



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

**GEMINI OPERATIONS HANDBOOK**  
**SPACECRAFT IO**  
**REVISION A** *entered 7/16/66*

**SECTION II**  
**CONTROLS AND DISPLAYS**

PREPARED BY  
MISSION OPERATIONS BRANCH  
FLIGHT CREW SUPPORT DIVISION

**JULY 1, 1966**



**MANNED SPACECRAFT CENTER**  
**HOUSTON, TEXAS**



## GEMINI OPERATIONS HANDBOOK - SECTION II

### SPACECRAFT 10

#### FOREWORD

The enclosed information details the operation of the Spacecraft 10 systems as it relates to the spacecraft crew. Each subsection is divided into control, displays, circuit breaker, and general systems data. The information in this section complements the spacecraft systems schematics contained in Section I (produced under separate cover by the Flight Control Division, MSC) and also provides the system background for the spacecraft operations procedures contained in Section III (produced under a separate cover by the Flight Crew Support Division, MSC). This edition reflects the configuration of Spacecraft 10 as of the indicated date. Revisions will be distributed as required to maintain the information current with the spacecraft configuration. Revision A changes from the S/C 10 preliminary, dated 20 May, 1966, are indicated in the table of contents and on affected pages by a black bar in the margin.

Section II has been prepared by the Mission Operations Branch, Flight Crew Support Division of the Manned Spacecraft Center, Houston, Texas, with the technical support of the McDonnell Aircraft Corporation. All comments and/or corrections should be sent to the Mission Operations Branch.

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# GEMINI OPERATIONS HANDBOOK

## SECTION II

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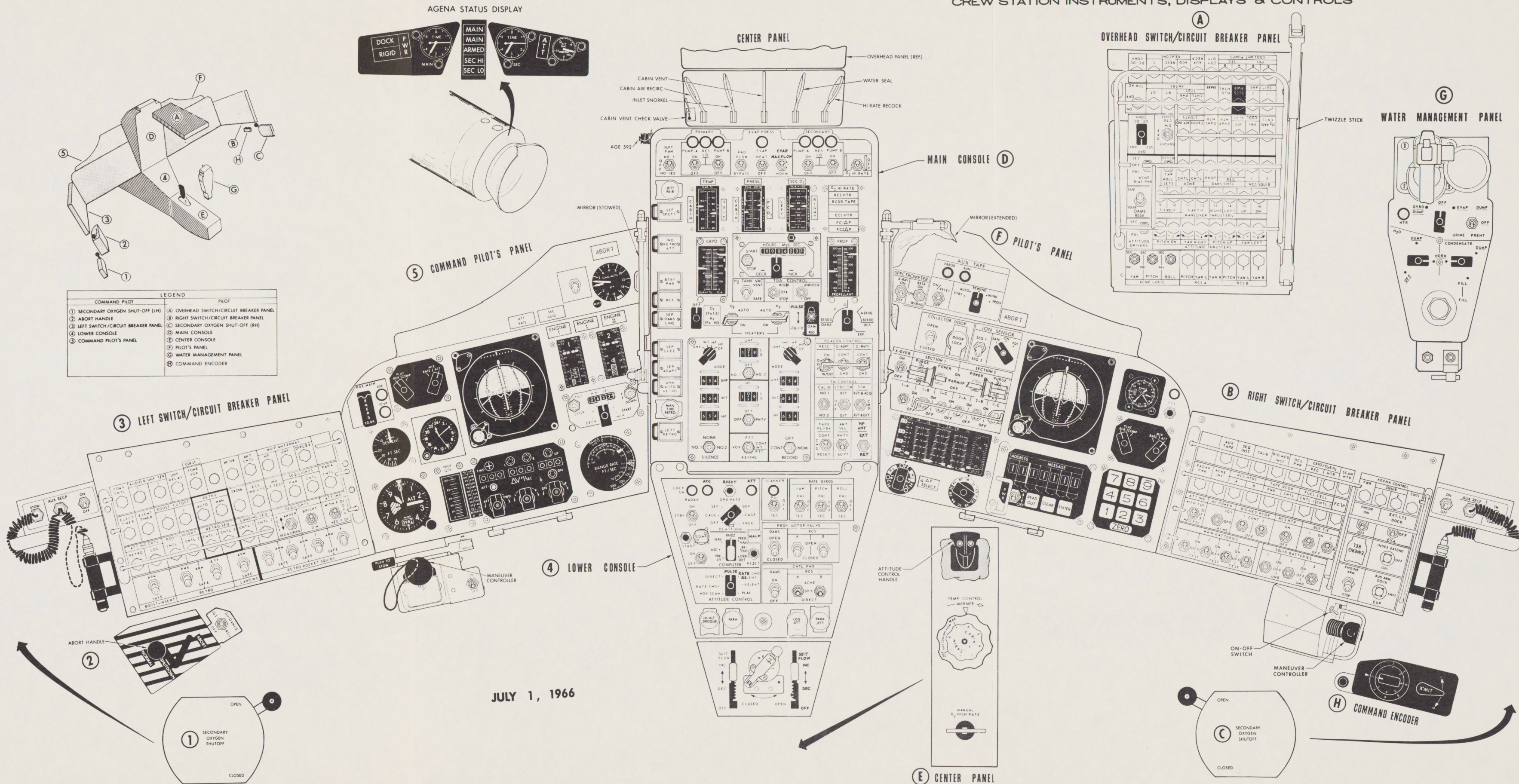


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# SPACECRAFT 10 INSTRUMENT PANEL

## CREW STATION INSTRUMENTS, DISPLAYS & CONTROLS





# SEQUENTIAL

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>JETT FAIR</u> Push on -	<p>(Jettison Fairing Switch)</p> <p>(a) Powers dual Horizon Scanner cover squibs thru 2 relays and 2 single bridgewire cartridges - jettison scanner covers.</p> <p>(b) Powers dual fairing jettison thru 2 relays and a dual bridgewire cartridge - jettisons nose fairing.</p> <p>(c) Latches two redundant relays which enable functions (i) and (j) of the JETT RETRO switch.</p>
Center Panel	<u>SEP SPCFT</u> Depress Switch -	<p>(Separate S/C Telelight Switch)</p> <p>(a) Arms V<sub>SEPQ1</sub> &amp; 2- pyrotechnics for Functions (b) (c), (d), and (f) (as applicable) are powered from these buses thru fusistors.</p> <p>(b) Ignites GLV-S/C Pyro Switch - disconnects GLV-S/C wiring and removes power from coil of Ascent Scale Factor relay.</p> <p>(c) Ignites dual GLV-S/C Wire Guillotines (120 MS TD)-severs wiring on each side of GLV-S/C interface.</p> <p>Continued</p>
GEMINI OPERATIONS HANDBOOK Pg 1 Section 2.1.1	Flight Crew Support Division Mission Operations Branch	Prepared by <u>SLB</u> Checked by <u>SLB</u> Approved by <u>SLB</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) BOOST-INSERT CNTL 1 &/or 2 (V <sub>BIAZ1</sub> &/or 2). (b) Same as (a). (c) Same as (a).		1. Push Button Switch. 2. Actuate at SECO + 30 seconds. (Approx) (yaw steering constraint) 3. BOOST-INSERT Switch arms V <sub>BIAQ1</sub> & 2. 4. Jettison squibs are powered thru fusistors. 5. Function (a): Not an Abort Handle function. Scanner covers & scanner heads jettisoned by JETT RETRO Switch. 6. Function (b): Not an Abort Handle function. Nose fairing may be jettisoned prior to drogue deploy by actuating JETT FAIR Switch. (BIA Squib Bus must be armed as indicated in C/B BUS column) 7. Function (c): Not an Abort Hnadle function. Docking latches and latch doors may be released after Fairing Jettison is accomplished by depressing the JETT RETRO switch again. (RETRO PWR switch must be ARMED & RETRO SEQ CNTL C/B's closed).
(a) BOOST-INSERT CNTL 1 &/or 2. (V <sub>BIAQ1</sub> &/or 2). (b) BOOST-INSERT CNTL 1 &/or 2 (V <sub>BIAQ1</sub> &/or 2). (V <sub>SEPQ1</sub> &/or 2). (c) Same as (b).	Continued	1. Push at SECO + 30 seconds. 2. BOOST-INSERT Switch arms V <sub>BIAQ1</sub> & 2. 3. Pyro devices are powered thru fusistors. (a) Function (b) is an Abort Handle function. (b) Ignition thru 2,50-70 MS T.D. relays and a dual bridgewire cartridge. The Ascent Scale Factor relay provides for proper scale range reading on FDI's during insertion & Mode III Abort. (c) Each guillotine is ignited by a single bridgewire cartridge.
S/C 10 Rev A Date 7/1/66	Sequential Launch to Insertion	GEMINI OPERATIONS HANDBOOK Section 2.1.1 Pg 2

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
		<p>(d) Ignites dual Shaped Charges (240 MS TD) - separates S/C GLV at 2 separate stations near the interface.</p> <p>(e) Releases covers and extends UHF Quadriplexer Antenna (retro adapter) and UHF Diplexer Whip Antenna (equipment adapter).</p> <p>(f) Powers MSC-3 and MSC-6 experiment cover jettison pyros (relays 1 &amp; 2).</p> <p>(g) Enables T/M CONTROL Switch to control Acquisition Aid Beacon.</p> <p>(h) Enables T/M of SEP SPCFT.</p>
	Green Light -	Indicates at least 2 of 3 limit switches have been actuated by 1.5 inches separation between GLV and S/C.
GEMINI OPERATIONS HANDBOOK Pg 3 Section 2.1.1		Flight Crew Support Division Mission Operations Branch Prepared by <u>SAF</u> Checked by <u>SAF</u> Approved by <u>DAIS</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(d) Same as (b).  (e) BOOST-INSERT CNTL 1 &/or 2 (V <sub>BIAQ1</sub> &/or 2). UHF WHIP ANTENNA (V <sub>CC</sub> ). DIPLEX WHIP ANTENNA (V <sub>CC</sub> ).  (f) BOOST-INSERT CNTL (g) BOOST-INSERT CNTL 1 &/or 2 (V <sub>BIAQ1</sub> &/or 2). ACQ BEACON (V <sub>M</sub> ). ANT CNTL (V <sub>CC</sub> ). (h) SEQ INST (V <sub>CC</sub> )		(d) There are 3 detonators; each is capable of firing both shaped charges. Two detonators are single bridgewire; the third is a dual bridgewire detonator.  (e) This function is initiated by redundant relays. (ANT SEL Switch must be in ADAPT to use UHF Quadriplexer Antenna.)  (f) This function is initiated by redundant relays. (h) This function is initiated by redundant relays and is dependent upon 2 or 3 sep sensor limit switch closures.
BOOST INSERT CNTL 1 &/or 2 (V <sub>BIAQ1</sub> &/or 2). SEQ LIGHTS PWR (V <sub>M</sub> ).	<u>T/M (D/T)</u> GLV-S/C separation (actuated by limit switches).	1. Light goes out when BOOST-INSERT Switch is returned to SAFE. 2. Each limit switch closes redundant switches.
S/C 10      Rev A Date 7/1/66	Sequential Launch to Insertion	GEMINI OPERATIONS HANDBOOK Section 2.1.1      Pg 4

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Misc	<u>Ejection Seat</u> <u>D Ring</u> Pulled on -	Each D Ring activates <u>both</u> hatch actuators and <u>both</u> seat catapults (for Mode I Abort).
Misc	<u>Abort Handle</u> SHUT DOWN -	<p>(a) Redundantly shuts down GLV.</p> <hr/> <p>(b) Initiates T/M of Booster cut-off command.</p> <hr/> <p>ABORT -</p> <p>(a) Performs the same functions as the SHUT DOWN position (see functions a &amp; b above).</p> <hr/> <p>(b) Initiates T/M of astro actuated abort.</p> <hr/> <p>(c) Initiates T/M of Emergency retro salvo.</p> <hr/> <p>(d) Arms V<sub>RQ1</sub> from V<sub>OAMSQ1</sub>. Arms V<sub>RQ2</sub> from V<sub>OAMSQ2</sub>. Arms V<sub>RCC</sub> from V<sub>CC</sub>.</p> <hr/>
GEMINI OPERATIONS HANDBOOK Pg 1 Section 2.1.2	Flight Crew Support Division Mission Operations Branch	Prepared by <u>[Signature]</u> Checked by <u>[Signature]</u> Approved by <u>[Signature]</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
None. Manual.	<u>T/M (D/T)</u> Right and Left eject seat gone (bilevel).	1. D Ring located on each seat between astro's legs. 2. 41 to 60 lbs required to actuate D Ring. 3. Separation sensor actuates T/M. (SEQ INST C/B & $V_{CC}$ Req'd for T/M)
BOOST CUT-OFF 1 &/or 2 ( $V_{BIACC}$ ). $V_{APS}$ &/or $V_{IPS}$ .	<u>T/M (D/T)</u> Booster cut-off command.	1. Located below left panel. 2. BOOST-INSERT Switch arms $V_{BIACC}$ .
BOOST CUT-OFF 1 &/or 2 ( $V_{BIACC}$ ). SEQ INST ( $V_{CC}$ )		
		1. BOOST-INSERT CNTL 1, AUTO RETRO, RETRO SEQ CNTL 1, RCS SQUIB 1, and ACME CNTL 1 circuit breakers comprise one complete system. BOOST-INSERT CNTL 2, MAN RETRO, RETRO-SEQ CNTL 2, RCS SQUIB 2, and ACME CNTL 2 circuit breakers comprise the redundant system. The two systems are not interconnected. All C/B's in a system must be closed for that system to operate properly.
BOOST-INSERT CNTL 1 &/or 2 ( $V_{BIAQ1}$ &/or 2). SEQ INST ( $V_{CC}$ )	<u>T/M (D/T)</u> 1. Astro actuated abort 2. Abort light relay actuate (bilevel)	
BOOST-INSERT CNTL 1 &/or 2 ( $V_{BIAQ1}$ &/or 2) SEQ INST ( $V_{CC}$ )	<u>T/M (D/T)</u> Emerg retro salvo.	
Same as (b).		2. The Abort Handle is powered by arming the BOOST-INSERT Switch. 3. The retro rockets are powered via the RETRO PWR Switch and the RETRO ROCKET SQUIB Switches.
		Continued
S/C 10      Rev A Date 7/1/66	Sequential Mode I and II Aborts	GEMINI OPERATIONS HANDBOOK Section 2.1.2    Pg 2

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
		(e) Automatically selects ACME for RCS RING A & B if switches were OFF. Does not affect the CONTROL if the switches were in DIRECT .
		(f) Performs functions of RCS Telelight Switch automatically (see Section 2.1.3).
		(g) Performs functions of SEP OAMS LINES Telelight Switch automatically (see Section 2.1.3).
		(h) Performs functions of SEP ELECT Telelight Switch automatically (see Section 2.1.3).
		(i) Performs functions of SEP ADAPT Telelight Switch automatically (see Section 2.1.3).
		(j) Disables PLATFORM Mode Switch.
		Continued
GEMINI OPERATIONS HANDBOOK Pg 3 Section 2.1.2	Flight Crew Support Division Mission Operations Branch	Prepared by <u>SPZ</u> Checked by <u>SPZ</u> Approved by <u>RHS</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
		4. Functions (d), (e), (f), (g), (h), (i), (j), (k), (l) are initiated by redundant relays.
BOOST-INSERT CNTL 1 &/or 2 ( $V_{BIAQ1}$ &/or 2) ACME CNTL 1 & 2 ( $V_{CC}$ ).		5. The abort handle does not arm $V_{LQ1}$ , $V_{LQ2}$ and $V_{LCC}$ ; these buses must be armed by the LANDING Switch on the Left Switch C/B panel.
BOOST-INSERT CNTL 1 &/or 2 ( $V_{BIAQ1}$ &/or 2) RCS SQUIB 1 &/or 2 ( $V_{RQ1}$ &/or 2).		6. $V_{RJQ1}$ & $V_{RJQ2}$ must be armed by the RETRO JETT Switch on the Left Switch C/B panel prior to Retro Jettison. 7. DCS PWR C/B ( $V_M$ ) is required for T/M only.
BOOST-INSERT CNTL 1 &/or 2 ( $V_{BIAQ1}$ &/or 2) RETRO-SEQ CNTL 1 &/or 2 ( $V_{RQ1}$ &/or 2). RCS SQUIB 1 &/or 2 ( $V_{RQ1}$ &/or 2).	<u>T/M (D/T)</u>	
Same as (g).		
Same as (g).	<u>T/M (D/T)</u>  Equipment section separation.	
BOOST-INSERT CNTL 2 ( $V_{BIAQ2}$ ). RCS SQUIB 2 ( $V_{RQ2}$ ). RETRO SEQ CNTL 2 ( $V_{RQ2}$ ). MAN RETRO ( $V_{RCC}$ ).		
S/C 10 Rev A Late 7/1/66	Sequential Mode I and II Aborts	GEMINI OPERATIONS HANDBOOK Section 2.1.2 Pg 4

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
		<p>(k) Initiates salvo firing of retro rockets.</p> <hr/> <p>(l) Enables power to 45 seconds TD relay which illuminates JETT RETRO amber light.</p>

GEMINI OPERATIONS HANDBOOK Pg 5 Section 2.1.2	Flight Crew Support Division Mission Operations Branch	Prepared by <u>                    </u> Checked by <u>                    </u> Approved by <u>                    </u>
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<u>CIRCUIT BREAKER</u> BUS	<u>TELEMETRY</u> <u>POWER REQUIRED</u>	REMARKS
BOOST-INSERT CNTL 1 &/or 2 ( $V_{BIAQ1}$ &/or 2) MAN &/or AUTO RETRO ( $V_{RCC}$ ).	<u>T/M (D/T)</u>  1. Emerg Retro  Salvo Relay. 2. Manual Retrofire. 3. Auto Retrofire 4. Retro Rockets 2, 3, and 4 fire.	
Same as (g).		
S/C 10      Rev A Date 7/1/66	Sequential Mode I and Mode II Aborts	GEMINI OPERATIONS HANDBOOK Section 2.1.2      Pg 6

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel ①	<u>IND RETRO ATT</u> Amber Light -	(Indicate Retro Attitude Telelight Switch) T <sub>R</sub> -256 sec signal from TRS illuminates the amber light indicating to the astro to depress switch.
	Depress Switch -	(a) Initiates 16° pitch down bias on FDI's thru ATT IND Switch in WITH FDI, thru FDR Switch in PLAT, and thru FDM Switch in ATT.  (b) Automatically places yaw and roll FDI's in the BEF Mode (thru IMU Electronics).  (c) Disables amber light and initiates green light.
	Green Light -	Indicates the relay which enables functions (a) & (b) has been powered.
Center Panel ②	<u>BTRY PWR</u> Amber Light -	(Battery Power Light) A T <sub>R</sub> -256 sec signal from the TRS illuminates the amber light indicating to the astro to turn all Main Batteries on.
	Green Light -	Indicates all 4 Main Batteries are on (amber light goes off).
GEMINI OPERATIONS HANDBOOK Pg 1 Section 2.1.3		Flight Crew Support Division Mission Operations Branch
		Prepared by Checked by Approved by



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
$T_R 256 (V_{CC})$ SEQ LIGHTS PWR ( $V_M$ ). ELECT TIMER ( $V_M$ ).		
(a) ATT IND CNTL RETRO ( $V_{RCC}$ ). ACME INV ( $V_M$ ) or IGS Power Supply. (b) ATT IND CNTL RETRO ( $V_{RCC}$ ). IGS Power Supply only (not ACME). (c) ATT IND CNTL RETRO ( $V_{RCC}$ ). SEQ LIGHTS PWR ( $V_M$ ).		1. Not Abort Handle functions. 2. ACME Inverter and IGS Power Supply furnish AC power from ACME INV C/B and IGS Power fuse resp. 3. RETRO PWR Switch arms $V_{RCC}$ .
Same as (c).		
$T_R - 256 (V_{CC})$ SEQ LIGHTS PWR ( $V_M$ ). ELECT TIMER ( $V_M$ ).		1. Indicator light only. 2. Not an Abort function as batteries are on during launch.
SEQ LIGHTS CNTL ( $V_{CC}$ ). SEQ LIGHTS PWR ( $V_M$ ).		3. Green light will illuminate any time all 4 Main Batteries are on.
S/C 10      Rev A Date      7/1/66	Sequential Retro	GEMINI OPERATIONS HANDBOOK Section 2.1.3 Pg 2

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	③ <u>RCS</u> Amber Light -	(Reentry Control System Telelight Switch) T <sub>R</sub> -256 sec signal from the TRS illuminates amber light reminding the astro to depress Switch. (See remarks column.)
	Depress Switch -	Power RCS Ring A & B: (a) Pressure Isolation Squibs - pressurize fuel and oxidizer tanks. (b) Oxidizer Isolation Squibs - allow pressurized oxidizer to flow to thrust chamber valves. (c) Fuel Isolation Squibs allow pressurized fuel to flow to thrust chamber valves. (d) Disables amber light and initiates green light.
	Green Light -	Indicates at least one of the four relays which enable functions (a), (b), & (c) has been powered (at least one ring enabled at least one time).
Center Panel	④ <u>SEP OAMS LINE</u> Amber Light -	(Separate OAMS Line Telelight Switch) A T <sub>R</sub> -30 signal from the TRS illuminates the amber light reminding astro to depress switch.
Continued		
GEMINI OPERATIONS HANDBOOK Pg 3 Section 2.1.3	Flight Crew Support Division Mission Operations Branch	Prepared by <u>[Signature]</u> Checked by <u>[Signature]</u> Approved by <u>[Signature]</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
$T_R-256 (V_{CC})$ SEQ LIGHTS PWR ( $V_M$ ). ELECT TIMER ( $V_M$ ).		1. This function to be performed per the PRERETRO CHECKLIST and RCS operation verified at approximately $T_R-1$ hour.
(a), (b), & (c) RCS SQUIB 1 &/or 2 ( $V_{RQ1}$ &/or 2).  (d) RCS SQUIB 1 &/or 2 ( $V_{RQ1}$ &/or 2). ACME CNTL 1 ( $V_{CC}$ ). SEQ LIGHTS PWR ( $V_M$ ).		1. RCS Ring B isolation squibs can be redundantly fired prior to launch from the block house (however no green RCS light). 2. Squib power is thru fusistors. 3. These switch functions performed by the Abort Handle. 4. RETRO PWR Switch arms $V_{RQ1}$ & 2. 5. Each pyro is powered from redundant buses thru one dual bridgewire cartridge for each of the A, C, & D packages.
Same as (d).		Green light remains on for remainder of flight.
MAN RETRO ( $V_{RCC}$ ). SEQ LIGHTS PWR ( $V_M$ ). ELECT TIMER ( $V_M$ ).		1. This function to be performed per the $T_R-1$ (min) Checklist. 2. RETRO PWR switch must be ARMED to get TR-30 Amber Light.
Continued		Continued
S/C 10      Rev A Date 7/1/66	Sequential Retro	GEMINI OPERATIONS HANDBOOK Section 2.1.3 Pg 4

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
	Depress Switch -	<p>(a) Powers dual propellant line single cartridge, single bridgewire cutter/Sealers which cut and seal OAMS propellant lines on each side of the equipment adapt-retro adapt interface.</p> <p>(b) Powers 4 adapter equipment wiring pyro switch and 2 fuel cell power wiring pyro switch dual bridge-wire cartridges - thru 4 50-70 MS TD relays - disconnects wiring.</p> <p>(c) Powers LV-S/C wire guillotine single bridgewire 120 MS TD Cartridge-severs wiring.</p> <p>(d) Powers GLV-S/C wire guillotine single bridgewire 120 MS TD Cartridge-severs wiring.</p> <p>(e) Powers power wire guillotine single bridgewire 120 MS TD Cartridge-sever wiring.</p> <p>(f) Disables amber light and initiates green light.</p>
	Green Light -	Indicates that power has enabled at least one of the two propellant line guillotine igniters.
Center Panel	<p>⑤ <u>SEP ELECT</u> Amber Light -</p>	<p>(Separate Electrical Telelight Switch)</p> <p>A T<sub>R</sub>-30 signal from the TRS illuminates the amber light indicating to astros to depress switch.</p>
	Depress Switch -	<p>(a) Powers GLV-S/C wire guillotine single bridgewire cartridge - severs wiring.</p> <p>(b) Powers adapter equipment wire guillotine igniter - severs wiring.</p> <p>(c) Powers power wire guillotine igniter - severs wiring.</p>
Continued		
GEMINI OPERATIONS HANDBOOK Pg 5 Section 2.1.3	Flight Crew Support Division Mission Operations Branch	Prepared by <u>SLP</u> Checked by <u>SLP</u> Approved by <u>RB/3</u>





PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
		(d) Disables amber light and initiates green light.
	Green Light -	Indicates that functions (a), (b) & (c) of SEP ELECT and functions (c), (d), & (e) of SEP OAMS LINE have been enabled.
Center Panel	<u>SEP ADAPT</u> (6) Amber Light -	(Separate Adapter Telelight Switch) A T <sub>R</sub> -30 signal from the TRS illuminates the amber light indicating to astro to depress switch.
	Depress Switch -	(a) Ignites dual adapter shaped charges thru 2 single bridgewire and one dual bridgewire detonator-separates equipment adapter from the retro adapter at 2 stations near the interface.  (b) Initiates T/M of adapter shaped charge fire.  (c) Adapter shaped charge firing initiates firing of shaped charge tubing cutter via explosive interconnect. Shaped charge tubing cutter is also fired by a dual bridgewire cartridge powered thru a pole on each of the Adapter Shaped charge ignition relays.
	Green Light -	Indicates that at least 2 of the 3 separation sensors have been actuated by 1.5 inches of separation.
GEMINI OPERATIONS HANDBOOK Pg 7 Section 2.1.3		Flight Crew Support Division Mission Operations Branch Prepared by <u>SPJ</u> Checked by <u>ATB</u> Approved by <u>RGB</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(d) RETRO SEQ CNTL 1 &/or 2 ( $V_{RQ1}$ &/or 2) SEQ LIGHTS PWR ( $V_M$ )  Same as (d).		          NOTE: The SEP ELECT functions are redundant to functions (c), (d), & (e) of SEP OAMS LINES except there is no pyro time delay. The SEP OAMS LINE and SEP ELECT guillotines sever wiring on both sides of the equipment and retro adapters interface.
MAN RETRO ( $V_{RCC}$ ). SEQ LIGHTS PWR ( $V_M$ ). ELECT TIMER ( $V_M$ ).		1. This function to be performed per the $T_R$ -1(min) checklist. 2. RETRO PWR Switch must be armed to $T_R$ -30 amber lights.
(a) RETRO SEQ CNTL 2 ( $V_{RQ2}$ ).  (b) SEQ INST ( $V_{CC}$ ) RETRO SEQ CNTL 1 &/or 2 ( $V_{RQ1}$ &/or 2)	<u>T/M (D/T)</u>  Equipment section separated.	1. Igniters are powered thru fusistors. 2. These functions performed by the Abort Handle. 3. RETRO PWR Switch arms $V_{RQ1}$ & 2. 4. There are 3 igniters, each is capable of firing both shaped charges. Two of the igniters are powered from separate sources. The third igniter is powered from 2 sources.
RETRO SEQ CNTL 1 &/or 2 ( $V_{RQ1}$ &/or 2). SEQ LIGHTS PWR ( $V_M$ ).		
S/C 10      Rev A Date    7/1/66	Sequential Retro	GEMINI OPERATIONS HANDBOOK Section 2.1.3    Pg 8

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>ARM AUTO RETRO</u> Amber Light -	(Telelight Switch) A $T_R - 30$ signal from the TRS illuminates the amber light indicating to astro to depress switch.
	Depress Switch -	(a) Enables programmed TRS signal to fire retro rockets sequentially at time of retrograde. (b) Enables programmed TRS signal to disable power to the Platform Mode Switch (free platform). (c) Enables programmed TRS signal to power 45 sec TD relay which illuminates JETT RETRO amber light. (d) Enables programmed TRS signal to start the computer (into reentry equations) at $T_R = 0$ . (e) Redundantly enables T/M of each retro rocket fire. (f) Disables amber light and initiates green light.
	Green Ligh -	Indicates arming circuit is closed.
Center Panel	<u>MAN FIRE RETRO</u> <u>Switch</u> On -	(a) Initiates sequential firing of the retro rockets. (b) Disables Platform Mode Switch (free platform). (c) Enables power to 45 sec TD relay which illuminates JETT RETRO amber light. (d) Enables T/M of each retro rocket fire. (e) Manually starts computer (into reentry equations) if not done at $T_R = 0$ .
GEMINI OPERATIONS HANDBOOK Pg 9 Section 2.1.3		Flight Crew Support Division Mission Operations Branch Prepared by <u>SLB</u> Checked by <u>SLB</u> Approved by <u>SLB</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
MAN RETRO ( $V_{RCC}$ ). SEQ LIGHTS PWR ( $V_M$ ). ELECT TIMER ( $V_M$ ).		1. This function is to be performed per the $T_R$ -1(min) checklist. 2. RETRO PWR Switch must be armed to get $T_R$ -30 amber lights.
(a) AUTO RETRO ( $V_{RCC}$ ). ELECT TIMER ( $V_M$ ). (b) Same as (a). (c) Same as (a). (d) Same as (a). & IGS Power Fuse ( $V_M$ ) (e) AUTO RETRO ( $V_{RCC}$ ). SEQ INST ( $V_{CC}$ ). (f) AUTO RETRO ( $V_{RCC}$ ). SEQ LTS PWR ( $V_M$ ).	T/M (D/T) 1. Auto retro fire initiation. 2. Rocket No. 3 fire. 3. Rocket No. 2 fire. 4. Rocket No. 4 fire.	1. Power to ignite retro rockets is thru fusistors. The fusistors are armed by the RETRO ROCKET SQUIB Switches. 2. RETRO PWR Switch arms $V_{RCC}$ .
Same as (e).		
(a) MAN RETRO ( $V_{RCC}$ ). (b) Same as (a). (c) Same as (a). (d) MAN RETRO ( $V_{RCC}$ ). SEQ INST ( $V_{CC}$ ) (e) IGS Power Fuse ( $V_M$ ).	T/M (D/T) 1. Manual retro fire. 2. Rocket No. 3 fire. 3. Rocket No. 2 fire. 4. Rocket No. 4 fire.	1. Push button switch. 2. Power to ignite rockets is thru fusistors. 3. The fusistors are armed by the RETRO ROCKET SQUIB Switches. 4. RETRO PWR Switch arms $V_{RCC}$ .
S/C10 Date: Rev A 7/1/66	Sequential Retro	GEMINI OPERATIONS HANDBOOK Section 2.1.3 Pg10

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>JETT RETRO</u> 8 Amber Light -	(Jettison Retro Telelight Switch) Amber light 45 sec after retro fire initiation.
	Depress Switch -	<p>(a) Powers the Pyro Switch 80 MS TD dual bridgewire cartridge-disconnects wiring (including power to SEP OAM LINE, SEP ELECT, SEP ADAPT, ARM AUTO RETRO-green telelights, and JETT RETRO amber telelight.</p> <p>(b) Initiates the 3 Retro Adapter FLSC thru 3 dual bridgewire 160 MS TD detonators - severs all tubing wiring, and the 3 metal straps which hold the retro adapter and the S/C together.</p> <p>(c) There are also explosive interconnects between each FLSC.</p> <p>(d) Disables 16° pitch down bias to FDI's.</p> <p>(e) Switches roll channel of FDI's to MIX mode.</p> <p>(f) Turns off green IND RETRO ATT Telelight.</p> <p>(g) Initiates scanner head jettison (also scanner cover jettison if not previously accomplished. Need BOOST-INSERT Switch ARMED.)</p> <p>(h) Powers the docking bar Extend dual bridgewire cartridge (if not already extended) and ignites two 1 sec TD jettison cartridges.</p> <p>(i) Initiates redundant docking latch jettison cartridges (2/latch) if not already accomplished and fires redundant cable cutter 2 sec TD cartridges (2/door) which enable the latch doors to function.</p>
Left Sw C/B Panel	<u>RETRO ROCKET</u> <u>SQUIB</u> Arm - Safe -	<p>(Switches 1, 2, 3, 4) Four Switches (one for each retro rocket).</p> <p>Arms fusistors which ignite retro rockets.</p> <p>No power to fusistors.</p>
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
<p>SEQ LIGHTS PWR (<math>V_M</math>). MAN &amp;/or AUTO RETRO (<math>V_{RCC}</math>).</p> <hr/> <p>(a) RETRO SEQ CNTL 1 &amp;/or 2 (<math>V_{RQ1}</math> &amp;/or 2)</p> <p>(b) Same as (a).</p> <p>(d) RETRO SEQ CNTL 1 &amp;/or 2 (<math>V_{RQ1}</math> &amp;/or 2) ATT IND CNTL RETRO (<math>V_{RCC}</math>).</p> <p>(e) Same as (d). (f) Same as (a). (g) RETRO SEQ CNTL 1 &amp;/or 2 (<math>V_{RQ1}</math> &amp;/or 2)</p> <p>(h) Same as (g). (i) Same as (g).</p>		<p>1. The pyro devices are powered from <math>V_{RJQ1}</math> &amp; 2 thru fusistors. <math>V_{RJQ1}</math> &amp; 2 are armed by the RETRO JETT Switch.</p> <p>2. Retro Power Switch arms <math>V_{RQ1}</math> &amp; 2, <math>V_{RCC}</math>, and the RETRO JETT Switch. Thus both the RETRO PWR &amp; JETT Switch must be armed.</p> <p>3. Function (a): This igniter is powered redundantly.</p> <p>4. Function (b): There are 3 igniters. Each igniter is capable of firing each shaped charge. Each igniter is powered redundantly.</p> <p>5. Functions (h) and (i) Not an abort function. <u>Fairing Jettison must be accomplished to enable.</u> The docking bar extend cartridge is powered redundantly. Each jettison cartridge (docking bar and latches) is powered by a separate source. Each redundant cable cutter cartridge is powered by a separate source.</p>
$V_{RQ1}$ &/or 2		RETRO POWER Switch arms $V_{RQ1}$ & 2
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Pedestal 1.1.5	<u>HI ALT DROGUE Switch</u> Push on -	<p>(a) Powers dual drogue chute mortar 0.5 sec TD cartridge - mortar deploys the 8.3 feet drogue chute.</p> <p>(b) Powers dual cabin air inlet door igniters - jettisons Inlet Snorkel fairing.</p>
Pedestal	<u>PARA</u> Push on -	<p>(Parachute Switch)</p> <p>(a) Powers 3 drogue chute disconnect guillotines (80 MS TD). This cuts the drogue bridle at its 3 attach points releasing the bridle, allowing the drogue to deploy the 18 ft pilot chute. (Each guillotine has two separate 80 MS TD cartridges ignited by separate sources.) The pilot chute is dereefed 6 sec after deployment.</p> <p>After a 2.5 sec TD:</p> <p>(b) Powers R &amp; R section pyro switch dual bridgewire cartridge - disconnects wiring. (The cartridge is redundantly powered thru a 60 MS TD relay).</p> <p>(c) Powers dual R &amp; R section wire guillotines (thru a 120 MS TD single bridgewire cartridge) - severs wiring on each side of R &amp; R section - S/C interface.</p> <p>(d) Powers dual R &amp; R section coax guillotines (120 MS TD) - severs coax cables on each side of R &amp; R section - S/C interface.</p> <p>(e) Powers dual R &amp; R section mild detonating fuse cord</p> <p>Continued</p>
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) LANDING SEQ CNTL 1 &/or 2 ( $V_{LQ1}$ &/or 2) (b) Same as (a).	<u>T/M (D/T)</u> Drogue chute deployed.	<ol style="list-style-type: none"> <li>1. Deploy at 50K ft. max. on normal re-entry, 40K ft. max. on all aborts. Indicator light on at <math>40K \pm 2K</math> ft (reminds astro to deploy drogue). Manual deployment capability only.</li> <li>2. Pyro devices powered thru fusistors.</li> <li>3. Guarded push button Switch.</li> <li>4. LANDING Switch arms <math>V_{LQ1}</math> &amp; 2.</li> <li>5. T/M is initiated by actuation of limit switches &amp; requires SEQ INST C/B.</li> <li>6. Each cartridge is powered from a separate source.</li> <li>7. Drogue chute dereefed about 17 sec after switch is depressed.</li> <li>8. The drogue chute is of subsonic design and should not be deployed until s/c velocity is below Mach 1.</li> </ol>
LANDING SEQ CNTL 1 &/or 2 ( $V_{LQ1}$ &/or 2).	<u>T/M (D/T)</u> <ol style="list-style-type: none"> <li>1. Pilot chute deployed.</li> <li>2. Drogue chute release.</li> </ol>	<ol style="list-style-type: none"> <li>1. Astro should deploy at 11K feet. Indicator light on at 10.6K feet (reminds astro to deploy main chute). Manual deployment capability only.</li> <li>2. Pyro devices powered thru fusistors.</li> <li>3. Push button Switch.</li> <li>4. LANDING Switch arms <math>V_{LQ1}</math> &amp; 2.</li> <li>5. T/M is initiated by limit switches (Pilot chute deploy) &amp; relays (Drogue release). SEQ INST C/B required for T/M.</li> </ol>
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(CONTINUED)

