

J.D. Kilstad

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VOLUME II

APOLLO OPERATIONS HANDBOOK

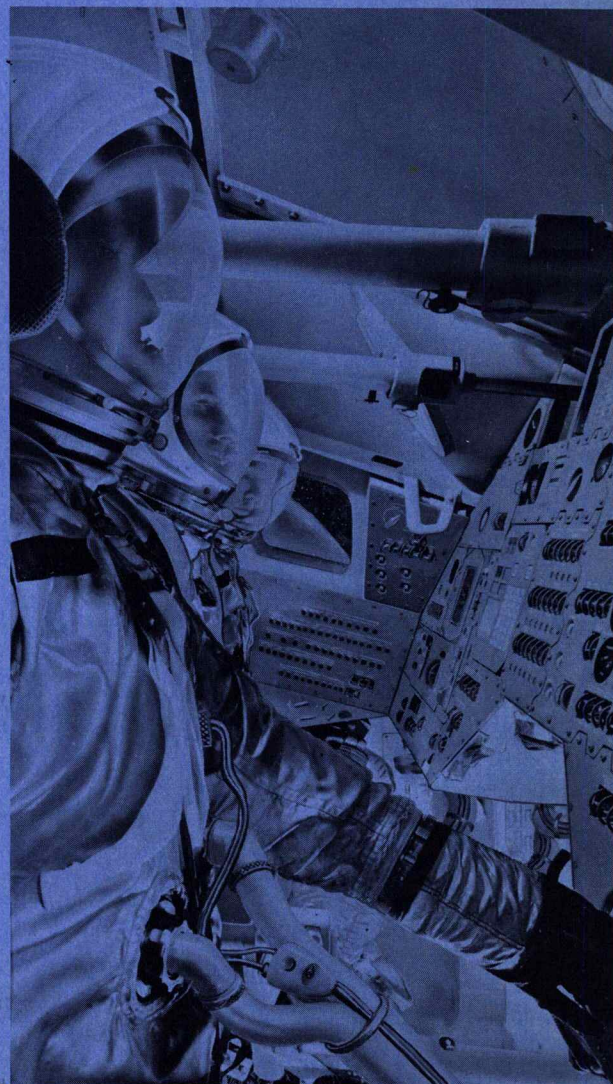
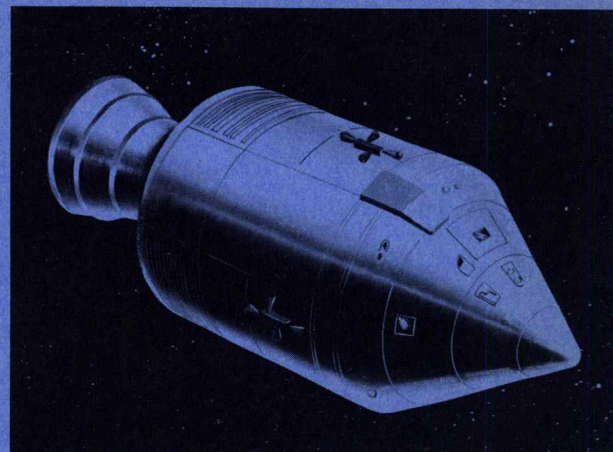
**COMMAND AND
SERVICE MODULE**

SPACECRAFT 014

Prepared Under Direction of
NASA-MSC MISSION OPERATIONS BRANCH
FLIGHT CREW SUPPORT DIVISION



NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION



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APOLLO OPERATIONS HANDBOOK
COMMAND AND SERVICE MODULE
SPACECRAFT 014

VOLUME 2

PERFORMANCE DATA AND PROCEDURES

Contract NAS9-150
Exhibit I; Paragraph 10.3

PREPARED BY NORTH AMERICAN AVIATION, INC.
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SECTION 5

PERFORMANCE

INTRODUCTION.

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

5.1 CREW DISPLAY INSTRUMENT MARKINGS AND ACCURACY DATA.

Paragraphs 5.1.1 through 5.1.7.4 include information on instrument markings and instrument accuracy. Adjoining tabular lists provide accuracy data for each indicator scale and list the measurement number of the signal which is monitored on each indicator scale. Some indicators can, by selection, monitor more than one signal; in which case, the measurement number of all signals monitored by the indicator are listed. Selector switch and indicator functions are covered in detail in section 2.

Some of the system indicators shown in the associated illustrations (figures 5-1 through 5-12) are provided with vertical or horizontal green-colored bands to show normal operating ranges, vertical yellow bands to show permissible operating ranges requiring caution, and horizontal red bands or lines to show system limitations. The color markings, operating ranges, and limitations for these system indicators are as follows:

System	Indicator Scale	Color Marking	Operating Range or Limitation
SPS (MDC-20) (figure 5-1)	PROP TEMP	Red	80°F (upper limit) and -40°F (lower limit)
	PRESSURE-FUEL	Green	170 to 195 psia (normal band)
	PRESS-OX	Green	Same as PRESSURE-FUEL scale.

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

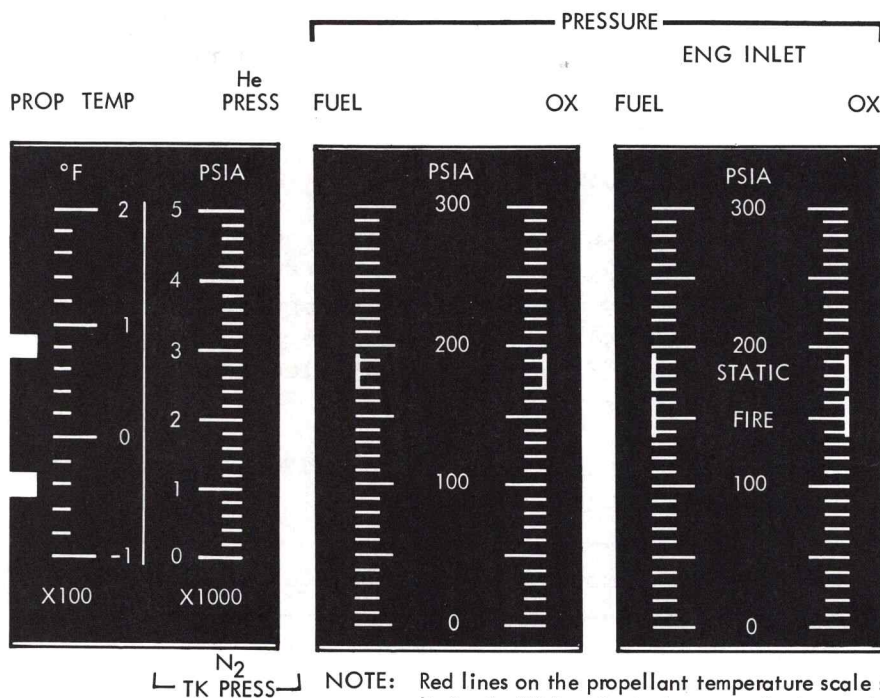
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System	Indicator Scale	Color Marking	Operating Range or Limitation
PGA (figure 5-9)	PRESS-CABIN	Red	4.7 psia (low limit line)
	PART PRESS-CO ₂	Red	15 mm Hg (high limit line)
		Yellow	7.6 to 15 mm Hg (caution band)
	PGA pressure indicator	Red	2.0 to 3.5 psia (emergency band)
		Green	3.5 to 10 psia (normal band)

5.1.1 SERVICE PROPULSION SYSTEM INDICATORS.

Instrument markings for the SPS indicators (MDC-20) are shown in figure 5-1. The indicators present a visual display of SPS temperatures and pressures. Visual displays of SPS fuel and oxidizer remaining aboard the S/C are shown in the adjacent OXID-FUEL QUANTITY display windows (as selected by the SPS quantity SENSOR switch). (Refer to section 3.)



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

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Figure 5-1. Service Propulsion System Indicators

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

Indicator Scale	Measurement Number	Indicator Accuracy
PROP TEMP	SP 0002 T	±5°F at 75°F ±10°F at 0° and 150°F
He PRESS	SP 0001 P	±100 psia at 75°F ±150 psia at 0° and 150°F
Tk PRESS-N ₂	SP 0600 P (Primary) SP 0601 P (Secondary)	±100 psia at 75°F ±150 psia at 0° and 150°F
PRESSURE-FUEL	SP 0006 P	±5 psia at 75°F ±10 psia at 0° and 150°F
PRESSURE-OX	SP 0003 P	±5 psia at 75°F ±10 psia at 0° and 150°F
PRESSURE-ENG INLET-FUEL	SP 0010 P	±5 psia at 75°F ±10 psia at 0° and 150°F
PRESSURE-ENG INLET-OX	SP 0009 P	±5 psia at 75°F ±10 psia at 0° and 150°F

5.1.2 REACTION CONTROL SYSTEM INDICATORS.

Instrument markings for the S/M and C/M RCS indicators (MDC-12) are shown in figure 5-2. The indicators present a visual display of system temperatures and pressures. Visual displays of S/M RCS fuel and oxidizer remaining are shown on the adjacent PROPELLANT QUANTITY indicator (as selected by the RCS INDICATORS switch). (Refer to section 3.)

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

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

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

5.1.3 ELECTRICAL POWER SYSTEM INDICATORS.

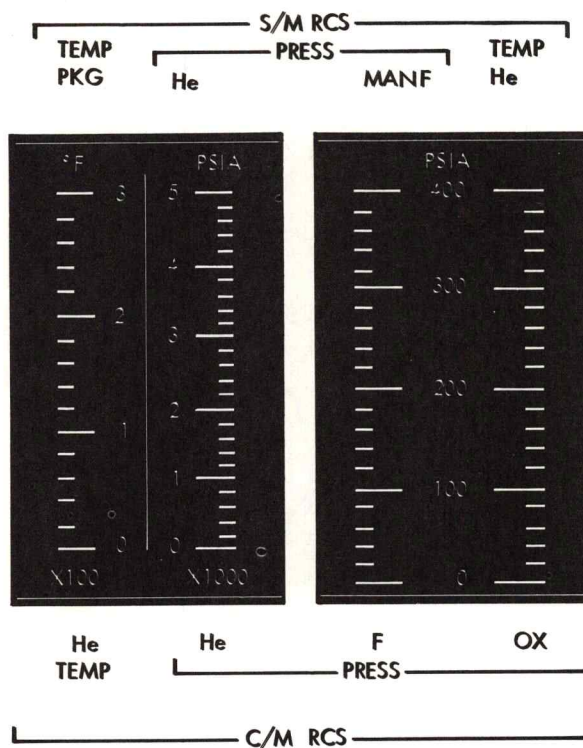
5.1.3.1 EPS (Cryogenic Storage) Tank Pressure Indicators.

Instrument markings for the EPS (cryogenic storage) tank pressure indicators (MDC-13) are shown in figure 5-3. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

NOTE TANK PRESSURE-O₂-1 scale is used to display cryogenic storage tank 1 pressure or ECS surge tank pressure as selected by O₂ PRESS IND toggle switch located immediately below the display.

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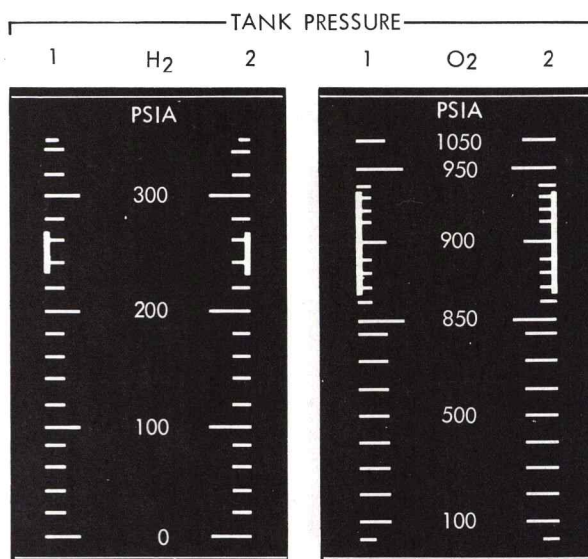
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Figure 5-2. S/M and C/M Reaction Control System Indicators

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

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

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Figure 5-3. EPS (Cryogenic Storage) Tank Pressure Indicators

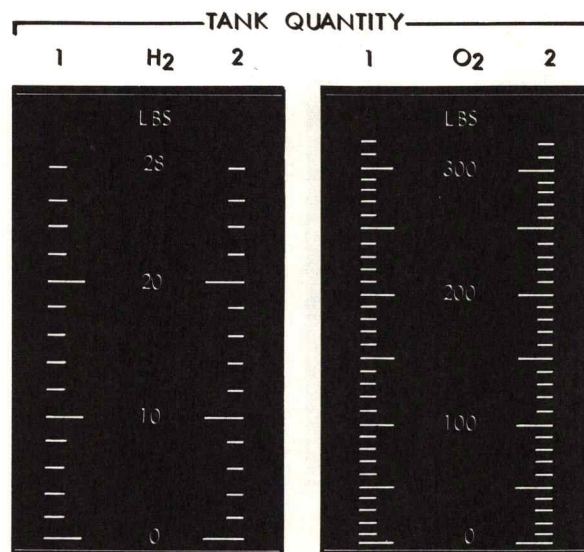
5.1.3.2 EPS (Cryogenic Storage) Tank Quantity Indicators.

Instrument markings for the EPS (cryogenic storage) tank quantity indicator (MDC-13) are shown in figure 5-4. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

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

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Figure 5-4. EPS (Cryogenic Storage) Tank Quantity Indicators

5.1.3.3 EPS Fuel Cell Power Plant Indicators.

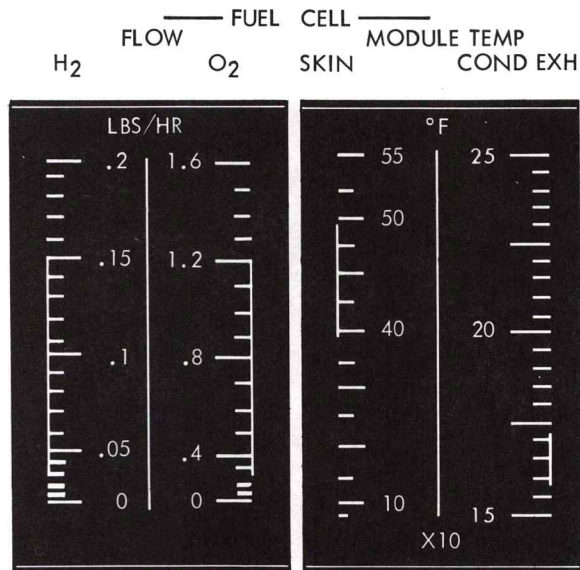
Instrument markings for the EPS fuel cell power plant indicators (MDC-18) are shown in figure 5-5. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

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

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

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Figure 5-5. EPS Fuel Cell Indicators

5.1.3.4 EPS Volts, Amperes, and Frequency Meters.

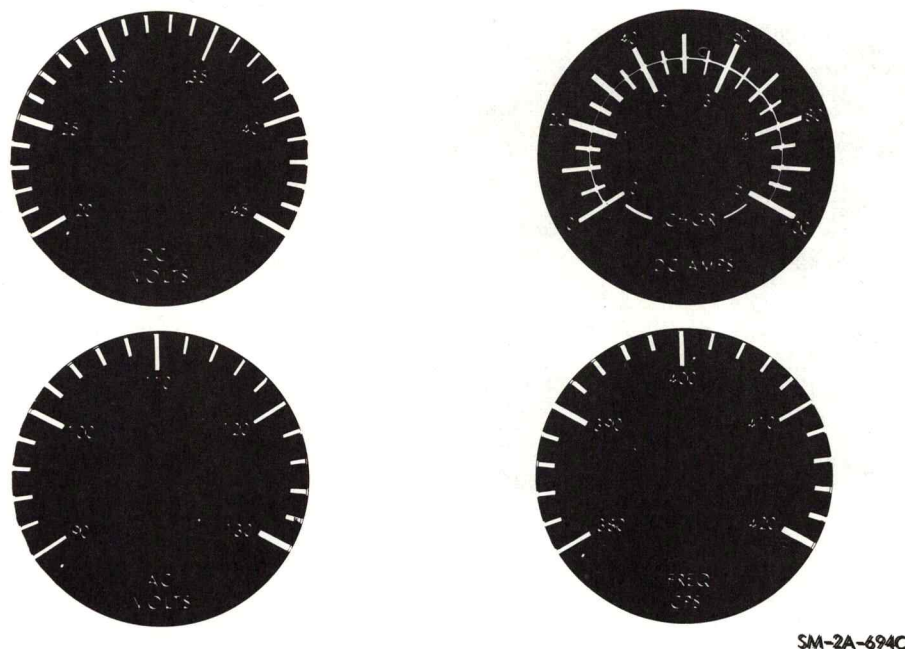
Instrument markings for the EPS-volts, amperes, and frequency meters (MDC-18) are shown in figure 5-6. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

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

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Figure 5-6. EPS Volts, Amperes, and Frequency Meters

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

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5.1.4 ENVIRONMENTAL CONTROL SYSTEM INDICATORS.

5.1.4.1 ECS Pressure and Slow-Rate Indicators.

Instrument markings for the ECS pressure and rate-of-flow indicator (MDC-13) are shown in figure 5-7. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

Indicator Scale	Measurement Number	Indicator Accuracy
GLY EVAP STEAM PRESS	CF 0034 P	±5% of full scale between 0° and 150°F
PRESS GLY DISCH	CF 0016 P	Same as above.
FLOW O ₂	CF 0035 R	Same as above.
ΔP SUIT COMPR	CF 0115 P	Same as above.

5.1.4.2 ECS Quantity and Outlet Temperature Indicators.

Instrument markings for the ECS quantity and outlet temperature indicators (MDC 13 and 14) are shown in figure 5-8. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

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

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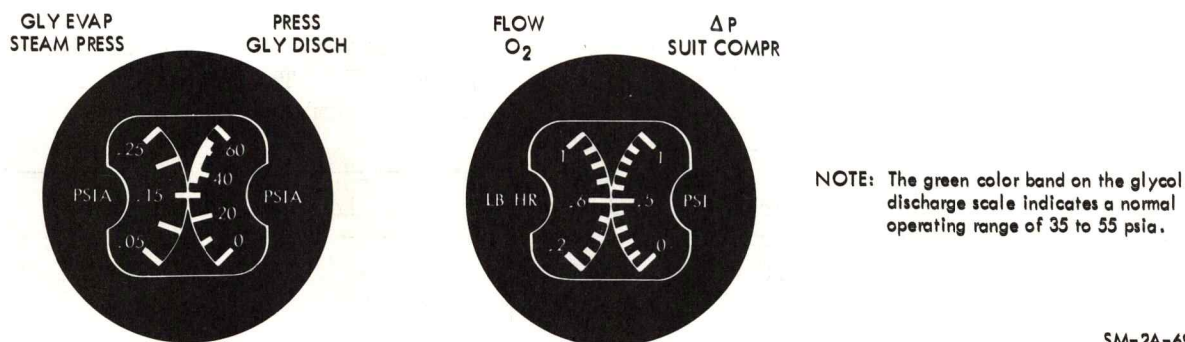


Figure 5-7. ECS Pressure and Flow Indicators

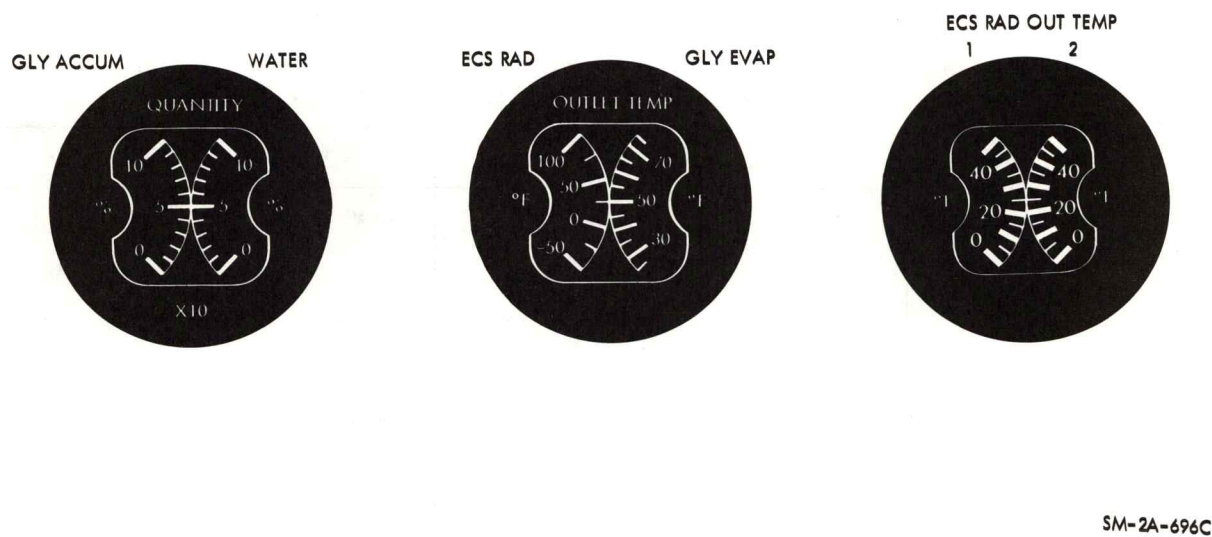


Figure 5-8. ECS Quantity and Outlet Temperature Indicators

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5.1.4.3 ECS Suit and Cabin Temperature/Pressure Indicators.

Instrument markings for the ECS suit and cabin temperature/pressure indicators are shown in figure 5-9. The accuracy for each indicator scale and the measurement number of the associated signal is as follows:

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

5.1.5 TELECOMMUNICATION SYSTEM METERS.

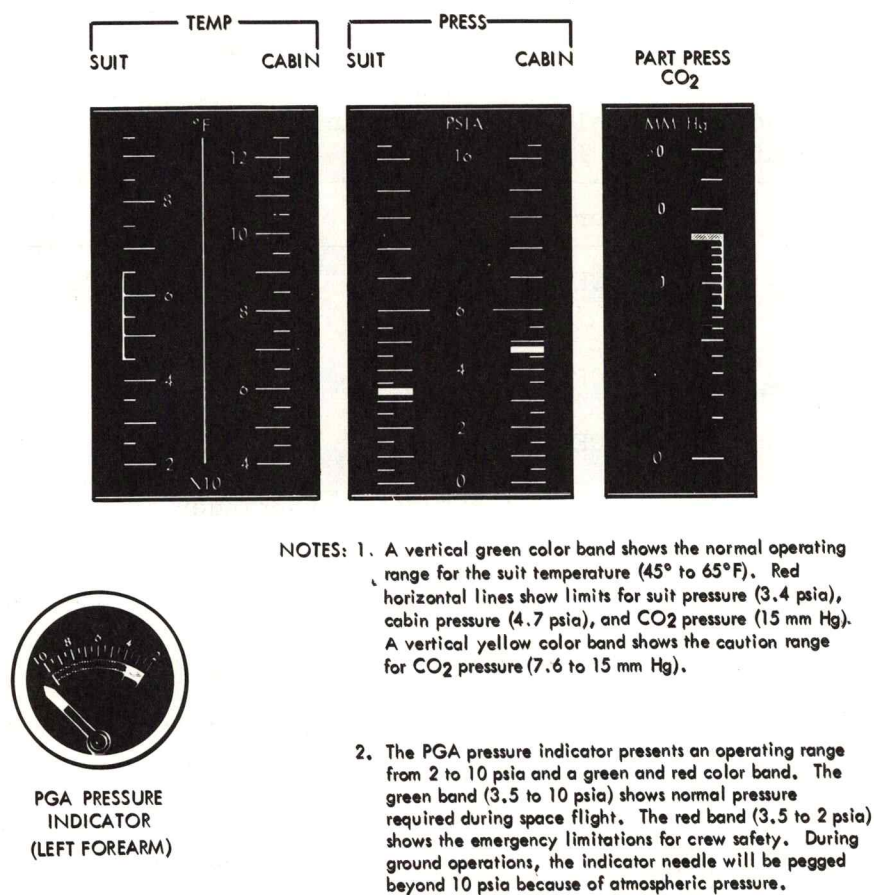
Instrument markings for the telecommunication system meters are shown in figure 5-10.

5.1.5.1 Auxiliary DC VOLTS Meter.

The auxiliary DC VOLTS meter, located on RHFEB-200 (figure 5-10), is used to monitor selected measurements for which there is either no other crew display or the crew display is an event indicator capable of displaying only in-tolerance and out-of-tolerance conditions. The voltmeter is used in conjunction with the adjacent FUNCTION SELECT and TEST SELECT

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Figure 5-9. ECS Suit and Cabin Temperature/Pressure Indicators



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Figure 5-10. Telecommunication System Meters

CREW DISPLAY INSTRUMENT MARKINGS AND ACCURACY DATA

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

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

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

5.1.5.2 S-Band ANT Meter.

The S-Band ANT meter, on MDC-19 (figure 5-10), utilizes the automatic gain control (AGC) signal in the S-Band receiver to display, in a clockwise direction, the relative magnitude of signals received by the unified S-band equipment (USBE). The meter is used in determining the correct S-band antenna and S/C attitude for optimum S-band performance.

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

5.1.6 SEQUENTIAL SYSTEMS INDICATORS.

Instrument markings for the sequential systems indicators are shown in figure 5-11. The indicators present visual displays required during launch, in-flight SPS operation, and the earth landing sequence of events. (Refer to paragraphs 5.1.6.1 and 5.1.6.2.)

5.1.6.1 Barometric Pressure Indicator (Altimeter).

The barometric pressure indicator, an altimeter on MDC-1 (figure 5-11), is used in conjunction with the earth landing system (ELS) and indicates the pressure altitude of the S/C under low-altitude, low-Mach conditions. This altimeter is monitored during the earth landing phase of the mission to verify that the ELS sequencer is initiating various phases of landing system deployment at the proper pressure altitude points. A knob, located left of the altimeter dial face, is used in setting the adjacent marker (to display the corrected main parachute deploy altitude for low-altitude aborts). The adjustable marker, based

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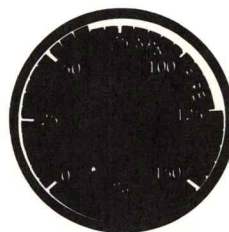
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Barometric Pressure Indicator
(Altimeter)

NOTE:

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



L/V AOA/SPS P_c Indicator

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Figure 5-11. Sequential System Indicators

on barometric pressure, is set prior to launch. (Refer to paragraph 5.4.2.2 for altimeter error and C/B base pressure effects.)

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

5.1.6.1 L/V AOA/SPS P_c Indicator.

The L/V AOA/SPS P_c indicator, on MDC-3 (figure 5-11), is used to display the launch vehicle angle of attack (in percentage of pressure from the Q-ball) during launch. After launch vehicle separation from the S/C, the gauge is used to display SPS combustion chamber pressure during engine operation. Inputs to this time-shared gauge are determined by the position of the L/V AOA/SPS P_c switch, located on the same panel.

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

5.1.7 MISCELLANEOUS INDICATORS.

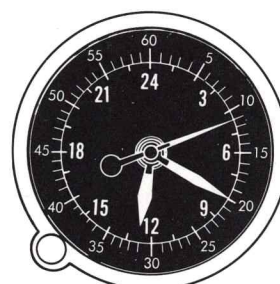
Instrument markings for mechanically operated indicators such as clocks, timers, and an accelerometer are shown in figure 5-12 and described in paragraphs 5.1.7.1 through 5.1.7.4.

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

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400-Hour Clock



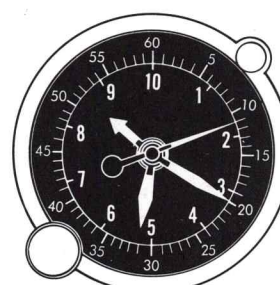
GMT Clock



Accelerometer Indicator (G-Meter)



To: EVENT Timer



From: EVENT Timer

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Figure 5-12. Miscellaneous Indicators

5.1.7.1 Mission-Elapsed Time (400-Hour) Clock.

The 400-hour clock, on MDC-12 (figure 5-12), has a 10-hour dial face with second, minute, and hour hands. A display window is also provided to show mission elapsed time in 10-hour increments up to 400 hours (when window display returns to 0.000). The hour and minute hands are set by a knob at the bottom left of the dial face. A knob at the top right of the dial is used to reset, start, and stop the clock. This clock is illuminated when the floodlights switch on MDC-27 is actuated.

5.1.7.2 GMT (Greenwich Mean Time) Clock.

The GMT clock, LHFEB-306 (figure 5-12), has a 24-hour dial face with standard second, minute, and hour hands. A time-set screw, at the bottom left of the dial face, is used to

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synchronize the clock with Greenwich mean time. This clock illuminates when the CLOCKS-BRT-OFF-DIM switch (LEB-98) is actuated.

5.1.7.3 TO EVENT and FROM EVENT Timers.

The TO EVENT and FROM EVENT timers, on LHFEB-306 (figure 5-12), have 10-hour dial faces with second, minute, hour, and 10-hour hands. A knob at the bottom left of each timer is used to set the timer hands. Each timer can be reset, started, or stopped by a pushbutton control at the top right of the timer. These timers illuminate when the CLOCKS-BRT-OFF-DIM switch (LEB-100) is actuated.

5.1.7.4 Accelerometer Indicator (G-Meter).

The accelerometer indicator or g meter, on MDC-2 (figure 5-12), is provided with an indicating pointer for showing S/C positive and negative g loads. In addition to the indicating pointer, there are two recording pointers (one for positive and one for negative g loads) which follow the indicating pointer to its maximum attained travel. The recording pointers will remain at the maximum positive and negative positions attained to provide a record of maximum g loads encountered. To return the recording pointers to the normal 1-g position, it is necessary to press the RESET knob on the lower left-side of the accelerometer.

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

5.2 CONSUMABLE REQUIREMENTS.

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

5.2.1 S/M RCS PROPELLANT CONSUMPTION DATA.

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

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the individual S/M RCS consumables (maximum usable tank capacity of 790 pounds) are as follows:

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

5.2.1.1 Manual Attitude Control Maneuvers

S/M RCS propellant consumption rates for manual attitude control maneuvers (proportional and direct control) are presented in figure 5-13. Assumptions applicable to the curves shown in figure 5-13 are as follows:

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

The manual single-axis maneuver propellant consumption is the same as the single-axis maneuver in paragraph 5.2.1.2.

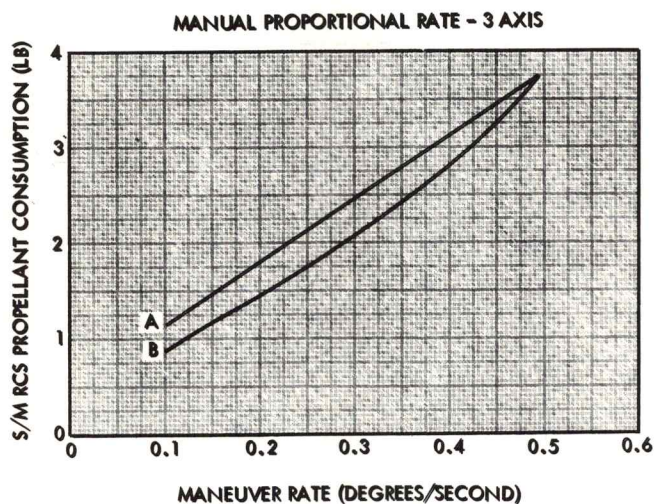
5.2.1.2 Automatic Attitude Control Maneuvers and Attitude Hold.

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

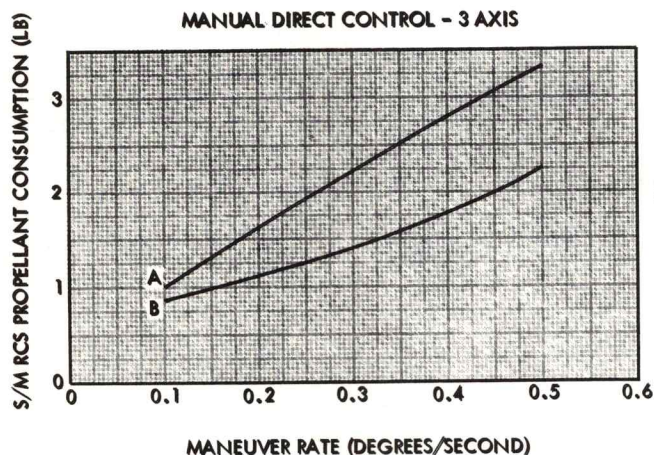
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CURVE	WEIGHT (LB)	INERTIA (SLUG-FEET SQUARED)		
		I _{XX}	I _{YY}	I _{ZZ}
A	29,500	15,800	53,500	54,000
B	22,300	12,600	40,000	38,700



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

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Figure 5-13. S/M RCS Propellant Consumption During Manual Attitude Control Maneuvers

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weight, are presented in figure 5-14. The same assumptions in paragraph 5.2.1.1 also apply to figure 5-14, in addition to the following:

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

The S/M RCS propellant consumption rates for the attitude thermal (barbecue) control mode versus S/C weight are presented in figure 5-15. Applicable additional assumptions are as follows:

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

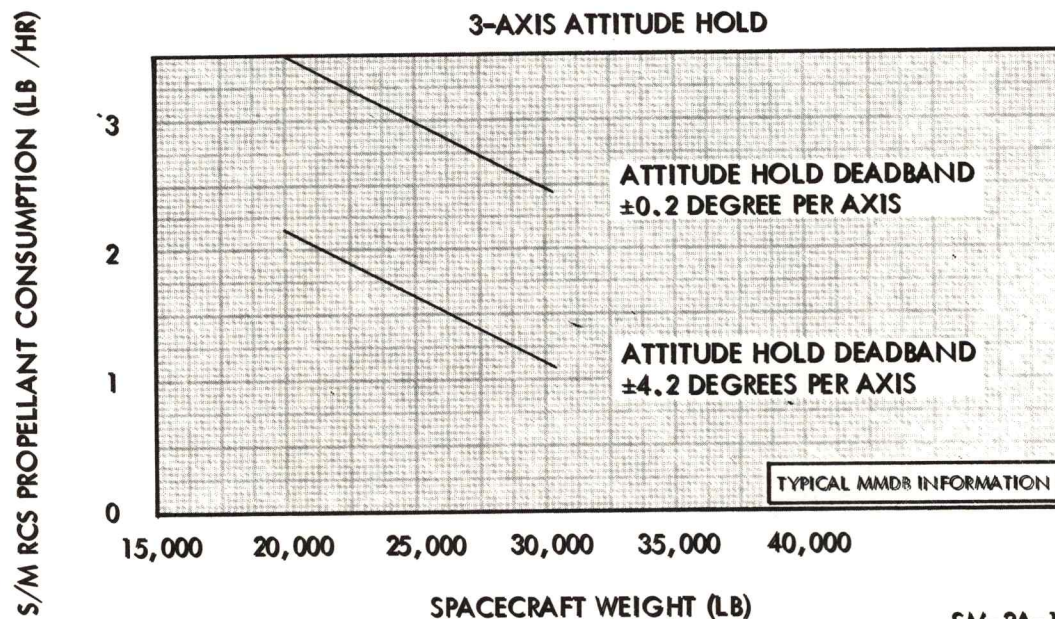
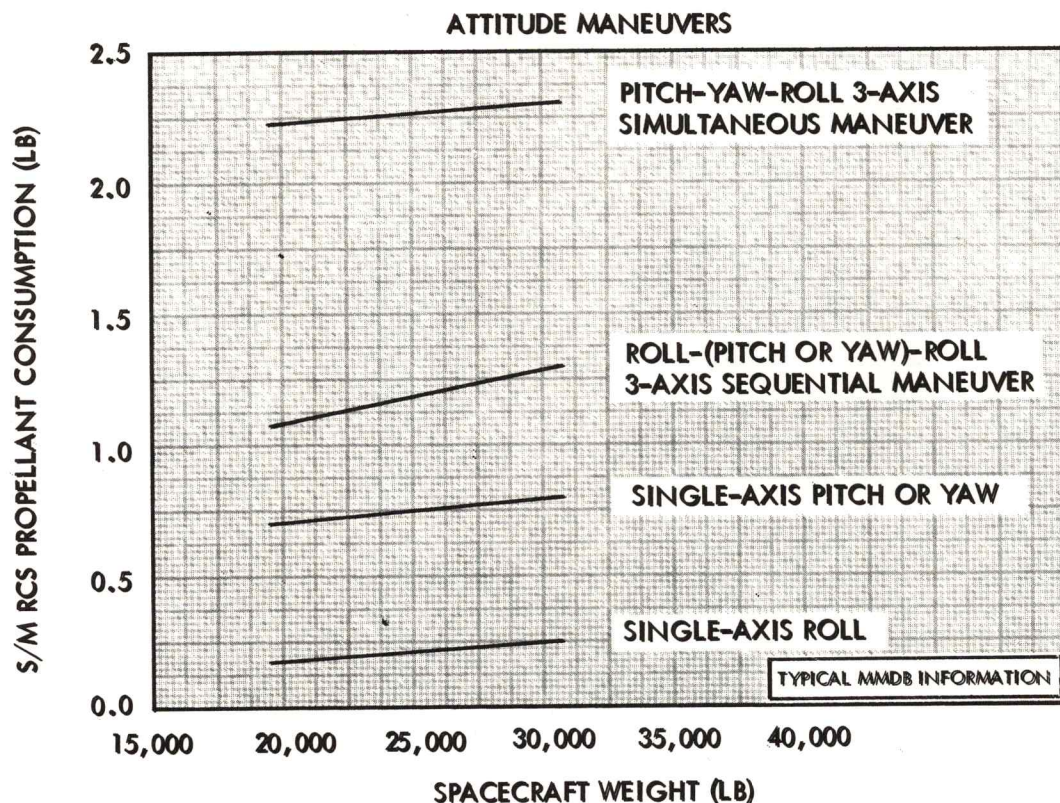
The S/M RCS propellant consumption required to damp free drift rates (caused by dynamic disturbances) versus time in free drift are presented in figure 5-16.

