REPORT OF
APOLLO 204
REVIEW BOARD

TO

THE ADMINISTRATOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APPENDIX C

SECTION 2

SECTION 2

SUBSECTION 2.9

SEQUENTIAL SYSTEMS

2.9.1 INTRODUCTION.

The sequential systems consist of control and detection systems which function during ascent and entry portions of a mission or in pre-orbital aborts. The control functions are sensing L/V status, displaying L/V status to the crew, automatically initiating LES aborts in an emergency during early ascent, and automatically sequencing the ELS during descent. Backup controls are provided for critical functions and normal events. The systems are the sequential events control system (SECS), emergency detection system (EDS), launch escape system (LES), and earth landing system (ELS). The systems interface with the reaction control system (RCS), guidance and navigation (G&N), service propulsion system (SPS), stabilization and control system (SCS), electrical power system (EPS), telecommunications (T/C), and controls and displays (C&D).

2.9.2 FUNCTIONAL DESCRIPTION.

The purpose of the sequential systems is to provide safety for the crew during the ascent and descent phases of a mission, and to perform normal separation functions. The EDS monitors operation of the L/V and will initiate an automatic abort in an emergency. The LES is provided for use during an emergency arising from malfunction of the L/V or other systems affecting crew safety. The LES will be utilized to abort the mission in an emergency by separating the C/M from the L/V and S/M. The LES can be operational from the launch pad until the launch escape tower is jettisoned. Following second stage booster ignition, the LES tower is jettisoned from the CSM-L/V combination. The ELS is provided to stabilize and decelerate the C/M following an entry into the earth atmosphere or following an abort. The ELS parachutes will lower the C/M at a suitable velocity and attitude until time of touchdown. A functional description of the sequential systems is contained in the following paragraphs.

SEQ

2.9.2.1 Sequential Events Control System (SECS).

The SECS consists of controllers (figure 2.9-1) that provide automatic, semiautomatic, and manual control for initiation or termination of functional events during various phases of the Apollo mission. The controllers are the master events sequence controller (MESC), earth landing sequence controller (ELSC), C/M reaction control system controller (C/M RCSC), service module jettison controller (SMJC). Each controller consists of redundant relays, timers, and other devices to control systems operation and automatic timing of events. Two controllers are provided in all cases for dual redundancy. The SECS will control the automatically sequenced events during a mission abort, normal CSM-SLA separation, normal C/M-S/M separation, and events during the earth landing phase. The SECS provides conditioned signals to telemetry equipment through the data distribution box so that vital information may be telemetered to MSFN.

The SECS will control the launch escape system (LES) during an abort up to the time of normal launch escape tower jettison. The SPS engine is utilized during an abort after LES tower jettison to propel the CSM away from the L/V. Normal separation of the SLA is performed by the SECS following manual initiation after earth orbit is attained. Emergency separation of the SLA is performed automatically 1.7 seconds after an SPS abort is manually initiated. C/M-S/M separation is performed by the SECS, and is manually initiated during the entry phase or subsequent to an SPS abort. During a LES abort, the C/M-S/M separation is performed automatically by the SECS. Events performed by the earth landing system are automatically controlled by the SECS during normal descent. Switches are provided for manual backup of critical events.

The basic functions performed by the SECS are as follows:

Event	Originates	Function/Input	Manual Control
Auto abort enable	MESC	Lift-off signal	EDS AUTO switch (MDC-16)
LE and PC motors fire	MESC	C/M-S/M separation relays	LES MOTOR FIRE switch (MDC-5)
Pitch motor inhibit	C/M RCSC	Lift-off + 61 seconds	ABORT SYSTEM-OX DUMP switch (MDC-16)
Auto RCS oxidizer dump inhibit	C/M RCSC	Lift-off + 61 seconds	ABORT SYSTEM-OX DUMP switch (MDC-16)
LES tower jettison	MESC	ELS armed and 24K ft baroswitch closure on LES aborts, manual 3 minutes after lift-off	ABORT SYSTEM-MODE switches A and B (MDC-16)
CSM-SLA separation	MESC	Translation control + 1.7 seconds	ADAP SEP switch (MDC-5)

SYSTEMS DATA

Event	Originates	Function/Input	Manual Control
RCS/SCS enable	MESC	Adapter separation + 2.5 seconds or C/M-S/M deadface +1 second	REACTION CONTROL SYSTEM-CMD switch (MDC-16)
LES abort initiation	MESC	EDS abort signal from L/V-IU	Translation control
C/M-S/M separation	MESC	C/M-S/M deadface relays +0.1 second	C/M-S/M SEP switches A and B (MDC-15)
Canard deploy	MESC	LES abort lockup relays +11 seconds	CANARD DEPLOY switch (MDC-5)
SPS abort initiation	MESC	Manual	Translation control
RCS/SCS disable	MESC	ELS armed and 24K ft baroswitch closure	REACTION CONTROL SYS-CMD switch (MDC-16)
Apex cover jettison	MESC	ELS armed and 24K ft baroswitch closure +0.4 second	APEX COVER JETT switch (MDC-5)
Drogue parachutes deploy	ELSC	ELS armed and 24K ft baroswitch closure +2 seconds	DROGUE DEPLOY switch (MDC-5)
Drogue parachutes release and main parachutes deploy	ELSC	ELS armed and 24K ft baroswitch closure + 14 seconds + 10K ft baroswitch closure	MAIN DEPLOY switch (MDC-5)
RCS propellants burn	C/M RCSC	Manual	C/M PROP JETT DUMP switch (MDC-8)
RCS purge	C/M RCSC	Manual	C/M PROP JETT PURGE switch (MDC-8)

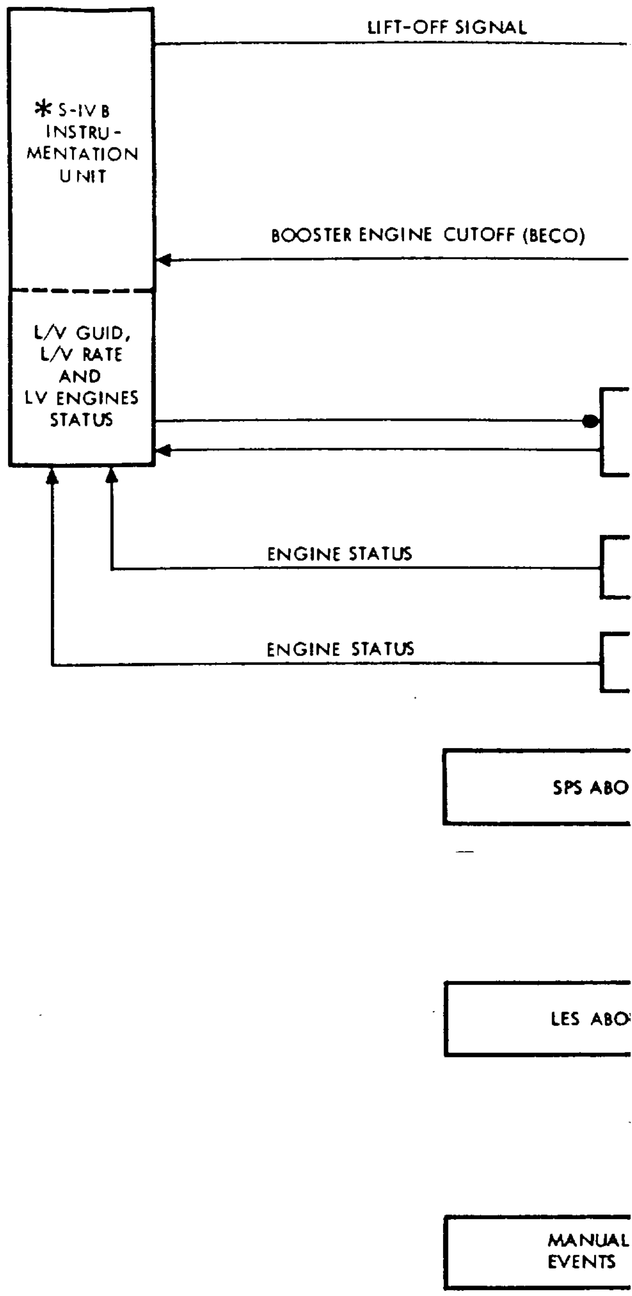
Event	Originates	Function/Input	Manual Control
Main parachutes release	ELSC	Manual	MAIN CHUTE release switch (MDC-16)
Postlanding antenna deploy	MESC	Manual	POST LANDING-ANTENNA-DEPLOY switches A and B (MDC-25)

2.9.2.2 Emergency Detection System.

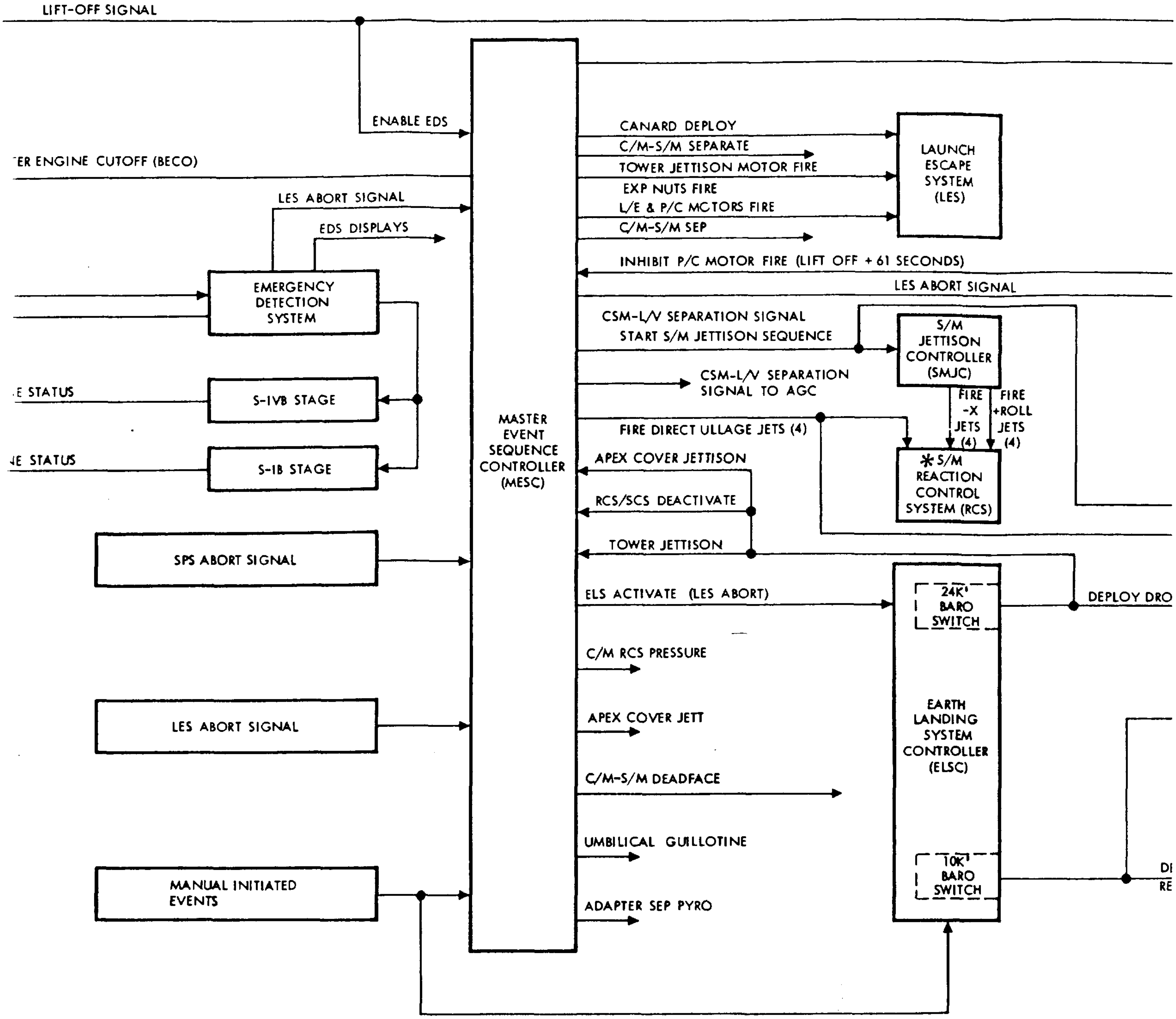
The EDS is designed to detect and display status and emergency conditions of the launch vehicle-spacecraft combination to the astronaut. The EDS also provides automatic abort initiation, under certain conditions, after lift-off up to the normal time of LES tower jettison.

The EDS display circuitry is enabled when the EDS POWER switch (MDC-24) is in the ON position and will illuminate lights on MDC-5 to indicate L/V status. The red L/V RATE light will illuminate when L/V rates are in excess of 20 degrees per second in roll and 5 degrees per second in pitch and yaw. The rates are sensed by three rate gyros mounted on each L/V axis in the instrumentation unit (IU). The red L/V GUID light (MDC-5) illuminates to indicate failure of the guidance unit which is also located in the instrumentation unit. The yellow L/V ENGINES lights (MDC-5) illuminate when a respective S-I booster engine is developing less than 90 percent of total thrust output. The L/V ENGINES lights are monitored for engine status during thrusting periods. During staging, the L/V ENGINES lights are monitored for illumination to indicate BECO and extinguish to indicate stage separation. After staging, the number 1 L/V ENGINE light indicates the status of the S-IVB Stage engine, it will be extinguished when the engine is producing 65 percent rated thrust. The ABORT light (MDC-3) is a red lamp assembly containing 4 bulbs. Two bulbs are in system A and two bulbs are in system B for redundancy. The ABORT light is illuminated if an abort is requested by launch control center for a pad abort or an abort during lift-off via radio. The ABORT light can be illuminated after lift-off by the Range Safety Officer transmitting a destruct arm command. The destruct arm command will also initiate BECO. An abort may also be requested via radio from the MSFN after lift-off +10 seconds.

The EDS automatic abort circuitry is enabled at lift-off providing the EDS AUTO switch (MDC-16) is in the AUTO position. (See figure 2.9-2.) A circuit is completed through the lift-off enable and first motion relays at lift off. The lift-off enable relays are latching

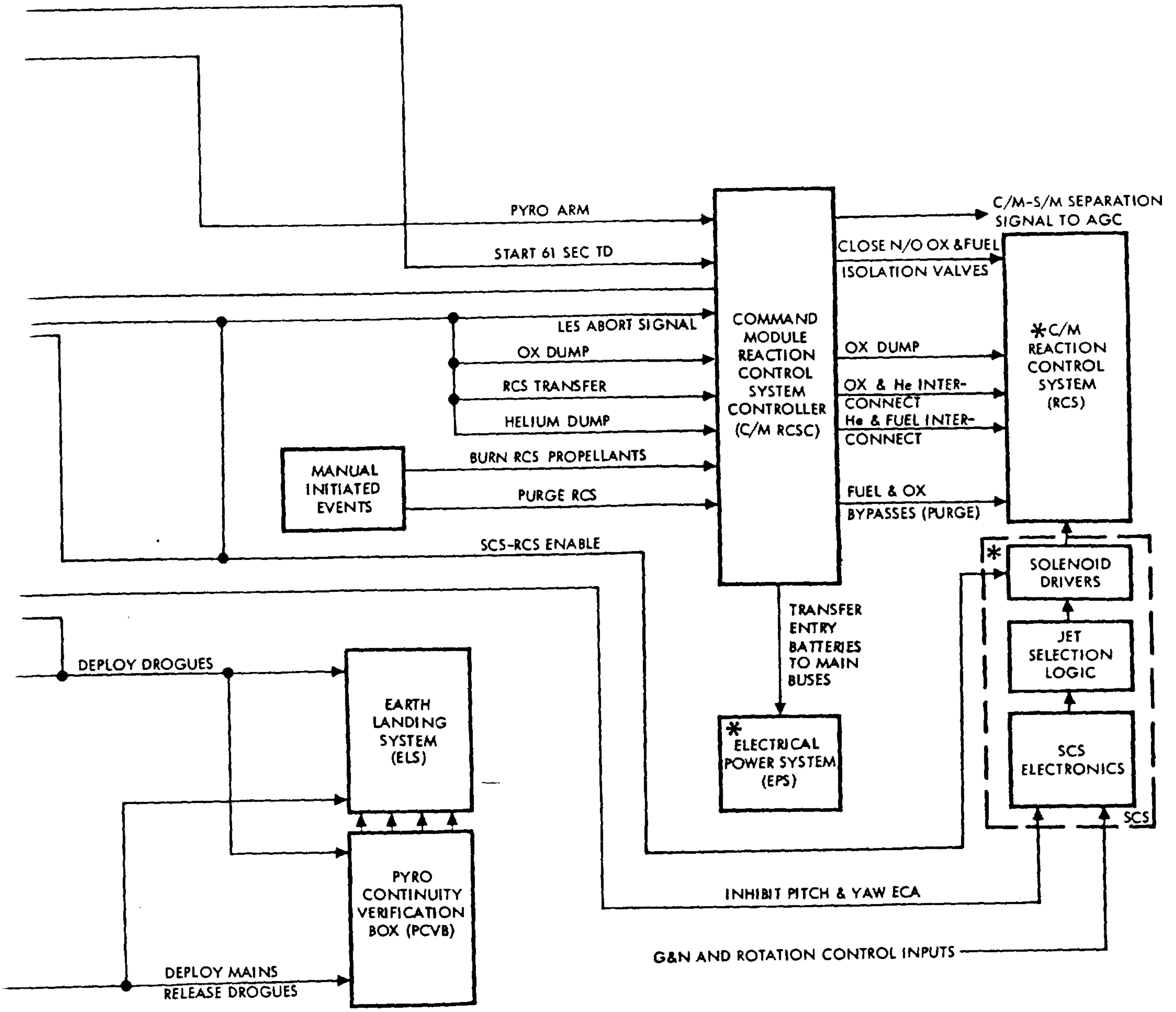


FOLDOUT FRAME 1



FOLDOUT FRAME 2

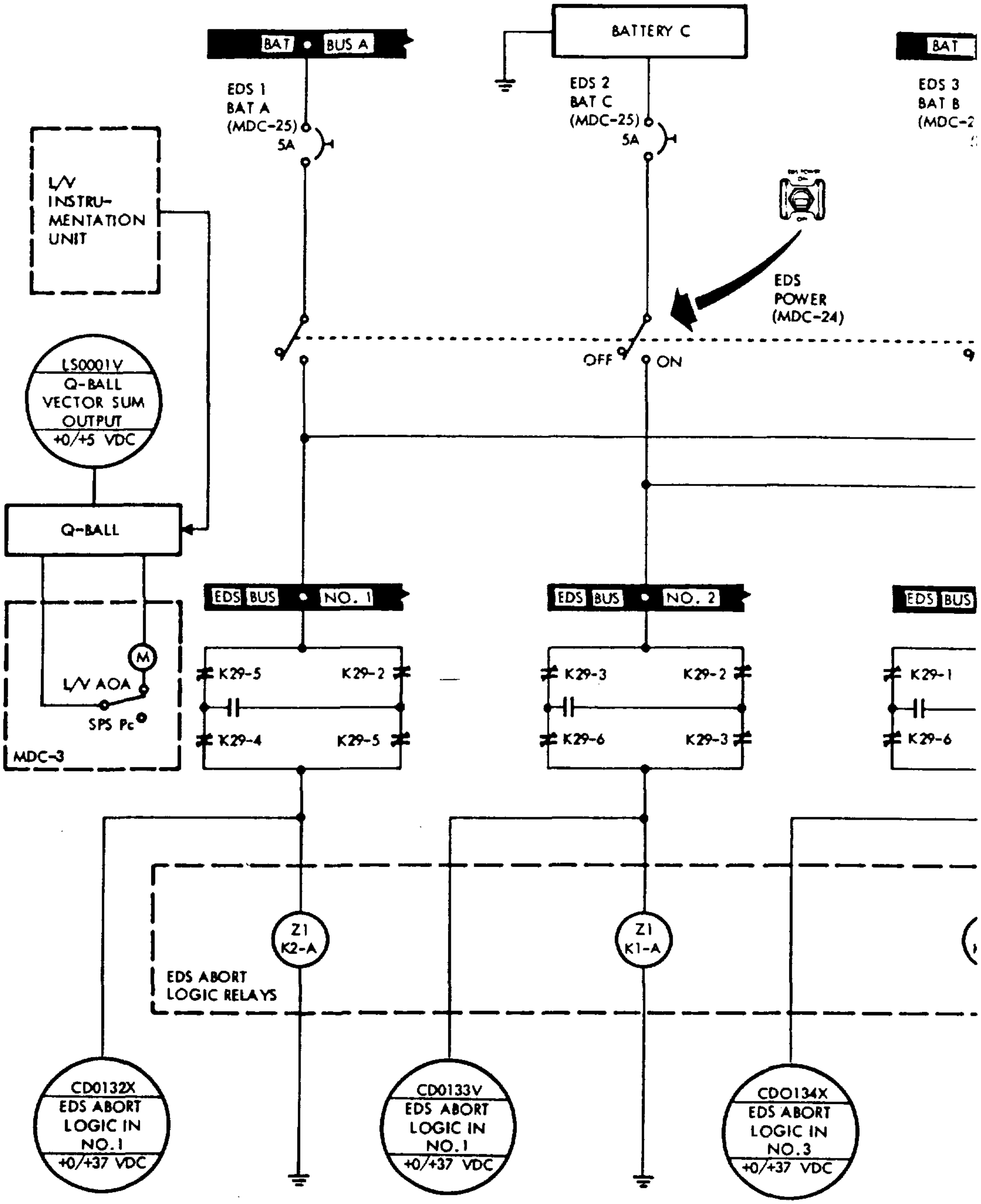
Mi

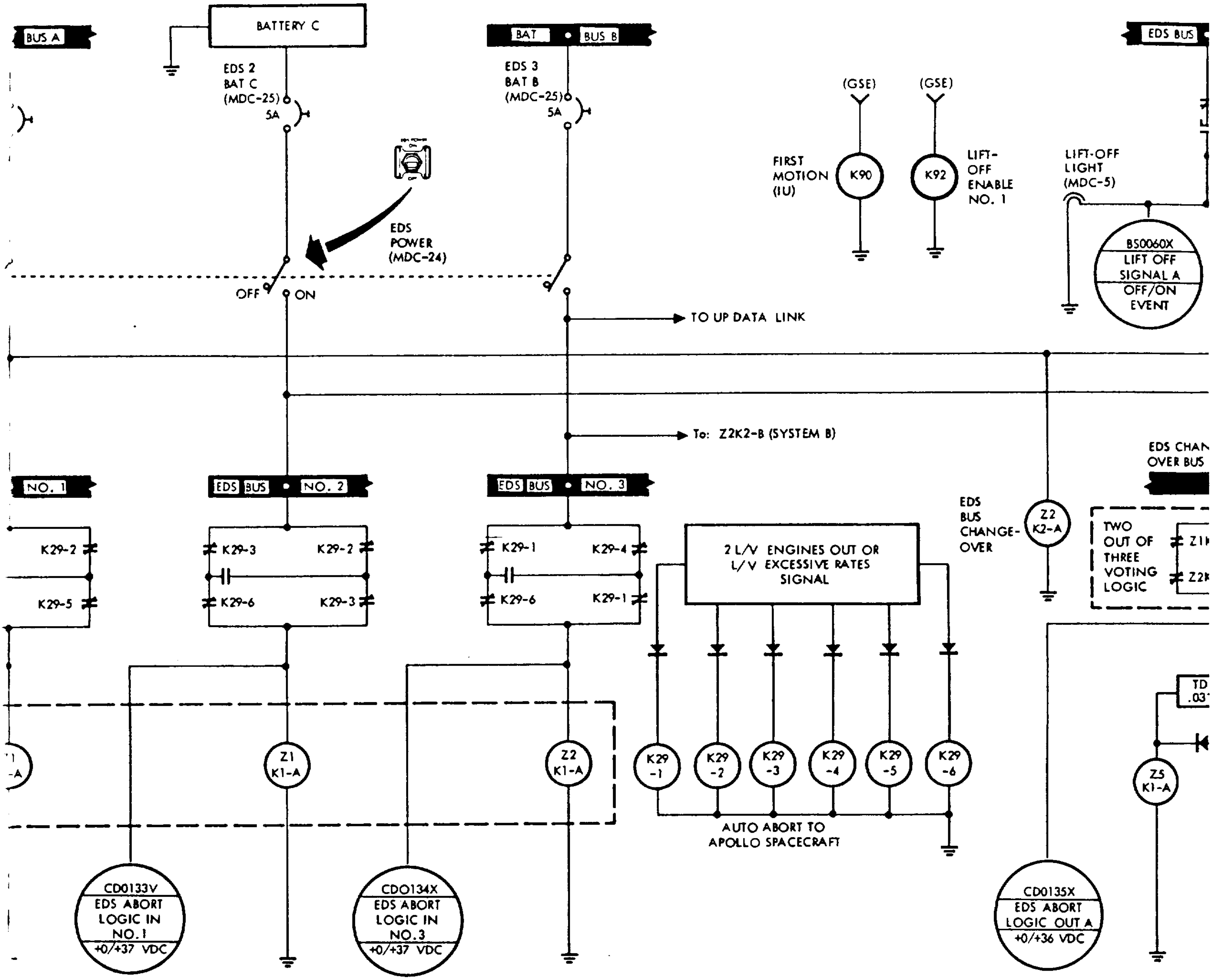


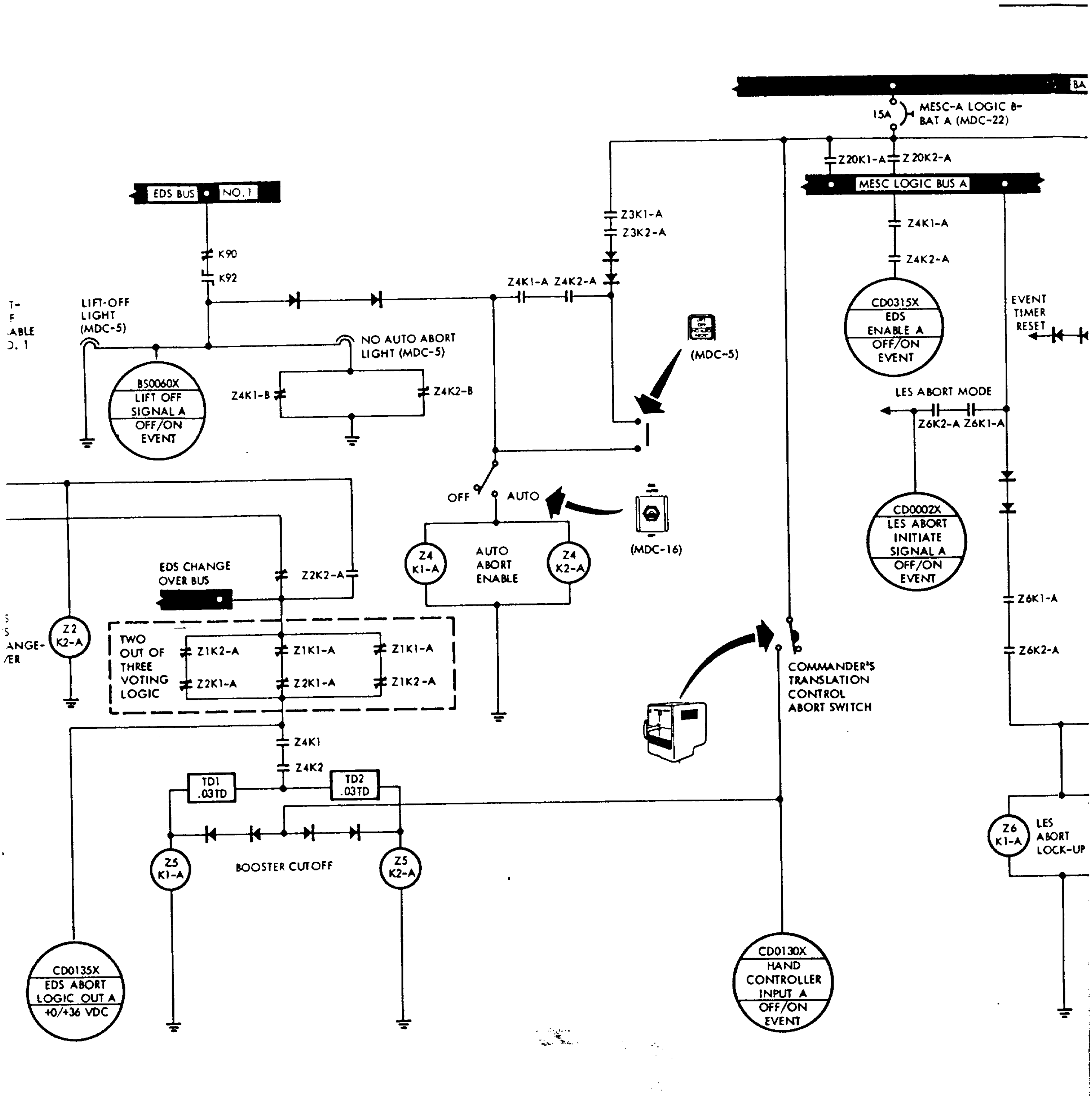
* NOT PART OF SECS (INTERFACE).

SM-2A-821C

Figure 2.9-1. SECS Controllers Interface Block Diagram


BAT • BUS A
BATTERY C
BAT
EDS 1
BAT A
(MDC-25)
5A
EDS 2
BAT C
(MDC-25)
5A
EDS 3
BAT B
L/V INSTRU-MENTATION UNIT
EDS POWER (MDC-24)
OFF
ON
LS0001V
Q-BALL VECTOR SUM OUTPUT
+0/+5 VDC
Q-BALL
EDS BUS • NO. 1
EDS BUS • NO. 2
EDS BUS
M
L/V AOA
SPS Pc
MDC-3
K29-5
K29-2
K29-4
K29-5
K29-3
K29-2
K29-6
K29-3
K29-1
K29-6
Z1 K2-A
Z1 K1-A
EDS ABORT LOGIC RELAYS
CD0132X
EDS ABORT LOGIC IN NO.1
+0/+37 VDC
CD0133V
EDS ABORT LOGIC IN NO.1
+0/+37 VDC
CDO134X
EDS ABORT LOGIC IN NO.3
+0/+37 VDC


BUS A
BATTERY C
EDS 2
BAT C
(MDC-25)
5A
BAT
BUS B
EDS 3
BAT B
(MDC-25)
5A
EDS BUS
(GSE)
(GSE)
FIRST
MOTION
(IU)
K90
K92
LIFT-
OFF
ENABLE
NO. 1
LIFT-OFF
LIGHT
(MDC-5)
BS0060X
LIFT OFF
SIGNAL A
OFF/ON
EVENT
EDS
POWER
(MDC-24)
OFF
ON
TO UP DATA LINK
To: Z2K2-B (SYSTEM B)
EDS CHAN
OVER BUS
NO. 1
EDS BUS NO. 2
EDS BUS NO. 3
K29-2
K29-5
K29-3
K29-2
K29-6
K29-3
K29-1
K29-4
K29-6
K29-1
2 L/V ENGINES OUT OR
L/V EXCESSIVE RATES
SIGNAL
EDS
BUS
CHANGE-
OVER
Z2
K2-A
TWO
OUT OF
THREE
VOTING
LOGIC
Z1
Z2
TD
.03
Z1
K1-A
Z2
K1-A
K29
-1
K29
-2
K29
-3
K29
-4
K29
-5
K29
-6
Z5
K1-A
AUTO ABORT TO
APOLLO SPACECRAFT
CD0133V
EDS ABORT
LOGIC IN
NO. 1
+0/+37 VDC
CD0134X
EDS ABORT
LOGIC IN
NO. 3
+0/+37 VDC
CD0135X
EDS ABORT
LOGIC OUT A
+0/+36 VDC


BA
15A
MESC-A LOGIC B-BAT A (MDC-22)
Z20K1-A
Z 20K2-A
MESC LOGIC BUS A
EDS BUS
NO. 1
Z3K1-A
Z3K2-A
K90
K92
Z4K1-A
Z4K2-A
Z4K1-A Z4K2-A
CD0315X
EDS ENABLE A
OFF/ON EVENT
EVENT TIMER RESET
LIFT-OFF LIGHT (MDC-5)
NO AUTO ABORT LIGHT (MDC-5)
(MDC-5)
BS0060X
LIFT OFF SIGNAL A
OFF/ON EVENT
Z4K1-B
Z4K2-B
LES ABORT MODE
Z6K2-A Z6K1-A
CD0002X
LES ABORT INITIATE SIGNAL A
OFF/ON EVENT
OFF
AUTO
Z4 K1-A
AUTO ABORT ENABLE
Z4 K2-A
(MDC-16)
EDS CHANGE OVER BUS
Z2K2-A
Z2 K2-A
TWO OUT OF THREE VOTING LOGIC
Z1K2-A
Z1K1-A
Z1K1-A
Z2K1-A
Z2K1-A
Z1K2-A
Z6K1-A
Z6K2-A
COMMANDER'S TRANSLATION CONTROL ABORT SWITCH
Z4K1
Z4K2
TD1 .03TD
TD2 .03TD
BOOSTER CUTOFF
Z5 K1-A
Z5 K2-A
Z6 K1-A
LES ABORT LOCK-UP
CD0135X
EDS ABORT LOGIC OUT A
+0/+36 VDC
CD0130X
HAND CONTROLLER INPUT A
OFF/ON EVENT

Mission

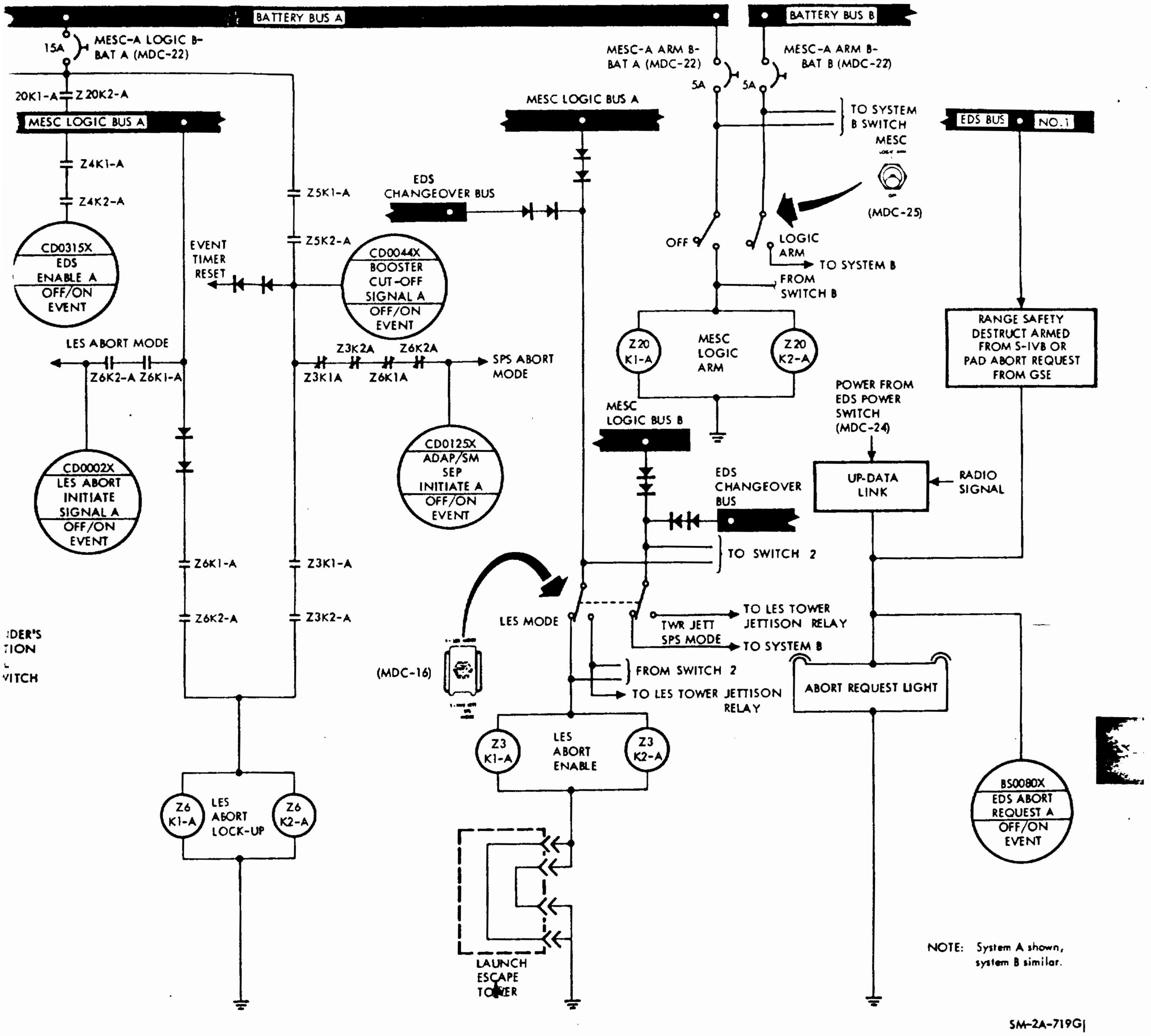


Figure 2.9-2. EDS Functional Schematic

type and are latched closed by GSE just prior to lift-off. The normally closed first motion relays remain energized by GSE until actual lift-off occurs. A circuit is completed through the relays and the EDS AUTO switch upon lift-off. The white LIFT-OFF light (MDC-5) illuminates and the red NO AUTO ABORT light (MDC-5) should remain extinguished. The astronaut presses the NO AUTO ABORT switch-light if it illuminates. The NO AUTO ABORT switch-light should also be pressed if the LIFT OFF light does not illuminate at lift-off. This would indicate that the circuit was not completed for illuminating the LIFT OFF light and energizing the auto abort enabling relays. Pressing the NO AUTO ABORT switch-light will energize the auto abort enabling relays through circuitry in the MESC. The EDS AUTO switch must be at AUTO to complete the circuit. The LIFT OFF light would not illuminate in this case. (Refer to Malfunction Procedures in section 9.) The LIFT OFF light is extinguished by circuitry in the L/V IU at approximately 5 seconds after illumination at lift-off. The EDS will automatically initiate an abort when two L/V engines fail or L/V excessive rates are sensed if these two functions are enabled. The two functions are enabled with the ABORT SYSTEM - 2 ENG OUT switch (MDC-16) and ABORT SYSTEM - RATES switch (MDC-16). The two switches are set to off to inhibit the two functions prior to S-IB staging. L/V guidance failure will not initiate an automatic abort. The crew will contact MSFN and a decision made on the action to be taken. If a destruct arm command is transmitted prior to inhibiting the two-engine out auto abort capability, the EDS will detect BECO and initiate an automatic abort. If a destruct arm command is transmitted after the two-engine out auto abort capability is inhibited, a manual abort must be initiated immediately when the ABORT light illuminates. Structural breakup or separation of the structure between the IU and C/M will also be detected by the EDS and an automatic abort initiated. During ascent on a normal mission, the EDS AUTO switch must be set to OFF prior to launch escape tower jettison. Inhibiting of the auto abort capability ensures that an automatic abort can not be initiated at the same time that the launch escape tower is being jettisoned. An abort may be initiated manually by rotating the commander's translation control to the counterclockwise detent position (20 degrees).

The parameters being sensed by the EDS are extremely time-critical at various periods during the boost phase. When these parameters are exceeded, an LES abort is automatically initiated to propel the escaping vehicle (C/M and LES) safely away from the launch vehicle prior to a catastrophic condition. Concurrently with abort initiation, either automatically or manually, logic circuitry will shut down engines in the L/V activate stage. The engine shutdown signal is inhibited by circuitry in the IU for the first 40 seconds of launch because of range safety restrictions.

A Q-ball (figure 2.9-3) mounted above the LES motors, provides an electrical signal input to the L/V AOA/SPS P_c indicator on MDC-3 and an electrical signal input to ground control via telemetry.

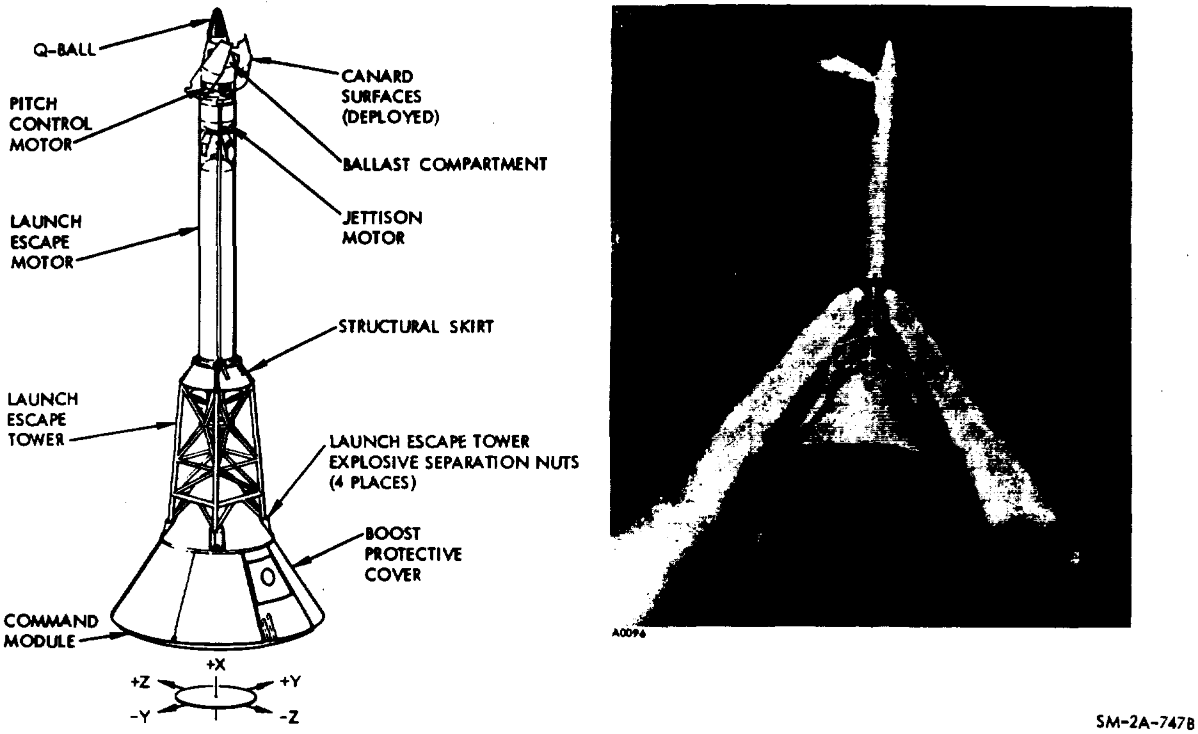


Figure 2. 9-3. Launch Escape System

The Q-ball has four static ports for measuring ΔP which is a function of angle of attack. The ΔP is related to pitch and yaw, and is electronically analyzed and displayed on the L/V AOA SPS P_c indicator on MDC-3. The indicator is graduated to 150 percent because of start transients of the SPS. The indicator is monitored for the L/V AOA function from 40 seconds after lift-off until approximately one minute and 40 seconds.

Position of the red line is based on vehicle structural limits and launch vehicle capabilities. A decision for manual abort initiation will be made when the indicator pointer reaches the red line and a movement is also observed on the FDAI.

2. 9. 2. 3 Launch Escape System.

Purpose of the LES (figure 2. 9-3) is to provide immediate abort capabilities from the launch pad to the normal time of LES tower jettison. The ABORT SYSTEM - MODE switches 1 and 2 (MDC-16) are in the LES MODE position prior to LES tower jettison, and an abort will be accomplished by utilizing the launch escape system. A manual or automatic initiated abort signal will activate a master event sequence controller (MESC). The MESC will initiate C/M-S/M separation, and ignite the launch escape and pitch control motors. Firing of the pitch control motor is automatically inhibited 61 seconds after lift-off by a time-delay relay. The LES motors provide sufficient thrust for the lift and lateral translation of the C/M away from the launch pad, or trajectory of the launch vehicle. Two canard surfaces (figure 2. 9-3) are deployed 11 seconds after abort initiation to orient the C/M to a blunt-end-forward attitude. (Refer to Abort Procedures in section 9.)

During a normal mission, the LES tower is jettisoned shortly after second stage booster (S-IVB) engine ignition. LES tower jettison is manually initiated approximately 3 minutes after lift-off by setting the ABORT SYSTEM - MODE switches 1 and 2 (MDC-16) to the TWR JETT SPS MODE position. Either switch will enable systems A and B of the redundant circuitry. Both switches should be set at the same time. Any abort, after LES tower jettison, must be accomplished in the SPS mode by utilizing the SPS engine. (Refer to Abort Procedures in section 9.)

A boost protective cover (BPC) completely covers the conical section of the command module. The cover protects the command module and windows from heating during the ascent phase, and soot at launch escape tower jettison in the event of an abort. The cover is attached to and is jettisoned with the LES tower. A removable section allows access to the C/M crew compartment. The cover has one window fabricated of fused silica glass and is located over the forward viewing window.

2. 9. 2. 4 Earth Landing System.

The ELS provides for safe return of the command module and crew following an earth orbital mission, a lunar mission, or mission abort. The ELS consists of two earth landing system controllers (ELSC) and parachutes. The ELS logic circuitry is armed automatically during an abort in the LES mode, and is armed manually with the ELS LOGIC switch on MDC-8 during a SPS abort or normal entry. The ELSC contains baro switches and time-delay relays. After the logic circuitry is armed, the ELSC automatically senses altitude and initiates deployment of the parachutes at the proper time. The time-delay relays control initiation of automatic events after the 24, 000 feet baro switch closes. The parachutes (figure 2. 9-4) are located in the forward compartment of the C/M, under the apex cover. During a normal entry or descent from an abort initiated above 30, 000 feet, the 24, 000 feet baro switch closes and completes a circuit to the MESC which jettisons the launch escape tower. The MESC initiates apex cover jettison 0. 4 seconds after launch escape tower jettison. Closing of the 24, 000 feet baro switch completes a circuit to a 2-second time delay and a 14-second time delay to jettison the drogue parachutes in 2 seconds. The 14-second time delay completes a circuit to the 10, 000 feet baro switch.

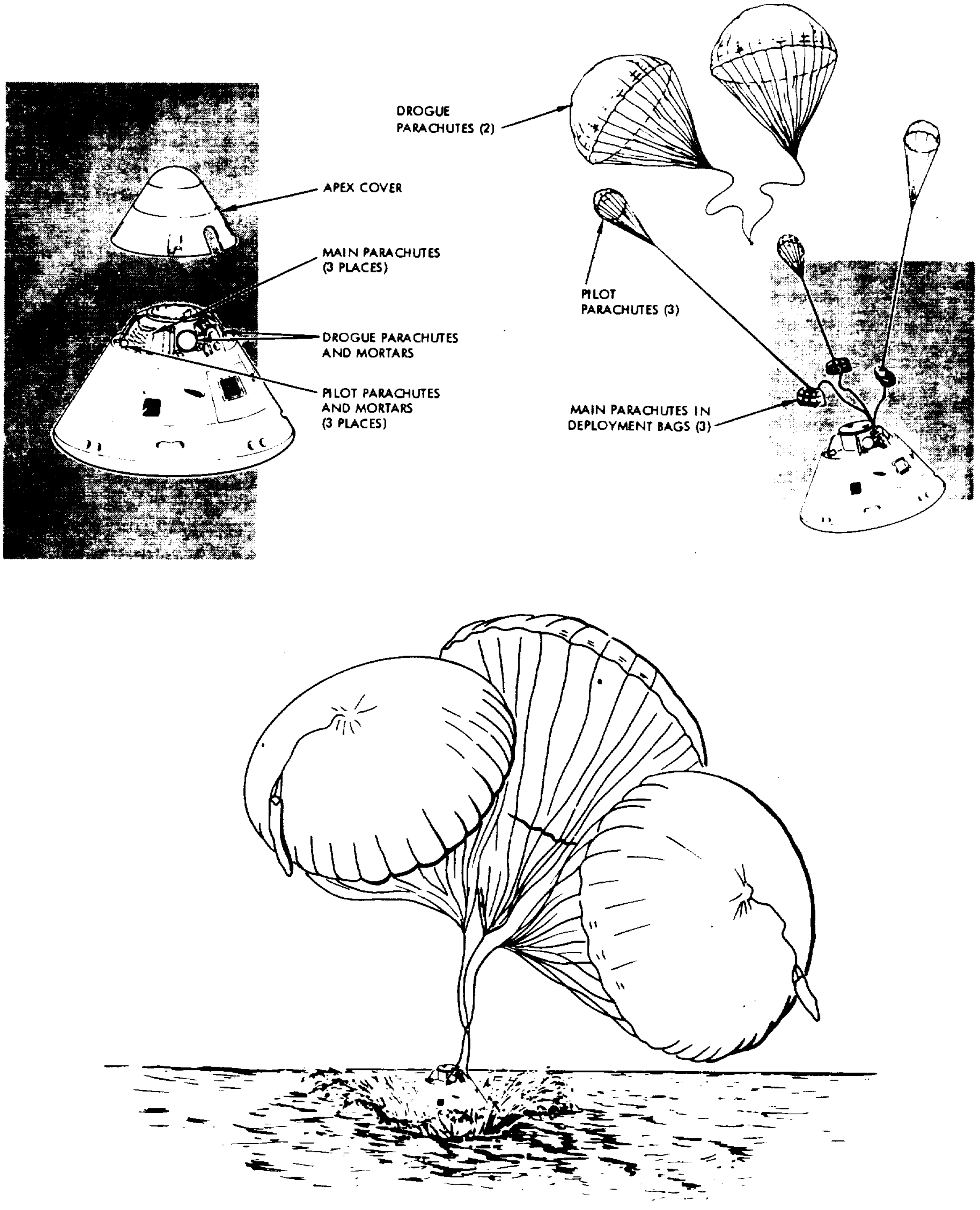


Figure 2.9-4. ELS Parachute Equipment

The drogue parachutes are held in a reefed condition for 8 seconds by two reefing lines. Each reefing line has two reefing line cutters. A pyrotechnic time-delay train in each reefing line cutter is ignited at the time of drogue parachute line stretch, causing automatic disreefing after 8 seconds. The drogue parachutes remain attached to the command module until descent to approximately 10,000 feet where the 10,000 feet baro switch closes to initiate drogue parachute disconnect. Simultaneously with drogue parachute disconnect, three pilot parachutes are independently mortar deployed, which removes the main parachute packs from the C/M and extracts the main parachutes from their deployment bags. The main parachutes are reefed for 8 seconds. Disreefing then occurs, and the parachutes fully inflate to lower the C/M safely to landing. Three reefing line cutters are employed on each of the two reefing lines for the main parachutes.

A 27-1/2-degree hang-angle of the C/M is maintained by means of the main parachutes attachment. The hang-angle contributes to the crew tolerance impact by ensuring that impact occurs at the specifically designed C/M structural attenuation point. This attenuation point is on the +Z-axis.

Special note should be made that the apex cover jettison and deployment of the drogue parachutes may be manually initiated at 45,000 feet during a normal entry if the flight characteristics of the command module become unstable. (Refer to operational limitations and restrictions.)

An ELS - AUTO/MAN switch (MDC-16) is provided for the crew to inhibit automatic deployment of the main parachutes during a low-altitude abort initiated prior to 61 seconds after lift-off. The switch is set to the AUTO position prior to launch. In the event of an abort prior to 61 seconds after lift-off, the crew will set the switch to MAN after drogue parachute deployment if the C/M is above an altitude of 3300 feet. Deployment of the main parachutes will be manually initiated by pressing the MAIN DEPLOY switch on MDC-5, when the altimeter pointer reaches the adjustable marker setting (3300 feet) on the altimeter face. This action will preclude the possibility of the command module drifting back on a land area. The ELS switch should be returned to AUTO after the main parachutes are deployed. This will allow a 14-second time delay to time out and permit release of the main parachutes when the MAIN CHUTE RELEASE switch is actuated after touchdown.

The postlanding recovery aids consist of a sea dye marker, swimmers umbilical, C/M vent fan, C/M uprighting system, HF recovery antenna, and a flashing beacon light. The sea dye marker and swimmers umbilical are deployed automatically when the recovery antenna is deployed. The marker and swimmers umbilical are tethered to the C/M forward compartment deck. The sea dye marker will last approximately 12 hours. The C/M vent fan (part of the ECS) is turned on after landing to vent the C/M to the outside atmosphere. The C/M uprighting system is activated only if the C/M is in a stable inverted attitude. (Refer to Command Module Uprighting System in section 2.)

The flashing beacon light and two VHF antennas located on the forward compartment deck on the C/M are automatically deployed to an upright position after main parachute deployment. The risers of the main parachutes actuate reefing line cutters, which cut retention ties and allows the beacon light and VHF antennas to be extended in 8 seconds. The beacon light has a self-contained power supply capable of operating the light for three 8-hour duty cycles. The flash rate is 15 per minute at an intensity of 1.2 candle-seconds per flash.

The postlanding control switches are located on MDC-25. A recovery pickup cable is provided on the command module for retrieval by recovery forces.

2.9.3 MAJOR COMPONENT/SUBSYSTEM DESCRIPTION.

Each of the sequential systems employ redundant circuits for reliability. Seven batteries are provided in the spacecraft to furnish electrical power for the spacecraft portion of the systems during operation. Entry batteries A, B, and C, and two pyro batteries are located in the command module, and two S/M jettison batteries are located in the service module. Entry batteries A, B, and C are the only batteries that are rechargeable during the mission.

Entry batteries A and B furnish power for the EDS displays and MESC logic circuitry. The pyro batteries furnish power for detonation of pyrotechnic devices during aborts, separation functions, and parachute operation during the normal landing sequence. (See figure 2.9-5 for a C/M battery bus tie-in schematic.) A description of each of the sequential systems is contained in the following paragraphs.

2.9.3.1 Sequential Events Control System.

The SECS consists of two master events sequence controllers (MESC), two earth landing sequence controllers (ELSC), two command

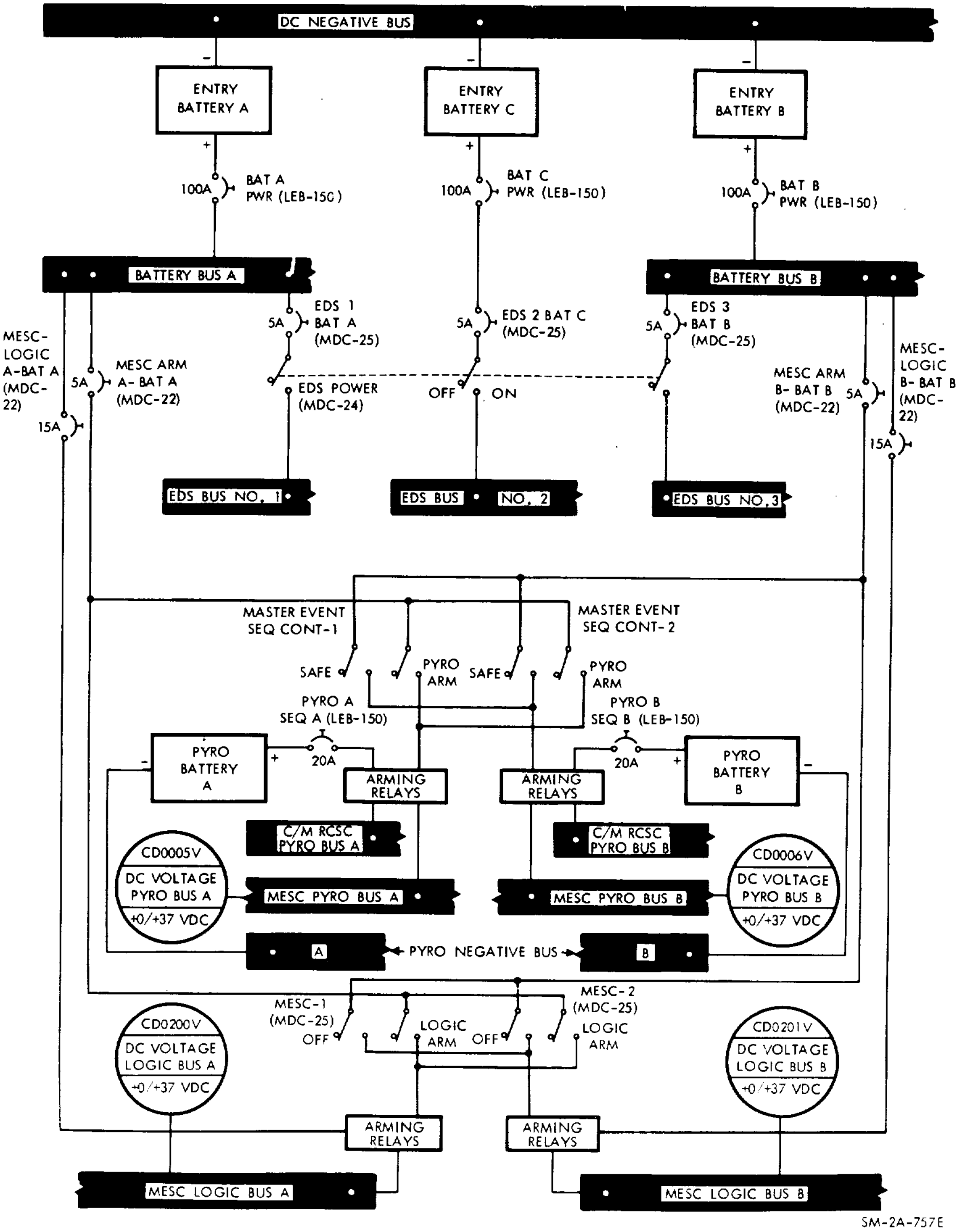


Figure 2.9-5. C/M Battery Bus Tie-In Schematic

SEQ

mortars | ELSC | (MDC-5)

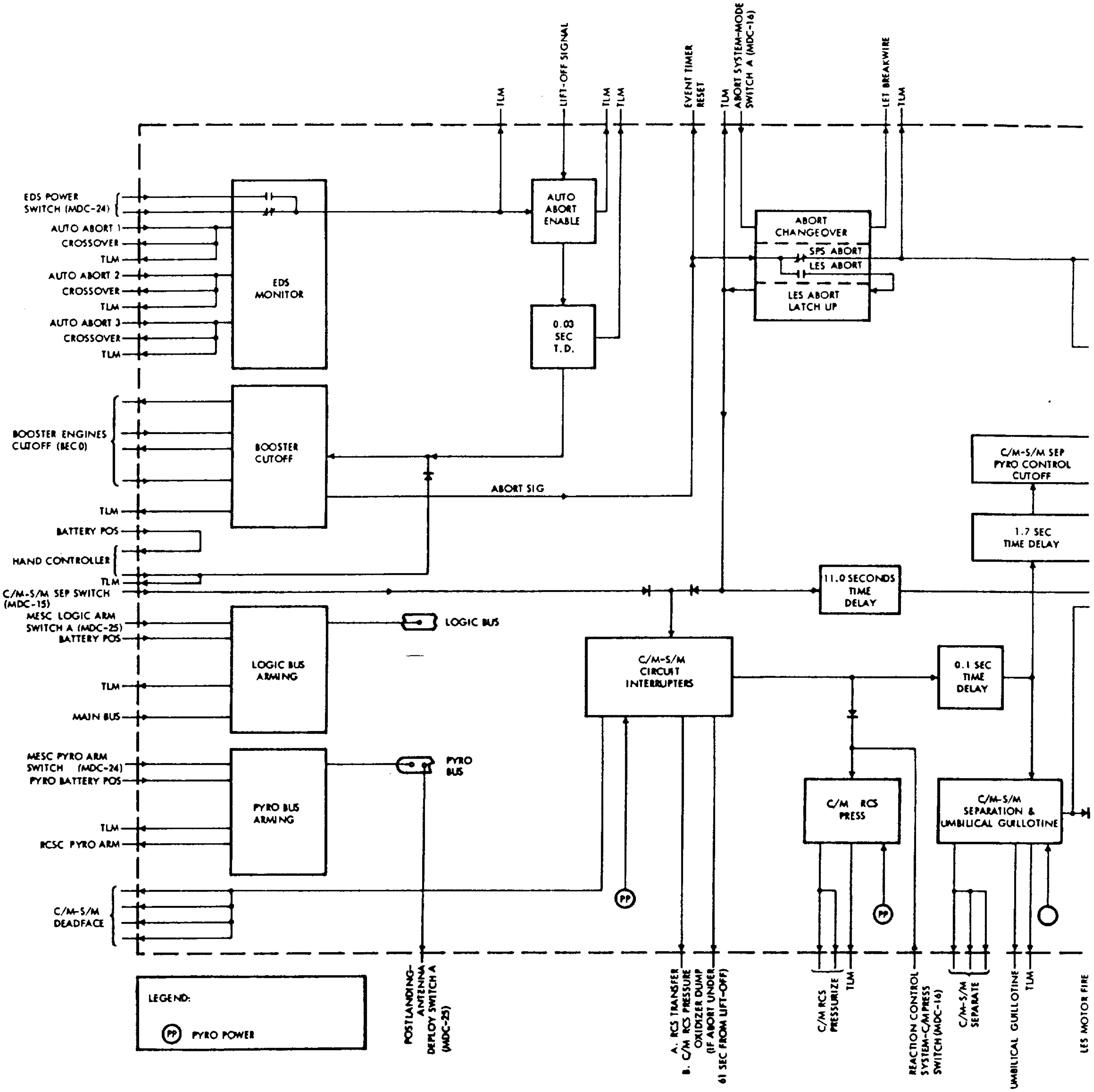
module reaction control system controllers (C/M RCSC), and two service module jettison controllers (SMJC). The SMJC is located in the service module. All other controllers are located in the command module. Each controller consists of relays, timers, and other devices to provide automatic and semiautomatic control of the systems.

Many operations in the SECS are accomplished by pyrotechnic devices of various types. Apollo standard initiators (ASI) are used

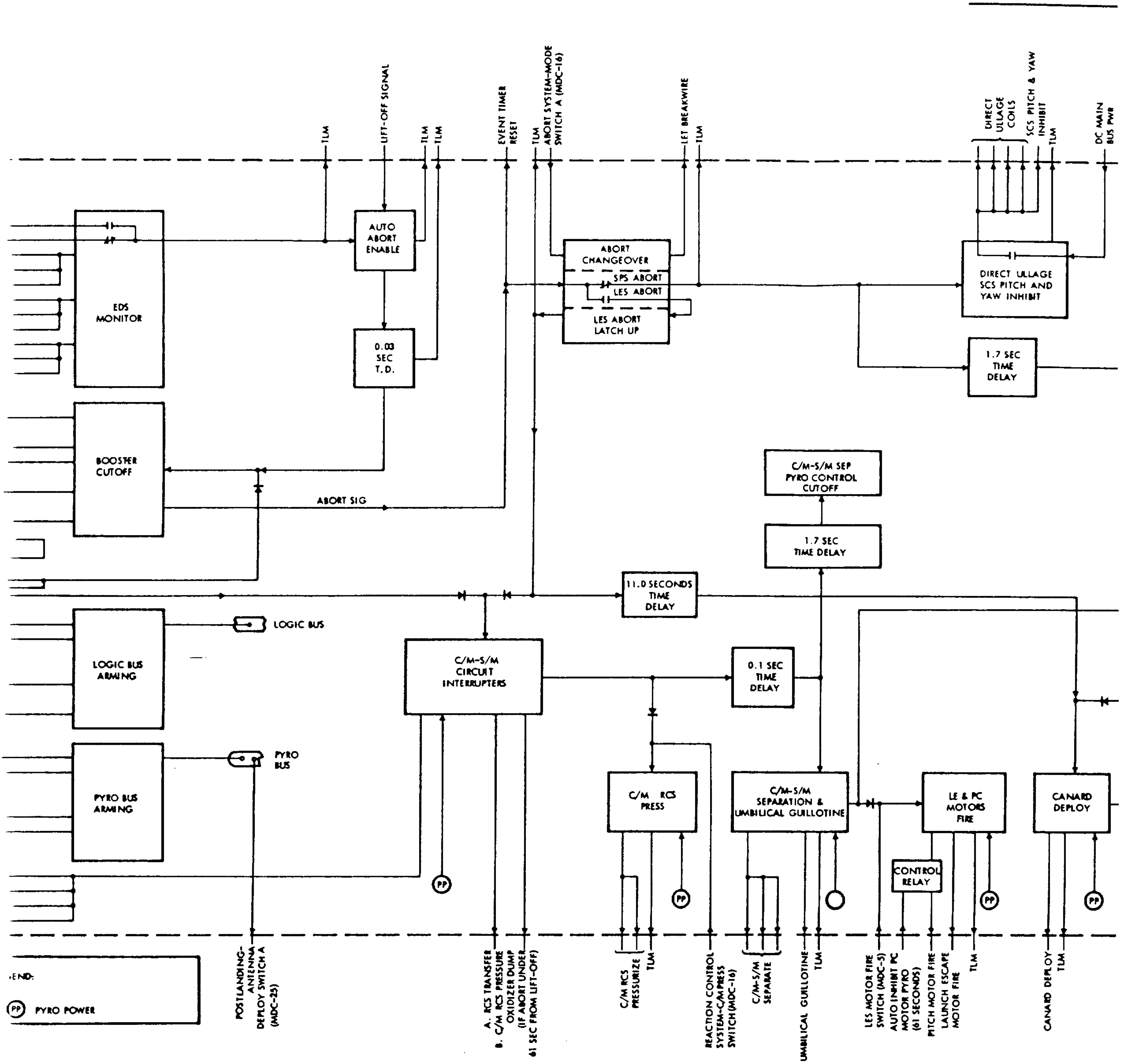
Function and Pyro Device	Normal Actuating Control	Backup Control
b. C/M-RCS pressurizing valves		
c. Circuit interrupters		
d. C/M-S/M umbilical guillotine		
e. LE and Pc motors igniter cartridges		
LE tower (TWR) jettison	Automatic signal from MESC or manual control from ABORT SYSTEM - MODE switches 1 and 2	ABORT SYSTEM - MODE switches 1 and 2 (MDC-16)
a. TWR to C/M attaching nuts (explosive)		
b. TWR jettison motor igniter cartridges		
Postlanding antenna deploy	Manual actuation of POSTLANDING - DEPLOY switches 1 and 2 (MDC-25)	

2.9.3.1.1 Master Events Sequence Controllers (MESC).

The MESC (figure 2.9-6) provides the logic and timing to initiate and terminate events associated with the ascent and abort modes. Controller A is in system A and controller B is in system B of the redundant systems. Crossover circuitry between controllers A and B ensures correct outputs for detonating pyrotechnic devices even if one redundant circuit is inoperative. The logic circuitry is armed with the two MESC-LOGIC ARM switches 1 and 2 on MDC-25. The pyro circuitry is armed with the two MASTER EVENT SEQ CONT-PYRO ARM switches 1 and 2 on MDC-24. Backup controls are provided for most of the events controlled by the MESC



FOLDOUT FRAME /



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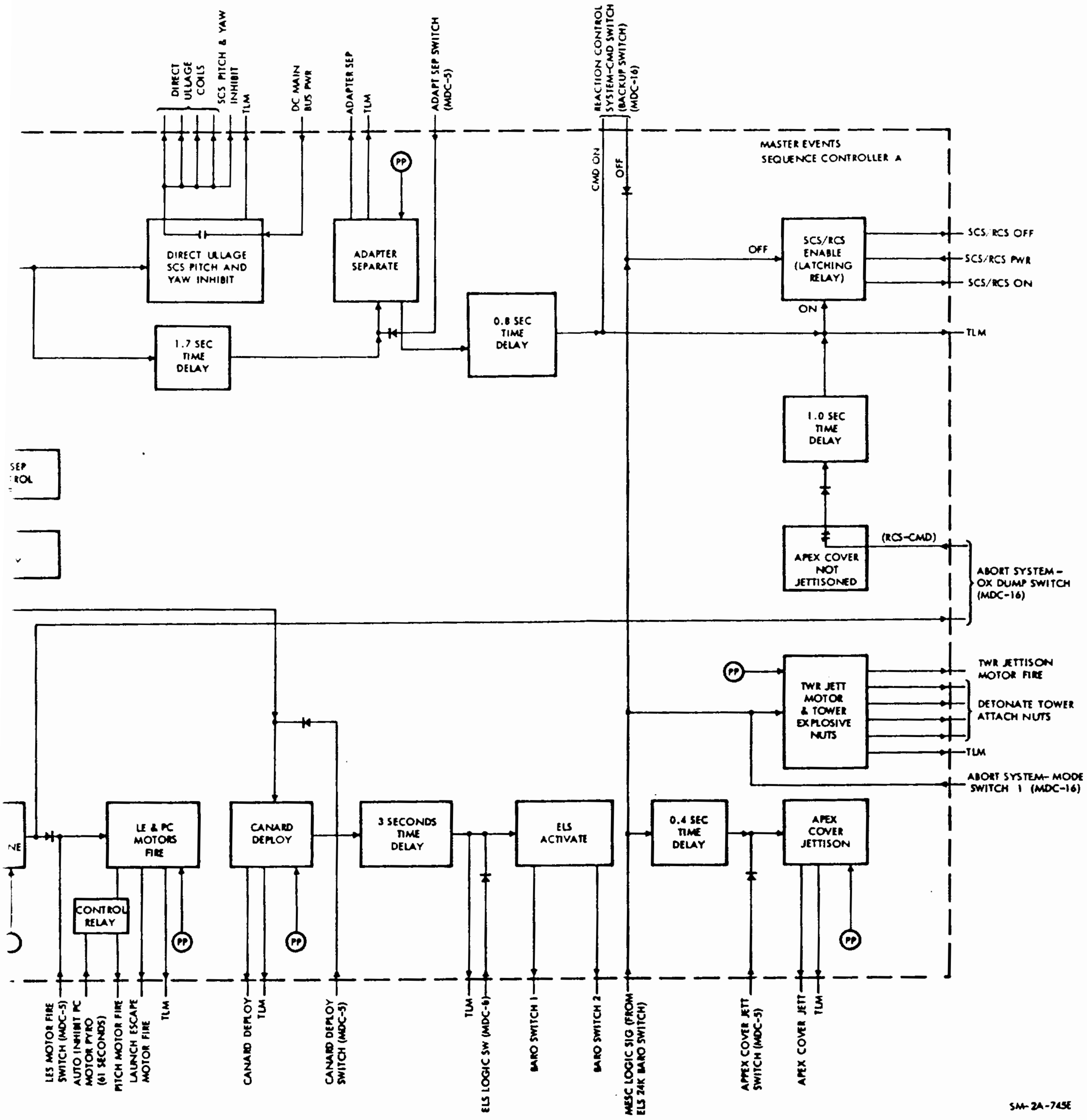

SEQ

Figure 2.9-6. Master Events Sequence Controller Block Diagram

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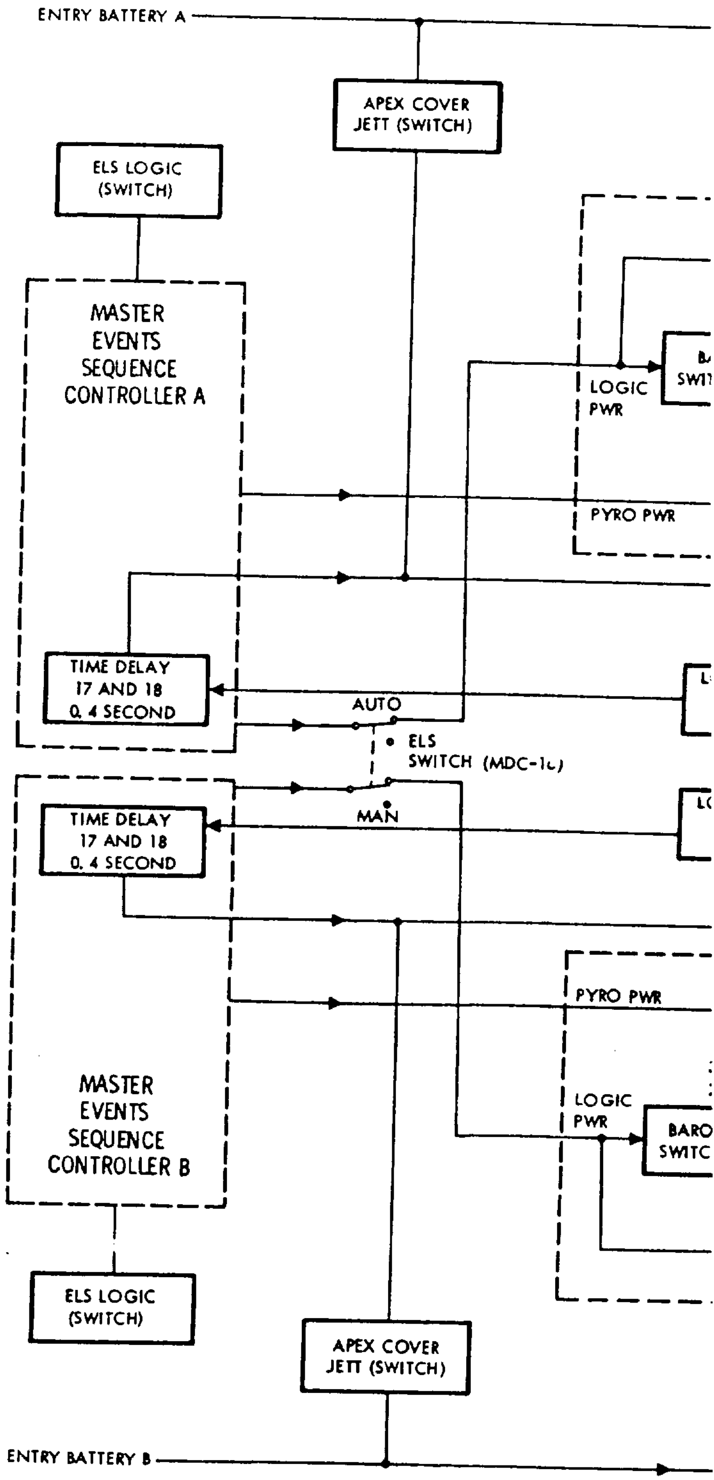

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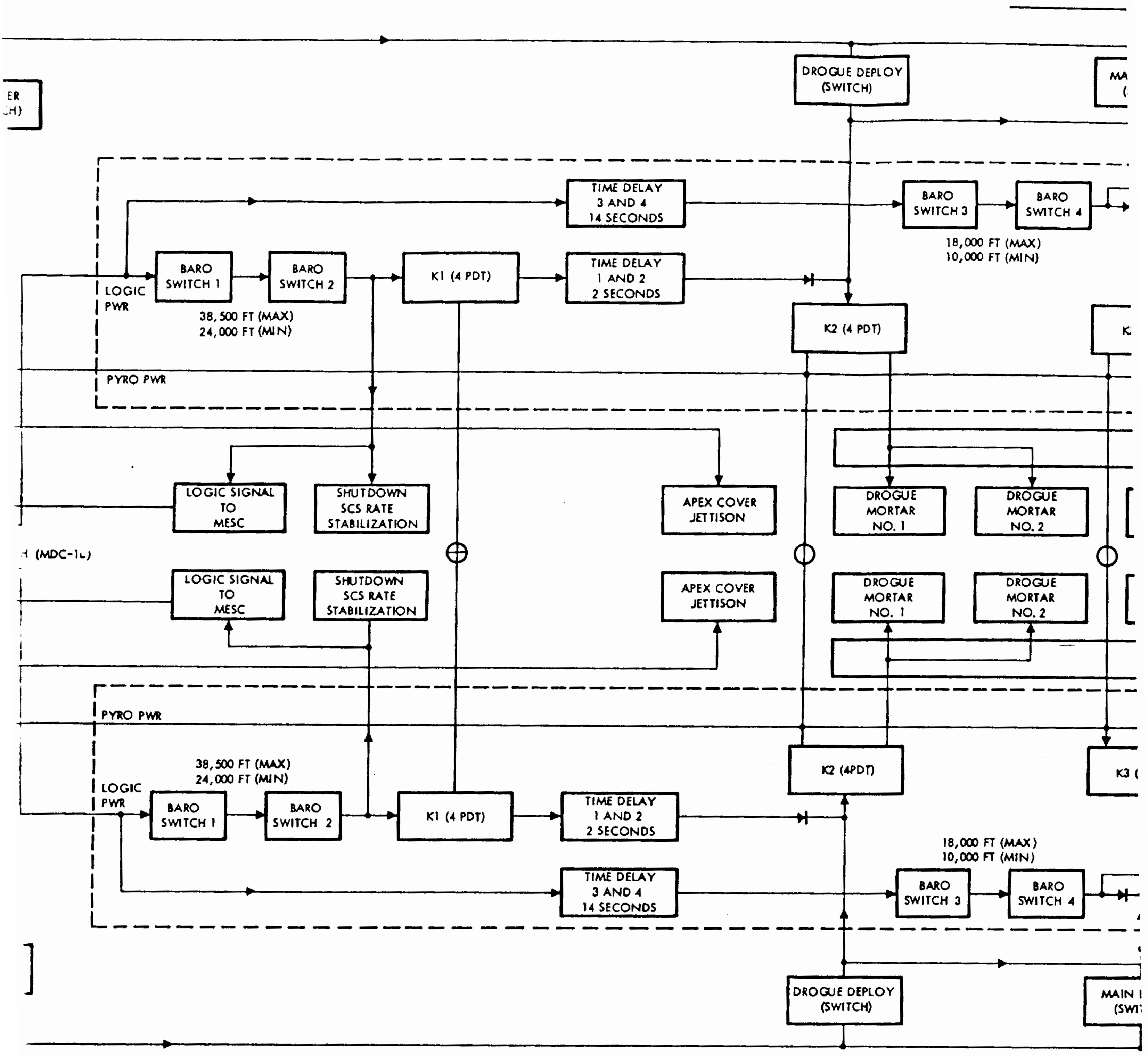

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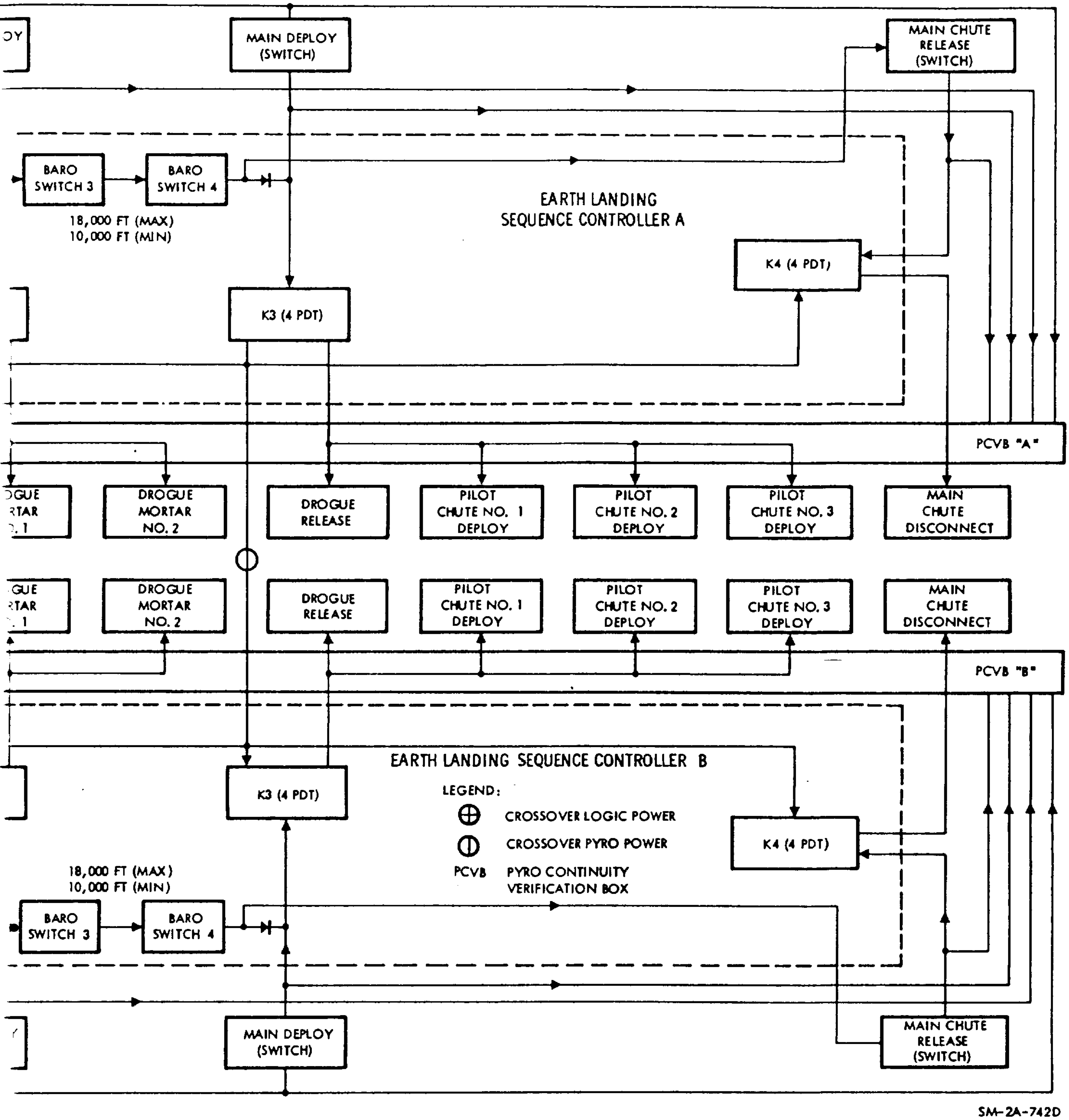

Figure 2.9-7. Earth Landing System Controller Block Diagram

the baro switch setting. Other events are controlled by time-delay relays after the baro switches close. Refer to functional description of the ELS.

2.9.3.1.3 Command Module Reaction Control System Controllers (C/M RCSC).

The C/M RCSC (figure 2.9-8) provide automatic and manual control of events that occur in the reaction control system. Two redundant controllers are provided for dual redundancy. During an abort initiated prior to 61 seconds after lift-off, the C/M RCS oxidizer and helium are automatically dumped. When the abort signal is received, the following pyro valves are fired by initiators to pressurize and dump the RCS oxidizer:

a. Two helium isolation valves
b. Helium interconnect valve
c. Oxidizer interconnect valve
d. Two oxidizer overboard dump valves

The oxidizer overboard dump valves route the oxidizer to a blow-out plug in the aft heat shield of the C/M. Pressure buildup shears a pin which releases the blowout plug and dumps the oxidizer overboard.

The helium pressure is dumped into the aft compartment 18 seconds after abort initiation when the following pyro valves are fired by initiators:

a. Helium interconnect valve
b. Two oxidizer tanks bypass valves
c. Helium overboard dump valve

The three entry batteries are automatically connected to d-c main buses A and B during an LES abort or normal C/M-S/M separation, RCS control is transferred (S/M to C/M). (See figure 2.9-9 for RCS control schematic.) The controllers inhibit automatic oxidizer dump, helium dump, and LES pitch control motor firing automatically at 61 seconds after lift-off. RCS propellant burn and purge must be manually selected.

The pyro buses are armed when the MASTER EVENT SEQ CONT - PYRO ARM switches 1 and 2 are set to the PYRO ARM position. Backup controls are provided for most of the functions performed by the RCSC.

2.9.3.1.4 Service Module Jettison Controllers (SMJC).

The SMJC (figure 2.9-10) program the operation to impart a desired motion to the service module after C/M-S/M separation. The S/M reaction control system will be controlled by the SMJC and command continuous firing of the -X jets. It is possible that the resultant -X thrusting will be offset from the S/M X-axis; therefore, the S/M RCS + roll jets are activated for a 5.5-second interval, 2 seconds after separation. This ensures that a major component of the jettison thrusting will be in a direction that was parallel to the CSM (-X) axis at severance. The dual controllers are powered by dual separation batteries located in the S/M. The batteries are not rechargeable during the mission.

2.9.3.1.5 C/M-S/M Separation Mechanism.

The C/M-S/M separation mechanism (figure 2.9-11) consists of electrical circuit interrupters, shear compression pads, tension ties, linear-shaped charges, and a dual-blade guillotine (umbilical severance device). Redundant systems (A and B) in the MESC provide dual redundant commands to fire dual initiators and charges to ensure sudden complete tension and umbilical severance with adequate reliability. Prior to umbilical severance, sensitive circuits in the umbilical are deadfaced by circuit interrupters. The shear compression pads are designed for interference-free separation after the tension ties are severed. A separation signal is sent to dual redundant service module jettison controllers which control the S/M after it separates from the C/M.

2.9.3.1.6 Spacecraft LEM Adapter (SLA) Separation Mechanism.

A command for CSM-SLA separation is automatically sent to the MESC when a SPS abort is manually initiated. An ADAPT SEP switch on MDC-5 may be used as a backup and for normal CSM-SLA separation during a normal mission. Separation of the adapter into four panels (figure 2.9-12) is accomplished by an explosive train. The explosive train consists of 28 charge holders, 2 initiators and shields, 8 panel thrusters, 8 initiator pressure cartridges, and an umbilical separation system. Redundant detonator assemblies fire dual lines of mild detonating fuse (MDF) installed between the adapter panels, top and bottom, and between each panel. Either line will sever the splice plates between the four panels and around both ends. Crossover boosters are used in the charge holder joints to ensure that both lines are firing simultaneously for complete reliability. The detonating lines are continuous lead sheaths surrounding an explosive core which is virgin RDX, class G. The mild detonating fuse separates the adapter panels and fires cartridges for the panel thrusters which open the four panels. Simultaneously with this operation, umbilical disconnect takes place. Four spring-loaded reels hold the panels in a 45-degree open position. The panels are stopped in the open position by eight attenuators that have honeycomb cores.

2.9.3.2 Emergency Detection System.

The EDS consists of sensors, logic circuitry and signal conditioners located in the launch vehicle, displays and controls located in the C/M, and Q-ball which is located on the forward tip of the LES tower above the canard. The displays and controls consist of L/V rates, L/V guidance, abort, and engines lights, along with an angle-of-attack

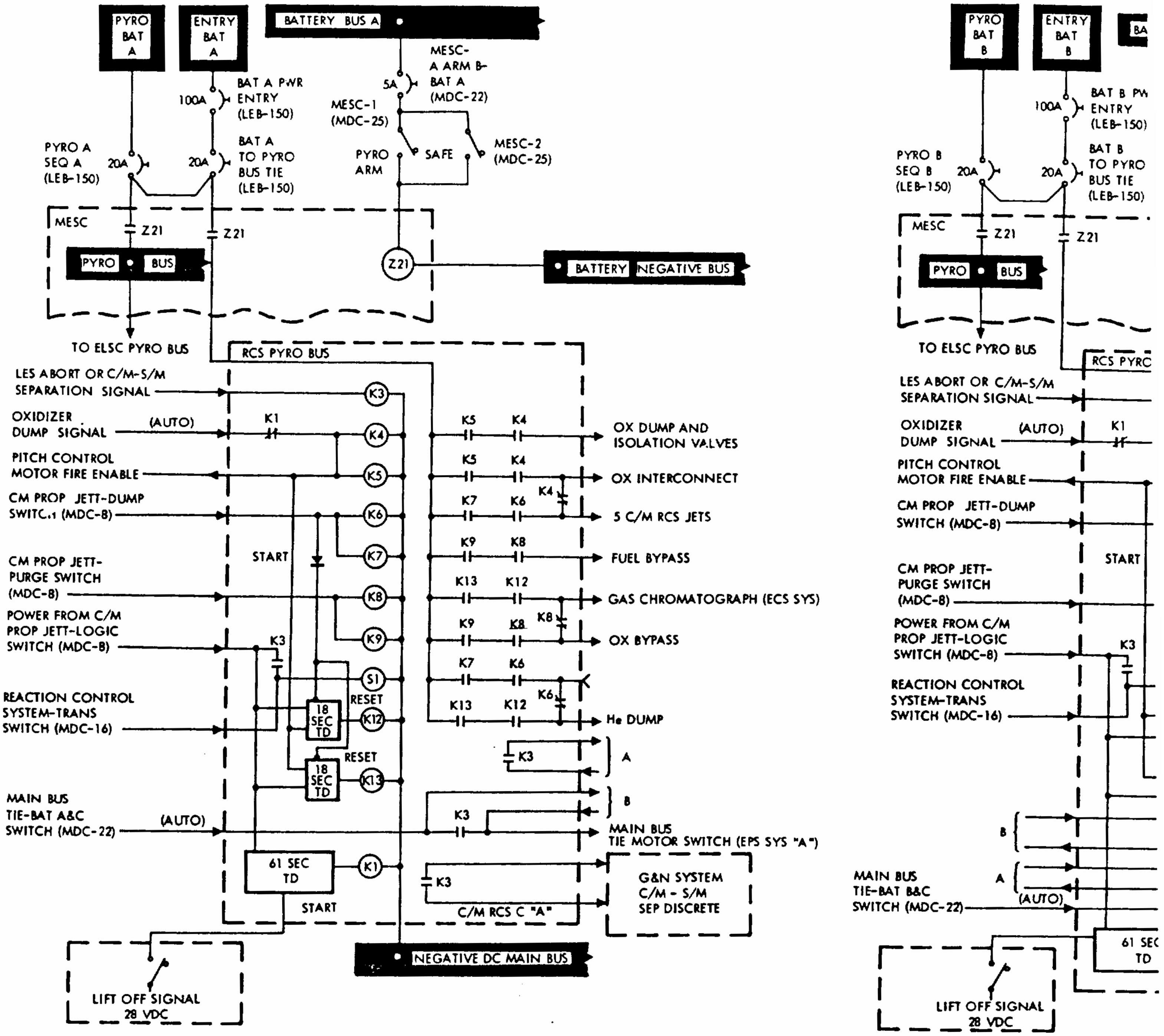

Figure 2.9-8. C/M Reac

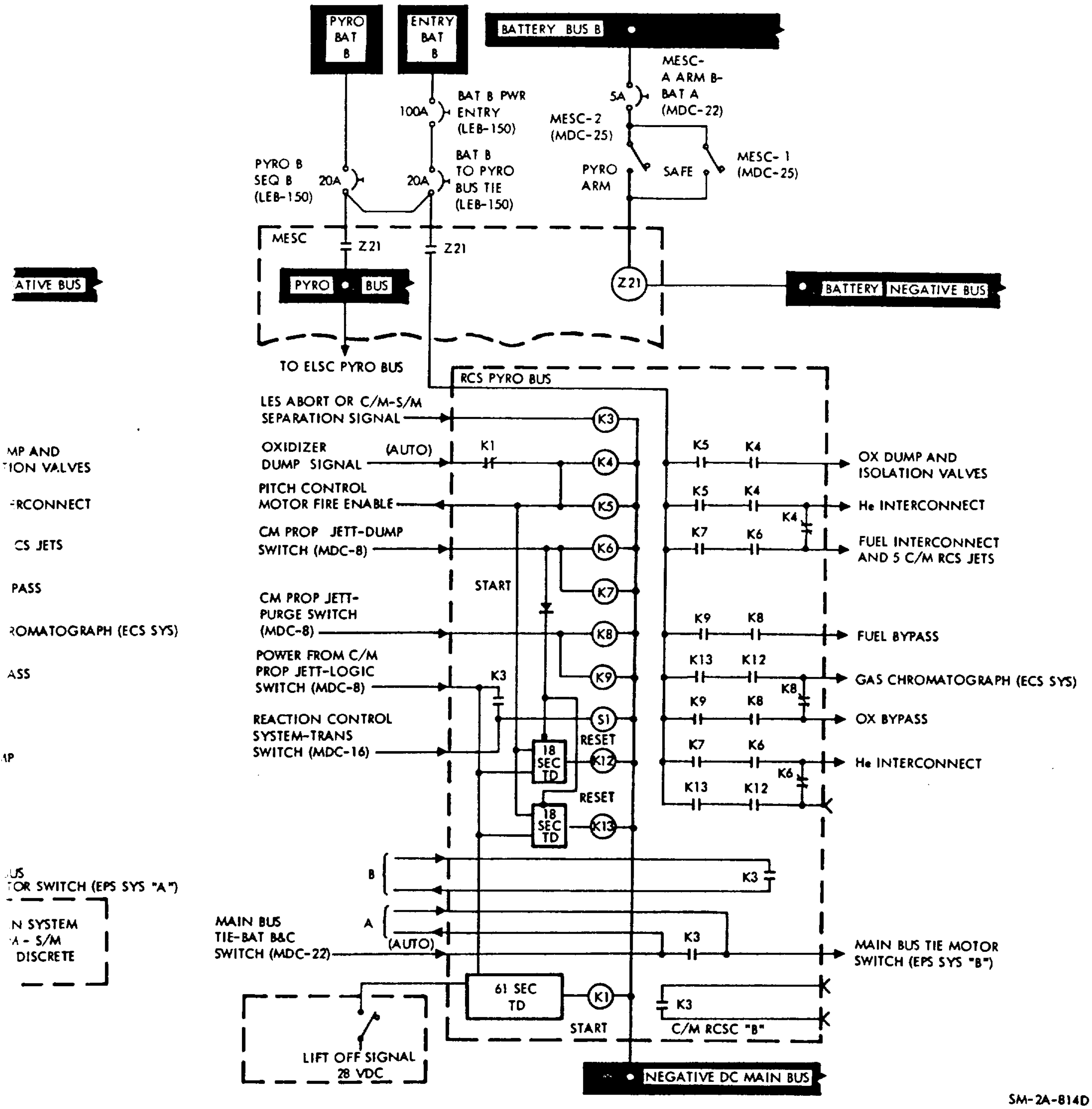

Figure 2.9-8. C/M Reaction Control System Controller Schematic

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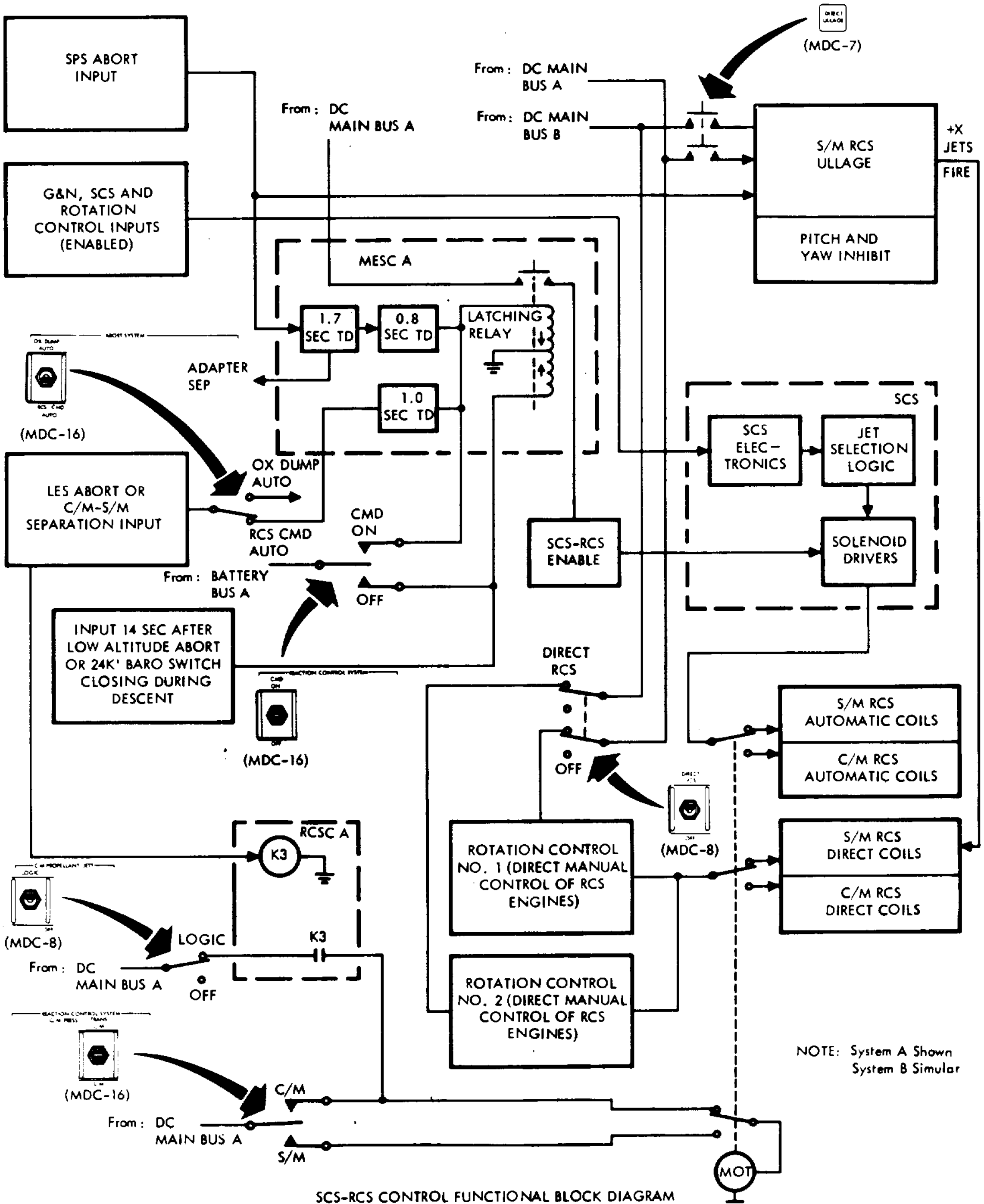


Figure 2.9-9. SCS-RCS Functional Block Diagram

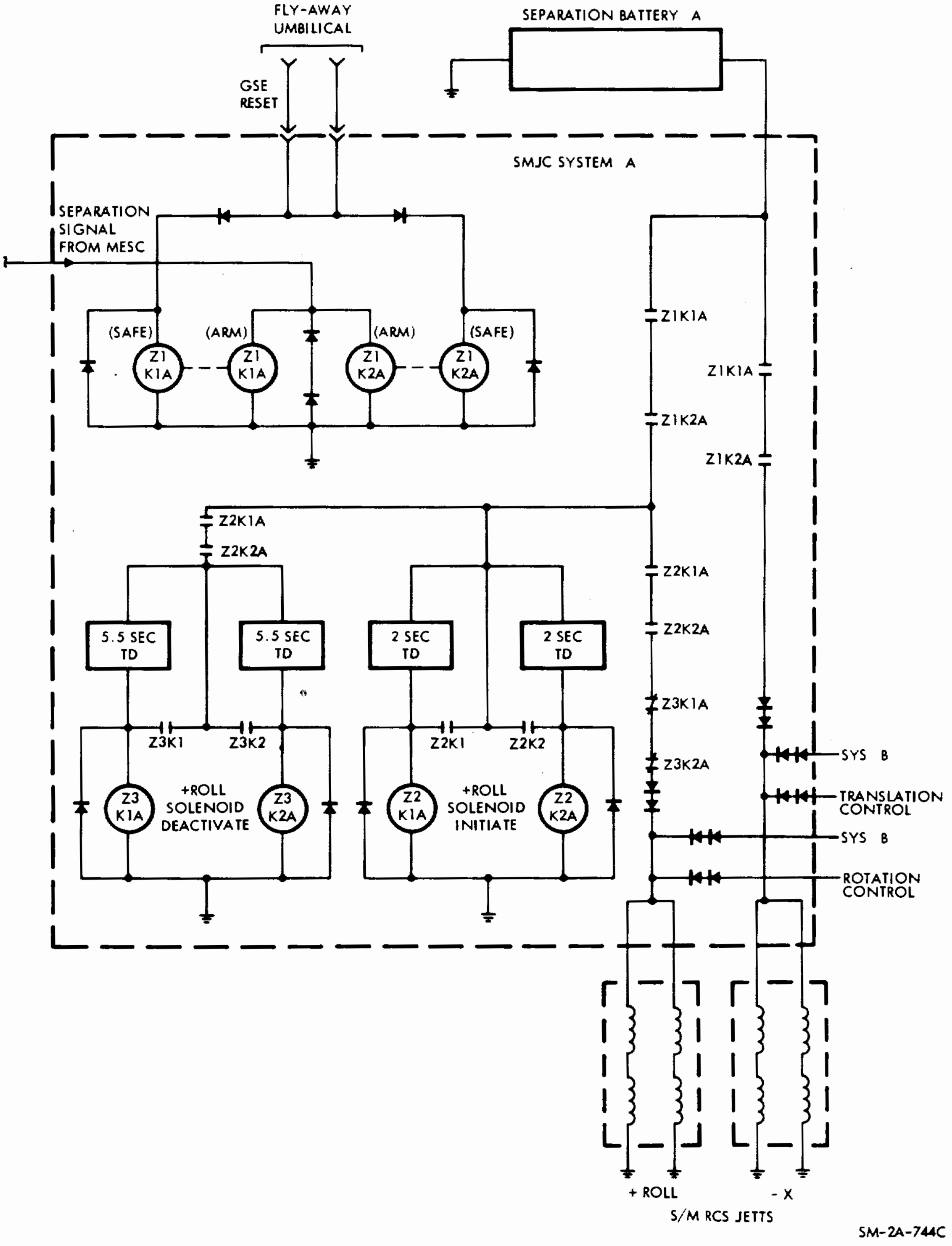
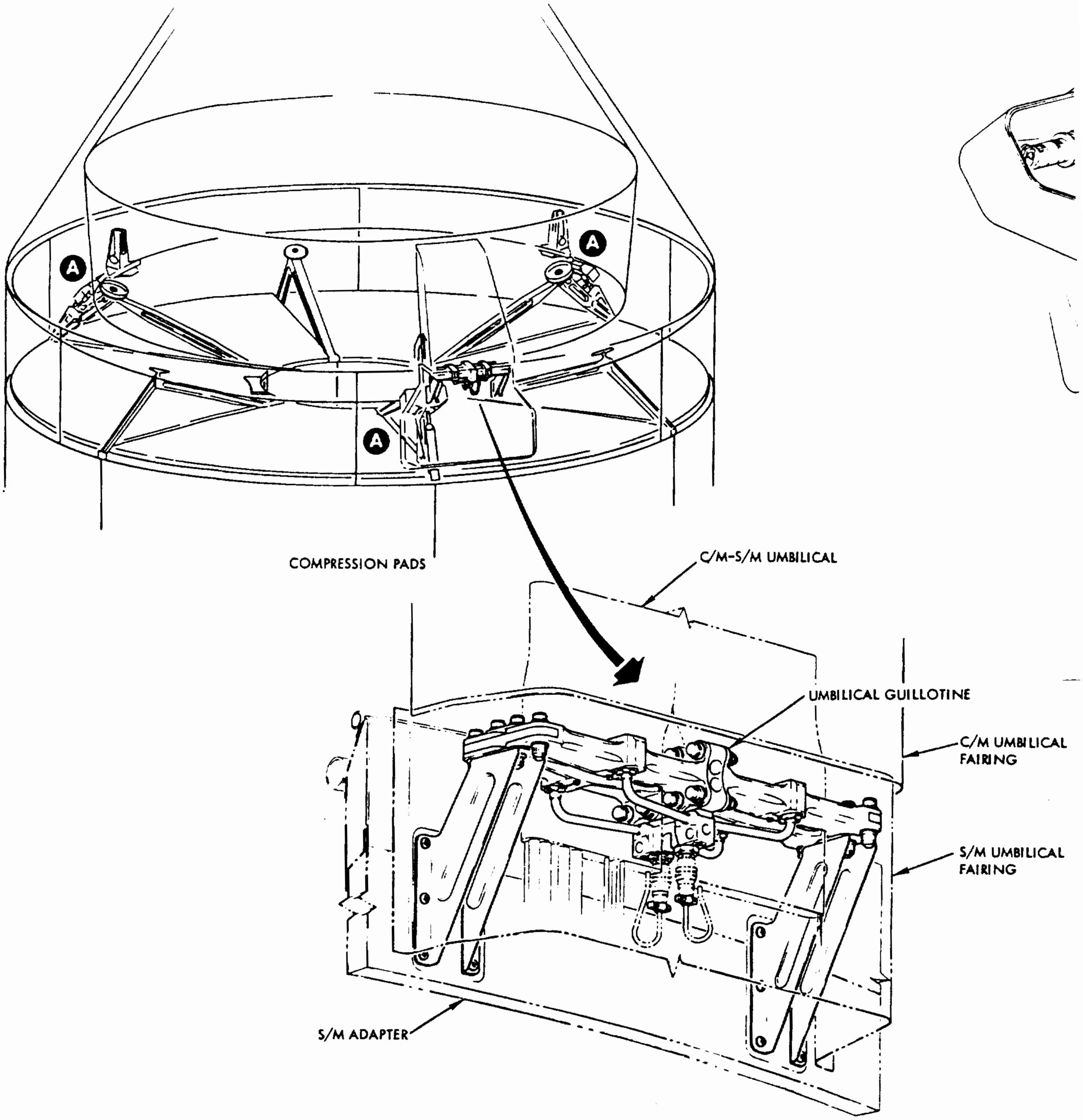


Figure 2.9-10. Service Module Jettison Controller Schematic


A
A
A
COMPRESSION PADS
C/M-S/M UMBILICAL
UMBILICAL GUILLOTINE
C/M UMBILICAL FAIRING
S/M UMBILICAL FAIRING
S/M ADAPTER

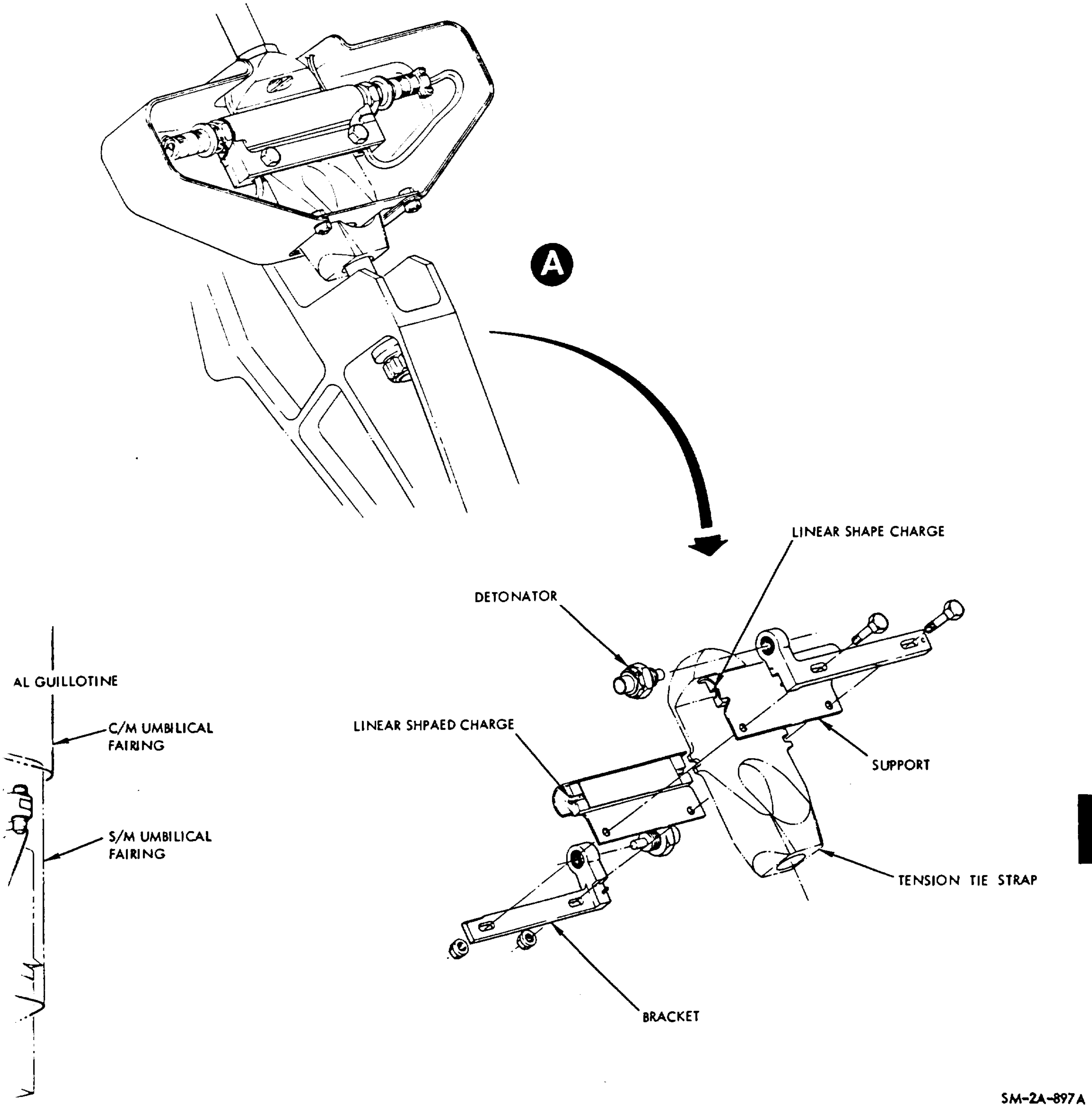


Figure 2. 9-11. C/M-S/M Separation Mechanism

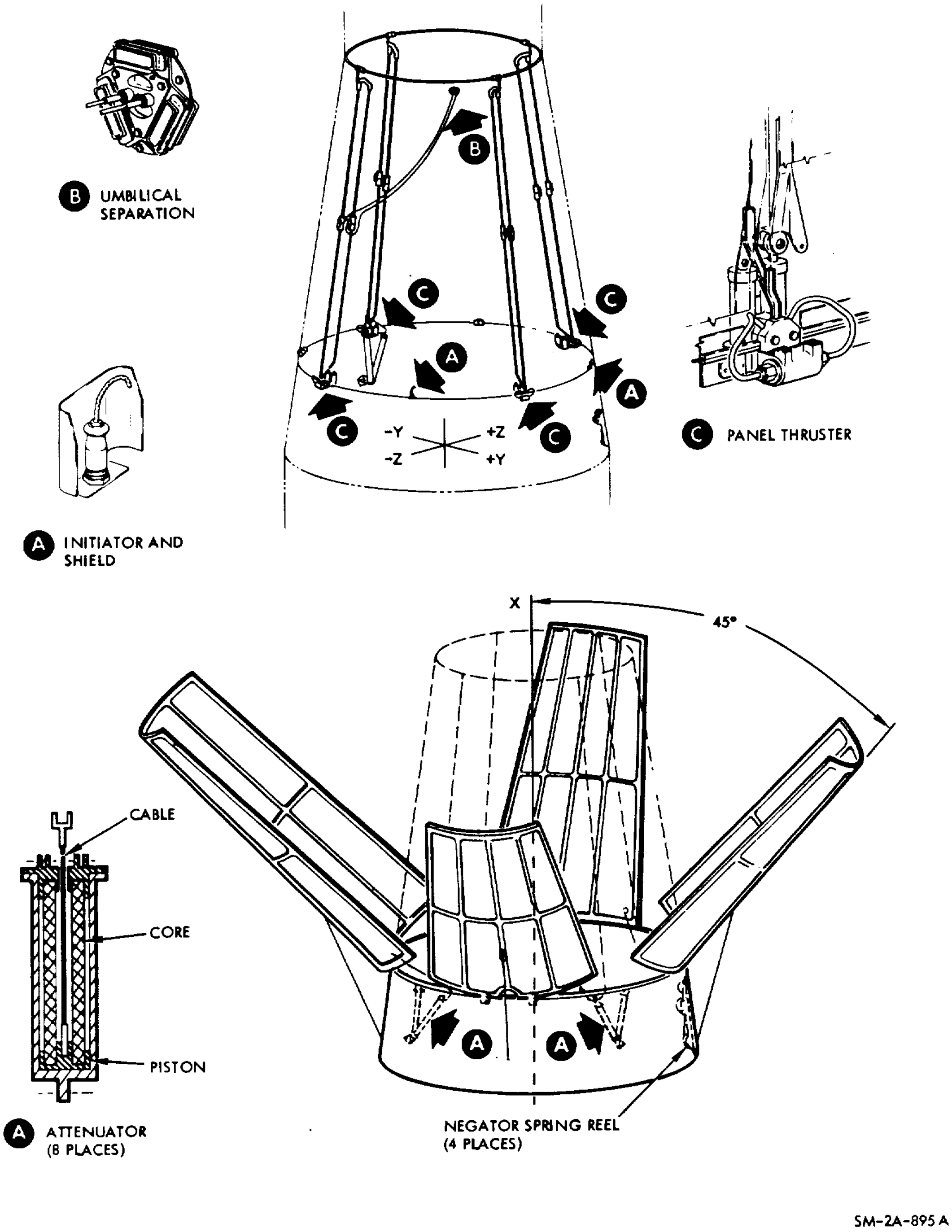


Figure 2.9-12. Adapter Separation Mechanism

indicator and control switches. The L/V portion of the EDS and the Q-ball are powered by eight L/V batteries. The displays are powered by two entry batteries A and B.

2.9.3.3 Launch Escape System.

The LES consists of two major assemblies (figure 2.9-3) that are installed on top of the command module prior to launch. The first structure is a four-legged, welded tubular titanium tower. The tower is attached to the command module with four frangible nuts on studs. Two detonator assemblies are installed in each nut to break it when LES tower jettison is commanded. The second structure is cylindrical in shape topped by the Q-ball, and houses the launch escape, tower jettison, and pitch control motors. A canard subsystem is installed near the forward end below the Q-ball.

2.9.3.3.1 LES Motors.

Each of the three motors in the LES (figure 2.9-3) are fired by two igniter assemblies. The three motors are the launch escape motor, tower jettison motor, and pitch control motor. The pitch control motor works in conjunction with the launch escape motor during a LES abort initiated prior to 61 seconds after lift-off. The pitch control motor has a fixed zero-degree, single-exhaust nozzle and is mounted below the ballast enclosure in a horizontal position. The motor produces approximately 2500 pounds of thrust for about 0.5 second to force the nose of the LES tower in the -Z direction. Firing of the pitch control motor is inhibited 61 seconds after lift-off by a signal from the C/M RCSC. The launch escape motor has four nozzles that have a centerline cant angle of 35 degrees. The resultant thrust vector deflection is obtained by offsizing the nozzle throat diameters and producing a thrust vector in the -Z direction. Thrust output is approximately 150,000 pounds which starts dropping in approximately 4 seconds. Lateral translation of the escape vehicle is aided by the thrust vector alignment offset during an LES abort. The tower jettison motor has two nozzles in which the thrust vector alignment is offset approximately 4 degrees to produce a thrust component in the +Z direction. Thrust output is approximately 33,000 pounds.

2.9.3.3.2 Canard Subsystem.

The canard subsystem (figure 2.9-3) consists of two deployable surfaces faired into the outer skin of the LES below the Q-ball interface. Each surface is mounted on two hinges and is operated open by a pyrotechnic thruster with redundant gas cartridges. The surfaces are approximately 47 inches long, clam-shell shaped, and constructed of double-skin ribbed inconel. The canard surfaces are automatically opened during a LES abort and aerodynamic forces acting on the surfaces control a turnaround maneuver of the C/M. (Refer to Abort Procedures in section 9.)

2.9.3.4 Earth Landing Subsystem.

The ELS consists of the parachute subsystem (figure 2.9-4), two earth landing sequence controllers (figure 2.9-7), and the apex cover jettison mechanism.

The parachute subsystem is comprised of two fist-ribbon-type nylon drogue parachutes, 13.7 feet in diameter; three ring-slot-type nylon pilot parachutes, 7.2 feet in diameter; three ring-sail-type nylon main parachutes, 83.5 feet in diameter; deployment bags; bridles; suspension lines; mortars; and the necessary hardware for attachment to the C/M. The parachute subsystem is housed in the forward compartment under the apex cover of the C/M.

The earth landing sequence controllers are located in the right equipment bay of the C/M and controls automatic operation of the ELS. Crossover circuitry between the controllers ensures correct output signals. Backup emergency switches are provided on MDC-5 for apex cover jettison and parachute deployment. The apex cover is jettisoned by four gas-operated thrusters. Two gas-type cartridges are employed for redundancy and operate two thrusters each. Either pair of thrusters will jettison the apex cover. A pilot parachute and mortar are installed in the forward end of the apex cover. The mortar is fired at exactly the same time as the apex cover thrusters to deploy the parachute. The parachute will pull the apex cover from the negative pressure area following the C/M.

2.9.4 PERFORMANCE AND DESIGN DATA.

Entry descent velocities, altitude, and time are contained in the following tabulated data. The figures are based on a command module recovery weight of 11,000 pounds and a standard day barometric pressure.

The tabulated data states the automatic events that normally occur in the ELS during descent. Under certain entry conditions, the apex cover may be manually jettisoned, and the drogue parachutes manually deployed at 45,000 feet. Refer to operational limitations and restrictions that follow the tabulated data.

Occurrence	Altitude	Time on Parachutes	Descent Velocity
TWO DROGUE PARACHUTES			
24,000 feet baro switch closes	24,900 to 21,500 feet		
Apex cover jettison	24,000 feet baro switch closure + 0.4 seconds		425 ft/sec
Drogue parachutes (2) deploy	24,000 feet baro switch closure +2.0 seconds		410 ft/sec
10,000 feet baro switch closes	10,950 to 9,100 feet		
Drogue parachutes (2) release and main parachutes deploy	10,000 feet baro switch closure	45 to 46 seconds	225 ft/sec
Main parachutes open (reefed) after two drogue parachutes release			235 ft/sec
Main parachutes disreef	8400 ±500 feet	8 seconds after line stretch	110 ft/sec
ONE DROGUE PARACHUTE			
Drogue parachute (1) releases and main chutes deploy	10,000 feet baro switch closure	40 seconds	275 ft/sec
Main parachutes open (reefed) after one drogue parachute releases			290 ft/sec
Main parachutes disreef	8200 ±500 feet	8 seconds after line stretch	120 ft/sec
Touchdown (3 main parachutes.		5 minutes	28 ft/sec
Touchdown (2 main parachutes)		4.2 minutes	33.5 ft/sec

2.9.4.1 Power Requirements.

The SECS requires power only during the launch and ascent phase, for CSM-SLA separation in orbit, for C/M-S/M separation during the pre-entry phase, and during the parachute descent phase. Most all events performed by the SECS occur instantaneously, and not on a continuous duty cycle. In accordance with the Mission Modular Data Book (SID 66-1177), dated 1 September 1966, there are no power requirements for the SECS.

2.9.5 OPERATIONAL LIMITATIONS AND RESTRICTIONS.

Under certain entry conditions, the spacecraft may become unstable. Because of the erratic aerodynamic damping coefficients, wind gusts, and shears, the astronaut may not be able to damp the oscillations with single RCS. If this should occur, the apex cover and drogue parachutes may be manually deployed at 45,000 feet. This will stabilize and keep the C/M in a heat shield forward descending attitude. Figure 2.9-13 portrays the drogue development design envelope. The following precautions should be observed.

