speaker unit.

The third output of the A tone generator sends all alarms to the BYPASS TONE VOLUME control, located on middeck panel M042F. If the TONES switch (also on panel M042F) is in the ACCU/BYPASS position (rather than the ACCU position), the A tones are sent directly to the middeck speaker unit. These go to the same speaker that the first output goes to (via the ACCU).

The third output of the B tone generator sends all alarms to the sleepstation headset connector.



TD4020910, PNL 1

Figure 9-5. Alarm tone distribution

Appendix A

Acronyms, Abbreviations, and Symbols

ACA	Annunciation Control Assembly
ACCU	Audio Central Control Unit
ACK	Acknowledge
APU	Auxiliary Power Unit
ATU	Audio Terminal Unit
B/U	Backup
BFS	Backup Flight System
C/L	Checklist
C/W	Caution and Warning
C&W	Caution and Warning
cb	circuit breaker
CDR	Commander
CNS	Central Nervous System
CO	Carbon Monoxide
CPA	Combustion Products Analyzer
CRT	Cathode Ray Tube
CSI	Crew Software Interface
CWEU	Caution and Warning Electronics Unit
D&C	Display and Control
dP/dt	Delta Pressure/Delta Time
DPS	Data Processing System
ECLSS	Environmental Control and Life Support System
EPS	Electrical Power System
ESS	Essential
FC	Fuel Cell
FDA	Fault Detection and Annunciation
FDF	Flight Data File
FF	Fight Forward
FSR	Flight Software Requirements
FUNC	Function
GAX	Guidance, Navigation, and Control Annunciation Interface
GNC	Guidance, Navigation, and Control
GPC	General Purpose Computer
HCI	Hydrogen Chloride
HCN	Hydrogen Cyanide
HF	Hydrogen Fluoride
Hz	Hertz (cycles per second)

ID	Identification
IDLH	Immediate Danger to Life and Health
IFM	In-Flight Maintenance
LL	Lower Limit
m ³	cubic meter
μg	microgram
MA	Master Alarm
MCC	Mission Control Center
MDM	Multiplexer/Demultiplexer
MET	Mission Elapsed Time
mg	milligram
MM	Major Mode
MMU	Mass Memory Unit
ms	millisecond
N ₂	nitrogen
NORM	Normal
NSI	NASA Standard Initiator
O ₂	oxygen
OPS	Operational Sequence Operations
OV	Orbiter Vehicle
PASS	Primary Avionics Software System
pbi	pushbutton indicator
PIC	Pyro Initiation Controller
PKT	Pocket
PL	Payload
PPM	Parts per million
PROM	Programmable Read-Only Memory
psia	pounds per square inch absolute
psig	pounds per square inch gauge
RM	Redundancy Management
SELS	SFOC Electronic Library System
SFOC	Space Flight Operations Contract
SM	Systems Management
SMAC	Spacecraft Maximum Allowable Concentration
SRB	Solid Rocket Booster
SSSH	Space Shuttle Systems Handbook
TLV	Threshold Limit Value
TMBU	Table Maintenance Block Update
UL	Upper Limit

Training Materials Evaluation

Please answer the following questions regarding the lesson you just completed. Your feedback will allow us to produce more effective training materials. When complete, mail to: **Shuttle Systems Group/DT36.**

TITLE/CODE OF LESSON: Caution and Warning/C&W 21002

SIZE OF AUDIENCE/CLASS: _____

1. How well did this lesson meet its purpose?

For each statement below, mark one box on the scale:

- | | Strongly
Disagree | | | | | Strongly
Agree |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| a. <i>The lesson objectives are clearly stated.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| b. <i>The lesson objectives are clearly defined.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| c. <i>The lesson effectively teaches skills and information.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| d. <i>The lesson meets its purpose and objectives.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

2. How satisfying is the content of this lesson?

For each statement below, mark one box on the scale:

- | | Strongly
Disagree | | | | | Strongly
Agree |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| a. <i>The information is structured in a logical flow.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| b. <i>The content is clear.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| c. <i>The content is complete.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| d. <i>The level of detail is correct for this information.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| e. <i>The amount of information is effective.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| f. <i>The graphics contribute to my understanding.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

3. How appealing was the presentation of this lesson?

For each statement below, mark one box on the scale:

- | | Strongly
Disagree | | | | | Strongly
Agree |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| a. <i>The overall presentation is appealing.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| b. <i>The visuals chosen are appropriate for the lesson.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| c. <i>The visuals make the information more interesting.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| d. <i>The graphics are legibly reproduced.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| e. <i>The audio/visual or print quality is good.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

4. How valuable is this information?

For each statement below, mark one box on the scale:

- | | Strongly
Disagree | | | | | Strongly
Agree |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| a. <i>The lesson teaches skills and information I need.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| b. <i>The lesson meets my expectations.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| c. <i>This information is useful for later reference.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| d. <i>I would recommend this lesson to others.</i> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

**PLEASE WRITE YOUR COMMENTS/QUESTIONS ON THE BACK OF THIS FORM.
EXPLAIN ANY NEGATIVE ANSWERS IN SPECIFIC TERMS
THANK YOU IN ADVANCE FOR YOUR ASSISTANCE!**