5.2.1.3 Translation Maneuvers.

S/M RCS propellant consumption required for settling SPS propellants versus S/C weight, for three configurations of RCS engine utilization, is presented in the upper chart of figure 5-17. The lower chart shows propellant required for RCS +X axis delta velocity maneuvers. Assumptions applicable to both charts in figure 5-17 are as follows:

- The RCS engine thrust equals 100 pounds.
- I_{sp} at attitude correction equals 185 seconds.
- I_{sp} at translation equals 278 seconds.
- Dynamic disturbances (stated in paragraph 5.2.1.1) are neglected.
- Roll control propellant requirements are neglected.

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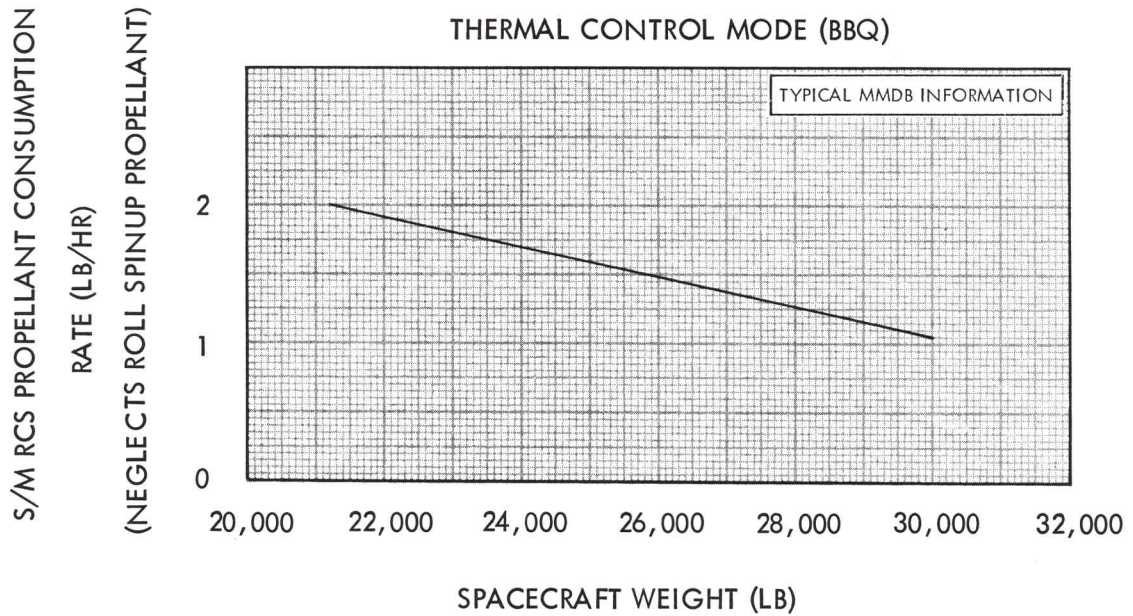


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Figure 5-14. S/M RCS Propellant Consumption During Attitude Control Maneuvers and Attitude Hold

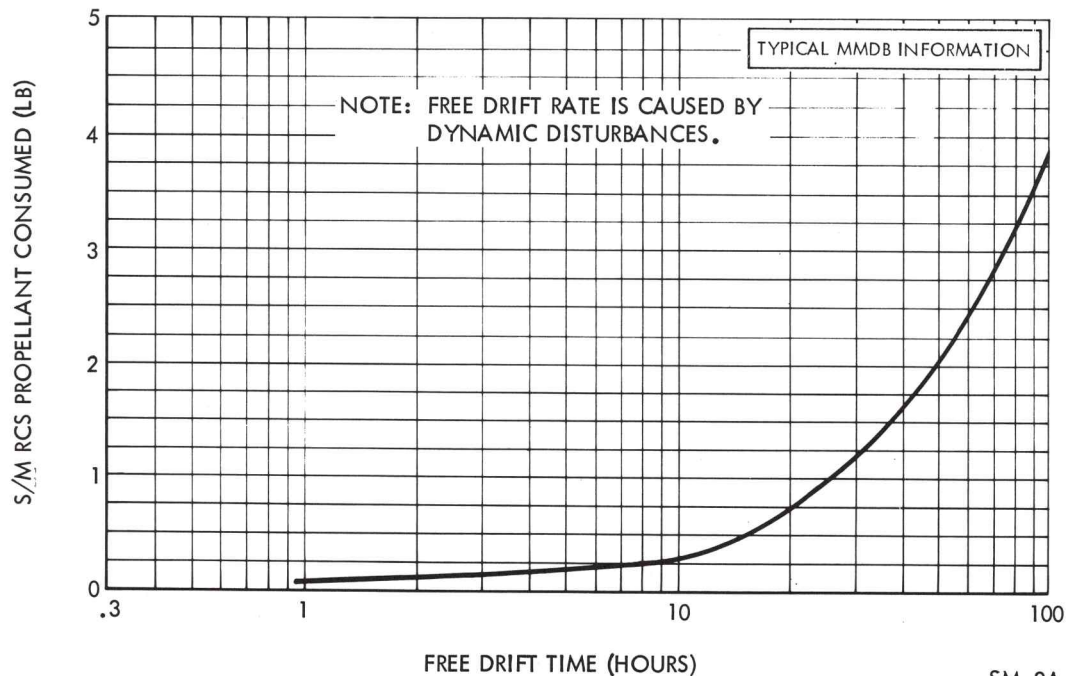
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Figure 5-15. S/M RCS Propellant Consumption for Thermal Control Modes



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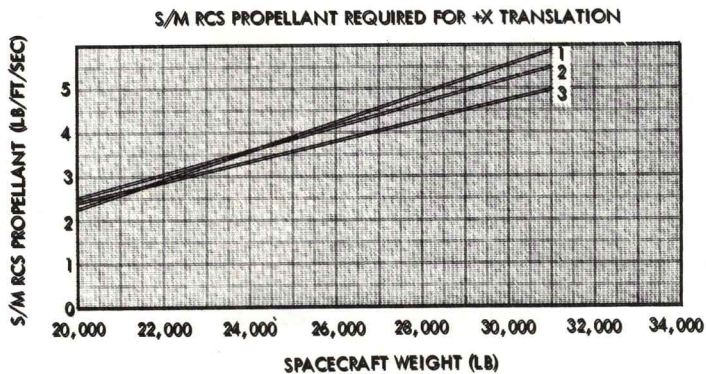
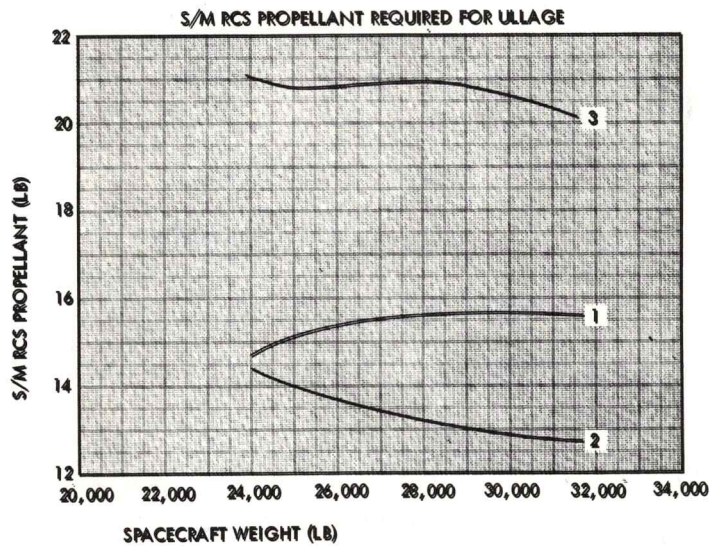
Figure 5-16. S/M RCS Propellant Consumption for Damping Out Free Drift Rate

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



NOTE:

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

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Figure 5-17. S/M RCS Propellant Consumption for SPS Propellant Settling and Translation Maneuvers

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5.2.1.4 Attitude Hold Following SPS Burn.

S/M RCS propellant consumption required for attitude hold in three axes, immediately following an SPS burn and extending over a 10-minute period after the SPS burn, is presented in the upper chart of figure 5-18. (This curve includes the total RCS requirement and should not be added to the results obtained from figure 5-14. However, after the end of the 10-minute slosh damping period, the rates in the lower chart of figure 5-14 should be used.) For attitude holds delayed after the termination of an SPS burn, both charts in figure 5-18 are used for adjusting RCS propellant consumption rates.

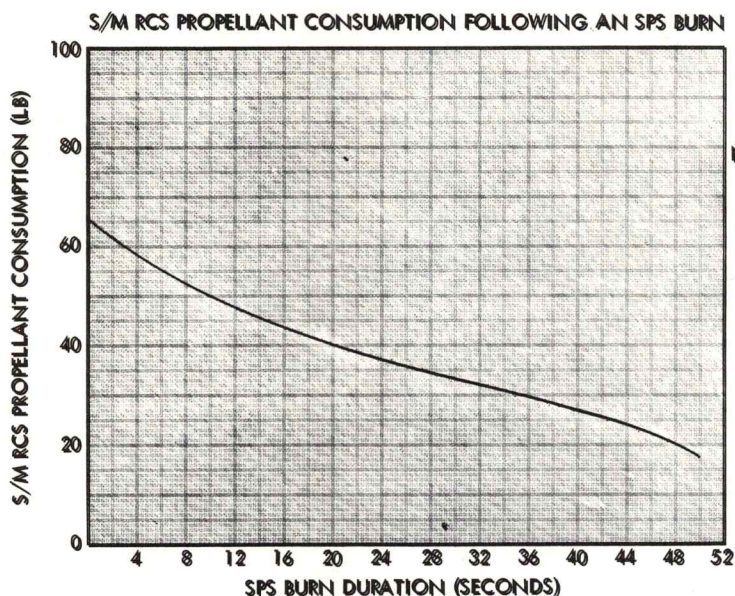
5.2.2 C/M RCS PROPELLANT CONSUMPTION DATA.

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

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

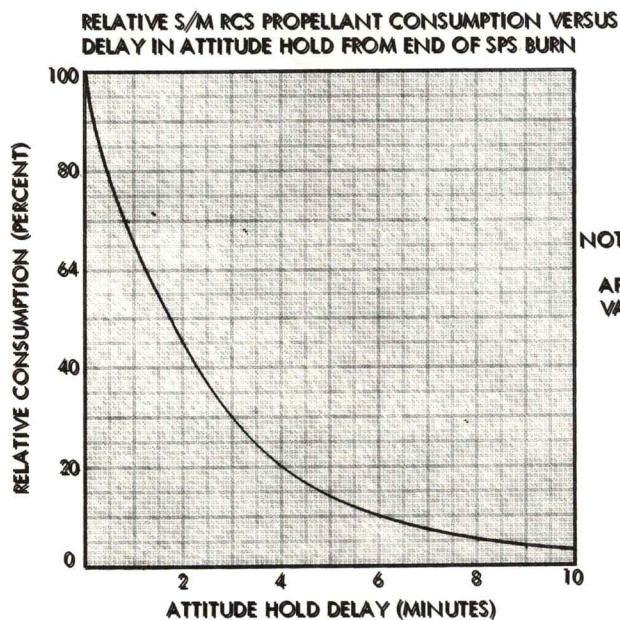
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NOTES:

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



NOTE:

APPLY PERCENT TO PROPELLANT VALUE FROM CURVE ABOVE

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Figure 5-18. S/M RCS Attitude Hold Propellant Consumption Following SPS Burn

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

5.2.3 SPS PROPELLANT CONSUMPTION DATA.

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

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

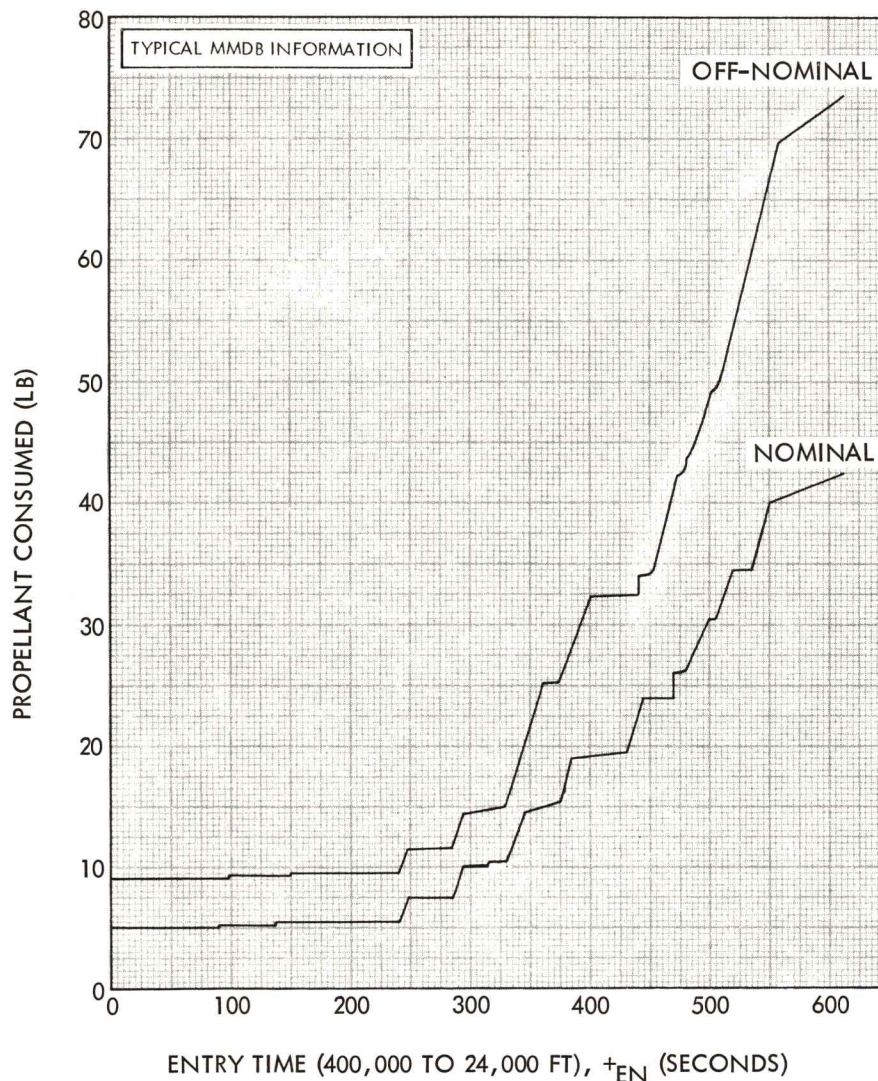
NOTE Storage tanks for the SPS fuel and oxidizer also include a sump tank. S/C 014 will not be scheduled to carry the possible total propellant load of about 45,900 pounds.

Spacecraft weight is plotted against characteristic velocity for nominal and minimum values of specific impulse. (See figure 5-20) A sample path traces a typical solution for propellant weight when initial weight, specific impulse, and characteristic velocity change are given. Arrows on the chart, starting with an initial value for weight (W_1) indicate the direction of flow for the sample problem. It is important to note that the characteristic velocity (V_c) scale does not represent values of ΔV remaining aboard the S/C, but is intended to serve as a reference only on which increments (ΔV_c) may be taken as shown in the sample.

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

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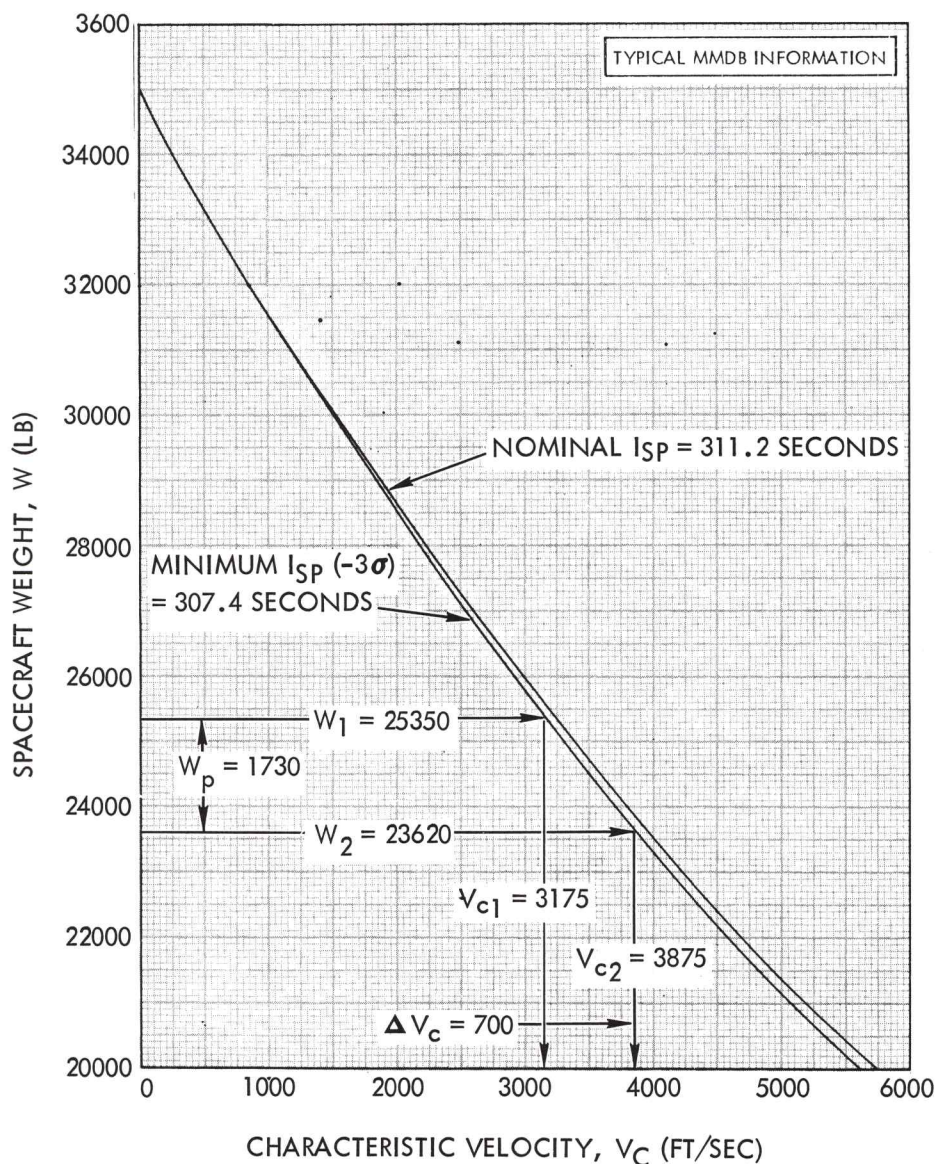
	NOMINAL	OFF-NOMINAL
V_g	24,216 FPS	24, 216 FPS
γ_g	-1.65 DEG	-1.65 DEG
α	156 DEG	156 DEG
β	0 DEG	0 DEG
ϕ_{EN}	0 DEG	0 DEG
C_{Lo}	-0.0004 DEG	-0.00006
GUST	NONE	HALF SINE WAVE
σ	52.7 DEG	52.7 DEG
RANGE	1547 NM	1547 NM

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Figure 5-19. C/M RCS Propellant Consumption
Time Histories - Single System

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GIVEN: INITIAL SPACECRAFT WEIGHT, W_1
SPECIFIC IMPULSE, I_{sp}
CHARACTERISTIC VELOCITY
CHANGE, ΔV_c
 $g = 32.174 \text{ FT/SEC}^2$

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

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Figure 5-20. SPS Propellant Consumption

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

5.2.4 EPS AND ECS CONSUMPTION DATA.

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

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

NOTE Both the EPS and ECS utilize oxygen from the same cryogenic storage system (489 pounds of usable O₂ for the EPS and 151 pounds for the ECS).

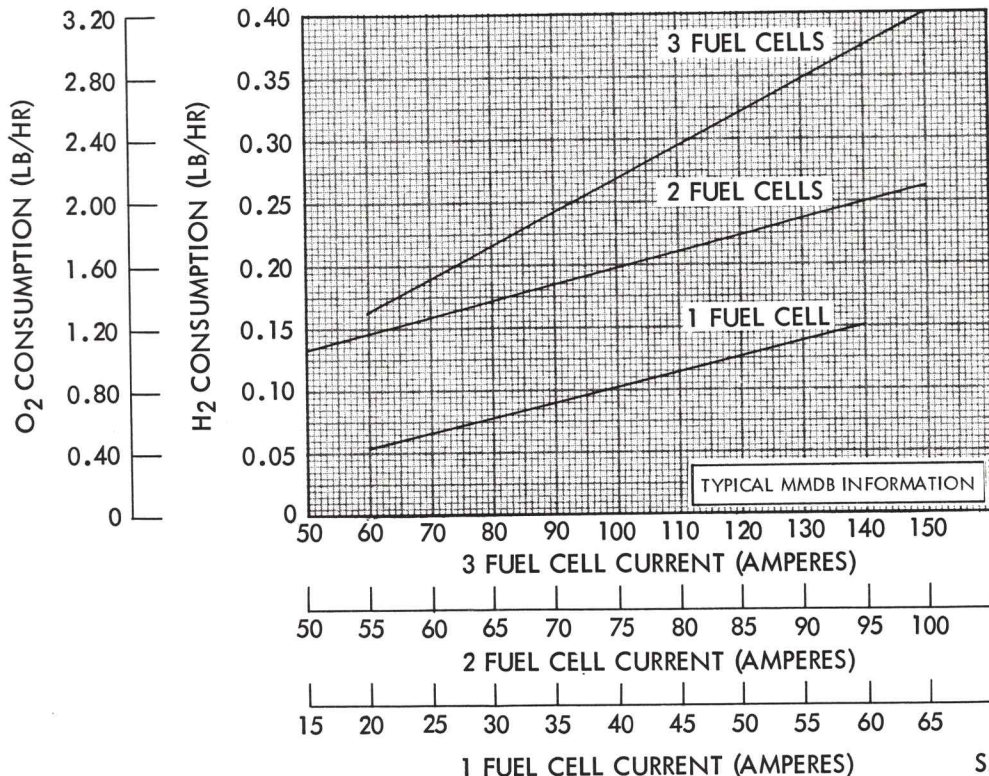
5.2.4.1 EPS Fuel Cell Reactants Consumption.

The O₂ and H₂ consumption versus electrical output for one, two, or three fuel cell power plants is shown in figure 5-21. Only the H₂ curve is given. (The O₂ consumption rate is eight times the H₂ rate.) Water generated by the fuel cells may be calculated by multiplying the H₂ consumption rate by nine.

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NOTE:
WATER GENERATION RATE IS
OBTAINED BY MULTIPLYING H₂
CONSUMPTION RATE BY NINE



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Figure 5-21. Cryogenic Consumption Versus Fuel Cell Current

In order to maintain fuel cell operating efficiency, purging of each power plant is accomplished every 7 hours. The purges will normally be staggered so that a H₂ purge will follow an O₂ purge by 3.5 hours. The present purging cycle of 7 hours is based upon the maximum normal power output of 1420 watts per fuel cell. The time between purges is based upon the ratio of the present maximum of 1420 watts/fuel cell power plant to the actual maximum gross power demand times 7 hours. Thus, if the actual maximum gross power demand is 710 watts/fuel cell module, the nominal purge interval of 7 hours would be increased by 1420/710 or 2. Multiplying 2 times 7 would then provide a purge interval of 14 hours. During purging, the power plant continues to consume reactants in the quantities required to produce the power demanded by S/C electrical loads. The duration of each H₂ purge is 80 seconds and 120 seconds for each O₂ purge.

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5.2.4.2 EPS Electrical Power Output.

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

NOTE The EPS requires a minimum steady-rate power level of 1689 watts with three fuel cells operating or 1550 watts with two fuel cells operating during orbit. However, a minimum transient power level of 1500 watts for three fuel cells can be reached without causing an overvoltage in the EPS.

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

5.2.4.3 ECS Oxygen and Water Consumption.

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

Consumables	Source	Usable Weight (lb)	Remarks
Oxygen (O ₂)	<p>Cryogenic storage system tanks (2).</p> <p>NOTE The cryogenic storage system supplies O₂ to both the ECS and EPS (151 pounds for the ECS and 489 pounds for the EPS).</p>	151.0	<p>The basic purpose of the ECS oxygen is for crew metabolic consumption and control of the C/M pressure as follows:</p> <p>a. Metabolic - three men at 0.075 lb/hr/man or 0.225 lb/hr total</p> <p>b. C/M leakage - 0.2 lb/hr</p>

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

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

- The ECS radiator inlet temperature is affected by heat transfer from EPS components. As the components become warmer from increased electrical loads, a greater rate of heat transfer will take place. ECS radiator freezing may result if both radiators are exposed to deep space for more than 1 hour and the inlet temperature is below 75°F

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with an electrical current level of about 55 amps. By rolling or tumbling the S/C, to allow for periodic exposure of the radiators to the sun, the inlet temperature can be 70°F with an electrical current level of about 50 amps before the space radiators start to freeze.

5.3 RCS AND SPS THRUSTING DATA.

5.3.1 RCS TRANSLATION CONTROL.

RCS translational acceleration data versus spacecraft weight will be provided when available.

NOTE When the C/M has separated from the S/M, the C/M does not have an RCS translational capability.

5.3.2 RCS ROTATION CONTROL.

RCS rotational acceleration data versus spacecraft weight and control modes will be provided when available.

5.3.3 SPS ENGINE THRUST PERFORMANCE.

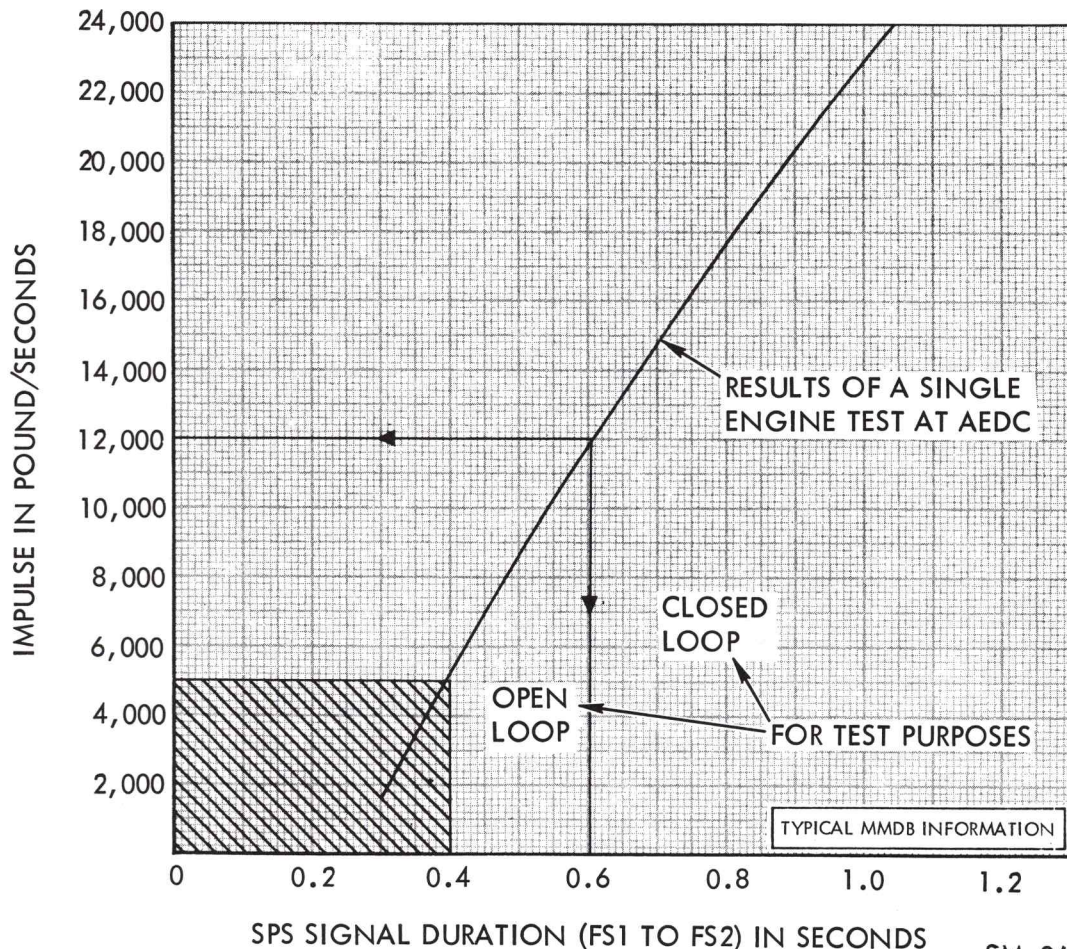
5.3.3.1 SPS Small-Impulse Operation.

The SPS engine is capable of accepting a shutdown signal at any time after receipt of a start signal. A nominal minimum impulse bit of 12,000 pound-seconds is developed when the engine is fired for an open-loop operation period of 0.6 seconds. (See figure 5-22.) The run-to-run minimum impulse-bit tolerance is ± 300 pound-seconds (1 sigma). Impulse value as a function of start-to-shutdown signal duration (FS1 to FS2), is estimated from qualification tests generated at AEDC (Arnold Engineering Development Center). (Propellant consumption for small impulse firings including the 14.4-pound propellant loss for each SPS engine start is covered by the equation $W_p = (\text{Impulse} + 4500)/I_{sp}$.)

5.3.3.2 SPS Engine Start and Shutdown Transients.

The SPS engine start and shutdown transients are presented in figure 5-23. Curves show the percentage of rated thrust as a function of elapsed time from start (FS1) and shutdown (FS2) command signals. Rated thrust is based on nominal inlet condition. All data estimates are from AEDC qualification tests. The start transient total impulse from FS1 to 90-percent rated thrust is limited to the range from 100 pound-seconds (minimum) to 400 pound-seconds (maximum). The run-to-run tolerance on start transient impulse is ± 100 pound-seconds (1 sigma). The shutdown

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Figure 5-22. SPS Small Impulse Firings for Open-Loop Operations

impulse from FS2 to 10-percent rated thrust is limited to a range from 8000 pound-seconds (minimum) to 12,000 pound-seconds (maximum). The run-to-run tolerance on the shutdown impulse is ± 300 pound-seconds (1 sigma).

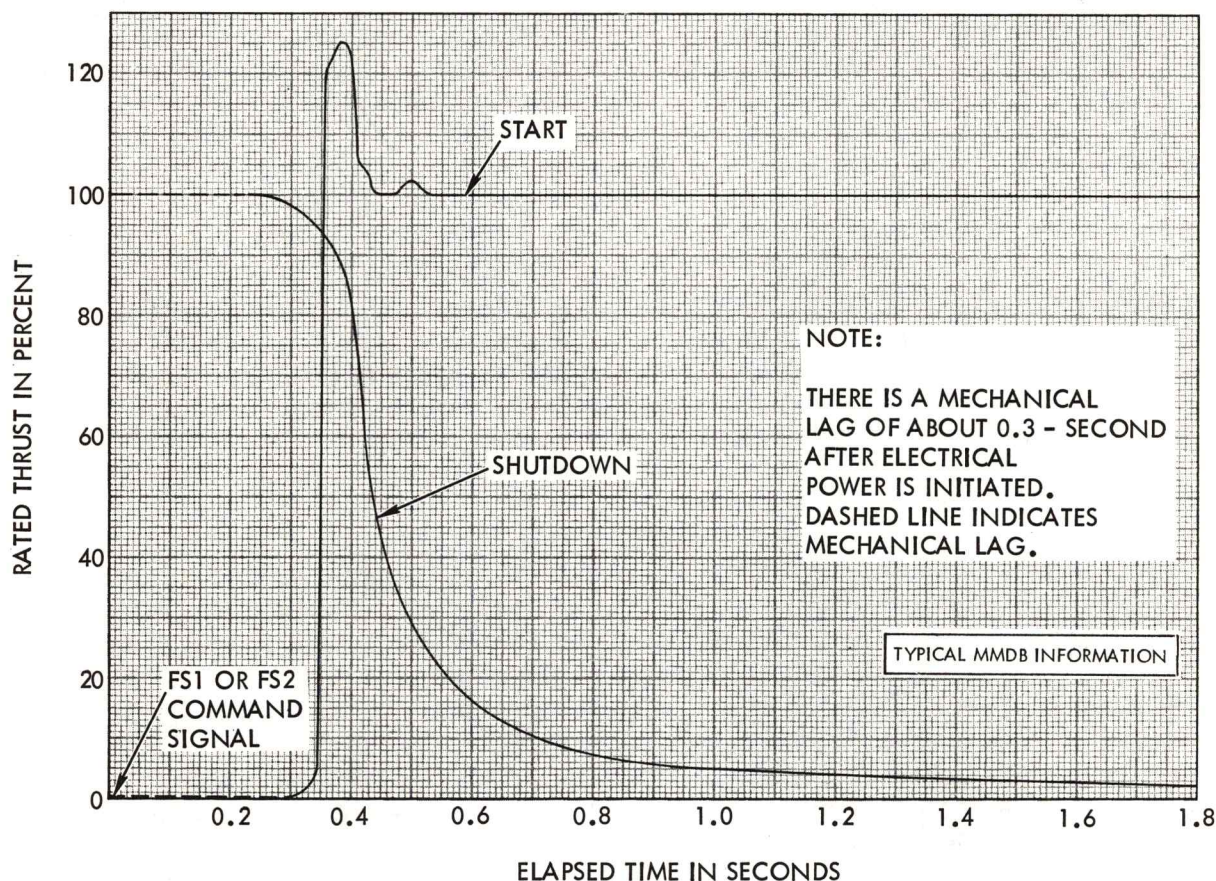
5.3.3.3 SPS Delta V Capability.

The SPS delta V capability remaining versus SPS propellant remaining is presented in figure 5-24. Additional performance data will be provided at a later date.

5.3.3.4 SPS Engine Gimbal Angle Determinations.

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

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Figure 5-23. SPS Engine Start and Shutdown Transients

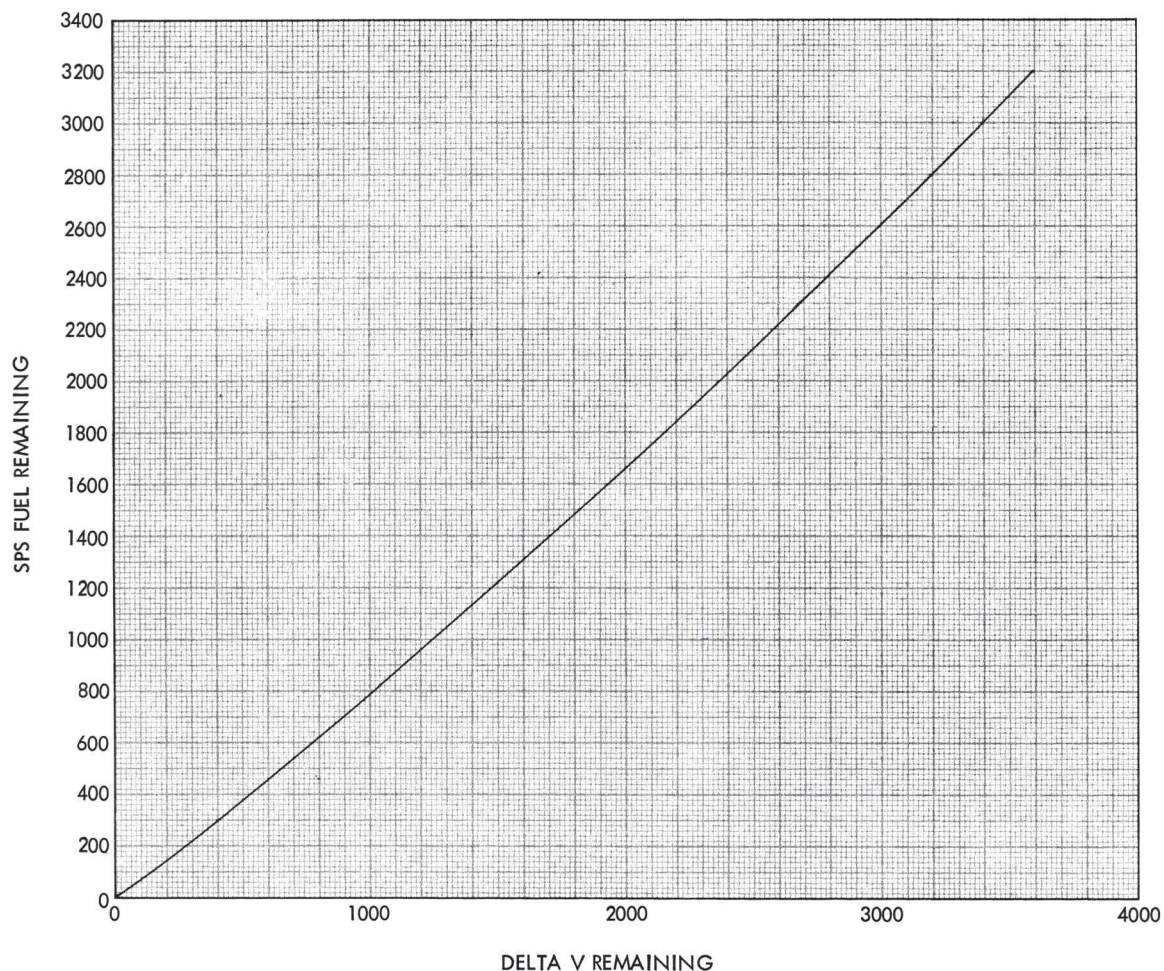
flight by the amount of SPS fuel remaining aboard the spacecraft. (See figure 5-25.) The ground controller will determine SPS engine gimbal angles if propellant leaks and/or other than nominal oxidizer to fuel ratios occur.