- Manual initiation of apex cover jettison and drogue parachute deployment should never be accomplished above 45,000 feet during entry.
- The C/M RCS must be turned off prior to apex cover jettison.
- The LES tower and apex cover should never be manually jettisoned above the automatic mode of 24,000 feet during LES aborts.

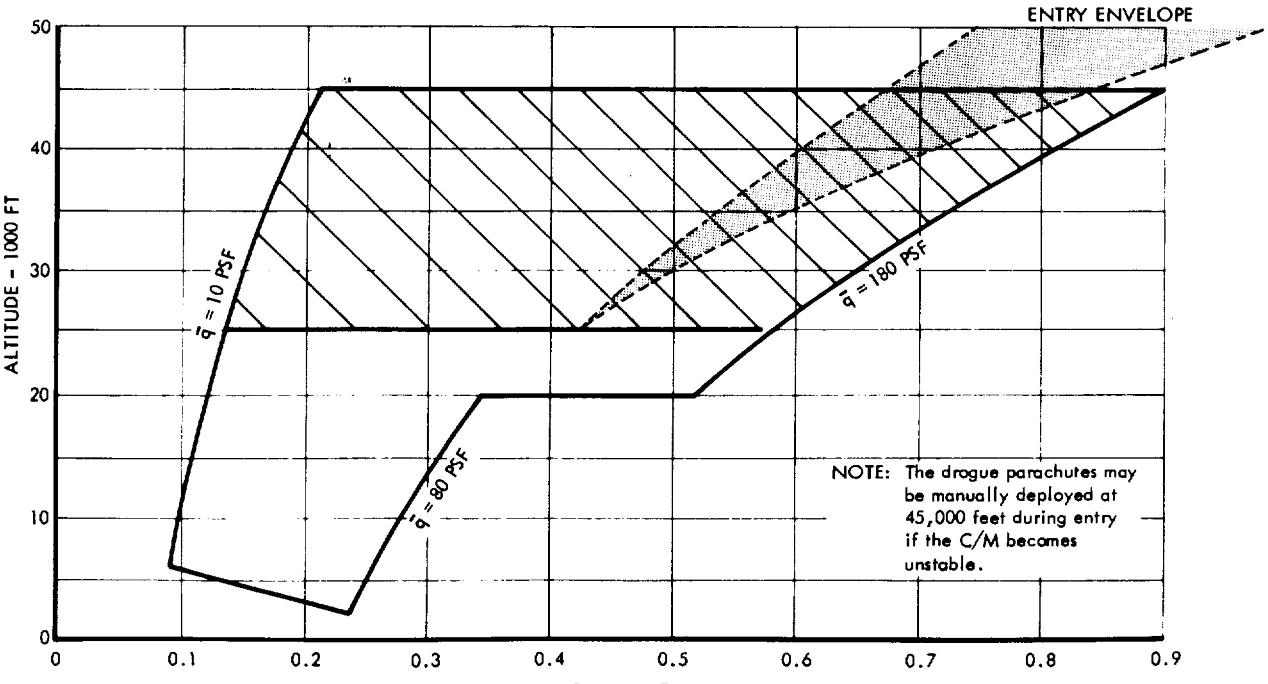


Figure 2.9-13. Drogue Parachute Deployment Design Envelope

2.9.6 TELEMETRY MEASUREMENTS.

The following is a complete list of all sequential systems telemetry data that is monitored by flight controllers and ground support personnel. The last column contains the name and type of S/C crew display. The display utilizes the same pickoff or signal sources as telemetry, unless a separate measurement number is included in the display column.

An asterisk (*) by the measurement number denotes information which is not available for recording or telemetry transmission during PCM low bit rate operation.

Measurement Number	Description	Sensor Range	Crew Display
CD 0136 X	EDS abort logic out B	Event	None
CD 0140 X	Direct ullage on A	Event	None
CD 0141 X	Direct ullage on B	Event	None
CD 0170 X	RCS activate signal A	Event	None
CD 0171 X	RCS activate signal B	Event	None
CD 0173 X	CM-RCS pressurize signal A	Event	None
CD 0174 X	CM-RCS pressurize signal B	Event	None
*CD 0200 V	DC voltage logic bus A	+0. +37 vdc	None
*CD 0201 V	DC voltage logic bus B	+0/+37 vdc	None
CD 0230 X	Forward heat shield jettison A	Event	None
CD 0231 X	Forward heat shield jettison B	Event	None
CD 0315 X	EDS enable A	Event	None
CD 0316 X	EDS enable B	Event	None
CD 1006 X	LES motor fire initiate A	Event	None
CD 1007 X	LES motor fire initiate B	Event	None
CE 0001 X	Drogue deploy relay close A	Event	None
CE 0002 X	Drogue deploy relay close B	Event	None
CE 0003 X	Main parachute deploy-drogue release relay A	Event	None

SYSTEMS DATA

Measurement Number	Description	Sensor Range	Crew Display
CE 0004 X	Main parachute deploy-drogue release relay B	Event	None
CE 0007 X	Baroswitch lock-in relay close A	Event	None
CE 0008 X	Baroswitch lock-in relay close B	Event	None
*CE 0035 P	Barometric pressure static reference	+0/+15 psia	Indicator
CE 0321 X	Main chute disconnect relay A	Event	None
CE 0322 X	Main chute disconnect relay B	Event	None
*LS 0001 V	Q-ball vector sum output	+0/+5 vdc	Indicator
BS 0016 X	Launch vehicle guidance fail A	Event	L/V GUID light
BS 0020 X	Launch vehicle rate excessive A	Event	L/V RATE light
BS 0030 X	Engine No. 1 out A	Event	ENGINES 1 light
BS 0032 X	Engine No. 2 out A	Event	ENGINES 2 light
BS 0034 X	Engine No. 3 out A	Event	ENGINES 3 light
BS 0036 X	Engine No. 4 out A	Event	ENGINES 4 light
BS 0038 X	Engine No. 5 out A	Event	ENGINES 5 light
BS 0040 X	Engine No. 6 out A	Event	ENGINES 6 light
BS 0042 X	Engine No. 7 out A	Event	ENGINES 7 light
BS 0044 X	Engine No. 8 out A	Event	ENGINES 8 light
BS 0061 X	Lift-off signal B	Event	LIFT OFF light

SYSTEMS DATA

Measurement Number	Description	Sensor Range	Crew Display
CS 0080 X	EDS abort request A	Event	ABORT light
*LS 0090 X	Tower physical separation monitor A	Event	None
*LS 0091 X	Tower physical separation monitor B	Event	None
CS 0100 X	CM-SM physical separation monitor A	Event	None
CS 0101 X	CM-SM physical separation monitor B	Event	None
SS 0120 X	SM/adapter physical separation monitor A	Event	None
SS 0121 X	SM/adapter physical separation monitor B	Event	None

SECTION 2

SUBSECTION 2.10

CAUTION AND WARNING SYSTEM (C&WS)

2.10.1 INTRODUCTION.

The C&WS monitors critical parameters of most S/C systems in the C/M and S/M. When a malfunction or out-of-tolerance condition occurs in any of these systems, the crew is immediately alerted in order that corrective action may be taken.

2.10.2 FUNCTIONAL DESCRIPTION.

Upon receipt of malfunction or out-of-tolerance signals, the C&WS simultaneously identifies the abnormal condition and alerts the crew to its existence. Each signal will activate an appropriate systems status indicator and a master alarm circuit. The master alarm circuit visually and aurally attracts the crew's attention by alarm indicators on the MDC and an alarm tone in the headsets. Crew acknowledgement of an abnormal condition consists of resetting the master alarm circuit, but retaining the particular systems status malfunction indication. The capability exists for the crew to select several modes of observing systems status and master alarm indicators, and of monitoring C/M or S/M systems.

2.10.3 MAJOR COMPONENT/SUBSYSTEM DESCRIPTION.

The C&WS consists of one major component, the detection unit. It is located behind MDC-13 and, therefore, is neither visible nor accessible to the crew during the mission. The balance of the system is made up of visual indicators, aural alerting and associated circuits, and those switches required to control the various system functions. Visual indicators include the five upper-most electromechanical event devices on MDC-18, as well as all systems status and master alarm lights.

The detection unit circuits consist of comparators, logic, level detectors, lamp drivers, and a master alarm and tone generator. Also incorporated are two redundant power supplies that furnish regulated +12 and -12 d-c voltages for the electronics. Inputs to the detection unit consist of both analog and event-type signals.

The analog signals, totaling 51 inputs, are in the 0- to 5-volt d-c range. Alarm limits for these signals trigger voltage comparators, which, in turn, activate logic and lamp-driver circuits. This causes activation of the master alarm circuit and tone generator, illumination of application systems status lights on MDC-10 and -11, and/or activation of applicable electromechanical event indicators on MDC-18. A total of 25 event inputs are fed to the C&WS detection unit. These signals originate from solid state and mechanical switch closures in malfunction sensing devices. Of this number, 19 signals will directly illuminate applicable system status lights, and through logic circuitry, activate the master alarm circuit (and tone generator). Two other event signals directly illuminate the system status lights, but require level detectors to activate the master alarm circuit. Each of the four remaining event signals to set to an OR gate, which is also fed by two analog signals. The resulting output will activate lamp drivers and the master alarm circuit. One other event signal, originating within the detection unit directly, illuminates the CAUT/WARN FAIL light, out activates only the MASTER ALARM lights of the MASTER ALARM circuit.

The master alarm circuit alerts crewmembers whenever abnormal conditions are detected. This is accomplished visually by the illumination of remote MASTER ALARM switch-lights on MDC-3 and -18, and the MASTER ALARM light on LEB-103. An audio alarm tone, sent to the three headsets, aurally alerts the crew, regardless of whether the telecom system is activated. The output signal of the tone generator is a square wave that is alternately 750 cps and 2000 cps, changing at a frequency of 2.5 cps. Although the tone is audible above the conversation level, it does not render normal conversation indistinct or garbled. When the crew has noted the abnormal condition, the three alarm lights and the tone generator are deactivated and reset by pressing either MASTER ALARM switch-light, both of which incorporate a push-switch. This action leaves the systems status lights illuminated, and resets the master alarm circuit for alerting the crew to the next abnormal condition. The individual system status lights will remain illuminated until the malfunction or out-of-tolerance condition is corrected.

The C&WS power supplies include sensing and switching circuitry that assure unit self-protection should high-input current, or high- or low-output voltage occur. Any of these conditions will cause the illumination of the master alarm lights and the CAUT-WARN FAIL systems status light. The tone generator, however, will not be activated due to requiring the 12-volt output from the malfunctioned power supply for its operation. The crew must then manually select the redundant power supply to return the C&WS to operation. In so doing, the CAUT/WARN FAIL status light is extinguished, but the master alarm circuit is activated, thus requiring it to be reset.

Incorporated into the C&WS is the capability to test the lamps of systems status and master alarm lights. Position 1 of the LAMP TEST switch (MDC-23) controls the illumination of status lights on MDC-10 and the MASTER ALARM switch-lights on MDC-3 and MDC-18. Position 2 tests only the status lights on MDC-11. The remaining MASTER ALARM light is on LEB-103, and is tested along with the nine G&N condition lights on that panel by pressing the CHECK CONDITION LAMPS push-switch on LEB-105. Although these nine lights are not part of the C&WS, all but three of them (PGNS, ZERO ENCODER, and IMU DISPLAY) are duplicated on MDC-10.

Switches on the MDC enable the crew to select C&WS operational modes. The position of the MODE switch (MDC-11) establishes the S/C systems to be monitored. Before separation and entry, systems in both the C/M and S/M are monitored for malfunction or out-of-tolerance conditions. After CSM separation, however, only those systems in the C/M are monitored. Repositioning the switch also prevents S/M systems status lights and event indicators from remaining activated after separation.

The C/W switch (MDC-13) permits three modes of status and alarm light illumination. For most of the mission the switch is set to the NORMAL position to give normal C&WS light operation; that is, upon receipt of abnormal condition signals, all systems status lights and master alarm lights are capable of illumination. During the ascent phase the switch is set to the BOOST position, so that although all other C&WS lights operate normally, the MASTER ALARM switch-light on MDC-3 will not illuminate. This prevents possible confusion on MDC-3 between the red MASTER ALARM light and the adjacent red ABORT light. The ACK switch position is selected when the crew desires to adapt their eyes to orbital darkness, or if a continuously illuminated systems status light is undesirable. While in this mode, incoming signals will activate only the master alarm lights and the tone generator. To determine the abnormal condition, the crew must press either MASTER ALARM switch-light. This illuminates the applicable systems status light, and deactivates and resets the master alarm circuit. The systems status light will remain illuminated only as long as the switch-light is pressed. However, it may be recalled as long as the abnormal condition exists by again pressing either switch-light.

2. 10. 3. 1 Electrical Power Distribution.

The C&WS only receives power from 28-volt d-c sources. (See figure 2. 10-1.) Before CSM separation, the power source is from the fuel cells in the S/M, and following separation, from batteries located in the C/M.

2. 10.4 PERFORMANCE AND DESIGN DATA.

2. 10. 4. 1 C&WS Power Consumption Data.

Total power consumed by the C&WS amounts to 7.5 watts, which is the maximum quiescent power for detection unit operation. Very small amounts of power are also required to illuminate several lamps whenever the C&WS is activated by malfunction input signals. These small amounts, however, are not considered in the overall C&WS power requirements.

2. 10.5 OPERATIONAL LIMITATIONS AND RESTRICTIONS.

2. 10.5. 1 C&WS General Data.

With the C/W switch in the BOOST position during ascent, the MASTER ALARM switch-light on MDC-3 will not illuminate should a malfunction occur. The master alarm circuit reset capability of the light is also disabled during this time. This requires the MASTER ALARM switch-light on MDC-18 to be used exclusively for monitoring and resetting functions.

Several peculiarities should be noted in regard to the CAUT/WARN-POWER switch. Whenever this switch is moved from, or through, the OFF position to either power supply position, the master alarm circuit is activated, which then requires it be reset. Also, switching from one power supply to another (when there is not power supply failure) will cause the CAUT/WARN FAIL status light to illuminate at the OFF position, and then be extinguished when the other power supply position is reached.

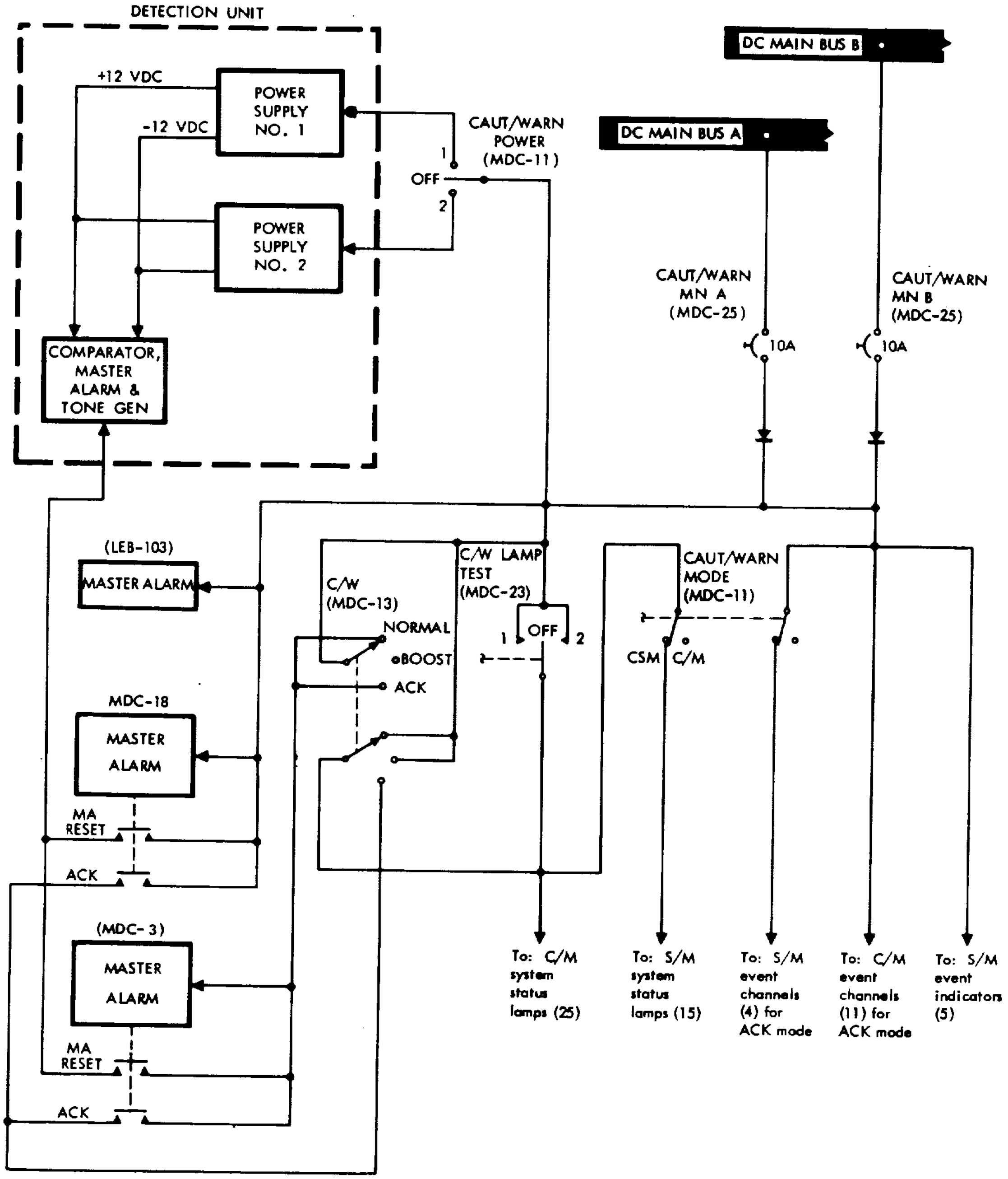


Figure 2.10-1. C&WS Power Distribution Diagram

Should the redundant power supply also fail, the C&WS is degraded to the following extent. Rendered inoperative is the complete master alarm circuit, as well as those status lights that illuminate as the result of analog-type input signals. This leaves only those status lights operative that require event-type input signals. Included are the following S/M and C/M lights: CDU FAIL, G&N ACCEL FAIL, IMU FAIL, G&N ERROR, IMU TEMP, GMBL LOCK, AGAP TEMP, SPS ROUGH ECO, H_2P ACCUM FAIL, PITCH GMBL DR FAIL, YAW GMBL DR FAIL, SPS PU SNSR FAIL, O_2 FLOW HI, F/C BUS DISCONNECT, AC 1 BUS FAIL, AC BUS 1 OVERLOAD, AC 2 BUS FAIL, AC BUS 2 OVERLOAD, MN BUS A UNDERVOLT, MN BUS B UNDERVOLT, and CAUT/WARN FAIL.

The CAUT/WARN-MODE switch must be in the CSM position in order to conduct a lamp test of those status lights associated with S/M systems. The status lights of C/M systems may be tested with the MODE switch in either position. Circuit design also permits a complete lamp test to be conducted with the C/W switch in the ACK position.

Normally, each abnormal condition signal will activate the C&WS master alarm circuit and tone generator, and illuminate an applicable systems status light. The one exception to this concept is when the C&WS power supply fails. The visual indicators will function, but not the tone generator portion of the master alarm circuit. This is due to the tone generator requiring the +12 and -12 d-c voltage output of the failed power supply for its operation.

The MASTER ALARM light on LEB-103 is part of the master alarm circuit of the C&WS. As such, it is illuminated whenever the master alarm circuit is activated by an incoming abnormal condition signal. A lamp check of this light, however, it not accomplished by the C&WS. Instead, the light is checked by pressing the CHECK CONDITION LAMPS push-switch on LEB-105. The primary function of this switch is to check the lamps of the nine G&N condition lights on LEB-103, none of which are part of the C&WS.

2.10.5.2 System Status Light Data.

The following list provides the lamp trigger values and associated information for all system status lights on MDC-10 and -11.

Status Light	Lamp Trigger Value	TLM Code No.	Other Indication	S/C Mode	Remarks
CDU FAIL	1. Loss (-50%) 25.6KC supply 2. Loss (-50%) motor excitation 3. ICDU error >1.2 mr for 5 seconds 4. MCDU error >1.2 mr for 5 seconds 5. OCDU error >1.2 mr for 5 seconds	CG5002X	PGNS light illuminated (LEB-103).	C/M	Light enabled in fine align mode only.
IMU FAIL	1. Loss (-50%) 3200 cps 2. Loss (-50%) 800 cps wheel power 3. IG servo air > 2.9 mr for 2 seconds 4. MG servo air > 2.9 mr for 2 seconds 5. OG servo air >2.9 mr for 2 seconds	CG5001X	PGNS light illuminated (LEB-103).	C/M	Inhibited (by AGC program) in coarse align mode.
IMU TEMP	1. IRIG temp <132°F 2. IRIG temp >138°F 3. PIPA temp <132°F 4. PIPA temp >138°F	CG5006X	None	C/M	IRIG temp (135°F) is internal and not end cap temp.
AGAP TEMP	1. Any BMAG <160°F 2. Any BMAG >171°F	CH2030V	None	C/M	
G&N ACCEL FAIL	1. X PIPA error >27 mr for 5 seconds 2. Y PIPA error >27 mr for 5 seconds 3. Z PIPA error >27 mr for 5 seconds	CG5000X	PGNS light illuminated (LEB-103).	C/M	
G&N ERROR	1. Down TLM word rate too high or low 2. Up TLM bit rate too high 3. Up-link data in error	CG5005X	DSKY-TM FAIL (LEB-106) and PGNS lights (LEB-103) illuminated.	C/M	
GMBL LOCK	MG angle > ±60°	CG5003X	FDAI attitude ball red zone under new axis indicator.	C/M	
H_2 PRESS	1. Tank 1 < 220 psia 2. Tank 1 >270 psia 3. Tank 2 <220 psia 4. Tank 2 >270 psia	SF0039P SF0040P	TANK PRESSURE-H_2-1 indicator TANK PRESSURE-H_2-1 indicator	S/M	
C/M RCS A	1. Fuel tk He press <265 psia 2. Fuel tk He press >325 psia 3. Ox tk He press <265 psia 4. Ox tk He press >325 psia	CR0005P CR0011P	C/M RCS PRESS-F indicator C/M RCS PRESS-OX indicator	C/M	Light functional only when CAUT/WARN-MODE switch in C/W.
C/M RCS B	1. Fuel tk He press <265 psia 2. Fuel tk He press >325 psia 3. Ox tk He press <265 psia 4. Ox tk He press >325 psia	CR0006P CR0012P	C/M RCS PRESS-F indicator C/M RCS PRESS-OX indicator	C/M	Light functional only when CAUT/WARN-MODE switch in C/M.
AGC PWR FAIL	1. Loss of +28 vdc supply 2. Loss of +13 vdc supply 3. Loss of -3 vdc supply	CG5030X	PGNS light illuminated (LEB-103).	C/M	

SYSTEMS DATA

Status Light	Lamp Trigger Value	TLM Code No.	Other Indication	S/C Mode	Remarks
O_2 PRESS	1. Tank 1 < 800 psia 2. Tank 1 > 950 psia 3. Tank 2 < 800 psia 4. Tank 2 > 950 psia	SF0037P SF0038P	TANK PRESSURE-O_2-1 indicator TANK PRESSURE-O_2-2 indicator	S/M	
S/M RCS A	1. Pkg temp < 63°F 2. Pkg temp > 175°F 3. Reg He press < 155 psia 4. Reg He press > 215 psia	SR5065T SR5729P	S/M RCS TEMP-PKG indicator S/M RCS PRESS-MANF indicator	S/M	
S/M RCS B	1. Pkg temp < 63°F 2. Pkg temp > 175°F 3. Reg He press < 155 psia 4. Reg He press > 215 psia	SR5066T SR5776P	S/M RCS TEMP-PKG indicator S/M RCS PRESS-MANF indicator	S/M	
S/M RCS C	1. Pkg temp < 63°F 2. Pkg temp > 175°F 3. Reg He press < 155 psia 4. Reg He press > 215 psia	SR5067T SR5817P	S/M RCS TEMP-PKG indicator S/M RCS PRESS-MANF indicator	S/M	
S/M RCS D	1. Pkg temp < 63°F 2. Pkg temp > 175°F 3. Reg He press < 155 psia 4. Reg He press > 215 psia	SR5068T SR5830P	S/M RCS TEMP-PKG indicator S/M RCS PRESS-MANF indicator	S/M	
SPS ROUGH ECO	1. 180G's for 70 m seconds 2. 360G's for 30 m seconds	None	Engine cuts off.	S/M	G-levels are peak-to-peak.
H_2O ACCUM FAIL	Three O_2 bubbles (min) in outlet water line	None	None	C/M	
F/C BUS DISCONNECT	1. Fwd current at 75 amps for 15 min, or at 112 amps for 25 to 300 seconds 2. Reverse current at 4 amps for 10 sec, or 20 amps for 1 sec.	SC2120X SC2121X SC2122X SC2125X SC2126X SC2127X	MN BUS A event indicator (3) MN BUS B event indicator (3)	S/M	
F/C 1	1. H_2 flow < 0.018 lb/hr 2. H_2 flow > 0.16 lb/hr 3. O_2 flow < 0.14 lb/hr 4. O_2 flow > 1.27 lb/hr 5. At pH factor of 9 6. Skin temp < 360°F 7. Skin temp > 500°F 8. Cond exh < 155°F 9. Cond exh > 175°F 10. Rad out temperature below -30°F 11. H_2 reg press > 75 psia 12. O_2 reg press > 75 psia 13. N_2 reg press > 70 psia	SC2139R SC2142R SC2160X SC2084T SC2081T SC2087T SC2069P SC2066P SC2060P	FUEL CELL-FLOW-H_2 indicator FUEL CELL-FLOW-O_2 indicator pH HI event ind MODULE TEMP-SKIN indicator MODULE TEMP-COND EXH indicator F/C RAD TEMP LOW event indicator REG OUT PRESS HI -H_2 event ind REG OUT PRESS HI -O_2 event ind REG OUT PRESS HI -N_2 event ind	S/M	Event indicators pH, HI, F/C RAD TEMP LO, H_2 PRESS, O_2 PRESS, and N_2 PRESS are activated at lamp trigger values.
INV 1 TEMP HI	At 241°F	CC0175T	None	C/M	
GLYCOL TEMP LOW	At -30°F	CF0020T	GLY EVAP-OUTLET TEMP indicator	C/M	

Status Light	Lamp Trigger Value	TLM Code No.	Other Indication	S/C Mode	Remarks
SPS PRESS	1. Fuel tk He press <160 psia 2. Fuel tk He press >200 psia 3. Ox tk He press <160 psia 4. Ox tk He press >200 psia	SP0006P SP0003P	PRESSURE-FUEL indicator PRESSURE-OX indicator	S/M	
F/C 2	1. H_2 flow <0.018 lb/hr 2. H_2 flow >0.16 lb/hr 3. O_2 flow <0.14 lb/hr 4. O_2 flow >1.27 lb/hr 5. At pH factor of 9 6. Skin temp <360°F 7. Skin temp >500°F 8. Cond exh <155°F 9. Cond exh >175°F 10. Rad out temp below -30°F 11. H_2 reg press >75 psia 12. O_2 reg press >75 psia 13. N_2 reg press >70 psia	SC2140R SC2143R SC2161X SC2085T SC2082T SC2088T SC2070P SC2067P SC2061P	FUEL-CELL-FLOW-H_2 indicator FUEL CELL-FLOW-O_2 indicator pH HI event ind MODULE TEMP-SKIN indicator MODULE TEMP-COND EXH indicator F/C RAD TEMP LOW event indicator REG OUT PRESS HI-H_2 event indicator REG OUT PRESS HI-O_2 event indicator REG OUT PRESS HI-N_2 event indicator	S/M	Event indicator pH HI, F/C RAD TEMP LO, H_2 PRESS, O_2 PRESS, and N_2 PRESS are activated at lamp trigger values.
INV 2 TEMP HI	At 240°F	CC0176T	None	C/M	
PITCH GMBL DR FAIL	1. Under 6 amps 2. Over 40 amps	SP1000X	None	S/M	Overcurrent conditions dependent upon time and temp.
SPS WALL TEMP HI	At 378°F	SP0020T	None	S/M	
F/C 3	1. H_2 flow <0.018 lb/hr 2. H_2 flow >0.16 lb/hr 3. O_2 flow <0.14 lb/hr 4. O_2 flow >1.27 lb/hr 5. At pH factor of 9 6. Skin temp <360°F 7. Skin temp >500°F 8. Cond exh <155°F 9. Cond exh >175°F 10. Rad out temp below -30°F 11. H_2 reg press >75 psia 12. O_2 reg press >75 psia 13. N_2 reg press >70 psia	SC2141R SC2144R SC2162X SC2086T SC2083T SC2089T SC2071P SC2068P SC2062P	FUEL CELL-FLOW-H_2 indicator FUEL CELL-FLOW-O_2 indicator pH HI event ind MODULE TEMP-SKIN indicator MODULE TEMP-COND EXH indicator F/C RAD TEMP LOW event indicator REG OUT PRESS HI-H_2 event indicator REG OUT PRESS HI-O_2 event indicator REG OUT PRESS HI-N_2 event indicator	S/M	Event indicators pH HI, F/C RAD TEMP LO, H_2 PRESS, O_2 PRESS, and N_2 PRESS are activated at lamp trigger values.
INV 3 TEMP HI	At 241°F	CC0177T	None	C/M	
YAW GMBL DR FAIL	1. Under 6 amps 2. Over 40 amps	SP1001X	None	S/M	Overcurrent condition dependent upon time and temp.
SPS PU SNSR FAIL	1. F/OX ratio unbalance over 300 lbs, or 90% of critical unbalance. 2. Primary and aux systems 1 to 3% discrepancy.	None	UNBALANCE indicator (for over 300 lbs only)	S/M	Light functional only during SPS firing.

SYSTEMS DATA

Status Light	Lamp Trigger Value	TLM Code No.	Other Indication	S/C Mode	Remarks
MN BUS A UNDERVOLT	At 26.25±0.1 vdc	CG0206V	DC VOLTS meter	C/M	
MN BUS B UNDERVOLT	At 26.25±0.1 vdc	CG0207V	DC VOLTS meter	C/M	
CO_2 PP HI	At 7.6 mm Hg	CF0005P	PART PRESS CO_2 indicator	C/M	
AC BUS 1 FAIL	1. At 95±3 vdc 2. At 130±2 vdc	CG0200V CG0201V CG0202V	AC VOLTS meter	C/M	
AC BUS 2 FAIL	1. At 95±3 vdc 2. At 130±2 vdc	CC0203V CC0204V CC0205V	AC VOLTS meter	C/M	
CAUT/WARN FAIL	1. At +11.7 vdc or -11.7 vdc 2. At +13.9 vdc or -13.9 vdc	None	MASTER ALARM lights (3)	C/M	Alarm tone inoperative.
O_2 FLOW HI	At 1.0 lb/hr	None	FLOW O_2 indicator	C/M	
AC BUS 1 OVERLOAD	1. 3Ø at 9 amp/Ø for 15±5 sec 2. 1Ø at 11 amp for 5±1 sec	None	AC VOLTS meter	C/M	Overload disconnects inverter from bus.
AC BUS 2 OVERLOAD	1. 3Ø at 9 amp/Ø for 15±5 sec 2. 1Ø at 11 amp for 5±1 sec	None	AC VOLTS meter	C/M	Overload disconnects inverter from bus.

2.10.6 TELEMETRY MEASUREMENTS

The following is a complete list of all C&WS telemetry data that is monitored by flight controllers and ground support personnel. The last column contains the name and type of S/C crew display. The display utilizes the same pickoff or signal source as telemetry, unless a separate measurement number is included in the display column.

Measurement Number	Description	Sensor Range	Crew Display
CS0150X	Master caution-warning on	Off/on event	MASTER ALARM lights

SECTION 2

SUBSECTION 2.11

MISCELLANEOUS SYSTEMS DATA

2.11.1 INTRODUCTION.

Miscellaneous systems data pertains to items that were not covered in a previous system. These items consist of clocks, timers, accelerometers (G-meter), interior lighting, etc.

2.11.2 CLOCKS.

Two clocks and two clock-like event timers, all mechanical, are provided for the crew in the command module. The 400-hour clock (MDC-12), used in monitoring mission elapsed time, is illuminated by floodlights. The GMT 24-hour clock and two 10-hour event timers are located on panel 306 in the LH forward equipment bay and lighted by integral bulbs controlled by the CLOCKS-BRT/OFF/DIM switch on LEB 100. For further information, refer to section 4.

2.11.3 DIGITAL EVENT TIMERS.

The digital event timers provide the crew with a means of monitoring and timing events. One event timer is located on MDC-5 the other is located on MDC-11. The event timers start automatically when lift-off occurs, and the timer located on MDC-5 will be reset if an abort is automatically or manually initiated. For further information, refer to section 3.

2.11.4 ACCELEROMETER (G-METER).

The accelerometer or G-meter (MDC-2), provides the crew with a visual indication of spacecraft positive and negative G-loads. This meter is illuminated by floodlights controlled by the LH area control panel (MDC-26). For detailed information on the accelerometer (G-meter), refer to section 4.

2.11.5 COMMAND MODULE INTERIOR LIGHTING.

The interior lighting provides light for the main display console and LEB panels in the command module.

2.11.5.1 Functional Description.

The interior lighting equipment consists of eight floodlight fixture assemblies and three control panels. Each fixture assembly contains two fluorescent lamps (one primary and one secondary) and a converter. The interior lighting is powered by 28 volts dc from main buses A and B for redundancy (figure 2.11-1). This assures a power source for lights in all areas in the event that either bus fails. The converter in each floodlight fixture converts 28 volts dc to a-c power to operate the fluorescent lamps. The floodlights are used to light three areas: the main display console (left and right areas) and the LEB area. Control panel (MDC-26) is located on the left and control panel (MDC-23) is located on the right of the main display console (figure 2.11-2). The third control panel is located in the lower equipment bay area on LEB-100. The floodlight fixtures are located around the interior of the command module. (See figure 2.11-2.)

Each control panel has a primary and secondary control for the floodlights in its respective area. The primary control is a rheostat that controls brightness of the primary floodlights. The secondary control is an ON-OFF switch for the secondary floodlights and is turned to ON when additional brightness is desired. The floodlight circuit breakers are on MDC-25. The operational use, or brightness level of the floodlights depends on two factors: the g-level and the task being performed. The floodlights should be turned up bright during ascent and entry. The floodlights will be adjusted as required while in earth orbit. The FDAI (MDC-4) is lighted by integral bulbs which are controlled by the FDAI LTG switch on MDC-25 and FDAI BRIGHTNESS rheostat on MDC-2. A switch is provided on the LEB floodlight control panel to control lighting for the clocks on LHFEB-306.

2.11.6 COMMAND MODULE UPRIGHTING SYSTEM.

The C/M uprighting system is manually controlled and operated after the C/M has assumed a stable inverted floating attitude. The system consists of three inflatable air bags, two relays, three solenoid control valves, two air compressors, control switches, and air lines. The inflatable bags are located in the C/M forward compartment and the air compressors are located in the aft compartment. The control switches and circuit breakers are located in the crew compartment. Switches 1 and 2 are powered by the postlanding bus switch 3 and the compressors are powered by battery buses A and B. (See figure 2.11-3.)

2.11.6.1 Functional Description.

POSTLANDING - FLOAT BAG switch 1 controls inflation of the air bag on +Y axis, switch 2 controls inflation of the air bag on the -Y axis, and switch 3 controls inflation of the air bag on the +Z axis of the C/M. (See figure 2.11-3.) Each bag is 43 inches in diameter and has a capacity of approximately 24 cubic feet when inflated. If the C/M becomes inverted

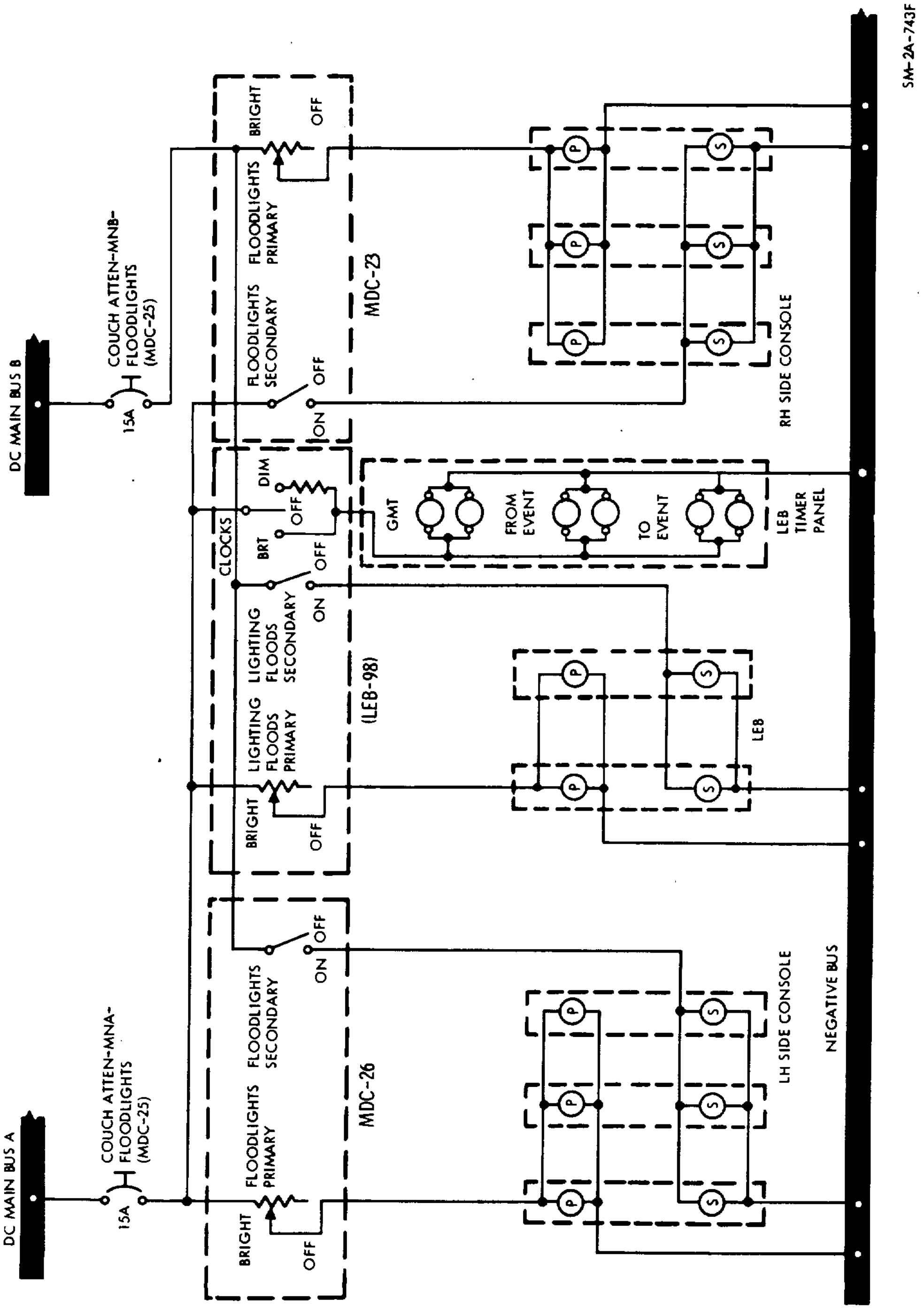


Figure 2.11-1. C/M Interior Lighting Schematic

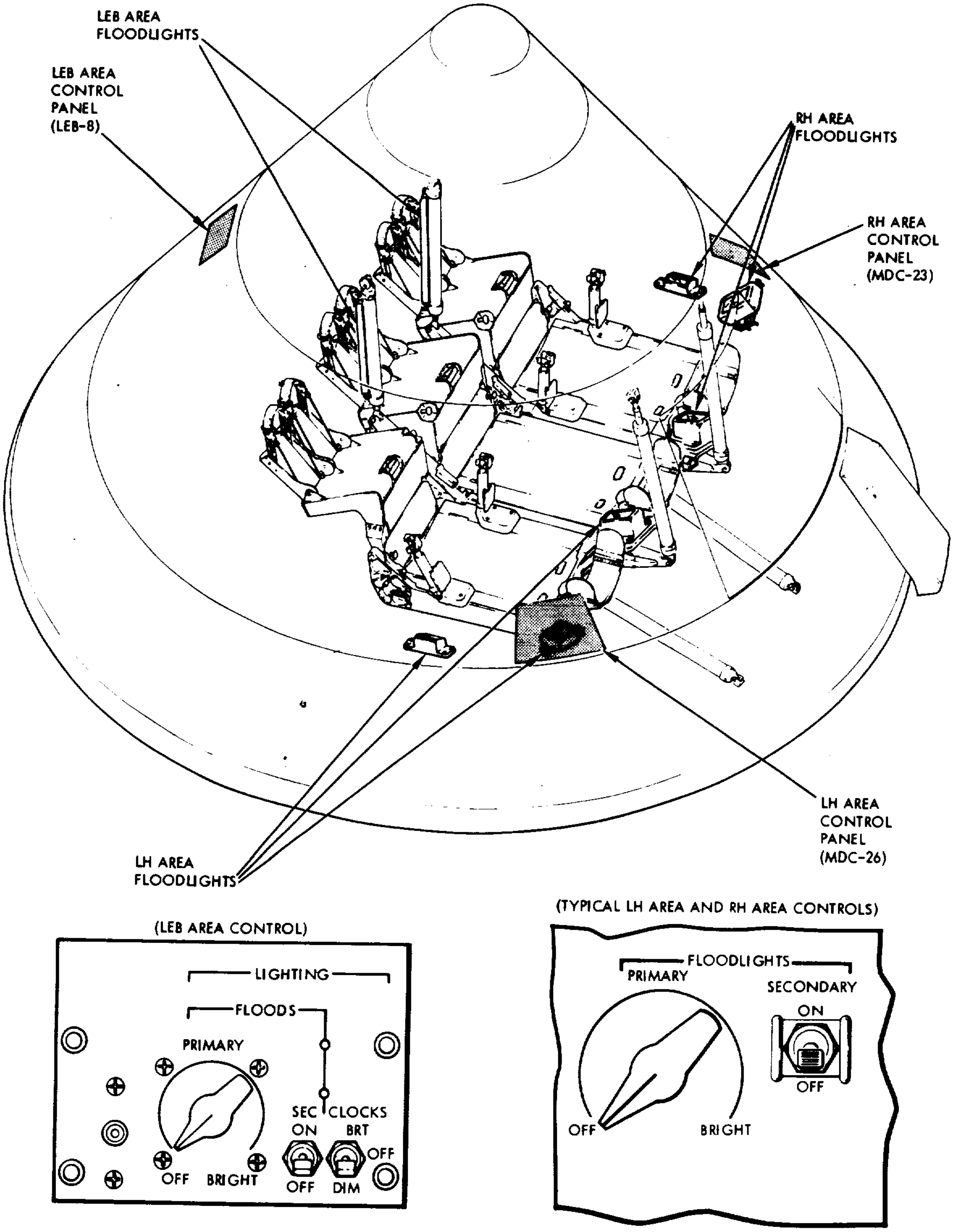


Figure 2.11-2. C/M Interior Lighting Configuration

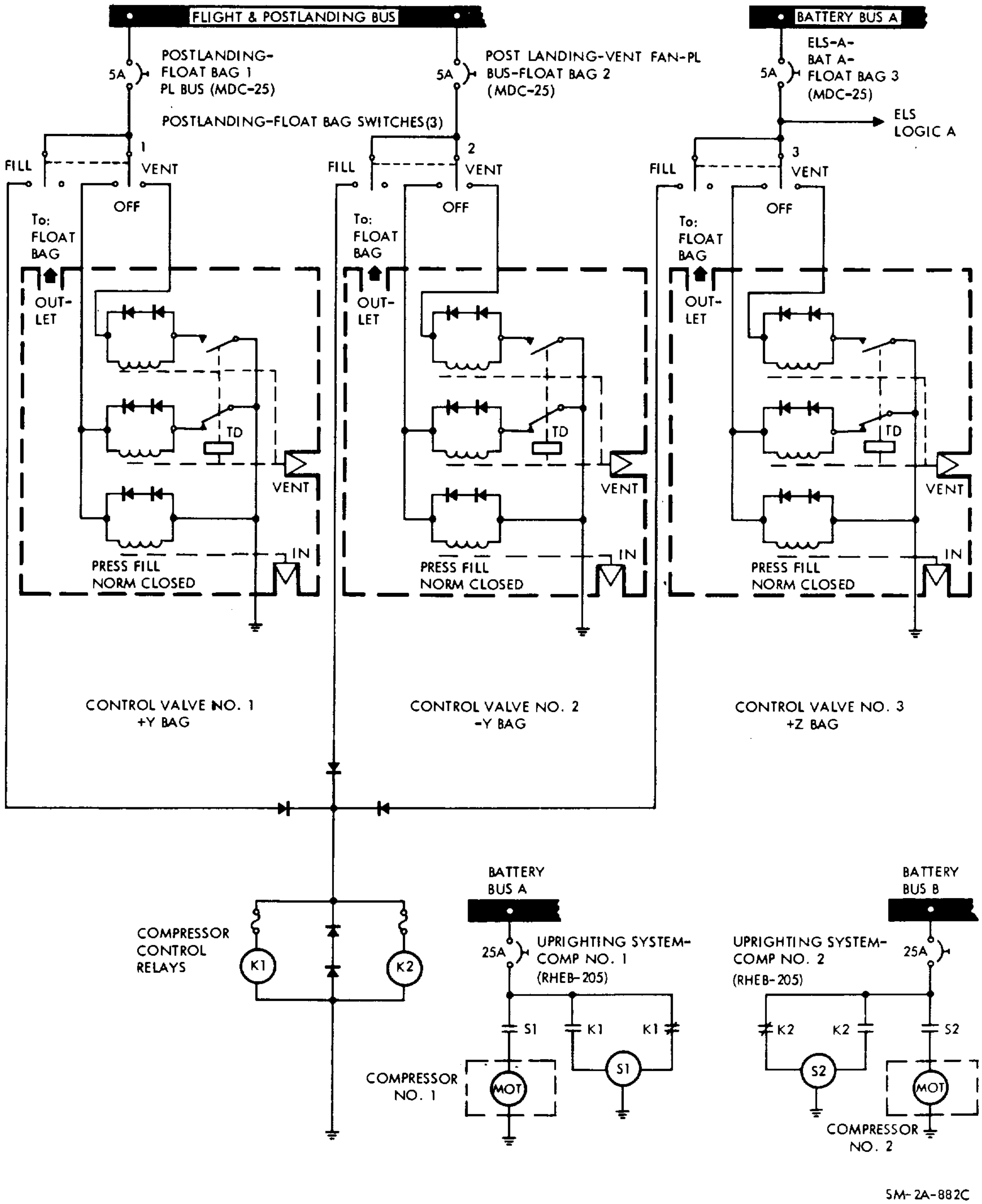


Figure 2.11-3. C/M Uprighting System Electrical Schematic

after landing, the crewmember at station 1 initiates filling of the three bags by setting the POSTLANDING - FLOAT BAG switches 1, 2, and 3 to FILL. When the C/M is uprighted, the three FLOAT BAG switches will be set to OFF. A 4.25±0.25 psi relief valve is located in the inlet of each bag. Backup relief valves set at 13.5 psi are located in the outlet of each compressor.

SECTION 3

CONTROLS AND DISPLAYS

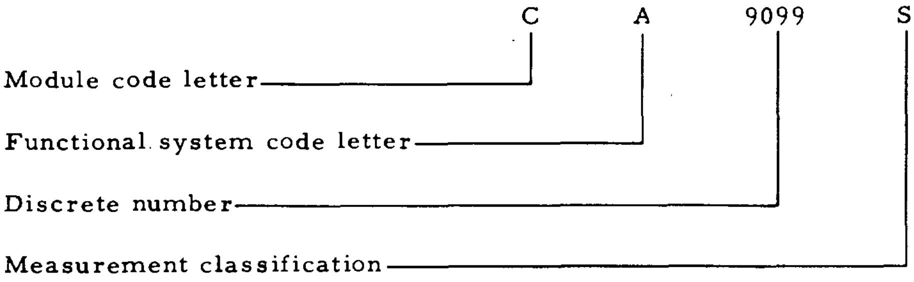
INTRODUCTION.

This section identifies each control and display in the command module and lists panel location, item nomenclature, positions and related functions, power source, telemetry measurement number, and associated explanatory data. Controls and displays are presented in a tabulated list in numerical order by panel number. Panel numbers are those appearing on the main display console drawing and the lower equipment bay drawing in figure 3-1. (The command module itself does not incorporate numbers on the panels.) The following is a detailed explanation of the columnar data presented in the tabulated list.

Location	Gives the location of a particular control or display by panel number or other descriptive information such as "LH couch armrest, etc."
Name and Position	Gives the exact nomenclature of a particular control or display and the control positions, as placarded on the panel. In the absence of a placard, a functional name is assigned and the positions are described physically ("up," "down," etc).
Function	Describes the function of each control in each position.
Circuit Breaker	Gives the name and location of the circuit breaker(s) controlling the electrical power to each control & display.
Power Source	Identifies and gives the rating of the immediate bus or source supplying power to a particular control or display.
Telemetry Code No. and Identity	Gives the measurement numbers for telemetry signals which are used to monitor the performance of components, systems, and subsystems; the status of consumable items; and the proper sequencing of critical

operations during all phases of the spacecraft mission. This information is monitored at MSFN stations for spacecraft management from the ground by use of voice or command links. Measurement numbers are entered only for displayed measurements. Those for undisplayed measurements are included in the telemetry measurements table for the appropriate system in section 2 of this handbook.

The number consists of seven characters; two letters followed by four numbers and one letter. An example is as follows:



a. The first letter designates the module in which the measurement originates. Module code letters are as follows:

A Adapter
B Booster
C Command module
L Launch escape tower
S Service module

b. The second letter denotes the system in which the measurement originates. Functional system code letters are as follows:

A Structures
C Electrical power
D Launch escape
E Earth landing
F Environmental control
G Guidance and navigation
H Stabilization and control
J Life systems
K Flight technology
P Propulsion
R Reaction control
S Crew safety
T Telecommunications and instrumentation

c. Characters three through six are numerals comprising a number which is assigned to a particular measurement point. These numbers are listed sequentially or are grouped for clarity within each system.

d. The seventh letter denotes measurement classification. Classification code letters are as follows:

A	Acceleration
B	Phase
C	Current
D	Vibration
E	Power
F	Frequency
G	Force
H	Position
J	Biomedical
K	Radiation
L	Velcotiy
M	Mass
N	Camera
P	Pressure
Q	Quantity
R	Rate
S	Strain
T	Temperature
V	Voltage
W	Time
X	Discrete event
Y	Acoustical
Z	pH - acidity

<u>Remarks</u> Contains additional data and explanatory remarks.

3.1 CONTROLS/DISPLAYS LOCATOR INDEX.

To aid in finding data within this section, a locator index precedes the tabulated list. The index is sub-divided into spacecraft systems. Under each system is listed, in alphabetical order, all controls and displays associated with the particular system with cross reference to the panel on which the control or display is located. Where items, such as circuit breakers, are associated with more than one system, such items are repeated under each applicable system. Each panel number is preceded by an abbreviated descriptor to aid in quickly determining the general location of each item, as follows:

MDC	main display console (panels 1 thru 26)
LEB	lower equipment bay (panels 100 thru 107, 120, 150)
LHEB	left hand equipment bay (panels 307 thru 317 and 319)
LHFEB	left hand forward equipment bay (panels 300 thru 306 and 318)
RHEB	right hand equipment bay (panels 201 thru 206)
RHFEB	right hand forward equipment bay (panels 200 and 207)

The controls/displays locator index is sub-divided as follows:

GUIDANCE AND NAVIGATION SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
ACCEL FAIL	Lt	LEB-103
ACTIVITY COMP	Lt	MDC14, LEB-106
AGC MODE	Sw	LEB-107
AGC PWR FAIL	Lt	MDC-10, LEB-103
ATT CONT MODE	Lt	LEB-101
ATTITUDE IMPULSE	Control	LEB-105
ATTITUDE IMPULSE ENABLE	Sw	LEB-105
BRIGHTNESS	Control	MDC-14, LEB-106
CDU FAIL	Lt	MDC-10, LEB-103
CDU MAN MODE	Lt	LEB-101
CHECK CONDITION LAMPS	Sw	LEB-105
CHECK COOLANT	Sw	LEB-105
CHECK COOLANT	Windows (2)	LEB-105
CHECK FAIL	Lt	LEB-106
CHECK MODE LAMPS	Sw	LEB-105
CLEAR	Sw	MDC-14, LEB-106
COARS ALIGN MODE	Lt	LEB-101
COMP FAIL	Lt	MDC-14
COMPUTER	CB (2)	MDC-22
CONDITION LAMP	Sw	LEB-105
COUNTER FAIL	Lt	LEB-106
DOOR LATCH	Control	LEB-105
DSKY	Keys	MDC-14, LEB-106
ENTER	Sw	MDC-14, LEB-106
ENTRY MODE	Lt	LEB-101
ERROR RESET	Sw	MDC-14, LEB-106
FINE ALIGN MODE	Lt	LEB-101
GMBL LOCK	Lt	MDC-10, LEB-103
G&N ACCEL FAIL	Lt	MDC-10
G&N ERROR	Lt	MDC-10
G&N VIEWER	Sw	MDC-22
IMU-CDU DIFFERENCE	Ind	LEB-101
IMU	CB (2)	MDC-22
IMU DELAY	Lt	LEB-103
IMU FAIL	Lt	MDC-10, LEB-103
IMU HTR	CB (2)	MDC-22
IMU TEMP	Lt	MDC-10, LEB-103
IMU TEMP MODE GAIN IRIG	Sw	LEB-105
IMU TEMP MODE GAIN PIPA	Sw	LEB-105
IMU TEMP MODE	Mode sw	LEB-105
IMU TEMP MODE ZERO	Sw	LEB-105
INNER GIMBAL (PITCH)	Ind	LEB-102
KEY RLSE	Lt	MDC-14, LEB-106
KEY RLSE	Sw	MDC-14, LEB-106
MANUAL ALIGN	Lt	LEB-101
MARK	Sw	LEB-105
MASTER ALARM	Lt	MDC-3, LEB-103

GUIDANCE AND NAVIGATION SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

GUIDANCE AND NAVIGATION SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
MIDDLE GIMBAL (YAW)	Ind	LEB-102
-(minus sign switch)	Sw	MDC-14, LEB-106
NOUN	Sw	MDC-14, LEB-106
NOUN	End	MDC-14, LEB-106
OPTICS	CB (2)	MDC-22
OPTICS CONTROLLER MODE	Sw	LEB-105
OPTICS CONTROLLER SPEED	Sw	LEB-105
Optics hand controller (no placard)	Control	LEB-105
OPTICS HOLD	Sw	LEB-105
OPTICS	Mode sw	LEB-105
OPTICS SLAVE TELESCOPE	Sw	LEB-105
OUTER GIMBAL (ROLL)	Ind	LEB-102
PANEL BRIGHTNESS	Control	LEB-105
PARITY FAIL	Lt	LEB-106
PGNS	Lt	LEB-103
+ (plus sign switch)	Sw	MDC-14, LEB-106
PROG ALM	Lt	LEB-106
PROGRAM	Ind	MDC-14, LEB-106
REGISTER 1	Ind	MDC-14, LEB-106
REGISTER 2	Ind	MDC-14, LEB-106
REGISTER 3	Ind	MDC-14, LEB-106
RUPT LOCK	Lt	LEB-106
Sextant (not placarded)	SXT	LEB-104
SCALER FAIL	Lt	LEB-106
SHAFT ANGLE	Ind	LEB-102, LEB-104
SHAFT	Manual drive	LEB-104
Telescope (not placarded)	SCT	LEB-104
TC TRAP	Lt	LEB-106
TM FAIL	Lt	LEB-106
TRANSFER	Sw	LEB-101
TRUNNION ANGLE	Ind	LEB-104
TRUNNION	Manual drive	LEB-104
UPTEL ACCEPT BLOCK	Sw	MDC-14
VERB	Ind	MDC-14, LEB-106
VERB	Sw	MDC-14, LEB-106
VIEWER	CB (2)	MDC-22
ZERO ENCODE MODE	Lt	LEB-101
ZERO ENCODER	Lt	LEB-103
2X TRUNNION	Ind	LEB-102

GUIDANCE AND NAVIGATION SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

STABILIZATION AND CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
AGAP TEMP	Warn lt	MDC-10
ATT DEADBAND	Sw	MDC-8
ATT SET	Sw	MDC-6
ATTITUDE IMPULSE-ENABLE	Sw	LEB-105
ATTITUDE/MONITOR/ENTRY	Sw	MDC-8
ATTITUDE SET-ROLL, PITCH, YAW	Thumbwheel (3)	MDC-6
ATTITUDE SET-ROLL, PITCH, YAW	Ind (3)	MDC-6
BMAG POWER	Sw	MDC-24
C/W-NORMAL/BOOST/ACK	Sw	MDC-13
CAUT/WARN-MNA, MNB	CB (2)	MDC-25
CAUTION/WARNING-MODE	Sw	MDC-11
DIRECT RCS	Sw	MDC-8
DIRECT ULLAGE	Sw	MDC-7
FCSM AUTO/OVERRIDE	Sw	MDC-2
FCSM ON/RESET	Sw	MDC-2
FDAI	Ind	MDC-4
FDAI ALIGN	Sw	MDC-6
FDAI BRIGHTNESS	Control	MDC-2
FDAI LTG	Sw	MDC-25
FDAI SELF TEST	Sw	MDC-2
.05G ENTRY	Sw	MDC-8
GIMBAL POSITION	Ind	MDC-6
G&N/SCS	Sw	MDC-8
G&N SYNC	Sw	MDC-25
LCL VERT	Sw	MDC-8
LIMIT CYCLE	Sw	MDC-8
MASTER EVENT SEQ CONT-A LOGIC B-BAT A, BAT B	CB (2)	MDC-22
NORMAL/OFF/DIRECT ON	Sw	MDC-7
PARTIAL SCS POWER	Sw	MDC-24
RATE GYRO POWER	Sw	MDC-24
RATE GYRO-ROLL, PITCH, YAW	Sw (3)	MDC-8
REACTION CONTROL SYS-TRANS	Sw	MDC-16
Rotational Controllers (not placarded)	Controls (2)	LH couch, RH armrest, RH couch, LH armrest
ROTATION CONTROL POWER	Sw	-24
SCS CHANNEL-A&C ROLL, B&D ROLL, PITCH, YAW	Sw (4)	MDC-8
STABILIZATION & CONTROL SYSTEM- A&C ROLL-MNA, MNB B&D ROLL-MNA, MNB DIRECT CONT-MNA, MNB GROUP 1-AC1, AC2 GROUP 1-MNA, MNB GROUP 2-AC1, AC2 GROUP 2-MNA, MNB	CB (18)	MDC-25

STABILIZATION AND CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

STABILIZATION AND CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
THRUST ON	Sw	MDC-7
Translational Controllers (not placarded)	Control (2)	LH couch, LH armrest
TVC 1 POWER	Sw	MDC-24
TVC 2 POWER	Sw	MDC-24
ΔV	Sw	MDC-8
ΔV REMAINING	Ind	MDC-7
ΔV SET	Sw	MDC-7
YAW, PITCH	Thumbwheel (2)	MDC-6

SERVICE PROPULSION SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
ABORT SYSTEM-TWR JETT SPS MODE—A (B) two	Sw	MDC-16
CAUT/WARN-MNA (MNB)	CB (2)	MDC-25
ΔV	Sw	MDC-8
ΔV REMAINING	Sw	MDC-7
ΔV SET	Sw	MDC-7
DIRECT ULLAGE	Sw	MDC-7
FCSM-G&N	Sw	MDC-2
FCSM-SCS	Sw	MDC-2
G&N/SCS	Sw	MDC-8
GIMBAL POSITION-PITCH	Ind	MDC-6
GIMBAL POSITION-PITCH	Thumbwheel	MDC-6
GIMBAL POSITION-YAW	Ind	MDC-6
GIMBAL POSITION-YAW	Thumbwheel	MDC-6
H_e TANK-PRESS	Ind	MDC-20
H_e TANK-TEMP	Ind	MDC-20
INSTRUMENTS-ESS-MNA (MNB)	CB (2)	MDC-22
L/V AOA/SPS P_c	Ind	MDC-3
L/V AOA/SPS P_c	Sw	MDC-3
MASTER EVENT SEQ CONT-A LOGIC B-BAT A (BAT B)	CB (2)	MDC-22
NORMAL/OFF/DIRECT ON (Thrust)	Sw	MDC-7
OXID FLOW	Sw	MDC-20
OXID FLOW-DECREASE	Ind	MDC-20
OXID FLOW-INCREASE	Ind	MDC-20
PITCH GMBL DR FAIL	Status lts	MDC-11
PRESSURE-ENG INLET-FUEL	Ind	MDC-20
PRESSURE-ENG INLET-OX	Ind	MDC-20
PRESSURE-FUEL	Ind	MDC-20
PRESSURE-OX	Ind	MDC-20
QUANTITY-FUEL	Display	MDC-20
QUANTITY-OXID	Display	MDC-20
SENSOR	Sw	MDC-20
SERVICE PROPULSION SYSTEM-		
GAUGING-AC1 (AC2)	CB (2)	MDC-25
GAUGING-MNA (MNB)	CB (2)	MDC-25
GIMBAL MOTOR CONTROL -1 PITCH -BAT A (PITCH 2-BAT B)	CB (2)	MDC-25
GIMBAL MOTOR CONTROL -1 YAW -BAT A (YAW 2-BAT B)	CB (2)	MDC-25
H_e VALVE-MNA (MNB)	CB (2)	MDC-25
SPS ENGINE INJECT VALVE -1 (2, 3, 4)	Ind (4)	MDC-20
SPS GAUGING	Sw	MDC-25
SPS HELIUM (left hand and right hand)	Ind (2)	MDC-20
SPS HELIUM (left hand and right hand)	Sw (2)	MDC-20
SPS-INJECT PRE-VALVES-A (B)	Sw (2)	MDC-3
SPS-GIMBAL MOTORS -1 PITCH (PITCH 2)	Sw (2)	MDC-3

SERVICE PROPULSION SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
SPS-GIMBAL MOTORS -1 YAW (YAW 2)	Sw (2)	MDC-3
SPS LINE HTR	Sw	MDC-19
SPS PRESS	Status lts	MDC-11
SPS PU SNSR FAIL	Status lts	MDC-11
SPS ROUGH ECO	Status lts	MDC-10
SPS TANK PRESS	Sw	MDC-20
STABILIZATION & CONTROL SYSTEM		
-DIRECT CONT-MNA (MNB)	CB (2)	MDC-25
-1 GROUP-AC 1 (GROUP 2-AC 2)	CB (2)	MDC-25
-1 GROUP-MNA (GROUP 2-MNB)	CB (2)	MDC-25
TELECOMMUNICATIONS—GROUP 5	CB	MDC-22
TEST/AUTO/TEST (propellant quantity)	Sw	MDC-20
THRUST ON	Switch-light	MDC-7
TK PRESS-N_2	Ind	MDC-20
UNBALANCE	Ind	MDC-20
VALVE	Sw	MDC-20

SERVICE PROPULSION SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

REACTION CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
ABORT SYSTEM-OX DUMP	Sw	MDC-16
CM PROP JETT-DUMP	Sw	MDC-8
CM PROP JETT-LOGIC	Sw	MDC-8
CM PROP JETT-PURGE	Sw	MDC-8
C/M RCS	Sw	MDC-26
C/M RCS A	Status lts	MDC-10
C/M RCS B	Status lts	MDC-10
C/M RCS HTRS	Sw	RHFEB-200
C/M RCS PRESS F	Ind	MDC-12
C/M RCS TEMP H_e	Ind	MDC-12
C/M RCS PRESS OX	Ind	MDC-12
C/M RCS PRPLNT-A	Sw	MDC-15
C/M RCS PRPLNT-A	Event ind	MDC-15
C/M RCS PRPLNT-B	Sw	MDC-15
C/M RCS PRPLNT-B	Event ind	MDC-15
C/M RCS TEMP H_e	Ind	MDC-12
C/M-S/M-SEP-A (B)	Sw (2)	MDC-15
DIRECT RCS	Sw	MDC-8
INSTRUMENTS-ESS-MNA (MNB)	CB (2)	MDC-22
MASTER EVENT SEQ CONT		
-A ARM B-BAT A (BAT B)	CB (2)	MDC-22
-A LOGIC B-BAT A (BAT B)	CB (2)	MDC-22
PROPELLANT QUANTITY-FUEL (bottom window)	Digital ind	MDC-12
PROPELLANT QUANTITY-OXIDIZER (top window)	Digital ind	MDC-12
PYRO A-RCS FUEL DUMP	CB	LEB-150
PYRO B-RCS FUEL DUMP	CB	LEB-150
RCS HEATERS-A MNB	CB	MDC-21
RCS HEATERS-B MNA	CB	MDC-21
RCS HEATERS-C MNB	CB	MDC-21
RCS HEATERS-D MNA	CB	MDC-21
RCS INDICATORS selector		
C/M section	Sw	MDC-12
S/M section	Sw	MDC-12
REACTION CONTROL SYS-CMD	Sw	MDC-16
REACTION CONTROL SYS-C/M PRESS	Sw	MDC-16
REACTION CONTROL SYS-TRANS	Sw	MDC-16
REACTION CONTROL SYSTEM		
-C/M-S/M TRANSFER-MNA (MNB)	CB (2)	MDC-25
-GAUGING-MNA (MNB)	CB (2)	MDC-25
-PROP ISOL-MNA (MNB)	CB (2)	MDC-25
S/M RCS-A (B, C, D)-HELIUM 1	Sw (4)	MDC-15
S/M RCS-A (B, C, D)-HELIUM 1	Event ind (4)	MDC-15
S/M RCS-A (B, C, D)-HELIUM 2	Sw (4)	MDC-15
S/M RCS-A (B, C, D)-HELIUM 2	Event ind (4)	MDC-15
S/M RCS PRESS H_e	Ind	MDC-12

REACTION CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

REACTION CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
S/M RCS PRESS MANF	Ind	MDC-12
S/M RCS-A (B, C, D)-PROPELLANT	Event ind (4)	MDC-15
S/M RCS-A (B, C, D)-PROPELLANT	Sw (4)	MDC-15
S/M RCS TEMP PKG	Ind	MDC-12
S/M RCS A	Status lts	MDC-10
S/M RCS B	Status lts	MDC-10
S/M RCS C	Status lts	MDC-10
S/M RCS D	Status lts	MDC-10

ELECTRICAL POWER SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
AC BUS 1 FAIL	Lt	MDC-11
AC BUS 2 FAIL	Lt	MDC-11
AC BUS 1 OVERLOAD	Lt	MDC-11
AC BUS 2 OVERLOAD	Lt	MDC-11
AC INDICATORS	Sw	MDC-18
AC INVERTER—AC BUS 1-RESET	Sw	MDC-18
AC INVERTER—AC BUS 2-RESET	Sw	MDC-18
AC INVERTER—1	Sw	MDC-18
AC INVERTER—1-AC BUS 1	Sw	MDC-18
AC INVERTER—1-AC BUS 2	Sw	MDC-18
AC INVERTER—2	Sw	MDC-18
AC INVERTER—2-AC BUS 1	Sw	MDC-18
AC INVERTER—2-AC BUS 2	Sw	MDC-18
AC INVERTER—3	Sw	MDC-18
AC INVERTER—3-AC BUS 1	Sw	MDC-18
AC INVERTER—3-AC BUS 2	Sw	MDC-18
AC SNSR SIG-AC1	CB	MDC-25
AC SNSR SIG-AC2	CB	MDC-25
AC VOLTS	Meter	MDC-18
BAT A PWR-ENTRY	CB	LEB-150
BAT B PWR-ENTRY	CB	LEB-150
BAT CHGR	Sw	MDC-22
BAT CHGR-BAT C	CB	LEB-150
BAT C PWR-POSTLANDING ENTRY	CB	LEB-150
BAT RLY BUS-BAT A	CB	MDC-22
BAT RLY BUS-BAT B	CB	MDC-22
BATTERY CHARGER	Sw	MDC-18
BATTERY CHARGER-AC PWR	CB	MDC-22
BATTERY CHARGER-BAT A CHGE	CB	MDC-22
BATTERY CHARGER-BAT B CHGE	CB	MDC-22
BATTERY CHARGER-MNA	CB	MDC-22
BATTERY CHARGER-MNB	CB	MDC-22
CRYOGENIC SYSTEM-QTY AMPL-AC 1-ØC	CB	MDC-22
CRYOGENIC SYSTEM-QTY AMPL-AC 2-ØC	CB	MDC-22
CRYOGENIC SYSTEM-TANK HEATERS-H_2	CB	MDC-22
CRYOGENIC SYSTEM-TANK HEATERS-O_2	CB	MDC-22
CRYOGENIC TANK FAN MOTORS-AC 1-ØA	CB	MDC-22
CRYOGENIC TANK FAN MOTORS-AC 1-ØB	CB	MDC-22
CRYOGENIC TANK FAN MOTORS-AC 1-ØC	CB	MDC-22
CRYOGENIC TANK FAN MOTORS-AC 2-ØA	CB	MDC-22
CRYOGENIC TANK FAN MOTORS-AC 2-ØB	CB	MDC-22
CRYOGENIC TANK FAN MOTORS-AC 2-ØC	CB	MDC-22
DC AMPS	Meter	MDC-18
DC INDICATORS	Sw	MDC-18
DC SNSR SIG-MNA	CB	MDC-22
DC SNSR SIG-MNB	CB	MDC-22
DC VOLTS	Meter	MDC-18

ELECTRICAL POWER SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
DC VOLTS (auxiliary)	Meter	RHFEB-200
F/C-BUS DISCONNECT	Lt	MDC-11
F/C RAD TEMP LOW	Ind	MDC-18
F/C VALVES	Sw	MDC-19
F/C 1	Lt	MDC-11
F/C 2	Lt	MDC-11
F/C 3	Lt	MDC-11
FREQUENCY	Meter	MDC-18
FUEL CELL-FLOW-H_2	Ind	MDC-18
FUEL CELL-FLOW-O_2	Ind	MDC-18
FUEL CELL INDICATORS	Sw	MDC-18
FUEL CELL-MAIN BUS A-RESET	Sw	MDC-18
FUEL CELL-MAIN BUS B-RESET	Sw	MDC-18
FUEL CELL-MODULE TEMP-COND EXH	Ind	MDC-18
FUEL CELL-MODULE TEMP-SKIN	Ind	MDC-18
FUEL CELL 1-BUS CONT	CB	MDC-22
FUEL CELL 1-CIR & SEP MOTORS	CB	MDC-22
FUEL CELL 1-H_2&O_2 VALVE	CB	MDC-22
FUEL CELL 1-PURGE	CB	MDC-22
FUEL CELL-1-MAIN BUS A	Ind	MDC-18
FUEL CELL-1-MAIN BUS A	Sw	MDC-18
FUEL CELL-1-MAIN BUS B	Ind	MDC-18
FUEL CELL-1-MAIN BUS B	Sw	MDC-18
FUEL CELL-1 purge	Sw	MDC-18
FUEL CELL-1-REACTANTS	Ind	MDC-18
FUEL CELL-1-REACTANTS	Sw	MDC-18
FUEL CELL 2-BUS CONT	CB	MDC-22
FUEL CELL 2-CIR & SEP MOTORS	CB	MDC-22
FUEL CELL 2-H_2&O_2 VALVE	CB	MDC-22
FUEL CELL 2-PURGE	CB	MDC-22
FUEL CELL-2-MAIN BUS A	Ind	MDC-18
FUEL CELL-2-MAIN BUS A	Sw	MDC-18
FUEL CELL-2-MAIN BUS B	Ind	MDC-18
FUEL CELL-2-MAIN BUS B	Sw	MDC-18
FUEL CELL-2 purge	Sw	MDC-18
FUEL CELL-2-REACTANTS	Ind	MDC-18
FUEL CELL-2-REACTANTS	Sw	MDC-18
FUEL CELL 3-BUS CONT	CB	MDC-22
FUEL CELL 3-CIR & SEP MOTORS	CB	MDC-22
FUEL CELL 3-H_2&O_2 VALVE	CB	MDC-22
FUEL CELL 3-PURGE	CB	MDC-22
FUEL CELL-3-MAIN BUS A	Ind	MDC-18
FUEL CELL-3-MAIN BUS A	Sw	MDC-18
FUEL CELL-3-MAIN BUS B	Ind	MDC-18
FUEL CELL-3-MAIN BUS B	Sw	MDC-18
FUEL CELL-3 purge	Sw	MDC-18
FUEL CELL-3-REACTANTS	Ind	MDC-18
FUEL CELL-3-REACTANTS	Sw	MDC-18

ELECTRICAL POWER SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

ELECTRICAL POWER SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
FUEL CELL PUMP-1	Sw	MDC-22
FUEL CELL PUMP-2	Sw	MDC-22
FUEL CELL PUMP-3	Sw	MDC-22
FUNCTION SELECT	Sw	RHFEB-200
H_2 FANS-1	Sw	MDC-13
H_2 FANS-2	Sw	MDC-13
H_2 HEATERS-1	Sw	MDC-13
H_2 HEATERS-2	Sw	MDC-13
H_2 PRESS	Lt	MDC-10
INVERTER CONTROL-1	CB	MDC-22
INVERTER CONTROL-2	CB	MDC-22
INVERTER CONTROL-3	CB	MDC-22
INVERTER PWR-NO. 1 MNA	CB	RHEB-203
INVERTER PWR-NO. 2 MNB	CB	RHEB-203
INVERTER PWR-NO. 3 MNA	CB	RHEB-203
INVERTER PWR-NO. 3 MNB	CB	RHEB-203
INV 1 TEMP HI	Lt	MDC-11
INV 2 TEMP HI	Lt	MDC-11
INV 3 TEMP HI	LT	MDC-11
MAIN A-BAT BUS A	CB	RHEB-203
MAIN A-BAT C	CB	RHEB-203
MAIN B-BAT BUS B	CB	RHEB-203
MAIN B-BAT C	CB	RHEB-203
MAIN BUS TIE-BAT A&C	Sw	MDC-22
MAIN BUS TIE-BAT B&C	Sw	MDC-22
MN BUS A UNDERVOLT	Lt	MDC-11
MN BUS B UNDERVOLT	Lt	MDC-11
NON ESS BUS	Sw	MDC-22
O_2 FANS-1	Sw	MDC-13
O_2 FANS-2	Sw	MDC-13
O_2 HEATERS-1	Sw	MDC-13
O_2 HEATERS-2	Sw	MDC-13
O_2 PRESS	Lt	MDC-10
pH HI	Ind	MDC-18
POST LDG-BAT BUS A	CB	RHEB-203
POST LDG-BAT BUS B	CB	RHEB-203
POST LDG-BAT C	CB	RHEB-203
POST LDG-MAIN A	CB	RHEB-203
POST LDG-MAIN B	CB	RHEB-203
REG OUT PRESS HI-H_2	Ind	MDC-18
REG OUT PRESS HI-N_2	Ind	MDC-18
REG OUT PRESS HI-O_2	Ind	MDC-18
SNSR UNIT-AC BUS-1	CB	MDC-21
SNSR UNIT-AC BUS-2	CB	MDC-21
SNSR UNIT-DC BUS-A	CB	MDC-21
SNSR UNIT-DC BUS-B	CB	MDC-21

ELECTRICAL POWER SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

ELECTRICAL POWER SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
TANK PRESSURE-H_2-1	Ind	MDC-13
TANK PRESSURE-H_2-2	Ind	MDC-13
TANK PRESSURE-O_2-1	Ind	MDC-13
TANK PRESSURE-O_2-2	Ind	MDC-13
TANK QUANTITY-H_2-1	Ind	MDC-13
TANK QUANTITY-H_2-2	Ind	MDC-13
TANK QUANTITY-O_2-1	Ind	MDC-13
TANK QUANTITY-O_2-2	Ind	MDC-13
TEST SELECT	Sw	RHFEB-200
H_2 PURGE LINE HTR	Sw	MDC-15
INV. PHASE LOCK	Sw	RHEB 208

ELECTRICAL POWER SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

SEQUENTIAL SYSTEMS— CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
ABORT	Lt	MDC-3
ABORT SYSTEM-MODE	Sw (2)	MDC-16
ABORT SYSTEM-L/V RATES	Sw	MDC-16
ABORT SYSTEM-OX DUMP	Sw	MDC-16
ABORT SYSTEM-2 ENG OUT	Sw	MDC-16
ADAPT SEP	Sw	MDC-5
ALTIMETER	Indicator	MDC-1
APEX COVER JETT	Sw	MDC-5
CANARD DEPLOY	Sw	MDC-5
C/M-S/M SEP	Sw (2)	MDC-15
COUCH UNLOCK	Sw	MDC-8
Digital Event Timer Indicator (no placard)	Window	MDC-5
DIGITAL EVENT TIMER-MIN	Sw	MDC-8
DIGITAL EVENT TIMER-RESET	Sw	MDC-8
DIGITAL EVENT TIMER-SEC	Sw	MDC-8
DIGITAL EVENT TIMER-START	Sw	MDC-8
Digital Event Timer Indicator (no placard)	Window	MDC-11
DIGITAL EVENT TIMER-MIN	Sw	MDC-11
DIGITAL EVENT TIMER-RESET	Sw	MDC-11
DIGITAL EVENT TIMER-SEC	Sw	MDC-11
DIGITAL EVENT TIMER-START	Sw	MDC-11
DROGUE DEPLOY	Sw	MDC-5
EDS	Sw	MDC-16
EDS	CB (3)	MDC-25
EDS POWER	Sw	MDC-24
ELS	CB (3)	MDC-25
ELS LOGIC	Sw	MDC-8
EVENT TIMER	CB (2)	MDC-25
LES MOTOR FIRE	Sw	MDC-5
LIFT-OFF	Lt	MDC-5
LOCK/UNLOCK	Control	MDC-5
L/V AOA/SPS P_C	Ind	MDC-3
L/V AOA/SPS P_C	Sw	MDC-3
L/V ENGINE	Lt (8)	MDC-5
L/V GUID	Lt	MDC-5
L/V RATE	Lt	MDC-5
MAIN CHUTE RELEASE	Sw	MDC-16
MAIN DEPLOY	Sw	MDC-5
MAIN DEPLOY-AUTO	Sw	MDC-16
MASTER EVENT SEQ CONT-ARM	CB (2)	MDC-22
MASTER EVENT SEQ CONT-LOGIC	CB (2)	MDC-22
MASTER EVENT SEQ CONT-PYRO ARM	Sw (2)	MDC-24
MESC-LOGIC ARM	Sw (2)	MDC-25
NO AUTO ABORT	Lt	MDC-5
POST LDG BEACON LIGHTS	Sw	MDC-26
PYRO A-RCS FUEL DUMP	CB	LEB-150
PYRO A-SEQ A	CB	LEB-150
PYRO B-RCS FUEL DUMP	CB	LEB-150
PYRO B-SEQ B	CB	LEB-150

SEQUENTIAL SYSTEMS—CONTROLS/DISPLAYS LOCATOR INDEX

TELECOMMUNICATIONS—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
BIO-MED COMM-MNA	CB	MDC-25
BIO-MED COMM-MNB	CB	MDC-25
C-BAND	Sw	MDC-20
CENTRAL TIMING SYS-MNA	CB	MDC-22
CENTRAL TIMING SYS-MNB	CB	MDC-22
FLIGHT QUAL RCDR	Sw	MDC-19
RCDR/HF	Sw	MDC-13, -23, -26
INST PWR CONT		RHEB-204
ESSENTIAL 1 THRU 4	CB (4)	
NON-ESSENTIAL 5 THRU 10	CB (6)	
INSTRUMENTS-ESS-MNA	CB	MDC-22
INSTRUMENTS-ESS-MNB	CB	MDC-22
INSTRUMENTS-NONESS	CB	MDC-22
INSTRUMENTS-NONESS BUS	CB	MDC-22
INSTRUMENTS-RCDR NONESS	CB	MDC-22
INSTRUMENTS-SCIEN	CB	MDC-22
INTERCOM	Sw	MDC-13, -23, -26
INTERCOM BALANCE	Sw	MDC-13, -23, -26
NONESS BUS	Sw	MDC-22
POSTLANDING ANTENNA DEPLOY	Sw	MDC-25
POWER		MDC-13, -23, -26
POWER-PMP	Sw	MDC-20
POWER-SCE	Sw	MDC-20
RECOVERY-HF-ON/OFF	Sw	MDC-20
RECOVERY-HF-SSB/BCN/AM	Sw	MDC-20
RECOVERY-VHF BCN	Sw	MDC-20
S-BAND	Sw	MDC-13, -23, -26
S-BAND ANT	Ind	MDC-19
S-BAND ANTENNA	Sw	MDC-20
S-BAND-EMERG	Sw	MDC-20
S-BAND-OSC	Sw	MDC-20
S-BAND-PWR AMPL	Sw	MDC-20
S-BAND-VOICE-RNG/RNG ONLY	Sw	MDC-20
S-BAND-VOICE-TAPE	Sw	MDC-20
S-BAND-VOICE-TV	Sw	MDC-20
S-BAND-XPONDER/XPONDER PWR AMPL	Sw	MDC-20
TAPE RECORDER-FWD/REV	Sw	MDC-20
TAPE RECORDER-PLAY	Sw	MDC-20
TAPE RECORDER-RECORD/PLAY	Sw	MDC-20
TAPE RECORDER-SPEED	Sw	MDC-20
TELECOM-ESS	Sw	MDC-22
TELECOM-NONESS	Sw	MDC-22
TELECOMMUNICATIONS-GROUP 1 AC	CB	MDC-22
TELECOMMUNICATIONS-GROUP 2 AC	CB	MDC-22
TELECOMMUNICATIONS-GROUP 3	CB	MDC-22
TELECOMMUNICATIONS-GROUP 4	CB	MDC-22
TELECOMMUNICATIONS-GROUP 5	CB	MDC-22

TELECOMMUNICATIONS—CONTROLS/DISPLAYS LOCATOR INDEX

TELECOMMUNICATIONS—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
TELECOMMUNICATIONS-PCM TLM AC	CB	MDC-22
TELECOMMUNICATIONS-SIG COND S-BAND PA AC	CB	MDC-22
TLM INPUTS-BIOMED	Sw	MDC-20
TLM INPUTS-PCM	Sw	MDC-20
UP DATA	Sw	MDC-20
UP TLM CMD	Sw	MDC-19
VHF-AM	Sw	MDC-13, -23, -26
VHF-AM RCVR	Sw	MDC-20
VHF-AM SQUELCH	Control	MDC-20
VHF-AM-T/R/REC	Sw	MDC-20
VHF-ANTENNA	Sw	MDC-20
VHF-FM	Sw	MDC-20
VOICE RECORD	Indicator	MDC-19
VOLUME	Control	MDC-13, -23, -26
VOX SENS	Control	MDC-13, -23, -26

TELECOMMUNICATIONS—CONTROLS/DISPLAYS LOCATOR INDEX.

ENVIRONMENTAL CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
BATTERY VENT	Valve	RHEB-203
Cabin air control louver	Control	LHFEB-303
CABIN AIR/AUTO/SUIT AIR	Sw	LEB-120
CABIN AIR FAN-1 & 2	Sw (2)	MDC-21
CABIN PRESSURE RELIEF	Valve (2)	LHEB-307
CABIN REPRESS	Valve	LHEB-314
CABIN TEMP	Valve	LHFEB 303
CABIN TEMP-AUTO	Control	MDC-13
CABIN TEMP-AUTO/MAN	Sw	MDC-13
CO_2-odor absorber diverter	Valve	LHEB-313
CO_2 PP HI	Light	MDC-11
DIRECT O_2	Valve	MDC-24
DRINKING WATER SUPPLY	Valve	LHFEB-304
ΔP SUIT COMPR	Ind	MDC-13
ECS-CABIN AIR FAN-1 & 2	CB (6)	MDC-22
ECS-GLYCOL PUMPS-AC 1 & AC 2	CB (6)	MDC-22
ECS-GLYCOL-PUMP 1/PUMP 2	Sw (2)	MDC-21
ECS-H_2O ACCUM-MNA & MNB	CB (2)	MDC-22
ECS-POT H_2O HTR-MNA & MNB	CB (2)	MDC-22
ECS-RADIATOR	Sw (4)	MDC-21
ECS RAD-OUTLET TEMP	Ind	MDC-13
ECS RAD OUT TEMP-1 & 2	Ind (2)	MDC-19
ECS-RAD VALVE-AC 1 & AC 2	CB (4)	MDC-22
ECS STEAM DUCT HTR-MNA & MNB	CB (2)	RHEB-206
ECS-SUIT COMPRESSORS-AC 1 & AC 2	CB (6)	MDC-22
ECS-TRANSDUCER-PRESS GROUPS 1 & 2	CB (4)	MDC-22
ECS-TRANSDUCER-TEMP-MNA & MNB	CB (2)	MDC-22
ECS-TRANSDUCER-WASTE & POT H_2O-MNA & MNB	CB (2)	MDC-22
EMERGENCY CABIN PRESSURE	Valve	LHEB-314
EVAP H_2O	Valve	LHEB-311
FLOW O_2	Ind	MDC-13
FOOD PREPARATION WATER-COLD & HOT	Valve (2)	LHFEB-305
GAS ANAL	CB	MDC-22
GLY ACCUM-QUANTITY	Ind	MDC-13
GLY EVAP WATER CONTROL BYPASS	Valve	LHEB-317
GLYCOL ACCUMULATOR	Valve	LHEB-312
GLYCOL EVAP-H_2O FLOW	Sw	MDC-13
GLYCOL EVAP-STEAM PRESS-AUTO/MAN	Sw	MDC-13
GLYCOL EVAP-STEAM PRESS-INCR/DECR	Sw	MDC-13
GLYCOL EVAP-STEAM PRESS-TEMP IN	Sw	MDC-13
GLYCOL EVAP TEMP IN	Valve	LHEB-311
GLYCOL PRESS RELIEF BYPASS-1 & 2	Valve (2)	LHEB-309
GLYCOL RESERVE	Valve	LHEB-311
GLYCOL RESERVOIR-BYPASS	Valve	LHEB-307
GLYCOL RESERVOIR-INLET	Valve	LHEB-307
GLYCOL RESERVOIR-OUTLET	Valve	LHEB-307
GLYCOL TEMP LOW	Light	MDC-11

ENVIRONMENTAL CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

ENVIRONMENTAL CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
GLYCOL TO RAD	Valve	LHEB-307
GLY EVAP-OUTLET TEMP	Ind	MDC-13
GLY EVAP STEAM PRESS	Ind	MDC-13
H_2O ACCUM-AUTO/MAN	Sw	MDC-13
H_2O ACCUM FAIL	Light	MDC-11
H_2O ACCUM-ON 1/ON 2	Sw	MDC-13
H_2O ACCUMULATOR-1 & 2	Valve (2)	LHEB-311
H_2O IND	Sw	MDC-13
INST PWR CONT-ESSENTIAL 2	CB	RHEB-204
MAIN REGULATOR	Valve	LHEB-314
O_2 FLOW HI	Light	MDC-11
O_2 PRESS IND	Sw	MDC-13
OXYGEN-ENTRY	Valve	LHEB-307
OXYGEN-S/M SUPPLY	Valve	LHEB-307
OXYGEN-SURGE TANK	Valve	LHEB-307
PART PRESS CO_2	Ind	MDC-13
PGA pressure	Ind (3)	PGA sleeve
PLSS FILL	Valve	LHEB-314
PLVC	Sw	LHEB-316
POST LANDING-VENT FAN	Sw	MDC-25
POST LANDING-VENT FAN-PL BUS/FLOAT BAG 2	CB	MDC-25
POTABLE TANK INLET	Valve	LHEB-315
POT H_2O HEATER	Sw	MDC-21
PRESS-CABIN	Ind	MDC-13
PRESS GLY DISCH	Ind	MDC-13
PRESS-SUIT	Ind	MDC-13
PRESSURE RELIEF	Valve	LHEB-315
START/OFF/PREHEAT	Sw	LEB-120
Suit circuit return air	Valve	LHEB-319
SUIT COMPRESSOR-COMPR 1/COMPR 2	Sw	MDC-21
Suit demand pressure regulator selector	Valve	LHEB-310
SUIT EVAP	Sw	MDC-13
SUIT EVAP	Valve	LHEB-311
SUIT EVAP GLYCOL	Valve	LHEB-311
SUIT FLOW	Valve (3)	LHFEB-300, -301, -302
SUIT FLOW RELIEF	Valve	LHEB-311
SUIT HT EXCH	Sw	LHEB-310
SUIT TEST	Valve	LHEB-310
SURGE TANK PRESSURE RELIEF	Valve	LHEB-308
TANK PRESSURE-O_2-1	Ind	MDC-13
TEMP-CABIN	Ind	MDC-13
TEMP-SUIT	Ind	MDC-13
WASTE H_2O TK REFILL	Sw	MDC-13
WASTE MANAGEMENT-OVBD DRAIN	Valve	RHEB-201
WASTE MANAGEMENT-SELECTOR	Valve	RHEB-201

ENVIRONMENTAL CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

ENVIRONMENTAL CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

Control/Display Name	Type	Panel Locator
WASTE TANK INLET	Valve	LHEB-315
WASTE TANK SERVICING	Valve	LHEB 315
WATER & GLYCOL TANKS PRESSURE-REGULATOR-SELECTOR INLET	Valve	LHEB-314
WATER & GLYCOL TANKS PRESSURE-RELIEF-SELECTOR OUTLET	Valve	LHEB-314
WATER-QUANTITY	Ind	MDC-13

ENVIRONMENTAL CONTROL SYSTEM—CONTROLS/DISPLAYS LOCATOR INDEX

CAUTION AND WARNING SYSTEM—LOCATOR INDEX

Control/Display Name	Type	Panel Locator
AC BUS 1 FAIL	Lt	MDC-11
AC BUS 2 FAIL	Lt	MDC-11
AC BUS 1 OVERLOAD	Lt	MDC-11
AC BUS 2 OVERLOAD	Lt	MDC-11
AGAP TEMP	Lt	MDC-10
AGC PWR FAIL	Lt	MDC-10
CAUT/WARN-FAIL	Lt	MDC-11
CAUT/WARN-MNA & MNB	CB (2)	MDC-25
CAUT/WARN-MODE	Sw	MDC-11
CAUT/WARN-POWER	Sw	MDC-11
CDU FAIL	Lt	MDC-10
C/M RCS A	Lt	MDC-10
C/M RCS B	Lt	MDC-10
CO_2 PP HI	Lt	MDC-11
C/W	Sw	MDC-13
C/W LAMP TEST	Sw	MDC-23
F/C 1	Lt	MDC-11
F/C 2	Lt	MDC-11
F/C 3	Lt	MDC-11
F/C BUS DISCONNECT	Lt	MDC-11
GLYCOL TEMP LOW	Lt	MDC-11
GMBL LOCK	Lt	MDC-10
G&N ACCEL FAIL	Lt	MDC-10
G&N ERROR	Lt	MDC-10
H_2O ACCUM FAIL	Lt	MDC-11
H_2 PRESS	Lt	MDC-10
IMU FAIL	Lt	MDC-10
IMU TEMP	Lt	MDC-10
INV 1	Lt	MDC-11
INV 2	Lt	MDC-11
INV 3	Lt	MDC-11
MASTER ALARM	Lt	MDC-3
MASTER ALARM	Lt	MDC-18
MASTER ALARM	Lt	LEB-103
MN BUS A UNDERVOLT	Lt	MDC-11
MN BUS B UNDERVOLT	Lt	MDC-11
O_2 FLOW HI	Lt	MDC-11
O_2 PRESS	Lt	MDC-10
PITCH GMBL DR FAIL	Lt	MDC-11
S/M RCS A	Lt	MDC-10
S/M RCS B	Lt	MDC-10
S/M RCS C	Lt	MDC-10
S/M RCS D	Lt	MDC-10
SPS PRESS	Lt	MDC-11
SPS PU SNSR FAIL	Lt	MDC-11
SPS ROUGH ECO	Lt	MDC-10
SPS WALL TEMP HI	Lt	MDC-11
YAW GMBL DR FAIL	Lt	MDC-11

CAUTION AND WARNING SYSTEM—LOCATOR INDEX

MISCELLANEOUS SYSTEMS—CONTROLS/DISPLAYS LOCATOR INDEX

Controls/Display Name	Type	Panel Locator
COUCH ATTEN-FLOODLIGHTS	CB (2)	MDC-25
ELS-FLOAT BAG 3	CB	MDC-25
FLOODLIGHTS-PRIMARY	Sw	MDC-23
FLOODLIGHTS-SECONDARY	Sw	MDC-23
FLOODLIGHTS-PRIMARY	Sw	MDC-26
FLOODLIGHTS-SECONDARY	Sw	MDC-26
LIGHTING-CLOCKS	Sw	LEB-100
LIGHTING-FLOODS-PRIMARY	Sw	LEB-100
LIGHTING-FLOODS-SEC	Sw	LEB-100
POST LANDING-FLOAT BAG	Sw (3)	MDC-25
POST LANDING-FLOAT BAG 1 PL BUS	CB	MDC-25
POST LANDING-VENT FAN-PL BUS-FLOAT BAG 2	CB	MDC-25
UPRIGHTING SYSTEM-COMPR NO. 1 AND NO. 2	CB	RHEB-205

MISCELLANEOUS SYSTEMS—CONTROLS/DISPLAYS LOCATOR INDEX

SCIENTIFIC EXPERIMENTS—CONTROLS/DISPLAYS LOCATOR INDEX

Controls/Display Name	Type	Panel Locator
SCIEN EQUIP SEB 1	CB	MDC-22
SCIEN EQUIP SEB 2	CB	MDC-22
INSTRUMENTS—SCIEN (not used)	CB	MDC-22
SCIEN EQUIP HATCH	CB	MDC-22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-1	ALTIMETER	Indicates altitude of command module up to 60,000 feet.	None	None	None	The altimeter is monitored to verify deployment of the drogue and main parachutes at the proper altitude. An adjustable marker on the dial is set prior to launch. The marker is used as a reference for manual deployment of the main parachutes during an abort initiated prior to 61 seconds after lift-off.
MDC-2	FCSM controls G&N/RESET/OVERRIDE switch					
	G&N	Receives power from the SCS-GROUP 1-MNA and B circuit breakers through the G&N mode switch, altitude mode switch, and ΔV switch in ON position. Applies power to the FCSM and the G&N, SCS ΔV gates. If unstable combustion is sensed, the FCSM automatically energizes relays that remove power from the G&N, SCS ΔV gates, automatically shutting the engine down; other relay contact points will illuminate the SPS ROUGH ECO caution and warning light on MDC-10.	SCS-GROUP 1 MNA MNB	G&N switch attitude switch V switch ON	None	Two-position toggle switch. Placed in G&N position when G&N ΔV mode is utilized.
	RESET/OVERRIDE	Applies power to the G&N, SCS ΔV gates, bypassing the FCSM system. If unstable combustion is sensed, the SPS engine will not shut down and the SPS ROUGH ECO caution and warning light on MDC-10 will not illuminate. Will also be utilized to RESET the FCSM system if an automatic shutdown has occurred.				Placed to this position when SCS ΔV mode is utilized. The ΔV switch placed to OFF will also RESET the FCSM as a backup to the RESET/OVERRIDE position.
	SCS RESET/OVERRIDE switch	Receives power from the SCS GROUP 1 - MNA and B circuit breakers through the G&N mode switch, attitude mode switch, and the ΔV switch in ON position. Applies power to the FCSM and the SCS ΔV gates. If unstable combustion is sensed, the FCSM automatically energizes relays that remove power from the SCS ΔV gates, automatically shutting the engine down; other relay contact points will illuminate the SPS ROUGH ECO caution and warning light on MDC-10.				Two-position toggle switch. Placed in SCS position when SCS ΔV mode is utilized.

MAIN DISPLAY CONSOLE— PANELS 1 AND 2

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-2	RESET/OVERRIDE	Applies power to the SCS ΔV gates bypassing the FCSM system. If unstable combustion is sensed, the SPS engine will not shut down and the SPS ROUGH ECO caution and warning light on MDC-10 will not illuminate. Will also be utilized to RESET the FCSM system if an automatic shutdown has occurred.	SCS - GROUP 1 MNA MNB	G&N switch attitude switch ΔV switch ON	None	Placed to this position when G&N ΔV mode is utilized. The ΔV switch placed to OFF would also RESET the FCSM as a backup to the RESET/OVERRIDE position.
	LONG ACCEL indicator	Displays S/C positive and negative g loads along spacecraft X axis and records maximum g readings encountered. A RESET knob enables manual reset of recording pointers to normal 1g position.	(TBD)	(TBD)	(TBD)	The indicator has three pointers; one for normal g indications and the other two for recording maximum +g and -g readings, respectively. Scale +16 to -6g, readable increments 0.2g. Sensor is located behind instrument face.

MAIN DISPLAY CONSOLE—PANEL 2

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-2 (Cont)	FDAI BRIGHTNESS control		SCS— GROUP 2 AC 1 AC 2 (MDC-25)	A-C buses No. 1 and No. 2	None	
	OFF	Turns off FDAI panel lighting (white light) (MDC-4) and THRUST ON switch face lighting (MDC-7).				
	INCR	Adjusts intensity of FDAI panel lighting and THRUST ON switch face lighting.				
	FDAI SELF TEST switch		SCS— GROUP 1 MN A MN B (MDC-25)	D-C main buses A and B		In backup SCS rate mode, the SCS rate electronics receive the sum of the SELF TEST and BMAG inputs. Therefore rate deflection will be 4/5 full scale (fixed) plus deflection caused by the analog of the rate signal, if any. SELF TEST is used each time the FDAI is activated.
	SELF TEST (up)	Normal SCS rate mode a. Removes rate gyro input from SCS rate electronics. b. Applies test signal to SCS rate electronics, causing negative deflection of all FDAI rate indicators to 4/5 full scale.				
	OFF	Removes test signal from rate indicators and permits normal operation of FDAI.				
MDC-3	L/V AOA/SPS P_c switch					Two-position toggle switch which enables the crew to select applicable input to L/V AOA/SPS P_c indicator. The switch is placed in the L/V AOA position prior to lift-off, and in the SPS P_c position at approximately 1 minute and 40 seconds after lift-off.
	L/V AOA	Connects output of Q-ball to L/V AOA/SPS P_c indicator.	None	N/A	None	
	SPS P_c	Connects output of SPS engine combustion chamber pressure sensor to L/V AOA/SPS P_c indicator.				
	L/V AOA/SPS P_c indicator	Time-shared indicator with input determined by position of L/V AOA/SPS P_c switch.				Indicator range: 0 to 150%.
		a. L/V AOA input: the indicator displays a percentage of ΔP measured by the Q-ball which is a function of pitch and yaw.		D-C voltage from S-IVB I. U.		Small changes in air pressures are sensed through four holes in the Q-ball. The indicator is monitored from 40 seconds to approximately one minute and 40 seconds after lift-off. It is red-lined at approximately 100 percent for the L/V AOA function. A decision for manual abort will be made when the indicator pointer reaches the red line and a movement is also noted on the FDAI.

MAIN DISPLAY CONSOLE—PANELS 2 AND 3

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-3 (Cont)		b. SPS P_c input: the indicator displays SPS engine combustion chamber pressure during SPS thrusting as percentage of reference pressure value.	INSTRUMENTS—ESS MN A MN B (MDC-22)	D-C voltage from signal conditioner	SP0661P (Combustion chamber pressure sensor)	Reference pressure value for SPS P_c input is 100 psia (nominal). Normal thrusting readout is 100 percent. Scale is graduated in % increments.
	MASTER ALARM switch-light	Red light illuminates to alert crewman in LH couch of a malfunction or out-of-tolerance condition. This is indicated by illumination of applicable system status lights on MDC-10 or -11.	CAUT/WARN MN A MN B (MDC-25)	D-C main buses A and B	CS0150X (Master caution-warning on)	MASTER ALARM lights on MDC-3, -18, and LEB-103 are simultaneously illuminated and an audio alarm tone is sent to each headset. The C/W switch (MDC-13) is set to BOOST during the ascent phase only, preventing this MASTER ALARM switchlight from illuminating in order to avoid confusion with the adjacent red ABORT light. The switch-light loses its reset function during this time. The MASTER ALARM switch-light contains an integral pushbutton switch. Pressing the switch-light will reset the master alarm circuit, extinguishing the MASTER ALARM lights and shutting off the audio alarm.
	ABORT light	Illuminates red to indicate that an abort has been requested by the range safety officer or ground control.	EDS-1, 3 BAT A BAT B (MDC-25)	Battery buses A and B when the EDS POWER switch is ON (MDC-24)	BX0080X (EDS abort request A)	The light serves to alert the crew of an emergency situation where an abort is required immediately. The light is a backup to voice communications from ground control. Redundant bulbs are controlled by redundant commands through the UDL real-time command system.
	SPS switches GIMBAL MOTORS group PITCH 1, PITCH 2, YAW 1, YAW 2 switches START	Four operationally identical switches. Energizes motor switch in applicable overcurrent relay which, in turn, applies +28 vdc to the applicable gimbal actuator drive motor.	SPS—GIMBAL MOTOR CONTROL 1 PITCH BAT A PITCH 2 BAT B 1 YAW BAT A YAW 2 BAT B (MDC-25)	Battery buses A and B	None	Three-position toggle switch with upper (START) position spring-loaded to return switch to center (ON) position when released. PITCH 1 and YAW 1 switches control gimbal actuator primary drive motors. PITCH 2 and YAW 2 switches control gimbal actuator secondary drive motors. START position provides gimbal motor starting capability.

MAIN DISPLAY CONSOLE—PANEL 3

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-3 (Cont)	ON	Applies +28 vdc to over-undercurrent sensing circuitry in applicable overcurrent relay.	SPS—GIMBAL MOTOR CONTROL 1 PITCH BAT A PITCH 2 BAT B 1 YAW BAT A YAW 2 BAT B (MDC-25)	Battery buses A and B	None	ON position provides for over or undercurrent sensing (under 6 amps or over 40 amps nominal). During primary channel operation an over or undercurrent will automatically cause power to be removed from the primary drive motor, clutch commands switched to the secondary channel, and applicable GMBL DR FAIL status indicator to illuminate (MDC-11). During secondary operation, pitch 2 motor circuit is protected by CB 1 and yaw 2 motor circuit is protected by CB 2. CB 1 and CB 2 are 70 amp circuit breakers located in the S/M. No status indicators are provided for the secondary control circuits. During ascent, when GIMBAL MOTORS switches (4) are OFF, engine positioning is maintained by application of a quiescent current (60 +10, -5 ma) to the electromagnets of the extend and retract clutches when TVC 1 and 2 POWER switches (MDC 24) are on.
	OFF	Energizes motor switch in applicable overcurrent relay which removes +28 vdc from the current sensing circuitry and gimbal actuator drive motor.				
	INJECT PRE-VALVES group A (B) switch	Two operationally identical switches. Each switch controls the pneumatic (GN_2) pressurization of the SPS engine valve-actuators within their respective half of a series/parallel propellant feed line configuration to the engine combustion chamber.	SPS—He VALVE MN A MN B (MDC-25)	D-C main buses A and B		Two-position toggle switch which must be in ON position (i.e., solenoid is actuated) before automatic or manual SPS engine valve-actuator control of the main propellant valves can be initiated.
	ON	Applies +28 vdc to SPS engine system A pilot pre-valve solenoid.				
	OFF	Removes +28 vdc from SPS engine system A pilot pre-valve solenoid.				

MAIN DISPLAY CONSOLE—PANEL 3

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-4	Flight director attitude indicator Total attitude indication	Displays S/C total attitude, attitude errors, and angular rates. S/C inertial attitude is displayed by orientation of the 3-axis attitude ball, with readouts as follows: a. Roll attitude is read from the ball-driven movable index (roll bug) referenced to the calibrated bezel ring around the ball, with respect to S/C navigation axes only. b. Pitch and yaw are read directly from the calibrated surface of the ball, with respect to either the S/C body axes index or the navigation axes index. Two 30° red circular areas on the ball surface denote attitude regions in which G&N IMU gimbal lock or excessive SCS AGCU error can occur.	SCS— GROUP 1 AC 1 GROUP 1 AC 2 (MDC-25)	A-C bus No. 1 or No. 2 (via SCS display/ AGAA ECA)		Total attitude indicator calibration Pitch: 0° - 360° (ball longitude) Yaw: 270° - 0° -90° (ball latitude) Roll: 0° - 360° (bezel ring) Total attitude indicator direction of positive (+) rotation Axis of rotation (other two axes fixed at 0°) — Direction of Ball Rotation pitch — up: from top to bottom yaw — right: from right to left roll — right: counterclockwise Total attitude indication follows attitude deviations only in the following situations: a. When G&N system supplies inputs b. When CSS + translation control CW + .05g + (ATTITUDE IMPULSE-ENABLE) + (SCS attitude mode) + (pitch disabled + yaw disabled + both roll disabled) (BUR in any axis)'. (MTVC)'. (FDAI align)'.
	Attitude error indication	S/C attitude errors are displayed by three fly-to-type needles mounted on the bezel ring around the attitude ball, with the top, right, and bottom needles corresponding to roll, pitch, and yaw, respectively. The readouts denote one of the following: a. Difference between present S/C attitude and the S/C reference attitude stored in either the G&N ICDUs or the SCS AGCU. The readouts are always referenced to S/C body axes, except during G&N-controlled				Attitude error indicator calibration (full-scale deflection) Modes — Roll — Pitch — Yaw Monitor (G&N): ±25° — ±15° — ±15° G&N entry, SCS entry: ±25° — ±5° — ±5° All other modes: ±5° — ±5° — ±5°

MAIN DISPLAY CONSOLE—PANEL 4

CONTROLS AND DISPLAYS

<table>
<tr><th>Location</th><th>Name and Position</th><th>Function</th><th>Circuit Breaker</th><th>Power Source</th><th>Telemetry Code No. and Identity</th><th>Remarks</th></tr>
<tr><td>MDC-4 (Cont)</td><td></td><td>entry when the roll error needle is referenced to the S/C navigation axis. The pitch and yaw error needles will be zero after 0.05 g switching in a G&N entry mode, and there will be no attitude error displayed after 0.05 g in an SCS entry mode.
b. Difference between the present S/C reference attitude stored in the SCS AGCU and a desired attitude dialed into the attitude set/gimbal position display, with the ATTITUDE SET function engaged. Dialed in and stored attitudes are referenced to S/C navigation axes, with the difference angles inverted to body axes for display by the error needles.</td><td>SCS-
GROUP 1
AC 1
GROUP 1
AC 2
(MDC-25)</td><td>A-C bus No. 1 or No. 2 (via SCS display/ AGAA ECA</td><td></td><td>Attitude error indicator deflection for positive (+) rotational input commands
<table>
<tr><th>Axis of Rotation (positive command)</th><th>Indicator Deflection from Zero (center)</th></tr>
<tr><td>roll</td><td>left</td></tr>
<tr><td>pitch</td><td>up</td></tr>
<tr><td>yaw</td><td>left</td></tr>
</table></td></tr>
<tr><td></td><td>Angular rate indication</td><td>S/C angular velocities are displayed by three fly-to-type indicators mounted above, to the right of, and below the attitude ball, corresponding to roll, pitch, and yaw, respectively. The readouts are always referenced to S/C body axes except during atmospheric entry (after 0.05 g) when the yaw rate indicator is referenced to the S/C stability axis. Inputs to the indicators are supplied by either the SCS rate gyros (normal) or the SCS BMAGs (backup).</td><td></td><td></td><td></td><td>Angular rate indicator calibration (full-scale deflection)
<table>
<tr><th>Modes</th><th>Roll</th><th>Pitch</th><th>Yaw</th></tr>
<tr><td>Monitor (G&N)
G&N entry
SCS entry</td><td>±25°/ sec</td><td>±5°/ sec</td><td>±5°/ sec</td></tr>
<tr><td>G&N delta V
SCS delta V</td><td>±5°/ sec</td><td>±5°/ sec</td><td>±5°/ sec</td></tr>
<tr><td>G&N att cont
SCS att cont
SCS lcl vert</td><td>±1°/ sec</td><td>±1°/ sec</td><td>±1°/ sec</td></tr>
</table>
Angular rate indicator deflection for positive (+) rotational input commands
<table>
<tr><th>Axis of Rotation (positive command)</th><th>Indicator Deflection from Zero (center)</th></tr>
<tr><td>roll</td><td>left</td></tr>
<tr><td>pitch</td><td>up</td></tr>
<tr><td>yaw</td><td>left</td></tr>
</table></td></tr>
</table>

MAIN DISPLAY CONSOLE—PANEL 4

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-5	Digital event timer	The event timer provides the crew with a means of monitoring and timing events. Indications from 00 minutes and 00 seconds (00-00) to 59 minutes and 59 seconds (59-59) are obtainable in a countup or countdown mode. In a countup mode, when 59-59 is recorded, the counter will proceed to 00-00 and continue to count up. In a countdown mode, continuous counting is also available.	EVENT TIMER MN A MN B (MDC-25)	D-C main buses A and B	None	The event timer is a reference system only and is automatically reset to zero when an abort is automatically or manually initiated. The event timer starts automatically when lift-off occurs.
	L/V RATE light	Illuminates red to indicate that the permissible angular rates in any of pitch, roll, or yaw axes have been exceeded. Rates in excess of 20 degrees/seconds in roll and 5 degrees/second in pitch or yaw illuminate the rate light.	EDS-1, 3 BAT A BAT B (MDC-25)	Battery buses A and B when the EDS POWER switch (MDC-24) is ON.	BS0020X (Launch vehicle rate excessive A)	When used in conjunction with the angle-of-attack display and the attitude error reading of the FDAI, will indicate the necessity for manual abort initiation. The light also illuminates when an auto abort is initiated because of excessive rates.
	L/V GUID light	Illuminates red to indicate platform failure in the L/V guidance system (loss of attitude control).			BS0016X (Launch vehicle guidance fail A)	
	L/V ENGINES lights					All engine lights are yellow. The lights are used to indicate staging and the necessity for initiating a manual abort when two S-IB engines are operating below 90 percent of thrust. When enabled in the auto abort mode, an auto abort will be initiated with two engines below 90 percent of thrust.
	Light No. 1	Illuminates to indicate S-IB or S-IVB engine No. 1 operating below 90 percent of total thrust capability.			BS0030X (Engine No. 1 out A)	
	Light No. 2	Illuminates to indicate S-IB engine No. 2 operating below 90 percent of total thrust capability.			BS0032X (Engine No. 2 out A)	
	Light No. 3	Illuminates to indicate S-IB engine No. 3 operating below 90 percent of total thrust capability.			BS0034X (Engine No. 3 out A)	
	Light No. 4	Illuminates to indicate S-IB engine No. 4 operating below 90 percent of total thrust capability.			BS0036X (Engine No. 3 out A)	

MAIN DISPLAY CONSOLE—PANEL 5

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-5 (Cont)	Light No. 5	Illuminates to indicate S-IB engine No. 5 operating below 90 percent of total thrust capability.	EDS-1, 3 BAT A BAT B (MDC-25)	Battery buses A and B when the EDS POWER switch (MDC-24) is ON.	BS0038X (Engine No. 5 out A)	
	Light No. 6	Illuminates to indicate S-IB engine No. 6 operating below 90 percent of total thrust capability.			BS0040X (Engine No. 6 out A)	
	Light No. 7	Illuminates to indicate S-IB engine No. 7 operating below 90 percent of total thrust capability.			BS0042X (Engine No. 7 out A)	
	Light No. 8	Illuminates to indicate S-IB engine No. 8 operating below 90 percent of total thrust capability.			BS0044X (Engine No. 8 out A)	
	LIFT-OFF and NO AUTO ABORT lights					
	LIFT-OFF light	White light illuminates at lift-off.			BS0060X BS0061X (Lift-off signal A & B)	The LIFT OFF/NO AUTO ABORT switch/light combination should be pressed if the LIFT OFF light does not illuminate at lift off. (Refer to malfunction procedures.) The relay controlling the white light is reset 5 seconds after lift-off by a timer in the L/V instrumentation unit.
	NO AUTO ABORT light	Switch-light will illuminate red at lift-off if either of the LV-EDS auto abort systems has not been automatically enabled.			None	The astronaut will press the switch-light which will electrically enable the LV-EDS automatic abort system. If the light still does not go out, it indicates that one or both of the dual redundant EDS systems is not enabled. In this event, the crew must be prepared to initiate a manual abort, if necessary.
	LES MOTOR FIRE switch	a. Backup switch to fire the launch escape motor. b. Backup switch to jettison the LES tower in the event the jettison motor failed to ignite	MASTER EVENTS SEQ CONT-A ARM B BAT A BAT B (MDC-22)	Battery buses A and B	CD0101X LE/P_c motor fire initiate A CD0102X LE/P_c motor fire initiate B	The LES motor is normally (automatically) fired approximately 0.1 second by the MESC following abort initiation. It may be used for a backup for the jettison motor only after normal means of TWR jettison has failed. This is assuming that the TWR separation nuts are fractured.

MAIN DISPLAY CONSOLE—PANEL 5

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-5 (Cont)	CANARD DEPLOY switch	Backup switch to deploy the canard when it does not deploy automatically during an abort.	MASTER EVENTS SEQ CONT-A ARM B BAT A BAT B (MDC-22)	Battery buses A and B	CD0120X CD0121X Canard deploy A and B	Push-type switch. The canard will normally (automatically) deploy 11 seconds after a LES abort initiation.
	ADAP SEP switch	a. Switch for normal CSM/S-IVB separation after the ascent phase of the mission. (Refer to adapter separation mechanism in section 2.) b. Backup switch for CSM/S-IVB separation if it does not separate automatically during an SPS abort. (Refer to SPS abort procedures.)			CD0125X Adapter/SM separate initiate A CD0126X Adapter/SM separate initiate B	Push-type switch to separate the adapter when an SPS abort cannot be initiated with the commanders translational control. SPS ullage and firing would be manual functions.
	APEX COVER JETT switch	Backup switch to jettison the C/M apex cover.	ELS A— BAT A-FLOAT BAG 3 ELS B— BAT B (MDC-25)		CD0230X Forward heat shield jettison A CD0231X Forward heat shield jettison B	Push-type switch to jettison the C/M apex cover if the automatic system fails during an abort or earth landing after a normal mission.
	DROGUE DEPLOY switch	Backup switch to deploy the drogue parachutes.			CE0001X Drogue deploy relay close A CE0002X Drogue deploy relay close B	Push-type switch. The drogue parachutes will normally (automatically) deploy 2 seconds after the 24, 000 feet baro switch closes.
	MAIN DEPLOY switch	Backup switch to deploy the main parachutes.			CE0003X Main parachute deploy-drogue release relay A CE0004X Main parachute deploy-drogue release relay B	Push-type switch. The main parachutes will normally (automatically) deploy when the 10, 000 feet baro switch closes during descent. The switch is also used to initiate manual deployment of the main parachutes during aborts initiated prior to 61 seconds after lift-off.

MAIN DISPLAY CONSOLE—PANEL 5

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-5 (Cont)	Backup switches lock control		N/A	N/A	None	
	LOCK	Locks the backup switches to prevent inadvertent operation.				
	UNLOCK	Unlocks and enables the backup switches to be pushed manually.				
MDC-6	ATTITUDE SET group	Enables manual insertion of a desired attitude reference into the SCS, either for AGCU alignment or for a commanded S/C attitude maneuver reference during SCS flight modes.				
	ROLL, PITCH, YAW thumbwheels and indicators	Enable manual selection and display of desired roll, pitch, and yaw attitude settings referenced to S/C navigation axes.	SCS— GROUP 1 AC 1 GROUP 1 AC 2 (MDC-25)	A-C bus No. 1 or No. 2	None	Yaw thumbwheel is marked with a stripe, denoting yaw angles of 75° and 285°, as a caution against dialing in settings at which G&N IMU gimbal lock or excessive SCS AGCU error can occur. Indicators provide digital type displays.
	FDAI ALIGN switch	a. Couples manually selected (dialed in) attitude settings into the SCS for alignment of the present S/C reference attitude stored in the AGCU to the desired reference attitude. b. Decouples normal SCS BMAG inputs to the AGCU and the BMAGS are free gyros until the switch is released. c. Aligns the FDAI attitude ball to the dialed-in attitude, referenced to S/C navigation axes, in SCS flight modes only.	SCS— GROUP 1 MN A MN B (MDC-25)	D-C main bus A or B		Momentary-contact pushbutton switch which must be held engaged until alignment is completed. SCS AGCU alignment slew rates roll — 20°/sec pitch — 5°/sec yaw — 5°/sec Perform the FDAI/AGCU align function.

MAIN DISPLAY CONSOLE—PANELS 5 AND 6

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-6 (Cont)	ATT SET switch		SCS— GROUP 1 MN A MN B (MDC-25)	D-C main bus A or B	None	The attitude set function which enables S/C maneuver to a desired (dialed in) attitude is applicable to SCS flight modes only. The desired attitude is achieved by flying out the attitude error needles, using the rotation control.
	On (up)	a. Couples the attitude difference angles to the FDAI attitude error indicators, referenced to S/C body axes. b. Decouples normal SCS BMAG inputs to the FDAI attitude error indicators. (BMAGs continue to operate normally otherwise.)				
	OFF	Inhibits the attitude set function.				
	GIMBAL POSITION group	Provides display and manual control of gimbaled SPS engine thrust axis orientation with respect to S/C body axes.	SCS GROUP 1 AC 1 & AC 2 GROUP 2 AC 1 & AC 2 (MDC-25)	A-C bus No. 1 or No. 2		
	YAW, PITCH indicators	Provide display of engine gimbal position readouts with respect to S/C yaw and pitch (body) axes, respectively.		(via yaw and pitch ECAs)	CH3135V (pitch GPI amp demod out)	Yaw indicator and thumbwheel are calibrated in 0.5° increments from -3° to +13°. Center reading of +4° corresponds to yaw gimbal position null, due to engine offset for S/C CG.
	YAW, PITCH thumbwheels	Provide manual yaw and pitch input commands to respective engine gimbal position servos for alignment of SPS engine thrust axis through S/C CG, prior to SPS thrusting. Thumbwheel displacement in a positive direction will provide a relative positive gimbal position indicator display indicating nozzle positioning for a positive axis displacement when thrust is initiated.		(via display/ AGAA ECA)	None	Pitch indicator and thumbwheel are calibrated in 0.5° increments from -9° to +9°. Center reading of 0° corresponds to pitch gimbal position null. Trimming of gimbal positions by use of the thumbwheels is possible when performing MTVC. Group 2 circuit provides power to MTVC circuits.