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
		<p>igniters (160 MS TD) - separates the R &amp; R section from the S/C. The pilot chute then retards the R &amp; R section providing the separation velocity from the reentry module to deploy the main chute. The main chute is dereefed 10 seconds after deployment.</p> <p>(f) Selects Descent Antenna for Quadriplexer.</p> <p>(g) Powers Umbilical pyro switch dual bridgewire cart-ridge - disconnects reentry umbilical wiring.</p>
Pedestal	<u>LDG ATT</u> Push on -	<p>(Landing Attitude Switch)</p> <p>Initiates main chute single point release to obtain bridle suspension landing attitude.</p> <p>Single point release in turn extends descent and recovery antennas.</p>
Pedestal	<u>PARA JETT</u> Push on -	<p>(Parachute Jettison Switch)</p> <p>(a) Powers main chute fore and aft jettison pyros - releases the main chute.</p> <p>(b) Powers hoist loop flashing recovery light release c/c- automatically extends hoist loop and flashing recovery light.</p>
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
		9. Function (f) & (g): Each function is enabled by redundant relays. 10. Pilot chute is dereefed about 7.5 sec after the switch is depressed. Thus the pilot chute deploys the R & R section while in the reefed position.
LDG SEQ CNTL 1 &/or 2 ( <sup>V</sup> <sub>LQ1</sub> &/or 2).		1. Astro initiates single point release when he observes main chute has been deployed and has been dereefed. 2. No communications should be attempted (except C-Band Beacon) between R & R section separation and single point release as no antennas are available. 3. Push button switch. 4. Pyro devices powered thru fusistors. 5. The single point release is initiated by two single bridgewire cartridges powered from separate sources. 6. The crew should be prepared the shock of single point release.
(a), (b) LANDING SEQ CNTL 1 &/or 2 ( <sup>V</sup> <sub>LQ1</sub> &/or 2).		1. LANDING Switch arms <sup>V</sup> <sub>LQ1</sub> & 2. 2. Pyro devices powered thru fusistors. 3. Push button switch. 4. Function (a) & (b) There are two cartridges in each device (fwd disconnect, aft disconnect, and release cable cutter). Two 6 pole relays power these six cartridges.
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PANEL LOCATION	NAME AND POSITION	FUNCTION
SECTION I PAGE		
Left Astro Panel	<u>EMERG PRE-MAIN</u> On -	<p>(Emergency Pre-Main Switch)</p> <p>(a) Initiates pilot chute apex cable guillotine thru 2 single bridgewire cartridges - cuts connecting line between drogue and pilot chutes.</p> <p>(b) Powers 3 drogue chute disconnect guillotines (80 MS TD). This cuts the drogue bridle at its 3 attach points releasing the bridle (Each guillotine has two separate 80 MS TD cartridges ignited by separate sources).</p> <p>(c) Pilot chute mortar thru 2 single bridgewire 0.5 sec TD cartridges - deploys pilot chute. 2.5 seconds after switch is depressed:</p> <p>(d) Powers R &amp; R section pyro switch dual bridgewire cartridge - disconnects wiring. (The cartridge is redundantly powered thru a 60 MS TD relay).</p> <p>(e) Powers dual R &amp; R section wire guillotines (thru a 120 MS TD single bridgewire cartridge) - severs wiring on each side of R &amp; R section - S/C interface.</p> <p>(f) Powers dual R &amp; R section coax guillotines (120 MS TD) - severs coax cables on each side of R &amp; R section - S/C interface.</p> <p>(g) Powers dual R &amp; R section mild detonating fuse cord igniters (160 MS TD) - separates the R &amp; R section from the S/C. The pilot chute then retards the R &amp; R section providing the separation velocity from the reentry module to deploy the main chute. The main chute is dereefed 10 seconds after deployment.</p> <p>(h) Selects Descent Antenna for Quadriplexer.</p> <p>(i) Powers Umbilical pyro switch dual bridgewire cartridge - disconnects reentry umbilical wiring.</p>
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) thru (g) LDG SEQ CNTL 1 &/or 2 ( <sup>V</sup> <sub>LQ1</sub> &/or 2).	<u>T/M (D/T)</u> 1. Drogue chute deployed. 2. Pilot chute deployed. 3. Drogue chute release.	1. Should the drogue chute be unsuccessful- fully deployed, the EMERG PRE-MAIN. Switch should be used at 11K feet, instead of the PARA. This would jettison the malfunctioned drogue chute and mortar deploy the pilot chute and thus the main chute. 2. LANDING Switch arms <sup>V</sup> <sub>LQ1</sub> & 2. 3. Pyro devices are powered thru fusistors fusistors. 4. T/M is initiated by actuation of limit Switches. (Drogue & Pilot chute deploy & relays (Drogue Chute release) 5. Functions (a) & (c): The guillotine and mortar are each redundantly powered. 6. Functions (b), (d), (e), (f), (g), (h) & (i): Same redundancy as in PARA Switch functions. 7. SEQ INST C/B ( <sup>V</sup> <sub>CC</sub> ) required for T/M only.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Astro Panel	<u>40K Amber Light</u> On -	Indicator light to remind astro to deploy drogue chute.
Left Astro Panel	<u>10.6K Amber Light</u> On -	Indicator light to remind astro to deploy main chute.
<div> <div>GEMINI OPERATIONS HANDBOOK Pg 7 Section 2.1.4</div> <div> Flight Crew Support Division Mission Operations Branch </div> <div> Prepared by _____  Checked by _____  Approved by <u>12/7/63</u> </div> </div>		



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
SEQ LIGHT PWR ( $V_M$ ). PARA CNTL ( $V_{LCC}$ ).		Light actuated at $40K \pm 2K$ via a barostat. Barostat armed by LANDING Switch. Returning the LANDING Switch to SAFE turns the light off.
SEQ LIGHTS PWR ( $V_M$ ). PARA CNTL ( $V_{LCC}$ ).		Light actuated at $10.6K \pm .75K$ via a barostat. Barostat armed by LANDING Switch. Returning the LANDING Switch to SAFE turns the light off.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Astro Panel	<u>ALT</u>  	(Altimeter) Standard 3-pointer aircraft altimeter. Warning marker appears between 84K & 116K ft. & below 16, 000 ft.
	Zero Adjust Knob	Adjusts "zero" to barometric pressure (31.0 to 28.1 inches Hg).
Left Sw C/B Panel	<u>SEQ LIGHTS</u> Bright - Dim -	(Sequential Lights Switch) Selects intensity of Sequential Telelights and DCS light (bright light power is thru a diode; dim light power is thru a resistor).
Left Astro Panel	<u>DESCENT</u> 	(Rate of Descent Indicator) Indicates vertical velocity component of the reentry module. Condition of the main chute should also be checked visually. (See remarks column)
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
		Readings are not valid above 60K feet. The nominal drogue deployment altitudes of 50K ft. and 40K ft. <u>Indicated</u> altitudes for normal reentry and Mode II Abort reentry; respectively, have been chosen taking into account aerodynamic effects and should be adhered to.
		The altimeter should be set to 29.92 in. Hg (Standard S.L. pressure alt.) in the event that the local barometric pressure is not available to the crew.
SEQ LIGHTS PWR ( $V_M$ ).		All the lights are not powered from the same resistor - diode combination. Resistor -                      Lights Powered Diode A              JETT RETRO. B              SEP OAMS LINES, SEP ELECT. SEP ADAPT, & ARM AUTO RETRO. C              SEP SPCFT (green light). D              IND RETRO ATT. E              BTRY PWR F              O <sub>2</sub> HIGH RATE (Amber)  H              RCS.
		1. Indication will vary from nominal as follows: a. 5 fps higher at 10K ft than at sea level. b. Higher when density is less than at standard. c. <u>Indicator tolerance (- 4 ft/sec)</u>
		2. Because of these effects, an instrument which correctly reads 30 fps at sea level on a standard day could read as much as 40 fps when the parachute becomes fully inflated.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Sw C/B Panel	Circuit Breaker <u>AUTO-RETRO</u> Closed -	No. 4-1 ( $V_{RCC}$ ) (a) Powers ARM AUTO RETRO Switch. (b) Enables Abort Handle to salvo fire retro rockets in conjunction with RETRO SEQ CNTL 1, RCS SQUIB 1, and BOOST-INSERT CNTL 1 C/B's. (c) Powers 45 sec TD relay which enables JETT RETRO amber light. (d) Enables TR timer relay to switch platform to "Free"
Left Sw C/B Panel	Circuit Breaker <u>MAN RETRO</u> Closed -	No. 4-2 ( $V_{RCC}$ ) (Manual Retro) (a) Powers MAN FIRE RETRO Switch. (b) Enables Abort Handle to salvo fire retro rockets in conjunction with RETRO SEQ CNTL 2, RCS SQUIB 2, and BOOST-INSERT CNTL 2 C/B's. (c) Enables programmed $T_R$ -30 signal from TRS to illuminate amber SEP OAMS LINE, SEP ELECT, SEP ADAPT, and ARM AUTO RETRO Telelights. SEQ LIGHTS PWR C/B also needed. (d) Enables MAN FIRE RETRO Switch to start Computer. (e) Powers 45 sec TD relay which enables JETT RETRO amber light. (f) Enables TR Timer relay to switch platform to "Free"
Left Sw C/B Panel	Circuit Breaker $T_R$ 256 Closed -	No. 8-16 ( $V_{CC}$ )  Enables programmed $T_R$ -256 signal from TRS to illuminate amber IND RETRO ATT, BTRY PWR, and RCS Telelights. SEQ LIGHTS PWR, and ELECT TIMER C/B's also needed.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Sw C/B Panel	Circuit Breaker <u>SEQ LIGHTS PWR</u> Closed -	No. 6-1 ( $V_M$ )  (a) Powers sequential telelights (thru SEQ LIGHTS Switch).  (b) Powers 40K and 10.6K amber lights (thru barostats). PARA CNTL C/B also needed. (c) Powers $O_2$ HIRATE light ( $O_2$ RATE CNTL C/B also req'd) (d) Powers MAP light while docked.
Left Sw C/B Panel	Circuit Breaker <u>SEQ LIGHTS CNTL</u> Closed -	No. 1-13 ( $V_{CC}$ )  (a) Enables green BTRY PWR Telelight thru MAIN BATTERY Switches when all 4 switches are on. (b) Controls T/M of $V_{CC}$ voltage.
Left Sw C/B Panel	Circuit Breaker <u>PARA CNTL</u> Closed -	No. 5-80 ( $V_{LCC}$ ) (Parachute Control)  Enables 40K and 10.6K amber lights (thru barostats). SEQ LIGHT PWR C/B also needed.
Left Sw C/B Panel	Circuit Breaker <u>ATT IND CNTL</u> <u>RETRO</u> Closed -	No. 12-7 ( $V_{RCC}$ ) (Attitude Indicator Control Retro) (a) Powers IND RETRO ATT Telelight Switch. (b) Enables functions (d), & (e) of the JETT RETRO Telelight Switch. RETRO SEQ CNTL C/B also needed.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Sw C/B Panel	Circuit Breaker <u>ATT IND CNTL LDG</u> Closed -	No. 12-8 (V <sub>CC</sub> ) (Attitude Indicator Control Landing) (a) Powers horizon scanner ignore relay (allows scanner ignore signal to be sent to the IMU and ACE). SCAN HTR C/B also needed. (b) Enables ascent scale factor signal to left and right FDI's (thru COMPUTER Mode Switch in ASCENT position) until S/C SEP.
Left Sw C/B Panel	Circuit Breaker <u>BOOST-INSERT</u> <u>CNTL 1 &amp; 2</u> Closed -	No. 3-1 and 3-11 (V <sub>BIAQ1 &amp; 2</sub> )  Each C/B powers: (a) SEP SPCFT Telelight Switch. (b) JETT FAIRING Switch. (c) SEP S/C limit switches. (d) Abort Handle (ABORT position).

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Sw C/B Panel	Circuit Breaker <u>RETRO-SEQ CNTL 1 &amp; 2</u> Closed -	No. 4-3 and 4-28 (V <sub>RQ1</sub> & 2)  Each C/B enables Abort Handle to: (a) Power SEP OAMS LINE, SEP ELECT, and SEP ADAPT Telelight Switches in conjunction with BOOST-INSERT CNTL 1 & 2, and RCS SQUIB C/B's. (b) Disable PLATFORM Mode Switch in conjunction with BOOST-INSERT CNTL 2, RCS SQUIB 2, RETRO SEQ CNTL 2, and MAN RETRO C/B's.  Each C/B powers: (c) SEP OAMS LINE Telelight Switch. (d) SEP ELECT Telelight Switch. (e) SEP ADAPT Telelight Switch. (f) JETT RETRO Telelight Switch. (g) Equipment Adapter separation limit switches.
Left Sw C/B Panel	Circuit Breaker <u>LDG SEQ CNTL 1&amp;2</u> Closed -	No. 5-2 and 5-33 (V <sub>LQ1</sub> & 2) (Landing Sequential Control 1 & 2)  Each C/B powers: (a) DROGUE Switch. (b) PARA Switch. (c) EMERG PRE-MAIN Switch. (d) LDG ATT Switch. (e) PARA JETT Switch.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Sw C/B Panel	Circuit Breaker <u>SEQ INST</u> Closed -	<p>No. 9-19 (<math>V_{CC}</math>) (Sequential Instrumentation) Provides T/M of:</p> <ul style="list-style-type: none"> <li>(a) GLV - S/C separation</li> <li>(b) Booster cut-off command.</li> <li>(c) Astro actuated abort.</li> </ul> <p>BOOST-INSERT CNTL 1 &amp;/or 2 and BOOST CUT-OFF 1 &amp;/or 2 C/B's also needed for a, b, and c.</p> <ul style="list-style-type: none"> <li>(d) Equip Section separation.</li> <li>(e) Emer retro salvo relay.</li> <li>(f) Auto retrofire initiation.</li> <li>(g) Manual retrofire initiation.</li> <li>(h) Retro rocket No. 2 fire.</li> <li>(i) Retro rocket No. 3 fire.</li> <li>(j) Retro rocket No. 4 fire.</li> <li>(k) Drogue chute deployed.</li> <li>(l) Pilot chute deployed.</li> <li>(m) Drogue chute released.</li> <li>(n) Left and right eject seats gone.</li> <li>(o) <math>O_2</math> High Rate.</li> <li>(p) IGS pitch, roll, &amp; yaw attitudes (thru platform mode switch.)</li> </ul>

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## SEQUENTIAL

### NOTES

1. All Sequential Telelights have dual bulbs.
2. SEP SPCFT Telelight Switch

There are 3 separate spacecraft limit switches located 120° apart. Closure of at least 2 of the switches will illuminate the green SEP SPCFT Telelight. Indications that the pyros have fired are:

Audio cue.

Full scale failure of Stage II fuel and oxid gauge.

Engine 2 light goes out.

3. RCS Telelight Switch

The RCS Telelight Switch fires RCS Ring A & B isolation squibs. The green RCS Telelight will illuminate if at least one ring is activated by the telelight switch or the ABORT handle.

4. SEP OAMS LINE & SEP ELECT Telelight Switches

The SEP OAMS LINE wire guillotines sever the wiring on the equipment adapter side of the equip adapter-retro adapter interface. The SEP ELECT wire guillotines sever the same wiring on the retro adapter side of the interface. The SEP OAMS LINE green light will illuminate if the OAMS tubing cutter/sealer firing is enabled. However, the SEP ELECT green light will illuminate only if both fore and aft guillotine firing is enabled. Thus it is possible that the wires could be severed, yet there would be no green SEP ELECT light. Indications that the pyros fired are:

Audio cue.

PROP QTY gauge fails rapidly to "0".

PRIMARY ECS O<sub>2</sub> and OAMS PROP pressure gauges fail to "0".

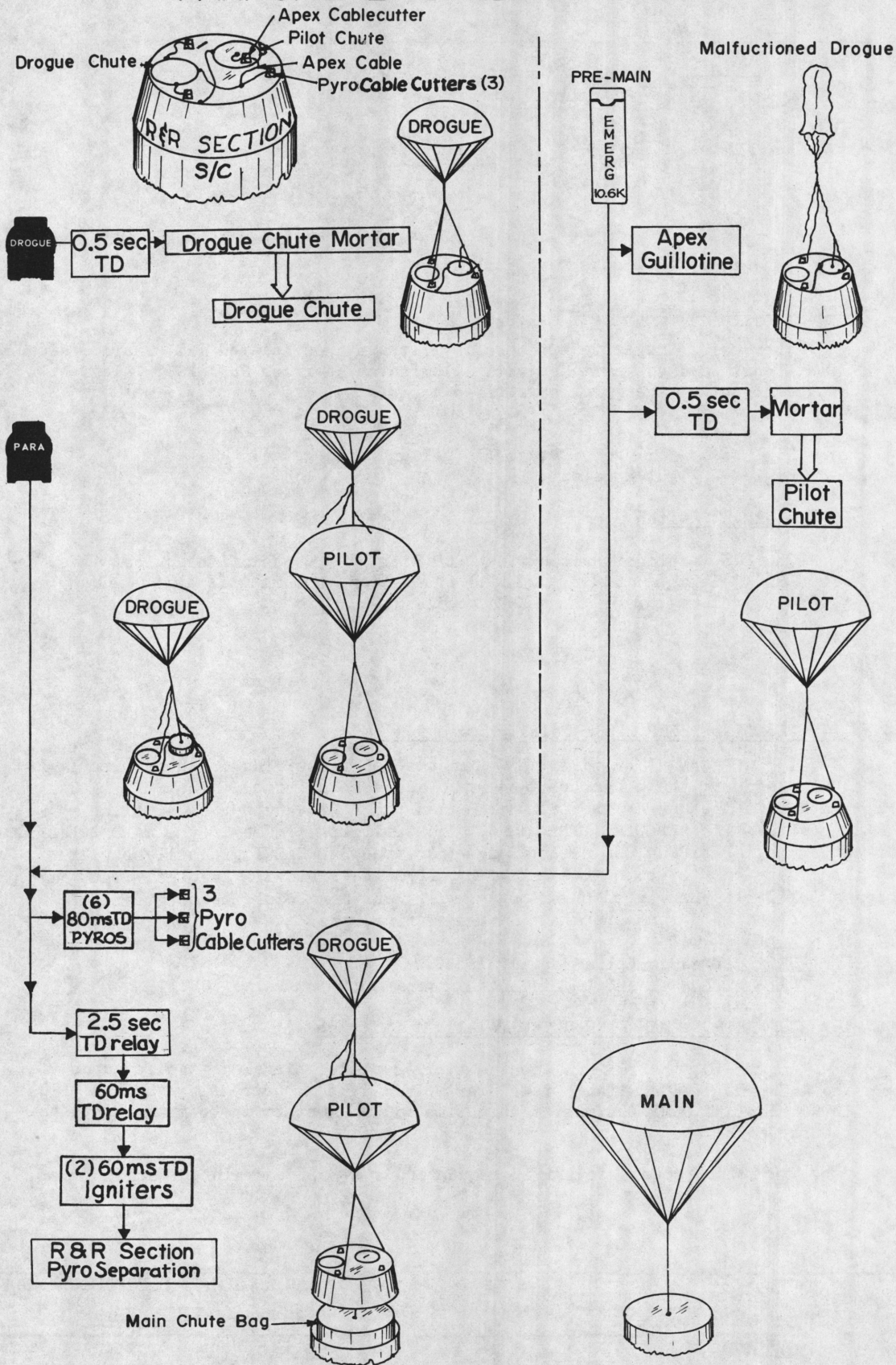
5. ARM AUTO RETRO & MAN FIRE RETRO Telelight Switches

At  $T_D = 0$ , the TRS will send a start computer signal to the computer via the ARM AUTO RETRO Switch (Green Start COMP Light). Depressing the MAN FIRE RETRO or START COMP Buttons at this time will also start the computer into the reentry equations.

The retro rockets are fired sequentially at 5.5 sec. intervals.

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# PARACHUTE LANDING SYSTEM





## EJECTION SEAT

### NOTES

#### 1. D-Ring

During an ejection, the following sequence of events occurs:

- (a) The D-Ring is pulled upward to initiate the ejection sequence. This action ignites an explosive charge in the initiator. Astro continues to hold D-Ring to prevent arm flailing. (hatch pawls must be in neutral before ejection)
- (b) A pressure wave is generated thru mild detonator fuse into both hatch actuators and ignites the breech gas generator causing the hatch to be unlatched and the stroke of the hatch actuator to begin. Hatches are automatically locked in open position when actuators reach full travel.
- (c) When hatch actuators reach approximately 0.5 inches from full travel, the gas being generated is also directed to the catapult firing mechanism of each seat.
- (d) The catapult firing mechanism initiates the primer which ignites the catapult main charge, ejecting the seat from the spacecraft. This trips a switch in the instrumentation circuitry, which transmits a signal to ground stations, indicating astronaut ejection.
- (e) 6.5 to 7.0 inches from the end of the catapult stroke, hot gases from the catapult main charge cause ignition of the sustainer rocket which is utilized to provide additional clearance from the spacecraft proper.
- (f) As the seat leaves the spacecraft, a 1.08 second delay cartridge is ignited, which at runout initiates seat-man separation. One additional S/c-to-seat lanyard is actuated disconnecting the S/C oxygen supply to the pressure suit.
- (g) Following seat-man separation above 7,500 feet, the ballute is deployed to stabilize the astronaut's free fall. Deployment is initiated by means of a lanyard attached to the seat. At 7,500 feet, the ballute release cuts the ballute riser and allows the ballute to pull free. Below 7,500 feet, the ballute is not deployed but the riser is cut as a safety precaution.
- (h) After free-falling to  $5,700 \pm 600$  feet, parachute deployment is initiated by an aneroid altitude sensor. Backup deployment is provided by manual drogue mortar actuation (T handle).
- (i) Five seconds after drogue gun fires, the backboard and egress kit are automatically jettisoned. The ECS hoses and communication lines are separated from the egress kit automatically at this time.

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## 2. Ditch Handle

- (a) Releases the backboard, egress kit, and "drogue" mortar barostat arming cable from the seat.
- (b) Used for overside bail-out or to provide access to the survival kit.
- (c) Used in the event of failure of the Harness Release Actuator.

## 3. Shoulder Strap Inertial Reel Handle

Manual Lock (handle forward) - Astro's shoulders are restrained from moving forward. The lock ratchets permitting the astro to move backwards but not forwards used during launch and descent.

Automatic Lock (handle aft) - Allows astro to move forward; but locks with a shock of 3 g's. In the automatic lock, the lock ratchets permitting the astro to move backward but not forward. The automatic lock can be released by cycling the control handle.

## 4. T-Handle

Lanyard used to fire "drogue" mortar if barostat fails to do so ("drogue" mortar deploys the chute).

## 5. Survival Kit and Survival Kit Lanyard

The survival kit consists of 2 separate packages, one on the front side (A) and one on the back side (B) of the backboard. The survival kit lanyard connects the survival kit to the astro's harness. It can be used to open the survival kit in the S/C (postlanding). For aborts, the survival kit is automatically opened as the backboard is jettisoned. This allows the life raft and rucksack to fall out of package B and allows the water container and machete to fall out of package A. Each of the above contents is attached to the lanyard.

The rucksack contains:

- |                          |  |
|--------------------------|--|
| 1. Signal mirror         | 11. Knife blade  |
| 2. Fishing hooks         | 12. Sunglasses   |
| 3. Sewing kit            | 13. Radio/beacon   |
| 4. Nylon line            | 14. Medication kit   |
| 5. Fire starter and fuel | a. 6 tablet packets  |
| 6. Whistle               | b. 1 small injector  |
| 7. Compass               | c. 1 large injector  |
| 8. Desalter kit          | d. 1 compress, 3" x 3", wrapped with 12" x 12" aluminum foil |
| 9. Strobe light          | e. Zinc oxide ointment                                       |
| 10. Flashlight           |  |

Note: The Radio/Beacon incorporated into the survival package is automatically switched to DF Mode by a lanyard at seat-man separation.

Package A contains:

- 1. Machete and sheath
- 2. Water container with  
3 lbs. of water

The life raft contains:

- 1. CO<sub>2</sub> cylinder and valve
- 2. Sea anchor
- 3. Lanyard retainer ring
- 4. Sponge pad
- 5. Sea dye markers (2)
- 6. Sun bonnet

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9. Lap Belt

Holds the astronaut in the seat. After seat-man separation or the ditching handle is actuated, it holds the egress kit and the bottom of the boackboard to the astronaut.

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SEQUENCE TIMES FOR ABORTS AT 5,700  $\pm$  600 FEET OR BELOW

GEMINI EJECTION SEAT

Nominal Elapsed Time (Sec)	Action
0.0	Initiation of ejection sequence (pulling of D-Ring).
.001	Initiation of Hatch Actuator
.260	Hatch fully open and catapult initiated.
.333	Initiation of Harness Release Actuator.
.394	Catapult stroke complete (seat has about 4 inches of travel to end of rail) and rocket ignited.
.664	Rocket web burnout.
1.418	Harness Release Actuator fires (harness released).
1.508	Seat-man separation complete. Radio/Beacon is actuated. At this time the ballute release barostat actuates to lock out the ballute deploy actuator and to cut the ballute riser, insuring that the ballute is not deployed. Parachute drogue mortar 2.3 second delay is initiated.
3.808	Drogue mortar slug is fired.
6.808	Parachute fully inflated.
8.808	Backboard and Egress Kit are jettisoned.

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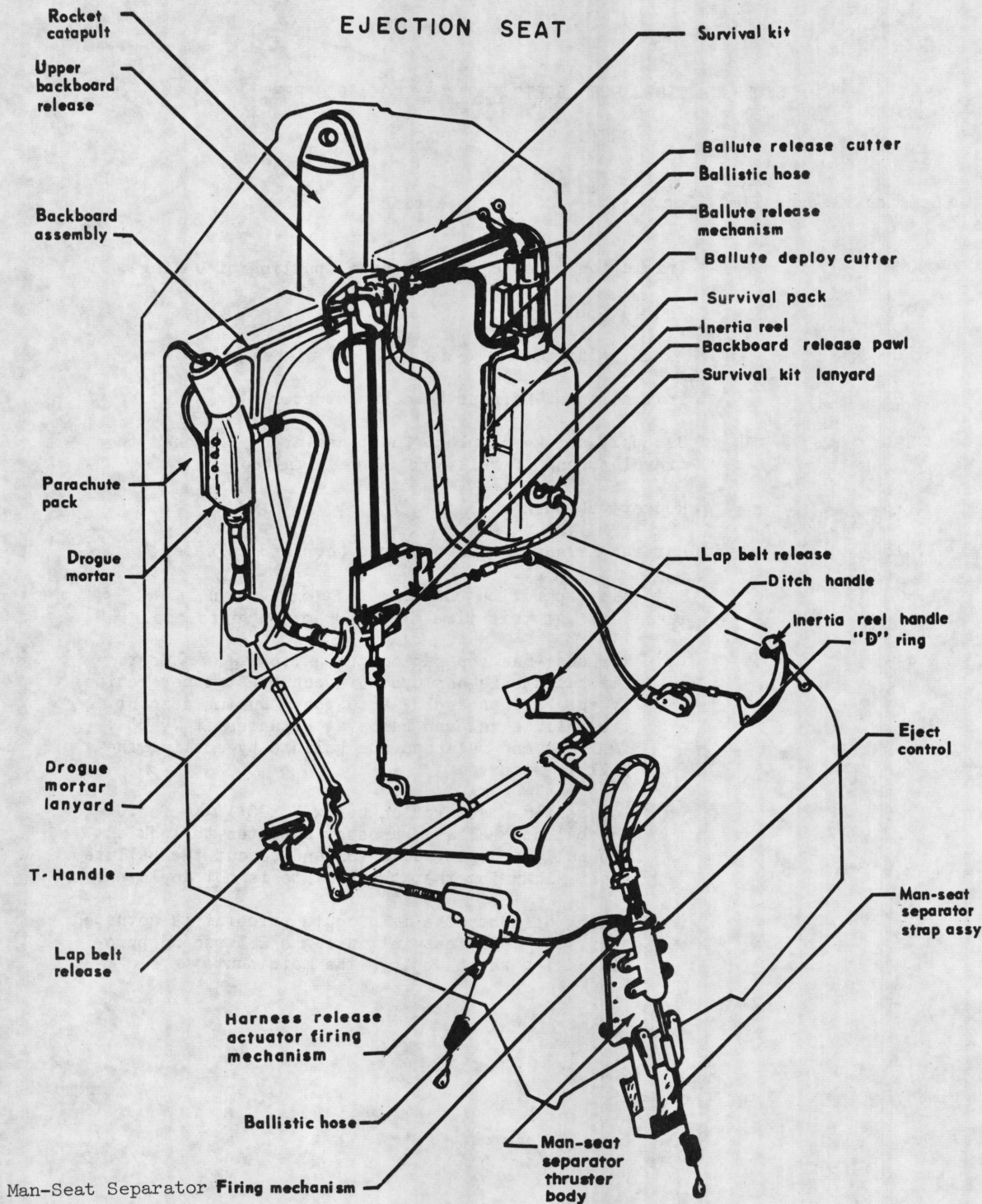
# SEQUENCE TIMES FOR ABORTS ABOVE 5,700 $\pm$ 600 FEET

## GEMINI EJECTION SEAT

Nominal Elapsed Time (Sec)	Action
0.0	Initiation of ejection sequence (pulling of D-Ring).
.001	Initiation of Hatch Actuator.
.260	Hatch fully open and catapult initiated.
.333	Initiation of Harness Release Actuator.
.394	Catapult stroke complete (seat has about 4 inches to travel to end of rail) and rocket ignited.
.664	Rocket web burnout.
1.418	Harness Release Actuator fires (harness released).
1.508	Seat-man separation complete. Radio/Beacon is actuated. At this time the following events occur:
6.499	<p>(a) For seat-man separation above 7,500 <math>\pm</math> 700 feet, the ballute is deployed 5 seconds after separation by the ballute deploy actuator. During descent the ballute release barostat actuates at 7,500 <math>\pm</math> 700 feet and releases the ballute by cutting the ballute riser.</p> <p>(b) For seat-man separation below 7,500 <math>\pm</math> 700 feet, the ballute release barostat actuates to lock out the ballute deploy actuator and to cut the ballute riser, insuring that the ballute is not deployed.</p> <p>(c) During descent, the main chute barostat is actuated at 5,700 <math>\pm</math> 600 feet initiating a 2.3 second pyro time delay which deploys the main chute.</p>

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# EJECTION SEAT



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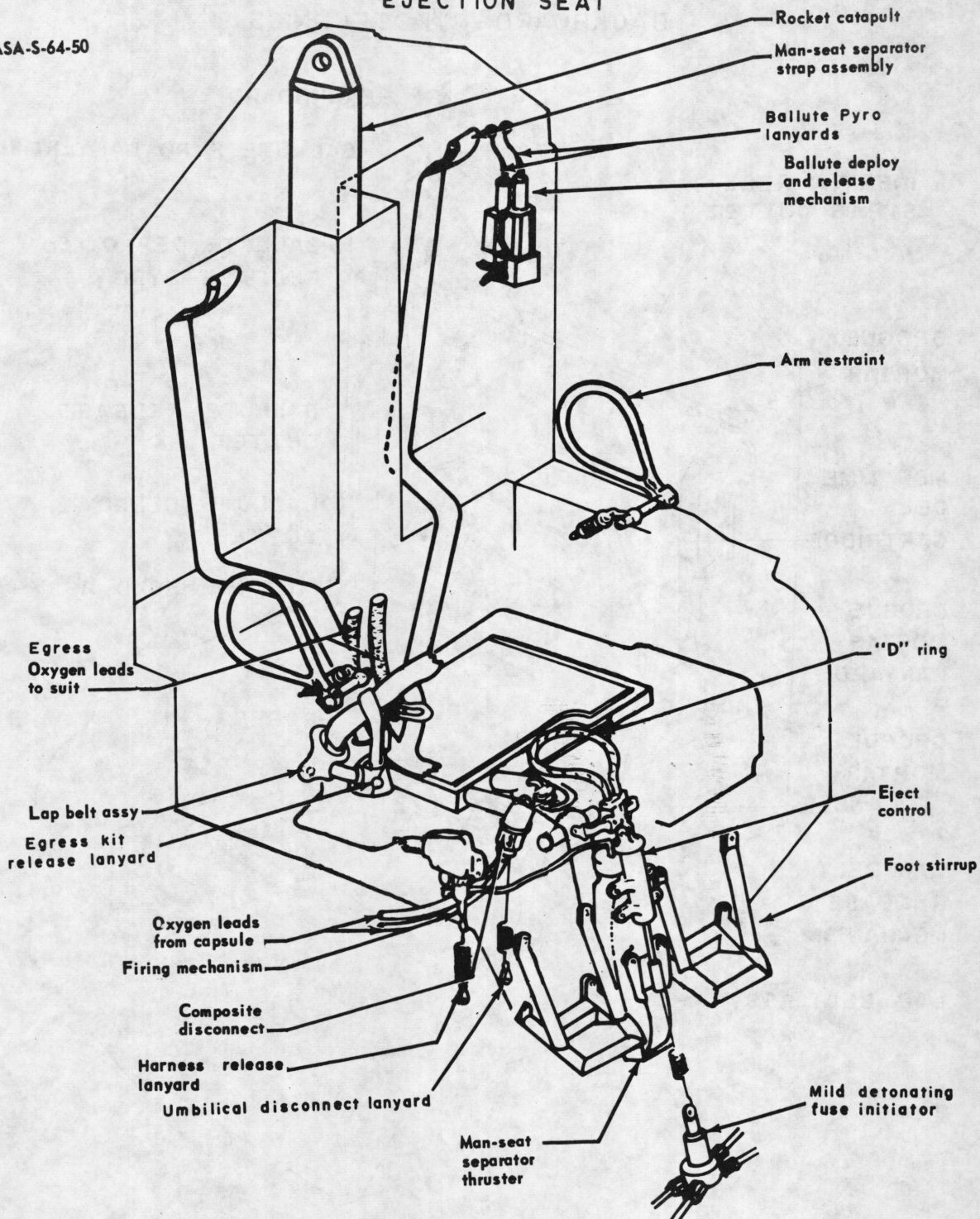
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# EJECTION SEAT