5.4 S/C OPERATIONAL CONSTRAINTS AND LIMITATIONS.

5.4.1 OPERATIONAL CONSTRAINTS.

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

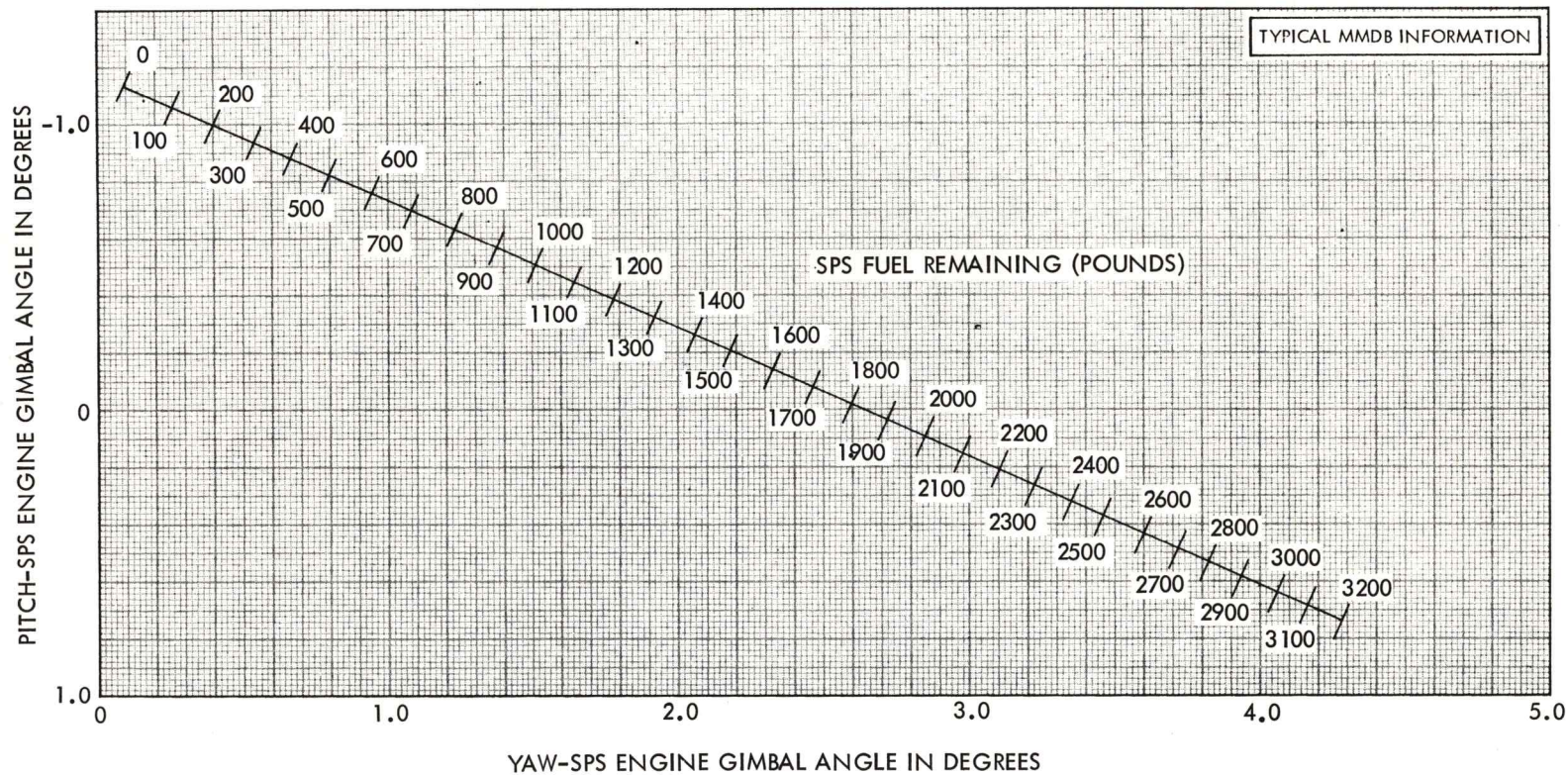
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Figure 5-24. SPS Delta V Remaining Versus
Propellant Remaining

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Figure 5-25. SPS Engine Gimbal Angle Settings

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5.4.1.1 ECS Radiator Inlet Temperature.

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

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

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

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

5.4.1.2 S/M RCS Engine Temperatures.

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

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

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5.4.1.3 SPS Propellant Feedline Temperatures.

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

5.4.1.4 Heat Shield Temperature.

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

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

5.4.2 OPERATIONAL LIMITATIONS.

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

5.4.2.1 Acoustic and Vibration Effects.

The crew will be exposed to acoustic and vibration effects during ascent (130 seconds), possible LES aborts (10 seconds), and entry (100 seconds). Vibration effects will also be experienced during high-altitude aborts (SPS induced) and spaceflight SPS firings. (See figures 5-26 and 5-27.)

5.4.2.2 Altimeter Error and C/M Base Pressure Effects.

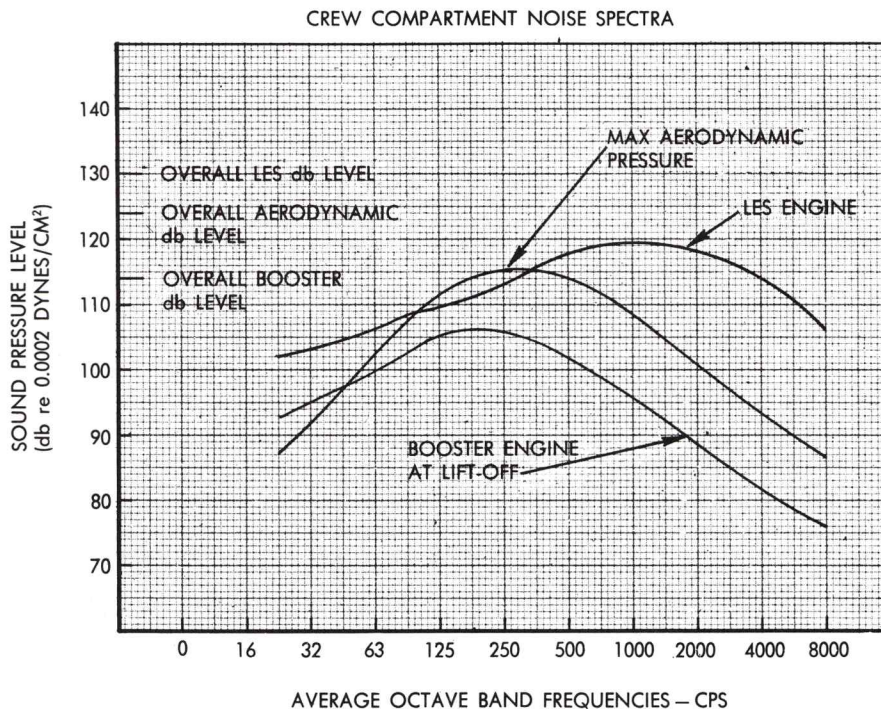
The altimeter (barometric pressure indicator) error resulting from velocity pressures on the command module (below 14,000 feet) is shown in figure 5-28.

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

Charts showing the C/M lift/drag profile and time histories for normal entries are shown in figures 5-29 through 5-31.

S/C OPERATIONAL CONSTRAINTS AND LIMITATIONS

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55 db = Sound pressure level (SPL) under average office conditions.
79 db = Maximum SPL inside S/C during space flight with all equipment operating.

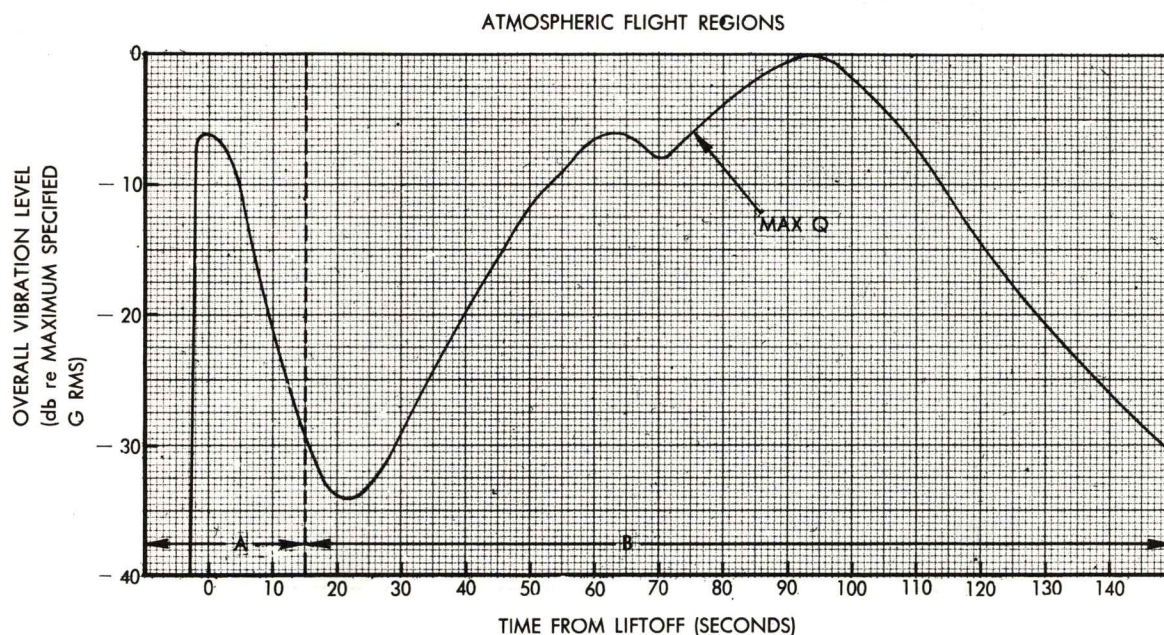
NOTES: 1. During space flight, C/M inside noise level is mainly due to equipment operation. SPS and RCS engine firings have little effect on the internal noise level.
2. Each astronaut can reduce the crew compartment noise level about 15 db by utilizing his space suit and closing the helmet visor.

120 db = SPL where discomfort is experienced.
140 db = SPL where pain is encountered.
160 db = SPL where the human ear drum can be ruptured.
200 db = SPL equivalent to a 50-pound TNT blast at 10 feet.

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Figure 5-26. C/M Crew Compartment Acoustics

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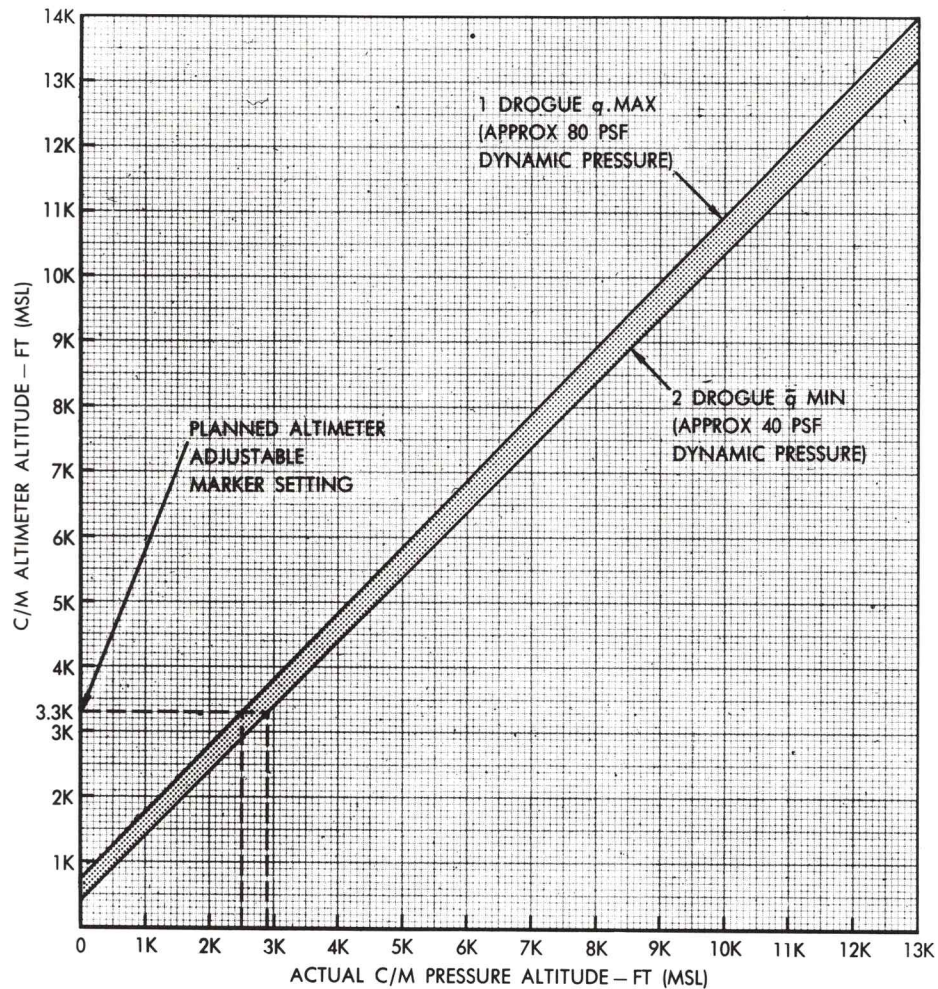


- NOTES: 1. Zero on the vertical scale indicates the maximum vibration experienced during flight. The vibration levels are based on boilerplate and spacecraft flight test measurements.
2. Letter "A" indicates vibration time induced by booster engine exhaust (influenced by the flame buckets) and noise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

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Figure 5-27. S/C Relative Vibration Intensity Time History

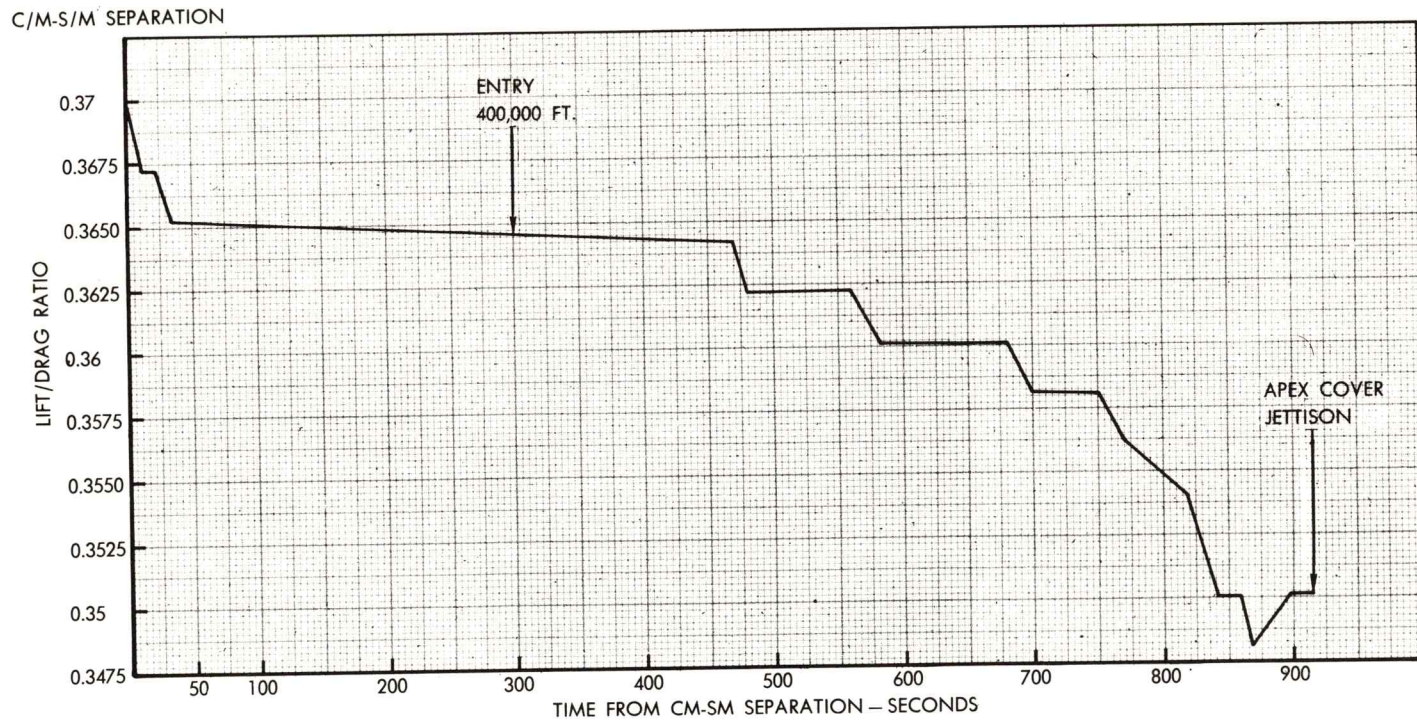
PERFORMANCE



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Figure 5-28. Altimeter Error and C/M Base Pressure Effects

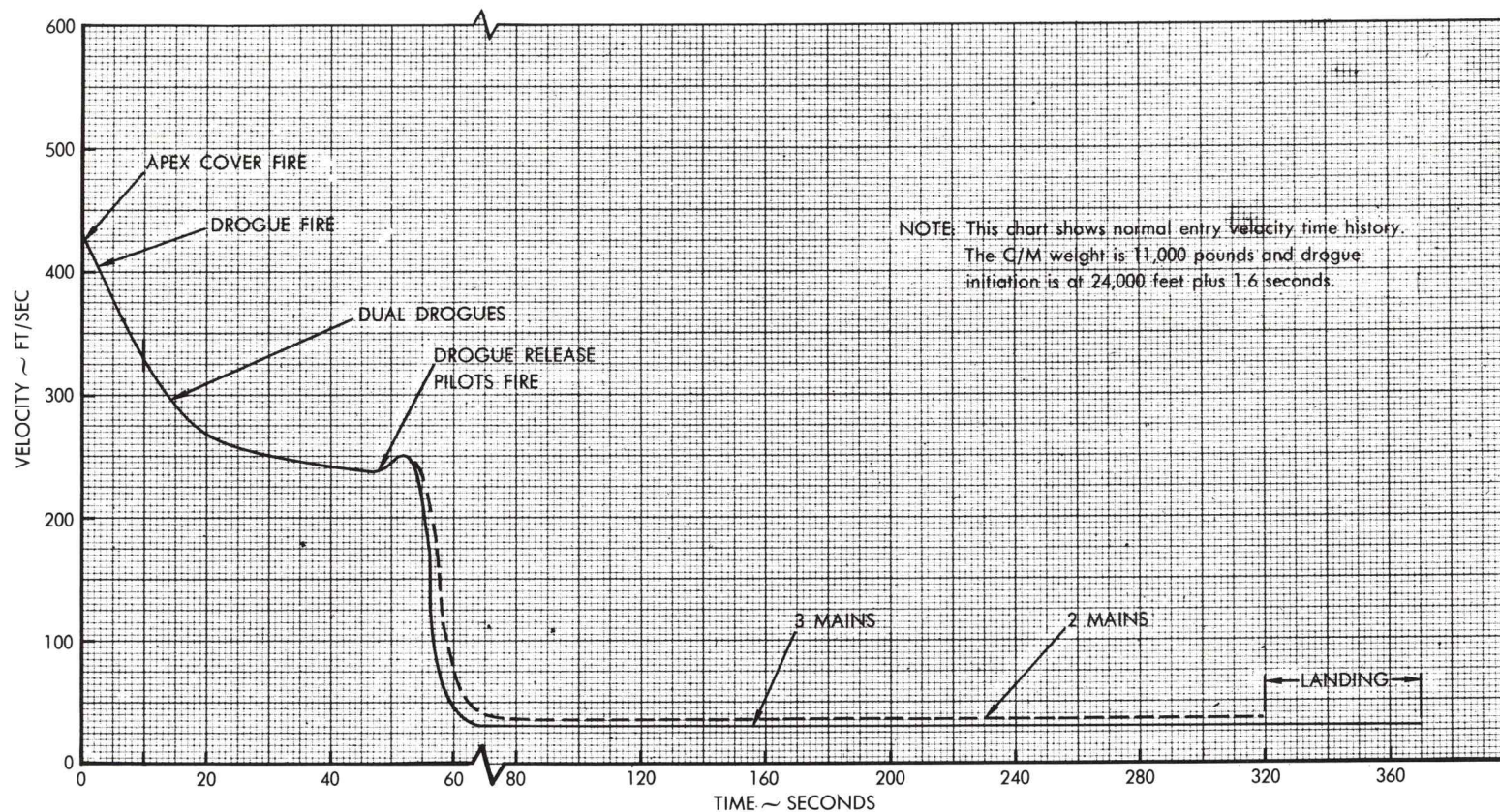
PERFORMANCE



SM-2A-931A

Figure 5-29. C/M Entry - Lift/Drag Profile

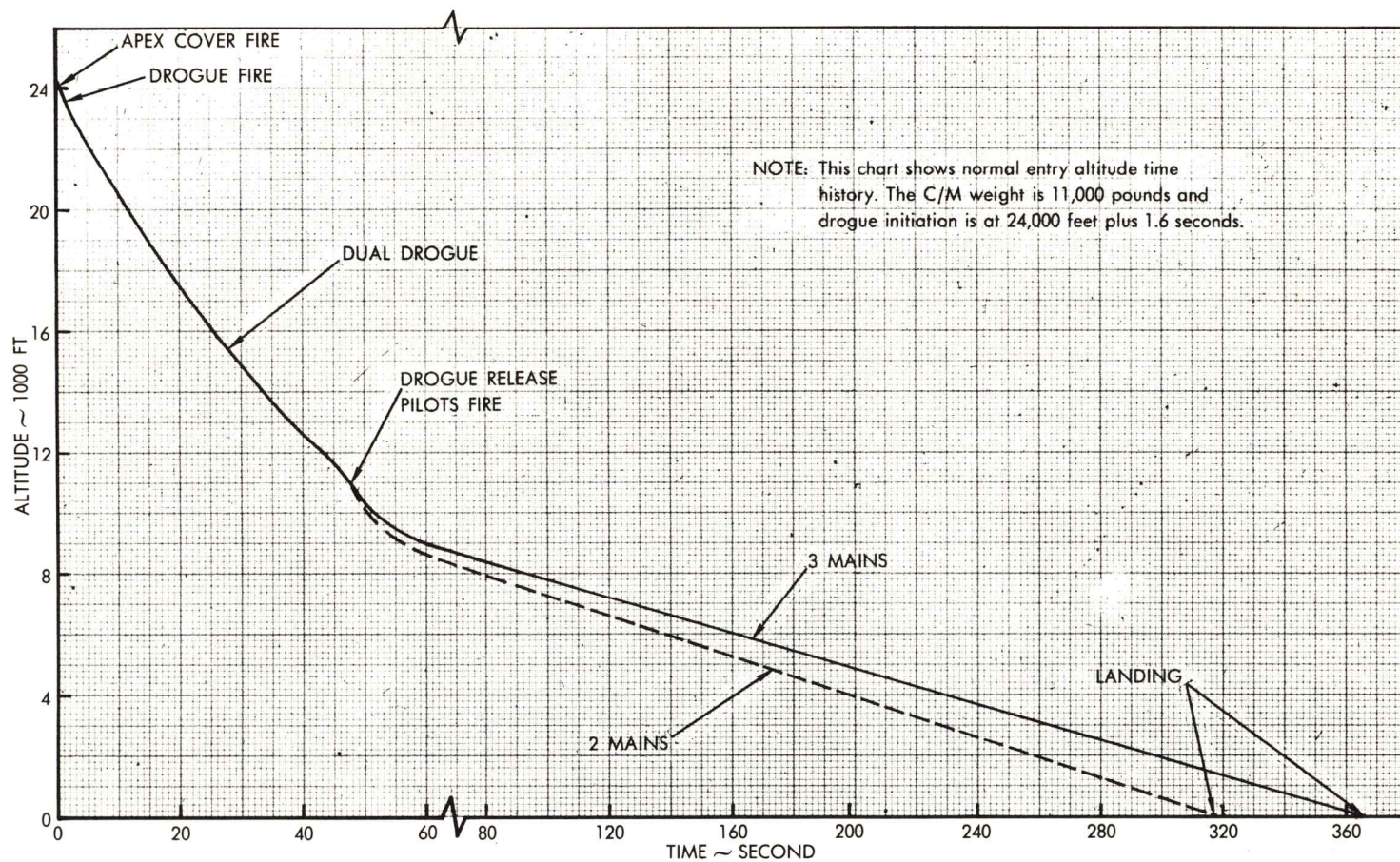
PERFORMANCE



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Figure 5-30. Normal Entry - Velocity Time History

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Figure 5-31. Normal Entry - Altitude Time History

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MAJFUNCTION PROCEDURES

ABORT PROCEDURES

EMERGENCY PROCEDURES

EXPERIMENTS PROCEDURES

SECTION 6

NORMAL/BACKUP PROCEDURES

INTRODUCTION.

Procedures in sections 6 through 9 are based on S/C 014 design information and the NASA reference trajectory, and have not been validated. Initial verification programs are in process and, as changes are generated, the procedures herein will be replaced.

This section comprises the normal and backup crew procedures required for the successful operation of the spacecraft. Procedures are presented for all phases of the mission.

All procedures are system-integrated and arranged in operational time sequence. The procedures performed during earth orbit are divided into two functional groups: systems management and guidance and control operations.

Systems management consists of those procedures involved in the activation and in-flight management of spacecraft systems including system monitoring, periodic checks, and unique functions.

Guidance and control (G&C) procedures are system-integrated, involving primarily the guidance and navigation, and stabilization and control functions and their operational interfaces. The G&C procedures facilitate the performance of G&N/SCS alignment, navigational sightings, and spacecraft attitude and thrust control.

The procedural steps are presented in tabular form in numerical sequence, organized by subgroupings into functions. The columns together with an explanation of the entries under each, are listed as follows:

<u>Step</u>	The step is the numerical indication of the elements to be followed and their sequence in performing a complete procedure.
<u>Procedure</u>	The procedure is a group of steps or an overall task involved in performing a complete function or operation.

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<u>Station</u>	The station is equivalent to the crewmember assigned to the spacecraft location where a procedure or step is performed. Stations C, S, and P correspond to the left, middle, and right crew couch positions, respectively. The S also pertains to the lower equipment bays inaccessible to the other crewmembers.
<u>Location</u>	The location is the spacecraft location of a particular control or display by panel number. The main display panels are numbered 1 through 26; the lower equipment bay, 100 through 150; the right-hand equipment bays, 200 through 208; and the left-hand equipment bays, 300 through 319.
<u>Remarks</u>	The remarks column contains detailed information pertaining to one or more steps of a procedure.

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STA/T	Step	PROCEDURES	Panel	REMARKS
	6.1	<u>BACKUP CREW PRELAUNCH CHECKS.</u> Prelaunch checks consist of the operational and configuration checks performed by the backup crew prior to launch. It is assumed that a complete prelaunch checkout, including loose gear stowage, has been performed by ground support personnel prior to backup flight crew ingress into the command module and that all systems are in an active configuration at the time of ingress.		
	6.1.1	<u>BACKUP CREW STATUS CHECKS.</u>		
C	1	Backup crew ingress procedures MESC-PYRO ARM (2) - SAFE (locked) Connect cobra cable	24	
	2	Audio panel/intercom check POWER - VOX S-BAND - RCV RCDR-HF - OFF VHF AM - T/R INTERCOM - T/R Cobra cable PTT/CW - PTT	13,23,26	
CSP P C CP	3	Voice recorder check RECOVERY-HF mode - AM RCDR-HF - T/R Speak and check VOICE RECORD TB - striped RCDR-HF - OFF, VOICE RECORD TB - gray	20	

BACKUP CREW PRELAUNCH CHECKS

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STA/T	Step	PROCEDURES	Panel	REMARKS
CSP	4	C&WS status check		
S		C/W - NORMAL	11	
		CAUT/WARN-MODE - CSM		
		CAUT/WARN-POWER - 2		CAUT/WARN FAIL status light will illuminate momentarily when power switch gives through the off position.
CSP		MASTER ALARM on - press	3,18	
S		CAUT/WARN-POWER - 1	11	
CSP		MASTER ALARM on - press	3,18	
P		C/W LAMP TEST - 1	23	
CP		MASTER ALARM lts (2) - on	3.18	
S		LH system status lts - on	10	
S		C/W - BOOST	11	
C		L/H MASTER ALARM lt - off	3	
S		C/W - NORMAL	11	
C		L/H MASTER ALARM lt - on	3	
P		C/W LAMP TEST - 2	23	
S		RH system status lts - on	11	
P		C/W LAMP TEST - OFF	23	
C	5	ECS status check		
		CABIN PRESSURE RELIEF (2) - BOOST ENTRY	307	
		(safety latch off)		
		GLYCOL TO RAD - OPEN		
		GLYCOL RESERVOIR-INLET - OPEN		
		GLYCOL RESERVOIR-BYPASS - CLOSE		
		GLYCOL RESERVOIR-OUTLET - OPEN		
		OXYGEN-ENTRY - ON		
		OXYGEN-S/M SUPPLY - ON		
		OXYGEN-SURGE TANK - ON		
		DIRECT O ₂ - CLOSE (CW)	24	
		SURGE TANK PRESSURE RELIEF - OPEN (CW)	308	
		PLVC - NORMAL	316	
		O ₂ DEMAND REG sel - 1&2	310	
		SUIT HT EXCH - GLY/EVAP		
		GLY EVAP WATER CONT BYPASS - OFF	317	

BACKUP CREW PRELAUNCH CHECKS

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STA/T	Step	PROCEDURES	Panel	REMARKS
P	6	<p>ECS status check</p> <p>O₂ PRESS IND - SURGE TANK</p> <p>TANK PRESSURE-1-O₂ - 865 - 935 psia</p> <p>O₂ PRESS IND - TANK 1</p> <p>TANK PRESS-O₂ (2) - 865 - 935 psia</p> <p>TANK QUANTITY-O₂ (2) - 320 lb nominal</p> <p>TANK PRESS H₂ (2) - 225 - 260 psia</p> <p>TANK QUANTITY H₂ (2) - 28 lb nominal</p> <p>GLY EVAP STEAM PRESS - 0.25 psia (pegged)</p> <p>PRESS GLY DISCH - 20 - 28 psia</p> <p>GLY ACCUM-QUANTITY - 15 - 60%</p> <p>ECS GLYCOL - PUMP 1-AC1</p> <p>GLY PRESS DISCH - 36 - 44 psia</p> <p>GLY ACCUM-QUANTITY - 15 - 60%</p> <p>H₂O IND - POT</p> <p>WATER-QUANTITY (POT) - 83%</p> <p>H₂O IND-WASTE</p> <p>WATER-QUANTITY (WASTE) - 89%</p> <p>ECS RAD-OUTLET TEMP - 40° - 50°F</p> <p>GLY EVAP-OUTLET TEMP - 40° - 50°F</p> <p>H₂O ACCUM-AUTO/MAN - AUTO 1</p> <p>WASTE H₂O TK REFILL - OFF</p> <p>SUIT EVAP - MAN</p> <p>GLYCOL EVAP-H₂O FLOW - OFF (center)</p> <p>GLYCOL EVAP STEAM PRESS-AUTO/MAN - AUTO</p> <p>GLYCOL EVAP-TEMP IN - MAN</p> <p>CABIN TEMP - AUTO</p> <p>CABIN TEMP - FULL DECREASE</p> <p>ECS RAD OUT TEMP (2) - 50°F (pegged)</p> <p>CABIN AIR FAN (2) - ON</p> <p>POT H₂O HEATER - MNA</p> <p>ECS RADIATOR (4) - ON</p>	<p>13</p> <p>21</p> <p>19</p>	

BACKUP CREW PRELAUNCH CHECKS

NORMAL/BACKUP

STA/T	Step	PROCEDURES	Panel	REMARKS
	6.1.2	BACKUP CREW C&D CHECKS.		
S	1	LHEB panels check		
		GLYCOL PRESS RELIEF BYPASS (2) - ON	309	
		GLYCOL ACCUMULATOR - ON (CCW)	312	
		MAIN REGULATOR - NORMAL	314	
		TANKS PRESS REG-SEL INLET - NORMAL		
		TANKS PRESS REL-SEL OUTLET - NORMAL		
		PLSS FILL - CLOSE (CW)		
		EMERGENCY CABIN PRESSURE - OFF		
		CABIN REPRESS - CLOSE (CCW)		
		WASTE TANK SERVICING - CLOSE	315	
		PRESSURE RELIEF - BOTH		
		POTABLE TANK INLET - OPEN		
		WASTE TANK INLET - AUTO		
		DRINKING WATER SUPPLY - ON	304	
		GMT clock - check	306	
		PLV lockpins - IN	Fwd tunnel	
S	2	G&N system and panel checks		
		TRANSFER - COMPUTER	101	
		OPTICS-SLAVE TELESCOPE - STAR LOS	105	
		OPTICS HOLD - OFF		
		OPTICS mode - ZERO OPTICS		
		CONTROLLER SPEED - HI		
		CONTROLLER MODE - DIRECT		
		ATTITUDE IMPULSE-ENABLE - OFF		
		CONDITION LAMP - ON		
		IMU TEMP MODE - AUTO OVERRIDE		
		AGC MODE - ON	107	
		TEST ALARM - press and check	103,106	
		CHECK COOLANT - press and check	105	

BACKUP CREW PRELAUNCH CHECKS

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STA/T	Step	PROCEDURES	Panel	REMARKS
		CHECK MODE LAMPS - press and check	101,105	
		CHECK CONDITION LAMPS - press and check		
		IMU TEMP MODE-GAIN-PIPA - press and check		
		IMU TEMP MODE-GAIN-IRIG - press and check	103,105	
		CABIN AIR/AUTO/SUIT AIR - AUTO	120	
		START/PREHEAT - START		
		CB on panel 150 - ALL CLOSED, except:	150	
		BAT A TO PYRO BUS TIE & BAT B TO PYRO BUS TIE - OPEN		
	3	RHEB C&D checks		
		FUNCTION SELECT - A & B	200	
		TEST SELECT - 1 through 12 (Leave on 10)		
		Aux DC-VOLTS - *		*Refer to chart in paragraph 6.4.1.2.
		FUNCTION SELECT - OFF		
		C/M RCS HTRS - OFF		
S		WASTE MANAGEMENT (2) - OFF	201	
		BATTERY VENT - VENT	202	
		CB ECS STEAM DUCT HTR-MN A & MN B - OPEN	206	
C	4	LH panels		
		POST LDG BEACON LIGHTS - OFF	26	
		C/M RCS He DUMP - OFF (guarded and safetied)		
		CB LH panel - all closed	25	
		VENT FAN - OFF		
		FLOAT BAG (3) - VENT		
		ANTENNA DEPLOY (2) - OFF		
		MESC LOGIC ARM (2) - OFF		
		FDAI LTG - AC1		
		G&N SYNC - OFF		
		SPS GAUGING - OFF		
		EDS POWER - OFF	24	

BACKUP CREW PRELAUNCH CHECKS

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STA/T	Step	PROCEDURES	Panel	REMARKS
		TVC 2 POWER - OFF BMAG POWER - AC2 MNB TVC 1 POWER - OFF ROTATION CONTROL POWER - AC2 PARTIAL SCS POWER - AC1 MNA RATE GYRO POWER - AC1 THC (2) - LOCKED Rot. cont (1) - pinned		
C	5	Center panel Altimeter - check Altimeter index - set 3.3K FCSM-G&N - ON SCS - RESET/OVERRIDE LONG ACCEL - check L/V AOA/SPS Pc - L/V AOA L/V AOA - zero GIMBAL MOTORS (4) - OFF INJECT PRE-VALVES (2) - OFF AME - MONITOR FDAI error and rate (6) - 0° FDAI attitude ball - nav axis: R - 165° P - 58° Y - 10° DET - 00:00 Panel 5 - LOCK ATT SET - OFF Thrust cont - OFF DIRECT RCS - OFF LIMIT CYCLE - OFF ATT DEADBAND - MAX .05 G ENTRY - OFF LCL VERT - OFF ΔV sw - ON G&N/SCS - SCS	1 2 3 8 4 5 8	

BACKUP CREW PRELAUNCH CHECKS

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STA/T	Step	PROCEDURES	Panel	REMARKS
		RATE GYROS (3) - NORMAL SCS CHANNELS (4) - OFF ELS LOGIC - OFF (guarded) DET-mode - UP DET-START/STOP - center PROP JETT-LOGIC - ON PROP JETT-DUMP - OFF (guarded and safetied) PROP JETT-PURGE - OFF LH UTILITY PLUG - OFF	318	
P	6	Center panel F/C-PURGE (3) - OFF REACTANTS TB (3) - gray F/C 1&2-MAIN BUS A - ON F/C 2&3-MAIN BUS B - ON MAIN BUS A-RESET - CENTER MAIN BUS A TB (3) - 2 gray, 1 striped F/C 1 MAIN BUS B - OFF F/C 3 MAIN BUS A - OFF MAIN BUS B-RESET - CENTER MAIN BUS B TB (3) - 2 gray, 1 striped F/C INDICATORS - 1 BATTERY CHARGER - OFF DC INDICATORS - MAIN BUS A DC VOLTS - 27 - 31 vdc DC AMPS - zero INVERTER 1 - MNA INVERTER 2 and 3 - OFF AC BUS 1 - RESET - OFF INVERTER-1-AC BUS 1 - ON INVERTER-2 and 3-AC BUS 1 - OFF AC BUS 1 - RESET - ON AC BUS 2 - RESET - OFF INVERTER-1-AC BUS 2 - ON INVERTER-2 and 3-AC BUS 2 - OFF	18	

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STA/T Step	PROCEDURES	Panel	REMARKS
	AC BUS 2-RESET - ON	18	
	AC INDICATORS - BUS 1-ØA		
	AC VOLTS - 113 - 117 vac		
	FREQ - 398 - 402 cps		
	S-BAND XPONDER - XPONDER PWR AMPL	20	
	S-BAND-PWR AMPL - LOW		
	S-BAND-OSC - PRIM		
	S-BAND-VOICE-RNG - RNG		
	S-BAND-VOICE-TAPE - OFF		
	S-BAND-VOICE-TV - OFF		
	S-BAND-EMERG - OFF		
	Up-DATA - UHF		
	S-BAND ANTENNA - UPPER		
	VHF-AM mode - T/R		
	VHF-AM-RCVR - 1		
	C-BAND - 2 PULSE		
	VHF-FM - ON		
	RECOVERY-VHF-BCN - OFF		
	RECOVERY-HF-POWER - OFF		
	RECOVERY HF MODE - AM		
	TAPE RECORDER-PLAY - NORM		
	TAPE RECORDER-SPEED - NORM		
	TAPE RECORDER-mode - OFF		
	TAPE RECORDER-FWD/REV - OFF		
	SCE PWR - ON		
	PMP PWR - ON		
	TLM INPUTS-PCM - HIGH		
	TLM-INPUTS-BIOMED - 1		
	VHF ANTENNA - UPPER		
	SPS TANK PRESS - HE		
	SPS HELIUM (2) - AUTO		
	OX FLOW - INCREASE		
	VALVE - PRI		
	SENSOR - NORM		

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STA/T	Step	PROCEDURES	Panel	REMARKS
P	7	RH panels		
		F/C PUMP (3) - PUMP 1-AC1, PUMP 2&3 - AC2	22	
		MAIN BUS TIE (2) - OFF		
		BAT CHGR - AC1		
		NON ESS BUS - MNB		
		G&N LIGHTING - AC1		
		TELECOM-ESS - AC1		
		TELECOM-NONESS - AC2		
		CB-RH upper panel - ALL CLOSED, except		
		OPTICS (2) - OPEN		
		CB-RH lower panel - ALL CLOSED	21	
		Rot. cont - pinned		
		CB-ON 203, 204, 205, 206 all closed		
		except:		
		POST LDG-BAT BUS A - OPEN	203	
		POST LDG-BAT BUS B - OPEN		
		POST LDG-BAT C - OPEN		
		MAIN A&B-BAT C (2) - OPEN		
		RH UTILITY PLUG - OFF	207	
S	8	Center Panel		
		DET - 00:00	11	
		DET-mode - UP		
		DET-START/STOP - CENTER		
		MET - 00:00		
		UPTL - BLOCK	14	
		H ₂ PURGE LINE HTR - OFF	15	
		S/M RCS-HELIUM & PROPELLANT (12) -	15	
		CENTER		
		C/M-S/M SEP (2) - DOWN		
		(guarded and safetied)		
		C/M RCS PRPLNT (2) - ON - CENTER		
		RCS TB (14) - gray	16	
		ELS - AUTO		
		OX DUMP - AUTO		

BACKUP CREW PRELAUNCH CHECKS

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	2 ENG OUT - OFF L/V RATES - OFF LES tower jett mode (2) - LES MODE (guarded) RCS-CMD - OFF C/M PRESS (2) - DOWN - (guarded) RCS-TRANS - S/M EDS - OFF MAIN CHUTE RELEASE - DOWN (guarded and safetied)		
	C/W - BOOST H ₂ & O ₂ HEATERS (4) - AUTO H ₂ & O ₂ FANS (4) - AUTO S-BAND AND ind (signal) - TBD F/C VALVES - DOWN SPS LINE HTR - OFF UP TLM CMD - OFF FLIGHT QUAL RCDR - REWIND - STOP	13 14	<u>WARNING</u> This switch must never be actuated prior to splash- down.