MAIN DISPLAY CONSOLE—PANEL 6

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-7	DIRECT ULLAGE switch	Provides backup capability for initiating ullage (+X translation) prior to SPS burns. a. Energizes injector valve direct coils of four +X SM RCS engines. b. Disengages automatic attitude hold capability in pitch and yaw axes.	SCS—DIRECT CONT MN A MN B (MDC-25)	D-C main bus A or B	None	Momentary-contact pushbutton switch which must be held engaged until ullage is completed. Translation control provides normal capability for initiating ullage.
	THRUST ON switch light	a. Switch actuation applies manual SPS engine thrust-on logic command to SCS electronics which energizes coils of SPS engine helium isolation valves (if SPS He switch on MDC-20 is in AUTO position) and pilot control valves.	SCS—GROUP 1 MN A MN B (MDC-25)		CH4320X (SPS solenoid control valve energized)	Pushbutton momentary-contact-type switch. Provides normal SPS engine ignition control in SCS ΔV mode, backup control in G&N ΔV mode. FDAI BRIGHTNESS control must be on to provide switch face illumination.
		b. Switch face illumination indicates application of SPS engine thrust-on signal from G&N system or THRUST ON switch to SCS electronics. Light is extinguished when SPS engine thrust-off signal from G&N system, ΔV REMAINING counter, or flight combustion stability monitor is detected in SCS electronics.			CH4321X (SPS solenoid control valve energized)	Switch face does not indicate application of thrust on/off commands via the NORMAL/OFF/DIRECT ON switch (MDC-7).
	NORMAL/OFF/DIRECT ON switch		SCS—DIRECT CONT MN A MN B (MDC-25)		None	Switch is a three-position lever-lock toggle switch. To set the switch in the NORMAL position or the DIRECT ON position, pull the lever out past the lever lock (shoulder stop) and move the lever up and down, respectively. The in-flight position of the switch is the OFF (center) position. DIRECT ON position provides capability of bypassing thrust on logic circuit and initiating SPS engine firing directly.
	NORMAL	Enables circuit capability for energizing of SPS fuel and oxidizer control solenoids by either AGC or THRUST ON switch stimuli, providing all other logic is complied with.				
	OFF	Provides capability to remove power from the four SPS engine pilot control valve solenoids directly, thereby, terminating thrust.				

MAIN DISPLAY CONSOLE—PANEL 7

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-7 (Cont)	DIRECT ON	Connects +28 vdc direct from circuit breaker to SPS pilot control valve solenoids. Energizes SPS driver relays K1 and K2, which provide power application to helium isolation valves and PUGS.	SCS DIRECT CONT MN A MN B (MDC-25)	D-C main buses A or B	None	The DIRECT ON switch overrides FCSM.
	ΔV SET switch	Enables desired ΔV to be placed on ΔV REMAINING display.	SCS GROUP 1 AC 1 GROUP 1 AC 2 (MDC-25)	±15 vdc from DISP/AGAA ECA		The ΔV set switch is a five-position switch with two + (ΔV increase) positions, two - (ΔV decrease) positions, and an OFF (center) position.
	Upper hardstop (uppermost position)	Enables increase of ΔV REMAINING display at rate of 64 digits per sec.				
	Upper softstop (upper middle position)	Enables increase of ΔV REMAINING display at rate of 2 digits per sec.				
	Center position	Provides inhibit to ΔV counter after TVC #1 power switch is turned on until a xX ullage is initiated, except when open.				
	Lower softstop (lower middle position)	Enables decrease of ΔV REMAINING display at rate of 2 digits/per sec.				
	Lower hardstop (bottommost position)	Enables decrease of ΔV REMAINING display at rate of 64 digits/per sec.				
	ΔV REMAINING indicator	Displays ΔV magnitude and/or ΔV REMAINING in feet per second.		DISP/AGAA ECA	CH3186V ΔV remaining	When the SPS engine is thrusting, the ΔV REMAINING indicator receives a signal from the SCS X-axis accelerometer, driving the indicator toward zero. The ΔV REMAINING display is activated when the TVC 1 POWER switch is set to either AC 1 or AC 2 position and the integrator circuit threshold of 5 x 10^{-4} g has been attained while performing a +X (only) translation maneuver. Acceleration sensing will begin at ullage or +X RCS translation initiation. An indicating range from -1000 (99, 000) to 12, 999 feet/second (f/s) is provided at an accuracy of ±1. 5 percent or 0. 75 f/s, whichever is greater.

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-7 (Cont)			SCS GROUP 1 AC 1 GROUP 2 AC 2 (MDC-25)	DISP/AGAA ECA	CH3816V ΔV remaining	When thrusting in SCS ΔV mode, thrust-off signal is terminated when ΔV REMAINING display reaches 00000. The thrust-off signal is inhibited by the AGC when operating in G&N ΔV mode. No inhibit is provided by the ΔV REMAINING display circuits when in the G&N ΔV mode.
MDC-8	DIRECT RCS switch	Provides capability for direct manual control of S/M or C/M-RCS engines.	SCS DIRECT CONT MIN A MIN B (MDC-25)	D-C main buses A or B	None	DIRECT RCS position provides the crew with direct control of the S/M or C/M RCS engines for rotational maneuver commands. Direct control is achieved by positioning the rotation control to engage the direct switches for the desired axis change. Direct switches are engaged at I ±0.5 degree from any hard stop. All SCS electronics are bypassed during this function.
	DIRECT RCS (up)	Applies d-c power to rotation control, enabling direct manual control of S/M or C/M-RCS engines.				
	OFF	Removes manual direct control capability of the S/M or C/M-RCS engines.				
	LIMIT CYCLE switch	Provides manual capability to retain or inhibit SCS pseudo rate (limit cycling) during RCS engine operation.	None	None		The primary purpose of the LIMIT CYCLE switch is to provide the crew with the capability of manually inhibiting the pseudo rate circuit operation during maneuvering and the entry phase of the mission. For fuel conservation, the switch should be set to LIMIT CYCLE position when holding attitude with the S/M RCS. The LIMIT CYCLE position function is disabled when the breakout switches in the rotation control are actuated, or when manual translation is commanded.
	LIMIT CYCLE	Allows normal operation of SCS pseudo rate circuit, providing limit cycling of RCS engines during attitude control modes.				
	OFF	Prevents operation of SCS pseudo rate circuit in pitch, yaw, and roll ECAs.				
	ATT DEADBAND switch	Enables selection of attitude deadband control sensitivity.	SCS GROUP I MN A MN B (MDC-25)	D-C main buses A or B		This switch selects a deadband in SCS that prevents attitude correction signals from being applied to the RCS until the attitude error exceeds the selected deadband.
	MAX	Selects maximum attitude deadband of ±4.2°.				

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-8 (Cont)	MIN	Selects minimum deadband of ±0.2°.	SCS—GROUP 1 MN A MN B (MDC-25)	D-C main buses A or B	None	Minimum deadband is used only when tight attitude control is required; e.g., during navigational sightings and prior to and during ΔV maneuvers. No power to this switch during SCS or G&N entry modes; therefore, minimum deadband cannot be selected during entry.
	RATE GYRO switches	Provide manual capability to place the roll, pitch, or yaw BMAG in the backup rate mode of operation.				These switches place any or all of the BMAGs in backup rate mode of operation so that they may be used in place of the rate gyros to provide spacecraft rate stabilization. In addition, with any one of the RATE GYRO switches in the BMAG position and any one of the following selected, the remaining two BMAGs will automatically assume the backup rate mode of operation: .05G ENTRY switch to .05G ENTRY position, monitor mode selected, G&N attitude control mode selected, minimum impulse attitude control mode engaged, G&N entry mode selected, either rotation control out of neutral position, SCS local vertical, or one SCS channel disabled while in SCS attitude control mode.
	ROLL					
	NORMAL	Allows normal BMAG and rate gyro operation.				
	BMAG	Enables BMAG rate mode of operation removing rate gyro signal from rate indicators, etc.				
	PITCH					
	NORMAL	Allows normal BMAG and rate gyro operation.				
	BMAG	Enables BMAG rate mode of operation, removing rate gyro signal from rate indicators, etc.				
	YAW					
	NORMAL	Allows normal BMAG and rate gyro operation.				When in an SCS mode, the attitude reference capability is lost when any one of the BMAGs is in backup rate mode. Attitude information is maintained if operating in a G&N mode.
	BMAG	Enables BMAG rate mode of operation, removing rate gyro signal from rate indicators, etc.				
	.05G ENTRY switch	Enables the SCS for atmospheric flight during entry and after 0.05gs				.05G ENTRY switch is effective only when a G&N or SCS entry mode is selected.
	.05G ENTRY	a. Removes attitude error signals from pitch and yaw channels in G&N mode and pitch, yaw, and roll channels in SCS modes.				After .05G ENTRY position is selected, placing any one of the BMAGs in backup rate mode will automatically place all BMAGs in backup rate mode configuration. This

MAIN DISPLAY CONSOLE—PANEL 8

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-8 (Cont)		b. Increases the rate deadband from 0.2° per sec to 2° per sec. c. Energizes a circuit which couples a component of the roll rate signal into the yaw channel.	SCS—GROUP 1 MN A MN B (MDC-25)	D-C main buses A or B	None	results in loss of FDAI total attitude display, otherwise, total attitude display is provided. During entry the S/C is maneuvered about the stability roll axis rather than the body roll axis. Consequently the yaw rate gyro generates an undesirable rate signal. By coupling a component of the roll signal into the yaw channel, the undesirable signal is cancelled.
	OFF	Allows normal system operation.				
	LCL VERT switch	Enables SCS for local vertical mode operation.			CH1103X (SCS local vertical mode control)	The local vertical mode maintains the S/C attitude with respect to the earths local vertical.
	LCL VERT (up)	Selects SCS local vertical mode when used in conjunction with G&N/SCS switch and ATTITUDE/MONITOR/ENTRY switch.				With local vertical mode engaged, an orbit rate signal equivalent to pitch rate of approximately 4.1° per minute is applied to the pitch BMAG torque motor. This figure is for a 100 NM earth orbit. FDAI total attitude is referenced to local vertical. Attitude error values represent deviation from selected local vertical attitude.
	OFF	Disengages local vertical mode.				If the S/C is maneuvered after local vertical mode is selected, the 4.1° per minute orbit rate signal previously applied only to the pitch gyro will be applied to all three gyros. This is accomplished by summing and resolving the new stepper motor position outputs with the orbital rate signal in the nav-to-body transformation circuits.
	ΔV switch	Enables SCS for G&N or SCS ΔV mode operation or MTVC.			CH0100X (G&N ΔV mode) CH1100X (5c ΔV mode) CH1104X (MTVC mode)	This switch works in conjunction with the G&N/SCS switch and the ATTITUDE/MONITOR/ENTRY switch. MTVC is actuated only when the ΔV switch is in the ΔV position and when the translation control is rotated CW. MTVC is independent of G&N/SCS switch.
	ΔV (up)	Applies a signal to the SCS electronics enabling the system for ΔV modes of operation and also enables manual thrust vector control (MTVC), of the translation control SW switch is closed.				In the ΔV position, DC power is applied to the FCSM-G&N and FCSM-SCS switches (MDC-2).

MAIN DISPLAY CONSOLE—PANEL 8

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-8 (Cont)	OFF	Inhibits ΔV and MTVC modes of operation and permits operation of the SCS in other modes.				
	G&N/SCS switch	Selects either G&N or SCS control of the various flight control modes.	SCS— GROUP 1 MN A MN B (MDC-25)	D-C main buses A or B	CH0101X (G&N attitude control mode control) CH1101X (SCS attitude control mode)	The G&N/SCS switch works in conjunction with the other flight control mode switches. When the switch is positioned to G&N or SCS position, ΔV maneuvers and attitude control of the S/C is accomplished by the selected system.
	G&N (up)	Enables G&N control for the following modes: attitude control, entry, and ΔV maneuvers.				
	SCS	Enables SCS control for the following modes: attitude control, monitor, local vertical, entry, and ΔV maneuvers.				
	ATTITUDE/MONITOR/ENTRY switch	Selects one of the following basic flight control modes: attitude control, monitor, or entry.			CH0103X (Monitor mode control) CH0102X (G&N entry mode control) CH1102X (SCS entry mode)	The ATTITUDE/MONITOR/ENTRY switch works in conjunction with the G&N/SCS switch, the ΔV switch, and the LCL VERT switch to enable crew selection of the various flight control modes. For details of the switch positions required to select the flight control modes, refer to Normal/Backup Procedures. In the attitude or monitor modes, the rate deadband for all axes is 0.2 /sec. The rate deadband for all axes in entry mode is 2.0°/sec. This applies to either entry mode: SCS or G&N. Monitor position selects the G&N monitor mode independent of other mode switches.
	ATTITUDE	Enables G&N or SCS attitude control mode. (Refer to Remarks.)				
	MONITOR	Enables monitor mode. (Refer to Remarks.)				
	ENTRY	Enables G&N or SCS entry mode. (Refer to Remarks.)				
	SCS CHANNEL switches	Provides capability to manually deactivate the RCS engines.			None	These switches are used to disable the RCS engines in the event of a malfunction or whenever it may be operationally desirable; e.g., S/C three-axis free drift for purposes of propellant conservation. Direct control of the RCS is available, using the DIRECT MODE switch and the rotation control. Maneuver function - engine activation.
	A&C ROLL		SCS— A&C ROLL MN A MN B and GROUP 1 MN A and MN B (MDC-25)			
	On (up)	Applies +28 vdc to the normal injector valve solenoids and solenoid driver electronic, allow allowing normal RCS engine operation.				
	OFF	Removes +28 vdc from the normal injector valve solenoids and the driver solenoid amplifier. Inhibits normal manual rotation control capability and SCS automatic control of RCS engine operation.				

Switch	Function	S/M RCS Engine
A&C ROLL	Roll right	A13, C15
A&C ROLL	Roll left	A16, C14
B&D ROLL	Roll right	B9, D11
B&D ROLL	Roll left	B12, D10
PITCH	Pitch up	A3, C1
PITCH	Pitch down	A2, C4

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks		
MDC-8 (Cont)						Switch	Function	S/M RCS Engine
						YAW YAW	Yaw right Yaw left	B7, D5 B6, D8
	B&D ROLL		SCS— B&D ROLL MN A MN B and GROUP 1 MN A and MN B (MDC-25)	D-C main buses A or B	None	Switch	Function	C/M RCS Engine
	On (up)	Applies +28 vdc to the normal injector valve solenoids and solenoid driver electronics, allowing normal RCS engine operation.				B&D ROLL B&D ROLL PITCH PITCH YAW YAW	Roll right Roll left Pitch up Pitch down Yaw right Yaw left	A9, B11 A12, B10 A1, B3 A2, B4 A5, B7 A8, B6
	OFF	Removes +28 vdc from the normal injector valve solenoids and the driver solenoid amplifier. Inhibits normal manual rotation control capability and SCS automatic control of RCS engine operation.				AC roll switch is applicable to S/M-RCS engines only and provides no function after CM/SM separation.		
	PITCH		SCS— PITCH MN A MN B and GROUP 1 MN A and MN B (MDC-25)			These switches are used to disable the RCS engines in the event of a malfunction or whenever it may be operationally desirable; e.g., S/C free drift for purposes of propellant conservation. Direct control of the RCS is available, using the DIRECT RCS switch and the rotation control.		
	On (up)	Applies +28 vdc to the normal injector valve solenoids and solenoid driver electronics, allowing normal RCS engine operation.						
	OFF	Removes +28 vdc from the normal injector valve solenoids and the driver solenoid amplifier. Inhibits normal manual rotation control capability and SCS automatic control of RCS engine operation.						
	YAW		SCS— MN A MN B and GROUP 1 MN A and MN B (MDC-25)					
	On (up)	Applies +28 vdc to the normal injector valve solenoids and solenoid driver electronics, allowing normal RCS engine operation.						
	OFF	Removes +28 vdc from the normal injector valve solenoids and the driver solenoid amplifier. Inhibits normal manual rotation control capability and SCS automatic control of RCS engine operation.						

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-8 (Cont)	ELS LOGIC switch		ELS – A BAT A - FLOAT BAG 3 ELS – B BAT B (MDC-25)	Battery buses A and B	None	The logic switch is positioned up during entry or after an SPS abort to arm the ELS logic circuitry. This circuitry is armed automatically on LES aborts. The ELS is controlled by baroswitch closure and time-delay relays after being armed. The switch should never be positioned up under 42, 000 feet except as backup during an LES abort. The LES tower, apex cover and parachutes might be jettisoned.
	Up	Connects 28 vdc to the ELS logic arm circuitry. The circuitry is automatically armed during an LES abort if the MAIN DEPLOY-AUTO/MAN switch (MDC-16) is in the AUTO position.				
	OFF	Disconnects 28 vdc from ELS logic circuitry.				
	DIGITAL EVENT TIMER switches		EVENT TIMER MN A MN B (MDC-25)	D-C main buses A and B		
	RESET/UP/DOWN switch					The event timer is automatically reset to zero and starts counting up when an abort is automatically or manually initiated. The switch is momentary on towards the RESET position and maintain on in the other two positions.
	RESET	Reset the event timer (MDC-5) to zero.				
	UP	Completes circuitry for the event timer to time up.				
	DOWN	Completes circuitry for the event timer to time down.				
	START/STOP switch					The event timer starts automatically when lift-off occurs. The switch is momentary on towards the START position and maintain on in the other two positions.
	START	Starts the event timer.				
	Center	No function.				
	STOP	Stops the event timer.				
	MIN switch					The control switches provide a means of running the event timer to any desired setting and are spring-loaded to the center position. The indicating drums can be run up or down, depending on the position of the RESET/UP/DOWN switch.
	TENS	Runs the MIN indicating drums in tens.				
	Center	No function.				
	UNITS	Runs the second MIN indicating drum in units.				

MAIN DISPLAY CONSOLE—PANEL 8

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-8 (Cont)	SEC switch		EVENT TIMER MN A MN B (MDC-25)	D-C main buses A and B	None	
	TENS	Runs the SEC indicating drums of the event timer in tens.				
	Center	No function.				
	UNITS	Runs the second SEC indicating drun in units.				
	COUCH UNLOCK switch		COUCH ATTEN MN A MN B FLOOD-LIGHTS (MDC-25)			The attenuators will be unlocked by a breakout (approximately 20gs) upon landing.
	UNLOCK	Inoperative				
	Down position					
	CM PROP JETT switches		RCS—C/M-S/M TRANSFER MN A MN B (MDC-25)			
	LOGIC switch					Two-position toggle switch. Switch must be in up position before power is available to the DUMP switch, PURGE switch, RCS HTRS switch, and circuitry controlling automatic transfer of engine firing commands from S/M RCS to C/M RCS.
	On (up)	Applies power to DUMP switch on MDC-8. Applies power to the 0 to 61-second time delay (from lift-off) and the 18-second time delay after the abort is initiated. Applies power to relay contact points that are closed upon receipt of an abort signal (from 0 to tower jettison) which applies power automatically to RCS transfer motors. Applies power to the C/M RCS engine manual coils (excluding +P) manual coils when the DUMP switch is placed to the on position. Applies power to the C/M RCS HTRS switch (RHFEB-200).				
	OFF	Removes power and resets RCS logic circuitry.				

MAIN DISPLAY CONSOLE—PANEL 8

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-8 (Cont)		Removes power from C/M RCS HTRS switch (RHFEB-200).	RCS—C/M-S/M TRANSFER MN A MN B (MDC-25)	D-C main buses A and B	None	
	DUMP switch	Enabled by LOGIC switch.				
	On (up)	Energizes relays required to activate C/M-RCS propellant dump-burn operation through 10 engine-injector valves.				Guarded two-position toggle switch (activates explosive-operated valves). During normal entry, switch is placed to DUMP (up) position when main parachute line stretch is felt. Remaining propellants are then burned off through 10 of the 12 RCS engines.
	OFF	De-energizes relays.				The two positive pitch engines do not permit fuel dump or burn. DUMP switch will not be utilized during pad aborts or low altitude aborts, fuel only is retained on-board and the CM will land with fuel tanks full, but depressurized.
	PURGE switch					Two-position toggle switch. Switch manually set to the up position after C/M propellant supply has been depleted (approximately 88 seconds, after activation of FUEL DUMP/BURN switch, for 10-engine burn and 132 seconds for 5-engine burn). All four propellant tank lines are purged with helium to ensure that no hypergolic propellant remains in the propellant distribution or engine systems. (Purge operation approximately 10 seconds.) The LOGIC and DUMP switches must both be in the up position before the purge operation can be initiated.
	On (up)	Energizes relays required to activate the following: a. C/M RCS propellant system purge operation b. ECS gas chromatograph helium dump operation.				
	OFF	De-energizes relays.				Switch will not be utilized during abort operations if fuel is retained on-board.

MAIN DISPLAY CONSOLE—PANEL 8

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-9	Coaxial bracket MDC		N/A	None	None	
	Normal installation	Connects VHF recovery antenna No. 1 to the VHF recovery beacon and VHF recovery antenna No. 2 to the VHF/AM transmitter-receiver.				Change is implemented by manually disconnecting RF coaxial connector from VHF recovery antenna No. 1 or No. 2 connector and reconnecting to coaxial connector on cable to GFAE survival transceiver.
	Survival transceiver installation	Connects either recovery antenna No. 1 or No. 2 to the GFAE survival transceiver.				
	Crossover installation	Connect GFAE survival transceiver to recovery antenna No. 1 (right connector).				Permits two-way AM voice communications or beacon transmission on GFAE survivals transceiver (243. 0 mc) over antenna No. 1 and VHF-AM two-way voice communication (296. 8) on antenna No. 2.
		Connect GFAE survival transceiver to recovery antenna No. 2 (left connector).				Permits two-way AM voice communications or beaccn transmission on GFAE survival transceiver (243. 0 mc) over antenna No. 2 and VHF recovery beacon transmission (243. 0 mc) on antenna No. 2.
MDC-10	G&N system status lights		CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B		
	CDU FAIL	Indicates a failure in one or more of the coupling display units.			CG5002X (CDU fail)	Yellow lights indicate failure or out-of-tolerance condition when illuminated.
	IMU FAIL	Indicates a failure in the inertial measurement unit.			CG5001X (IMU fail)	
	IMU TEMP	Indicates that the IMU temperature is out of tolerance, i.e., exceeds normal temperature by ±4°.			CG5006X (IMU temp light)	
	G&N ACCEL FAIL	Indicates a failure in one or more of the PIP accelerometers.			CG5000X (PIPA fail)	
	G&N ERROR	Indicates an IMU, CDU, accelerometer and/or AGC error.			CG5005X (Error detect)	
	GMBL LOCK	Indicates a potential gimbal lock condition in the IMU (middle gimbal angle is greater than ±60 degrees with respect to the outer gimbal).			CG5003X (Gimbal lock warning)	

MAIN DISPLAY CONSOLE—PANELS 9 AND 10

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-10 (Cont)	AGC PWR FAIL	Indicates a power failure in the Apollo guidance computer.	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	CG5030X (Computer power fail light)	
	SCS status light AGAP TEMP	Illuminates when the temperature of any one of three BMAGs in the SCS attitude gyro accelerometer package varies from 170±2°F.			CH2030T (Combined attitude gyro temp)	When illuminated, the status light indicates an out-of-temperature condition in one or more of the three BMAGs. When light is out, BMAG outputs are usable.
	EPS status lights H_2 PRESS	Indicates hydrogen tank pressure is as follows: a. 220 psia or below b. 270 psia or above.			SF0039P (Press H_2 tank 1) SF0040P (Press H_2 tank 1)	Yellow lamp will illuminate if either or both H_2 tanks are above or below proper pressure limits. Pressure in H_2 tanks can be monitored by indicators on MDC-13.
	O_2 PRESS	Indicates oxygen tank pressure is as follows: a. 800 psia or below b. 950 psia or above.			.SF0037P (Press O_2 tank 1) SF0039 (Press O_2 tank 2)	Yellow lamp will illuminate if either or both O_2 tanks are above or below proper pressure limits. Pressure in O_2 tanks can be monitored by indicators on MDC-13.
	RCS status lights	A and B lights are identical in operation within their respective systems. Indicates an underpressure condition in the fuel and oxidizer tanks of the respective system prior to system pressurization.			None	All lights are yellow. The RCS INDICATOR switch can be used in conjunction with the propellant indicating devices to isolate a malfunction to a specific temperature, or pressure, within a particular RCS package. A temperature transducer is located on the inner surface of each S/M-RCS quad. A pressure transducer is installed in the helium line of each S/M-RCS quad and each C/M-RCS system. When the status lights are out, the applicable system is operable.
	C/M RCS A, B	Indicates an over or underpressure condition (below 265 psia or above 325 psia) in the fuel and oxidizer tanks of the respective propellant system.				
	S/M RCS A, B, C, D	Indicates one of the following: a. Package temperature below 63°F or above 175°F (nominal)				

MAIN DISPLAY CONSOLE—PANEL 10

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-10 (Cont)		b. Regulated helium pressure below 155 psia or above 215 psia (nominal).	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	None	
	SPS status light SPS ROUGH ECO	Indicates FCSM cut-off of SPS engine due to excessive engine vibration level.	CAUT/ WARN MN A MN B (MDC-25)			Yellow light. Delay time for cutoff is nominally 70±20 milliseconds at a vibration level of 180 g's peak-to-peak. Delay time will be 30 to 70 milliseconds at a vibration level of 360 g's peak-to-peak. Light will extinguish when FCSM circuitry is reset.
MDC-11	ECS status lights H_2O ACCUM FAIL	Indicates when a minimum of three oxygen bubbles are detected in water expelled from H_2O accumulators.	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	None	The yellow light illuminates in event of water accumulator diaphragm rupture. Oxygen will then enter the waste water network. A sensor is placed in the accumulator water outlet line. Oxygen bubbles in the water are sensed as a change in voltage. When three positive pulse signals (corresponding to three bubbles) are received, a voltage divider is unbalanced, resulting in light illumination.
	GLYCOL TEMP LOW	Indicates when water-glycol from space radiator outlet decreases to -30°F.			CF0020T (Temp space radiator outlet)	The yellow light illuminates to indicate water-glycol is approaching the temperature where flow is reduced. Continuous temperature is displayed by ECS RAD-OUTLET TEMP indicator (MDC-13). Transducer is placed in line downstream of space radiator outlet in LHEB, and furnishes signal for light and indicator.

MAIN DISPLAY CONSOLE—PANELS 10 AND 11

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11 (Cont)	CO_2 PP HI	Indicates when CO_2 partial pressure reaches 7.6 mm Hg.	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	CF0005P (Press CO_2 partial)	The yellow light illuminates at upper end of normal range. A CO_2-odor absorber filter change is required only if the illumination of the light is not the result of temporarily increased crew activities. Continuous partial pressure is displayed by PART PRESS - CO_2 indicator (MDC-13).
	O_2 FLOW HI	Indicates when total ECS oxygen flow reaches 1 lb per hr.			None	The red light illuminates at critical flow rate which, if continuous, indicates cabin leakage, oxygen subsystem leakage, or mismanagement of oxygen subsystem. Continuous O_2 flow is displayed by FLOW O_2 indicator (MDC-13).
	SPS status lights					
	PITCH GMBL DR. FAIL	Indicates an over or undercurrent has occurred in the primary drive motor of the pitch gimbal actuator.				Yellow lights. Light indicator is a constant visual aid to assist in evaluating functional status of engine gimbal drive components.
	YAW GMBL DR FAIL	Indicates an over or undercurrent has occurred in the primary drive motor of the yaw gimbal actuator.				
	SPS PRESS	Indicates oxidizer and/or fuel tank pressures (regulated helium pressures) are not within proper operating range (160 to 200 psia).				Yellow light. Two pressure transducers, one located in each (Ox and Fuel) regulated helium supply line, provide input to indicator. Continuous pressures are displayed by PRESSURE indicators on MDC-20.
	SPS WALL TEMP HI	Indicates wall temperature of SPS engine combustion chamber exceeds high operating temperature limit of 380°F.				Yellow light. Indicator input is provided by temperature sensor mounted in engine combustion chamber wall assembly.
	SPS PU SNSR FAIL	Indicates one of the following: a. An unbalance in the remaining SPS propellants from the desired ratio (by weight) in excess of 300 lb or 90 percent of critical unbalance.				Yellow light is functional only during SPS engine firing or when TEST/ AUTO/TEST switch (MDC-20) is in the TEST up or down position. Critical unbalance is that point at which the propellant utilization valve will no longer provide oxidizer adjustment

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11 (Cont)		b. Discrepancy of 300 lbs between the primary and auxiliary sensing systems.	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	None	great enough to permit simultaneous propellant depletion.
	C&WS status light CAUT/WARN FAIL	Indicates when power supply voltage (positive or negative) is outside of the 11.7 to 13.9 volt normal range.				Switching to redundant power supply will extinguish status light. Audio portion of master alarm circuit will not operate, as the 12-volt tone generator power will be interrupted by a power supply failure.
	EPS status lights F/C-BUS DISCONNECT	Indicates a fuel cell has automatically disconnected from the d-c main buses.			SC2120X Fuel cell 1 bus A disconnect SC2121X Fuel cell 2 bus A disconnect SC2122X Fuel cell 3 bus A disconnect SC2125X Fuel cell 1 bus B disconnect SC2126X Fuel cell 2 bus B disconnect SC2127X Fuel cell 3 bus B disconnect	Yellow lamp illuminates when any fuel cell is disconnected from the S/M d-c bus A and/or B. The overload and reverse current units on each fuel cell automatically disconnect the fuel cell output from the bus when a reverse current >4 amps or a forward current >75 amps is sensed. The lamp will not illuminate when the affected fuel cell main bus switch is in the off position. Event indicators below the FUEL CELL-1, -2, and -3 MAIN BUS A and B switches indicate with a striped display which fuel cell is disconnected from which bus.

MAIN DISPLAY CONSOLE—PANEL 11

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11 (Cont)	F/C 1, F/C 2, and F/C 3	Indicates one of the following conditions exist in the respective fuel cell:	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B		Yellow lights illuminate when any of the sensed parameters are out of tolerance. Switching the FUEL CELL INDICATORS switch (MDC-18) to the position indicated by the illuminated status lights and observing the fuel cell displays, enables the crew to determine which parameter is out of tolerance. Alarm trigger values are presented in the Function column.
		a. H_2 flow rate below 0.028 lb/hr or above 0.153 lb/hr			a. SC2139R Flow rate H_2 F/C 1 SC2140R Flow rate H_2 F/C 2 SC2141R Flow rate H_2 F/C 3	
		b. O_2 flow rate below 0.22 lb/hr or above 1.22 lb/hr			b. SC2142R Flow rate O_2 F/C 1 SC2143R Flow rate O_2 F/C 2 SC2144R Flow rate O_2 F/C 3	
		c. pH factor of 9 or over			c. SC2160X pH factor water condition F/C 1 SC2161X pH factor water condition F/C 2 SC2162X pH factor water condition F/C 3	

MAIN DISPLAY CONSOLE—PANEL 11

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11 (Cont)		d. F/C skin temperature below 360°F or above 500°F	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	d. SC2084T Temp F/C 1 skin SC2085T Temp F/C 2 skin SC2086T Temp F/C 3 skin	
		e. F/C condenser exhaust temperature below 155°F or above 175°F			e. SC2081T Temp F/C 1 cond exhaust SC2082T Temp F/C 2 cond exhaust SC2083T Temp F/C 3 cond exhaust	
		f. F/C outlet radiator temperature below -30°F			f. SC2087T Temp F/C 1 radiator outlet SC2088T Temp F/C 2 radiator outlet SC2089T Temp F/C 3 radiator outlet	

MAIN DISPLAY CONSOLE—PANEL 11

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11 (Cont)		g. H_2 regulator pressure above 75 psia	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	g. SC2069P H_2 pressure F/C 1 regulated SC2070P H_2 pressure F/C 2 regulated SC2071P H_2 pressure F/C 3 regulated	
		h. O_2 regulator pressure above 75 psia			h. SC2066P O_2 pressure F/C 1 regulated SC2067P O_2 pressure F/C 2 regulated SC2068P O_2 pressure F/C 3 regulated	
		i. N_2 regulator pressure above 70 psia.			i. SC2060P N_2 pressure F/C 1 regulated SC2061P N_2 pressure F/C 2 regulated	

MAIN DISPLAY CONSOLE—PANEL 11

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11 (Cont)			CAUT/ WARN MN A MN B (MDC-25	D-C main buses A and B	i. (Cont) SC2062P N_2 pressure F/C 3 regulated	
	INV 1 TEMP HI, INV 2 TEMP HI, and INV 3 TEMP HI	Indicates an overtemperature (241°F) exists in the respective inverter.			CC0175T (Temp static inverter 1) CC0176T (Temp static inverter 2) CC0177T (Temp static inverter 3)	The yellow inverter overtemperature lights illuminate at +241°F and above.
	MN BUS A UNDERVOLT and MN BUS B UNDERVOLT	Indicates a d-c voltage drop below 26.25 ± 0.1 vdc on the respective d-c main bus.			None	The yellow main d-c bus undervoltage lights will not illuminate when the affected main bus reset switch is in the OFF position.
	AC BUS 1 FAIL and AC BUS 2 FAIL	Indicates the following conditions exist in any of the three phases of the respective a-c bus: a. Undervoltage (95±3 vac) b. Overvoltage (130±2 vac)				The yellow a-c bus fail lights will not illuminate when affected a-c bus reset switch is in the OFF position. The inverters will not disconnect from the buses on an undervoltage condition, but will disconnect from bus on overload. Light must be reset.
	AC BUS 1 OVERLOAD and AC BUS 2 OVERLOAD	Indicates an overload (3Ø, 9 amps/Ø for 15±5 seconds or 1Ø, 11 amps for 5±1 second) exists on the respective a-c bus.				The inverter supplying the bus will be automatically disconnected at the time either of these yellow lights illuminate. Time versus overload is 5±1 seconds for a short circuit of 300-percent-rated current per phase and 10(-0, +5) seconds for a short circuit of 250-percent-rated current. Lamps will not illuminate when affected a-c bus reset switch is in the OFF position.
	CAUT/WARN switches POWER switch					The output of both power supplies is +12 and -12 vdc, which is used in the caution and warning system electronics.

MAIN DISPLAY CONSOLE—PANEL 11

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11 (Cont)	1	Applies d-c power to caution and warning system power supply No. 1.	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	None	Nominal switch position is 1.
	OFF	Removes d-c power from caution and warning system power supplies No. 1 and No. 2.				Power is still applied to the C&WS; however, the master alarm circuit and those status lights activated as the result of analog signals will be inoperative.
	2	Applies d-c power to caution and warning system power supply No. 2.				
	MODE switch					Power to C/M system status lights is not removed with switch in either position. Power is removed only by placing C/W switch (MDC-13) to ACK position.
	CSM	a. Applies d-c power to 15 S/M system status lights, permitting illumination of lights upon receipt of malfunction signals.				CSM mode is selected at all times prior to CSM separation. Power is applied to the following 15 S/M status lights: PITCH GMBL DR FAIL, YAW GMBL DR FAIL, SPS PU SNSR FAIL, F/C BUS DISCONNECT, O_2 PRESS, H_2 PRESS, SPS PRESS, S/M RCS A, S/M RCS B, S/M RCS C, S/M RCS D, SPS WALL TEMP HI, F/C 1, F/C 2, and F/C 3.
		b. Applies d-c power to 4 S/M event channels, permitting circuitry to simulate lamp load when C/W switch is in ACK position.				Power is applied to the following 4 S/M event channels: PITCH GMBL DR FAIL, YAW GMBL DR FAIL, SPS PU SNSR FAIL, and F/C BUS DISCONNECT.
		c. Opens d-c ground return path, inhibiting C/M RCS A and C/M RCS B lamp circuits prior to CSM separation.				
	C/M	a. Removes d-c power to 15 S/M system status lights. b. Removes d-c power to 4 S/M event channels. c. Completes d-c ground return path, enabling C/M RCS A and C/M RCS B lamp circuits after CSM separation.				C/M mode is selected subsequent to CSM separation.

MAIN DISPLAY CONSOLE—PANEL 11

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11	DIGITAL EVENT TIMER window	The event timer provides the crew with a means of monitoring and timing events. Indications from 00 minutes and 00 seconds (00-00) to 59 minutes and 59 seconds (59-59) are obtainable in a countup or countdown mode. In a countup mode, when 59-59 is recorded, the counter will proceed to 00-00 and continue to count up. In a countdown mode, continuous counting is also available.	EVENT TIMER MN A MN B (MDC-25)	D-C main buses A and B	None	The event timer is a reference system only and is automatically reset to zero when an abort is automatically or manually initiated. The event timer starts automatically when lift-off occurs.
	DIGITAL EVENT TIMER switches					
	RESET/UP/DOWN switch					
	RESET	Reset the event timer (MDC-5) to zero.				The event timer is automatically reset to zero and starts counting up when an abort is automatically or manually initiated. The switch is momentary on towards the RESET position and maintain on in the other two positions.
	UP	Completes circuitry for the event timer to time up.				
	DOWN	Completes circuitry for the event timer to time down.				
	START/STOP switch					
	START	Starts the event timer.				The event timer starts automatically when lift-off occurs. The switch is momentary on towards the START position and maintain on in the other two positions. The control switches provide a means of running the event timer to any desired setting and are spring-loaded to the center position. The indicating drums can be run up or down, depending on the position of the RESET/UP/DOWN switch.
	Center	No function.				
	STOP	Stops the event timer.				
	MIN switch					
	TENS	Runs the MIN indicating drums in tens.				
	Center	No function.				
	UNITS	Runs the second MIN indicating drum in units.				
	SEC switch					
	TENS	Runs the SEC indicating drums of the event timer in tens.				
	Center	No function.				
	UNITS	Runs the second SEC indicating drum in units.				

MAIN DISPLAY CONSOLE—PANEL 8

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-11 (Cont)	DIGITAL EVENT TIMER switches	The event timer provides the crew with a means of monitoring and timing events. Indications from 00 minutes and 00 seconds (00-00) to 59 minutes and 59 seconds (59-59) are obtainable in a countup or countdown mode. In a countup mode, when 59-59 is recorded, the counter will proceed to 00-00 and continue to count up. In a countdown mode, continuous counting is also available.	EVENT TIMER MN A MN B (MDC-25)	D-C main buses A and B	None	This event timer is for reference only. The event timer starts automatically when lift-off occurs.
	RESET/UP/DOWN switch					
	RESET	Reset the event timer (MDC-11) to zero.				The switch is momentary on towards the RESET position and maintained on in the other two positions.
	UP	Completes circuitry for the event timer to time up.				
	DOWN	Completes circuitry for the event timer to time down.				
	START/STOP switch					
	START	Starts the event timer.				The event timer starts automatically when lift-off occurs. The switch is momentary on towards the START position and maintained on in the other two positions.
	Center	No function.				
	STOP	Stops the event timer.				
	MIN switch					The control switches provide a means of running the event timer to any desired setting and are spring-loaded to the center position. The indicating drums can be run up or down, depending on the position of the RESET/UP/DOWN switch.
	TENS	Runs the MIN indicating drums in tens.				
	Center	No function.				
	UNITS	Runs the second MIN indicating drum in units.				

MAIN DISPLAY CONSOLE—PANEL 11

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-12	S/M RCS indicators TEMP PKG	Indicates temperature of S/M RCS package A, B, C, or D, as selected by the RCS INDICATORS switch. (Meter range: 0° to 200°F.)	INSTRU-MENTS—ESS MN A MN B (MDC-22)	D-C main buses A and B	Package temp: A-SR5065T B-SR5066T C-SR5067T D-SR5068T	Four indicators are identical in operation. Each one consists of a d'Arsonval-type meter with a fixed dial and movable pointer. Pointer movement is vertical, as observed from crew couch. Each indicator is capable of accepting input signals from the C/M or S/M RCS. Displayed information is determined by the position of the RCS INDICATORS switch.
	He	Indicates temperature of S/M RCS helium supply for A, B, C, or D, as selected by the RCS INDICATORS switch. (Meter range: 0 to 400 psia, must be transposed to degrees. Refer to Remarks.)			He TANK TEMPERATURE: A-SR5013T B-SR5014T C-SR5015T D-SR5016T	The S/M RCS helium tank supply temperature is indicated as psia on this indicator. The range of the indicator is 0 to 400 psia, bottom to top scale. 0 psia is equivalent to 0°F and 400 psia is equivalent to 150°F. The indicated number (psia) on this indicator, plus the helium tank supply pressure readout (psia) would be utilized by the crew to determine on the nomogram the propellant quantity remaining in a given quad in percent.
	PRESS He	Indicates helium tank pressure of S/M RCS package A, B, C, or D, as selected by the RCS INDICATORS switch. (Meter range: 0 to 5000 psia.)			He tank pressure: A-SR5001P B-SR5002P C-SR5003P D-SR5004P	
	MANF	Indicates regulated helium pressure of S/M-RCS package A, B, C, or D, as selected by the RCS INDICATORS switch. (Meter range: 0 to 400 psia.)			Regulated He press: A-SR5729P B-SR5776P C-SR5817P D-SR5830P	
	C/M RCS indicators TEMP He	Indicates helium tank temperature of C/M RCS system A or B, as selected by the RCS INDICATORS switch. (Meter range: 0 to 200°F.)			He tank temp: A-CR0003T B-CR0004T	
	PRESS He	Indicates helium tank pressure of C/M RCS system A or B, as selected by the RCS INDICATORS switch. (Meter range: 0 to 5000 psia.)			He tank press: A-CR0001P B-CR0002P	

MAIN DISPLAY CONSOLE—PANEL 12

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-12 (Cont)	F	Indicates regulated helium pressure to the fuel tank of C/M RCS system A or B, as selected by the RCS INDICATORS switch. (Meter range: 0 to 400 psia.)	INSTRUMENTS—ESS MN A MN B (MDC-22)	D-C main buses A and B	Regulated He press (Fuel system) A-CR0005P B-CR0006P	
	OX	Indicates regulated helium pressure to the oxidizer tank of C/M RCS system A or B, as selected by the RCS INDICATORS switch. (Meter range: 0 to 400 psia.)			Regulated He press (OX system) A-CR0011P B-CR0012P	
	RCS INDICATORS switch	Selects inputs to the propellant temperature, and pressure indicating devices. C/M sections A and B functions are identical within their respective systems. S/M sections A, B, C, and D functions are identical within their respective systems.	N/A	N/A	None	Six-position rotary switch. C/M section of switch, positions A and B, permits monitoring command module propellant systems A and B. S/M section of switch, positions A, B, C, and D permits monitoring service module propellant systems of quads A, B, C, and D.
	C/M section					
	A (B)	Connects C/M RCS system A (B) signal outputs from temperature and pressure transducers to the appropriate indicating devices.				
	S/M section					
	A (B, C, D)	Connects S/M RCS quad A (B, C, and D) signal outputs from temperature and pressure transducers and the propellant quantity sensing computer to the appropriate indicating devices.				

MAIN DISPLAY CONSOLE—PANEL 12

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-12 (Cont)	400-hour clock	Displays mission elapsed time in 10-hour increments up to 400 hours.	None	None	None	The indicator has two set-knobs. One starts, stops, and resets the clock; the other sets the hour and minute hands, and winds the clock.
MDC-13	C/W switch		CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	None	
	NORMAL	Applies d-c power to the following: a. Twenty-five C/M system status lights, permitting illumination of lights upon receipt of malfunction signals. b. One pole of CAUT/WARN-MODE switch, which in turn may apply power to 15 S/M system status lights. c. MASTER ALARM switch-light on MDC-3, permitting illumination of light upon receipt of malfunction signals.				Switch is set to NORMAL at all times other than during the ascent phase or when dark adaptation is required. With switch in this position and upon receipt of a malfunction signal, the appropriate system status light and the MASTER ALARM lights will illuminate, and an audio alarm tone is sent to each headset. Power is applied to the following 25 C/M system status lights: CDU FAIL, G&N ACCEL FAIL, AGC PWR FAIL, IMU FAIL, G&N ERROR, IMU TEMP, GMBL LOCK, AGAP TEMP, SPS ROUGH ECO, H_2O ACCUM FAIL, O_2 FLOW HI, AC BUS 1 FAIL, AC BUS 1 OVERLOAD, AC BUS 2 FAIL, AC BUS 2 OVERLOAD, MN BUS A UNDERVOLT, MN BUS B UNDERVOLT, INV 1 TEMP HI, INV 2 TEMP HI, INV 3 TEMP HI, C/M RCS A, C/M RCS B, GLYCOL TEMP LOW, CO_2 PP HI, and CAUT/WARN FAIL. For a list of the 15 S/M system status lights, refer to Remarks column of CAUT/WARN-MODE switch (MDC-11), CSM position.

MAIN DISPLAY CONSOLE—PANELS 12 AND 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	BOOST	a. Applies d-c power to 25 C/M system status lights, permitting illumination of lights upon receipt of malfunction signals. b. Applies d-c power to one pole of CAUT/WARN-MODE switch, which in turn may apply power to 15 S/M-systems status lights. c. Removes d-c power from MASTER ALARM switch-light on MDC-3, preventing illumination of light upon receipt of malfunction signals during the ascent phase.	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	None	Switch set to BOOST at prelaunch to preclude the possibility of confusion on MDC-3 between the red MASTER ALARM light and the adjacent red ABORT light during the critical ascent phase.
	ACK	a. Removes d-c power from 25 C/M system status lights, preventing illumination of lights upon receipt of malfunction signals. b. Removes d-c power from one pole of CAUT/WARN MODE switch, thereby removing power to 15 S/M system status lights. c. Places push-switch function of both MASTER ALARM switch-lights into the d-c circuit of the system status lights. This prevents illumination of the system status lights upon receipt of malfunction signals until either push-switch is pressed to complete the circuit.				Switch is set to ACK to retain dark adaptation. With switch in this position and upon receipt of a malfunction signal, only the MASTER ALARM lights will illuminate and an alarm tone be sent to each headset. To determine the malfunction either MASTER ALARM switch-light may be pressed to illuminate the appropriate system status light. The light will remain illuminated only as long as the switch-light is pressed. Although upon release all system status lights are extinguished, they may be recalled as long as the malfunction exists by again pressing either switch-light.
	POWER switch	Controls power to senior pilots module in audio center equipment.	T/C GROUP 5 (MDC-22)	Flight and postlanding bus		The audio center will not be activated unless the POWER switch is in PTT or VOX position.
	PTT	Applies d-c power to audio and control circuits.				Intercom capability when cobra cable PTT/CW switch is in CW and transmit capability with PTT/CW switch in PTT.
	OFF	Removes power from senior pilots audio center equipment module and controls.				

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	VOX	a. Applies d-c power to audio and control circuits. b. Enables VOX control of mike amplifier by supplying ground to VOX circuitry.	T/C GROUP 5 (MDC-22)	Flight and postlanding bus	None	VOX operation permits voice transmission and transmitter keying of intercom, HF Recovery transceiver and voice recorder when cobra cable PTT/CW switch is at PTT.
	S-BAND switch		N/A	Audio center equipment		The S-BAND, HF, VHF-AM, and INTERCOM switches all control ground return paths for appropriate diode switching and isolation circuitry in the senior pilots module of the audio center equipment to allow transmission and reception, or reception alone, of voice signals over selected equipment. The HF and VHF-AM switches also provide ground return paths for the HF and VHF-AM transmitter keying circuits when in the T/R position.
	T/R	No effect. S-Band T/R function supplied by cobra cable PTT key.				
	OFF	Prevents senior pilot from transmitting or receiving voice over USBE.				
	REC	Enables senior pilot to receive voice from USBE.				
	RCDR/HF switch					
	T/R	a. Enables senior pilot to transmit and receive voice over HF transceiver when operating in AM or SSB mode. b. Enables voice recorder through VOX circuit.				Provides power ground through audio center VOX circuit for HF transceiver transmit-receive relay and voice recorder power relay.
	OFF	Prevents senior pilot from transmitting or receiving voice over HF transceiver.				
	REC	Enables senior pilot to receive voice from HF transceiver when operating in AM or SSB mode.				
	VHF-AM switch					
	T/R	Enables senior pilot to transmit and receive voice over VHF-AM transmitter-receiver when operating in T/R mode.				VHF-AM transmits, in addition to S-Band voice, when cobra cable PTT key is closed. Cobra cable PTT/CW switch must be at PTT, and audio center POWER switch must be at PTT.
	OFF	Prevents senior pilot from transmitting or receiving voice over VHF-AM transmitter-receiver.				

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	REC	Enables senior pilot to receive voice from VHF-AM transmitter-receiver.	N/A	Audio center equipment	None	
	INTERCOM switch					
	T/R	Enables senior pilot to transmit and receive voice over the intercom system.				Audio center POWER switch must be at VOX to enable mike amplifier when cobra cable PTT/CW switch is at PTT.
	OFF	Prevents senior pilot from transmitting or receiving voice over intercom system.				
	REC	Enables senior pilot to receive voice from intercom system.				
	VOX SENS control	Increases or decreases sensitivity of voice-operated relay circuitry in senior pilots audio center module.				These three controls are thumbwheel-type potentiometers which may be rotated upward or downward, as required.
	INTERCOM BALANCE control	Increases or decreases level of audio signal received by senior pilot from RF equipment relative to that received from intercom bus.				Position 9 most sensitive.
	VOLUME control	Increases or decreases level of audio signal from senior pilots earphone amplifier to earphone.				
	TANK PRESSURE indicators					Displays for H_2 and O_2 tanks No. 1 and 2 operate prior to CSM separation only.
	H_2 group					
	Indicators 1 and 2	Displays H_2 tank No. 1 and No. 2 pressure and is used as follows: a. Determine tank heater performance. b. Detect leaks.	ESSENTIAL-3 (RHEB 204) and fuse in S/M	S/M INST PWR DIST	SF0039P (Press H_2 tank No. 1) SF0040P (Press H_2 tank No. 2)	The indicator function is controlled by pressure transducers located in H_2 tank No. 1 and No. 2 outlet lines. These transducers are also connected to C&WS, operating the H_2 PRESS light on MDC-10. H_2 operating range is 230 to 260 psia. Alarm trigger values are 220 psia low, and 270 psia high.

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	O_2 group Indicator 1	Displays pressure of O_2 tank No. 1 or ECS surge tank as selected by O_2 PRESS IND switch (MDC-13) and is used as follows: a. Determine tank heater performance. b. Detect leaks. c. Verify surge tank pressure.	ESSEN-TIAL-3 (RHEB 204) and fuse in S/M	S/M INST PWR DIST	SF0037P (Press O_2 tank No. 1 CF0006P (Press surge tank)	With O_2 PRESS IND switch at TANK 1, the indicator function is controlled by a pressure transducer located in O_2 tank No. 1 outlet line. Transducer also connected to C&WS, operating O_2 PRESS light on MDC-10. O_2 operating range is 865 to 935 psia. Alarm trigger values are 800 psia low and 950 psia high. With O_2 PRESS IND switch at SURGE TANK position, indicator displays signal from ECS surge tank pressure transducer.
	Indicator 2	Displays O_2 tank No. 2 pressure and is used as follows: a. Determine tank heater performance. b. Detect leaks.			SF0038P (Press O_2 tank No. 2)	The indicator function is controlled by a pressure transducer located in O_2 tank No. 2 outlet line. Transducer also connected to C&WS, operating O_2 PRESS light on MDC-10. O_2 operating range is 865 to 935 psia. Alarm trigger values are 800 psia low, and 950 psia high.
	TANK QUANTITY indicator H_2 group Indicator 1	Displays quantity of H_2 remaining in tank No. 1.	CRYO-GENIC SYSTEM-QTY AMPL 1 AC 1 - ϕC (MDC-22)	A-C bus No. 1 ϕC	SF0030Q (Quantity H_2 tank No. 1)	H_2 quantity display range is 0 to 28 lb.
	Indicator 2	Displays quantity of H_2 remaining in tank No. 2.	CRYO-GENIC SYSTEM-QTY AMPL 2 AC 2 - ϕC (MDC-22)	A-C bus No. 2 ϕC	SF0031Q (Quantity H_2 tank No. 2)	

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	O_2 group					
	Indicator 1	Displays quantity of O_2 remaining in tank No. 1.	CRYO-GENIC SYSTEM - QTY AMPL 1 AC 1 - ØC (MDC-22)	A-C bus No. 1 ØC	SF0032Q (Quantity O_2 tank No. 1)	O_2 quantity display range is 0 to 320 lb.
	Indicator 2	Displays quantity of O_2 remaining in tank No. 2.	CRYO-GENIC SYSTEM - QTY AMPL 2 AC 2 - ØC (MDC-22)	A-C bus No. 2 ØC	SF0033Q (Quantity O_2 tank No. 2)	
	H_2 HEATERS switches				None	Redundant heater elements in each H_2 tank requires 10 watts of power for each element.
	Switches 1 and 2	Controls d-c power to H_2 tanks No. 1 and 2 heater elements, respectively.	CRYO-GENIC SYSTEM - TANK HEATERS - H_2 - 1 MN A (MDC-22)	D-C main bus A		
	AUTO	Enables automatic pressure switches to control d-c power to H_2 tanks No. 1 and 2 heater elements.				Switch at AUTO position will apply d-c voltage to H_2 tanks No. 1 and 2 redundant heater elements when pressure switches in both tanks are in a low-pressure position at 230 psia or lower, and remove d-c voltage when either pressure switch is in a high-pressure position at 260 psia or higher.
			CRYO-GENIC SYSTEM - TANK HEATERS - H_2 - 2 MN B (MDC-22)	D-C main bus B		
	OFF	Disconnects d-c power from H_2 tanks No. 1 and 2 heater elements.				
	ON	Controls d-c power directly to H_2 tanks No. 1 and 2 heater elements.				Switch at ON (manual) position by-passes the pressure switches applying d-c voltage directly to the same redundant heater elements employed for automatic operation.

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	O_2 HEATERS switches				None	Redundant heater elements in each O_2 tank requires 77.5 watts of power for each element.
	Switches 1 and 2	Controls d-c power to O_2 tanks No. 1 and 2 heater elements, respectively.	CRYOGENIC SYSTEM - TANK HEATERS - O_2 - 1 MN A (MDC-22) CRYOGENIC SYSTEM - TANK HEATERS - O_2 - 2 MN B (MDC-22)	D-C main bus A D-C main bus B		
	AUTO	Enables automatic pressure switches to control d-c power to O_2 tanks No. 1 and 2 heater elements.				Switch at AUTO position will apply d-c voltage to O_2 tanks No. 1 and 2 redundant heater elements when pressure switches in both tanks are in a low-pressure position at 865 psia or lower and will remove d-c voltage when either pressure switch is in a high-pressure position at 935 psia or higher.
	OFF	Disconnects d-c power from O_2 tanks No. 1 and 2 heater elements.				
	ON	Controls d-c power directly to O_2 tanks No. 1 and 2 heater elements.				Switch at ON (manual) position bypasses the pressure switches, applying d-c voltage directly to the same redundant heater elements employed for automatic operation.
	O_2 PRESS IND switch					TANK PRESSURE-1-O_2 indicator is shared by two pressure signals.
	TANK 1	Connects output of O_2 tank No. 1 pressure transducer to O_2 tank No. 1 TANK PRESSURE indicator (MDC-13).	ESSENTIAL -3 (RHEB 204) and fuse in S/M	S/M INSTR PWR DIST	SF0037P (Press O_2 tank 1)	Normal position of switch prior to CSM separation except for periodic surge tank readouts.
	SURGE TANK	Connects output of ECS SURGE TANK pressure transducer to O_2 tank No. 1 TANK PRESSURE indicator.	INSTRUMENTS ESS - MN A and MN B (MDC-22), also ESSENTIAL -2 (RHEB 204)	D-C main buses A and B	CF0006P (Press surge tank)	Normal position of switch following CSM separation.

MAIN DISPLAY CONSOLE—PANEL 13

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	H_2 FANS switches				None	Redundant fan motors in each H_2 tank requires 63VA total.
	Switches 1 and 2	Controls a-c power to H_2 tanks No. 1 and 2 fan motors, respectively.	CRYOGENIC TANK FAN MOTORS -1- AC 1 ϕA ϕB ϕC (MDC-22)	A-C bus No. 1		
	AUTO	Applies a-c power to contacts on motor switch which controls 3ϕ a-c power to circulating fan motors in H_2 tanks No. 1 and 2.				Switch at AUTO position will apply a-c voltage to H_2 tanks No. 1 and 2 redundant fan motors when pressure switches in both tanks are in a low-pressure position at 230 psia or lower and will remove a-c voltage when either pressure switch is in a high-pressure position at 260 psia or higher.
	OFF	Disconnects 3ϕ a-c power from H_2 tanks No. 1 and 2 circulating fan motors.	CRYOGENIC TANK FAN MOTORS -2- AC 2 ϕA ϕB ϕC (MDC-22)	A-C bus No. 2		
	ON	Controls 3ϕ a-c power directly to circulating fan motors in H_2 tanks No. 1 and 2				Switch at ON (manual) position bypasses the pressure switches, applying a-c power directly to the same redundant H_2 tank fan motors employed for automatic operation.
	O_2 FANS switches					Redundant fan motors in each O_2 tank requires 148VA total.
	Switches 1 and 2		CRYOGENIC TANK FAN MOTORS -1- AC 1 ϕA ϕB ϕC (MDC-22)	A-C bus No. 1		
	AUTO	Applies a-c power to contacts on motor switch which controls 3ϕ a-c power to circulating fan motors in O_2 tanks No. 1 and 2.				Switch at AUTO position will apply a-c power to O_2 tank No. 1 and 2 redundant fan motors when pressure switches in both tanks are in a low pressure position at 865 psia or lower and will remove a-c voltage when either pressure switch is in a high pressure position at 935 psia or higher.
	OFF	Disconnects 3ϕ a-c power from O_2 tanks No. 1 and 2 circulation fan motors.	CRYOGENIC TANK FAN MOTORS -2- AC 2 ϕA ϕB ϕC (MDC-22)	A-C bus No. 2		
	ON	Controls 3ϕ a-c power directly to circulating fan motors in O_2 tanks No. 1 and 2.				Switch at ON (manual) position bypasses the pressure switches, applying a-c power directly to the same redundant O_2 tank fan motors employed for automatic operation.
	GLY EVAP STEAM PRESS indicator	Provides pressure indication of steam discharged from water-glycol evaporator.	ECS - TRANS-DUCER PRESS GROUPS 2 MN A MN B (MDC-22)	D-C main buses A and B	CF0034P (Press glycol evap out steam)	Normal steam duct pressure operating range is 0.97 to 0.145 psia.

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	PRESS GLY DISCH indicator	Provides static pressure indication of water-glycol pump discharge.	ECS-TRANSDUCER-PRESS GROUPS 1 MN A MN B (MDC-22)	D-C main buses A and B	CF0016P (Press glycol pump outlet)	Normal water-glycol pump operating range indications are as follows: Prelaunch (GSE and onboard pumps): 14 to 18 psia Prelaunch (onboard pumps): 45 to 55 psia Normal flight: 37 to 45 psia Emergency flight: 37 to 45 psia
	FLOW O_2 indicator	Provides total rate-of-flow indication of oxygen supplied to the ECS downstream of the flow transducer.	ECS TRANSDUCER - PRESS GROUPS 2 MN A MN B (MDC-22)		CF0035R (Flow rate ECS O_2)	Indicator will not show O_2 flow upstream of transducer, such as through PLSS FILL valve (LHEB-314), main regulator or surge tank relief valve action, or line leakage. O_2 FLOW HI system status light (red) is located on MDC-11 and illuminates at a flow rate of 1.0 lb/hr. Normal O_2 flow operating range indications are from 0.20 to 0.45 lb/hr during prelaunch and in flight.
	ΔP SUIT COMPR indicator	Provides pressure differential indication between suit compressor inlet and outlet manifolds to determine degree of compressor efficiency.	ECS TRANSDUCER - PRESS GROUPS 1 MN A MN B (MDC-22)		CF0015P (Press suit compressor diff)	Suit compressor ΔP operating range indications are as follows: 0.7 to 0.9 psi during prelaunch 0.3 to 0.4 psi during normal space flight 0.2 to 0.3 psi during emergency space flight.
	GLY ACCUM-QUANTITY indicator	Provides quantity indication of water-glycol in accumulator.			CF0019Q (Quantity glycol accum)	Capacity of accumulator is 1.36 lb. Normal accumulator operating range indications are as follows: Prelaunch (GSE) and onboard pump): 0% Normal flight: 40 to 60% Emergency flight: 40 to 60%
	WATER-QUANTITY indicator	Provides quantity indication of waste water tank or potable water tank as selected by H_2O IND switch (MDC-13).	ECS TRANSDUCER WASTE & POT H_2O MN A MN B (MDC-22)		CF0009Q (Quantity waste water tank) CF0010Q (Quantity potable H_2O tank)	Capacities of the water tanks are 36 lb of potable water and 56 lb of waste water. Water quantity indications are dependent upon a selected mission profile and specific times during the mission.

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	ECS RAD-OUTLET TEMP indicator	Provides temperature indication of water-glycol returned to C/M from S/M space radiators (or from GSE during prelaunch).	ECS TRANS-DUCER TEMP MN A MN B (MDC-22)	D-C main buses A and B	CF0020T (Temp space radiator outlet)	GLYCOL TEMP LOW system status light (yellow) is located on MDC-11, and illuminates at -30°F. Normal ECS radiator outlet temperature operating range is 30° to 102°F.
	GLY EVAP-OUTLET TEMP indicator	Provides temperature indication of water-glycol at outlet of water-glycol evaporator.			CF0018T (Temp glycol evap outlet liquid)	Normal water-glycol operating range indications are 40° to 50°F during prelaunch and 40° to 50.5°F in flight.
	TEMP indicators SUIT	Provides temperature indication of suit circuit atmosphere.			CF0008T (Temp suit supply mani)	Temperature sensor located in suit heat exchanger outlet duct. Normal suit circuit operating range indications are 45° to 55°F during prelaunch and in flight.
	CABIN	Provides average temperature indication of cabin atmosphere.			CF0002T (Temp cabin)	Sensor located near inlet to cabin air fans. Normal cabin operating range indications are 50° to 70°F during prelaunch and 70° to 80°F in flight.
	PRESS indicators SUIT	Provides pressure indication of suit circuit atmosphere.	ECS-TRANS-DUCER PRESS GROUPS 1 MN A MN B (MDC-22)		CF0012P (Press suit demand reg sense)	Pressure transducer located at demand regulator sensing port. Normal suit circuit operating range indications are as follows: 14.7 psia during prelaunch, 4.7 to 5.3 psia during normal flight mode, and 3.75±0.25 psia during emergency flight mode.

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	CABIN	Provides pressure indication of cabin atmosphere.	ECS - TRANS-DUCER - PRESS GROUPS 2 MN A MN B (MDC-22)	D-C main buses A and B	CF0001P (Pressure cabin)	Pressure transducer located inside LHFEB. Normal cabin operating range indications are as follows: 14.7 psia during prelaunch, 4.8 to 5.2 psia during normal space flight, and 0.0 psia during emergency space flight.
	PART PRESS CO_2 indicator	Provides partial pressure indication of CO_2 in suit circuit atmosphere.	ECS - TRANS-DUCER - PRESS GROUPS 2 MN A (MDC-22)	D-C main bus A	CF0005P (Press CO_2 partial)	CO_2 sensor is located between inlet and outlet manifolds of suit circuit in LHEB. The CO_2 partial pressure normal metabolic operating range is 0.0 to 7.6 mm Hg, and the emergency metabolic operating range is 7.6 to 15.0 mm Hg. Both ranges are for an unlimited length of time. CO_2 PP HI system status light (MDC-11) illuminates at 7.6 mm Hg. This indicates CO_2 level has risen to the upper end of the normal operating range.
	H_2O ACCUM switches AUTO 1/MAN/ AUTO 2 switch				None	In automatic mode, 10-second pulse signal for accumulator operation is received from CTE.
	AUTO 1	a. Removes d-c power from H_2O ACCUM-ON 1/ON 2 switch (MDC-13). b. Applies d-c power to No. 1 cyclic accumulator control unit to automatically time and actuate No. 1 cyclic accumulator valve for 10 seconds every 10 minutes.	ECS-H_2O ACCUM- MN A (MDC-22)	D-C main bus A		
	MAN	a. Removes d-c power from No. 1 and No. 2 cyclic accumulator control units. b. Applies d-c power to H_2O ACCUM-ON 1/ON 2 switch, permitting manual control of No. 1 or No. 2 cyclic accumulator valves.	ECS-H_2O ACCUM- MN A MN B (MDC-22)	D-C main buses A and B		Switch position selects manual backup mode, permitting manual cyclic accumulator valve actuation in event both cyclic accumulator automatic control units should fail.

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	AUTO 2	a. Removes d-c power from H_2O ACCUM-ON 1/ON 2 switch. b. Applies d-c power to No. 2 cyclic accumulator control unit to automatically time and actuate No. 2 cyclic accumulator valve for 10 seconds every 10 minutes.	ECS - H_2O ACCUM- MN B (MDC-22)	D-C main bus B	None	
	ON 1/ON 2 switch					
	ON 1	Back up switch position to apply d-c power to solenoid valve of No. 1 cyclic accumulator, manually controlling oxygen flow to accumulator.	ECS - H_2O ACCUM- MN A (MDC-22)	D-C main bus A		Switch position is momentary to preclude possibility of expending oxygen needlessly. Switch may be operated when convenient or when suit circuit humidity level becomes uncomfortable.
	Off (center)	Removes power from both solenoid valves, shutting off oxygen flow to either accumulator.				
	ON 2	Back up switch position to apply d-c power to solenoid valve of No. 2 cyclic accumulator, manually controlling oxygen flow to accumulator.	ECS - H_2O ACCUM- MN B (MDC-22)	D-C main bus B		This switch position is momentary to preclude possibility of expending oxygen needlessly. Switch may be operated when convenient or when suit circuit humidity level becomes uncomfortable.
	WASTE H_2O TK REFILL switch		POT H_2O HTR MN B (MDC-22)			Switch positions are not momentary; therefore, water quantity indicators must be monitored to prevent overfilling. Potable tank will fill first, unless POTABLE TANK INLET valve is closed. Flow is at the rate of 2.92 lb per minute.
	1	Applies d-c power to solenoid valve of S/M water tank No. 1, permitting water flow to refill C/M water tanks.				
	OFF	Removes power from both solenoid valves.				
	2	Applies d-c power to solenoid valve of S/M water tank No. 2, permitting water flow to refill C/M water tanks.				

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	SUIT EVAP switch					
	AUTO	Applies a-c power to the following to automatically regulate suit circuit temperature by the water-glycol or water evaporation cooling modes: a. Suit evaporator wetness control unit b. Steam pressure control unit c. Diverter valve control unit.	ECS-GLYCOL PUMPS - AC 1 ØB (MDC-22)	A-C bus No. 1	None	The AUTO position must be selected in conjunction with the use of the SUIT HT EXCH switch (LHEB-310). The control unit temperature sensor is located in the suit evaporator outlet. The suit temperature indicator sensor, however, is located at the suit heat exchanger outlet duct.
	MAN	Removes a-c power from the following to permit manual override operation of SUIT EVAP GLYCOL valve (LHEB-314): a. Suit evaporator wetness control unit b. Steam pressure control unit c. Diverter valve control unit.				The MAN position is selected in event of failure of any automatic control unit.
	H_2O IND switch		ECS-TRANSDUCER - WASTE & POT H_2O - MN A MN B (MDC-22)	D-C main buses A and B		WATER-QUANTITY indicator is shared by two quantity signals.
	POT	Selects potable water tank quantity signal for display on WATER-QUANTITY indicator (MDC-13).				
	WASTE	Selects waste water tank quantity signal for display on WATER-QUANTITY indicator.				
	GLYCOL EVAP switches					
	H_2O FLOW switch					
	AUTO	a. Applies a-c power to water control section. b. Closes circuit from control section to water control valve for automatically regulating water inflow to water-glycol evaporator.	ECS - GLYCOL PUMPS - AC 1 ØC (MDC-22)	A-C bus No. 1		
	Off (center)	Removes a-c power from water control section and d-c power from water control valve.				Water control valve is solenoid-operated.

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	ON	Manual backup mode to apply d-c power to solenoid-operated water control valve, which opens valve and permits water to enter water-glycol evaporator.	ECS - POT H_2O HTR MN A MN B (MDC-22)	D-C main buses A and B	None	This switch position is not momentary. Close coordination between switch actuation and the GLY EVAP-OUTLET TEMP indicator (MDC-13) is necessary to obtain correct water-glycol temperature and/or to prevent flooding the evaporator.
	STEAM PRESS group					Steam pressure control valve full-travel requires 58 seconds (max).
	AUTO/MAN switch					
	AUTO	a. Removes a-c power from GLYCOL EVAP - STEAM PRESS - INCR/DECR switch (MDC-13). b. Applies a-c power to steam pressure control section. c. Closes circuit from control section to steam pressure control valve to automatically regulate pressure in steam duct.	ECS-GLYCOL PUMPS- AC 1 ØC (MDC-22)	A-C bus No. 1		
	MAN	a. Removes a-c power from steam pressure control section. b. Opens circuit from control section to steam pressure control valve. c. Applies a-c power to GLYCOL EVAP-STEAM PRESS-INCR/DECR switch.				This switch position selects manual backup mode, permitting manual operation of steam pressure control valve actuator in event of steam pressure control section malfunction.
	INCR/DECR switch					
	INCR	Applies a-c power to actuator of steam-pressure control valve, which moves valve in the closed direction and increases the steam duct pressure.				This switch position is momentary. Until motor-driven steam pressure control valve reaches its maximum limit, short periods of switch activation result in proportional increases in steam duct pressure. Valve full-travel requires 58 seconds (max).
	Off (center)	Removes a-c power from valve actuator.				

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	DECR	Applies a-c power to actuator of steam pressure control valve, which moves valve in the open direction and decreases the steam duct pressure.	ECS-GLYCOL PUMPS-AC 1 ØC (MDC-22)	A-C bus No. 1	None	This switch position is momentary. Until motor-driven steam pressure control valve reaches it maximum limit, short periods of switch activation result in proportional decreases in steam duct pressure. Valve full-travel requires 58 seconds (max).
	TEMP IN switch		ECS-GLYCOL PUMPS-AC 1 ØA (MDC-22)			Temperature control unit sensor is located at inlet to water-glycol evaporator.
	AUTO	Applies a-c power to water-glycol temperature control unit, which automatically regulates temperature of coolant entering evaporator by mixing hot and cold water-glycol.				Water-glycol evaporator temperature control valve full travel requires 37.5 seconds (max).
	MAN	Removes a-c power from water-glycol temperature control unit, permitting manual override operation of GLYCOL EVAP TEMP IN valve (LHEB-311) by T-handle tool.				Manual control of water-glycol evaporator temperature control valve is required in event of failure of automatic control unit. Close coordination between valve adjustments and GLY EVAP-OUTLET TEMP and ECS RAD-OUTLET TEMP indicators (MDC-13) is necessary to obtain correct water-glycol temperature.
	CABIN TEMP controls					
	AUTO/MAN switch					Temperature control unit sensor is located at inlet to cabin air fans; also, an anticipator (sensor) is located at outlet of cabin air fans.
	AUTO	Applies a-c power to cabin temperature control unit to automatically regulate temperature of water-glycol flow through cabin heat exchanger.	ECS-CABIN AIR FAN 2 ØC (MDC-22)	A-C bus No. 2		Cabin temperature control valve full travel requires 25 seconds (max).
	MAN	Removes a-c power from cabin temperature control unit, permitting manual override operation of the CABIN TEMP control valve (LHFEB-303) by properly positioning control knob.				Manual control of cabin temperature control valve is required in event of failure of automatic control unit. There is a definite time lag in cabin temperature response following a manual adjustment; therefore, close coordination between manual adjustments and the TEMP-CABIN indicator (MDC-13) is not necessary.

MAIN DISPLAY CONSOLE—PANEL 13

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-13 (Cont)	AUTO control					
	INCR (upward)	Thumbwheel permits manual adjustment of cabin temperature automatic control unit. The higher the number selected, the greater proportional increase in cabin temperature.	None	None	None	Cabin temperature can be selected between 70° and 80°F. Numbers on thumbwheel do not correspond to any temperature.
MDC-14 AGC DSKY panel	COMP FAIL light	Indicates AGC malfunction.	G&N - COMPUTER MN A MN B (MDC-22)	D-C main buses A and B	None	
	KEY RLSE light	Internal AGC program needs DSKY circuits to cintinue program.				Request for operator to press KEY RLSE pushbutton.
	UPTEL switch	Controls acceptance of telemetered data from MSFN.				
	ACCEPT	Allows AGC to accept data from MSFN.				
	BLOCK	Inhibits AGC reception of MSFN data.				
	ACTIVITY lights	Indicates activity the computer is presently engaged in.			GG5021X (AGC alarm 2)	
	UPTL	AGC is receiving data link information by telemetry.				
	COMP	AGC is engaged in computation.				
	PROGRAM indicator	A two-digit display indicating the number of the program (major mode) presently in progress.			None	On-board data provides definition of PROGRAM, NOUN, and VERB digits.
	VERB indicator	A two-digit display indicating verb code selected.				
	NOUN indicator	A two-digit display indicating noun code selected.				
	REGISTER 1 indicator	Displays contents of selected register or memory location. First component of extended-length data word, if applicable.				Displays may be selected manuall or by AGC program.

MAIN DISPLAY CONSOLE—PANELS 13 AND 14

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-14 (Cont)	REGISTER 2 indicator	Displays contents of selected register or memory location. Second component of extended-length data word, if applicable.	G&N COMPUTER MN A MN B (MDC-22)	D-C main buses A and B	None	
	REGISTER 3 indicator	Displays contents of selected register or memory location. Third component of extended-length data word, if applicable.				Displays may be selected manually or by AGC program.
	BRIGHTNESS control	Varies brightness of electro-luminescent data displays: REGISTER 1, REGISTER-2, and REGISTER 3.				
	KEY RLSE pushbutton	Enables program control of DSKYs. Releases operator control of DSKY circuits.				
	ERROR RESET pushbutton	Resets alarm light relays. AGC recycles to start of current operation.				Verifies alarms. Alarms triggered by transients should not repeat.
	Keyboard switches	Provide for entering data into or commanding operation of the AGC.				Pushbutton-type switches (selectors). Each key generates a specific 5-bit key code denoting the instruction or number being selected.
	CLEAR	Place all zeros (logic 0s) in register being loaded.				
	VERB	Sets computer to accept next two digits as verb code.				
	NOUN	Sets computer to accept next two digits as noun code.				
	ENTER	Transfers contents of input register to central processor and initiates execution of instructions.				
	+	Denotes data to follow has positive decimal value.				
	-	Denotes data to follow has negative decimal value.				
	0 to 9	Enters the binary equivalent of the key pressed.				

MAIN DISPLAY CONSOLE—PANEL 14

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-15	H_2 PURGE LINE HTR switch		FUEL CELL 1 - PURGE and FUEL CELL 2 - PURGE (MDC-22)	D-C main buses A and B	None	Two-position double-pole toggle switch provides heater power during H_2 purge of fuel cells. Positioned to ON 30 min before H_2 purge.
	ON	Applies +28 vdc power to two 2-watt heaters in fuel cell H_2 vent line.				
	OFF	Remove +28 vdc power from heaters.				Positioned to OFF after completing H_2 purge.
	HELIUM 1 switches	Four functionally identical switches. Each switch controls one helium isolation valve in the HELIUM 1 half of a parallel helium pressurization system. Each of the four RCS packages contains identical systems.	RCS-PROP ISOL MN A MN B (MDC-25)			Each switch is a three-position toggle switch, spring-loaded, causing it to return to the center position after setting it to the ON or OFF position. Each valve contains a position micro-switch which completes the circuit for operating the valve position event indicator mechanism. Each valve also contains an open and close mechanical latching feature.
	A (B, C, D)					
	ON	Energizes helium isolation valve solenoid that drives the valve to the open position.				
	Center	Removes solenoid excitation; valve remains in last commanded position.				
	OFF	Energizes helium isolation valve solenoid that drives the valve to the closed position.				

MAIN DISPLAY CONSOLE—PANEL 15

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-15 (Cont)	HELIUM 1 event indicators		RCS-PROP ISOL MN A MN B (MDC-25)	D-C main buses A and B	None	Each indicator is a two-position device with striped-line display controlled by solenoid action and gray display by permanent magnet action.
	A (B, C, D)	Striped-line display indicates closed condition of valve controlled by switch located directly above event indicator. Gray display indicates open condition.				
	HELIUM 2 switches	Four functionally identical switches. Each switch controls one helium isolation valve in the HELIUM 2 half of a parallel helium pressurization system. Each of the four RCS packages contain identical systems.				Each switch is a three-position toggle switch, spring loaded, causing it to return to the center position after placing it to the ON or OFF positions. Each valve contains a position microswitch which completes the circuit for operating the valve position event indicator mechanism. Each valve is mechanically latched open and spring-loaded closed.
	A (B, C, D)					
	ON	Energizes helium isolation valve solenoid that drives the valve to the open position.				
	Center	Removes solenoid excitation; valve remains in last commanded position.				
	OFF	Energizes helium isolation valve solenoid that drives the valve to the closed position.				
	HELIUM 2 event indicators					Each indicator is a two-position device with striped-line display controlled by solenoid action and gray display by permanent magnet action.
	A (B, C, D)	Striped-line display indicates closed condition of valve controlled by switch located directly above event indicator. Gray display indicates open condition.				
	PROPELLANT switches	Four functionally identical switches. Each switch controls two isolation valves (one fuel, one oxidizer) within each of the four S/M RCS packages.				Each switch is a three-position toggle switch, spring-loaded, causing it to return to the center position after placing it to the ON or OFF positions. Each valve contains a position microswitch which completes the circuit for operating the valve position event indicator. Each valve is magnetically latched open and spring-loaded closed.

MAIN DISPLAY CONSOLE—PANEL 15

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-15 (Cont)	A (B, C, D)		RCS—PROP ISOL MN A MN B (MDC-25)	D-C main buses A and B	None	
	ON	Energizes propellant isolation valve solenoids that drive two valves to the open position.				
	Center	Removes solenoid excitation; valves remain in last commanded position.				
	OFF	Energizes propellant isolation valve solenoids that drive two valves to the closed position.				
	PROPELLANT event indicators					Each indicator is a two-position device with striped-line display controlled by solenoid action and gray display by permanent magnet action. Indicator will function (striped-line display) if either valve is in a closed position.
	A (B, C, D)	Striped-line display indicates closed condition of valves controlled by switch located directly above event indicator. Gray display indicates open condition.				
	C/M-S/M SEP switches					The switches are spring-loaded to the down position.
	Switch 1 and 2		MASTER EVENT SEQ CONT A ARM B BAT A and BAT B (MDC-22)	Battery buses A and B		
	Up	Activates systems A and B to perform the following functions: a. C/M-S/M deadface b. C/M-RCS pressurize c. C/M-S/M separation d. Transfer entry batteries to d-c main buses A and B e. C/M-S/M separation pyro control shut-off f. RCS control transfer g. C/M-S/M separation signal to SMJC.			CD0023X CM-SM separate relay close A CD0024X CM-SM separate relay close B	The two switches are guarded redundant switches.
	Down	Off position.				
	C/M RCS PRPLNT group	Two functionally identical switches. Each switch controls two isolation valves (one fuel, one oxidizer) within its respective propellant system.	RCS-PROP ISOL MN A MN B (MDC-25)	D-C main buses A and B		Each switch is a three-position switch. Switch is spring-loaded from the OFF position to center position only. Each valve contains a position microswitch which completes the circuit for operating the valve position event indicator mechanism. Each valve also contains an open and close latching feature.

MAIN DISPLAY CONSOLE—PANEL 15

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-15 (Cont)	A (B) switch		RCS-PROP ISOL MN A MN B (MDC-25)	D-C main buses A and B	None	
	ON	Energizes propellant isolation valve solenoids that drive two valves to the open position.				
	Center	Removes solenoid excitation; valves remain in last commanded position.				
	OFF	Energizes propellant isolation valve solenoids that drive two valves to the closed position.				
	A (B) event indicators	Striped-line display indicates closed condition of valves controlled by switch located directly above event indicator. Gray display indicates open condition.				Each indicator is a two-position device with striped-line display controlled by solenoid action and gray display by permanent magnet action. Indicator will function (striped-line display) if either valve is in a closed position.
MDC-16	ELS switch			MESC logic bus through Z12 ELS activate relays	None	
	AUTO	a. Prepares ELS for automatic enabling during LES abort. b. Allows the ELS to function automatically during descent of C/M.				Normal position of switch.
	MAN	Disconnects logic arming circuitry from ELS controller.				Switch is set to the MAN position after drogue parachute deployment during an abort initiated prior to 61 seconds after lift-off. The main parachutes must be deployed manually with the MAIN DEPLOY pushbutton (MDC-5) after the switch is set to the MAN position. If the main parachutes are deployed manually, the MAIN DEPLOY-AUTO switch must be set back to AUTO to allow 14-second timer to enable parachute release after touchdown.

MAIN DISPLAY CONSOLE—PANELS 15 AND 16

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-16 (Cont)	ABORT SYSTEM switches					
	OX DUMP switch					
	AUTO	Enables circuitry through a 61-second timer to automatically dump the C/M RCS oxidizer during a pad or low-altitude abort prior to 61 seconds-after lift-off.	MASTER EVENT SEQ CONT-A LOGIC B-BAT A BAT B (MDC-22)	Logic bus in the master event sequence controller	None	The 61-second timer, enabled by CM PROP JETT-LOGIC switch (MDC-8), starts at lift-off. The auto dump capability is disabled after the 61-seconds. Dump time is approximately 11 seconds.
	RCS CMD AUTO	Disables the auto oxidizer dump and allows the G&N/SCS system to be automatically enabled upon C/M-S/M separation to control the command module RCS during descent.				During normal ascent, the OX DUMP switch is moved to the RCS CMD AUTO position 61 seconds after lift-off.
	2 ENG OUT switch		None	L/V-IU batteries	L/V telemetry via IU	
	AUTO	Activates the EDS for a two-engine out automatic abort capability by de-energizing the two-engine out auto abort deactivate relays.				
	OFF	Deactivates the EDS for a two-engine out automatic abort capability by energizing the two-engine out auto abort deactivate relays.				The two-engine out auto abort capability is also shutoff automatically by the IU.
	L/V RATES switch					
	AUTO	Activates the EDS for an excessive rates automatic abort capability by de-energizing the excessive rates auto abort deactivate relays.				
	OFF	Deactivates the EDS for an excessive rates automatic abort capability by energizing the excessive rates auto abort deactivate relays.				The excessive rates auto abort capability is also shut off automatically by the IU.

MAIN DISPLAY CONSOLE—PANEL 16

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-16 (Cont)	MODE switches					The two switches are guarded.
	LES MODE	Enables systems A and B to use the launch escape system in case of an abort.	MASTER EVENT SEQ CONT - A LOGIC B - BAT A (MDC-22)	a. Battery buses A and B when the MESC LOGIC/OFF switch is in the LOGIC position b. EDS change over bus	None	
	TWR JETT SPS MODE	Initiates jettison of the LES tower and arms system A and B of the SPS abort circuitry.			CD0105X Tower jettison A CD0106X Tower jettison B	After LET jettison, all aborts must be manually initiated and made in the SPS mode.'
	REACTION CONTROL SYS group					
	CMD switch		MASTER EVENT SEQ CONT - A ARM B BAT A BAT B (MDC-22)	Battery buses A and B		Three-position toggle switch, spring-loaded to the center position. Switch allows manual inhibit-enable of SCS inputs to the automatic coils of the C/M or S/M RCS engines. Inhibit-enable functions provide backup capability to MESC control of the RCS latching relay.
	ON	Energizes latching relay, connecting SCS jet selection logic to RCS engines.				
	Center	Enables MESC automatic control of latching relay.			None	Switch is momentarily set to ON after adapter separation. This function is accomplished automatically by the MESC 0.8 seconds after initiation of adapter separation with the ADAPT SEP pushbutton (MDC-5). If LES abort occurs after T + 61 seconds, the MESC automatically closes the relay 1 second after abort initiation. If an SPS abort occurs, the MESC automatically closes the relay 2.5 seconds after abort initiation. The MESC baroswitch input automatically causes the relay to open at approximately 24, 000 feet during C/M descent.
	OFF	De-energizes latching relay, disconnecting SCS jet selection logic from RCS engines.				

MAIN DISPLAY CONSOLE—PANEL 16

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-16 (Cont)	C/M PRESS switch		MASTER EVENT SEQ CONT-A ARM B BAT A BAT B (MDC-22)	Battery buses A and B	None	
	Up	Activates helium isolation squib valves in both systems A and B.				
	Down	No function.				
	TRANS switch		RCS-C/M - S/M TRANSFER MN A MN B (MDC-25)	D-C main buses A and B		Three-position switch, spring-loaded to the center position. Switch provides manual backup for automatic transfer function.
	C/M	Energizes motor switch causing the following: a. Connects C/M RCS engines to SCS jet selection logic control circuits. b. Disables translation controls.				
	Center	Enables MESC automatic control of motor switch.				
	S/M	Energizes motor switch, causing contacts to close which connect S/M RCS engines to SCS jet selection logic control circuits.				
	EDS switch		MASTER EVENT SEQ CONT-A LOGIC B- BAT A BAT B (MDC-22)	Battery buses A and B		Two-position toggle switch.
	AUTO	Prepares the L/V EDS auto abort circuitry for automatic enabling at lift-off.				
	OFF	All auto abort capabilities are disabled.				
	MAIN CHUTE RELEASE switch		MASTER EVENT SEQ CONT - A LOGIC B- BAT A BAT B (MDC-22)	MESC logic buses A and B	CE0321X CE0322X (Main chute disconnect relays A and B)	The switch is electrically enabled when the 10, 000 feet baroswitch closes during descent and will release the parachutes when actuated. The switch should never be moved to the up (release) position until after landing impact. The switch is spring-loaded to the down position and guarded.
	Up	Releases the main parachutes from the command module.				
	Down	Disables the parachutes release circuitry.				

MAIN DISPLAY CONSOLE—PANEL 16

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18	MASTER ALARM switch-light	Red light illuminates to alert crewman in RH couch of a malfunction or out-of-tolerance condition. This is indicated by illumination of applicable system status lights on MDC-10 or -11.	CAUT/ WARN- MN A MN B (MDC-25)	D-C main buses A and B	CS0150X (Master caution-warning on)	MASTER ALARM lights on MDC-3, -18, and LEB-103 are simultaneously illuminated, and an audio alarm tone is sent to each headset. The MASTER ALARM switch-light contains an integral push-switch. Pressing the switch-light will reset the master alarm circuit, extinguishing the MASTER ALARM lights and shutting off the audio alarm.
	pH HI event indicator				SC2160Z (pH factor water condition F/C No. 1) SC2161Z (pH factor water condition F/C No. 2) SC2162Z (pH factor water condition F/C No. 3)	A pH factor of 7 designates pure water. (Water is potable with a pH factor below 9.) Fuel cell to be monitored is selected by FUEL CELL INDICATORS switch (MDC-18). The pH HI event indicator is part of the C&WS.
	Striped-line display	Indicates pH factor of water from selected fuel cell is over 9, indicating a leakage of KOH electrolyte into the potable water supply.				
	Gray display	Indicates pH factor of water from selected fuel cell is below 9.				

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	F/C RAD TEMP LOW event indicator		CAUT/ WARN- MN A MN B (MDC-25)	D-C main buses A and B		
	Striped-line display	Indicates selected fuel cell glycol temperature at radiator outlet has dropped to -30°F or less.			SC2087T (Temp F/C No. 1 radiator outlet) SC2088T (Temp F/C No. 2 radiator outlet) SC2089T (Temp F/C No. 3 radiator outlet)	Glycol operating range is -50° to +300°F. Fuel cell to be monitored is selected by FUEL CELL INDICATORS switch (MDC-18). The F/C RAD TEMP LOW event indicator is part of the C&WS.
	Gray display	Indicates selected fuel cell glycol temperature at radiator outlet is above -30°F.				
	FUEL CELL indicators					
	FLOW group					
	H_2 indicator	Indicates flow rate of H_2 into selected fuel cell.			SC2139R (Flow rate H_2 F/C No. 1) SC2140R (Flow rate H_2 F/C No. 2) SC2141R (Flow rate H_2 F/C No. 3)	Normal operating range (indicator green band) is 0.036 lb/hr to 0.163 lb/hr. Alarm limits to caution and warning system are 0.028 lb/hr lower, 0.153 lb/hr upper. Sensors for the indicator are located in the F/C H_2 inlet lines. Fuel cell to be monitored is selected by FUEL CELL INDICATORS switch (MDC-18).

MAIN DISPLAY CONSOLE—PANEL 18

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	O_2 indicator	Indicates flow rate of O_2 into selected fuel cell.	CAUT/ WARN- MN A MN B (MDC-25)	D-C main buses A and B	SC2142R (Flow rate O_2 F/C No. 1) SC2143R (Flow rate O_2 F/C No. 2) SC2144R (Flow rate O_2 F/C No. 3)	Normal operating range (indicator green band) is 0.288 lb/hr to 1.304 lb/hr. Alarm limits to caution and warning system are 0.22 lb/hr lower, 1.22 lb/hr upper. Sensors for the indicator are located in the FUEL CELL O_2 inlet lines. Fuel cell to be monitored is selected by FUEL CELL INDICATORS switch (MDC-18).
	MODULE TEMP group SKIN indicator	Indicates skin temperature of selected fuel cell.			SC2084T (Temp F/C No. 1 skin) SC2085T (Temp F/C No. 2 skin) SC2086T (Temp F/C No. 3 skin)	Normal indication is 385° to 500°F. Alarm limits to caution and warning system are 360°F lower, 500°F upper. Sensors for the indicator are located in the pressurized portion of the fuel cells. Fuel cell to be monitored is selected by FUEL CELL INDICATORS switch (MDC-18).
	COND EXH indicator	Indicates temperature of selected fuel cell condenser exhaust.			SC2081T (Temp F/C No. 1 cond exhaust) SC2082T (Temp F/C No. 2 cond exhaust) SC2083T (Temp F/C No. 3 cond exhaust)	Condenser exhaust operating range is 155°F to 175°F. Alarm limits to caution and warning system are 155°F to 175°F. Sensors for the indicator are located in the exhaust manifolds of the fuel cell condensers. Fuel cell to be monitored is selected by FUEL CELL INDICATORS switch (MDC-18).

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	REG OUT PRESS HI event indicators		CAUT/ WARN- MN A MN B (MDC-25)	D-C main buses A and B		Fuel cell to be monitored is selected by FUEL CELL INDICATORS switch (MDC-18). The REG OUT PRESS HI event indicators are part of the C&WS.
	H_2 event indicators				SC2069P (H_2 pressure F/C No. 1 regulated)	Sensors for the indicator are located in the hydrogen pressure regulators.
	Striped-line display	Indicates when output pressure of H_2 regulator rises to 75 psia or greater on selected fuel cell.				
	Gray display	Indicates pressure is less than 75 psia.			SC2070P (H_2 pressure F/C No. 2 regulated)	Normal regulator output pressure is 61.5 psia.
					SC2071P (H_2 pressure F/C No. 3 regulated)	
	O_2 event indicator				SC2066P O_2 pressure F/C No. 1 regulated)	Sensors for the indicator are located in the F/C oxygen pressure regulators.
	Striped-line display	Indicates when output pressure of O_2 regulator rises to 75 psia or greater on selected fuel cell.				
	Gray display	Indicates pressure is less than 75 psia.			SC2067P O_2 pressure F/C No. 2 regulated)	Normal regulator output pressure is 63.5 psia.
					SC2068P O_2 pressure F/C No. 3 regulated)	

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	N_2 event indicator		CAUT/ WARN- MN A MN B (MDC-25)	D-C main buses A and B	SC2060P (N_2 pressure F/C No. 1 regulated)	Sensors for the indicator are located in the nitrogen pressure regulators.
	Striped-line display	Indicates when output pressure of N_2 regulator rises to 70 psia or greater on selected fuel cell.				
	Gray display	Indicates pressure is less than 70 psia.			SC2061P (N_2 pressure F/C No. 2 regulated)	Normal regulator output pressure is 53 psia.
					SC2062P (N_2 pressure F/C No. 3 regulated)	
	FUEL CELL switches				None	
	Purge group	Accomplish purging of selected fuel cell.				When purging the selected fuel cell, the C&WS will alarm if the reactants flow rate increases beyond the maximum normal flow rate. Purging (when operating at a 1420 w/fuel cell power level) is accomplished every 7 hours, alternating every 3-1/2 hours between O_2 and H_2. O_2 purge time (switch ON) is 2 minutes and H_2 purge time (switch ON) is 80 seconds. O_2 and H_2 maximum flow rates during purge is 0.6 and 0.75 lb/hr above normal flow rates, respectively. Effect of purge can be monitored by FUEL CELL INDICATORS switch and DC INDICATORS switch and their associated displays.
	Switches 1, 2 and 3		FUEL CELL 1 - PURGE (MDC-22) FUEL CELL 2- PURGE (MDC-22) FUEL CELL 3- PURGE (MDC-22)			
	H_2 PURGE	Opens purge valve on H_2 side of selected fuel cell to purge impurities from H_2 electrodes.				
	Center (off)	Disconnects power from selected F/C O_2 or H_2 purge valve, closing valve (normal switch position).				
	O_2 PURGE	Opens purge valve on O_2 side of selected fuel cell to purge impurities from O_2 electrodes.				
	REACTANTS group	Provides ON - OFF control of reactant flow (H_2 and O_2) for selected fuel cells.				These switches control solenoid valves, which accomplish control of reactant flow.

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	Switches 1, 2 and 3		FUEL CELL 1 - H_2 & O_2 VALVE (MDC-22) FUEL CELL 2 - H_2 & O_2 VALVE (MDC-22) FUEL CELL 3 - H_2 & O_2 VALVE (MDC-22)	Battery relay bus	SC2323X (Fuel cell No. 1 shutoff monitor) SC2324X (Fuel cell No. 2 shutoff monitor) SC2325X (Fuel cell No. 3 shutoff monitor)	Event indicators, located directly below their respective switches, display striped lines when both H_2 and O_2 shutoff valves are in closed (abnormal) position. **Warning** Do not inadvertently position REACTANT switches OFF. Loss of fuel cell may result.
	ON	Momentary switch position connects d-c power to selected fuel cell O_2 and H_2 shutoff valve actuators, driving valves to open position.				
	(Center)	Valves remain in last selected position (normal switch position).				
	OFF	Momentary switch position connects d-c power to selected fuel cell O_2 and H_2 shutoff valve actuators, driving valves to closed position.				
	Event Indicators 1, 2 and 3		FUEL CELL 1 - BUS CONT (MDC-22) FUEL CELL 2 - BUS CONT (MDC-22) FUEL CELL 3 - BUS CONT (MDC-22)		SC2323X (Fuel cell No. 1 shutoff monitor) SC2324X (Fuel cell No. 2 shutoff monitor) SC2325X (Fuel cell No. 3 shutoff monitor)	Event indicators function in conjunction with their respective switches located directly above.
	Striped-line display	Indicates when H_2 and O_2 shutoff valves are closed on selected fuel cell.				
	Gray display	Indicates normal (open) position of valves.				
	MAIN BUS A group					
	Switches 1, 2 and 3	Controls fuel cells No. 1, 2 and 3 electrical output to d-c main bus A.	FUEL CELL 1 - BUS CONT (MDC-22) FUEL CELL 2 - BUS CONT (MDC-22) FUEL CELL 3 - BUS CONT (MDC-22)		SC2120X (Fuel cell No. 1 bus A disconnect SC2121X (Fuel cell No. 2 bus A disconnect) SC2122X (Fuel cell No. 3 bus A disconnect)	When fuel cell main bus switches are placed to ON position, power is applied to a motor-driven switch located in an overload and reverse current sensing unit in the S/M. This accomplishes actual switching function required to apply output of selected fuel cell to d-c main bus A. Only one F/C BUS DISCONNECT status light (MDC-11) for all three F/C's.
	ON	Momentary switch position connects electrical output of selected fuel cell to d-c main bus A.				
	(Center)	Connects C&W alarm and F/C - BUS DISCONNECT indicator light (MDC-11) to selected fuel cell motor switch (normal position of switch).				

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	OFF	Disconnects electrical output of selected fuel cell from d-c main bus A.	FUEL CELL 1 - BUS CONT (MDC-22) FUEL CELL 2 - BUS CONT (MDC-22) FUEL CELL 3 - BUS CONT (MDC-22)	Battery relay bus	SC2120X (Fuel cell No. 1 bus A disconnect) SC2121X (Fuel cell No. 2 bus A disconnect) SC2122X (Fuel cell No. 3 bus A disconnect)	
	Reset switch	Provides capability of resetting d-c main bus A undervoltage protection circuit.	SNSR UNIT - DC BUS - A (MDC-21)		None	D-C main bus A undervoltage sensing circuit energizes MN BUS A UNDER-VOLT warning light (MDC-11) when d-c voltage drops below 26.25 vdc.
	RESET	Momentary switch position resets d-c main bus A under-voltage sensing unit.				
	(Center)	Connects MN BUS A UNDER-VOLT warning light to d-c bus A undervoltage sensing circuit.				
	OFF	Disconnects MN BUS A UNDER-VOLT warning light from d-c bus A undervoltage sensing circuit.				
	Event Indicators 1, 2 and 3		FUEL CELL 1 - BUS CONT (MDC-22) FUEL CELL 2 - BUS CONT (MDC-22) FUEL CELL 3 - BUS CONT (MDC-22)		SC2120X (Fuel cell No. 1 bus A disconnect) SC2121X (Fuel cell No. 2 bus A disconnect) SC2122X (Fuel cell No. 3 bus A disconnect)	Event indicators function in conjunction with their respective switches located directly above.
	Striped-line display	Indicates when selected F/C is removed from d-c main bus A.				
	Gray display	Indicates selected F/C is connected to bus.				

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	MAIN BUS B group					
	Switches 1, 2 and 3	Controls fuel cells No. 1, 2 and 3 electrical output to d-c main bus B.	FUEL CELL 1 - BUS CONT (MDC-22) FUEL CELL 2 - BUS CONT (MDC-22) FUEL CELL 3 - BUS CONT (MDC-22)	Battery relay bus	SC2125X (Fuel cell No. 1 bus B disconnect) SC2126X (Fuel cell No. 2 bus B disconnect) SC2127X (Fuel cell No. 3 bus B disconnect)	When fuel cell main bus switches are placed to ON position, power is applied to a motor-driven switch located in an overload and reverse current sensing unit in the S/M. This accomplisnes actual switching function required to apply output of selected fuel cell to d-c main bus B. Only on F/C BUS DISCONNECT status light (MDC-11) for all three fuel cells.
	ON	Momentary switch position connects electrical output of selected fuel cell to d-c main bus B.				
	(Center)	Connects C&W alarm and F/C BUS DISCONNECT indicator light (MDC-11) to selected fuel cell motor switch (normal position of switch).				
	OFF	Disconnects electrical output of selected fuel cell from d-c main bus B.				
	Reset Switch	Provides capability of resetting d-c main bus B undervoltage protection circuit.	SNSR UNIT - DC BUS - B (MDC-21)		None	D-C main bus B undervoltage sensing circuit energizes MN BUS B UNDER-VOLT warning light (MDC-11) when d-c voltage drops below 26.25 vdc.
	RESET	Momentary switch position resets d-c main bus B undervoltage sensing circuit.				
	(Center)	Connects MN BUS B UNDER-VOLT warning light to d-c bus B undervoltage sensing circuit.				
	OFF	Disconnects MN BUS B UNDER-VOLT warning from d-c bus B undervoltage sensing circuit.				
	Event Indicators 1, 2 and 3)		FUEL CELL 1 - BUS CONT (MDC-22) FUEL CELL 2 - BUS CONT (MDC-22) FUEL CELL 3 - BUS CONT (MDC-22)		SC2125X (Fuel cell No. 1 bus B disconnect) SC2126X (Fuel cell No. 2 bus B disconnect) SC2127X (Fuel cell No. 3 bus B disconnect)	Event indicators function in conjunction with their respective switches located directly above.
	Striped-line display	Indicates when selected fuel cell is removed from d-c main bus B.				
	Gray display	Indicates selected fuel cell is connected to bus.				

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	FUEL CELL INDICATORS switch	Selects desired fuel cell to be monitored by the fuel cell display indicators.		Dependent on position (insignificant)	None	Indicators associated with switch are as follows: a. FLOW indicators H_2 and O_2 b. MODULE TEMP indicators SKIN and COND EXH c. REG OUT PRESS HI - O_2 d. REG OUT PRESS HI - H_2 e. REG OUT PRESS HI - N_2 f. pH HI g. F/C RAD TEMP LOW. **NOTE** Items a and b are analog signals. Items c through g are ON-OFF signals (event indicators).
	1	Applies selected outputs of fuel cell No. 1 to fuel cell display indicators.				
	2	Applies selected outputs of fuel cell No. 2 to fuel cell display indicators.				
	3	Applies selected outputs of fuel cell No. 3 to fuel cell display indicators.				
	BATTERY CHARGER switch	Controls a-c and d-c power to battery charger, and selects battery to be charged.	BATTERY CHARGER- MN A MN B AC PWR (MDC-22)	D-C main bus A and B and a-c bus No. 1 or No. 2	CC0214V (D-C voltage bat charger out)	Switch actuates battery charger input-power control relay, routing a-c and d-c voltages through relay contacts to battery charger. Current flow is negligible when a battery is fully charged. MAIN BUS TIE switches (MDC-22) for selected battery must be off before a battery can be charged. A-C power for the battery charger is selected from a-c bus No. 1 or a-c bus No. 2 by the BAT CHGR switch (MDC-22).
	OFF	Disconnects electrical power from battery charger.				
	A	Controls a-c and d-c power to battery charger and routes output of battery charger to entry battery A.			CC0215C (D-C current bat charger out)	
	B	Controls a-c and d-c power to battery charger and routes output of battery charger to entry battery B.				
	C	Controls a-c and d-c power to battery charger and routes output of battery charger to postlanding battery C.				
	SUIT PACK	No function.				

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	DC VOLTS meter	Indicates d-c voltage of selected source, unit, or bus.		As selected by DC INDICATORS switch.	Refer to DC INDICATORS switch.	Meter functions in conjunction with DC INDICATORS switch. DC VOLTS meter range is 20 to 45 vdc.
	DC AMPS meter	Indicates d-c current of selected source, unit, or bus.				Meter functions in conjunction with DC INDICATORS switch. DC AMPS meter range is 0 to 100 amperes, 0 to 5 amperes expanded scale battery charger output.
	DC INDICATORS switch	Selects power source, bus, or unit to be monitored by DC VOLT and DC AMPS meters.				In some cases, only current or voltage is indicated by DC VOLTS and DC AMPS meters. In other cases, both voltage and current are indicated. These are listed in the function column associated with each position. The DC VOLTS meter will read slightly below 20 vdc when not in use. The DC AMPS meter will read zero amperes when not connected to a load.
	FUEL CELL - 1	Applies output of fuel cell No. 1 shunt to DC AMPS meter.		Fuel cell No. 1	SC2113C (D-C current F/C No. 1 output)	
	FUEL CELL - 2	Applies output of fuel cell No. 2 shunt to DC AMPS meter.		Fuel cell No. 2	SC2114C (D-C current F/C No. 2 output)	
	FUEL CELL - 3	Applies output of fuel cell No. 3 shunt to DC AMPS meter.		Fuel cell No. 3	SC2115C (D-C current F/C No. 3 output)	
	MAIN BUS - A	Applies voltage of d-c main bus A to DC VOLTS meter.	SNSR UNIT - DC BUS - A (MDC-21)	D-C main bus A	CC0206V (D-C voltage main bus A)	
	MAIN BUS - B	Applies voltage of d-c main bus B to DC VOLTS meter.	SNSR UNIT - DC BUS - B (MDC-21)	D-C main bus B	CC0207V (D-C voltage main bus B)	
	BAT BUS - A	Applies both voltage and current of battery bus A to DC VOLTS and DC AMPS meters.		Battery bus A	CC0210V (D-C voltage battery bus A) CC0222C (D-C current battery A)	MASTER EVENT SEQ CONT-LOGIC-BAT A c/b (MDC-22) controls d-c voltage indication (voltage only) and measurement for telemetry.

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	BAT BUS -B	Applies both voltage and current of battery bus B to DC VOLTS and DC AMPS meters.		Battery bus B	CC0211V (D-C voltage battery bus B) CC0223C (D-C current battery B)	MASTER EVENT SEQ CONT-LOGIC-BAT B c/b (MDC-22) controls d-c voltage indication (voltage only) and measurement for telemetry.
	BAT CHARGER	Applies both voltage and current output of battery charger to DC VOLT and DC AMPS meter (inner scale 0 to 5 amps).		Battery charger	CC0214V (D-C voltage battery charger out) CC0215C (D-C current battery charger out)	Charger current output will be according to charge required by battery (up to 2. 5 amps).
	BAT C	Applies both voltage and current outputs of battery C to DC VOLTS and DC AMPS meters.	BAT CHGR BAT C (LEB-150)	Battery C	CC0212V (D-C voltage post-landing battery) CC0224C (D-C current post-landing battery)	Listed C/B will control d-c voltage indication and measurement for telemetry.
	PYRO BAT-A	Applies pyro battery A voltage to DC VOLTS meter when SEQ A cb is closed.	PYRO A - SEQ A	Pyro battery A		Normally closed cb. Open circuit monimal voltage of 37. 2 vdc will be read on meter.
		Applies entry battery A voltage to DC VOLTS meter when BAT A to PYRO BUS TIE cb is closed.	BAT A TO PYRO BUS TIE	Entry battery A		Normally open cb. Open circuit nominal voltage of 37. 2 vdc, or load voltage of 28 vdc will be read on meter.
	PYRO BAT-B	Applies pyro battery B voltage to DC VOLTS meter when SEQ B cb is closed.	PYRO B - SEQ B	Pyro battery B		Normally closed cb. Open circuit nominal voltage of 37. 2 vdc will be read on meter.
		Applies entry battery B voltage to DC VOLTS meter when BAT B to PYRO BUS TIE cb is closed.	BAT B TO PYRO BUS TIE	Entry battery B		Normally closed cb. Open circuit nominal voltage of 37. 2 vdc, or load voltage of 28 vdc will be read on meter.
	AC INVERTER switches				Refer to AC INDICATORS switch	Interlocking circuitry between AC INVERTER-AC BUS 1 and AC BUS 2 switches (MDC-18) prevents more than one inverter from being connected to any one bus at the same time.

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	Switch 1	Controls d-c power to a-c inverter No. 1 by actuating a motor-driven switch which accomplishes actual switching function.	INVERTER CONTROL - 1 (MDC-22)	Battery relay bus	Refer to AC INDICATORS switch	Circuit breakers associated with delivering power to AC INVERTER No. 1 from d-c main bus A is INVERTER PWR - No. 1 - MN A on main circuit breaker panel (RHEB-203).
	MN A	Applies d-c power to a-c inverter No. 1.				
	OFF	Disconnects d-c power from a-c inverter No. 1.				
	Switch 2	Controls d-c power to a-c inverter No. 2 by actuating a motor-driven switch which accomplishes actual switching function.	INVERTER CONTROL - 2 (MDC-22)			Circuit breaker associated with delivering power to AC INVERTER No. 2 from d-c main bus B is INVERTER PWR - No. 2 - MN B on main circuit breaker panel (RHEB-203).
	MN B	Applies d-c power to a-c inverter No. 2.				
	OFF	Disconnects d-c power from a-c inverter No. 2.				
	Switch 3	Controls d-c power to a-c inverter No. 3 by actuating one of two motor-driven switches depending on bus selected.	INVERTER CONTROL - 3 (MDC-22)			Inverter No. 3 can receive power from either d-c main bus A or d-c main bus B. Associated circuit breakers are INVERTER PWR - No. 3 - MN A and - MN B (RHEB-203).
	MN A	Applies d-c power from main bus A to a-c inverter No. 3.				
	OFF	Disconnects d-c power from a-c inverter No. 3.				
	MN B	Applies d-c power from main bus B to a-c inverter No. 3.				
	AC BUS 1 group					Actuates a motor-driven switch which accomplishes actual switching function.
	Switch 1	Controls a-c output of inverter No. 1 to a-c bus No. 1	INVERTER CONTROL - 1 (MDC-22)			
	ON	Applies a-c output of inverter No. 1 to a-c bus No. 1				
	OFF	Disconnects a-c output of inverter No. 1 from a-c bus No. 1.				

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	Switch 2	Controls a-c output of inverter No. 2 to a-c bus No. 1.	INVERTER CONTROL - 2 (MDC-22)	Battery relay bus	Refer to AC INDICA-TORS switch	
	ON	Applies a-c output of inverter No. 2 to a-c bus No. 1.				
	OFF	Disconnects a-c output of inverter No. 2 from a-c bus No. 1.				
	Switch 3	Controls a-c output of inverter No. 3 to a-c bus No. 1.	INVERTER CONTROL - 3 (MDC-22)			
	ON	Applies a-c output of inverter No. 3 to a-c bus No. 1.				
	OFF	Disconnects a-c output of inverter No. 3 to a-c bus No. 1.				
	RESET/OFF switch	Provides capability of resetting a-c bus No. 1 over undervoltage and overload sensing unit. Also releases relay which reconnects the operating inverter to a-c bus No. 1, if it had been tripped off due to overvoltage or overload	SNSR UNIT - AC BUS - 1 (MDC-21)		None	Resetting a-c bus 1 over-undervoltage and overload sensing unit also turns AC BUS 1 FAIL and AC BUS 1 OVERLOAD caution and warning lights off. Circuit breaker associated with the a-c sensing lines on a-c bus No. 1 is AC SNSR SIG - AC1 (MDC-25).
	RESET	Momentary position resets a-c bus No. 1 over-undervoltage and overload sensing unit.				
	(Center)	Energizes a-c bus No. 1 over-undervoltage and overload sensing unit.				
	OFF	Disconnects a-c bus No. 1 over-undervoltage and overload sensing unit from system.				
	AC BUS 2 group				Refer to AC INDICA-TORS switch	Actuates a motor-driven switch which accomplishes actual switching function.
	Switch 1	Controls output of inverter No. 1 to a-c bus No. 2.	INVERTER CONTROL - 1 (MDC-22)			
	ON	Applies output of inverter No. 1 to a-c bus No. 2.				
	OFF	Disconnects output of inverter No. 1 from a-c bus No. 2.				

MAIN DISPLAY CONSOLE—PANEL 18

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	Switch 2	Controls output of inverter No. 2 to a-c bus No. 2.	INVERTER CONTROL - 2 (MDC-22)	Battery relay bus	Refer to AC INDICATORS switch	
	ON	Applies output of inverter No. 2 to a-c bus No. 2.				
	OFF	Disconnects output of inverter No. 2 from a-c bus No. 2.				
	Switch 3	Controls output of inverter No. 3 to a-c bus No. 2.	INVERTER CONTROL - 3(MDC-22)			
	ON	Applies output of inverter No. 3 to a-c bus No. 2.				
	OFF	Disconnects output of inverter No. 3 from a-c bus No. 2.				
	RESET/OFF switch	Provides capability of resetting a-c bus No. 2 over-undervoltage and overload sensing unit. Also releases relay which reconnects the operating inverter to a-c bus No. 2 if it has been tripped off due to over-voltage or overload.	SNSR UNIT-AC BUS - 2 (MDC-21)		None	Resetting a-c bus No. 2 over-undervoltage and overload sensing unit also turns AC BUS 2 FAIL and AC BUS 2 OVERLOAD caution and warning lights (MDC-11) ON. Circuit breaker associated with sensing lines on a-c bus No. 2 is AC SNSR SIG - AC2 (MDC-25).
	RESET	Resets a-c bus No. 2 over-undervoltage and overload sensing unit.				
	(Center)	Energizes a-c bus No. 2 over-undervoltage and overload sensing unit.				
	OFF	Disconnects a-c bus No. 2 over-undervoltage and overload sensing unit from the system.				
	AC VOLTS meter	Indicates a-c voltage of selected source and phase.	AC SNSR SIG - AC 1 AC 2 (MDC-25)	As selected by AC INDICATORS switch	Refer to AC INDICATORS switch	Meter functions in conjunction with AC INDICATORS switch. AC VOLTS meter range is 90 to 130 vac.
	FREQ CPS meter	Indicates frequency of selected source and phase.				FREQ CPS meter range is 380 to 420 cps.
	AC INDICATORS switch	Provides means of monitoring 3φ voltage and frequency output of a-c inverters.				Operating rnage for phase A, B, and C (a-c bus No. 1 or a-c bus No. 2) is 115 ±2 vac 400 cps, during emergency mode 393 to 407 cps. Only phase A frequency measurement of a-c buses 1 and 2 are telemetered to MSFN ground stations.

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-18 (Cont)	BUS 1 group		AC SNSR SIG - AC1 (MDC-25)	A-C bus No. 1		
	ØA	Applies a-c phase A voltage from a-c bus No. 1 to AC VOLTS and FREQUENCY meters.			CC0200V (A-C voltage main bus 1 phase A) CC0213F (Frequency a-c bus 1 phase A)	
	ØB	Applies a-c phase B voltage from a-c bus No. 1 to AC VOLTS and FREQUENCY meters.			CC0201V (A-C voltage main bus 1 phase B)	
	ØC	Applies a-c phase C voltage from a-c bus No. 1 to AC VOLTS and FREQUENCY meters.			CC0202V (A-C voltage main bus 1 phase C)	
	BUS 2 group		AC SNSR SIG - AC2 (MDC-25)	A-C bus No. 2		
	ØA	Applies a-c phase A voltage from a-c bus No. 2 to AC VOLTS and FREQUENCY meters.			CC0203V (A-C voltage main bus 2 phase A) CC0217F (Frequency a-c bus 2 - phase A)	
	ØB	Applies a-c phase B voltage from a-c bus No. 2 to AC VOLTS and FREQUENCY meters.			CC0204V (A-C voltage main bus 2 - phase B)	
	ØC	Applies a-c phase C voltage from a-c bus No. 2 to AC VOLTS and FREQUENCY meters.			CC0205V (A-C voltage main bus No. 2 phase C)	

MAIN DISPLAY CONSOLE—PANEL 1

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-19	ECS RAD OUT TEMP-1 indicator	Provides temperature indication of water-glycol at outlet of 6-tube circuit of radiator 1 (S/M sector V).	INSTRU-MENT-NONESSEN-TIAL (MDC-22) also NONESSEN-TIAL -9 (RHEB-204)	NONESSEN-TIAL BUS No. 1 (D-C main buses A or B)	SF0671T (Tank ECS radiator outlet 1)	Sensors located in outlet lines of radiators 1A and 2A on S/M forward bulkhead. Normal radiator outlet temperatures should not decrease below 30°F.
	ECS RAD OUT TEMP-2	Provides temperature indication of water-glycol at outlet of 6-tube circuit of radiator 2 (S/M sector II).			SF0672T (Tank ECS radiator outlet 2)	
	S-BAND ANT indicator	Indicates relative strength of signal being received by USBE.	N/A	USBE	CT0147V (S-Band RCVR AGC voltage)	Signal strength meter that operates off of voltage obtained from AGC circuitry in USBE. No calibration, tune for maximum signal by switching S-band antennas or rotating S/C for optimum reception.
	UP TLM CMD switch		T/C-GROUP 5 (MDC-22)	Flight and postlanding bus	None	DPDT switch, spring-loaded in the OFF position.
	RESET	Applies 28 vdc to the reset windings of all real-time command relays in the UDL RTC relay box. This cancels any real-time commands previously received via the UDL and returns control to the S/C.				
	OFF	None				
	FLIGHT QUAL RCDR switch		RCDR NON ESS (MDC-22)	FQR (Refer to Remarks.)	CT0013X (Tape motion monitor R&D)	Power to the switch is provided by the FQR control logic. The non-essential bus supplies 28-vdc power to the FQR through the RCDR NON ESS circuit breaker (MDC-22). Three-phase a-c power from the TELCOM-NON ESS switch is supplied to the FQR through the T/C - GROUP 1 AC circuit breaker (MDC-22).
	RECORD	Activates FQR electronic circuits and tape transport mechanism to record flight qualification data. Tape moves in forward direction at 15 IPS.				
	F/C VALVES					
	RESET	Provides +28 vdc to motor switch to disconnect holding voltage applied to the open solenoids of F/C 1, 2, and 3 reactant shutoff valves.	FUEL CELL 1 H_2 and O_2 VALVE and FUEL CELL 2 H_2 and O_2 VALVE (MDC-22)	BATTERY RELAY BUS	None	Switch operated to momentary RESET position only after earth orbit insertion.
	OFF	Normal position of switch.				

MAIN DISPLAY CONSOLE—PANEL 19

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-19 (Cont)	STOP	Remove power from FQR electronic circuits and tape transport mechanism. Tape is locked in place.	FUEL CELL 1 H_2 and O_2 VALVE and FUEL CELL 2 H_2 and O_2 VALVE (MDC-22)	BATTERY RELAY BUS	None	NOTE The total record time for the FQR is 30 minutes. Since there are no dumping capabilities, the FQR must be used conservatively.
	REWIND	Activates FQR tape transport mechanism to rewind tape. Tape moves in reverse direction at 120 IPS.				The rewind function is provided to allow the crewman to back the tape up to the beginning in case a launch hold occurs after the tape has begun to run or inadvertently left in RECORD. MSFN will direct time of rewind.
	VOICE RECORD event indicator		RCDR NON ESS (MDC-22)	DC NON ESS BUS No. 1		
	Gray area	Voice recorder inactive				Visible when not recording or when tape supply is exhausted.
	Striped area	Voice recorder tape is in motion.				Recording in progress.
	F/C VALVES switch		FUEL CELL 1-H_2&O_2 VALVE (MDC-22) FUEL CELL 2-H_2&O_2 VALVE (MDC-22)	Battery Relay Bus	None	Motor switch activated by GSE, provides open side of all F/C reactant valves with holding voltage to prevent inadvertent closing of reactant valves during launch, ascent, and orbital insertion.
	RESET	Momentary switch position actuates motor switch to remove holding voltage from open side of all F/C reactant valves.				NOTE To shut down a fuel cell when holding voltage is still applied to F/C reactant valves, F/C VALVES switch must be reset prior to closing F/C reactant valves.
	(Down)	Normal switch position disconnects power to motor switch.				Once the F/C reactant valves holding voltage is removed, F/C VALVES switch is inoperative.
	SPS LINE HEATER switch		SPS GAUGING MN A MN B (MDC-25)	D-C MAIN BUS A and B	None	The SPS HEATER switch provides power to the SPS electrical strip heaters mounted on the tank feed and engine feed line, brackets, and the injector valve assembly of the engine. The SPS HEATER switch will enable power to 26 electrical system A element strip heaters or will enable power to the 26 electrical system B element strip heaters, which will provide temperature control to the SPS engine compartment, thus the propellants.
	A	Provides power to the 26 electrical system A element strip heaters on the tank feed and engine feed line brackets and the injector valve assembly. Switch would be placed to A if the propellant temperature indicator on panel 20 indicated -40°F (propellant temperature equivalent to +40°F).				
	OFF	Removes power from electrical system A or B element strip heaters. Switch placed to OFF when propellant temperature indicator on panel 20 indicated +80°F (equivalent to propellant temperature of +120°F).				