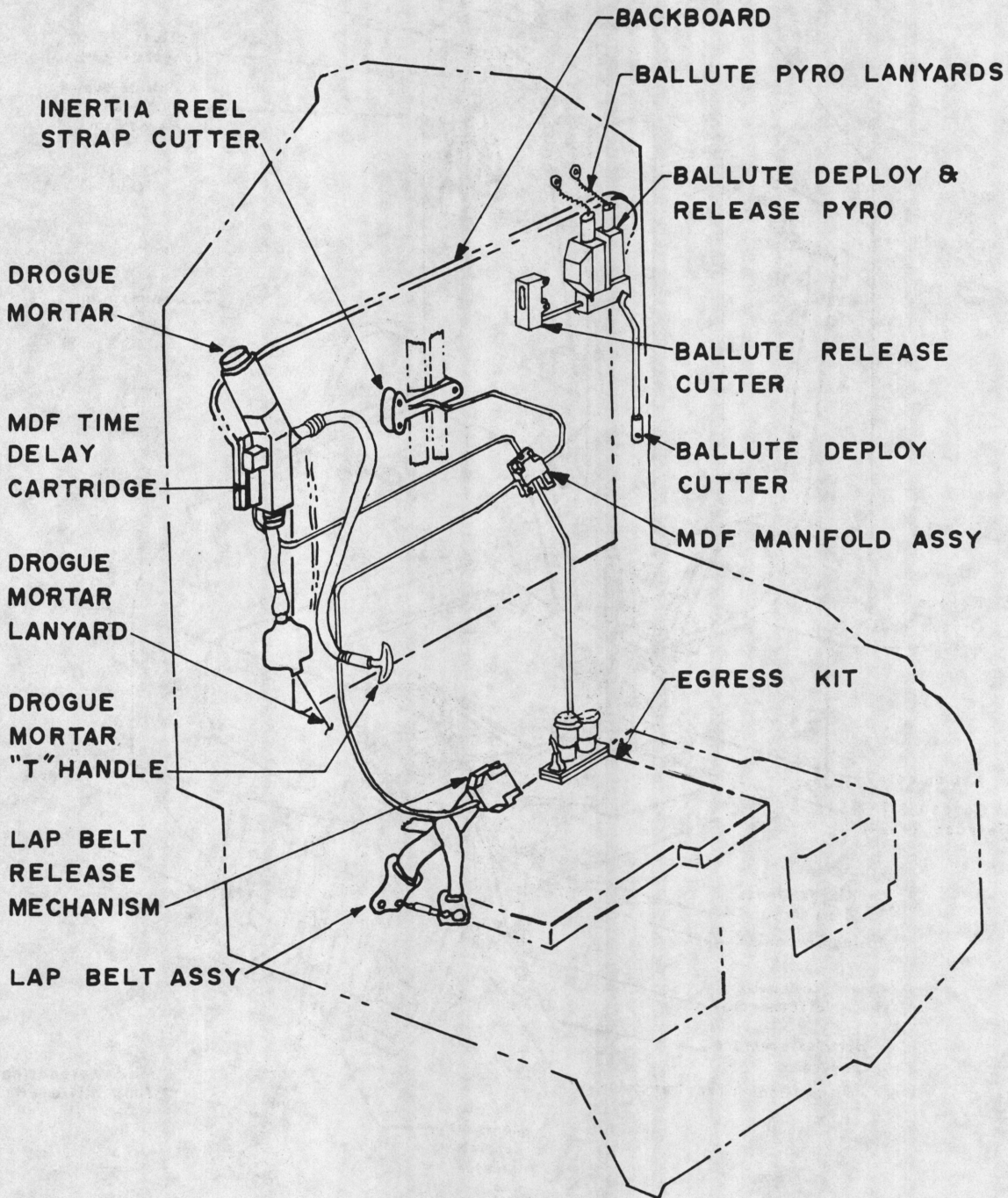


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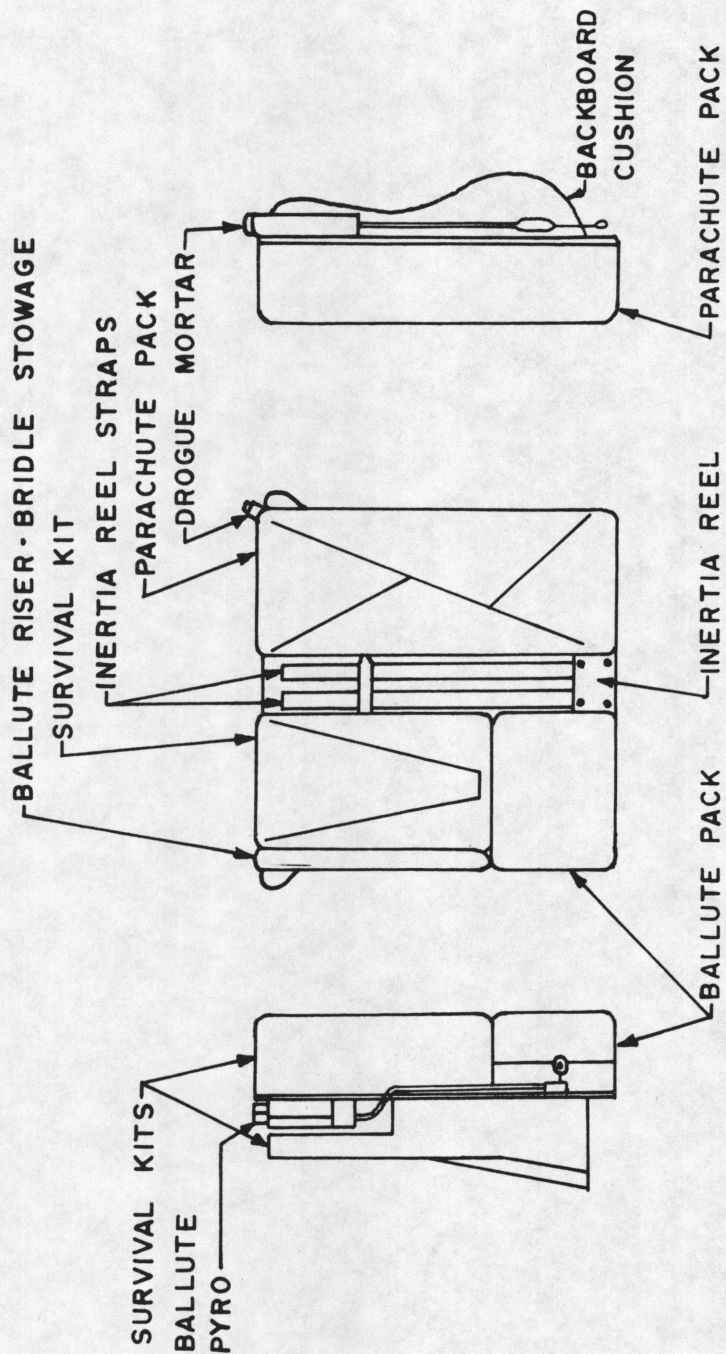
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# BACKBOARD PYROTECHNICS





# BACKBOARD AND SURVIVAL GEAR ASSEMBLY



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## SECTION 2.2

# ELECTRICAL

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Panel	FC 1 ΔP Light AMBER	(Fuel Cell Section 1 Delta Pressure Warning Light) Warning light for pilot indicating out of tolerance ΔP between H <sub>2</sub> -O <sub>2</sub> and/or O <sub>2</sub> -H <sub>2</sub> O in Fuel Cell Section No. 1.  ΔP H <sub>2</sub> to O <sub>2</sub> : low - .036 to .252 psi high - 1.152 to 1.476 psi ΔP O <sub>2</sub> to H <sub>2</sub> O: low - 1.098 to 1.494 psi high - 2.772 to 3.276 psi
Right Panel	FC 2 ΔP Light AMBER	(Fuel Cell Section 2 Delta Pressure Warning Light) Same as above except warning light indicating out of tolerance ΔP in Fuel Cell Section No. 2.
Right Astro Panel	ΔP SELECT Switch	
	H <sub>2</sub> (#1)	Enables readout on ΔP meter the ΔP between O <sub>2</sub> and H <sub>2</sub> in Section 1.
	H <sub>2</sub> O (#1)	Enables readout on ΔP meter the ΔP between O <sub>2</sub> and H <sub>2</sub> O in Section 1.
	H <sub>2</sub> (#2)	Enables readout on ΔP meter the ΔP between O <sub>2</sub> and H <sub>2</sub> in Section 2.
	H <sub>2</sub> O (#2)	Enables readout on ΔP meter the ΔP between O <sub>2</sub> and H <sub>2</sub> O in Section 2.
GEMINI OPERATIONS HANDBOOK Pg. 1 Section 2.2.1	Flight Crew Support Division Mission Operations Branch	Prepared by <u>P. H.</u> Checked by <u>DEL</u> Approved by <u>RHB</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
FCAP ( $V_M$ )	<u>T/M (D/T)</u> Bilevel of $O_2$ to $H_2O \Delta P$ Bilevel of $H_2$ to $O_2 \Delta P$	Fuel Cell $\Delta P$ lights will normally come on during an hydrogen purge in a section.
DC-DC Converter (24 VDC)  Same as above  Same as above  Same as above		$O_2$ to $H_2$ values read on left scale of $\Delta P$ meter  $O_2$ to $H_2O$ values read on right scale of $\Delta P$ meter.
S/C 10      Rev A Date 7/1/66	Electrical Fuel Cell	GEMINI OPERATIONS HANDBOOK Section 2.2.1      Pg 2

PANEL LOCATION	NAME AND POSITION	FUNCTION
SECTION I PAGE		
Center Panel	CRYO Indicator	(a) Displays CRYO O <sub>2</sub> quantity and pressure when Quantity Switch is in O <sub>2</sub> . (Displays Primary O <sub>2</sub> pressure when Quantity Switch is in O <sub>2</sub> or OFF.)
		(b) Displays CRYO H <sub>2</sub> Quantity and Pressure when Quantity Switch is in H <sub>2</sub> .
GEMINI OPERATIONS HANDBOOK Pg 3 Section 2.2.1		
Flight Crew Support Division Mission Operations Branch		Prepared by <u>L. J. R.</u> Rev. A Checked by <u>177</u> Approved by <u>7/1/66</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) CRY QTY ( $V_M$ ).  DC-DC Converter  ( $V_{5V}$ ).	T/M (D/T)  1. Cryo Quantity (0 to 100%).  2. Cryo O <sub>2</sub> Pressure (0 to 1.2K psia)  3. Cryo O <sub>2</sub> Supply Bottle Temp (-100°F to -300°F).	(a) & (b) Approximately 17 sec is required for accurate quantity readout. (a), (b) The range of the pressure transducers has been changed to expand the upper limit and the pressure gage is no longer direct reading. The approximate correction factor to be applied to displayed pressures is 1.2 for O <sub>2</sub> and .45 for H <sub>2</sub> . Note that the T/M pressure transducers have also been changed to a range of 1.2K psia and 450 psia respectively and will require a scale change at the sites to be direct reading. The gages will be individually calibrated to the pressure transducers installed and an exact correction card will be supplied to the crew before flight. In addition, the S/C gages will be marked to indicate the nominal operating range.
Same as above.	1. Cryo Quantity (0 to 100%).  2. Cryo H <sub>2</sub> Pressure (0 to 450 psia).  3. Cryo H <sub>2</sub> Bottle Temp (-300° to -425°F).	(a) & (b) Planned loading of reactants are: H <sub>2</sub> - 6.9 lbs (119%), usable - 6.66 lbs O <sub>2</sub> - 106 lbs (100%), usable - 97.4 lbs  (a) & (b) Nominal flow rates are: O <sub>2</sub> - 0.02357 lbs./Amp-hr (Fuel Cell only) H <sub>2</sub> - 0.00297 lbs./Amp-hr  Actual loading will not be available until approximately T-45 hrs.  (a) O <sub>2</sub> pressure readout must be multiplied by 1.2.  (b) H <sub>2</sub> pressure readout must be multiplied by 0.45.  Each position readout has separate DC-AC inverter (2) and indicator control (2).  (a)&(b) DC-DC converter is not necessary for O.B. CRYO QTY readings.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	Quantity Selector Switch	
	O <sub>2</sub> -	Powers CRYO O <sub>2</sub> Sensor for quantity readout & T/M of O <sub>2</sub> Quantity. Enables CRYO O <sub>2</sub> Pressure Reading.
	H <sub>2</sub> -	Powers CRYO H <sub>2</sub> Sensor for quantity readout and T/M of H <sub>2</sub> Quantity. Enables Cryo H <sub>2</sub> Pressure Reading.
	OFF -	No power to above but last quantity read-out will appear on CRYO meter and CRYO O <sub>2</sub> pressure can be read on pressure meter.
Center Panel	O <sub>2</sub> HEATER Switch	
	ON -	Continuous power to CRYO O <sub>2</sub> tank auto and manual heaters.
	OFF -	No power to CRYO O <sub>2</sub> tank heater
	AUTO -	Intermittent powering of CRYO O <sub>2</sub> auto heater. Heater ON - pressure 15 to 75 psid below OFF pressure Heater OFF - pressure reaches 900 <sup>+10</sup> <sub>-25</sub> psid
GEMINI OPERATIONS HANDBOOK Pg 5 Section 2.2.1	Flight Crew Support Division Mission Operations Branch	Prepared by <u>L.J.R.</u> Rev. A Checked by <u>422</u> 7/1/66 Approved by <u>RAT</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
CRY QTY ( $V_M$ ) DC-DC Converter ( $V_{5V}$ )	<u>T/M (D/T)</u> Same as above. Bilevel of $O_2$ selected  Bilevel of $H_2$ selected	<ol style="list-style-type: none"> <li>1. Approximately 17 secs. are required for accurate quantity readout in each switch position.</li> <li>2. T/M of <math>O_2</math>, &amp; <math>H_2</math> pressure is continuous and not dependent on Selector Switch position.</li> <li>3. Cryo quantity is a continuous T/M readout and requires correlation with bilevels for identification of parameter being monitored.</li> </ol>
CRYO $O_2$ & $H_2$ HTR ( $V_M$ )	<u>T/M (D/T)</u> $O_2$ tank temp ( $-100^\circ$ to $-300^\circ F$ ) $O_2$ Tank Pressure (0 - 1200 psia) Cryo Quantity (0 to 100%) auto-.37 amps manual-10.7 amps	<ol style="list-style-type: none"> <li>1. Turn heater off when 9% quantity is reached.</li> <li>2. Heater pressure sensor separate from gage pressure sensor.</li> <li>3. Heater Switch should normally be in the AUTO position until quantity depleted to 9% unless a failure of the Automatic Heater Pressure Switch is suspected.</li> </ol> <p>NOTE: It is anticipated that the heater will not be required to maintain pressure.</p> <ol style="list-style-type: none"> <li>4. ECS HTR amber light illuminates when <math>O_2</math> HEATER Sw. is in the ON position.</li> <li>5. "ON" heaters duty cycle is 75%. Maximum continuous on time is 30 minutes.</li> </ol>
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	H <sub>2</sub> Heater Switch  ON -  OFF - AUTO -	Continuous power to CRYO H <sub>2</sub> tank heater  No power to CRYO H <sub>2</sub> tank heater Intermittent powering to CRYO H <sub>2</sub> tank heater. Heater ON - pressure 10 to 30 psid below OFF Heater OFF - pressure reaches 240 $\pm 10$ psid
Right Astro Panel	Stack Control Switch 1A-1B-1C 2A-2B-2C  ON -  OFF -	(a) Opens individual H <sub>2</sub> Stack Solenoid Valves allowing H <sub>2</sub> to flow to the Stack (Stack energized) (b) Connects Stack DC output to Main Bus thru section power switches in the ON position. (a) Closes individual H <sub>2</sub> Stack Solenoid Valves de-energizing the Stack. (b) Disconnects Stack DC output to Main Bus.
GEMINI OPERATIONS HANDBOOK    Flight Crew Support Division    Prepared by <u>L.J.B.</u> Rev. A Pg 7    Section 2.2.1    Mission Operations Branch    Checked by <u>RMB</u> 7/1/66 Approved by <u>RMB</u>		



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
CRYO O <sub>2</sub> & H <sub>2</sub> HTR (V <sub>M</sub> )  Same as above	<u>T/M(D/T)</u> H <sub>2</sub> tank temp (-300° to -425°F) H <sub>2</sub> Tank pressure (0 - 350 psia) H <sub>2</sub> Mass Quant (0 to 100%) 0.55 AMPS (both positions)	1. Heater is no longer required below <u>10 %</u> quantity and should be turned off at 4% remaining. 2. Heater Switch should normally be in the AUTO position unless a failure of the automatic heater pressure Switch is suspected. NOTE: It is anticipated that the heater will not be required to maintain <u>pressure.</u>
FUEL CELL CNTL 1 (V <sub>CC</sub> ) FUEL CELL CNTL 2 (V <sub>CC</sub> )	<u>T/M(D/T)</u> Stack 1B current (0 to 25 amps) Stack 1C current (0 to 25 amps) Stack 2B current (0 to 25 amps) Stack 2C current (0 to 25 amps)	Normal flow rates are: O <sub>2</sub> - 0.02357 lbs/amp-hr H <sub>2</sub> - 0.00297 lbs/amp-hr
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Astro Panel	<u>SECT 1 POWER</u> <u>Switch</u> ON -	<p>(a) Enables stacks 1A, 1B, 1C to power main bus thru Stack Control Switches 1A, 1B, and 1C in the ON position.</p> <p>(b) Enables FC1 ΔP warning light.</p>
	WARMUP -	<p>(a) Removes stacks 1A, 1B, 1C from the main bus thru Stack Control Switches 1A, 1B, and 1C in the ON position.</p> <p>(b) Opens Section #1 H<sub>2</sub> and O<sub>2</sub> reactant valves allowing H<sub>2</sub> and O<sub>2</sub> to flow from the respective tanks to the fuel cell.</p> <p>(c) Opens Section 1 H<sub>2</sub>O Solenoid Valve allowing fuel cell product water to flow to the water tanks.</p> <p>(d) Enables FC1 ΔP warning light.</p>
	OFF-	<p>(a) Closes Section #1 H<sub>2</sub> and O<sub>2</sub> reactant valves, stopping reactant flow to the fuel cell.</p> <p>(b) Closes Section #1 H<sub>2</sub>O Solenoid valve stopping fuel cell product water flow.</p> <p>(c) Disables FC1 ΔP warning light.</p>
GEMINI OPERATIONS HANDBOOK Pg 9 Section 2.2.1		Flight Crew Support Division Mission Operations Branch Prepared by <u>L. J. R.</u> Checked by <u>[Signature]</u> Approved by <u>RHTS</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
<p>(a) FC CNTL 1 (<math>V_{CC}</math>).</p> <p>(b) FC <math>\Delta P</math> (<math>V_M</math>).</p>	<p><u>T/M (D/T)</u></p> <p>Sect. 1 current (0 to 50 amps)</p>	
<p>(a), (b) &amp; (c) FC CNTL 1 (<math>V_{CC}</math>).</p> <p>(d) FC <math>\Delta P</math> (<math>V_M</math>).</p>		<p>Functions (b) &amp; (c) are performed by the ON position of the switch if not accomplished by the WARMUP position.</p>
<p>(a) &amp; (b) FC CNTL 1 (<math>V_{CC}</math>)</p> <p>(c) FC <math>\Delta P</math> (<math>V_M</math>).</p>		
<p>S/C 10 Rev Orig Date 5/20/66</p>	<p>Electrical Fuel Cells</p>	<p>GEMINI OPERATIONS HANDBOOK Section 2.2.1 Pg 10</p>

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Astro Panel	<u>SECT 2 POWER</u> <u>Switch</u> ON -	<p>(a) Enables stacks 2A, 2B, 2C to power main bus thru Stack Control Switches 1A, 1B, and 1C in the ON position.</p> <p>(b) Enables FC2 ΔP warning light.</p>
	WARMUP -	<p>(a) Removes stacks 2A, 2B, 2C from the main bus thru Stack Control Switches 2A, 2B, and 2C in the ON position.</p> <p>(b) Opens Section #2 H<sub>2</sub> and O<sub>2</sub> reactant valves allowing H<sub>2</sub> and O<sub>2</sub> to flow from the respective tanks to the fuel cell.</p> <p>(c) Opens Section #2 H<sub>2</sub>O Solenoid Valve allowing fuel cell product water to flow to the water tanks.</p> <p>(d) Enables FC2 ΔP warning light.</p>
	OFF -	<p>(a) Closes Section #2 H<sub>2</sub> and O<sub>2</sub> reactant valves, stopping reactant flow to the fuel cell.</p> <p>(b) Closes Section #2 H<sub>2</sub>O Solenoid valve stopping fuel cell product water flow.</p> <p>(c) Disables FC2 ΔP warning light.</p>
GEMINI OPERATIONS HANDBOOK Pg 11 Section 2.2.1		Flight Crew Support Division Mission Operations Branch Prepared by <u>L. J. R.</u> Checked by <u>[Signature]</u> Approved by <u>RHB</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
<p>(a) FC CNTL 2 (<math>V_{CC}</math>).</p> <p>(b) FC <math>\Delta P</math> (<math>V_M</math>).</p>	<p>T/M (D/T) Sect. 2 current (0 to 50 amps)</p>	
<p>(a),(b) &amp; (c) FC CNTL 2 (<math>V_{CC}</math>).</p> <p>(d) FC <math>\Delta P</math> (<math>V_M</math>).</p>		<p>Functions (b) &amp; (c) are performed by the ON position of the switch if not accomplished by the WARMUP position.</p>
<p>(a) &amp; (b) FC CNTL 2 (<math>V_{CC}</math>).</p> <p>(c) FC <math>\Delta P</math> (<math>V_M</math>).</p>		
<p>S/C 10      Rev Orig Date 5/20/66</p>	<p>Electrical Fuel Cells</p>	<p>GEMINI OPERATIONS HANDBOOK Section 2.2.1      Pg 12</p>

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Astro Panel	SECT #1 PURGE Switch	
	H <sub>2</sub> -	Opens three H <sub>2</sub> Purge Solenoid Valves in Stacks 1A,1B,1C dumping contaminated H <sub>2</sub> overboard. (Stack Switches 1A, 2B, 1C must be ON.)
	OFF -	Closes H <sub>2</sub> & O <sub>2</sub> Purge Solenoid Valves
	O <sub>2</sub> -	Opens one O <sub>2</sub> Purge Solenoid Valve in Section #1 dumping contaminated O <sub>2</sub> overboard.
GEMINI OPERATIONS HANDBOOK Pg13 Section 2.2.1		Flight Crew Support Division Mission Operations Branch
		Prepared by <u>L.J.R.</u> Checked by <u>ATB</u> Approved by <u>RHB</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
FC CNTL 1 ( $V_{CC}$ )	<u>T/M (D/T)</u> Bi-level of $H_2$ Purge (SECT #1)	1. Purging should not be attempted if a rapid drop in a stack ammeter is indicated. After the affected stack is removed from the line, purging may be safely accomplished on the remaining stacks. 2. Switch spring loaded to center-camwheel holds switch in selected position.
FC CNTL 1 ( $V_{CC}$ )		3. $\Delta P$ light will normally come on during $H_2$ purging and serve to indicate a correct purge operation. 4. Purge duration: $H_2$ - 13 seconds $\pm$ 2 second $O_2$ - 2 minutes $\pm$ 6 seconds 5. Purge frequency: Less than 6 amps/stack every 6 hrs. Less than 10 amps/stack every 4 hrs. More than 10 amps/stack every 2 hrs. 6. Purge rates: $O_2$ - 1.75 lbs/hr/section $H_2$ - 0.92 lbs/hr/section

S/C 10 Rev A  
 Date 7/1/66

Electrical  
 Fuel Cell

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Astro Panel	SECT # 2 Purge Switch	
	H <sub>2</sub> -	Opens three H <sub>2</sub> Purge Solenoid Valves in Stacks 2A,2B,2C dumping contaminated H <sub>2</sub> overboard. (Stack Switches 2A, 2B, 2C must be ON)
	OFF -	Closes H <sub>2</sub> & O <sub>2</sub> Purge Solenoid Valves
	O <sub>2</sub> -	Opens one O <sub>2</sub> Purge Solenoid Valve in Section #2 dumping contaminated O <sub>2</sub> overboard.
Right Astro Panel	XOVER Switch	
	ON	Opens the O <sub>2</sub> & H <sub>2</sub> Crossover Valves, enabling either one or both of the dual pressure regulators to supply H <sub>2</sub> & O <sub>2</sub> to either or both Fuel Cell Sections.
	OFF	Closes the O <sub>2</sub> & H <sub>2</sub> crossover valves.
Center Panel	H <sub>2</sub> TANK VAC SWITCH VENT-  SAFE-	Fires dual FC H <sub>2</sub> squibs (thru AGENA CNTL BUS ARM Switch in EXP position) which allows venting of void between inner and outer H <sub>2</sub> tank walls when in orbit.
GEMINI OPERATIONS HANDBOOK Pg15 Section 2.2.1		Flight Crew Support Division Mission Operations Branch
		Prepared by <u>E. J. R.</u> Rev.A Checked by <u>[Signature]</u> Approved by <u>[Signature]</u> 7/1/66



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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Astro Panel	Power System Monitor	<ol style="list-style-type: none"> <li>1. Continuously displays 1A, 1B, 1C, 2A, 2B, &amp; 2C currents on respective ammeters.</li> <li>2. Displays stack 1A, 1B, 1C, 2A, 2B, 2C, Main Bus, Common Control Bus, Squib Battery No. 1, Squib Battery No. 2, and battery test voltages on DC voltmeter when selected by Voltmeter Selector Switch.</li> <li>3. Displays IGS or ACME AC voltages when AC is selected by Voltmeter Selector Switch.</li> <li>4. Displays main battery test currents (see below).</li> <li>5. Displays FC <math>\Delta</math>P on <math>\Delta</math>P meter when selected by <math>\Delta</math>P selector switch.</li> </ol>
Right Astro Panel	Voltmeter Selector Switch 1A-1B-1C-2A-2B- 2C	Displays selected stack voltage on DC voltmeter.
	AC -	Displays 26V 400 cps from ACME inverter or IGS power supply (thru AC POWER Switch in ACME or IGS position, respectively).
	BT -	Displays individual main battery voltage on DC voltmeter when a main battery switch is in TEST position.
	M -	Displays main bus voltage on DC voltmeter.
	S1 -	Displays Squib Battery No. 1 voltage on DC voltmeter.
	S2 -	Displays Squib Battery No. 2 voltage on DC voltmeter.
	C -	Displays Common Control Bus voltage on DC voltmeter. Displays Squib Battery No. 3 voltage if Squib Batteries 1 and 2 are off.
GEMINI OPERATIONS HANDBOOK Pg 17 Section 2.2.1 Flight Crew Support Division Mission Operations Branch Prepared by <u>L. J. R.</u> Checked by <u>[Signature]</u> Approved by <u>[Signature]</u>		



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
	<u>T/M (D/T)</u> Stack 1B current (0 to 25 amps) Stack 1C current (0 to 25 amps) Sect. #1 current (0 to 50 amps) Sect. #2 current (0 to 50 amps) Stack 2B current (0 to 25 amps) Stack 2C current (0 to 25 amps)	Main Batteries 1, 2, 3, & 4 currents are read on Stack Ammeters 1A, 1B, 2A, & 2B respectively.
	Main bus voltage (15 to 35 V) Squib Bus 1 voltage (armed) (15 to 35V) Squib Bus 2 voltage (armed) (15 to 35V) Control Bus voltage (15 to 35V)	For TM of Vm voltage Ind LTS TEST C/B must be closed.  For TM of Vcc voltage SEQ LTS CNTL C/B must be closed.
S/C 10      Rev A Date 7/1/66	Electrical Fuel Cells	GEMINI OPERATIONS HANDBOOK Section 2.2.1    Pg 18

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Sw C/B Panel	<u>SQUIB BATTERY</u> <u>No. 1 Switch</u>	
	ON -	(a) Powers $V_{CC}$ & $V_{OAMSQ1}$ from SQUIB BATTERY 1. (b) Enables BUS TIE 1 Switch to power $V_M$ from Squib Battery 1.
	OFF -	(a) Enables powering of $V_{OAMSQ1}$ and $V_{CC}$ from $V_M$ (thru BUS TIE 1 Switch) (b) Remove Squib Battery 1 from $V_{CC}$ & $V_{OAMSQ1}$ . (c) Removes Squib Battery 1 from $V_M$ (thru BUS TIE 1 Switch).
	UMB -	(a) Allows AGE to power $V_{CC}$ & $V_{OAMSQ1}$ . (b) Allows AGE to power $V_M$ (thru BUS TIE 1 Switch).
Right Sw C/B Panel	<u>SQUIB BATTERY</u> <u>No. 2 Switch</u>	
	ON -	(a) Powers $V_{CC}$ & $V_{OAMSQ2}$ from SQUIB BATTERY 2. (b) Enables BUS TIE 2 Switch to power $V_M$ from Squib Battery 2.
	OFF -	(a) Enables powering of $V_{OAMSQ2}$ and $V_{CC}$ from $V_M$ (thru BUS TIE 2 Switch). (b) Removes Squib Battery 2 from $V_{CC}$ & $V_{OAMSQ2}$ . (c) Removes Squib Battery 2 from $V_M$ (thru BUS TIE 2 Switch).
	UMB -	(a) Allows AGE to power $V_{CC}$ & $V_{OAMSQ2}$ . (b) Allows AGE to power $V_M$ (thru BUS TIE 2 Switch).
Right Sw C/B Panel	<u>SQUIB BATTERY</u> <u>No. 3 Switch</u>	
	ON -	Powers $V_{CC}$ from SQUIB BATTERY No. 3.
	OFF -	Removes SQUIB BATTERY 3 from $V_{CC}$ .
	UMB -	Not applicable to S/C 10.
GEMINI OPERATIONS HANDBOOK Pg 1 Section 2.2.2 Flight Crew Support Division Mission Operations Branch Prepared by _____ Checked by _____ Approved by _____		



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
	<u>T/M (D/T)</u> Squib Bus 1 (+15 to 35V)	1. No diode protection between SQUIB BATTERY 1 and $V_{OAMSQ1}$ or BUS TIE 1 Switch. 2. Function (b) is recommended for use only if necessary.
NONE.	<u>T/M (D/T)</u> Squib Bus 2 (+15 to 35V).	1. No diode protection between SQUIB BATTERY 2 and $V_{OAMSQ2}$ or BUS TIE 2 Switch. 2. Function (b) is recommended for use only if necessary.
NONE.  NONE.	<u>T/M (D/T)</u> $V_{CC}$ voltage (+15 to 35V).	For T/M of $V_{CC}$ voltage, SEQ LTS CNTL C/B must be closed.
S/C 10 Date 5/20/66	Rev Orig. Electrical Squib Batteries	GEMINI OPERATIONS HANDBOOK Section 2.2.2 Pg 2

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Astro Panel	BUS TIE 1 Switch ON -	<p>(a) Enables powering of main bus (<math>V_M</math>) thru SQUIB BATTERY 1 Switch.</p> <p>(b) Enables powering of <math>V_{OAMSQ1}</math> and <math>V_{CC}</math> from <math>V_M</math>.</p> <p>(c) Enables monitoring of <math>V_M</math> voltage on position S1 of Voltmeter Selector Switch.</p>
	OFF -	<p>(a) No power from SQUIB BATTERY 1 to main bus (<math>V_M</math>).</p> <p>(b) No power from <math>V_M</math> to <math>V_{OAMSQ1}</math> and <math>V_{CC}</math>.</p>
Right Astro Panel	BUS TIE 2 Switch ON -	<p>(a) Enables powering to main bus (<math>V_M</math>) thru SQUIB BATTERY 2 Switch.</p> <p>(b) Enables powering of <math>V_{OAMSQ2}</math> and <math>V_{CC}</math> from <math>V_M</math>.</p> <p>(c) Enables maonitoring of <math>V_M</math> voltage on position S2 of Voltmeter Selector Switch.</p>
	OFF -	<p>(a) No power from SQUIB BATTERY 2 to main bus (<math>V_M</math>).</p> <p>(b) No power from <math>V_M</math> to <math>V_{OAMSQ2}</math> and <math>V_{CC}</math>.</p>
GEMINI OPERATIONS HANDBOOK Pg 3 Section 2.2.2		Flight Crew Support Division Mission Operations Branch Prepared by <u>L. J. K.</u> Checked by <u>[Signature]</u> Approved by <u>RMB</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
		<p>(a) This function is recommended for use only if necessary.</p> <p>(b) Failed Squib battery should be turned off prior to turning the BUS TIE Switch ON.</p>
		<p>(a) This function is recommended for use only if necessary.</p> <p>(b) Failed battery should be turned off prior to turning the BUS TIE Switch ON.</p>
S/C 10      Rev Orig. Date 5/20/66	ELECTRICAL SQUIB BATTERIES	GEMINI OPERATIONS HANDBOOK Section 2.2.2    Pg 4

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Sw C/B Panel	<u>MAIN BATTERY</u> <u>Switches</u> M <sub>1</sub> , M <sub>2</sub> , M <sub>3</sub> , M <sub>4</sub> ON - OFF - TEST -	Connects individual main silver-zinc batteries to V <sub>M</sub> . Inserts a load resistor into battery circuit, permitting use of voltmeter and stack ammeters in monitoring main battery outputs under loaded conditions (BT position).
Left Sw C/B Panel	<u>Sequential Lights</u> <u>Test Switch</u> AMBER - OFF - RED & GREEN -	Illuminates the following amber lights: ECS HTR, DCS, 1OK, 4OK, RCS HTR, PRI & SEC PUMP A & B, PRI & SEC RES LO, EVAP PRESS, IND RETRO ATT, O <sub>2</sub> HIGH RATE, BTRY PWR, RCS, SEP OAMS, SEP ELECT, SEP ADAPT, ARM AUTO RETRO, JETT RETRO, ACC, ATT, SCANNER, Computer MALF & RCDR TAPE, FC 1 ΔP, FC 2 ΔP, ATM error, Urine Dump Htr Removes power from SEQ LIGHTS Test. Tests the following red and green lights: SEP SPCFT, START COMP, LOCK-ON, IND RETRO ATT, BTRY PWR, RCS, SEP OAMS, SEP ELECT, SEP ADAPT, ARM AUTO RETRO, JETT RETRO, MAP and ATM run.
Overhead Sw C/B Panel	<u>Center Light</u> <u>Switch</u> DIM - OFF - BRIGHT -	Powers dimmable low intensity white light. Removes power from center flood lamps. Powers non-dimmable bright white light.
GEMINI OPERATIONS HANDBOOK Pg 1 Section 2.2.3		Flight Crew Support Division Mission Operations Branch Prepared by <u>L.J.R.</u> Rev. A Checked by <u>[Signature]</u> 7/1/66 Approved by <u>[Signature]</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
NONE.	<u>T/M (D/T)</u> 1. $V_M$ voltage ( 15 to 35V). (IND LTS TEST C/B must be closed.)	1. Main Batteries 1, 2, 3 & 4 currents are read on stack ammeters 1A, 1B 2A, 2B, respectively. 2. To obtain the test current of a main battery when only the fuel cells are operating, note appropriate ammeter current before the test and during the test. The difference between the two readings is the test current (10 amps approximately). 3. To obtain the test current of a main battery when only the main batteries are on or when both the fuel cells and main batteries are on, turn the battery being tested off. Note reading on appropriate ammeter before and during the test. The difference between the two readings is the test current (10 amps approximately).
IND LT TEST ( $V_M$ ).		The ABORT, ATT RATE SEC GUID, ENGINE II, and both ENGINE I lights are not tested by the Sequential Lights Test Switch.
IND LT TEST ( $V_M$ ).		
CABIN LIGHTS ( $V_M$ ).	Power Required 0.27 amps dim	Rheostat controlled intensity in dim position only.
CABIN LIGHTS ( $V_M$ ).	0.52 amps bright	

S/C 10 Rev A  
 Date 7/1/66

Electrical  
 Main Batteries (Lighting)

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 Section 2.2.3 Pg 2

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Sw - C/B Panel 1.2.2	<u>SEQ LIGHTS Switch</u> BRIGHT -  DIM -	Selects high intensity of sequential telelights  Selects low intensity of sequential telelights
Door (L) 1.2.2	<u>Left Cabin Light Switch</u> RED OFF WHITE	Powers red light on left door. Removes power from left cabin light. Powers white light on left door.
Door (R) 1.2.2	<u>Right Cabin Light Switch</u> RED OFF WHITE	Powers red light on right door. Removes power from right cabin light. Powers white light on right door.
Right Sw C/B Panel	<u>EXT Lights</u> DOCK - OFF - EVA -	Powers Docking Light. No power to Docking Light or EVA Night Light. Powers the EVA Night Light.
<div style="display: flex; justify-content: space-between;"> <div>GEMINI OPERATIONS HANDBOOK Pg 3 Section 2.2.3</div> <div>Flight Crew Support Division Mission Operations Branch</div> <div> Prepared by <u>                    </u>  Checked by <u>                    </u>  Approved by <u>                    </u> </div> </div>		



<u>CIRCUIT BREAKER</u> BUS	<u>TELEMETRY</u> POWER REQUIRED	REMARKS
SEQ LIGHTS PWR ( $V_M$ ).		
CABIN LIGHTS ( $V_M$ )	0.27 amps. (max)	Rheostat controlled intensity.
CABIN LIGHTS ( $V_M$ )	0.27 amps. (max)	Rheostat controlled intensity.
CABIN LIGHTS ( $V_M$ ). CABIN LIGHTS ( $V_M$ ).	1.24 amps 1.24 amps	EVA Night Light located in Retro adapter. Wires not pyroed, therefore, switch must be in off position prior to retro Adapter Separation.
S/C 10 Date 7/1/66	Rev A Electrical Main Batteries	GEMINI OPERATIONS HANDBOOK Section 2.2.3 Pg 4