BACKUP CREW PRELAUNCH CHECKS

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STA/T	Step	PROCEDURES	Panel	REMARKS
	6.2	<u>PRIME CREW PRELAUNCH CHECKS.</u>		
		Primary crew prelaunch checks consist of the crew equipment, S/C closeout checks and launch preparation. It is assumed that control positioning has been accomplished by the backup crew per paragraph 6.1 of this document.		
	6.2.1	<u>PRIME CREW STATUS CHECKS.</u>		
CSP	1	Prime crew ingress procedures		
C		MESC-PYRO ARM (2) - SAFE (unlocked)	24	
CSP		Connect C/M O ₂ and cobra cables (3)		
S		SUIT FLOW valves (3) - SUIT FULL FLOW	300,301,302	
CSP	2	PGA and pressure suit circuit check		
P		SUIT COMPRESSOR - COMPR 2-AC1	21	
		FLOW O ₂ - 0.2 - 0.45 lb/hr	13	
		ΔP SUIT COMPR - 0.7 - 0.9 psi		
		SUIT TEMP - 45° - 55°F		
		SUIT PRESS - 14.7 psia (amb)		
		PART PRESS CO ₂ - 0.0 - 7.6 mm Hg		
		SUIT COMPRESSOR - COMPR 1-AC1	21	
		ΔP SUIT COMPR - 0.7 - 0.9 psi	13	
C		SUIT TEST valve - PRESS	310	
P		O ₂ FLOW HI lt - ON	13	
		SUIT-PRESS - 17 psia max. (approx 40 sec)	13	Approximately 75 seconds required for suit circuit to stabilize at full pressure
S		SUIT FLOW VALVES (3) - OFF (15 sec)	300,301,302	
CSP		PGAs do not noticeably deflate		
S		SUIT FLOW VALVES (3) - SUIT FULL FLOW		
C		SUIT TEST VALVE - PRESS	310	

PRIME CREW PRELAUNCH CHECKS

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STA/T	Step	PROCEDURES	Panel	REMARKS
P		SUIT-PRESS - 14.7 psia (amb)		Approximately 75 seconds required for suit circuit to return to normal pressure range
C		SUIT TEST VALVE - OFF	310	
CSP	3	Cabin closeout and purge		
S		Secure inner hatch (ground crew assist)		
CSP		Connect restraints		
		Perform cabin closeout and purge		
C		Purge complete, CABIN PRESSURE RELIEF cont (2) - BOOST ENTRY (safety latch off)	307	
S	4	RCS status check		
		RCS INDICATORS - S/M A, B, C, D	12	
		PKG TEMP - 63° - 100°F		
		He-PRESS - 4500 or below		
		MANF-PRESS - 178 - 188 psia		
		He-TEMP 60° - 80°F		
		Record quantity		
		RCS INDICATORS - C/M A, B		
		He-TEMP - 95°F max.		
		He-PRESS - 3800 - 4500 psia		
		F & OX PRESS (2) - 30 psia max.		
		RCS INDICATORS - S/M A		
P	5	Initiate dual inverter operation		
		PHASE LOCK-ON	208	
		AC BUS 2-RESET - OFF	18	
		INVERTER-2 - MNB		
		INVERTER-1 - AC BUS 2 - OFF		
		INVERTER-2 - AC BUS 2 - ON		
		AC BUS 2 - RESET - center		
P	6	EPS status check		
		TANK PRESSURE-H ₂ (2) - 225 - 260 psia	13	

PRIME CREW PRELAUNCH CHECKS

PRIME CREW PRELAUNCH CHECKS

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STA/T Step	PROCEDURES	Panel	REMARKS
C P	<p>N2 A PRESS - record</p> <p>N2 B PRESS - record</p> <p>SPS TANK PRESS - He</p> <p>SPS HELIUM TB (2) - gray</p> <p>QUANTITY OX & F (2) - record</p> <p>UNBALANCE ind - -50 - +50</p> <p>SPS GAUGING - AC 1</p> <p>OX FLOW - INCREASE</p> <p>TEST - up 8 secs</p> <p>C&W PU SENSOR FAIL AT _____ secs</p> <p>QUANTITY - OX & F - increase (OX 3 digits/sec - F 1-1/2 digits/sec)</p> <p>CHECK QUANTITY</p> <p>OX FLOW TB-upper striped, lower - gray</p> <p>OX FLOW - decrease</p> <p>TEST - up 8 sec</p> <p>OX FLOW TB - upper - gray, lower - striped</p> <p>OX FLOW - NORM</p> <p>TEST - up 8 sec</p> <p>OX FLOW TB (2) - gray</p> <p>UNBALANCE ind - reading changes</p> <p>TEST - down</p> <p>QUANTITY - OX & F - within 2 digits of recorded value</p> <p>SENSOR - AUX</p> <p>TEST - up 5 sec</p> <p>QUANTITY-OX & F - increase</p> <p>UNBALANCE ind - reading changes</p> <p>TEST - down</p> <p>QUANTITY-OX & F - within 2 digits of recorded value</p> <p>SENSOR sw - NORM</p>	25	2500±50 psia at 60°F and 2900±50 psia at 130°F.

PRIME CREW PRELAUNCH CHECKS

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STA/T Step	PROCEDURES	Panel	REMARKS
	6.2.2 G&C VERIFICATION.		
CP	1 FDAI alignment		
	FDAI-SELF TEST - ON (deflect 4/5 scale)	2	
	AME - ATTITUDE	8	
	Set ATT SET dials - R 165°, P 58°, Y 10°	6	
	FDAI ALIGN - press		
	Set ATT SET dials - R 150°, P 80°, Y 20°		
	ATT SET - ON		
	FDAI error - full R-left, P-dn, Y-left		
	ATT SET - OFF		
	FDAI ALIGN - press		
	FDAI att ball - nav axis: R 150°, P 80°, Y 20°		
	Set ATT SET dials - R 164.8°, P 58.3°, Y 9.7°		
	ATT SET - ON		
	FDAI error-full R-right, P-up, Y-right		
	ATT SET - OFF		
	FDAI ALIGN - press		
	FDAI att ball - nav axis: R 164.8°, P 58.3°, Y 9.7°		
	2 Gimbal motors check		
	TVC-1 AC1 MNA	24	
	TVC-2 - AC2		
	ΔV SET - press until ΔV REMAINING = 2400	7	
	<u>WARNING</u> Verify MESC LOGIC ARM (2) - OFF	25	
	MESC PYRO ARM (2) - SAFE	24	
	GIMBAL PITCH 2 - START ON	3	

PRIME CREW PRELAUNCH CHECKS

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	GIMBAL YAW 2 - START ON CONFIRM TRIM CONTROL ON GPI GIMBAL PITCH 1 - START ON GIMBAL YAW 1 - START ON ΔV sw - ON SCS CHANNELS (4) - OFF THC - CW MFVC - CONTROL CHECK THC - NEUTRAL GIMBAL PITCH 2 - OFF GIMBAL YAW 2 - OFF CONFIRM and TRIM GPI YAW +3.6° PITCH +0.4°	8	
		3	
		6	
			NOTE SPS gimbal angle settings are based on CSM center of gravity and will vary with propellant loading.
		3	
	GIMBAL PITCH 1 - OFF GIMBAL YAW 1 - OFF TVC 1 and 2 - OFF MESC LOGIC ARM (2) - ON MESC PYRO ARM (2) - ARM AME - MONITOR FDAI att ball R 164.8, P 58.3, Y 9.7	24	
		25	
		24	
		8	
3	RCS testing		
	CB-A&C ROLL-MNB, B&D ROLL-MNA & MNB-OPEN	25	
	SCS CHANNEL-A&C and B&D ROLL-ON		
	RCS CMD-ON	16	
	<u>CAUTION</u> On the following steps, pulse each jet once only and for less than one second.		

PRIME CREW PRELAUNCH CHECKS

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STA/T	Step	PROCEDURES	Panel	REMARKS
		Rot. cont - pulse minus roll, ground verifies jet A 16 fires CB-A&C ROLL MNA - OPEN CB-A&C ROLL MNB - CLOSED Rot. cont - pulse minus roll, ground verifies jet C 14 fires CB-A&C ROLL MNB - OPEN CB-B&D ROLL MNA - CLOSED Rot. cont - pulse minus roll, ground verifies jet B 12 fires CB-B&D ROLL MNA - OPEN CB-B&D ROLL MNB - CLOSED Rot. cont - pulse minus roll, ground verifies jet D 10 fires RCS CMD-OFF SCS CHANNEL (4) - OFF CB-A&C ROLL MNA & B, B&D ROLL MNA - closed Rot. cont - rotate all six directions, ground verifies no jets fire DIRECT ULLAGE PB-PRESS, ground verifies 4 jets fire down, A2, B6, C1, and D5	16 8 25 5	
	6.2.3	LAUNCH PREPARATION.		
CSP	1	LCC confirm launch ready Couch restraints and inertia reels - check		
C		Panel 5 - UNLOCK EDS POWER-ON RATE GYRO (3) - BMAG INJECT PRE-VALVES (2) - ON	5 24 8 3	
S		Rot. cont - unpin		
C		DIRECT RCS - ON	8	

PRIME CREW PRELAUNCH CHECKS

NORMAL/BACKUP

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STA/T	Step	PROCEDURES	Panel	REMARKS
-05:00		RCS CMD - OFF	16	
		SCS-CHANNEL-B&D ROLL, PITCH and YAW - ON	8	
		TVC 1 POWER - AC1 MNA	24	
		TVC 2 POWER - AC2		
		RATE GYROS (3) - NORMAL	8	
C		THRUST sw - NORMAL	7	
		EDS - AUTO	16	
		LV RATES - AUTO		
		2 END OUT - AUTO		
		MAIN BUS TIE (2) - ON	22	
CSP	2	Systems preparation		
		RCDR-HF - T/R (voice recorder)	13	
		Audio power - PTT		
		Cobra cable PTT/CW - CW		
P		TAPE RECORDER-mode - RECORD	20	
		TAPE RECORDER-FWD/REV - FWD		
-01:15		ECS RADIATOR (4) - OFF	21	
S		PRESS GLY DISCH - 45 - 55 psia	13	
		GLY ACCUM QUANTITY - 35 - 60%		
C	3	G&C preparation		
		P02	14	
		Insert V75		
		FDAI ALIGN - press (10 sec)	6	
		G&N/SCS - G&N	8	
		READY FOR S-IB IGNITION		

PRIME CREW PRELAUNCH CHECKS

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STA/T Step	PROCEDURES	Panel	REMARKS
6.3	<u>BOOST-INSERTION AND SEPARATION.</u> Ascent and orbital insertion procedures include the monitoring and verification functions necessary to check proper sequence and trajectory from S-IB engine ignition through insertion of the spacecraft into earth orbit.		
6.3.1	<u>BOOST-INSERTION.</u>		
-00:03	Ignition	5	
-00:01	Engine lights - out		
00:00	LIFT OFF lt - on	00:00	
	Backup: IF NO LIGHT - PRESS		The NO AUTO ABORT switch-light should be pressed at lift-off to ensure enabling of the auto abort circuitry. Illumination of the switch-light indicates that one or both of the redundant ECS systems are not enabled. If the LIFT OFF light does not illuminate, it indicates that the circuit was not completed to enable an auto abort. Pressing the NO AUTO ABORT switch-light will complete the auto abort circuitry via another path.
S	DET - start MET - start P11 Key verb - key release	12 14	

BOOST-INSERTION AND SEPARATION

NORMAL/BACKUP

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STA/T Step	PROCEDURES	Panel	REMARKS
	Backup: IF NO LIFT-OFF SIGNAL - ENTER, START DET		
	VI6 N40	MODE IA (CONT) PARA 7.2.1.1	
	GAMMA XXX.XX Deg VI XXXXX FPS H PAD XXXX.X NM		
+00:10C	Roll program - report		
C	Pitch program - report		
+00:38C	Roll program - complete	2	
+00:40C	Monitor AOA to T + 01:40		
+00:50C	Rate limit change to 5°/sec - report		
P	CABIN PRESS - monitor for decrease	13	Indicates cabin pressure relief valve operation of T + 48 seconds.
+01:01S	OX DUMP - RCS CMD AUTO	+01:01	
S	C/M RCS PRPLNT (2) - ON	16	
+01:17	MAX Q	15	
+01:40S	2 ENG OUT - off		
	L/V RATES - off	3	
	EDS AUTO - off		
C	L/V AOA/SPS - SPS PC	MODE IB PARA 7.2.1.2	
+02:00		2	
+02:10C	Report GO-NO GO for staging		
P	GLYCOL EVAP-H ₂ O FLOW - AUTO	13	

BOOST-INSERTION AND SEPARATION

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STA/T Step	PROCEDURES	Panel	REMARKS
+02:21	IECO		
+02:24	OECO		
+02:25	S-IB separation - staging		
+02:27	S-IVB ignition command - lt on		
+02:30	S-IVB - 60% lt off		
	MODE IC PARA 7.2.1.3	5	
+02:50C	GIMBAL MOTORS (4) - START - ON	3	<u>CAUTION</u> Allow 1 second between starting each motor. The motors should not be operated continuously for longer than 12 minutes.
	Check GPI YAW + 3.6 PITCH + 0.4	6	
+03:00	TWR JETT (2) - ON	16	
	Backup: LES MOTOR FIRE PB - PRESS	5	
	AGC displays P 12 V16 N41 G max. Hp TFF	14	
	XXX.XXG XXXX.X NM XXBXX MIN/SEC		
+03:05	Guidance initiate		
+04:00C	Report status		
+05:00	Report status		
+06:00	Report status		
+07:00	Report status		

BOOST-INSERTION AND SEPARATION

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
+08:00 +09:48	Report status <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> +09:48 MODE III (CONT) PARA 7.2.2.2 ↓ INSERTION </div> <div style="text-align: center;"> +09:50 MODE IV (CONT) PARA 7.2.2.3 ↓ INSERTION </div> </div>		
+09:50S	Report/confirm COI		
+10:04C	SECO - report		
	Backup: THC - CCW-RETURN WITHIN 1 SEC		
	DSKY DISPLAYS (INSERTION)	14	
	FL V16 N42		
	ΔR	XXXX.X NM	
	Hp	XXXX.X NM	
	TFF	XXBXX MIN/SEC	
	V33E		
	FL V16 N43		
	HA	XXXX.X NM	
	Hp	XXXX.X NM	
	TFF	XXBXX MIN/SEC	
	V33E		
	FL V16 N35 (IF Hp EI)		
	T to perigee	000XX HRS 000XX MIN 0XX.XX SEC	
	V33E		

BOOST-INSERTION AND SEPARATION

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STA/T	Step	PROCEDURES	Panel	REMARKS
		FL V50 NO7 R 00000		
		Key V37 E00 E		
		6.3.2 POSTORBITAL INSERTION CHECK.		
CSP	1	STATUS CHECK LIST		
		RCDR HF - as desired	13,23,26	
		TAPE RECORDER MODE - OFF	20	
		POWER - VOX	13,23,26	
SP		Cobra cable PTT/CW - PTT		
C		GIMBAL MOTORS (4) - OFF	3	
		INJECT PRE-VALVES (2) - OFF		
		ΔV sw - OFF	8	
		THRUST sw - OFF	7	
		TVC POWER 1 & 2 - off	24	
		EDS POWER - OFF		
		MESC-LOGIC ARM (2) - OFF	25	
		MESC-PYRO ARM (2) - SAFE	24	
		SCS-CHANNELS (4) - OFF	8	
		CB GIMBAL PITCH 1 BAT A & YAW 1	25	
		BAT A (2) - OPEN		
		CB ELS BAT A & BAT B - OPEN		
		PROP JETT LOGIC - OFF	8	
		MAIN BUS TIE (2) - OFF - AUTO	22	
		CABIN PRESSURE RELIEF (2) - NORMAL	307	
		(safety latch on)		
		Monitor S-IVB pitchover and pitch rate		
		C&W - NORMAL	13	
		F/C VALVES - RESET	19	<u>CAUTION</u> F/C VALVES must be reset prior to opening H ₂ & O ₂ VALVES circuit breakers.
		CB F/C H ₂ & O ₂ VALVE (3) - OPEN		
		C/M RCS PRPLNT (2) - OFF	16	

BOOST-INSERTION AND SEPARATION

NORMAL/BACKUP

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STA/T	Step	PROCEDURES	Panel	REMARKS
	2	S/M RCS MONITORING CHECK - para 6.4.2 complete		
	3	C/M RCS MONITORING CHECK - para 6.4.2 complete		
	4	EPS PERIODIC VERIFICATION - para 6.4.3 complete		
	5	ECS PERIODIC VERIFICATION - para 6.4.7 complete		
	6	SPS MONITORING CHECK - para 6.4.2 complete		
	7	EPS ORBITAL CONFIGURATION Initiate battery charging (BAT C first) para 6.4.4 Single inverter operation PHASE LOCK - OFF AC BUS 2 RESET - OFF INVERTER-2 - OFF INVERTER-2-BUS 2 - OFF INVERTER-1-BUS 2 - ON AC BUS 2 RESET - ON (center)	208 18	
P	8	ECS POST INSERTION CONFIGURATION POT H ₂ O HEATER - MN A CB ECS STEAM DUCT HTR-MN A & MN B - CLOSED ECS RADIATORS (4) - ON (before T + 30 min)	21 206	
S		FUNCTION SELECT - B		

BOOST-INSERTION AND SEPARATION

STA/T	Step	PROCEDURES	Panel	REMARKS
SP		ECS RADIATOR OUTLET TEMP - below inlet TEMP (from panel 200)	200	
		Backup: ECS RADIATORS (4) - OFF, recheck in 5 min	21	
		GLYCOL EVAP TEMP IN - AUTO	13	
	6.3.3	CSM/S-IVB SEPARATION CHECK.		
	1	PREPARE FOR SEPARATION		
		Stop battery charging		
		MAIN BUS TIE (2) - ON	22	
P		PHASE LOCK - ON	208	
		AC BUS 2-RESET - OFF		
		INVERTER-2 - MNB		
		INVERTER 1-AC BUS 2 - OFF		
		INVERTER 2-AC BUS 2 - ON		
		AC BUS 2-RESET - CENTER		
S		POO	14	
		FINE ALIGN 1t - ON	101	
C		G&N/SCS - SCS	8	
		RATE GYRO (3) - BMAG		
P		TAPE RECORDER-FWD/REV - as reqd	20	
		TAPE RECORDER mode - RECORD		
		DET set for sep = 0	8	
		S/M RCS monitoring check para 6.4.2		
		PARTIAL SCS POWER - AC1	24	
		TVC-1 POWER - AC1 MNA		
		EDS POWER - ON		
		L/V ENG 1t 1 - ON	5	
		ΔV REMAINING - TBD	7	
		FDAI-SELF TEST - ON	2	
		RATE GYRO (3) - NORMAL	8	

BOOST-INSERTION AND SEPARATION

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	Set ATT SET dials - R 0°, P 8° from present, Y 0°	6	
	FDAI ATTITUDE - verify S-IVB attitude hold	4	
	AME - ATTITUDE	8	
	SCS CHANNEL (4) - ON		
	THC - ARMED		
	Rot. cont - unpinned		
	Panel 5 - UNLOCK	5	
	MESC LOGIC ARM (2) - ON	25	
	MESC PYRO ARM (2) - ARM	24	
2	SEPARATION PROCEDURES		
	THC-CCW, after sep - center		
	Backup:		
	DIRECT ULLAGE PB - press and hold	7	
	ADAP SEP PB - press	5	
	RCS CMD - ON	16	
	Initiate +X translation		
	DIRECT ULLAGE PB - release	7	
	RCS CMD - ON	16	
	THC - +X		
3	POSTSEPARATION CHECKS		
	TAPE RECORDER-mode - OFF	20	
	EDS POWER - OFF	24	
	TVC 1 - OFF		
	MESC-LOGIC ARM (2) - OFF	25	
	MESC PYRO ARM (2) - SAFE	24	
	CB - CM/SM TRANSFER MNA & B - OPEN	25	
	MAIN BUS TIE (2) - OFF - AUTO		
	PHASE LOCK - OFF	208	

BOOST-INSERTION AND SEPARATION

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STA/T	Step	PROCEDURES	Panel	REMARKS
		AC BUS 2-RESET - OFF		
		INVERTER-2 - OFF		
		INVERTER-2 - AC BUS 2 - OFF	18	
		INVERTER 1 AC BUS 2 - ON		
		AC BUS 2-RESET - ON		
		CB-PYRO A-SEQ A AND PYRO B-SEQ B - OPEN		
		EPS periodic verification check, para 6.4.3		
	4	CHARGE BATTERIES, para 6.4.4		
CSP	5	POSTSEPARATION ECS CONFIGURATION		
C		GLYCOL RESERVOIR-BYPASS - OPEN	307	
		GLYCOL RESERVOIR-INLET - CLOSE		
		GLYCOL RESERVOIR-OUTLET - CLOSE		
P		GLY ACCUM-QUANTITY - > 30%	13	
		If not:		
S		Remove attenuation panel		
		GLYCOL RESERVE - ON (CCW)	311	
P		GLYCOL ACCUM-QUANTITY - 30 - 60%	13	
S		GLYCOL RESERVE - OFF (CW)	311	
P		PRESS GLY DISCH - 37 - 45 psia	13	
S		Remove attenuation panel		
		SUIT CIRCUIT RETURN SHUT-OFF VALVE - OPEN (CCW)	319	
		Replace attenuation panel		
		GLYCOL PRESSURE RELIEF BYPASS-2 - OFF	309	

BOOST-INSERTION AND SEPARATION

NORMAL/BACKUP

NORMAL/BACKUP PROCEDURES

6.4 SYSTEMS MANAGEMENT.

Systems management is a compilation of procedures that are common to more than one mission phase. These procedures involve system monitoring, periodic checks, and unique functions of the following systems only: SPS, RCS, EPS, ECS, C&WS and T/C. Systems integrated procedures for the prelaunch through deorbit and entry phases will repeatedly reference the material contained in systems management.

6.4.1 GENERAL REQUIREMENTS.

6.4.1.1 Periodic Requirements.

The following is a list of systems management procedures that are accomplished at a specific time, or as the result of a specific condition or event. Management procedures not listed are carried out at random intervals or only when required.

Procedure

EPS Periodic Verification and Tests

ECS Periodic Verification - Check

SPS Periodic Verification and Tests

S/M RCS Monitoring - Check

S/M RCS Quantity Gauging Test

Fuel Cell Power Plant Purging

C/M RCS Monitoring - Check

Redundant Component Periodic Operational - Check

Battery Charge Level Check

Pyro Batteries - Check

Inverter No. 3 Status - Check

Inverter No. 2 Status - Check if not activated within past 24 hours.

SM2A-03-SC014
APOLLO OPERATIONS HANDBOOK

NORMAL/BACKUP PROCEDURES

Procedure

CO₂-Odor Absorber Filter Replacement

Cabin Cold-Soak Operation

SPS Periodic Verification and Tests

RCS Periodic Verification and Tests

EPS DC Voltage-Amperage Check and AC Power Check

Battery Charging

PGA Verification - Check

Dark Adaptation Adjustment

Every four days

6.4.1.2 Telemetry Measurement Checks.

An auxiliary DC VOLTS meter and two switches, FUNCTION SELECT and TEST SELECT, are installed in the RHFEB to allow the crewmen to monitor specific measurements which are telemetered to MSFN. A chart for converting the auxiliary DC VOLTS meter readings to the measurement ranges is presented in section 2. The measurements consist of the following:

- Fuel cells 1, 2, and 3 regulated N₂, H₂, and O₂ pressure
- Fuel cells 1, 2, and 3 radiator outlet temperature
- Temperature of six RCS oxidizer valves
- ECS radiator inlet temperature
- Battery compartment manifold pressure
- IMU heater and blower current
- IRIG and PIPA temperature.

The following list presents each switch position, telemetry code number, telemetry measurement which can be monitored on the auxiliary DC VOLTS meter, and operating range.

Function & Test Select	Aux DC VOLTS Meter				
	System		Nominal Range		
Sw Pos	Function	Measurement No.	Range	System	Display
A 1	F/C 1 N ₂ REG PRESS	SC 2060 P	0 - 75 psia	49 - 53 psia	3.2 - 3.5v
A 2	F/C 2 N ₂ REG PRESS	SC 2061 P	0 - 75 psia	49 - 53 psia	3.2 - 3.5v
A 3	F/C 3 N ₂ REG PRESS	SC 2062 P	0 - 75 psia	49 - 53 psia	3.2 - 3.5v
A 4	F/C 1 O ₂ REG PRESS	SC 2066 P	0 - 75 psia	60 - 64 psia	4.0 - 4.3v
A 5	F/C 2 O ₂ REG PRESS	SC 2067 P	0 - 75 psia	60 - 64 psia	4.0 - 4.3v
A 6	F/C 3 O ₂ REG PRESS	SC 2068 P	0 - 75 psia	60 - 64 psia	4.0 - 4.3v
A 7	F/C 1 H ₂ REG PRESS	SC 2069 P	0 - 75 psia	57 - 61 psia	3.8 - 4.1v
A 8	F/C 2 H ₂ REG PRESS	SC 2070 P	0 - 75 psia	57 - 61 psia	3.8 - 4.1v
A 9	F/C 3 H ₂ REG PRESS	SC 2071 P	0 - 75 psia	57 - 61 psia	3.8 - 4.1v
A10	F/C 1 RAD OUT TEMP	SC 2087 T	-50° +300°F	-20° +200°F	0.4 - 3.5v
A11	F/C 2 RAD OUT TEMP	SC 2088 T	-50° +300°F	-20° +200°F	0.4 - 3.5v
A12	F/C 3 RAD OUT TEMP	SC 2089 T	-50° +300°F	-20° +200°F	0.4 - 3.5v
B 1	C/M RCS -P SYS A ENG	CR 2205 T	-50° +250°F	-14° +200°F	0.6 - 4.2v
B 2	C/M RCS +Y SYS B ENG	CR 2203 T	-50° +250°F	-50° +250°F	0.6 - 4.2v
B 3	C/M RCS -P SYS B ENG	CR 2204 T	-50° +250°F	-50° +250°F	0.6 - 4.2v
B 4	C/M RCS CW SYS B ENG	CR 2206 T	-50° +250°F	-50° +250°F	0.6 - 4.2v
B 5	PIPA TEMP	CG 2300 T	125° 135°F	129° 131°F	1.6 - 2.4v
B 6	IRIG TEMP	CG 2301 T	128.5° 138.5°F	133° 136°F	1.7 - 3.2v
B 7	IMU HEATER CURRENT	CG 2302 C	0 - 2000 ma	750 - 1600 ma	1.0 - 2.8v
B 8	IMU BLOWER CURRENT	CG 2303 C	0 - 1000 ma	150 - 550 ma	0.5 - 2.3v
B 9	BAT MANIF PRESS	CC 0188 P	0 - 18 psia	<1 psia	<0.2v
B10	ECS RAD INLET TEMP	SF 0665 T	60° 150°F	65° 85°F	0.3 - 1.4v
B11	C/M RCS CCW SYS A ENG	CR 2201 T	-50° +250°F	-14° +200°F	0.6 - 4.2v
B12	C/M RCS -Y SYS A ENG	CR 2202 T	-50° +250°F	-14° +200°F	0.6 - 4.2v

STA/T	Step	PROCEDURES	Panel	REMARKS
P	6.4.2	PROPELLANT PERIODIC VERIFICATION.		
	1	SPS MONITORING CHECK He TANK TEMP - 40° - +80°F He TANK PRESS - record N2A Press - record N2B Press - record SPS TANK PRESS - He F & OX Tank Press - (2) 170-195 PSIA Engine Inlet Press F & OX 135-195 PSIA SPS ENGINE INJECT VALVE (4) - CLOSE SPS HELIUM TB (2) - gray	20	Initial helium tank pressure is 3950 to 4050 psig at 70°F, decaying with SPS propellant usage. Receive SPS propellant line temperature data from MSFN. Activate and deactivate SPS heaters switch on panel 19 at MSFN direction. Each meter indicates position of one oxidizer and one fuel ball valve.
P	2	SPS QUANTITY GAUGING & PU VALVE CHECK SENSOR - PRI QUANTITY-OX & F - record UNBALANCE - record PU VALVE - PRI OX FLOW - INCREASE TEST - TEST (up) 8 sec		OXID display X20 indicates remaining on-board oxidizer in pounds. FUEL display X10 indicates remaining on-board fuel in pounds. Switch is spring-loaded to AUTO (center) position.

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>QUANTITY-OX & F - reading increases</p> <p>OX FLOW TB - upper - striped OX FLOW TB - lower - gray OX FLOW - DECREASE TEST - TEST (up) 8 sec OX FLOW TB - upper - gray OX FLOW TB - lower - striped OX FLOW - NORM TEST - TEST (up) 8 sec C&W PU SENSOR FAIL AT 300 OX FLOW TB (2) - gray UNBALANCE - new reading TEST - TEST (down) OX & F - within 2 digits of recorded values SENSOR - AUX TEST - TEST (up) 5 sec QUANTITY-OX & F - readings increase UNBALANCE - new reading TEST - TEST (down) OX & F - within 2 digits of recorded values SENSOR - NORMAL</p>		<p>A time delay of approximately 4 seconds from TEST switch activation is required before digits will operate. Test rate for OXID digits is approximately 3 digits per second. Test rate for FUEL digits is approximately 1.5 digits per second.</p>
S 3	<p>S/M RCS MONITORING CHECK</p> <p>Specific functions of the RCS subsystem must be monitored during earth orbit to maintain operational readiness and status, thus ensuring the capability of the RCS</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>to function as required. All S/M RCS monitoring check and quantity calculation test procedures will be performed at 4-hour intervals during earth orbit. S/M RCS monitoring check procedures will also be performed before and after each SPS burn. All C/M RCS monitoring check procedures will be performed at 12-hour intervals during earth orbit and prior to entry.</p> <p>S/M RCS TB (12) - gray Check Quads A, B, C, D for: PKG TEMP - 63° - 175°F</p> <p>MANF PRESS - 177 - 19⁴ psia</p> <p>He PRESS - 4100 - 4200 psia He TEMP - 60° - 80°F Determine quantity</p> <p>4 C/M RCS MONITORING CHECK PRPLNT TB (2) - gray Check Ring A & B for: He TEMP - 95°F max He PRESS - 4000 - 4500 psia</p>	<p>15 12</p> <p>15 12</p>	<p>Acceptable package temperature is maintained by thermostatically controlled electric heaters. Thermostat control limits are on +77 (+10, -7)°F, OFF +90 to +118°F.</p> <p>Primary regulator control 177 to 185 psia. Secondary regulator control 177 to 19⁴ psia.</p> <p>Initial helium tank pressure is 4100 to 4200 psia at 70°F, decaying with C/M RCS propellant usage.</p>

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STA/T	Step	PROCEDURES	Panel	REMARKS
		F & OX PRESS - 285 - 308 psia		Prior to C/M-S/M pressurization - below 200 psia. After pressurization - between 287 and 308 psia.
	6.4.3	EPS PERIODIC VERIFICATION.		
P	1	CRYOGENIC PRESSURE-QUANTITY CHECK. TANK PRESSURE H ₂ (2) - 225 - 260 psia TANK PRESSURE O ₂ (2) - 865 - 935 psia TANK QUANTITY H ₂ (2) - record TANK QUANTITY O ₂ (2) - record	13	
P	2	F/C POWER PLANT CHECK F/C-REACTANTS TB (3) - gray F/C INDICATORS - 1, 2, 3 F/C TB (5) - gray FLOW-H ₂ 0.018 - 0.1606 lb/hr FLOW-O ₂ 0.140 - 1.276 lb/hr MODULE TEMP-SKIN - 385° - 495°F MODULE TEMP-COND EXH - 157.5° - 172.5°F F/C INDICATORS - 1	18	
P	3	D-C VOLTAGE-AMPERAGE CHECK DC INDICATORS - F/C 1, 2, & 3 DC AMPS check DC INDICATORS-Main Bus A & B DC VOLTS - 27 to 31 vdc MAIN BUS TIE (2) - OFF DC INDICATORS - BAT BUS-A, B, BAT C DC VOLTS - 37.2 vdc PYRO BAT A, B (every 24 hr CB - PYRO A & B - SEQ A & B (2) - CLOSE, 36.9 - 37.4 vdc, OPEN). DC AMPS - zero	18 22 18	When charging a battery, meter indications may be different than shown.