MAIN DISPLAY CONSOLE—PANEL 19

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-19 (Cont)	B	Provides power to the 26 electrical system B element strip heaters on the tank feed and engine feed line brackets and the injector valve assembly. If switch was not placed to A, would be placed to B when the propellant temperature indicator on panel 20 is at -40°F (equivalent to +40°F propellant temperature).	SPS GAUGING MN A MN B (MDC-25)	D-C MAIN BUS A and B	None	

MAIN DISPLAY CONSOLE—PANEL 19

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20	S-BAND switches		T/C - GROUP 5 (MDC-22)	Flight and postlanding bus	None	
	XPONDER/OFF/ XPONDER PWR AMPL switch	Activates USBE, with or without S-band PA, and PMP circuitry which is required for S-band operations.				
	XPONDER	a. De-energizes holding relay K2 in circuit utilization box which: 1. Applies 3-phase a-c power from the T/C - GROUP 2 AC circuit breaker to the USBE power supply 2. Applies 28-vdc power from the T/C - GROUP 5 circuit breaker to the 20 VDC voltage regulator in the PMP. (Refer to Remarks.)				This position can be selected to conserve power if S-band communications are good enough to permit operations without the S-band PA equipment. The 20 vdc regulator in the PMP supplies power to those circuits in the PMP which are required for S-band emergency voice, emergency key, and UDL operations.
		b. Applies 28-vdc power to the S-BAND ANTENNA switch.				
	OFF	a. Energizes holding relay K2 in circuit utilization box which removes power from circuits described in Function a, XPONDER position. b. Removes 28-vdc power from the S-BAND ANTENNA switch.				
	XPONDER PWR AMPL	a. (Same as for XPONDER position, Function a.) b. (Same as for XPONDER position, Function b.) c. Energizes relay K1 in circuit utilization box which applies 3-phase a-c power from the T/C - SIG COND S-BAND PA AC circuit breaker (MDC-22) to the S-BAND PA.				This position will normally be selected for S-band communications to ensure adequate strength of transmitted signal. After selecting this position, a 90-second delay occurs to allow for warmup before application of B+ and switching of RF signal to the PA.

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	PWR AMPL switch		N/A	S-band PA internal circuitry	None	Supplies ground for S-band PA control relays. Effective only when S-BAND-XPONDER/OFF/XPONDER PWR AMPL switch is in XPONDER PWR AMPL position.
	HIGH	Selects high-power (20-watt) output mode of S-BAND PA.				
	LOW	Selects low-power (5-watt) output mode of S-BAND PA.				
	OSC switch			USBE		Supplies ground for USBE control circuitry.
	PRIM	Selects primary oscillator frequency for USBE transmitter. It is obtained from USBE receiver VCO that is controlled by frequency of received S-band carrier to ensure doppler accuracy.				The primary oscillator is selected for all S-band operations unless USBE receiver has a malfunction.
	SEC	Selects secondary oscillator frequency for USBE transmitter. It is obtained from a crystal-controlled auxiliary oscillator.				The S-BAND—VOICE—RNG/RNG ONLY switch must also be in the off (center) position to enable selection of the secondary oscillator. (The secondary oscillator will be selected automatically when ever the S-BAND—EMER switch is set to VOICE.)
	VOICE group	Used to determine USBE/PMP mode and select data to be transmitted via S-band carrier. Only one of the three switches may be moved from the OFF (center) position at any one time. With all three switches at the OFF (center) position the USBE will transmit real-time voice and PCM data in a PM mode.				Three DP3T switches; one pole of each is used to control PMP circuits; the other pole is used to control USBE circuits. Voice transmission controlled by cobra cable PTT pushbutton when audio centers (MDC-13, -23, -26) POWER switch is at either PTT or VOX. Cobra cable PTT/CW switches must be at PTT.
	RNG/RNG ONLY switch			USBE and PMP internal circuitry (Refer to Remarks.)		Supplies ground returns for USBE and PMP control circuits.
	RNG	Enables PM transmission of received PRN ranging code in addition to real-time voice and PCM data.				Closes a diode switch in the USBE transmitter which allows the PRN ranging signal from the USBE receiver to be modulated in the PM circuit.
	Off (center)	(Refer to VOICE group Function.)				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	RNG ONLY	Enables PM transmission of received PRN ranging code and real-time voice. PCM data is eliminated to reduce bandwidth and increase range.	N/A	USBE and PMP internal circuitry (Refer to Remarks.)	None	Removes power from PCM processing circuits in PMP.
	TAPE switch					One pole of this switch supplies ground for USBE control circuits. The other pole supplies 28-vdc control power obtained from the PMP power supply to PMP control circuits.
	TAPE	Enables FM transmission of real-time voice and stored PCM and/or analog data, as follows: a. Supplies 28-vdc control power to TAPE RECORDER—PLAY switch (MDC-20). b. Selects FM output mode of PMP. c. Selects FM transmission mode of USBE.				Refer to TAPE RECORDER—PLAY switch (MDC-20) Function and Remarks for further discussion of recorded data transmission capabilities.
	Off (center)	(Refer to VOICE group Function.)				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	TV switch		N/A	USBE and PMP internal circuitry (Refer to Remarks.)	None	One pole of this switch supplies ground for USBE control circuits. The other pole supplies 28-vdc control power obtained from the PMP power supply to PMP control circuits.
	TV	Enables FM transmission of real-time video data from the TV camera along with real-time voice and PCM data, as follows: a. Closes diode switch in PMP to pass video signal to FM mixer. b. Selects FM output mode of PMP. c. Selects FM transmission mode of USBE				ON/OFF slide switch on TV camera handle must also be set to ON.
	Off (center)	(Refer to VOICE group Function.)				
	EMERG switch	Enables transmission of voice or CW code over the S-band carrier with nonessential PMP circuitry disabled.	T/C - GROUP 5 (MDC-22)	Flight and postlanding bus and USBE internal circuitry		Switch applies 28-vdc control power to PMP circuits; supplies ground for USBE circuits.
	VOICE	Enables FM transmission of real-time voice only, as follows: a. Activates a-c power control relay in PMP, turning off 28-vdc power supply that supplies power to nonessential PMP circuits. b. Deactivates voice control relay in PMP, allowing voice signal from audio center equipment to bypass PMP voice processing circuits and go directly to USBE. c. Selects auxiliary oscillator and PM transmission mode in USBE. (Voice signal is applied directly to the auxiliary oscillator.)				Voice transmission possible when audio center (MDC-13, -23, or -26) POWER switch is at either PTT or VOX and cobra cable PTT pushbutton pressed, cobra cable PTT/CW switch must be at PTT.

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	Off (center)	Allows normal USBE and PMP operation.	T/C - GROUP 5 (MDC-22)	Flight and postlanding bus and USBE internal circuitry	None	
	KEY	Enables PM transmission of CW code, as follows: a. Activates a-c power control relay in PMP, turning off 28-vdc power supply that supplies power to nonessential PMP circuits. b. Applies 28-vdc power to emergency key circuitry in PMP. c. Selects PM transmission mode in USBE. Either the primary or secondary (auxiliary) oscillator frequency may be used.				Keying of transmitted CW code is accomplished by pressing the PTT pushbutton on cobra cables. (The cobra cable PTT/CW toggle switch must be set to CW.)
	Up-DATA switch			Flight and postlanding bus		
	S-BAND	Activates UDL equipment in S-band mode by applying 28-vdc power to UDL power supply only (UHF/FM receiver portion of UDL equipment is disabled).				Reception of up-data from the MSFN in the S-band mode is via the USBE receiver and PMP up-data discriminator.
	Off (center)	Removes power from UDL equipment.				
	UHF	Activates UDL equipment in UHF mode by applying 28-vdc power to UDL power supply, UHF/FM receiver, and mode switch, all contained in UDL equipment.				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	S-BAND ANTENNA switch	Applies 28-vdc control power to 2-KMC antenna switch, either directly or via the USBE threshold selector (when in AUTO position).	N/A	S-BAND - XPONDER/ OFF/ XPONDER PWR AMPL switch (MDC-20)	None	The 28-vdc power is supplied to the S-BAND ANTENNA switch when the S-BAND—XPONDER/OFF/XPONDER PWR AMPL switch (MDC-20) is in the XPONDER or XPONDER PWR AMPL position. This power comes from the flight and postlanding bus via the T/C—GROUP 5 circuit breaker (MDC-22).
	AUTO	Permits automatic selection of SCIN antenna for S-band transmission and reception.				When in automatic mode, selection is made by a threshold selector in the USBE. Selection is based on strength of received signal.
	UPPER	Selects the upper (-Z) SCIN antenna for S-band transmission and reception.				Upper or lower antenna selected manually. S-BAND ANTENNA meter (MDC-19) indicates received signal strength at selected antenna.
	LOWER	Selects the lower (+Z) SCIN antenna for S-band transmission and reception.				
	VHF—AM controls			VHF/AM transmitter-receiver internal circuitry		
	SQUELCH control					
	Rotated upward or downward as required	Increases or decreases sensitivity of squelch gate. Position 9 most sensitive.				Squelch gate sensitivity determines strength of received signal that is required to permit detected audio to pass to audio center equipment.
	T/R/OFF/REC switch		T/C - GROUP 4 (MDC-22)	Flight and postlanding bus		
	T/R	Applies power to transmitter and receiver circuitry in VHF/AM transmitter-receiver.				In the T/R mode the transmitter operates in standby with filaments lit; B+ is not applied until keying occurs by closing PTT pushbutton on cobra cable when PTT/CW switch is at PTT.
	OFF	Removes power from VHF/AM transmitter-receiver.				
	REC	Applies power to receiver circuitry only in VHF/AM transmitter receiver.				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	RCVR switch		N/A	VHF/AM transmitter-receiver internal circuitry	None	
	1	Selects VHF/AM receive frequency No. 1 (296.8 mc).				Receive 1 frequency is used for simplex communications.
	2	Selects VHF/AM receive frequency No. 2 (259.7 mc).				Receive 2 frequency is used for duplex communications.
	C-BAND switch		T/C - GROUP 5 (MDC-22)	Flight and postlanding bus		
	1 PULSE	Activates C-band transponder in 1-pulse mode, as follows: a. Activates holding relay K3 in circuit utilization box which applies 3-phase a-c power from T/C - GROUP 1 AC circuit breaker (MDC-22) to C-band transponder power supply. b. Applies control to decoder circuit to select 2-pulse mode.				The 1 PULSE mode is selected only when C-band tracking is required by a MSFN station having no capability for 2-pulse operations. One-pulse mode will be responsive to a 1- or 2-pulse MSFN station. One-pulse operation may be changed by UDL to 2-pulse mode.
	Off (center)	Deactivates C-band transponder equipment.				UDL may turn on C-band in 2-pulse mode.
	2 PULSE	Activates C-band transponder in 2-pulse mode, as follows: a. Activates holding relay K3 in circuit utilization box which applies 3-phase a-c power from T/C - GROUP 1 AC circuit breaker (MDC-22) to C-band transponder power supply. b. Applies control to decoder circuit to select 2-pulse mode.				The 2-pulse mode is selected for launch and when C-band tracking is required by MSFN stations having capability for 2-pulse operation. Activation of the C-band transponder in the 2-pulse mode can also be commanded by MSFN by a UDL real-time command.
	VHF-FM switch					The VHF/FM transmitter is the primary means for transmitting PCM TLM, real time or stored. Activation of the VHF/FM transmitter can also be commanded by the MSFN by a UDL real-time command. This command occurs simultaneously with a command to the PCM TLM equipment for high bit-rate PCM.
	ON	Activates VHF/FM transmitter by energizing a relay that applies 3-phase a-c power from the T/C - GROUP 1 AC circuit breaker (MDC-22) to its power supply.				
	OFF	Deactivates VHF/FM transmitter.				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	RECOVERY switches		T/C - GROUP 3 (MDC-22)	Flight and postlanding bus	None	
	VHF-BCN switch					A CW signal is transmitted at 3-second intervals for a period of 2 seconds (2 seconds on, 3 seconds off). Activate following dereefing of main parachutes.
	ON	Applies 28-vdc power to activate VHF recovery beacon.				
	OFF	Removes 28-vdc power from VHF recovery beacon.				
	HF group					
	ON/OFF switch		T/C - GROUP 4 (MDC-22)			
	ON	Activates HF transceiver, as follows: a. Applies 28-vdc power to receiver and oscillator circuits b. Applies 28-vdc control power to transmitter and antenna switching relays. (Refer to Remarks.)				Activate following deployment of HF recovery antenna. The transmitter keying relay controls application of 28-vdc power to transmitter circuits. The antenna switching relay disconnects antenna from receiver input and connects it to transmitter output. This provides for simplex HF operation. These relays will not energize until a ground return path is provided by keying the transmitter or selecting the beacon mode of operation.
	OFF	Deactivates HF transceiver.				
	SSB/BCN/AM switch		N/A			Supplies ground for mode control circuits.
	SSB	Selects SSB mode of HF transceiver.				
	BCN	a. Selects BCN mode of HF transceiver. b. Provides ground to voice recorder power control relay				In the BCN mode, the HF transceiver emits a continuous unmodulated carrier. This mode will also energize the voice recorder power control relay, circumventing the normal VOX control.
	AM	Selects AM mode of HF transceiver.				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	TAPE RECORDER switches			S-BAND—VOICE TAPE switch, (MDC-20)	None	The PMP power supply, when activated, supplies 28 vdc to the S-BAND—VOICE—TAPE switch (MDC). When the TAPE position is selected, this 28 vdc is supplied to the TAPE RECORDER—PLAY switch.
	PLAY switch	Applies 28-vdc control power to appropriate PMP circuits and relays to select DSE outputs for transmission via USBE.	N/A			
	PCM	Selects stored PCM data only.				PCM and NORM perform same function.
	NORM	Selects stored PCM and analog data. No real-time PCM data can be transmitted in this mode.				
	SPEED switch	Applies 28-vdc control power from TAPE RECORDER—FWD/REV switch (FWD or REV position) to DSE control logic.		TAPE RECORDER-FWD/REV switch, FWD or REV position	CT0012X	DSE control logic reverts to 15 ips (NORM) tape speed if power to FWD/REV switch is lost.
	HIGH	Selects high tape speed (120 IPS).				Used during DSE tape rewind and for playback of recorded LBR used for recording and playback of HBR.
	Norm (center)	Selects normal tape speed (15 IPS).				
	LOW	Selects low tape speed (3.75 IPS).				Used while recording LBR only. DSE cannot dump in LOW.
	RECORD/PLAY switch	Applies 28-vdc control power to DSE control logic.	T/C - GROUP 5 (MDC-22)	Flight and postlanding bus		
	RECORD	Activates DSE record electronics.				
	Off (center)	None				DSE control logic requires the switch to be placed at other than OFF and FWD or REV selected prior to tape motion.
	PLAY	Activates DSE playback electronics.				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	FWD/REV switch		T/C - GROUP 5 (MDC-22)	Flight and postlanding bus	None	DSE control logic requires this switch to be placed at other than OFF and RECORD or PLAY selected prior to tape motion.
	FWD	Applies 28-vdc control power to: a. DSE control logic to activate tape transport in forward direction. b. TAPE RECORDER—SPEED switch.				
	Off (center)	Removes 28 vdc from control logic and SPEED switches.				
	REV	Applies 28-vdc control power to: a. DSE control logic to activate tape transport in reverse direction b. TAPE RECORDER—SPEED switch.				This position used for rewind and also during reverse data dump.
	PWR switches					
	SCE switch					This switch set to ON prior to launch and should remain on throughout entire mission.
	ON	Activates "latch" coil of relay in SCE, applying 3-phase a-c power from SIG COND S-BAND PA AC circuit breaker (MDC-22) to SCE power supply.				
	OFF	Activates "unlatch" coil of relay in SCE, removing 3-phase a-c power.				
	PMP switch					
	ON	Allows 3-phase a-c power from T/C - GROUP 2 AC circuit breaker to be applied to PMP 28 vdc power supply.				
	OFF	Activates relay in PMP to remove 3-phase a-c power from PMP 28 vdc power supply.				OFF position causes loss of normal voice, TV, ranging and S-band PCM TLM.

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	TLM INPUTS switches PCM switch		N/A	PCM/TLM Equipment and TAPE RECORDER-RECORD/PLAY switch	None	Supplies 28-vdc control power from TAPE RECORDER—RECORD/PLAY switch (RECORD position) to the DSE control logic and ground for programmer control circuitry in the PCM/TLM equipment.
	HIGH	a. Selects wide-band PCM TLM data mode (51.2 KBPS bit-rate) in PCM/TLM equipment. b. Selects normal-speed assurance mode of DSE.				The low (1.6 KBS) PCM bit-rate cannot also be commanded by the MSFN by an UDL real-time-command in this position.
	LOW	a. Selects narrow-band PCM TLM data mode (1.6 KBPS bit-rate) in PCM/TLM equipment. b. Selects low-speed assurance mode in DSE.				UDL command from MSFN may change bit rate to high (51.2 kbs). Switch will, however, remain in LOW.
	BIOMED switch		BIOMED COMM—MN B (MDC-25) & T/C - GROUP 5 (MDC-22)	D-C main bus B & flight & postlanding bus (Refer to Remarks.)		Supplies 28-vdc power from BIOMED COMM—MN B circuit breaker to physiological amplifier of selected astronaut, and supplied 28 vdc from T/C - GROUP 5 circuit breaker to control transmission of proper PCM signal to indicate position of switch to MSFN.
	1	Selects operational biomedical data from command pilot for transmission or storage in DSE.				
	2	Selects operational biomedical data from senior pilot for transmission or storage in DSE.				
	3	Selects operational biomedical data from pilot for transmission or storage in DSE.				
	VHF ANTENNA switch	Applies 28-vdc control power to VHF antenna switch latching relay circuits.	T/C - GROUP 5 (MDC-22)	Flight and postlanding bus		
	RECOVERY	Connects VHF recovery antenna No. 2 to VHF multiplexer.				This position not used until after parachute deployment and disreefing.
	UPPER	Connects VHF portion of SCIN antenna on the -Z axis to VHF multiplexer.				Upper and lower antennas manually selected to permit most advantageous reception and transmission of VHF-AM communications and VHF-FM telemetry.

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	LOWER	Connects VHF portion of SCIN antenna on the +Z axis to VHF multiplexer	T/C - GROUP 5 (MDC-22)	Flight and postlanding bus	None	Lower antenna will burn off on entry.
	He TANK indicators		INSTRU-MENTS— ESS MN A MN B (MDC-22)	D-C main buses A and B		Each indicator consists of d-Arsonval-type meter with fixed dial and movable pointer. Pointer movement is vertical as observed from crew couch.
	PRESS	Indicates SPS helium storage tank pressure when SPS TANK PRESS switch (MDC-20) is in the He position.			SP0001P (He tank pressure)	
	N_2 TK PRESS	Indicates SPS gaseous nitrogen storage tank pressure of engine pneumatic valve control system A and B when SPS TANK PRESS switch (MDC-20) is in the N_2 A or N_2 B position, respectively.			SP0600P (N_2 A tank pressure) SP0601P (N_2 B tank pressure)	Pressure indicator display is in psia, and range is 0 to 5000 psia.
	PRESSURE indicators					Four indicators are identical in operation. Each consists of d'Arsonval-type meter with fixed dial and movable pointer. Pointer movement is vertical as observed from crew couch.
	FUEL	Provides constant monitoring of SPS fuel tank regulated helium pressure.			SP0006P (fuel tank pressure)	
	OX	Provides constant monitoring of SPS oxidizer tank regulated helium pressure.			SP0003P (oxidizer tank pressure)	Each indicator is calibrated in psia with range of 0 to 300 psia.
	ENG INLET group					
	FUEL	Provides constant monitoring of SPS fuel pressure at the engine main propellant valves.			SP0010P (fuel line engine inlet)	
	OX	Provides constant monitoring of SPS oxidizer pressure at the engine main propellant valves.			SP0009P (oxidizer line engine inlet)	
	TEMPERATURE indicator	Propellant temperature is monitored in the engine fuel feed line plumbing at the gimbal ring of the engine. The indicator displays the measurement as noted in the Remarks column:			SP0048T (fuel line engine inlet)	Same indicator as helium tank press.
	ENGINE INLET PROPELLANT TEMP					Propellant temperature is indicated in degrees Fahrenheit. The range of the indicator is -100° to +200°F. When the indicator reads -40°F (equivalent propellant temperature of +40°F) the SPS HEATER switch is placed to position A or B. When the indicator reads +80°F (equivalent propellant temperature +120°F) the SPS HEATER switch is placed to OFF. The indicator has red line markings at +80°F and -40°F.

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	SPS ENGINE INJECT VALVE indicators		T/C - GROUP 5 (MDC-22)	Flight and postlanding bus	Valve position: A-1 SP0022H A-2 SP0023H B-3 SP0024H B-4 SP0025H **NOTE** Separate pickoffs for display and T/M signals.	Four identical indicators. Each is needle-movement-type meter with inputs supplied by position potentiometer located on valve actuator arm. Left needle deflection indicates CLOSE; right deflection indicates OPEN.
	1 (2, 3, 4)	Provides visual indication of SPS engine main propellant valves open or closed condition (one oxidizer and one fuel valve per pair and one indicator for each pair of valves).				
	SPS TANK PRESS switch		N/A	N/A	None	Three-position toggle switch used to select SPS helium or nitrogen tank pressure input to He TANK PRESS or N_2 TK PRESS indicator on MDC-20.
	He	Connects SPS helium storage tank pressure output to He TANK PRESS indicator (MDC-20).				
	N_2A	Connects SPS gaseous nitrogen storage tank pressure output of engine control valve system A to TK PRESS indicator (MDC-20).				
	N_2B	Connects SPS gaseous nitrogen storage tank pressure output of engine control valve system B to TK PRESS indicator (MDC-20).				
	SPS HELIUM switches (two, left hand and right hand)	Two operationally identical switches.	SPS-He VALVE MN A MN B (MDC-25)	D-C main buses A and B		Each switch is a three-way toggle switch. With this switch in the AUTO position, valve opening and closing is controlled automatically by G&N system and/or SCS. Complete manual control of valve position can be maintained by utilizing ON - OFF switch positions. D-C main buses A and B provide power to helium pressurizing systems A and B, respectively.
	AUTO	Provides for automatic application and removal of power from helium isolation valve solenoid.				
	OFF	Removes power from helium isolation valve solenoid.				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	ON	Applies power to helium isolation valve solenoid.	SPS-He VALVE MN A MN B (MDC-25)	D-C main buses A and B	None	Each switch controls helium flow to one of two redundant pressure regulator assemblies.
	SPS HELIUM event indicators (two)	Striped-line display indicates open conditions of valve controlled by switch located directly below indicator. Gray display indicates closed condition.				Two identical indicators. Each is two-condition device with striped-line display controlled by solenoid action and gray display controlled by permanent magnet action.
	QUANTITY display windows		SPS—GAUGING MN A MN B AC 1 AC 2 (MDC-25)	400-cps a-c input from quantity gauging system control unit		Digital display in oxidizer quantity (OXID) window and fuel quantity (FUEL) window represent remaining tank quantities and are marked X20 and X10, respectively. These markings facilitate determination of correct remaining propellant quantities. Since desired oxidizer/fuel ratio is 2:1, digital display in both windows should be identical when propellant ratio is correct.
	OXID	Digital counter display window indicating total oxidizer tank quantity remaining (in pounds times 20).				
	FUEL	Digital counter display window indicating total fuel tank quantity remaining (in pounds times 10).				
	UNBALANCE indicator	Indicates unbalance of remaining SPS propellants.				Indicator is graduated into six major divisions, each representing 100 pounds of propellant unbalalnce. Upper half indicates increased oxidizer flow required; lower half, decreased flow. Indicator needle at 0 (horizontal position) indicates desired propellant ratio.
	TEST/AUTO/TEST switch			D-C and a-c test inputs from quantity gauging system control unit		Three-position toggle switch, spring-loaded to AUTO position. TEST position allows for visual check of proper electrical and mechanical operation of propellant indicating devices. In addition to indicator checks, TEST position may be used to aid in isolating a malfunction in either primary or auxiliary propellant quantity sensing system.
	TEST (up)	Applies simulated input to propellant quantity gauging and utiliziation system control unit, causing digital display counters and UNBALANCE indicator to function for test check.				
	AUTO	Normal operating position.				
	TEST (down)	Applies simulated input for same purposes as TEST (up) position, except in reverse polarity.				Test rate for OXID digits is approximately 3 digits/second; FUEL 1.5 digits/second.

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	OXID FLOW switch		SPS–GAUGING MN A MN B AC 1 AC 2 (MDC-25)	D-C and a-c test inputs from quantity gauging system control unit	None	Three-position toggle switch used as required to regulate oxidizer flow rate to maintain proper propellant utilization. Remaining propellant SPS unbalance may be determined by monitoring UNBALANCE meter or by calculations, utilizing information displayed in OXID and FUEL quantity digital display windows. Maximum PU valve response time from increase to decrease position in 3.5 seconds.
	INCREASE	Supplied increased signal to propellant utilization valve PRI or SEC motor selected by VALVE switch. INCREASE position —46.65 lb/sec.				
	NORM	Supplies normal signal to propellant utilization valve PRI or SEC motor selected by VALVE switch. NORM position —. 45.27 lb/sec at 70°F and 168±4 PSIG.				
	DECREASE	Supplies decreased signal to propellant utilization valve PRI or SEC motor selected by VALVE switch. DECREASE position – 43.87 lb/sec.				
	OXID FLOW event indicators					Two identical indicators. Each is a two-condition device controlled by servo action. When propellant utilization valve is in normal oxidizer flow rate position, gray display will appear in both indicator windows.
	Upper indicator	Striped-line display indicates propellant utilization valve is in increased oxidizer flow rate position; gray display indicates it is not.				
	Lower indicator	Striped-line display indicates propellant utilization valve is in decreased oxidizer flow rate position; gray display indicates it is not.				
	VALVE switch			D-C input from quantity gauging system		Two-position toggle switch which provides manual selection of primary or secondary gates in propellant utilization valve. The PU valve secondary gate is capable of adjusting for increased, decreased, or normal oxidizer flow area regardless of a primary gate failure in any position.
	PRI	Applies power to propellant utilization valve primary servo amplifier.				
	SEC	Applies power to propellant utilization valve secondary servo amplifier.				

MAIN DISPLAY CONSOLE—PANEL 20

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-20 (Cont)	SENSOR switch		SPS—GAUGING MN A MN B AC 1 AC 2 (MDC-25)	400-cps a-c input from quantity gauging system control unit	None	Three-position toggle switch, with switch in NORM position during normal operation. This switch, when used in conjunction with TEST switch (MDC-20), can be useful in isolating a malfunction in propellant quantity sensing system.
	PRI	Applies output from primary propellant quantity sensing system to propellant quantity indicating and warning devices.				
	NORM	Applies outputs from both primary and auxiliary sensing systems to propellant quantity warning devices and output from primary propellant sensing system to propellant quantity indicating devices.				
	AUX	Applies output from auxiliary propellant sensing system to propellant quantity indicating and warning devices.				
MDC-21	SUIT COMPRESSOR selector switch				None	Only one suit compressor is normally operated at a time, with second compressor for standby redundancy. Output of each compressor is as follows: a. Prelaunch mode - 32.7 cfm and ΔP of 0.7 to 0.9 psi. b. Normal mode - 35 cfm and ΔP of 0.3 to 0.4 psi. c. Emergency mode - 33.6 cfm and ΔP of 0.2 to 0.3 psi.
	COMPR 1					
	AC 2	Applies a-c power to motor of suit compressor No. 1 from bus No. 2.	ECS-SUIT COM-PRESSORS AC 2 ϕA ϕB ϕC (MDC-22)	A-C bus No. 2		
	AC 1	Applies a-c power to motor of suit compressor No. 1 from bus No. 1.	ECS-SUIT COM-PRESSORS AC 1 ϕA ϕB ϕC (MDC-22)	A-C bus No. 1		
	OFF	Removes a-c power from motors of suit compressors.				
	COMPR 2					
	AC 1	Applies a-c power to motor of suit compressor No. 2 from bus No. 1.				

MAIN DISPLAY CONSOLE—PANELS 20 AND 21

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-21 (Cont)	AC 1/1 AC 2/2	Applies a-c power to the following motors: a. NO. 1 suit compressor from bus NO. 1. b. NO. 2 suit compressor from bus NO. 2.	ECS-SUIT COM-PRESSORS AC 1 ϕ A ϕ B ϕ C and AC 2 ϕ A ϕ B ϕ C (MDC-22)	A-C buses No. 1 and 2	None	Switch position permits simultaneous operation of both suit compressors during periods of high suit heat loads.
	ECS GLYCOL pump selector switch					Only one water-glycol pump can be operated at a time, with second pump for standby redundancy.
	PUMP 1					
	AC 2	Applies a-c power to motor of No. 1 water-glycol pump from bus No. 2	ECS-GLYCOL PUMPS- AC 2 ϕ A ϕ B ϕ C (MDC-22)	A-C bus No. 2		Pump design specification figures are 200 lb/hr flow at a pressure rise of 29.5 psi, with a pump inlet of 7.5±1.5 psig at 100°F (max). Actual flow varies inversely with system pressure drop.
	AC 1	Applies a-c power to motor of No. 1 water-glycol pump from bus No. 1	ECS-GLYCOL PUMPS- AC 1 ϕ A ϕ B ϕ C (MDC-22)	A-C bus No. 1		
	OFF	Removes a-c power from motors of water-glycol pumps.				
	PUMP 2					
	AC 1	Applies a-c power to motor of No. 2 water-glycol pump from bus No. 1				

MAIN DISPLAY CONSOLE—PANEL 21

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-21 (Cont)	AC 2	Applies a-c power to motor of No. 2 water-glycol pump from bus No. 2.	ECS-GLYCOL PUMPS-AC 2 ϕ A ϕ B ϕ C (MDC-22)	A-C bus No. 2	None	
	CABIN AIR FAN switches					
	1 switch					
	ON	Applies a-c power to motor of No. 1 cabin air fan, directing airflow through cabin heat exchanger.	ECS-CABIN AIR FAN 1 ϕ A ϕ B ϕ C (MDC-22)	A-C bus No. 1		Cabin air fans No. 1 and No. 2 are operated simultaneously to obtain adequate cooling. Output of fan is as follows: a. Prelaunch mode - 171.45 cfm. b. Normal mode - 170.67 cfm. c. Emergency mode - 0 cfm (fan off).
	OFF	Removes a-c power from motor of No. 1 cabin air fan.				In event of malfunction, fan No. 1 is turned off and fan closure cover manually installed over inlet to prevent backflow.
	2 switch					
	ON	Applies a-c power to motor of No. 2 cabin air fan, directing airflow through cabin heat exchanger.	ECS-CABIN AIR FAN 2 ϕ A ϕ B ϕ C (MDC-22)	A-C bus No. 2		Cabin air fans No. 1 and No. 2 are operated simultaneously to obtain adequate cooling. Output of fan is as follows: a. Prelaunch mode - 171.45 cfm. b. Normal mode - 170.67 cfm. c. Emergency mode - 0 cfm (fan off).
	OFF	Removes a-c power from motor of No. 2 cabin air fan.				In event of malfunction, fan No. 2 is shut down and fan closure cover is manually installed over inlet to prevent backflow.

MAIN DISPLAY CONSOLE—PANEL 21

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-21 (Cont)	POT H_2O HEATER switch					
	MN A	Applies d-c power to potable water heater from main bus A.	ECS-POT H_2O HTR MN A (MDC-22)	D-C main bus A	None	Two heating elements totaling 45 watts (20 and 25 watts each) are mounted at separate locations inside the food preparation water unit. Operating simultaneously, they heat the water from an inlet temperature of 60°F to 154±4°F. The maximum time to heat 1.9 lb of water (reservoir capacity) is approximately 2 hours.
	OFF	Removes d-c power from potable water heater.				
	MN B	Applies d-c power to potable water heater from main bus B.	ECS-POT H_2O HTR MN B (MDC-22)	D-C main bus B		
	ECS RADIATOR switches					Under most normal conditions all space radiator valves are placed in the open position. Exceptions to this are during ground checkout and ascent. The only other time a valve is closed is when a radiator circuit is isolated in event of leakage. Space radiator valves, which must be in the full open or full closed position, require 17 seconds (max) for full travel.
	Group 1					
	A (on)	Applies a-c power to actuator of space radiator isolation valve 1A to place valve in open position, permitting water-glycol flow to the six-tube circuit of the radiator located in S/M sector V (-Y axis).	ECS-RAD VALVE AC 1 1A (MDC-22)	A-C bus No. 1 ØA		
	OFF	Applies a-c power to actuator of space radiator isolation valve 1A to place valve in closed position, cutting off water-glycol flow to the radiator tube circuit.				
	B (on)	Applies a-c power to actuator of space radiator isolation valve 1B to place valve in open position, permitting water-glycol flow to the four-tube circuit of the radiator located in S/M sector V (-Y axis).	ECS-RAD VALVE AC 2 1B (MDC-22)	A-C bus No. 2 ØA		
	OFF	Applies a-c power to actuator of space radiator isolation valve 1B to place valve in closed position, cutting off water-glycol flow to the radiator tube circuit.				

MAIN DISPLAY CONSOLE—PANEL 21

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-21 (Cont)	Group 2				None	
	A (on)	Applies a-c power to actuator of space radiator isolation valve 2A to place valve in open position, permitting water-glycol flow to the six-tube circuit of the radiator located in S/M sector II (+Y axis).	ECS-RAD VALVE AC 2 2A (MDC-22)	A-C bus No. 2 ϕC		
	OFF	Applies a-c power to actuator of space radiator isolation valve 2A to place valve in closed position, cutting off water-glycol flow to the radiator tube circuit.				
	B (on)	Applies a-c power to actuator of space radiator isolation valve 2B to place valve in open position, permitting water-glycol flow to the four-tube circuit of the radiator located in S/M sector II (+Y axis).	ECS-RAD VALVE AC 1 2B (MDC-22)	A-C bus No. 1 ϕB		
	OFF	Applies a-c power to actuator of space radiator isolation valve 2B to place valve in closed position, cutting off water-glycol flow to the radiator tube circuit.				
	RCS HEATERS circuit breakers		N/A	+28 vdc		Thermal, push-pull manual reset-type circuit breakers with the amperage rating of each denoted by a white placard.
	A MN B (20 amp)	Applies power from d-c main bus B to the following: a. SM RCS quad A package heater b. Normally open contacts of relay activated by CM RCS HTRS switch (RHFEB-200) for CM RCS system B engine injector valve direct coils utilized for engine preheating.				

MAIN DISPLAY CONSOLE—PANEL 21

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-21 (Cont)	B MN A (20 amp)	Applies power from d-c main bus A to the following: a. SM RCS quad B package heater b. Normally open contacts of relay activated by CM RCS HTRS switch (RHFEB-200) for CM RCS system A engine injector valve direct coils utilized for engine preheating.	N/A	+28 vdc	None	
	C MN B (5 amp)	Applies power from d-c main bus B to package heater in S/M RCS quad C.				
	D MN A (5 amp)	Applies power from d-c main bus A to package heater in S/M RCS quad D.				
	SNSR UNIT circuit breakers					
	DC BUS group					
	A (5 amp)	Applies d-c power from battery relay bus through MAIN BUS A-RESET switch to d-c main bus A undervoltage sensing unit.				Sensing unit is inoperative when MAIN BUS A-RESET switch is in the OFF position.
	B (5 amp)	Applies d-c power from battery relay bus through MAIN BUS B-RESET switch to d-c main bus B undervoltage sensing unit.				Sensing unit is inoperative when MAIN BUS B-RESET switch is in the OFF position.
	AC BUS group					
	1 (5 amp)	Applies d-c power from battery relay bus through AC BUS 1-RESET switch to a-c bus No. 1 over-undervoltage and overload sensing unit.				Sensing unit is inoperative when AC BUS 1-RESET switch is in the OFF position.
	2 (5 amp)	Applies d-c power from battery relay bus through AC BUS 2-RESET switch to a-c bus No. 2 over-undervoltage and overload sensing unit.				Sensing unit is inoperative when AC BUS 2-RESET switch is in the OFF position.

MAIN DISPLAY CONSOLE—PANEL 21

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22	FUEL CELL PUMP switches				None	Two parallel pump motors are associated with each fuel cell. One motor drives the H_2 circulating pump and the water separation centrifuge. The other motor drives the glycol circulating pump. Switches are located between bus and c/b's.
	Switch 1	Is capable of selecting a-c bus No. 1, a-c bus No. 2, or off for fuel cell No. 1 pump motors.	FUEL CELL 1 - CIR & SEP MOTORS (MDC-22)			
	AC 1	Controls 3ϕ a-c power from a-c bus No. 1 to fuel cell No. 1 pump motors.		A-C bus No. 1		
	OFF	Disconnects 3ϕ a-c power from pump motors.				
	AC 2	Controls 3ϕ a-c power from a-c bus No. 2 to fuel cell No. 1 pump motors.		A-C bus No. 2		
	Switch 2	Is capable of selecting a-c bus No. 1, a-c bus No. 2, or off for fuel cell No. 2 pump motors.	FUEL CELL 2 - CIR & SEP MOTORS (MDC-22)			
	AC 1	Controls 3ϕ a-c power from a-c bus No. 1 to fuel cell No. 2 pump motors.		A-C bus No. 1		
	OFF	Disconnect 3ϕ a-c power from pump motors.				
	AC 2	Controls 3ϕ a-c power from a-c bus No. 2 to fuel cell No. 2 pump motors.		A-C bus No. 2		
	Switch 3	Is capable of selecting a-c bus No. 1, a-c bus No. 2, or off for fuel cell No. 3 pump motors.	FUEL CELL 3 - CIR & SEP MOTORS (MDC-22)			
	AC 1	Controls 3ϕ a-c power from a-c bus No. 1 to fuel cell No. 3 pump motors.		A-C bus No. 1		
	OFF	Disconnects 3ϕ a-c power from pump motors.				
	AC 2	Controls 3ϕ a-c power from a-c bus No. 2 to fuel cell No. 3 pump motors.		A-C bus No. 2		

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	MAIN BUS TIE switches					
	BAT A & C/AUTO/OFF switch		BATTERY CHARGER-BAT A CHGE (MDC-22)	Battery bus A		
	BAT A & C	Allows manual control of bus tie motor switch to: a. Connect battery bus A to d-c main bus A and battery C to d-c main bus B. b. Disconnect BATTERY CHARGER selector switch (MDC-18) from battery bus A and battery C.				Actuates motor-driven switch which accomplishes actual switching function.
	AUTO	In the event of an LES abort or normal CSM separation, this position allows the C/M RCS control box to control bus tie motor switch connecting battery bus A to d-c main bus A and battery C to d-c main bus B and disconnects BATTERY CHARGER selector switch (MDC-18).				
	OFF	Allows manual control of motor switch to: a. Disconnect battery bus A from d-c main bus A and battery C from d-c main bus B. b. Connects BATTERY CHARGER selector switch (MDC-18) to battery bus A and battery C.				
	BAT B & C/AUTO/OFF switch		BATTERY CHARGER-BAT B CHGE (MDC-22)	Battery bus B		
	BAT B & C	Allows manual control of bus tie motor switch to: a. Connect battery bus B to d-c main bus B and Battery C to d-c main bus A. b. Disconnects BATTERY CHARGER selector switch (MDC-18) from battery bus B and battery C.				Actuates motor-driven switch which accomplishes actual switching function.

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	AUTO	In the event of an LES abort or normal CSM separation, this position allows the C/M RCS control box to control bus tie motor switch connecting battery bus B to d-c main bus B and battery C to d-c main bus A, and disconnects BATTERY CHARGER selector switch (MDC-18).	BATTERY CHARGER-BAT B CHGE (MDC-22)	Battery bus B	None	
	OFF	Allows manual control of motor switch to: a. Disconnects battery bus B from d-c main bus B and battery C from d-c main bus A. b. Connect BATTERY CHARGER selector switch (MDC-18) to battery bus B and battery C.				
	BAT CHGR switch	Provides means of selecting a-c bus No. 1 or a-c bus No. 2 for battery charger a-c power source.	BATTERY CHARGER-AC PWR (MDC-22)			Switch works with BATTERY CHARGER selector switch (MDC-18) to enable battery charger operation.
	AC 1	Controls 3ϕ a-c power from a-c bus No. 1 to battery charger during battery charging operation.		A-C bus No. 1		
	AC 2	Controls 3ϕ a-c power from a-c bus No. 2 to battery charger during battery charging operation.		A-C bus No. 2		
	NON ESS BUS switch					Equipment associated with this switch is: a. Scientific equipment bay No. 1 } NON ESS BUS NO. 2 b. Scientific equipment bay No. 2 } NON ESS BUS NO. 2 c. Scientific equipment hatch } NON ESS BUS NO. 2 d. Flight qualification recorder } NON ESS BUS NO. 1 e. Nonessential instrumentation } NON ESS BUS NO. 1 f. Voice recorder flag } NON ESS BUS NO. 1
	MN A	Connects nonessential bus No. 1 and No. 2 to d-c main bus A.		D-C main bus A		
	OFF	Disconnects nonessential buses from d-c main buses				
	MN B	Connects nonessential bus No. 1 and No. 2 to d-c main bus B.		D-C main bus B		

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	G&N VIEWER switch	Provides means of selecting a-c bus No. 1 or a-c bus No. 2 for LEB panel brightness control, SCT and SXT reticle lights and signal conditioner.	VIEWER AC 1 and AC 2 (MDC-22)		None	
	AC 1	Selects 3φ a-c power from a-c bus No. 1		A-C bus No. 1		
	AC 2	Selects 3φ a-c power from a-c bus No. 2		A-C bus No. 2		
	TELCOM switches					
	ESS switch	Provides control of 3φ a-c power to the TELECOMMUNICATIONS-GROUP - 2 and SIG CONDS-BAND PA (MDC-22) telecommunications (T/C) equipment which is essential to safety of flight.				Equipment associated with this switch is: a. Unified S-band equipment b. Premodulation processor c. Signal conditioning equipment d. S-band power amplifier.
	AC 1	Controls 3φ a-c power from a-c bus No. 1 to essential T/C equipment controlled by TELECOMMUNICATIONS - GROUP - 2 and SIG COND S-BAND PA (MDC-22).	None	A-C bus No. 1		
	OFF	Disconnects 3φ a-c power from essential T/C equipment.		A-C bus No. 2		
	AC 2	Controls 3φ a-c power from a-c bus No. 2 to essential T/C equipment.				
	NONESS switch	Provides control of 3φ a-c power to TELECOMMUNICATIONS-GROUP - 1 and PCM TLM (MDC-22) telecommunications (T/C) equipment which is not essential to safety of flight.				Equipment associated with this switch is: a. PCM telemetry b. VHF/FM transmitter c. C-band transponder d. Data storage equipment e. Flight qualification recorder f. Voice recorder
	AC 1	Controls 3φ a-c power from a-c bus No. 1 to nonessential T/C equipment.				
	OFF	Disconnects 3φ a-c power from nonessential T/C equipment.				
	AC 2	Controls 3φ a-c power from a-c bus No. 2 to nonessential T/C equipment.		A-C bus No. 2		

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	FUEL CELL 1 circuit breaker		N/A		None	
	CIR & SEP MOTORS (3 amp)	a. Applies power from a-c bus No. 1 or 2 through FUEL CELL PUMP - 1 switch to C/B, and to circulator and separator pump motors in fuel cell 1. b. Provides ØA power to pH sensor probe.		115 vac 400 cps 3Ø		
	H_2 & O_2 VALVE (10 amp)	Applies d-c power from battery relay bus to FUEL CELL 1 - REACTANTS switch (MDC-18), and to F/C VALVES-RESET switch (MDC-19).		+28 vdc		Opened after operation of F/C VALVES-RESET switch (MDC-19).
	BUS CONT (10 amp)	a. Applies d-c power from battery relay bus to F/C 1 bus disconnect control through FUEL CELL 1 - MAIN BUS A and MAIN BUS B switches (MDC-18). b. Provides power to reactants event indicator.				
	PURGE (5 amp)	Applies power from d-c main buses A and B to F/C 1 purge valve control through FUEL CELL 1 - O_2 PURGE - H_2 PURGE switch (MDC-18), and to H_2 PURGE LINE HTR switch (MDC-15).				H_2 PURGE LINE HTR switch (MDC-15) positioned to ON 30 minutes prior to an H_2 purge operation.
	FUEL CELL 2 circuit breakers					
	CIR & SEP MOTORS (3 amp)	a. Applies power from a-c bus No. 1 or 2 through FUEL CELL PUMP - 2 switch to C/B, and to circulator and separator pump motors in fuel cell 2. b. Provides ØA power to pH sensor probe.		115 vac 400 cps 3Ø		

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	H_2 & O_2 VALVE (10 amp)	Applies d-c power from battery relay bus to FUEL CELL 2 - REACTANTS switch (MDC-18), and to F/C VALVES-RESET switch (MDC-19).	N/A	+28 vdc	None	Opened after operation of F/C VALVES-RESET switch (MDC-19).
	BUS CONT (10 amp)	a. Applies d-c power from battery relay bus to F/C 2 bus disconnect control through FUEL CELL 2 - MAIN BUS A and MAIN BUS B switches (MDC-18). b. Provides power to reactants event indicator.				
	PURGE (5 amp)	Applies power from d-c main buses A and B to F/C 2 purge valve control through FUEL CELL 2 - O_2 PURGE - H_2 PURGE switch (MDC-18), and to H_2 PURGE LINE HTR switch (MDC-15).				H_2 PURGE LINE HTR switch (MDC-15) positioned ON 30 minutes prior to an H_2 purge operation.
	FUEL CELL 3 circuit breakers					
	CIR & SEP MOTORS (3 amp)	a. Applies power from a-c bus No. 1 or 2 through FUEL CELL PUMP - 3 switch to C/B, and to circulator and separator pump motors in fuel cell 3. b. Provides ØA power to pH sensor probe.		115 vac 400 cps 3Ø		
	H_2 & O_2 VALVE (10 amp)	Applies d-c power from battery relay bus to FUEL CELL 3 - REACTANTS switch (MDC-18).		+28 vdc		Opened after operation of F/C VALVES-RESET switch (MDC-19).

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	BUS CONT (10 amp)	a. Applies d-c power from battery relay bus to F/C 3 bus disconnect control through FUEL CELL 3 - MAIN BUS A and MAIN BUS B switches (MDC-18) b. Provides power to reactants event indicator.	N/A	+28 vdc	None	
	PURGE (5 amp)	Applies power from d-c main buses A and B to F/C purge valve control through FUEL CELL 3 - O_2 PURGE - H_2 PURGE switch (MDC-18).				
	INVERTER CONTROL circuit breakers					
	1 (10 amp)	Applies d-c power from battery relay bus to AC INVERTER 1 and AC INVERTER 3 switches (MDC-18).				
	2 (10 amp)	Applies d-c power from battery relay bus to AC INVERTER 2 and AC INVERTER 1 switches (MDC-18).				
	3 (10 amp)	Applies d-c power from battery relay bus to AC INVERTER 2 and AC INVERTER 3 switches (MDC-18).				
	MASTER EVENT SEQ CONT circuit breakers					
	ARM group					
	BAT A (5 amp)	Applies d-c power from battery bus A to the following switches: a. MESC-LOGIC ARM switches 1 and 2 (MDC-25) b. MASTER EVENT SEQ CONT-PYRO ARM switches 1 and 2 (MDC-24) c. LES MOTOR FIRE switch (MDC-5) d. CANARD DEPLOY switch (MDC-5)				

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)		e. ADAPT SEP switch (MDC-5) f. REACTION CONTROL SYSTEM - C/M PRESS switch (MDC-16) g. REACTION CONTROL SYSTEM - CMD/ON/OFF switch (MDC-16) h. C/M - S/M SEP switches 1 and 2 (MDC-15).	N/A	+28 vdc	None	
	BAT B (5 amp)	Applies d-c power from battery bus B to the following switches: a. MESC-LOGIC ARM switches 1 and 2 (MDC-25) b. MASTER EVENT SEQ CONT - PYRO ARM switches 1 and 2 (MDC-24) c. LES MOTOR FIRE switch (MDC-5) d. CANARD DEPLOY switch (MDC-5) e. ADAPT SEP switch (MDC-5) f. REACTION CONTROL SYSTEM - C/M PRESS switch (MDC-16) g. REACTION CONTROL SYSTEM - CMD/ON/OFF switch (MDC-16) h. C/M - S/M SEP switches 1 and 2 (MDC-15).				
	LOGIC group BAT A (15 amp)	a. Applies d-c power from battery bus A to the logic A bus in the master event sequence controller when the MESC - LOGIC ARM switches 1 and 2 (MDC-25) are in the LOGIC ARM position. The logic bus in turn provides power to the ABORT SYSTEM—MODE switches 1 and 2 and, during LES aborts, to the ABORT SYSTEM—OX DUMP switch.				

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)		b. Arms the abort switch in commanders translation control c. Provides part of the power to the LES and SPS abort circuitry.	N/A	+28 vdc	None	
	BAT B (15 amp)	a. Applies d-c power from battery bus B to the logic B bus in the master event sequence controller when the MESC - LOGIC ARM switches 1 and 2 (MDC-25) are in the LOGIC ARM position. The logic bus in turn provides power to the ABORT SYSTEM—MODE switches 1 and 2 and,, during LES aborts provides power to the ABORT SYSTEM—OX DUMP switch. b. Arms the abort switch in commanders translation control. c. Provides part of the power for the LES and SPS abort circuitry.				
	DC SNSR SIG circuit breakers					Unit receives power from battery relay bus through circuit breakers on MDC-21.
	MN A (5 amp)	Applies power from d-c main bus A to d-c undervoltage sensing unit and DC INDICATORS switch.				
	MN B (5 amp)	Applies power from d-c main bus B to d-c undervoltage sensing unit and DC INDICATORS switch.				
	CENTRAL TIMING SYS circuit breakers		None			The CTE contains two power supplies for redundancy, No. 1 and No. 2. If either one fails, the other will provide sufficient power for the CTE.
	MN A (5 amp)	Applies 28-vdc power to CTE power supply No. 1		D-C main bus A		
	MN B (5 amp)	Applies 28-vdc power to CTE power supply No. 2		D-C main bus B		
	SCIEN EQUIP circuit breakers					
	SEB-1 (20 amp)	Applies power from non-essential bus to scientific equipment outlet in component A.		NON ESS BUS NO. 2 +28 vdc		Compartment A scientific equipment outlet is located in the LEB. (See figure 4-13.)

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	SEB-2 (20 amp)	Applies power from non-essential bus to scientific equipment outlet in compartment B. (Proposed)	None	NON ESS BUS NO. 2 +28 vdc	None	(See figure 4-13.)
	BAT RLY BUS circuit breakers					
	BAT A (20 amp)	Applies d-c power from battery bus A through an isolation diode to battery relay bus.				
	BAT B (20 amp)	Applies d-c power from battery bus B through an isolation diode to battery relay bus.				
	BATTERY CHARGER circuit breakers			+28 vdc		
	BAT A CHGE (10 amp)	Applies d-c power from battery bus A to MAIN BUS TIE - BAT A & C switch (MDC-22) and through contacts of bus tie motor switch to position A of BATTERY CHARGER selector switch (MDC-18).				
	BAT B CHGE (10 amp)	Applies d-c power from battery bus B to MAIN BUS TIE - BAT B & C switch (MDC-22) and through contacts of bus tie motor switch to position B of BATTERY CHARGER selector switch (MDC-18).				
	MN A (5 amp)	Applies power from d-c main bus A, through an isolation diode, to BATTERY CHARGER selector switch (MDC-18) and d-c contacts of battery charger input-power control relay.				
	MN B (5 amp)	Applies power from d-c main bus B, through an isolation diode, to BATTERY CHARGER selector switch (MDC-18) and d-c contacts of battery charger input-power control relay.				

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	AC PWR (2 amp)	Applies power from a-c bus No. 1 or a-c bus No. 2 to contacts of battery charger input-power control relay.	None	115 vac 400 cps 3 phase	None	
	TELECOMMUNICATIONS circuit breakers GROUP number					
	1 AC (2 amp)	Applies 115-vac 3-phase power to: a. VHF-FM transmitter via internal power control relay controlled by VHF/FM switch (MDC-20) b. C-band transponder via power control relay K3 in circuit utilization box; relay is controlled by C-BAND switch (MDC-20) c. DSE; controlled by TAPE RECORDER switches (MDC-20) and logic circuitry in DSE d. FQR; controlled by FLIGHT QUAL RCDR switch (MDC-19) and logic circuitry in FQR. e. Voice recorder power converter, controlled by RCDR/HF-T/R and POWER-VOX switches MDC-13, -23, -26.		A-C bus No. 1 or 2		A-C bus supplying power to this equipment is determined by position of TELCOM—NON ESS switch (MDC-22).
	2 AC (2 amp)	Applies 115-vac 3-phase power to: a. USBE power supply via power control relay K2 in circuit utilization box, relay is controlled by S-BAND-XPONDER/OFF/XPONDER PWR AMPL switch (MDC-20) b. PMP power supply via internal power control relay, controlled by PWR-PMP switch and S-BAND-EMERG switch (MDC-20).				A-C bus supplying power to this equipment is determined by position of TELCOM—ESS switch (MDC-22).

MAIN DISPLAY CONSOLE—PANEL 22

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	3 (5 amp)	Applies 28-vdc power to: a. Engineer's audio center POWER switch (MDC-23) b. RECOVERY—VHF-BCN switch (MDC-20) c. Commander's left microphone amplifier d. Engineer's right microphone amplifier.	None	Flight and Postlanding Bus	None	
	4 (10 amp)	Applies 28-vdc power to: a. Commander's audio center POWER switch (MDC-26) b. VHF/AM transmitter-receiver and HF transceiver keying relay coils c. RECOVERY—HF—ON/OFF switch (MDC-20) d. VHF-AM—T/R/OFF/REC switch (MDC-20) e. Navigator's left microphone amplifier f. Commander's right microphone amplifier.				
	5 (7.5 amp)	Applies 28-vdc power to: a. Navigator's audio center POWER switch (MDC-13) b. TAPE RECORDER—FWD/REV switch (MDC-20) c. TAPE RECORDER—RECORD/PLAY switch (MDC-20) d. POWER—SCE switch (MDC-20) e. POWER—PMP switch (MDC-20) f. S-BAND—EMERG switch (MDC-20) g. VHF-FM—ON/OFF switch (MDC-20)				

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)		h. S-BAND—PWR AMPL switch (MDC-20) i. C-BAND—1 PULSE/2 PULSE switch (MDC-20) j. S-BAND PA equipment k. TV equipment l. DSE m. USBE power control relays n. UP-DATA switch (MDG-20) and up-data link equipment o. VHF ANTENNA switch (MDC-20) p. S-BAND ANTENNA switch through S-BAND-XPONDER/OFF/XPONDER PWR AMPL switch (MDC-20) q. Engineer's left microphone amplifier r. Navigator's right microphone amplifier s. BIO-MED PCM/TLM	None	Flight and Postlanding Bus	None	
	PCM TLM (2 amp)	Applies 115 vac 3-phase power to PCM/telemetry equipment.		AC NON ESS BUS 1 or 2		A-C bus supplying power to this equipment is determined by position of TELCOM—NON ESS switch (MDC-22).
	SIG COND S-BAND PA AC (2 amp)	Applies 115 vac 3-phase power to: a. SCE power supply via internal latching relay controlled by PWR-SCE switch (MDC-20) b. S-band PA power supplies via power control relay K1 in circuit utilization box; relay is controlled by S-BAND-XPONDER/OFF/XPONDER PWR AMPL switch (MDC-20).				A-C bus supplying power to this equipment is determined by position of TELCOM—ESS switch (MDC-22).
	SCIEN EQUIP HATCH circuit breaker (20 amp)	Applies power from nonessential bus to No. 2 to scientific equipment receptacle below RH and LH observation windows.		DC NON ESS BUS NO. 2 +28 vdc		(See figures 5-3 and 5-4.)

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	ECS circuit breakers		None	+28 vdc	None	
	H_2O ACCUM group					
	MN A (5 amp)	Applies power from d-c main bus A to the following: a. H_2O ACCUM-AUTO 1/MAN/ AUTO 2 switch (MDC-13) b. H_2O accumulator pump failure detection unit.				
	MN B (5 amp)	Applies power from d-c main bus B to the following: a. H_2O ACCUM-AUTO 1/MAN/ AUTO 2 switch (MDC-13) b. H_2O accumulator pump failure detection unit.				
	GAS ANAL circuit breaker					
	AC 1 (2 amp)	Applies ØA a-c power to gas chromatograph package (GFE) located in scientific equipment compartment of LEB.		115 vac 400 cps 3Ø		
	INSTRUMENTS circuit breakers					
	ESS group					
	MN A (15 amp)	Applies 28-vdc power to ESSENTIAL - 1, -2, -3, & -4 circuit breakers on INST PWR CONT panel (RHEB-204).		D-C main bus A		
	MN B (15 amp)	Applies 28-vdc power to ESSENTIAL - 1, -2, -3, & -4 circuit breakers on INST PWR CONT panel (RHEB-204).		D-C main bus B		
	NON ESS BUS (5 amp)	None				
	NON ESS (15 amp)	Applies 28-vdc power to NON ESSENTIAL-5 through -10 circuit breakers on INST PWR CONT panel (RHEB-204).		D-C main bus A or B		

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	RCDR NON ESS (5.0 amp)	Applies 28-vdc power to FQR. Applies 28-vdc power to VOICE RECORD event indicator (MDC-19)	None	D-C main bus A or B	None	The nonessential buses No. 1 and No. 2 obtain 28 vdc power from D-C main bus A or B, depending on position of NON ESS BUS switch (MDC-22).
	SCIEN (7.5 amp)	Applies power from nonessential bus No. 1 for scientific instruments. (Not used.)				
	GUIDANCE & NAVIGATION circuit breakers		N/A	+28 vdc		
	IMU HTR group					
	MN A (7.5 amp)	Applies power from d-c main bus A to IMU heaters.				
	MN B (7.5 amp)	Applies power from d-c main bus B to IMU heaters.				
	IMU group					
	MN A (25 amp)	Applies power from d-c main bus A to IMU.				
	MN B (25 amp)	Applies power from d-c main bus B to IMU.				
	COMPUTER group					
	MN A (10 amp)	Applies power from d-c main bus A to AGC.				
	MN B (10 amp)	Applies power from d-c main bus B to AGC.				
	OPTICS group					
	MN A (10 amp)	Applies power from d-c main bus A to optics.				
	MN B (10 amp)	Applies power from d-c main bus B to optics.				
	VIEWER group			115 vac 400 cps ϕB		
	AC 1 (1 amp)	Applies power from a-c bus No. 1 to G&N VIEWER switch.				
	AC 2 (1 amp)	Applies power from a-c bus No. 2 G&N VIEWER switch.				

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	ENVIRONMENTAL CONTROL SYSTEM circuit breakers		N/A		None	
	CABIN AIR FAN - 1 group					
	AC 1 ØA (2 amp) ØB (2 amp) ØC (2 amp)	Applies 3Ø power from a-c bus No. 1 to the following: a. CABIN AIR FAN - 1 switch MDC-21) b. Waste management blower switch (RHEB-201).		115 vac 400 cps 3Ø		
	CABIN AIR FAN - 2 group					
	AC 2 ØA (2 amp) ØB (2 amp) ØC (2 amp)	Applies power from a-c bus No. 2 to the following: a. 3Ø to CABIN AIR FAN-2 switch (MDC-21) b. ØC to CABIN TEMP - AUTO/MAN switch (MDC-13).				
	GLYCOL PUMPS group					
	AC 1 ØA (2 amp) ØB (2 amp) ØC (2 amp)	Applies power from a-c bus No. 1 to the following: a. 3Ø to ECS GLYCOL pump switch (MDC-21) b. ØA to GLYCOL EVAP - TEMP IN switch (MDC-13) c. ØB to SUIT EVAP switch (MDC-13) d. ØC to GLYCOL EVAP - STEAM PRESS - AUTO/MAN switch (MDC-13). e. ØC to GLYCOL EVAP - H_2O FLOW switch (MDC-13).				
	AC 2 ØA (2 amp) ØB (2 amp) ØC (2 amp)	Applies 3Ø power from a-c bus No. 2 to ECS GLYCOL pump switch (MDC-21).				

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	TRANSDUCER group		N/A		None	
	WASTE & POT H_2O			+28 vdc		
	MN A (5 amp)	Applies power from d-c main bus A to the following pressure transducers: a. Waste water tank b. Potable water tank.				
	MN B (5 amp)	Applies power from d-c main bus B to the following pressure transducer: a. Waste water tank b. Potable water tank.				
	PRESS GROUPS-1					
	MN A (5 amp)	Applies power from d-c main bus A to the following pressure transducers: a. Suit b. Compressor ΔP c. Water-glycol pump discharge d. Water-glycol accumulator (quantity) e. Water-gly evap steam.				
	MN B (5 amp)	Applies power from d-c main bus B to the following pressure transducers: a. Suit b. Compressor ΔP c. Water-glycol pump discharge d. Water-glycol accumulator (quantity) e. Water-gly evap steam.				
	PRESS GROUPS-2					
	MN A (5 amp)	Applies power from d-c main bus A to the following pressure transducers: a. O_2 flow rate b. O_2 supply regulator outlet (telemetered only)				

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)		c. Cabin d. CO_2 partial pressure.	N/A	+28 vdc	None	
	MN B (5 amp)	Applies power from d-c main bus B to the following pressure transducers: a. O_2 flow rate b. O_2 supply regulator outlet (telemetered only) c. Cabin d. CO_2 partial pressure.				
	TEMP group MN A (5 amp)	Applies power from d-c main bus A to the temperature transducer power supply, and in turn to the following transducer amplifiers: a. Water-gly evap liquid outlet b. Cabin c. Suit d. Steam duct (telemetered only) e. Space radiator outlet.				
	MN B (5 amp)	Applies power from d-c main bus B to the temperature transducer power supply, and in turn to the following transducer amplifiers: a. Water-gly evap liquid outlet b. Cabin c. Suit d. Steam duct (telemetered only) e. Space radiator outlet.				
	SUIT COMPRESSORS group AC 1 φA (2 amp) φB (2 amp) φC (2 amp)	Applies power from a-c bus No. 1 to SUIT COMPRESSOR switch (MDC-21).		115 vac 400 cps 3φ		

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	AC 2 φA (2 amp) φB (2 amp) φC (2 amp)	Applies power from a-c bus No. 2 to SUIT COMPRESSOR switch (MDC-21).	N/A	115 vac 400 cps 3φ	None	
	RAD VALVE group					
	AC 1					
	1A (2 amp)	Applies φA power from a-c bus No. 1 to ECS - RADIATOR-1-A switch (MDC-21).				
	2B (2 amp)	Applies φB power from a-c bus No. 1 to ECS - RADIATOR-2-B switch (MDC-21).				
	AC 2					
	1B (2 amp)	Applies φA power from a-c bus No. 2 to ECS - RADIATOR-1-B switch (MDC-21).				
	2A (2 amp)	Applies φC power from a-c bus No. 2 to ECS - RADIATOR-2-A switch (MDC-21).				
	POT H_2O HTR group					
	MN A (5 amp)	Applies power from d-c main bus A to the following: a. POT H_2O HEATER switch (MDC-21) b. GLYCOL EVAP - H_2O FLOW switch (MDC-13).		+28 vdc		
	MN B (5 amp)	Applies power from d-c main bus B to the following: a. POT H_2O HEATER switch (MDC-21) b. GLYCOL EVAP - H_2O FLOW switch (MDC-13) c. WASTE H_2O TK REFILL switch (MDC-13).				

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	CRYOGENIC TANK FAN MOTORS circuit breakers		N/A		None	
	AC 1 group					
	φA (2 amp)	Applies a-c φA power from a-c bus No. 1 φA to: a. H_2 FANS - 1 switch (MDC-13) b. O_2 FANS - 1 switch (MDC-13).		115 vac φA		
	φB (2 amp)	Applies a-c φB power from a-c bus No. 1 φB to: a. H_2 FANS - 1 switch (MDC-13) b. O_2 FANS - 1 switch (MDC-13).		115 vac φB		
	φC (2 amp)	Applies a-c φC power from a-c bus No. 1 φC to: a. H_2 FANS - 1 switch (MDC-13) b. O_2 FANS - 1 switch (MDC-13).		115 vac φC		
	AC 2 group					
	φA (2 amp)	Applies a-c φA power from a-c bus No. 2 φA to: a. H_2 FANS - 2 switch (MDC-13) b. O_2 FANS - 2 switch (MDC-13).		115 vac φA		
	φB (2 amp)	Applies a-c φB power from a-c bus No. 2 φB to: a. H_2 FANS - 2 switch (MDC-13) b. O_2 FANS - 2 switch (MDC-13).		115 vac φB		
	φC (2 amp)	Applies a-c φC power from a-c bus No. 2 φC to: a. H_2 FANS - 2 switch (MDC-13) b. O_2 FANS - 2 switch (MDC-13).		115 vac φC		

MAIN DISPLAY CONSOLE—PANEL 22

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-22 (Cont)	CRYOGENIC SYSTEM circuit breakers		N/A	+28 vdc	None	
	TANK HEATERS group					
	H_2 circuit breakers					
	MN A (5 amp)	Applies power from d-c main bus A to H_2 HEATERS switch (MDC-13).				
	MN B (5 amp)	Applies power from d-c main bus B to H_2 HEATERS switch (MDC-13).				
	O_2 circuit breakers					
	MN A (15 amp)	Applies power from d-c main bus A to O_2 HEATERS switch (MDC-13).				
	MN B (15 amp)	Applies power from d-c main bus B to O_2 HEATERS switch (MDC-13).				
	QTY AMPL group			115 vac 400 cps ØC		
	AC1-ØC (2 amp)	Applies power from a-c bus No. 1 (ØC) to H_2 and O_2 No. 1 tanks signal conditioning boxes.				
	AC2-ØC (2 amp)	Applies power from a-c bus No. 2 (ØC) to H_2 and O_2 No. 2 tanks signal conditioning boxes.				
MDC-23	FLOODLIGHTS control		COUCH ATTEN MN A MN B FLOOD-LIGHTS (MDC-25)	D-C main buses A and B	None	FLOODLIGHTS controls on MDC-23, -26, and LEB-100 are functionally identical and each controls the floodlights in its respective area.
	PRIMARY rheostat					
	OFF	Removes power from C/M primary floodlights.				
	BRIGHT	Indicates maximum floodlight brightness has been reached.				The rheostat control may be adjusted for desired brightness of primary
	SECONDARY switch					
	ON	Illuminates secondary floodlights.				
	OFF	Removes power from secondary floodlights.				

MAIN DISPLAY CONSOLE—PANELS 22 AND 23

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-23 (Cont)	C/W LAMP TEST switch		CAUT/ WARN- MN A MN B (MDC-25)	D-C main buses A and B	None	Lamp check of G&N condition lights and the MASTER ALARM light on LEB-103 is accomplished by pressing CHECK CONDITION LAMPS switch (LEB-105).
	1	Completes d-c ground return path for test illumination of system status lights on MDC-10 and the MASTER ALARM switch-lights on MDC-3 and -18.				Master alarm tone is not activated by test illumination of lights.
	OFF	Opens d-c ground return path of lamp test circuit, extinguishing system status lights on MDC-10 and -11.				
	2	Completes d-c ground return path for test illumination of system status lights on MDC-11.				
	POWER switch	Controls power to pilots module in audio center equipment.	T/C— GROUP 3 (MDC-22)	Flight and postlanding bus		The audio center will not be activated unless the POWER switch is in PTT or VOX position.
	PTT	Applies d-c power to audio and control circuits.				Intercom capability when cobra cable PTT/CW switch is in CW and transmit when switch is in PTT.
	OFF	Removes power from pilots audio center equipment module and controls.				
	VOX	a. Applies d-c power to audio and control circuits b. Enables VOX control of mike amplifier by supplying ground to VOX circuitry.				VOX operation permits voice transmission and transmitter keying of intercom, HF recovery transceiver and voice recorder when cobra cable PTT/CW switch is at PTT.
	S-BAND switch		N/A	Audio center equipment		The S-BAND, HF, VHF-AM, and INTERCOM switches all control ground return paths for appropriate diode switching and isolation circuitry in the pilots module of the audio center equipment to allow transmission and reception, or reception alone, of voice signals over selected equipment. The HF and VHF-AM switches also provide ground return paths for the HF and VHF-AM transmitter keying circuits when in the T/R position.
	T/R	No effect. S-band T/R function supplied by cobra cable PTT key.				
	OFF	Prevents pilot from transmitting or receiving voice over USBE.				
	RCV	Enables pilot to receive voice from USBE.				

MAIN DISPLAY CONSOLE—PANEL 23

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-23 (Cont)	RCDR/HF switch		N/A	Audio center equipment	None	Provides power ground through audio center VOX circuit for HF transceiver transmit-receive relay and voice recorder power relay.
	T/R	a. Enables pilot to transmit and receive voice over HF transceiver when operating in AM or SSB mode. b. Enables voice recorder through VOX circuit.				
	OFF	Prevents pilot from transmitting or receiving voice over HF transceiver.				
	RCV	Enables pilot to receive voice from HF transceiver when operating in AM or SSB mode.				
	VHF AM switch					VHF-AM transmits, in addition to S-band voice, when cobra cable PTT key is closed. Cobra cable PTT/CW switches must be at PTT, and audio center POWER switch must be at PTT.
	T/R	Enables pilot to transmit and receive voice over VHF/AM transmitter-receiver when operating in T/R mode.				
	OFF	Prevents pilot from transmitting or receiving voice over VHF-AM transmitter-receiver.				
	RCV	Enables pilot to receive voice from VHF-AM transmitter-receiver.				
	INTERCOM switch					Audio center POWER switch must be at VOX to enable mike amplifier when cobra cable PTT/CW switch is at PTT.
	T/R	Enables pilot to transmit and receive voice over the intercom system.				
	OFF	Prevents pilot from transmitting or receiving voice over intercom system.				
	RCV	Enables pilot to receive voice from intercom system.				

MAIN DISPLAY CONSOLE—PANEL 23

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-23 (Cont)	VOX SENS control	Increase or decreases sensitivity of voice-operated relay circuitry in pilots audio center module.	N/A	Audio center equipment	None	These three controls are thumbwheel-type potentiometers which may be rotated upward or downward, as required.
	INTERCOM BALANCE control	Increases or decreases level of audio signal received by pilot from RF equipment relative to that received from intercom bus.				Position 9 most sensitive
	VOLUME control	Increases or decreases level of audio signal from pilot's earphone amplifier to earphone.				
MDC-24	EDS POWER switch		EDS-1, 2, 3 BAT A BAT C and BAT B (MDC-25)	Battery buses A, B, and entry battery C	None	Closing of the EDS POWER switch provides power to the EDS display circuitry and also supplies power for the EDS auto abort initiating circuitry.
	ON	Supplies entry battery A, B, and C power to the EDS buses 1, 2, and 3.				
	OFF	Removes power from EDS buses 1, 2, and 3.				
	MASTER EVENT SEQ CONT—PYRO ARM switches					Lever lock-type switches are locked in the SAFE position and must be unlocked before they can be set to PYRO ARM position. The lock and guard assembly must be unlocked with a key prior to hatch closeout. The range safety officer will have possession of the key.
	Switches 1 and 2					
	PYRO ARM	Energizes relays in the MESC which perform the following: a. Connects pyro battery A to the MESC pyro bus A b. Connects pyro battery B to the MESC pyro bus B c. Connects pyro battery A to the C/M RCSC pyro bus A d. Connects pyro battery B to the C/M RCSC pyro bus B.	MASTER EVENT SEQ CONT- A ARM B BAT A and BAT B (MDC-22)	Battery buses A and B	CD0005V DC voltage pyro bus A CD0006V DC voltage pyro bus B	
	SAFE	Removes pyro battery power from the MESC pyro buses A and B, and RCS controllers.				
	SCS GROUP 2 controls					
	TVC 2 POWER switch					TVC 2 POWER switch supplies power to the redundant TVC electronics. Switch must be set to AC 1 or AC 2 position during any ΔV maneuver. It will provide the backup TVC capability required for automatic switchover from TVC 1 in the event of a malfunction. MTVC can only be accomplished using TVC 2 electronics. The TVC 2 power switch also provides power to the MTVC electronics.
	AC 1	Applies a-c power to the gimbal positioning portion of the following: a. Yaw ECA b. Pitch ECA c. Redundant gimbal trim pot.	SCS— GROUP 2 AC 1 (MDC-25)	A-C bus No. 1		

MAIN DISPLAY CONSOLE—PANELS 23 AND 24

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-24 (Cont)	OFF	Removes a-c power from units supplied by AC 1 and AC 2 positions.	SCS—GROUP 2 AC 1 (MDC-25)	A-C bus No. 1	None	
	AC 2	Applies a-c power to the following: a. Yaw ECA b. Pitch ECA c. Redundant gimbal trim pot.	SCS—GROUP 2 AC 2 (MDC-25)	A-C bus No. 2		
	ROTATION CONTROL POWER switch					Switch is a three-position toggle and must be in either the 1 or 2 position for normal rotation control operation. This switch has no affect on the rotation control direct mode function. Power for the two rotation controls is provided through the yaw, pitch, and roll ECAs. The power applied to yaw, pitch, and roll ECAs is demodulator reference voltage for rotation control output signals.
	AC 1	Applies a-c power to the following: a. Command pilot's rotation control b. Senior pilot's rotation control c. Pitch ECA d. Yaw ECA e. Roll ECA	SCS—GROUP 2 AC 1 (MDC-25)	A-C bus No. 1 ϕA		
	OFF	Removes a-c power from units supplied by positions 1 and 2.				
	AC 2	Applies a-c power to the following: a. Command pilot's rotation control b. Senior pilot's rotation control c. Pitch ECA d. Yaw ECA e. Roll ECA	SCS—GROUP 2 AC 2 (MDC-25)	A-C bus No. 2 ϕA		
	BMAG POWER switch					The power applied to DISPLAY/AGAA ECS is used to operate the BMAGs, torquing amplifiers, and preamplifiers in the AGAA. The power applied to pitch, yaw, and roll ECAs is demodulator reference voltage for BMAG error signal.
	AC 1	Applies a-c and d-c power to the following: a. DISPLAY/AGAA ECA b. Pitch ECA c. Yaw ECA d. Roll ECA e. Attitude gyros spin motor power through DISPLAY/AGAA ECA	SCS—GROUP 2 AC 1 MN A (MDC-25)	A-C bus No. 1 D-C main bus A		

MAIN DISPLAY CONSOLE—PANEL 24

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-24 (Cont)	OFF	Removes a-c and d-c power from units supplied by position AC 1 and AC 2.	SCS—GROUP 2 AC 1 MN A (MDC-25)	A-C bus No. 1 D-C main bus A	None	Provides power for backup rate function.
	AC 2	Applies a-c and d-c power to the following: a. DISPLAY/AGAA ECS b. Pitch ECA c. Yaw ECA d. Roll ECA e. Attitude gyros spin motor power through DISPLAY/AGAA ECA.	SCS—GROUP 2 AC 2 MN B (MDC-25)	A-C bus No. 2 D-C main bus B		
	SCS GROUP 1 controls PARTIAL SCS POWER switch AC 1	Applies a-c and d-c power to the following: a. DISPLAY/AGAA ECA b. Pitch ECA c. Roll ECA d. Auxiliary ECA e. Yaw ECA f. Velocity change indicator g. Attitude set/gimbal position indicator.	SCS—GROUP 1 AC 1 MN A (MDC-25)	A-C bus No. 1 D-C main bus A		Switches are three-position rotary type. Refer to section 6, Normal/Backup Procedures, for the various switch positions required for the flight control modes. D-C voltage is provided to AS/GPI and the FDAI ALIGN switch. Three-phase a-c voltage is provided for the following: a. Aux ECA demodulator reference voltages and AGCU power supplies b. FDAI total attitude display motor, and associated electronics. Phase A a-c voltage is provided for the following: a. FDAI error needles b. FDAI ball drive servo amplifier c. FDAI rate needles for backup rate d. FDAI self-test circuit e. AS/GPI gimbal position excitation voltage f. Square wave generator reference voltage g. AGCU amplifier demodulator reference voltage.
	OFF	Removes a-c and d-c power from units supplied by AC 1 and AC 2 positions.				
	AC 2	Applies a-c and d-c power to the following: a. DISPLAY/AGAA ECA b. Pitch ECA c. Roll ECA d. Auxiliary ECA e. Yaw ECA f. Velocity change indicator g. Attitude set/gimbal position indicator.	SCS—GROUP 1 AC 2 MN B (MDC-25)	A-C bus No. 2 D-C main bus B		

MAIN DISPLAY CONSOLE—PANEL 24

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-24 (Cont)	RATE GYRO POWER switch				None	The RATE GYRO POWER switch applies three-phase, 115-vac power to the rate gyro assembly. Phase A, 115-vac power is provided for the following: a. Roll, pitch, yaw ECA rate demodulator reference voltage. b. Roll, pitch, and yaw rate demodulators reference in display/AGAA ECA.
	AC 1	Applies a-c power to the following: a. Rate gyro assembly. b. Yaw ECA c. Pitch ECA d. Roll ECA e. Display/AGAA ECA;	SCS—GROUP 1 AC 1 (MDC-25)	A-C bus No. 1		
	OFF	Removes a-c power from units supplied by AC 1 and AC 2 positions.				
	AC 2	Applies a-c power to the following: a. Rate gyro assembly b. Yaw ECA c. Pitch ECA d. Roll ECA e. Display/AGAA ECA.	SCS—GROUP 1 AC 2 (MDC-25)	A-C bus No. 2		
	TVC 1 POWER switch					The TVC 1 POWER switch applies 115 vac and 28 vdc to the pitch and yaw TVC power supplies in the TVC electronics. Provide necessary power for operating the ΔV REMAINING electronics. After completion of a burn, the switch must be placed to OFF then on to reactivate the ΔV inhibit circuit. Provides power to the X-axis accelerometer on associated electronics through circuits in the display/AGAA ECA.
	AC 1	a. Applies a-c power to the pitch and yaw ECAs. b. Applies d-c power to the DISPLAY/AGAA ECA c. X-axis accelerometer.	SCS—GROUP 1 AC 1 MN A (MDC-25)	A-C bus No. 1 D-C main bus A		
	OFF	Removes a-c and d-c power from units supplied by AC 1 and AC 2 positions.				
	AC 2	a. Applies a-c power to the pitch and yaw ECAs. b. Applies d-c power to the DISPLAY/AGAA ECA. c. X-axis accelerometer.	SCS—GROUP 1 AC 2 MN B (MDC-25)	A-C bus No. 2 D-C main bus B		

MAIN DISPLAY CONSOLE—PANEL 24

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-24 (Cont)	DIRECT O_2 metering valve		N/A	N/A	None	Valve has a shaft rotation of 1-3/4 turns from OPEN to close, and is manually controlled by a T-handle tool. This tool is stowed in DIRECT O_2 valve socket for use in positioning other valves accessible to crewman in LH couch. A second T-handle tool is stowed in LHEB-314 for operating valves in that area.
	OPEN (ccw)	Permits controlled flow of oxygen directly into suit circuit.				Valve is opened in event of contamination or inability of demand pressure regulator to maintain minimum pressure. It may also be opened for cooling during descent, if necessary. In full open position flow rate is 0.66 pound/minute for approximately 5 minutes.
	Close (cw)	Shuts off flow of oxygen directly into suit circuit.				Normal position of valve is closed.
MDC-25	POSTLANDING controls		N/A		None	
	FLOAT BAG 1 PL BUS circuit breaker (5 amp)	Applies d-c power from the flight and postlanding bus to the POST-LANDING-FLOAT BAG switch No. 1 (MDC-25).		+28 vdc		
	VENT FAN group					
	PL BUS-FLOAT BAG 2 circuit breaker (5 amp)	Applies d-c power from flight and postlanding bus to the following: a. FLOAT BAG switch 2 (MDC-25) b. VENT FAN-HIGH/LOW/OFF switch (MDC-25).				
	HIGH/LOW/OFF switch		POST-LANDING—VENT FAN PL BUS—FLOAT BAG 2 (MDC-25)	Flight and postlanding bus		Prior to switch actuation, lockpins installed in both vent valves must be pulled.
	HIGH	Applies d-c power to the following: a. Inlet and outlet vent valve motors, placing valves in open position. b. Vent fan motor for high flow output.				Output of cabin vent fan in HIGH is 150 cfm. Cabin vent valve full travel requires 1.5 seconds (max).

MAIN DISPLAY CONSOLE—PANELS 24 AND 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	LOW	Applies d-c power to the following: a. Inlet and outlet vent valve motors, placing valve in open position. b. Vent fan motor for low flow output.	POST-LANDING—VENT FAN PL BUS—FLOAT BAG 2 (MDC-25)	Flight and postlanding bus	None	Output of cabin vent fan in LOW is 100 cfm. Cabin vent valve full travel requires 1.5 seconds (max).
	OFF	Removes d-c power from motor of cabin vent fan, and applies power to motors of inlet and outlet cabin vent valves, placing valves in closed position.				Both vent valves will be immediately closed by activation of the PLV attitude switch when the C/M becomes inverted or rolls beyond a specified limit. Switch must be set to OFF position before reactivating the PLV.
	FLOAT BAG group		POST-LANDING—FLOAT BAG 1 PL BUS (MDC-25)			
	Switch 1					Lever lock-type switch.
	FILL	Starts two compressors which inflate flotation bag No. 1				Flotation bag No. 1 is located on the +Y axis in the forward compartment of the C/M.
	Center	Neutral (off) position.				Solenoid valve in "seal" mode.
	VENT	Disconnects 28 vdc from the two compressors and opens vent line to flotation bag No. 1				The switch must remain in the VENT position during launch and throughout flight.
	Switch 2		POST-LANDING—VENT FAN-PL BUS-FLOAT BAG 2 (MDC-25)			Lever lock-type switch.
	FILL	Starts two compressors which inflate flotation bag No. 2.				Flotation bag No. 2 is located on the +Z axis in the forward compartment of the C/M.
	Center	Neutral (off) position.				Solenoid valve in "seal" mode.
	VENT	Disconnects 28 vdc from the two compressors and opens vent line to flotation bag No. 2.				The switch must remain in the VENT position during launch and throughout flight.
	Switch 3		ELS-A BAT A—FLOAT BAG 3 (MDC-25)	Battery bus A		Lever lock-type switch
	FILL	Starts two compressors which inflate flotation bag No. 3.				Flotation bag No. 3 is located on the +Z axis in the forward compartment of the C/M.
	Center	Neutral (off) position				Solenoid valve in "seal" mode.
	VENT	Disconnects 28 vdc from the two compressors and opens vent line to flotation bag No. 3				The switch must remain in the VENT position during launch and throughout flight.

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	ANTENNA DEPLOY switches				None	
	DEPLOY					
	A	Connects 28 vdc to the postlanding antenna deploy circuitry.	PYRO A GROUP—SEQ A and PYRO B group - SEQ B (LEB-150)	Pyro bus A and pyro bus B in the MESC when the MASTER EVENT SEQ CONT—PYRO switches A and B are in the ARM position		Two-position toggle switch that is set to A after landing when C/M is in upright position.
	OFF	Normal position, no function.				
	B	Connects 28 vdc to the postlanding antenna deploy circuitry. Backup switch for DEPLOY switch A.				Two-position toggle switch that is set to B after landing when C/M is in upright position.
	OFF	Normal position, no function.				
	MESC—LOGIC ARM switches				CD0200V D-C voltage logic bus A CD0201V D-C voltage logic bus B	Lever lock-type switches.
	Switches 1 and 2		MASTER EVENT SEQ CONT-A ARM B BAT A and BAT B (MDC-22)	Battery buses A and B		
	LOGIC ARM	Energizes relays in both MESC which perform the following: a. Connects battery bus A to the MESC A logic bus A b. Connects battery bus B to the MESC B logic bus B.				
	OFF	Removes 28 vdc from MESC logic buses A and B.				
	EVENT TIMER circuit breakers		N/A	+28 vdc	None	
	MN A (5 amp)	Applies d-c power from d-c main bus A to event timer switches (MDC-8).				
	MN B (5 amp)	Applies d-c power from d-c main bus B to event timer switches (MDC-8).				
	COUCH ATTEN - FLOODLIGHTS circuit breakers					
	MN A (15 amp)	Applies d-c power from d-c main bus A to the following controls: a. FLOODLIGHTS-PRIMARY rheostat (MDC-26).				

MAIN DISPLAY CONSOLE—PANEL 25

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)		b. LIGHTING-FLOODS-PRIMARY rheostat (LEB-100) c. FLOODLIGHTS-SECONDARY switch (MDC-23) d. COUCH UNLOCK switch (MDC-8) e. LIGHTING-FLOODS-CLOCKS switch (LEB-100)	N/A	+28 vdc	None	
	MN B (15 amp)	Applies d-c power from d-c main bus B to the following controls: a. FLOODLIGHTS-PRIMARY rheostat (MDC-23) b. LIGHTING-FLOODS-SEC switch (LEB-100) c. FLOODLIGHTS-SECONDARY switch (MDC-26) d. COUCH UNLOCK switch (MDC-8).				
	STABILIZATION & CONTROL SYSTEM circuit breakers (top row) DIRECT CONT group					
	MN A (30 amp)	Applies power from d-c main bus A to the following: a. DIRECT RCS switch on MDC-8 b. DIRECT ULLAGE switch on MDC-7 c. NORMAL/OFF/DIRECT ON switch on MDC-7 d. Arms command pilot's rotation control for direct commands through direct RCS switch				
	MN B (30 amp)	Applies power from d-c main bus B to the following: a. DIRECT RCS switch on MDC-8 b. DIRECT ULLAGE switch on MDC-7				

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)		c. NORMAL/OFF/DIRECT ON switch on MDC-7 d. Arms senior pilot's rotation control for direct commands, through direct RCS switch.	N/A	+28 vdc	None	
	A & C ROLL group					Maneuver function - engine activation
	MN A (20 amp)	Applies power from d-c main bus A to A & C ROLL channel switch on MDC-8.				
	MN B (20 amp)	Applies power from d-c main bus B to A & C ROLL channel switch on MDC-8.				
	B & D ROLL group					
	MN A (20 amp)	Applies power from d-c main bus A to B & D ROLL channel switch on MDC-8.				
	MN B (20 amp)	Applies power from d-c main bus B to B & D ROLL channel switch on MDC-8.				
	PITCH group					
	MN A (20 amp)	Applies power from d-c main bus A to PITCH channel switch on MDC-8.				
	MN B (20 amp)	Applies power from d-c main bus B to PITCH channel switch on MDC-8.				
	YAW group					
	MN A (20 amp)	Applies power from d-c main bus A to YAW channel switch on MDC-8.				
	MN B (20 amp)	Applies power from d-c main bus B to YAW channel switch on MDC-8.				

SCS CB	Function	S/M RCS Engine
A&C ROLL MN A	roll right	A13
A&C ROLL MN B	roll right	C15
A&C ROLL MN A	roll left	A16
A&C ROLL MN B	roll left	C14
B&D ROLL MN A	roll right	B9
B&D ROLL MN B	roll right	D11
B&D ROLL MN A	roll left	B12
B&D ROLL MN B	roll left	D10
PITCH MN B	pitch up	A3
PITCH MN A	pitch up	C1
PITCH MN A	pitch down	A2
PITCH MN B	pitch down	C4
YAW MN A	yaw right	B7
YAW MN B	yaw right	D5
YAW MN B	yaw left	B6
YAW MN A	yaw left	D8

SCS CB	Function	C/M RCS Engine
B&D ROLL MN A	roll right	A9
B&D ROLL MN B	roll right	B11
B&D ROLL MN A	roll left	A12
B&D ROLL MN B	roll left	B10
PITCH MN A	pitch up	A1
PITCH MN B	pitch up	B3
PITCH MN A	pitch down	A2
PITCH MN B	pitch down	B4
YAW MN A	yaw right	A5
YAW MN B	yaw right	B7
YAW MN A	yaw left	A8
YAW MN B	yaw left	B6

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	STABILIZATION & CONTROL SYSTEM controls (bottom row)				None	
	FDAI LTG switch	Controls application of a-c power to the FDAI brightness control on MDC-2 for FDAI lighting and for illumination of the lamp in the THRUST ON switch on MDC-7.	SCS—GROUP 2 AC 1 or AC 2	A-C bus 1 or a-c bus 2		
	AC 1	Applies a-c bus 1 phase B power to FDAI brightness control.				
	OFF	Removes all a-c power from FDAI brightness control.				
	AC 2	Applies a-c bus 2 phase B power to FDAI brightness control.				
	GROUP 1 circuit breakers		N/A	115 vac 400 cps 3 phase		
	AC 1 (2 amp)	Applies power from a-c bus No. 1 to the following switches on MDC-24: a. SCS POWER b. RATE GYRO POWER c. TVC 1 POWER.				
	AC 2 (2 amp)	Applies power from a-c bus No. 2 to the following switches on MDC-24: a. SCS POWER b. RATE GYRO POWER c. TVC 1 POWER.				
	GROUP 2 circuit breakers					
	AC 1 (2 amp)	Applies power from a-c bus No. 1 to the following switches on MDC-24: a. BMAG POWER b. ROTATION CONTROL POWER c. TVC 2 POWER				

MAIN DISPLAY CONSOLF—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	AC 2 (2 amp)	Applies power from a-c bus No. 2 to the following switches on MDC-24: a. BMAG POWER b. ROTATION CONTROL POWER c. TVC 2 POWER.	N/A	115 vac 400 cps 3 phase	None	
	GROUP 1 circuit breakers			+28 vdc		
	MN A (15 amp)	Applies power from d-c main bus A to the following: a. SCS POWER switch on MDC-24 b. TVC 1 POWER switch on MDC-24 c. SCS switches on MDC-8 d. Translation control prior to CM-SM separation.				
	MN B (15 amp)	Applies power from d-c main bus B to the following: a. SCS POWER switch on MDC-24 b. TVC 1 POWER switch on MDC-24 c. SCS switches on MDC-8 d. Translation control prior to CM-SM separation.				
	GROUP 2 circuit breakers					
	MN A (15 amp)	Applies power from d-c main bus A to the following: a. BMAG POWER switch on MDC-24 b. Command pilot's rotation control c. Command pilot's translation control.				

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	MN B (15 amp)	Applies power from d-c main bus B to the following: a. TVC 2 POWER switch on MDC-24 b. Senior pilot's rotation control c. Senior pilot's translation control.	N/A	+28 vdc	None	
	BIO MED COMM circuit breakers					
	MN A (5 amp)	Used on unmanned mission only.				
	MN B (5 amp)	Applies power from d-c main bus B to TLM INPUTS—BIO MED switch (MDC-20).		D-C main bus B		
	SERVICE PROPULSION SYSTEM circuit breakers					
	GAUGING group					
	MN A (5 amp)	Applies power from d-c main bus A to the following propellant utilization and gauging subsystem control unit circuits: a. Self-test b. Primary power supply only when SPS engine ignition driver relay is energized.				
	MN B (5 amp)	Applies power from d-c main bus B to propellant utilization and gauging subsystem control unit auxiliary power supply only when SPS engine ignition driver relay is energized.		+28 vdc		
	AC 1 (2 amp)	Applies power from a-c bus No. 1 to AC 1 contacts of SPS GAUGING switch on MDC-25.		115 vac 400 cps ØC		
	AC 2 (2 amp)	Applies power from a-c bus No. 2 to AC 2 contacts of SPS GAUGING switch on MDC-25.				

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	He VALVE group					
	MN A (7.5 amp)	Applies power from d-c main bus A to the following: a. Left-hand SPS HELIUM switch (MDC-20) b. INJECT PRE-VALVES A switch (MDC-3) c. FCSM-G&N switch (MDC-2) d. FCSM-SCS switch (MDC-2)	N/A	+28 vdc	None	
	MN B (7.5 amp)	Applies power from d-c main bus B to the following: a. Right-hand SPS HELIUM switch (MDC-20) b. INJECT PRE-VALVES B switch (MDC-3) c. FCSM-G&N switch (MDC-2) d. FCSM-SCS switch (MDC-2).				
	GIMBAL MOTOR CONTROL group					
	1 - PITCH - 2					
	BAT A (15 amp)	Applies power from battery bus A to SPS GIMBAL MOTORS PITCH 1 switch on MDC-3.				
	BAT B (15 amp)	Applies power from battery bus B to SPS GIMBAL MOTORS PITCH 2 switch on MDC-3.				
	1 - YAW - 2					
	BAT A (15 amp)	Applies power from battery bus A to SPS GIMBAL MOTORS YAW 1 switch on MDC-3.				
	BAT B (15 amp)	Applies power from battery bus B to SPS GIMBAL MOTORS YAW 2 switch on MDC-3.				

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	G&N SYNC switch	Provides manual maneuver capability in G&N attitude control mode.	SCS GROUP 2 MN A	D-C main bus A	None	When the G&N SYNC switch is returned to OFF and the rotation control is returned to detent, the G&N system will maintain S/C attitude within the selected deadband limits. This switch will not be used per procedural constraint.
	On (up)	Permits detent switch in rotational control to place CDUs in a follow mode.				
	OFF	Does not affect G&N attitude control mode.				
	SPS GAUGING switch		SPS—GAUGING AC 1 AC 2 (MDC-25)	A-C bus No. 1		Three-position toggle switch which controls application of a-c power to propellant quantity utilization and gauging system control unit. Power for control unit self-test circuitry is applied directly by switch. Power for propellant quantity measuring circuitry is applied only when engine ignition driver relay is energized by engine firing signal.
	AC 1	Applies a-c power to the following: a. Quantity gauging system control unit self-test circuitry. b. Normally open contacts of SPS engine ignition driver relay.				
	OFF	Removes all a-c power.				
	AC 2	Applies a-c power to the following: a. Quantity gauging system control unit self-test circuitry. b. Normally open contacts of SPS engine ignition driver relay.		A-C bus No. 2		
	AC SNSR SIG circuit breaker		N/A	115 vac 400 cps 3 phase		
	AC 1 (2 amp)	Applies power from a-c bus No. 1 to a-c over-undervoltage and overload sensing unit to AC INDICATORS switch (MDC-18).				
	AC 2 (2 amp)	Applies power from a-c bus No. 2 to a-c over-undervoltage and overload sensing unit and to AC INDICATORS switch (MDC-18).				

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	REACTION CONTROL SYSTEM circuit breakers		N/A		None	
	PROP ISOL group					
	MN A (10 amp)	Applies power from d-c main bus A to the following: a. SM RCS quads B and D HELIUM 1, HELIUM 2, and PROPELLANT switches. b. CM RCS system A PROPELLANT switch. c. Microswitch in each isolation valve controlled by switches listed in steps a and b. Microswitch controls event indicator operation. d. RCS control box relay contacts which cause automatic closure of system A fuel and oxidizer isolation valves in the event of an abort initiation prior to T + 61 seconds.				
	MN B (10 amp)	Applies power from d-c main bus B to the following: a. SM RCS quads A and C HELIUM 1, HELIUM 2, and PROPELLANT switches. b. CM RCS system B PROPELLANT switch. c. Microswitch in each isolation valve controlled by switches listed in steps a and b. Microswitch controls event indicator operation.				

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)		d. RCS control box relay contacts which cause automatic closure of system B fuel and oxidizer isolation valves in the event of an abort initiated prior to T + 61 seconds.	N/A	+28 vdc	None	
	C/M - S/M TRANSFER group					
	MN A (15 amp)	Applies power from d-c main bus A to the following: a. RCS TRANSFER switch (MDC-16) b. C/M PROPELLANT JETT group LOGIC switch (MDC-8) c. C/M RCS HTRS switch RHFEB-200 d. C/M RCS He DUMP switch (MDC-26).				
	MN B (15 amp)	Applies power from d-c main bus B to the following: a. RCS TRANSFER switch (MDC-16) b. C/M PROPELLANT JETT group LOGIC switch (MDC-8) c. C/M RCS HTRS switch RHFEB-200 d. C/M RCS He DUMP switch (MDC-26).				
	CAUT/WARN circuit breakers					
	MN A (10 amp)	Applies power from d-c main bus A to caution and warning system.				
	MN B (10 amp)	Applies power from d-c main bus B to caution and warning system.				
	EDS-1, 2, 3 circuit breakers					
	BAT A (5 amp)	Applies d-c power from battery bus A to the EDS POWER switch (MDC-24).				

MAIN DISPLAY CONSOLE—PANEL 25

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-25 (Cont)	BAT C (5 amp)	Applies d-c power from entry battery C to the EDS POWER switch (MDC-24).	N/A	+28 vdc	None	
	BAT B (5 amp)	Applies d-c power from battery bus B to the EDS POWER switch (MDC-24).				
	ELS-A, B circuit breakers BAT A - FLOAT BAG 3 (10 amp)	Applies d-c power from battery bus A to the following: a. ELS LOGIC switch (MDC-8) b. APEX COVER JETT switch (MDC-5) c. MAIN DEPLOY switch (MDC-5) d. MAIN DEPLOY switch (MDC-5) e. POST LANDING-FLOAT BAG - switch 3 (MDC-25).				
	BAT B (10 amp)	Applies d-c power from battery bus B to the following: a. ELS LOGIC switch (MDC-8) b. APEX COVER JETT switch (MDC-5) c. DROGUE DEPLOY switch (MDC-5) d. MAIN DEPLOY switch (MDC-5)				
MDC-26	FLOODLIGHTS controls		COUCH ATTEN MN A MN B FLOOD-LIGHTS (MDC-25)	D-C main buses A and B	None	FLOODLIGHTS controls on MDC-23, -26, and LEB-100 are functionally identical and each controls the floodlights in its respective area. The rheostat control may be adjusted for desired brightness of primary floodlights.
	PRIMARY rheostat					
	Off	Removes power from C/M primary floodlights.				
	Bright	Indicates maximum floodlight brightness has been reached.				
	SECONDARY switch					
	ON	Illuminates secondary floodlights.				
	OFF	Removes power from secondary floodlights.				

MAIN DISPLAY CONSOLE—PANELS 25 AND 26

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-26 (Cont)	POST LDG BEACON switch		N/A	Beacon light battery	None	
	LIGHT	Applies power to the beacon lights.				
	OFF	Removes power from the beacon lights.				
	POWER switch	Controls power to command pilot's module in audio center equipment	T/C — GROUP 4 (MDC-22)	Flight and postlanding bus		The audio center will not be activated unless the POWER switch is in PTT or VOX position. Intercom capability when cobra cable PTT/CW switch is in C/W and transmit when switch is at PTT.
	PTT	Applies d-c power to audio and control circuits.				
	OFF	Removes power from command pilot's audio center equipment module and controls.				
	VOX	a. Applies d-c power to audio and control circuits. b. Enables VOX control of mike amplifier by supplying ground to VOX circuitry.				VOX operation permits voice transmission and transmitter keying of intercom, HF recovery transceivers and voice recorder when cobra cable PTT/CW switch is at PTT.
	S-BAND switch		N/A	Audio center equipment		The S-BAND, HF, VHF-AM, and INTERCOM switches all control ground return paths for appropriate diode switching and isolation circuitry, in the command pilot's module of the audio center equipment, to allow transmission and reception, or reception alone, of voice signals over selected equipment. The HF and VHF-AM switches also provide ground return paths for the HF and VHF-AM transmitter keying circuits when in the T/R position.
	T/R	No effect. S-band T/R function supplied by cobra cable PTT key.				
	OFF	Prevents command pilot from transmitting or receiving voice over USBE.				
	RCV	Enables command pilot to receive voice from USBE.				
	RCDR/HF switch					Provides power ground through audio center VOX circuit for HF transceiver transmit-receive relay and voice recorder power relay.
	T/R	a. Enables command pilot to transmit and receive voice over H-F transceiver when operating in AM or SSB mode. b. Enables voice recorder through VOX circuit.				
	OFF	Prevents command pilot from transmitting or receiving voice over H-F transceiver.				

MAIN DISPLAY CONSOLE—PANEL 26

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-26 (Cont)	RCV	Enables command pilot to receive voice from H-F transceiver when operating in AM or SSB mode.	N/A	Audio center equipment	None	
	VHF AM switch					VHF-AM transmits, in addition to S-band voice, when cobra cable PTT key is closed. Cobra cable PTT/CW switch must be at PTT and audio center POWER switch must be at PTT.
	T/R	Enables command pilot to transmit and receive voice over VHF-AM transmitter-receiver when operating in T/R mode.				
	OFF	Prevents command pilot from transmitting or receiving voice over VHF-AM transmitter-receiver.				
	RCV	Enables command pilot to receive voice from VHF-AM transmitter-receiver.				
	INTERCOM switch					Audio center POWER switch must be at VOX to enable mike amplifier when cobra cable PTT/CW switch is at PTT.
	T/R	Enables command pilot to transmit and receive voice over the intercom system.				
	OFF	Prevents command pilot from transmitting or receiving voice over intercom system.				
	RCV	Enables command pilot to receive voice from intercom system.				
	VOX SENS control	Increases or decreases sensitivity of voice-operated relay circuitry in command pilot audio center module.				These three control are thumbwheel-type potentiometers which may be rotated upward or downward, as required.
	INTERCOM BALANCE control	Increases or decreases level of audio signal received by command pilot from R-F equipment relative to that received from intercom bus.				Position 9 most sensitive.
	VOLUME control	Increases or decreases level of audio signal from command pilot earphone amplifier to earphone.				

MAIN DISPLAY CONSOLE—PANEL 26

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
MDC-26 (Cont)	C/M RCS switch		RCS – C/M-S/M TRANSFER MN A MN B (MDC-25)	D-C main buses A and B	None	Two-position guarded toggle switch which provides backup capability for initiating helium purge operation in the event of C/M PROP JETT PURGE switch failure (MDC-8). The switch receives power directly from the circuit breakers.
	He DUMP (up)	Energizes relays required to activate C/M RCS helium purge operation.				
	OFF (down)	De-energize relays.				
LEB-100	LIGHTING controls		COUCH ATTEN MN A MN B FLOOD-LIGHTS (MDC-25)	D-C main buses A and B	None	FLOODLIGHTS controls on MDC-23, -26, and LEB-100 are functionally identical and each controls the floodlights in its respective area.
	FLOODS group					
	PRIMARY rheostat					
	OFF	Removes power from C/M primary floodlights.				
	BRIGHT	Indicates maximum floodlight brightness has been reached.				The rheostat control may be adjusted for desired brightness of primary floodlights.
	SEC switch					
	ON	Illuminates secondary floodlights.				
	OFF	Removes power from secondary floodlights.				
	CLOCKS switch					
	BRT	Brightly illuminates the integral lighting for the mechanical clocks on LHFEB-306.				
	OFF	Disconnects power from the lighting circuit to the clocks.				
	DIM	Dimly illuminates the integral lighting for the mechanical clocks on LHFEB-306.				

MAIN DISPLAY CONSOLE--PANEL 26
LOWER EQUIPMENT BAY–PANEL 100

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-101	IMU-CDU DIFFERENCE indicator	Displays the difference between the IMU gimbal angles and the CDU shaft angles in degrees.	G&N—IMU MN A MN B (MDC-22)	D-C main buses A and B	None	A three-dial panel meter. The signals applied to the meter are the demodulated outputs of the CDU single speed receivers. Depending upon the IMU mode, the differences shown can represent the following: a. Misalignment of the IMU b. Error in the orientation of the spacecraft c. Error in the CDU display of actual gimbal angles.
	TRANSFER switch	Controls selection of ISS operating modes.				SPST toggle switch
	MANUAL	Enables manual selection of ISS operating modes through the use of MODE switches.				
	COMPUTER	Enables AGC selection of ISS operating modes by setting mode relays directly.				
	MANUAL ALIGN switch	Causes the IMU gimbals to align CDU angles.				SPST momentary contact pushbutton. Used in conjunction with CDU MAN mode pushbutton to coarse align the IMU gimbals.
	MODE switches	Allow selection and display of ISS operating modes.				SPST illuminates pushbutton switches. Computer controlled when TRANSFER switch is in COMPUTER position. Manually controlled when TRANSFER switch is in MANUAL position.

LOWER EQUIPMENT BAY—PANEL 101

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-101 (Cont)	ZERO ENC	Selects zero encoder mode of ISS operation. This mode sets the shafts and encoders of the CDUs and CDU registers in the computer to zero.	G&N—IMU MN A MN B (MDC-22)	D-C main buses A and B	None	CDUs must be zeroed whenever the G&N system is turned on.
	COARS ALIGN	Selects coarse align mode of IMU operation. This mode positions the stable member of the IMU. Selects coarse align mode of ISS operation. This mode positions the stable member to within 1.5° of desired inertial reference attitude.				In this mode. the CDUs are driven to angles commanded by the AGC. These angles define an inertial reference.
	FINE ALIGN	Selects fine align mode of ISS operation. This mode completes stable member alignment to desired inertial reference attitude.				Upon completion of the fine align mode, the stable member is fine aligned to an inertial reference and the CDU readouts indicate gimbal angles relative to that reference.
	CDU MAN	Selects manual CDU mode of ISS operation. This mode provides for backup-manual alignment of the stable member. Stable member drives to CDU angles when MANUAL ALIGN switch is depressed.				Actuation of CDU MAN switch energizes a relay which removes the excitation to the CDU motors to lock the CDUs in position.
	ATT CONT	Selects attitude control mode of IMU operation. Selects attitude control mode of ISS operation. This mode provides attitude and velocity change sensing with respect to the space stabilized, stable member.				The attitude error signals generated in this mode represent the difference between IMU gimbal angles and CDU angles.
	ENTRY	Selects entry mode of IMU operation. This mode is similar to attitude control mode; however, the gain of the roll control loop is increased by a factor of 16 to increase roll rate and decrease response time.				This mode is used during spacecraft entry into the earth atmosphere.
LEB-102	CDU angle display readouts 2X TRUNNION, SHAFT ANGLE, OUTER GIMBAL (ROLL), INNER GIMBAL (PITCH), MIDDLE GIMBAL (YAW)	Provide visual representation of ICDU and OCDU angles.			None	Drum-type readout. Reads down to 0.001 degree. Five such readouts are on this panel: two for optics and three for inertial CDUs.

LOWER EQUIPMENT BAY—PANELS 101 AND 102

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-103	G&N condition lights	Warning lights denote detected malfunction.	G&N—IMU MN A MN B (MDC-22)	D-C main buses A and B		Yellow caution lights.
	PGNS	Indicates an IMU, CDU accelerometer and/or AGC failure.			CG5005X (Error detect)	
	AGC PWR FAIL	Indicates a failure in the Apollo guidance computer power supply.			CG5030X (Computer power fail light)	
	IMU FAIL	Indicates a failure in the inertial measurement unit.			CG5001X (IMU fail)	
	CDU FAIL	Indicates a failure in one or more of the coupling display units.			CG5002X (CDU fail)	
	ACCEL FAIL	Indicates a failure in one or more of the PIPAs.			CG5000X (PIPA fail)	
	GIMBAL LOCK	Indicates a potential gimbal lock condition in the IMU (middle gimbal angle is greater than ±60° with respect to outer gimbal).			CG5003X (Gimbal lock warning)	
	IMU TEMP	Indicates that the IMU temperature is out of tolerance, i.e., exceeds normal temperature by ±4°F (if IMU TEMP MODE switch is in AUTO OVERRIDE or PROPORTIONAL positions).			CG5006X (IMU temp light)	
	ZERO ENCODER	Indicates that the CDU encoders are being zeroed; lamp is extinguished after all encoders have been zeroed. (Remains illuminated for approximately 30 seconds. If AGC commanded zero encode mode, indicator may be illuminated for approximately 60 seconds.)			CG5007X (Zero encoder light)	White light.
	IMU DELAY	IMU coarse alignment to CDU angles taking place. Stable member is caged. Remains illuminated for approximately 100 seconds.			CG5008X (IMU delay light)	White light. Illuminates only at initial IMU turn-on or immediately after switching from standby operation.

LOWER EQUIPMENT BAY—PANEL 103

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-103 (Cont)	MASTER ALARM light	Red light illuminates to alert crewmembers at lower equipment bay of malfunction or out-of-tolerance condition. This is indicated by illumination of applicable system status lights on MDC-10 or -11.	CAUT/ WARN MN A MN B (MDC-25)	D-C main buses A and B	CS0150X (Master caution-warning on)	Upon illumination of MASTER ALARM light, the MASTER ALARM switch-lights on MDC-3 and -18 are simultaneously illuminated and an audio tone is sent to each headset. The MASTER ALARM light does not contain an integral switch. Light may be extinguished only by pressing the MASTER ALARM switch-light on MDC-3 or -18.
LEB-104	Sextant	Optical instrument for measuring the angle between two objects.	None	None	None	The SXT is a dual line-of-sight instrument used to determine the following: a. The angle between a landmark and a star. b. The angle between a star line of sight and the navigation base. c. Tracking an unknown landmark. This information is used by the AGC for the following: a. Determine spacecraft position. b. Calculate required ΔV corrections. c. To fine align the IMU. The SXT has a 1.8° field of view with a magnification of 28.
	Scanning telescope	Optical instrument used for the following: a. Tracking a landmark in earth orbit. b. Identifying and centering a star within the sextant field of view.				The scanning telescope has a 60° field of view and a 1X magnification (long relief eyepiece = 0.6X).
	TRUNNION control	Enables manual positioning of the trunnion angles.				These controls are manually operated by means of a universal tool. They are used in the event of optics electronic failure.
	SHAFT control	Enables manual positioning of the shaft angles.				
	TRUNNION ANGLE display	Provides a mechanical readout of the SCT trunnion angle that is commanded manually or by the computer.				Drum-type readouts in degrees, mechanically connected to the scanning telescope (SCT) trunnion and shaft drives, respectively. (SXT angles are identical.)
	SHAFT ANGLE display	Provides a mechanical readout of the SCT shaft angle that is commanded manually or by the computer.				

LOWER EQUIPMENT BAY—PANELS 103 AND 104

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-105	Optics hand controller	Provides electrical commands to the optics shaft and trunnion drive motors.	G&N-OPTICS MN A MN B (MDC-22)	D-C main buses A and B	None	SP4T, five-position switch spring-loaded to center OFF position. direction of target movement with respect to controller movement depends upon mode selected by CONTROLLER MODE switch. Rate of image movement is proportional to amount of hand controller movement.
	CHECK COOLANT switch	When pressed, applies power to floodlamps behind the display and control panel. Enables the crew to view the IMU quick-disconnect couplings through CHECK COOLANT windows.				Pushbutton switch, momentary contact.
	CHECK COOLANT windows (two)	Permit observation of IMU coolant supply system quick-disconnect couplings for detecting leaks.	None	None		
	AGC code numbers display (not shown)	Provides the crew with a quick reference for computer code numbers.				Panel inscribed, nonreplaceable.
	MARK switch	Supplies an interrupt signal to the AGC which commands it to read the optics CDU angles, the time, and the IMU gimbal angles (if the IMU is operating).	G&N-OPTICS MN A MN B (MDC-22)	D-C main buses A and B		Pushbutton, SPST, momentary-contact switch. If MARK is satisfactory, computer proceeds normally. If MARK is unsatisfactory, flight crew inhibits computer processing of data by making DSKY entry of V52E.
	PANEL BRIGHTNESS control	Provides adjustment of the illumination level of all integrally lighted G&N system controls and displays. In addition, the control provides power to the lamp in the THRUST ON switch.				Thumbwheel potentiometer.
	CHECK MODE LAMPS switch	Applies power to all MODE indicators on the IMU control panel LEB-101.				Pushbutton, SPST, momentary-contact switch. Used to check operation of the MODE lamps.
	CHECK CONDITION LAMPS switch	Applies power to all condition (caution and warning) lamps on panel LEB-103.				Pushbutton, SPST, momentary-contact switch. Used to check the operation condition of the condition lamps.

LOWER EQUIPMENT BAY—PANEL 105

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-105 (Cont)	CONDITION LAMPS switch		G&N-IMU MN A MN B (MDC-22)	D-C main buses A and B	None	SPST toggle switch.
	ON	Applies d-c power to G&N condition lamps.				
	OFF	Removes d-c power from lamps.				
	ATTITUDE IMPULSE group		SCS — GROUP 1 AC 1 AC 2 (MDC-25)	Essential bus		
	Attitude impulse control	A control stick used to apply small rotational thrust impulses to the spacecraft by means of the service module reaction jets.				SP6T, seven-position switch, spring-loaded to center off. The control is used to apply one or any combination of pitch, roll, or yaw minimum thrust impulses to the S/C providing rate damping impulses of 2.4 arc-minutes/second/pulse or less. One pulse is produced each time the control is moved from the center position.
	ENABLE switch	Enables the attitude impulse control.				Toggle-type, solenoid-held-to-on microswitch. The SCS must be in the G&N or SCS attitude control modes to enable solenoid holding. Attitude impulse is not enabled in the SCS local vertical mode. To enable the attitude impulse control circuit, the LIMIT CYCLE switch must also be ON.
	ON	Supplies a signal to the G&N and SCS systems which disables the active S/C attitude control mode, allowing the S/C to drift freely, and enables the attitude impulse control.				
	OFF	Disables the attitude impulse control.				
	IMU TEMP MODE group		G&N IMU HTR MN A MN B (MDC-22)	D-C main buses A and B		
	Mode switch	Enables the crew to select any one of the four modes of IMU temperature controls.				Rotary, four-position, three-wafer switch.
	PROPORTIONAL	Temperature control is furnished by same control circuit used in AUTO/OVERRIDE mode.				PROPORTIONAL mode is used if a malfunction occurs in the temperature indicating circuit, causing cycling to the EMERGENCY mode.
	BACKUP	Temperature control is furnished by temperature sensing circuits.				BACKUP mode is used if a malfunction occurs in the normal control circuit. In this mode, the IMU TEMP light will illuminate when the heaters are off and will extinguish when the heaters are on. MSFN must monitor

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-105 (Cont)			G&N IMU HTR MN A MN B (MDC-22)	D-c main buses A and B	None	the IMU temperature. Manual switching to emergency mode is necessary if the temperature becomes excessive.
	AUTO OVERRRIDE	Normal mode of temperature control. If IMU temperature exceeds normal tolerances by ±4°F, system automatically switches to emergency mode and IMU TEMP light illuminates.				When a malfunction occurs, the temperature alarm relays turn off the control heaters. Emergency heaters continue to operate under the control of an emergency mercury thermostat. When the temperature returns to within 1°F of normal, the IMU TEMP light extinguishes and the system switches back to the normal control mode.
	EMERGENCY	IMU temperature is controlled to approximately 130°F by means of mercury thermostat and emergency heaters.				A thermostat provides overheat protection for the IMU by opening the emergency heater circuit when the temperature exceeds 130°F. When this temperature drops below 128°F, the thermostat closes the circuit to reactivate the heaters.
	ZERO switch	Used to check calibration of IRIG and PIPA temperature monitoring devices.				Pushbutton, DPST, momentary-contact switch.
	GAIN switches	Used to check temperature alarm circuit.				
	IRIG	Simulates low temperature error (-5°F) to check IRIG temperature sensors and also tests alarm circuit				Pushbutton, momentary-contact switch. When it is pressed, the IMU TEMP indicator (LEB-103) should be illuminated. If not, a malfunction exists in the system.
	PIPA	Simulates high temperature error (+5°F) to check PIPA temperature sensors and also test alarm circuits.				
	MAP AND DATA VIEWER group	None	None	None		Function deleted as a result of map and data viewer deactivation.
	OPTICS group		G&N OPTICS MN A MN B (MDC-22)	D-C main buses A and B		
	SLAVE TELESCOPE switch					Single pole, three-position toggle switch
	STAR LOS	Slaves SCT trunnion axis to SXT trunnion.				

LOWER EQUIPMENT BAY—PANEL 105

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-105 (Cont)	LANDMARK LOS 0°	Drives SCT trunnion to zero independently of CDU trunnion.	G&N OPTICS MN A MN B (MDC-22)	D-C main buses A and B	None	Zero position is parallel to SXT shaft axis.
	OFFSET 25°	Drives telescope trunnion to 25° offset from shaft axis.				This will bring the star and landmark within the 60° field-of-view of the SCT, while rotating about the shaft axis.
	OPTICS HOLD	Opens input to motors to prevent CDU creep.				SPST, toggle switch.
	Mode switch	Selects optics mode of operation.				Rotary, three-position switch.
	ZERO OPTICS	Optics and CDU resolvers are driven to zero. AGC register is set to all zeros.				Completed in approximately 60 seconds.
	MANUAL	Normal operating position enabling crew to position optics by means of optics hand controller.				In this position, the crew may select either the DIRECT or RESOLVED controller mode of operation.
	COMPUTER	Optics are automatically positioned by the AGC. Panel-mounted controls are disabled.				
	CONTROLLER SPEED switch	Provides attenuation of shaft and trunnion slew commands from optics hand controller.				Single-pole, three-position toggle switch. Attenuated output is applied to the MODE switch.
		Direct Mode Maximum Drive Rates				
		Trunnion Shaft				
	HI	8.8°/sec 17.3°/sec				
	MED	1.05°/sec 2.06°/sec				
	LOW	0.105°/sec 0.206°/sec				
		Resolved Mode Maximum Drive Rates				
		Trunnion Shaft				
	HI	8.8°/sec 8.8°/sec				
	MED	1.05°/sec 1.05°/sec				
	LOW	0.105°/sec 0.105°/sec				
	CONTROLLER MODE switch	Controls control stick output configuration.				SPDT, two-position, toggle switch.