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Sw C/B Panel	<u>BOOST-INSERT Switch</u>  ARM -    SAFE -	Powers: (a) $V_{BIAQ2}$ from $V_{OAMSQ2}$ . (b) $V_{BIAQ1}$ from $V_{OAMSQ1}$ . (c) $V_{BIACC}$ from $V_{CC}$ . No power to these buses.
Left Sw C/B Panel	<u>RETRO PWR Switch</u>  ARM -    SAFE -	Powers: (a) $V_{RQ1}$ from $V_{OAMSQ1}$ . (b) $V_{RCC}$ from $V_{CC}$ . (c) $V_{RQ2}$ from $V_{OAMSQ2}$ . (d) Retro Jett Switch. (e) RETRO ROCKET Squib Switches. No power to these buses.
Left Sw C/B Panel	<u>RETRO JETT Switch</u>  ARM -    SAFE -	Powers: (a) $V_{RJQ1}$ thru $V_{RQ1}$ from $V_{OAMSQ1}$ thru RETRO PWR Switch. (b) $V_{RJQ2}$ thru $V_{RQ2}$ from $V_{OAMSQ2}$ thru RETRO PWR Switch. No power to these buses.
Left Sw C/B Panel	<u>LANDING Switch</u>  ARM -       SAFE-	Powers: (a) $V_{LQ2}$ from $V_{OAMSQ2}$ . (b) $V_{LQ1}$ from $V_{OAMSQ1}$ . (c) $V_{LCC}$ from $V_{CC}$ . (d) Allows HF ANT SELECT switch to extend Reentry HF Whip Antenna in EXT position. (a) No power to above buses. (b) Allows HF ANT Select Switch to extend Adapter HF Whip Antenna in EXT position.
GEMINI OPERATIONS HANDBOOK Pg 1 Section 2.2.4		Flight Crew Support Division Mission Operations Branch Prepared by _____ Checked by _____ Approved by _____ Rev A 7/1/66



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
No C/B's. (a) $V_{OAMSQ2}$ . (b) $V_{OAMSQ1}$ . (c) $V_{CC}$ .		These busses can be armed <u>only by this switch</u> (the busses armed by this switch power the ABORT Handle). See SEQUENTIAL Section 2.1 for functions of powered busses.
No C/B's. (a) $V_{OAMSQ1}$ . (b) $V_{CC}$ . (c) $V_{OAMSQ2}$ .		These 3 busses can also be armed from the respective power source busses via the ABORT Handle. See SEQUENTIAL Section 2.1 for functions of powered busses.
No C/B's. (a) $V_{RQ1}$ . (b) $V_{RQ2}$ .		$V_{RQ1}$ and $V_{RQ2}$ can be armed thru the ABORT Handle. See SEQUENTIAL Section 2.1 for functions of powered busses.
No C/B's. (a) $V_{OAMSQ2}$ . (b) $V_{OAMSQ1}$ . (c) $V_{CC}$ . (d) HF WHIP ANT ( $V_{CC}$ )		Arming of $V_{LQ1}$ , $V_{LQ2}$ , and $V_{LCC}$ is not an Abort Handle function.
HF WHIP ANT ( $V_{CC}$ ).		
S/C 10 Date 7/1/66	Electrical Power Control	GEMINI OPERATIONS HANDBOOK Section 2.2.4 Pg 2

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Sw C/B Panel	<u>AC POWER Switch</u> IGS -  OFF - ACME -	Powers IGS Inverter which provides 26V AC 1ø 400 ~ power to all systems using AC power.  No power to inverters. Powers ACME Inverter which provides 26V AC 1ø 400 ~ power to all systems except platform and computer, using AC power.
Overhead Sw. C/B Panel	DC-DC CONV Switch  PRI- OFF- SEC-	Powers Primary DC-DC Converter No power to converters Powers Secondary DC-DC Converter
Left Sw C/B Panel	<u>AUX RECP Switch</u> On - Off -	Powers left AUX Receptacle. No power to receptacle.
Right Sw C/B Panel	<u>AUX RECP Switch</u> On - Off -	Powers right AUX Receptacle. No power to receptacle.
Right Sw C/B Panel	<u>TM RECP</u>	Provides high level Analog Channel for experiment use.
GEMINI OPERATIONS HANDBOOK Pg 3 Section 2.2.4		Flight Crew Support Division Mission Operations Branch Prepared by <u>MBB</u> Rev A Checked by <u>JAC</u> 7/1/66 Approved by <u>JAC</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
No C/B ( $V_M$ )          ACME INV ( $V_M$ ).	<u>T/M (D/T)</u> 1) 10.2 VDC (IGS only (5.5 to 12.5 VDC) Only if computer is ON. 2) AC Voltage (IGS or ACME) 3) AC Freq. (IGS or ACME) (380 to 420 cps)	1. IGS powered thru IGS power fuse. 2. 26V AC 400 cps voltages read on AC meter when selected by Voltmeter Selector Switch. 3. Platform and computer receive AC power from IGS Inverter only. 4. Some items of equipment have integral inverters (as coolant pumps) and are not considered as AC systems
DC-DC CONV ( $V_M$ )   DC-DC CONV ( $V_M$ )		The DC-DC Converters provide instru- mentation power of $\pm 5V$ & $\pm 24 V$ .  See section 2.2.6 for list of DC-DC Converter power uses.
AUX RECEP ( $V_M$ ).	<u>T/M (D/T)</u> CAMERA EVENT (0 or 28V) Also routes CAMERA EVENT Bi-level to PCM Recorder.	Auxiliary power receptacle to operate onboard equipment and utility light.
AUX RECEP ( $V_M$ ).	<u>T/M (D/T)</u> CAMERA EVENT (0 or 28V) Also routes PHOTO EVENT Bi-level to PCM Recorder.	Auxiliary power receptacle to operate onboard equipment and utility light.
DC/DC CONV ( $V_M$ )	<u>T/M (D/T)</u> Photo meter	
S/C 10      Rev A Date 7/1/66	Electrical Power Control	
GEMINI OPERATIONS HANDBOOK Section 2.2.4      Pg 4		

PANEL LOCATION	NAME AND POSITION	FUNCTION
SECTION I PAGE		
Right Sw C/B Panel	BUS ARM Switch	
	Dock-	(a) Powers Index Bar extend pyros (POD EJECT/INDEX EXTEND Switch - INDEX EXTEND).  (b) Powers Emergency latch release pyros (EMERG LATCH REL Switch - REL)
	OFF-	No power
	EXP-	(a) Powers D-10 pitch & yaw sensor cover pyros (exposes sensors) (ION SENSOR BOOM EXT Switch - SEQ 2, ION SENSOR Switch - FDI or ON)  (b) Powers D-10 pitch & yaw dual boom guillotine ignitors (extends booms)(ION SENSOR EXT Switch - SEQ 1)  (c) Powers OAMS reserve oxidizer pyros (OAMS RESV Switch - SQUIB)  (d) Powers H <sub>2</sub> tank vent pyros (H <sub>2</sub> TANK VAC Switch - VENT)
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
AGENA CONTROL SQUIB1&2		The BUS ARM Switch supplies power to the AGENA CONTROL SQUIB 1 & 2 C/B
(a through d) AGENA CONTROL SQUIB 1 & 2		
(d) CYRO O <sub>2</sub> & H <sub>2</sub> REG		
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Sw C/B Panel	Circuit Breaker <u>IND LT TEST</u> Closed -	No. 6-2 ( $V_M$ ) (Indicator Lights Test) (a) Powers test circuit of instrument panel indicator lights thru Sequential Lights Test Switch as listed pg. 1 Sec. 2.2.3. (b) Enables T/M of $V_M$ voltage.
Left Sw C/B Panel	Circuit Breaker <u>SEQ LIGHTS CNTL</u> Closed -	No. 1-13 ( $V_{CC}$ ) (Sequential Lights Control) (a) Enables green light on Battery Power Telelight when all battery power switches are ON. (b) Enables T/M of $V_{CC}$ voltage.
Overhead Sw C/B Panel	Circuit Breaker <u>AUX RECP</u> Closed -	No. 2-3 ( $V_M$ ) (Auxiliary Receptacle) Supplies power from $V_M$ to Left and Right outlets in cabin for astro use.
Overhead Sw C/B Panel	Circuit Breaker DC-DC CONV Closed -	No. 9-37 ( $V_M$ )  Powers DC-DC Converters (thru DC-DC Converter Switch).
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	Circuit Breaker <u>CABIN LIGHTS</u> Closed -	No. 6-3 ( $V_M$ )  Powers cabin lights (center, left, and right), the EVA lt and docking light (thru respective light switches) Rheostat to regulate intensity of left, right, and center lights.
Overhead Sw C/B Panel	Circuit Breaker <u>ATT IND LIGHTS</u> Closed -	No. 12-5 ( $V_M$ ) (Attitude Indicator Lights) Powers both attitude display units back lighting. The C/B is the only On-Off control of the Attitude Indicator lights; there is no switch.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Sw C/B Panel	Circuit Breaker <u>ACME INV</u> Closed -	No. 12-4 ( $V_M$ ) (ACME Inverter) Powers ACME Inverter (thru AC POWER Switch in ACME position).
	Fuse <u>IGS PWR</u>	( $V_M$ ) Powers IGS power supply (thru AC POWER Switch in IGS position).
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Sw. C/B Panel	Circuit Breaker CRYO O <sub>2</sub> & H <sub>2</sub> HTR - Closed -	No. 1-2 (V <sub>M</sub> )  Enables CRYO O <sub>2</sub> & H <sub>2</sub> HEATERS Switch to power  O <sub>2</sub> & H <sub>2</sub> tank heaters respectively. Enables URINE DUMP SW to pwr Urine Dump Htr & Light.
Right Switch C/B Panel	Circuit Breaker FC ΔP -  Closed -	No. 1-15 (V <sub>M</sub> )  1.Enables powering of fuel cell ΔP lights 2.Enables bilevel T/M of ΔP lights (see Sect. 2.2.1, page 2).
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Sw C/B Panel	Circuit Breaker FUEL CELL CNTL 1- Closed -	No. 1-4 ( $V_{CC}$ )  a. Enables SECTION 1 POWER Switches & Stack Control Switches 1A, 1B, 1C to power $V_M$ from Stacks 1A, 1B, and 1C. b. Enables SECT #1 PURGE Switch to purge $O_2$ & $H_2$ in Section 1.
Right Sw C/B Panel	Circuit Breaker FUEL CELL CNTL 2- Closed -	No. 1-5 ( $V_{CC}$ )  a. Enables SECTION 2 POWER Switch and Stack Control Switches 2A, 2B, 2C to power $V_M$ from Stacks 2A, 2B, 2C. b. Enables SECT #2 PURGE Switch to purge $O_2$ & $H_2$ in Section 2.
	Circuit Breaker CRYO $O_2$ & $H_2$ REG - Closed -	No. 1-14 ( $V_{CC}$ )  a. Enables XOVER Switch to power $O_2$ & $H_2$ Crossover Valves.  Enables $H_2$ TANK VAC Switch to fire FC $H_2$ squibs. (if experiment bus is armed)
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# ELECTRICAL

## NOTES

Below is a table indicating the capabilities of the main and squib batteries. The main batteries can provide a minimum of one orbit plus postlanding requirements capability in event of fuel cell failure.

Battery	Amp-Hrs	No. of Batteries	No. of cells each	Open Circuit Voltage (Plateau)	Load Voltage (Cont. Rate)	Discharge Rate (Cont. Amp)
Main	45	4	16	25.0	24.5	20
Squib	15	3	16	25.0	24.0	8

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O/B INDICATORS USING DC-DC CONVERTER POWER

The DC-DC converters are actually DC-AC-DC converters.

Indicators requiring 24V DC Regulated Power:

1. Cabin Temperature
2. Suit Temperature
3. CO<sub>2</sub> P-P  $\pm$ 24V
4. Propellant Quantity
5. Propellant Temperature
  - (a) RCS System A & B Source Temperature
  - (b) OAMS Source H<sub>E</sub> Temperature
  - (c) OAMS Regulated H<sub>E</sub> @ Fuel Tank Temperature
  - (d) OAMS Regulated H<sub>E</sub> @ Oxid Tank Temperature

Indicators requiring 5V DC Regulated Power

1. Cabin Pressure
2. LT & RT Sec O<sub>2</sub>
3. CRYO O<sub>2</sub> Pressure
4. CRYO H<sub>2</sub> Pressure
5. Prop Pressures
  - (a) RCS System A & B Source Pressure
  - (b) OAMS Source H<sub>E</sub> Pressure
  - (c) OAMS Regulated H<sub>E</sub> Fuel Tank Pressure
  - (d) OAMS Regulated H<sub>E</sub> Oxid Tank Pressure

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## SECTION 2.3

# ENVIRONMENTAL CONTROL SYSTEM

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>CABIN AIR RECIRC</u> <u>Handle</u> Open - (Up)	(Cabin Air Recirculation)  (a) Allows cabin air to circulate thru the suit circuit thus removing CO <sub>2</sub> odor and moisture from the cabin. Cabin air enters the suit circuit thru the recirc valve and is discharged back into the cabin thru an open visor or glove.  (b) Prevents a negative suit pressure, relative to the cabin, by providing a common point in both loops downstream of the suits (an opened visor or glove is not necessary).  (c) After landing, prevents the suit fan from <u>holding</u> the inlet snorkel closed should the snorkel be momentarily closed by submersion.
Center Panel	<u>INLET SNORKEL</u> <u>Handle</u> Open - (Down)	(a) Provides atmospheric ventilation of suits and cabin thru snorkel.  (b) Enables the SUIT FAN Switch to power the suit fan, if the switch was previously disabled by O <sub>2</sub> High Rate.
Center Panel	<u>CABIN VENT Handle</u> Open - (Down)	Opens a one way valve(outflow only) to: (a) Decompress cabin while in orbit (approx 50 sec required).  (b) Relieve cabin over pressure during ascent should the automatic cabin pressure relief valve fail.
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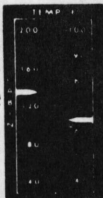
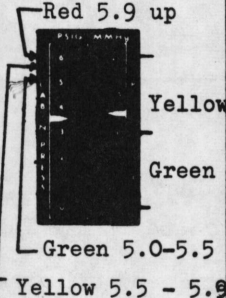


<u>CIRCUIT BREAKER</u> BUS	<u>TELEMETRY</u> POWER REQUIRED	REMARKS
None (mechanical).		1. The handle locks in 3 positions: closed, 45° open, and full open. (b) A negative suit (poor circulation) will be experienced if recirc is closed.
(a) None. (b) SUIT FANS 1 & 2 (V <sub>M</sub> ).		1. Inlet Snorkel Fairing is jettisoned at 50K feet by the DROGUE Switch. 2. Inlet snorkel should not be opened until after splashdown to prevent the intake of RCS fumes into the cabin. 3. When water closes the snorkel float, it will be held closed by the partial vacuum created by the suit fans, unless: CABIN RECIRC is opened, or Suit fans are turned off.
None.		1. A plug is installed in the cabin vent to prevent cabin decompression in the event of cabin vent valve failure. 2. A one way valve provides an automatic water seal for water landing.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>WATER SEAL Handle</u> Open (Up) -  Closed (Down) -	Allows the dual cabin pressure relief valve to operate normally.  Makes the dual cabin pressure relief valve water tight and disables the normal pressure limiting function.  The Inlet Snorkel should be opened before closing the WATER SEAL above 2K ft. during reentry.
Center Panel	<u>O<sub>2</sub> HIGH RATE RECOCK Handle</u> Recock (Down) -	(a) Restores normal O <sub>2</sub> flow rate (b) Enables the SUIT FAN Switch to power the suit fans.  The switch was previously disabled by O <sub>2</sub> High Rate.  (c) Turns off O <sub>2</sub> High Rate amber light. (d) Disconnects T/M of O <sub>2</sub> High Rate.
Center Panel	<u>SUIT FAN Switch</u> NO. 1 - OFF - NO. 1 & NO. 2 -	Powers Suit Fan No. 1  Both suit fans off.  Powers both Suit Fans No. 1 & No. 2.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
None.		Open on launch, orbit, and descent. Closed after landing.
(a) O <sub>2</sub> RATE CNTL (V <sub>CC</sub> ). (b) O <sub>2</sub> RATE CNTL (V <sub>CC</sub> ).  SUIT FANS 1 & 2 (V <sub>M</sub> ). (c) Same as (a). (d) Same as (a).	<u>T/M (D/T)</u> O <sub>2</sub> High Rate (bilevel).  SEQ INST (V <sub>CC</sub> ) required	Recock function actuated at end of travel (down). Handle should then be returned to the up position.
SUIT FAN 1 (V <sub>M</sub> ).  SUIT FAN 1 (V <sub>M</sub> ). SUIT FAN 2 (V <sub>M</sub> ):	Sea level 2.55 amps. Orbit 3.55 amps. (one fan).	1. Both suit fans disabled when O <sub>2</sub> High Rate is on and if the Inlet Snorkel is closed. 2. Flow rate is approximately 0.6 lb/min at 10 inches of water pressure rise and 5 psia (one fan).
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>Cabin &amp; Suit Temperature Indicators</u> 	<p>CABIN</p> <p>(a) Indicates cabin temperature.</p> <hr/> <p>SUIT</p> <p>(b) Indicates <u>average</u> of both suit temperatures.</p>
Center Panel	<u>Cabin Pressure &amp; Suit CO<sub>2</sub> Pressure Indicator</u> 	<p>CABIN PRESS</p> <p>(a) Indicates cabin pressure.</p> <hr/> <p>P CO<sub>2</sub> SUIT</p> <p>(b) Indicates CO<sub>2</sub> partial pressure.</p>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) DC-DC CONV ( $V_{24V}$ ).	<u>T/M (D/T)</u> Cabin temperature (40° to 200°F).	Cabin temperature dual sensor (onboard readout and T/M sensor) is located on the bulkhead behind the center panel.
(b) DC-DC CONV ( $V_{24V}$ ).	<u>T/M (D/T)</u> Each suit inlet temperature (40° to 100°F).	T/M sensor is upstream of onboard readout sensor. Both sensors are located between suit flow rate control and suit.
(a) DC-DC CONV ( $V_{5V}$ ).	<u>T/M (D/T)</u> 1. Cabin pressure (to forward compartment) (0 to 8 psid).	1. Cabin pressure dual sensor (onboard readout and T/M) is located on forward bulkhead behind left instrument panel.
(b) DC-DC CONV ( $V_{+24V}$ & $V_{-24V}$ ).	<u>T/M (D/T)</u> CO <sub>2</sub> partial pressure (0 to 20 mm of Hg).	1. CO <sub>2</sub> dual sensor is located downstream of CO <sub>2</sub> absorber. 2. CO <sub>2</sub> absorber capacity is 80 ± 0.5 lbs of <sup>2</sup> LiOH capable of absorbing 71 lbs of CO <sub>2</sub> . 3. CO <sub>2</sub> gage will normally read near zero
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>Left &amp; Right SECONDARY O<sub>2</sub> Pressure Indicators</u>	Indicate left and right secondary O <sub>2</sub> tank pressures.
Center Panel	<u>Cryo Indicator</u>	<p>(Repeated in Section 2.2.1, page 2)</p> <p>(a) Displays CRYO O<sub>2</sub> quantity and pressure when O<sub>2</sub> is selected on Quantity Switch.</p> <p>(b) Displays H<sub>2</sub> quantity and pressure when H<sub>2</sub> is selected on Quantity Switch.</p> <p>(c) Displays O<sub>2</sub> Pressure when quantity sw OFF.</p>
Center Panel	<u>Quantity Selector Switch</u>  O <sub>2</sub> -  H <sub>2</sub> -  OFF -	<p>(Repeated in Section 2.2.1, pg. 5)</p> <p>Powers CRYO O<sub>2</sub> Sensor for quantity &amp; pressure readout and T/M of O<sub>2</sub> quantity.</p> <p>Powers Fuel Cell H<sub>2</sub> Sensor for quantity &amp; pressure readout and T/M of H<sub>2</sub> quantity.</p> <p>No power to above but last quantity readout will appear on meter and CRYO O<sub>2</sub> pressure can be read on pressure meter.</p>
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
DC-DC CONV (V <sub>5V</sub> ).	T/M (D/T) Sec O <sub>2</sub> pressure for each tank (0 to 6K psia).	6.5# usable in each bottle.
CRY QTY (V <sub>M</sub> ). DC-DC Converter (V <sub>5V</sub> ).	T/M (D/T) CRYO O <sub>2</sub> pressure (0 to 1.2K psia)  CRYO O <sub>2</sub> Quantity (0 to 100%)  CRYO O <sub>2</sub> Supply Bottle Temp -300°F to -100°F.	<ol style="list-style-type: none"> <li>1. Container capacity 106 lbs of which 8.6 lbs are residual. Pressure relief valve set at 1000 <math>\begin{smallmatrix} +50 \\ -55 \end{smallmatrix}</math> psid.</li> <li>2. The range of the pressure transducers has been changed to expand the upper limit and the pressure gage is no longer direct reading. The approximate correction factor to be applied to displayed pressures is 1.2 for O<sub>2</sub> and .45 for H<sub>2</sub>. Note that the T/M pressure transducers have also been changed to a range of 1.2K psia and 450 psia respectively and will require a scale change at the sites to be direct reading. The gages will be individually calibrated to the pressure transducers installed and an exact correction card will be supplied to the crew before flight. In addition, the S/C gages will be marked to indicate the nominal operating range.</li> </ol>
CRY QTY (V <sub>M</sub> ). DC-DC Converter (V <sub>5V</sub> ).	T/M (D/T) Same as above.  Bilevel of O <sub>2</sub> selected.  Bilevel of H <sub>2</sub> selected.	<ol style="list-style-type: none"> <li>1. Approximately 17 sec are required for accurate quantity readout in each switch position.</li> <li>2. Cryo quantity is a continuous T/M readout and requires correlation with bilevels for identification of parameter being monitored.</li> </ol>
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>O<sub>2</sub> HEATER Switch</u>  ON -   OFF -   AUTO -   <u>AMBER LT</u>	Continuous power to CRYO O <sub>2</sub> Auto and manual heaters  (Guarded in the ON position only.)    Intermittent powering of CRYO O <sub>2</sub> auto heater. Off: $\geq 900$ $\begin{smallmatrix} +10 \\ -25 \end{smallmatrix}$ psid. On: 15 to 75 psid below opening point.  Illuminates when O <sub>2</sub> HEATERS Switch is in the ON position.
Center Console	<u>MANUAL O<sub>2</sub> HIGH RATE Handle</u>  On - (Pull up)	(a) Initiates O <sub>2</sub> High Rate. (b) Initiates T/M of O <sub>2</sub> High Rate.   (c) Disables suit fans if Inlet Snorkel is closed.  (d) Initiates AMBER O <sub>2</sub> High Rate light.
Center Panel	<u>O<sub>2</sub> HI RATE (Amber Light)</u>	Indicates the O <sub>2</sub> High Rate Valves have been powered.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
CRYO O <sub>2</sub> & H <sub>2</sub> HTR (V <sub>M</sub> ) for the auto heater and a fuse for the manual heater.	<u>On</u> 10.77 amps	1. The "On" heater is composed of the manual (10.43 amps) and the Auto (.34 amps) heaters. The "Auto" heater is composed of the auto (0.37 amps) heater only.
CRYO O <sub>2</sub> & H <sub>2</sub> HTR (V <sub>M</sub> )	<u>Auto</u> 0.34 <sup>1</sup> amps	2. Turn heater off when 9% quantity is reached. 3. "ON" heaters duty cycle is 75%. Maximum continuous on time is 30 minutes.
Fuse (V <sub>M</sub> )		
(a) O <sub>2</sub> RATE CNTL (V <sub>CC</sub> ). (b) O <sub>2</sub> RATE CNTL (V <sub>CC</sub> ). SEQ INST (V <sub>CC</sub> ) (c) Same as (a). (d) O <sub>2</sub> RATE CNTL (V <sub>CC</sub> ). SEQ LIGHTS PWR (V <sub>M</sub> ).	<u>T/M (D/T)</u> Bilevel of O <sub>2</sub> H1 Rate.	1. O <sub>2</sub> High Rate using primary supply or secondary supply is 12.0 lb/hr or 9.0 lb/hr resp. 2. O <sub>2</sub> High Rate from the primary O <sub>2</sub> bottle may require use of the manual (ON position) O <sub>2</sub> heater to maintain bottle pressure.
SEQ LIGHTS PWR (V <sub>M</sub> ).		
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	O <sub>2</sub> HI RATE Switch	
	OFF -  O <sub>2</sub> HI RATE -	No power to O <sub>2</sub> high rate valves.  (a) Initiates O <sub>2</sub> Hi Rate. (b) Initiates T/M of O <sub>2</sub> Hi Rate.  (c) Disables suit fans if Inlet Snorkel is closed. (d) Initiates O <sub>2</sub> High Rate AMBER Lt.
<div> <div>GEMINI OPERATIONS HANDBOOK</div> <div>Pg 11 Section 2.3.1</div> </div> <div> <div>Flight Crew Support Division</div> <div>Mission Operations Branch</div> </div> <div> <div>Prepared by <u>L.J.R</u></div> <div>Checked by <u>[Signature]</u></div> <div>Approved by <u>[Signature]</u></div> </div>		

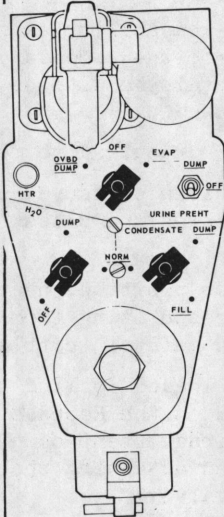


CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) O <sub>2</sub> RATE CNTL (V <sub>CC</sub> ). (b) O <sub>2</sub> RATE CNTL (V <sub>CC</sub> ). SEQ INST (V <sub>CC</sub> )  (c) Same as (a). (d) Same as (a). SEQ LIGHTS PWR (V <sub>M</sub> )	<u>T/M (D/T)</u> O <sub>2</sub> High Rate ON (bilevel).	1. Momentary contact switch in O <sub>2</sub> Hi Rate position.
		</

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Pedestal	<u>SUIT FLOW Controls</u> (One for each suit) OFF -  Open -	Shuts off all O <sub>2</sub> flow to suit except when O <sub>2</sub> High Rate is initiated.  Variable control of O <sub>2</sub> flow to individual suits when on normal flow rate.
Pedestal	<u>REPRESS Handle</u> Open -	(Cabin Repressurization) Repressurizes cabin from primary (110 psi regulated) or secondary (75 psi regulated) O <sub>2</sub> bottles. Normal flow rate is 0.35 lb/min at 100 psig inlet and 5 psia outlet conditions.
Misc	<u>LEFT and RIGHT SECONDARY O<sub>2</sub> BOTTLE SHUTOFF Handles</u> OPEN - SHUT -	Manual OPEN - SHUT control of secondary O <sub>2</sub> tanks. Each astro controls one tank.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
None.		A change in setting by one astro affects both suit loops. Both loops are also affected if one astro opens his visor or removes a glove.
		<ol style="list-style-type: none"> <li>1. While the capability exists to repressurize from the secondary bottles under certain conditions, this should not be done.</li> <li>2. 2.5# of O<sub>2</sub> required to repressurize.</li> <li>3. Monitor cabin pressure during repressurization as the pressure source is 110 psig.</li> <li>4. Manual (on position) heater required when repressurizing from primary O<sub>2</sub> bottle to maintain bottle pressure.</li> <li>5. A spring loaded locking pin has been installed on the Repress Handle to prevent inadvertent opening of the valve when adjusting the suit flow control valves.</li> </ol>
None.		<p>Handles located beside Left Switch C/B Panel and Right Switch C/B Panel.</p> <p><u>Each</u> tank supplies <u>both</u> astros.</p>
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PANEL LOCATION SECTION 1 PAGE	NAME AND POSITION	FUNCTION
Misc	<u>Water Management Panel</u> URINE VALVE - CONDENSATE VALVE - H <sub>2</sub> O TANK VALVE - 	Three rotary valves for control of the water system. Controls dumping of urine thru the urine dump line or, in event of blockage, thru the evaporator. Controls dumping of water from the suit heat exchanger and/or water tank. Controls filling of water tank from suit heat exchanger. Controls drinking, filling, and dumping of water from the water tank. See Notes (2.3.6) for relative selection of each valve.
Water Panel	<u>Urine Heater Light</u>	Illuminates amber when Urine Dump Switch is in PREHT or DUMP.
Water Panel	<u>URINE DUMP Switch</u> PREHT - OFF - DUMP -	Powers urine dump heater to preheat line prior to dumping urine overboard. No power. (a) Powers urine dump heater (to heat line). (b) Powers urine solenoid valve (opens valve).
GEMINI OPERATIONS HANDBOOK Pg 15 Section 2.3.1		
Flight Crew Support Division Mission Operations Branch		Prepared by <u>Lt J. R.</u> Checked by <u>REB</u> Approved by <u>REB</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
None.		<ol style="list-style-type: none"> <li>1. Located between the seats, aft of the center console.</li> <li>2. Use the portable light to illuminate the transparent water storage tank.</li> <li>3. To prevent membrane rupture in the suit water separator, the CONDENSATE VALVE should not be placed in either FILL or DUMP positions when there is water in the Reentry and Adapter water tanks.</li> </ol>
CRYO O <sub>2</sub> & H <sub>2</sub> HTR (V <sub>M</sub> )		
CRYO O <sub>2</sub> & H <sub>2</sub> HTR (V <sub>M</sub> ). (a) CRYO O <sub>2</sub> & H <sub>2</sub> HTR (V <sub>M</sub> ). (b) SEC COOL VLVS (V <sub>CC</sub> ).	2.06 amps (both positions)	PREHT position must be selected 3 to 4 min before placing switch to FLUSH.  NOTE: Heater ON time must not exceed 5 minutes.
S/C 10 Date 7/1/66	Rev A Environmental Control System Life Support System	GEMINI OPERATIONS HANDBOOK Section 2.3.1 Pg 16

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>PRIMARY PUMP A Switch</u> ON -	<p>(a) Powers coolant pump - Primary A.</p> <p>(b) Enables PRIMARY PUMP A Amber light to indicate pump failure and enables T/M of pump on.</p>
Center Panel	<u>PRIMARY PUMP B Switch</u> ON -	<p>(a) Powers coolant pump - Primary B.</p> <p>(b) Enables PRIMARY PUMP B Amber light to indicate pump failure and enables T/M of pump on.</p> <p>Continued</p>
GEMINI OPERATIONS HANDBOOK Pg 1 Section 2.3.2 Flight Crew Support Division Mission Operations Branch Prepared by <u>L.T.R.</u> Rev. A Checked by <u>[Signature]</u> 7/1/66 Approved by <u>[Signature]</u>		



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) PRI COOLANT PUMP A (V <sub>M</sub> ).  (b) ECS IND LTS (V <sub>M</sub> ).	<u>T/M (D/T)</u> 1. Pri Pump A On (bilevel). 2. Pri loop inlet pump pressure (0 - 100 psia).  <u>Power Required:</u> 4.02 amp @ 24 volts & 50 psid.  4.53 amp @ 24 volts & 100 psid.	Nominal output is 225 lb/hr @ 100 psid.
(a) PRI COOLANT PUMP B (V <sub>M</sub> ).  (b) ECS IND LTS (V <sub>M</sub> ).	<u>T/M (D/T)</u> 1. Pri Pump B on (bilevel). 2. Pri loop inlet pump pressure (0 - 100 psia).  <u>Power Required</u> 1.83 amp @ 24 volts and 50 psid  2.26 amp @ 24 volts and 100 psid.	The Primary B Pump power supply has been modified to reduce input power requirements and therefore reduces the nominal coolant flow to approximately 130 lb/hr at 100 psid.
Continued	Continued	
S/C 10      Rev A Date 7/1/66	Environmental Control System Cooling System	GEMINI OPERATIONS HANDBOOK Section 2.3.2 Pg 2

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
	<u>SECONDARY PUMP A Switch</u> ON -	(a) Powers coolant pump - Secondary A.  (b) Enables SECONDARY PUMP A Amber light to indicate pump failure and enables T/M of pump on.
	<u>SECONDARY PUMP B Switch</u> ON -	(a) Powers coolant pump Secondary B.  (b) Enable SECONDARY PUMP B Amber light to indicate pump failure and enables T/M of pump on.
Center Panel	<u>PRIMARY A &amp; B SECONDARY A &amp; B PUMP Malfunction Amber Lights</u>	Four lights, one for each coolant pump, to indicate failure (no flow) of each of the coolant pumps. Light is enabled only when its respective pump is powered.
GEMINI OPERATIONS HANDBOOK Pg 3 Section 2.3.2		Flight Crew Support Division Mission Operations Branch
		Prepared by <u>L.J.R.</u> Rev. A Checked by <u>[Signature]</u> 7/1/66 Approved by <u>[Signature]</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) SEC COOLANT PUMP A (V <sub>M</sub> ). (b) Same as (b) above.	<u>T/M (D/T)</u> 1. Sec Pump A On (bilevel). 2. Sec loop inlet pump pressure (0 - 100 psia). <u>Power Required</u> 4.02 amp @ 24 volts & 50 psid. 4.53 @ 24 volts & 100 psid	Nominal output is 225 lb/hr @ 100 psid
(a) SEC COOLANT PUMP B (V <sub>M</sub> ). (b) Same as (b) above.	<u>T/M (D/T)</u> 1. Sec Pump B on (bilevel). 2. Sec loop inlet pump pressure (0 - 100psia). <u>Power Required</u> 1.83 amp @ 24 volt and 50 psi. 2.26 amp @ 24 volt and 100 psid.	The Secondary B Pump power supply has been modified to reduce input power requirements and therefore reduces the nominal coolant flow to approximately 130 lb/hr at 100 psid.
ECS IND LTS (V <sub>M</sub> ).		1. Information for amber lights given by flow - no flow magnetic reed valves located downstream of each pump. 2. Light will "flicker" when a pump is turned on. 3. These lights have iris type dimmers.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	RES LO PRIMARY - SECONDARY -	(Reservoir Low Amber Light) Indicates low reservoir level in primary loop. Indicates low reservoir level in secondary loop.
Center Panel	RAD FLOW -  BY-PASS -	(Radiator Switch) (a) Directs coolant flow in primary loop thru the radiator. (b) Directs coolant flow in secondary loop thru the radiator.  (a) Directs coolant flow in primary loop thru the ground cooled heat exchanger (bypassing radiator). (b) Directs coolant flow in secondary loop thru the ground cooled heat exchanger (bypassing radiator).
GEMINI OPERATIONS HANDBOOK    Flight Crew Support Division    Prepared by <u>L.L.R.</u> Pg 5 Section 2.3.2    Mission Operations Branch    Checked by <u>[Signature]</u> Approved by <u>R.R.Z.</u>		



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
ECS IND LTS ( $V_M$ ) Same as above.		<ol style="list-style-type: none"><li>1. There are two 53 in<sup>3</sup> reservoirs for each loop. Light comes on when quantity in reservoir decreases below 5 in<sup>3</sup>.</li><li>2. Reservoirs are sized such that the light will not come on due to temperature contractions of the coolant.</li><li>3. This light has an iris type dimmer.</li><li>4. Coolant reservoir level taken upstream of pumps.</li></ol>
(a) PRI COOL VLVS ( $V_{CC}$ ) (b) SEC COOL VLVS ( $V_{CC}$ )   (a) PRI COOL VLVS ( $V_{CC}$ ) (b) SEC COOL VLVS ( $V_{CC}$ )	<u>T/M (D/T)</u> <ol style="list-style-type: none"><li>1. Outlet radiator temp (-80 +80°F). (primary and secondary loops).</li></ol>	<ol style="list-style-type: none"><li>1. After insertion, the RAD Switch should remain in the BY-PASS position until the radiator cools down.</li><li>2. This switch may be used to bypass the radiator in the event of radiator blockage.</li></ol>
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>EVAP</u> MAX FLOW -  NORM -	(H <sub>2</sub> O Evaporator Flow Switch) (a) Directs all of fluid in primary loop thru evaporator. (b) Directs all of fluid in secondary loop thru evaporator. <hr/> (a) Directs a portion of fluid in primary loop thru evaporator (maximum of approximately 67%). The remainder of the fluid bypasses the evaporator and suit heat exchangers. (b) Directs a portion of fluid in secondary loop thru evaporator (maximum of approximately 67%). The remainder of the fluid bypasses the evaporator and suit heat exchangers.
Center Panel	<u>EVAP</u> HEAT -	(H <sub>2</sub> O Evaporator Heater Switch) Energizes heater in H <sub>2</sub> O evaporator exhaust port to de-ice the exhaust port.
Center Panel	<u>EVAP PRESS</u> <u>Amber Light</u>  ON -  OFF -	Indicated high H <sub>2</sub> O evaporator pressure. On at $4_{+0}^{-.3}$ psia.  Off at $3.1_{+.3}^{-0}$ psia
GEMINI OPERATIONS HANDBOOK Pg 7 Section 2.3.2		Flight Crew Support Division Mission Operations Branch Prepared by <u>L. J. R</u> Checked by <u>[Signature]</u> Approved by <u>R. J. S</u>