STA/T	Step	PROCEDURES	Panel	REMARKS
		MAIN BUS TIE (2) - AUTO DC INDICATORS - MAIN BUS-A	22 18	
P	4	A-C POWER CHECK AC INDICATORS - BUS 1 & 2, ϕ A, B, C AC VOLTS - 113 - 117 vac FREQUENCY - 398 - 402 cps		Frequency, with central timing equipment operating normally is 398 to 402 cps. Frequency, with central timing equipment not operating and inverter on internal frequency control, is 393 to 407 cps.
		AC INDICATORS - BUS 1- ϕ A Every 24 hours, check a-c inverters No. 3 and No. 2 as follows: a. Inverter changeover - Remove inverter No. 1 from a-c buses and replace with No. 3 b. Repeat A-C POWER CHECK above c. Return inverters to original operating configuration d. Repeat procedures for inverter No. 2.		
P	6.4.4	BATTERY CHARGING.		Battery charging is required following earth orbit insertion, SPS delta V, whenever battery voltage checks reveal the need, and in preparation for deorbit.
	1	Set controls (BAT A first) MAIN BUS TIE (2) - OFF CB BAT RLY BUS - BAT A - OPEN to charge BAT A CB BAT RLY BUS - BAT B - OPEN to charge BAT B		Placing MAIN BUS TIE switch at OFF completes circuit from charger to entry battery. Striped event indication for F/C 3 MAIN BUS A and F/C 1 MAIN BUS B will change. to gray if battery relay bus power is lost when BAT RLY BUS - BAT A & B CB (2) are open.

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STA/T Step	PROCEDURES	Panel	REMARKS
	DC INDICATORS - BAT CHARGER BATTERY CHARGER - A, B, or C DC VOLTS - 32 - 40 vdc DC AMPS - 2.8 - 0.6 as charge completed BATTERY CHARGER - OFF CB-BAT RLY BUS - BAT A & B (2) - CLOSE DC INDICATORS - MAIN BUS A MAIN BUS TIE (2) - AUTO	22	A-C and d-c power is supplied to charger when BATTERY CHARGER switch is positioned.
P 6.4.5	FUEL CELL POWER PLANT PURGING.		
	02 and H2 purging is required every 7 hours, alternating every 3-1/2 hours between 02 and H2 if fuel cell efficiency is decreasing. 1 02 PURGING 120 seconds are required for 02 purging F/C INDICATORS - 1, 2, or 3 Purge - 02 PURGE, 2 min F/C-FLOW-02 - increases 0.6 lb/hr	18	The 02 flow rate will increase by 0.6 lb/hr plus the normal rate. This may cause 02 flowmeter to exceed its normal limits, causing the F/C 1 (2 or 3) warning light and caution tone to come on. Alarm limits may be checked by monitoring FLOW-02 indicator at moment warning light illuminates.
	C&WS - check Purge - OFF		

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STA/T	Step	PROCEDURES	Panel	REMARKS
	2	H2 PURGING		
		80 seconds are required for H2 purging		
		H2 PURGE LINE HTR - ON (up)	MDC-15	The H2 purge line heater should be on
		F/C INDICATORS - 1, 2 or 3	MDC-18	30 minutes prior to H2 purge.
		Purge - H2 PURGE, 1 min 20 sec		
		F/C-FLOW-H2 - increases 0.75 lb/hr		
		C&WS - check		
		Purge - OFF		
		H2 PURGE LINE HTR - OFF	MDC-15	
	6.4.6	CRYOGENIC QUANTITY BALANCE.		
S	1	H2 OR O2 QUANTITY BALANCE CORRECTION		
		Quantity balance should be corrected only when cryogenic tanks exceed maximum allowable quantity differential.		
		On low quantity tank, H2 or O2 HEATER and FANS (2) - OFF	13	Normal quantity balance of H2 tanks is to be within 1 lb of each other, O2 tanks within 15 lb of each other.
		When balanced return HEATERS & FANS TO AUTO and resume normal operation		

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6.4.7 ECS PERIODIC VERIFICATION AND TESTS.

ECS systems management procedures during the earth orbit phase fit into two categories. The first category, consisting of four procedures that are carried out at specific time intervals, is described in the following sub-paragraphs.

a. An ECS verification check is recommended every hour from the time the S/C attains earth orbit until deorbit. This check provides the crew with the latest status of the ECS.

b. A redundant component checkout is accomplished at 24-hour intervals to determine the operational status of certain ECS redundant components. The test will reveal any inoperative or malfunctioning components that might have been selected for use later in the mission. Several redundant components cannot be checked, however, because of excessive use of oxygen, means of selection not incorporated, or lack of direct indication.

c. Replacement of one CO₂-odor absorber filter is required on an alternate basis, at 12-hour intervals, for the ECS to remain within the prescribed metabolic limit.

d. The cabin cold-soak operation is commenced 8 to 12 hours prior to entry. This provides a heat-sink to combat the excessive temperature buildup within the cabin after heat, developed during the entry phase, has penetrated the C/M heat shield.

The second category consists of the following five procedures that are accomplished at random intervals and only as required.

a. PGA/shirtsleeve mode changes require certain precautions to be taken in conjunction with ECS adjustments. This applies whether the change is from the PGA-to-shirtsleeve mode, or the shirtsleeve-to-PGA mode.

b. Waste management procedures provide the steps necessary for the collection, removal, and disposition of waste products (except perspiration) resulting from normal body functions. Collection and disposition of emesis, and the retrieval of solid matter within the C/M cabin are also covered.

c. Procedures are provided to repressurize the C/M cabin to 5 psia following depressurization for any reason. Although a choice of two flow rates is available, only the first is capable of repressurizing the cabin in the shortest possible time.

d. A verification of the PGA is carried out each time a crew-member dons his suit after being in the shirtsleeve mode. Although only one crewmember may be returning to the suited mode, all those already suited will be subjected to the PGA verification (leak check). The verification is also carried out prior to S-IVB separation, SPS burns, cabin pressure dumping, and deorbit.

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e. The unhinged attenuation panel in the LHEB must be removed to gain access to the suit circuit return air manual valve and the controls of LHEB-136. Following any ECS adjustments, the attenuation panel must be returned to its original position.

STA/T	Step	PROCEDURES	Panel	REMARKS
SP	1	ECS MONITORING CHECK		
P		GLY EVAP STEAM PRESS - 0.097 - 0.145 psia	13	
		GLY PRESS DISCH - 37 - 45 psia		
		FLOW O2 - 0.02 - 0.45 lb/hr		
		P SUIT COMPR - 0.3 - 0.4 psia		
		GLY ACCUM-QUANTITY - 30 - 60%		
		If < 30%:		
S		Remove attenuation panel	311	
		GLYCOL RESERVE - ON (ccw)		
P		GLY ACCUM-QUANTITY - 30 - 60%	13	
S		GLYCOL RESERVE - OFF (cw)	311	
		Replace attenuation panel		
		WATER-QUANTITY (POT) - 25 - 90%	13	
		WATER-QUANTITY (WASTE) - Function of (POT)		
		ECS RAD-OUTLET TEMP 30° - 102°F		
		GLY EVAP-OUTLET TEMP - 40° - 50.5°F		
		SUIT TEMP - 45° - 55°F		
		CABIN TEMP - 70° - 80°F		
		SUIT PRESS - 4.7 - 5.3 psia		
		CABIN PRESS - 4.8 - 5.2 psia		
		PART PRESS CO2 - 0.0 - 7.6 mm Hg		
		ECS RAD OUT TEMP-1 - >30°F	19	
		ECS RAD OUT TEMP-2 - >30°F		
S		ECS RAD INLET TEMP - >75°F	200	
CSP	6.4.8	ECS REDUNDANT COMPONENT CHECK.		
P	1	Set controls:		
		SUIT COMPRESSOR - redundant compressor	21	
		ΔP SUIT COMPR - 0.3 - 0.4 psi	13	
		ECS GLYCOL - redundant pump	21	
		PRESS GLY DISCH - 37 - 45 psia	13	
C		O2 DEMAND REG sel -1	310	SUIT TEST pressed only long enough to verify No. 1 demand regulator operation.
		SUIT TEST valve - PRESS		

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STA/T Step	PROCEDURES	Panel	REMARKS
P	FLOW O2 - increase	13	
	PGAs inflate		
CSP	O2 FLOW HI lt and MASTER ALARM lt - on	3,11,18 103	
C	SUIT TEST valve - DEPRESS	310	
P	FLOW O2 - normal	13	
	PGAs deflate		
C	SUIT TEST valve - OFF	310	
	Repeat for O2 DEMAND REG sel - 2		
P	O2 DEMAND REG sel - 1 & 2		
S	MAIN REGULATOR - 1	314	
	EMERGENCY CABIN PRESSURE - 1		
	PRESS TO TEST - PRESS		Press-to-test pushbutton held only long enough to obtain momentary high flow indication.
	FLOW O2 - increase		
CSP	O2 FLOW HI lt and MASTER ALARM lt - on	3,11,18 103	
C	MSFN reports - O2 PRESS 90 - 110 psig		Oxygen pressure is telemetered only, no C/M indication.
SP	Repeat for MAIN REGULATOR-2 valve		
S	MAIN REGULATOR - NORMAL	314	
	EMERGENCY CABIN PRESSURE - ON (if unsuited)		
P	H2O ACCUM - select redundant accum	13	
	H2O ACCUM FAIL lt - monitor	11	
S	GLYCOL PRESS RELIEF BYPASS-redundant valve	309	
P	PRESS GLY DISCH - no change	13	Decrease in pressure is indicative of a leak in newly selected relief valve. Increase in press indicates leak in previously selected relief valve.

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STA/T	Step	PROCEDURES	Panel	REMARKS
CSP	6.4.9	CABIN COLD-SOAK OPERATION.		
P	1	Set controls:		
S		CABIN TEMP - MAN		
P		CABIN TEMP valve - FULL COLD (CW)	303	
C		SUIT EVAP - AUTO (only in EMERG)	13	
		SUIT HT EXCH - EVAP (only in EMERG)	310	
CSP	6.4.10	PGA/SHIRTSLEEVE MODE CHANGE.		
		NOTE To be accomplished before first crewman changes to shirtsleeve mode.		
	1	Set controls:		
		To shirtsleeve, EMERGENCY CABIN PRESSURE - NORMAL	314	To be accomplished after last crewman has changed to PGA mode.
		O2 hoses - disconnect at suit and plug return hose		
		To PGA, EMERGENCY CABIN PRESSURE - OFF	314	This procedure will also be followed in event of sudden cabin decompression.
CSP	6.4.11	CABIN REPRESSURIZATION.		
	1	MINIMUM REPRESSURIZATION TIME		
C		Lower CABIN PRESSURE RELIEF - NORMAL	307	
S		EMERGENCY CABIN PRESSURE valve - NORMAL	314	
P		CABIN REPRESS valve - OPEN (CW)		
		O2 PRESS IND - SURGE TANK	13	Surge tank pressure must not decrease below 150 psia to prevent incorrect main O2 regulator operation.
S		TANK PRESSURE-1-O2 - monitor 150 psia min		
		EMERGENCY CABIN PRESSURE valve - OFF	314	

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STA/T	Step	PROCEDURES	Panel	REMARKS
		CABIN REPRESS valve - adjust for 150 psia min	314	It may be required to readjust valve several times to maintain 150 psia minimum.
P		CABIN PRESS - 5.0 psia (in 52 min)	13	Cabin pressure regulators automatically close at 5.0 psia.
S		CABIN REPRESS - CLOSE (CCW)	314	
CSP	2	NORMAL REPRESSURIZATION TIME		
C		Lower CABIN PRESSURE RELIEF valve - NORMAL	307	
S		EMERGENCY CABIN PRESSURE valve - OFF	314	
		CABIN REPRESS valve - open (CW)		
SP		CABIN PRESS - 5.0 psia (in 7 ⁴ min)	13	
		CABIN REPRESS valve - close (CCW)	314	
		6.4.12 PGA VERIFICATION CHECK.		
	1	Set controls:		
C		SUIT TEST valve - PRESS	310	
CSP		PGA sleeve ind - 8.95 - 9.55 psia		
		O2 FLOW HI lt - ON	3,11,18 103	
S		SUIT FLOW valve (3) - OFF	300,301 302	Valve shut off for minimum of 10 seconds, during which time crewman must hold breath
CSP		PGA sleeve ind - normal decay		Accuracy of decay rate increases with length of time valve is off; also sleeve indicator should not fluctuate during time crewman holds breath.
S		SUIT FLOW valve (3) - SUIT FULL FLOW	300,301 302	
C		SUIT TEST valve - DEPRESS	310	

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STA/T Step	PROCEDURES	Panel	REMARKS			
P	<p>SUIT TEST valve - OFF</p> <p>6.4.13 S/M-TO-C/M WATER TRANSFER.</p> <p>NOTE Water transfer to be carried out when WATER-QUANTITY (POT) indicator decreases to 25%.</p> <p>1 Set controls: H2O IND - POT WASTE H2O TK REFILL - 1</p> <p>WATER-QUANTITY (POT) - 90% max WASTE H2O TK REFILL - OFF</p>	13	<p>Valve must not be set to OFF before suit circuit returns to nominal pressure.</p> <p>No. 1 tank to be emptied before transferring from No. 2 tank.</p>			
S	6.4.14 WASTE MANAGEMENT PROCEDURES.		Filter Number	Stowage Container	Filter Number	Stowage Container
1	CO2-Odor Absorber Filter Replacement		1	(Canister A)	15	L
	Obtain torque wrench		2	(Canister B)	16	P
	Open attenuation panel		3	J	17	F
	Obtain unused filter		4	J	18	F
S	Diverter valve handle - up (or down)	313	5	K	19	E
	Up for canister B filter change, down for canister A filter change.		6	K	20	E
	Press manual bleed valve		7	H	21	D
	Unlock cover latching handle		8	H	22	D
	Replace used filter		9	G	23	C
	Lock cover latching handle		10	G	24	C
	Diverter valve handle - center		11	U	25	B
	Close attenuation panel		12	R	26	B
	Stow used filter		13	N	27	A
	Stow torque wrench		14	M	28	A

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STA/T	Step	PROCEDURES	Panel	REMARKS
CSP	2	<p>WMS-Urination</p> <p>Prepare USVMS for use</p> <p>USVMS sel valve - URINATE</p> <p>USVMS sel valve - SAMPLE</p> <p>Connect USVMS to dump line</p> <p>USVMS-SELECTOR valve - DUMP</p> <p>WASTE MANAGEMENT-SELECTOR valve - URINE FECES</p> <p>WASTE MANAGEMENT-OVBD DRAIN valve - DUMP</p> <p>WASTE MANAGEMENT valves (2) - OFF</p> <p>USVMS-SELECTOR valve - OFF</p> <p>Disconnect USVMS and stow</p>	201	Rotate USVMS injector level to obtain sample.
CSP	3	<p>WMS-UCD Dump Operation</p> <p>NOTE The PGA contains the provision for urination during the prelaunch and ascent phases only. Upon attaining orbit, remove PGA urine collection device (UCD) and empty contents as follows.</p> <p>Connect urine receptacle/transfer valve assy to dump line</p> <p>Install UCD clamp</p> <p>Remove UCD from PGA</p> <p>Insert transfer valve in UCD</p> <p>WASTE MANAGEMENT-SELECTOR valve - URINE FECES</p>	201	
CSP		<p>WASTE MANAGEMENT-OVBD DRAIN valve - DUMP</p> <p>WASTE MANAGEMENT valves (2) - OFF</p> <p>Stow urine receptacle/transfer valve assy & UCD</p>	201	

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STA/T	Step	PROCEDURES	Panel	REMARKS
CSP	4	<p>WMS-Defecation</p> <p>Position fecal canister in place and prepare for use</p> <p>Connect fecal canister to dump line</p> <p>WASTE MANAGEMENT-SELECTOR valve - URINE FECES</p> <p>WASTE MANAGEMENT - OVBD DRAIN valve - DUMP</p> <p>WASTE MANAGEMENT valves (2) - OFF</p> <p>Insert germicide pouch in inner fecal/ emesis bag</p> <p>Seal inner fecal/emesis bag & rupture pouch</p> <p>Insert inner fecal/emesis bag in outer fecal/emesis bag & knead</p> <p>Stow outer fecal/emesis bag</p> <p>Disconnect fecal canister and stow</p>	201	
CSP	5	<p>WMS-Emesis</p> <p>Obtain inner fecal/emesis bag</p> <p>Insert germicide pouch in inner fecal/ emesis bag</p> <p>Seal inner fecal/emesis bag & rupture pouch</p> <p>Insert inner fecal/emesis bag in outer emesis bag & knead</p> <p>Stow outer fecal/emesis bag</p>		
CSP	6	<p>WMS-Vacuum Cleaner Operation</p> <p>Obtain vacuum cleaner assy</p> <p>WASTE MANAGEMENT-SELECTOR valve - VACUUM CLEANER</p> <p>WASTE MANAGEMENT-SELECTOR valve - OFF</p> <p>Remove vacuum cleaner assy debris bag</p>	201	
CSP				

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STA/T Step	PROCEDURES	Panel	REMARKS
S	7	201	At present there is no provision for stowing loose panel.
Insert debris bag germicide pouch Seal debris bag & rupture pouch Insert debris bag in outer fecal/ emesis bag & knead Stow outer fecal/emesis bag Insert new debris bag in vacuum cleaner & stow			
Remove/Replace Unhinged Attenuation Panel Obtain torque wrench Loosen panel fasteners (3) Remove panel (pull on tabs) Adjust ECS Replace panel (align pins) Tighten panel fasteners Stow torque wrench			
CP	6.4.15 C&WS PERIODIC VERIFICATION AND TESTS.		At present there is no provision for stowing loose panel.
Systems management procedures for the C&WS consist of the following: a. A procedure is provided for an operational test of all systems status and master alarm lights. In addition to being accomplished during prelaunch, the test may be conducted at any time during flight at the discretion of the crew. b. An adjustment is made at each sunset during orbit to facilitate dark adaptation during the period of orbital darkness.			

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STA/T	Step	PROCEDURES	Panel	REMARKS
		c. Acknowledgement of C&WS status light illumination is required. The procedure applies during prelaunch or any flight phase of the mission.		
P	1	C&WS Lamp Verification Check C/W LAMP TEST - 1	23	A lamp test of MASTER ALARM light (LEB-103) is accomplished when G&N condition lights on LEB-103 are tested.
CP		MASTER ALARM lt (2) - on	3,18	
P		LH system status lt - on	10	
		C/W LAMP TEST -2	23	
CP		MASTER ALARM lt (2) - out	3,18	
P		LH system status lt - out	10	
		RH status light - on	11	
		C/W LAMP TEST - OFF	23	
		RH systems status lt - out	11	
P	2	Dark Adaptation Adjustment C/W - ACK	13	If an abnormal condition occurs, only lights of master alarm circuit will illuminate. Appropriate systems status light may be illuminated by pressing MASTER ALARM switch-light on MDC-3 or -18.
		C/W - NORMAL (at sunrise)		
CSP	3	Acknowledge/Reset Master Alarm Indication		
CP		MASTER ALARM lt - press	3 or 18	The MASTER ALARM light on LEB-103 does not contain an integral push-switch
CSP		Audio alarm tone - silenced	3,18,103	
		MASTER ALARM lt (3) - out		

SYSTEMS MANAGEMENT

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6.4.16 TELECOMMUNICATIONS.

The T/C system will be in operation throughout the entire mission. Procedures pertinent to specific phases of the mission are included in the integrated phase-oriented procedures contained elsewhere in this section. The information and procedures included here consist of all other normal and backup procedures that will be utilized during the earth orbital phase to accomplish mission requirements and satisfy test objectives. Some of these procedures will only be required during tests or contingencies due to the fact that much of the T/C equipment will remain activated throughout the mission, even when not required, in order to maintain the desirable minimum overall power load of 1500 watts on the electrical power system. This will reduce the amount of crew tasks involved with operation of the T/C system, since this equipment will not have to be turned on and off during station passes.

A standard revolution is a revolution during which no special testing, SPS burns, or contingencies occur. While no revolution will be exactly like another, most orbital paths will involve passage over several MSFN ground stations within acceptable slant ranges for VHF voice and data communications. Because of the 1500-watt minimum power level requirement discussed in the previous paragraph, all equipment necessary for voice communications, PCM, TLM transmission, and C-band tracking will be activated and operating at all times. The UDL will also remain activated and capable of receiving updata when required.

The only action required of the crew for voice communications and transmission of real-time PCM TLM will be to ensure optimum radiation and reception of RF signals either by maintaining S/C attitude such that the selected SCIN antenna is directed toward the MSFN station or by changing antennas with the VHF antenna switch on MDC-20. Also, the audio control panels (MDC-26, -13, and -23) must be set up in accordance with the desires and requirements of the individual crewman for control of voice transmission and reception.

The reception of updata for updating the CTE and receiving RTCs will require no action on the part of the crew since the UDL will normally remain activated in the UHF mode and utilizes the same SCIN antenna as that used for VHF voice and data operations. For updating the Apollo guidance computer, however, the UP TLM switch (MDC-14) must be set to the ACCEPT position.

C-band tracking will also require very little action on the part of the crew. The C-band transponder equipment, which automatically selects the best of four C-band antennas for transmission

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of response pulses, will normally remain activated in the 2-pulse mode. If C-band tracking is required over an MSFN equipped only for 1-pulse operation, the pilot must set the C-BAND switch (MDC-20) to the 1 PULSE position.

NOTE The following procedures imply that the appropriate electrical buses are powered and that the proper circuit breakers are closed.

STA/T	Step	PROCEDURES	Panel	REMARKS
		6.4.16.1 <u>Voice Communication and Recording.</u>		
CSP	1	AUDIO CENTER NORMAL CONFIGURATION POWER - VOX S-BAND - REC RCDR-HF (voice recorder) - OFF - T/R for voice record VHF-AM - T/R INTERCOM - T/R Cobra cable PTT/CW - PTT	13,23,26	
P	2	S-BAND NORMAL CONFIGURATION S-BAND-XPONDER - XPONDER PWR AMPL S-BAND-PWR AMPL - LOW S-BAND-OSC - PRIM S-BAND-VOICE-RNG - off S-BAND-VOICE-TAPE - off S-BAND-VOICE-TV - off S-BAND-EMERG - off S-BAND ANTENNA - UPPER or LOWER	20	The USBS will be activated with the PA in the low-power mode during prelaunch and remain in this configuration throughout the mission except during testing or contingencies.
	3	VHF-AM NORMAL CONFIGURATION VHF-AM power - T/R VHF-AM-RCVR - 1 VHF ANTENNA - UPPER or LOWER	20	

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STA/T	Step	PROCEDURES	Panel	REMARKS
		6.4 16.2 <u>Data Transmission and Reception.</u>		
P	1	TAPE RECORDER AND POWER SWITCHES NORMAL CONFIGURATION TAPE RECORDER-PLAY - PCM or NORM TAPE RECORDER-SPEED - NORM TAPE RECORDER-mode - NORM TAPE RECORDER-FWD/REV - NORM PMP PWR - ON SCE PWR - ON	20	
P	2	RECORD PCM TAPE RECORDER-SPEED - NORMAL(HBR) OR LOW (LBR) TAPE RECORDER-FWD/REV - as req TAPE RECORDER-mode - RECORD TLM INPUTS-PCM - HIGH(HBR) or LOW(LBR)	20	
P	3	REAL TIME PCM TRANSMISSION VHF-FM - ON and/or S-BAND XPONDER - ON TLM INPUTS-PCM - as req	20	VHF-AM switch is normally set to ON prior to launch and left at ON throughout the mission.
P	4	RECORDED PCM DUMP VHF-FM - ON and/or S-BAND XPONDER - ON S-BAND-VOICE-TAPE - TAPE TAPE RECORDER-SPEED - NORM(HBR) or HIGH (LBR) TAPE RECORDER-FWD/REV - opposite to recorded TAPE RECORDER-mode - PLAY		

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STA/T Step	PROCEDURES	Panel	REMARKS
P 5	TAPE RECORDER REWIND TAPE RECORDER MODE - NORM TAPE RECORDER-SPEED - HIGH TAPE RECORDER-FWD/REV - opposite to recorded direction TAPE RECORDER-mode - PLAY 6.4.16.3 <u>Backup and Recovery Modes.</u> 1 TRANSMIT VOICE EMERGENCY MODE USBS S-BAND-XPONDER - XPONDER PWR AMPL S-BAND-PWR AMPL - HIGH S-BAND-EMERG VOICE - EMERG VOICE S-BAND - REC Press cobra cable PTT key 2 TRANSMIT CW CODE IN EMERGENCY MODE, USBS S-BAND-XPONDER - XPONDER S-BAND-OSC - SEC S-BAND-EMERG - KEY Cobra cable sw - CW Key cobra cable or trans cont PTT 3 RECOVERY NORMAL CONFIGURATION RECOVERY-VHF-BCN - OFF RECOVERY-HF power - OFF RECOVERY-HF mode - AM or SSB VHF ANTENNA - RECOVERY		

TELECOMMUNICATIONS

STA/T Step	PROCEDURES	Panel	REMARKS
6.4.17	MISCELLANEOUS PROCEDURES.		
6.4.17.1	<u>In-Flight Exercise (CSP)</u> Each crewman will be scheduled for three 10-minute exercise periods daily. The periods will be prior to, or no less than 1 hour following meals, with one period occurring shortly before the sleep period. (Specific time-lines will be provided when available.) These periods may be utilized for exercise at the discretion of the crewmen. The crewmen may utilize the following isotonic or isometric exercise, or the exercise ergometer (provided for experiment S012).		Two or all crewmen can exercise simultaneously if each crewman selects a different exercise. Five minutes of isometric exercise should precede isotonic exercise.
6.4.17.1.1	Isometric Exercises.		
1	Hand on forehead - press head against hand.		
2	Hands behind head - press head against hand.		
3	Attempt to turn head left against pressure of left hand.		
4	Attempt to turn head right against pressure of right hand.		
5	Press palms together.		
6	Lock fingers and pull.		

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STA/T	Step	PROCEDURES	Panel	REMARKS
	7	Place right wrist in left palm - press.		
	8	Place left wrist in right palm - press.		
	9	Press hands up against overhead.		
	10	Press hands down against couch (at hip or thigh level).		
	11	Press knees together against push of hands (between knees).		
	12	Arch back and contract stomach muscles.		
	13	Pull with both hands against flexed right knee.		
	14	Pull with both hands against flexed left knee.		
	15	Press back of heels against couch.		
	16	Extend legs and point toes.		
	17	Press knees together.		
	18	Cross legs at ankles and push legs laterally.		
	19	Repeat steps until time period has elapsed.		

TELECOMMUNICATIONS

STA/T Step	PROCEDURES	Panel	REMARKS
6.4.17.1.2	Isotonic Exercises. Using the exerciser places a stress on the crewman's heart. Rest as little as possible between exercises. 1 Egress couch and retrieve in-flight exerciser from stowage. (RH canister) 2 Ingress couch. 3 Pull exerciser 45 times with arms. 4 Hold handle against stomach while pushing other handle 45 times with right leg. 5 Hold handle against stomach while pushing other handle 45 times with left leg. 6 Hold handle with arms and other handle with feet (legs straight); pull 45 times with back and arms. NOTE For this exercise, assume position backwards in center couch with hips and legs restrained by harness. Adjust position to avoid hitting head on MDC or LEB.		

STA/T Step	PROCEDURES	Panel	REMARKS
7	Repeat steps until time period has elapsed.		
8	Egress couch and stow exerciser. (RH canister)		
6.4.17.2	<u>Minimum Transient Power Level Configuration.</u>		
	The following is a list of controls and their positions required to maintain a 1500-watt-minimum transient power level:		
6.4.17.2.1	Stabilization and Control System.		
	ROTATION CONTROL POWER switch - AC1	MDC-24	
	BMAG POWER switch - AC 2 MNB		
	RATE GYRO POWER switch - AC1		
	PARTIAL SCS POWER switch - OFF		
	TVC 1 POWER switch - OFF		
	TVC 2 POWER switch - OFF		
6.4.17.2.2	Electrical Power System.		
	H ₂ HEATERS-1 and -2 switches (2) - AUTO	MDC-13	
	O ₂ HEATERS-1 and -2 switches (2) - AUTO		
	H ₂ FANS-1 and -2 switches (2) - AUTO		
	O ₂ FANS-1 and -2 switches (2) - AUTO		
	H ₂ PURGE LINE HTR switch - OFF	MDC-15	
	FUEL CELL-1, -2, and -3 purge switches (3) - off	MDC-18	

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>FUEL CELL-1, -2, and -3-REACTANTS switches (3) - ON</p> <p>FUEL CELL-1 and -2-MAIN BUS A switches (2) - ON</p> <p>FUEL CELL-3-MAIN BUS A switch - OFF</p> <p>MAIN BUS A-RESET/OFF switch - on (center)</p> <p>FUEL CELL-1-MAIN BUS B switch - OFF</p> <p>FUEL CELL-2 and -3-MAIN BUS B switches (2) - ON</p> <p>MAIN BUS B-RESET/OFF switch - on (center)</p> <p>BATTERY CHARGER switch - OFF</p> <p>DC INDICATORS switch - MAIN BUS A</p> <p>AC INVERTER-1 switch - MN A</p> <p>AC INVERTER-2 and -3 switches (2) - OFF</p> <p>AC INVERTER-1-AC BUS 1 switch - ON</p> <p>AC INVERTER-1-AC BUS 2 switch - ON</p> <p>AC INVERTER-2 and -3-AC BUS 1 switches (2) - OFF</p> <p>AC INVERTER-2 and -3-AC BUS 2 switches (2) - OFF</p> <p>AC BUS 1 and 2-RESET/OFF switches (2) - on (center)</p> <p>FUEL CELL PUMP-1 switch - AC1</p> <p>FUEL CELL PUMP-2 and -3 switches (2) - AC2</p> <p>MAIN BUS TIE switches (2) - AUTO</p> <p>BAT CHGR switch - AC 1 (or AC 2)</p> <p>NONESS BUS switch - OFF</p> <p>F/C VALVES switch - off (down)</p> <p>FUNCTION SELECT switch - OFF</p>	<p>MDC-18</p> <p>MDC-22</p> <p>MDC-19 RHFEB-200</p>	

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STA/T Step	PROCEDURES	Panel	REMARKS
6.4.17.2.3	Guidance and Navigation System.		
	AGC MODE switch - STANDBY	LEB-107	
	GUIDANCE & NAVIGATION-IMU-MNA and -MNB circuit breakers (2) - open		
	GUIDANCE & NAVIGATION-OPTICS-MNA and -MNB circuit breakers (2) - open		
	GUIDANCE & NAVIGATION-VIEWER-AC 1 and -AC 2 circuit breakers (2) - open		
6.4.17.2.4	Environmental Control System.		
	H ₂ O ACCUM-AUTO 1/MAN/AUTO 2 switch - AUTO 1	MDC-13	
	H ₂ O ACCUM-ON 1/ON 2 switch - off (center)		
	WASTE H ₂ O TK REFILL switch - OFF		
	SUIT EVAP switch - MAN		
	H ₂ O IND switch - WASTE		
	GLYCOL EVAP-H ₂ O FLOW switch - AUTO	MDC-13	
	GLYCOL EVAP-STEAM PRESS-AUTO/MAN switch - AUTO		
	GLYCOL EVAP-STEAM PRESS-INCR/DECR switch - off (center)		
	GLYCOL EVAP-TEMP IN switch - AUTO		
	CABIN TEMP-AUTO/MAN switch - AUTO		
	SUIT COMPRESSOR switch - COMPR 1 AC 1	MDC-21	
	ECS GLYCOL switch - PUMP 1 AC 1		
	CABIN AIR FAN-1 and -2 switches (2) - ON		
	POT H ₂ O HEATER switch - MNA		
	ECS RADIATOR switches (4) - on (up)		
	SUIT HT EXCH switch - GLY/EVAP	LHEB-310	
	WMS selector valve - off (microswitch)	RHEB-201	

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STA/T Step	PROCEDURES	Panel	REMARKS
6.4.17.2.5	Telecommunications.		
	VHF-FM switch - ON	MDC-20	
	VHF-AM-T/R/OFF/REC switch - T/R		
	VHF-AM-RCVR switch - 1		
	VHF-AM-SQUELCH control - as desired		
	VHF ANTENNA switch - UPPER or LOWER as required		
	S-BAND-XPONDER/OFF/XPONDER PWR AMPL switch - XPONDER PWR AMPL		
	S-BAND-PWR AMPL switch - LOW		
	S-BAND-OSC switch - PRIM		
	S-BAND-ANTENNA switch - AUTO, UPPER, or LOWER		
	C-BAND switch - 1 PULSE or 2 PULSE		
	POWER switch - VOX	MDC-26, -13, -23	
	S-BAND switch - REC		
	HF switch - OFF		
	VHF-AM switch - T/R		
	INTERCOM switch - T/R		
	S-BAND-VOICE-RNG/RNG ONLY switch - off (center)	MDC-20	
	S-BAND-TAPE/ANALOG switch - off (center)		
	S-BAND-TV/PLSS switch - off (center)		
	S-BAND-EMERG switch - off (center)		
	POWER-PMP switch - ON		
	POWER-SCE switch - ON		
	TLM INPUTS-PCM switch - HIGH		
	UP-DATA switch - UHF		
	TAPE RECORDER-PLAY switch - OFF		
	TAPE RECORDER-SPEED switch - off (center)		

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STA/T Step	PROCEDURES	Panel	REMARKS
6.4.17.2.6	Controls and Displays.		
	CAUT/WARN-POWER switch - 1	MDC-11	
	C/W switch - NORMAL	MDC-13	
	FLOODLIGHTS PRIMARY control - as required	MDC-26, -23	
	LIGHTING-FLOODS-PRIMARY control - as required	LEB-100	
	LIGHTING-FLOODS-SEC switch - ON and OFF as required		
6.4.17.3	<u>Limited Use Circuit Breakers.</u>		
	<p>The following list defines circuit breakers which will be open during major portions of flight time. Primary considerations are to maintain maximum crew safety, reduce consumable usage, and increase equipment reliability. A secondary consideration is that certain of the listed circuit breakers provide the only switching function used to power the equipment up or down.</p>		

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Circuit Breaker	Location	When Open	Remarks
PYRO A&B - BAT A&B TO PYRO BUS TIE (2)	LEB-150	Entire mission	Closed only when pyro batteries show discharge during EPS battery check prior to entry.
PYRO A&B - SEQ A&B (2)	LEB-150	Post S-IVB separation check	Closed during deorbit and entry procedures and pyro battery voltage checks.
ELS-A&B-BAT A&B (2)	MDC-25	Postorbital insertion check	Closed during deorbit and entry procedures.
POST LDG - BAT BUS A&B and BAT C (3)	RHEB-203	Prelaunch	Closed approximately 3 minutes prior to splash down.
F/C 1, 2 & 3 - H ₂ & O ₂ VALVE (3)	MDC-22	After activation of F/C	Closed prior to F/C deactivation.
RCS-C/M-S/M TRANSFER A&B (2)	MDC-25	Postseparation check	Closed during deorbit and entry procedures.
SPS-GIMBAL MOTOR CONTROL - PITCH & YAW - BAT A (2)	MDC-25	Orbit insertion check	Closed during launch preparation, ascent, and thrusting procedures.
G&N-OPTICS - A&B (2)	MDC-22	Prelaunch	Closed during IMU alignments and navigation programs.
G&N-IMU - A&B (2)	MDC-22	Post S-IVB separation	Closed during IMU alignments, thrusting procedures, G&N attitude hold, navigation programs, and deorbit and entry.
G&N-LIGHTING - 1&2 (2)	MDC-22	When IMU is powered down	Refer to G&N-IMU - A&B circuit breaker Remarks column.
MAIN A&B - BAT C (2)	RHEB-203	Prelaunch	Closed during deorbit and entry procedures.

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STA/T Step	PROCEDURES	Panel	REMARKS
6.5 <u>STOWAGE LISTS.</u>	<p>Unstowage checklists are prepared according to S/C area and the equipment contained therein. The lists are not time-lined and are not directed toward a specific mission phase. The Deorbit and Entry Stowage Checklist is prepared to cover all loose equipment according to compartment and S/C area.</p>		
6.5.1 UNSTOWAGE CHECKLIST - INSERTION.	<p>1 PGA stowage</p> <ul style="list-style-type: none"> UCD bags stowed LH PGA stowage bag Remove <ul style="list-style-type: none"> Waste bags (3) LH sleep restraint Stow <ul style="list-style-type: none"> PGA's (2) Life vests (3) Install - LH sleep restraint. Unstow comm helmets (3) (soft). Unstow lightweight headsets (3). RH PGA stowage bag <ul style="list-style-type: none"> Remove RH sleep restraint. Stow PGA (1). Install RH sleep restraint. Secure O₂ hose assays, as desired. 		