LOWER EQUIPMENT BAY—PANEL 105

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-105 (Cont)	DIRECT	Applies control movements directly to CDUs. Right/left movement commands shaft rotation. Up/down movement commands trunnion angle increase/decrease.	G&N— OPTICS MN A MN B (MDC-22)	D-C main buses A and B	None	Target moves about arcs with speed of target movement varying with magnitude of angle.
	RESOLVED	Applies control stick movements to angular resolving circuits before applying commands to the CDUs.				Target moves horizontally and vertically at a linear rate.
LEB-106	Alarm condition indicators	Indicate abnormal conditions of computer operation.	G&N COMPUTER MN A MN B (MDC-22)	D-C main buses A and B		
	PROG ALM	AGC program error detected.			CG5020X (AGC alarm 1)	Observe REGISTER displays for numerical flag denoting malfunction.
	COUNTER FAIL	Counter increment instruction not executed or not completed within 10 msec of initiation.			CG5026X (AGC alarm 7)	If malfunction is counter-increment not completed within 10 msec, the TC TRAP indicator will illuminate.
	RUPT LOCK	No interrupt within 80 msec or interrupt not completed within 10 msec.			CG5028X (AGC alarm 9)	
	TC TRAP	Transfer control not executed within 10 msec or not completed within 10 msec.			CG5029X (AGC alarm 10)	
	SCALER FAIL	100-pps signal from scaler A of computer timing section failed.			CG5024X (AGC alarm 5)	
	PARITY FAIL	Parity error exists in data word from memory.			CG5025X (AGC alarm 6)	
	TM FAIL	Telemetry data rate incorrect or transmission incorrect.			CG5022X (AGC alarm 3)	
	CHECK FAIL	Incorrect DSKY operation attempted.			CG5023X (AGC alarm 4)	
	KEY RLSE	Computer program cannot proceed until operator releases DSKY control.			CG5027X (AGC alarm 8)	Not a failure. Operator will press KEY RELEASE pushbutton. Computer will resume computation.

LOWER EQUIPMENT BAY—PANELS 105 AND 106

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-106 (Cont)	ACTIVITY lights	Indicates activity the computer is presently engaged in.	G&N COMPUTER MN A MN B (MDC-22)	D-C main buses A and B		
	UPTL	Computer is receiving information from telemetry up-data link.			CG5021X (AGC alarm 2)	
	COMP	Computer is engaged in computation.				
	PROGRAM indicator	A two-digit display, indicating the number of the program (major mode) presently in progress.			None	On-board data provides definition of PROGRAM, NOUN, and VERB digits.
	VERB indicator	A two-digit display, indicating verb code selected.				
	NOUN indicator	A two-digit display, indicating noun code selected.				
	REGISTER 1 indicator	Displays contents of selected register or memory location. First component of extended data word, if applicable.				Displays may be commanded manually or by AGC.
	REGISTER 2 indicator	Displays contents of selected register or memory location. Second componet of extended data word, if applicable.				
	REGISTER 3 indicator	Displays contents of selected register or memory location. Third component of extended data word, if applicable.				
	BRIGHTNESS control	Varies brightness of electroluminescent data displays: REGISTER 1, REGISTER 2, and REGISTER 3.				
	KEY RELEASE pushbutton	Enables program control of DSKY. Releases operator control of DSKY circuits.				
	TEST ALARM pushbutton	Illuminates the alarm displays for bulb test.				

LOWER EQUIPMENT BAY—PANEL 106

10

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-106 (Cont)	ERROR RESET pushbutton	Resets alarm light relays. AGC recycles to start of current operation.	G&N COMPUTER MN A MN B (MDC-22)	D-C main buses A and B	None	Verifies alarms. Alarms triggered by transients should not repeat.
	Keyboard switches	Provide for entering data into or commanding operations of the AGC.				Pushbutton-type switches (selectors). Each key generates a specific 5-bit keycode denoting the instruction or number being selected.
	CLEAR	Places all zeros (logic 0s) in register being loaded.				
	VERB	Prepares computer to accept next two digits as verb code.				
	NOUN	Prepares computer to accept next two digits as noun code.				
	ENTER	Transfers contents of input register to central processor and initiates execution of instructions.				
	+	Denotes data to follow has positive decimal value.				
	-	Denotes data to follow has negative decimal value.				
	0 to 9	Enters binary equivalent of key pressed.				
LEB-107	AGC MODE switch		G&N COMPUTER MN A MN B (MDC-22)	D-C main buses A and B	None	SPDT, toggle switch
	ON	Applies normal power to AGC.				
	STANDBY	Applies power timing section of AGC.				In STANDBY, AGC maintains timing signals and other circuits necessary to restart. STANDBY operation is used to conserve electrical power.
LEB-120	Gas chromotograph controls		GAS ANAL—AC 1 (MDC-22)	A-C bus No. 1 (ØA)		The gas chromotograph (GFE) is serviced and installed by ground support personnel prior to flight crew ingress. The unit operates on 80-minute cycles, during which it identifies 28 gas components.

LOWER EQUIPMENT BAY—PANELS 106, 107, AND 120

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-120 (Cont)	CABIN AIR/AUTO/ SUIT AIR switch		GAS ANAL—AC 1 (MDC-22)	A-C bus No. 1 (ØA)	CTO 108K (Gas analysis suit and cabin)	
	CABIN AIR	Selects C/M cabin atmosphere for gas component sampling.				Switch set to CABIN AIR position on command from MSFN.
	AUTO	Permits suit circuit and C/M cabin atmospheres to be alternately sampled for gas components.				Normal position of switch.
	SUIT AIR	Selects suit circuit atmosphere for gas component sampling.				Switch set to SUIT AIR position on command from MSFN.
	START/OFF/ PREHEAT switch				None	Oven requires 7 watts for preheat period and 5 watts during operation.
	START	Applies a-c power to operational portion of gas chromatograph.				Normal position of switch after completion of preheat operation.
	OFF	Removes a-c power from warmup oven and operational portion of gas chromatograph.				
	PREHEAT	Applies a-c power to oven for required preheating prior to unit being placed in operation.				A minimum of 30 minutes warmup is required before switch is set to START position.
	AMPL-CAL switch	Push-type switch for use during bench calibration only.				
LEB-150	Pyro battery circuit breakers		N/A	Pyro battery A +23 vdc	None	Thermal, push-pull, manual reset type circuit breakers with the amperage rating of each denoted by a white placard.
	PYRO A group					
	SEQ A (20 amp)	Applies d-c power from pyro battery A to the MESC pyro bus when the MASTER EVENT SEQ CONT—switch A or B (MDC-24) is in the PYRO ARM position, and to the open contacts of the C/M RCSC pryo arm relay in the MESC. The relay is energized when the MASTER EVENT SEQ CONT—switch A or B (MDC-24) is in the PYRO ARM position to arm the pyro bus in the C/M RCSC. Applies pyro battery A voltage to DC INDICATORS switch.				Normally closed in flight. Opened if pyro battery A fails.
	BAT A TO PYRO BUS TIE (20 amp)	Applies d-c power from entry battery A to above sequencer circuits, and entry battery A voltage to PYRO BAT A position of DC INDICATORS switch.	N/A	Entry battery A +28 vdc	None	Normally open in flight. Closed if pyro battery A fails.

LOWER EQUIPMENT BAY— PANEL 120 AND 150

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LEB-150 (Cont)	PYRO B group SEQ B (20 amp)	Applies d-c power from pyro battery B to the MESC pyro bus when the MASTER EVENT SEQ CONT—switch A or B (MDC-24) is in the PYRO ARM position, and to the open contacts of the C/M RCSC pyro arm relay in the MESC. The relay is energized when the MASTER EVENT SEQ CONT—switch A or B (MDC-24) is in the PYRO ARM position to arm the pyro bus in the C/M RCSC. Applies pyro battery B voltage to DC INDICATORS switch.	N/A	Pyro battery B +23 vdc	None	Normally closed on flight. Open if pyro battery B fails.
	BAT B TO PYRO BUS TIE (20 amp)	Applies d-c power from entry battery B to above sequencer circuits. Applies entry battery B voltage to PYRO BAT B position of DC INDICATORS switch.		Entry battery B +28 vdc		Normally open in flight. Closed if pyro battery B fails.
	BAT CHGR-BAT C circuit breaker (5 amp)	Applies d-c power from battery C to: a. BATTERY CHARGER selector switch. b. D-C INDICATORS selector switch.		+28 vdc	CC0212V (D-C voltage postlanding battery)	
	BAT C PWR - POSTLANDING ENTRY circuit breaker (100 amp)	a. Applies d-c power from battery C through 25-amp POSTLDG - BAT C circuit breaker to flight and post-landing bus. b. Applies d-c power to 80-amp MAIN A - BAT C and MAIN B - BAT C circuit breakers.			CC0224C (D-C current postlanding battery)	
	BAT B PWR-ENTRY circuit breaker (100 amp)	Applies d-c power from entry battery B to battery bus B			CC0223C (D-C current battery B)	
	BAT A PWR-ENTRY circuit breaker (100 amp)	Applies d-c power from entry battery A to battery bus A.			CC0222C (D-C current battery A)	

LOWER EQUIPMENT BAY—PANEL 150

10

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
RHFEB-200	C/M RCS HTRS switch		RCS—HEATERS A MN B B MN A (MDC-21)	+28 vdc	None	Two-position toggle switch, used to pre-heat all C/M RCS engine valves in order to preclude propellant freezing when system is pressurized prior to entry.
	On (up)	Activates relays which apply +28 vdc to the direct coils of all C/M RCS engine solenoid valves.				
	OFF	Deactivates relays which remove +28 vdc from the direct coils of all C/M RCS engine solenoid valves.				Switch is enabled by CM PROP JETT-LOGIC switch (MDC-8) in the ON (up) position.
	DC VOLTS meter (auxiliary)	Indicates d-c voltage of selected measurement points.	N/A	Instrumentation signal conditioners	Refer to TEST SELECT switch (RHFEB-97)	Meter functions in conjunction with FUNCTION SELECT and TEST SELECT switches located directly below meter. Meter range is 0 to 5 vdc.
	FUNCTION SELECT switch	Selects A or B wafer of TEST SELECT switch.				FUNCTION SELECT switch in conjunction with the TEST SELECT switch makes possible 24 measurement points for the Aux DC VOLTS meter.
	A	Connects Aux DC VOLTS meter to wafer A of TEST SELECT switch.				
	OFF	Disconnects Aux DC VOLTS meter from circuit.				
	B	Connects Aux DC VOLTS meter to wafer B of TEST SELECT switch.				
	TEST SELECT switch	Selects two groups of 12 measurements, depending on position of FUNCTION SELECT switch, A or B.				TEST SELECT switch has two independent wafers, each containing 12 contacts.
	1 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 1 nitrogen regulator.			SC2060P (N_2 pressure F/C 1 regulated)	N_2 pressure range is 0 to 75 psia.
	1 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of C/M oxidizer valve, -P engine (No. 2) system A.			CR2205T (Temp ox. valve -P engine system A	Temperature range is -50° to +250°F.

RH FORWARD EQUIPMENT BAY—PANEL 200

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
RHFEB-200 (Cont)	2 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 2 nitrogen regulator.	N/A	Instrumentation signal conditioners	SC2061P (N_2 pressure F/C 2 regulated)	N_2 pressure range is 0 to 75 psia.
	2 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of C/M oxidizer valve, +Y engine (No. 7) system B.			CR2203T (Temp ox. valve +Y engine system B.	Temperature range is -50° to +250°F.
	3 (A)	Applies a d-c measurement to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 3 nitrogen regulator.			SC2062P (N_2 pressure F/C 3 regulated)	N_2 pressure range is 0 to 75 psia.
	3 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of C/M oxidizer valve, -P engine (No. 4) system B.			CR2204T (Temp ox. valve -P engine system B	Temperature range is -50° to +250°F.
	4 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 1 oxygen regulator.			SC2066P (O_2 pressure F/C 1 regulated)	O_2 pressure range is 0 to 75 psia.
	4 (B)	Applies a d-c measurement voltage to DC VOLTS meter which indicates temperature of C/M oxidizer valve cw engine (No. 11) system B.			CR2206T (Temp ox. valve cw engine system B)	Temperature range is -50° to +250°F.
	5 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 2 oxygen regulator.			SC2067P (O_2 pressure F/C 2 regulated)	O_2 pressure range is 0 to 75 psia.
	5 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates PIPA temperature.			CG2300T (PIPA temperature)	Temperature range TBD.
	6 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 3 oxygen regulator.			SC2068P (O_2 pressure F/C 3 regulated)	O_2 pressure range is 0 to 75 psia.

RH FORWARD EQUIPMENT BAY—PANEL 200

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
RHFEB-200 (Cont)	6 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates IRIG temperature.	N/A	Instrumentation signal conditioners	CG2301T (IRIG temperature)	Temperature range TBD.
	7 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 1 hydrogen regulator.			SC2069P (H_2 pressure F/C 1 regulated)	H_2 pressure range is 0 to 75 psia.
	7 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates IMU heater current.			CG2302C (IMU heater current)	IMU heater current range is from 0 to 5 amperes.
	8 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 2 hydrogen regulator.			SC2070P (H_2 pressure F/C 2 regulated)	H_2 pressure range is 0 to 75 psia.
	8 (B)	Applies a d-c measurement to Aux DC VOLTS meter which indicates IMU blower current.			CG2303C (IMU blower current)	IMU blower current range is from 0 to 5 amperes.
	9 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates output pressure of fuel cell No. 3 hydrogen regulator.			SC2071P (H_2 pressure F/C 3 regulated)	H_2 pressure range is 0 to 75 psia.
	9 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates pressure of battery compartment manifold.			CC0188P (Press. bat. compartment manifold)	Battery compartment manifold pressure range is 0 to 18 psia.
	10 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of F/C No. 1 radiator outlet.			SC2087T (Temp F/C 1 radiator outlet)	F/C 1 radiator outlet temperature range is -50° to +300°F.
	10 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of ECS radiator inlet.			SF0665T (ECS radiator inlet temp)	ECS radiator inlet temperature sensor range is +60° to +150°F. Minimum inlet temperature is 75°F.
	11 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of F/C No. 2 radiator outlet.			SC2088T (Temp F/C 2 radiator outlet)	F/C 2 radiator outlet temperature range is -50° to +300°F.

RH FORWARD EQUIPMENT BAY—PANEL 200

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
RHFEB-200 (Cont)	11 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of C/M oxidizer valve, ccw engine (No. 12) system A.	N/A	Instrumentation signal conditioner)	CR2201T (Temp ox. valve ccw engine system A)	Temperature range is -50 to +250°F.
	12 (A)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of F/C No. 3 radiator outlet.			SC2089T (Temp F/C 3 radiator outlet)	F/C 3 radiator outlet temperature range is -50° to +300°F.
	12 (B)	Applies a d-c measurement voltage to Aux DC VOLTS meter which indicates temperature of C/M oxidizer valve, -Y engine (No. 8) system A.			CR2202T (Temp ox. valve -Y engine system A)	Temperature range is -50° to +250°F.
RHFEB-207	SCIENTIFIC EQUIPMENT receptacle switch		SCIEN EQUIP. HATCH (MDC-22)	+28 vdc	None	
	ON	Applies d-c power from nonessential bus No. 2 to SCIENTIFIC EQUIPMENT receptacle for M09A experiment 16 mm sequence camera.				
	OFF	Removes d-c power from SCIENTIFIC EQUIPMENT receptacle.				
RHEB-201	WASTE MANAGEMENT panel		N/A	N/A	None	
	OVBD DRAIN valve					This shutoff valve is manually controlled by bar knob.
	DUMP	Connects WMS overboard dump line from selector valve to outside atmosphere, permitting dumping urine and fecal odors overboard.				The valve is operated in conjunction with the SELECTOR valve. Valve is set to DUMP position after setting SELECTOR valve to URINE FECES position. Upon completion of dumping or venting operation, OVBD DRAIN valve is set to OFF position before SELECTOR valve is set to OFF position.
	OFF	Closes WMS overboard dump line to outside atmosphere.				
	SELECTOR valve					This valve is manually controlled by bar knob.

RH FORWARD EQUIPMENT BAY—PANELS 200 AND 207
RH EQUIPMENT BAY—PANEL 201

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
RHFEB-201 (Cont)	URINE FECES	a. Connects waste management dump line to overboard dump line. b. Closes switch that applies a-c power to WMS blower.	ECS-CABIN AIR FAN-1-AC 1 ØA ØB ØC (MDC-22)	A-C bus No. 1	None	Blower operation in this valve position is not functional due to WMS modifications. Valve is placed to URINE FECES position for dumping urine collected in the Urine Sample Volume Measurement System (USVMS), or for venting odors originating during fecal canister usage. This valve position is selected in conjunction with the OVBD DRAIN valve. Valve is set to URINE FECES position before setting OVBD DRAIN valve to DUMP position. Upon completion of dumping or venting operation, SELECTOR valve is set to OFF position after OVBD DRAIN valve is set to OFF position.
	VACUUM	a. Connects vacuum cleaner line to WMS blower. b. Closes switch that applies a-c power to WMS blower.				With valve to VACUUM position, WMS blower is activated and blower exhaust is directed into C/M cabin.
	OFF	a. Closes all valve ports, deactivating waste management system. b. Removes a-c power from WMS blower.	None	None		
RHEB-202	WASTE MANAGEMENT ACCESS panel		N/A	N/A	None	
	BATTERY VENT valve					This valve is manually controlled by a bar knob.
	VENT	Permits gases generated by C/M batteries to be vented into the urine/water dump line.				Normal position of valve is VENT to dump overboard gases generated by C/M batteries.
	CLOSE	Shuts off the venting of C/M batteries into the urine/water dump line.				Valve is closed in event of battery vent system leakage, which would permit C/M atmosphere leakage to space.
RHEB-203	MAIN A circuit breakers		N/A	+28 vdc	None	
	BAT BUS A (80 amp)	Applies d-c power from battery bus A to d-c main bus A through contacts of main bus tie bat A motor switch.				

RH EQUIPMENT BAY—PANELS 201, 202, AND 203

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
RHEB-203 (Cont)	BAT C (80 amp)	Applies d-c power from battery C to d-c main bus A through contacts of main bus tie bat B motor switch.	N/A	+28 vdc	None	
	MAIN B circuit breakers					
	BAT C (80 amp)	Applies d-c power from battery C to d-c main bus B through contacts of main bus tie bat A motor switch.				
	BAT BUS B (80 amp)	Applies d-c power from battery bus B to d-c main bus B through contacts of main bus tie bat B motor switch.				
	POST LDG circuit breakers					These circuit breakers remain disengaged during flight and are engaged (pushed in) prior to CSM separation.
	BAT BUS A (25 amp)	Applies d-c power from battery bus A to flight and postlanding bus.				
	BAT BUS B (25 amp)	Applies d-c power from battery bus B to flight and postlanding bus.				
	BAT C (25 amp)	Applies d-c power from 100-amp BAT C PWR circuit breaker to flight and postlanding bus.				
	MAIN A (10 amp)	Applies power from d-c main bus A to flight and postlanding bus.				
	MAIN B (10 amp)	Applies power from d-c main bus B to flight and postlanding bus.				
	INVERTER PWR circuit breakers					
	NO. 1 MN A (70 amp)	Applies power from d-c main bus A to inverter No. 1.				
	No. 2 MN B (70 amp)	Applies power from d-c main bus B to inverter No. 2.				

RH EQUIPMENT BAY—PANEL 203

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
RHEB-203 (Cont)	NO. 3 group		N/A	+28-vdc	None	
	MN A (70 amp)	Applies power from d-c main bus A to inverter No. 3.				
	MN B (70 amp)	Applies power from d-c main bus B to inverter No. 3.				
RHEB-204	INST PWR CONT circuit breaker		INSTRU-MENTS—ESS MN A and/or MN B (MDC-22)	D-C main bus A or d-c main bus B	None	
	ESSENTIAL group					
	1 (7.5 amp)	Applies +28-vdc power to RCS and structural operational instrumentation.				
	2 (7.5 amp)	Applies +28-vdc power to ELS, EPS, and ECS surge tank operational instrumentation.				
	3 (7.5 amps)	Applies +28-vdc power to operational instrumentation in S/M.				
	4 (5 amp)	(Spare)				
	NON ESSENTIAL group		INSTRU-MENTS—NONESS (MDC-22)	Non-essential bus No. 1		
	5 (5 amp)	(Spare)				
	6 (5 amp)	(Spare)				
	7 (5 amp)	(Spare)				
	8 (10 amp)	Applies 28-vdc power to flight qualification instrumentation.				
	9 (10 amp)	Applies 28-vdc power to flight qualification instrumentation and to ECS radiator outlet temperature sensors.	INSTRU-MENTS—NONESS (MDC-22)	Non-essential bus No. 1	None	
	10 (10 amp)	(Spare)				
RHEB-205	UPRIGHTING SYSTEM circuit breakers		N/A	+28-vdc	None	
	COMPR NO. 1 (25 amp)	Applies d-c power from battery bus A to the control motor switch of compressor No. 1.				The compressors are turned on and off by manual actuations of the POST LANDING—FLOAT BAG switches on MDC-25.
	COMPR NO. 2 (25 amp)	Applies d-c power from battery bus B to the control motor switch of compressor No. 2.				These circuit breakers remain disengaged during flight and are engaged only after landing.

RH EQUIPMENT BAY—PANELS 203, 204, AND 205

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
RHEB-206	ECS STEAM DUCT HTR circuit breakers		N/A	+28 vdc	None	
	MN A (5 amp)	Applies power from d-c main bus A to the following: a. Steam duct heater b. Urine/water dump nozzle heater.				There are no switches to control the operation of the heaters. When the circuit breakers are activated, power is applied directly to corresponding 3-watt heating elements of the steam duct heaters, and to the 5.7-watt urine/water dump nozzle heater. Normally, both the steam duct and urine/water dump nozzle heaters are in operation for the total length of the mission.
	MN B (5 amp)	Applies power from d-c main bus B to the following: a. Steam duct heater b. Urine/water dump nozzle heater.				
RHEB-208	INV PHASE LOCK	Central timing signal to inverters supplied through inverter phase synchronizer to provide in-phase a-c power to a-c bus 1 and 2 when a separate inverter is powering each a-c bus.	None	A-C ØB of inverter 1, 2, or 3	None	Normal position during flight (PSU draws power with control switch in either position).
	OFF	Provides central timing signal directly to inverters.				Position if phase synchronizer unit fails.
LHFEB-300, -301, -302	Suit flow control valve		N/A	N/A	None	There are three suit connector assemblies in the cabin. Although they vary slightly in appearance, their function is identical, thus suit flow control valve data is covered once. The three suit connector assemblies are located at LHFEB-300, -301, and -302, and are controlled by sliding levers.
	OFF	Closes valve, shutting off flow of oxygen to suit connector.				Suit hose may be connected or disconnected only with the valve in the OFF position. The number of suit flow control valves placed to either the CABIN FLOW or the SUIT FULL FLOW positions should always equal the number of crewmen in the C/M.

RH EQUIPMENT BAY—PANELS 206, 208
LH FORWARD EQUIPMENT BAY—PANELS 300, 301, AND 302

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHFEB-300, -301, -302 (Cont)	CABIN FLOW	Partially opens valve, permitting oxygen flow into cabin (or suit) at a rate compatible to the requirements of one crewman.	N/A	N/A	None	This valve position may be used for reduced flow to the PGA (suit connected), or for normal flow to the cabin for shirtsleeve mode (suit not connected). Suit hose is not disconnected from suit connector panel when going to shirtsleeve mode.
	SUIT FULL FLOW	Fully opens valve, permitting oxygen flow to suit at a rate compatible to the requirements of one crewman.				With the valve in SUIT FULL FLOW position (suit connected), the flow is at the rate of 17 lb/hr minimum. However, the flow rate will vary along the suit flow adjustment range from SUIT FULL FLOW to CABIN FLOW positions.

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHFEB-300, -301, -302	CONTROL LEVER RELEASE	Permits free movement of valve control lever by releasing lever locking mechanism.	N/A	N/A	None	When release pushbutton is pressed, locking detent is removed from notch. The release pushbutton must be pressed to permit movement of the control lever in and out of the OFF position. This prevents inadvertent valve movement out of the closed position when suit hose is disconnected, and into the closed position when the suit hose is connected.
LHFEB-303	CABIN TEMP valve					
	H (heat)	Manual backup mode position of cabin temperature control valve to increase cabin temperature.	N/A	N/A	None	Motor-operated valve is manually controlled by integral knob. Rotational movement from H to C is approximately 1/2 turn. Backup mode control knob is used in event of malfunction of cabin temperature control components. This is a dual valve on a single shaft permitting water-glycol flow to heat exchanger to be regulated. Rotation toward the H (heat) position results in proportional increase in cabin temperature by directing warm water-glycol to cabin heat exchanger. There is a definite time lag in cabin temperature response following a manual adjustment: therefore, close coordination between manual adjustments and the TEMP-CABIN indicator (MDC-13) is not necessary.
	C (cool)	Manual backup mode position of cabin temperature control valve to decrease cabin temperature.				Rotation towards the C (cool) position results in proportional decrease in cabin temperature by directing cool water-glycol to cabin heat exchanger. There is a definite time lag in cabin temperature response following a manual adjustment; therefore, close coordination between manual adjustments and the TEMP-CABIN indicator (MDC-13) is not necessary.
	Cabin air control louver	Manually operated louver for adjusting direction of airflow from cabin air fans.				

LH FORWARD EQUIPMENT BAY—PANELS 300, 301, 302, AND 303

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHFEB-304	DRINKING WATER SUPPLY shutoff valve		N/A	N/A	None	Shutoff valve manually controlled by T-handle tool.
	ON	Permits flow of potable water to water delivery unit.				Normal position of valve is on.
	OFF	Turns off flow of potable water to water delivery unit.				Valve is closed in event of leak in water delivery unit.
LHFEB-305	FOOD PREPARATION WATER supply unit					
	COLD valve	Upon actuation, permits metered amount of cold water (50°F) to food reconstitution nozzle.	N/A	N/A	None	Cold or hot water is metered at a rate of 1.00±0.05 ounce per valve actuation. Upon release, valves return to closed position.
	HOT valve	Upon activation, permits metered amount of hot water (154±4°F) to food reconstitution nozzle.				
LHFEB-306	GMT clock	Mission elapsed time indicator.	N/A	N/A	None	This clock has a 24-hour dial face with standard second, minutes, and hour hands. A time-set screw, at the bottom left of the dial face, is used to synchronize the clock with Greenwich mean time.
	TO EVENT and FROM EVENT timers	Provides crew with a means of monitoring and timing events.				Each timer has a 10-hour dial face with second, minute, hour and 10-hour hands. A knob at the bottom left of each timer is used to set the timer hands. Each timer can be reset, started, or stopped by a push-control at the top right of the timer.
LHFEB-318	SCIENTIFIC EQUIPMENT receptacle switch		SCIEN EQUIP. HATCH (MDC-22)	+28 vdc	None	
	ON	Applies d-c power from nonessential bus No. 2 to SCIENTIFIC EQUIPMENT receptacle for COAS and 16 mm sequence camera.				
	OFF	Removes d-c power from SCIENTIFIC EQUIPMENT receptacle.				

LH FORWARD EQUIPMENT BAY–PANELS 304, 305, 306, AND 318

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-307	CABIN PRESSURE RELIEF valves		N/A	N/A	None	There are two cabin pressure-relief valves that normally operate automatically to provide positive and negative cabin pressure relief. The upper manual control (three valve positions) and the lower manual control (four valve positions) can override their corresponding relief valves to the CLOSE and NORMAL positions, while only the lower manual control can override its corresponding relief valve to the DUMP position. Horizontal pressure must be applied to move controls out of detent.
	CLOSE	Manual override position to close either cabin pressure-relief valve.				Both relief valves are closed for prelaunch checkout and during C/M RCS propellant dump, while either one or both relief valves are closed in flight in event of valve malfunction.
	NORMAL	Manual override position to partially restrict travel of either cabin pressure-relief valve in the automatic mode.				Normal position of controls for flight period between ascent and entry. Valves are limited to the partially open position to prevent rapid cabin decompression in event valves fail open.

LH EQUIPMENT BAY—PANEL 307

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-307 (Cont)	BOOST ENTRY	Neutral position of override mechanism to permit both cabin pressure-relief valves full travel in the automatic mode.	N/A	N/A	None	Except for time required to dump RCS propellants during descent, both controls are normally set to the BOOST ENTRY position for the ascent and entry phases.
	DUMP	Manual override position of lower control to open corresponding cabin pressure-relief valve.				Valve is opened to intentionally vent cabin to outside atmosphere in event of contamination or fire. Mechanical safety latch must be off to set lever in dump position.
	GLYCOL TO RAD valve					Shutoff valve is manually controlled by T-handle tool.
	OPEN	Permits flow of water-glycol from C/M to space radiators in S/M.				Normal position of valve is OPEN.
	CLOSE	Shuts off flow of water-glycol from C/M to space radiators in S/M.				Valve is closed prior to CSM separation to shut off water-glycol flow to S/M.
	GLYCOL RESERVOIR controls					
	INLET valve					Shutoff valve is manually controlled by T-handle tool.
	OPEN	Permits flow of water-glycol from system into reservoir.				Valve is opened to direct water-glycol flow through reservoir during prelaunch and ascent phases and is operated in conjunction with GLYCOL RESERVOIR OUTLET and GLYCOL RESERVOIR BYPASS valves.
	CLOSE	Shuts off flow of water-glycol from system into reservoir.				Valve is closed upon completion of ascent phase to isolate reservoir from system.
	BYPASS valve					Shutoff valve is manually controlled by T-handle tool.
	OPEN	Opens bypass line permitting flow around water-glycol reservoir.				Valve is opened upon completion of ascent phase to bypass and isolate reservoir from system, and is operated in conjunction with GLYCOL RESERVOIR OUTLET and GLYCOL RESERVOIR INLET valves.
	CLOSE	Closes bypass line that permits flow around water-glycol reservoir.				Valve is closed to direct water-glycol flow through reservoir during prelaunch and ascent phases.

LH EQUIPMENT BAY—PANEL 307

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-307 (Cont)	OUTLET valve		N/A	N/A	None	Shutoff valve is manually controlled by T-handle tool.
	OPEN	Permits flow of water-glycol from outlet of reservoir into system.				Valve is opened to direct water-glycol flow through reservoir during prelaunch and ascent phases, and is operated in conjunction with GLYCOL RESERVOIR INLET and GLYCOL RESERVOIR BYPASS valves.
	CLOSE	Shuts off flow of water-glycol from outlet of reservoir into system.				Valve is closed upon completion of ascent phase to isolate reservoir from system.
	OXYGEN controls					
	ENTRY valve					Shutoff valve is manually controlled by T-handle tool.
	ON	Permits flow from 1-lb entry oxygen tank into C/M oxygen supply subsystem.				Valve furnishes 1 lb of oxygen as a redundant supply to the normal surge tank quantity of 3.7 lb.
	OFF	Shuts off flow between 1-lb entry tank and C/M oxygen supply subsystem.				
	FILL	Permits flow from C/M oxygen supply subsystem to bypass the check valve and thus fill the 1-lb entry tank.				Tank filled to approximately 900 psig at a rate of 0.66 pounds/minute.
	S/M SUPPLY valve					Shutoff valve is manually controlled by T-handle tool.
	ON	Permits flow of oxygen to C/M from supply in S/M.				Normal position of valve is ON.
	OFF	Shuts off flow of oxygen to C/M from supply in S/M.				Valve is closed prior to CSM separation to prevent C/M entry oxygen supply from flowing overboard in event of check valve failure.
	SURGE TANK valve					Shutoff valve is manually controlled by T-handle tool.
	ON	Permits flow of oxygen to and from surge tank.				Normal position of valve is ON, permitting surge tank to carry out function of supplying additional oxygen

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-307 (Cont)			N/A	N/A	None	beyond the normal maximum flow capability from the S/M. and for entry. Set O_2 PRESS IND switch (MDC-13) to SURGE TANK to obtain indication.
	OFF	Shuts off flow of oxygen to and from surge tank.				Valve is closed to preserve surge tank supply in event cryogenic oxygen tank pressure drops to 900 psig or below.
LHEB-308	SURGE TANK PRESSURE RELIEF shutoff valve		N/A	N/A	None	Shutoff valve is manually controlled by T-handle tool. Rotational movement from OPEN to close is 1/4 turn.
	OPEN (cs)	Opens line from surge tank to relief valve permitting relief function.				OPEN position enables relief valve to function when surge tank pressure increases to 1045±25 psig.
	Close (ccw)	Closes line from surge tank to relief valve eliminating relief function.				Valve is closed only if surge tank relief valve fails open.
LHEB-309	GLYCOL PRESS RELIEF BYPASS valves		N/A	N/A	None	Except for ascent and entry, one pressure-relief valve is selected for use at a time, with the second valve for standby redundancy.
	Valve 1					Shutoff valve is manually controlled by T-handle tool.
	ON	Permits flow of water-glycol to No. 1 water-glycol pressure-relief valve.				Normal position of valve No. 1 when valve No. 2 is OFF.
	OFF	Shuts off flow of water-glycol to No. 1 water-glycol pressure-relief valve.				Normal position of valve No. 1 when valve No. 2 is ON, or in event of malfunction of No. 1 pressure-relief valve:
	Valve 2					Shutoff valve is manually controlled by T-handle tool.
	ON	Permits flow of water-glycol to No. 2 water-glycol pressure-relief valve.				Normal position of valve No. 2 when valve No. 1 is OFF.
	OFF	Shuts off flow of water-glycol to No. 2 water-glycol pressure-relief valve.				Normal positon of valve No. 2 when valve No. 1 is ON, or in event of malfunction of No. 2 pressure relief valve.

LH EQUIPMENT BAY—PANELS 307, 308, AND 309

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-310	O_2 DEMAND REGULATOR		N/A	N/A	None	Valve is manually controlled by T-handle tool.
	1	Directs regulated oxygen (100±10 psig) to No. 1 suit demand pressure regulator.				Valve set to position 1 in event of malfunction of No. 2 demand pressure regulator.
	1 & 2	Directs regulated oxygen (100±10 psig) to No. 1 and No. 2 suit demand pressure regulators.				Both demand pressure regulators are selected for simultaneous use under normal conditions for redundancy in event of one regulator malfunctioning.
	2	Directs regulated oxygen (100±10 psig) to No. 2 suit demand pressure regulator.				Valve set to position 2 in event of malfunction of No. 1 demand pressure regulator.
	OFF	Shuts off regulated oxygen (100±10 psig) to No. 1 and No. 2 suit demand pressure regulators.				Valve set to OFF position only if both suit demand pressure regulators malfunction.
	SUIT TEST valve					Valve is operated by an integral lever.
	PRESS	Routes regulated oxygen flow (100±10 psig) directly into suit circuit through a pressurization orifice at a maximum buildup rate of 4 psig per minute for PGA/suit circuit tests.				With valve in PRESS position, suit circuit will increase 4.25 psia above the nominal pressure of 5.0±0.3 psia. Approximately 75 seconds must be allowed for suit circuit pressure to reach maximum. This test may be performed at ground checkout or during flight.
	DEPRESS	Shuts off O_2 flow to suit circuit upon completion of test, permitting reduction of pressure buildup at an average bleedoff rate of 4 psig per minute.				Approximately 75 seconds must be allowed for the increased suit circuit pressure to bleed back to the nominal 5.0±0.3 psia.
	OFF	Permits normal O_2 flow to suit circuit through suit demand pressure regulator.				Normal position of valve when not conducting a PGA/suit circuit test. Valve must not be set to off position before suit circuit has returned to nominal pressure.
	SUIT HT EXCH switch					Regardless of switch position, the SUIT EVAP switch (MDC-13) must be in AUTO position for automatic control of suit circuit temperature.

LH EQUIPMENT BAY—PANEL 310

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-310 (Cont)	GLY/EVAP	Places suit circuit temperature control complex in full automatic mode, whereby, cooling is accomplished either by water-glycol or water evaporation.	N/A	N/A	None	In the GLY/EVAP position, the switch is open. This prevents shorting across the circuit of the suit heat exchanger air outlet temperature sensor, and permits the sensor to automatically activate the water evaporation mode if the temperature reaches 60°F or more.
	EVAP	Overrides full automatic mode of suit heat exchanger temperature control complex by positioning the water-glycol diverter valve in the bypass position, thereby, initiating the automatically controlled water evaporation cooling mode.				In the EVAP position, the switch is closed. This shorts across the circuit of the suit exchanger air outlet temperature sensor, and creates the same effect as an overtemp condition (above 60°F) on this sensor. This switch position is selected for cabin cold-soak operation, or if suit temperature control complex malfunctions.
LHEB-311	SUIT EVAP GLYCOL valve		N/A	N/A	None	Motor-operated valve is manually controlled by T-handle tool.
	ON	Manual override position of water-glycol diverter valve, routing coolant flow to the suit heat exchanger for suit circuit cooling.				Normal position of valve is ON to permit the automatic suit temperature control complex to select the water-glycol or water evaporation cooling mode.
	OFF	Manual override position of water-glycol diverter valve, bypassing coolant flow around suit heat exchanger and activating water evaporation cooling mode.				Valve is set to OFF position for backup cabin cold-soak operation or in event of suit temperature control malfunction. Movement of diverter valve mechanically operates switch that activates water evaporation cooling mode.

LH EQUIPMENT BAY—PANELS 310 AND 311

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-311 (Cont)	SUIT FLOW RELIEF valve		N/A	N/A	None	Valve is manually controlled by T-handle tool.
	AUTO	Removes override lever from poppet valve, permitting automatic pressure-relief action to take place at a ΔP of 5 (+0. 6, -0. 2) inches H_2O.				Normal position of valve is AUTO to maintain constant suit flow in event of suit circuit flow resistance fluctuations.
	OFF	Applies override lever to poppet valve holding valve in closed position.				Valve is manually closed in event of its failure to close when in the automatic mode.
	GLYCOL EVAP TEMP IN valve					Motor-operated valve is manually controlled by T-handle tool. Rotational movement from HEAT to cool is just over 1/4 turn.
	HEAT (ccw)	Manual backup mode position of water-glycol temperature control valve to increase temperature of water-glycol entering evaporator.				Backup mode is used in event of malfunction of water-glycol temperature control components. Rotation toward the HEAT position results in a proportional temperature increase by changing the mixture ratio of hot-to-cold water-glycol. Close coordination between valve adjustments and GLY EVAP — OUTLET TEMP indicator (MDC-13) is necessary to obtain correct water-glycol temperature.
	Cool (ccw)	Manual backup mode position of water-glycol temperature control valve to decrease temperature of water-glycol entering evaporator.				Rotation toward the cool position results in a proportional temperature decrease by changing the mixture ratio of cold-to-hot water-glycol. Close coordination between valve adjustments and GLY EVAP — OUTLET TEMP indicator is necessary to obtain correct water-glycol temperature.
	H_2O ACCUMULATOR selector valves					Valves manually controlled by T-handle tool.
	Valve 1					
	MAN	Routes regulated oxygen (100±10 psig) to No. 1 cyclic accumulated, bypassing solenoid shutoff valve.				Valve position is selected only when No. 2 accumulated has failed and No. 1 solenoid shutoff valve cannot be operated automatically or by

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-311 (Cont)			N/A	N/A	None	manually selected electrical impulse. Valve will then be positioned to MAN for approximately 10 seconds every 30 minutes.
	OFF	Shuts off regulated oxygen (100±10 psig) to solenoid shutoff valve and bypass line to No. 1 cyclic accumulator.				
	RMTE	Routes regulated oxygen (100±10 psig) to solenoid shutoff valve of No. 1 cyclic accumulator.				Normal position of valve is RMTE, permitting automatic (CTE) or manually selected electrical impulse to operate solenoid shutoff valve. Manually selected electrical operation is used in event of automatic control unit malfunction.
	Valve 2					Valve manually controlled by T-handle tool.
	MAN	Routes regulated oxygen (100±10 psig) to No. 2 cyclic accumulator, bypassing solenoid shutoff valve.				Valve position is selected only when No. 1 accumulator has failed and No. 2 solenoid shutoff valve cannot be operated automatically or by manually selected electrical impulse. Valve will be positioned to MAN for approximately 10 seconds every 30 minutes.
	OFF	Shuts off regulated oxygen (100±10 psig) to solenoid shutoff valve and bypass line to No. 2 cyclic accumulator.				
	RMTE	Routes regulated oxygen (100±10 psig) to solenoid shutoff valve of No. 2 cyclic accumulator.				Normal position of valve is RMTE permitting automatic CTE or manually selected electrical impulse to operate solenoid shutoff valve. Manually selected electrical operation is used in event of automatic control unit malfunction.
	GLYCOL RESERVE valve					Shutoff valve is manually controlled by T-handle tool.
	ON	Permits flow of water-glycol from reservoir into system.				Valve is opened to refill water-glycol system following the discovery and isolation of a leak.

LH EQUIPMENT BAY—PANEL 311

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-311 (Cont)	OFF	Shuts off flow of water-glycol from reservoir into system.	N/A	N/A	None	Normal position of valve is OFF to isolate water-glycol reservoir from system.
	EVAP H_2O valve					Valve is manually controlled by T-handle tool.
	AUTO	Permits water flow to water-glycol evaporator solenoid-operated water inflow control valve.				Normal position of valve.
	OFF	Shuts off water flow to water-glycol evaporator water inflow control valve.				Valve is manually closed to prevent flooding water-glycol evaporator in event solenoid valve facts open.
	SUIT EVAP selector valve					Valve is manually controlled by T-handle tool.
	AUTO	Routes flow of water to solenoid-operated water inflow control valve for suit circuit evaporative cooling.				Valve set to AUTO position during all automatic suit temperature control operations.
	OFF	Shuts off flow of water to water inflow control valve and bypass line to suit evaporator.				Valve set to OFF position in event water inflow control valve fails open.
	MAN	Bypasses flow of water around water inflow control valve, routing it directly into the suit evaporator.				Valve set to MAN position for manual backup mode of evaporative cooling. This method is effective only if the steam-pressure control valve is in any position other than close. A malfunction in the temperature control components could leave the steam pressure control valve in any position.
LHEB-312	GLYCOL ACCUMULATOR shutoff valve		N/A	N/A	None	Shutoff valve is manually controlled by torque wrench and 10-inch driver.
	On (ccw)	Permits flow of water-glycol from system to and from water-glycol accumulator.				Normal position of valve is on, permitting accumulator to carry out function of damping surges and oscillations, and maintaining pump inlet pressure.
	OFF (cw)	Shuts off flow of water-glycol from system to water-glycol accumulator.				Valve is closed to isolate a leaking accumulator from water-glycol system.

LH EQUIPMENT BAY—PANELS 311 AND 312

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-313	CO_2-odor absorber diverter valve		N/A	N/A	None	The diverter valve linkage includes a mechanical interlock that assures cover removal of only the canister that has been isolated from the suit flow.
	UP	Shuts off suit circuit flow to canister B and diverts the full flow to canister A.				
	Center	Neutral position of valve permitting equal suit circuit flow to each canister.				
	Down	Shuts off suit circuit flow to canister A and diverts the full flow to canister B.				
LHEB-314	MAIN REGULATOR selector valve		N/A	N/A	None	Selector valve is manually controlled by integral knob.
	NORMAL	Directs supply of oxygen from S/M to No. 1 and No. 2 main pressure regulator and relief valves.				Regulators No. 1 and No. 2 are selected for simultaneous use under normal conditions.
	1	Directs supply of oxygen from S/M to No. 1 main pressure regulator and relief valve.				Valve set to position 1 in event of malfunction of No. 2 main pressure regulator and relief valve.
	OFF	Shuts off supply of oxygen from S/M to No. 1 and No. 2 main pressure regulator and relief valves.				
	2	Directs supply of oxygen from S/M to No. 2 main regulator and relief valve.				Valve set to position 2 in event of malfunction of No. 1 main pressure regulator and relief valve.
	WATER & GLYCOL TANKS PRESSURE controls					
	REGULATOR-SELECTOR INLET valve					Selector valve is manually controlled by T-handle tool.
	NORMAL	Directs regulated oxygen (100±10 psig) to No. 1 and No. 2 tank pressure regulators for reduction to 20±-psig tank pressure.				Both tank pressure regulators are selected for simultaneous use under normal conditions for redundancy in event of one regulator malfunctioning. **Caution** If the SELECTOR INLET valve is placed to position 1 or 2, the SELECTOR OUTLET valve must be placed to the corresponding position (or NORMAL) to prevent shutting off supply of oxygen for pressurizing the water tanks and water-glycol reservoir.

LH EQUIPMENT BAY—PANELS 313 AND 314

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-314 (Cont)	1	Directs regulated oxygen (100±10 psig) to No. 1 tank pressure regulator for reduction to 20±2-psig tank pressure.	N/A	N/A	None	Valve is set to position 1 in event of malfunction of No. 2 tank pressure regulator.
	OFF	Shuts off regulated oxygen (100±10 psig) to No. 1 and No. 2 tank pressure regulators.				With valve in OFF position, tank pressurization system is isolated from regulated oxygen supply.
	2	Directs regulated oxygen (100±10 psig) to No. 2 tank pressure regulator for reduction to 20±2-psig tank pressure.				Valve is set to position 2 in event of malfunction of No. 1 tank pressure regulator.
	RELIEF-SELECTOR OUTLET valve					Selector valve is manually controlled by T-handle tool.
	NORMAL	Directs oxygen pressure from potable and waste water tanks to No. 1 and No. 2 tank pressure regulator relief valves.				Both tank pressure-relief valves are selected for simultaneous use under normal conditions for redundancy in event of one relief valve malfunctioning. There is no meter to indicate pressurization of potable and waste water tanks and glycol reservoir. **Caution** If the SELECTOR OUTLET valve is placed to position 1 or 2, the SELECTOR INLET valve must be placed to the corresponding position (or NORMAL) to prevent shutting off supply of oxygen for pressurizing the water tanks and water-glycol reservoir.
	1	Directs oxygen pressure from potable and waste water tanks to No. 1 tank pressure regulator relief valve.				Valves set to position 1 in event of malfunction of No. 2 tank pressure regulator relief valve.
	OFF	Shuts off oxygen pressure from potable and waste water tanks to No. 1 and No. 2 tank pressure regulator relief valves.				With valve in OFF position, any increase in oxygen pressure is trapped and cannot be relieved.
	2	Directs oxygen pressure from potable and waste water tanks to No. 2 tank pressure regulator relief valve.				Valve set to position 2 in event of malfunction of No. 1 tank pressure regulator relief valve.
	PLSS FILL valve	Manual shutoff valve controlling filling of PLSS tank with oxygen from supply in surge tank.				Valve is manually controlled by integral T-handle. Rotational movement from open to CLOSE is approximately 2 turns.

LH EQUIPMENT BAY—PANEL 314

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-314 (Cont)			N/A	N/A	None	Normal position of valve is closed. Valve is opened when used in conjunction with adjacent PLSS FILL connector.
	EMERGENCY CABIN PRESSURE selector valve					Selector valve is manually controlled by T-handle tool.
	NORMAL	Directs regulated oxygen (100±10 psig) to No. 1 and No. 2 emergency cabin pressure regulators.				Both emergency regulators are selected for simultaneous use under normal conditions, for redundancy in event of emergency decompression as a result of cabin wall puncture.
	1	Directs regulated oxygen (100±10 psig) to No. 1 emergency cabin pressure regulator.				Valve set to position 1 in event of malfunction of No. 2 emergency regulator.
	OFF	Shuts off regulated oxygen (100±10 psig) to No. 1 and No. 2 emergency cabin pressure regulators				Valve is set to OFF position whenever all crewmen are suited. With valve in OFF position, both emergency regulators are isolated from regulated oxygen supply.
	2	Directs regulated oxygen (100±10 psig) to No. 2 emergency cabin pressure regulator.				Valve set to position 2 in event of malfunction of No. 1 emergency regulator.
	PRESS TO TEST pushbutton	Permits No. 1 and No. 2 emergency cabin pressure regulators to be simultaneously tested for operational verification.				With pushbutton pressed, vents to reference pressure chambers of both regulators are closed off. This allows an artificial reference pressure to build up which results in regulator operation. This test may be accomplished at ground checkout or during flight.
	CABIN REPRESS manual valve					Shutoff valve is manually controlled by integral knob. Rotational movement from OPEN to close is approximately 3/4 turn.
	OPEN (cw)	Directs oxygen into cabin up to the maximum flow rate of 7.2 lb per hr. Poppet-type valve is an independent unit of the cabin pressure regulator assembly.				Both normal cabin pressure regulators are in use simultaneously and cannot be selected or turned off. In the event both regulators fail in the closed or fail-safe position, the manual shutoff valve is used to maintain cabin pressure. Valve is also used to repressurize cabin after decompression.
	Close (ccw)	Shuts off oxygen flow into cabin.				

LH EQUIPMENT BAY—PANEL 314

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-314 (Cont)	TOOL STORAGE receptacle	Flush-mounted receptacle for storing universal T-handle tool used in positioning numerous manually operated valves.	N/A	N/A	None	A second T-handle tool is stowed in socket of suit circuit DIRECT O_2 metering valve (MDC-24) for use in positioning those valves accessible to crewman in LH couch.
LHEB-315	WASTE TANK SERVICING valve		N/A	N/A	None	Shutoff valve is manually controlled by T-handle tool.
	OPEN	Permits flow of water into waste water tank from ground servicing connection.				Valve is opened when used in conjunction with adjacent WASTE TANK SERVICING connector.
	CLOSE	Shuts off flow of water into waste water tank from ground servicing condition.				
	PRESSURE RELIEF selector valve					Selector valve is manually controlled by integral lever.
	BOTH	Directs flow of excess potable or waste water to No. 1 and No. 2 pressure relief valves.				Both pressure relief valves are selected for simultaneous use under normal conditions, for redundancy in event of one relief valve malfunctioning.
	1	Directs flow of excess potable or waste water to No. 1 pressure relief valve.				Valve set to position 1 in event No. 2 pressure relief valve malfunctions.
	OFF	Shutoff flow of excess potable and waste water to No. 1 and No. 2 pressure relief valves.				With valve in OFF position, excess water cannot be dumped overboard. Unless both relief valves fail to open, this valve position is used for ground checkout only.
	2	Directs flow of excess potable and waste water to No. 2 pressure relief valve.				Valve set to position 2 in event No. 1 pressure relief valve malfunctions.
	POTABLE TANK INLET valve					Shutoff valve is manually controlled by T-handle tool.
	OPEN	Permits flow of water from fuel cells into potable water tank.				Normal position of valve is OPEN.
	CLOSE	Shuts off flow of water from fuel cells into potable water tank.				Valve set to CLOSE position to isolate potable water tank in event water from fuel cells becomes contaminated.

LH EQUIPMENT BAY—PANELS 314 AND 315

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
LHEB-315 (Cont)	WASTE TANK INLET valve		N/A	N/A	None	Shutoff function of this relief-shutoff valve is manually controlled by T-handle tool.
	AUTO	Permits flow of water from fuel cells into waste water tank when relief valve differential pressure reaches 6.0±0.5 psi.				Normal position of valve is AUTO. If potable water tank is full or waste tank is empty, water from fuel cells will flow into waste water tank when relief valve reaches 6.0±0.5 psid.
	CLOSE	Shuts off flow of water from fuel cells to differential pressure-relief valve and waste water tank.				Valve set to CLOSE position in event relief valve fails open, prematurely permitting potable water flow into waste water tank.
LHEB-316	PLVC switch		POSTLANDING VENT FAN - PL BUS/FLOAT BAG 2 (MDC-25)	Flight and Postlanding Bus	None	
	NORMAL	Applies d-c power to pendulum-type attitude sensing switch of PLV system during normal postlanding operations.				Switch set to NORMAL position to permit normal operation of attitude sensing switch (to close PLV valves) when C/M becomes inverted or tilts beyond a specified limit.
	OPEN	Applies d-c power directly to PLV valves, placing valves in open position in event of abnormal postlanding operations.				Switch set to OPEN position in event of attitude sensing switch failure, or to aid crew to escape from inverted C/M.
LHEB-317	GLY EVAP WATER CONTROL BYPASS valve		N/A	N/A	None	LHEB-317 consists of two components. A manually operated water control valve installed in the LHEB, and a plug-in unit to measure glycol evaporator wick temperature stowed in the C/M cabin. Data on plug-in unit TBD.
	ON	Permits flow of water directly into water-glycol evaporator by bypassing solenoid-operated water inflow control valve.				Valve set to ON position in event of water-glycol evaporator temperature control failure.
	OFF	Shuts off flow of water bypassing water-glycol evaporator inflow control valve.				Normal position of valve is OFF.
LHEB-319	SUIT CIRCUIT RETURN SHUT-OFF VALVE		N/A	N/A	None	Shutoff valve is manually controlled by knurled knob.
	O (open)	Permits flow of cabin gases to enter suit circuit for processing.				Normal position of valve is open.
	C (closed)	Shuts off flow of cabin gases entering suit circuit.				Valve is closed during ascent and descent, as access to valve is blocked. Valve is also closed to isolate suit circuit in event of cabin contamination.

LH EQUIPMENT BAY—PANELS 315, 316, 317, AND 319

CONTROLS AND DISPLAYS

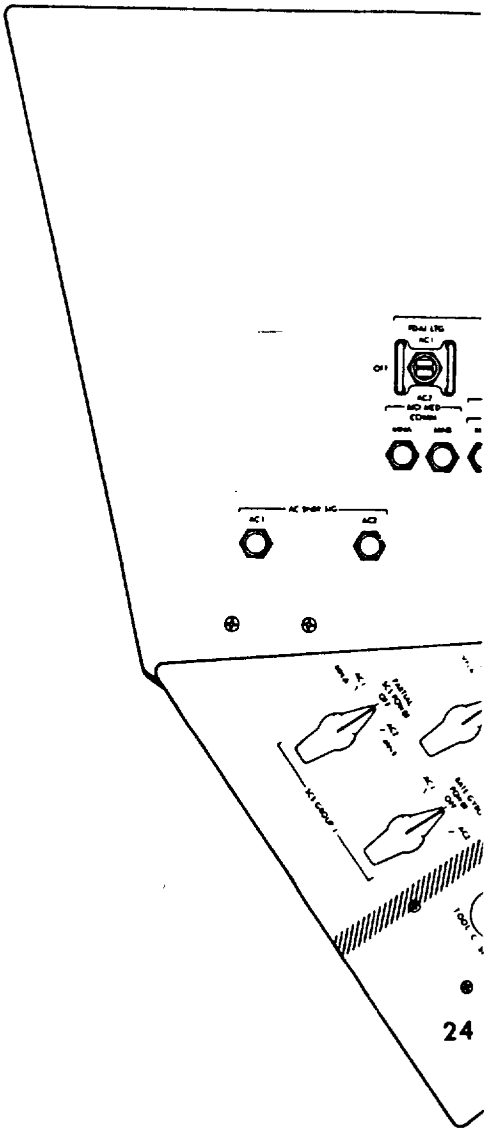
Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
Left Armrest LH Couch	Translation controls		SCS– GROUP 1 MN A MN B (MDC-25)	D-C main bus A or B	None	Two nearly identical translation controls are installed in the S/C. The functions are identical with one exception: the CCW switch function is not available from the No. 2 control. S/C translations are accomplished by use of S/M RCS only. Physically, the No. 1 control is identified by the presence of yellow diagonal striping on the top and right hand side. A push-to-talk mike switch is located on the control handle. When pressed, the switch enables audio transmission capability in certain modes of communication system operation. The electrical cabling plugs, for the two translation controls, are connected at the LHEB.
	Neutral position	Actuates all switches located within the control to the open position.				
	In/out	Applies +X or -X translation command signal to SCS electronics.				
	Left/right	Applies +Y or -Y translation command signal to SCS electronics.				
	Up/down	Applies +Z or -Z translation command signal to SCS electronics.				

LEFT ARMREST, LH COUCH

CONTROLS AND DISPLAYS

Location	Name and Position	Function	Circuit Breaker	Power Source	Telemetry Code No. and Identity	Remarks
Left Armrest LH Couch (Cont)	CCW (rotation)	a. Initiates manual abort command signal to the MESC. b. Provides a backup for CSM/booster separation after all stages are expended.	MASTER EVENT SEQ CONT — A LOGIC B BAT A BAT B (MDC-22)	Battery buses A and B	None	The translation control must be in the neutral position prior to engaging MESC logic A and B circuit breakers. Failure to confirm neutral positioning could result in an inadvertent abort or separation. Due to a positive detent the translation control must be manually returned to neutral from the CCW or CW position. This function is used when normal booster separation fails to occur.
	CW (rotation)	a. Engages manual thrust vector control mode during G&N or SCS ΔV. ΔV switch must be in the ΔV position prior to selecting MTVC. b. Disengages automatic attitude control during G&N or SCS attitude hold.	SCS—GROUP 2 MN A MN B (MDC-25)	D-C main bus A or B		This position may be used to place the S/C in free drift, and at the same time provide S/C attitude information on the FDAI depending on mode selected.
Crew Couches	Rotation controls	Provides manual control of C/M - S/M attitude in all axes.	SCS—GROUP 2 AC 1 AC 2 (MDC-25)	A-C bus No. 1 or A-C bus No. 2	None	Two identical rotation controls are installed in the S/C. The function of both controls is identical. The electrical cabling plugs for the two rotation controls are connected at the RH couch junction box.
	Forward/back (movement)	a. Commands S/C rotation in the pitch axis. b. Provides manual control of SPS engine pitch gimbal after MTVC is engaged.	SCS—DIRECT CONT MN A MN B (MDC-25)	D-C main bus A or B		When using a control, S/C rotation can be commanded two ways, either by proportional rate commands or by direct on commands. Proportional rate command is obtained by utilization of the SCS electronics, and is considered the normal method. Direct on commands are available when the DIRECT RCS switch is used in conjunction with the rotation control.
	Left/right (movement)	Commands S/C rotation in the roll axis.	SCS—GROUP 2 MN A MN B (MDC-25)			
	CW/CCW (rotation)	a. Commands S/C rotation in the yaw axis. b. Provides manual control of SPS engine yaw gimbal after MTVC is engaged.				
Pressure Garment Assembly	PGA pressure indicator	Indicates oxygen pressure (PSIA) inside pressure garment assembly.	None	None	None	The indicator is located on the left sleeve between wrist and elbow, on top of arm. The indicator range is from 2 to 10 psia.

LEFT ARMREST, LH COUCH — CREW COUCHES
PRESSURE GARMENT ASSEMBLY



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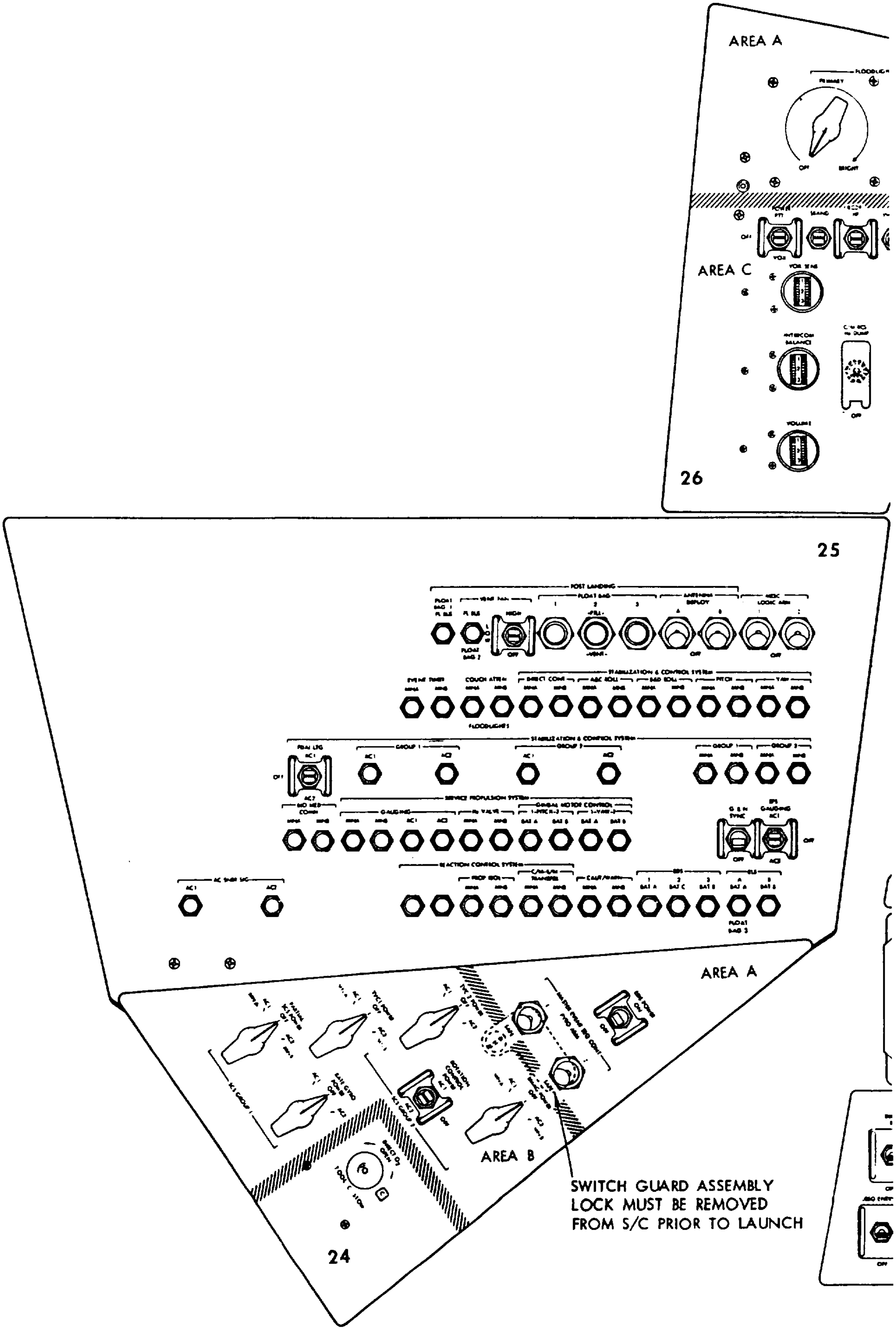
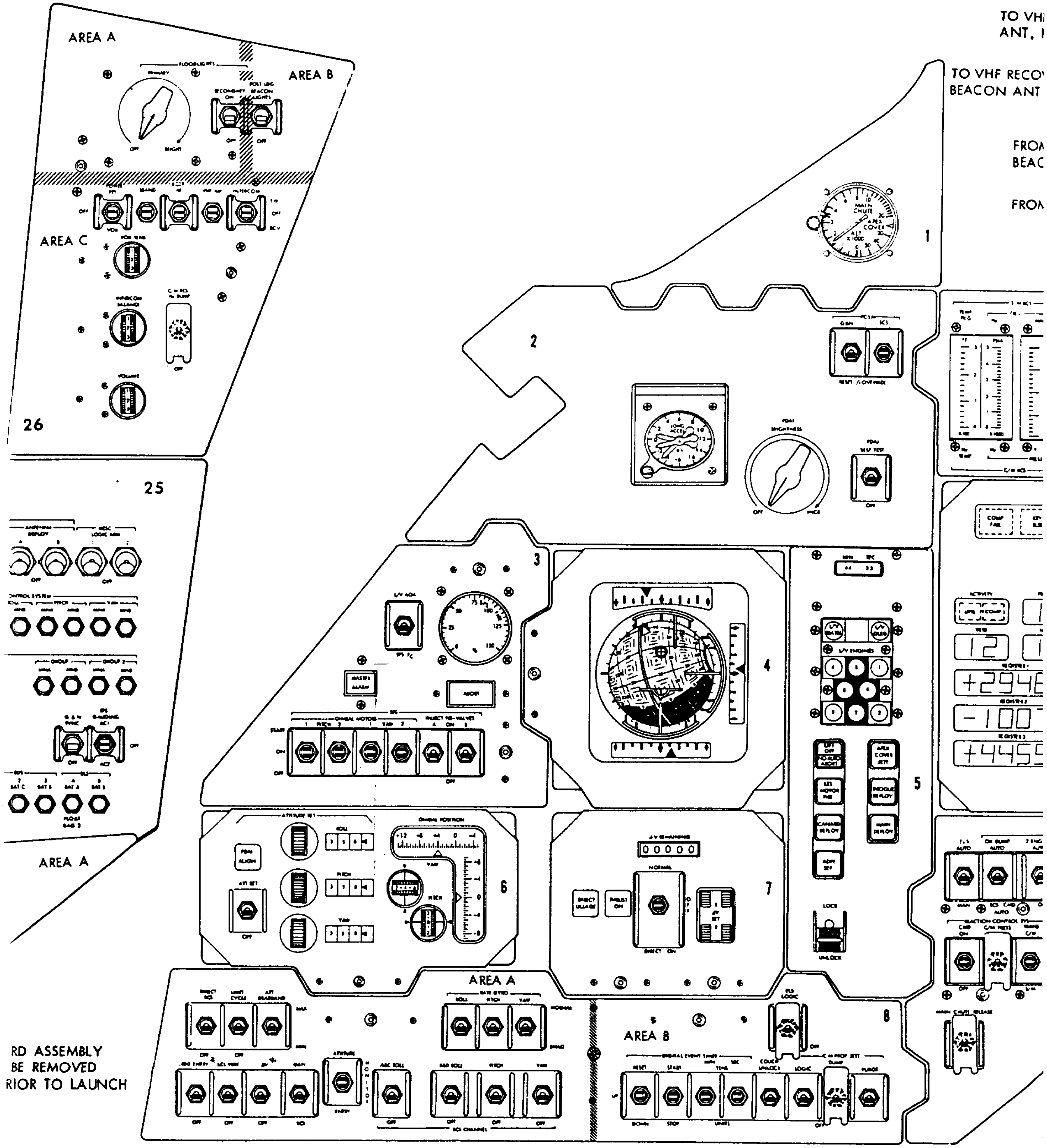


SWITCH GUARD ASSEMBLY
LOCK MUST BE REMOVED
FROM S/C PRIOR TO LAUNCH

FOLDOUT FRAME 2



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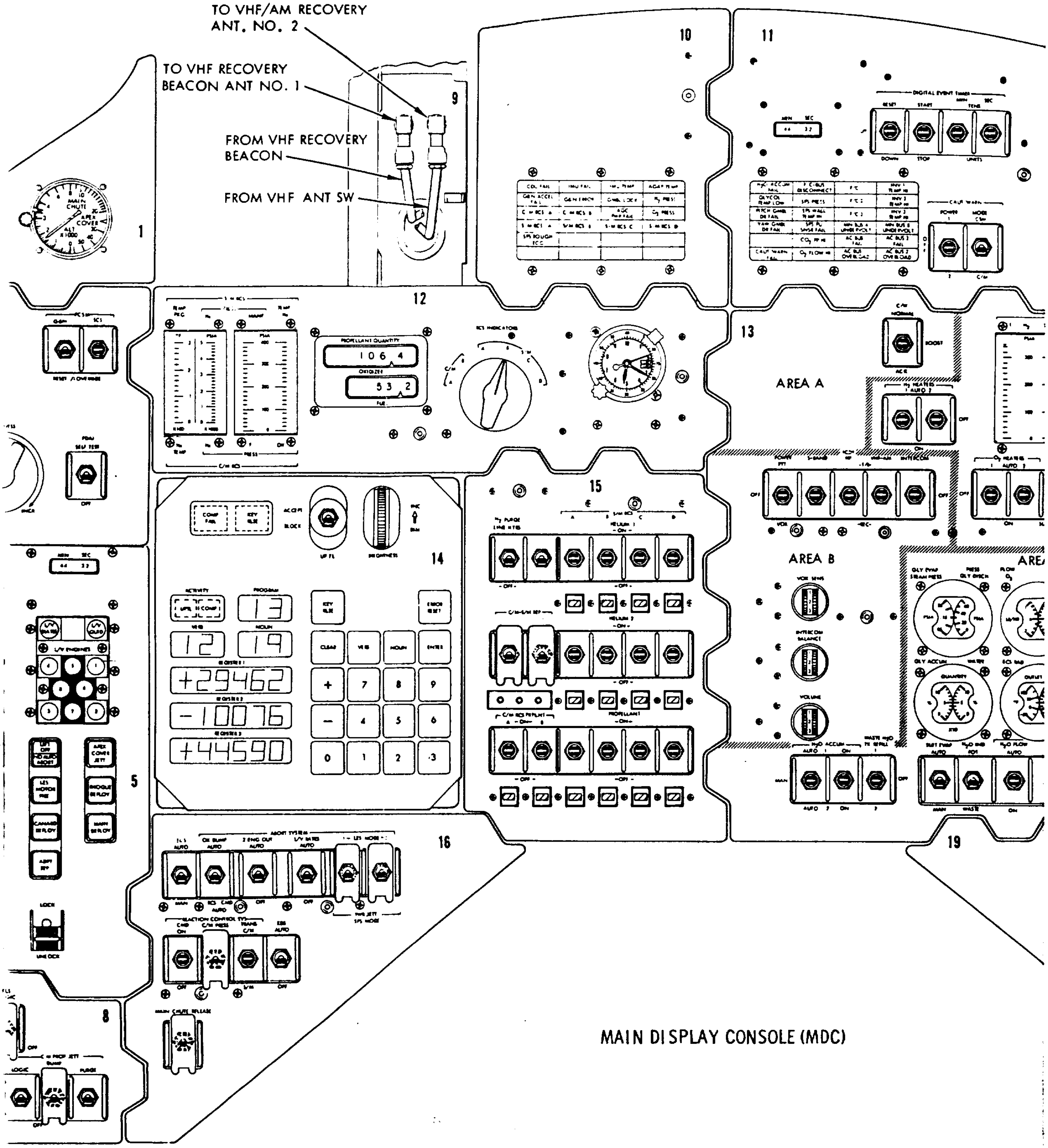
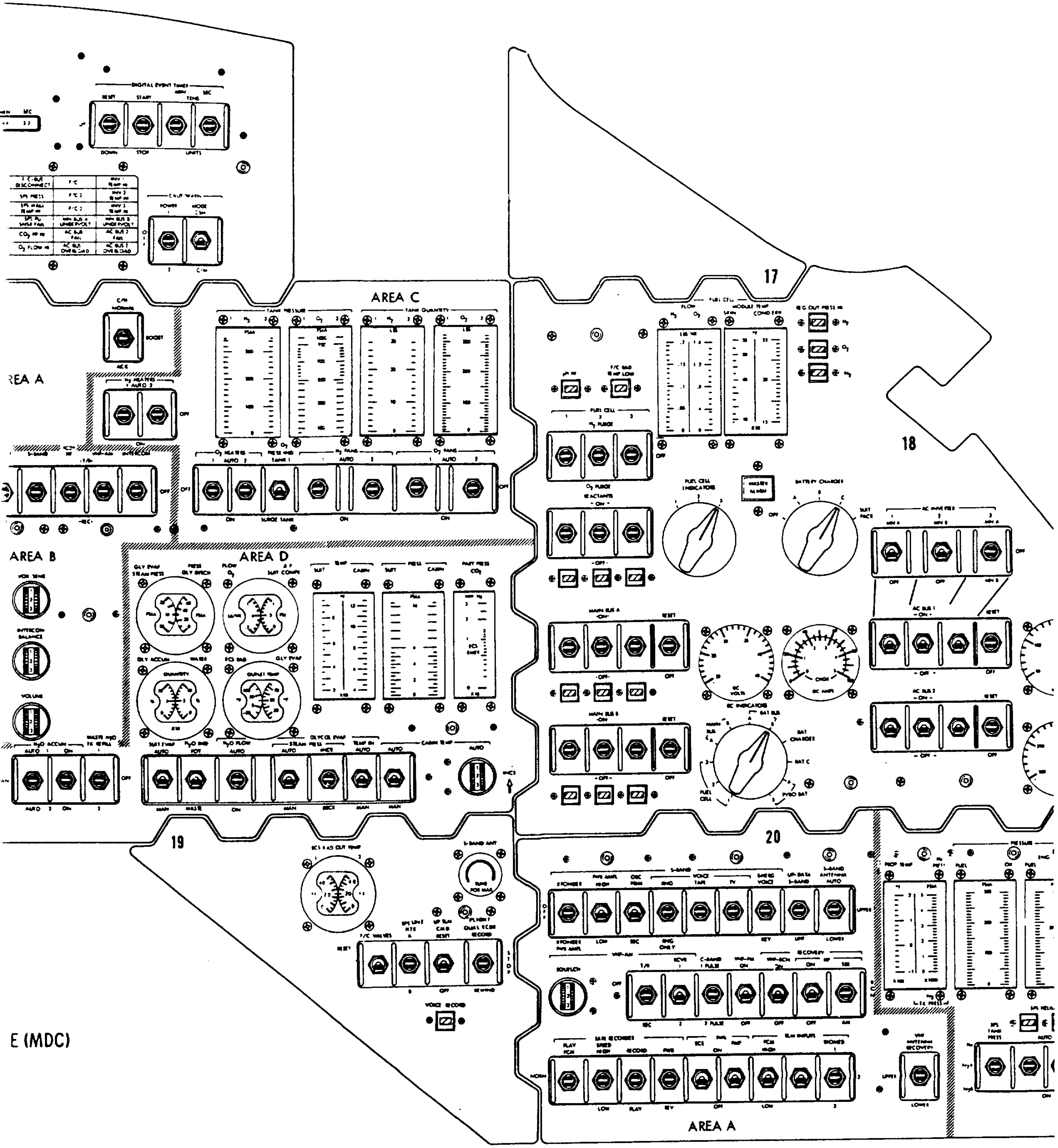
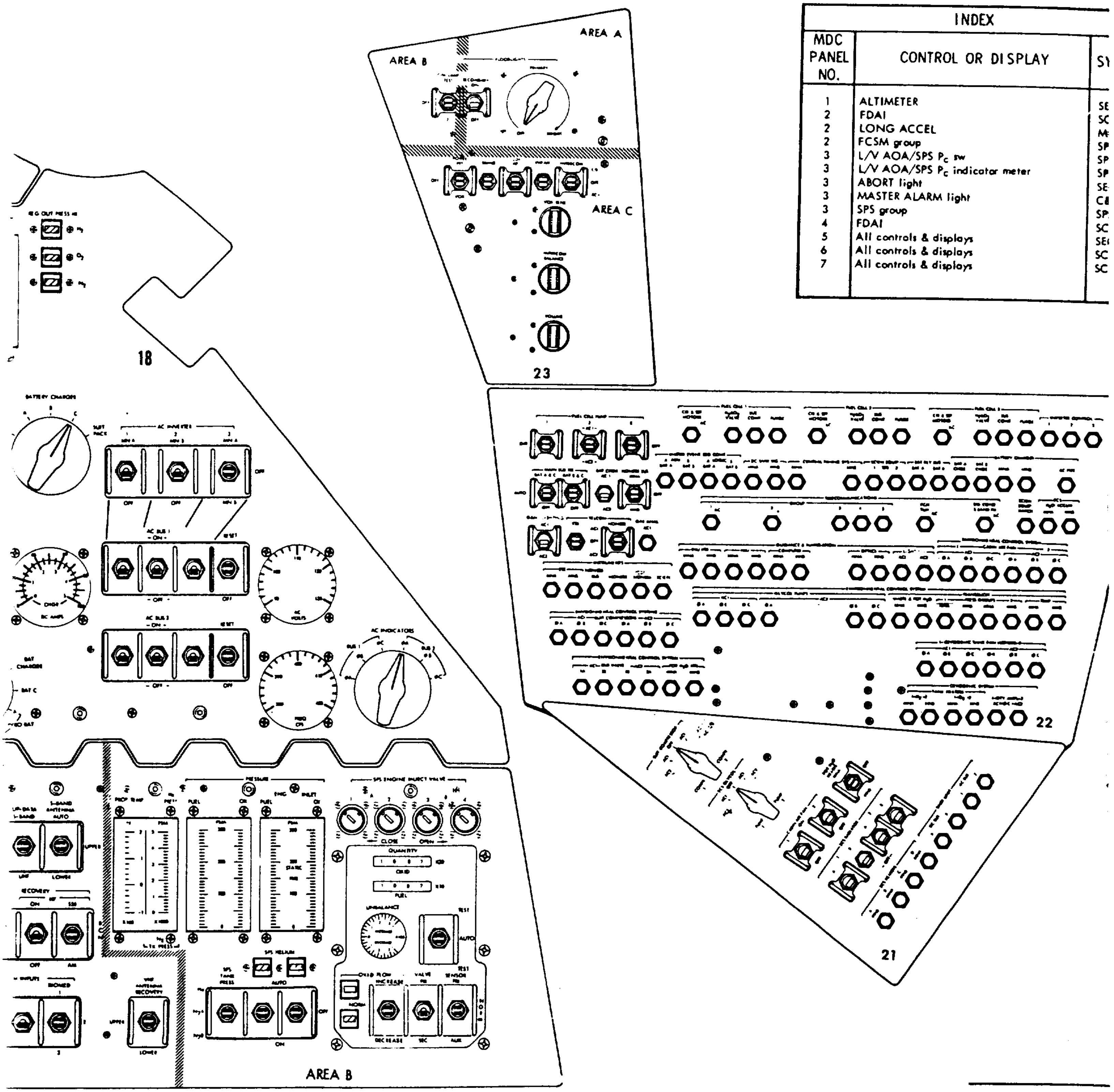


MAIN DISPLAY CONSOLE (MDC)

FOLDOUT FRAME 4



FOLDOUT FRAME 5



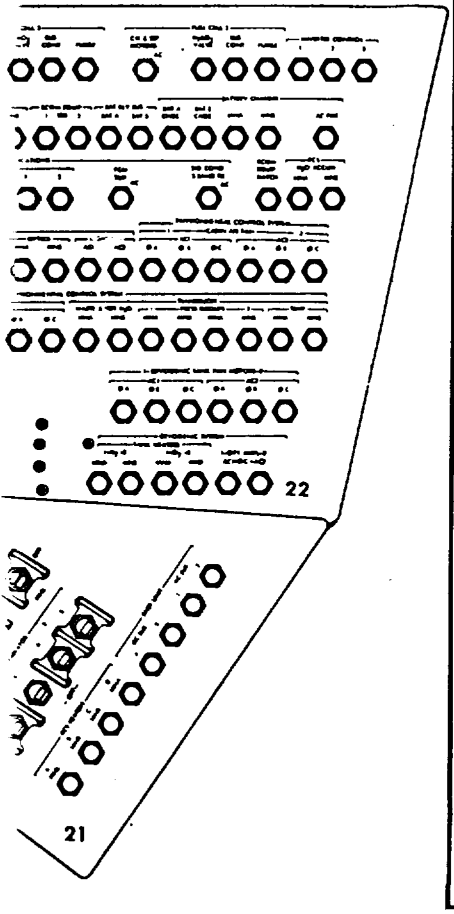
INDEX		
MDC PANEL NO.	CONTROL OR DISPLAY	SY
1	ALTIMETER	SE
2	FDAI	SC
2	LONG ACCEL	M
2	FCSM group	SP
3	L/V AOA/SPS P_c sw	SP
3	L/V AOA/SPS P_c indicator meter	SP
3	ABORT light	SE
3	MASTER ALARM light	C&
3	SPS group	SP
4	FDAI	SC
5	All controls & displays	SE
6	All controls & displays	SC
7	All controls & displays	SC

Mission_______

FOLDOUT FRAME 6

INDEX

CONTROL OR DISPLAY	SYSTEM
ALTIMETER	SEQ
FDAI	SCS
LONG ACCEL	MISC
CSM group	SPS
/V AOA/SPS P_c sw	SPS, SEQ
/V AOA/SPS P_c indicator meter	SPS, SEQ
ABORT light	SEQ
MASTER ALARM light	C&W
SPS group	SPS
FDAI	SCS
All controls & displays	SEQ
All controls & displays	SCS
All controls & displays	SCS



INDEX

MDC PANEL NO.	CONTROL OR DISPLAY	SYSTEM
8	Area A	SCS
8	Area B - ELS LOGIC, COUCH UNLOCK and DIGITAL EVENT TIMER group	SEQ
8	Area B - CM PROP JETT group	RCS, SEQ
9	Coaxial bracket	T/C

10	G&N	G&N	G&N	SCS
	G&N	G&N	G&N	EPS
	RCS	RCS	G&N	EPS
	RCS	RCS	RCS	RCS
	SPS			
11	ECS	EPS	EPS	EPS
	ECS	SPS	EPS	EPS
	SPS	SPS	EPS	EPS
	SPS	SPS	EPS	EPS
		ECS	EPS	EPS
	C&W	ECS	EPS	EPS

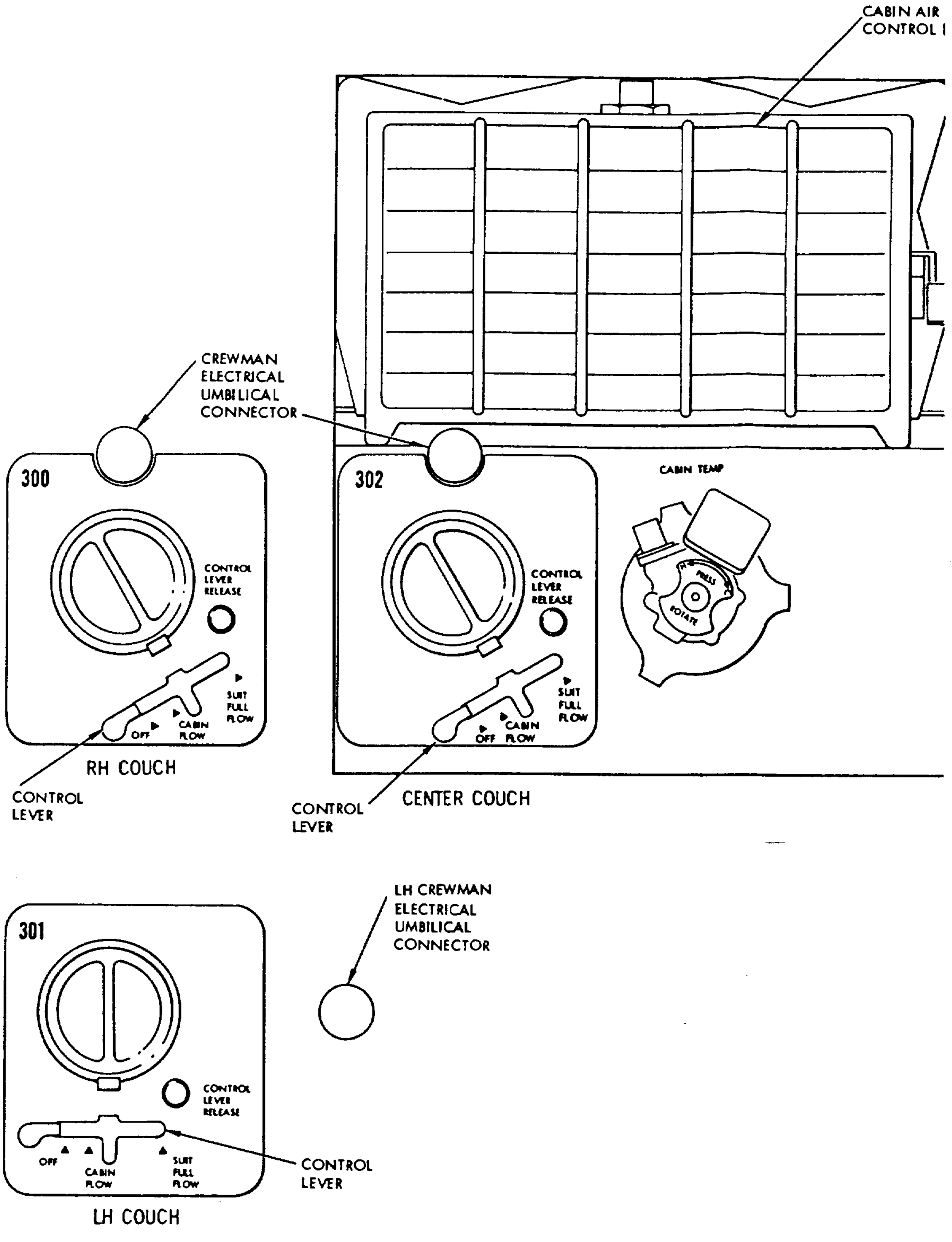
MDC PANEL NO.	CONTROL OR DISPLAY	SYSTEM
11	CAUT/WARN group	C&W
11	DIGITAL EVENT TIMER	SEQ
12	All controls & displays except MISSION ELAPSED TIME	RCS
12	MISSION ELAPSED TIME	MISC
13	Area A	C&W
13	Area B	T/C
13	Area C	EPS
13	Area D	ECS
14	All controls & displays	G&N
15	All controls & displays except C/M-S/M SEP group & H_2 PURGE LINE HTRS	RCS
15	C/M-S/M SEP group	SEQ
15	H_2 PURGE LINE HTRS	EPS
16	ABORT SYSTEM group & ELS AUTO	SEQ
16	MAIN CHUTE RELEASE	SEQ
16	REACTION CONTROL SYS group	RCS
18	All controls & displays except MASTER ALARM LIGHT	EPS
18	MASTER ALARM LIGHT	C&W
19	F/C VALVES	EPS
19	S-BAND ANT., UP TLM CMD, FLIGHT QUAL RCDR and VOICE RECORD	T/C
19	ECS, RAD OUT TEMP	ECS
19	SPS LINE HTR	SPS
20	AREA A	T/C
20	AREA B	SPS
21	RCS HEATERS group	SM-RCS
21	SNSR UNIT group	EPS
21	ECS RADIATOR group	ECS
21	CABIN AIR FAN group	ECS
21	POT H_2O HEATER	ECS
21	ECS GLYCOL	ECS
21	SUIT COMPRESSOR	ECS
22	All controls on top row	EPS
22	ECS group	ECS
22	SCIEN EQUIP HATCH	EXP
22	MAIN BUS TIE group	EPS
22	BAT CHGR and NONESS BUS	EPS
22	DC SNSR SIG group	EPS
22	CENTRAL TIMING SYS group	T/C
22	SCIEN EQUIP group	EXP
22	BAT RLY BUS group	EPS
22	BATTERY CHARGER group	EPS

INDEX

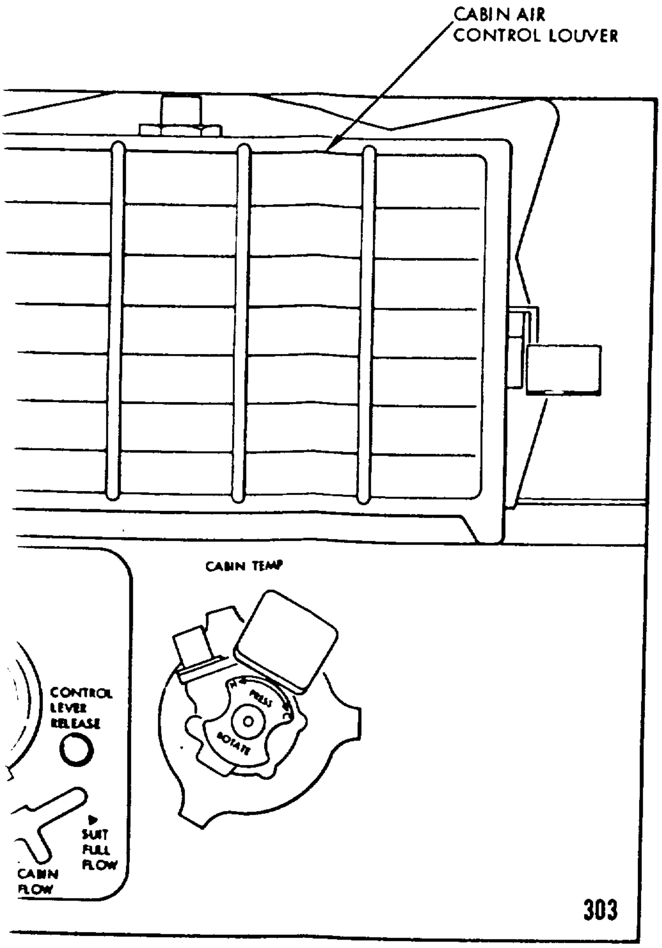
MDC PANEL NO.	CONTROL OR DISPLAY	SYSTEM
22	G&N LIGHTING	G&N
22	TELCOM group	T/C
22	TELECOMMUNICATIONS group	T/C
22	MASTER EVENT SEQ CONT group	SEQ
22	GUIDANCE & NAVIGATION group	G&N
22	1 - CRYOGENIC SYS TANK FAN MOTORS - 2	EPS
22	CRYOGENIC SYSTEM group	EPS
22	ENVIRONMENTAL CONTROL SYSTEM groups	ECS
22	INSTRUMENTS-ESS group	ECS
22	INSTRUMENTS-NONESS BUS	EPS
22	INSTRUMENTS-NONESS	T/C
22	INSTRUMENTS-PAM XMTR NONESS	T/C
22	INSTRUMENTS-SCIEN	EXP
22	GAS ANAL	ECS
23	AREA A	MISC
23	AREA B	C&W
23	AREA C	T/C
24	AREA A	SEQ
24	AREA B	SCS
24	DIRECT O_2	ECS
25	POSTLANDING FLOAT BAG 1 PL BUS & POSTLANDING FLOAT BAG 1, 2 & 3 switches	MISC
25	POSTLANDING VENT FAN PL BUS FLOAT BAG 2	ECS, MISC
25	POSTLANDING VENT FAN HIGH LOW OFF	ECS
25	POST LANDING-VENT FAN group	ECS
25	POST LANDING - ANTENNA DEPLOY group	T/C
25	MESC LOGIC ARM A&B	SEQ
25	EVENT TIMER group	SEQ
	COUCH ATTEN & FLOODLIGHTS	MISC
25	STABILIZATION & CONTROL SYSTEM	SCS
25	groups	
	BIO MED COMM group	T/C
25	SERVICE PROPULSION SYSTEM group	SPS
25	G&N SYNC	G&N
25	SPS GAUGING	SPS
25	AC SNSR SIG group	EPS
25	REACTION CONTROL SYS group	RCS
25	CAUT/WARN	C&W
25	EDS group	SEQ
25	ELS group	SEQ
25	AREA A	MISC
26	AREA B	SEQ
26	AREA C except CM RCS He DUMP	T/C
26	CM RCS He DUMP	RCS

SM-2A-672J

Figure 3-1. Controls and Displays (Sheet 1 of 3)



FOLDOUT FRAME 1



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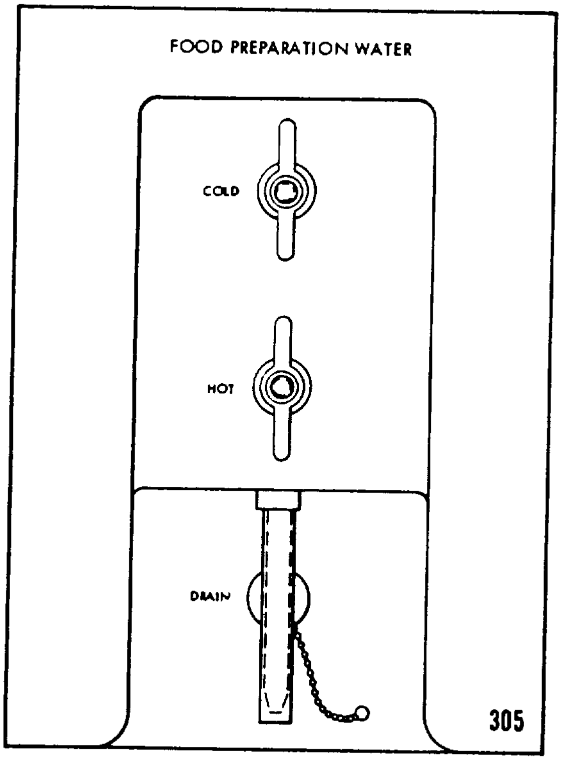
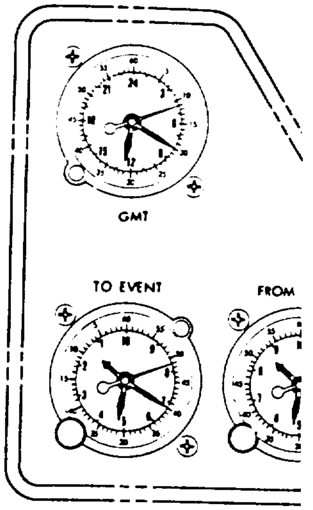
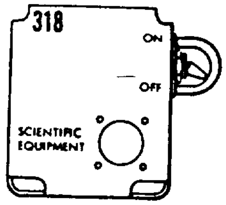
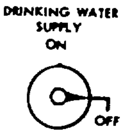






LH UTILITY PLUG

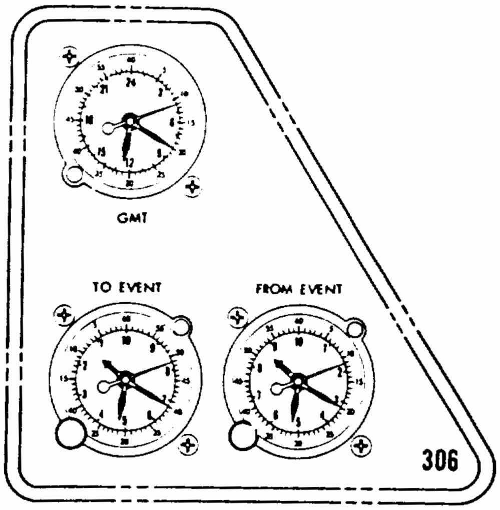


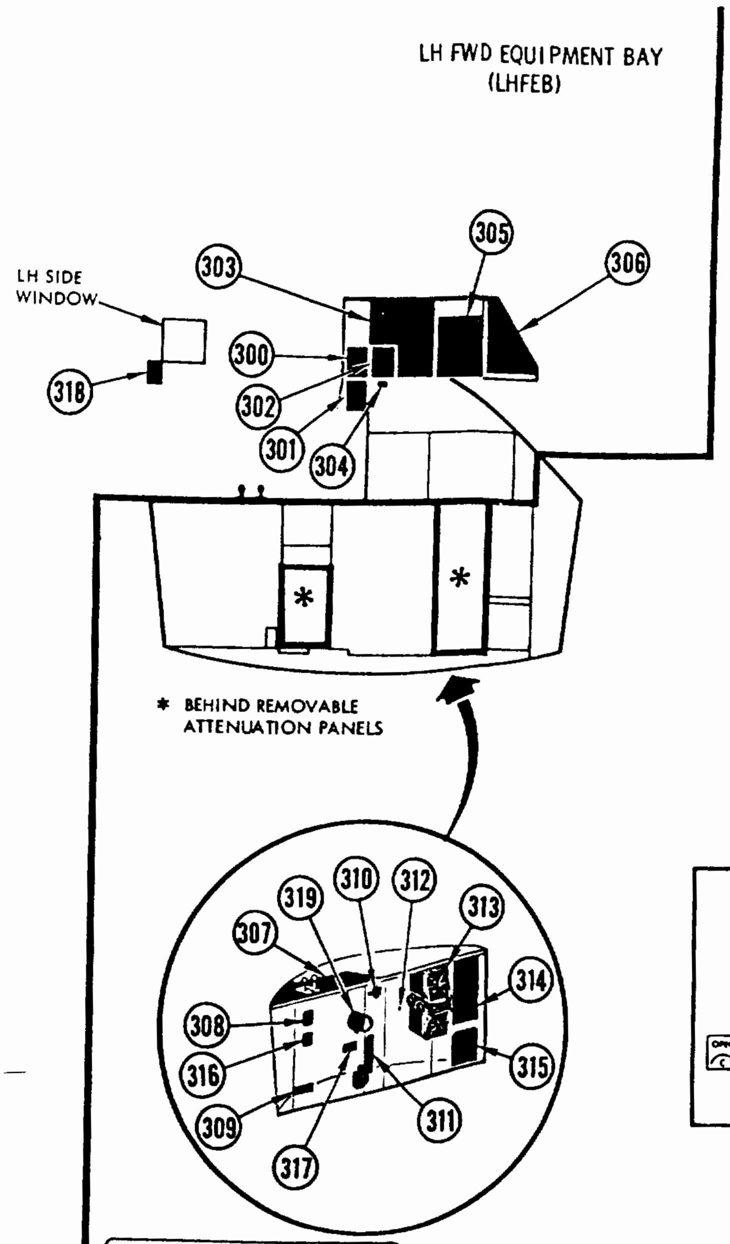
304

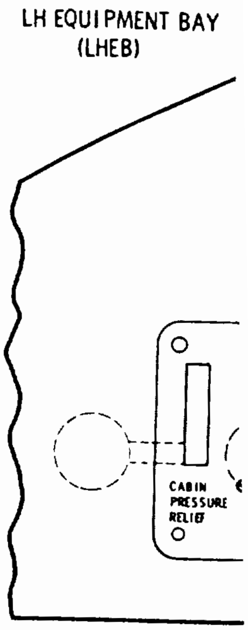
LHFEB INDEX

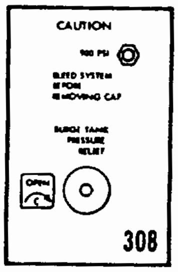
PANEL NO.	PANEL NAME AND S
304	DRINKING WATER SUPPLY SH (UNDERSIDE OF FWD EQUIPM
300, 301, 302	SUIT CONNECTOR PANEL (3) (
303	CABIN TEMPERATURE CONTRO
305	FOOD PREPARATION WATER SU
306	CLOCK AND EVENT TIMERS PA
318	SCIENTIFIC EQUIPMENT RECEP SWITCH (EXP)

FOLDOUT FRAME 2





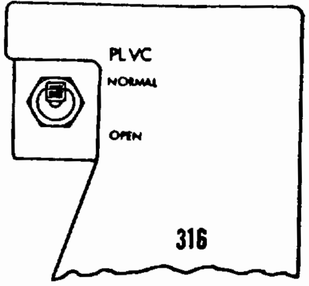


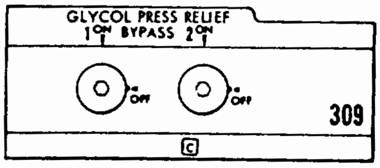


PAN NO
30
30
30
31
310
312
313
314
315
311
316
317

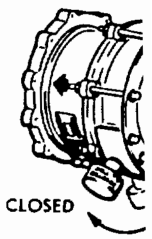
LHFEB INDEX

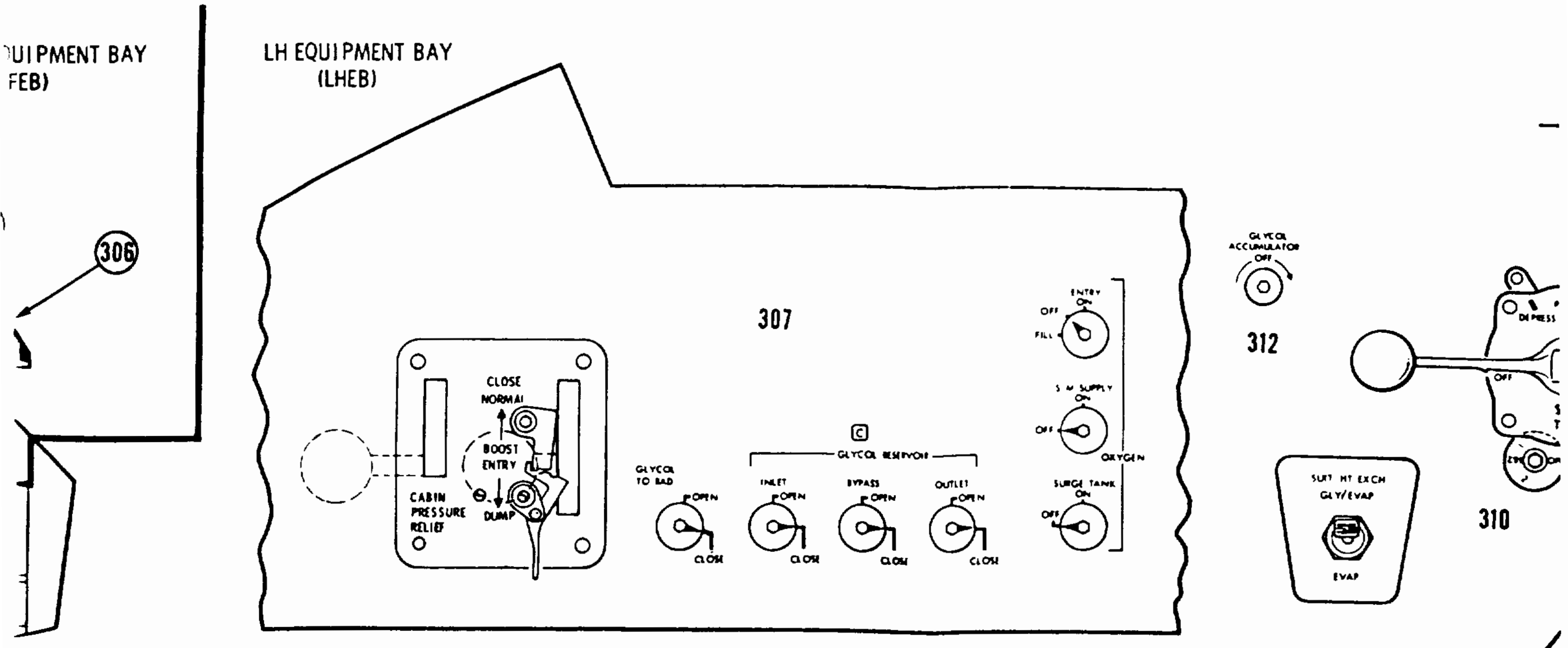
PANEL NO.	PANEL NAME AND SYSTEM
304	DRINKING WATER SUPPLY SHUTOFF VALVE (UNDERSIDE OF FWD EQUIPMENT BAY) (ECS)
300,301,302	SUIT CONNECTOR PANEL (3) (ECS)
303	CABIN TEMPERATURE CONTROL PANEL (ECS)
305	FOOD PREPARATION WATER SUPPLY UNIT (ECS)
306	CLOCK AND EVENT TIMERS PANEL (MISC)
318	SCIENTIFIC EQUIPMENT RECEPTACLE SWITCH (EXP)





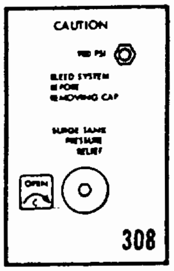
SUIT CIRC
SHUT-OFF

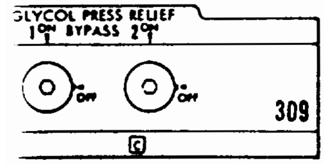




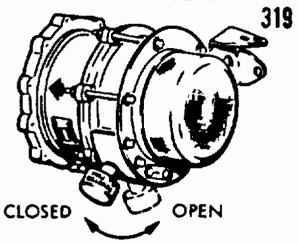
LHEB INDEX

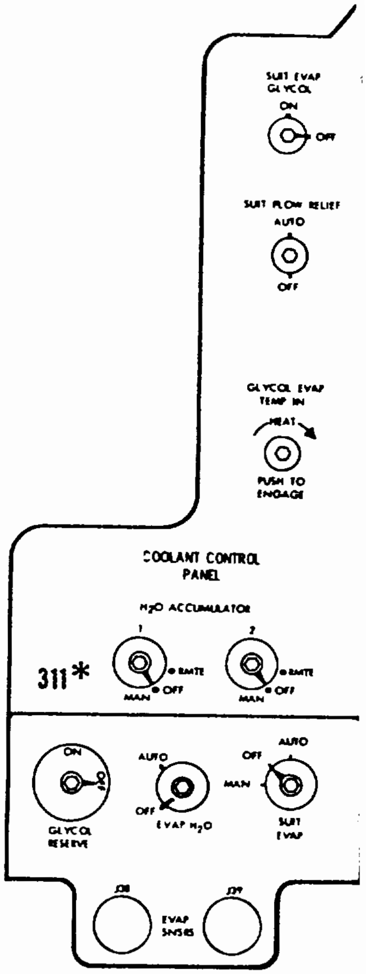
PANEL NO.	PANEL NAME AND SYSTEM
309	GLYCOL PRESSURE RELIEF BYPASS CONTROL PANEL (ECS)
308	SURGE TANK PRESSURE RELIEF SHUTOFF VALVE (ECS)
307	GIRTH FRAME SHELF CONTROLS (ECS)
319	SUIT CIRCUIT RETURN SHUT-OFF VALVE (ECS)
310	O_2 DEMAND REGULATOR AND SUIT HEAT EXCHANGER SWITCH (ECS)
312	GLYCOL ACCUM SHUTOFF VALVE (BACK OF ATTENUATOR PANEL) (ECS)
313	CO_2 - ODOR ABSORBER DIVERTER VALVE (ECS)
314	OXYGEN CONTROL PANEL (ECS)
315	WATER CONTROL PANEL (ECS)
311	COOLANT CONTROL PANEL (ECS)
316	PLVC CONTROL PANEL (ECS)
317	GLY EVAP WATER CONTROL BYPASS PANEL (ECS)





SUIT CIRCUIT RETURN
SHUT-OFF VALVE *





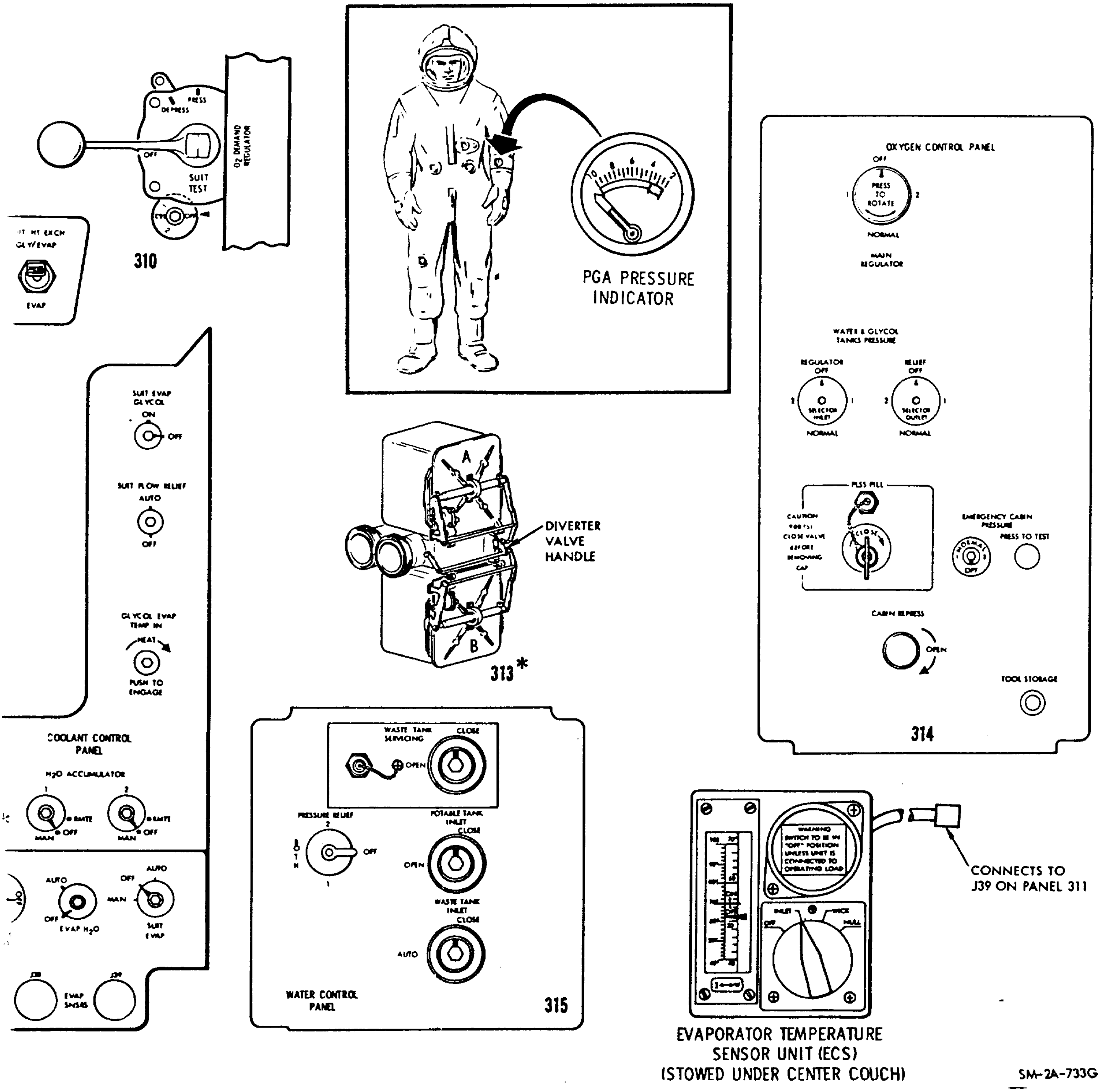
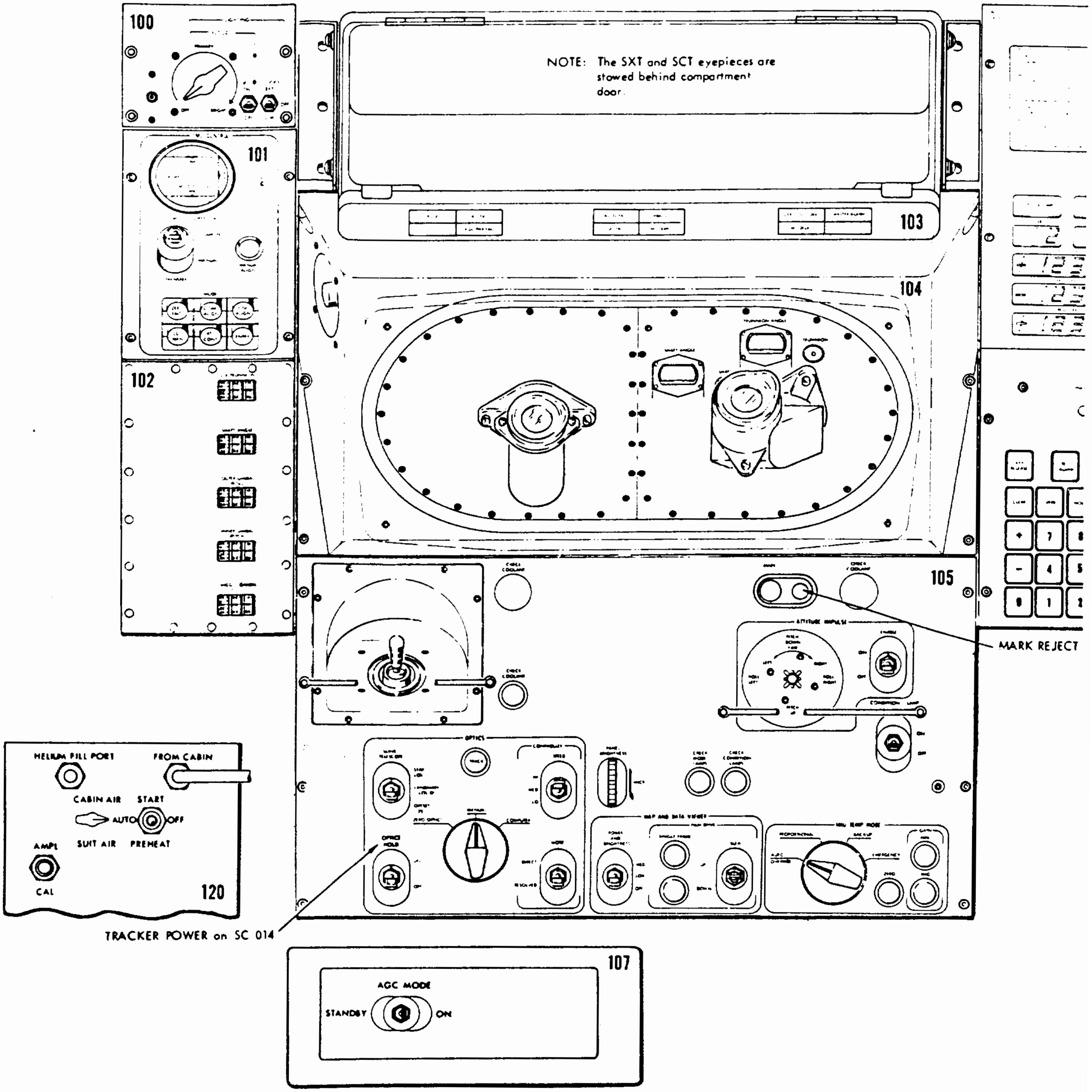
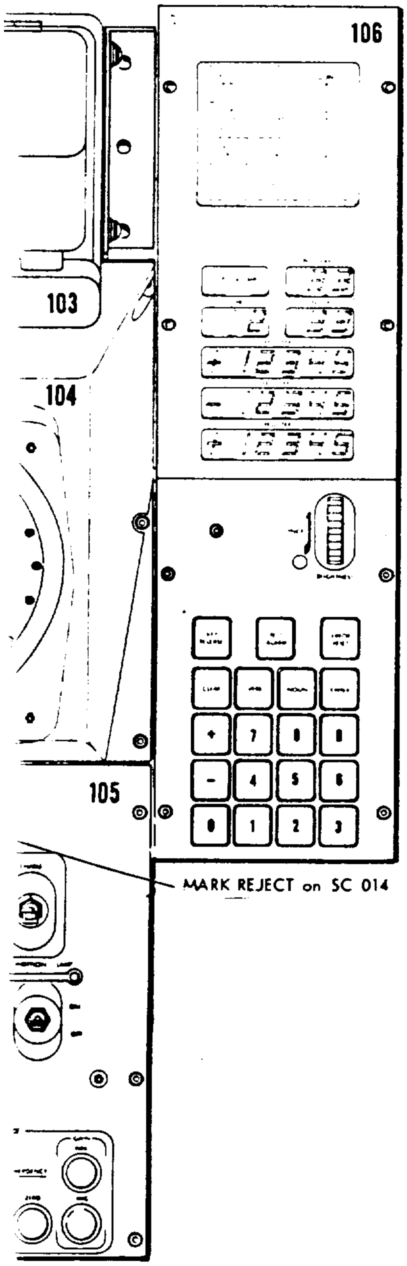


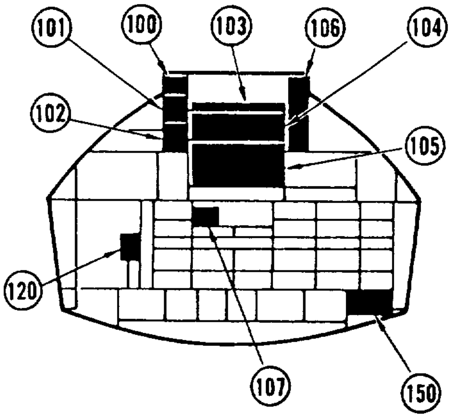
Figure 3-1. Controls and Displays (Sheet 2 of 3)


100
101
102
103
104
105
107
120
NOTE: The SXT and SCT eyepieces are stowed behind compartment door.
CHECK COOLANT
MARK REJECT
ATTITUDE IMPULSE
OPTICS
MAP AND DATA VIEWER
OPTICS HOLD
HELIUM FILL PORT
FROM CABIN
CABIN AIR
START
AUTO
OFF
SUIT AIR
PREHEAT
AMPL
CAL
TRACKER POWER on SC 014
AGC MODE
STANDBY
ON

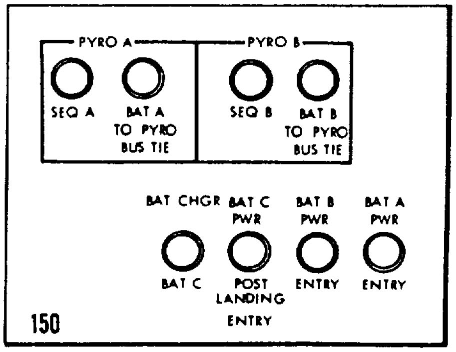


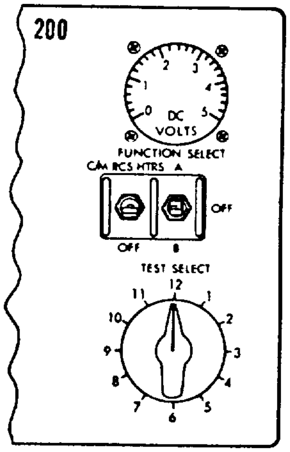
MARK REJECT on SC 014

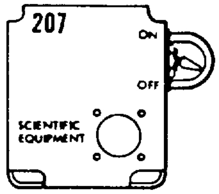
LOWER EQUIPMENT BAY (LEB)



LEB INDEX		
PANEL NO.	CONTROL OR DISPLAY	SYSTEM
101 THRU 107	All controls & displays	G&N
100	LIGHTING	MISC
150	Top row	SEQ
150	Bottom row	EPS
120	All controls	ECS

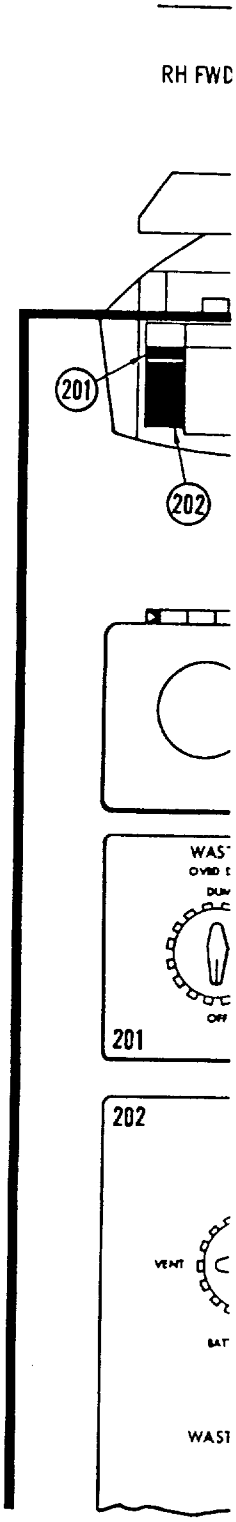




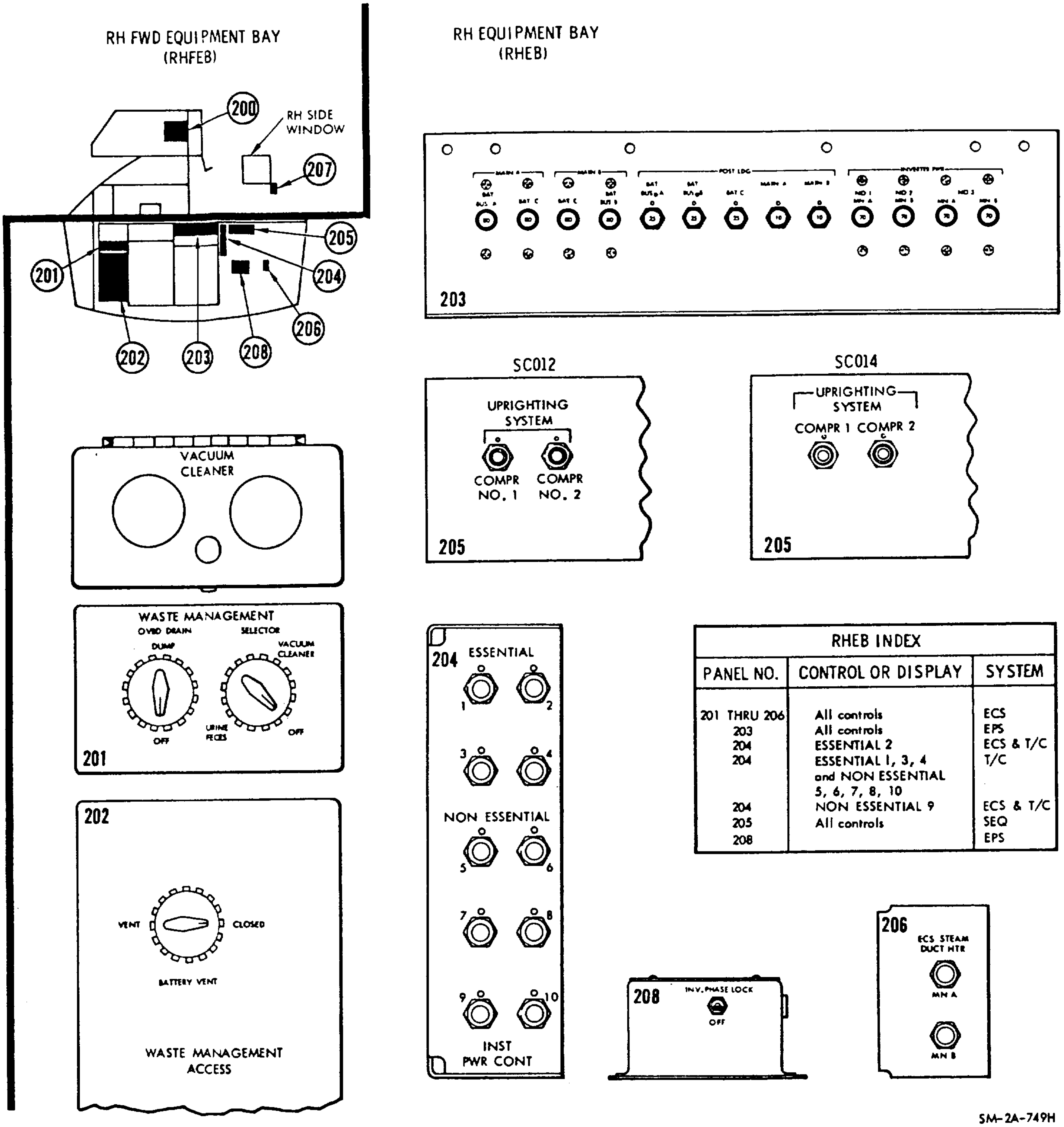


RH UTILITY PLUG

RHFEB INDEX		
PANEL NO.	CONTROL OR DISPLAY	SYSTEM
200	DC VOLTS, FUNCTION SELECT, and TEST SELECT	EPS
200	C/M RCS HTRS	RCS
207	SCIENTIFIC EQUIPMENT RECEPTACLE SWITCH	



FOLDOUT FRAME 2



RHEB INDEX

PANEL NO.	CONTROL OR DISPLAY	SYSTEM
201 THRU 206	All controls	ECS
203	All controls	EPS
204	ESSENTIAL 2	ECS & T/C
204	ESSENTIAL 1, 3, 4 and NON ESSENTIAL 5, 6, 7, 8, 10	T/C
204	NON ESSENTIAL 9	ECS & T/C
205	All controls	SEQ
208		EPS

SM-2A-749H

Figure 3-1. Controls and Displays (Sheet 3 of 3)

FOLDOUT FRAME 3

SECTION 4

PERFORMANCE

INTRODUCTION.