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
(a) PRI COOL VLVS ( $V_{CC}$ ). (b) SEC COOL VLVS ( $V_{CC}$ ). <hr/> (a) PRI COOL VLVS ( $V_{CC}$ ). (b) SEC COOL VLVS ( $V_{CC}$ ).		1. Evaporator does not operate unless incoming fluid is above 44 - 50°F.  2. MAX FLOW used during launch. NORM used after insertion. 3. When the water pressure builds up to $2.75 \pm 0.25$ psig, it is dumped overboard. 4. When using the "B" pumps only, no fluid is expected to bypass the evaporator.
EVAP HTR ( $V_M$ ).	No T/M of heater on. 234 amps.	1. Turn on to HEAT when EVAP PRESS amber light comes on. 2. The heater should not be needed since the port is heated by warm coolant fluid. 3. Do not leave on for more than 5 minutes. If light remains on, heater may be actuated after 30 minutes have elapsed. Do not turn on or leave on unless EVAP PRESS light is illuminated.
ECS IND LTS ( $V_M$ ).	No T/M of evaporator pressure.	1. High pressure probably due to evaporator freeze up. 2. This light has iris type dimmer.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>TEMP CONTROL Knobs</u>  SUIT COOLANT FLOW -          CABIN COOLANT FLOW -	<p>Concentric rotating knobs (clockwise is warmer).</p> <p><u>Outer knob</u> regulates amount of coolant flow thru Suit heat exchanger (both suits affected). Effective operating range is between OFF and MAX (30° and 120°, respectively, counterclockwise from the fully closed position).</p> <p>Not applicable to S/C 10 (no cabin heat exchanger).</p>
<div> <div>GEMINI OPERATIONS HANDBOOK Pg 9      Section 2.3.2</div> <div>           Flight Crew Support Division Mission Operations Branch         </div> <div>           Prepared by <u>L. J. R.</u>            Checked by <u>[Signature]</u>            Approved by <u>RHS</u> </div> </div>		



<u>CIRCUIT BREAKER</u> BUS	<u>TELEMETRY</u> POWER REQUIRED	REMARKS
None.		Adjustment of the Suit Temperature control knob is the recommended method of increasing suit temperature.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Left Sw C/B Panel	Circuit Breaker <u>ECS IND LTS</u> Closed -	No. 7-15 ( $V_M$ ) (ECS Indicator Lights) (a) Powers PRIMARY A & B and SECONDARY A & B coolant pump amber malfunction lights thru magnetic reed valves. (b) Powers PRIMARY & SECONDARY RES LO amber lights thru low level switches. (c) Powers EVAP PRESS Light thru evaporator pressure switch. (d) Powers T/M of Primary A & B and Secondary A & B coolant pumps "On."
Overhead Sw C/B Panel	Circuit Breaker <u>COOLANT PUMPS</u> <u>PRI A</u> Closed -	No. 7-2 ( $V_M$ )  Powers Primary A coolant pump thru PRIMARY PUMP A Switch.
Overhead Sw C/B Panel	Circuit Breaker <u>COOLANT PUMPS</u> <u>SEC A</u> Closed -	No. 7-3 ( $V_M$ )  Powers Secondary A coolant pump thru SECONDARY PUMP A Switch.
	<u>COOLANT PUMPS</u> <u>PRI B</u> Closed -  <u>COOLANT PUMPS</u> <u>SEC B</u> Closed -	No. 7- 8 ( $V_M$ )  Powers Primary B coolant pump thru PRIMARY PUMP B Switch.  No. 7-9 ( $V_M$ )  Powers Secondary B coolant pump thru SECONDARY PUMP B Switch.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	Circuit Breaker <u>CRY QTY</u> Closed -	No. 7-21 ( $V_M$ ) (Cryogenic Quantity) Powers CRYO $O_2$ and $H_2$ , onboard and T/M quantity readouts thru QTY Selector Switch.
Right Sw C/B Panel	Circuit Breaker <u>CRYO <math>O_2</math> &amp; <math>H_2</math> HTR</u> Closed -	No. 7-4 ( $V_M$ ) (Primary $O_2$ Heater) (a) Powers $H_2$ heater thru $H_2$ Heater Sw (b) Powers Primary $O_2$ Auto Heater thru $O_2$ HEATER Switch. (c) Powers Urine Dump Heater & light thru URINE DUMP Switch in either PREHT or DUMP position.
Overhead Sw C/B Panel	Circuit Breaker <u>SUIT FAN 1</u> Closed -	No. 7-1 ( $V_M$ ) Powers Suit Fan No. 1: (a) Thru SUIT FAN Switch. (b) Thru SUIT FAN and INLET SNORKEL Switches during descent if $O_2$ High Rate had been initiated.
Overhead Sw C/B Panel	Circuit Breaker <u>SUIT FAN 2</u> Closed -	No. 7-7 ( $V_M$ ) Same as above except for Suit Fan No. 2.
<div> <div> Prepared by <u>LJR</u>  Checked by <u>[Signature]</u>  Approved by <u>RAB</u> </div> <div> Flight Crew Support Division  Mission Operations Branch  Date <u>7/17/66</u> </div> <div> GEMINT OPERATIONS HANDBOOK  S/C 10 Rev A  Section <u>2.3.3</u> Pg <u>2</u> </div> </div>		

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	Circuit Breaker <u>EVAP HTR</u> Closed -	No. 7-6 ( $V_M$ ) (Evaporator Heater Control) Powers evaporator heater thru EVAP Heater Switch.
Overhead Sw C/B Panel	Circuit Breaker <u>PRI COOL VLVS</u> Closed -	No. 7-13 ( $V_{CC}$ ) (Primary Coolant Valves) (a) Powers primary loop evaporator flow solenoid thru EVAP Flow Switch. (b) Powers primary loop radiator flow solenoid thru RAD Flow Switch.
Overhead Sw C/B Panel	Circuit Breaker <u>SEC COOL VLVS</u> Closed -	No. 7-14 ( $V_{CC}$ ) (Secondary Coolant Valves) (a) Same as above except for the secondary loop. (b) Powers Urine Solenoid Valve thru URINE DUMP Switch in DUMP position.
Overhead Sw C/B Panel	Circuit Breaker <u>O<sub>2</sub> RATE CNTL</u> Closed -	No. 7-11 ( $V_{CC}$ ) (O <sub>2</sub> Rate Control) (a) Enables O <sub>2</sub> HI RATE Switch to select O <sub>2</sub> HI RATE. (b) Disables suit fans when in O <sub>2</sub> HI RATE.  (c) Enables absolute pressure switches to initiate O <sub>2</sub> High Rate. (d) Enables T/M of O <sub>2</sub> High Rate thru MANUAL O <sub>2</sub> HI RATE, and SEQ INST circuit breaker. (e) Enables O <sub>2</sub> HI RATE Amber light thru SEQ LTS PWR circuit breaker.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right Sw C/B Panel	Circuit Breaker SEQ INST  Closed -	No. 9-19 ( $V_{CC}$ ) (Sequential Instrumentation)  Provides T/M of: (a) $O_2$ High Rate (See section 2.1.5 page 5 for other functions).  1  1
Overhead Sw C/B Panel	Circuit Breaker <u><math>H_2O</math> HTRS</u> Closed - 1.2 amps	No. 7-23 ( $V_M$ )  Powers the parallel connected $H_2O$ drink line, $H_2O$ waste line, and $H_2O$ tank heaters. (8.0 watts for $H_2O$ drink line heaters, 5.28 watts for $H_2O$ waste line heaters, 6.67 for Retro Tank and 6.95 watts for Fuel Cell Tank total current approx. 1.2 amps).  NOTE: 1. The Circuit Breaker must be used for ON - OFF control of these heaters as no switch is provided.
Overhead Sw C/B Panel	Circuit Breaker <u>ELSS PWR</u> Closed -	Supplies power to ELSS Chest Pack thru the 50 ft. Umbilical during EVA.

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### SUIT NOTES

#### 1. Suit Integrity Check

Should the suit be opened for any purpose (urine dump, defecation, etc.), it should be checked for leakage after it has been resealed. This is accomplished as follows:

- |   |  |
|---|--|
| 1. MANUAL O <sub>2</sub> HIGH RATE - Pull                                   | 5. Monitor pressure decay for approximately 30 sec. (rate of decay must be less than $\frac{1}{2}$ psi/min.) |
| 2. SUIT Flow Handle - OFF   | 6. Connect O <sub>2</sub> outlet hose  |
| 3. Disconnect O <sub>2</sub> outlet hose. Let Suit pressure reach 8.5 psia. | 7. Suit Flow Handle - INC.   |
| 4. O <sub>2</sub> HIGH RATE RECOCK - Pull                                   |  |

#### 2. Suit Pressure Indicator (located on left arm of suit).

Indicates absolute suit pressure. The indicator is graduated in 0.5 psi intervals from 2 to 10 psia. Accuracy is  $\pm 0.2$  psi.

#### 3. Ventilation Umbilical

Nozzles and suit fittings are color coded to prevent improper connections. Blue denotes inlet, and red, outlet.

#### 4. Suit Pressure Relief Valves 1 for each suit

Relieves suit pressure when it reaches  $4.6 \pm .3$  psi greater than cabin pressure.

#### 5. Drinking Port (located on helmet)

Permits drinking of water without opening the faceplate. Drinking nozzle is inserted through port and into mouth.

#### 6. Glove Fingertip Lighting

On each glove there are 2 white lights (on index and middle fingers). The control switch and battery is contained on the back of each glove.

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(a) Pri O<sub>2</sub> pressure is regulated to 110 psi.

(b) The Repress Valve is used to pressurize the cabin to 4.3 psia (takes about 5 minutes).

(c) The Repress Valve is turned off and the cabin pressure regulator brings cabin pressure to 5.1 psia (takes about 4 hours).

There is a possibility that the manual heaters will not be able to maintain Pri O<sub>2</sub> pressure in the normal range during repressurization. Should the pressure drop below 110 psia (normal regulated pressure), the flow rate will decrease and thus the time to repress will increase. Maximum ON time for the manual heaters is 30 minutes.

6. O<sub>2</sub> High Rate can be selected by:

(a) Manual O<sub>2</sub> High Rate handle

(b) O<sub>2</sub> HI RATE Switch in O<sub>2</sub> HI RATE position.

(c) Absolute pressure switch (3.0 to 3.37 psia) (automatic)

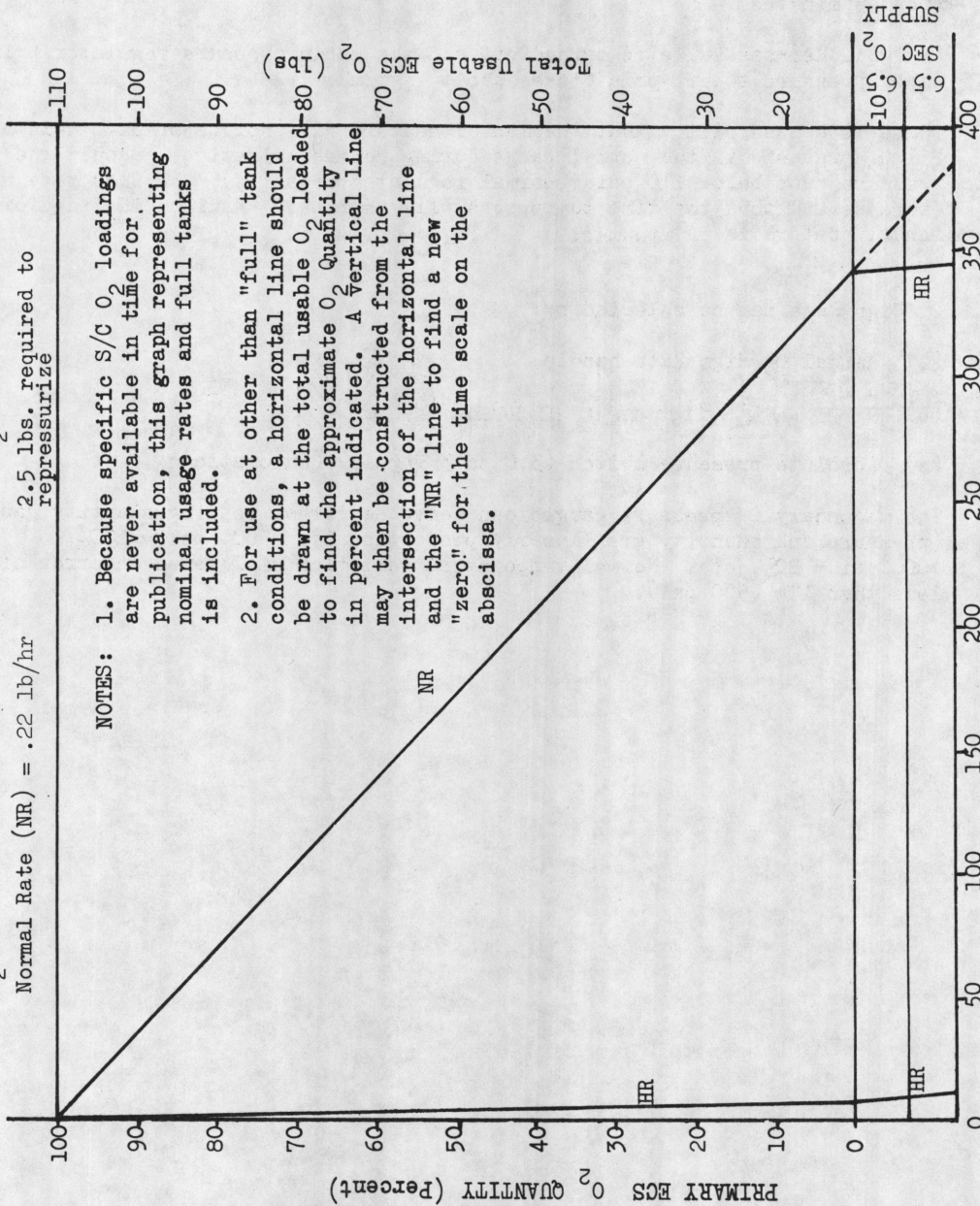
7. The secondary O<sub>2</sub> pressure gauges can serve as direct reading quantity gauges (pressure and quantity are linearly proportional). 5000 psi = 100%, 4000 psi = 80%, etc. Normal temperature variation will cause an error of less than 10% (500 psi).

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Approved by <u>8415</u>	Date <u>7/1/66</u>	Section <u>2.3.5</u> Pg <u>2</u>
MSC Form 1097B (Dec 63)		NASA - Manned Spacecraft Center

# OXYGEN SUPPLY USAGE

Cabin Leakage = .053 lb/hr  
 $O_2$  Consumption = .167 lb/hr (HR)  
 Normal Rate (NR) = .22 lb/hr

Pri  $O_2$  Hi Rate = 12.0 lb/hr  
 Sec  $O_2$  Hi Rate = 9.0 lb/hr (approx.)  
 2.5 lbs. required to repressurize



TIME - HOURS FROM LIFT-OFF  
 (Based on 97.4 lbs. Useable Primary  $O_2$  + 13 lbs. Secondary  $O_2$ )

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## WATER MANAGEMENT SYSTEM

### NOTES

#### 1. Water Tanks (See diagrams on following pages.)

In Spacecraft <sup>10</sup> there are three water tanks, two in the Adapter Module called Tank A and Tank B, and one in the Reentry Module called the Reentry Tank.

Tank A is a 42 lb tank initially serviced with nitrogen at 19.0 psia. Fuel Cell product water is transferred into Tank A replacing nitrogen which is vented overboard through two pressure relief valves set at  $20 \pm 0.5$  psia. Tank B is a 42 lb tank initially serviced with potable water and pressurized with fuel cell water at 19.0 psia. As fuel cell product water flows into Tank B, potable water is transferred into the Reentry Tank.

The Reentry Tank is serviced to 16 lbs with potable water and marked at the 13 lb level (minimum requirements for postlanding). Since the Reentry Tank is referenced to cabin pressure (nominally 5.0 psia), the Adapter Tanks will keep the Reentry Tank filled.

#### 2. Tank Pressurization (See diagrams on following pages.)

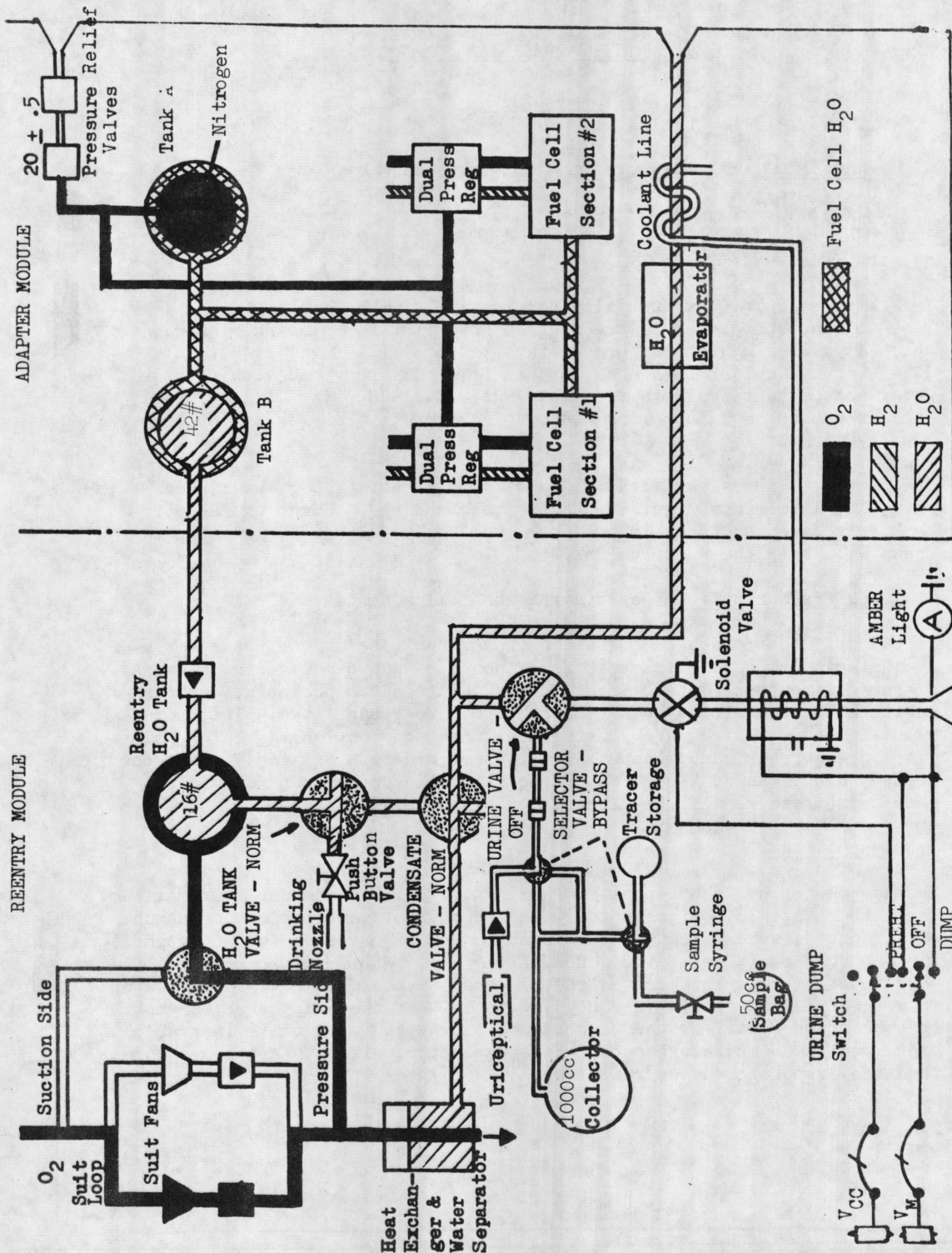
In the different modes of operation, the water tank may be pressurized by the suit compressor inlet (2 to 3 inches of  $H_2O$  below cabin pressure) or the suit outlet (7 to 8 inches of  $H_2O$  above cabin pressure), and in addition, by the biomed bulb (36 inches of  $H_2O$  capability). The biomed bulb aids in drinking water during prelaunch and postlanding. The bulb has a pressure or vacuum capability (determined by a fitting). When the biomed bulb is used, the PRESS OFF position of the  $H_2O$  tank should be selected (pressure will be directed only to the  $H_2O$  tank).

#### 3. Evaporator

The evaporator has the capacity of using up to 13 pounds per hour maximum. The evaporator will be preloaded with 7 pounds of water prior to launch. During orbit, water from the suit heat exchanger is routed to the evaporator via the NORM position of the CONDENSATE Valve. When this water has been used up or becomes inadequate, the evaporator should be filled with water from the drinking tank. The only way to tell if the evaporator is empty is to compare (via T/M) the temperature out of the -491 valve (entrance to evap) and the temperature out of the evaporator. If both are above normal, then the evaporator needs refilling.

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WATER MANAGEMENT PANEL - NORMAL AND DRINK MODE

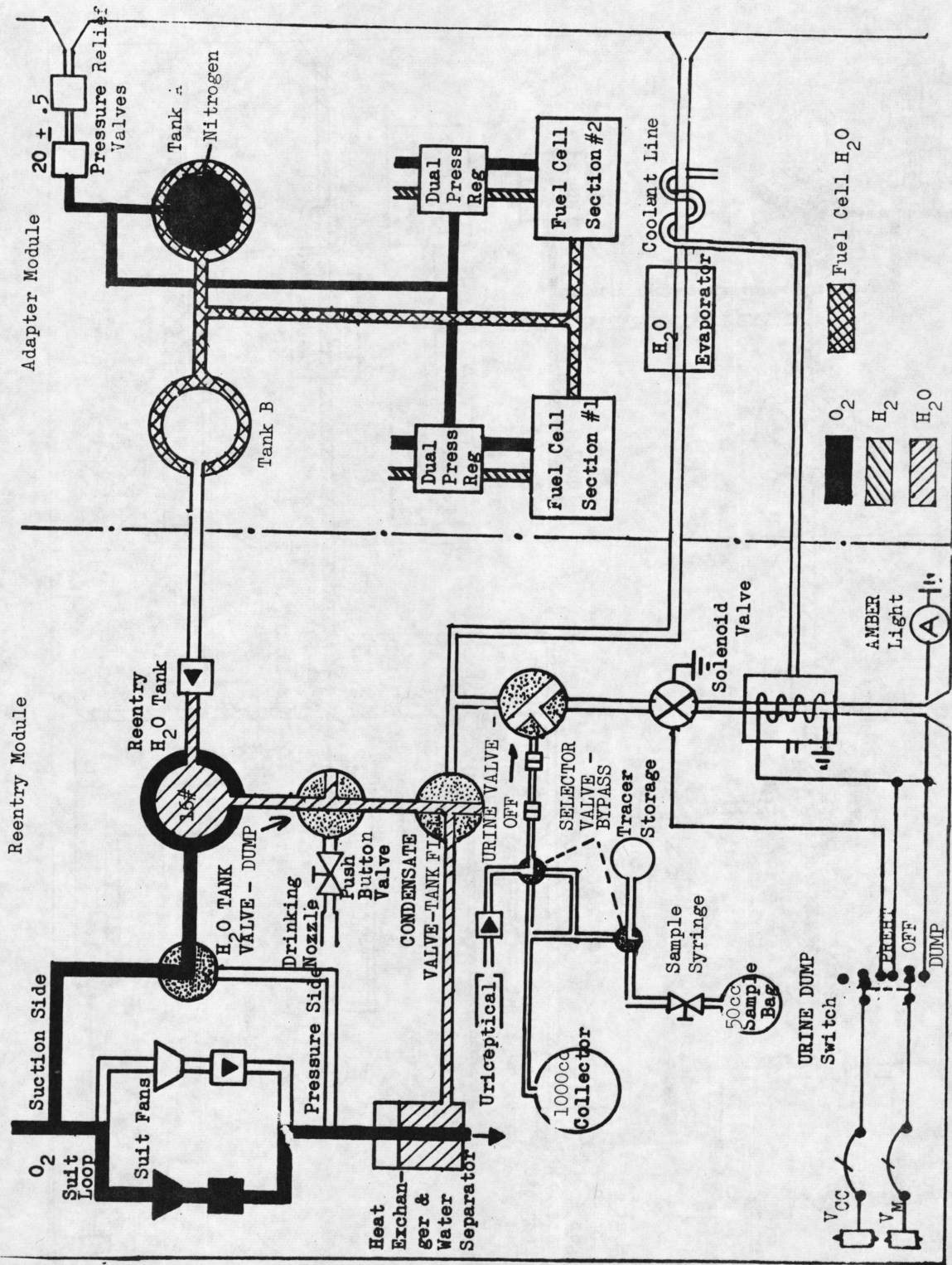
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*L. J. R.*  
*R. E. B.*

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WATER MANAGEMENT SYSTEM - TANK FILL MODE (Use only if Reentry Tank and Tank B are empty).

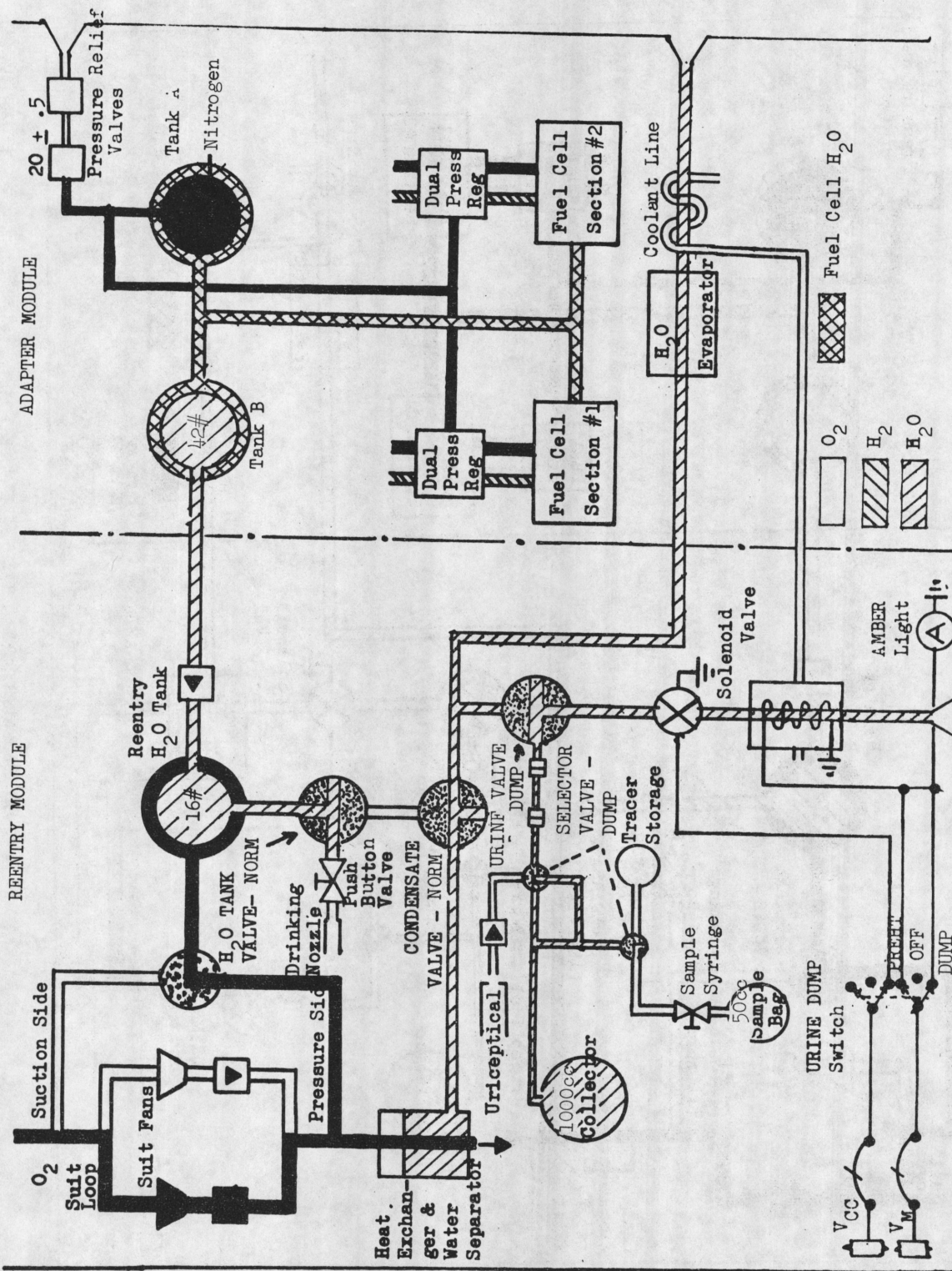
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Flight Crew Support Division  
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Date 7/1/66

Prepared by LJR  
Checked by RJB  
Approved by RJB

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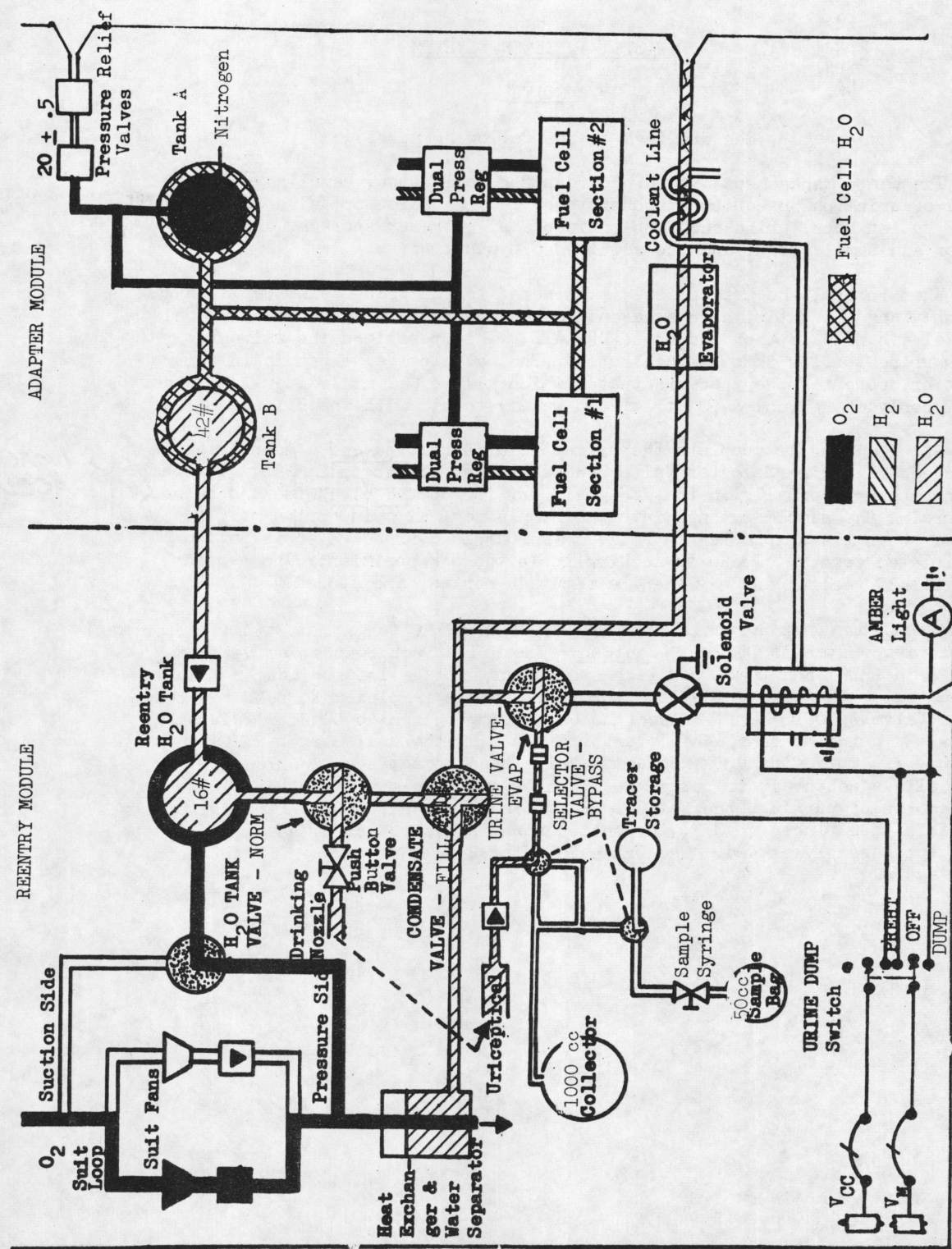
WATER MANAGEMENT SYSTEM - FLUSH MODE (See also sect. 2.3.6 pgs 7-9)

Prepared by LJR  
 Checked by RHS  
 Approved by RHS

Flight Crew Support Division  
 Mission Operations Branch  
 Date 7/1/66

GEMINI OPERATIONS HANDBOOK  
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WATER MANAGEMENT SYSTEM - EVAPORATOR FILL MODE  
(Note: Hose is installed between drink nozzle and uricepticle.)

## WASTE MANAGEMENT SYSTEM

### NOTES

(See drawings on the following pages)

The Waste Management System provides for collection, sampling, and disposal of urine. The equipment consists of a Urine Selector Valve Assembly, urine outlet hose, urine receiver (uriceptical), tracer storage, urine collector and sample bags, and the required S/C plumbing.

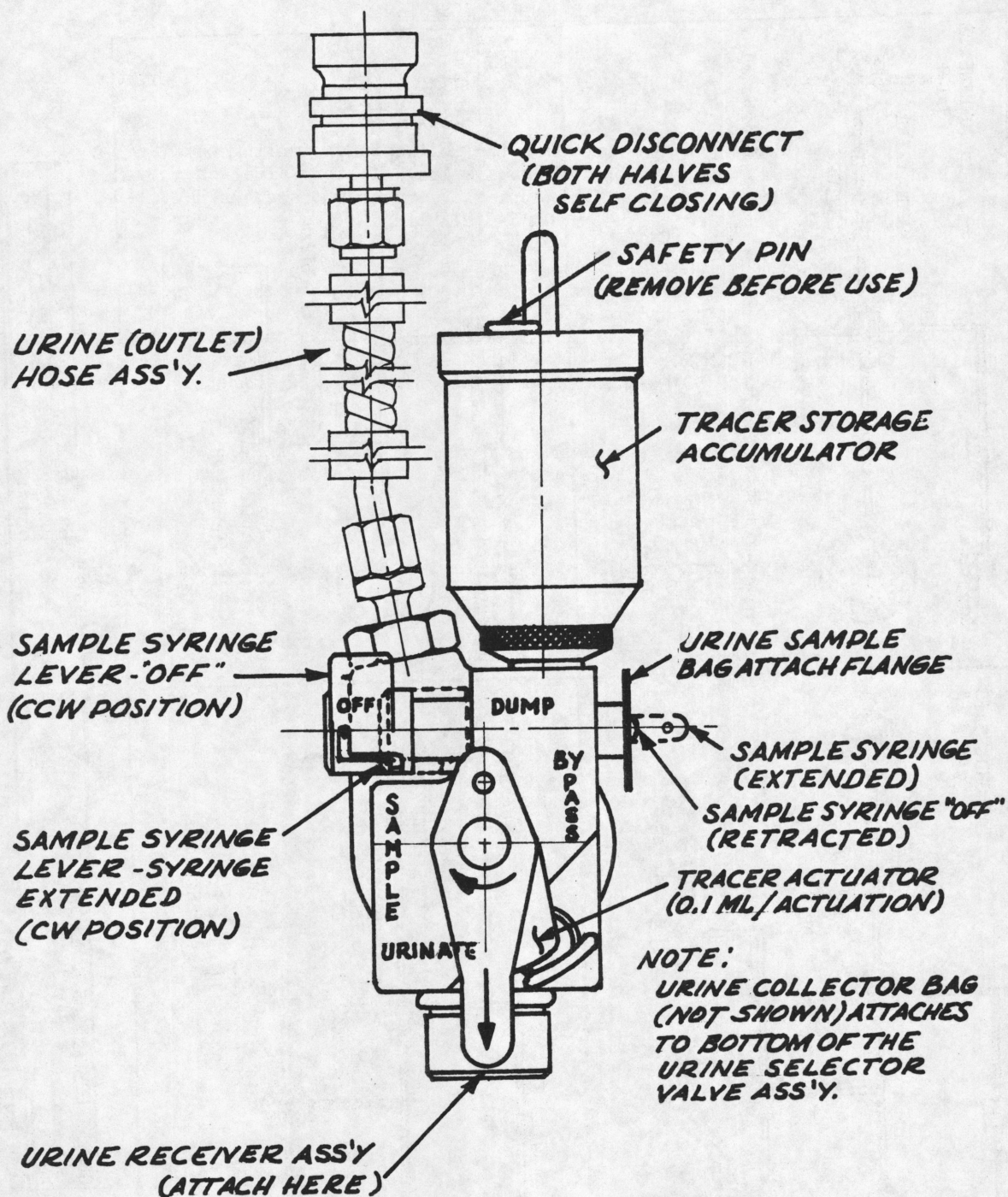
When in use, the uriceptical is attached to the Urine Selector Valve Assembly and the outlet hose attached to the overboard urine hose. The Selector Valve Handle is then placed to URINATE. This positions the valves to allow urine to flow into the collector. The Selector Valve Handle in this position depresses the tracer actuator which allows 0.1 milliliters of tracer (50% propylene glycol & 50% tritiated water) to mix with the urine.