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STA/T Step	PROCEDURES	Panel	REMARKS
2	Lower equipment bay Remove and secure G&N optics panel cover. Scientific experiment A compartment Remove camera equipment, as required.		
3	Right-hand equipment bay Electrical adapters compartment Remove CWG electrical adapters.		
4	Left-hand forward equipment bay Loose parts compartment Remove and install G&N handholds.		
5	Aft bulkhead compartments Remove COAS.		
6.5.2	DEORBIT AND ENTRY STOWAGE CHECKLIST.		
1	Lower equipment bay G&N eyepiece components (4) - stowed Optics cover - secure Food storage doors (5) - secure Scientific experiment A compartment 16 mm camera w/film pack 16 mm camera power cable 18 mm lens (16 mm camera) 25 mm lens (16 mm camera) 100 mm lens (16 mm camera) 16 mm camera mirror assy 16 mm film packs (3) 70 mm Hasselblad camera wiring sight and film pack 250 mm lens (70 mm camera)		

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STA/T Step	PROCEDURES	Panel	REMARKS
	70 mm film packs (2) Exposure dial Spotmeter Binoculars Compartment secured SR pilot flight data file drawer Landmark maps S/C systems data Experiments checklist Star chart Orbital map Drawer secured Tool table drawer Workshelf Torque wrench Adapter handle End wrenches (2) 10" driver 4" short driver 4" CPC driver 4" torque set driver Tether Tool set pouch Drawer secured Scientific experiment B drawer M-9A goggles M-9A mouthpieces (3) 16 mm film packs (7) 70 mm film packs (8) Drawer secured		

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STA/T Step	PROCEDURES	Panel	REMARKS
	Scientific experiment C drawer Med data acq set (MDAS) Drawer secure Clinical monitoring instrument set Compartment Clin mon inst set Urine receptacle and transfer valve assy UCD clamps (3) Compartment secured Towels compartment door secured		
2	Aft bulkhead stowage TV zoom lens - stowed Compartment secured Fecal canister - stowed In-flight exerciser - stowed LH PGA stowage bag Crewman waste bags (3) Left-hand sleep restraint Fecal canister pad Bag secured RH PGA stowage bag RH sleep restraint Bag secured Compartment S COAS alignment sight, cord, and bulbs PPK's (2) Compartment secured Compartment T M-9A camera brkt PPK Compartment secured		

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STA/T Step	PROCEDURES	Panel	REMARKS
	Compartment Y PGA helmet bags Comm helmets (3) (soft) Lightweight headsets (3) Compartment secured Compartment Z Extra penlights Compartment secured		
3	Left-hand equipment bay Commander's data file bag secured T handles (2) Food compartment door secured CWG and sandal compartment Flight coveralls (3) Sandals (3) CWGs (3) Compartment secured		
4	Right-hand equipment bay Vacuum cleaner compartment Vacuum cleaner assy w/hose Compartment secured Medical accessories kit compartment Biomed accessories kit Compartment secured Scientific experiment E/towels compartment T-3 nephelometer Compartment secured Electrical adapters compartment CWG electrical adapters (3) Sanitation supplies compartment secured Auxiliary food compartment door secured		

STOWAGE LISTS

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STA/T Step	PROCEDURES	REMARKS
	<p>Pilot's flight data file bag Mission log and data Bag secured</p> <p>5 Left-hand forward equipment bay Scientific experiment D compartment Scien exp stowage box D Octopus cable Dew point sensor and control unit Compartment secured Loose parts compartment G&N short handhold G&N long handhold LEB rotational control mount Long sextant eyepiece Compartment secured Fan closure secured Water metering dispenser secured</p> <p>6 Sidewall and hatch Internal mirrors (3) secured Upper and lower external mirrors (3) - positioned and locked</p> <p>7 Crew couch items Emergency medical kit Translation control adapter TV camera mount 16 mm camera mount</p> <p>8 Kickshelf D-ring extension handle TV camera cord</p>	

STOWAGE LISTS

STA/T Step	PROCEDURES	Panel	REMARKS
9	Tunnel TV camera with wide angle lens		

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6.6 GUIDANCE AND CONTROL.

6.6.1 GUIDANCE AND CONTROL GENERAL INSTRUCTIONS.

The general instructions for the guidance and control (G&C) crew procedures section listed in the following paragraphs are divided into constraints to cover general operations; and backup procedures to provide operational procedures for contingencies.

6.6.1.1 G&C Constraints.

Certain constraints apply to the use of G&C procedures in consideration of crew safety and optimal system operation. Where applicable, the reasons for the constraints are given. The following constraints apply, unless a particular procedure specifies otherwise.

a. The ATT DEADBAND switch (MDC-8) is set to MAX to reduce the number of attitude corrections, or to prevent a large apparent altitude error from appearing upon certain mode or switch position changes.

b. When the IMU is switched from standby to operation, a one-hour delay prior to use is required to allow the inertial components to stabilize. IMU alignment may be performed 15 minutes after switching on, if so desired.

c. The AGC must be ON before the IMU can be operated.

d. DSKY operations (MDC-14 and LEB-106) require certain restrictions to operation, loading of data, and display of data which are necessary to proper operation. These restrictions are as follows:

1. For octal display verb (01-05), octal monitor verbs (11-15), and for all load verbs (21-25), the number of components of the verb must not exceed the number of components of the noun being used. If an attempt is made to violate this restriction the CHECK FAIL indicator will illuminate when ENTER is pressed to execute the verb/noun action. (Noun 01 may be used with any verb regardless of number of components.

2. No mixing of octal and decimal data will be allowed for loads having more than one component. If an attempt is made to violate this restriction, the CHECK FAIL indicator will illuminate when ENTER is pressed for the last entry.

3. Loading decimal data requires that each complete entry be made with a sign (+,-), followed by five digits. If the desired data load does not contain five significant digits, zeros (0) must be entered ahead of the most

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significant digit (e.g., for a data load of +925, the entry will be made by pressing DSKY keys +, 0, 0, 9, 2, 5, ENTER). Octal data loads only require that the significant digits be pressed.

4. Machine addresses loaded must be in octal.

5. If an attempt is made to load a data word which is too large in magnitude for the noun being used, the CHECK FAIL indicator will illuminate.

6. Verify all data loads before pressing ENTER key for the last register being loaded. (The CLEAR key has no effect after last ENTER is pressed.) If any of the data is incorrect, the register may be cleared by pressing the CLEAR key. Each successive pressing of the CLEAR key will clear the preceding register until the first register is cleared. (This backing up action will only operate on components called by the load verb used.)

7. All VERB/NOUN flashes require operator action and the program in progress is halted until appropriate action is taken.

6.6.1.2 G&C Subprocedures

The following subprocedures include frequently used sub-routines, and alternate or optional methods of performing G&C operational functions. These methods may be called for as steps or as a backup to a step in a major procedure by the exact title as shown.

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STA/T Step	PROCEDURES	Panel	REMARKS
6.6.2	BASIC GUIDANCE AND CONTROL		
6.6.2.1	<u>G&C Basic.</u>		
1	Panel 8 DIRECT RCS - ON LIMIT CYCLE - OFF ATT DEADBAND - MAX .05G ENTRY - OFF LCL VERT - OFF ΔV sw - OFF G&N/SCS - G&N AME - MONITOR A&C ROLL - OFF B&D ROLL - ON PITCH - ON YAW - ON RATE GYROS (3) - NORMAL	8	
2	Panel 25 MESC LOGIC ARM A & B - OFF CB DIRECT CONT-MNA & B - CLOSED CB A&C ROLL-MNA & B - CLOSED CB B&D ROLL-MNA & B - CLOSED CB PITCH-MNA & B - CLOSED CB YAW-MNA & B - CLOSED FDAI LTG - AC1 CB GROUP 1-AC1 & 2 - CLOSED CB GROUP 2-AC1 & 2 - CLOSED CB GROUP 1-MNA & B - CLOSED CB GROUP 2-MNA & B - CLOSED	25	

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STA/T Step	PROCEDURES	Panel	REMARKS
	G&N SYNC - OFF SPS GAUGING PWR - AC-1 CB GIMBAL-PITCH-1-BAT A - OPEN CB GIMBAL-PITCH-2-BAT B - CLOSED CB GIMBAL-YAW-1-BAT A - OPEN CB GIMBAL-YAW-2-BAT B - CLOSED CB ELS BAT A & B - OPEN		
3	Miscellaneous THC - LOCKED Rot. cont - PINNED		
4	Panel 6 ATT SET - OFF	6	
5	Panel 7 THRUST sw - OFF	7	
6	Panel 2 FCSM-G&N - OVERRIDE/RESET FCSM-SCS - OVERRIDE/RESET	2	
7	Panel 24 SCS POWER - AC1 MNA RATE GYRO POWER - AC1 TVC 1 POWER - OFF BMAG POWER - AC2 MNB ROTATION CONTROL POWER - AC2 TVC 2 POWER - OFF	24	
8	Panel 3 GIMBAL MOTORS (4) - OFF INJECT PREVALVES (2) - OFF		

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STA/T	Step	PROCEDURES	Panel	REMARKS
9	Panel 14	UPTTEL - BLOCK		
10	Panel 22	CB MESC LOGIC A & B - OPEN CB IMU HTR-MNA & B - CLOSED CB IMU - MNA & B - CLOSED CB COMPUTER-MNA & B - CLOSED CB OPTICS MNA & B - OPEN CB LIGHTING AC 1 & 2 - CLOSED G&N LIGHTING - AC1	22	
11	Panel 11	CAUT/WARN MODE - CSM	11	
12	Panel 16	CM/SM SEP A & B - OFF	16	
13	LEB	IMU TRANSFER - COMPUTER OPTICS SLAVE TELESCOPE - STAR LOS OPTICS MODE - ZERO OPTICS OPTICS HOLD - OFF OPTICS CONTROLLER SPEED - HI OPTICS CONTROLLER MODE - DIRECT IMU TEMP MODE - AUTO OVERRIDE ATTITUDE IMPULSE ENABLE - OFF CONDITION LAMPS - ON AGC MODE - ON INV PHASE LOCK - ON	101 105 107 208	

GUIDANCE AND CONTROL

NORMAL/BACKUP

COMMAND MODULE					
S/C MOTION	SCS NO.	BUS	.		SYS
+P	1	A			A
+P	3	B			B
-P	2	A			A
-P	4	B			B
+Y	5	A			A
+Y	7	B			B
-Y	6	B			B
-Y	8	A			A
+R	9	A			A
+R	11	B			B
-R	10	B			B
-R	12	A			A

Terminology reflecting jet selection is as follows:

4, 2, 2 - 4 roll, 2 pitch, 2 yaw

2, 2, 2 - 2 roll, 2 pitch, 2 yaw

2, 1, 1 - 2 roll, 1 pitch, 1 yaw

1, 1, 1 - 1 roll, 1 pitch, 1 yaw

When a jet select control setup (other than 4, 2, 2) is determined, the quantities of each quad should be obtained and the fullest quad(s) used.

Figure 6-1. RCS Jet Select

SERVICE MODULE					
S/C MOTION	SCS NO.	BUS			SYS
+P/+X	1	A			C
-P/+X	2	A			A
+P/-X	3	B			A
-P/-X	4	B			C
+Y/+X	5	B			D
-Y/+X	6	B			B
+Y/-X	7	A			B
-Y/-X	8	A			D
+R/+Z	9	A			B
-R/+Z	10	B			D
+R/-Z	11	B			D
-R/-Z	12	A			B
+R/+Y	13	A			A
-R/+Y	14	B			C
+R/-Y	15	B			C
-R/-Y	16	A			A

STA/T Step	PROCEDURES	Panel	REMARKS
6.6.2.2	<u>SCS Power Control Procedures.</u>		
1	SCS Power Down Set controls - G&C BASIC except: SCS POWER - OFF RATE GYRO POWER - OFF BMAG POWER - OFF ROTATION CONTROL POWER - OFF SCS-CHANNELS (4) - OFF	24 8	
2	SCS Power Up Set controls - G&C BASIC except: RATE GYRO (3) - BMAG G&N/SCS - SCS FDAI-SELF TEST - ON One minute (minimum) after PARTIAL SCS POWER-ON, RATE GYRO (3) - NORMAL	8 2 8	
6.6.2.3	<u>SCS Subprocedures.</u> Gimbal Motor Selection for Deorbit with Gimbal Motor Failure		 This procedure assumes a multiple failure wherein the No. 1 system has failed and the automatic transfer to No. 2 accomplished. Subsequently, the No. 2 system has been determined inoperable. Crew personnel may then initiate this procedure to enable the No. 1 SPS gimbal system for deorbit. The failure sensing circuit is eliminated permitting use of the No. 1 system regardless of electrical load required to drive the engine gimbals.

STA/T	Step	PROCEDURES	Panel	REMARKS
1	No. 1 failure			
		GIMBAL MOTORS - PITCH 1 & YAW 1 - OFF	3	
2	No. 2 failure			
	<u>WARNING</u>	Do not engage MTVC in this mode. Engaging MTVC will inhibit servo No. 1 clutch control.		
		GIMBAL MOTORS - PITCH 1 & YAW 1 - START & HOLD		
		CB PITCH 1 & BAT A - OPEN	25	
		CB YAW 1 & BAT A - OPEN		
		GIMBAL MOTORS - PITCH 1 & Yaw 1 - RELEASE	3	
		GIMBAL MOTORS - PITCH 2 & YAW 2 - OFF		
6.6.2.4	<u>Monitor Procedures.</u>			
1	Free drift establishment and monitor (POO)			
	Set controls - G&C BASIC except:			
	Jet select - as desired			
	RATE GYROS (3) - BMAG	8		
	AME - ATTITUDE			
	SCS CHANNELS - OFF			
	AGC MODE - STANDBY	107		
	CONDITION LAMPS - OFF	105		
	CB LIGHTING AC 1 & 2 - OPEN	22		
	CB IMU MNA & B - OPEN			
	Adjust drift with DIRECT RCS			

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STA/T Step	PROCEDURES	Panel	REMARKS
	Backup:		
	B&D ROLL, PITCH, YAW - ON	8	
	ATTITUDE IMPULSE-ENABLE - ON	105	
	ATTITUDE IMPULSE cont - adjust rates		
	ATTITUDE IMPULSE ENABLE - OFF		
	SCS CHANNELS (4) - OFF	8	
	SCS POWER - OFF	24	
	AME - MONITOR		
6.6.2.5	<u>Attitude Control Procedures.</u>		
1	SCS Attitude Hold		Attitude should hold within the limits of maximum dead band.
	Set controls - G&C BASIC except:		
	Jet select - as desired		
	LIMIT CYCLE - ON	8	
	G&N/SCS - SCS		
	AME - ATTITUDE		
	If G&N on, POO	14	
	FINE ALIGN lt - ON	101	
	FDAI - attitude, error and rates	4	
	Backup:		
	TWO AXIS ATTITUDE HOLD (P & Y)		
	RATE GYRO-ROLL - BMAG	8	
	Roll rate as desired		
	Check external reference		
	Rot. cont - pinned		

GUIDANCE AND CONTROL

NORMAL/BACKUP

STA/T	Step	PROCEDURES	Panel	REMARKS
2	Attitude maneuver to attitude set reference	Set controls - G&C BASIC except: Jet select - as desired G&N/SCS - SCS AME - ATTITUDE Obtain FDAI nav att and external cues SET ATT SET dials ATT SET - ON Maneuver FDAI - attitude errors nulled LIMIT CYCLE - ON Rot. cont - pinned ATT SET - OFF	8 6 4 8 6	
3	Attitude maneuver to attitude ball reference	Set controls - G&C BASIC except: Jet select - as desired G&N/SCS - SCS AME - ATTITUDE Obtain FDAI nav att and external cues Maneuver FDAI - attitude errors nulled LIMIT CYCLE - ON Rot. cont - pinned	8 4 8	
4	Attitude maneuver to external reference	Set controls - G&C BASIC except: Jet select - as desired G&N/SCS - SCS AME - ATTITUDE Obtain external cues Maneuver to desired external reference LIMIT CYCLE - ON Rot. cont - pinned	8	

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STA/T	Step	PROCEDURES	Panel	REMARKS
5		Coarse SCS attitude reference alignment to IMU gimbal angles		
		Set controls - G&C BASIC except:		
		Jet select - as desired		
		POO	14	
		FDAI - read nav total attitude	4	
		Set ATT SET dials	6	
		THC - CW		
		ΔV sw - ON	8	
		G&N/SCS - SCS		
		AME - ATTITUDE		
		FDAI ALIGN - PRESS	6	
		ΔV sw - OFF	8	
		AME - MONITOR		
		FDAI - ball motion within dead band limits	4	
		G&N/SCS - G&N	8	
		THC - neutral		
6		Precise SCS attitude reference alignment to IMU gimbal angles		
		Set controls - G&C BASIC except:		
		AME - ATTITUDE	8	
		ATT DEADBAND - MIN		
		Jet select - as desired		
		POO	14	
		V44E		
		ATT CONT 1t - ON		
		V16 N20E display gimbal angles		
		SET ATT SET dials	6	
		ΔV sw - ON	8	
		FDAI ALIGN - PRESS (32 sec)	6	

GUIDANCE AND CONTROL

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	ΔV sw - OFF	8	
	G&N/SCS - SCS		
	FDAI - no ball/roll bug movement	4	
	G&N/SCS - G&N	8	
	ATT DEADBAND - MAX		
	V34E	14	
7	SCS attitude reference comparison		
	Set controls - G&C BASIC except:		
	G&N/SCS - SCS	8	
	AME - ATTITUDE		
	POO	14	
	VL6 N2OE display gimbal angles		
	Set ATT SET dials	6	
	ATT SET - ON		
	ATT SET dials (3) - null errors	6,4	
	ATT SET (3) - record		
	ATT SET - OFF		
	V34E	14	
8	Precise wobble mode (CSP)		
C	Maneuver S/C to desired attitude		
	RATE GYRO (3) - BMAG	8	
	AME - MONITOR		
	Jet select - as desired		
	Establish pitch up and yaw right rates		
	0.1 to 0.2°/sec		
	PITCH & YAW - OFF		
	Initiate +0.5°/sec roll rate		
	A&C ROLL, B&D ROLL (2) - OFF		
	Rot. cont - neutral		
	PARTIAL SCS POWER - OFF	24	
	Rot. cont - pinned		
	If G&N on - G&N POWER DOWN paragraph 6.6.5.11.		

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STA/T Step	PROCEDURES	Panel	REMARKS
6.6.2.6	<u>SCS - ARS and/or IMU Alignment (AGC Failed, CDU Cover Removed).</u>		
1	Obtain update: Prim & sec nav stars Euler angles for att set and ICDU's Boresight star and boresight reticle coordinates		
2	Maneuver to sighting attitude ATT DEADBAND - MIN Set ATT SET dials	8 6	
3	Set ICDU Position shaft to 180° and trunnion to 7.5° ATT IMP ENABLE - ON Locate primary nav star at 50° mark on "R" line of SCT reticle and maintain while positioning secondary nav star on "R" line.	104,105 105	
4	ATT SET - ON	6	
5	When stars are positioned in SCT and SC rates are nulled: ATT IMP ENABLE - OFF IMU MANUAL ALIGN PB - press	105 101	
6	FDAI ALIGN - press	6	

STA/T Step	PROCEDURES	Panel	REMARKS
7	Set ATT SET dials to: For orbit change - 180°, 328°, 0° For deorbit - 180°, 212°, 0°		
8	Maneuver SC to ΔV attitude; For orbit change - 180°, 0°, 0° (Ω) For deorbit - 180°, 180°, 0° () Null ATT ERRORS		
6.6.3	SCS ORBIT CHANGE.		
1	Pre ΔV preparation Obtain orbit change update Loose equipment stowed Set DET for TTI Set COMM MODE Systems Periodic Verification, paragraph 6.4.3	8,5 20	
2	Set controls - G&C BASIC except: Set ATT SET dials ATT SET - ON G&N/SCS - SCS AME - ATTITUDE FCSM - G&N to OVERRIDE/RESET SCS to SCS FDAI BRIGHTNESS - adjust	6 8 2	
3	Maneuver to ΔV attitude FDAI - errors nulled LIMIT CYCLE - ON Confirm attitude - external ref ATT SET - OFF	4 8 6	

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STA/T	Step	PROCEDURES	Panel	REMARKS						
4	Set up for 2 jet ullage									
		<table><tr><th>To use</th><th>OPEN</th></tr><tr><td>Quad B&D Yaw jets - Y axis</td><td>CB PITCH MNA CB YAW MNA</td></tr><tr><td>Quad A&C Pitch jets - Z axis</td><td>CB PITCH MNB CB YAW MNB</td></tr></table>	To use	OPEN	Quad B&D Yaw jets - Y axis	CB PITCH MNA CB YAW MNA	Quad A&C Pitch jets - Z axis	CB PITCH MNB CB YAW MNB	25	
To use	OPEN									
Quad B&D Yaw jets - Y axis	CB PITCH MNA CB YAW MNA									
Quad A&C Pitch jets - Z axis	CB PITCH MNB CB YAW MNB									
5	Pre-ignition preparation									
	MAIN BUS TIE (2) - ON		22							
	PHASE LOCK - ON		208							
	AC BUS 2-RESET - OFF									
	INVERTER-2 - MN B		18							
	INVERTER-1-AC BUS 2 - OFF									
	INVERTER-2-AC BUS 2 - ON									
	AC BUS 2-RESET - CENTER									
	Check AC and DC ind									
	Set gimbal trim		6							
	Set ATT SET dials - R , P , Y									
05:00	6	Gimbal checkout								
	Set controls:									
	TVC 1 POWER - AC 1, MNA		24							
	TVC 2 POWER - AC 2									
	ΔV counter - SET		7							
	CB GIMBAL PITCH 1 BAT A - CLOSED		25							
	CB GIMBAL YAW 1 BAT A - CLOSED									
	GIMBAL PITCH 2 - START, ON		3							

GUIDANCE AND CONTROL

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	GIMBAL YAW 2 - START, ON		
	Confirm trim control on GPI	6	
	GIMBAL PITCH 1 - START, ON	3	
	GIMBAL YAW 1 - START, ON		
	ΔV sw - ON		
	SCS CHANNEL (4) - OFF	8	
	THC - CW		
	MTVC control - check		
	ΔV sw - OFF	8	
	Att dead band - MIN		
	G&D roll, pitch, yaw channels - ON		
	Null att error needles	4	
	THC - neutral		
	ΔV sw - ON	8	
	Confirm and trim GPI	6	
-02:00 7	Report TTI - 2 min		
	THRUST sw - NORMAL	7	
	INJECT PREVALVES (2) - ON	3	
	Prim THC - ARMED		
	FDAI ALIGN - PRESS	6	
-00:20 8	Start ullage		
00:00 9	THRUST ON PB - press for ignition	7	
	THRUST ON 1t - ON		
	Backup: DIRECT ON		
	Terminate ullage		
	ΔV REMAINING - 00000		

GUIDANCE AND CONTROL

STA/T Step	PROCEDURES	Panel	REMARKS
	THRUST ON lt - out Backup cutoff with THRUST sw THRUST sw - OFF Report engine - OFF		
10	Set controls after tailoff: SCS CHANNELS - OFF GIMBAL MOTORS (4) - OFF INJECT PREVALVES (2) - OFF ATT DEADBAND - MAX LIMIT CYCLE - OFF ΔV sw - OFF TVC POWER 1 & 2 - OFF CB GIMBAL PITCH 1 BAT A - OPEN CB GIMBAL YAW 1 BAT A - OPEN THC - NEUTRAL, LOCKED FCSM - G&N - OVERRIDE/RESET SCS - OVERRIDE/RESET MAIN BUS TIE (2) - OFF PHASE LOCK - OFF AC BUS 2-RESET - OFF INVERTER 2 - OFF INVERTER 2-BUS 2 - OFF INVERTER 1-BUS 2 - ON AC BUS 2 RESET - CENTER Record SPS propellant remaining	8 3 8 24 25 2 22 208 18 20	
11	Charge batteries, para 6.4.4		

STA/T	Step	PROCEDURES	Panel	REMARKS
	6.6.4	SCS DEORBIT AND ENTRY.		
	6.6.4.1	<u>Pre-Entry Preparation.</u>		
	1	Systems preparation		
		Cabin cold soak GETI - 8 hrs		
		F/C purge GETI - 6 hrs	18	
		Stowage checklist complete		
		Obtain retro update		
		Set DET for TTI	8,5	
		Set COMM MODE	20	
		Propellant periodic verification -		
		1 & 2, Para 6.4.2		
		ECS periodic verification check - 1,		
		Para 6.4.7		
		EPS periodic verification C - 3, Para 6.4.3		
		CB-MAIN A&B-BAT C - CLOSE	203	
		Backup:		
		If PYRO BAT A or B checks low: <32.0 vdc		
		PYRO BAT CB SEQ A or SEQ B - OPEN	150	
		CB BAT A or BAT B TO PYRO BUS TIE -		
		CLOSED		
CP	2	Fill ECS entry tank		
P		O ₂ PRESS IND - SURGE TANK	13	
		TANK PRESSURE-1-O ₂ - 865 - 935 psia		
C		OXYGEN-ENTRY valve - FILL	307	
P		TANK PRESSURE-1-O ₂ - 865 - 935 psia	13	
C		OXYGEN-ENTRY valve - ON	307	
CSP	3	Configure ECS:		
P		GLYCOL EVAP-TEMP IN - AUTO (MAN for RCS	13	
		deorbit)		

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STA/T Step	PROCEDURES	Panel	REMARKS
CSP	PGAs - CLOSED		
S	Remove attenuation panel		
	SUIT CIRCUIT RETURN SHUT-OFF - CLOSED	319	
	GLYCOL EVAP TEMP IN valve - as is (FULL HOT (CCW) for RCS deorbit)	311	
	Install attenuation panel		
	GLYCOL PRESS RELIEF BYPASS (2) - ON (OFF for RCS deorbit)	309	
C	GLYCOL TO RAD - CLOSE	307	
	GLYCOL RESERVOIR-BYPASS - OPEN (CLOSE for RCS deorbit)		
	GLYCOL RESERVOIR-INLET - CLOSED		
	GLYCOL RESERVOIR-OUTLET - CLOSE		
	CABIN PRESSURE RELIEF (2) - BOOST ENTRY (safety latch off)		
4*	C/M RCS engine preheating		
	CB C/M-S/M TRANSFER A & B - CLOSED	25	
C	C/M PROP JETT-LOGIC - ON	8	
-26:00	FUNCTION SELECT - B	200	
S	TEST SELECT -1, 2, 3, 4, 11, 12	200	
	If any reading 1.80 TEST SELECT - lowest		
	C/M RCS HTRS - ON		
	DC VOLTS - 2.50 or 13 minutes		
	C/M RCS HTRS - OFF		
5	Deorbit retro procedure		
CS	Set controls - G&C BASIC except:		
	Jet select - as desired		
C	Set ATT SET dials - R, P, Y (R 0, P 212, Y 0 for RCS)	6	
*May be accomplished after retro burn for RCS deorbit.			

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STA/T Step	PROCEDURES	Panel	REMARKS										
	ATT SET - ON	8											
	G&N/SCS - SCS												
	AME - ATTITUDE												
	FCSM - G&N to OVERRIDE/RESET (omit for RCS)	2											
	SCS to SCS												
	FDAI BRIGHTNESS - adjust												
6	Maneuver to retro attitude:												
	FDAI - errors nulled	4											
	LIMIT CYCLE - ON	8											
	Confirm attitude - external ref	6											
	ATT SET - OFF												
7	Set up for 2 jet ullage (omit for RCS)												
	<table><tr><td>To use</td><td>OPEN</td></tr><tr><td>Quad B&D</td><td></td></tr><tr><td>Yaw jets - Y axis</td><td>CB-PITCH MNA CB-YAW MNA</td></tr><tr><td>Quad A&C</td><td></td></tr><tr><td>Pitch jets - Z axis</td><td>CB-PITCH MNB CB-YAW MNB</td></tr></table>	To use	OPEN	Quad B&D		Yaw jets - Y axis	CB-PITCH MNA CB-YAW MNA	Quad A&C		Pitch jets - Z axis	CB-PITCH MNB CB-YAW MNB		
To use	OPEN												
Quad B&D													
Yaw jets - Y axis	CB-PITCH MNA CB-YAW MNA												
Quad A&C													
Pitch jets - Z axis	CB-PITCH MNB CB-YAW MNB												
8	Pre-ignition preparation:												
	MAIN BUS TIE (2) - ON (omit for RCS)	22											
	PHASE LOCK - ON	208											
	AC BUS 2-RESET - OFF												
	INVERTER-2 - MNB	18											
	INVERTER-1-AC BUS 2 - OFF												

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STA/T Step	PROCEDURES	Panel	REMARKS
C	INVERTER-2-AC BUS 2 - ON		
	AC BUS 2-RESET-CENTER		
	Check AC & DC ind		
	Set gimbal trim	6	
	Null att errors	6,4	
	FDAI ALIGN - press	6	
	NOTE Perform step 9 for RCS burns only		
9	RCS burn procedures		
	TVC 1 POWER - AC 1 MNA	24	
	ΔV COUNTER - set	8	
	LIMIT CYCLE - OFF		
00:00	Ignition:		
	THC - +X		
	Backup: DIRECT ULLAGE PB - press	7	
	ΔV REMAINING - 00000		
	THC - neutral	24	
	TVC-1 POWER - OFF		
	Go to SEP procedures, step 15		
05:00 10	Gimbal checkout		
	Set controls:		
	TVC 1 POWER - AC1 MNA	24	
	TVC 2 POWER - AC2		
	ΔV counter - SET	7	
	CB-GIMBAL PITCH 1 BAT A - CLOSED	25	
	CB-GIMBAL YAW 1 BAT A - CLOSED		
	GIMBAL PITCH 2 - START - ON		
	GIMBAL YAW 2 - START - ON		
	Confirm trim control on GPI	6	
	GIMBAL PITCH 1 - START - ON	3	

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STA/T	Step	PROCEDURES	Panel	REMARKS
		GIMBAL YAW 1 - START - ON	8	
		ΔV sw - ON		
		SCS CHANNELS - OFF	8	
		THC - CW		
		MTVC control - check	4	
		ΔV sw - OFF	8	
		ATT DEADBAND - MIN		
		SCS CHANNELS - ON		
		Null att error needles	4,6	
		THC - neutral		
		ΔV sw - ON	8	
		Confirm and trim GPI	6	
02:00	11	Report TTI = 2 min		
		THRUST sw - NORMAL	7	
		INJECT PREVALVES (2) - ON	3	
		PRIM THC - ARMED	6	
		FDAI align - PRESS		
00:20	12	Start ullage		
00:00	13	THRUST ON PB - press for ignition	7	
		THRUST ON 1t - on		
		Backup: DIRECT ON		
		Terminate ullage		
		ΔV REMAINING - 00000		
		THRUST ON 1t - out		
		Backup cutoff with THRUST sw		
		THRUST sw - OFF		
		Report engine - OFF		

GUIDANCE AND CONTROL

STA/T	Step	PROCEDURES	Panel	REMARKS
C	14	Set controls after tailoff: GIMBAL MOTORS (4) - OFF INJECT PREVALVES (2) - OFF ATT DEADBAND - MAX LIMIT CYCLE - OFF ΔV sw - OFF TVC POWER 1 & 2 - OFF THC - NEUTRAL, LOCKED	3 8 24 2	
	15	C/M-S/M SEPARATION PROCEDURE Set controls - G&C BASIC except: Set ATT SET dials - R , P , Y ATT SET - ON	6	
	16	Maneuver to separation attitude: ATT DEADBAND - MIN FDAI - errors nulled LIMIT CYCLE - ON Confirm attitude - external ref ATT SET - OFF	8	
	6.6.4.2 <u>SCS Separation and Entry.</u>			
	1	Set controls OXYGEN-SM SUPPLY valve - OFF LIMIT CYCLE - OFF AME - ENTRY MAIN BUS TIE (2) - ON (RCS ONLY) CB-F/C H ₂ & O ₂ valves (3) - CLOSE F/C MAIN BUS A & B (6) - OFF F/C REACTANTS (3) - OFF F/C PUMPS (3) - OFF CB MESC ARM BAT A & B - CLOSED CB MESC LOGIC BAT A & B - CLOSED	307 8 22 18 22	

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NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	MESC LOGIC ARM 1 & 2 (2) - ARM		
	CB A&C ROLL MNA & B - OPEN	25	
	CB B&D ROLL MNB - OPEN		
	CB PITCH MNA - CLOSED		
	CB PITCH MNB - OPEN		
	CB YAW MNA - CLOSED		
	CB YAW MNB - OPEN		
	CB ELS BAT A & B - CLOSED		
	MESC PYRO ARM 1 & 2 - ARM	25	
	C/M PROP JETT LOGIC - ARM	8	
	C/M RCS PROP. A & B - ON	15	
	OX DUMP-RCS CMD - AUTO	16	
	RCS C/M PRESS - PRESS	12	
	RCS indicators - CM A then B		
	RCS TRANS - CM	16	
	Test C/M jets - roll, yaw only		
	C/M-S/M SEP A & B (2) - SEP	15	
	ATT DEADBAND - MAX	8	
	C&W MODE sw - C/M	13	
	FLT QUAL RCDR - RECORD	19	
	USBE MODE - HBR with high power	20	
	VHF-FM - ON		
	TAPE RECORDER - RECORD		
	FWD/REV - FWD (from beginning)		
	TAPE SPEED - NORMAL		
	VHF ANTENNA - UPPER		
	S-BAND ANTENNA - UPPER		
2	Maneuver to entry attitude		
	ATT errors - nulled	4	
	Confirm attitude - external ref		
	ATT SET - OFF	6	

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STA/T	Step	PROCEDURES	Panel	REMARKS
	3	DET - monitor for .05G time .05G ENTRY - ON ATT DEADBAND - MAX Fly entry profile	5 8	
50K ft:	4	ELS LOGIC - LOGIC ELS AUTO - AUTO Panel 5 - UNLOCK C/M UNSTABLE RCS CMD - OFF APEX COVER JETT PB - press DROGUE DEPLOY PB - press (2 sec after apex cover jett) C/M STABLE	16 5 16 5 .	
45K ft:	5	RCS CMD - OFF RCS CHANNELS (4) - OFF APEX COVER PB - JETT DROGUE DEPLOY PB - press (2 sec after apex cover jett)	8 5	
24K ft:	6	MAIN DEPLOY PB - press CABIN PRESSURE RELIEF (2) - CLOSE (safety latch off) C/M PROP JETT DUMP - DUMP DET - RESET - START Couch UNLOCK - UNLOCK (Check for unlock or pull 4 pins) Set watch	5 307 8	
00:00		C/M PROP JETT PURGE - PURGE C/M RCS He DUMP - DUMP		
02:40				

GUIDANCE AND CONTROL

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	Backup: Rot. hand cont to zero He press		
	NO PITCH		
	CABIN PRESSURE RELIEF (2) - BOOST ENTRY	307	
	(safety latch off)		
	C/M PROP JETT-LOGIC - OFF	8	
	C/M RCS PRPLNT-A & B (2) - OFF		
	S-BAND XPONDER - OFF	20	
	C-BAND - OFF		
	VHF-FM - OFF		
	RECOVERY VHF - ON		
	VHF ANTENNA - RECOVERY		
	CB POSTLDG BAT BUS A, B, AND BAT C -	203	
	CLOSE		
	MAIN BUS TIE (2) - OFF		
	DIRECT O ₂ - OPEN (CCW)	24	
	SPLASHDOWN		

GUIDANCE AND CONTROL

STA/T Step	PROCEDURES	Panel	REMARKS
	<p>6.6.5 G&N GENERAL PROCEDURES.</p> <p>6.6.5.1 <u>Verb List.</u></p> <p>01 Disp oct compnt 1 (R1) 02 Disp oct compnt 2 (R1) 03 Disp oct compnt 3 (R1) 04 Disp oct compnt 1, 2 (R1,R2) 05 Disp oct compnt 1, 2, 3 06 Disp decimal 07 DP decimal disp (R1,R2) 10 Request waitlist 11 Monitor octal compnt 1 (R1) 12 Monitor octal compnt 2 (R1) 13 Monitor octal compnt 3 (R1) 14 Monitor octal compnt 1, 2 (R1,R2) 15 Monitor octal compnt 1, 2, 3 16 Monitor decimal 17 Monitor DP decimal (R1,R2) 20 Request executive 21 Load compnt 1 (R1) 22 Load compnt 2 (R2) 23 Load compnt 3 (R3) 24 Load compnt 1, 2 25 Load compnt 1, 2, 3 31 Bank disp 33 Pro W/O data 34 Terminate prog 35 Release disp system 36 Fresh start 37 Change prog 40 Zero (ICDU or OCDU) 41 Coarse align (ICDU or OCDU)</p>		

STA/T Step	PROCEDURES	Panel	REMARKS
42	Fine align IMU		
43	Lock IMU		
44	Set IMU to att control		
45	Set IMU to re-entry control		
46	Return IMU to coarse align		
50	Please perform		
51	Please mark		
52	Reject mark		
53	Free (ICDU or OCDU)		
54	Pulse torque gyros		
55	Align time		
56	Perform banksum		
57	System test		
60	Prepare for stdby		
61	Recover from stdby		
64	Disp orbl parmts		
65	Calc T of arr at long		
66	Calc lat long at spec T		
67	Calc max dec, T or arr		
70	Man att maneuver		
71	MTVC takeover		
72	Min imp aim pt update		
73	Ret-earth aim pt update		
74	Orb chge aim pt update		
75	Perform backup lift-off		
76	R, V, T update (state vec)		
77	Lift-off time update		
6.6.5.2 <u>Noun List.</u>			
01	Specify machine address (fract)	.XXXXX	
02	Specify machine address (whole)	XXXXX.	
05	Angular error	XXX.XX DEG	

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STA/T Step	PROCEDURES	Panel	REMARKS
07	Change of program (perform)	OCTAL	
11	Engine on enable (perform)		
12	Gimbal angles Roll	XXX.XX DEG	
	Pitch	XXX.XX DEG	
	Yaw	XXX.XX DEG	
13	Delta V measured	XXXXX. FT/SEC	
14	Delta V counter setting	XXXXX. FT/SEC	
15	Increment machine address	OCTAL	
16	AGC clock time	00XXX. HRS	
		000XX. MIN	
		0XX.XX SEC	
17	Final ICDU angles Roll	XXX.XX DEG	
	Pitch	XXX.XX DEG	
	Yaw	XXX.XX DEG	
20	Present ICDU angles Roll	XXX.XX DEG	
	Pitch	XXX.XX DEG	
	Yaw	XXX.XX DEG	
21	PIPA pulses X	XXXXX. PULSES	
	Y	XXXXX. PULSES	
	Z	XXXXX. PULSES	
22	New angles I X	XXX.XX DEG	
	Y	XXX.XX DEG	
	Z	XXX.XX DEG	
23	Delta angles I	XXX.XX DEG	
		XXX.XX DEG	
		XXX.XX DEG	
24	Delta time for AGC clock	00XXX. HRS	
		000XX. MIN	
		0XX.XX SEC	
25	Checklist (please perform)	XXXXX.	
26	Prio/delay	XXXXX.	
27	Self-test ON/OFF sw	XXXXX.	
30	Star number	+000XX.	