This section contains information on crew display instrument markings, instrument accuracy consumable requirements, thrusting data (as available), and S/C operational constraints and limitations.

4.1 CREW DISPLAY INSTRUMENT MARKINGS AND ACCURACY DATA.

Paragraphs 4.1.1 through 4.1.7.4 include information on instrument markings and instrument accuracy. Adjoining tabular lists provide accuracy data for each indicator scale and list the measurement number of the signal which is monitored on each indicator scale. Some indicators can, by selection, monitor more than one signal; in which case, the measurement number of all signals monitored by the indicator are listed. Selector switch and indicator functions are covered in detail in section 2.

Some of the system indicators shown in the associated illustrations (figures 4-1 through 4-12) are provided with vertical or horizontal green-colored bands to show normal operating ranges, vertical yellow bands to show permissible operating ranges requiring caution, and horizontal red bands or lines to show system limitations. The color markings, operating ranges, and limitations for these system indicators are as follows:

System	Indicator Scale	Color Marking	Operating Range or Limitation
SPS (MDC-20) (figure 4-1)	PROP TEMP	Red	80°F (upper limit) and -40°F (lower limit)
	PRESSURE-FUEL	Green	170 to 195 psia (normal band)
	PRESS-OX	Green	Same as PRESSURE-FUEL scale.

PERFORMANCE

System	Indicator Scale	Color Marking	Operating Range or Limitation
	PRESSURE-ENG INLET-FUEL	Green	STATIC 170 to 195 psia (normal band) FIRE 135 to 165 psia (normal band)
	PRESSURE-ENG INLET-OX	Green	Same as PRESSURE-ENG INLET-FUEL scale.
SPS (MDC-3) (figure 4-11)	L/V AOA/SPS P_c indicator	Green	SPS FIRE 65 to 125% (normal band)
EPS (MDC-13) (figure 4-3)	TANK PRESSURE-H_2-1	Green	230 to 265 psia (normal band)
	TANK PRESSURE-H_2-2	Green	Same as TANK PRESSURE-H_2-1 scale.
	TANK PRESSURE-O_2-1	Green	865 to 935 psia (normal band)
	TANK PRESSURE-O_2-2	Green	Same as TANK PRESSURE-O_2-1 scale
(MDC-18) (figure 4-5)	FUEL CELL-FLOW-H_2	Green	0.03 to 0.15 lb/hr (normal band)
	FUEL CELL-FLOW-O_2	Green	0.25 to 1.20 lb/hr (normal band)
	FUEL CELL-MODULE TEMP-SKIN	Green	385° to 495°F (normal band)
	FUEL CELL-MODULE TEMP-COND EXH	Green	157.5° to 172.5°F (normal band)
ECS (MDC-13) (figure 4-9)	PRESS GLY DISCH	Green	35 to 55 psia (normal band)
	TEMP-SUIT	Green	45° to 65°F (normal band)
	PRESS-SUIT	Red	3.4 psia (low limit line)

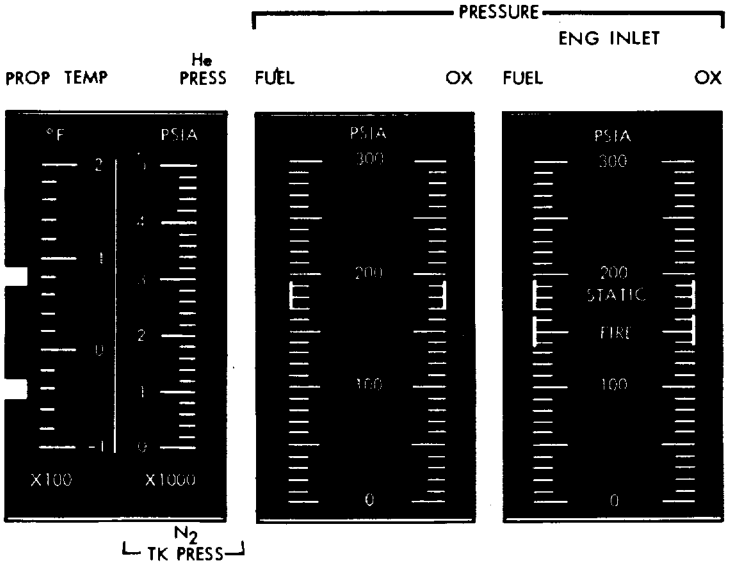
CREW DISPLAY INSTRUMENT MARKINGS AND ACCURACY DATA

PERFORMANCE

System	Indicator Scale	Color Marking	Operating Range or Limitation
	PRESS-CABIN	Red	4.7 psia (low limit line)
	PART PRESS-CO_2	Red Yellow	15 mm Hg (high limit line) 7.6 to 15 mm Hg (caution band)
PGA (figure 4-9)	PGA pressure indicator	Red Green	2.0 to 3.5 psia (emergency band) 3.5 to 10 psia (normal band)

4.1.1 SERVICE PROPULSION SYSTEM INDICATORS.

Instrument markings for the SPS indicators (MDC-20) are shown in figure 4-1. The indicators present a visual display of SPS temperatures and pressures. Visual displays of SPS fuel and oxidizer remaining aboard the S/C are shown in the adjacent OXID-FUEL QUANTITY display windows (as selected by the SPS quantity SENSOR switch). (Refer to section 3.)



NOTE: Red lines on the propellant temperature scale show upper limit of 80°F and lower limit of -40°F. Vertical green color bands show normal operating ranges for fuel and oxidizer pressure (170 to 195 psia) and engine inlet pressures for STATIC (170 to 195 psia) and FIRE (135 to 165 psia).

SM-2A-689H

Figure 4-1. Service Propulsion System Indicators

The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

Indicator Scale	Measurement Number	Indicator Accuracy
PROP TEMP	SP 0002 T	±5°F at 75°F ±10°F at 0° and 150°F
He PRESS	SP 0001 P	±100 psia at 75°F ±150 psia at 0° and 150°F
Tk PRESS-N_2	SP 0600 P (Primary) SP 0601 P (Secondary)	±100 psia at 75°F ±150 psia at 0° and 150°F
PRESSURE-FUEL	SP 0006 P	±5 psia at 75°F ±10 psia at 0° and 150°F
PRESSURE-OX	SP 0003 P	±5 psia at 75°F ±10 psia at 0° and 150°F
PRESSURE-ENG INLET-FUEL	SP 0010 P	±5 psia at 75°F ±10 psia at 0° and 150°F
PRESSURE-ENG INLET-OX	SP 0009 P	±5 psia at 75°F ±10 psia at 0° and 150°F

4.1.2 REACTION CONTROL SYSTEM INDICATORS.

Instrument markings for the S/M and C/M RCS indicators (MDC-12) are shown in figure 4-2. The indicators present a visual display of system temperatures and pressures. Visual displays of S/M RCS fuel and oxidizer remaining are shown on the adjacent PROPELLANT QUANTITY indicator (as selected by the RCS INDICATORS switch). (Refer to section 3.)

The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

Indicator Scale	Measurement Number	Indicator Accuracy
S/M RCS-TEMP PKG	SR 5065 T (Quad A) SR 5066 T (Quad B) SR 5067 T (Quad C) SR 5068 T (Quad D)	±5°F at 75°F ±10°F at 0° and 150°F

PERFORMANCE

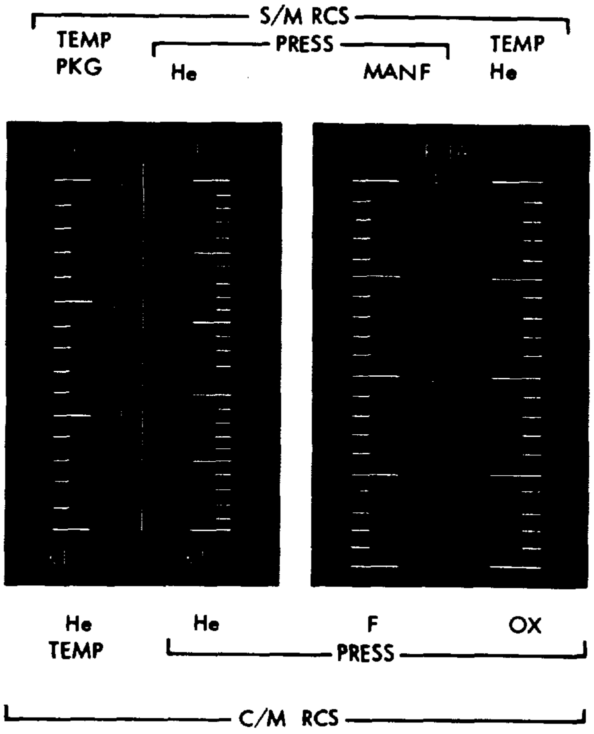
Indicator Scale	Measurement Number	Indicator Accuracy
S/M RCA-PRESS-H_e	SR 5001 P (Quad A) SR 5002 P (Quad B) SR 5003 P (Quad C) SR 5004 P (Quad D)	±100 psia at 75°F ±150 psia at 0° and 150°F
S/M RCS-PRESS-MANF	SR 5729 P (Quad A) SR 5776 P (Quad B) SR 5817 P (Quad C) SR 5830 P (Quad D)	At 75°F, ±5 psia from 140 to 340 psia and ±10 psia over balance of scale. At 0° and 150°F, ±10 psia from 145 to 340 psia and ±15 psia over balance of scale.
S/M RCS-TEMP H_e	SR 5013 T (Quad A) SR 5014 T (Quad B) SR 5015 T (Quad C) ST 5016 T (Quad D)	Same as S/M RCS-PRESS-MANF indicator
C/M RCS-H_e TEMP	CR 0003 T (System A) CR 0004 T (System B)	±5°F at 75°F ±10°F at 0° and 150°F
C/M RCS-PRESS-H_e	CR 0001 P (System A) CR 0002 P (System B)	±100 psia at 75°F ±150 psia at 0° and 150°F
C/M RCS-PRESS-F	CR 0005 P (System A) CR 0006 P (System B)	Same as S/M RCS-PRESS-MANF indicator.
C/M RCS-PRESS-OX	CR 0011 P (System A) CR 0012 P (System B)	Same as S/M RCS-PRESS-MANF indicator.

4.1.3 ELECTRICAL POWER SYSTEM INDICATORS.

4.1.3.1 EPS (Cryogenic Storage) Tank Pressure Indicators.

Instrument markings for the EPS (cryogenic storage) tank pressure indicators (MDC-13) are shown in figure 4-3. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

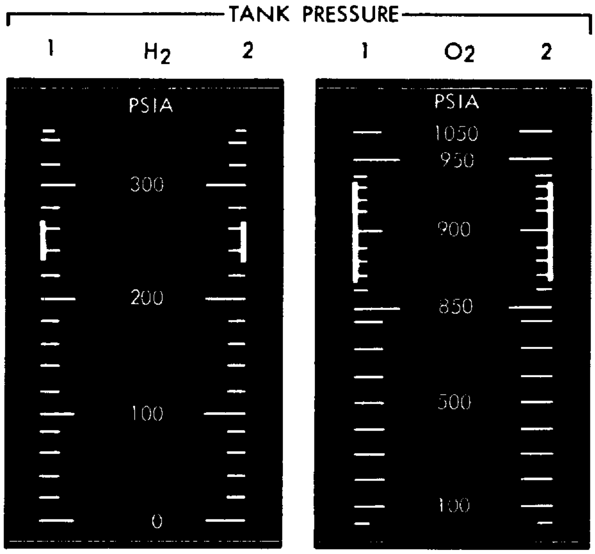
NOTE TANK PRESSURE-O_2-1 scale is used to display cryogenic storage tank 1 pressure or ECS surge tank pressure as selected by O_2 PRESS IND toggle switch located immediately below the display.



SM-2A-688C

Figure 4-2. S/M and C/M Reaction Control System Indicators

Indicator Scale	Measurement Number	Indicator Accuracy
TANK PRESSURE-H_2-1	SF 0039 P	±5 psia at 75°F ±10 psia at 0° and 150°F
TANK PRESSURE-H_2-1	SF 0040 P	Same as TANK PRESSURE-H_2-1 indicator.
TANK PRESSURE-O_2-1	SF 0037 P (Storage tank) CF 0006 P (Surge tank)	At 75°F, ±5 psia at 850 to 950 psia and ±3% of remaining scale. At 0° and 150°F, ±10 psia at 850 to 950 psia and 4% of remaining scale.
TANK PRESSURE-O_2-2	SF 0038 P	Same as TANK PRESSURE-O_2-2 indicator.



NOTE: Vertical green color bands on the indicators show normal operating ranges for hydrogen tank pressures (230 to 265 psia) and oxygen tank pressures (865 to 935 psia).

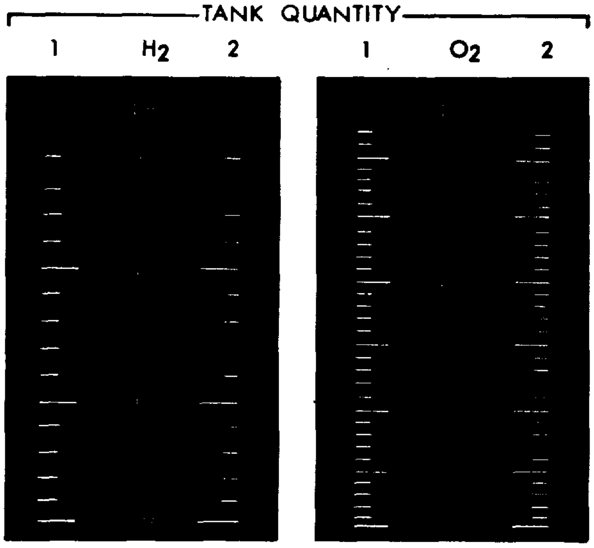
SM-2A-690D

Figure 4-3. EPS (Cryogenic Storage) Tank Pressure Indicators

4.1.3.2 EPS (Cryogenic Storage) Tank Quantity Indicators.

Instrument markings for the EPS (cryogenic storage) tank quantity indicator (MDC-13) are shown in figure 4-4. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

Indicator Scale	Measurement Number	Indicator Accuracy
TANK QUANTITY-H_2-1	SF 0030 Q	±0.5 lb at 75°F ±1.0 lb at 0° and 150°F
TANK QUANTITY-H_2-2	SF 0031 Q	Same as TANK QUANTITY-H_2-1 indicator.
TANK QUANTITY-O_2-1	SF 0032 Q	±5.0 lb at 75°F ±10.0 lb at 0° and 150°F
TANK QUANTITY-O_2-2	SF 0033 Q	Same as TANK QUANTITY-O_2-1 indicator.



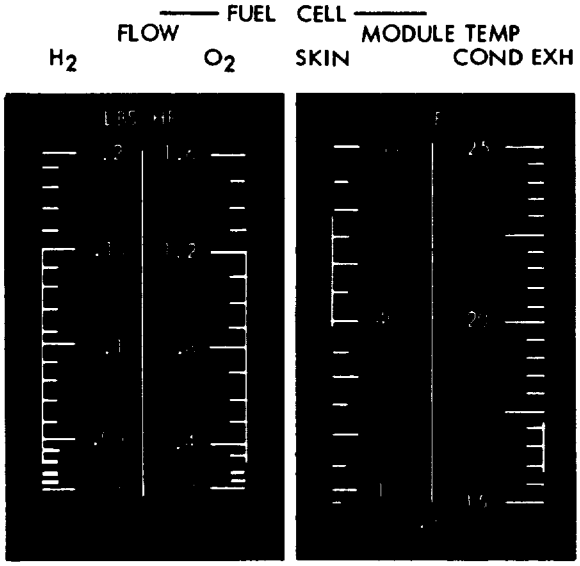
SM-2A-691B

Figure 4-4. EPS (Cryogenic Storage) Tank Quantity Indicators

4.1.3.3 EPS Fuel Cell Power Plant Indicators.

Instrument markings for the EPS fuel cell power plant indicators (MDC-18) are shown in figure 4-5. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

Indicator Scale	Measurement Number	Indicator Accuracy
FUEL CELL-FLOW-H_2	SC 2139 R (F/C 1) SC 2140 R (F/C 2) SC 2141 R (F/C 3)	±0.005 lb/hr at 75°F ±0.0075 lb/hr at 0° and 150°F
FUEL CELL-FLOW-O_2	SC 2141 R (F/C 1) SC 2143 R (F/C 2) SC 2144 R (F/C 3)	±0.05 hr/hr at 75°F, and at 0° and 150°F
FUEL CELL-MODULE TEMP-SKIN	SC 2084 T (F/C 1) SC 2085 T (F/C 2) SC 2086 T (F/C 3)	At 75°F, ±7°F for 400° to 550° scale and 3% of remaining scale. At 0° and 150°F, ±14°F for 400° to 500° scale and 3% of remaining scale.
FUEL CELL-MODULE TEMP-COND EXH	SC 2081 T (F/C 1) SC 2082 T (F/C 2) SC 2083 T (F/C 3)	±3°at 75°F ±5°F at 0° and 150°F



NOTE: Vertical green color bands on the indicators show normal operating ranges for hydrogen flow (0.03 to 0.15 lb/hr), oxygen flow (0.25 to 1.20 lb/hr), module skin temperature (385° to 495°F), and the condenser exhaust temperature (157.5° to 172.5°F).

SM-2A-692D

Figure 4-5. EPS Fuel Cell Indicators

4.1.3.4 EPS Volts, Amperes, and Frequency Meters.

Instrument markings for the EPS-volts, amperes, and frequency meters (MDC-18) are shown in figure 4-6. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

Indicator Scale	Measurement Number	Indicator Accuracy
DC VOLTS	CC 0206 V (Main Bus A) CC 0207 V (Main Bus B) CC 0210 V (Bat Bus A) CC 0211 V (Bat Bus B) CC 0212 V (Post Ldg Bat) CC 0214 V (Bat Charger Output) CC 0227 V (Pyro Bat A) CC 0228 V (Pyro Bat B)	At 75°F, ±0.25 volts for 25 to 37 volts scale and ±1.0 volt for balance of scale. At 0° and 150°F, ±0.5 volts for 25 to 37 volts scale and ±1.0 volt for balance of scale.
DC AMPS	CC 0222 C (Bat Bus A) CC 0223 C (Bat Bus B) CC 0224 C (Post Ldg Bat) SC 2113 C (F/C 1 Output) SC 2114 C (F/C 2 Output) SC 2115 C (F/C 3 Output)	±1.0% of full scale at 75°F ±2.0% of full scale at 0° to 150°F

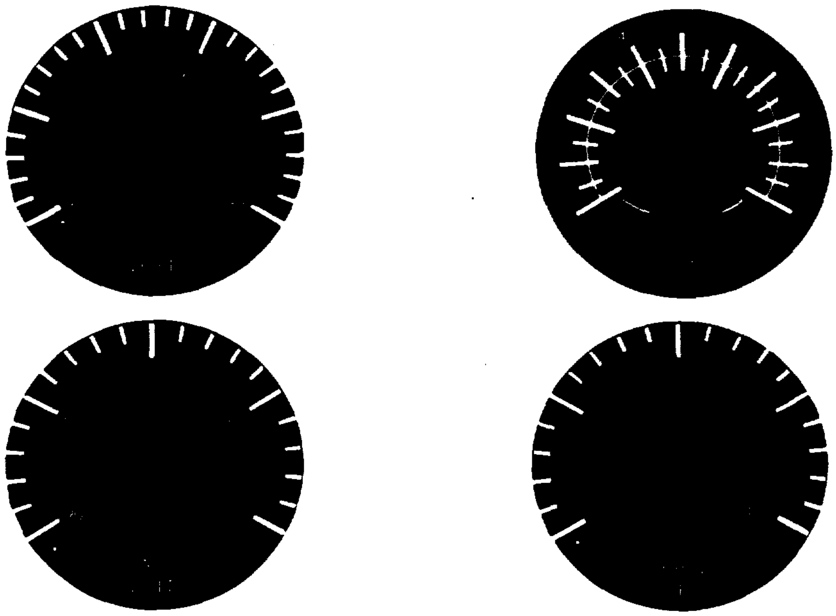


Figure 4-6. EPS Volts, Amperes, and Frequency Meters

Indicator Scale	Measurement Number	Indicator Accuracy
CHGR (Inner Scale)	CC 0215 C (Bat Charger Output)	Same as DC AMPS scale
AC VOLTS	CC 0200 V (Bus 1 ØA) CC 0201 V (Bus 1 ØB) CC 0202 V (Bus 1 ØC) CC 0203 V (Bus 2 ØA) CC 0204 V (Bus 2 ØB) CC 0205 V (Bus 2 ØC)	Between 0° and 150°F, ±1.0 volt for the 105 and 125 volts scale and ±2.0 volts for balance of scale. At 0° and 150°F, ±2.0 volts for the 105 and 125 volts scale.
FREQ CPS	CC 0213 F (Bus 1 ØA) CC 0181 F (Bus 1 ØB) CC 0182 F (Bus 1 ØC) CC 0217 F (Bus 2 ØA) CC 0183 F (Bus 2 ØB) CC 0184 F (Bus 2 ØC)	From 50° to 110°F, ±1 cycle at 400 cycles. From 0° to 150°F, ±2 cycles at 400 cycles and ±2.5 cycles for balance of scale.

CREW DISPLAY INSTRUMENT MARKINGS AND ACCURACY DATA

4.1.4 ENVIRONMENTAL CONTROL SYSTEM INDICATORS.

4.1.4.1 ECS Pressure and Slow-Rate Indicators.

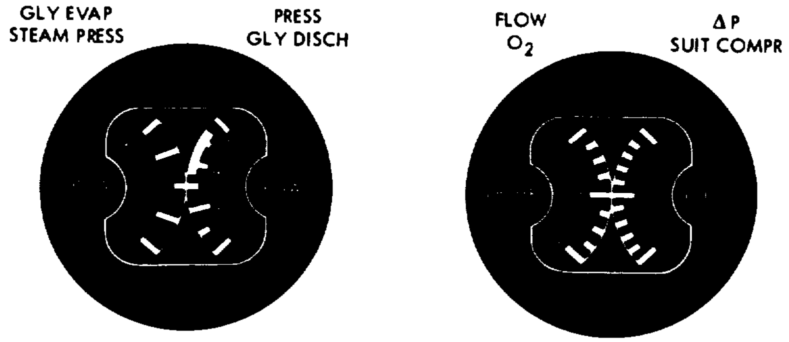
Instrument markings for the ECS pressure and rate-of-flow indicator (MDC-13) are shown in figure 4-7. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

Indicator Scale	Measurement Number	Indicator Accuracy
GLY EVAP STEAM PRESS	CF 0034 P	±5% of full scale between 0° and 150°F
PRESS GLY DISCH	CF 0016 P	Same as above.
FLOW O_2	CF 0035 R	Same as above.
ΔP SUIT COMPR	CF 0115 P	Same as above.

4.1.4.2 ECS Quantity and Outlet Temperature Indicators.

Instrument markings for the ECS quantity and outlet temperature indicators (MDC 13 and 14) are shown in figure 4-8. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

Indicator Scale	Measurement Number	Indicator Accuracy
GLY ACCUM-QUANTITY	CF 0019 Q	±5% full-scale 0° to 150°F
WATER QUANTITY	CF 0010 Q (Potable Water) CF 0009 Q (Waste Water)	Same as above.
ECS RAD-OUTLET TEMP	CF 0020 T	Same as above.
GLY EVAP-OUTLET TEMP	CF 0018 T	Same as above.
ECS RAD OUT TEMP-1	SF 0671 T	Same as above.
ECS RAD OUT TEMP-2	SF 0672 T	Same as above.



NOTE: The green color band on the glycol discharge scale indicates a normal operating range of 35 to 55 psia.

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Figure 4-7. ECS Pressure and Flow Indicators

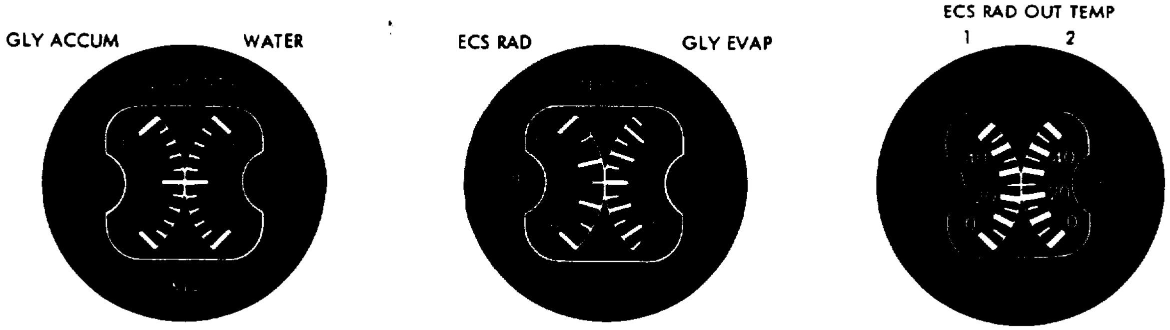

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Figure 4-8. ECS Quantity and Outlet Temperature Indicators

4.1.4.3 ECS Suit and Cabin Temperature/Pressure Indicators.

Instrument markings for the ECS suit and cabin temperature/pressure indicators are shown in figure 4-9. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

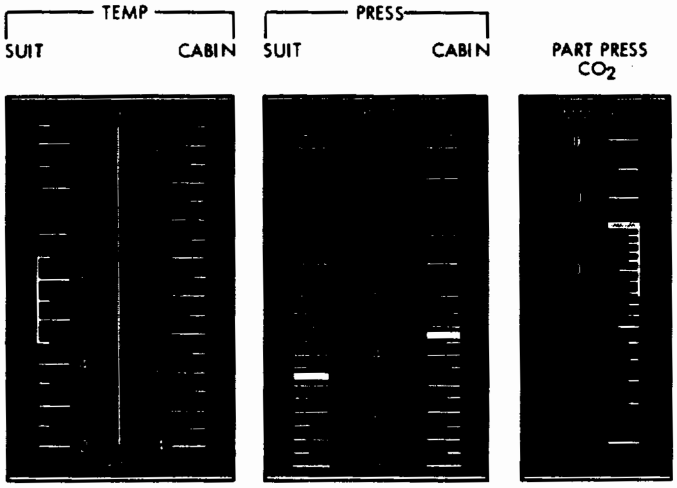
Indicator Scale	Measurement Number	Indicator Accuracy
TEMP-SUIT	CF 0008 T	±2.5°F overall at 0° to 150°F.
TEMP-CABIN	CF 0002 T	Same as above.
PRESS-SUIT	CF 0012 P	At 75°F, ±0.25 psia between 0 and 6 psia and ±3% for remainder of scale. At 0° and 150°F, ±0.375 psia between 0 and 6 psia, and ±4% for remainder of scale.
PRESS-CABIN	CF 0001 P	Same as PRESS-SUIT scale.
PART PRESS-CO_2	CF 0005 P	At 75°F, ±0.5 mm between 0 and 15 mm Hg, and ±1.0 mm for remainder of scale. At 0° and 150°F, ±1.0 mm between 0 and 15 mm Hg, and 1.5 mm for remainder of scale.
PGA Pressure Indicator	None	±2 psia overall at normal temperature range.

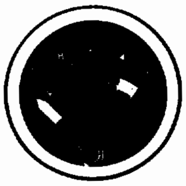
4.1.5 TELECOMMUNICATION SYSTEM METERS.

Instrument markings for the telecommunication system meters are shown in figure 4-10.

4.1.5.1 Auxiliary DC VOLTS Meter.

The auxiliary DC VOLTS meter, located on RHFEB-200 (figure 4-10), is used to monitor selected measurements for which there is either no other crew display or the crew display is an event indicator capable of displaying only in-tolerance and out-of-tolerance conditions. The voltmeter is used in conjunction with the adjacent FUNCTION SELECT and TEST SELECT





PGA PRESSURE INDICATOR (LEFT FOREARM)

NOTES: 1. A vertical green color band shows the normal operating range for the suit temperature (45° to 65°F). Red horizontal lines show limits for suit pressure (3.4 psia), cabin pressure (4.7 psia), and CO_2 pressure (15 mm Hg). A vertical yellow color band shows the caution range for CO_2 pressure (7.6 to 15 mm Hg).

2. The PGA pressure indicator presents an operating range from 2 to 10 psia and a green and red color band. The green band (3.5 to 10 psia) shows normal pressure required during space flight. The red band (3.5 to 2 psia) shows the emergency limitations for crew safety. During ground operations, the indicator needle will be pegged beyond 10 psia because of atmospheric pressure.

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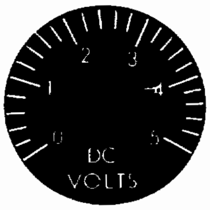
Figure 4-9. ECS Suit and Cabin Temperature/Pressure Indicators



Auxiliary DC VOLTS Meter

S-BAND ANT Meter

SM-2A-693C

Figure 4-10. Telecommunication System Meters switches to monitor 13 EPS, 6 RCS, 4 G&N and 1 ECS analog measurements. Refer to Controls and Displays (section 3) for information on which measurements are selected for monitoring by the auxiliary DC VOLTS meter.

The voltmeter provides a reading between 0 and 5 volts of the selected measurement. By use of a voltmeter conversion chart an interpolation of the value for the selected measurement can be made. (Refer to section 2.)

NOTE The accuracy of the auxiliary DC VOLTS meter (for the full scale) is ±1 percent at 75°F and ±2 percent at 0° and 150°F.

4.1.5.2 S-Band ANT Meter.

The S-Band ANT meter, on MDC-19 (figure 4-10), utilizes the automatic gain control (AGC) signal in the S-Band receiver to display, in a clockwise direction, the relative magnitude of signals received by the unified S-band equipment (USBE). The meter is used in determining the correct S-band antenna and S/C attitude for optimum S-band performance.

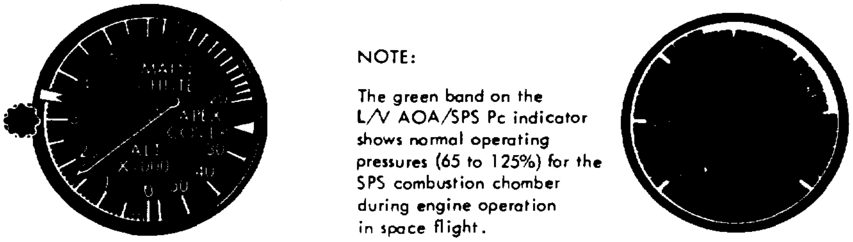
NOTE The accuracy of the S-BAND ANT meter (for the full scale) is ±5 percent at temperatures between 0° and 150° F.

4.1.6 SEQUENTIAL SYSTEMS INDICATORS.

Instrument markings for the sequential systems indicators are shown in figure 4-11. The indicators present visual displays required during launch, in-flight SPS operation, and the earth landing sequence of events. (Refer to paragraphs 4.1.6.1 and 4.1.6.2.)

4.1.6.1 Barometric Pressure Indicator (Altimeter).

The barometric pressure indicator, an altimeter on MDC-1 (figure 4-11), is used in conjunction with the earth landing system (ELS) and indicates the pressure altitude of the S/C under low-altitude, low-Mach conditions. This altimeter is monitored during the earth landing phase of the mission to verify that the ELS sequencer is initiating various phases of landing system deployment at the proper pressure altitude points. A knob, located left of the altimeter dial face, is used in setting the adjacent marker (to display the corrected main parachute deploy altitude for low-altitude aborts). The adjustable marker, based



NOTE:

The green band on the L/V AOA/SPS Pc indicator shows normal operating pressures (65 to 125%) for the SPS combustion chamber during engine operation in space flight.

Barometric Pressure Indicator (Altimeter)

L/V AOA/SPS P_C Indicator

SM-2A-700F

Figure 4-11. Sequential System Indicators

on barometric pressure, is set prior to launch. (Refer to paragraph 4.4.2.2 for altimeter error and C/B base pressure effects.)

> NOTE The accuracy of the altimeter is ±100 feet from 0 to 4000 feet and 5 percent of the altimeter reading from 4000 to 60,000 feet.

4.1.6.2 L/V AOA/SPS P_c Indicator.

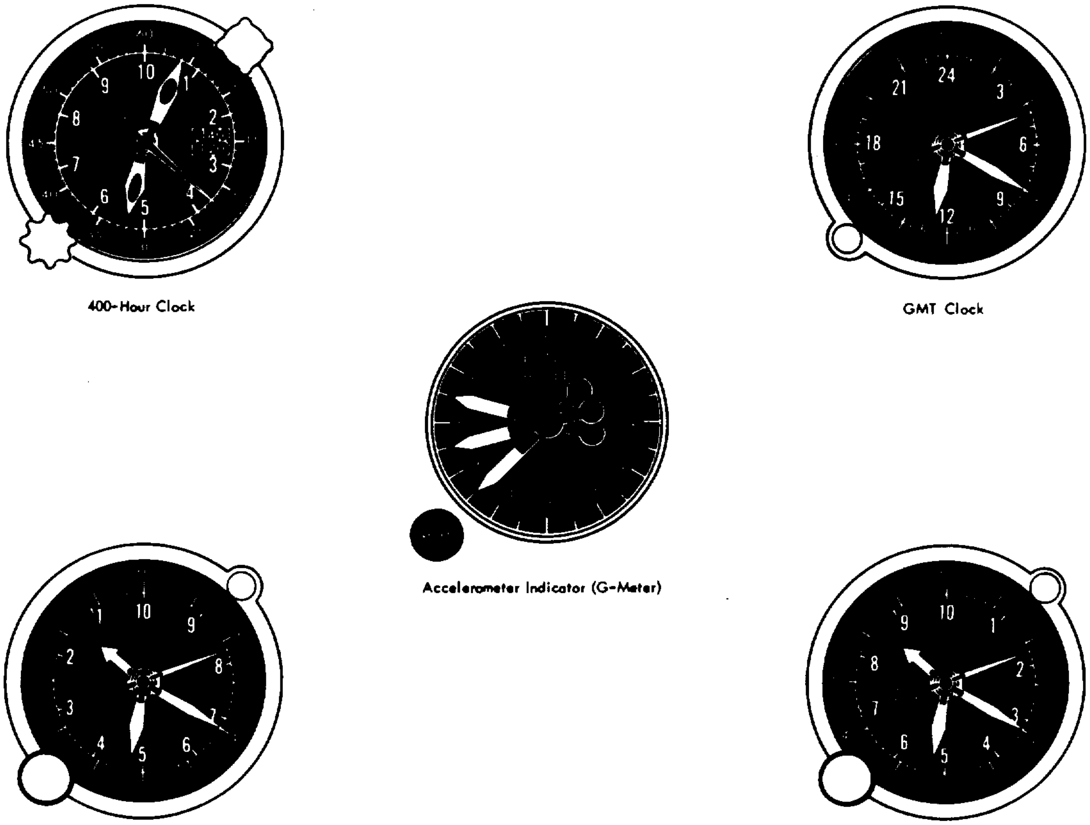
The L/V AOA/SPS P_c indicator, on MDC-3 (figure 4-11), is used to display the launch vehicle angle of attack (in percentage of pressure from the Q-ball) during launch. After launch vehicle separation from the S/C, the gauge is used to display SPS combustion chamber pressure during engine operation. Inputs to this time-shared gauge are determined by the position of the L/V AOA/SPS P_c switch, located on the same panel.

> NOTE The accuracy of the L/V AOA/P_c indicator (for the full scale) is 1 percent at 75°F and 2 percent at 0° and 150°F.

4.1.7 MISCELLANEOUS INDICATORS.

Instrument markings for mechanically operated indicators such as clocks, timers, and an accelerometer are shown in figure 4-12 and described in paragraphs 4.1.7.1 through 4.1.7.4.

> NOTE The accuracy of the S/C clocks and timers at temperatures between 60° and 90°F (and zero gravity) will not exceed ±5 seconds for 10 consecutive days (the arithmetic average of the daily rates). For environmental conditions above or below this temperature range, the average of daily rates for 5 consecutive days will not exceed 30 seconds.



400-Hour Clock

GMT Clock

Accelerometer Indicator (G-Meter)

To: EVENT Timer

From: EVENT Timer

SM-2A-731D

Figure 4-12. Miscellaneous Indicators

4.1.7.1 Mission—Elapsed Time (400-Hour) Clock.

The 400-hour clock, on MDC-12 (figure 4-12), has a 10-hour dial face with second, minute, and hour hands. A display window is also provided to show mission elapsed time in 10-hour increments up to 400 hours (when window display returns to 0.000). The hour and minute hands are set by a knob at the bottom left of the dial face. A knob at the top right of the dial is used to reset, start, and stop the clock. This clock is illuminated when the floodlights switch on MDC-27 is actuated.

4.1.7.2 GMT (Greenwich Mean Time) Clock.

The GMT clock, LHFEB-306 (figure 4-12), has a 24-hour dial face with standard second, minute, and hour hands. A time-set screw, at the bottom left of the dial face, is used to synchronize the clock with Greenwich mean time. This clock illuminates when the CLOCKS-BRT-OFF-DIM switch (LEB-98) is actuated.

4.1.7.3 TO EVENT and FROM EVENT Timers.

The TO EVENT and FROM EVENT timers, on LHFEB-306 (figure 4-12), have 10-hour dial faces with second, minute, hour, and 10-hour hands. A knob at the bottom left of each timer is used to set the timer hands. Each timer can be reset, started, or stopped by a pushbutton control at the top right of the timer. These timers illuminate when the CLOCKS-BRT-OFF-DIM switch (LEB-100) is actuated.

4.1.7.4 Accelerometer Indicator (G-Meter).

The accelerometer indicator or g meter, on MDC-2 (figure 4-12), is provided with an indicating pointer for showing S/C positive and negative g loads. In addition to the indicating pointer, there are two recording pointers (one for positive and one for negative g loads) which follow the indicating pointer to its maximum attained travel. The recording pointers will remain at the maximum positive and negative positions attained to provide a record of maximum g loads encountered. To return the recording pointers to the normal 1-g position, it is necessary to press the RESET knob on the lower left-side of the accelerometer.

NOTE The accuracy of the g meter is ±0.2 g from 0 to 4 g's, ±0.3 g at 6 g's, ±0.4 g from 8 to 10 g's, and ±0.75 g at 15 g's.

4.2 CONSUMABLE REQUIREMENTS.

Information relating to S/C 014 consumable materials for the RCS, SPS, EPS, and ECS is provided in this section. For detailed consumable data, refer Mission Modular Data Book (MMDB).

4.2.1 S/M RCS PROPELLANT CONSUMPTION DATA.

Propellant consumables utilized by the 16 S/M RCS engines provide thrust for three-axes rotational and translational control of the spacecraft (after S/C separation from the launch vehicle and until C/M-S/M separation prior to entry). The oxidizer/fuel ratio (by weight) for each engine is 2.03±0.075:1 at a propellant flow rate of 0.360 lb/sec. Nominal values for the individual S/M RCS consumables (maximum usable tank capacity of 790 pounds) are as follows:

Consumables	Storage Tank	Weight per Tank		Delivery Rate to Engine (lb/sec)
		Filled (lb)	Maximum Usable (lb)	
Nitrogen tetroxide (N_2O_4) (oxidizer)	4	138.1	131.7	0.241
50% unsymmetrical diamethylhydrazine and 50% hydrazine (UDMH/ N_2H_4) (fuel)	4	69.7	65.8	0.119
Helium (He) (pressurant)	4	0.52	0.52	N/A

4.2.1.1 Manual Attitude Control Maneuvers

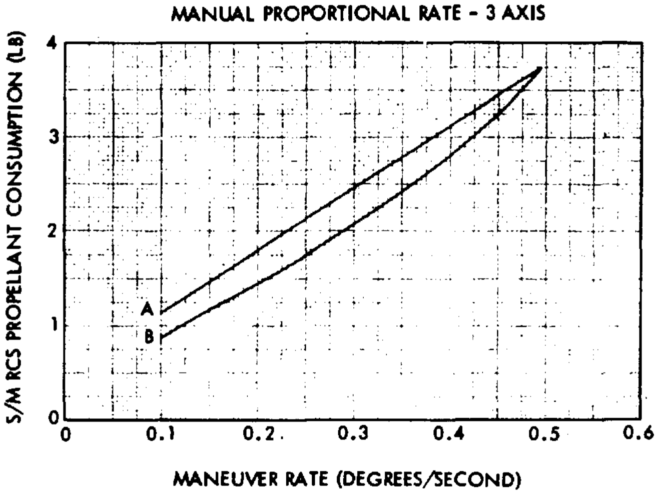
S/M RCS propellant consumption rates for manual attitude control maneuvers (proportional and direct control) are presented in figure 4-13. Assumptions applicable to the curves shown in figure 4-13 are as follows:

- The dynamic disturbances accounted for are SPS propellant slosh, the earth orbit aerodynamics and gravity gradient, ECS steam venting, and rotating EPS and ECS equipment.
- A nominal maneuver of 50±0.5 degrees per axis.
- This data may be ratioed to account for different maneuver angles. The propellant consumption must be decreased by 10 percent for a 30-degree maneuver and increased by 20 percent for a 100-degree maneuver.

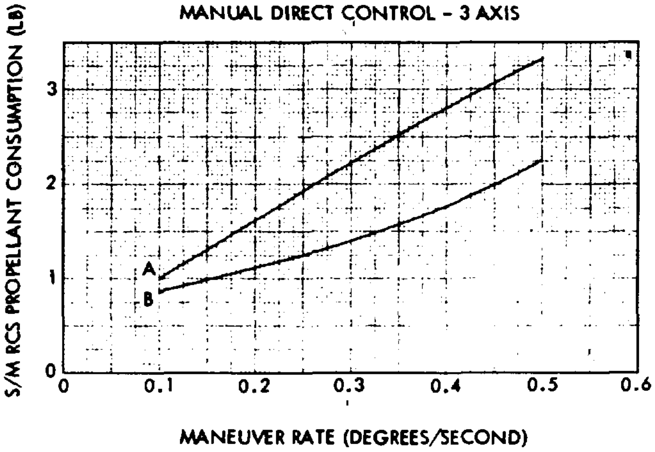
The manual single-axis maneuver propellant consumption is the same as the single-axis maneuver in paragraph 4.2.1.2.

4.2.1.2 Automatic Attitude Control Maneuvers and Attitude Hold.

S/M RCS propellant consumption rates for G&N control maneuvers (attitude control and attitude hold), versus S/C



CURVE	WEIGHT (LB)	INERTIA (SLUG-FEET SQUARED)		
		I_{XX}	I_{YY}	I_{ZZ}
A	29,500	15,800	53,500	54,000
B	22,300	12,600	40,000	38,700



NOTE: WEIGHTS AND INERTIAS FOR CURVES A AND B ARE SAME AS SHOWN ON UPPER CHART.

TYPICAL MMDB INFORMATION

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Figure 4-13. S/M RCS Propellant Consumption During Manual Attitude Control Maneuvers weight, are presented in figure 4-14. The same assumptions in paragraph 4.2.1.1 also apply to figure 4-14, in addition to the following:

- Non-maneuvered axes are held with a narrow deadband of ±0.2 degree while the other axes are moved.
- A specific impulse (I_{sp}) for a single jet RCS firing per axis that equals 180 seconds.
- A maneuver rate of 0.5 degree per second.

The S/M RCS propellant consumption rates for the attitude thermal (barbecue) control mode versus S/C weight are presented in figure 4-15. Applicable additional assumptions are as follows:

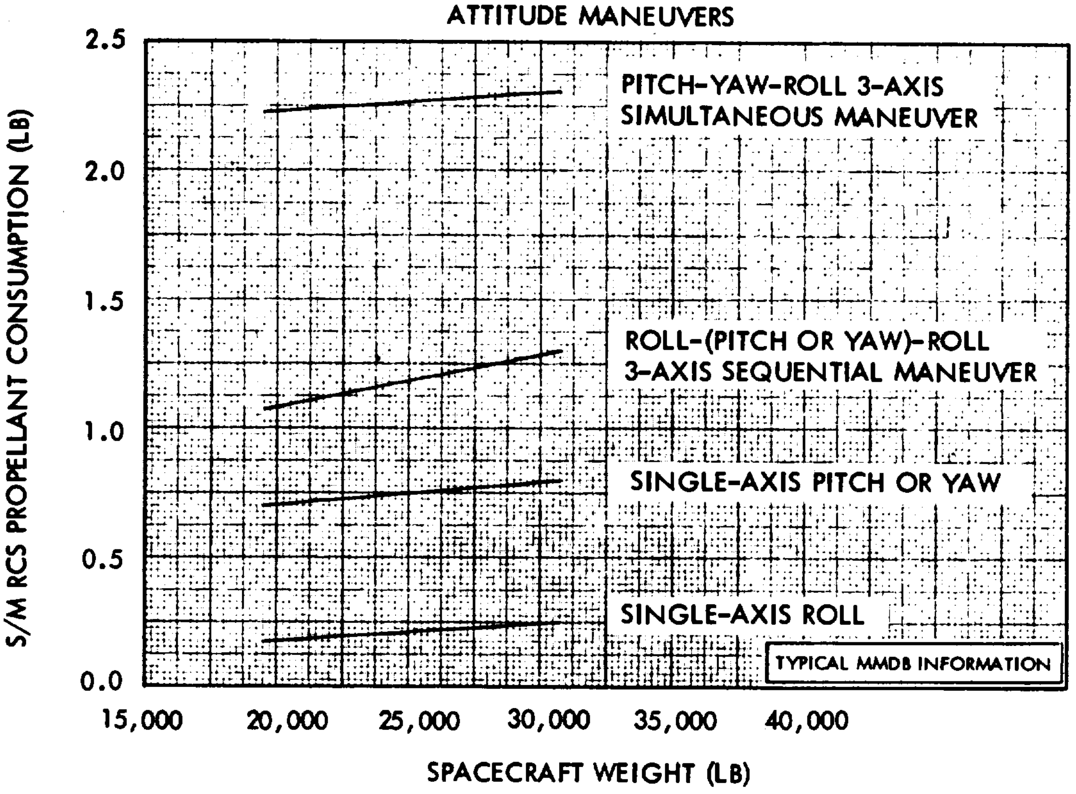
- Attitude hold in pitch and yaw are at a deadband of ±4.2 degrees.
- Roll axis spin is 0.5 degree per second.

The S/M RCS propellant consumption required to damp free drift rates (caused by dynamic disturbances) versus time in free drift are presented in figure 4-16.

4.2.1.3 Translation Maneuvers.

S/M RCS propellant consumption required for settling SPS propellants versus S/C weight, for three configurations of RCS engine utilization, is presented in the upper chart of figure 4-17. The lower chart shows propellant required for RCS +X axis delta velocity maneuvers. Assumptions applicable to both charts in figure 4-17 are as follows:

- The RCS engine thrust equals 100 pounds.
- I_{sp} at attitude correction equals 185 seconds.
- I_{sp} at translation equals 278 seconds.
- Dynamic disturbances (stated in paragraph 4.2.1.1) are neglected.
- Roll control propellant requirements are neglected.



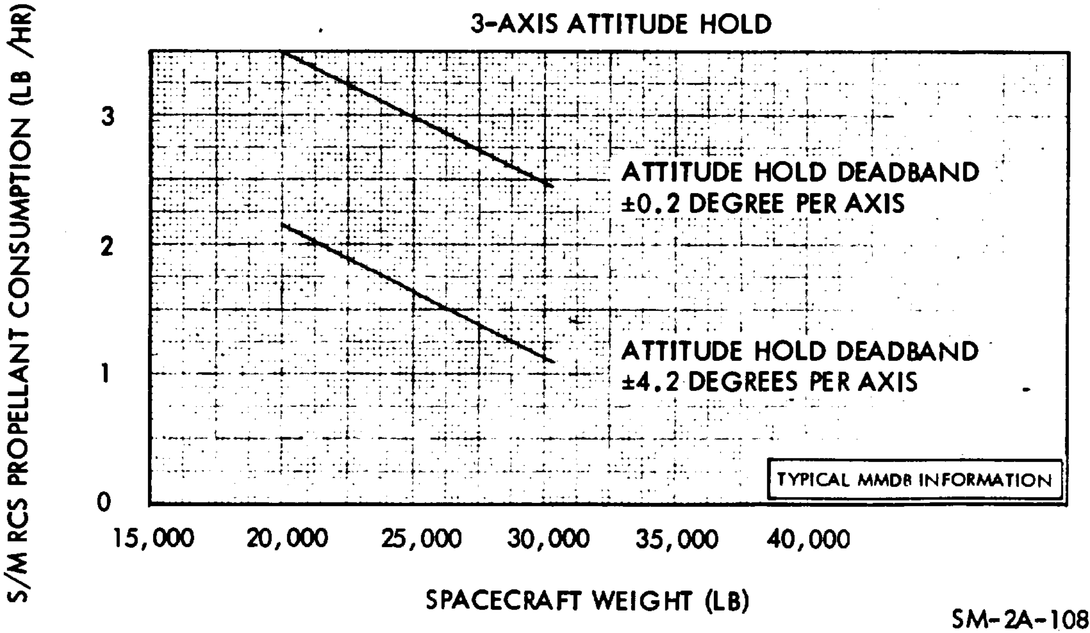


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Figure 4-14. S/M RCS Propellant Consumption During Attitude Control Maneuvers and Attitude Hold

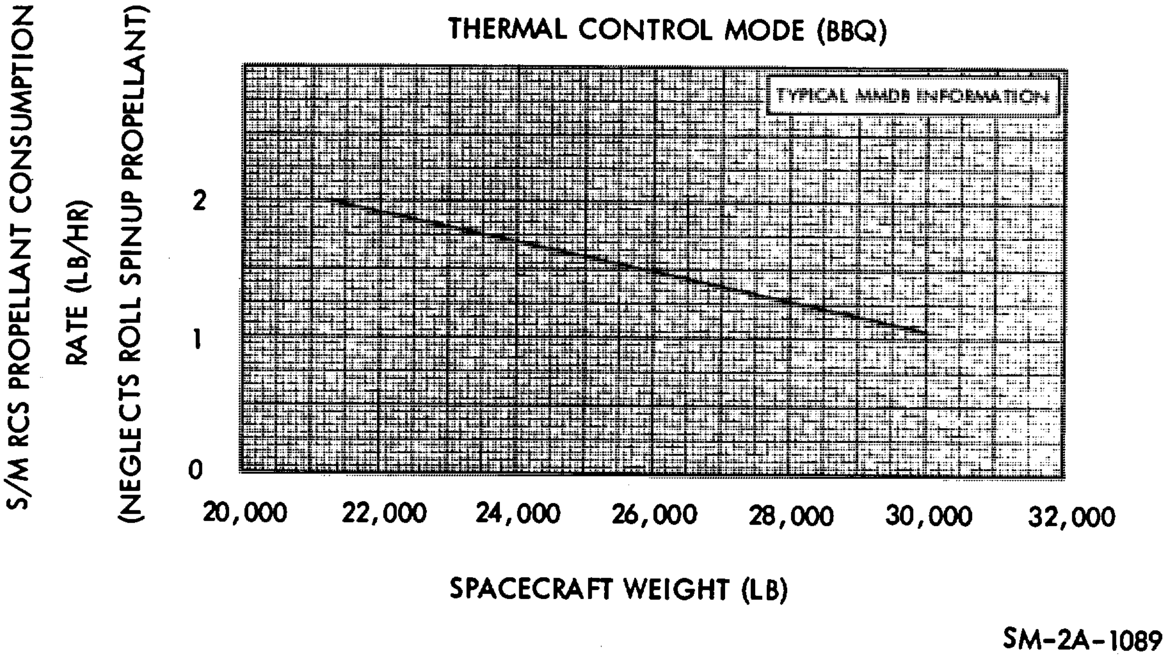


Figure 4-15. S/M RCS Propellant Consumption for Thermal Control Modes

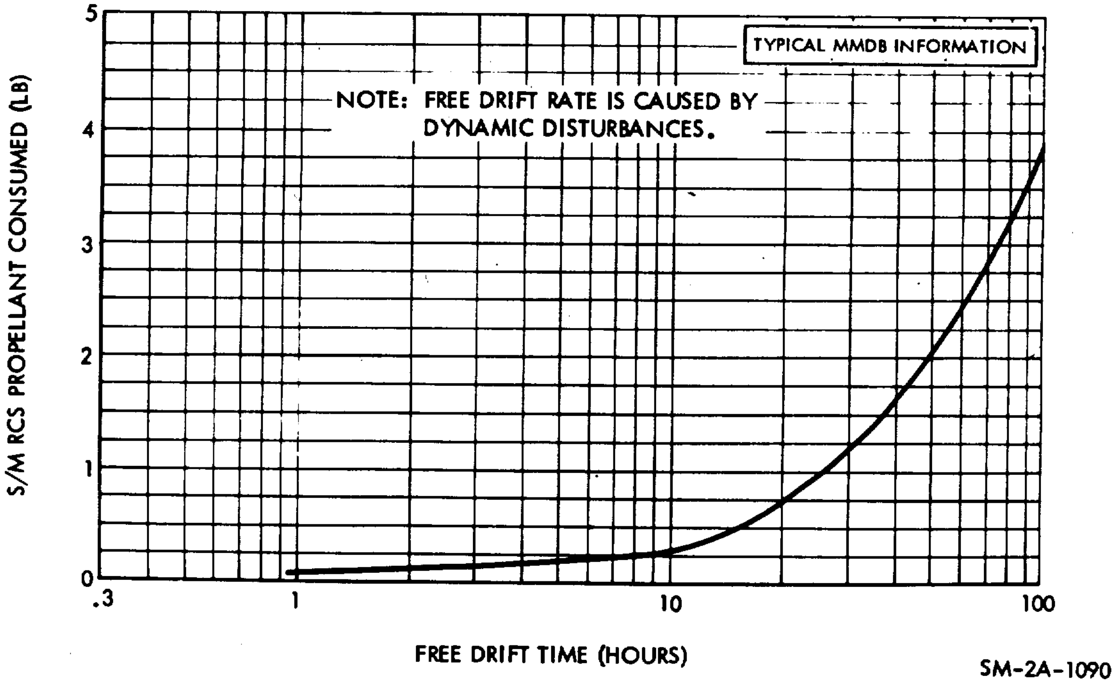
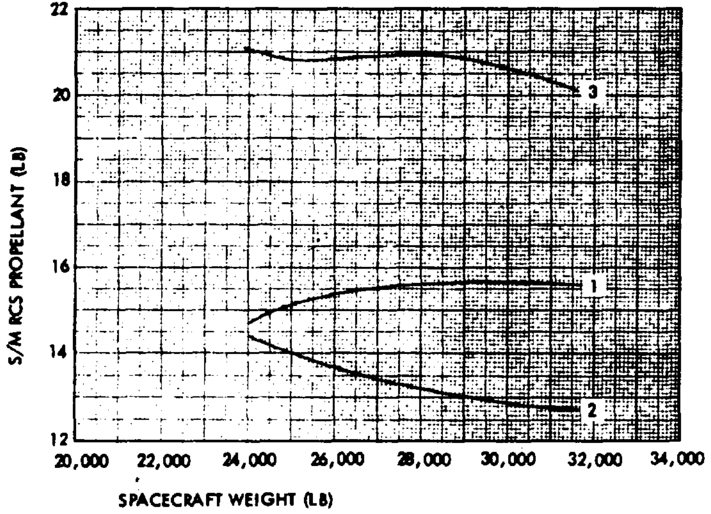


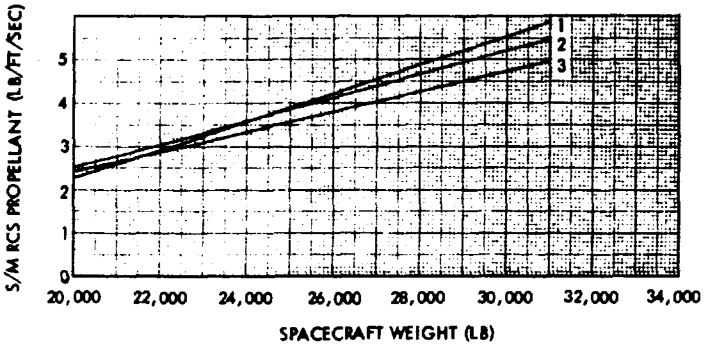
Figure 4-16. S/M RCS Propellant Consumption for Damping Out Free Drift Rate

CONFIGURATION	AXIS	S/M RCS ENGINES			
		DISABLED	USED FOR		
			ATTITUDE CONTROL		PLUS X TRANSLATION
			POSITIVE	NEGATIVE	
ONE	PITCH	3 & 4	1	2	2 & 1
	YAW	6 & 5	7	8	NONE
TWO	PITCH	2 & 1	3	4	NONE
	YAW	7 & 8	5	6	6 & 5
THREE	PITCH	NONE	3 & 1	2 & 4	2 & 1
	YAW	NONE	7 & 5	6 & 8	6 & 5

S/M RCS PROPELLANT REQUIRED FOR ULLAGE



S/M RCS PROPELLANT REQUIRED FOR +X TRANSLATION



NOTE:

Curves 1, 2, and 3 represent same engine configuration as above.

TYPICAL MMDB INFORMATION

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Figure 4-17. S/M RCS Propellant Consumption for SPS Propellant Settling and Translation Maneuvers

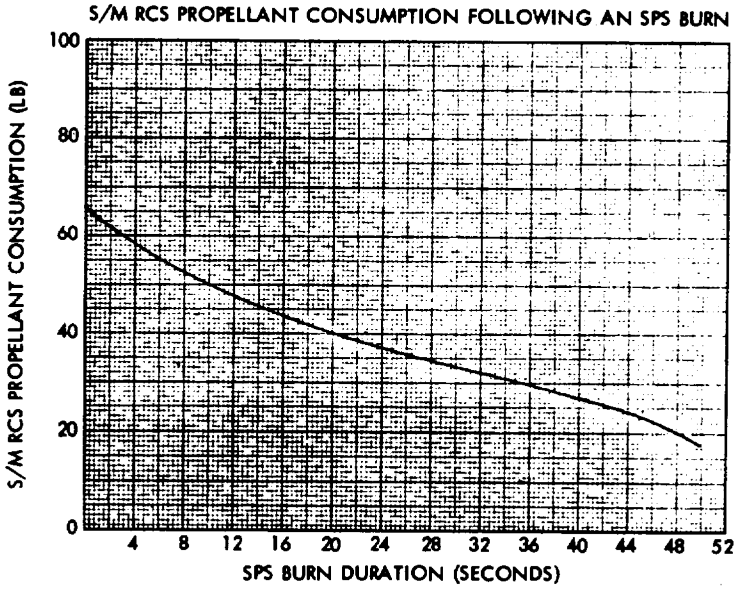
4.2.1.4 Attitude Hold Following SPS Burn.

S/M RCS propellant consumption required for attitude hold in three axes, immediately following an SPS burn and extending over a 10-minute period after the SPS burn, is presented in the upper chart of figure 4-18. (This curve includes the total RCS requirement and should not be added to the results obtained from figure 4-14. However, after the end of the 10-minute slosh damping period, the rates in the lower chart of figure 4-14 should be used.) For attitude holds delayed after the termination of an SPS burn, both charts in figure 4-18 are used for adjusting RCS propellant consumption rates.

4.2.2 C/M RCS PROPELLANT CONSUMPTION DATA.

Propellant consumables utilized by the 12 C/M RCS engines provide thrust for three-axes rotational and attitude control of the C/M (after an abort or during normal entry). The oxidizer/fuel ratio (by weight) for each of the four roll engines is 2.1±0.09:1 at a propellant consumption rate of 0.345 lb/sec. The oxidizer/fuel ratio (by weight) for each of the eight remaining engines is 2.0±0.09:1 at a propellant consumption rate of 0.342 lb/sec. Any remaining propellant, including the helium used as a pressurant, is ejected prior to C/M touchdown (for all mission modes). Nominal values for the individual C/M RCS consumables (usable tank capacity of 225 pounds) are as follows:

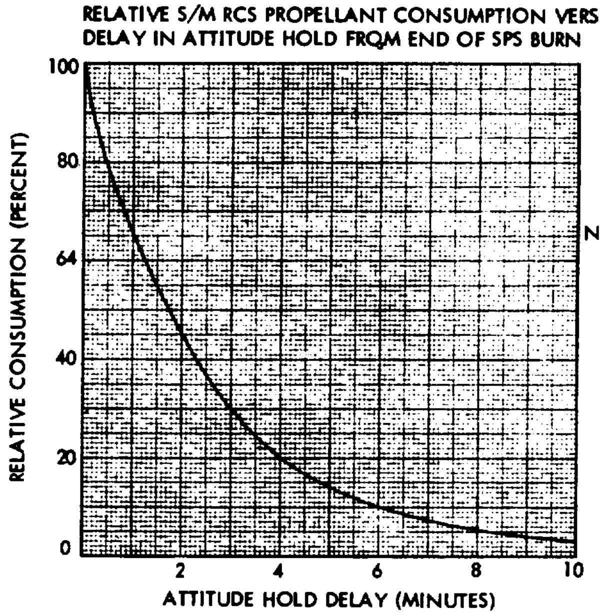
		Weight per Tank		
Consumables	Storage Tank	Filled (lb)	Usable (lb)	Delivery Rate to Engine
Nitrogen tetroxide (N_2O_4) (oxidizer)	2	89.2	75.0	0.228 lb/sec (oxidizer/fuel ratio of 2:1)
				0.234 lb/sec (oxidizer/fuel ratio of 2.1:1)
Monomethylhydrazine (MMH) (fuel)	2	45.2	37.5	0.114 lb/sec (oxidizer/fuel ratio of 2:1)
				0.111 lb/sec (oxidizer/fuel ratio of 2.1:1)
Helium (He) (pressurant)	2	0.52	0.52	N/A



S/M RCS PROPELLANT CONSUMPTION FOLLOWING AN SPS BURN

NOTES:

1. PROPELLANT CONSUMPTION IS BASED ON 3-AXIS HOLD INITIATED IMMEDIATELY FOLLOWING THE BURN FOR A PERIOD OF 10 MINUTES
2. HOLD IS IN MAXIMUM DEADBAND (4.2 DEGREES)
3. TWO ENGINE FIRINGS PER AXIS
4. OPEN-LOOP SLOSH MODEL



RELATIVE S/M RCS PROPELLANT CONSUMPTION VERSUS DELAY IN ATTITUDE HOLD FROM END OF SPS BURN

NOTE:

APPLY PERCENT TO PROPELLANT VALUE FROM CURVE ABOVE

TYPICAL MMDB INFORMATION

SM-2A-1092

Figure 4-18. S/M RCS Attitude Hold Propellant Consumption Following SPS Burn

Representative C/M RCS propellant consumption time histories are presented in figure 4-19 for nominal and off-nominal single-system RCS entries. The curves include pre-entry propellant expended (5 pounds for nominal and 9 pounds for off-nominal rates).

4.2.3 SPS PROPELLANT CONSUMPTION DATA.

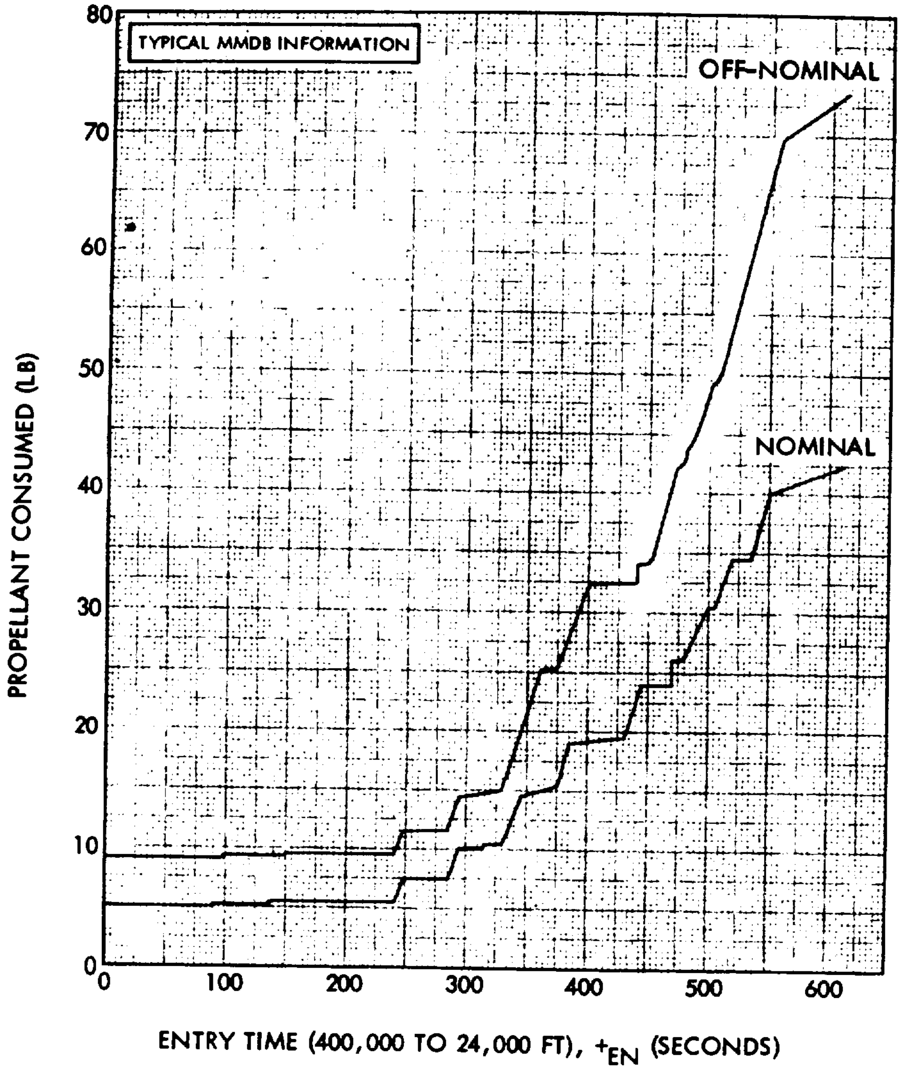
Propellant consumables utilized by the SPS engine (at 69.09 lb/sec) provide thrust for significant spacecraft velocity changes after booster separation. Nominal values for the SPS consumables are as follows:

Consumables	Storage (and Sump) Tank	Weight per Tank		Delivery Rate to Engine
		Filled (lb)	Usable (lb)	
Nitrogen tetroxide (N_2O_4) (oxidizer)	1	30,600	27,333	46.06 lb/sec
50% unsymmetrical dimethylhydrazine (UDMH/N_2H_4) (fuel)	1	15,300	13,677	23.03 lb/sec
Helium (He) (pressurant)	2	48.2	48.2	N/A

NOTE Storage tanks for the SPS fuel and oxidizer also include a sump tank. S/C 012 will not be scheduled to carry the possible total propellant load of about 45,900 pounds.

Spacecraft weight is plotted against characteristic velocity for nominal and minimum values of specific impulse. (See figure 4-20.) A sample path traces a typical solution for propellant weight when initial weight, specific impulse, and characteristic velocity change are given. Arrows on the chart, starting with an initial value for weight (W_1) indicate the direction of flow for the sample problem. It is important to note that the characteristic velocity (V_c) scale does not represent values of ΔV remaining aboard the S/C, but is intended to serve as a reference only on which increments (ΔV_c) may be taken as shown in the sample.

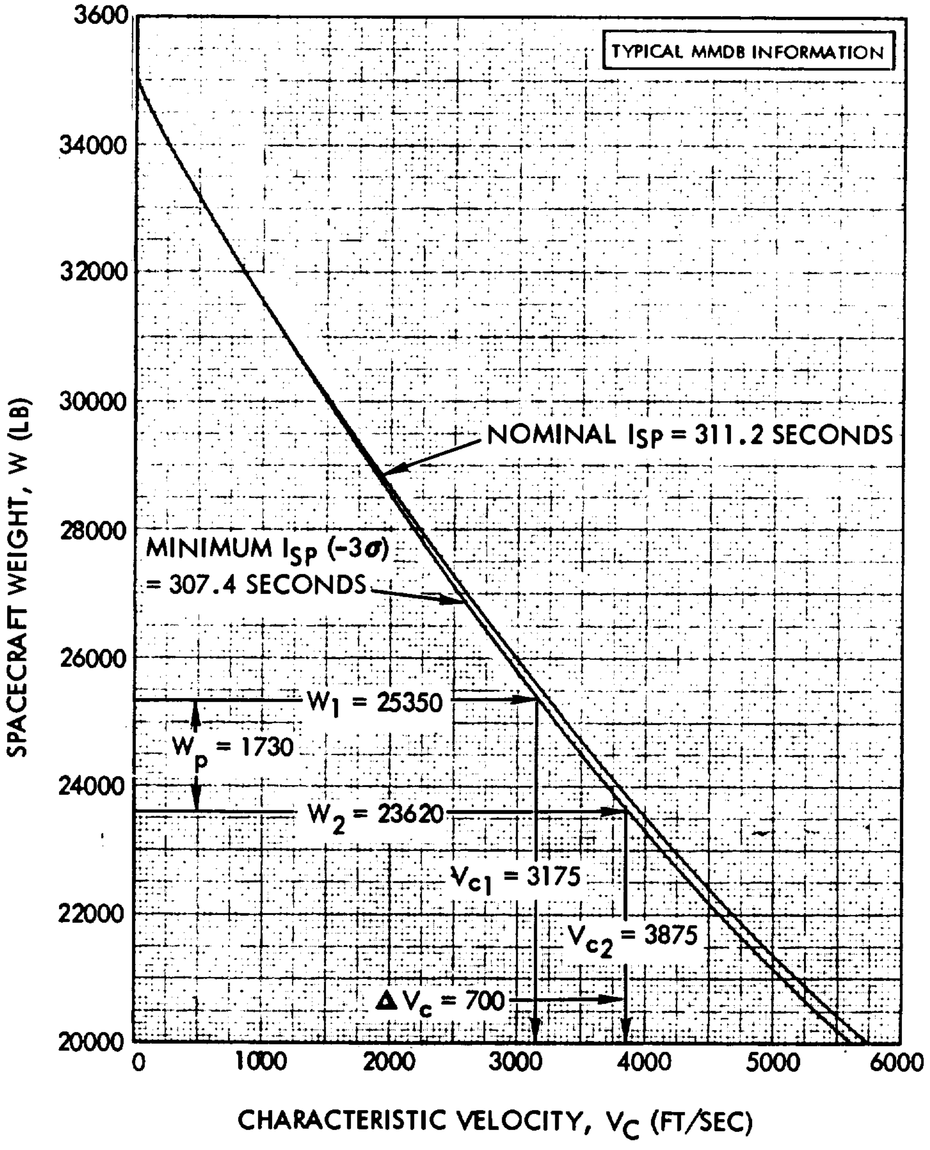
In order to account for a 4500 pound-seconds loss for each SPS engine start, 14.5 pounds of propellant must be added to the



	NOMINAL	OFF-NOMINAL
V_g	24,216 FPS	24, 216 FPS
γ_g	-1.65 DEG	-1.65 DEG
α	156 DEG	156 DEG
β	0 DEG	0 DEG
ϕ_{EN}	0 DEG	0 DEG
$C\ell_o$	-0.0004 DEG	-0.00006
GUST	NONE	HALF SINE WAVE
σ	52.7 DEG	52.7 DEG
RANGE	1547 NM	1547 NM

SM-2A-1093

Figure 4-19. C/M RCS Propellant Consumption Time Histories - Single System



GIVEN: INITIAL SPACECRAFT WEIGHT, W_1
SPECIFIC IMPULSE, I_{SP}
CHARACTERISTIC VELOCITY
CHANGE, ΔV_c
g = 32.174 FT/SEC2

PROPELLANT WEIGHT, $$W_P = W_1\left[1-\frac{1}{e^{\left(\frac{\Delta V_c}{g\, I_{SP}}\right)}}\right]$$

SM-2A-1094

Figure 4-20. SPS Propellant Consumption

propellant consumption noted during each firing. (The total propellant requirements are limited to the total usable propellants available to the S/C.)

4.2.4 EPS AND ECS CONSUMPTION DATA.

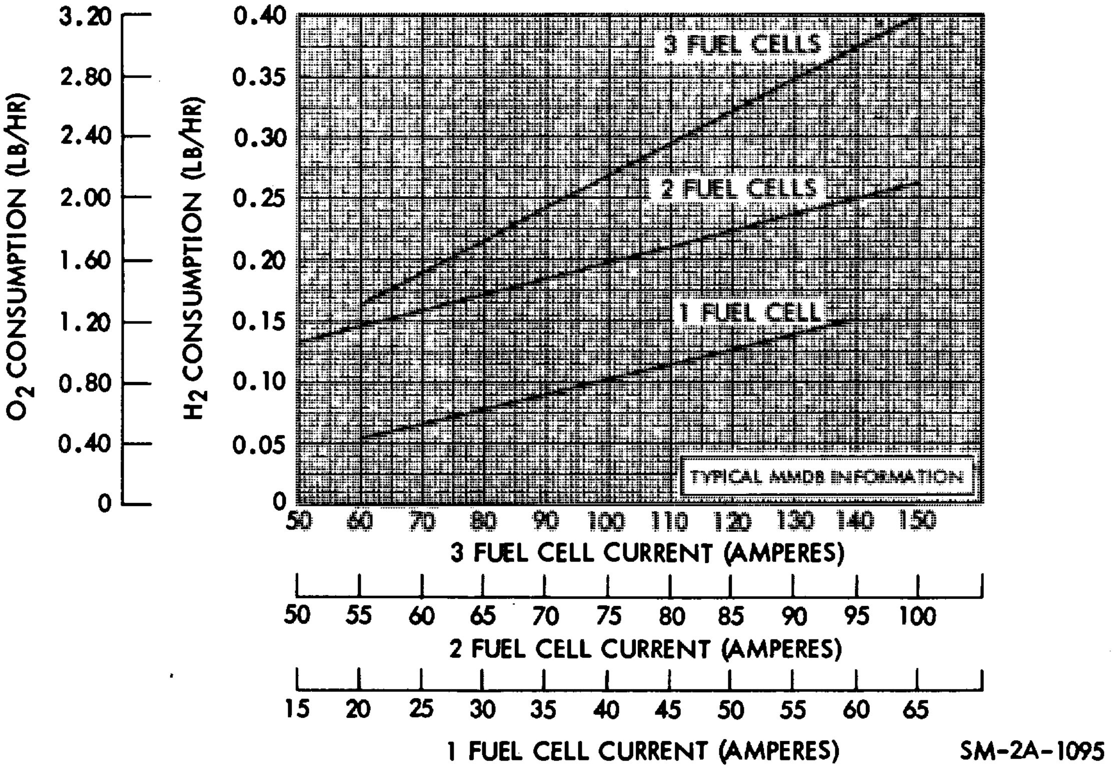
Oxygen and hydrogen reactants (from the cryogenic storage system) are consumed by the EPS fuel cell power plants in the generation of electrical power for the S/C. Water, as a byproduct, is provided for the ECS. Oxygen from the cryogenic storage system is also supplied to the ECS for metabolic consumption by the crewmembers and for pressurization of the crew compartment and the PGA. The cryogenic tanks for oxygen and hydrogen are initially filled to at least 97 percent of full capacity. Nominal values for these consumables are as follows:

Consumables	Storage Tank	Weight per Tank		Flow Rate to System
		Filled (lb)	Usable (lb)	
Hydrogen (H_2) (supercritical gas)	2	29.0	28.0	0.14 lb/hr (min) 0.27 lb/hr (max) (0.75 lb/hr-purge only)
Oxygen (O_2) (supercritical gas)	2	327.0	320.0	1.70 lb/hr (min) 2.58 lb/hr (max) (0.6 lb/hr-purge only)
Nitrogen (N_2) (fuel cell reference pressure)	3	0.44	0.44	N/A

NOTE Both the EPS and ECS utilize oxygen from the same cryogenic storage system (489 pounds of usable O_2 for the EPS and 151 pounds for the ECS).

4.2.4.1 EPS Fuel Cell Reactants Consumption.

The O_2 and H_2 consumption versus electrical output for one, two, or three fuel cell power plants is shown in figure 4-21. Only the H_2 curve is given. (The O_2 consumption rate is eight times the H_2 rate.) Water generated by the fuel cells may be calculated by multiplying the H_2 consumption rate by nine.



NOTE:
WATER GENERATION RATE IS OBTAINED BY MULTIPLYING H_2 CONSUMPTION RATE BY NINE

Figure 4-21. Cryogenic Consumption Versus Fuel Cell Current

In order to maintain fuel cell operating efficiency, purging of each power plant is accomplished every 7 hours. The purges will normally be staggered so that a H_2 purge will follow an O_2 purge by 3.5 hours. The present purging cycle of 7 hours is based upon the maximum normal power output of 1420 watts per fuel cell. The time between purges is based upon the ratio of the present maximum of 1420 watts/fuel cell power plant to the actual maximum gross power demand times 7 hours. Thus, if the actual maximum gross power demand is 710 watts/fuel cell module, the nominal purge interval of 7 hours would be increased by 1420/710 or 2. Multiplying 2 times 7 would then provide a purge interval of 14 hours. During purging, the power plant continues to consume reactants in the quantities required to produce the power demanded by S/C electrical loads. The duration of each H_2 purge is 80 seconds and 120 seconds for each O_2 purge.

4.2.4.2 EPS Electrical Power Output.

During a normal mission, from launch until entry, about 618 kwh of electrical power is supplied to the S/C by three fuel cell power plants operating in parallel. If one power plant should fail, the remaining two will provide for normal power loads. In the event two power plants fail, S/C emergency loads can be accommodated. The three batteries, normally reserved for entry and postlanding phases of the mission, can be utilized to provide for peak loads above operating fuel cell capacities.

NOTE The EPS requires a minimum steady-rate power level of 1689 watts with three fuel cells operating or 1550 watts with two fuel cells operating during orbit. However, a minimum transient power level of 1500 watts for three fuel cells can be reached without causing an overvoltage in the EPS. (Tests are being conducted to determine if a minimum transient power level of 1200 watts for three fuel cells is feasible.)

- By drawing on battery power and recharging, an additional 1.0 kwh of energy can be obtained for use during orbital flight.
- The S/C is capable of sustaining an emergency power load of 1200 watts with one fuel cell operating during orbit.

4.2.4.3 ECS Oxygen and Water Consumption.

Oxygen and water consumables are utilized by the ECS in providing for needs peculiar to the presence of men aboard the spacecraft. Nominal values for the ECS consumables are as follows:

Consumables	Source	Usable Weight (lb)	Remarks
Oxygen (O_2)	Cryogenic storage system tanks (2). NOTE The cryogenic storage system supplies O_2 to both the ECS and EPS (151 pounds for the ECS and 489 pounds for the EPS).	151.0	The basic purpose of the ECS oxygen is for crew metabolic consumption and control of the C/M pressure as follows: a. Metabolic - three men at 0.075 lb/hr/man or 0.225 lb/hr total b. C/M leakage - 0.2 lb/hr

CONSUMABLE REQUIREMENTS

PERFORMANCE

Consumables	Source	Usable Weight (lb)	Remarks
			c. 2 C/M repressurizations - 11.7 lb (5.85 lb/ea).
	Surge tank	3.7	Initially filled during ground service
	Entry tank	1.0	Initially filled during ground service
Potable water	One C/M potable water supply tank	36.0	Initially filled during ground service; the tank is replenished during flight by the EPS fuel cell power plants at a nominal rate of 0.77 lb per kilowatt. If tank is full, water will overflow into C/M waste water tank.
Waste water	One C/M waste water supply tank	56.0	Initially filled during ground service and then by overflow of water from potable water tank.
	Two S/M water supply tanks	112.0	Additional supply of water is carried in S/M to replenish C/M water tanks, if necessary.
Nitrogen (N_2) (pressurant)	One N_2 supply tank	1.5	Used to pressurize the S/M water supply tanks.

NOTE The ECS potable water will be primarily used for metabolic purposes by the crew and not for cooling purposes in the S/C (unless waste water becomes depleted).

- The ECS radiator inlet temperature is affected by heat transfer from EPS components. As the components become warmer from increased electrical loads, a greater rate of heat transfer will take place. ECS radiator freezing may result if both radiators are exposed to deep space for more than 1 hour and the inlet temperature is below 75°F with an electrical current level of about 55 amps By rolling or tumbling the S/C, to allow for periodic exposure of the radiators to the sun, the inlet temperature can be 70°F with an electrical current level of about 50 amps before the space radiators start to freeze.

4.3 RCS AND SPS THRUSTING DATA.

4.3.1 RCS TRANSLATION CONTROL.

Spacecraft translation is possible at any time after S-IVB separation and prior to the time when S/M-C/M separation occurs. Translation maneuvers are provided through the S/M RCS engines and are normally initiated manually by the translation control T-handle in the ±X, Y, and Z axes, or by the DIRECT ULLAGE switch in the +X axis. The translation control (manipulated in the counterclockwise position to the abort detent for about 2.5 seconds) also provides for CSM/S-IVB separation. While the control is in the abort detent position, the CSM attitude is not controlled. Upon confirmation of physical separation, the translation control is moved to the +X position and the SCS initiates attitude control to a maximum deadband of 5 degrees. (Refer to section 2 for systems operation.)

NOTE Each S/M RCS engine nominally develops 100 pounds of thrust. If four engines are ignited (as in a ±X translation), the S/C will accelerate at 0.4 to 0.8 ft/sec^2., depending on the S/C weight and control mode. (Only two engines are ignited for ±Y and ±Z translations.)

- The minimum RCS impulse duration, assuming average human response, is on the order of 200 milliseconds. The maximum translation duration is a function of the available propellant.

4.3.2 RCS ROTATION CONTROL.

Automatic or manual rotational control of the S/C is provided in both the G&N and the SCS control modes. (Refer to section 2 for systems operation.)

NOTE The S/C can have a maximum angular acceleration from 1.0 to 1.5 degrees per second^2, depending on the S/C mass configuration and RCS engines fired.)

4.3.2.1 G&N Attitude Control.

During the G&N attitude control mode, the inertial measurement unit (IMU) maintains the primary inertial attitude reference for the S/C. Rotation changes are commanded by either the Apollo guidance computer (AGC) when verb 70 is entered in the S/C display keyboard (DSKY) for manual maneuvers with the rotation control, or by manually dialing the coupling display units (CDU) for maneuvers preprogrammed in the AGC.

NOTE The AGC can be programmed to command a three-axis 60-degree reorientation of the S/C (and is similar in operation to an attitude orientation maneuver for an IMU alignment).

- All preprogrammed AGC maneuvers are executed at an attitude rate of 0.5 degree per second (4.0 degrees per second for abort or entry maneuvers only). In the G&N mode, a ±4.2 degree maximum or a ±0.2 degree minimum attitude error deadband is available The S/C will have a limit cycle rate of less than 0.2 degree per second within these deadbands.
- G&N attitude maneuver rates (used for IMU fine alignments and checks) are limited by the G&N digital program to 0.5 degree per second in pitch, roll, and yaw.

4.3.2.2 SCS Attitude Control.

During the SCS attitude control mode, the body mounted attitude gyros (BMAG) provide an automatic reference for holding the S/C at a specific attitude within a ±4 2 degrees maximum or a ±0.2 degree minimum attitude error deadband. If the S/C is then maneuvered manually by the rotation control, the attitude gyro coupling unit (AGCU) will automatically cage the attitude gyros, correct the attitude hold reference, and present a new display on the FDAI when the maneuver is completed.

4.3.2.3 Manual Attitude Control.

Manual maneuvers for attitude control of the S/C are provided by use of the rotation control for direct and proportional rates, and by the attitude impulse control for low-rotational rates (minimum impulse). The primary purpose of the manual attitude controls and pertinent data are as follows:

1. Direct rotation control, for emergency and backup conditions, is commanded by use of the rotation control (stick) about the desired axes to its hard stops. Just before engaging the hardstops, a switch closes and applies a direct command to the RCS direct coils. Rate feedback is not used to cancel the stick movement, but the BMAG-AGCU loop is closed and maintains an attitude reference to its limits.

   NOTE The attitude rate, commanded by direct rotation, is limited only by human endurance and the RCS propellant supply. Start and stop transients depend on pilot technique and the attitude reference (FDAI or visual landmark) used to close the outer control loop. The inertial references start to accumulate error (due to gyro slue rate limitations) at a rate of 20 degrees per second about the roll axis and 5.0 degrees per second about the pitch or yaw axis.

2. Proportional rotation control, for attitude corrections, is commanded by displacement of the manual S/C rotation control (stick) into a desired proportional rate (when referring to S/C attitude display on the FDAI).

   NOTE The resulting proportional rate will vary from a minimum of 0.2 degree per second to a maximum of 0.65 degree per second (depending on stick displacement). Attitude error deadbands are ±4.2 degrees maximum and ±0.2 degree minimum.

3. Attitude impulse control, for commanding low-rotational rates about all three axes, is available in either G&N or SCS modes of operation and is used as required during navigational sighting periods. This is accomplished through the attitude impulse control located on panel 105.

   NOTE After the attitude impulse control is enabled and displaced, a switch closure in the control unit will cause one pulse of 18±4 milliseconds, which is applied to the RCS jet selection logic. (One pulse is generated for each attitude impulse switch closure.)

- Attitude impulse control is not a proportional control and does not provide for attitude hold. When this control is enabled, relay action removes all rate attitude error and control inputs from the SCS electronics.

- Use of minimum impulse (for fine adjustment of S/C attitude) excites rates of about 0.01 degree per second minimum to 0.5 degree per second maximum.

4.3.3 SPS ENGINE THRUST PERFORMANCE.

4.3.3.1 SPS Small-Impulse Operation.

The SPS engine is capable of accepting a shutdown signal at any time after receipt of a start signal. A nominal minimum impulse bit of 12,000 pound-seconds is developed when the engine is fired for an open-loop operation period of 0.6 seconds. (See figure 4-22.) The run-to-run minimum impulse-bit tolerance is ±300 pound-seconds (1 sigma). Impulse value as a function of start-to-shutdown signal duration (FS1 to FS2), is estimated from qualification tests generated at AEDC (Arnold Engineering Development Center). (Propellant consumption for small impulse firings including the 14.4-pound propellant loss for each SPS engine start is covered by the equation W_p = (Impulse +4500)/Isp.

4.3.3.2 SPS Engine Start and Shutdown Transients.

The SPS engine start and shutdown transients are presented in figure 4-23. Curves show the percentage of rated thrust as a function of elapsed time from start (FS1) and shutdown (FS2) command signals. Rated thrust is based on nominal inlet condition. All data estimates are from AEDC qualification tests. The start transient total impulse from FS1 to 90-percent rated thrust is limited to the range from 100 pound-seconds (minimum) to 400 pound-seconds (maximum). The run-to-run tolerance on start transient impulse is ±100 pound-seconds (1 sigma). The shutdown impulse from FS2 to 10-percent rated thrust is limited to a range from 8000 pound-seconds (minimum) to 12,000 pound-seconds (maximum). The run-to-run tolerance on the shutdown impulse is ±300 pound-seconds (1 sigma).

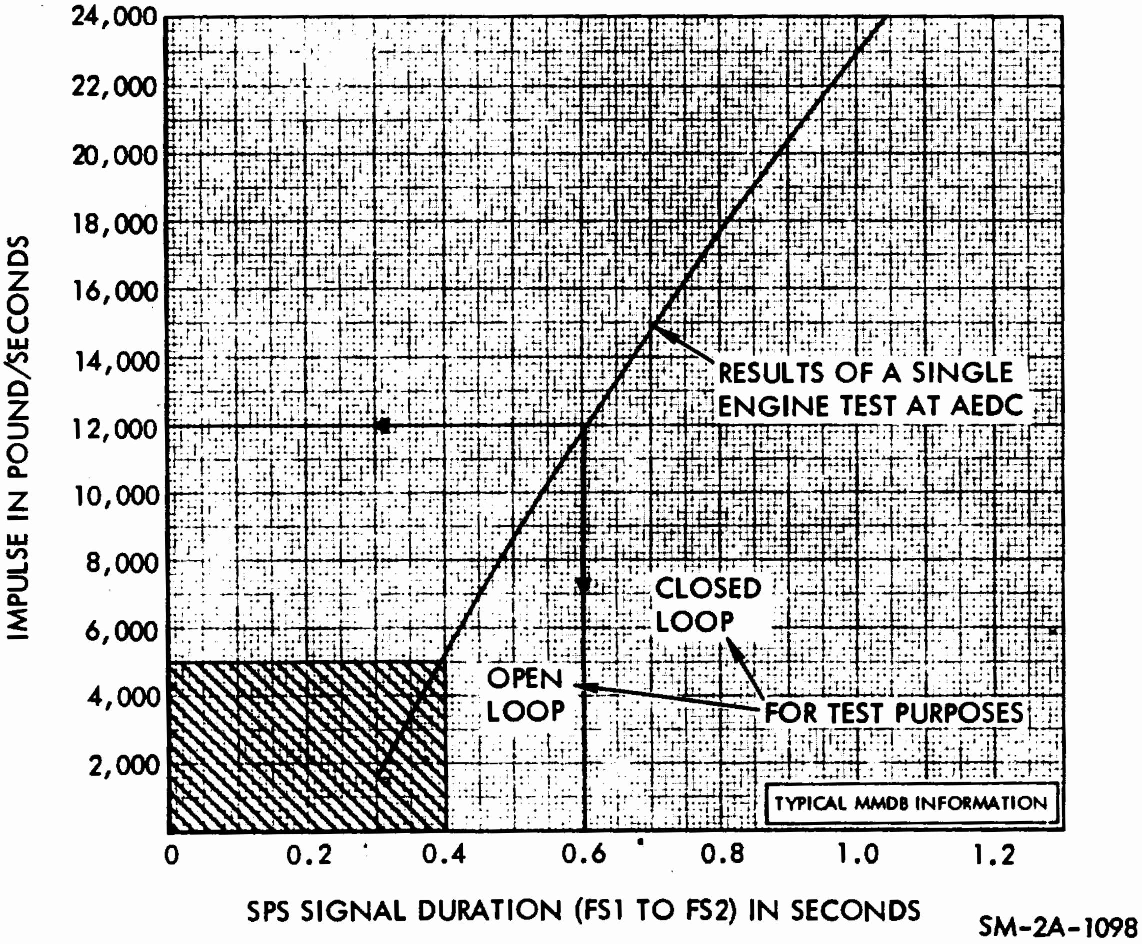


Figure 4-22. SPS Small Impulse Firings for Open-Loop Operations

4.3.3.3 SPS Delta V Capability.

The SPS delta V capability remaining versus SPS propellant remaining is presented in figure 4-24.

4.3.3.4 SPS Engine Gimbal Angle Determinations.

The engine gimbal angle determinations for an SPS firing (thrust vector through center of gravity) can be calculated during

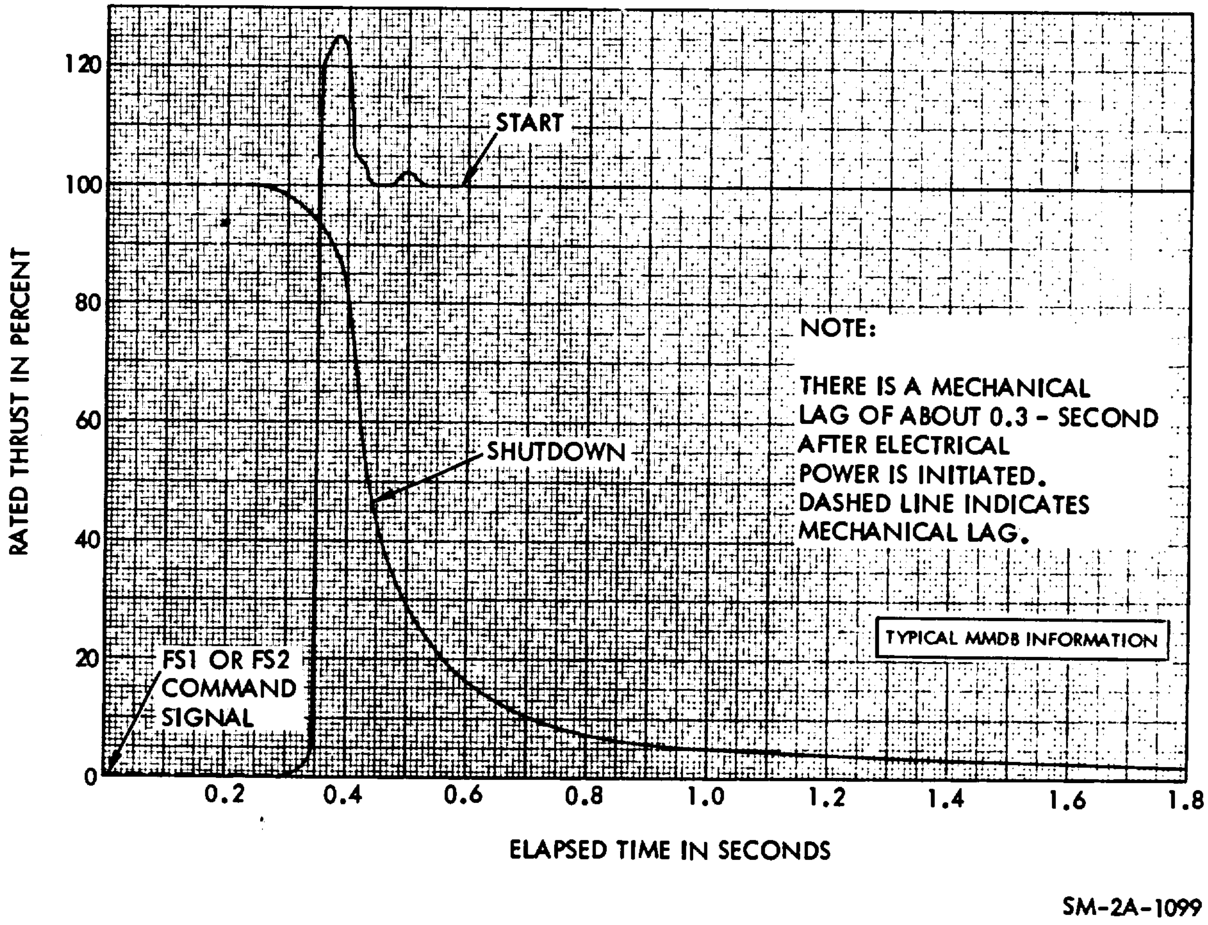


Figure 4-23. SPS Engine Start and Shutdown Transients

flight by the amount of SPS fuel remaining aboard the spacecraft. (See figure 4-25.) The ground controller will determine SPS engine gimbal angles if propellant leaks and/or other than nominal oxidizer to fuel ratios occur.

4.4 S/C OPERATIONAL CONSTRAINTS AND LIMITATIONS.

4.4.1 OPERATIONAL CONSTRAINTS.

Attitude constraints are necessary to prevent excessive exposure of certain spacecraft surface features to solar heating, earth albedo, or deep space. These constraints are required to control temperatures for the ECS radiator inlet, S/M RCS engines, SPS propellant feedlines, and the heat shield.

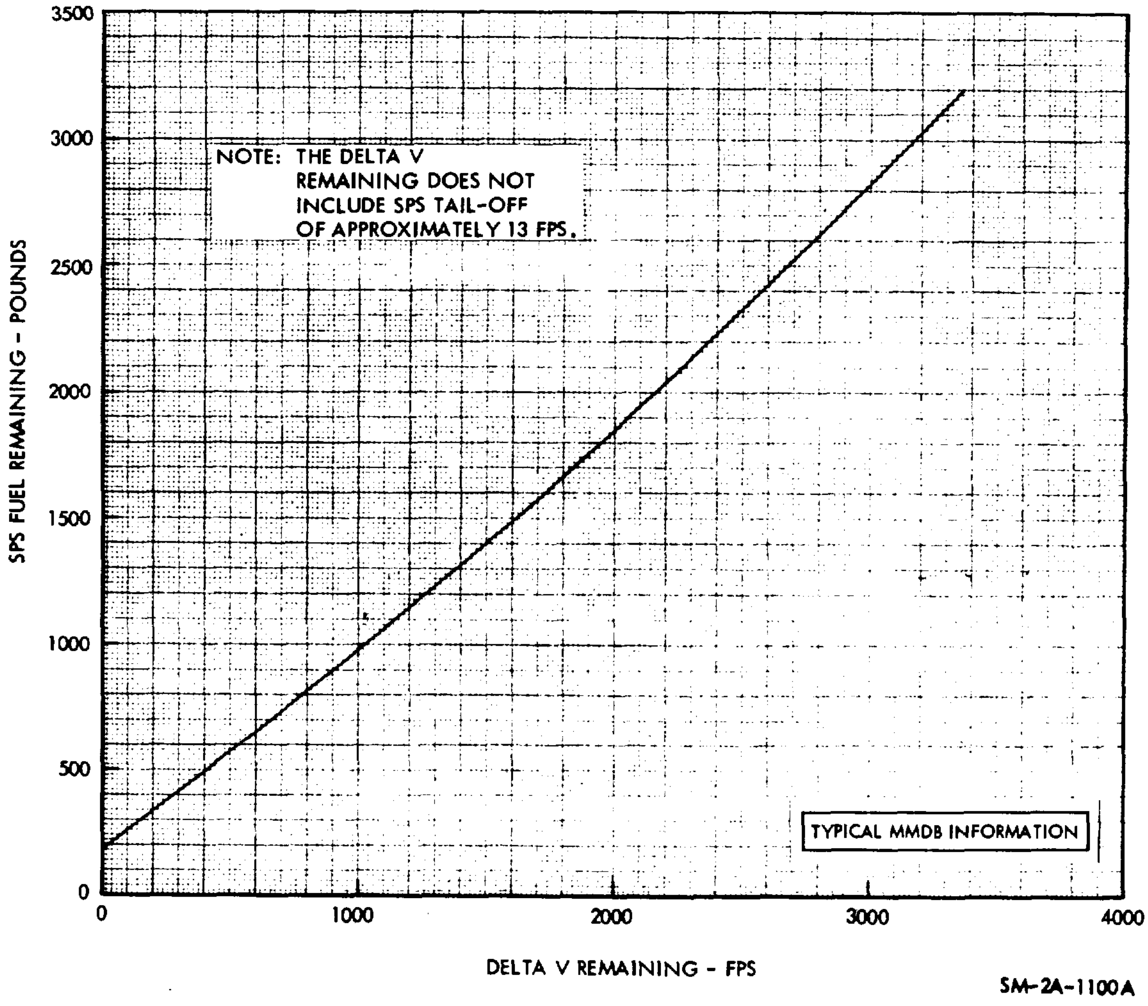


Figure 4-24. SPS Delta V Remaining Versus Propellant Remaining

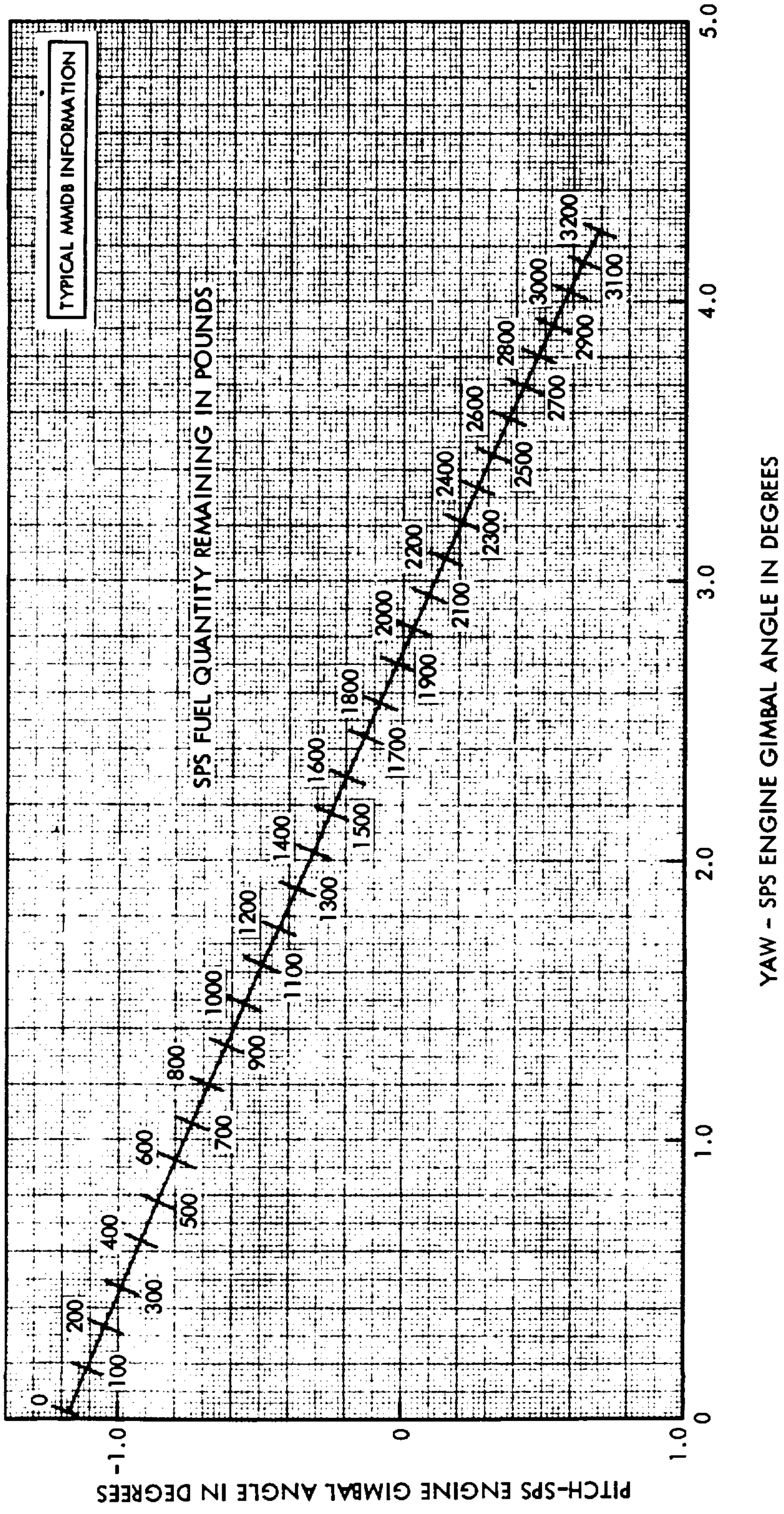


Figure 4-25. SPS Engine Gimbal Angle Settings

4.4.1.1 ECS Radiator Inlet Temperature.

The ECS radiator inlet temperature (obtained from MSFN or the auxiliary DC volts meter on panel 200) should be maintained at 75°F or warmer to prevent against radiator freezing. However, excessive water boiling will result if the radiators are directly exposed to the sun for prolonged periods. S/C orientations exposing the ECS radiator surface to solar incidence angles less than 45 degrees should not be maintained longer than 20 minutes per orbit. Also, the S/C attitude should be constrained inertially or held fixed relative to the earth without roll for a period longer than one orbit, if the solar incidence to the radiator is less than 45 degrees. To prevent excessive water consumption (boiling) the S/C attitude must not be constrained in an inertial or earth-fixed orientation without roll for longer than 3 hours.

CAUTION Extreme radiator sooting can be detected by a rapid depletion of the water supply and high radiator outlet temperature.

- If the radiator outlet temperature averages above 53°F as a result of extreme sooting, high electrical loads, or poor radiator orientation, the water tanks will be depleted at a rate incompatible with the planned mission duration time.

NOTE Observance of ECS radiator constraints will also ensure a satisfactory environment for EPS radiator operation.

4.4.1.2 S/M RCS Engine Temperatures.

The S/M RCS engines are qualified to work within the range of 35° to 175°F, the propellant valve temperature limits. A red warning light on panel 10 will illuminate to indicate when the temperatures exceed this range. Temperatures above 175°F are not expected, except temporarily (possible) during boost. Heaters that cycle automatically are provided on each quad to maintain temperatures above the lower limit. However, if one quad is continuously pointed away from the sun for longer than 10 hours, it is possible for the 40°F lower temperature limit (for the propellant) to be reached at the RCS tank outlet.

NOTE S/C attitude should be monitored during extended periods between RCS firings to ensure that safe temperatures are maintained.

4.4.1.3 SPS Propellant Feedline Temperatures.

SPS propellant feedlines are normally maintained above 40°F by heaters and insulation. The MSFN should monitor SPS external line temperatures and advise the crew whenever temperatures drop below 50°F. If S/C attitude is maintained so that the SPS is pointed away from the sun for an extended period and heater capacity is insufficient to maintain line temperatures above 40°F, the S/C should be reoriented until acceptable SPS line temperatures are reached.

4.4.1.4 Heat Shield Temperature.

The heat shield ablator lower temperature limit of -150°F can be exceeded and cause surface cracking if the thin (-Z) portion of the ablator is pointed away from the sun for longer than 3 hours. Because of the moderate response time, it is unlikely that a critical cold condition would be approached during the mission.

CAUTION If the heat shield ablator temperature is allowed to rise and remain above 200°F for any aggregate period longer than 2 hours, outgassing will result and cause a corresponding degradation to the ablator stress margin.

4.4.2 OPERATIONAL LIMITATIONS.

The available data in the subsequent paragraphs shows limitations imposed on the S/C and/or crew during ascent, descent or aborts, spaceflight, and entry.

4.4.2.1 Acoustic and Vibration Effects.

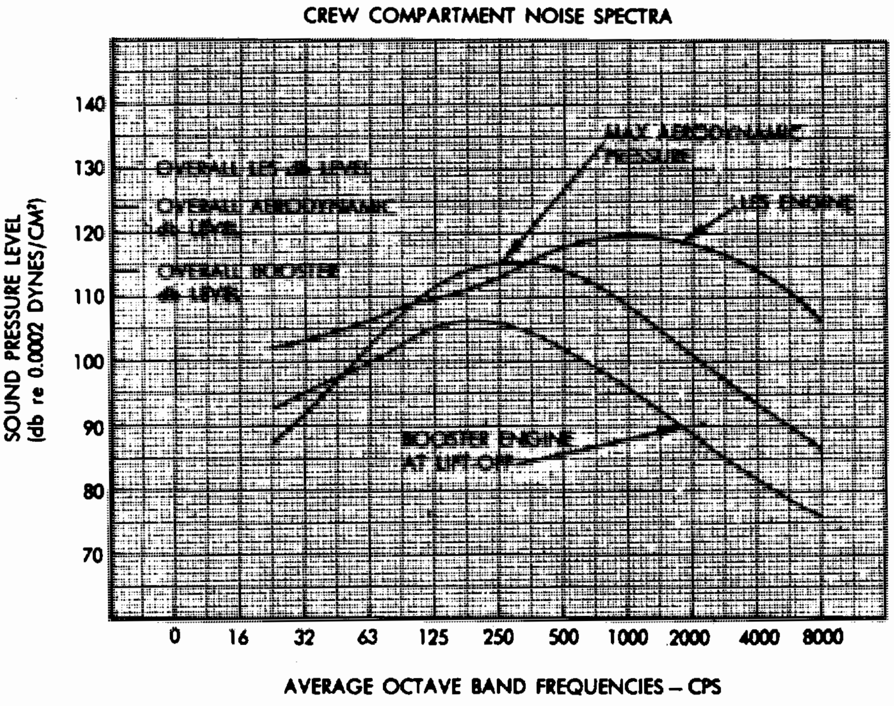
The crew will be exposed to acoustic and vibration effects during ascent (130 seconds), possible LES aborts (10 seconds), and entry (100 seconds). Vibration effects will also be experienced during high-altitude aborts (SPS induced) and spaceflight SPS firings. (See figures 4-26 and 4-27.)

4.4.2.2 Altimeter Error and C/M Base Pressure Effects.

The altimeter (barometric pressure indicator) error resulting from velocity pressures on the command module (below 14,000 feet) is shown in figure 4-28.

4.2.2.3 C/M Lift/Drag Profile and Entry Effects.

Charts showing the C/M lift/drag profile and time histories for normal entries are shown in figures 4-29 through 4-31.



55 db = Sound pressure level (SPL) under average office conditions.

79 db = Maximum SPL inside S/C during space flight with all equipment operating.

NOTES: 1. During space flight, C/M inside noise level is mainly due to equipment operation. SPS and RCS engine firings have little effect on the internal noise level.

2. Each astronaut can reduce the crew compartment noise level about 15 db by utilizing his space suit and closing the helmet visor.

120 db = SPL where discomfort is experienced.

140 db = SPL where pain is encountered.

160 db = SPL where the human ear drum can be ruptured.

200 db = SPL equivalent to a 50-pound TNT blast at 10 feet.

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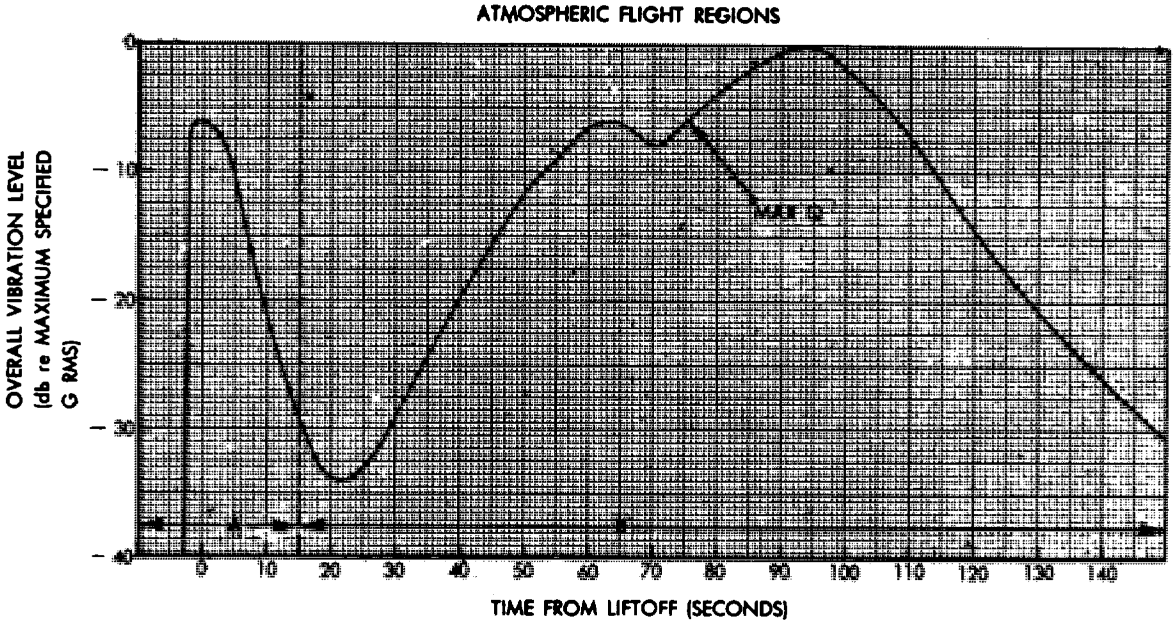
Figure 4 -26. C/M Crew Compartment Acoustics



NOTES:

1. Zero on the vertical scale indicates the maximum vibration experienced during flight. The vibration levels are based on boilerplate and spacecraft flight test measurements.
2. Letter "A" indicates vibration time induced by booster engine exhaust (influenced by the flame buckets) and noise reflected from the ground and launch pad.
3. Letter "B" indicates vibration induced by aerodynamic turbulence. As the launch vehicle velocity increases, pressure fluctuations in the turbulent boundary layer (and wake turbulence from the launch escape tower) excite vibration of increasing intensity until a maximum is reached at approximately the time of maximum aerodynamic pressure (MAX Q).
4. SPS engine operation provides the only significant source of C/M vibration during space flight maneuvers. This vibration, transferred mechanically throughout the S/C structure, can generally be expected to decrease with increasing distance from the engine. Since the RCS engines possess a very low thrust capacity, their operation will only produce modest and localized vibration (mostly due to jet impingement).