After mixing is complete the uricepticle is removed and a sample bag is attached. The Urine Selector Valve Handle is then placed to SAMPLE. The Sample Syringe Lever, normally in the OFF position, is rotated clockwise and pushed in forcing the sample syringe into the sample bag, allowing urine to flow into it. When the sample bag is filled, the Sample Syringe Lever is pulled out and rotated counter clockwise locking it in the OFF position. The sample bag is self sealing and may then be removed, marked, and stored.

The Urine Dump Switch should be placed in PREHT for at least 3 mins. prior to placing switch to DUMP. (Caution: The Urine Dump Switch activates a heater in PREHT and DUMP positions which must not be left on longer than 5 minutes.) Then the Urine Selector Valve handle is placed to DUMP and the Urine Valve to OVBD DUMP. Place the Urine Dump Switch to DUMP. This will allow the urine to be flushed overboard emptying the collector bag. When the bag is empty, the Urine Selector Valve handle is placed in BYPASS. This allows cabin air to purge the lines of any droplets of urine. After 30 seconds of purging, the Urine Dump Switch is placed to OFF. The Urine Valve is then placed to OFF, the outlet hose is disconnected, and the Urine Selector Assembly stowed. The Urine Selector Handle is left in BYPASS until used again.

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Pg <u>6</u> Section <u>2.3.6</u>	Date <u>5/20/66</u>	Approved by <u>RNTB</u>



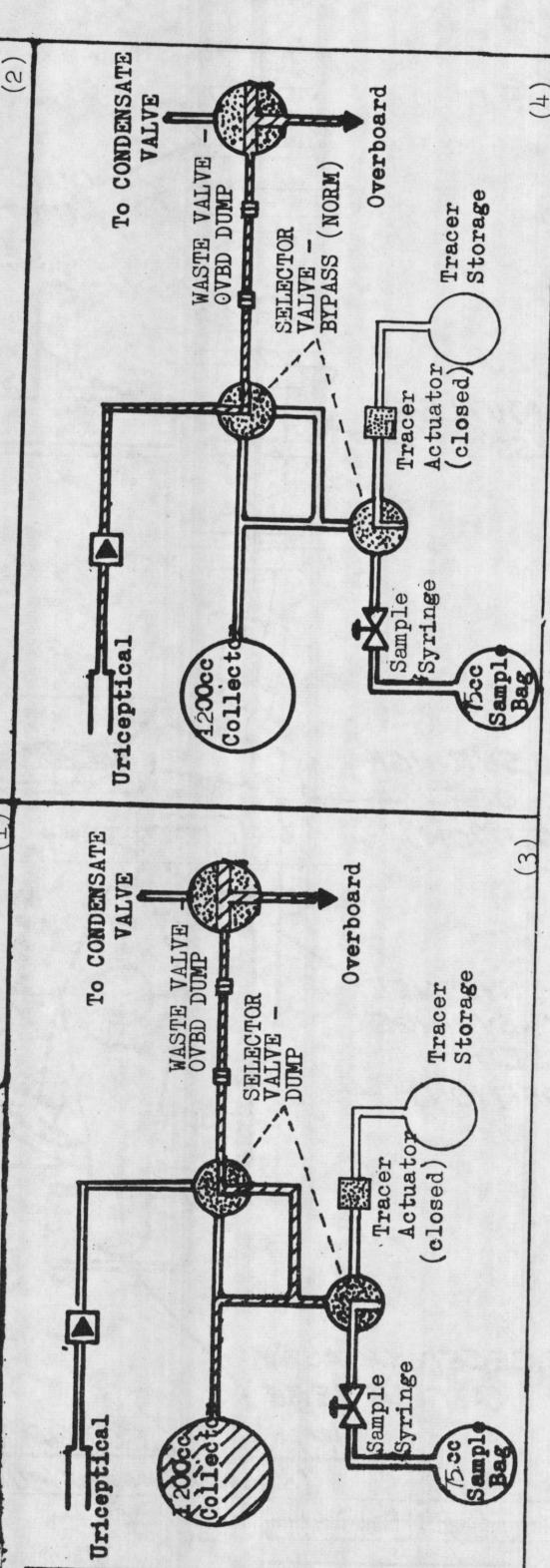
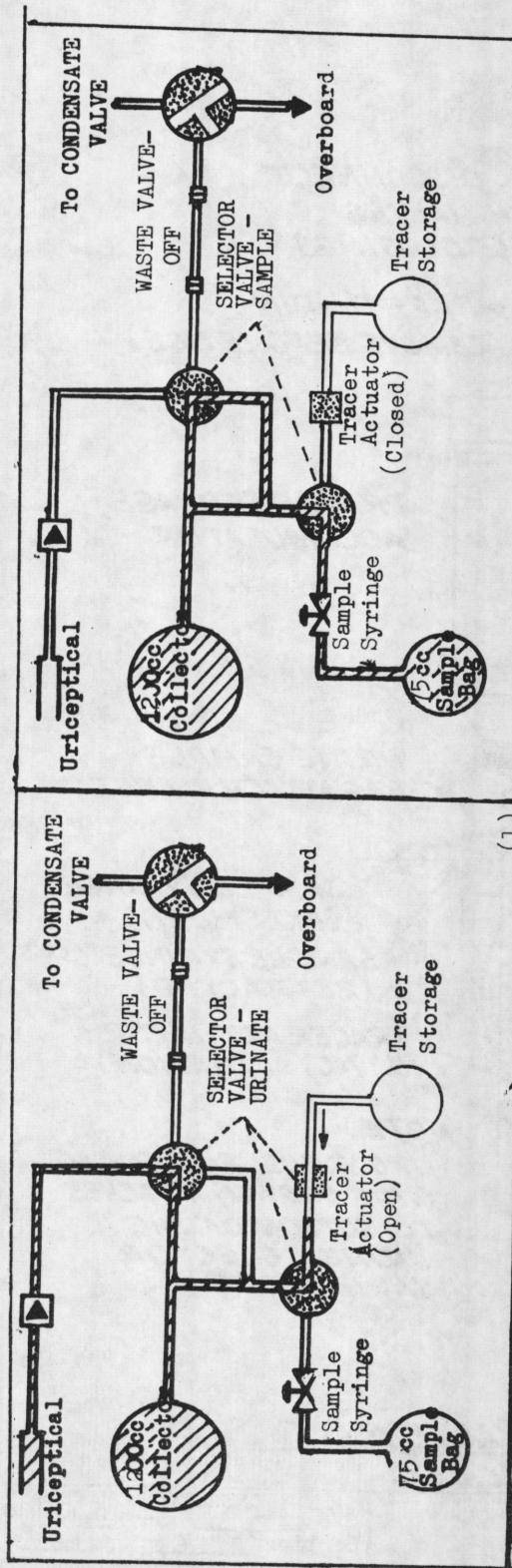


**URINE SELECTOR VALVE ASS'Y**  
**(SHOWN APPROX. FULL SIZE)**

Prepared by J.R.  
Checked by RHS  
Approved by RHS

Flight Crew Support Division  
Mission Operations Branch  
Date 5/20/66

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## COOLANT LOOP

### NOTES

1. Prelaunch - The RAD Flow Switch should be in the BY-PASS position so that the ground cooling heat exchanger can provide cooling. The EVAP Flow Switch can be in either MAX FLOW or NORM positions as they are not needed at this time.

Launch - The RAD Flow Switch should be in the BY-PASS position as there will still be some cooling from the ground heat exchanger (the radiator will be hot due to aerodynamic heating). The EVAP Flow Switch should be in the MAX FLOW position to provide max cooling from the evaporator (of course no ground heat exchanger or radiator cooling at this time). The evaporator itself is preloaded with 7 lbs of water for launch cooling use.

Orbit - The RAD Flow Switch should remain in the BY-PASS position until the radiator has cooled enough to provide cooling (approximately 35 minutes). This can be checked by periodically switching to FLOW and monitoring the radiator outlet temperature. The radiator has cooled sufficiently to remain in the FLOW position when the outlet is less than 80°F. The EVAP Flow Switch should then be placed in the NORM position. The RAD flow switch should be in BYPASS position when the repress valve is open more than 2 minutes.

### 2. Coolant Freezing

An unpowered secondary coolant loop is not expected to freeze in the O<sub>2</sub> cryogenic heat exchanger as there is heating from the primary loop (sec loop downstream of pri loop). The primary loop will probably be lost if it is unpowered (secondary loop used alone).

### 3. Temperature Control Valves

The modulating valve at the exit of the radiator warms the coolant should the radiator excessively cool the fluid. This is done by diverting the required portion of the fluid thru the regenerative heat exchanger to be warmed up so the resultant total fluid is a minimum of 36 to 42°F. In the regenerative heat exchanger, cold fluid leaving the radiator is heated by the warmer fluid entering the radiator.

It is possible that the radiator would cool the fluid so much that the regenerative heat exchanger would not be able to heat the fluid to the desired temperature. However, should the radiator temperature drop so low that the coolant pressure at the entrance to the radiator reaches 215 to 230 psi, the coolant would automatically be diverted around the radiator thru the ground heat exchanger.

Should the temperature at the exit of the radiator be above 44 to 55°F, the coolant would be diverted to the water boiler portion of the evaporator.

Continued

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Pg <u>1</u>	Section <u>2.3.7</u>	Date <u>5/20/66</u>	Approved by <u>RHB</u>

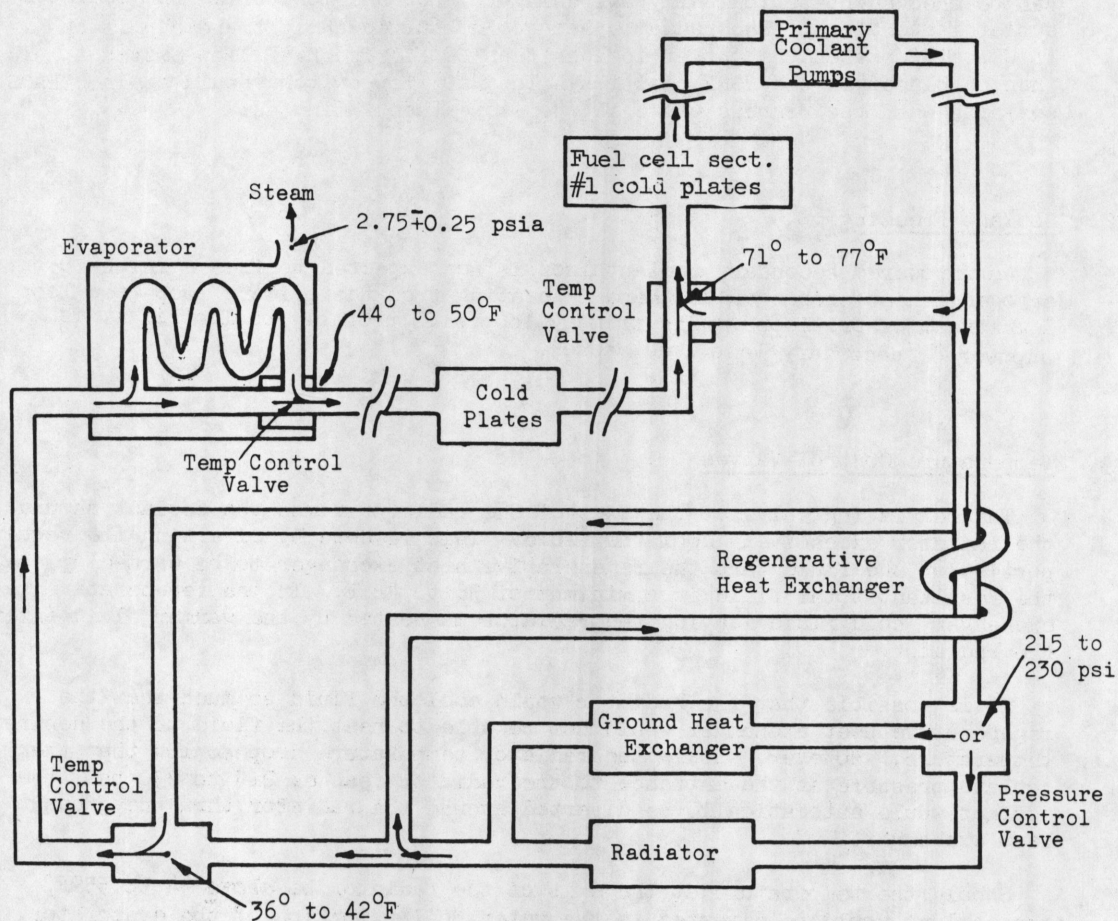
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Water (steam) is discharged overboard when the water pressure exceeds  $2.75 \pm .25$  psia. The water boiler portion of the evaporator will continue to operate so long as the incoming fluid is above  $44^\circ$  to  $50^\circ\text{F}$ .

Thus under normal conditions (within the capabilities of the regenerative heat exchanger and water boiler), the coolant is regulated to within  $36^\circ$  to  $50^\circ\text{F}$  before entering the cold plates.

The modulating valve downstream from the Fuel Cell cold plates warms the coolant to  $71^\circ$  to  $77^\circ\text{F}$  should the fluid be below this temperature. This is accomplished by mixing warmer fluid from the pumps to raise the fluid temperature entering the cold plates to the desired value.



Simplified Primary coolant loop shown, secondary loop similar



## SECTION 2.4

# CONTROL SYSTEMS

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	<u>ACME BIAS PWR Switch</u>  PRI -  OFF -  SEC -	Furnishes 26V AC single $\phi$ power from the ACME or IGS inverters to the primary ACE power supply.  Furnishes 26V AC single $\phi$ power from the ACME or IGS inverters to the redundant secondary ACE power supply.
Overhead Sw C/B Panel	<u>ROLL JETS Switch</u>  PITCH -  YAW -	Selects OAMS pitch jets to be used for roll. Selects OAMS yaw jets to be used for roll.
Pedestal	<u>OAMS CONTL PWR. SWITCH</u>  ON -  OFF -	(a) Enables OAMS attitude solenoid valve drivers. (b) Provides power to all OAMS attitude and maneuver C/B's.  (a) Disables use of OAMS attitude valve drivers. (b) Disables power to all OAMS attitude and maneuver C/B's.
Pedestal	<u>OAMS PROP MOTOR VALVE Switch</u>  OPEN -        CLOSED -	Initiates power to open OAMS motor driven valves in fuel and oxidizer lines.        Initiates power to close motor driven valves in the fuel and oxidizer lines.



CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
ACME INV ( $V_M$ ) or IGS Inverter.  ACME or IGS Inverter and ACME CNTL 1 ( $V_{CC}$ ).	<u>T/M (D/T)</u> Bilevel of Attitude Control mode selected.	ACE power supplies furnish $\pm 10V$ DC, +20V DC Bias voltages and 21V AC to ACE They also provide a +3V DC deadband reference voltage for the ACE.
		Not used in RCS.
ACME CNTL 1 ( $V_{CC}$ ).	<u>T/M (D/T)</u> Bi-level pulse of thruster firings.	1. OAMS PROP MOTOR VALVE Switch must be OPEN to obtain any OAMS thruster firing. 2. ACE power required to fire OAMS attitude thrusters. 3. All OAMS thrusters may be electrically disabled by placing OAMS CNTL FWR Switch to OFF.
OAMS CNTL PROP ( $V_{CC}$ ).		1. Approximately 3 sec are required to open valves.
Same.		Approximately 5 seconds are required to close valves.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	<u>PITCH-ROLL-YAW</u> <u>ACME LOGIC</u> <u>Switches</u>  PRI -  SEC -	Three switches - Pitch, Roll, and Yaw  Selects primary control torque logic circuits in the ACE package.  Selects secondary control torque logic circuits in the ACE package.
Pedestal	<u>RCS RING A &amp; B</u> <u>- CONTL FWR</u> <u>Switches</u>  ACME -        OFF -        DIRECT -	Two switches, one for each identical independent system. Either ring may be in any of the three positions.  Enables RCS thruster solenoid coil firing via the ACME circuitry.        Disables RCS thruster solenoid.        Enables direct firing of the RCS thruster solenoid coils via attitude control handle deflection.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
ACME CNTL 2 ( $V_{CC}$ ).		Momentary contact switch, spring loaded to center. Therefore, there is no switch indication of the selected system.
RCS - A (VCC) $\begin{matrix} 1 \\ \text{RCS} \end{matrix} \begin{matrix} 3 \\ B \end{matrix}$ (VCC) 1 - 3 ACME CNTL 1 (VCC) ACME CNTL 2 (VCC)	<u>T/M (D/T)</u> Bi-level pulse of RING A and/or RING B thruster firing.	1. ACME mode selection by ATTITUDE CONTROL Mode switch. All the various ACME Control modes are capable of being used in RCS. 2. RCS A and B PROP MOTOR VALVE Switches must be OPEN in order to have thruster firing on respective ring. 3. ACE power required. 4. If either ring is in ACME, the rate command deadbands are those of RCS.  If switch is OFF when ABORT Handle is used, RING A & B are automatically switched to ACME. DIRECT can still be selected after this event. Normal operation if BOOST-INSERT SW is SAFED after abort.
RCS - A (VCC) 1 - 3 RCS - B (VCC) 1 - 3	<u>T/M (D/T)</u> Bi-level pulse of Ring A and/or Ring B thruster firing.	1. By-passes all ACME control electronics for that ring placed in DIRECT. 2. RCS A and B PROP MOTOR VALVE Switches must be OPEN in order to have thruster firing on respective ring.  NOTE: When both RCS A & B rings are used the RCS RING A & B ATT CNTL FWR Switches should both be in either ACME or DIRECT.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Pedestal	<u>RCS RING A &amp; B</u> <u>PROP MOTOR VALVE</u> <u>Switches</u> Open -  Closed -	One switch per RCS Ring. Initiates power to open motor driven valves in RCS fuel and oxidizer lines. Initiates power to close motor driven valves in RCS fuel and oxidizer lines.
Overhead Sw C/B Panel	<u>ATTITUDE DRIVERS</u> <u>Switch</u> PRI -  SEC -	Selects primary OAMS attitude solenoid valve driver circuitry. Selects secondary OAMS attitude solenoid valve driver circuitry.
Pedestal	<u>ATTITUDE CONTROL</u> <u>HANDLE</u>	Enables manual control of S/C attitude and rates in OAMS and RCS. (See notes.)
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
RCS A 1 ( $V_{CC}$ ). RCS B 1 ( $V_{CC}$ ).		1. Switches are toggle lock type. RCS fuel and oxidizer isolation squib valves are in series with motor driven valves.  (See RCS Switch, Section 2.1.3 for operation of squib valve circuit.)  Requires 3 sec to open; 5 sec to close
ACME CNTL 2 ( $V_{CC}$ ).		OAMS CNTL PWR Switch must be ON for selection of PRI or SEC valve driver to take place.  Momentary contact switch, spring loaded to center. There is no switch indication of the selected system.
	<u>T/M (D/T)</u> Stick deflection in pitch, roll, yaw ( $\pm 10^\circ$ ).	1. Two push-to-talk buttons on top of hand controller for voice communications system. 2. Full stick travel in any one axis is $\pm 10^\circ$ from neutral position. 3. Requires ACME BIAS power except in RCS DIRECT.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
MANEUVER THRUSTERS 9 thru 16 ( $V_{CC}$ )		<p>Maneuver control is accomplished independent of ATTITUDE CONTROL Mode Switch.</p> <p>OAMS PROP MOTOR VALVE Switch must be OPEN and OAMS CNTL FWR Switch must be ON to obtain thruster firing.</p>
MANEUVER THRUSTERS 9 thru 16. ( $V_{CC}$ )	<p><u>T/M (D/T)</u></p> <p>Bi-level of all thruster firing.</p>	<p>1. 50% travel of handle required to fire thrusters.</p> <p>3. DIRECT, RATE CMD, PLT, RE-ENTRY RATE CMD, or RE-ENTRY mode must be used to control attitudes during maneuver thrusting. All other modes are incapable of overcoming torques generated during maneuver thrusting.</p>
ACME or IGS INVERTER and ACME CNTL 1 & 2 (VCC) SCANNER HTR ( $V_M$ )	<p><u>T/M (D/T)</u></p> <p>Bi-level of Primary and Secondary Horizon Sensors ON-OFF. Bilevel of HOR SCAN Mode selected.</p>	<p>1. Pitch &amp; roll are controlled to a <math>\pm 5^\circ</math> deadband about <math>0^\circ</math> roll and <math>-5^\circ</math> pitch.</p> <p>2. See HOR SCAN Notes for details of operation.</p> <p>3. ACE power required.</p>
Same as above.	<p><u>T/M (D/T)</u></p> <p>Bi-level of RATE CMD Mode selected.</p> <p>Continued</p>	<p>1. Deadband <math>\pm 0.2^\circ/\text{sec}</math> on OAMS, <math>\pm 0.5^\circ/\text{sec}</math> on RCS, about the commanded rates. Max commanded rate is <math>\pm 10^\circ/\text{sec}</math> in pitch and yaw and <math>\pm 15^\circ/\text{sec}</math> in roll.</p> <p>2. See RATE CMD Notes for details of operation.</p> <p>3. ACE power required.</p>
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
	DIRECT -	Enables direct control of the ATTITUDE solenoids with 25% stick deflection.
	PULSE -	Enables one 20 milli-second pulse for each ATTITUDE CONTROL HANDLE deflection beyond 35%.
	RE-ENT RATE CMD-	Enables manual control of S/C rates proportional to stick deflection. Primarily for use during re-entry.
	RE-ENT -	Enables auto pitch and yaw rate damping with roll slaved to a bank angle error commanded by the computer.
	PLATFORM -	Enables platform to automatically control attitude of S/C with reference to platform gimbal angles.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
ACME or IGS INVERTER and ACME CNTL 1 & 2 (V <sub>CC</sub> )	<u>T/M (D/T)</u> Bilevel of DIRECT Mode selected.	<ol style="list-style-type: none"> <li>1. Direct thru part of the Attitude Control Electronics (ACE).</li> <li>2. See DIRECT Notes for details of operation.</li> <li>3. ACE power required.</li> </ol>
Same as above.	<u>T/M (D/T)</u> Bilevel of PULSE Mode selected.	<ol style="list-style-type: none"> <li>1. Each pulse requires a separate stick deflection.</li> <li>2. See PULSE Notes for details of operation.</li> <li>3. ACE power required.</li> </ol>
Same as above.	<u>T/M (D/T)</u> Bilevel of REENTRY RATE CMD selected.	<ol style="list-style-type: none"> <li>1. Deadband about commanded rate of <math>\pm 4^\circ/\text{sec}</math> for pitch and yaw and <math>\pm 2^\circ/\text{sec}</math> for roll. Maximum commanded rates are <math>10^\circ/\text{sec}</math> for pitch and yaw and <math>15^\circ/\text{sec}</math> for roll.</li> <li>2. See RE-ENT RATE CMD notes for details of operation.</li> <li>3. ACE power required.</li> </ol>
IGS Inverter and ACME CNTL 1 & 2 (V <sub>CC</sub> )	<u>T/M (D/T)</u> Bilevel of REENT Mode selected.	<ol style="list-style-type: none"> <li>1. Deadbands are <math>\pm 4^\circ/\text{sec}</math> in pitch and yaw, <math>\pm 2^\circ</math> about the roll attitude or <math>\pm 2^\circ/\text{sec}</math> about <math>15^\circ/\text{sec}</math> commanded roll rate.</li> <li>2. See RE-ENT Notes for details of operation.</li> <li>3. ACME Inverter cannot be used because of computer. ACE power required.</li> </ol>
Same as above.	<u>T/M (D/T)</u> Bilevel of PLATFORM mode selected.	<ol style="list-style-type: none"> <li>1. S/C attitudes are maintained such that gimbal angles are <math>\pm 1.1^\circ</math> of zero platform gimbal angles.</li> <li>2. ACME Inverter cannot be used because of inertial platform. ACE power required.</li> <li>3. See PLATFORM notes for details of operation.</li> </ol>
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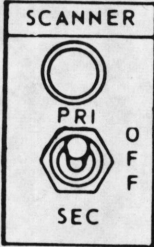
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
		<p>To prevent undesired thruster firing when powering down, the ACME CNTL 1 circuit breaker should be opened prior to removing AC power from the ACME system.</p>
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Pedestal	<u>SCANNER Switch</u> PRI - OFF - SEC -	Selects primary horizon sensor head and electronics. Disconnects AC Power to horizon sensors and opens the horizon sensor output circuits to the IMU and ACME. Selects secondary horizon sensor head and electronics.
	 <u>Scanner Ignore Light -</u>	An ignore signal causes the light to illuminate amber whenever horizon tracking is lost (usually at angles in excess of $\pm 20^\circ$ in either pitch or roll or at angles in excess of $\pm 14^\circ$ in pitch and roll).
Pedestal	<u>RATE GYROS Switches</u> PRI - OFF - SEC -	Three switches - Pitch, roll, and yaw Powers respective primary rate gyro. Removes power from rate gyro. Powers respective secondary rate gyro. (Repeated in NAVIGATION Section 2.5.1.)
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
ACME Inverter ( $V_M$ ). IGS Power Fuse ( $V_M$ ). <sup>or</sup> SCANNER HTR ( $V_M$ )	<u>T/M (D/T)</u> 1. Roll ( $\pm 20^\circ$ ). 2. Pitch ( $\pm 20^\circ$ ). 3. Bilevel of primary ON-OFF 4. Bilevel of secondary ON-OFF. 0.96 amps (ACME INV) 0.62 amps (IGS P.S.)	1. Requires 2 min warm-up. If track isn't acquired within this time and proper attitude has been maintained, switch to other scanner 2. Automatic scanner heaters when SCAN HTR circuit breaker is closed. 3. The stipulated currents are equivalent DC loads for the ACME inverter and the IGS power supply based on efficiencies of 50% and 77%, respectively.
ATT IND CNT LDG ( $V_{CC}$ ). SCANNER HTR ( $V_M$ ).	<u>T/M (D/T)</u> Bi-level of search mode.	1. A scanner ignore light may illuminate when the S/C is maneuvered in the range $\pm 14^\circ$ combined pitch and roll to $\pm 20^\circ$ in either pitch or roll from the $0^\circ$ position due to loss of horizon tracking in this range. 2. When PLATFORM is in SEF or BEF, an ignore signal will put platform in an effective orbit rate mode of operation. 3. The scanner ignore light will extinguish $7 \pm 2$ seconds after re-acquisition of horizon tracking due to a time delay control circuit in the TMU.
ACME Inverter ( $V_M$ ). IGS Power Fuse ( $V_M$ ). <sup>or</sup>	<u>T/M (D/T)</u> Pitch rate ( $\pm 20^\circ/\text{sec}$ ) Yaw rate ( $\pm 20^\circ/\text{sec}$ ) Roll rate ( $\pm 30^\circ/\text{sec}$ ) Bilevel of primary ON-OFF Bilevel of secondary ON-OFF Pitch, roll, & yaw rate gyro scale factors. 1.33 amps (ACME INV) 0.93 amps (IGS P.S.)	IGS or ACME thru AC Power Switch. Gyros require 30 sec spin-up. The stipulated currents are equivalent DC loads for the ACME Inverter and the IGS power supply based on efficiencies of 50% and 77%, respectively.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
DC-DC Converter. V <sub>+24V</sub> and V <sub>+5V</sub> .		<ol style="list-style-type: none"> <li>1. Gauge reads He pressure compensated for temperature at pressurant source. Gauge accuracy <math>\pm 10\%</math> F.S.</li> <li>2. At the estimated mixture ratio, the PROP QTY gage will not indicate oxidizer remaining in the reserve tank</li> <li>3. A PROP QTY Indicator Correction decal is placed adjacent to the gage to convert gage reading from an indicated percent to the actual propellant remaining in pounds at the estimated mixture ratio.</li> </ol>
DC-DC Converter. V <sub>+5V</sub> and V <sub>+24V</sub> .	T/M listed under Propellant Indicator Selector Switch.	<ol style="list-style-type: none"> <li>1. Readout selection made by Propellant Indicator Selector Switch located directly below indicator.</li> <li>2. OAMS S and RCS A and B pressurant readings must be multiplied by "10."</li> </ol>
DC-DC Converter V <sub>+24V</sub> and V <sub>+5V</sub> .	<u>T/M (D/T)</u> Helium Source Temperature ( $-100^{\circ}\text{F}$ to $200^{\circ}\text{F}$ ) and Pressure (0 to 5,000 psia) (separate sensors for T/M).	S (Source) pressurant indicator readings must be multiplied by "10."
	Continued	
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
	OAMS - F -	<p>Selects OAMS regulated Helium temperature at <u>fuel</u> tank and regulated Helium pressure to be read on the indicator.</p> <p>The pressure sensor is located on the "F" package and enables monitoring of regulated pressure and oxidizer depletion in the main tanks.</p>
	OAMS - O -	<p>Selects OAMS regulated Helium temperature at <u>oxidizer</u> tank and regulated Helium pressure to be read on the indicator.</p> <p>The pressure sensor is located on the "F" package and enables monitoring of regulated pressure and oxidizer depletion in the main tanks.</p>
	RCS - A -	<p>Selects RCS Ring A Nitrogen Pressurant source temperature and pressure to be read on the indicator.</p>
	RCS - B -	<p>Selects RCS Ring B Nitrogen Pressurant source temperature and pressure to be read on the indicator.</p>
	EXP -	Not used on S/C 10
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
DC-DC Converter V <sub>+24V</sub> and V <sub>+5V</sub> .	T/M (D/T) Regulated Helium Temperature at Fuel Tank (-100°F to +200°F) and Regu- lated Pressure (0 to 500 psia) (separate sensors for T/M). Fuel Feed Temper- ature (-20°F to +150°F).	1. Fuel and Oxidizer regulated pressure readouts use same sensor. 2. No onboard readout of fuel and oxidizer feed temperatures (T/M only). 3. Normal regulated pressure reading is 295 ± 15 psia. 4. Green decal on pressure indicator applies only to OAMS fuel and OAMS oxidizer regulated pressure readouts.
DC-DC Converter V <sub>+24V</sub> and V <sub>+5V</sub> .	T/M (D/T) Regulated Helium Temperature at Oxidizer Tank (-100°F to +200°F) and Regulated Pres- sure (0 to 500 psia) (separate sensors for T/M). Oxidizer Feed Temperature (-20°F to +150°F).	Same as above.
DC-DC Converter V <sub>+24V</sub> and V <sub>+5V</sub> .	T/M (D/T) Nitrogen Source Pressure (0 to 5000 psia) and Tem- perature (-100°F to +200°F). Regulated Nitrogen Pressure (0 to 500 psia for each RCS ring. Oxidizer Feed Temperature (-20°F to +150°F) (both rings)	1. Rings A and B source pressure indicator readings must be multiplied by "10." 2. No onboard readout of regulated Nitrogen pressures and oxidizer feed temperatures.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>OAMS REG</u> PULSE -	(OAMS Regulator By-Pass Switch) Opens OAMS Solenoid valve in OAMS Regulator by-pass line allowing pressurant to flow to the fuel and oxidizer tanks by-passing the OAMS Regulator in case of a failure. (Squib must first be fired)
	Normal (Neutral)	For normal Regulator operation.
	SQUIB -	(a) Fires squib to close a normally open squib valve disabling pressurant flow to the OAMS Regulator. (b) Fires squib to open a normally closed squib valve in OAMS Regulator by-pass line, allowing pressurant from the OAMS Solenoid valve to bypass the OAMS regulator. (See PULSE function)
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
<p>OAMS CNTL PROP (<math>V_{CC}</math>).</p> <p>OAMS CNTL PROP (<math>V_{CC}</math>) and thru fusistors. (<math>V_{OAMSQ1}</math> or 2).</p> <p>OAMS CNTL REG 1 &amp; 2 (<math>V_{OAMSQ1}</math> or 2)</p>		<p>1. Pressurant pressure is <math>3100^{+30}_{-0}</math> psia at <math>70^{\circ}\text{F}</math>.</p> <p>2. Momentary type switch used to manually regulate OAMS propellant pressure in case of regulator failure Closes when switch is released.</p> <p>3. System protection from overpressures is provided by a pressure relief valve which opens by 430 psid max. &amp; reseats at <math>371 \pm 1</math> psid. The burst diaphragms are installed. (burst pressure 410-500 psid.)</p> <p>(a) This function is accomplished automatically through a pressure switch if the regulated pressure exceeds <math>380 \pm 10</math> psia. Squib firing is through fusistors.</p>
<p>S/C 10      Rev A Date 7/1/66</p>	<p>Control Systems OAMS Propellant</p>	<p>GEMINI OPERATIONS HANDBOOK Section 2.4.2    Pg 6</p>

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Switch C/B Panel	<u>OAMS RESV Switch</u>  SQUIB -  SAFE -	Power dual isolation squibs in the "F" package and allows pressurant to reserve oxidizer tank.  Power removed from the "F" package squib circuit.  The BUS ARM switch must be in the EXP position.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
AGENA CNTL SQUIB 1 (Vexpq 1) AGENA CNTL SQUIB 2 (Vexpq 2)	<u>T/M (D/T)</u> Pressure Reserve Tankage (0-500psi)	<ol style="list-style-type: none"> <li>1. The OAMS reserve tank (a RCS oxidizer tank) contains, nominally, 23.6 lbs. of available oxidizer before activation of F package isolation squib valve.</li> <li>2. When the OAMS primary oxidizer tank is depleted as indicated by a 50 psi decay in the OAMS regulated pressure (OAMS-F or O position of the PROP PRESS-TEMP gauge), the isolation valve should be fired to allow use of the reserve oxidizer supply. The OAMS regulated pressure should then return to normal.</li> <li>3. When firing the isolation squibs, the experiment BUS must be armed<sup>d</sup> and then disarmed immediately after firing.</li> </ol>
S/C 10      Rev A Date 7/1/66	Control Systems OAMS Propellant	GEMINI OPERATIONS HANDBOOK Section 2.4.2      Pg 8