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STA/T	Step	PROCEDURES	Panel	REMARKS
31	Failure info	Fail reg Sfail Ercount	OCTAL OCTAL OCTAL	
33	Time of ignition		00XXX. HRS 000XX. MIN 0XX.XX SEC	
34	Event time		00XXX. HRS 000XX. MIN 0XX.XX SEC	
35	Delta event time		00XXX. HRS 000XX. MIN 0XX.XX SEC	
36	Delta event time		XXBXX MIN/SEC	
37	Sighting identification		OCTAL	
40	Gamma		XXX.XX DEG	
	Inertial velocity (VI),		XXXXX. FT/SEC	
	Altitude above launch pad (HPAD)		XXXX.X NM	
41	Max acceleration (Gmax),		XXX.XX G	
	Perigee altitude (HP)		XXXX.X NM	
	Free-fall time (TFF)		XXBXX MIN/SEC	
42	Miss distance (delta R),		XXXX.X NM	
	Perigee altitude (HP)		XXXX.X NM	
	Free-fall time (TFF)		XXBXX MIN/SEC	
43	Apogee altitude (HA),		XXXX.X NM	
	Perigee altitude (HP),		XXXX.X NM	
	Free-fall time (TFF)		XXBXX MIN/SEC	
44	Latitude,		XXX.XX DEG	
	Longitude		XXX.XX DEG	
	Altitude		XXXX.X NM	
45	Apogee altitude (HA)		XXXX.X NM	
	Perigee altitude (HP)		XXXX.X NM	
	Delta V required		XXXXX. FT/SEC	

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STA/T Step	PROCEDURES	Panel	REMARKS
46	Time to event, Velocity to be gained (VG), Perigee altitude (HP)	XXBXX MIN/SEC XXXXX. FT/SEC XXXX.X NM	
47	Gamma at EI, Miss distance (delta R), Inertial velocity (VI at EI)	XXX.XX DEG XXXX.X NM XXXXX. FT/SEC	
50	Time to event, (IG) Delta time burn Delta V measured	XXBXX MIN/SEC XXBXX MIN/SEC XXXXX. FT/SEC	
51	Time to event (IG or ECO) Velocity to be gained (VG), Measured velocity change along XSC	XXBXX MIN/SEC XXXXX. FT/SEC XXXXX. FT/SEC	
52	Time to event (ECO) Velocity to be gained (VG) Free-fall time (TFF)	XXBXX MIN/SEC XXXXX. FT/SEC XXBXX MIN/SEC	
53	Max acceleration (Gmax), Gamma EI Free-fall time (TFF)	XXX.XX G XXX.XX DEG XXBXX MIN/SEC	
54	Command roll angle (beta) Present acceleration (G), Range to targ	XXX.XX DEG XXX.XX G XXXX.X NM	
55	OCDU (Shaft) (Trunnion)	XXX.XX DEG XX.XXX DEG	
56	Mark data (Shaft) (Trunnion)	XXX.XX DEG XX.XXX DEG	
57	New angles OCU (Shaft) (Trunnion)	XXX.XX DEG XX.XXX DEG	
60	IMU mode status In3 Waskset Olderr	OCTAL OCTAL OCTAL	
61	Target Azimuth Elevation	XXX.XX DEG XX.XXX DEG	

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NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
62	Impact latitude Impact longitude Heads up/down	XXX.XX DEG XXX.XX DEG +00001/-00001	
63	Latitude Longitude/2 Altitude	XX.XXX DEG XX.XXX DEG XXX.XX NM	
64	Present lat Present long Present alt	XXX.XX DEG XXX.XX DEG XXXX.X NM	
65	Sampled AGC clock time	00XXX. HRS 000XX. MIN 0XX.XX SEC	
66	System test results	XXXXX. XXXXX. XXXXX.	
67	Delta gyro angles X Y Z	XX.XXX DEG XX.XXX DEG XX.XXX DEG	
70	Pitch trim Yaw trim Delta time tail-off	XXX.XX DEG XXX.XX DEG XXX.XX SEC	
71	Command roll angle (beta), Present acceleration (G), Predicted range-range to targ	XXX.XX DEG XXX.XX G XXXX.X NM	
72	Delta position X Y Z	XXXX.X KILO XXXX.X KILO XXXX.X KILO	
73	Delta velocity X Y Z	XXXX.X M/SEC XXXX.X M/SEC XXXX.X M/SEC	
74	Delta velocity allowable Delta time tail-off	XXXXX. FT/SEC XXX.XX SEC	

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STA/T Step	PROCEDURES	Panel	REMARKS
75	Delta position magnitude Delta velocity magnitude Multiple mark counter	XXXX.X NM XXXXX. FT/SEC 00XXX.	
	6.6.5.3 <u>Star List.</u>		
	<u>NO.</u> <u>STAR NAME</u>		
	1 Alpheratz		
	2 Diphda		
	3 Cassiopeia		
	4 Achernar		
	5 Polaris		
	6 Acamar		
	7 Menkar		
	8 Mirfak		
	9 Aldebaran		
	10 Rigel		
	11 Capella		
	12 Canopus		
	13 Sirius		
	14 Procyon		
	15 Regor		
	16 Dnoces		
	17 Alphard		
	18 Regulus		
	19 Denebola		
	20 Gienah		
	21 Acrux		
	22 Spica		
	23 Alkaid		
	24 Menkent		

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STA/T	Step	PROCEDURES	Panel	REMARKS																																																																																
<table><tr><th><u>NO.</u></th><th><u>STAR NAME</u></th><td colspan="3"></td></tr><tr><td>25</td><td>Arcturus</td><td colspan="3"></td></tr><tr><td>26</td><td>Alphecca</td><td colspan="3"></td></tr><tr><td>27</td><td>Antares</td><td colspan="3"></td></tr><tr><td>28</td><td>Atria</td><td colspan="3"></td></tr><tr><td>29</td><td>Rasalhaque</td><td colspan="3"></td></tr><tr><td>30</td><td>Vega</td><td colspan="3"></td></tr><tr><td>31</td><td>Nunki</td><td colspan="3"></td></tr><tr><td>32</td><td>Altair</td><td colspan="3"></td></tr><tr><td>33</td><td>Dabih</td><td colspan="3"></td></tr><tr><td>34</td><td>Peacock</td><td colspan="3"></td></tr><tr><td>35</td><td>Deneb</td><td colspan="3"></td></tr><tr><td>36</td><td>Enif</td><td colspan="3"></td></tr><tr><td>37</td><td>Formalhaut</td><td colspan="3"></td></tr></table>					<u>NO.</u>	<u>STAR NAME</u>				25	Arcturus				26	Alphecca				27	Antares				28	Atria				29	Rasalhaque				30	Vega				31	Nunki				32	Altair				33	Dabih				34	Peacock				35	Deneb				36	Enif				37	Formalhaut													
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STA/T Step	PROCEDURES	Panel	REMARKS																																																																				
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6.6.5.4	<u>Checklist Codes.</u>																																																																						
00001	SCS - G&N attitude																																																																						
00002	SCS - G&N delta V																																																																						
00003	SCS - G&N entry																																																																						
00004	SCS - SCS attitude																																																																						
00007	Att trim manuev enable																																																																						

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STA/T Step	PROCEDURES	Panel	REMARKS
00011	Auto optics pos		
00012	Target data entry		
00013	SW OSS to comp cont		
00014	Fine align check		
00015	Perform star acq		
00016	Terminate mark sequence		
00031	Engine on		
00035	Prep AGC for THRUST		
00036	THRUST terminate		
00041	CM/SM sep		
00051	Final IMU/final vehicle		
00052	Interim IMU/final vehicle		
00053	Final IMU/interim vehicle		
00054	Interim IMU/interim vehicle		
00060	IMU turn on		
00061	IMU power down		
00062	AGC power down		
6.6.5.5 <u>Error Codes.</u>			
1 <u>Optics Subsystem</u>			
00101	Zero CDU switch altered before expiration of 30-second wait		
00102	Computer unable to achieve desired optics mode		
00103	SXT-ON switch turned on with optics not in ZERO CDU mode		
00104	AGC has no desired optics angles		
00105	Internal marks request with mark system busy		
00106	SXT-ON switch not in desired state at mark time or mark with all requested marks accepted		

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STA/T Step	PROCEDURES	Panel	REMARKS
00107	Mark reject with mark system not in use		
00110	Mark reject with all requested marks accepted, or no marks sinc		
00112	No mark expected		
00122	Only one mark for unknown landmark		
00123	Mark data unavailable after restart		
2	<u>IMU Subsystem</u>		
00201	CDU ZERO switch altered before expria- tion of 30-second wait		
00202	Computer unable to acheive desired mode		
00203	No IMU mode indicated to computer		
00204	Mode switch with trn sw in COMPUTER but computer not commanding general mission program errors (error return on IMUSTALL, etc.)		
00205	Bad PIPA		
00310	Curtains		
	Procedural difficulty		
00401	Desired gimbal angles yield gimbal lock (MGA greater than 60 degrees)		
00402	Star out of field of view		
00405	SCS mode not in desired state		
00411	Maneuver in progress		
00412	Time and longitude too far apart		
3	<u>Computer Hardware Malfunctions</u>		
01101	Rupt 2 occurred		
01102	AGC self-test error (0 in SFail)		
01104	C-relay failed during C-relay test		

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STA/T Step	PROCEDURES	Panel	REMARKS
4	<u>List Overflows (All Aborts)</u>		
	01201 Executive overflow - no vac areas		
	01202 Executive overflow - no core sets		
	01203 Waitlist overflow - too many tasks		
	01204 Slight variation of 01203		
5	<u>Assembly and Operation Information</u>		
	01205 Master control overflow - too many jobs waiting		
	01206 Second job attempts to go to sleep via keyboard + display prog		
	01207 No vac area for marks		
	01210 Something already waiting in IMUSTALL		
6	<u>Interpreter Errors</u>		
	01301 Arccos-Arcsin input angle too large		
	01302 Sort called with negative argument		
7	<u>Display Alarms</u>		
	01401 THRUST misalignment exceeds 90 degrees		
	01403 Actual splash point now beyond desired		
	01405 Now less than 5 mins to desired ignition time		
	01406 Attitude maneuver has aborted		
	01407 Commanded CDUZ exceeds 60 degrees		
	01410 Entry conditions not computable		
	01411 Target lat. exceeds declination of orbit		
	01421 Navigation prog (average C) not running		

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STA/T	Step	PROCEDURES	Panel	REMARKS
	01426	IMU orientation unsatisfactory for entry (prog 61 + 62)		
	01427	IMU orientation reversed for entry (prog 61 + 62) Ball will read opposite to conventional meaning, i.e., 0 deg in roll with be lift-down		
	01430	CM/CM discrete received but not in P11 or P62		
	01431	S4B abort discrete received but not in P12 or P11		
8	<u>Keyboard and Display Program</u>			
	01501	Keyboard and display alarm during internal use (NVSUB). Abort		
	NOTES	1. 4XXXX Indicates multiple failure - more than one failure or same failure more than once. 2. XXXXX Indicates main alarms.		
		1426 and 1427 displayed for 10 sec and then program continues		
	6.6.5.6 <u>P00 - AGC Idling Program.</u>			
	1	Key V37E OOE FINE ALIGN mode light ON	14,106 101	

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STA/T Step	PROCEDURES	Panel	REMARKS
2	G&N ATTITUDE control desired Set controls - G&C BASIC except: Jet select - as desired		
3	Maneuver S/C to desired att V44E (ATT CONT 1t - ON	14,106	
4	FL V21 N23 Δ ICDU angles Accept: Load Δ angles Reject: V33E	XXX.XX DEG	
5	FL V21 N22 New ICDU angles Accept: Load new angles Reject: V33E (AGC uses old angles) Check FDAI error less than dead band AME - ATTITUDE LIMIT CYCLE - ON	XXX.XX DEG 8	
6	Terminate G&N ATTITUDE control V37E 00E	14,106	
6.6.5.7 <u>P01 - Initialization Program.</u>			
1	Set controls - G&C BASIC except: G&N/SCS - SCS	8	
2	Key V37E 01E	14,106	

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STA/T Step	PROCEDURES	Panel	REMARKS
3	FL V06 N61 Azimuth (X_{sm}) R2 - 00000 Accept: V33E Reject: Notify ground for new K start load V37E00E		
4	FL V06 N61 Azimuth (vehicle) Elev (S/C lat) Accept: V33E Reject: Notify ground for new K start load V37E00E	14,106	
	Check: ZERO ENCODE 1t - ON (35 sec) FINE ALIGN 1t - ON (10 sec) ATT. CONT. 1t - ON (2 sec) FINE ALIGN 1t - ON (20 sec) COARSE ALIGN 1t - ON (45 sec) FINE ALIGN 1t - ON	101	
5	AGC displays P02 (after 5 min)		
6.6.5.8	<u>P02 - Gyro Compassing Program.</u>		
	NOTE Do P03 as desired		
1	Set controls - G&C BASIC except: LIMIT CYCLE - ON ΔV sw - ON A&C Roll - ON TVC 1 POWER - AC1 MNA TVC 2 POWER - AC2 INJECT PREVALVES (2) - ON	8 24 3	

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STA/T	Step	PROCEDURES	Panel	REMARKS
	2	Key V75 (Do not press ENTER) (Permits backup of L/O discrete)	14,106	
00:00	3	Receive L/O notification from ground AGC displays P11 Backup: If no P11, ENTER		
		<u>6.6.5.9 P03 - Optical Verification of Azimuth.</u>		
	1	Key V37E 03E	14,106	
	2	CB optics MNA&B - CLOSED	8	
	3	FL V06 N61 - target #1 Az Elev ID Accept: V33E Reject: Load desired data	14,106	
	4	FL V06 N61 - target #2 Az Elev ID Accept: V33E Reject: Load desired data		

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STA/T	Step	PROCEDURES	Panel	REMARKS
	5	FL V51 (Please Mark) R1- +00001 or +00002 OPTICS Mode - MANUAL MARK Target #1 MARK Target #2	105	
	6	FL V50 N25 R1 00016 ENTER	14,106	
	7	FL V06 N67 Gyro angles X XX.XXX DEG Y XX.XXX DEG Z XX.XXX DEG If R1 or R2 >.55 deg, Notify ground Hold for instructions If R3 >.30 deg, Load +00000 into R1 & R2 Observe Z-gyro torquing AGC displays P02 If R3 <.30 deg, V34E		
	8	P02		
	6.6.5.10	<u>P05 - G&N Startup Program.</u>		
	1	Set controls - G&C BASIC except: G&N/SCS - SCS CB IMU - MNA & B - OPEN CB LIGHTING AC 1 & 2 - OPEN	8 22	

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STA/T Step	PROCEDURES	Panel	REMARKS
	<u>CAUTION</u> AGC must be ON before IMU turned ON.		
2	Key V37E 05E	14,106	
3	FL V50 N25 R1 00060 - (IMU turn on) Accept: CB-IMU MNA & B - CLOSED CB LIGHTING AC 1 & 2 - CLOSED G&N LIGHTING - AC1 COARSE ALIGN 1t - ON ENTER IMU DELAY - ON (100 sec) Reject: V37E00E	22 101 14,106	
4	FL V21 N23 (Load ICDU Δ angles) X Y Z Read ICDU angles from ICDU dials If all ICDU angles <0±10 deg: V33E If any ICDU angles >0±10 deg: Load present ICDU angles Observe ICDU's torqued to 0±5 deg Check: CDU ZERO 1t - ON (35 sec) FINE ALIGN 1t - ON (10 sec) ATT. CONT. 1t - ON (2 sec) FINE ALIGN 1t - ON	XXX.XX DEG XXX.XX DEG XXX.XX DEG 102 101	
5	P00		

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STA/T Step	PROCEDURES	Panel	REMARKS
6.6.5.11	<u>P06 - G&N Power Down Program.</u>		
1	Set controls - G&C BASIC except: G&N/SCS - SCS	8	
2	Key V37E 06E If IMU in operate condition: FINE ALIGN 1t - ON (20 sec)	101	
	COARSE ALIGN 1t - ON (45 sec)	102	
	ICDU's go to ZERO		
3	FL V50 N25 R1 00061 (IMU power down) Set:	14,106	
	CB-IMU MNA & B - OPEN	22	
	CB LIGHTING AC1 & 2 - OPEN		
	ENTER	14,106	
	<u>CAUTION</u> IMU must be powered down before AGC is powered down.		
4	FL V50 N25 R1 00062 (AGC power down) Accept:		
	AGC MODE - STANDBY	107	
	CONDITION LAMPS - OFF		
	PANEL BRIGHTNESS - OFF	106	
	BRIGHTNESS - OFF		
	Reject: (leave AGC ON)	14,106	
	V33E		
	P00		

STA/T Step	PROCEDURES	Panel	REMARKS
	<p>NOTE When in AGC STDBY, G&N ERROR appears on MDC and MASTER ALM occurs; crew may reset MASTER ALM; G&N ERROR stays ON as long as AGC remains in STDBY.</p> <p>6.6.5.12 <u>P07 - System Test Program, C Relay Test.</u></p> <p>1 Set IMU TRANSFER - MANUAL Key V57E 00006E P07 ISS in FINE ALIGN MODE V15 N01 E 00722E R3, R2, & R1 will, in turn, DISPLAY: 00001 00002 00004 00010 00020 00040 00100 00200 00400 01000 02000</p> <p>NOTE Each relay and associated display will be ON for 1.28 sec.</p> <p>2 The following condition lamps will be ON corresponding to the ON state of the appropriate relay: ZERO ENCODER (R1) -00020 CDU FAIL (R1) -00040</p>	<p>101 14,106</p> <p>101</p>	

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STA/T Step	PROCEDURES	Panel	REMARKS
	ACCEL. FAIL (R1) -00100 IMU FAIL (R1) -00200 (MASTER alarm lamps ON with latter three)		
3	Any malfunction will terminate test, light PROG ALARM lamp, and display V01 N31 R1-01103 Press ERROR RESET to RESET PROG ALARM lamp	14,106	
4	Successful test: V01 N31 R1 10000		
5	IMU TRANSFER - COMPUTER	101	
6	P00	14,106	
6.6.5.13	<u>DSKY Test.</u>		
1	Key V57E 00007E UPTL lamp - ON		
	Check: Each of 21 characters displays all 9's sequentially down to all ZEROS (each set on 10 sec) All characters blank (10 sec) 3 minus signs on (10 sec) 3 plus signs on (10 sec) Lamps: PROG ALARM TM		

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>KEY RISE CHECK FAIL UPTL lamp - OFF</p> <p>2 Press ERROR RESET & KEY RISE P00</p> <p>6.6.6 IMU ALIGNMENT PROCEDURES.</p> <p>6.6.6.1 <u>P51 - IMU Orientation Determination.</u></p> <p>1 Set controls - G&C BASIC except: If S-IVB attached: SCS CHANNELS (4) - OFF RATE GYRO POWER - OFF BMAG POWER - OFF ROTATION CONTROL POWER - OFF CB OPTICS MNA & B - CLOSED If S-IVB separated: Jet select - as desired LIMIT CYCLE - ON CB OPTICS MNA & B - CLOSED</p> <p>2 Key V37E 51E</p> <p>3 Check: FINE ALIGN 1t - ON (20 sec) COARSE ALIGN 1t - ON (45 sec) ICDU's go to ZERO IMU-CDU DIFF - ZERO ± 1.5 deg FDAI errors - ZERO ± 1.5 deg</p>	14,106	

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STA/T Step	PROCEDURES	Panel	REMARKS
4	FL V50 N25 R1 00015 (acquire star) Roll S/C to acquire 2 nav stars in SCT ENTER (R27 - Sighting Mark - Star #1)		
5	FL V51 (Please Mark) ATT IMP ENABLE - ON (optional) MARK		
6	FL V50 N25 R1 00016 (terminate marks) Accept: ENTER Reject: V52E		
7	FL V21 N30 Load STAR CODE +000XX. ENTER (R27 - Sighting Mark - Star #2)		
8	FL V51 (Please Mark) MARK (R29 - Star Data Test)		
9	FL V50 N25 R1 00016 (terminate marks) Accept: ENTER Reject: V52E		

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STA/T Step	PROCEDURES	Panel	REMARKS
10	FL V21 N30 Load STAR CODE +000XX ENTER (R27 - Sighting Mark - Star #2)		
11	V06 N05 (10 sec) Star angle diff. XXX.XX DEG Data good (angle <.05 deg) or FL V06 N05 Star angle diff. XXX.XX DEG Data bad (angle >.05 deg) Accept: V33E Reject: V37E 00E		
12	ATT IMP ENABLE - OFF		
13	P00		
14	CB OPTICS MNA & B - OPEN		
6.6.6.2	<u>P52 - S-IVB IMU Align Program.</u>		
1	Set controls - G&C BASIC except: If S-IVB attached: SCS CHANNELS (4) - OFF RATE GYRO POWER - OFF BMAG POWER - OFF ROT. CONT POWER - OFF CB OPTICS MNA & B - CLOSED		

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>If S-IVB separated: Jet select - as desired LIMIT CYCLE - ON CB OPTICS MNA & B - CLOSED</p> <p>2 Key V37E 52E Check FINE ALIGN lt - ON (R25 - Coarse Alignment)</p> <p>3 If any CDU gimbal angle change $\geq 5^\circ$ Check: COARSE ALIGN lt - ON (45 sec) IMU-CDU DIFF - ZERO $\pm 1.5^\circ$ FINE ALIGN lt - ON (20 sec) (R28 - Auto Optics Positioning - Star #1)</p> <p>4 FL V06 N30 R1 - Star Code +000XX. Accept: V33E Reject: Load new star code</p> <p>5 POSS FL V50 N25 R1 00013 (OPTICS MODE - COMPUTER) Accept: OPTICS MODE - COMPUTER ENTER Reject: V33E (Position Optics Manually)</p> <p>6 Identify target in SCT</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>(R27 - Sighting Mark - Star #1)</p> <p>7 FL V51 (Please Mark) ATTITUDE IMPULSE ENABLE - ON (optional) MARK</p> <p>8 FL V50 N25 R1 00016 (terminate marks) Accept: ENTER Reject: V52E</p> <p>9 FL V21 N30 Load star code +000XX. ENTER</p> <p>(R28 - Auto Optics Positioning - Star #2)</p> <p>10 FL V06 N30 R1 - star code +000XX. Accept: V33E Reject: Load new star code</p> <p>POSS FL V50 N25 R1 00013 (OPTICS MODE - COMPUTER) Accept: OPTICS MODE - COMPUTER ENTER Reject: V33E (position optics manually) Identify target in SCT</p> <p>(R27 - Sighting Mark - Star #2)</p> <p>11 FL V51 (Please Mark) ATTITUDE IMPULSE ENABLE - ON (optional) MARK</p>		

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12  FL V50 N25
    R1 00016 (terminate marks)
    Accept:  ENTER
    Reject:  V52E

13  FL V21 N30
    Load star code +000XX.
    ENTER
    ATTITUDE IMPULSE ENABLE - OFF

        (R29 - Star Data Test)

14  V06 N05 (10 sec)
    Star angle diff                      XXX.XX DEG
    (Data good, angle <.05 deg)

or

    FL V06 N05
    Star angle diff                      XXX.XX DEG
    (Data bad, angle >.05 deg)
    Accept:  V33E
    Reject:  V37E 00E

        (R30 - Gyro Torquing)
        (90-Sec Delay)

15  V06 N67 (10 sec)
    ΔGyro angles X                      XX.XXX DEG
                        Y                      XX.XXX DEG
                        Z                      XX.XXX DEG
    All angles <5 deg (gyros are torqued)