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Figure 4-27. S/C Relative Vibration Intensity Time History

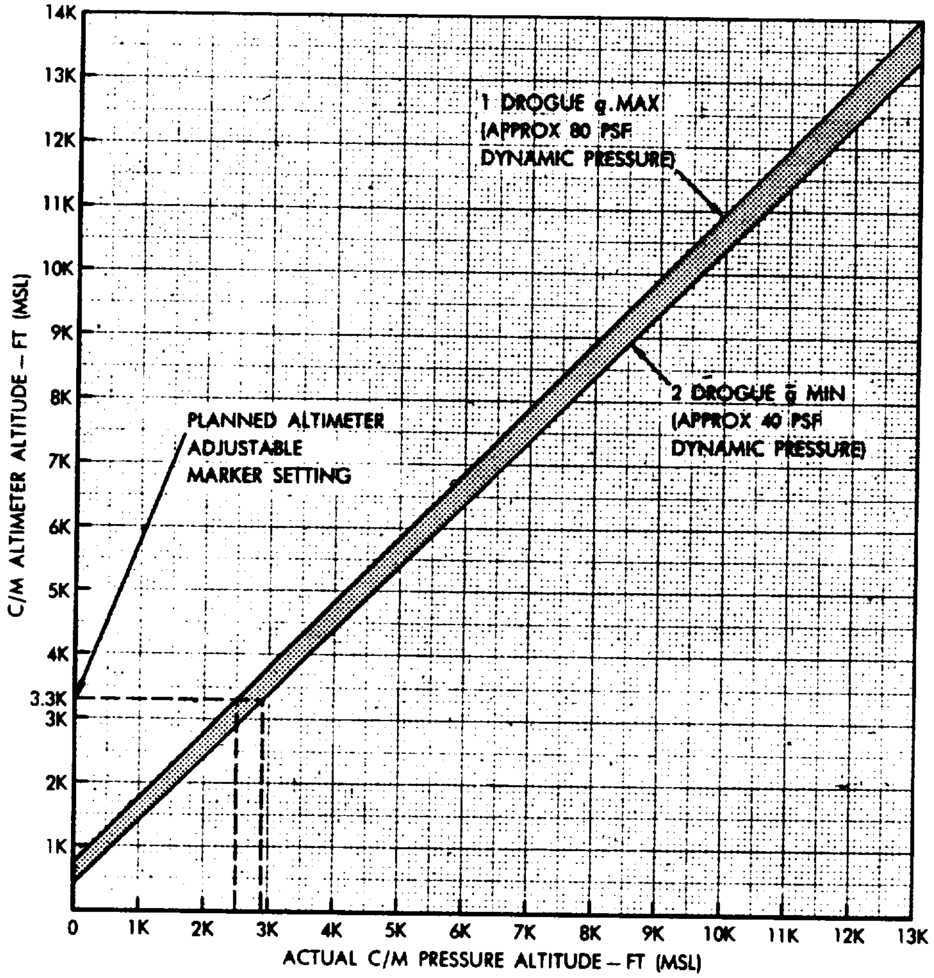

Figure 4-28. Altimeter Error and C/M Base Pressure Effects

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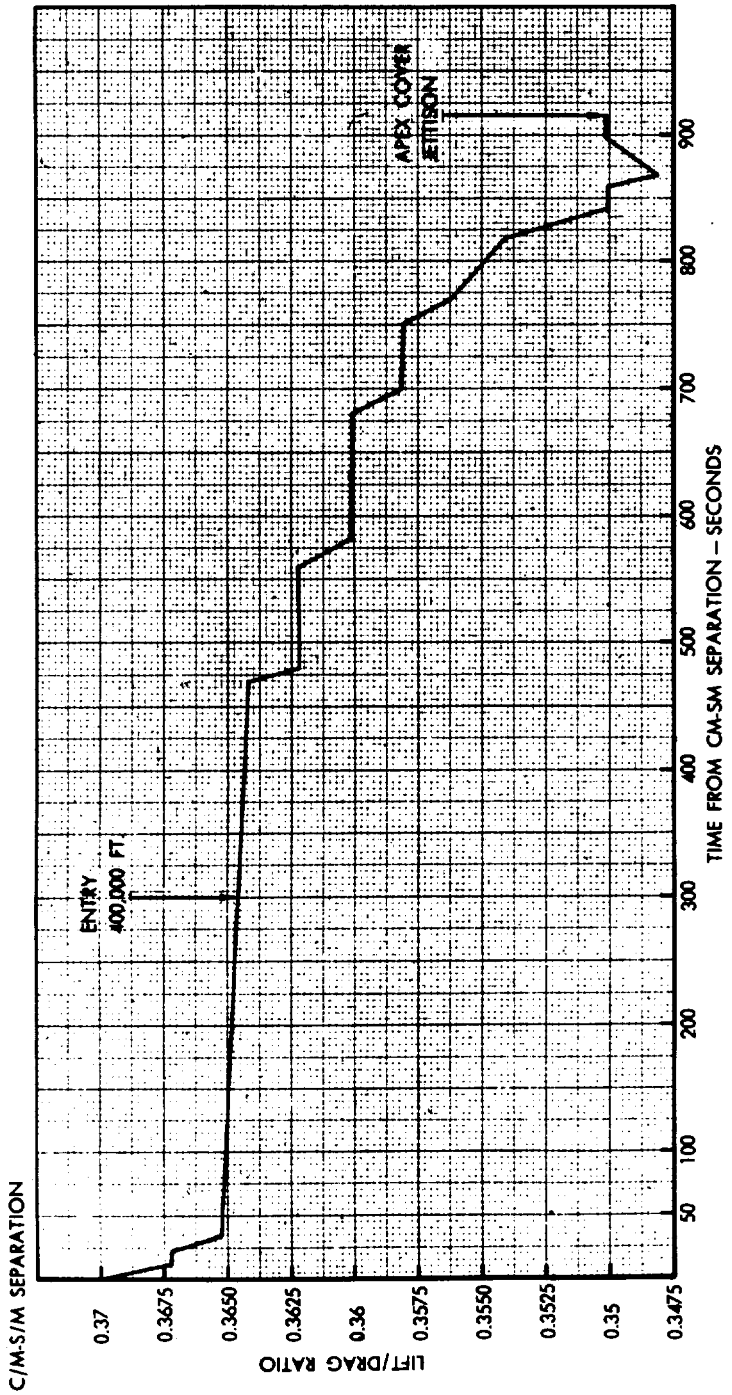
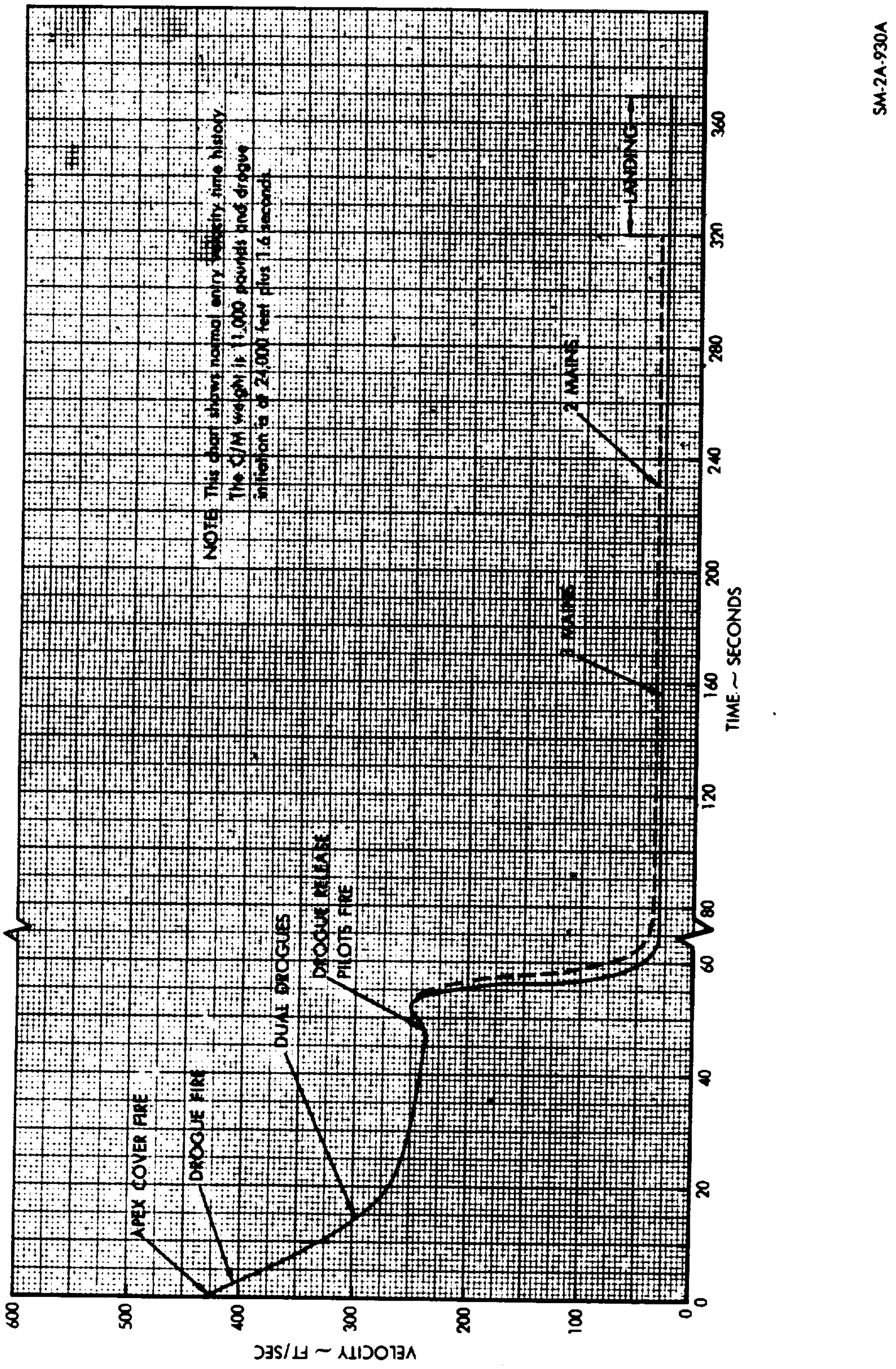
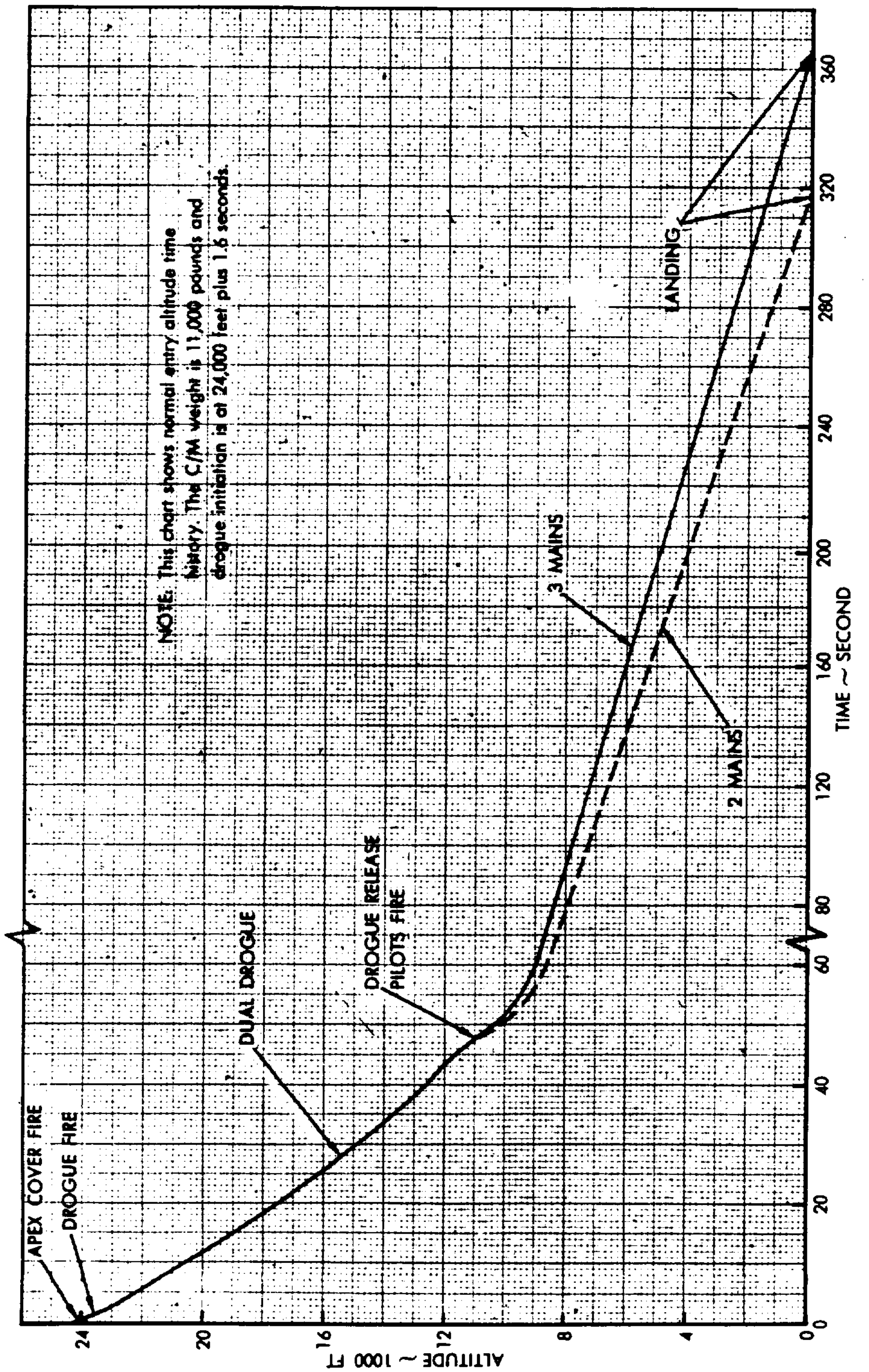


Figure 4-29. C/M Entry - Lift/Drag Profile



NOTE: This chart shows normal entry velocity time history. The C/M weight is 11,000 pounds and drogue initiation is at 24,000 feet plus 1.6 seconds.

Figure 4-30. Normal Entry - Velocity Time History



NOTE: This chart shows normal entry altitude time history. The C/M weight is 11,000 pounds and drogue initiation is at 24,000 feet plus 1.6 seconds.

Figure 4-31. Normal Entry - Altitude Time History

SECTION 5

EXPERIMENTS AND SCIENTIFIC EQUIPMENT DATA

INTRODUCTION

This section presents the objectives of mission 204A experiments and contains a description of associated equipment, stowage areas (figure 5-1), crew participation requirements for data collection, and related scientific equipment data. The in-flight tests are categorized as medical (M-), scientific (S-), and technical (T-) experiments as follows:

- In-Flight Exerciser (M-3A) (M003)
- In-Flight Phonocardiogram (M-4A) (M004)
- Bone Demineralization (M-6A) (M006)
- Human Otolith Function (Vestibular Effects)(M-9A) (M009)
- Cytogenetic Blood Studies (M-11) (M011)
- Cardiovascular Reflex Conditioning (M-48) (M048)
- Synoptic Terrain Photography (S-5A) (S005)
- Synoptic Weather Photography (S-6A) (S006)
- In-Flight Nephelometer (T-3) (T003).

NOTE The Planning and Management Office of the EPO (Experiments Program Office) is the coordinating facility for all of the experiments described in this section.

The experiments stowage areas location will be found in figure 5-1.

5.1 SCIENTIFIC EQUIPMENT.

5.1.1 MEDICAL DATA ACQUISITION SYSTEM (MDAS).

The medical data acquisition system, located in compartment C (figure 5-2), weighs 15.2 pounds and consists of a seven-channel tape recorder, associated signal conditioners, junction box, time code generator, and a front panel with switches and outlets for power and signal cables. This GFE unit uses 28-volt d-c power from compartment A to acquire and permanently record on magnetic tape all required medical (operational and experimental) data. The operational data required consists of electrocardiograph and impedance pneumograph outputs, while the experimental data consists only of phonocardiograph outputs. These medical parameters are routed from sensors and signal conditioners (attached to a crewman) through the PGA or CWG adapter cable, cobra cable, T-adapter, and octopus cable to specified channels in the MDAS. Although 100 watts of electrical power is provided for the MDAS from compartment A via the octopus cable, only about 19 watts are needed to operate the integral tape

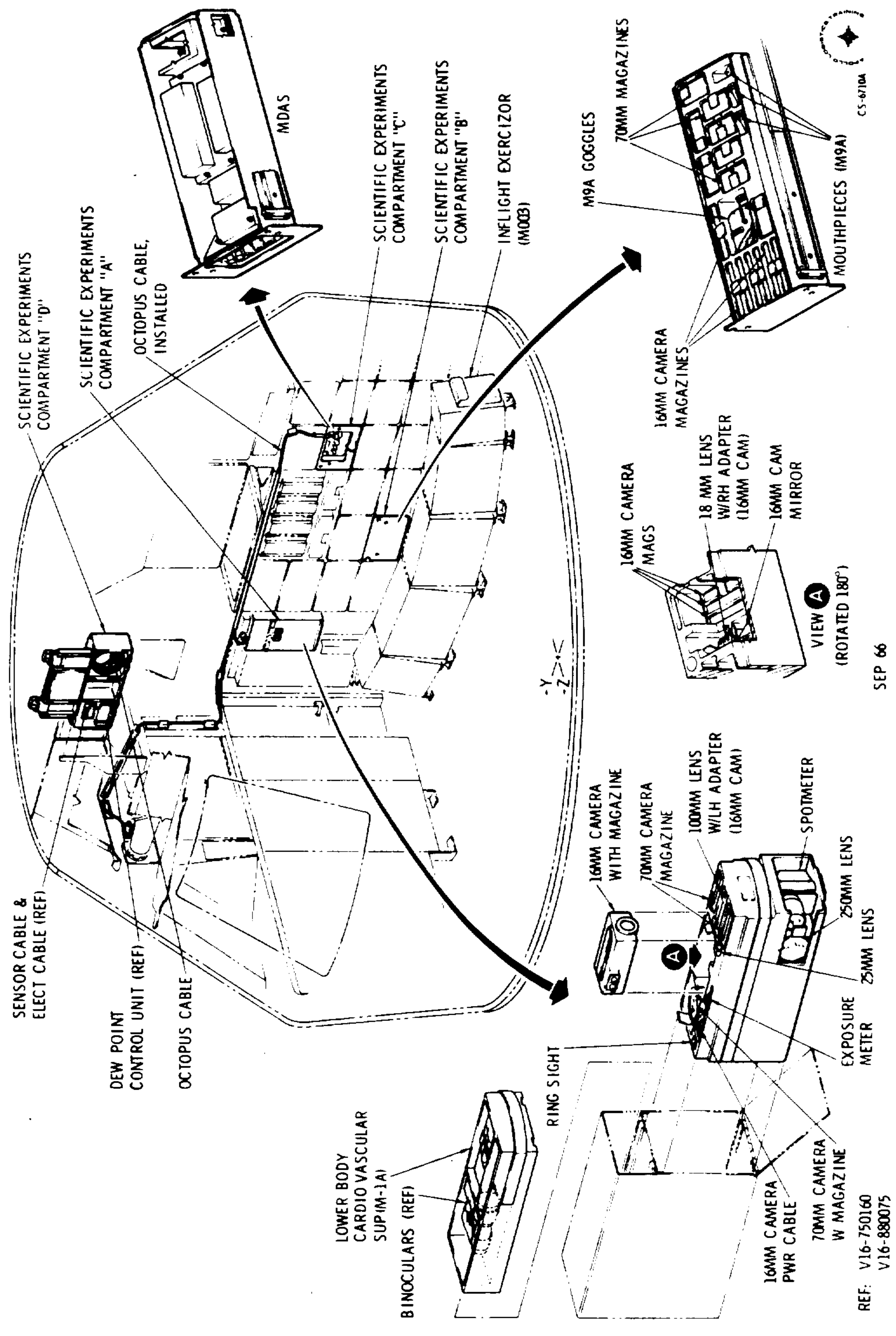


Figure 5-1. S/C 012 Mission Experiments Location, LEB (Sheet 1 of 2)

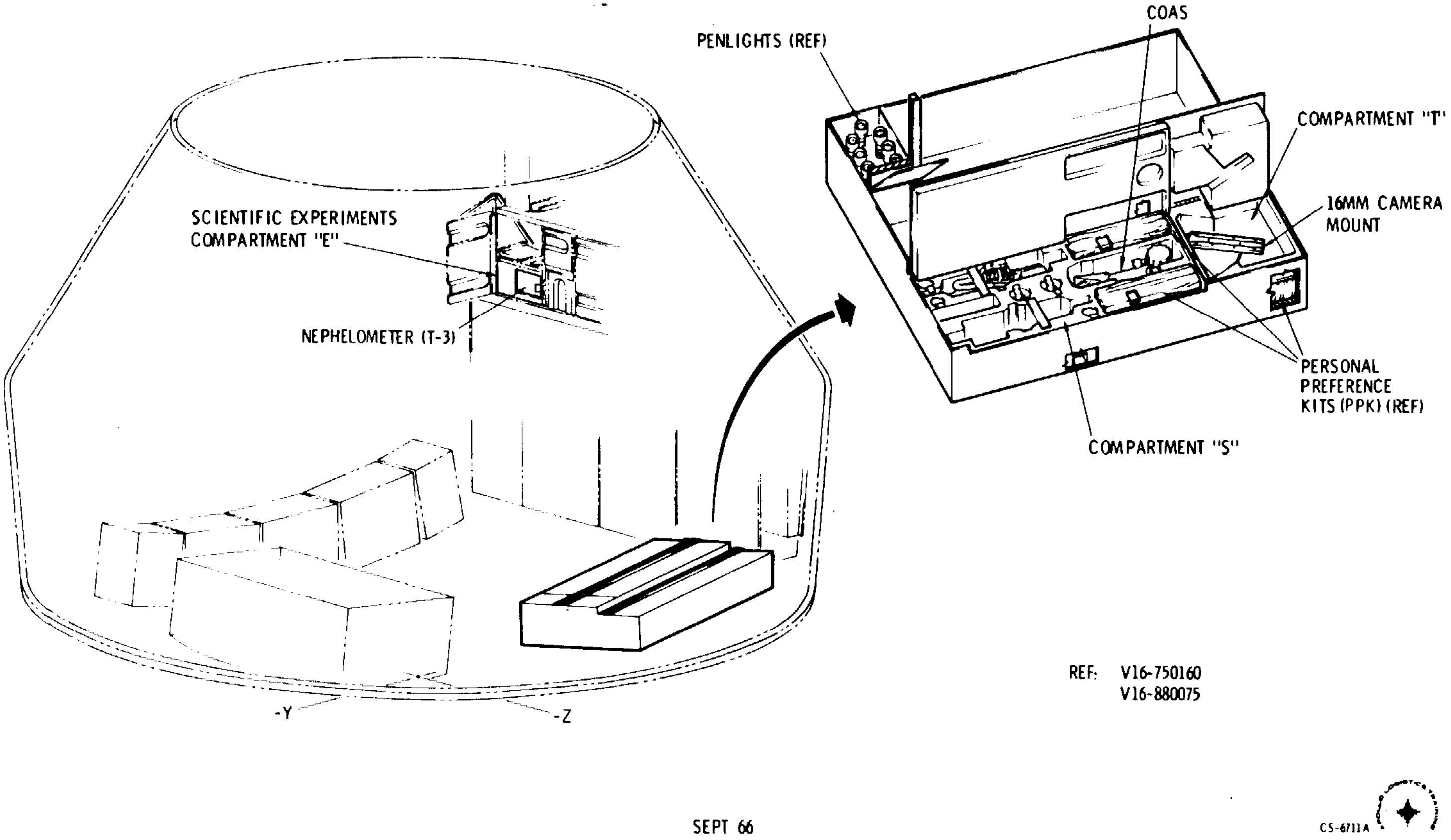
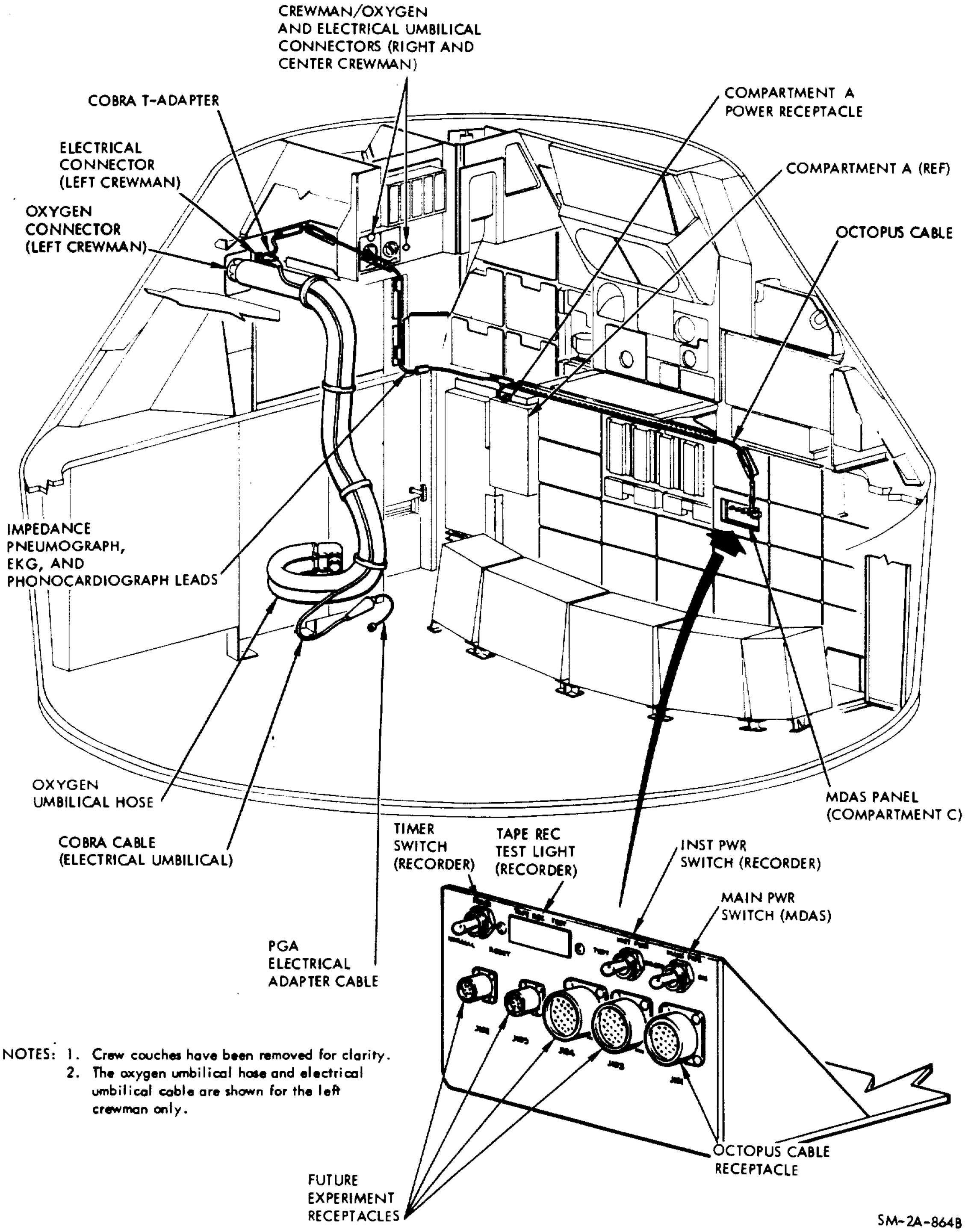


Figure 5-1. S/C 012 Mission Experiments Location, LEB (Sheet 2 of 2)



NOTES:
1. Crew couches have been removed for clarity.
2. The oxygen umbilical hose and electrical umbilical cable are shown for the left crewman only.

Figure 5-2. Experiments Tape Recorder and Electrical Connectors recorder. However, electrical outlets on the MDAS front panel are provided for additional or future experiments (via electrical cabling connected directly to the equipment and the MDAS). The MDAS front panel also contains a MAIN PWR switch for controlling power to the unit and unit outlets, an INSTR PWR switch for controlling power to the tape recorder and the recorder test light, and a TIMER switch for correlating mission elapsed time on the tape recorder.

All three crewmembers have the capability of being recorded for their physiological data when electrically connected to the tape recorder. However, only one crewman at a time will have his outputs recorded during flight. (See figure 5-3.) Total recording time for the tape recorder is 100 hours maximum with 880 feet of usable tape. There are seven channels available for collecting data (including the optional channel for recording code signals).

The MDAS tape recorder is removed from the spacecraft immediately after flight, placed in a GFE metal container for protection against strong magnetic fields, and transported to the NASA-MSC (where the magnetic tape is removed from the recorder).

5.1.2 ELECTRICAL CABLES AND ADAPTERS.

5.1.2.1 Octopus Cable.

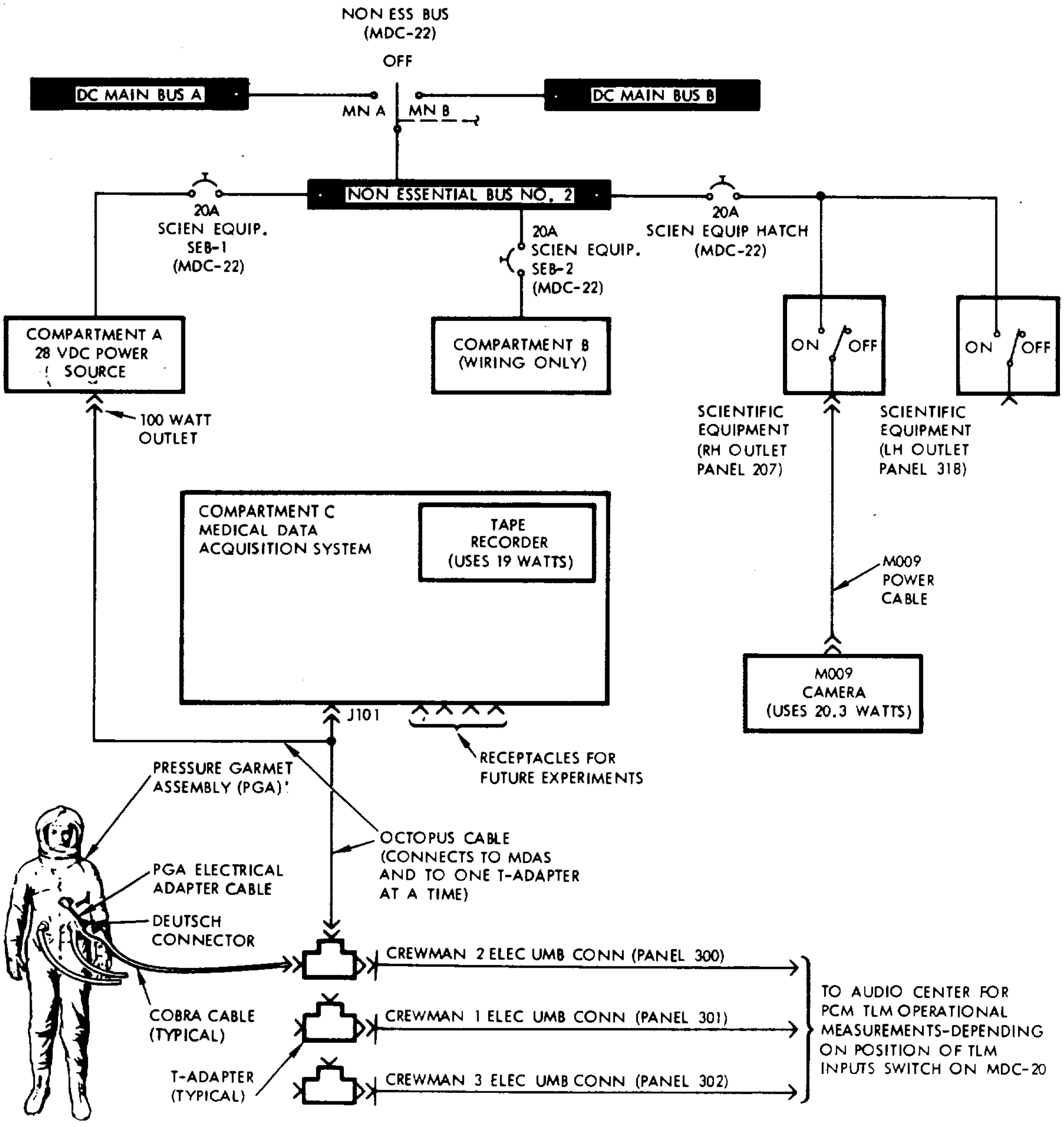
The octopus cable (figure 5-2) plugs into the MDAS tape recorder, is protected from electrical arcing by an on-off power switch on the recorder panel, and contains signal and power lines for the following:

- Provides for 28-volt d-c (100 watts) power from compartment A to the MDAS in compartment C

- Provides for biomedical signals from a crewman (attired in the PGA or CWG) to the tape recorder. These signals consist of EKG, phonocardiograph, and impedance pneumograph outputs. This cable weighs 1.5 pounds and is stowed in compartment D of the LHFEB during launch and entry. The cable remains connected to the MDAS and a crewman's T-adapter during orbital flight.

5.1.2.2 Cobra Cable T-Adapter.

The T-adapter (figure 5-2), provided for each crewmember, weighs 1/2 pound and remains attached to the cobra cable at all times. This three-way electrical connector mates the cobra cable to the appropriate crewman electrical umbilical connector (panels 300, 301, or 302) and the octopus cable. A relay incorporated in the T-adapter is controlled by the TLM INPUTS-BIOMED (MDC-20) or the MDAS MAIN PWR switch in compartment C (providing the octopus cable lead is connected to the T-adapter). This relay permits electrical signals, from a crewman's torso, to be transmitted as operational data and recorded in-flight as experimental data.



NOTES:

1. Signal conditioners, sensors, and associated wiring on a crewman's torso (attached to the Microdot connector inside the PGA or on the CWG) provide for PCM TLM operational measurements and scientific experiments data.
2. A T-adapter permits simultaneous transmission of operational measurements (selected for one crewman at a time) and the recording of in-flight experiments data. However, operational measurements can be transmitted from one crewman while another crewman is recording experiments data

SM-2A-902C

Figure 5-3. Scientific Equipment Power Distribution

Operational data from one crewman may also be transmitted while experimental data from another crewman is being taped on the MDAS. However, only one operational transmission and one experimental recording can be taken at the same time.

5.1.2.3 PGA and CWG Electrical Adapter Cables.

The PGA and CWG electrical adapter cables (crew personal equipment) are provided to connect the cobra cable to signal conditioners and communication equipment attached to a crewman's body. (See figure 5-3 and refer to section 6.)

5.1.2.4 Hardware Power and Signal Cables.

Hardware power and signal cables are used for connecting equipment electrically to various outlets in the crew compartment. (See figure 5-3.) Protection from electrical arcing is provided by switches on the equipment or on the outlet panels in the crew cabin. The M-9A camera power cable (figure 5-3) connects to the RH SCIENTIFIC EQUIPMENT outlet on panel 207. A SCIENTIFIC EQUIPMENT outlet on panel 318 (near the LH side window) is reserved for a future experiment but can also be used as a backup outlet for the camera cable. Outlets marked J102 through J105 on the MDAS are reserved for future experiments. (See figure 5-2.)

5.2 MEDICAL EXPERIMENTS.

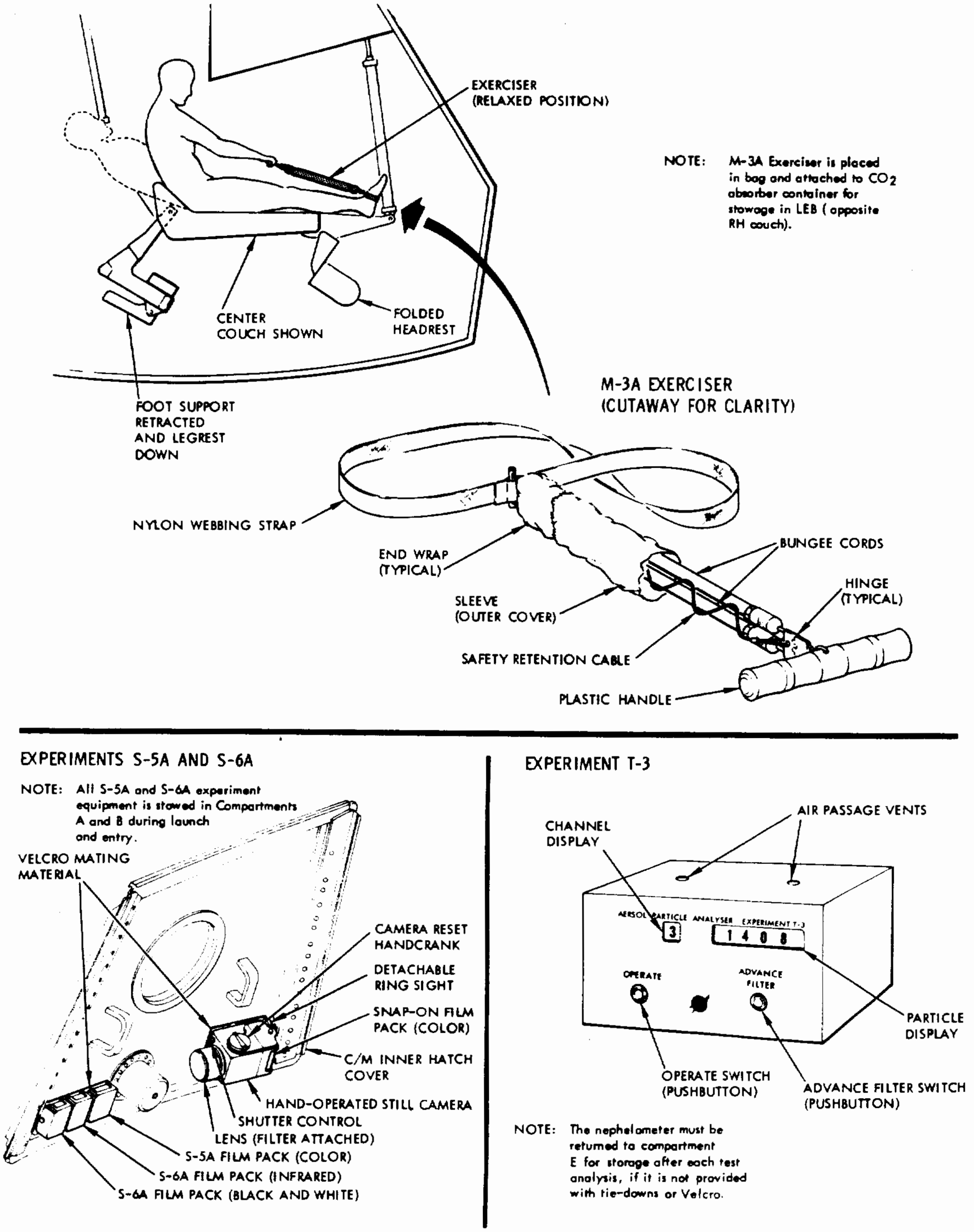
5.2.1 IN-FLIGHT EXERCISER (M-3A) (M003).

The purpose of experiment M-3A is to collect crew data for determining benefits of exercise during space flight. Recumbency (bed rest) studies have shown that exercise work tolerance for an individual is greatly reduced after being relatively immobile and in a horizontal position for a few days. Zero gravity during space flight may further increase the length of a crewman's reconditioning period.

5.2.1.1 Equipment Description.

The exerciser for experiment M-3A (figure 5-4) weighs about 1-1/2 pounds and consists of two rubber elastic (bungee) cords with a retaining cable. A nylon elastic sleeve covers the bungee cords and retaining cable. One end of the exerciser contains a looped strap made of webbing cloth that can be secured around a crewman's feet. The other end of the exerciser has a spherical plastic handle grooved to fit both hands of a crewman. The retaining or safety cable within the elastic sleeve permits the exerciser to be stretched from 9-1/2 to 21-1/2 inches.

A mechanical interface between the equipment and the S/C exists where the exerciser container is attached to the CO_2 absorber container in the LEB (opposite the RH couch). Although all three couches can be used



NOTE: M-3A Exerciser is placed in bag and attached to CO_2 absorber container for stowage in LEB (opposite RH couch).

NOTE: All S-5A and S-6A experiment equipment is stowed in Compartments A and B during launch and entry.

NOTE: The nephelometer must be returned to compartment E for storage after each test analysis, if it is not provided with tie-downs or Velcro.

Figure 5-4. Experiments Operational Arrangement (Sheet 1 of 2)

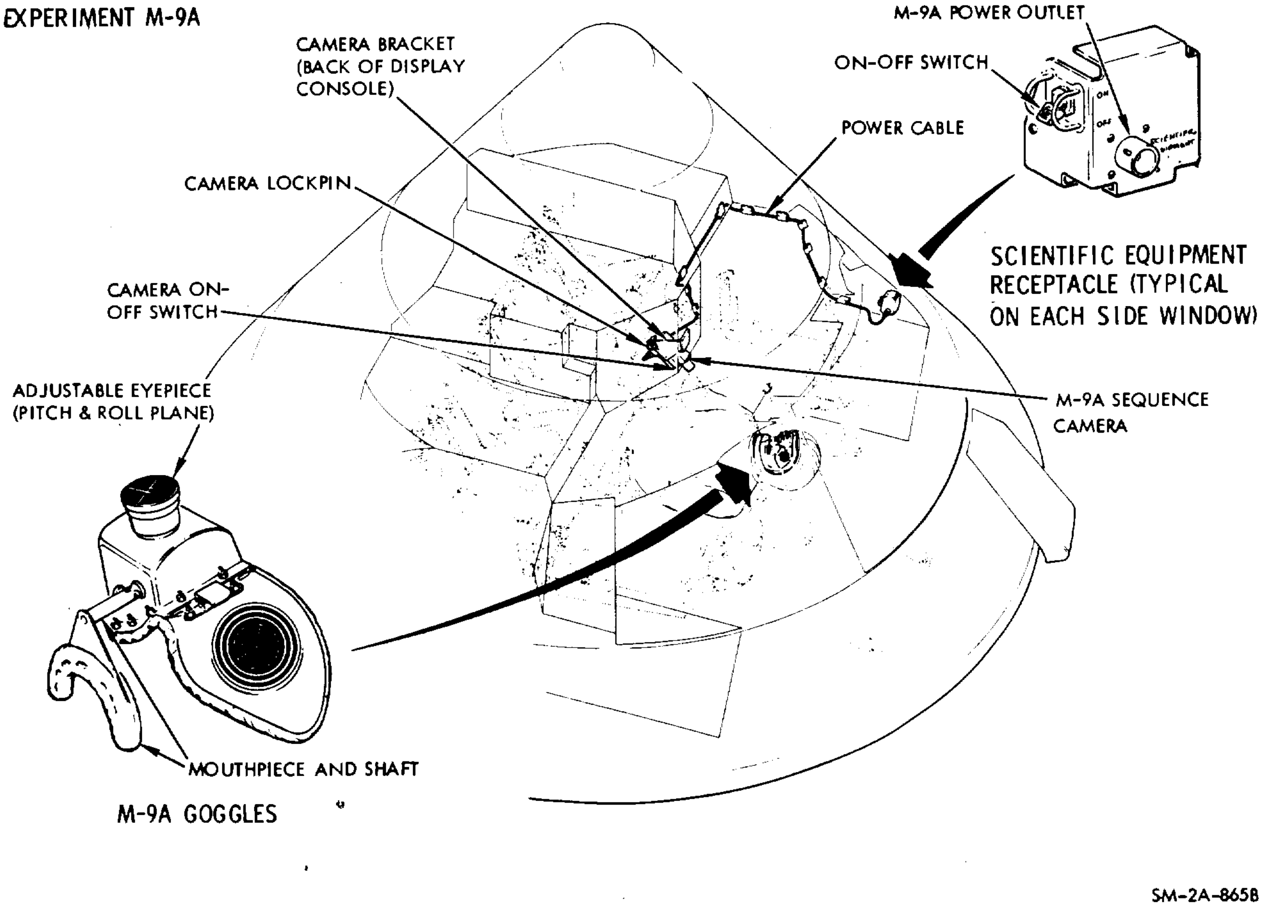


Figure 5-4. Experiments Operational Arrangement (Sheet 2 of 2)

during the M-3A isotonic and isometric exercises, only the center couch provides adequate head room to comfortably perform isotonic exercises when data recording periods are conducted. (Date includes EKG, impedance pneumograph, and phonocardiograph recordings taped on the MDAS recorder.)

5.2.1.2 Experiment Procedures.

All crewmen will exercise in-flight for 10 minutes three times every 24 hours. The base line preflight data will serve as a control for the study. A recording session is required once per day on one crewman before, during, and after an exercise period. Crewmembers will alternate each day for data recordings. (Detailed procedures are provided in section 11.)

5.2.1.3 Crewman Participation.

Requirements for crewman participation in the exercise experiment are as follows:

a. Preflight - Each crewman will be tested for exercise tolerance (physical fitness level) on three separate occasions 8 to 4 weeks prior to flight.

b. In-flight - Each crewman will be required to exercise 3 times daily for 10 minutes each exercise period. Medical data from one crewman will be recorded during one exercise period each day. (It will take 3 days to obtain medical data from all three crewmen.)

c. Postflight - Each crewman will undergo re-evaluation exercises on three separate occasions (12 to 24 hours, 1 week, and 2 weeks after touchdown).

5.2.1.4 Recovery Requirements.

There are no special recovery requirements for experiment equipment because the in-flight exerciser will remain stowed in the S/C during recovery. An exerciser of equivalent design will be available at the site where postflight evaluations are performed and the experiment is completed. The on-site coordinators will be responsible for removal of the magnetic recording tape from the MDAS and delivery of all data to the NASA-MSC.

5.2.2 IN-FLIGHT PHONOCARDIOGRAM (M-4A) (M004).

The purpose of experiment M-4A is to obtain information on the functional cardiac status of two crewman during prolonged space flight. An in-flight recording of the phonocardiographic heart sounds, compared with the highest EKG signal, will be made to determine the delta time interval between electrical activation of the heart muscle (mycardium) and the onset of ventricular systole (heart contraction).

5.2.2.1 Equipment Description.

The equipment worn by the crew commander and navigator in experiment M-4A consists of two phonocardiogram transducers (microphone biosensors), a phonocardiograph signal conditioner package (amplifier) with variable gain, and associated electrical wiring. The biosensors are attached to the crewman's torso (skin) and connected by electrical leads to the signal conditioner (fastened on the CWG) and the Microdot connector on the PGA or CWG. Signal outputs from the crewman's body to the biomedical tape recorder (compartment C) are routed via the PGA or CWG adapter cable, the cobra cable, T-adapter, and the GFE octopus cable. (See figure 5-3 for tape recorder and electrical connectors, and refer to paragraph 5-1 for data on scientific equipment.)

The total S/C electrical power for recording the experiment is approximately 1.4 watts. The octopus cable, for connecting the tape recorder to the PGA, is stowed in compartment D of the LHFEB. (See figure 5-1.)

5.2.2.2 Experiment Procedures.

Installation of phonocardiogram transducers on the chest of the two crewmen and the positioning and hookup of electrical leads, worn outside the CWG, are performed during the preflight suiting procedure. After hookup during flight, recordings are taken on the medical data acquisition system (MDAS). Supporting data such as EKG and impedance pneumograph signals are also recorded during the experiment. (Detailed in-flight procedures are provided in section 11.)

5.2.2.3 Crewman Participation.

Requirements for crewman participation in the phonocardiogram experiment are as follows:

a. Preflight - Sensor application should not exceed one hour. Approximately 5 minutes of recording will be required for collecting baseline data from each crewman.

b. In-flight - No effort will be required by the crewman other than hookup to the MDAS. The one special exception could be time spent in determining optimum placement or repositioning of a microphone biosensor.

c. Postflight - Approximately 5 minutes will be required for post-recovery recording for data comparison.

5.2.2.4 Recovery Requirements.

There are no special recovery requirements for the experiment other than removal of the magnetic recording tape from the MDAS. The recorded data will be processed by conventional methods.

5.2.3 BONE DEMINERALIZATION (M-6A) (M006).

The purpose of experiment M-6A is to determine the effect of weightlessness and immobilization during space flight on the demineralization of certain bones within the body of each astronaut.

5.2.3.1 Equipment Description.

This experiment does not require any in-flight equipment, S/C power or fuel, or recording equipment. (There are no interface problems between experiment M-6A and the S/C.)

5.2.3.2 Experiment Procedures.

In-flight procedures are not required for this experiment. Prior to flight, crewmen will have X-rays taken of their heel bones and the last joint of the little finger on the right hand. These exposures will be taken before and after flight at Kennedy Space Center X-ray facilities. The hematopietic (i. e., blood forming marrow) areas will not be exposed to the radiation source since the exposure field will be carefully limited.

5.2.3.3 Crewman Participation.

Requirements for crewman participation in the bone demineralization experiment are as follows:

a. Preflight - Approximately 45 minutes total time is required per crewman for obtaining X-ray films (three 15-minute sessions at T minus 10 days, T minus 2 days, and T minus 220 minutes).

b. In-flight - None

c. Postflight - Approximately 15 minutes per astronaut are required for obtaining X-ray films after spacecraft recovery. (A follow-on checkup may be required, depending on bone demineralization.)

5.2.3.4 Recovery Requirements.

On-site investigators will develop X-ray films, make bone densitometry measurements, and be responsible for delivery of all data to the NASA-MSC.

5.2.4 HUMAN OTOLITH FUNCTION (VESTIBULAR EFFECTS) (M-9A) (M009).

The purpose of experiment M-9A is to determine the effect of prolonged weightlessness on a crewman's orientation sensation, particularly to the otolith organ (inner ear). All data collected will be used to predict the ability of space crews to orient themselves in a weightless environment, especially when subjected to darkness (eyes covered).

5.2.4.1 Equipment Description.

The equipment used for the experiment consists of the otolith test goggles (a mask with a single eyepiece or monocular scope), a mouthpiece for each crewman to align the goggles with his head, a 16 mm sequence camera (part of the operational equipment), film packs for recording the actual orientation of the subject's head relative to the S/C, and an electrical cable for providing 28-volt d-c power to the camera. (See figures 5-1 and 5-4.)

A bracket, stowed in compartment T on the aft bulkhead, is mounted behind the main display panel in the egress tunnel to secure the camera during the experiment. The experiment goggles and mouthpieces weigh about 5 pounds and are stowed with most of the film packs in compartment B of the LEB. Additional film packs and the power cable are kept in compartment A with the operational camera and lens. The 28-volt d-c power source for the camera is provided by an outlet near the crew cabin RH side window. (See figure 5-4.)

5.2.4.2 Experiment Procedures.

In preparation for the experiment, shades are installed over the windows and all cabin lights are turned on to maximum intensity. The test subject (in the center couch) operates the camera, covers his eyes with the otolith test goggles, and manually adjusts a self-luminous target line in the monocular scope to what he thinks is straight ahead and parallel to the S/C Y-Y axes. A series of adjustments will be recorded by the camera (for each crewman) during flight and compared to test results obtained during preflight and postflight tests. (Detailed in-flight procedures are provided in section 11.)

5.2.4.3 Crewman Participation.

Requirements for crewman participation during the experiment are as follows:

a. Preflight - A total time of about 3 hours is required for familiarization and training, including collection of base line data (for all three crewmen).

b. In-flight - One test period of 15 minutes per day per crewman is required.

c. Postflight - Each crewman will be subjected to a 5-minute test period as soon as possible after S/C recovery (for a total time of about 15 minutes) to complete the experiment data.

5.2.4.4 Recovery Requirements.

Facilities in the primary recovery area will be used to complete the postflight examination and medical debriefing. The raw data consisting of film is recovered from the S/C along with the goggles and mouthpiece for delivery to the on-site coordinators.

5.2.5 CYTOGENETIC BLOOD STUDIES (M-11) (M011).

The purpose of experiment M-11 is to conduct preflight and postflight analyses to determine if space environment produces cellular changes in the blood of crewmen. These changes, which are important to the medical and scientific point of view, may not be apparent from routine monitoring procedures.

5.2.5.1 Equipment Description.

This experiment does not require any in-flight equipment, S/C power or fuel, or S/C recording equipment. (There is no interface between experiment M-11 and the S/C.)

5.2.5.2 Equipment Procedures.

On two occasions (preflight), approximately one month apart, blood specimens will be obtained from the crewmen for the experiment. The second occasion for drawing blood samples will be scheduled as close to lift-off time as conveniently possible. Blood samples for part A of the experiment (cytogenic studies of human hemic cells) and part B of the experiment (immunological system) will be drawn at a predetermined hospital site for analyses. Postflight requirements will be essentially the same, except that three such samples will be required over a period of one year. The first postflight blood sample will be drawn shortly after the termination of flight. (In-flight procedures are not required for this experiment.)

5.2.5.3 Crewman Participation.

Requirements for crewman participation in the M-11 experiment are as follows:

a. Preflight - On two occasions prior to flight (T minus 30 days and T minus one day), blood samples (10 cc for part A and 15 to 20 cc for part B of the experiment) will be drawn from each crewman.

b. In-flight - None

c. Postflight - On three occasions after S/C recovery, blood samples (10 cc for part A and 15 to 20 cc for part B of the experiment) will be drawn from the crewmen. It is not essential that blood samples for parts A and B are drawn at the same time.

5.2.5.4 Recovery Requirements.

After mission completion, blood samples must be drawn from the crewmen at a conveniently located, but predetermined, hospital for analyses. Blood determinations made should include immunoelectrophoresis, electrophoresis, electrophoresis on starch gel, measurement of gamma$_2$, gamma a, and gamma M globulin levels, measurement of whole hemolytic complement, titration of blood group antibodies, and measurement of pre-existent, antibacterial antibodies.

5.2.6 CARDIOVASCULAR REFLEX CONDITIONING (M-48) (M048).

The purpose of experiment M-48 is to determine the effectiveness of a lower body vascular support garment for preventing physical fatigue, insufficient circulating blood volume to maintain adequate venous return (blood-pooling), and a loss of venomotor reflexes in the legs of a crewman during entry and recovery (when exposed to earth 1-g gravity force).

5.2.6.1 Equipment Description.

The equipment used in experiment M-48 consists of an 8-ounce pair of waist-length tights for supporting veins in the lower portion of a crewman's body. These tights are composed of rubber strands wrapped with cotton and woven into a garment with dacron. When worn, the tights will extend from the crewman's waist to his heel and supply a decreasing pressure from the waist down. The M-48 equipment does not require any S/C electrical power, fuel for attitude maneuvers, or recording equipment. When not in use, the experiment tights are stowed in compartment A of the LEB.

5.2.6.2 Experiment Procedures.

The M-48 vascular support tights are donned by a crewman prior to entry and just before getting into the pressure garment assembly (PGA). This crewmember also wears a two-piece constant wear garment (CWG) to facilitate getting into the tights and replacing the CWG. (Detailed in-flight procedures are provided in section 11.)

5.2.6.3 Crewman Participation.

Requirements for crewman participation in the conditioning experiment are as follows:

a. Preflight - Each crewmember will be given a minimum of three tilt-table checkouts for control data (requiring about 90 minutes per crewman). These checkouts, performed by qualified flight surgeons or experiment medical team, will be conducted within 4 weeks of launch date.

b. In-flight - The in-flight portion of the experiment will consist of one crewmember donning the vascular support garment 1 to 2 hours prior to entry and wearing it until the first postflight tilt-table checkout. A total time of about 3 minutes will be required for in-flight experiment preparations.

c. Postflight - After recovery, a series of tilt-table tests will be given to both the control subjects and the experiment subject. The control subjects will be tested 2 to 4, 8 to 12, 24, and 48 hours after recovery. The experiment subject, wearing the vascular support garment, will be initially tested 2 to 4 hours after recovery. Twenty minutes after his first tilt-table test, the experiment subject will be given a second test without the support garment. The remaining tests will follow the same sequence as described for the control subjects.

NOTE Tilt-table checkouts for the experiment consist of a 5-minute supine tilt, a 15-minute vertical (70-degree head-up position) tilt, and a 5-minute supine recovery tilt. During each tilt phase, performed on a manual tilt table with a saddle support, the crewmember's blood pressure and heart rate will be automatically recorded each minute. Also, changes in the leg blood volume will be measured each minute during the 70-degree and supine recovery tilts.

- Additional data required to complete the experiment such as plasma volume, total blood volume, and red blood cell mass will be obtained during preflight and postflight hematology tests by the experiment medical team.

5.2.6.4 Recovery Requirements.

Tilt table, heart rate, blood pressure, and other medical support equipment for the experiment are required in the recovery area for collection of postflight data (gathered and processed by the experiment medical team).

5.3 SCIENTIFIC EXPERIMENTS.

5.3.1 SYNOPTIC TERRAIN PHOTOGRAPH (S-5A) (S005).

The purpose of experiment S-5A is to obtain photographs of selected areas of the earth from the S/C at orbital altitude. These photographs are required for research in geology, geophysics, geographys, oceanography, and for use in planning photography from a manned orbiting laboratory.

5.3.1.1 Equipment Description

The equipment used in experiment S-5A (figure 5-4) weighs about 5 pounds and consists of a hand-operated Hasselblad 70-mm general purpose camera (single frame) with a detachable ring sight, two color-film packs (55 exposures each), and an exposure dial and spotmeter (operational equipment used with the Hasselblad camera). Except for the film packs in compartments A and B, most of the camera equipment is stowed in compartment A. (See figure 5-1.) This equipment can be retrieved and set up for photography in about 5 minutes.

No special interface problems are anticipated for this experiment. When not in use, the camera may be temporarily secured to the inner hatch cover, or anywhere within the C/M where Velcro mating material is provided.

5.3.1.2 Experiment Procedures.

This experiment will consist of photographing certain areas and features along the S/C flight path. The desired camera angle for taking pictures (with S/C window in shade) will be 90 degrees from S/C level flight over the earth. The crewman will be required to record the time of each photograph, subject, frame number, and film pack number in the experiments log book. (Detailed in-flight procedures are provided in section 11.)

5.3.1.3 Crewman Participation.

Requirements for crewman participation in experiment S-5A (time shared with experiment S-6A) are as follows:

a. Preflight - The crewman-subjects will be provided with a briefing (1 to 3 hours) on the aims, methods, and procedures for in-flight photography of selected terrestrial areas.

b. In-flight - About 45 minutes (total time) will be devoted to photography during 9:00 AM to 3:00 PM local time conditions.

c. Postflight - About one hour will be required for debriefing.

5.3.1.4 Recovery Requirements.

There are no recovery requirements other than removal of the camera and film from the S/C. Personnel performing the postflight debriefing will be responsible for delivering the exposed film to the coordinating facility for processing, analysis, and evaluation.

5.3.2 SYNOPTIC WEATHER PHOTOGRAPHY (S-6A) (S006).

The purpose of experiment S-6A is to obtain selective, high-quality photographs of cloud patterns taken from the spacecraft at orbital altitude. These photographs will be used for studies of weather system structures around the earth.

5.3.2.1 Equipment Description.

The basic equipment used in experiment S-6A (figure 5-4) is the same as that used in experiment S-5A. In addition to the 70-mm general purpose camera and ring sight, the S-6A equipment includes an ultraviolet filter, one color-film pack, and one color-shifted infrared film pack. Except for the film packs in compartments A and B, most of the camera equipment is stowed in compartment A.

No special interface problems are anticipated for this experiment. When not in use, the camera may be temporarily secured to the inner hatch cover or anywhere within the C/M where Velcro mating material is provided.

5.3.2.2 Experiment Procedures.

This experiment will consist of photographing certain weather areas and cloud formations of special interest along the S/C flight path. (Detailed in-flight procedures are provided in section 11.)

5.3.2.3 Crewman Participation.

Requirements for crewman participation (time shared with experiment S-5A) in experiment S-6A are as follows:

a. Preflight - The crewman-subjects will be provided with a briefing (1 to 3 hours) on the aims, methods, and procedures for in-flight photographing of selected cloud formations.

b. In-flight - As required during 9:00 AM to 3:00 PM local time conditions (about 45 minutes total time will be devoted to photography).

c. Postflight - About one hour will be required for debriefing.

5.3.2.4 Recovery Requirements.

There are no recovery requirements other than removal of the camera and film from the S/C. Personnel performing the postflight debriefing will be responsible for delivering the exposed film to the coordinating facility for processing, analysis, and evaluation.

5.4 TECHNICAL EXPERIMENTS.

5.4.1 IN-FLIGHT NEPHELOMETER (T-3) (T003).

The purpose of experiment T-3 (figure 5-4) is to determine and obtain a quantitative evaluation of the size, concentration, and distribution of particles present in the C/M crew compartment. In-flight measurements will be made of particles in the 0.3 to 10 micron size.

5.4.1.1 Equipment Description.

The nephelometer is a portable, self-contained instrument approximately 7.2 by 3.5 by 5.2 inches in size, weighs about 5.5 pounds, contains its own battery power supply, electronics, air pump, and presents a readout display (five channels for particle sizes in five discrete ranges). This equipment provides a collimated light beam that is focused at a point in a moving path of grossly filtered air. The cabin atmosphere, when being evaluated for aerosol particles, is drawn through the particle size detector by the air pump within the analyzer.

There are no interface problems anticipated for this experiment. When not in use, the nephelometer is stowed in compartment E of the LEB. (See figure 5-1.)

5.4.1.2 Experiment Procedures.

Experiment T-3 requires that the nephelometer be initially positioned in a preselected area within the crew compartment for evaluating particles present in the cabin atmosphere. The concentration of aerosol per unit volumes will be determined in each of five ranges (0.3 to 0.6, 0.6 to 1.2, 1.2 to 2.4, 2.4 to 4.8, and above microns). Data will be recorded after each 2-minute test run has been conducted, once every 6 hours. Several different locations may be used for taking particle measurements after the first 2 days of flight. (Detailed in-flight procedures are provided in section 11.)

NOTE To ensure accurate determinations, do not use analyzer if visible particles are floating in cabin; if temperature is above 90°F; or if relative humidity in cabin is over 70 percent.

5.4.1.3 Crewman Participation.

Requirements for crewman participation in experiment T-3 are as follows:

a. Preflight - The crewman-subjects will be provided with sufficient time for equipment familiarization and training.

b. In-flight - Experiment measurements will be conducted once every 6 hours (for a 2-minute test run) until the nephelometer integral battery power is depleted. (The total duration of the experiment is limited by a battery with a 3-hour lifetime.)

c. Postflight - About one hour will be required for debriefing.

5.4.1.4 Recovery Requirements.

The recovery requirements will consist of removing the nephelometer and recorded data from the S/C. Personnel performing the postflight debriefing will be responsible for delivering data to the coordinating facility for analysis and evaluation.

SECTION 6

CREW PERSONAL EQUIPMENT

INTRODUCTION.

This section contains a description of Contractor-furnished crew personal equipment and spacecraft interface data on NASA-furnished crew personal equipment. All major items are identified as Contractor-furnished equipment (CFE), Government-furnished equipment (GFE), or Government-furnished property (GFP).

The following is a list of equipment or subsystems for which coverage is provided.

- Crew Compartment Configuration
- Sighting Systems (GFE)
- Space Suit Assembly (GFP)
  1. Constant Wear Garment (GFP)
     (a) Communication Hat (GFP)
  2. Pressure Garment Assembly (GFP)
- Crew Couches (CFE)
- Restraint Methods (CFE)
- In-flight Data Package (GFE)
- Crewman In-flight Tool Set and Work/Food Shlf (CFE)
- Crew Water (CFE)
- Food (GFP)
- Personal Hygiene (GFP)
- Medical Supplies and Monitoring (GFP)
- Survival Kit (GFP)
- Stowage

6.1 CREW COMPARTMENT CONFIGURATION AND CREW ENVIRONMENT.

The crew compartment is the pressurized compartment within the airtight inner structure (figure 6-1). The total volume within the inner structure is 366 cubic feet. Approximately 121 cubic feet of this pressurized space is occupied by the equipment bays,and control and display consoles surrounding the crew. The couches, astronauts, aft bulkhead equipment, and miscellaneous equipment occupy another 35 cubic feet making a total of 156 cubic feet. There is approximately 210 cubic feet of usable air space. The crew compartment is pressurized to 5±0.2 psi, with 100 percent oxygen atmosphere and approximately 50 percent humidity.

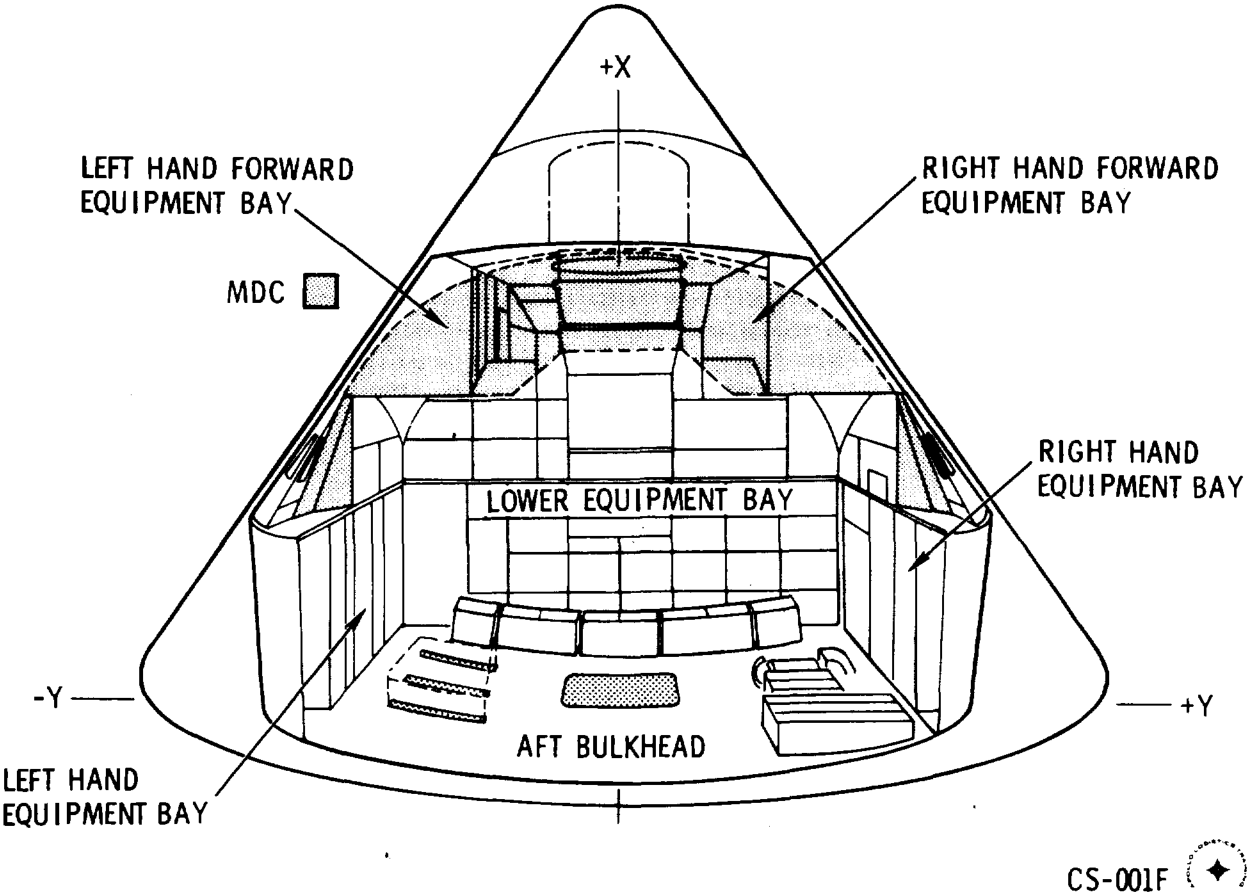


Figure 6-1. Apollo Crew Compartment, Internal View Form -Z-Axis

6.2 MIRRORS.

6.2.1 INTERNAL VIEWING MIRRORS (CFE). (Figure 6-2)

When the astronaut is in the pressure suit, pressurized, and on the couch, his field of vision is very limited. He can see only to the lower edge of the main display console (MDC), thus blanking out his stomach area where his restraint harness buckling and adjustment takes place. The internal viewing mirrors aid the astronaut in buckling and adjustment of the restraint harness and locating couch controls.

There are three mirrors, one for each couch position. The mirrors for the left and right astronaut are mounted on the side of the lighting and audio control console above the side viewing window and fold. The center astronaut's mirror is mounted on the left X-X head attenuator strut.

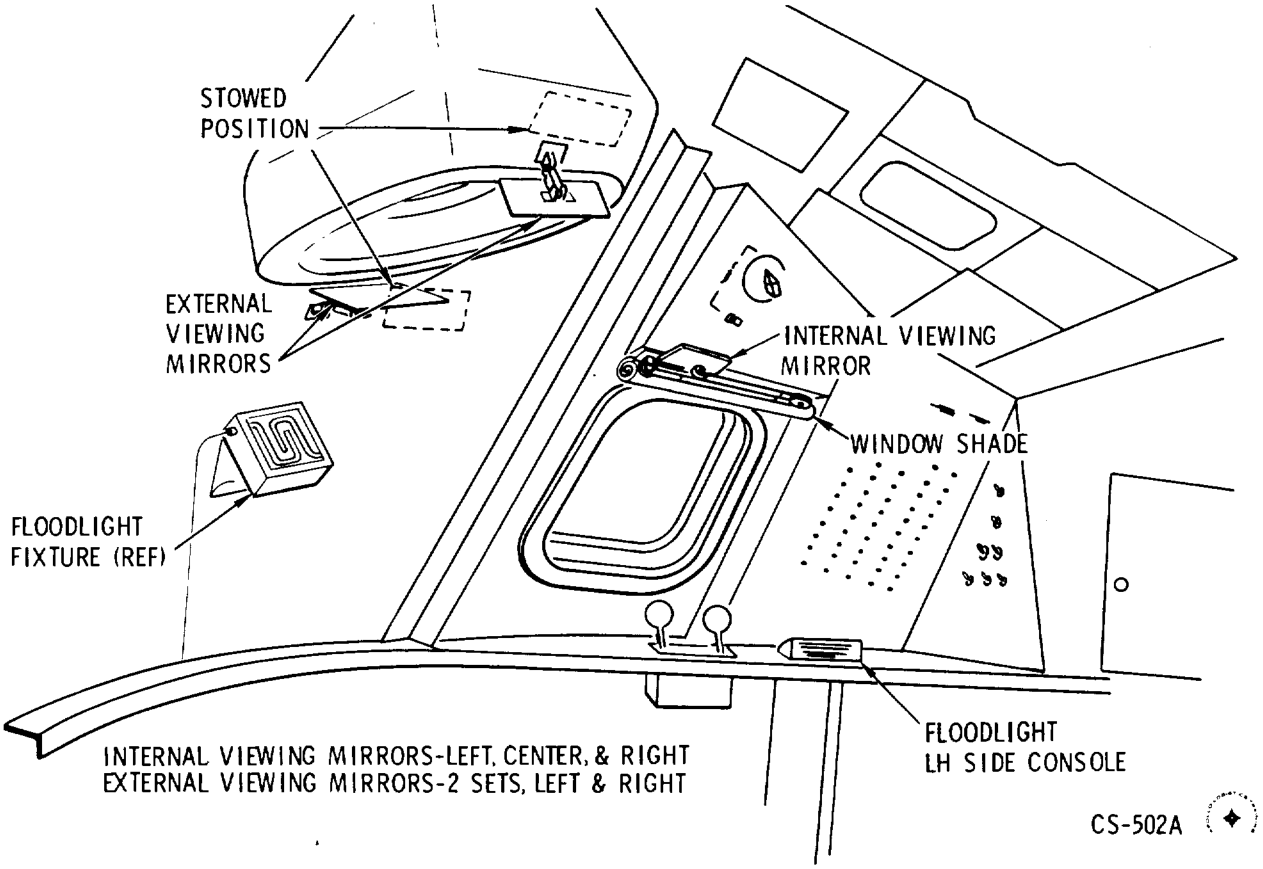


Figure 6-2. CM Mirrors, Block I and II

The mirror assembly consists of a mounting base, a two-segmented arm, and a mirror. The mirror is rectangular (4 by 6 inches), flat, rear surfaced, with a demagnification factor of 1:1. The two-segmented arm allows a reach of approximately 22 inches from the mount. The ends of the arm have swivel joints to position the mirrors in the desired angles. The mirrors are locked in position by a clamp during boost and entry.

6.2.2 EXTERNAL VIEWING MIRRORS (CFE). (Figure 6-2)

With the couches in the 96-degree position, the astronaut's left and right view, through the rendezvous windows, is restricted to +5 degrees to +42 degrees from the X-axis. Therefore, two sets of external viewing mirrors are installed in the CM to permit verification of parachute deployment during entry (figure 6-3). Another function is orientation of the command module in the event of an abort.

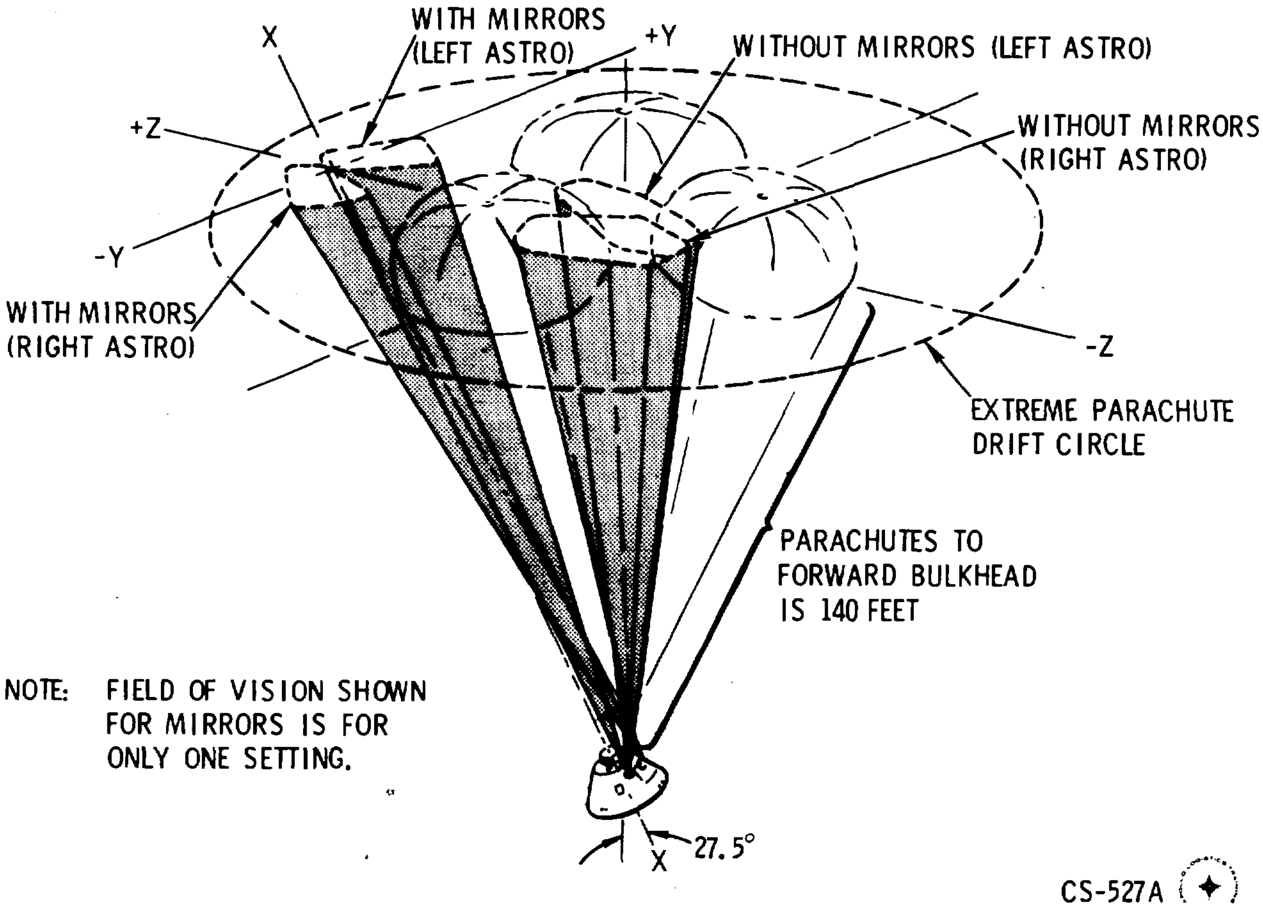


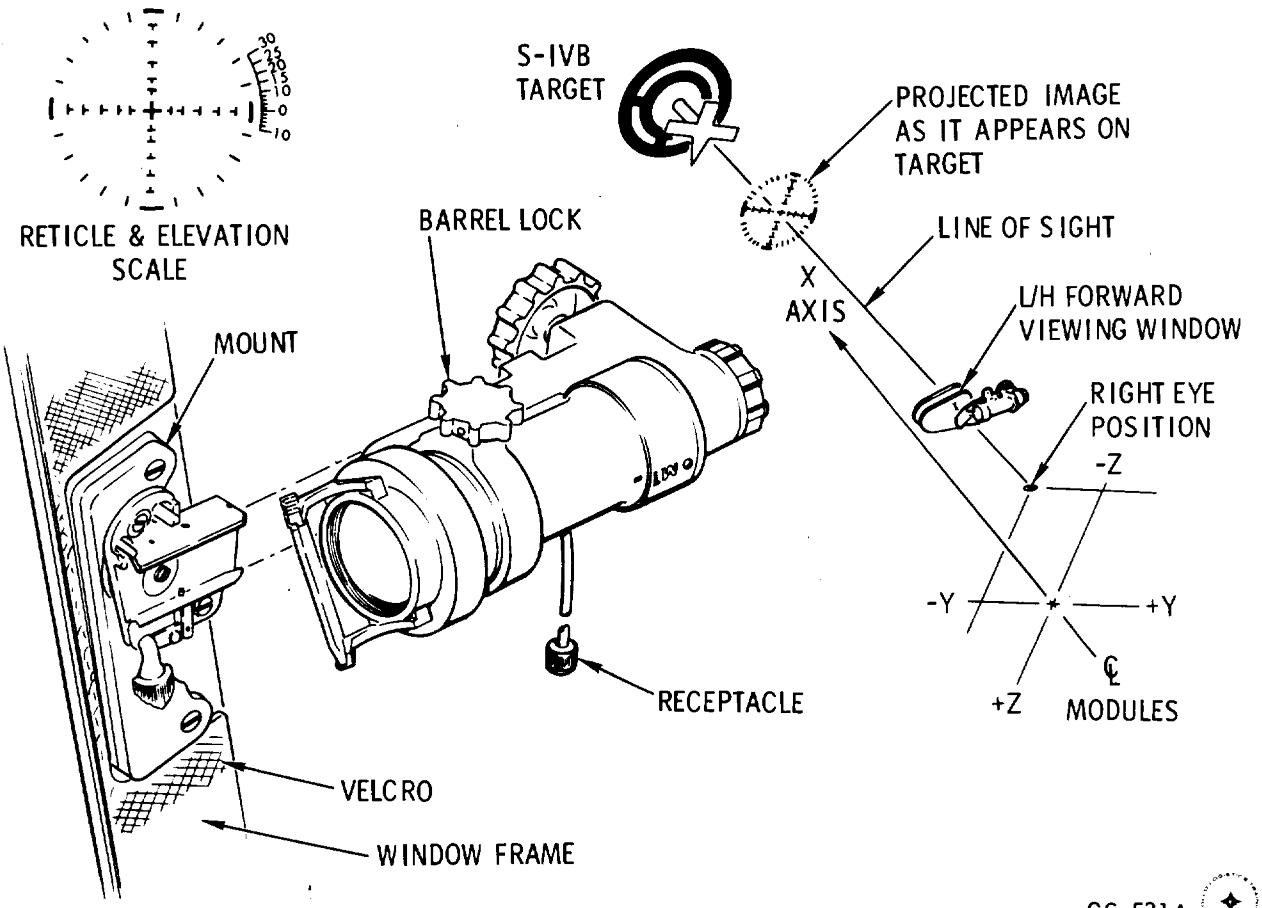
Figure 6-3. Parachute Field of Vision in Couch 96-Degree Position

A set of mirrors consist of an upper mirror assembly and a lower mirror assembly. The upper mirror assembly is mounted on the side wall near the upper rim on the rendezvous window frame. The lower mirror assembly is mounted on the rendezvous window housing near the lower rim of the window frame.

The mirror assembly consists of a mirror and a bracket. The bracket has a short arm with a swivel that allows positioning of the mirror. The short arm has a lock to immobilize the mirror during landing. The mirrors will have a 1:1 magnification factor and are rectangular in shape.

6.3 CREWMAN OPTICAL ALIGNMENT SIGHT (COAS). (Figure 6-4)

The crewman optical alignment sight provides the crewman a fixed line-of-sight attitude reference image which, when viewed through the forward window, appears to be the same distance away as the target. This image is foresighted (by means of a sight mount) parallel to the centerline (X-axis) of the CM and perpendicular to the Y-Z plane.



CS-531A

Figure 6-4. Apollo Crewman Alignment Sight System Configuration

The sight is a collimator device, similar to a gunsight. It weighs approximately 1.5 pounds and is 8 inches in length. It has a cord and receptacle and requires a 28-vdc power source. The sight is stowed in compartment T during boost and entry. When operationally required, it is mounted at the left rendezvous window frame. The power receptacle is connected to the SCIENTIFIC EXPERIMENTS receptacle (on the girth shelf).

6. 3. 1 OPERATIONAL USE.

When photographing activities or scenes outside the spacecraft with the 16 mm sequence camera, the COAS is used to orient the spacecraft and aim the camera. The camera will be mounted on the left sidewall handhold at a 90-degree angle to the X-axis and will be shooting out the left rendezvous window via a mirror assembly.

During rendezvous maneuvers with the S-IVB, the COAS can be used for alignment.

When the TV camera is mounted on the girth shelf for shooting out the right rendezvous window parallel to the X-axis, the COAS will be used for alignment. The COAS can also be used for backup for re-entry alignment and manual thrust vector control.

6.4 SPACE SUIT ASSEMBLY (GFP).

The space suit assembly (SSA) provides crewmembers with protective clothing and atmosphere for spacecraft command module environment. The assembly consists of a constant wear garment (CWG) and pressure garment assembly (PGA). For operational purposes, additional equipment is needed, such as communications and oxygen hoses. The equipment will be described in the two suit conditions: OFF and ON.

6.4.1 SPACE SUIT OFF OR SHIRTSLEEVE ENVIRONMENT.

During earth orbit, normal conditions (nondynamic) will allow the astronauts to remove the pressure garment assembly. The astronauts will wear an undergarment called the constant wear garment (CWG), a part of the space suit assembly. For communications, they will don a personal communications soft hat, connect it to a CWG adapter, and connect the adapter to an electrical umbilical which connects to the audio center.

6.4.1.1 Constant Wear Garment (CWG) (GFP).

The CWG (figure 6-5) is a one-piece, synthetic fabric garment for oxygen compatibility. It will be long sleeved or short sleeved. The short sleeve CWG has sleeve stiffeners. There are also pockets to hold radiation dosimeters. Around the mid-section are pockets for biomed preamplifiers. There are one or two cloth tabs (1 inch) near the chest to attach the cobra cable clip. An opening at the crotch is for urination and the rear opening is for defecation. A zipper up the chest allows easy donning and doffing.

The CWG can be worn for 6 to 7 days; therefore, a change will be needed. Each astronaut will wear a CWG under the pressure garment assembly. Three CWG's will be stowed in the left-hand equipment bay compartment CONSTANT WEAR GARMENT SANDALS. In the same compartment, three flight coveralls, one for each astronaut and three pair of weightless sandals, will be stowed.

6.4.1.2 Flight Coveralls (GFP).

Three flight coveralls will be stowed in the CHEB compartment, marked "CONSTANT WEAR GARMENT," for use while in shirtsleeve environment. The coveralls will be worn over the CWG, and will aid in keeping the CWG clean and the crewman warm.

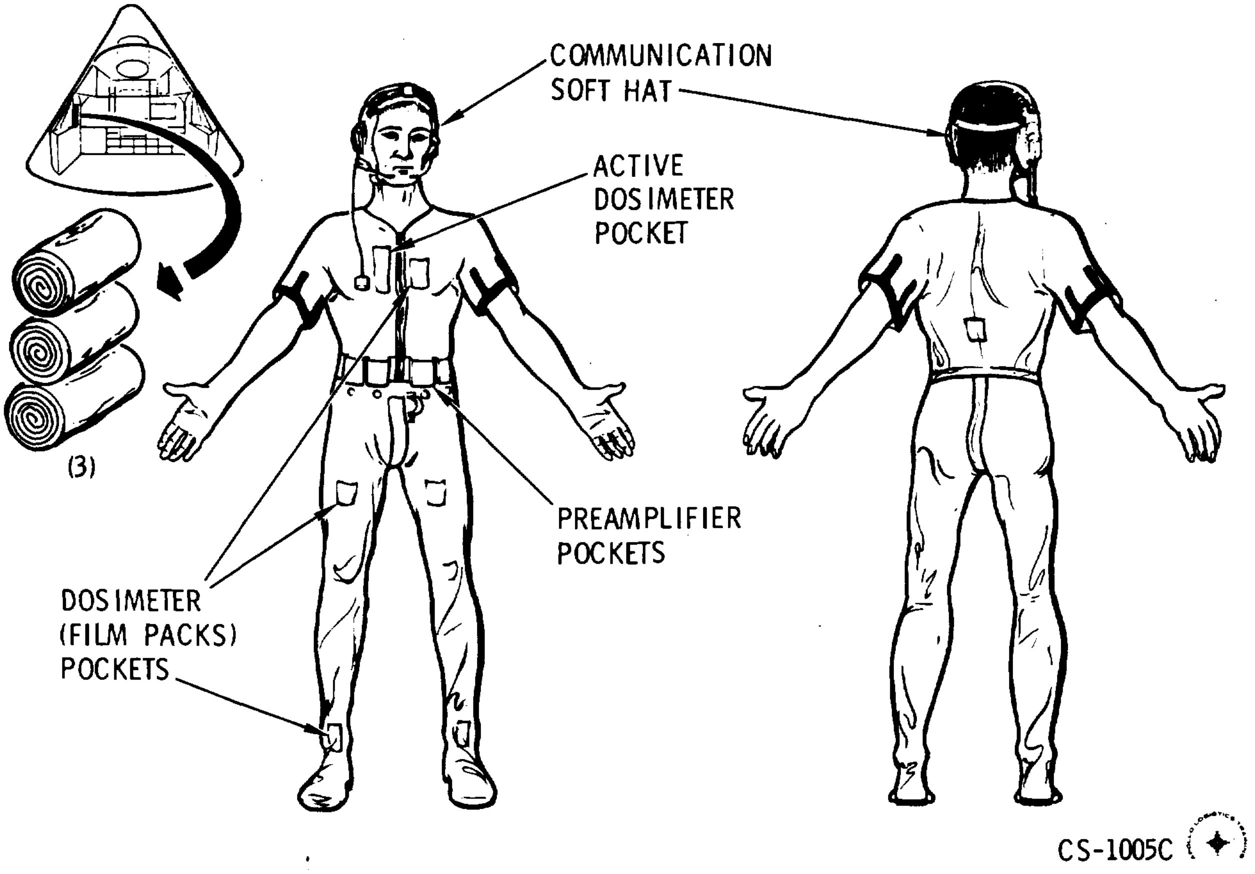


Figure 6-5. Constant Wear Garment (CWG)

6.4.1.3 Communications Soft Hat (GFP).

The personal communications carrier is a soft hat which supports communications equipment: redundant microphone/earphone sets and a connection to the audio center.

The microphones (voice tubes) have two positions: using and stowed. The stowed position is butted toward the forward edge of the helmet. The using position is in front of the mouth. Only one microphone needs to be used. The earphones will be in place over both ears all the time.

Three communications carriers will be stowed at launch and entry in the PGA helmet stowage bags on the aft bulkhead.

Three Lightweight Headsets will be evaluated during the mission and will share the soft hat stowage in the PGA helmet stowage bags.

6.4.1.4 Constant Wear Garment Electrical Adapter (CFE).

The function of the CWG adapter (figure 6-6) is to transmit the communications hat signals and the biomedical harness signals to the electrical umbilical or cobra cable.

The CWG adapter is a 37-pin connector which connects to the 21-socket connector from the communications soft hat. The nine-pin connector mates with the nine-socket connector of the biomedical harness connector.

Three CWG adapters will be required if all astronauts go shirtsleeve simultaneously. The three adapters will be stowed in the RHEB in a compartment marked ELECTRICAL ADAPTERS. The CWG adapter will timeshare the compartment with three PGA adapters.

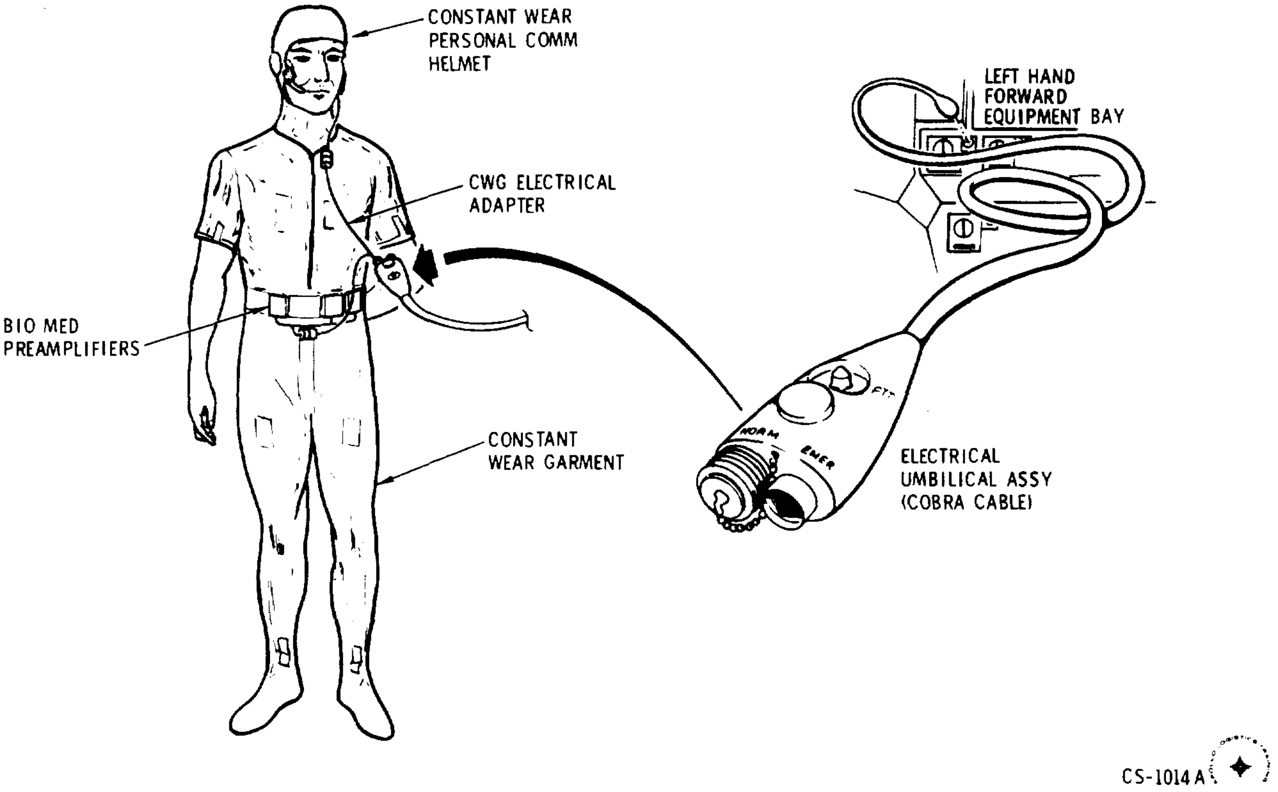


Figure 6-6. Personal Communications Equipment Connection, Block I (CWG)

6.4.1.5 Electrical Umbilical "Sleep" Adapter.

Two electrical umbilical "sleep" adapters will be stowed in the RHEB compartment marked ELECTRICAL ADAPTERS. The purpose of the "sleep" adapters is to eliminate voice communication signals passing through the caution/warning system, thus enabling uninterrupted sleep for two crewmen. The adapter, connected between the cobra cable and the CWG or PGA adapter, will play a pianissimo version of "Brahms Lullaby."

6.4.2 SPACE SUIT ON ENVIRONMENT.

6.4.2.1 PGA Unpressurized or Ventilated.

During launch, boost, entry, descent, and landing phases of the mission, the crew will be required to be suited. The crew will be fully suited but in the unpressurized or ventilated condition. That is, the cabin pressure will be 5 psi and the differential pressure of the suit will be a plus 2 inches of water or 0.072 psi. This is enough differential pressure to hold the suit comfortably away from the body. The oxygen will be flowing from the ECS suit loop, through the oxygen hose into the suit and returning through the return hose to the ECS suit loop. The cabin air is circulated about the cabin by the cabin air fans 1 and 2.

An alternate mode of ventilated usage is with helmet and gloves off, using neck and wrist dams. The gas circulation is the same, except the astronaut breathes cabin oxygen. This mode can only be sustained for 54 man-minutes out of 18 hours (1:20) because the cabin oxygen becomes saturated with water vapor which will condense on the structure. This is not a recommended mode.

6.4.2.2 PGA Pressurized.

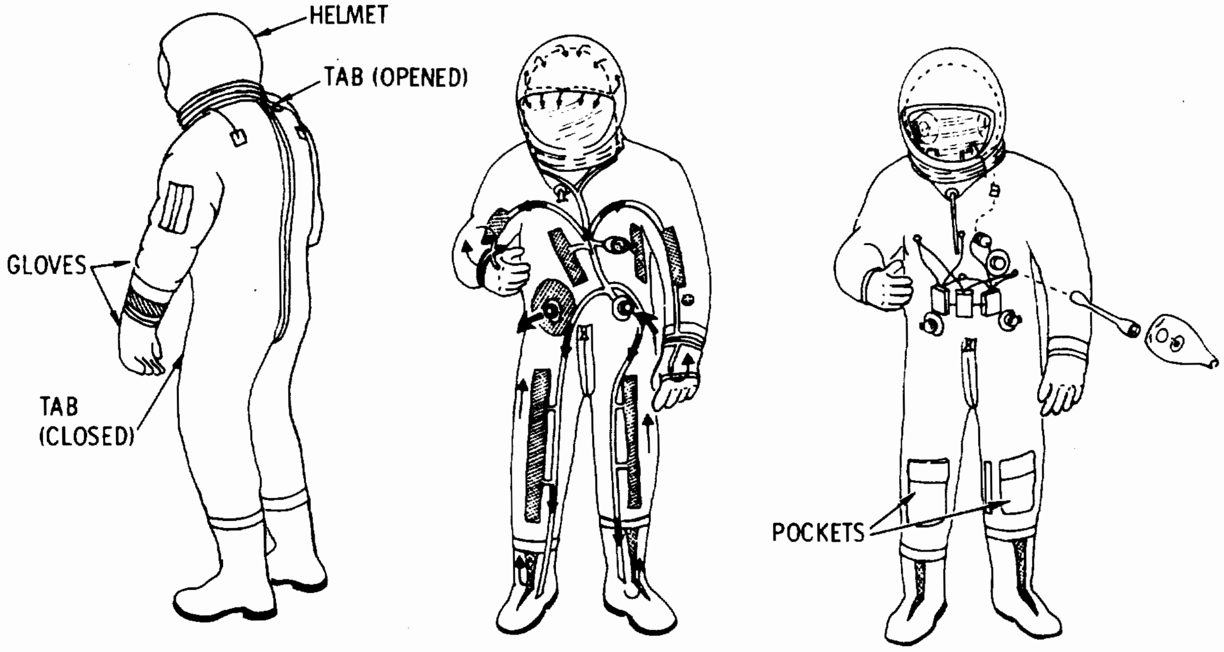
The PGA (space suit) will not be pressurized except during an emergency. This condition will exist during a cabin depressurization. If out of the suit, the ECS can maintain 3.5 psi in the cabin for 5 minutes if the hole or leak is less than 1/2 inch in diameter. Therefore, donning the suit must take less than 5 minutes. When the suit is pressurized, the differential pressure will be a plus 3.7 psi in the suit. This condition constrains the body mobility. For this reason, it is normally not desired to be pressurized.

The crew will perform a cabin depressurization to demonstrate confidence in the spacesuit and proper function of the hardware.

6.4.3 PGA DESCRIPTION. (Figure 6-7)

6.4.3.1 PGA Components.

The PGA is a three-piece suit: torso, helmet, and gloves. It is manufactured by Clark Manufacturing Co. of Massachusetts.



DONNING/FITTING VENTILATION COMM/INSTRUMENTATION

Figure 6-7. Apollo Block I Pressure Garment Assembly

Accessories of the suit are the neck and wrist dams, blood pressure cuffs, and urine collection bag. Operational use of the accessories is optional and will vary in accordance with the mission.

6.4.3.1.1 The Torso and Gloves.

The PGA torso has four layers. From the inside, the first layer is a combination liner and ventilation layer. The ventilation distribution tubes guide incoming oxygen to all extremities. The oxygen also passes through net openings to circulate around the astronaut. The actual cooling takes place as the gas flows from the extremities (higher pressure) to the return (lower pressure) over the CWG. The second layer is a pressure-tight layer, to contain the oxygen or the 3.7-psi operating pressure. The third layer is a restraint layer of strong netting to restrict bulging and enlarging so movement will be unimpared when pressurized. The last, and outside layer is a protective cover. There is a pressure line from the pressure layer (2nd layer) to a surface pressure gauge to allow the astronaut to monitor the pressure. At the waist is an intake connector valve on the left and a return connector valve on the right.

The outside protective layer has pockets on the arms and legs. The arm pockets contain such articles as neck and wrist dams, handkerchiefs, and pencils. The leg pockets contain scissors.

The neck ring is an aluminum ring, and when mated with the helmet, has O-ring seals. Cables are attached to the neck ring to hold it down when pressurized.

The boots are attached to the legs by laces and are not airtight. A sock from the leg fits into the boot and is airtight. The boots will not be removed during the mission.

The gloves are attached to the arms with a ball race lock and are scaled with O-rings.

A zipper runs from the navel, underneath the crotch, and up the spine to the neck ring. The tab is by the navel when sealed (closed) and by the neck ring when opened. To assist the one-man donning, the tab has a 6- to 10-inch lanyard attached to it. The suit has the capability of one-man donning in less than 5 minutes. It can be donned by having the helmet and gloves attached or attaching them after donning the torso.

The communication and biomedical cables exit through a 61-pin connection at the left breast.

6.4.3.1.2 The Helmet.

The helmet is a plastic shell. It has a liner inside, ear cushions with earphones, and two microphones. On the outside, a visor is pivoted at the ears. A visor protective cover of thin plastic (Cycolac) covers the top of the helmet. A ring seal is at the neck. It will set in the torso neck ring and is held in place by a clamp.

To pressurize the suit, the visor (or faceplate) must be closed. It is rotated down across the face and presses against a seal, and is held in position by a clamp-latch.

6.4.3.1.3 Neck and Wrist Dams.

The primary function of the dams is postlanding sealing of the PGA during water activity.

The dams are wide rubber bands. The neck dam fits over the torso neck ring and around the neck. This keeps the sea water out of the suit. The helmet must be removed. When the gloves are removed, the wrist dams seal the wrists and the crewman will float in the torso.

An optional dam use during the mission would be to cool the body while in the suit with the gloves and helmet off. This is restricted to a short period of time as the crewmans respiration would produce an excessive CO_2 concentration. The comm helmet will be used for communications during this period.

6.4.3.1.4 Urine Collection Device (GFP).

During the standby, hold, launch, and boost phases, the crewman will be suited. A continuous suited period of 3 to 6 hours can be experienced so provisions must be made to urinate within the PGA.

The function of the urine collection bag is to collect and store 1200 cc of urine. There is an external catheter (roll-on) connected to the bag. The bag fits around the crotch and hips and is held into place by Velcro attached to Velcro on the CWG.

When mission operations permit, the suit is unzipped and the urine bag is removed. A valve on the bag will connect to the waste management system, and the urine will be dumped overboard.

6.5 PGA STOWAGE.

6.5.1 TORSO AND GLOVE STOWAGE.

The gloves will be left attached to the torso and stowed together. The PGA helmets will be stowed separately. The suit stowage bag is made of sage green, nylon cloth, 36 inches long, 20 inches wide, and can be expanded from 3 to 12 inches high. It has an aluminum rod frame to maintain the form. A partition separates the bag into two compartments. On the top are flaps held closed with Velcro. Three strips of Velcro loop are on the bottom to anchor the bag on three strips of Velcro hook on the aft bulkhead.

The two-PGA stowage area is beneath the commander's couch (left) on the aft bulkhead. An additional stowage bag is located beneath the head of the pilot on the aft bulkhead near the hatch between the LiOH cartridge stowage boxes and the sidewall. The suit stowage bag is similar to the two-suit bag.

6.5.2 HELMET STOWAGE.

The PGA helmets are stowed only during nondynamic periods, or zero g. Three helmet mid-course stowage bags are provided. The bags (GFP) are located on the aft bulkhead under the center couch.

6.6 PGA CONNECTING EQUIPMENT.

6.6.1 PRESSURE GARMENT ASSEMBLY (PGA) ELECTRICAL ADAPTER (GFP).

The PGA electrical adapter provides interface between the PGA and the cobra cable since the connectors are not compatible.

The PGA adapter is 18 inches in length with a suit interface of a 61-socket connector and the cobra cable interface with a 37-pin connector. There are three adapters.

When the suits are removed and stowed, the PGA adapters will be disconnected from the suit and stowed. They will replace the CWG adapters in the ELECTRICAL ADAPTER stowage compartment in the RHEB.

6.6.2 OXYGEN HOSE (UMBILICAL) (GFP). (Figure 6-8)

The function of the oxygen hose is to interconnect the PGA and the CM ECS.

The oxygen hose is a dual hose, each hose having an inside diameter of 1.25 inches and made of silicon rubber with spiraling steel wire reinforcement.

The ECS end has a double D connector while the suit end splits the hoses about 15 inches from the end. Each hose has an elbow nozzle to connect to the suit.

There are two hoses: one 72 inches long and one 81 inches long. A nylon strap is bonded approximately every 12 inches to restrain the cobra cable to the hose during suit operations.

The double D connector on the ECS end remains connected during the mission. The hose is routed behind the MDC and held in place by tie-down straps. When disconnected from the suits, the ends are routed from the rear of the MDC to the forward bulkhead and strapped. To prevent the incoming oxygen from being sucked into the return side and not into the cabin, the return nozzle will be capped with the oxygen hose return cap, which is attached to the hose with a lanyard.

6.7 CREW COUCHES.

The crew couches support the crew during acceleration and maneuvers up to 30 g's forward, 30 g's aft, 18 g's up and down, and 15 g's laterally.

The spacecraft contains unitized crew couches integrally bolted together in a unit structure.

The couches are designated one of three ways. Structurally, they are left, center, and right. By crew positions, they are 1, 2, or 3 or commander, senior pilot, and pilot (left to right).

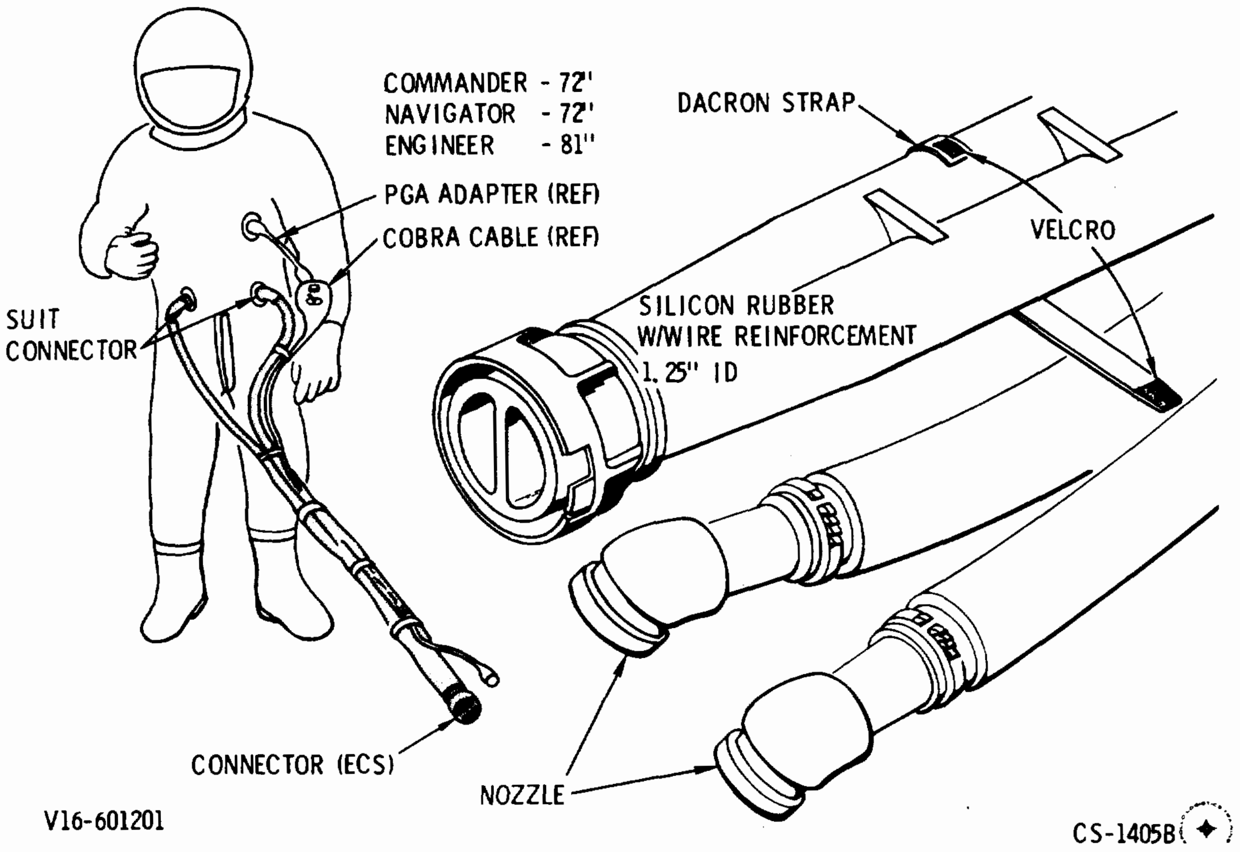


Figure 6-8. O_2 Umbilical Hose Assembly, Block I

6.7.1 CREW COUCH STRUCTURE.

The crew couch structure consists of three crew couches: the left, center, and right (figure 6-9). It is fabricated of aluminum and weighs approximately 400 pounds. The left and right couches are identical. The center couch connects the left and right couch into a single unified structure.

The couch structure, in a one-g environment, is supported by the impact attenuation struts: the four X-X struts from the forward bulkhead, the two Z-Z struts from the aft ring, and the two Y-Y struts in compression against the side panels. The X-X and Z-Z struts connect to the crew couch structure at the left and right couch main side beams.

The left and right couches are capable of the 170-degree position but will not be placed in that position because of equipment interference beneath those couches.

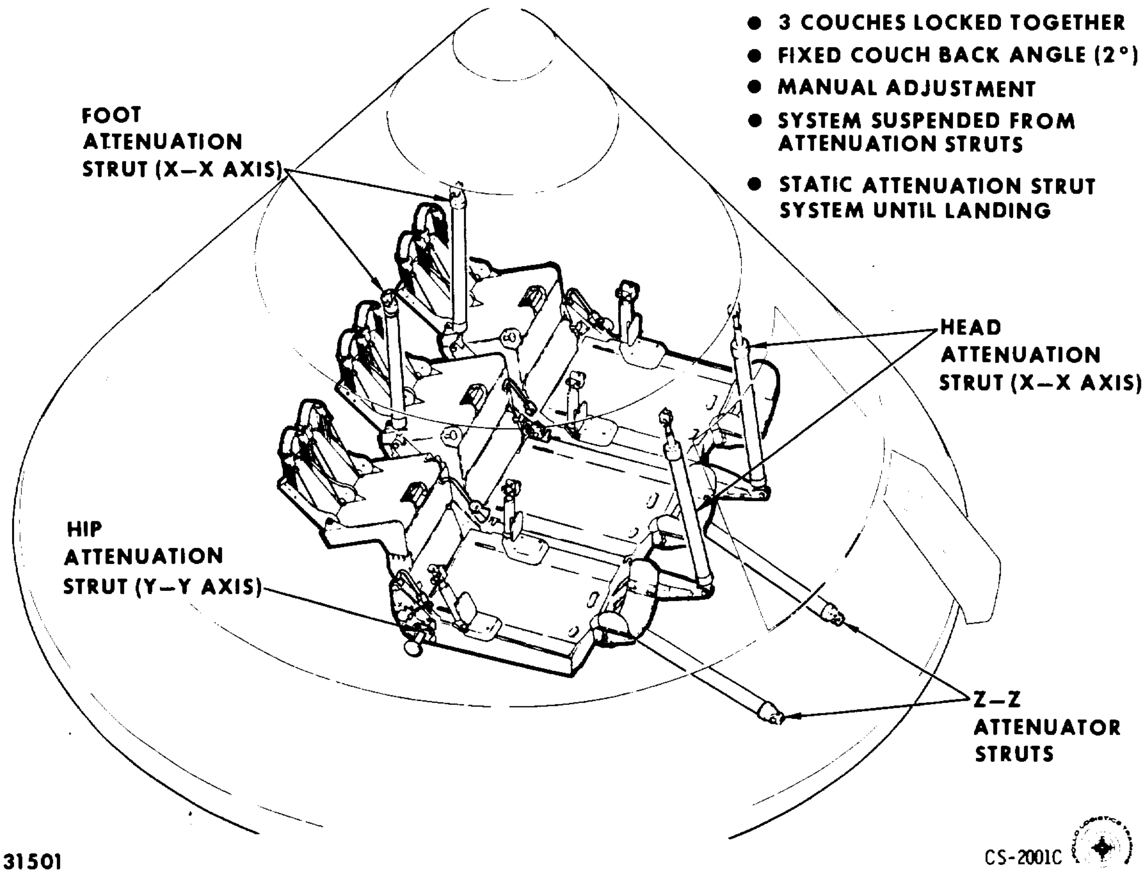


Figure 6-9. Crew Couch Installation

The additional LEB access/docking position will be used during orbit to gain room near the LEB. The seat pan angle remains 96 degrees while the couch structure (all couches) moves 6.5 inches toward the hatch.

6.7.2 CREW COUCH POSITIONS. (Figure 6-10)

6.7.2.1 Occupied Positions.

The most utilized position is the 96-degree position assumed for the launch, orbit, and entry phase. For a 50 percentile crewman, the hip angle is 108 degrees and very easy to assume. It gives maximum support to the body during high g loads.

The 170-degree or flat out position is used primarily for egressing from the center couch. All egressing to the LEB will be from the center couch. For this reason, the lower armrests are removed and stowed,

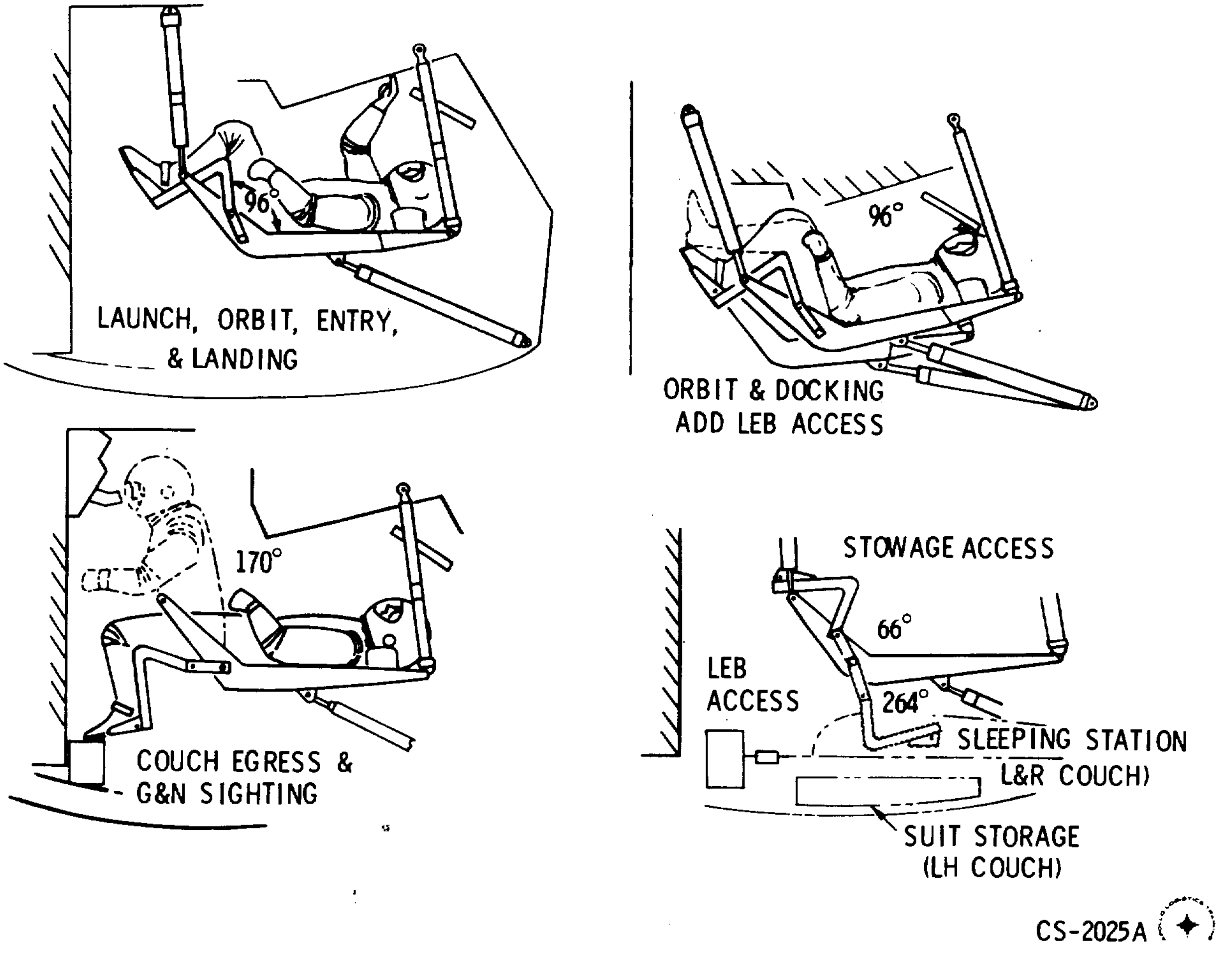


Figure 6-10. Crew Couch Mission Positions and Seat Angles, Block I

making easy egress from right and left couches into the center couch. Another use of the 170-degree position is G&N sighting. The 50 percentile crewman can position himself on the seat pan with his feet in the footrests and sight through the G&N eyepiece.

6.7.2.2 Unoccupied Positions.

The 66-degree seat pan angle position is used primarily for right and left equipment bay stowage access.

The 264-degree position necessitates rotating the seat pan under the backrest. This will clear the LEB area for maintenance activities. Due to restricted clearance beneath the left and right couches, this position is restricted to the center couch only. During use of the fecal canister, this is the desirable seat pan angle.

6.7.3 CREW COUCH COMPONENT DESCRIPTION. (Figure 6-11)

The crew couches are basically the same and the modular components interchangeable. The backrest assemblies differ the most because of the docking position mechanism in the center couch.

6.7.3.1 Headrest.

The headrest is constructed of honeycomb aluminum and has folding tips. It is padded on the inside and both sides of the tips. During maneuvers requiring PGA helmet restraint, the tips are left extended. For orbit and zero g, the tips are folded, affording freedom of movement for nominal visibility.

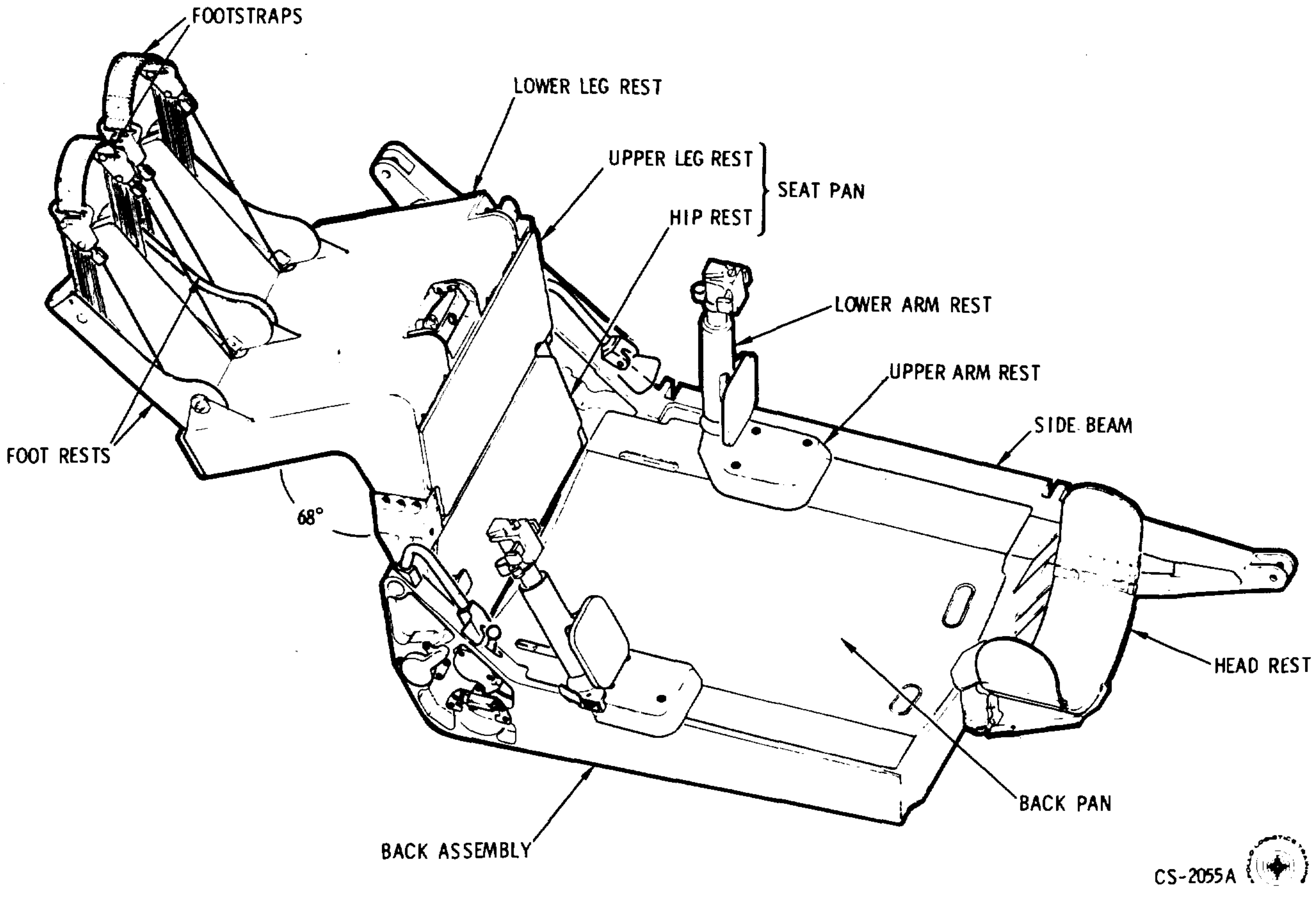


Figure 6-11. Left-Hand Couch Assembly (96-Degree Position)

The headrest has a 3-inch longitudinal movement for adjustment to crewman torso length. The headrest and support will fold under the couch for purposes of accessibility and ingress to the couches.

6.7.3.2 Backrest.

The backrest is constructed of ribs and beams covered with aluminum sheet and is 32 inches long and 22 inches wide. The left and right couch back pans are attached to the integral side beams, the inboard beam of which is 56 inches long and the primary structural member of the couch support.

The backrest assembly is contoured and contains the takeup reel system for the shoulder straps. The back pan is padded in the areas of crewman contact.

6.7.3.3 Armrests.

The armrests attach to the forward surface of the backrest and are adjustable. They consist of an upper and lower armrest. The upper armrest can be adjusted for length of arm and torso.

The lower armrest inserts into and is supported by the upper armrest at an angle of 90 degrees. It is secured by a leverized pin device for quick removal. A tubular shaft extends past the rest pad and contains the mounts for the controls. A major function of the armrests is to mount the SCS controls . The left couch left armrest has an adapter mount for both translation controls T1 and T2, and mounts at an angle of 120 degrees. All other armrests (3) mount at an angle of 90 degrees. The left couch right armrest supports a rotation control (R1). The center couch has no armrests.

On the right couch left armrest is a fitting to which the other rotation control (R2) can be attached for use by the center astronaut. By using an adapter, one translation control (T2) can be mounted for use by the right astronaut.

Normally, the right couch right armrest supports the second rotation control (R2). A third position for the rotation control (R2) is attached to the LEB G&N panel for use during navigational sightings.

6.7.3.4 Seat Pan and Footrest.

The seat pan and footrest has three components: the hiprest, legrest, and footrests.

The hiprest and upper legrest functions as a seat or seat pan. The lower legrest supports the lower legs, and the footrests support and restrain the feet. The hiprest makes an angle of about 170 degrees with the upper legrest, forming the seat pan. There are two pivot points: one at the aft of the hiprest, and the other where the hiprest and legrest intersect. Part of the mechanism for positioning the seat angles at 96, 170, and 264 degrees is housed in the hiprest.

The lower legrest houses the mechanism for positioning the seat in the 66-degree angle and tightening or loosening of the footstraps. The upper legrest to lower legrest angle is fixed at 68 degrees. The footrests pivot so they can fold parallel to the lower legrest. Footstrap rotation bars are spring-loaded to the release position and are pulled to the restraint position by cables. The cables run to a reel that can be locked or released by a control in the lower legrest.

6.7.3.5 Crew Couch Pads.

The following portions of the couches have pads: headrest, back pan, armrests, and seat pan.