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Center Panel	<u>RCS Telelight Switch</u>	(Reentry Control System Telelight Switch)
	Amber Light -	A T <sub>R</sub> -256 sec signal from the TRS illuminates amber light indicating to astro to depress switch.
	Depress Switch -	Powers RCS RING A and B: (a) Pressure Isolation Squibs - pressurizes fuel and oxidizer tanks. (b) Oxidizer Isolation Squibs - allow pressurized oxidizer to flow to thrust chamber valves. (c) Fuel Isolation Squibs - allow pressurized fuel to flow to the thrust chamber valves. (d) Disables amber light and illuminates green light.
	Green Light -	Indicates at least one of the four relays which enable functions (a), (b), & (c) has been powered (at least one ring enabled at least one time).
Center Panel	<u>RCS HTR Light</u> Amber -	Indicates RCS oxidizer valves and line filters between oxidizer and fuel tanks, and the RCS thrusters are below 40° - 48°F. Warns astro to turn RCS HTR Switch ON.
Right Sw C/B Panel	<u>RCS HTR Switch</u> ON -	(a) Powers automatic heaters in RCS oxidizer valves RCS thrusters, and heaters in the line filters between the oxidizer and fuel tanks and disables RCS heater light.
	OFF -	(a) Disables all RCS heaters. (b) Enables RCS HTR Light.
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CIRCUIT BREAKER BUS	TELEMETRY POWER REQUIRED	REMARKS
<p>TR-256 (<math>V_{CC}</math>) SEQ LIGHTS PWR (<math>V_M</math>) ELECT TIMER (<math>V_M</math>).</p> <hr/> <p>(a), (b) and (c) RCS SQUIB 1 and/or 2 (<math>V_{RQ1}</math> and/or 2).</p> <p>(d) RCS SQUIB 1 &amp;/or 2 (<math>V_{RQ1}</math> &amp;/or 2). ACME CNTL 1 (<math>V_{CC}</math>) SEQ LIGHTS PWR (<math>V_M</math>)</p> <hr/> <p>Same as (d).</p>		<p>Amber light out when switch is depressed or at <math>T_R</math> if switch is not depressed.</p> <hr/> <ol style="list-style-type: none"> <li>1. RCS RING B isolation squibs can be redundantly fired prior to launch from the blockhouse. (Green light does not illuminate.)</li> <li>2. Squib power is through fusistors.</li> <li>3. These switch functions performed by the ABORT Handle.</li> <li>4. RETRO PWR Switch arms <math>V_{RQ1}</math> and 2.</li> <li>5. Each pyro is powered from redundant buses. Each bus furnishes power for activation of each ring.</li> </ol> <hr/> <p>Green Light latches ON</p>
<p>RCS HTRS A (<math>V_M</math>). RCS HTRS B (<math>V_M</math>).</p>		<p>Light illuminates when temperature is below <math>40^\circ - 48^\circ\text{F}</math>, and RCS HTRS Switches are off. Heater should be turned ON to insure temperature does not decrease below this level. Light goes out when RCS Heater Switch is turned on or temp. exceeds <math>45-57^\circ\text{F}</math>.</p>
<p>RCS HTRS A (<math>V_M</math>). RCS HTRS B (<math>V_M</math>).</p>	<p><u>T/M (D/T)</u> Oxidizer Feed Temperature (<math>-20^\circ</math> to <math>+150^\circ\text{F}</math>)  (.39 amps - both rings included)</p>	<p>When RCS HTRS Switch is on, automatic heater comes on at <math>40^\circ - 48^\circ\text{F}</math>, cuts off at <math>49^\circ - 57^\circ\text{F}</math>.  RCS Heater Light on when temperature is below <math>40^\circ - 48^\circ\text{F}</math>.</p>
<p>S/C 10      Rev Orig Date 5/20/66</p>	<p>Control Systems RCS Propellant</p>	<p>GEMINI OPERATIONS HANDBOOK Section 2.4.3    Pg 2</p>

PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	Circuit Breaker <u>ACME CNTL 1</u>  Closed -       Open -	No. 11-62 ( $V_{CC}$ )  Enables power to: (a) ACME BIAS PWR Switch (SEC position only). (b) OAMS        CONTL POWER Switch (c) OAMS Attitude Solenoid Valve Drivers. (d) RCS RING A        CONTL POWER Switch (e) Relay which enables RCS green telelight and disables amber telelight (Sequential Lights C/B). (a) No RCS RING A control in ACME (b) OAMS jets are inoperative. (c) ACME power will operate only in primary regardless of selection.
Overhead Sw C/B Panel	Circuit Breaker <u>ACME CNTL 2</u>  Closed -       Open -	No. 11-74 ( $V_{CC}$ )  Enables power to: (a) ATTITUDE DRIVERS Switch. (b) PITCH ACME LOGIC Switch. (c) ROLL ACME LOGIC Switch. (d) YAW ACME LOGIC Switch. (e) RCS RING B        CONTL POWER Switch (f) Power for Horizon Scanner mode logic relays. (a) Normal attitude control in PULSE, DIRECT and HOR SCAN modes. HORIZON SCAN, without manual pulse, in all other control modes. RCS RING B has RCS DIRECT control only. RCS RING A has RCS DIRECT and ACME modes above.
Overhead Sw C/B Panel	Circuit Breaker <u>OAMS CNTL PROP</u>  Closed -	No. 11-7 ( $V_{CC}$ ) (OAMS Control Propellant) (a) Powers motor valves in OAMS fuel and oxidizer lines (thru OAMS PROP Switch). (b) Enables firing of normally closed squib valve in OAMS regulator by-pass line (through OAMS REG Switch in SQUIB position). (c) Enables PULSE position of OAMS REG Switch.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	Circuit Breaker <u>ATTITUDE</u> <u>THRUSTERS</u> 1 thru 8 Closed -	No. 11-12 to 11-19 ( $V_{CC}$ ) The OAMS CNTL PWR Switch controls power to these circuit breakers.  Powers solenoids which enables opening of OAMS Attitude fuel and oxidizer solenoid valves in appropriate thrusters. Clockwise and counter clockwise arrows designate direction of motion of S/C roll induced by each thruster. Numbers 1 thru 8 represent thruster numbers. The direction labeling (i.e., PITCH DN) indicates the direction relative to the crew in which the spacecraft moves upon actuation of the related thrusters.
Overhead Sw C/B Panel	Circuit Breaker <u>MANEUVER</u> <u>THRUSTERS</u> 9 thru 16 Closed -	No. 11-20 to 11-27 ( $V_{CC}$ ) The OAMS CNTL PWR Switch controls power to these circuit breakers.  Powers solenoids which enables opening of OAMS MANEUVER fuel and oxidizer valves in appropriate thrusters. Numbers 9 thru 16 represent maneuver thruster numbers. The direction labeling (i.e., FWD) indicates the direction of spacecraft translation as a result of actuation of each related thruster or thrusters.
Overhead Sw C/B Panel	Circuit Breaker <u>OAMS CNTL REG 1</u> Closed -	No. 11-1 ( $V_{OAMSQ1}$ )  Powers automatic and/or manual operation of OAMS regulator fail open relays (thru OAMS Regulator Switch or Auto Pressure Switch). Relay enables firing of normally open squib valve which allows pressurant flow to OAMS Regulator.  Redundant with OAMS Control Reg 2.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	Circuit Breaker <u>OAMS CNTL REG 2</u> Closed -	No. 11-2 ( $V_{OAMSQ2}$ )  Powers automatic and/or manual operation of OAMS Regulator fail open relays (thru OAMS Regulator Switch or Auto Pressure Switch). Relay enables firing of normally open squib valve which allows pressurant flow to OAMS Regulator.  Redundant with OAMS Control Reg 1.
Overhead Sw C/B Panel	Circuit Breaker <u>RCS SQUIB 1</u> Closed -	No. 11-63 ( $V_{RQ1}$ )  (a) Powers two squib fire relays, one in RCS RING A and the other in RING B (through RCS Telelight Switch or ABORT Handle). These relays enable redundant firing of the fuel, oxidizer, and pressurant isolation squibs, thus enabling the RCS Systems A & B.  Telelight green if one of the two squibs fire.  (b) Redundantly, with RCS Squib 2, powers retro abort interlock relay #1 (thru squib fire relays) enabling automatic sequential functions during a Mode II abort.
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PANEL LOCATION	NAME AND POSITION	FUNCTION
SECTION I PAGE		
Overhead Sw C/B Panel	Circuit Breaker <u>RCS SQUIB 2</u> Closed -	No. 11-64 ( $V_{RQ2}$ )  (a) Powers two squib fire relays, one in RCS RING A and the other in RING B (thru RCS Telelight Switch or ABORT Handle). These relays enable redundant firing of the fuel, oxidizer, and pressurant isolation squibs, thus enabling the RCS Systems A & B.  Telelight green if one of the two squibs fire. (b) Redundantly, with RCS Squib 1, powers retro abort interlock relay #2 (thru squib fire relays) enabling automatic sequential functions during a Mode II abort.
Overhead Sw C/B Panel	Circuit Breaker <u>RCS A 1</u> Closed -	No. 11-3 ( $V_{CC}$ )  Powers two pitch up and two pitch down thrusters (No. 1, 2, 5, and 6 fuel and oxidizer) in RING A        Powers RCS Ring A motor valves through the RCS Ring A Motor VALVE Switch.
Overhead Switch C/B Panel	Circuit Breaker <u>OAMS HTRS</u> Closed -	( $V_M$ )  Powers the OAMS oxidizer line heaters, OAMS oxidizer valve heaters and the redundant oxidizer valve heaters with thermostat control, and OAMS Reserve Oxidizer tank heaters with thermostat control.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	Circuit Breaker <u>RCS A 2</u> Closed -  Open -	No. 11-58 ( $V_{CC}$ )  Powers two yaw left thrusters (#7 & #8 fuel and oxidizer) in RING A. Powers eight ACE relays and relay driver circuitry for RCS RING A ACME control.  (Yaw thrusters also used for roll).  RING A ACME is lost and TCA 7 and 8 will not operate in RCS RING A DIRECT.
Overhead Sw C/B Panel	Circuit Breaker <u>RCS A 3</u> Closed -	No. 11-58 ( $V_{CC}$ )  Powers two yaw right thrusters (#3 & #4 fuel and oxidizer) in RING A  (Yaw thrusters also used for roll).
Overhead Sw C/B Panel	Circuit Breaker <u>RCS B 1</u> Closed -	No. 11-4 ( $V_{CC}$ )  Same as RCS A 1, except for RING B.
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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Overhead Sw C/B Panel	Circuit Breaker <u>RCS B 2</u> Closed -  Open --	No. 11-57 ( $V_{CC}$ )  Same as RCS A 2, except for RING B.  Same as RCS A2, except for RING B.
Overhead Sw C/B Panel	Circuit Breaker <u>RCS B 3</u> Closed -	No. 11-59 ( $V_{CC}$ )  Same as RCS A 3, except for RING B.
Right Sw C/B Panel	Circuit Breaker <u>RCS HTR A &amp; B</u> Closed -	No. 11-75 (A) and 11-76 (B) ( $V_M$ )  (a) Enables automatic heaters in RCS oxidizer valves, RCS thrust chamber assemblies, and heaters in line filters between the oxidizer and fuel tanks (thru RCS HTR Switch).  (b) Enables the RCS Heater Light for RING A and RING B thru RCS HTR Switch.  NOTE: Each C/B controls one RCS ring.
Right Sw C/B Panel	Circuit Breaker <u>SCAN HTR</u>  Closed -       Open -	No. 11-5 ( $V_M$ ) (Scanner Heater)  (a) Enables automatic heaters in each horizon sensor electronics. Heaters on at $10^{\circ}\text{F} \pm 5^{\circ}$ and off at $20^{\circ}\text{F} \pm 5^{\circ}$ .  (b) Provides power for scanner ignore light.  (c) Powers phasing logic in platform for FDI's and ACME.    Disables heaters and other functions listed.

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PANEL LOCATION SECTION I PAGE	NAME AND POSITION	FUNCTION
Right SW C/B Panel	Circuit Breaker <u>AGENA CONTROL</u> <u>SQUIB 1 &amp; 2</u>	<p>No. 13-28 and 13-29 (Voamsq 1 &amp; 2)</p> <p>Each C/B supplies power to:</p> <ul style="list-style-type: none"> <li>a. INDEX EXTEND Switch</li> <li>b. EMERG REL Switch</li> <li>c. ION SENSOR SEQ1/SEQ2 Switch</li> <li>d. OAMS RSV Switch</li> </ul> <p>NOTE: The BUS ARM Switch must be in EXP position for c. and d.</p> <p>The BUS ARM Switch must be DOCK position for a. (INDEX EXTEND position) and b.</p>
<div> <div>GEMINI OPERATIONS HANDBOOK</div> <div>Pg 7 Section 2.4.4</div> </div> <div> <div>Flight Crew Support Division</div> <div>Mission Operations Branch</div> </div> <div> <div>Prepared by <u>ASS</u></div> <div>Checked by <u>[Signature]</u></div> <div>Approved by <u>[Signature]</u></div> </div>		



## ATTITUDE CONTROL HANDLE

### NOTES

#### 1. General

The ATTITUDE CONTROL HANDLE provides 42 outputs to operate the pulse generator, RCS Ring A and Ring B thruster solenoid coils, ACE system, and to instrumentation system for T/M. Full stick travel in any one direction is  $\pm 10^\circ$  from the neutral position. There are two sets of 12 RCS DIRECT switches (a set for each RCS ring), 6 ACME Attitude DIRECT switches, 6 ACME Attitude PULSE switches, 3 rate command pots, and 3 telemetry pots. All switches and pots in the ATTITUDE CONTROL HANDLE are mechanically linked and working at all times. However, only particular sets of switches are enabled electrically at any one time, depending on the selection of the ATTITUDE CONTROL Mode Switch and RCS A and B switches.

#### 2. ACME DIRECT and PULSE Switches

The ACME DIRECT switches in the ATTITUDE CONTROL HANDLE are utilized whenever the DIRECT or PULSE mode is selected. PULSE and DIRECT switches are used when in PULSE mode. The six DIRECT switches close in  $2.5^\circ$  of full travel ( $10^\circ$ ) of the ATTITUDE CONTROL HANDLE. The six PULSE switches close in  $3.5^\circ$  of full travel ( $10^\circ$ ). Therefore, when in PULSE mode, the direction is selected closed before the PULSE switches are closed to initiate the 20 milli-second pulse.

#### 3. RCS DIRECT Switches

There are two sets of these switches, one set (containing 12 switches) for each ring. Whenever selection of any of these switches is made by movement of the ATTITUDE CONTROL HANDLE, ground is supplied to an already powered high side of the thruster solenoid coils. The RCS Ring A and/or Ring B Power switches must be in DIRECT. This circuit is completely independent of the ACME system. Other ACME modes are available when using the RCS, but utilize different switching points in the ATTITUDE CONTROL HANDLE.

#### 4. Rate Command Potentiometers

There are three rate command pots in the ATTITUDE CONTROL HANDLE electronics. These pots provide rate signals proportional to ATTITUDE CONTROL HANDLE displacement about all three axes to the ACE package. These signals are used in the RATE CMD and RE-ENT RATE CMD modes. The rate command pots have a  $1^\circ$  deadband at null position.

#### 5. Telemetry Potentiometers

The three telemetry pots provide pitch, roll, and yaw signals to the Data Acquisition System for R/T or D/T transmission to the ground, providing ATTITUDE CONTROL HANDLE displacement data ( $\pm 10^\circ$  in each axis). There is no deadband in these pots.

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# ATTITUDE HAND CONTROLLER

## NOTES

# ATTITUDE HAND CONTROLLER

CONTROL MODE	TYPE	PITCH	ROLL	YAW	REMARKS
HOR SCAN	AUTO & MAN	AUTO & PULSE	AUTO & PULSE	PULSE	PITCH & ROLL DEADBAND +5° ABOUT 0° IN ROLL. AND -5° IN PITCH. PULSE mode. CAPABILITY IN P, R, & Y
RATE CMD	MAN	RATE	RATE	RATE	MAX +15°/SEC ROLL, +10°/ SEC IN PITCH AND YAW. AUTO DAMPING; DEADBAND IS +0.2°/SEC in CAMS AND +0.5°/SEC in RCS.
DIRECT	MAN	ON-OFF	ON-OFF	ON-OFF	CONTINUOUS FIRING OF JETS BEYOND 25% STICK TRAVEL. (2.5°)
PULSE	MAN	PULSE	PULSE	PULSE	20 MIL-SEC PULSE FOR EACH STICK TRAVEL BEYOND 35%. (3.5°)
RE-ENT RATE CMD	MAN	RATE	RATE	RATE	DEADBAND IS +4°/SEC IN PITCH & YAW; +2°/SEC IN ROLL.
RE-ENT *	AUTO	AUTO RATE DAMPING	COMP BANK ANGLE	AUTO RATE DAMPING	DEADBAND IS +4°/SEC IN PITCH & YAW; +2° about roll attitude or +2°/sec roll rate.
PLATFORM*	AUTO	ATT	ATT	ATT	ATTITUDE MAINTAINED WITH- IN +1.1° OF GIMBAL ANGLES

\* Inactive stick in these modes, automatic only.

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ATTITUDE CONTROL HANDLENOTESATTITUDE CONTROL MODES

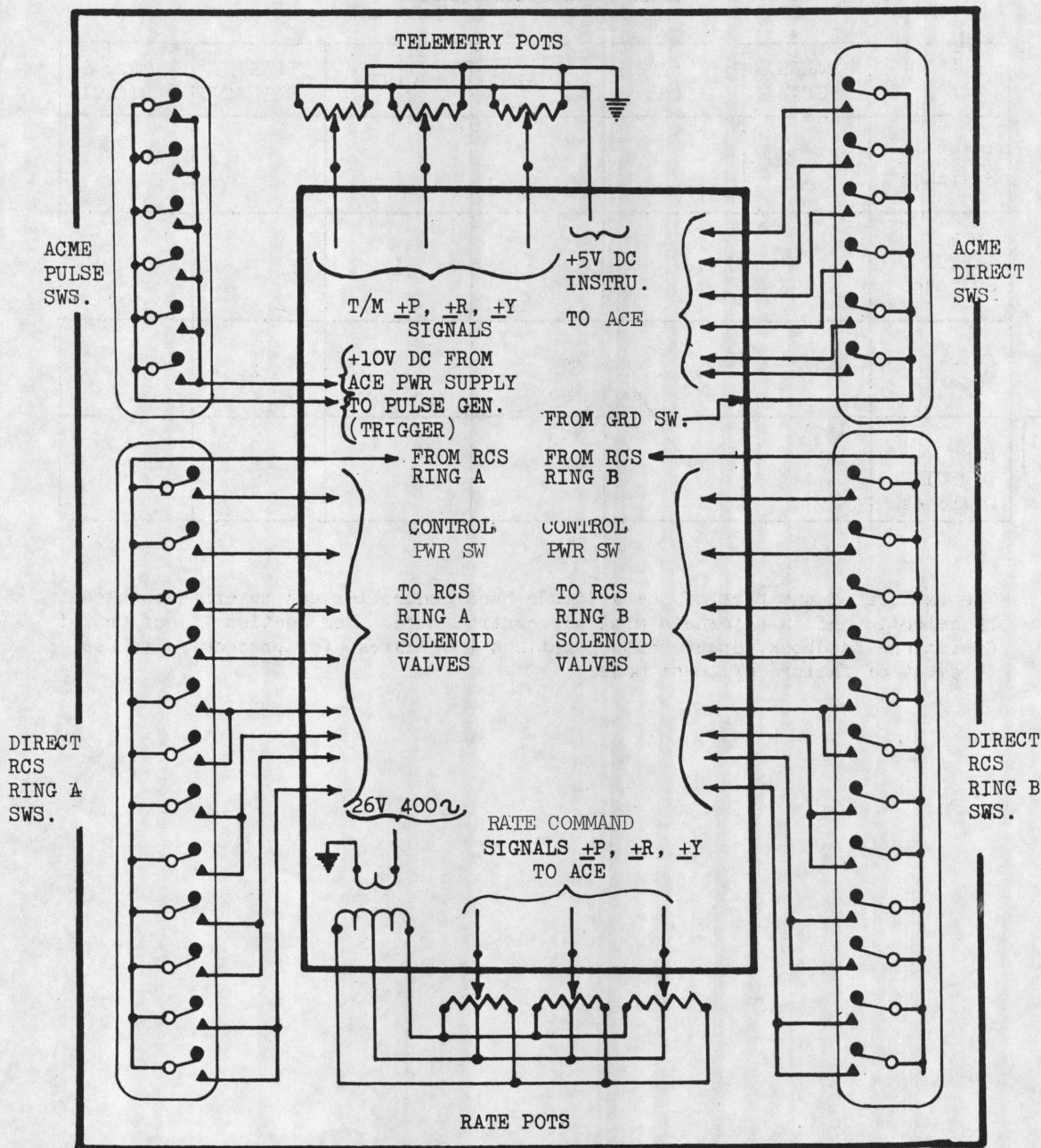
	HORIZON SCAN	RATE CMD	DIRECT	PULSE	REENTRY RATE CMD	RCS DIRECT
PULSE Switches	X			X		
ACME DIRECT Switches	X		X	X		
Rate Pots		X			X	
RCS DIRECT Switches						X

The failure of any part of the attitude hand controller can be cross-checked by selection of an alternate attitude control mode. See Section III of Gemini Operations Handbook, Spacecraft Operations Procedures, for procedures to use in event of failure of these modes.

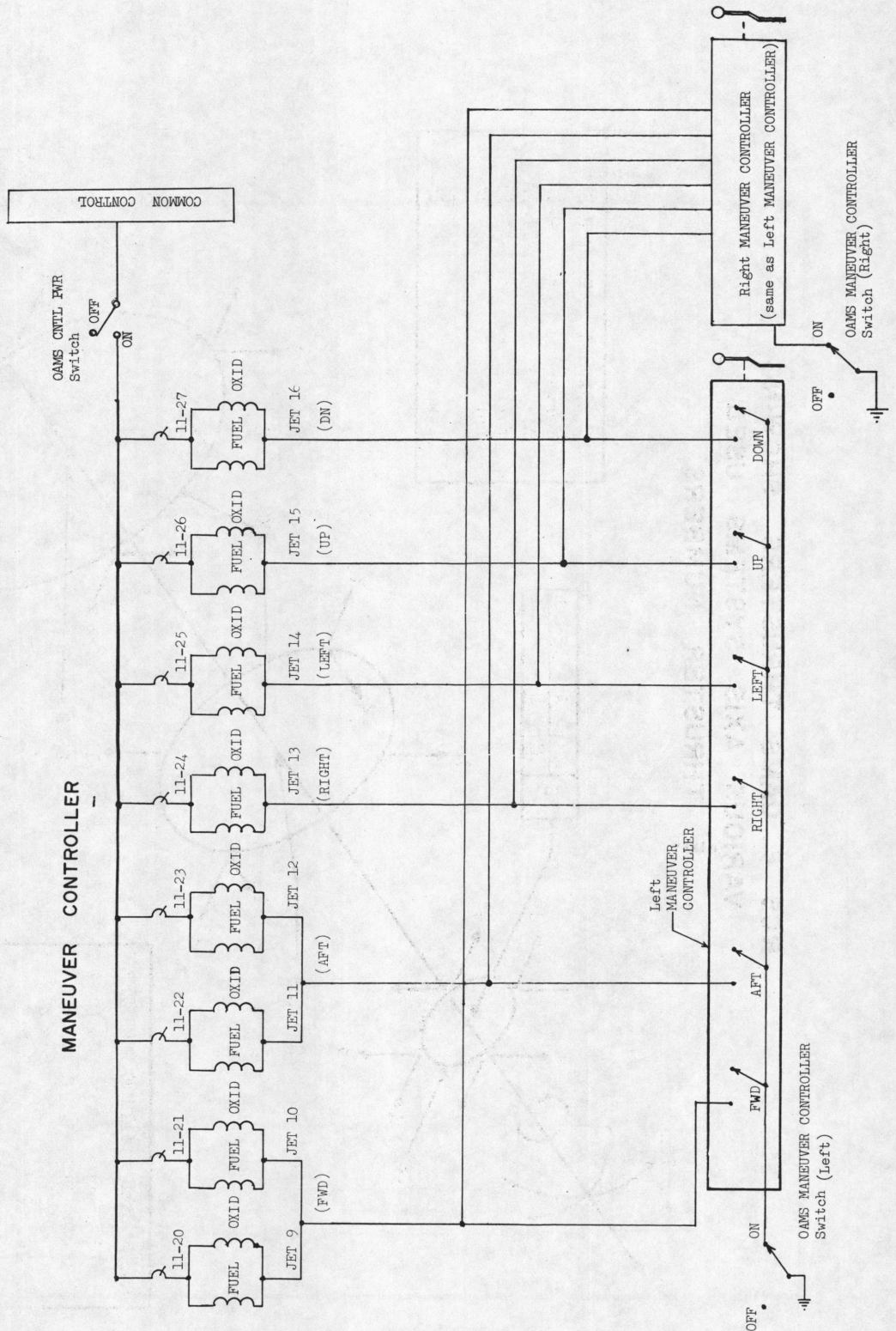
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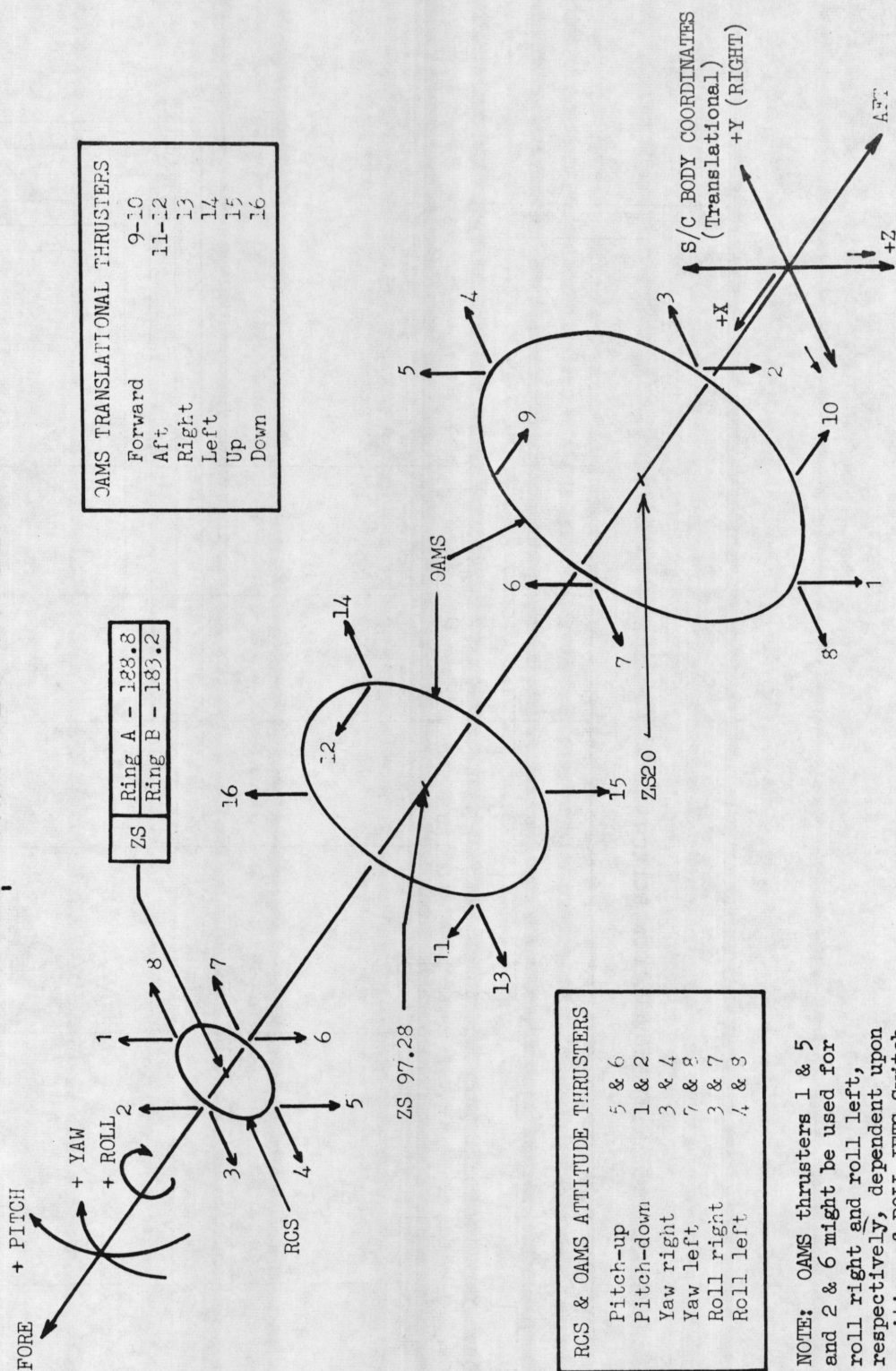
# ATTITUDE CONTROL HANDLE







# RCS & OAMS THRUSTERS SHOWING VARIOUS AXIS SYSTEMS USED & THRUSTER NUMBERS





## ATTITUDE AND MANEUVER CONTROL SYSTEM

### NOTES

#### 1. General

The Attitude Control and Maneuver Electronics (ACME) provides closed loop rate stabilization and attitude control, and manual attitude control when utilized in conjunction with the horizon sensors, the computer, platform and the ATTITUDE CONTROL HANDLE. The ACME is operational in seven control modes, selected by the ATTITUDE CONTROL Mode Switch. Each mode is discussed separately in the succeeding subsections. The ACME system consists of the Attitude Control Electronics (ACE), Orbit Attitude and Maneuver Electronics (OAME), ACME power inverter, and two identical rate gyro packages. The ACE package, rate gyro packages, and ACME inverter are located in the cabin section of the Reentry Module, while the OAME package is located in the Adapter Section. For attitude control, the ACME System utilizes either the Orbit Attitude and Maneuver System (OAMS) or the Reentry Control System (RCS).

The following block diagram shows the signal flow paths within the ACME. The various switches are connected to denote, in a general way, the signal routing when a particular switch position is chosen. These positions do not reflect the actual wiring in the spacecraft for sake of simplicity, since many of the switches actually power relays to accomplish the selection of signal paths.

#### 2. Attitude Control Electronics (ACE)

The Attitude Control Electronics (ACE) subsystem consists of power supplies, mode logic circuits, proportional circuits, control torque logic circuits, RCS relay drivers, and a pulse generator.

- a. The ACE power supply provides regulated  $\pm 10V$  and  $+20V$  DC bias power for transistor and relay circuits within the ACE. Twenty-one volt AC single phase power is also provided for the chopper and demodulator circuits and 3V ref. deadband. Two ACE power supplies are provided for redundancy, with selection via the ACME BIAS POWER Switch. Input power to the power supplies is via the ACME inverter or the IGS inverter.
- b. The ACE mode logic circuits switch, the input signals from the ATTITUDE CONTROL HANDLE, rate gyros, horizon sensors, platform, and computer to the proportional circuits in accordance with the position of the ATTITUDE CONTROL Mode Switch. In addition, the mode logic circuits de-energize all unused circuits within ACE when HOR SCAN mode is selected. Switching in these circuits is accomplished by transistors at the signal level and by relays at the power level.
- c. The Proportional Circuits consist of the rate and attitude preamplifiers, and primary and secondary switching amplifiers and demodulators for each axis. These circuits amplify and sum the AC input signals and convert them to DC analog signals for inputs to the Control Torque Logic Circuits.
- d. The Control Torque Logic Circuits consist of primary and secondary plus and minus switches and minimum pulse generators. The plus and minus switches

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convert DC analog signals into positive or negative jet firing commands which are fed to the OAMS attitude solenoid drives and/or the RCS attitude relay drivers. The minimum pulse circuits hold the plus and minus switches on, and thus the jet firing commands on, for 18 milli-seconds independent of the variation of the input signals to the switches. These minimum pulse circuits control pulse duration during the automatic pulsing for HOR SCAN mode operation in the pitch and roll axes.

### 3. Orbit Attitude and Maneuver System (OAMS)

The OAMS is enabled by the OAMS CNTL PWR Switch. This switch enables actuation of sixteen attitude and maneuver thruster solenoid valves. Attitude control is accomplished automatically or manually via the ATTITUDE CONTROL Mode Switch and the ACME. Maneuver Control is accomplished by utilization of the MANEUVER CONTROLLER (does not use ACME). The OAMS PROP MOTOR VALVE Switch must be on in order to have thruster firing.

### 4. Reentry Control System (RCS)

The RCS is enabled by the RCS RING A and RING B CNTL PWR Switches. The RCS PROP MOTOR VALVE Switches A and B must also be on to obtain thruster firing. Also, the RCS Telelight Switch or the ABORT Handle must be actuated before RCS thruster firing can be obtained. The RCS provides for attitude control only. Two rings of thrusters (eight each) are utilized in conjunction with the ACME. In addition, the RCS has an alternate system completely independent of ACME. It is a DIRECT mode which enables direct firing of thruster solenoid coils via the RCS DIRECT Switches in the ATTITUDE CONTROL HANDLE.

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## HORIZON SCAN MODE

### MODE

#### 1. General

In the Horizon Scan Mode, the spacecraft pitch and roll attitudes are automatically held within a  $\pm 5$  degree deadband by horizon sensor signals fed into the ACME. Except for the initial pulse which may be greater than 18 ms, depending on attitude error and initial velocity, the ACME provides fixed duration pulse firing commands to the proper jets in both OAMS and RCS. The pulse repetition frequency of the pulse firing is directly proportional to the amount by which the attitude error exceeds the deadband. The normal pitch variation will be between zero and ten degrees pitch down attitude, since a five-degree pitch down bias is incorporated into the ACME to keep the earth's horizon within astronaut field of view. No automatic control is provided in yaw. However, the manual PULSE Mode in all axis is also enabled when in HOR SCAN Mode. Figure 2.4.7.2-1 illustrates the control mode.

#### 2. Circuit Operation

The circuit operation within the ACE is as follows:

When the HOR SCAN position on the ATTITUDE CONTROL Mode Switch is selected, the mode logic circuit disconnects the computer, rate gyro, manual rate and platform signals to the proportional circuits. It also de-energizes all ACE circuitry not used in this mode. The DC pitch and roll signals from the Horizon Sensor are allowed to pass. Pitch up and roll right spacecraft motions give positive DC Horizon Sensor signals. The DC signals are routed into either primary or secondary logic circuits where they are chopped by an "out-of-phase" chopper and fed into an amplifier. In the pitch channel, a fixed positive DC voltage is added to the Horizon Sensor pitch signal. This bias voltage fixes the spacecraft pitch reference at a five-degree pitch down attitude.

- a. Signal Conversion. The "out-of-phase" chopper essentially converts the positive DC Horizon Sensor signals into "out-of-phase" AC signals and the negative DC Horizon Sensor signals into "in-phase" AC signals. The AC signals are then amplified and fed into a demodulator. If the input signal to the demodulator is "in-phase" with a fixed reference voltage, the plus switch is turned on; if the input signal is "out-of-phase," the minus switch is turned on.
- b. Plus and Minus Switches. The plus and minus switches, when turned on, send firing commands to the positive and negative attitude valve drivers. The outputs from the switches also trigger minimum pulse generators which feed back a pulse to the input of the switch circuits, clamping them on for 18 milli-seconds. The operation of the demodulator, switches, and minimum pulse circuits is discussed in more detail in the Rate Command Section (2.4.7.3).
- c. Pulse Repetition Frequency. In the HOR SCAN Mode, the plus and minus switches also route a positive DC signal into a lag network. The lag network consists of a resistance-capacitance circuit which integrates the switch output and feeds it back through a chopper to the input of the amplifier. The outputs

Continued

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from the switch circuits correspond to spacecraft acceleration since they are jet firing commands, thus the integrated signal fed back to the amplifier from the lag network corresponds to a rate signal. This rate signal subtracts from the Horizon Sensor signal and reduces the net signal into the amplifier below the switching level. The time required for the net signal into the amplifier to again increase above the switching level (and thus generate another firing command pulse) is a function of the magnitude of the horizon sensor signal and the time constants of the lag network. The time constants of the lag network are fixed; therefore, the time between firing command pulses is essentially governed by the magnitude of the Horizon Sensor signal into the amplifier. The larger the Horizon Sensor signal, the smaller the time between pulses or the higher the pulse repetition frequency. Since each pulse provides a constant acceleration, the spacecraft acceleration is proportional to pulse frequency. Thus, the repetition frequency or acceleration of the pulse firing commands is directly proportional to the magnitude of the Horizon Sensor signal and, hence, to the amount by which the attitude error exceeds the deadband.

- d. Manual PULSE Mode. The mode logic circuit also sets the pulse generator and connects the bias voltage from the ACE power supply through the PULSE switches to the pulse generator in this mode. Thus, full manual pulse capability is retained in this mode for pitch, roll, and yaw control just as in the PULSE Mode.

NOTE: Spurious jet firing commands may momentarily occur upon switching into the HOR SCAN mode from reentry, reentry rate command, rate command and platform modes. This is the result of lag networks charged by jet firing activity in the aforementioned modes.

Rapid switching of the AC power (AC POWER Switch or SCANNER Switch) can cause scanner reverse logic and 180° phase shift in the scanner pitch output. In the HOR SCAN Control Mode the jets would continue to pulse, in the direction of motion, until loss of track occurred. To correct, switch to other scanner or turn malfunctioning scanner off for a minimum of 15 sec and then back on.