The padding is a triloc material 3/16-inch thick. It is structured of woven dacron wire-like fibers in a low-density pattern giving good ventilation.

The back pan and seat pan pads are composed of three layers of triloc covered with nylon netting, making approximately 1/2 inch of padding.

The armrest and headrest pads are 3/16-inch-thick layers between nylon netting covers.

The pads are attached to the metal surfaces with Velcro strips and can be removed during the mission if the need arises.

6.7.4 MECHANICAL ADJUSTMENTS. (Figure 6-12)

6.7.4.1 Headrest Adjustments.

To adjust the headrest for crewman height, turn the adjustment with the tool set 4-inch CPS driver. It has a 7/32-inch hex drive.

The headrest is folded down by pulling the headrest lock headward. The headrest is spring-loaded to the stowed (down) position so it should be restrained by the hand. To bring it up, pull with the hand; pull headrest lock handle back to clear the hook, position headrest in the normal position, and push the lock handle footward.

6.7.4.2 Armrest Adjustments.

The lower armrests are removed by pulling the armrest lockpin release outward to pull the pin, and then pulling the armrest upward to remove. The left couch right armrest and the right couch left armrest are stowed on the couch side beams by Velcro seats and straps.

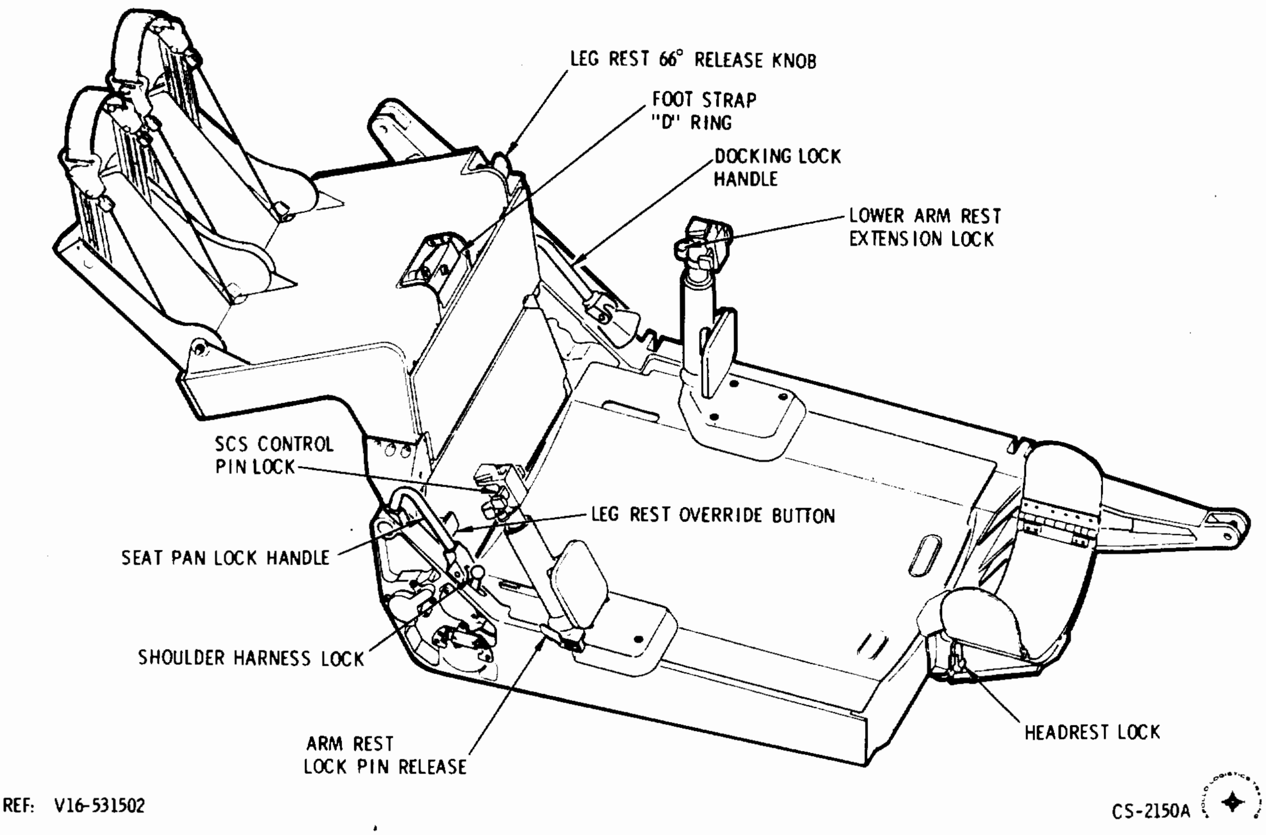


Figure 6-12. LH Crew Couch Operating Mechanisms, Block I

To attach SCS controls, push the SCS control pinlock to the left; slide the control on the dovetail; and push the lock to the right locking a retention pin.

The lower armrest can be extended by rotating the extension lock toward the left, extending the armrest and locking into position by pushing the lock to the right.

6.7.4.3 Seat Pan Adjustment Directions.

SPLH = Seat Pan Lock Handle

LRRK = Legrest Release Knob

LROB = Legrest Override Pushbutton

From (Deg)	To (Deg)	Procedure	Remarks
A 96	170	1. Lift the SPLH and push with feet. 2. Release the SPLM; continue pushing with feet until seat stops at 170°.	1. Key locking the leg pan will disengage. 2. Key on pivot cylinder will engage side beam keyway.
170	96	1. Lift the SPLH and pull with feet. 2. Continue lifting SPLH, pulling with feet until seat stops at 96°, release SPLH.	1. Key on pivot cylinder will disengage. 2. Key on pivot cylinder will engage side beam keyway.
B 96	264	1. Lift SPLH and rotate downward. 2. Continue to lift SPLH passing through 170° position. 3. Release SPLH and continue rotating until seat stops at 264°.	1. Key locking leg pan will disengage. 2. Maintains the leg pan pivot key in disengaged position. 3. Key on pivot cylinder will engage in 264° position slot.
264	96	1. Lift SPLH and rotate seat toward 170°/96° position. 2. Continue to lift SPLH, passing through 170° position. 3. Rotate to 96° position and release SPLH.	1. Leg pan pivot key disengages allowing rotation. 2. Leg pan pivot key maintained in disengaged position. 3. Leg pan point pivot key will engage 96° position slot.
C 96	66	1. Pull up with feet until 66° latch engages the side beam.	1. Disengages seat to hiprest detent. 66° latch will drop in slot on beams and catch.
66	96	1. Press the LRRK with feet until 96° position is reached.	1. 66° catch disengages. On reaching 96° position, detent will engage.

6.7.4.4 Footrest and Footstrap Adjustments.

The footstraps are controlled by a footstrap D-ring (FSDR) between the astronaut's knees. The D-ring is connected to a cable that runs through a tube to a drum-axle-drum mechanism. By pulling on the D-ring and rotating the drum and axle, cables pull the footstraps to the restrained position. The drums have ratchets that lock the footstraps in position and retain the feet in the footrest. To release the footstraps, the FSDR is pressed, forcing the connecting tube to disengage the ratchet and release the footstraps.

6.7.4.5 D-Ring Handle Extension.

The D-ring handle can be reached easily while the PGA is unpressurized. However, when pressurized, the PGA slightly restricts the 90 percentile crewman from reaching the D-ring, thus making it difficult to lock or free the feet. The D-ring extension has been designed to connect to the D-ring handle. The extension has a 7/16-inch hex shaft to insert into the D-ring handle and control it (paragraph 6.10.10). It has a ball-lock feature to connect to the D-ring. The D-ring extension will be accessible on the right girth shelf.

6.7.4.6 Docking Position Adjustment.

The mechanism that releases the lock which allows the couch structure to slide to the docking position is located in the backrest of the center couch; however, the docking lock handle is on the right side beam of the left couch.

The forward end of the Z-Z struts attaches to the couch by a slide that runs in tracks in the side beams. A lever-lock device (finger latch) locks the slide in two positions: normal and docking. The lever-lock is spring loaded in the lock position. The docking lock handle (DLH) disengages the lever-lock only while the DLH is lifted. The couch structure must be pulled to the docking position by the center astronaut pulling on hand holds located on the side hatch.

When transversing to the docking position, the seats remain in the 96-degree position. The left crewman then lifts the DLH and the center crewman grabs a handhold and pulls the couches toward the side hatch. After movement, the DLH can be released. When the couches have moved approximately 6.5 inches, the lever-locks will drop into slots, locking the couches in place.

To return to the couch normal position, the DLH is lifted and the couches are pushed toward the LEB. The DLH is released and the lever-locks will drop into slots when in position.

6.7.4.7 Shoulder Strap Adjustment.

The shoulder strap takeup reels are on the couch backrest. They allow 10 inches of play and are locked by the shoulder strap lock on the left sides of the couches. A headward pull will unlock the shoulder straps, and a forward and down push will lock the shoulder straps.

6.8 CREWMAN RESTRAINTS.

The crewman restraints provide restraint and physical attachment to the astronauts.

a. In the couches during launch, weightless phases, abort, entry, and landing
b. During weightless periods while performing tasks out of the crew couch
c. While in the sleep position
d. When performing extra vehicular activities

6.8.1 HIGH G-LOAD RESTRAINTS.

6.8.1.1 Crewman Restraint Harness.

There are three restraint harnesses per spacecraft, one for each crewman.

The restraint harness consists of a lap belt and two shoulder straps interfacing the lap belt at the buckle. The harness is permanently attached to the couch and is not removable. The lap belt interfaces straps connected between the seat and back pans. This configuration provides adequate hip support (figure 6-13).

The shoulder straps pass through slots in the upper portion of the back pan and are connected to spring-loaded takeup reels fastened on the underside of the back pan. The takeup reel allows 10 additional inches of strap travel at maximum 10-pound pull. The crewmember can lock or unlock these takeup reels simultaneously by actuating a lever on the side of the couch.

The lap belt buckle is a lever operated, three point release mechanism. By pulling a lever, the shoulder straps and right lap belt strap will be released. The strap ends and buckle are equipped with Velcro patches and may be fastened to mating patches on the couch when not in use. This also prevents the buckles and attachments from floating free during zero g. Each strap can be individually tightened or loosened by the crewman (figure 6-14).

The maximum force on the harness straps will be 3115 pounds at the chests. The straps are dacron, 1-7/8 inches wide, and have a strength of 6000 pounds.

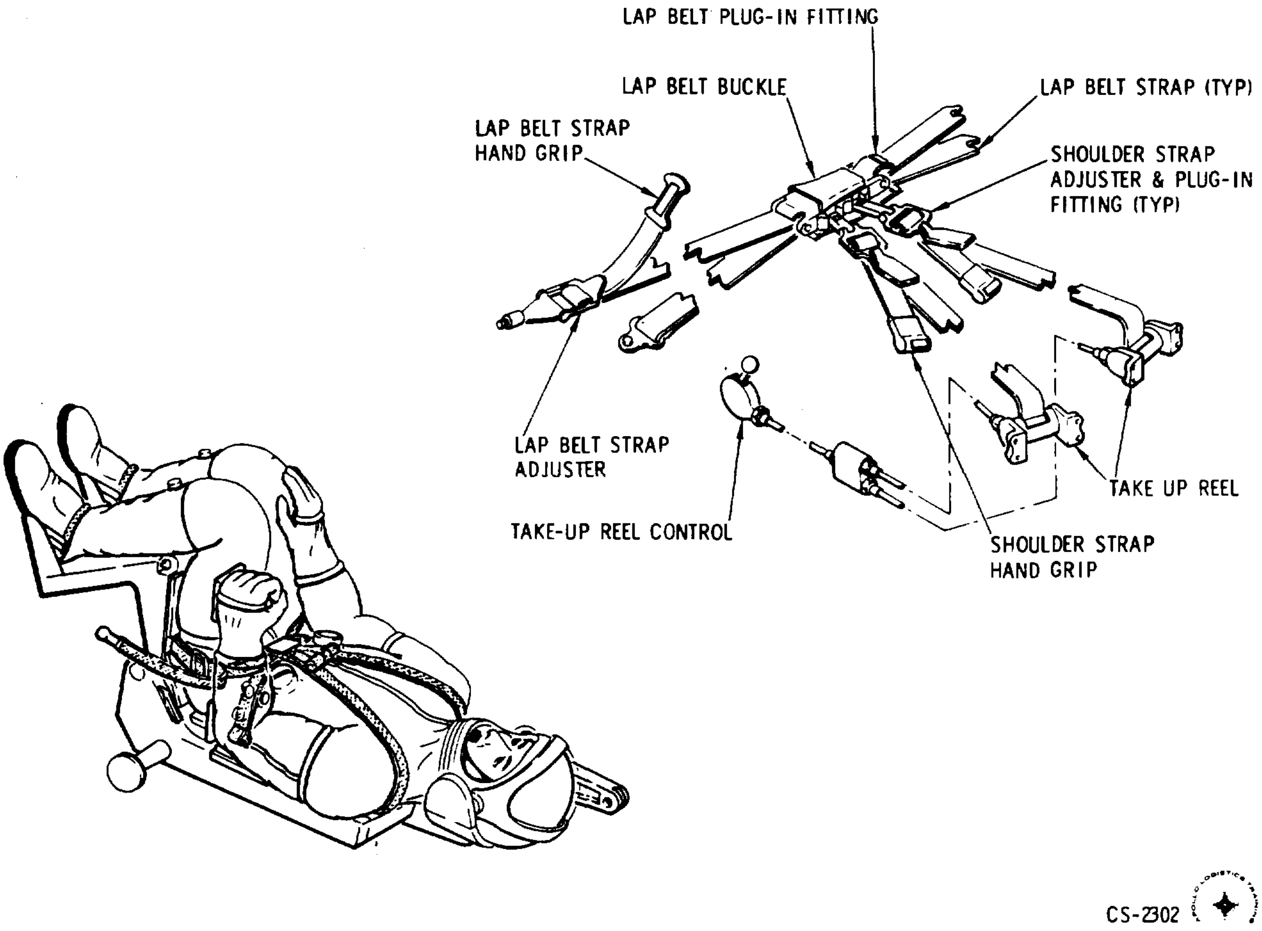


Figure 6-13. Crewman Restraint Harness Components

The harness will be on and locked during all maneuvers when g loads are expected such as launch, delta V, docking, entry, and landing. Securing in the couch prior to impact will include locking of the foot straps in addition to fastening of the harness. The harness can be tightened and loosened readily by the astronaut.

6.8.1.2 Weightless Restraint.

To assist the crew in egressing from the couch, five hand straps are attached behind the MDC (figure 6-15).

When out of the couch, the astronaut will restrain himself with handholds and Velcro foot restraints. Part of the aft bulkhead will be surfaced with Velcro hook material. The astronaut will wear Velcro pile material on the soles and heels of his PGA boots when in the PGA.

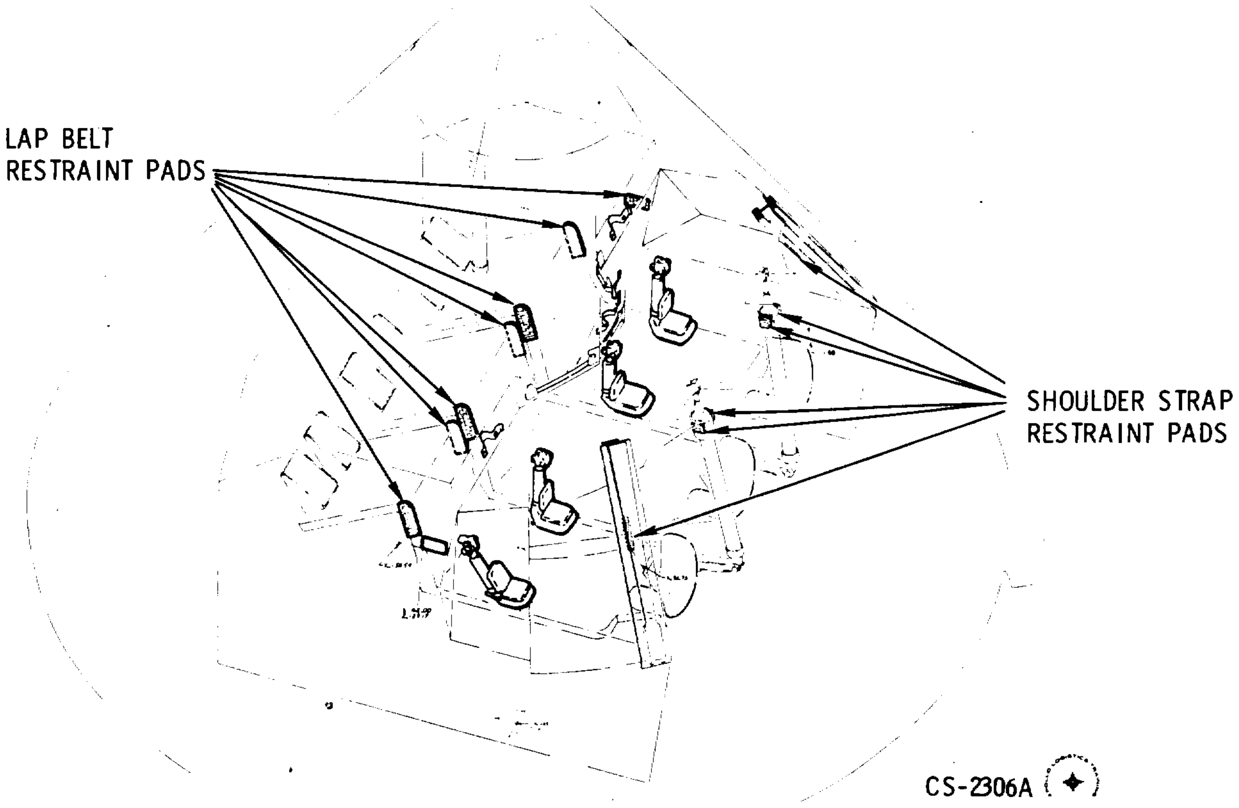


Figure 6-14. Restraint Harness Velcro Restraint Pads

Restraint sandals (figure 6-16) will be worn with the CWG. The sandals are fabricated of a flexible plastic Royalite PR55. Velcro pile material is bonded on the ball and heel of the sole. The sandal is held closed and on the foot by Velcro patches.

There are three pairs of sandals which are stowed in the LHEB with the CWGs and flight coveralls.

6.8.1.3 Guidance and Navigation Station Restraint.

Two positions may be utilized at the G&N station: standing position or center couch G&N position. The astronaut will restrain himself in the standing position by fastening his restraint sandals to the aft bulkhead and using a handhold on the left side of the G&N console.

The astronaut will restrain himself in the center couch at the G&N station by positioning the couch to the 170-degree hip angle and restraining his feet with the couch foot straps.

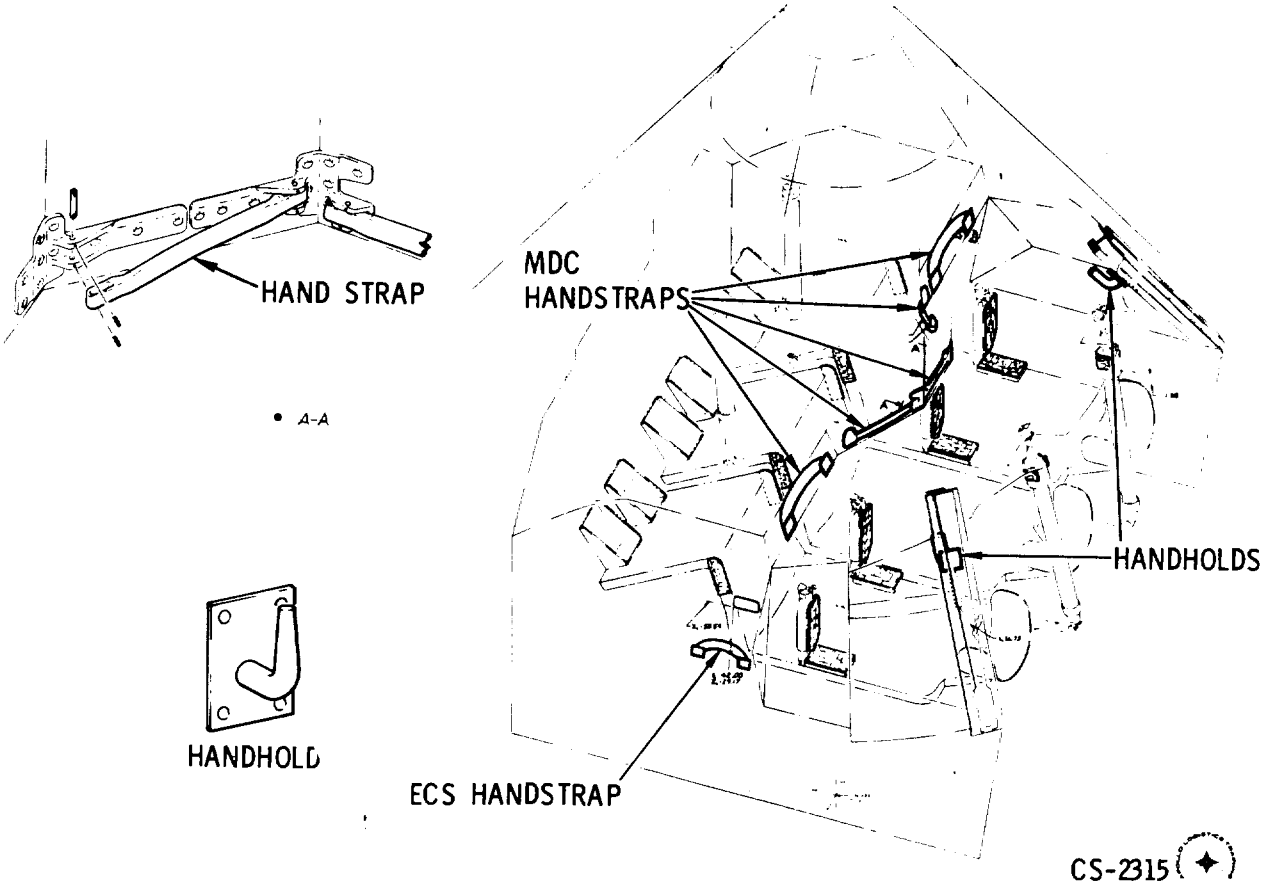


Figure 6-15. CM Interior Handgrips

6.8.1.4 Crewman Sleeping Restraints. (Figure 6-17)

The crewmen sleeping position will be under the left and right couch with the heads toward the hatch. He will be restrained in position by the crewman sleeping restraint.

The restraints (2) are dacron fabric, lightweight, sleeping bags, 64 inches long, with zipper openings for the torso and 7-inch diameter neck openings. They are supported by two longitudinal straps that attach to the LiOH canister storage boxes on one end (LEB) and to the CM inner structure at the other end.

The crewman will occupy the sleeping bag while wearing his CWG and communications soft hat, or lay on top if wearing his PGA. The cobra cable and "sleep" adapter will remain connected. One sleeping restraint will be stowed in each PGA stowage bag during boost and entry.

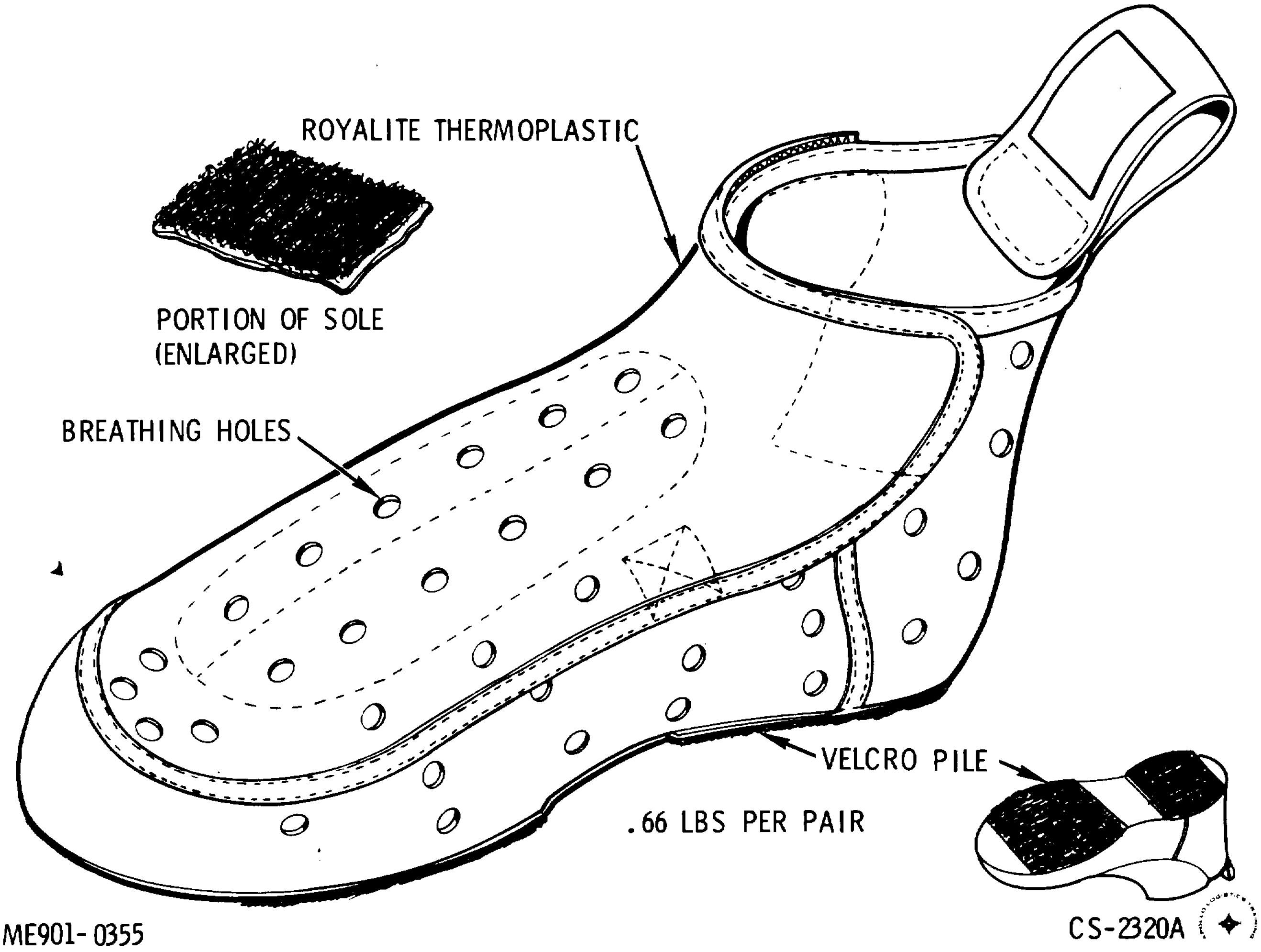


Figure 6-16. Weightless Crewman Restraint Sandal

6.9 FLIGHT DATA FILE (GFP).

The flight data file (figure 6-18) is a mission reference data file that is readily available to the crewman.

The data must be accessible to the commander and pilot in a pressurized suit while constrained in the crew couch. It must be available to the senior pilot at the lower equipment bay.

The flight data file contains checklists, manuals, and charts. The commander's and pilot's data file is stowed in nylon bags and the senior pilot's is stowed in a drawer container.

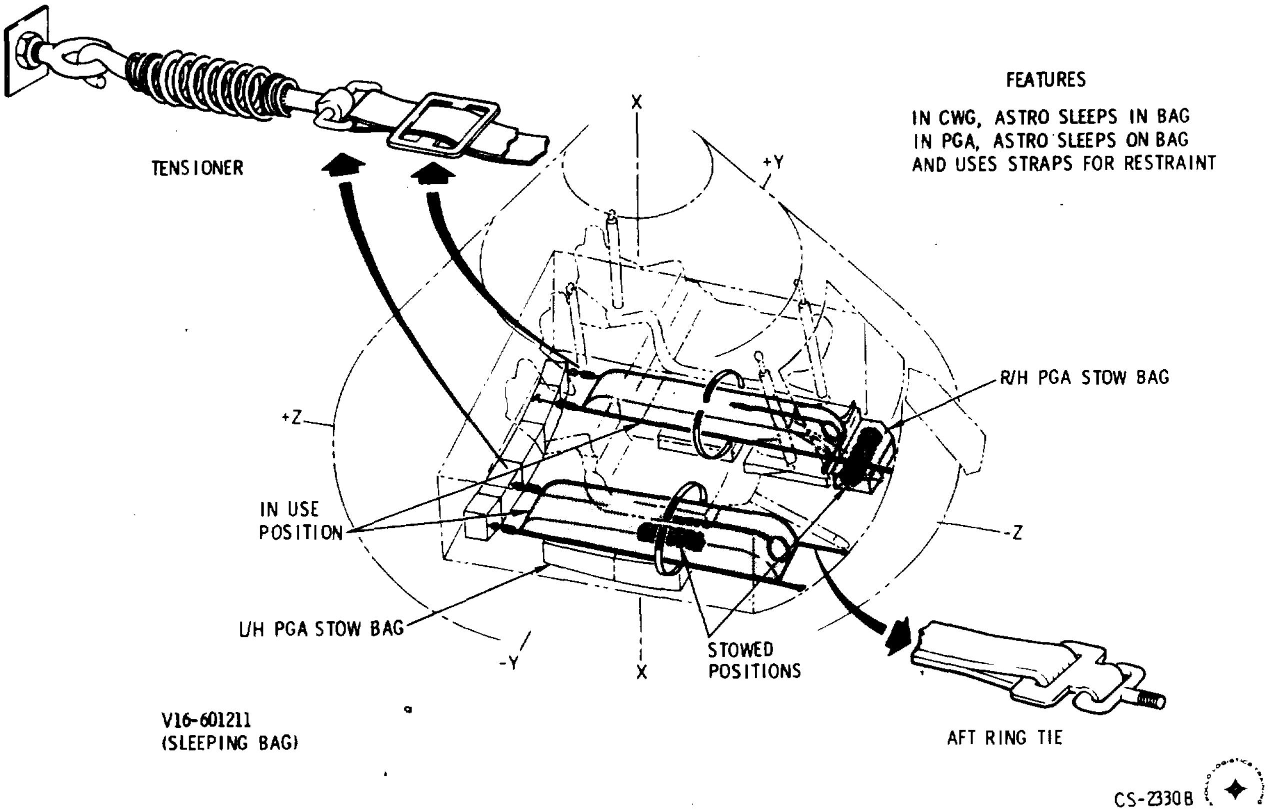


Figure 6-17. Sleeping Position Restraint Configuration

6.9.1 COMMANDER'S FLIGHT DATA FILE.

The commander's flight data file contains a commander's checklist, flight plan, and stowage bag. The stowage bag is nylon cloth material with pouches that close and are retain-closed by Velcro. A flap at the top is lined on the reverse side with Velcro attaching it to its stowage position. It is stowed on the left girth shelf near the commander's left shoulder.

6.9.2 SENIOR PILOT'S FLIGHT DATA FILE.

The senior pilot's data file contains a senior pilot's checklist, mission log and data, and stowage bag. The stowage bag is the same as the commander's except for the nomenclature. It is stowed on the right girth shelf near the senior pilot's left shoulder.

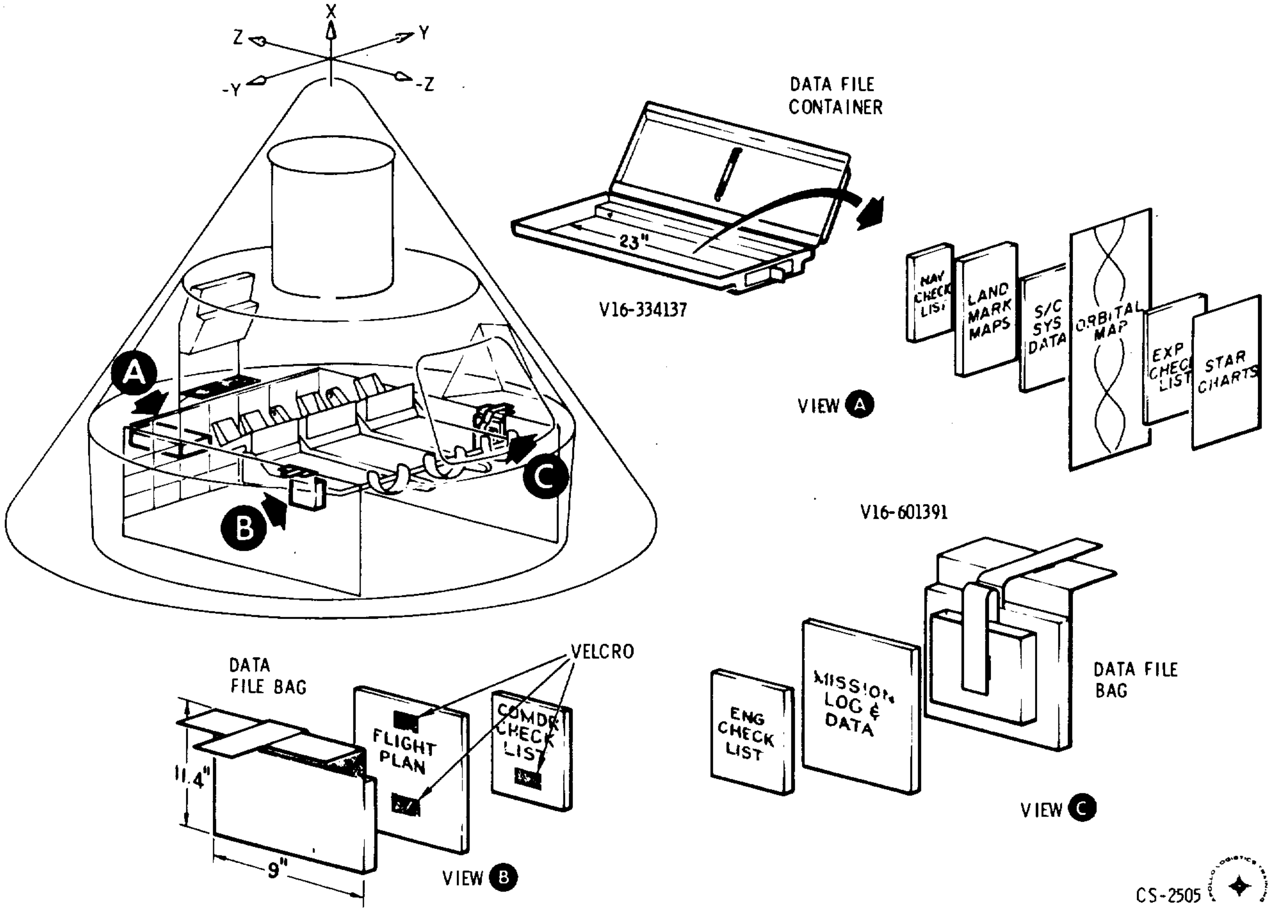


Figure 6-18. Flight Data File Configuration, Block I

6.9.3 PILOT'S FLIGHT DATA FILE.

The pilot's data file contains a pilot's checklist, landmark maps, star charts, S/C systems data, orbital map, and experiments checklist. Stowage is in a fiberglass container 23 inches long, 9.46 inches wide, and 1.75 inches deep. It has a hinged cover to contain the manuals when the container is removed from its stowage compartment in LEB. The container has nylon ribbon tab on each end to aid in pulling it out of the compartment. The compartment has a door with a simple bar latch to restrain the container.

6.10 CREWMAN IN-FLIGHT TOOL SET AND WORKSHELF (GFP).

The crewman in-flight tool set provides multipurpose tools and attachments for Apollo mission activities. The crewman in-flight tool set (figure 6-19) contains the following:

Torque wrench
Adapter handle
10" driver
5/32" short hex driver
7/32" hex driver
4" torque set driver
Emergency wrench
2 T-handles
2 end wrenches
20" tether
D-ring extension handle

Operationally, the tools are designated by a letter (A, B, C, D, etc.).

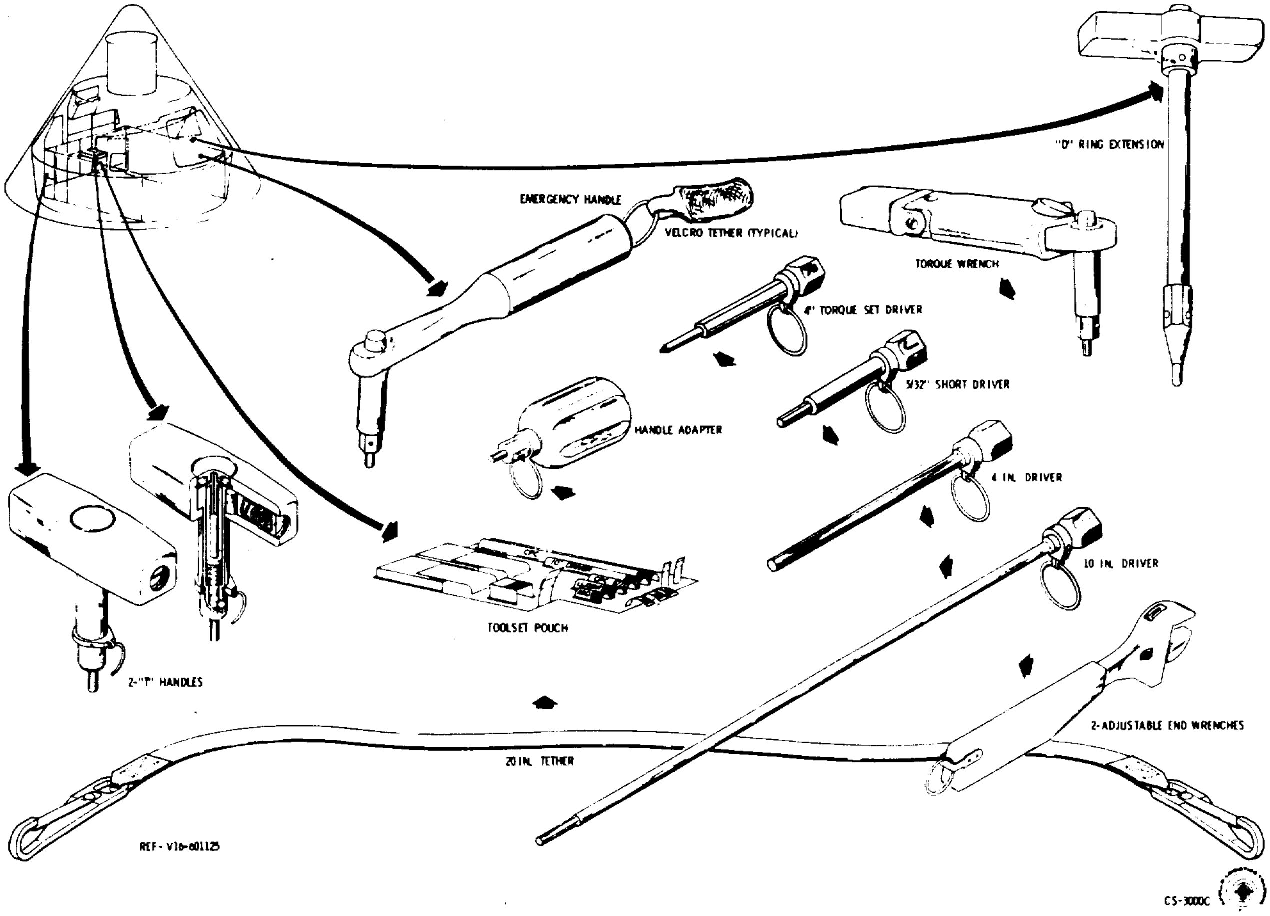


Figure 6-19. Crewman In-Flight Tool Set Configuration, Block I

6.10.1 TORQUE WRENCH (TOOL A).

The torque wrench has a torque limiting capacity of approximately 35 to 200 inch-pounds in the clockwise direction. It has a ratchet capability in the clockwise and counterclockwise direction. The pawl, which indicates operation, has three positions which are marked CW, LOCK, and CCW. The maximum torque capability in the LOCK position is approximately 400 inch-pounds.

The dual driving lug has a 7/16-inch hex male wrench with a ball-lock and a 5/32-inch hex male wrench. The drive lug fits all drivers. The pushbutton on top of the shaft controls the ball-lock which locks the drivers on. The lug reaches 2-1/4 inches beyond the face of the wrench.

Torque settings of 50, 100, 150, and 200 inch-pounds are calibrated and marked. The setting can be set by rotating the knob at the end of the handle and observing the bar in the slot on the underside of the handle. The following symbols indicate the torque values:

● = 50 inch-pounds
+ = 100 inch-pounds
◣ = 150 inch-pounds
■ = 200 inch-pounds.

6.10.2 ADAPTER HANDLE (TOOL E).

The adapter handle is approximately 3.5 inches long and 1.5 inches in diameter. It has a dual driving capability of 7/16- and 5/32-inch hexes and fits all drivers. A ball detent will assist in maintaining contact with the drivers.

6.10.3 10-INCH DRIVER (TOOL H).

All drivers have a 7/16-inch internal hex drive socket. The 10-inch driver is 11.125 inches long with a 10-inch shaft. The shaft end has a 5/32-inch hex drive.

6.10.4 4-INCH DRIVER (TOOL L).

The 4-inch driver is 5.125 inches long with a 4-inch hex shaft of 7/32-inch.

6.10.5 EMERGENCY WRENCH (TOOL B).

The emergency wrench is 6.25 inches long with a 2.5-inch drive shaft. The drive shaft has two hex drives: 7/16- and 5/32-inch. It is capable of applying a torque of 1475 inch-pounds and is a backup for the torque wrench. It has a ball-lock device to lock it in a drive. It is essentially a modified Allen head L-wrench.

6.10.6 T-HANDLE (TOOL C).

There are two T-handles per tool set. The T-handle is 2.75 inches long with an aluminum body. It has a 3/8-inch diameter ball-lock shaft with a 5/32-inch hex wrench. There is a torque break feature, calibrated by an adjustable screw at 35±5 inch-pounds, and then sealed. The ball-lock device is released by a pushbutton on the top of the handle.

6.10.7 END WRENCH (TOOL F) (2).

The adjustable end wrenches are a modified crescent wrench. It is very lightweight, made of aluminum, with an isotactic foam handle. The jaws openings width is from 1/4 inch to 1 inch.

6.10.8 5/32-INCH SHORT DRIVER (TOOL J).

The 5/32-inch short hex driver is 3.62 inches long with a 5/16-inch round shaft and a 5/32-inch hex drive of 0.7 inch.

6.10.9 4-INCH TORQUE SET DRIVER (TOOL R).

The 4-inch torque set driver has a No. 10 torque set on one end and a 5/16-inch driver on the other end.

6.10.10 IN-FLIGHT TOOL SET TETHER.

The tool set tether is a 20-inch strap with snaps at each end. Each tool has a tether ring or band to which the tether snap can be attached.

6.10.11 D-RING EXTENSION HANDLE (TOOL N).

The D-ring extension handle is a rod with a T-handle approximately 7 inches long. The rod end has a guide point tapering to a 7/16-inch hex about an inch long. Every other hex surface has a ball-lock. The T-handle has a pushbutton that controls the balls.

6.10.12 OPERATIONAL USE.

The in-flight tool set tools have multiple uses. Figure 6-20 is a matrix table for tool usage.

In the CM, items operated or adjusted by tools will have a small square placard nearby designating the tool (A through N and R) and the torque setting of the torque wrench. If the torque wrench is not used, just the designating letter (0.19-inch high) will be indicated.

The tool set is designated to be used either in the shirtsleeve environment or the PGA pressurized status.

6.10.13 STOWAGE. (Figure 6-19)

The tool set tools are stowed at various places. For launch and entry, some are stowed in positions ready for an emergency. During orbit, the tools are stowed in a location that affords easy access.

127

P = Primary Use
B = Backup
E = Emergency

Function (Designator)	Torque Wrench	10" Driver	7/32" Hex Driver	5/32" Hex Sht Drvr	Emergency Wrench	Adapter Handle	"T" Handle (2)	Crank Handle	Adj End Wrench (2)	"D" Ring Ext. Handle	4" Torque Set Driver
	A	H	L	J	B	E	C	D	F	N	R
A. Environmental Control System											
1. Open/close ECS valves on water (315) and O_2 panel (314). (LHEB)	B					B	P				
2. Close water-glycol accumulator isolation valve on panel 312. (LHEB)	P	P				B					
3. Unlatch/latch fasteners of ECU panel (313) over LiOH filter. (LHEB)	B	P				P					
4. Open/close water delivery device valve (304). (LHEB)	B						P				
5. Tighten fluid and gas line connections. (LHEB)									P		
6. Unlatch/latch fasteners of cabin atmosphere recirc. screen. (LHEB)	B	P				P					
7. Unlatch/latch fasteners (3) of access panel to coolant control panel (311). (LHEB)	B					P	P				
B. Guidance, Navigation, and Control System											
1. Unlatch/latch fasteners of "LOOSE PARTS STOWAGE" cover for G&N handles. (LHFEB)	B	P				P					
2. R/R G&N handles (2) on G&N panel. (LEB)	P					B					
3. R/R rotational control adapter on G&N panel (105). (LEB)	B	P				P					
4. R/R optics panel (104) cover. (LEB)	P					B					

Figure 6-20. Crewman In-Flight Tool Set Usage Chart (Sheet 1 of 2)

P = Primary Use
B = Backup
E = Emergency

	Torque Wrench	10" Driver	7/32" Hex Driver	5/32" Hex Sht Drvr	Emergency Wrench	Adapter Handle	"T" Handle (2)	Crank Handle	Adj End Wrench (2)	"D" Ring Ext. Handle	4" Torque Set Driver
Function (Designator)	A	H	L	J	B	E	C	D	F	N	R
5. Adjust scanning telescope shaft and trunnion axis. (LEB)				P		P					
6. Wind/set GMT clock (panel 306). (LHFEB)				P		B					
7. R/R sextant short and long eyepiece from eyepiece.	B	P				P					
8. R/R scanning telescope short and long eyepiece from eyepiece assembly.	B	P				P					
C. Mechanical Systems											
1. Adjust crew couch headrest.	B		P			P					
2. Adjust couch upper armrest.	B		P			P					
3. Stow translational control adapter-center couch legrest.	B		P			P					
4. Open side crew pressure (inner) hatch from C/M.					E						
5. Open side crew heatshield/thermal hatch from C/M (Emer).					B						
6. R/R sea water access tube plug. (LHEB)	P	P				B					
7. Lock/unlock couch footstraps when PGA pressurized.										P	
8. Tighten/loosen mirror U-joints.											P
D. Mission Experiments											
1. Lock/unlock screws (2) of SCIENT EQUIP B drawer.	B	P				P					

Figure 6-20. Crewman In-Flight Tool Set Usage Chart (Sheet 2 of 2)

6.10.13.1 In-Flight Tool Set Stowage Pouch and Tool Set Drawer.

The tool set pouch is located in the tool set drawer on the LEB. The workshelf is stowed in the drawer on top of the tool set. The following tools are stowed in the pouch.

10" Driver
4" Driver
5/32" hex short driver
4" torque set driver
Adapter handle
2 end wrenches
Tether

The pouch is 21.25 inches long and 7.5 inches wide and is made of green nylon cloth. It has a small pouch with a retention strap for each tool and is marked with the tool name and designation. The tool set pouch is held to the drawer bottom by Velcro strips on the underside. The tether will be attached to a driver tether ring and laid in the drawer. The tool set drawer slides in and out on tracks and is held closed by a latch. In a corner of the drawer, a polyurethane block with a cutout for the torque wrench is located.

6.10.13.2 Miscellaneous Stowage.

The T-handles are stowed in the ECS panels at all times when not in use.

The emergency wrench is placed in the inner hatch latch mechanism for the mission. If it is needed, it can be removed and used.

The D-ring extension handle is stowed near the light fixture on the right girth, shelf-accessible to the pilot.

6.10.14 WORKSHELF ASSEMBLY. (Figure 6-21)

The workshelf assembly provides a table for food preparation and map/manual reading.

The workshelf is of aluminum sheet construction approximately 24 by 10.5 inches. At each end, there is a hinged support frame with slide latches. The shelf has two pivots so that it can be folded lengthwise, making storage easier. When stored, it is 24.5 by 6 by 1 inches.

The working top of the shelf is surfaced with Velcro hook material. Items that will be used in conjunction with the shelf will be equipped with Velcro pile material, facilitating zero-g restraint.

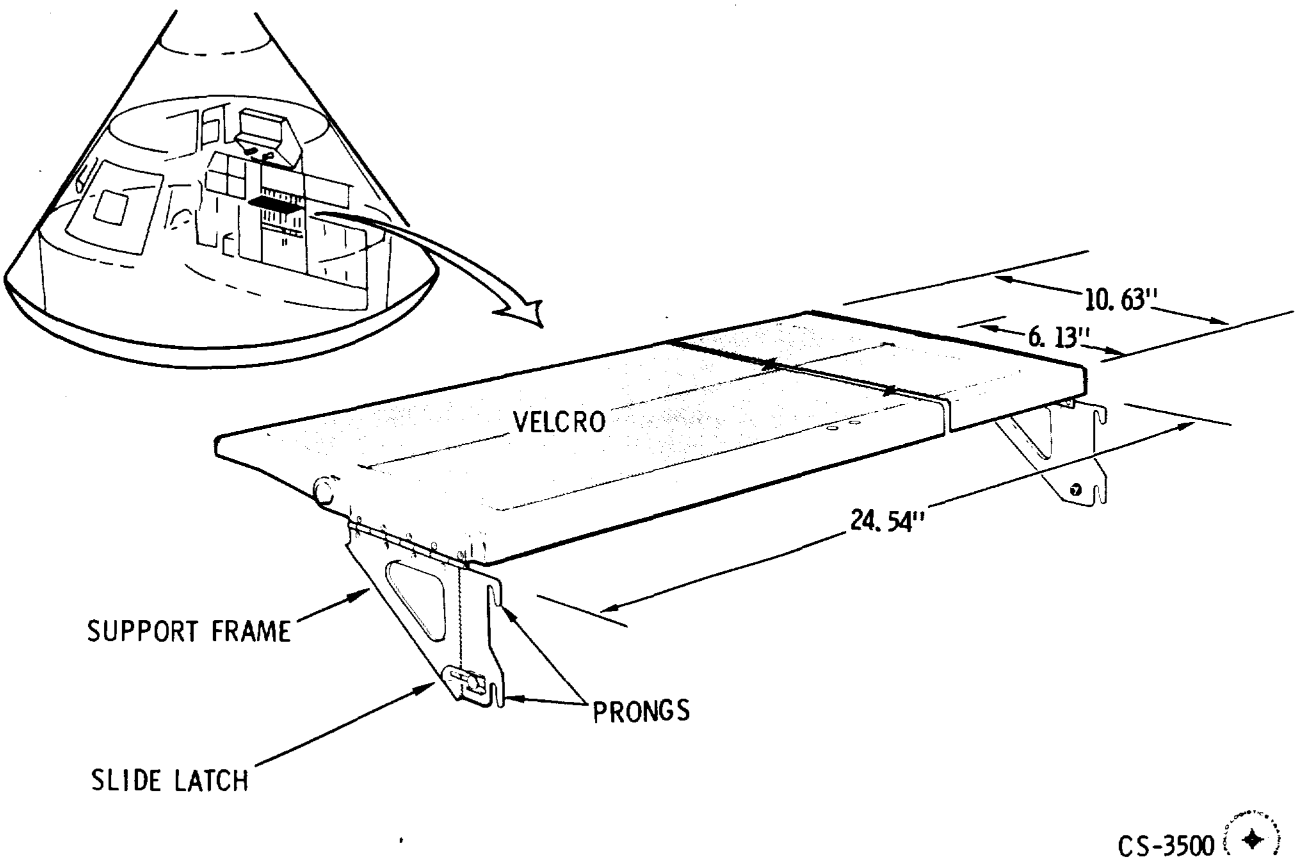


Figure 6-21. Worksheld, Block I

6.10.14.1 Usage.

The workshelf is stored in the lower equipment bay in the tool set drawer next to the flight data file storage. To remove, slide drawer out, lift, and unfold the shelf. Flip the support frames to the extended position and install on the lower bulkhead girth shelf below the G&N equipment by slipping the prongs into the slots. The prongs rest on small pins. Lock the shelf in by actuating the slide latch on each support frame. To remove, reverse the installation process and store.

The food packages and flight data manuals have patches of Velcro pile to interface with the workshelf surface.

6.11 DRINKING WATER SUBSYSTEM. (Figure 6-22)

The source of cold water for drinking is the water chiller. It is the same line that is routed to the cold water tap of the potable water tank. The crewman drinking water line is T'd off, routed through a shut-off valve, to the water dispenser located beneath the main display panel structure. It is handy to the left and center couch positions.

The water dispenser assembly consists of an aluminum mounting bracket, a coiled hose, and a water delivery valve in the form of a pushbutton actuated pistol. The pistol is GFE. It meters one-half ounce portions of water when the pushbutton is pressed. An accumulative counter is also on the side. It has a safety pushbutton to prevent discharge of water when passing the pistol from one crewman to the other. The uncoiled hose will

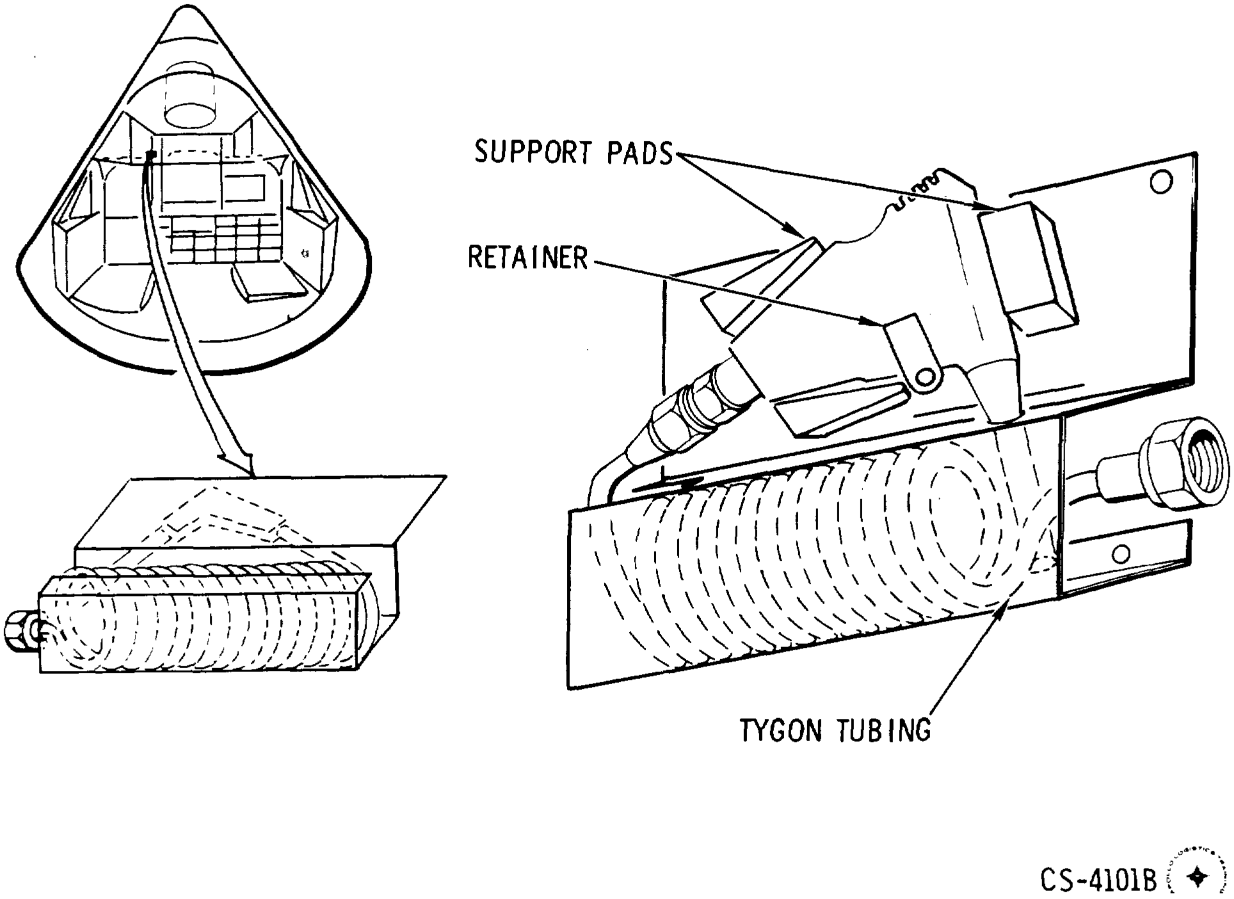


Figure 6-22. Crewman Water Dispenser Assembly

reach 72 inches. When the pistol is returned to the mount, the hose will re-coil into the housing. The pistol is stored in the mounting bracket and is held in place by a retainer.

During orbit, an alternate position is located on the MDC. The pistol is held in place by Velcro tabs.

6.12 FOOD.

The food furnishes a balanced diet of approximately 2650 calories per day to each crewmember. The astronaut's daily requirement for an earth orbital mission is 2650 calories. His daily intake will be 1.2 pounds of food, 6 pounds of water, and 2 pounds of oxygen. He will give off about 2.2 pounds of CO_2.

The food is in many forms such as dehydrated, freeze-dry, and bulk. It consists mainly of a highly nutritious and concentrated food. The food is packaged in plastic bags of a special design to allow food to be vacuum packaged. The food bag has a one-way poppet valve through which the potable water supply nozzle is inserted. The bag has another valve through which the food passes. The food bags are packaged in aluminum foil-backed plastic bags to make one meal for each astronaut. Breakfast, lunch, and snacks will be recycled every 4 days during the mission and the dinner every 8 days. The bags have red, white, and blue dots to identify them for the individual crewman.

6.12.1 USE.

The freeze-dry food is reconstituted by adding hot or cold water through a one-way valve on the food bag neck. It is then kneaded by hand for approximately 3 minutes. When the food is reconstituted, the neck is cut or torn off and placed in the mouth. A squeeze on the bag forces food into the mouth. When finished, a germicide tablet, attached to the bag, is slipped through the mouth piece, an ounce of water added, and the bag shook. The germicide will prevent fermentation and gas. The bag is then rolled as small as possible and returned to the food stowage drawer.

6.12.2 STOWAGE.

Food is stowed in three areas: the food stowage compartment in the lower equipment bay (LEB) on the left hand side, the auxiliary food compartment in the C/U-hand equipment bay (RHEB), and the food stowage compartment in the left-hand equipment bay (LHEB). Combined, they offer approximately 6,006 cubic inches of food storage volume.

6.12.2.1 LEB Food Stowage Compartment.

The food stowage compartment is structurally separate from the CM support structure and contains five bins and five drawers. The combined drawer volume is approximately 3725 cubic inches. The compartment is 23 inches high, 20 inches wide, 23 inches deep, and is constructed as a unit.

The top, bottom, right side, and shelves are 0.25-inch honeycombed aluminum sandwich. The left side is sheet aluminum 0.063-inch thick. The retainer doors are aluminum sheet and hinged at the bottom. The doors are latched at the top with latch bolts that pin into the side support structure.

The food stowage drawers are constructed of 0.020-inch-thick fiberglass: the largest weighs about 26 ounces. The end to be opened has a net closure held in place by Velcro providing easy access when the door is opened.

6.12.2.2 RHEB Auxiliary Food Compartment Drawer.

The auxiliary food compartment drawer is separate from the food stowage compartment and is located on the right-hand equipment bay. The volume is approximately 1000 cubic inches and its dimensions are 29 inches long, 10 inches high, and 10 inches deep.

The auxiliary food compartment drawer is a 3-ply, fiberglass box 0.030 inches thick. The front has a net closure hinged at the bottom and attached at the top by Velcro. It is supported structurally on an aluminum shelf and two sheet aluminum stops in the Z-Z direction. Its rear side fits against the inner structure face sheet. An aluminum door holds the drawer in and gives structural support.

6.12.2.3 LHEB Food Stowage Compartment.

The LHEB food stowage compartment has a volume of 1281 cubic inches. The food stowage drawer is a fiberglass drawer similar in construction to the other food drawers, with a net closure on the front. The drawer rests in the structure and is held in place by a sliding door.

6.13 PERSONAL HYGIENE (GFP). (Figure 6-23)

Personal hygiene items consist of an oral hygiene assembly containing a toothbrush and ingestible gum, wet and dry cleaning cloths, and towels.

6.13.1 CLEANSING OF TEETH - ORAL HYGIENE ASSEMBLY.

An effective method of cleansing teeth is Trident brand chewing gum. It is chewed and then swallowed. One stick is used after each of four meals per day. A stick is approximately 1 by 7/8 inch. To maintain healthy gums, a toothbrush for massaging by brushing is used. The brush also has a rubber prong on the handle for dislodging food particles.

These items are packaged in a one-man module to be used for a 14-day period. The module contains one toothbrush and 28 packs of gum. In each pack, there are two sticks giving a total of 56 sticks per astronaut. The module is stored in the first days food storage drawer to be used for the entire mission.

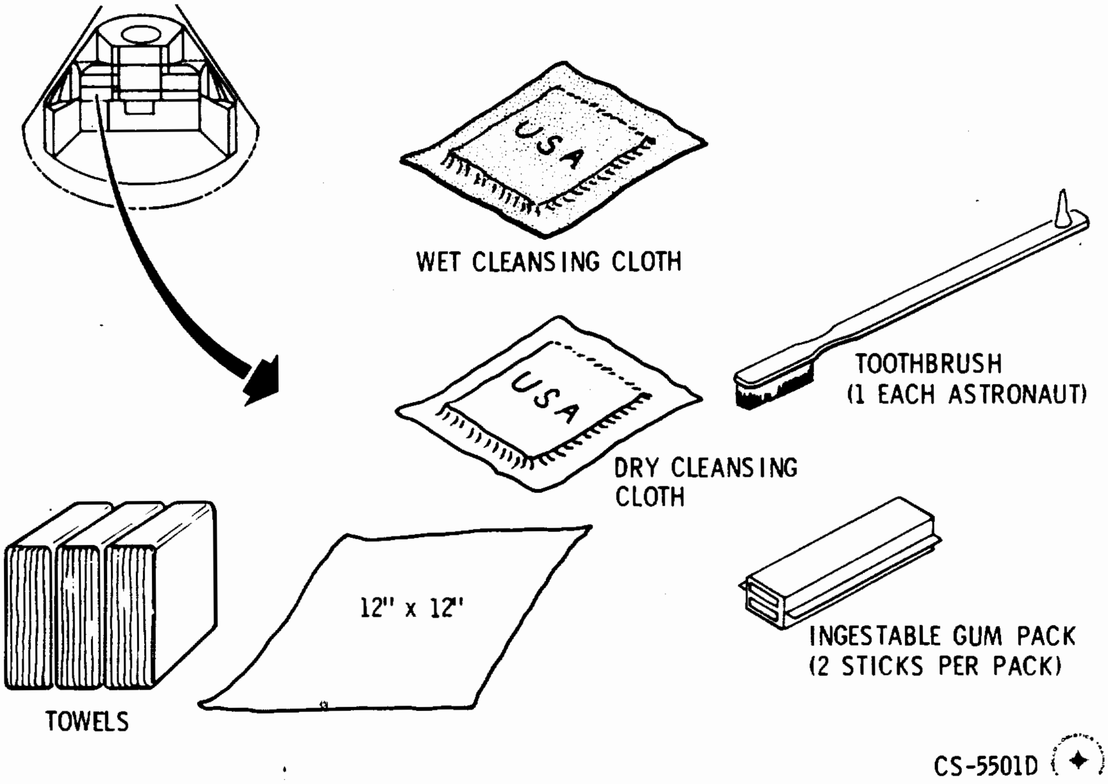


Figure 6-23. Personal Hygiene Items

6.13.2 WET CLEANSING CLOTH.

Wet cleansing cloths will be used for post-meal and post-defecation hygiene. The cloths are 4 by 4 inches folded into a 2-inch square and sealed in plastic. They are saturated with a germicide and water. The cloths for post-meal cleansing are stored, along with the dry cleansing cloth, in the food packages for easy accessibility. The post-defecation cleansing cloths (62 or more) are located in a sanitation supply stowage box.

6.13.3 DRY CLEANING CLOTH.

The dry cleaning cloths will be alternated with the wet cleansing cloths for post-meal cleanup. They are the same size and texture; however, they do not contain water and a germicide. They are also packaged with the food. There are 168 wet and dry cleansing cloths to be placed in the food packages.

6.13.4 TOWELS.

The towels will be used for utility purposes. There are 21, each 12 by 12 inches, and packaged in 3 plastic bags. One bag is stowed on the left couch, and two bags are stowed in the RHEB.

6.13.5 TISSUE DISPENSERS.

The cleansing tissues will also be used for defecation cleanup and utility use. There are nine tissue dispensers, seven are located on the back of the center couch, and two in other areas. They are mounted with Velcro.

6.14 MEDICAL SUPPLIES (GFP).

The medical equipment is used for the following:

- Monitor current physiological condition of the crewmen.
- Furnish medical supplies for treatment of crewman in-flight medical emergencies.

The medical equipment is subdivided into two functional types: monitoring equipment and emergency medical equipment. The monitoring equipment includes the clinical physiological monitoring instrument set, personal biomedical sensors instrument assembly, biomedical preamplifier instrument assembly, and the personal radiation dosimeters. There is also a bioinstrumentation accessories kit for spares. The emergency medical equipment is the emergency medical kit.

6.14.1 MONITORING EQUIPMENT.

6.14.1.1 Clinical Physiological Monitoring Instrument Set.

There is a requirement for periodic measurements of body temperature, blood pressure, heart beat rate, and respiratory rate to be logged by the crewman. This set of instruments will accomplish the measurements. The instruments include the following:

- Individual thermometers for body temperature measurements
- Aneroid sphygmomanometer for measuring blood pressure
- Stethoscope for heart beat measurement.

The physiological monitoring set is stored in the forward medical compartment of the LEB.

6.14.1.2 Personal Biomedical Sensors Instrument Assembly.

Constant monitoring of the heart beat and respiration is required. The sensors assembly automatically and continually senses these functions when the main display panel switch is positioned to the crewman to be monitored. The personal biomedical sensors instrument assembly consists of the following:

- Electrodes (silver silver chloride), 4 or more
- Accessories, such as paste and application tape.

The sensors will be used to gain the following:

- 2 electrocardiographs (ECG)
- Respiration rate.

The sensor assemblies are attached to the body of the astronaut at areas of sparse muscles (to reduce artifact level) by use of paste and tape, and remain throughout the mission.

6.14.1.3 Biomedical Preamplifier Instrument Assembly.

Because of their weak magnitude, the sensor signals have to be amplified before being telemetered. This function is performed by the preamplifiers (or signal conditioners). The preamplifiers are about the size of a cigarette pack and weigh about 100 grams. They operate on a source voltage of 16.8 volts, therefore one dc-dc converter. There are three preamplifiers which are to be used for the following measurements:

- ECG No. 1
- ECG No. 2 or phonocardiograph (uses same preamplifier)
- Respiration rate

The preamplifiers fit into pockets in the constant wear garment, circumferentially around the stomach diaphragm. Wire leads connect to the sensors, which act as electrodes. The sensors act as an electrode for one or more preamplifiers. The difference of resistance between two electrodes is measured. Muscle activity (breathing) changes the skin resistance and this change is measured and sent to the telemetry equipment. One electrode or sensor can be wired to more than one lead for a preamplifier. Each preamplifier will have a lead (to an umbilical) terminating with a connector. The connectors will plug into a larger common umbilical.

6.14.1.4 Bioinstrumentation Accessories Kit.

A kit of spares and possible use for additional scientific experiments will be located in the right-hand equipment bay on the kick ring adjacent to the LEB. The kit will have 35 sensors, 50 micropore discs, 8 wet wipe towels, and 1 tube of electrolyte paste.

6.14.1.5 Personal Radiation Dosimeters.

The crew will wear five passive dosimeters in the form of film packs in the CWG. One crewman will also wear an ionization chamber of the active type in his CWG. Personal dosimeter information will not be telemetered.

6.14.2 MEDICAL KIT (GFP).

The medical supplies are contained in oral drugs, injectable drugs, dressings, topical agents, and an inhaler. The content of the medical kit is as follows:

Oral Drugs

Drug	Use	No. of Tabs
Bismuth subcarbonate	Fever, pain reducer	24
Darvon compound 65	Fever, pain reducer	12
Globaline	Suppresses infection of gastro-intestinal system	50
Tigan, Bonodoxin, or Marezine	Anti-nauseant (6-man day treatment)	24
Dexedrine	Stimulant	12
Acromycin (250 mg)		24
Elective medication		9

Injectable Drugs

Drug	Use	No. of Units
Morphine Sulphate Demerol	Pain killer	3
Tigan, Bonodoxin, or Marezine	Anti-nauseant	3

Drug is contained in an automatic medical injector

Dressings

Item	Qty Reqd
Elastic bandage or compress (3" x 60")	2
Bandaids (1" x 3")	12

Topical Agents and Inhaler

Item	Use	Qty Reqd
General purpose ointment, antibiotic	Skin irritations	2 (1/2 oz. tubes)
Benzedrex inhaler	Anti-nasal congestant	1

6.14.2.1 Packaging.

The medical kit is in a single package, accessible at all times during the mission. The package is approximately 4 by 5-1/2 by 4 inches and weighs 2.1 pounds.

6.14.2.2 Storage. (Figure 6-24)

The medical kit will be stowed on the back of the left couch lower leg support.

6.14.2.3 Medical Kit Additional Usage.

In the event the astronauts have to evacuate the command module during the recovery phase, the medical kit will be detached from the couch and carried by an astronaut.

6.15 SURVIVAL KIT (GFP).

There are two survival kits with three packages in each. One package contains three rafts; the other package contains water and miscellaneous survival equipment. They are readily accessible from the right-hand forward equipment bay by the right-hand seat occupant. The kits and containers weigh approximately 70 pounds. In addition to the survival kit, a sea water pump is provided. The pump is used after splashdown if the crew requires water and the onboard supply is exhausted.

6.15.1 STOWAGE.

The kits and the sea water pump are stowed in the right-hand forward equipment bay. They are inserted into the structural framework from the bottom and held in place by a quick-release bar retainer.

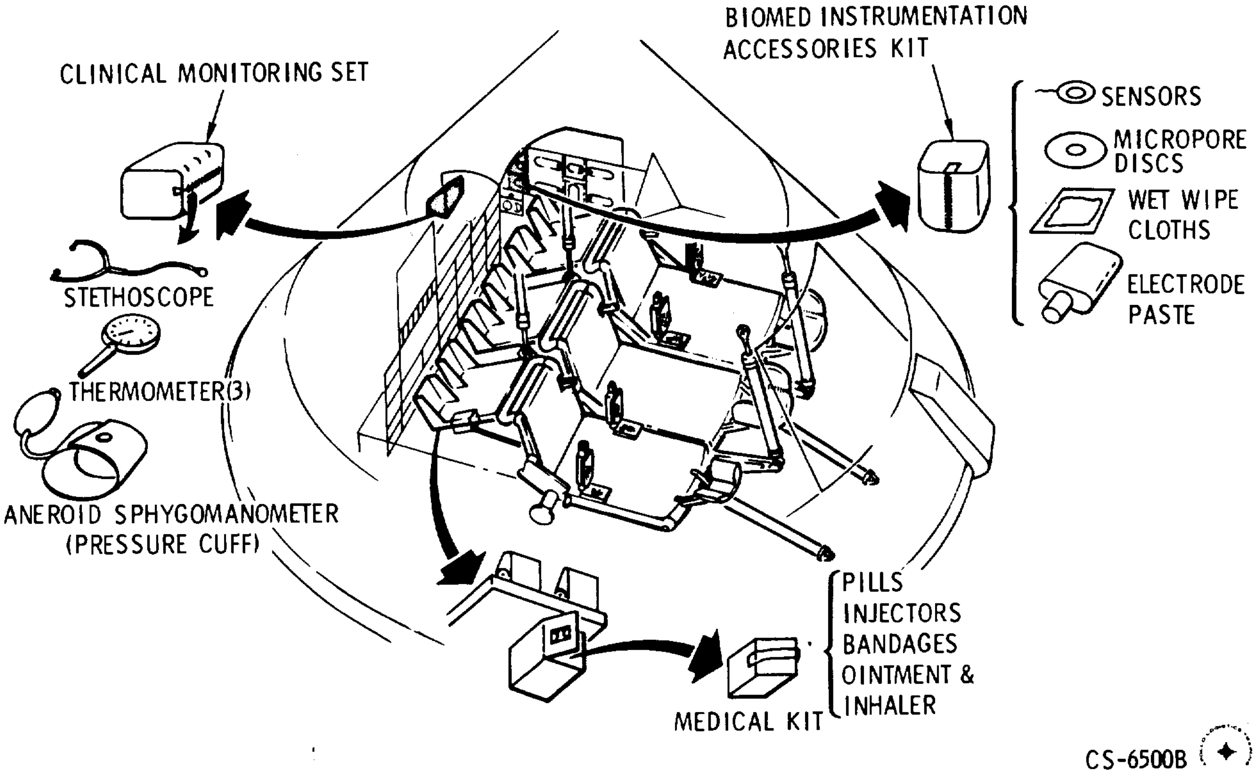


Figure 6-24. Medical Supplies and Equipment C/M Locations

The individual kits are contained in fiberglass boxes called a survival provisions container assembly (hereafter called a container). Thickness varies from 0.040 inch to 0.070 inch, and varies in ply from 4 to 7; a ply being 0.101 inch. One end is a cover and is attached by a breakaway hinge and locked close by a hinge and pin assembly. The cover has Dacron webbing straps that act as a handle. The weight and volumes are as follows:

Container	Weight	Volume
No. 1	5 pounds	0.90 cubic feet
No. 2	4.25 pounds	0.85 cubic feet

6.15.2 SURVIVAL KIT CONTAINER OPERATION.

After impact, and if the CM is damaged or sinking, it has been determined by the crew commander to evacuate, the pilot will release the survival containers by pulling a ring on the bar retainer. He will hand a container to each of the other astronauts. Two astronauts must retrieve the flight data mission logs. The side hatch is removed and the astronauts enter the water. In the water, container top is removed by (1) pulling hinge pin completely out and discarding and (2) rotating top against breakaway hinge until it falls off. Reach inside, pull out contents, activate the one-man raft and climb aboard.

6.15.3 CONTENTS OF THE SURVIVAL KITS. (Figure 6-25)

Container No. 1 contains two cloth pouches. One pouch contains three aluminum containers, each with 5 inches of water. The second pouch contains the following:

Survival radio with battery
Survival radio battery
2 combination survival lights
3 survival glasses
2 survival knives
2 desalting kits with 16 tablets

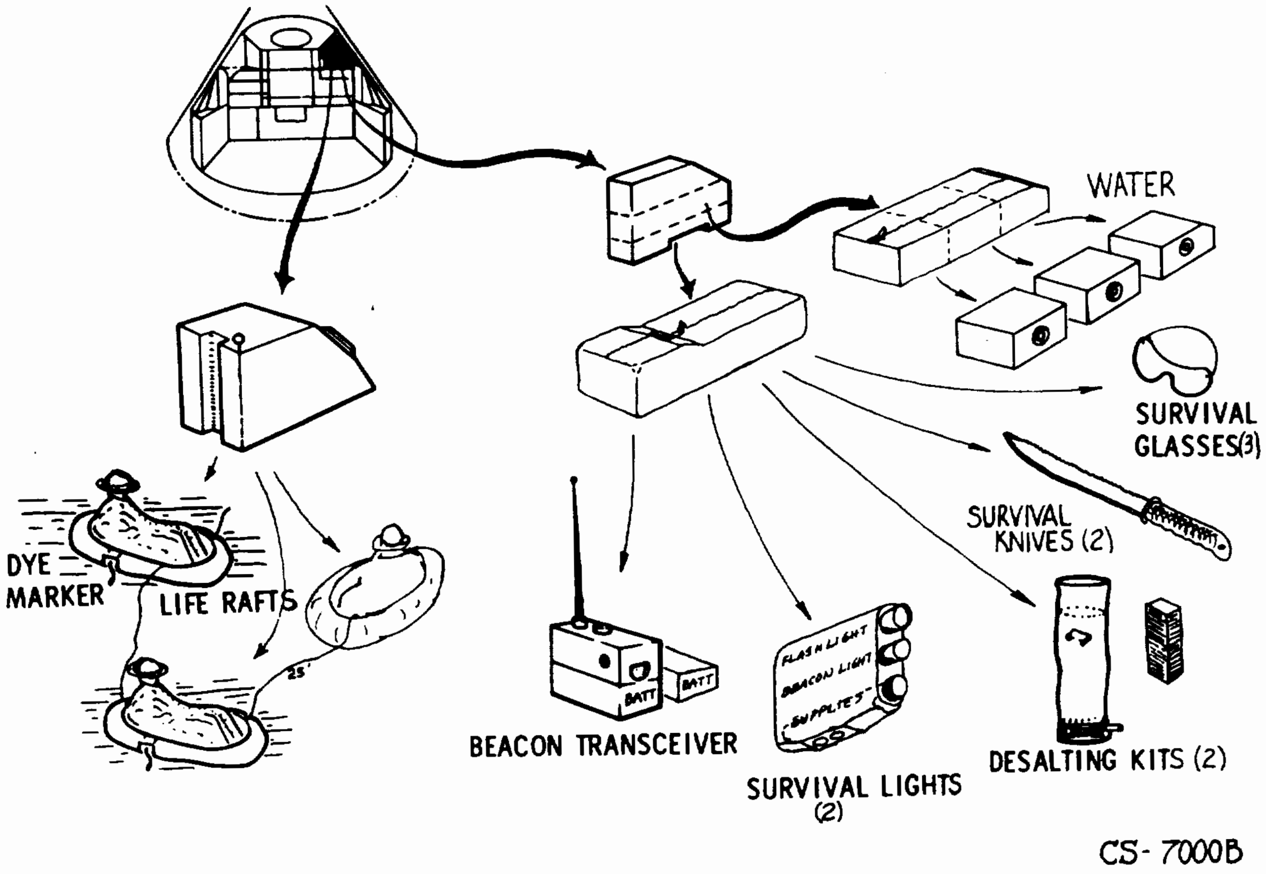


Figure 6-25. Apollo Survival Kit and Components, Block I

Container No. 2 contains one pouch with three one-man liferafts tethered together with 25-foot tethers. The pouches open by use of zippers and have lacings on the bottom to adjust the fit.

6.15.4 DESCRIPTION AND USE OF SURVIVAL KIT COMPONENTS.

6.15.4.1 Liferafts.

The liferafts are of lightweight nylon or mylar and inflated with CO_2. Each has a sea anchor, sponge pad, sun bonnet, tether, and sea dye marker.

6.15.4.2 Beacon/Transceiver.

The UHF beacon/transceiver is a hand-held, battery-powered radio, fixed-tuned to a VHF frequency of 243 mc and manufactured by Sperry Phoenix Company. The radio consists of a receiver-transmitter assembly, a battery pack assembly, and a quarter-wave antenna (figure 6-26). The receiver-transmitter assembly and battery pack assembly mate to form a watertight unit measuring 8 by 4-1/2 by 3 inches. The antenna is an 11-1/2-inch-long tapered, flexible steel tape, terminating in a coaxial RF connector, and is normally stored in a retaining spool and clip on top of the radio unit.

The radio is capable of line-of-sight operation in either of two modes (beacon or voice) through use of either its own antenna or a suitable

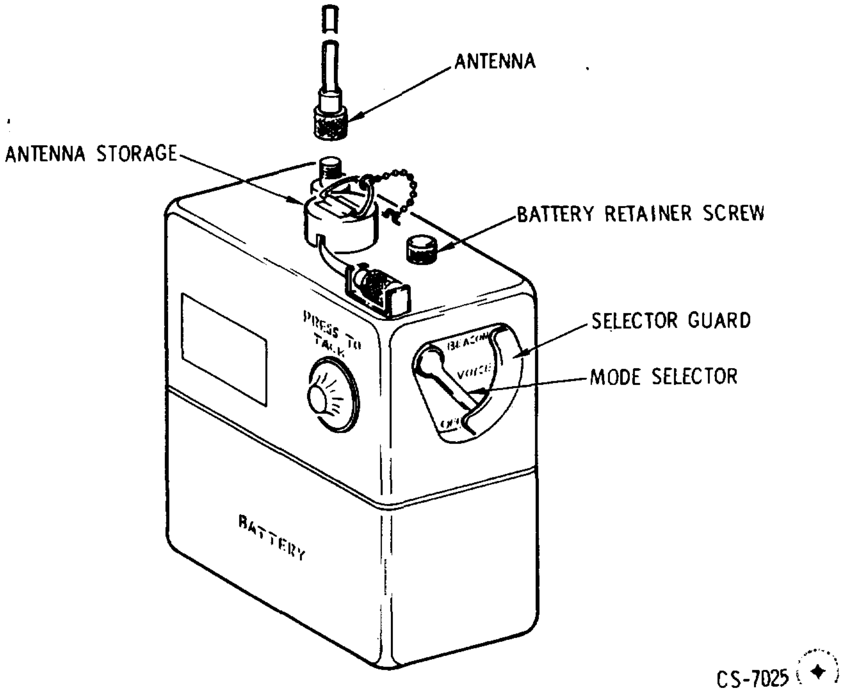


Figure 6-26. Survival Beacon/Transceiver Radio

connected remote antenna. The transmitter output is protected against damage while operating due to accidental shorting of the antenna or submergence of the unit in salt water. In the beacon mode, the transmitter operates unattended, for periods up to 24 hours, to transmit an interrupted 1000 cps tone, amplitude-modulated 25 percent on the 243 mc RF carrier. In the voice mode, the radio provides two-way AM voice communication through use of an integral speaker-microphone and push-to-talk switch. An extra battery is included in the pouch.

The following is a summation of the operating characteristics:

Characteristic	Voice Mode	Beacon Mode
Average power output	1.2 watts into a 50-ohm resistive load	2 watts into a 50-ohm resistive load
Frequency	243 mc carrier. 300 to 3000 cps voice signal	243-mc carrier, 1000-cps signal
Modulation	90-percent maximum	25 percent
Duty cycle	Continuous when PUSH-TO-TALK switch is pressed	2 seconds on 3 seconds off
Receiver sensitivity	10 db signal plus noise-to-noise ratio with 7.5 microvolts signal on antenna	

6.15.4.3 Survival Lights (2).

The survival light is a three units in one device as it contains three compartments. The whole device is waterproof. The controls for the light are on the bottom.

The first unit is a flashlight. The second unit is a strobe light for night signaling. The third unit is a waterproof compartment containing a fish hook and line, a "sparky" kit (striker and pith balls), needle and thread, and whistle. The top of the unit is a compass and on one side is a signal mirror that folds flat to the case.

6.15.4.4 Survival Glasses (3).

For protection of the eyes against the sun and glare, three survival glasses are included. They are a polarized plastic sheet with Sierra Coat III, a gold coating that reflects heat and radio waves.

6.15.4.5 Survival Knives (2).

The survival knives are protected with a cloth sheath. The knives are very thin with razor edges. The back edge is a saw.

6.15.4.6 Water Cans (3).

One pouch contains three aluminum water cans, one for each crewman. The cans have a drinking valve and hold 5 pounds of water.

6.15.4.7 Desalting Kits (2) Plus Tablets (16).

The desalting kits are plastic bags with a filter at the bottom. Approximately one pint of water is put in the bag and one tablet added. The water is desalted after approximately one hour.

6.15.4.8 Emergency Medical Survival Kit.

In the event the medical kit cannot be retrieved before egress, an emergency medical survival kit is in the survival kit. It contains 6 band-aids, 6 injectors, 30 tablets, and one tube of all purpose ointment.

6.15.5 SEA WATER PUMP (CFE). (Figure 6-27)

The pump assembly contains an intake check valve, a discharge check valve, and a 3-inch-diameter bellows, which is operated by means of a fingerhold and extends 1-1/8 inches from a 2/5-inch compressed thickness.

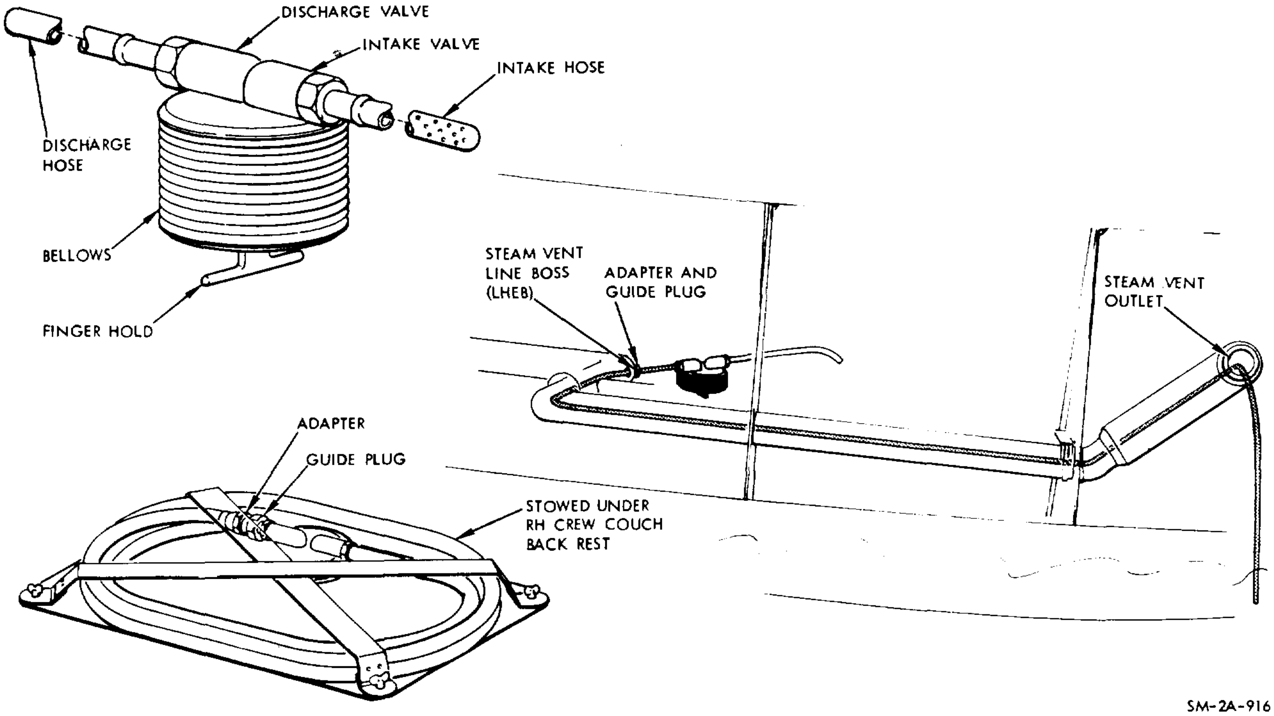


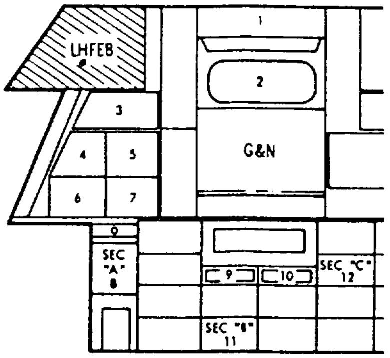
Figure 6-27. Sea Water Pump

A 10-foot-long plastic hose, fitted with a guide plug and an adapter, is attached to the intake valve; a 1-foot-long hose is attached to the discharge valve. To use the pump, the plug is removed from the steam vent hose located just forward of the aft bulkhead in the LHEB; the adapter on the intake hose is threaded into the boss; and the perforated end of the intake hose is fed through the guide plug into the steam vent, along the vent about 5 feet to the vent outlet, and through the outlet into the sea. The guide plug is then tightened into the adapter to form a seal around the hose, and the bellows is extended and compressed to pump water from the short discharge hose into the desalting kit bag. The pump is packaged in a semiflexible plastic container and stowed on the backside of the RH couch position legrest.

6.16 STOWAGE.

The numerous activities of the crew make housekeeping very important. All loose equipment must be stowed during launch and boost. Prior to entry, loose equipment must be stowed for entry and landing. Figure 6-28 defines S/C 012 stowage locations for equipment.

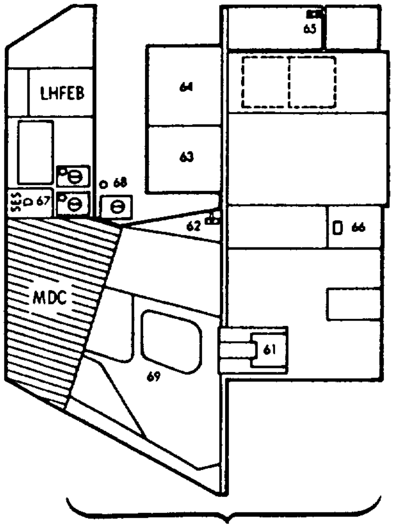
STOW AREA	LEB STOWAGE ITEMS
1	"G&N EYEPIECE" COMPARTMENT
A	SHORT TELE EYEPIECE
B	SHORT SEXTANT EYEPIECE
C	LONG TELE EYEPIECE
D	OPTICS FILTER
2	G&N OPTICS PAN COVER
3	"FOOD A" CONTAINER
4	"FOOD B" CONTAINER
5	"FOOD C" CONTAINER
6	"FOOD D" CONTAINER
7	"FOOD E" CONTAINER
8	"SCIENT EXP A" COMPARTMENT
A	16MM CAMERA W/FILM PACK
B	16MM CAMERA POWER CABLE
C	18MM LENS (16MM CAMERA)
D	25MM LENS (16MM CAMERA)
E	100MM LENS (16MM CAMERA)
F	16MM CAMERA MIRROR ASSY
G	3-16MM FILM PACKS
H	70MM HASS CAMERA W/RING SIGHT & FILM PACK
I	250MM LENS (70MM CAMERA)
J	2-70MM FILM PACKS
K	EXPOSURE DIAL
L	SPOTMETER
M	LOWER VASCULAR SUPPORTS
N	BINOCULARS
9	SR PILOT FLT "DATA FILE"DWR
A	NAVIGATOR CHECK LIST
B	LANDMARK MAPS
C	S/C SYSTEM DATA
D	EXPERIMENTS CHECKLIST
E	STAR CHART
F	ORBITAL MAP
10	"TOOL-TABLE" DRAWER
A	WORKSHELF
B	A - TORQUE WRENCH
C	E - ADAPTER HANDLE
D	F - 2 END-WRENCHES
E	H - 10" DRIVER
F	J - 4" X 5/32" SHORT DRIVER
G	L - 4" CPC" (7/32") DRIVER
H	R - 4" TORQUE SET DRIVER
I	TETHER
J	TOOLSET POUCH
11	"SCIENT EXP B" DRAWER
A	M009 GOGGLES
B	3 M009 MOUTHPIECES
C	7 16MM FILM PACKS
D	8 70MM FILM PACKS
12	"SCIENT EXP C" DWR
A	MED DATA ACQ SYS (MDAS)
13	"CLIN MON INST SET" COMP
A	CLIN MON INSTR SET
B	URINE RECEPTACLE & TRANSFER VALVE ASSY
C	3 UCD CLAMPS
14	"TOWELS" COMPARTMENT
A	14 TOWELS (2 PKGS)



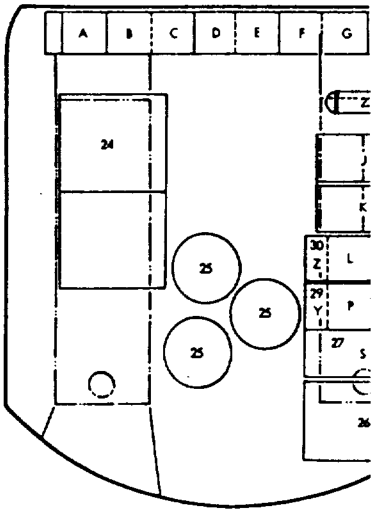
LOWER EQUIPMENT BAY (LEB)

STOW AREA	LHEB STOWAGE ITEMS
61	COMDR DATA FILE BAG
62	T-HANDLE
63	"FOOD" COMPARTMENT
A	FOOD STOW SUP CONT
64	"CWG & SANDAL" COMP
A	3 CWG'S
B	3 FLT OVERALLS
C	3 PR SANDALS
65	T-HANDLE
66	REMOVABLE ECS ATTEN PAN

STOW AREA	LHFEB STOWAGE ITEMS
67	"SCIENTIFIC EXP D" COMP
A	SCIENT EQUIP STOW BOX "D"
B	OCTOPUS CABLE
C	DEWPOINT CONT UNIT W/ELEC CABLE, SENSOR & CABLE
68	3-CREWMAN UMBL ASSY'S
A	3 O_2 HOSE ASSY W/NOZZLES
B	3 COBRA CABLES
C	3 PGA ELEC ADAPTERS
D	3 ELECT. COBRA "T" ADAPTERS



LEFT HAND EQUIPMENT BAY (LHEB)



AFT BULKHEAD (AB)

FOLDOUT FRAME 1

OWR
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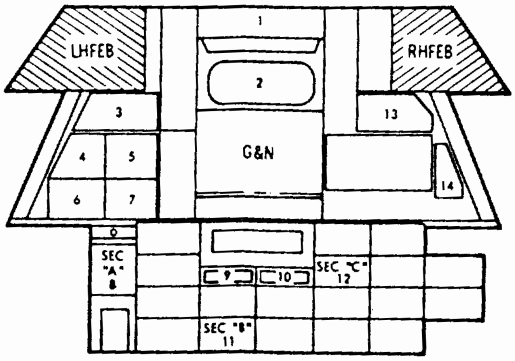
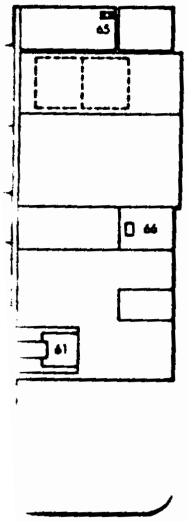


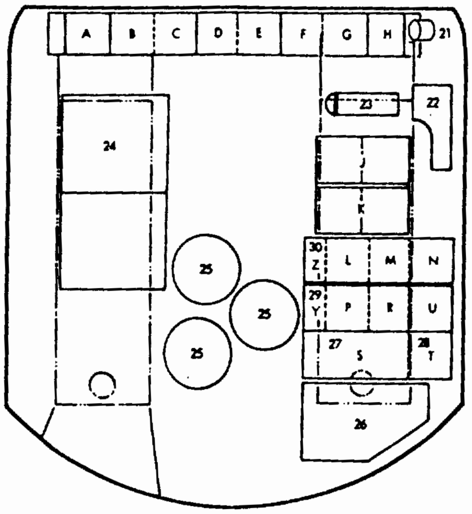
LOWER EQUIPMENT BAY (LEB)

STOW AREA	AFT BULKHEAD STOWAGE ITEMS
A-H	16 LIOH CARTRIDGES
J,K	4 LIOH CARTRIDGES
L,M,N	3 LIOH CARTRIDGES
P,R,U	3 LIOH CARTRIDGES
21	M003 INFLIGHT EXERCIZER
22	TV OPTICS CONTAINER
A	TV ZOOM LENS
23	FECAL CANISTER
A	URINE FILTER ASSY W/POUCH
24	L/H PGA STOW BAG
A	3 CREWMAN WASTE BAGS
B	L/H SLEEP RESTRAINT
C	FECAL CANISTER PAD

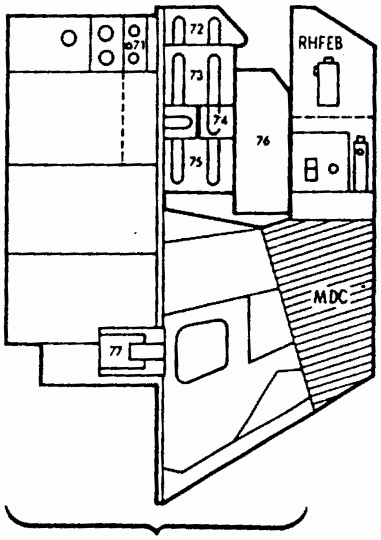
STOW AREA	AFT BULKHEAL STOWAGE ITEN
25	3 PGA HEL STOW BAGS
A	3 COMM SOFT HAT
B	3 LIGHTWEIGHT HE
26	R/H PGA STOW BAG
A	R/H SLEEP RESTRAIN
27	COMPARTMENT "S"
A	SPARE URINE LINE F
B	CREW OP ALIGN SIC
	POWER CORD
C	1 COAS BULB & SPAR
D	2 PPK'S
28	COMPARTMENT "T"
A	M009 CAMERA BRKT
B	PPK
29	COMPARTMENT "Y"
30	COMPARTMENT "Z"
A	9 PENLIGHTS



'IENT BAY (LHEB)



AFT BULKHEAD (AB)

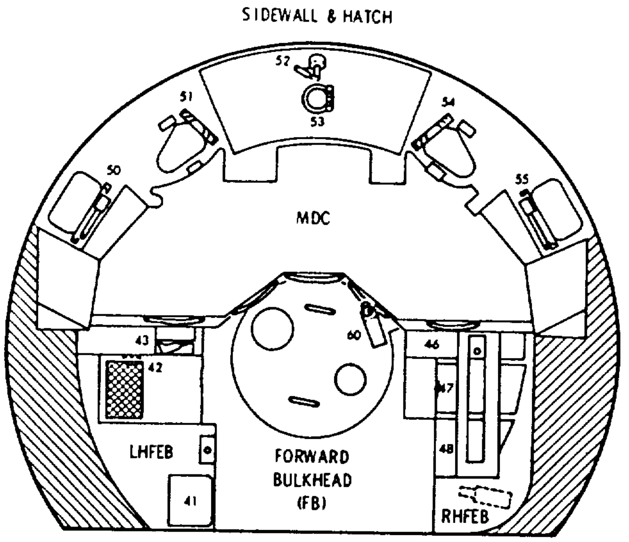


RIGHT HAND EQUIPMENT BAY (RHEB)

STOW AREA	RHEB STOWAGE ITEMS
71	"VACUUM CLEANER" COMPAR
A	VACUUM CLEANER ASSY W
B	5 VAC CLEAN REF BAG ASS
	FE OUTER BAG
	DEBRIS BAG
	GERMICIDE POUCH
	TIF BAND
72	"MEDICAL ACCESSORIES KIT" C
A	BIO-MED ACCESSORIES KIT
	35 ELECTRODES
	50 MICROPORE DISCS
	1 ELECTRODE PASTE
	8 WET-PIPE TOWELS
73	"SCIENT EXP E/TOWELS" COMP
A	T003 NEPHELOMETER
B	10 SAN SUP ASSY'S
	7 TOWELS (1 PKG)
C	5 VAC CLEAN REF BAG ASSY'
74	"ELECT ADAPTERS" COMP
A	3 CWG ELECT ADAPTERS
B	2 SLEEP ELEC ADAPTERS
75	"SANITATION SUPPLIES" COMP
A	SAN SUP BOXES A, B & C
	52 SAN SUP ASSY'S
76	"FOOD COMPARTMENT
A	AUX FOOD CONTAINER
77	PILOT FLT DATA FILE BAG
A	ENGR CHECK-LIST
B	MISSION LOG & DATA

FOLDOUT FRAME 2

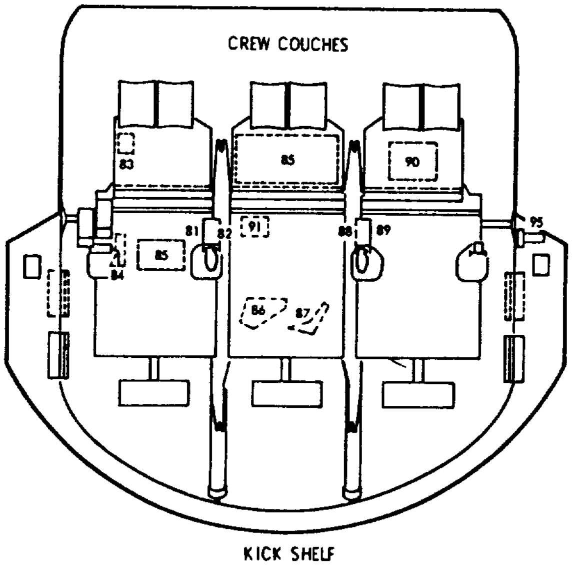
STOW AREA	AFT BULKHEAD STOWAGE ITEMS
25	3 PGA HEL STOW BAGS
A	3 COMM SOFT HATS
B	3 LIGHTWEIGHT HEADSETS
26	R/H PGA STOW BAG
A	R/H SLEEP RESTRAINT
27	COMPARTMENT "S"
A	SPARE URINE LINE FILTER
B	CREW OP ALIGN SIGHT & POWER CORD
C	1 COAS BULB & SPARE
D	2 PPK'S
28	COMPARTMENT "T"
A	M009 CAMERA BRKT
B	PPK
29	COMPARTMENT "Y"
30	COMPARTMENT "Z"
A	9 PENLIGHTS



STOW AREA	LHFEB STOWAGE ITEMS
41	"LOOSE PARTS" COMPARTMENT
A	G&N SHORT HANDHOLD
B	G&N LONG HANDHOLD
C	LEB ROT CONTROL MOUNT
D	LONG SEXTANT EYEPIECE
42	FAN CLOSURE
43	WATER DISPENSER (PISTOL)

STOW AREA	RHFEB STOWAGE AREAS
46	SURVIVAL KIT CONT "A"
A	SURV KIT RUCKSACK (1)
B	SURV KIT RUCKSACK (2)
47	SURVIVAL KIT CONT "B"
A	SURVIVAL KIT RUCKSACK (3
B	SEA HOSE & PUMP
48	SURVIVAL KIT CONT "C"

STOW AREA	RHEB STOWAGE ITEMS
71	"VACUUM CLEANER" COMPARTMENT
A	VACUUM CLEANER ASSY W/HOSE
B	5 VAC CLEAN REF BAG ASSY'S
	FE OUTER BAG
	DEBRIS BAG
	GERMICIDE POUCH
	TIF BAND
72	"MEDICAL ACCESSORIES KIT" COMP
A	BIO-MED ACCESSORIES KIT
	35 ELECTRODES
	50 MICROPORE DISCS
	1 ELECTRODE PASTE
	8 WET-PIPE TOWELS
73	"SCIENT EXP E/TOWELS" COMP
A	T003 NEPHELOMETER
B	10 SAN SUP ASSY'S
	7 TOWELS (1 PKG)
C	5 VAC CLEAN REF BAG ASSY'S
74	"ELECT ADAPTERS" COMP
A	3 CWG ELECT ADAPTERS
B	2 SLEEP ELEC ADAPTERS
75	"SANITATION SUPPLIES" COMP
A	SAN SUP BOXES A, B & C
	52 SAN SUP ASSY'S
76	"FOOD COMPARTMENT
A	AUX FOOD CONTAINER
77	PILOT FLT DATA FILE BAG
A	ENGR CHECK-LIST
B	MISSION LOG & DATA



STOW AREA	CREW COUCH STOWAGE ITEMS
81	STA 1 LWR ARMREST, R/H
82	STA 1 ROTATION CONTROL
83	EMERGENCY MEDICAL KIT
84	TRANS CONTROL ADAPTER
85	7 TISSUE DISPENSERS
86	TV CAMERA MOUNT
87	16 MM CAM. MOUNT
88	STA 3 LOWER ARM REST L/H
89	STA 3 ROTATION CONTROL
90	"SCIENT EXP G" COMP
A	16 MM CAMERA
B	70 MM CAMERA (SUP WIDE ANGLE)
C	5 MM LENS (16 MM CAM)
91	EVAPORATOR TEMP SENSOR

STOW AREA	KICK-SHELF STOWAGE ITEMS
95	"D" RING EXTEN HANDLE

FIGURE 1-15-1

LHFEB STOWAGE ITEMS
"LOOSE PARTS" COMPARTMENT G&N SHORT HANDHOLD G&N LONG HANDHOLD LEB ROT CONTROL MOUNT LONG SEXTANT EYEPIECE
FAN CLOSURE
WATER DISPENSER (PISTOL)

STOW AREA	SIDEWALL & HATCH STOWAGE ITEMS
50	LEFT SIDE VIEW WIND SHADE
51	LEFT REND WIND SHADE
52	TOOL B- EMER WRENCH
53	HATCH SHADE
54	RIGHT REND WIND SHADE
55	RT SIDE VIEW WIND SHADE

RHFEB STOWAGE AREAS
SURVIVAL KIT CONT "A" SURV KIT RUCKSACK (1) SURV KIT RUCKSACK (2)
SURVIVAL KIT CONT "B" SURVIVAL KIT RUCKSACK (3) SEA HOSE & PUMP
SURVIVAL KIT CONT "C"

STOW AREA	TUNNEL STOWAGE ITEMS
60	TV CAMERA W/ WIDE ANGLE LENS

CREW COUCH STOWAGE ITEMS
STA 1 LWR ARMREST, R/H
STA 1 ROTATION CONTROL
EMERGENCY MEDICAL KIT
TRANS CONTROL ADAPTER
7 TISSUE DISPENSERS
TV CAMERA MOUNT
16 MM CAM. MOUNT
STA 3 LOWER ARM REST L/H
STA 3 ROTATION CONTROL
"SCIENT EXP G" COMP 16 MM CAMERA 70 MM CAMERA (SUP WIDE ANGLE) 5 MM LENS (16 MM CAM)
EVAPORATOR TEMP SENSOR

KICK-SHELF STOWAGE ITEMS
"D" RING EXTEN HANDLE

ITEM	STOW AREA	CREW APPAREL (EACH CREWMAN)
100	24/28	PGA
101	CREW	PENLIGHT
102	CREW	SUN GLASSES W/CONT
103	24	LIFE VEST
104	CREW	CHRONOGRAPH W/WATCH BAND
105	CREW	2 MARKING PENS
106	CREW	2 MECHANICAL PENCILS
107	CREW	SURGICAL SCISSORS
108	64	CWG
109	CREW	5 PASSIVE DOSIMETERS
110	WASTE	URINE COLLECTION DEVICE
111	CREW	POCKET DOSIMETER (1 FOR 3)
112	CREW	BIO-INSTRUMENT HARNESS

APOLLO EQUIPMENT STOWAGE (LAUNCH)

(S/C 012)

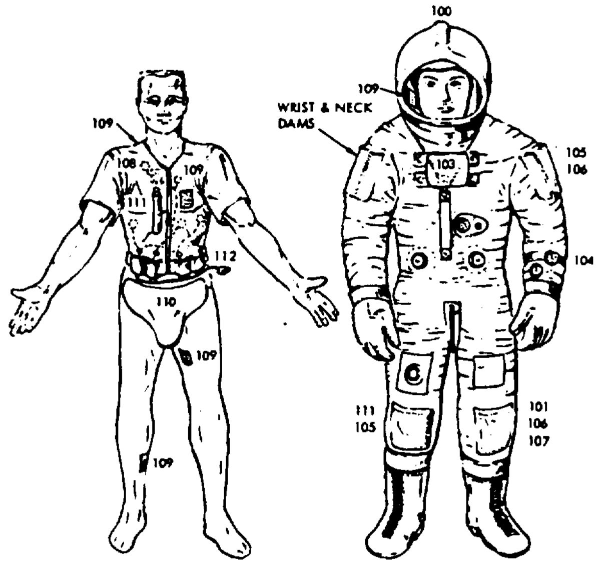
DATE: 1 AUG 1966
REV: 1 OCT 1966

"MARKED" COMPARTMENT

A-R, U - AFT BKHD LIOH STORAGE CONTAINERS (BOXES)
SEC A-E, G - SCIENTIFIC EXPERIMENT COMPARTMENTS
S, T, Y, Z - MISC SCIENT EXP EQUIP & CREW EQUIP
FOOD A-E - LEB FOOD COMPARTMENTS

CHART NUMBERING SYSTEM

1 - 20 LEB
21 - 40 AFT BULKHEAD
41 - 60 LHFEB, RHFEB, SIDEWALL & HATCH, TUNNEL
61 - 70 LHEB
71 - 80 RHEB
81 - 99 CREW COUCH & KICKSHELF
100 - CREW APPAREL



CS-9700A

Figure 6-28. Crew Equipment Stowage

SECTION 7

SYSTEM SCHEMATICS

NOTE This section will contain a brief description of each system, utilizing charts, flow diagrams, and schematics. Information for this section will be provided at a later date by MSC.

Sections 8 through 11 will be submitted at a later date.

APPENDIX A

SYMBOLS AND DEFINITIONS

AB	Aft bulkhead
A/C	Audio center
ACCEL	Accelerometer
ACCUM	Accumulator
ACE	Acceptance checkout equipment
ACK	Acknowledge
ADA	Angular differentiating accelerometer
ADAP	Adapter
ADJ	Adjust
AESB	Aft equipment storage bay
AF	Audio frequency
AF	Atmospheric flight
AGAA	Attitude gyro accelerometer assembly
AGC	Apollo guidance computer
AGC	Automatic gain control
AGCU	Attitude gyro coupling unit
AM	Amplitude modulation
AMPL	Amplifier
AMS	Apollo mission simulator
ANAL	Analyzer
ANLG	Analog
ANT	Antenna
ASD	Apollo standard detonator
ASD	Astrosextant door
ASI	Apollo standard initiator
AS/GPI	Attitude set/gimbal position indicator
ATT	Attenuator
ATT	Attitude
AUTO	Automatic
AUX	Auxiliary
AVC	Automatic volume control
BAT	Battery
BCD	Binary coded decimal
BCN	Beacon
BECO	Booster engine cutoff
BIOMED	Biomedical
BLWR	Blower
BMAG	Body-mounted attitude gyro
BPC	Boost protective cover
bps	Bits per second
Btu	British thermal unit
BUR	Backup rate
BURR	Backup rate roll
BURP	Backup rate pitch
BURY	Backup rate yaw
$CA\ (OH)_2$	Calcium hydroxide
CAUT/WARN	Caution and warning
cb	Circuit breaker
cc	Cubic centimeter
CCW	Counterclockwise
CDU	Coupling display unit
CF	Coasting flight
CFE	Contractor-furnished equipment
cfm	Cubic feet per minute
CG	Center of gravity
CHGR	Charger
CIR & SEP	H_2 circulation, water separation centrifuge, and glycol circulation
C/M	Command module
CMD	Command
C/M RCS	Command module reaction control system
COAS	Crewman optical alignment sight
COMP	Compressor
COMP	Computing
COMPR	Compressor
COND	Condenser
COND	Conditioner
CONT	Control
CO_2	Carbon dioxide
CPC	Coldplate clamp

APPENDIX A

cps	Cycles per second
CYRO	Cryogenic
CSM	Command and service module
CSS	Computer subsystem
CTE	Central timing equipment
C/W	Caution and warning
CW	Clockwise
CW	Continuous wave
C&WS	Caution and warning system
db	Decibel
DISP/AGAA/ECA	Display and attitude gyro accelerometer assembly electronic control assembly
DDP	Data distribution panel
DECR	Decrease
DEMOD	Demodulate
DET	Detector
DISCH	Discharge
DPST	Double-pole single-throw
DSE	Data storage equipment
DSIF	Deep space instrumentation facility
DSKY	Display and keyboard
ECA	Electronic control assembly
ECO	Engine cutoff
ECS	Environmental control system
ECU	Environmental control unit
EDS	Emergency detection system
EEG	Electroencephalogram
E_{ig}	Voltage-inner gimbal
EKG	Electrocardiogram
ELS	Earth landing system
ELSC	Earth landing system controller
EMERG	Emergency
E_{mg}	Voltage-middle gimbal
EMS	Entry monitor subsystem
ENC	Encode
ENG	Engine
E_{og}	Voltage-outer gimbal
EPS	Electrical power system
ESS	Essential
EVA	Extravehicular activity
EVAP	Evaporator
EVL	Egocentric visual localization
EXH	Exhaust
F	Fuel
F/C	Fuel cell
FCSD	Flight Crew Support Division (MSC)
FCSM	Flight combustion stability monitor
FDAI	Flight director attitude indicator
FLSC	Flexible linear-shaped charge
FM	Frequency modulation
FOV	Field of view
FQR	Flight qualification recorder
FWD	Forward
g	Gravity
GFAE	Government-furnished airborne equipment
GFE	Government-furnished equipment
GFP	Government-furnished property
GLY	Water-glycol
GMBL	Gimbal
GMT	Greenwich mean time
G&N	Guidance and navigation
GN_2	Gaseous nitrogen
GSE	Ground support equipment
g/v	Gravity vs velocity
HBR	High-bit rate
He	Helium
HEX	Hexagonal
HF	High frequency
HI	High
HT EXCH	Heat exchanger
H_2	Hydrogen
H_2O	Water
HTRS	Heaters
ICDU	Inertial coupling display unit

ICS	Intercommunication system
IGN	Ignition
IMU	Inertial measurement unit
INCR	Increase
IND	Indicator
INSTR	Instrumentation
INT	Interphone
INV	Inverter
ips	Inches per second
IRIG	Inertial rate integrating gyroscope
ISOL	Isolation
ISS	Inertial subsystem
I/U	Instrument unit
JETT	Jettison
kbps	Kilobits per second
kc	Kilocycle
kmc	Kilomegacycle
KOH	Potassium hydroxide
lb/hr	Pounds per hour
lb min	Pounds per minute
LBR	Low-bit rate
LCC	Launch control center
LEB	Lower equipment bay
LM	Lunar module
LES	Launch escape system
LET	Launch escape tower
LH	Left-hand
LHEB	LH equipment bay
LHFEB	LH forward equipment bay
LIQ	Liquid
LLOS	Landmark line of sight
LO	Low
LOR	Lunar orbit rendezvous
LOS	Line of sight
LTG	Lighting
LV	Launch vehicle
MA	Master
MAN	Manual
MANF	Manifold
MAX	Maximum
mc	Megacycles
mcs	Megacycles per second
MCT	Memory cycle-time
MDC	Main display console
MED	Medium
MESC	Master events sequence controller
MGMT	Management
MIN	Minimum
MMH	Monomethylhydrazine (fuel)
mmHg	Millimeters of mercury
MN A	Main bus A
MN B	Main bus B
MSC	Manned Spacecraft Center (NASA) (Clear Lake, Texas)
MSD	Monitor selection decoder
MDF	Mile detonating fuse
MSFN	Manned space flight network
MSL	Mean sea level
MSM	Monitor selector matrix
MTRS	Motors
MTVC	Manual thrust vector control
MULTI	Multiplexer
N/A	Not applicable
NB	Navigational base
NCS	Navigator communication station
NON ESS	Nonessential
NRZ	Nonreturn to zero
N_2	Nitrogen
N_2H_4	Hydrazine (fuel)
N_2O_4	Nitrogen tetroxide (oxidizer)
OCDU	Optics coupling display unit
OL	Overload
OMNI	Omnidirectional
OSC	Oscillator
OSS	Optics subsystem
OX	Oxidizer
OXID	Oxidizer
O_2	Oxygen
PA	Power amplifier
PAM	Pulse amplitude modulation

PART	Partial
PCM	Pulse-code modulation
PCVB	Pyro continuity verification box
PECA	Pitch electronic central assembly
PF	Powered flight
PGA	Pressure garment assembly
PGNS	Primary guidance and navigation system
pH	Alkalinity to acidity content (hydrogen ion concentration)
PIP	Pulsed integrating pendulous (accelerometer)
PIPA	Pulsed integrating pendulous accelerometer
PKG	Package
PL	Postlanding
PLSS	Portable life support system
PLV	Postlanding ventilation
PM	Phase modulation
PMP	Premodulation processor
POT	Potable
PP	Partial pressure
pps	Pulses per second
PRESS	Pressure
PRF	Pulse repetition frequency
PRI, PRIM	Primary
PRN	Pseudo-random noise
PROG	Program
PROP	Propellant
PRR	Pulse repetition rate
PSA	Power and servo assembly
psi	Pounds per square inch
psia	Pounds per square inch absolute
psid	Pounds per square inch differential
psig	Pounds per square inch gauge
PTT	Push-to-talk
PU	Propellant utilization
PUGS	Propellant utilization and gauging subsystem
PWR	Power
PYRO	Pyrotechnic
QTY	Quantity
RAD	Radiator
RBC	Red blood cell
RCS	Reaction control system
RCSC	Reaction control system controller
RCVR	Receiver
REC	Receive
RECA	Roll electronic control assembly
RECT	Rectifier
RECY	Recovery
REG	Regulator
RESVR	Reservoir
REV	Reverse
RF	Radio frequency
RGA	Rate gyro assembly
RH	Right-hand
RHEB	RH equipment bay
RHFEB	RH forward equipment bay
RLSE	Release
RLY	Relay
RMT, RMTE	Remote
RNG	Range
R/R	Remove and replace
RTC	Real-time commands
RUPT	Interrupt
RZ	Return to zero
S-	Saturn stage (prefix)
S/C	Spacecraft
SCE	Signal conditioner equipment
SCIN	Scimitar-notch
SCS	Stabilization and control system
SCT	Scanning telescope
SEC	Secondary
SECS	Sequential events control system
SENSE	Sensing
SEP-	Separation
SEP	Space electronic package
SEQ	Sequencer
SHA	Sidereal hour angle
SIG	Signal

SIG COND	Signal conditioner
SLA	Spacecraft lunar-excursion-module adapter
SLOS	Star line of sight
S/M	Service module
SMJC	Service module jettison controller
S/M RCS	Service module reaction control system
SNSR	Sensor
SOV	Shutoff valve
SPDT	Single-pole double-throw
SPL	Sound pressure level
SPS	Service propulsion system
SPST	Single-pole single-throw
SQG	Sequencer generator
SSB	Single sideband
Sw	Switch
SXT	Sextant
SYNC	Synchronize
SYS	System
TBD	To be determined
T/C	Telecommunications
TC	Transfer control
TEC	Transearth coast
TEMP	Temperature
TFL	Time from launch
TK	Tank
TLC	Translunar coast
TLM, T/M	Telemetry
T/R	Transmit/receive
TTE	Time-to-event
TV	Television
TVC	Thrust vector control
TWR	Tower
UDL	Up-data link

UDMH	Unsymmetrical dimethyl hydrazine (fuel)
UHF	Ultra high frequency
UPTL	Up-link telemetry
USBE	Unified S-band equipment
USBS	Unified S-band system
USM	Service module umbilical
UV	Undervoltage
UVMS	Urine volume measurement system
VAC	Volts ac
VCO	Voltage controlled oscillator
VDC	Volts dc
VHF	Very high frequency
VOX	Voice-operated relay
V/V	Valve
WMS	Waste management system
XDUCER	Transducer
XFMR	Transformer
XMTR	Transmitter
XCVR	Transceiver
XPONDER	Transponder
YECA	Yaw electrical control assembly
Zn	Zinc
ΔP	Change in pressure
ΔV	Change in velocity, differential velocity
ϕ	Phase