Propellant consumption in the SCAN mode is approximately .225#/orbit.

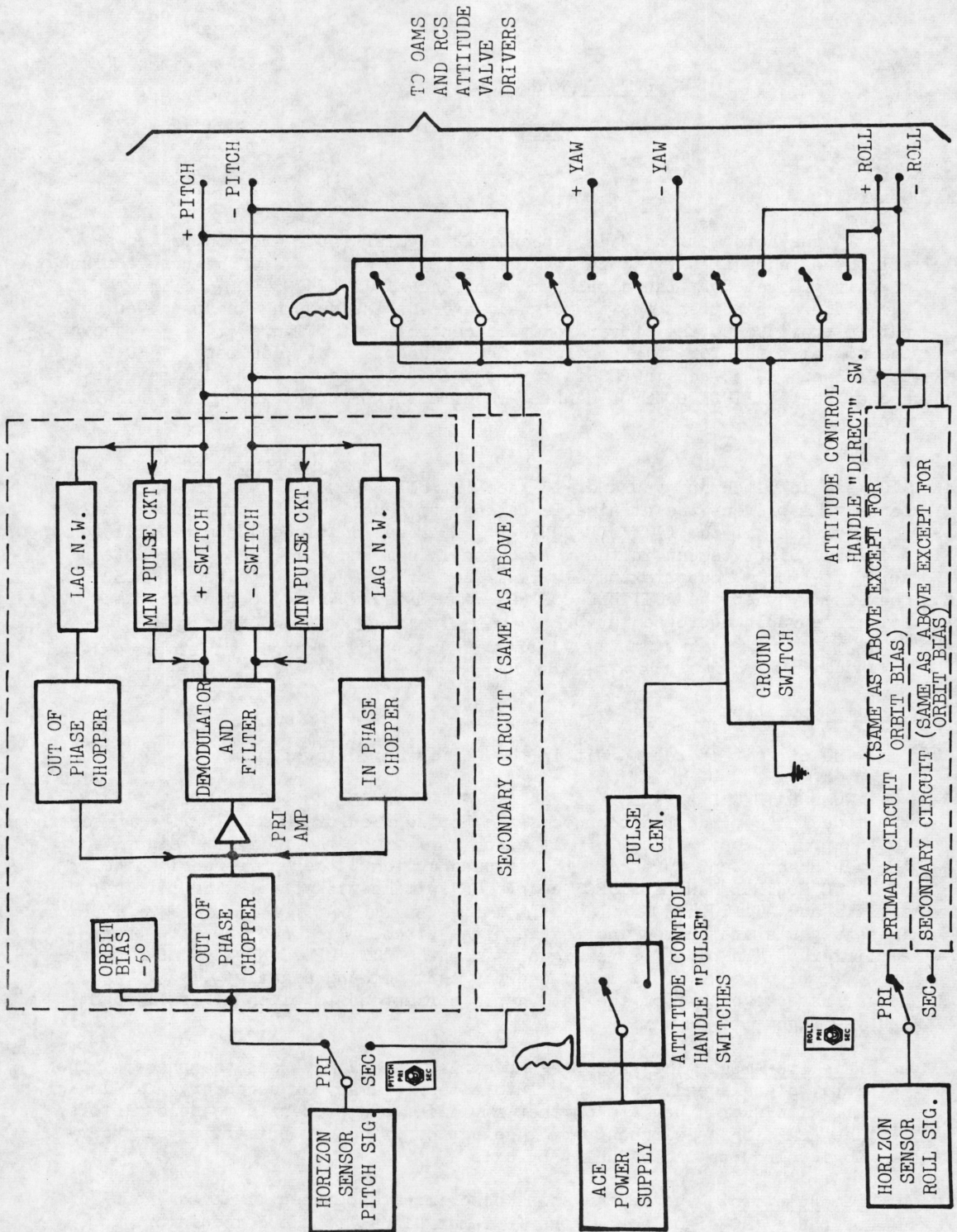
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Fig. 2.4.7.2-1



TO OAMS  
AND RCS  
ATTITUDE  
VALVE  
DRIVERS

ACME - HORIZON SCAN ATTITUDE CONTROL MODE

## RATE COMMAND MODE

### NOTES

#### 1. General

In the Rate Command Mode, spacecraft angular rates are controlled around all three major axes by comparing the rate gyro outputs and the rate command signals generated by the displacement of the ATTITUDE CONTROL HANDLE. When the difference between the two signals exceeds the damping deadband, an output is provided to the proper reaction control jet. Figure 2.4.7.3-1 shows the signal paths for this control mode. A damping rate deadband of  $-0.2^\circ/\text{sec}$  in OAMS and  $+0.5^\circ/\text{sec}$  in RCS is provided in this mode. Commanded rates by use of the ATTITUDE CONTROL HANDLE are directly proportional to its displacement.

Maximum commanded rates are  $+10^\circ/\text{sec}$  in pitch and yaw and  $+15^\circ/\text{sec}$  in roll. However, the rate deadbands will prevent the attainable rates from equalling the commanded rates. For instance, if the ATTITUDE CONTROL HANDLE was displaced from neutral to a maximum displacement in the roll channel (commanded  $15^\circ/\text{sec}$ ), the attainable rate would be approximately  $14.8^\circ/\text{sec}$  in OAMS and  $14.5^\circ/\text{sec}$  in RCS. Conversely, when the ATTITUDE CONTROL HANDLE is returned to neutral, the roll rate would decrease to  $+0.2^\circ/\text{sec}$  in OAMS and  $0.5^\circ/\text{sec}$  in RCS. From this, it can be seen that the attainable rates will always differ from the commanded rates by  $\frac{1}{2}$  the total deadband.

#### 2. Circuit Operation

The circuit operation within the ACE is as follows:

When RATE CMD position on the ATTITUDE CONTROL Mode Switch is selected, the mode logic circuit disconnects the Horizon Sensor, Platform and computer inputs to the proportional circuits. It also grounds the roll rate signal to the yaw channel and turns off the "ground switch," thereby rendering the ATTITUDE CONTROL HANDLE DIRECT and PULSE switches inactive. The rate gyro signals and ATTITUDE CONTROL HANDLE rate command signals are allowed to pass. These signals are summed and fed into the pitch, roll, and yaw rate pre-amplifiers. "In-phase" rate signals from the ATTITUDE CONTROL HANDLE correspond to pitch down, roll left, and yaw left command signals, and "in phase" rate signals from the rate gyros correspond to pitch up, roll right, and yaw right rate motions.

- a. Rate Pre-Amps. The rate pre-amp amplifies and reverses the phase of the input signals and feeds them into either primary or secondary ACME logic circuits where they are further amplified and presented to demodulators. The ACME logic switches permit selection of either primary or secondary logic circuits individually by axis.
- b. Demodulators. The demodulators discriminate between "in-phase" and "out-of phase" AC signals. If the AC input signal to the demodulators is

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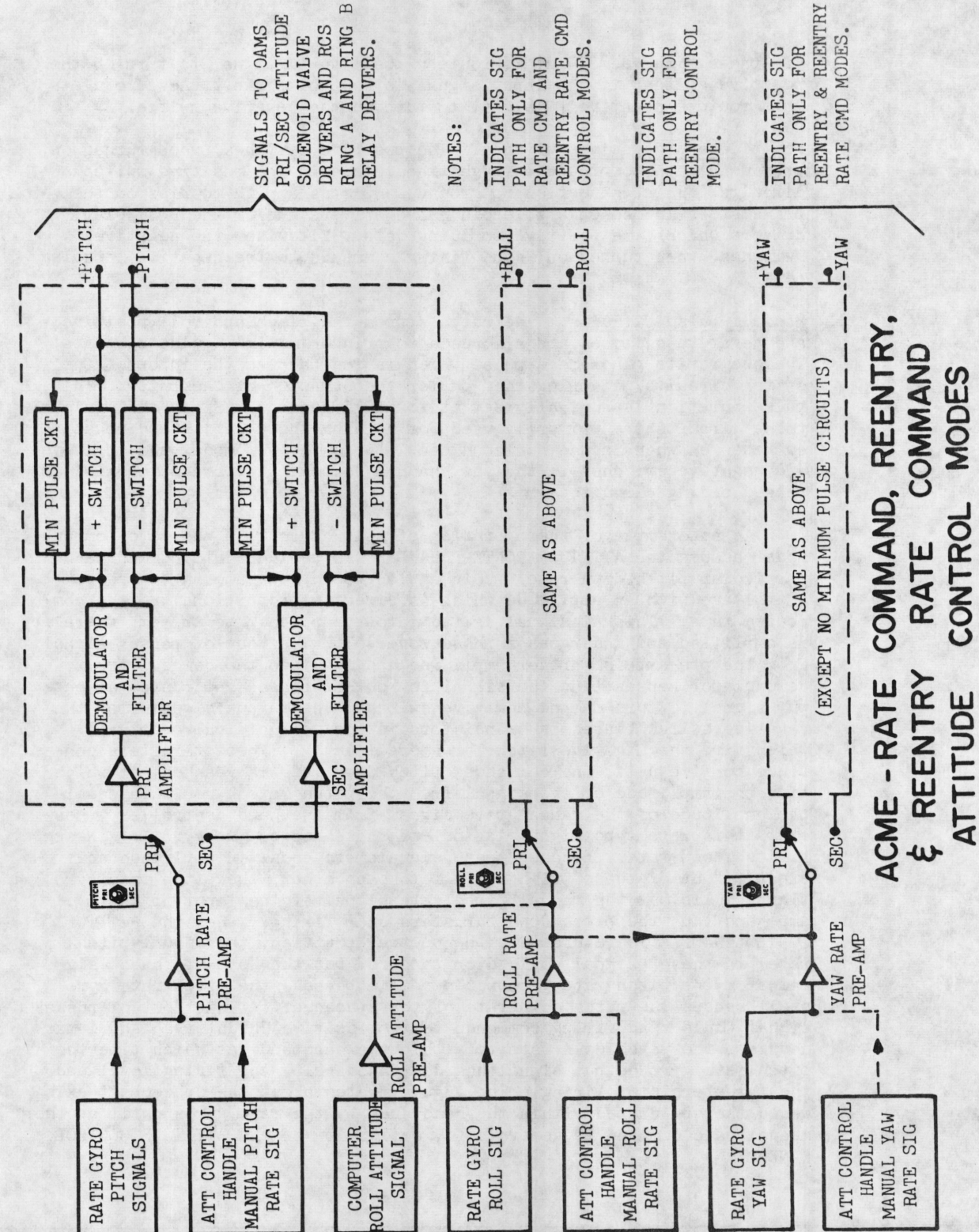
"in-phase," the demodulators route a positive DC signal to turn on the positive switch; if the input signal is "out-of-phase," the demodulators route a negative DC signal to turn on the negative switch.

- c. Positive and Negative Switches. The positive switches, when turned on, provide a path to ground through transistors in the positive switch circuits. This connection to ground completes a path to bias on the transistors in the OAMS solenoid valve drivers and/or the RCS relay drivers which fire positive torquing jets. Likewise, the negative switches, when turned on, send firing commands to the negative torquing jets.
- d. Minimum Pulse Circuits. The outputs from the pitch and roll positive and negative switches are also used to trigger minimum pulse circuits. These circuits generate a pulse which is fed back to the input of the switch circuits, clamping them on for the duration of the pulse. This pulse duration is nominally set at 18 milli-seconds. Since the minimum pulse circuits are primarily used for holding the positive and negative switches on when in the Horizon Scan mode, the positive and negative switches in the yaw channel do not incorporate the minimum pulse holding circuits.

As an example of the operation of this circuit in the Rate Command Mode, assume the ATTITUDE CONTROL HANDLE was deflected to command a particular pitch down rate. This action would generate an "in-phase" AC voltage with an amplitude which is directly proportional to the commanded rate. This AC signal is fed into the pitch rate pre-amp where it is amplified and undergoes a phase-reversal. The "out-of-phase" signal from the pre-amp is further amplified and fed into the demodulator. The demodulator senses that the signal is "out-of-phase" and routes an output signal to turn on the negative switch. The output signal from the negative switch biases on transistors in the solenoid valve drivers, which fire the negative Pitch Thrusters 1 and 2. These thrusters continue to fire until the commanded pitch down rate is reached, at which time the amplitude of the signal from the pitch rate gyro would equal the amplitude of the manual rate signal from the hand controller. However, this rate gyro signal is "out-of-phase" since the gyro is sensing a pitch down rate. Because these signals are equal in amplitude and exactly "out-of-phase" with respect to each other, the pitch rate gyro signal nulls out the manual pitch rate signal at the input of the pre-amp, and thus the pitch down thrusters stop firing. When the ATTITUDE CONTROL HANDLE is returned to the neutral position, the manual pitch rate "in-phase" signal would drop to zero, but the "out-of-phase" signal from the pitch rate gyro would remain because the pitch rate gyro still senses the pitch down rate of the spacecraft. This "out-of-phase" signal would send firing commands to the Positive Thrusters 5 and 6 to decrease the pitch down rate to within the deadband, at which time the pitch rate gyro output signal has decreased below the firing level and the thrusters stop firing. The angular rates about the spacecraft axis would then be damped within the deadbands by the rate gyros until another manual rate command is generated by deflection of the ATTITUDE CONTROL HANDLE.

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Fig. 2.4.7.3-1





## DIRECT MODE

### NOTES

#### 1. General

This is a manual mode of operation in which continuous jet firing commands are supplied to the OAMS attitude solenoid drivers and/or the RCS relay drivers, whenever the displacements of the ATTITUDE CONTROL HANDLE are greater than a preset threshold of  $2.5^{\circ}$  of full travel ( $10^{\circ}$ ). Figure 2.4.7.4-1 shows the signal path.

#### 2. Circuit Operation

When the DIRECT position on the ATTITUDE CONTROL Mode Switch is selected, the mode logic circuit disconnects the horizon sensor, computer, rate gyro, platform & manual rate signals to the proportional circuits. A bias voltage from the ACE power supply is connected to the base terminal of a transistor denoted as the "ground switch." This bias voltage turns on the "ground switch" transistor and holds it on as long as the DIRECT mode is selected. Sufficient displacement of the ATTITUDE CONTROL HANDLE in a particular direction will close the corresponding DIRECT switch and connect the ground point to the proper OAMS attitude solenoid driver and/or the RCS relay driver. This ground connection to the driver circuits completes a path to bias on transistors which fire the proper torquing jets.

This mode should not be confused with the RCS DIRECT mode, in which all ACME electronics is by-passed.

### PLATFORM MODE NOTES

#### 1. General

The PLATFORM Mode is a fully automatic mode of operation. This mode does not incorporate manual capability to use the ATTITUDE CONTROL HANDLE. The PLATFORM Mode can be utilized for inertial platform alignment and will relieve the astros from the duty of S/C attitude keeping.

#### 2. Circuit Operation

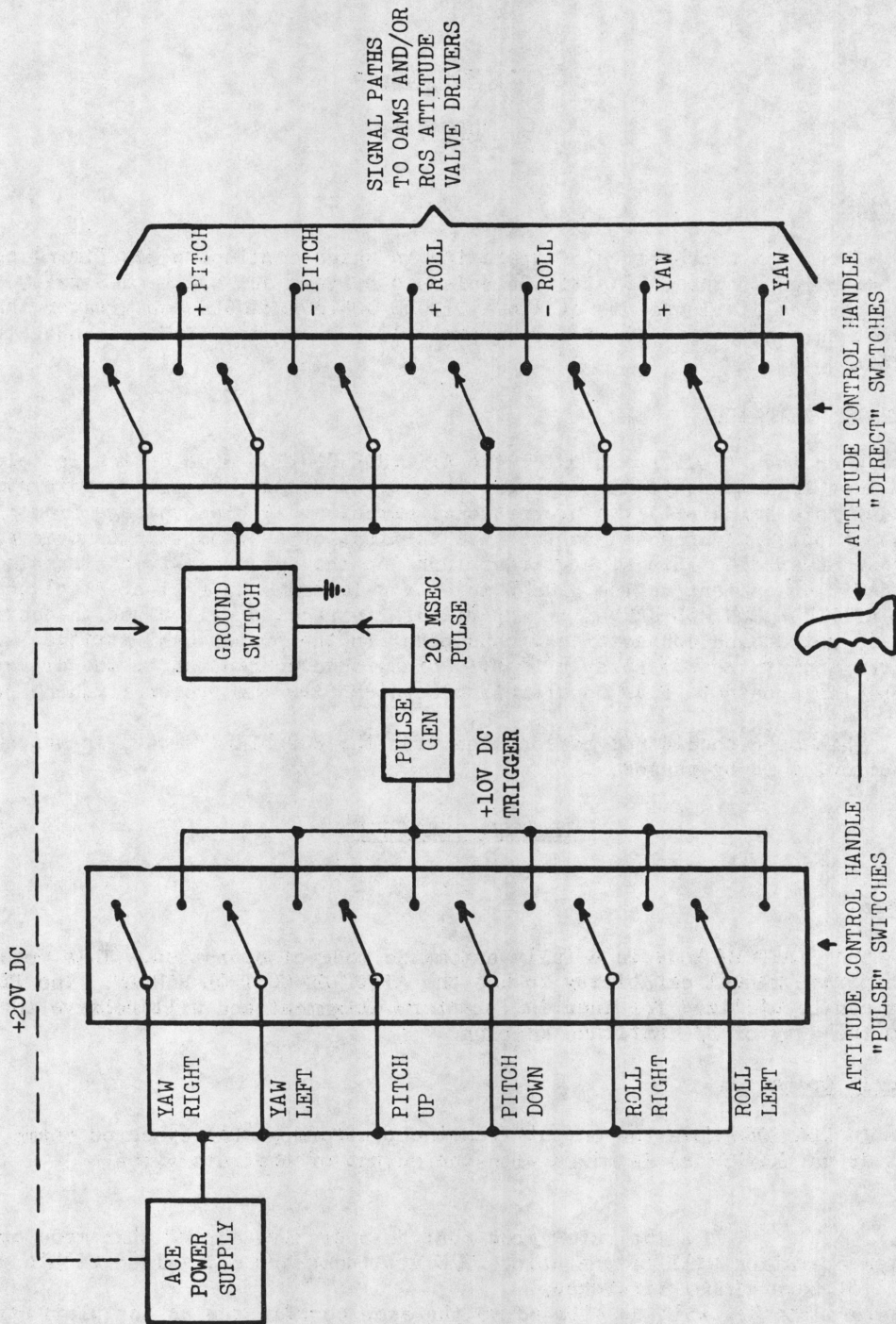
In PLATFORM Mode the output from the platform gimbal synchros (same signals that drive the FDI's) is mixed with the output of the rate gyros.

The rate gyros must be operative during this mode or system operation will be unstable. S/C attitudes are maintained within  $\pm 1.1^{\circ}$  of zero gimbal reference. Therefore the S/C will be aligned to the same coordinates as the platform. Propellant consumption is approximately .85 lbs/hr.

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Fig. 2.4.7.4-1



# ACME - DIRECT & PULSE ATTITUDE CONTROL MODES



## PULSE MODE

### NOTES

#### 1. General

In the PULSE Mode of operation, a fixed duration firing command (20 milli-seconds) is supplied to the OAMS attitude solenoid drivers and/or the RCS relay drivers each time the ATTITUDE CONTROL HANDLE is displaced beyond  $3.5^\circ$  of full travel ( $10^\circ$ ). Figure 2.4.7.4-1 shows the signal flow paths.

#### 2. Circuit Operation

The mode logic circuit disconnects the horizon sensor, computer, rate gyro, platform and manual rate signals to the proportional circuits as in the DIRECT Mode. However, in this mode the bias voltage from the ACE power supply is not connected directly to the base terminal of the "ground switch" but is connected through the PULSE switches and the pulse generator. Sufficient displacement of the ATTITUDE CONTROL HANDLE in any direction will connect the bias voltage from the ACE power supply to the pulse generator. This bias voltage triggers the pulse generator which biases the "ground switch" on. After a 20 milli-second duration, the pulse generator circuit shuts off the output from the pulse generator, which removes the bias voltage from the "ground switch," and opens the circuitry to the solenoid drivers, cutting them off. The pulse generator cannot be reset until the ATTITUDE CONTROL HANDLE is returned to the neutral position because the bias voltage, which is fed through the PULSE switches, keeps the triggering capacitor within the pulse generator charged up. This capacitor must be discharged before the pulse generator can be retriggered to supply another pulse to the "ground Switch" transistor (200 micro-seconds required). During the 20 milli-seconds when it is biased on, the "ground switch" transistor connects the common points of the DIRECT switches to ground just as it did in the DIRECT mode. The DIRECT switches then connect the ground to the proper OAMS solenoid driver and/or RCS relay driver to fire the thrusters. The DIRECT switches are mechanically adjusted to close with one degree less displacement of the attitude control handle than is required to close the PULSE switches. (See ATTITUDE CONTROL HANDLE Notes.) This insures that the full 20 milli-second pulse command is connected to the solenoid drivers or RCS relay drivers.

NOTE: The pulse generator discussed here has an output of 20 milli-seconds and is used in manual PULSE mode. It is not to be confused with the minimum pulse generators (18 milli-second output) used in the pitch and roll channels of the automatic HOR SCAN mode.

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## REENTRY RATE COMMAND MODE

### NOTES

#### 1. General

The operation of the Reentry Rate Command Mode is identical with the operation of the Rate Command Mode with two exceptions.

#### 2. Circuit Operation

First, the mode logic circuit allows an attenuated roll rate signal to be routed into the yaw channel when the RE-ENT RATE CMD position is selected by means of the ATTITUDE CONTROL Mode Switch. The purpose of mixing the attenuated roll rate signals with the yaw rate signals is to null out any yaw error signals generated by the yaw rate gyro (due to the offset c.g. location) whenever a roll rate is commanded during reentry. This prevents the yaw jets from continuously firing to compensate for the yaw error. Since the roll signal is  $180^\circ$  out of phase with the yaw signals, the yaw signals are nulled out preventing continuous firing of the yaw jets to compensate for the yaw error. This causes the lift vector to rotate about the flight path angle, thus giving a resultant zero lift. It also decreases the RCS fuel consumption during reentry.

Secondly, the mode logic circuit increases the amount of negative feedback around the rate pre-amplifiers when in the Reentry Rate Command Mode. This decreases the gain of the rate pre-amps and, hence, the sensitivity of the control loop. Thus, the damping deadband in the Reentry Rate Command Mode ( $\pm 4^\circ/\text{sec}$  in pitch and yaw and  $\pm 2^\circ/\text{sec}$  in roll) is larger than in the Rate Command Mode and therefore larger error signals are required to initiate jet firing commands. As in the RATE CMD mode, commanded rates by the ATTITUDE CONTROL HANDLE are directly proportional to its displacement. Commanded rates are also the same as in the RATE CMD mode ( $\pm 10^\circ/\text{sec}$  in pitch and yaw,  $\pm 15^\circ/\text{sec}$  in roll). However, since the deadbands are larger in RE-ENT RATE CMD mode, the attainable rates are smaller. For example, a roll rate of  $\pm 13^\circ/\text{sec}$  would be attained whenever a maximum roll rate of  $\pm 15^\circ/\text{sec}$  is commanded. Releasing the ATTITUDE CONTROL HANDLE would allow the roll rate to decrease to the deadband rate, or  $\pm 2^\circ/\text{sec}$ . Further, if a roll rate greater than  $13^\circ/\text{sec}$  is desired while in the RE-ENT RATE CMD mode, it could be obtained by creating a roll rate greater than  $15^\circ/\text{sec}$   $\pm 2^\circ/\text{sec}$  in DIRECT mode, and then switching the ATTITUDE CONTROL mode switch to RE-ENT RATE CMD mode while keeping the ATTITUDE CONTROL HANDLE fully displaced. If the rate attained in DIRECT was greater than  $17^\circ/\text{sec}$ , then the roll rate in RE-ENT RATE CMD would be  $17^\circ/\text{sec}$ . If the roll rate attained in DIRECT was greater than  $13^\circ/\text{sec}$  but within the deadband of  $13-17^\circ/\text{sec}$ , the rate would remain the same when switching to RE-ENT RATE CMD.

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## REENTRY MODE

### NOTES

#### 1. General

The Reentry Mode is a fully automatic mode of operation. In contrast to the Rate Command and Reentry Rate Command modes, this mode does not incorporate manual capability to use the ATTITUDE CONTROL HANDLE (AC power is removed from the ATTITUDE CONTROL HANDLE rate potentiometers).

#### 2. Circuit Operation

When RE-ENT is selected on the ATTITUDE CONTROL Mode Switch, the mode logic circuit disconnects the Horizon Sensor and platform input signal to the proportional circuits and deactivates the ATTITUDE CONTROL HANDLE DIRECT and PULSE switches. However, it allows the computer roll signal to pass to the roll attitude pre-amp.

Pitch and yaw are rate damped (deadbands  $\pm 4^\circ/\text{sec}$ ).

Roll is rate damped  $\pm 2^\circ/\text{sec}$  about the  $15^\circ/\text{sec}$  roll rate and attitude controlled  $\pm 2^\circ$  about the commanded roll attitude. As in Reentry Rate Command, a portion of the roll rate gyro signal is added to the yaw rate gyro signal.

See REENTRY notes Sec. 2.5.7 Pg. 9 for a detailed description of computer REENTRY mode operation.

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## ACME/DIRECT RCS RING A AND RING B CIRCUIT

### NOTES

#### 1. ACME

Whenever a RCS RING A and/or RING B ATTITUDE CONTROL SWITCH (or switches) is in the ACME position, the ACME attitude jet firing signals are allowed to fire the appropriate RCS thrusters. All the various ACME control modes are capable of being used in RCS. The RCS PRO MOTOR VALVE Switches must be ON in order to have thruster firing. And this is only possible after the RCS telelight switch or the ABORT Handle has been actuated.

The attitude thrusters firing commands from the ATTITUDE CONTROL HANDLE DIRECT switches or the ACE control torque logic switches provide a ground connection which completes a path to bias on transistors in the relay driver circuits.. These transistors, when biased on, provide a ground connection to the relays. This ground connection completes a path to energize the relays from the common control bus. The relay contacts close and connect the jet solenoids to ground if the RCS ring switch is in the "ACME" position. The ground connection completes the circuit to energize the thruster solenoids from the common control bus.

Whenever an abort sequence is initiated by means of the ABORT Handle, the OFF position of both RCS switches is automatically connected in parallel with the ACME position. The RCS cannot be switched off after this point except through the RCS A and B C/B's or the RCS PROPELLANT Switches. However, the DIRECT position can still be selected.

#### 2. DIRECT

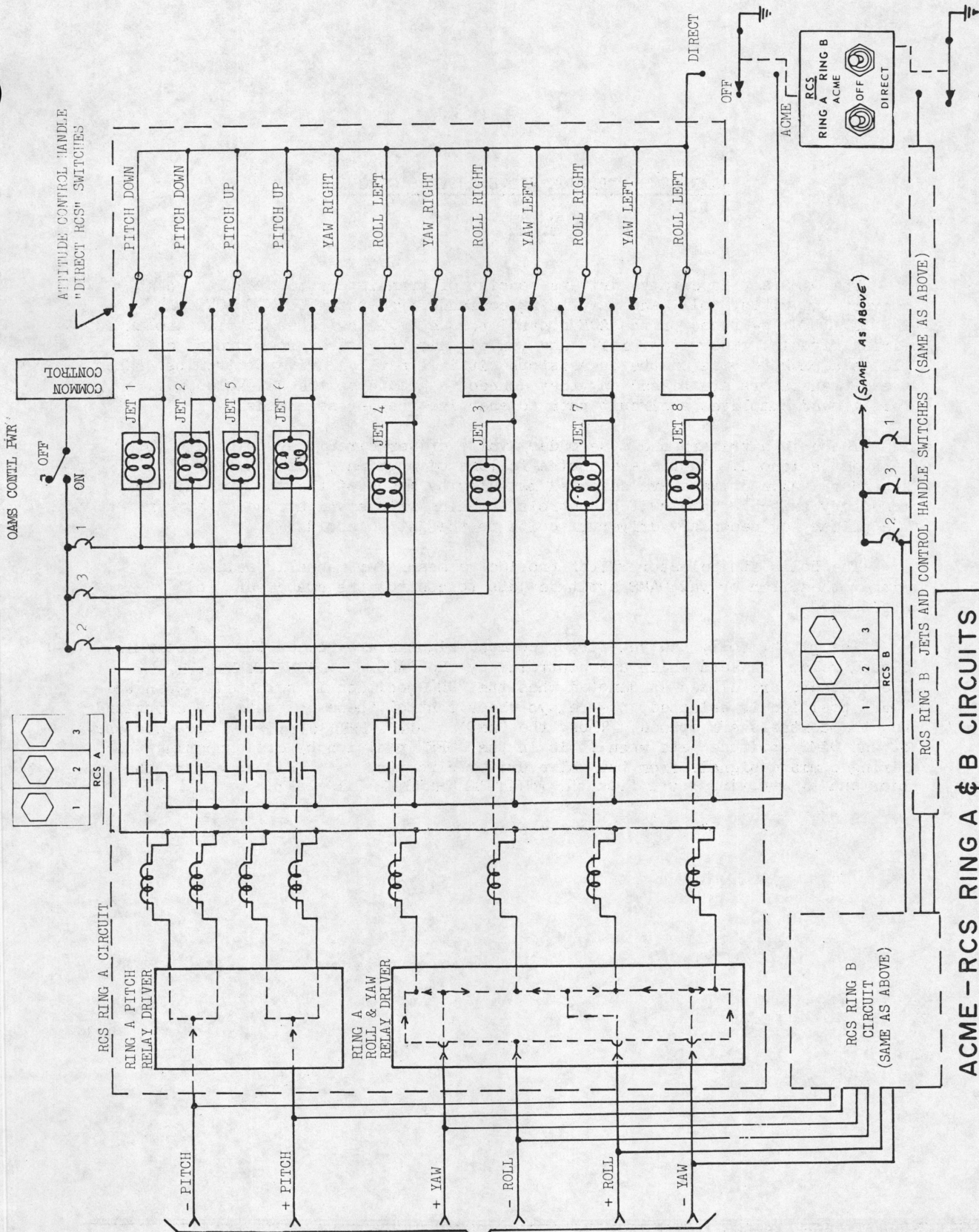
If the DIRECT position on the RCS power switches is selected, the entire ACME system is by-passed. The RCS thruster solenoids are controlled directly by the ATTITUDE CONTROL HANDLE DIRECT RCS Switches. When the control handle is deflected sufficiently, the RCS DIRECT switch closes and connects the RCS thruster solenoids directly to ground, thus completing a path to energize the solenoids from the common control bus ( $V_{CC}$ ). However, the RCS PRO MOTOR VALVE Switch (or switches) must be ON in order to obtain thruster firing. Further, the RCS telelight switch or the ABORT Handle has to be actuated before thruster firing can be obtained.

NOTE: The spacecraft roll attitude is always controlled by means of the yaw jets when using the RCS.

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## ACME-OAMS ATTITUDE VALVE DRIVERS CIRCUIT

### NOTES

The OAMS attitude valve drivers consist of transistorized circuits which convert the pitch, roll, and yaw firing commands from the ATTITUDE CONTROL HANDLE DIRECT switches or the ACE control torque logic switches into jet solenoid firing signals. The pitch, roll, and yaw signals provide a ground which completes a path to bias on the transistors within the valve drivers circuits. When these transistors are biased on, they connect a ground to the jet solenoids. This ground completes a circuit path to energize the jet solenoids.

There is a primary and a secondary valve driver circuit associated with each jet solenoid. In the event of a failure of a primary valve driver, the secondary valve drivers are selected manually by means of the attitude drivers momentary switch. This switch controls latching relays which connect either the primary or secondary driver circuits to the jet solenoids.

The Roll Jets Selector Switch provides a means for manually selecting either the pitch or yaw OAMS attitude jets to control the spacecraft roll attitude.

The pitch, roll, and yaw firing command signals are routed through normally closed relay contacts which are controlled by the OAMS CNTL PWR Switch. The contacts are closed as denoted when the "ON" position is selected. When the "OFF" position is selected, the relays which control these contacts are energized and the contacts are opened. Thus, the OAMS CNTL PWR Switch prevents use of the OAMS attitude jets when it is in the "OFF" position by disconnecting the firing command signals from the valve driver circuits, disconnecting the bias and by removing power from the ATTITUDE THRUSTER C/B's 1-8.

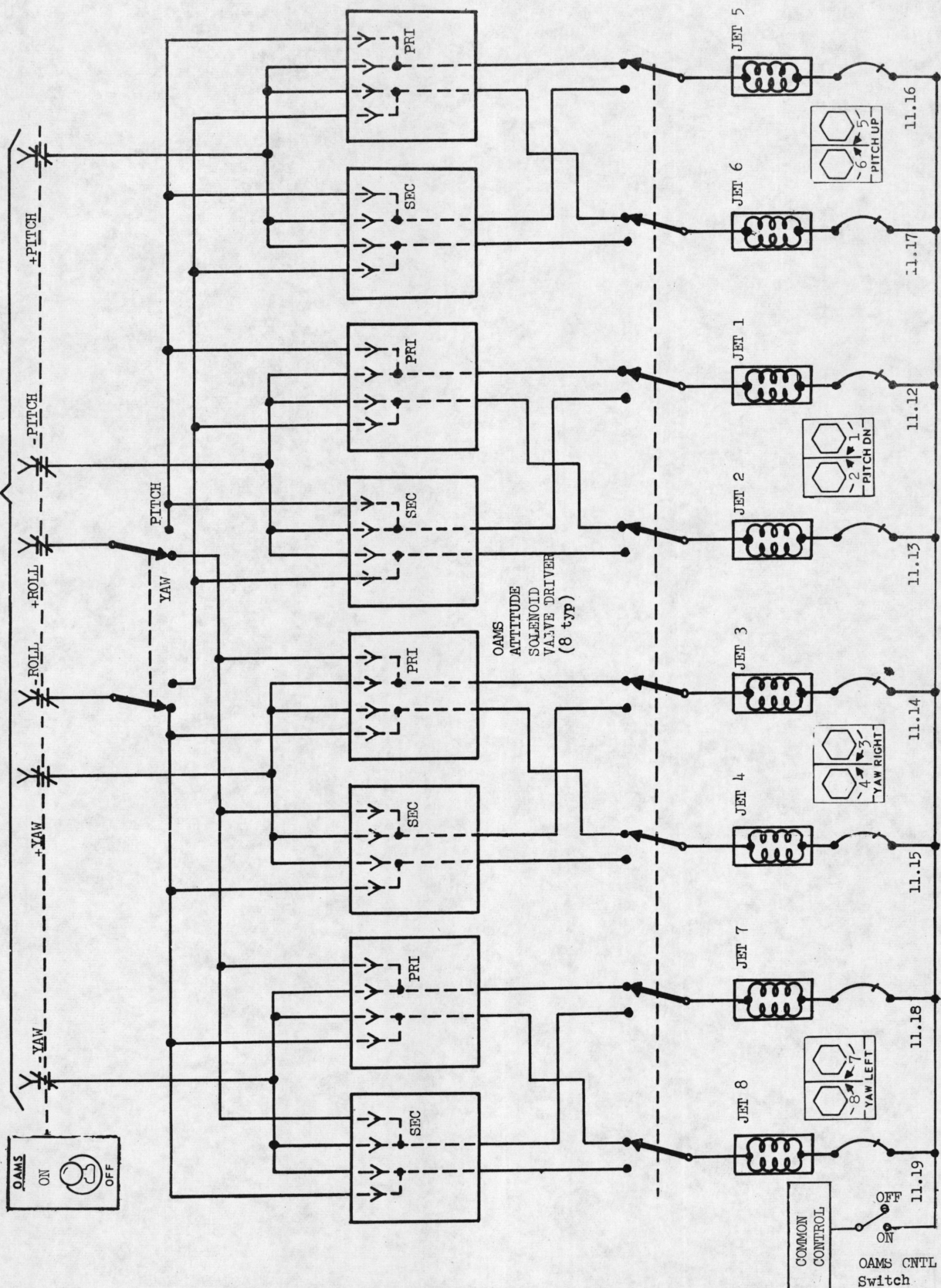
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# ACME-OAMS ATTITUDE VALVE DRIVER CIRCUITS

OAMS ATTITUDE JET COMMANDS

OAMS CNTL FWR



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