or

```

STA/T Step	PROCEDURES	Panel	REMARKS
	<p>FL V06 N67</p> <p>Δ Gyro angles X XX.XXX DEG</p> <p> Y XX.XXX DEG</p> <p> Z XX.XXX DEG</p> <p>If any angle >5 deg,</p> <p> Accept: V33E (gyros are torqued)</p> <p> Reject: V34E AGC displays P00</p> <p>16 FL V50 N25</p> <p> R1 00014 (fine align check)</p> <p> Accept: ENTER</p> <p> Return to step 5</p> <p> Reject: V33E</p> <p>17 P00</p> <p>18 CB OPTICS MNA & B - OPEN</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
6.6.6.3	<p><u>P53 - CSM/IMU Align Program.</u></p> <p>1 Set controls - G&C BASIC except: Jet select as desired CB OPTICS MNA & B - CLOSED</p> <p>2 Key V37E 53E (R01 - Attitude Control Mode Check)</p> <p>3 FL V50 N25 R1 00001 (G&N attitude) Accept: FDAI Errors - 0+5 deg AME - ATTITUDE ENTER Bypass SCS discrete monitor V33E Reject: Use an SCS control mode V33E</p> <p>4 V01 N25 R1 - Code for IMU & S/C orientations 00051 Final IMU/final S/C 00052 Interim IMU/final S/C 00053 Final IMU/interim S/C 00054 Interim IMU/interim S/C (R25 - Coarse Alignment)</p>		

STA/T Step	PROCEDURES	REMARKS
	<p>5 If any CDU gimbal angle change $\geq 5^\circ$ Check: COARSE ALIGN 1t - ON (45 sec) IMU-CDU DIFF - ZERO $\pm 1.5^\circ$ FINE ALIGN 1t - ON (20 sec)</p> <p> (R21 - Attitude Maneuver)</p> <p>6 FL V16 N20 - present ICDU angles Roll, pitch, yaw XXX.XX DEG Align AGCU V33E</p> <p>7 FL V06 N17 - final ICDU angles Roll, pitch, yaw XXX.XX DEG Set ATT SET Dials G&N maneuver: V33E Manual maneuver: (1) Note OG angle THC - CW Maneuver to final ICDU angles V70E FL V50 N25 R1 00007 (att trim enable) Maneuver complete ENTER THC - CENTER (when att error <5 deg) or (2) THC - CW V33E Maneuver to final ICDU angles THC - CENTER (when att error <5 deg)</p>	

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STA/T Step	PROCEDURES	Panel	REMARKS
8	<p>If R1 code was 00052 or 00054, (R25-coarse alignment for final IMU) Check: COARSE ALIGN 1t - ON (45 sec) IMU-CDU DIFF - ZERO ± 1.5 deg FINE ALIGN 1t - ON (20 sec)</p> <p>(R28 - Auto Optics Positioning - Star #1)</p>		
9	<p>RL V06 N30 R1 - star code +000XX. Accept: V33E Reject: Load new star code</p> <p>POSS FL V50 N25 R1 00013 (OPTICS MODE - COMPUTER Accept: OPTICS MODE - COMPUTER ENTER Reject: V33E (position optics manually)</p>		
10	<p>Identify target in SCT</p> <p>(R27 - Sighting Mark - Star #1)</p>		
11	<p>FL V51 (Please Mark) ATT IMP ENABLE - ON (optional) MARK</p>		
12	<p>FL V50 N25 R1 00016 (terminate marks) Accept: ENTER Reject: V52E</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
13	FL V21 N30 Load star code +000XX. ENTER (R28 - Auto Optics Positioning - Star #2)		
14	FL V06 N30 R1 - star code +000XX. Accept: V33E Reject: Load new star code Possible FL V50 N25 R1 00013 (OPTICS MODE - COMPUTER) Accept: OPTICS MODE - COMPUTER ENTER Reject: V33E (position optics manually)		
15	Identify target in SCT (R27 - Sighting Mark - Star #2)		
16	FL V51 (Please Mark) MARK		
17	FL V50 N25 R1 00016 (terminate marks) Accept: ENTER Reject: V52F		
18	FL V21 N30 Load star code +000XX. ENTER ATT IMP ENABLE - OFF		

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STA/T Step	PROCEDURES	Panel	REMARKS
	(R29 - Star Data Test)		
19	V06 N05 (10 sec) Star angle diff. XXX.XX DEG (Data good, angle $\leq .05$ deg)		
	or FL V06 N05 Star angle diff. XXX.XX (Data bad, angle $> .05$ deg) Accept: V33E Reject: V37E 00E		
	(R30 - Gyro Torquing) (90-Sec Delay)		
20	V06 N67 (9 sec) Δ Gyro angles X XX.XXX DEG Y XX.XXX DEG Z XX.XXX DEG All angles > 5 deg (gyros are torqued)		
	or FL V06 N67 Gyro angles X XX.XXX DEG Y XX.XXX DEG Z XX.XXX DEG If any angle > 5 deg, Accept: V33E (gyros are torqued) Reject: V34E AGC displays P00		
21	FL V50 N25 R1 00014 (fine align check) Accept: ENTER Return to step 8 Reject: V33E		

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STA/T Step	PROCEDURES	Panel	REMARKS
22	<p>If R1 code was 00053 or 00054, (R21-attitude maneuver to final S/C attitude) FL V06 N20 - preset ICDU angles Roll, pitch, yaw XXX.XX DEG Align AGCU V33E FL V06 N17 - final ICDU angles Roll, pitch, yaw XXX.XX DEG Set ATT. SET dials G&N maneuver: V33E Manual maneuver: (1) Note OG angle THC - CW Maneuver to final ICDU angles V70 E FL V50 N25 R1 00007 (att. trim enable) Maneuver complete ENTER THC - CENTER (when att. error <5 deg) or (2) THC - CW V33E Maneuver to final ICDU angles THC - CENTER (when att. error <5 deg)</p>		
23	<p>If P53 called by P22, P22</p>		
24	<p>FL V50 N07 R1 000XX Select P41, P42, or P43 as requested</p>		
25	<p>CB OPTICS MNA & B - OPEN</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
6.6.6.4	<p><u>P54 - IMU Realignment Program.</u></p> <p>1 Set controls - G&C BASIC except: Jet select as desired LIMIT CYCLE - ON G&N/SCS - SCS AME - ATTITUDE CB OPTICS MNA & B - CLOSED</p> <p>NOTE If desire later return to present S/C att., record present ICDU angles for use during manual att. maneuvers.</p> <p>2 Key V37E 54E</p> <p>3 FINE ALIGN 1t - ON</p> <p>4 Maneuver S/C to acquire 2 navigation stars (R27 - Sighting Mark - Star #1)</p> <p>5 FL V51 (Please Mark) ATT IMP ENABLE - ON (optional) MARK</p> <p>6 FL V50 N25 R1 00016 (terminate marks) Accept: ENTER Reject: V52E</p> <p>7 FL V21 N30 Load star code +000XX. ENTER</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
8	FL V51 (Please Mark) MARK		
9	FL V50 N25 R1 00016 (terminate marks) Accept: ENTER Reject: V52E		
10	FL V21 N30 Load star code +000XX. ENTER ATT IMP ENABLE - OFF (R29 - Star Data Test)		
11	V06 N05 (10 sec) Star angle diff. (Data good, angle $\leq .05$ deg)	XXX.XX DEG	
	or FL V06 N05 Star angle diff. (Data bad, angle $> .05$ deg) Accept: V33E Reject: V37E 00E (R30 - Gyro Torquing) (90-Sec Delay)	XXX.XX	
12	V06 N67 (90 sec) Δ Gyro angles X Y Z All angles < 5 deg (gyros are torqued)	XX.XXX DEG XX.XXX DEG XX.XXX DEG	

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>or FL V06 N67</p> <p> Δ Gyro angles X XX.XXX DEG</p> <p> Y XX.XXX DEG</p> <p> Z XX.XXX DEG</p> <p> If any angle >5 deg,</p> <p> Accept: V33E (gyros are torqued)</p> <p> Reject: V34E AGC displays P00</p> <p>13 FL V50 N25</p> <p> R1 00014 (fine align check)</p> <p> Accept: ENTER</p> <p> Return to step 5</p> <p> Reject: V33E</p> <p>14 P00</p> <p>15 CB OPTICS MNA & B - OPEN</p> <p>6.6.7 ORBITAL NAVIGATION.</p> <p>6.6.7.1 <u>P27 - AGC Update Program.</u></p> <p>6.6.7.1.1 Auto Update.</p> <p> 1 UPTEL sw - ACCEPT</p> <p> Update complete:</p> <p> UPTEL sw - BLOCK</p> <p>6.6.7.1.2 Voice Transmission Update.</p> <p> 1 Key: V72E (MIN. IMP.)</p> <p> or V73E (ENTRY)</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>or V74E (ORBIT CHANGE)</p> <p>or V76E (STATE VECTOR, RVT)</p> <p>or V77E (TIME UPDATE)</p> <p>2 FL V21 N01 R1 - BLANK R2 - UNCHANGED R3 - UPADR (May terminate P27 when desired - V34E)</p> <p>3 Key in data for update (Data loaded displayed in R1)</p> <p>4 FL V21 N02 (Load Complete) R1 - BLANK R2 - UNCHANGED R3 - UPADR</p> <p>Accept: V33E</p> <p>Review data: V01 N01E</p> <p>Key octal address of first word R1 will display word 01 Key N15E to see next word Key ENTER until viewing is complete</p> <p>Change data: V21 N01E</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>Key in octal identifier of register to be changed (Data loaded displayed in R1) V33E</p> <p>5 P00 (8 sec time delay)</p> <p>6.6.7.1.3 Time Update.</p> <p>1 Key V55E</p> <p>2 FL V21 N24 (V25) Load time R₁ = hrs +XXXXXE R₂ = mins +XXXXXE R₃ = sec +XXX.XXE</p> <p>3 Check updated AGC time V16 N16E V37E 00E</p> <p>6.6.7.1.4 Type III Update.</p> <p>1 Key V37E 00E</p> <p>2 For sequential addresses V21N 01E Load first address XXXXE Load first data word XXXXXE N15E verify address increments by one Load second data word XXXXXE Load third data word XXXXXE Continue until last address in sequence is filled</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
3	<p>For non-sequential addresses</p> <p>V21 N01E</p> <p>Load first address XXXXE</p> <p>Load first data word XXXXXE</p> <p>Load second address XXXXE</p> <p>Load second data word XXXXXE</p> <p>4 To verify data loaded in sequential address:</p> <p>V01 N01E</p> <p>Load first address XXXXE</p> <p>Check first data word in R1</p> <p>N15E</p> <p>Check second data word in R1</p> <p>Enter</p> <p>Check third data word in R1</p> <p>Enter</p> <p>5 To verify data loaded in non-sequential addresses:</p> <p>V01 N01E</p> <p>Load address of data word to XXXXE</p> <p>be verified</p> <p>Check data word in R1</p> <p>6.6.7.2 <u>P22 - Landmark Tracking Navigation Measurement Program.</u></p> <p>1 Set controls - G&C BASIC except:</p> <p>S-IVB attached:</p> <p>G&N/SCS - SCS</p> <p>SCS CHANNELS (4) - OFF</p> <p>RATE GYROS (3) - BMAG</p> <p>CB OPTICS MNA & B - CLOSED</p> <p>DIRECT RCS - OFF</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>S-IVB Separated: Jet select as desired LIMIT CYCLE - ON G&N/SCS - SCS AME - ATTITUDE PITCH RATE GYRO - BMAG CB OPTICS MNA & B - CLOSED</p> <p>2 Key V37E 22E</p> <p>NOTE If IMU in STDBY, AGC displays P05, P00. Crew selects P51, then P22.</p> <p>3 FL V50 N07 R1 00053</p> <p>If IMU not satisfactorily aligned, a. Select P53 (S-IVB separated) b. Select P52 (S-IVB attached)</p> <p>or If IMU satisfactorily aligned, V33E (20-Sec Delay)</p> <p>4 FINE ALIGN 1t - ON</p> <p>5 Select landmark from charts</p> <p>6 FL V50 N25 R1 00011 (auto optics positioning) Accept: ENTER Reject: V33E</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS
	(R28 - Auto Optics Positioning)		
7	FL V06 N44 - landmark Lat XXX.XX DEG Long XXX.XX DEG Alt XXXX.X NM Accept: V33E Reject: Reload data		
8	FL V50 N25 R1 00013 (OPTICS MODE - COMPUTER) Accept: OPTICS MODE - COMPUTER ENTER Reject: V33E (position optics manually)		
	(R27 - Sighting Mark)		
9	FL V51 (Please Mark) OPTICS MODE - MANUAL MARK LANDMARK Known (1-5 marks) SCT Unknown (2 marks) SXT (Mark reject: V52E)		
	NOTE OPTICS MODE - COMPUTER, to reposition optics with AGC; return OPTICS MODE - MANUAL.		
	ENTER (when finished marking) (If number of marks = max number permitted, FL V50 N25 R1 00016 ENTER)		

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STA/T Step	PROCEDURES	Panel	REMARKS
10	FL V21 N37 Known landmark Load 1 ENTER FL V21 N63 Load landmark ID: Lat XX.XXX DEG Long XX.XXX DEG Alt XXX.XX NM (Fischer) or Unknown landmark Load 0 ENTER		
11	FL V06 N75 ΔR XXXX.X NM ΔV XXXXX. FT/SEC Mult mark ctr 00XXX. * *3rd character - 1st or 2nd data display for mark being processed 4th character - Number of mark now being processed 5th character - Number of marks made in sequence Accept: V33E Reject: V34E NOTE Navigator accept or reject data in each display.		
12	P00		
13	CB OPTICS MNA & B - OPEN		

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>6.6.7.3 <u>P23 - Star-Landmark Navigation Measurement Program.</u></p> <p>1 Set controls - G&C BASIC except: Jet select as desired DIRECT RCS - OFF LIMIT CYCLE - ON G&N/SCS - SCS AME - ATTITUDE A&C ROLL - ON CB IMU MNA & B - OPEN (optional) CB OPTICS MNA & B - CLOSED</p> <p>2 Key V37E 23E</p> <p>3 FL V51 (Please Mark) Acquire selected landmark, then star, with SCT Perform MARK with SXT</p> <p>4 FL V50 N25 R1 00016 (terminate marks) ENTER</p> <p>5 FL V06 N57 Shaft XXX.XX DEG Trun XX.XXX DEG Coordinate data with MSFN V33E</p>		

GUIDANCE AND CONTROL

STA/T Step	PROCEDURES	Panel	REMARKS
6	FL V06 N34 T mark Coordinate data with MSFN V33E	00XXX. HRS 000XX. MIN 0XX.XX SEC	
7	P00		
8	CB OPTICS MNA & B - OPEN		
6.6.7.4	<u>P24 - Ground Track Determination.</u>		
6.6.7.4.1	Orbital Parameter Display - V64E.		
1	FL V16 N43 HA HP TFF V33E	XXXX.X NM XXXX.X NM XXBXX MIN/SEC	
2	FL V16 N35 T to Perigee V33E	00XXX. HRS 000XX. MIN 0XX.XX SEC	
3	P00		

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STA/T Step	PROCEDURES	Panel	REMARKS
6.6.7.4.2 T-Arrive at Specified Long - V65E.			
1 FL V21 N34			
Load-T PERM		00XXX. HRS	
		000XX. MIN	
		0XX.XX SEC	
2 FL V22 N44			
Load-long		XXX.XX DEG	
3 FL V06 N34			
T-long		00XXX. HRS	
		000XX. MIN	
		0XX.XX SEC	
V33E			
4 FL V06 N44			
Lat	XXX.XX DEG		
Long	XXX.XX DEG		
Alt	XXXX.X MN (Fischer)		
V33E			
5 P00			
6.6.7.4.3 Lat, Long, Alt at Specified T - V66E.			
1 FL V21 N34			
Load - T		00XXX. HRS	
		000XX. MIN	
		0XX.XX SEC	

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STA/T Step	PROCEDURES	Panel	REMARKS
2- FL V06 N44			
Lat	XXX.XX DEG		
Long	XXX.XX DEG		
Alt	XXXX.X NM (Fischer)		
V33E			
	AGC increments T by 10 min and displays		
FL V06 N44			
Lat	XXX.XX DEG		
Long	XXX.XX DEG		
Alt	XXXX.X NM (Fischer)		
or			
V34E			
3 P00			
6.6.7.4.4	Max Dec and Time to Max Dec - V67E.		
1 FL V21 N34			
Load - T PERM	00XXX. HRS		
	000XX. MIN		
	0XX.XX SEC		
2 FL V06 N34			
T max dec	00XXX. HRS		
	000XX. MIN		
	0XX.XX SEC		
V33E			
3 FL V06 N44 - max dec			
Lat	XXX.XX DEG		
Long	XXX.XX DEG		
Alt	XXXX.X NM (Fischer)		
V33E			
4 P00			

GUIDANCE AND CONTROL

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STA/T	Step	PROCEDURES	Panel	REMARKS
	6.6.8	G&N ORBIT CHANGE PROCEDURES.		
			V16 N16 V 64	
1	Time of Perigee GET	: :		
	Time to Perigee	: :		
	Time of Perigee	: :	GET	
2	Present Period ($T_2 \text{ perm} = T_1 + \Delta t > 1/2 \text{ Period.}$)			
	T_2 Max Dec	: :	GET	
	T_1 Max Dec	: :	GET	
	Present Period	: :		
	1/2 Present period	: :		
	1/4 Present period			
3	Time of Apogee			
	Time of Perigee	: :	GET	
	1/2 Period	: :		
	Time of Apogee	: :	GET	
	Figure 6-2. Targeting Worksheet P24 Orbit Change (Sheet 1 of 2)			

GUIDANCE CONTROL

STA/T	Step	PROCEDURES	Panel	REMARKS
4	TIG			
	+1/4 Period	: : GET *		
		: :		
	Target Tim	: : GET		
5	Target Location		V66	
		.	°Lat *	
		.	°Long*	
		.	NM Alt	

Figure 6-2. Targeting Worksheet P24
 Orbit Change (Sheet 2 of 2)

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STA/T Step	PROCEDURES	Panel	REMARKS
	Present HA _____ NM Alt of AP: _____ HP _____ NM Desired ΔH _____ (AorP) . NM x 0.4 0.4 NM Target ΔH _____ . NM Present Target (H) _____ . NM Aim Pt H _____ . NM *		
	New Period: Desired ΔH + _____ . NM x _____ secs/ NM (from chart) Δ Period+ _____ secs Present Period _____ : : New Period EST. _____ : : *		
	Period _____ Alt of AP _____ HA _____ HP _____ ΔV _____ Period _____		
	Figure 6-3. Targeting Worksheet P31, 33 (Sheet 1 of 2)		

GUIDANCE CONTROL

STA/T Step	PROCEDURES	Panel	REMARKS
Alt of AP HA HP ΔV			

Figure 6-3. Targeting Worksheet P31, 33
 (Sheet 2 of 2)

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STA/T Step	PROCEDURES	Panel	REMARKS
6.6.8.1	<u>G&N Orbit Change.</u>		
1	Preburn preparation Obtain orbit change update Loose equipment - Stowed Set DET for TTI System periodic verifications complete Go to P 31 or P 33		
6.6.8.2	<u>P31 - Prethrusting - Orbit Change Program.</u>		
1	Key V37E 31E (R35 - orbit change data load)		
2	FL V06 N33 GETI 00XXX. HRS 000XX. MIN OXX.XX SEC Accept: V33E Reject: Reload data		
3	FL V06 N44 LAT XXX.XX DEG LONG XXX.XX DEG ALT XXXX.X NM (PAD) (Alt=00000 for circularization) Accept: V33E Reject: Reload data		

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STA/T	Step	PROCEDURES	Panel	REMARKS
	4	FL V06 N34 PERIOD O0XXX. HRS 000XX. MIN OXX.XX SEC Accept: V33E Reject: Reload data		
	5	FL V06 N70 P trim XXX.XX DEG Y trim XXX.XX DEG ΔT tailoff XXX.XX SEC Accept: V33E Reject: Reload data		
	6	FL V06 N45 HA XXXX.X NM HP XXXX.X NM ΔV required XXXXX. FT/SEC Record data for reference after burn Accept: V33E Reject: Return to P00; reselect P31 or P27-P31		
	7	FL V16 N35 TTI O0XXX. HRS 000XX. MIN OXX.XX SEC Set clocks V33E		

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STA/T Step	PROCEDURES	Panel	REMARKS
8	<p>FL V06 N17 - gimbal angles at thrust Roll, pitch, yaw XXX.XX DEG Backup: If IMU alignment not satisfactory: Select P53-P41 V37E 53E (If MG (R3) > 15 deg, or If > hrs since IMU alignment) If IMU alignment satisfactory: Set controls - G&C BASIC V33E (R01 - att control mode check)</p>	P31	
9	<p>FL V50 N25 R1-00001 (G&N attitude) Accept: a. FDAI error needles - 0+5 deg AME - ATTITUDE ENTER b. Bypass SCS discrete monitor: V33E Reject: Use an SCS control mode (R21 - Attitude Maneuver)</p>		
10	<p>FL V16 N20 - present ICDU angles Roll, pitch, yaw XXX.XX DEG Align AGCU V33E</p>		

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STA/T	Step	PROCEDURES	Panel	REMARKS
	11	<p>FL V06 N17 - final ICDU angles Roll, pitch, yaw XXX.XX DEG</p> <p>Set ATT. SET dials</p> <p>a. G&N maneuver: V33E</p> <p>b. Manual maneuver:</p> <p>(1) Note OG angle THC - CW Maneuver to final ICDU angles V70E FL V50 N25 R1-00007 (att. trim) Maneuver complete ENTER THC - CENTER (when att. error <5 deg)</p> <p>or (2) THC - CW V33E</p> <p>Maneuver to final ICDU angles</p> <p>THC - CENTER (when att. error <5 deg)</p>		
	12	<p>FL V50 N07</p> <p>R1-00041</p>		

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STA/T Step	PROCEDURES	Panel	REMARKS						
6.6.8.3	<u>P41 - Thrusting-Orbit Change Program.</u>								
1	<p>Controls - G&C BASIC except: DIRECT RCS - OFF LIMIT CYCLE - ON AME - ATTITUDE FCSM - G&N - G&N SCS - RESET/OVERRIDE FDAI BRIGHTNESS - adjust Set up for 2 jet ullage</p> <table><tr><td>To use</td><td>OPEN</td></tr><tr><td>Quad B&D Yaw jets - Y-axis</td><td>CB PITCH MNA CB YAW MNA</td></tr><tr><td>Quad A&C Pitch jets - Z-axis</td><td>CB PITCH MNB CB YAW MNB</td></tr></table>	To use	OPEN	Quad B&D Yaw jets - Y-axis	CB PITCH MNA CB YAW MNA	Quad A&C Pitch jets - Z-axis	CB PITCH MNB CB YAW MNB		
To use	OPEN								
Quad B&D Yaw jets - Y-axis	CB PITCH MNA CB YAW MNA								
Quad A&C Pitch jets - Z-axis	CB PITCH MNB CB YAW MNB								
2	<p>Preignition preparation MAIN BUS TIE (2) - ON PHASE LOCK - ON AC BUS 2 - RESET - OFF INVERTER 2 - MNB INVERTER 1 - AC BUS 2 - OFF INVERTER 2 - AC BUS 2 - ON AC BUS 2 RESET - CENTER Check AC & DC INDICATORS Set COMM MODE</p>	<p>MDC-22 208 MDC-18</p>							

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STA/T	Step	PROCEDURES	Panel	REMARKS
	3	Key V37E 41E		
	4	FL V16 N20 - present ICDU angles Roll, pitch, yaw XXX.XX DEG Set ATT SET dials V33E (R31 - Backup Δ V Counter)		
	5	FL V06 N14 R1 = Δ VG XXXXX. FT/SEC Obtain Δ V(SCS) from chart TVC 1 POWER - AC1 MNA TVC 2 POWER - AC2 Set Δ V COUNTER V33E		
	6	V06 N51 TTI XXBXX MIN-SEC VG XXXXX. FT/SEC Δ VM XXXXX. FT/SEC (=0) Update DET Test C/W lamps Check sight on boresight star using pitch angle and X-axis deflection		
-06:00	7	Key in V06 N70E (optional) P trim XXX.XX DEG Y trim XXX.XX DEG KEY RELEASE (R02 - Thrust Control Mode Check)		

GUIDANCE CONTROL

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
-05:00 8	FL V50 N25 RL-00002 (G&N Δ V) Set controls: CB GIMBAL PIT PITCH 1 BAT A - CLOSED CB GIMBAL YAW 1 BAT A - CLOSED GIMBAL PITCH 2 - START - ON GIMBAL YAW 2 - START - ON Confirm TRIM control on GPI GIMBAL PITCH 1 - START - ON GIMBAL YAW 1 - START - ON Δ V sw - ON SCS channels (4) - OFF THC - CW MTVC control - check Δ V sw - OFF ATT DEADBAND - MIN B&D ROLL, PITCH, YAW CHANNELS - ON Null att. error needles THC - neutral Δ V sw - ON G&N/SCS - SCS FDAI ALIGN - PRESS G&N/SCS - G&N Confirm and trim GPI ENTER		
9	V06 N51 TTI VG Δ VM	XXBXX MIN-SEC XXXXX. FT/SEC XXXXX. FT/SEC	

GUIDANCE CONTROL

STA/T	Step	PROCEDURES	Panel	REMARKS
-02:00	10	Report TTI - 2 min Set: THRUST sw - NORMAL INJECT PREVALVES (2) - ON PRIM. THC - ARMED (R37 - SPS Engine Ignition Average G ON)		
-00:30	11	Check Δ VM for PIPA bias		
-00:20	12	Start ULLAGE		
-00:05	13	FL V50 N11 (thrust on enable)		
-00:02	14	ENTER		
00:00		Check THRUST lt - ON Backup: If ENTER not keyed in:		
+00:15		VO6 N51 TTI XXBXX MIN-SEC VG XXXXX. FT/SEC Δ VM XXXXX. FT/SEC		
+00:30		FL V50 N07 RL-00000 <u>CAUTION</u> If no ignition go to R38.		

GUIDANCE CONTROL

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
15	VO6 N51 (at thrust on) TG XXBXX MIN-SEC VG XXXXX. FT/SEC ΔVM XXXXX. FT/SEC Backup: Manual TVC: THC - CW (V71E) no att errors THRUST sw OFF at ΔV remaining=0		
16	Monitor engine cutoff: Backup cutoff with THRUST sw THRUST lt - OUT THRUST sw - OFF Report engine OFF		
17	FL V16 N51 (at thrust cutoff) TG(ECO) XXBXX MIN-SEC VG(ECO) XXXXX. FT/SEC VM XXXXX. FT/SEC V33E		
18	Set controls after tailoff: SCS CHANNELS (4) - OFF GIMBAL MOTORS (4) - OFF INJECT PREVALVES (2) - OFF ATT DEADBAND - MAX LIMIT CYCLE - OFF ΔV sw - OFF TVS POWER 1&2 - OFF CB GIMBAL PITCH 1 BAT A - OPEN CB GIMBAL YAW 1 BAT A - OPEN		

GUIDANCE CONTROL

STA/T Step	PROCEDURES	Panel	REMARKS
	THC - neutral, LOCKED FCSM - G&N - OVERRIDE/RESET SCS - OVERRIDE/RESET MAIN BUS TIE (2) - OFF - AUTO PHASE LOCK - OFF AC BUS 2 RESET - OFF INVERTER 2 - OFF INVERTER 2 - BUS 2 - OFF INVERTER 1 - BUS 2 - ON AC BUS 2 RESET - RESET - CENTER Record SPS propellant remaining Charge batteries (R34 - Orbital Parameter Display)	208 MDC-18	
19	FL V16 N43 HA XXXX.X NM HP XXXX.X NM TFF XXBXX MIN-SEC V33E		
20	FL V16 N35 T to perigee 00XXX. HRS 000XX. MIN 0XX.XX SEC V33E		
21	FL V50 N07 RL-00000 V37E 00E		

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STA/T Step	PROCEDURES	Panel	REMARKS
6.6.8.3.1	<u>R38 - SPS Engine Thrust Fail.</u>		
1	Check for alarms: SPS ROUGH ECO lt - ON MASTER ALARM lt - ON		
2	Reset C/W system		
3	FL V50 N 11 (engine ON enable) (10 secs after AGC detects THRUST FAIL) Accept: Maintain ULLAGE FCSM G&N - OVERRIDE/RESET, then G&N SPS ROUGH ECO lt - OUT, Backup: If ECO light not out, set FCSM G&N/OVERRIDE - OVERRIDE ENTER THRUST lt - ON <u>WARNING</u> Override bypasses safety feature of rough ECO detection.		
4	VO6 N51 TG VG ΔVM	XXBXX MIN-SEC XXXXX. FT/SEC XXXXX. FT/SEC	

GUIDANCE CONTROL

STA/T Step	PROCEDURES	Panel	REMARKS
	<p>Terminate ULLAGE after satisfactory ignition Return to TVC monitoring</p> <p>If no engine restart prior to TIG+00:15, reject restart</p> <p>Reject:</p> <p>Set:</p> <p>THRUST sw - OFF INJECT PREVALVES A&B - OFF</p> <p>GIMBAL MOTORS (4) - OFF ΔV sw - OFF</p> <p>a. V33E Observe orbit parameters Select new program</p> <p>or b. V34E</p> <p>5 FL V50 NO7 R1-00000</p> <p>Key V37E 00E</p> <p>6.6.8.4 <u>P33 - Prethrusting - SPS Minimum Impulse Program.</u></p> <p>1 Key V37E 31E (R33-SPS Minimum Impulse Data Load)</p>		

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STA/T	Step	PROCEDURES	Panel	REMARKS
	2	FL VO6 N33 GETI Accept: V33E Reject: Reload data	OOXXX. HRS OOOXX. MIN OXX.XX SEC	
	3	FL VO6 N44 LAT LONG ALT Accept: V33E Reject: Reload data	XXX.XX DEG XXX.XX DEG XXXX.X NM (PAD)	
	4	FL VO6 N34 PERIOD Accept: V33E Reject: Reload data	OOXXX. HRS OOOXX MIN OXX.XX SEC	
	5	FL VO6 N70 P TRIM Y TRIM Δ T TAILOFF Accept: V33E Reject: Reload data	XXX.XX DEG XXX.XX DEG XXX.XX SEC	
	6	FL VO6 N35 Δ T BURN	OOXXX HRS OOOXX MIN OXX.XX SEC	

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STA/T Step	PROCEDURES	Panel	REMARKS
	Accept: V33E Reject: Reload data		
7	FL VO6 N45 HA XXXX.X NM HP XXXX.X NM ΔV required XXXXX. FT/SEC Accept: V33E Reject: Return to P00; reselect P33, or P27-P33		
8	FL V16 N35 TTI OOOXX. HRS OOOXX. MIN OXX.XX SEC Set clocks V33E		
9	FL VO6 N17 - gimbal angles at thrust Roll, pitch, yaw XXX.XX DEG Backup: If IMU alignment NOT satisfactory: Select P53-P41 V37E 53E (If MG (R3) 15 deg, or If ___ hrs since IMU alignment) If IMU alignment satisfactory: Set controls - G&C BASIC V33E (R01 - Att Control Mode Check)		

GUIDANCE CONTROL

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
10	FL V50 N25 R1-00001 (G&N attitude) Accept: a. FDAI error needles - 0+5 deg AME - ATTITUDE ENTER or b. Bypass SCS discrete monitor: V33E Reject: Use an SCS control mode (R21 - Attitude Maneuver)		
11	FL V16 N20 - present ICDU angles Roll, pitch, yaw XXX.XX DEG Align AGCU V33E		
12	FL V06 N17 - final ICDU angles Roll, pitch, yaw XXX.XX DEG SET ATT SET dials a. G&N maneuver: V33E b. Manual maneuver: (1) Note OG angle THC - CW Maneuver to final ICDU angles V70E FL V50 N25 R1-00007 (att trim) Maneuver complete ENTER THC - CENTER (when att error < 5 deg)		

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STA/T Step	PROCEDURES	Panel	REMARKS										
	<p>or (2) THC - CW V33E Maneuver to final ICDU angles THC - CENTER (when att. error < 5 deg)</p> <p>13 FL V50 NO7 RL-00043</p> <p>6.6.8.5 <u>P43 - Thrusting-Orbit Change Program</u> <u>Minimum Impulse.</u></p> <p>1 Set controls - G&C BASIC except: DIRECT RCS - OFF LIMIT CYCLE - ON AME - ATTITUDE FCSM - G&N to G&N SCS to OVERRIDE/RESET FDAI BRIGHTNESS - ADJUST Set up for 2 jet ullage</p> <table><tr><th>To Use</th><th>OPEN</th></tr><tr><td>Quad B&D</td><td></td></tr><tr><td>Yaw jets - Y-axis</td><td>CB PITCH MNA CB YAW MNA</td></tr><tr><td>Quad A&C</td><td></td></tr><tr><td>Pitch jets - Z-axis</td><td>CB PITCH MNB CB YAW MNB</td></tr></table> <p>2 Preignition preparation MAIN BUS TIE (2) - ON PHASE LOCK - ON</p>	To Use	OPEN	Quad B&D		Yaw jets - Y-axis	CB PITCH MNA CB YAW MNA	Quad A&C		Pitch jets - Z-axis	CB PITCH MNB CB YAW MNB		
To Use	OPEN												
Quad B&D													
Yaw jets - Y-axis	CB PITCH MNA CB YAW MNA												
Quad A&C													
Pitch jets - Z-axis	CB PITCH MNB CB YAW MNB												
		MDC-22 208											

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STA/T Step	PROCEDURES	Panel	REMARKS
	AC BUS 2 RESET - OFF INVERTER 2 - MN B INVERTER 1 - AC BUS 2 - OFF INVERTER 2 - AC BUS 2 - ON AC BUS 2 RESET - CENTER Check AC & DC indicators Set COMM mode	MDC-18	
3	Key V37E 41E		
4	FL V16 N20 - present ICDU angles Roll, pitch, yaw XXX.XX DEG V33E (R31 - Backup Δ V Counter)		
5	FL V06 N14 R1 = VG XXXXX. FT/SEC Obtain V (SCS) from chart TVC 1 POWER - AC1 MNA TVC 2 POWER - AC2 Set Δ V COUNTER V33E		
6	V06 N50 TTI XXBXX MIN-SEC Δ T BURN XXBXX MIN-SEC Δ VM XXXXX. FT/SEC (=0) Update DET Test C/W lamps Check sight on boresight star using pitch angle and X-axis deflection		

GUIDANCE CONTROL

STA/T Step	PROCEDURES	Panel	REMARKS
-06:00 7	Key in VO6 N70E (optional) P trim XXX.XX DEG Y trim XXX.XX DEG KEY RELEASE (R02 - Thrust Control Mode Check)		
-05:00 8	FL V50 N25 RL-0002 (G&N Δ V) Set controls: CB GIMBAL PITCH 1 BAT A - CLOSED CB GIMBAL YAW 1 BAT A - CLOSED GIMBAL PITCH 2 - START, ON GIMBAL YAW 2 - START, ON Confirm TRIM control on GPI GIMBAL PITCH 1 - START, ON GIMBAL YAW 1 - START, ON THC - CW ATT DEADBAND - MIN NULL ATT, ERROR NEEDLES THC - NEUTRAL Δ V sw - ON G&N/SCS - SCS FDAI ALIGN - PRESS G&N/SCS - G&N Confirm and trim GPI ENTER		
9	VO6 N50 TTI XXBXX MIN-SEC Δ T BURN XXBXX MIN-SEC Δ VM XXXXX. FT/SEC		

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STA/T Step	PROCEDURES	Panel	REMARKS
-02:00 10	Report TTI = 2 min Set: THRUST sw - NORMAL INJECT PREVALVES A&B - ON PRIM. THC - ARMED (R37 - SPS Engine Ignition Average G ON)		
-00:30 11	Check Δ VM for PIPA bias		
-00:20 12	Start ULLAGE		
-00:05 13	FL V50 N11 (thrust on enable)		
-00:02 14	ENTER		
00:00	Check THRUST lt - ON Backup: If ENTER not keyed in:		
+00:15	V06 N50 TTI Δ T BURN Δ VM	XXBXX MIN-SEC XXBXX MIN-SEC XXXXX. FT/SEC	
+00:30	FL V50 N07 R1-00000		
15	Monitor engine cutoff: Backup cutoff with THRUST sw THRUST lt - OUT Report engine OFF THRUST sw - OFF		

GUIDANCE CONTROL

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GUIDANCE CONTROL

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
19	FL V16 N35 T to perigee	00XXX. HRS 000XX. MIN 0XX.XX SEC	
20	V33E FL V50 N07 R1-00000 V37E 00E		

GUIDANCE CONTROL

STA/T Step	PROCEDURES	Panel	REMARKS
6.7	G&N DEORBIT AND ENTRY.		
1	Time of Perigee	V 64	
	GET : :		
	Time to Perigee : :		
	Time of Perigee : : GET		
2	Present Period ($T_2 \text{ perm} = T_1 + \Delta t > 1/2 \text{ period}$)		
	T_2 Max Dec. : : GET	V 67	
	T_1 Max Dec. : : GET		
	Present Period : :		
	1/2 Present Period : :		
3	Time of Apogee		
	Time of Perigee : : GET		
	1/2 Period : :		
	Time of Apogee : : GET		
4	TIG PERM : : GET *		

Figure 6-4. Targeting Worksheet P24 Deorbit Burn
(Sheet 1 of 2)

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T	Step	PROCEDURES	Panel	REMARKS
5	Splash Longitude	<div>°Lat</div> <div>°Long</div> <div>NM Alt</div>	V 66	
6	Target Location	<div>°Lat</div> <div>°Long</div> <div>NM Alt</div>	V 65	

Figure 6-4. Targeting Worksheet P24 Deorbit Burn
(Sheet 2 of 2)

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STA/T Step	PROCEDURES	Panel	REMARKS																		
	<div><table border="1"><caption>Data points estimated from Figure 6-5</caption><thead><tr><th>PTRIM</th><th>HA (NM)</th></tr></thead><tbody><tr><td>43</td><td>80</td></tr><tr><td>45</td><td>100</td></tr><tr><td>47</td><td>125</td></tr><tr><td>50</td><td>170</td></tr><tr><td>52</td><td>220</td></tr><tr><td>54</td><td>270</td></tr><tr><td>56</td><td>320</td></tr><tr><td>58</td><td>380</td></tr></tbody></table></div>	PTRIM	HA (NM)	43	80	45	100	47	125	50	170	52	220	54	270	56	320	58	380		
PTRIM	HA (NM)																				
43	80																				
45	100																				
47	125																				
50	170																				
52	220																				
54	270																				
56	320																				
58	380																				
Figure 6-5. Targeting Worksheet P24 Deorbit, Burn, Pitch Trim Versus Apogee Altitude																					

G&N DEORBIT AND ENTRY

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STA/T	Step	PROCEDURES	Panel	REMARKS
P	3	Configure ECS		
		GLYCOL EVAP-TEMP IN - AUTO (MAN for RCS deorbit)	13	
CSP		PGAs - CLOSED		
		Remove attenuation panel		
S		SUIT CIRCUIT RETURN SHUT-OFF - CLOSED	319	
		GLYCOL EVAP TEMP IN valve - as is (FULL HOT (CCW) for RCS deorbit)	311	
		Install attenuation panel		
		GLYCOL PRESS RELIEF BYPASS (2) - ON (OFF for RCS deorbit)	309	
C		GLYCOL TO RAD - CLOSE	307	
		GLYCOL RESERVOIR-BYPASS - OPEN (CLOSE for RCS deorbit)		
		GLYCOL RESERVOIR INLET - CLOSE		
		GLYCOL RESERVOIR OUTLET - CLOSE		
		CABIN PRESSURE RELIEF (2) - BOOST ENTRY (safety latch off)		
	4	C/M RCS engine preheating*		
		CB C/M-S/M-S/M TRANSFER MNA&B - CLOSED	25	
		C/M PROP JETT LOGIC - ON		
-26:00		FUNCTION SELECT - B	200	
		TEST SELECT - 1, 2, 3, 4, 11, 12		
		If any reading >1.80 TEST SELECT - lowest		
		C/M RCS HTRS - ON		
		DC VOLTS - 2.50 vdc or 13 minutes		
		C/M RCS HTRS - OFF		
		*For RCS deorbit: may be accomplished after retro burn		

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
6.7.1.2	<u>P32 - Pre-Thrusting - Return to Earth Program (RCS Deorbit Data).</u>		
1	Key V37E 32E (R36 - Return to Earth Data Load)		
2	FL V06 N44 - splashdown LAT (BIAS) XXX.XX DEG LONG (BIAS) XXX.XX DEG ALT 00000 Accept: V33E Reject: reload data		
3	FL V06 N74 ΔV allow. XXXXX. FPS ΔT TAILOFF XXX.XX SEC (00000) Accept: V33E Reject: reload data		
4	FL V06 N70 P TRIM (See figure 6-5.) XXX.XX DEG Y TRIM XXX.XX DEG ΔT TAILOFF XXX.XX SEC Accept: V33E Reject: reload data		
5	FL V06 N34 GETI PERM 00000 HRS 00000 MIN 0XX.XX SEC Accept: V33E Reject: reload data		

G&N DEORBIT AND ENTRY

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STA/T	Step	PROCEDURES	Panel	REMARKS
6	FL V06 N33			
	GETI	00XXX HRS 000XX MIN OXX.XX SEC		
	Accept: V33E			
	Reject: return to P00; reselect P32, or P27-P32			
7	FL V06 N47			
	Gamma (300k)	XXX.XX DEG		
	ΔR (X range)	XXXX.X NM		
	VI (300k)	XXXX. FT/SEC		
	Accept: V33E			
	Reject: return to P00; reselect P32, or P27-P32			
8	FL V16 N35			
	TTI	00XXX. HRS 000XX. MIN OXX.XX SEC		
	Set clocks V33E			
9	FL V06 N17 - gimbal angles at thrust			
	Roll, pitch, yaw	XXX.XX DEG		
	Backup:			
	If IMU alignment NOT satisfactory:			
	Select P53-P41 V37E 53E			
	(If MG(R3) > 15°, or			
	If > - hrs since IMU alignment)			

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
10	<p>If IMU alignment satisfactory: Set controls - G&C BASIC V33E</p> <p>(R01 - Att Control Mode Check)</p> <p>FL V50 N25 R1 00001 (G&N attitude) Accept: a. FDAI error needles -0±5 deg AME - ATTITUDE ENTER b. By pass SCS discrete monitor: V33E Reject: Use an SCS control mode</p> <p>(R21 - Attitude Maneuver)</p>		
11	<p>FL V16 N20 - present ICDU angles Roll, pitch, yaw XXX.XX DEG Align AGCU V33E</p>		
12	<p>FL V06 N17 - final ICDU angles Roll, pitch, yaw XXX.XX DEG SET ATT SET DIALS a. G&N Maneuver: V33E</p>		

G&N DEORBIT AND ENTRY

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>b. Manual maneuver:</p> <p>(1) Note OG angle THC - CW Maneuver to final ICDU angles V7OE FL V50 N25 R1-00007 (att trim) Maneuver complete ENTER THC - CENTER (when att error <5°)</p> <p>or (2) THC - CW V33E Maneuver to final ICDU angles THC - CENTER (when att error <5°)</p> <p>13 FL V50 N07 R1-00042 Go to P42 SPS or P42 RCS</p> <p>6.7.1.3 <u>P42 - Thrusting - Return to Earth Program (SPS).</u></p> <p>1 Set controls - G&C BASIC, except: DIRECT RCS - OFF LIMIT CYCLE - ON AME - ATTITUDE FCSM - G&N to G&N SCS to OVERRIDE/RESET FDAI BRIGHTNESS - ADJUST SPS GAUGING - AC1 Set up for 2 jet ullage</p>	8	

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

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STA/T Step	PROCEDURES	Panel	REMARKS										
	<table><tr><th>To Use</th><th>OPEN</th></tr><tr><td>Quad B&D</td><td></td></tr><tr><td>Yaw jets - Y axis</td><td>CB PITCH MNA CB YAW MNA</td></tr><tr><td>Quad A&C</td><td></td></tr><tr><td>Pitch jets - Z axis</td><td>CB PITCH MNB CB YAW MNB</td></tr></table>	To Use	OPEN	Quad B&D		Yaw jets - Y axis	CB PITCH MNA CB YAW MNA	Quad A&C		Pitch jets - Z axis	CB PITCH MNB CB YAW MNB		
To Use	OPEN												
Quad B&D													
Yaw jets - Y axis	CB PITCH MNA CB YAW MNA												
Quad A&C													
Pitch jets - Z axis	CB PITCH MNB CB YAW MNB												
2	Pre-ignition preparation												
	PHASE LOCK - ON	208											
	MAIN BUS TIE (2) - on	22											
	AC BUS 2 - RESET - OFF	18											
	INVERTER 2 - MNB												
	INVERTER 1 - AC BUS 2 - OFF												
	INVERTER 2 - AC BUS 2 - ON												
	AC BUS 2 RESET - CENTER												
3	Key V37E 42E												
4	FL V16 N20 - present ICDU angles												
	Roll, pitch, yaw XXX.XX DEG												
	SET ATT SET DIALS												
	V33E												
	(R31 - Backup ΔV Counter)												
5	FL V06 N14												
	R1 = VG XXXXX. FT/SEC												
	Obtain ΔV(SCS) from chart												
	TVC 1 POWER - AC1 MNA	24											
	TVC 2 POWER - AC2												
	Set ΔV Counter	7											
	V33E												

G&N DEORBIT AND ENTRY

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G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T	Step	PROCEDURES	Panel	REMARKS
		THC - CW MTVC control - check ΔV sw - OFF ATT DEADBAND - MIN B&D ROLL, PITCH, YAW CHANNELS - ON Null att error needles THC - neutral ΔV sw - ON G&N/SCS - SCS FDAI ALIGN-PRESS G&N/SCS - G&N Confirm and trim GPI ENTER	8 8	
	9	VO6 N51 TTI VG ΔVM		XXBXX MIN-SEC XXXXX. FT/SEC XXXXX. FT/SEC
-02:00	10	Report TTI = 2 min Set: THRUST sw - NORMAL INJECT PREVALVES (2) - A & B - ON Prim. THC - ARMED (R37 - SPS Engine Ignition Average G ON)	7	
-00:30	11	Check ΔVM for PIPA bias		
-00:20	12	Start ULLAGE		
-00:05	13	FL V50 N11 (thrust on enable)		
-00:02	14	ENTER		

G&N DEORBIT AND ENTRY

STA/T Step	PROCEDURES	Panel	REMARKS
00:00	<p>Check THRUST lt - ON</p> <p>Backup:</p> <p>If ENTER not keyed in:</p> <p>+00:15 VO6 N51</p> <p>TTI XXBXX MIN-SEC</p> <p>VG XXXX. FT/SEC</p> <p>ΔVM XXXX. FT/SEC</p> <p>+00:30 FL V50 NO7</p> <p>RL-00000</p> <p><u>CAUTION</u> If no ignition go to R38.</p>		
15	<p>VO6 N52 (at thrust on)</p> <p>TG XXBXX MIN-SEC</p> <p>VG XXXX. FT/SEC</p> <p>TFF XXBXX. MIN-SEC</p> <p>Backup:</p> <p>Manual TVC:</p> <p>THC - CW</p> <p>(V71E no att errors)</p> <p>THRUST sw OFF at ΔV REMAINING=0</p>		
16	<p>Monitor engine cutoff:</p> <p>Backup cutoff with THRUST sw</p> <p>THRUST lt - OUT</p> <p>Report engine OFF</p> <p>THRUST SW - OFF</p>		

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
17	FL V16 N52 (at thrust cutoff) TG(ECO) XXBXX MIN-SEC VG(ECO) XXXXX. FT/SEC TFF XXBXX MIN-SEC V33E		
18	Set controls after tailoff: GIMBAL MOTORS (4) - OFF INJET PREVALVES (2) - OFF ATT. DEADBAND - MAX LIMIT CYCLE - OFF ΔV sw - OFF TVC POWER 1 & 2 - OFF CB-GIMBAL PITCH 1 BAT A - OPEN THC - NEUTRAL, LOCKED (R34 - Orbital Parameter Display)	3 8 24 25	
19	FL V16 N47 Gamma (300k) XXX.XX DEG ΔR XXXX.X NM VI (300k) XXXXX. FPS V33E		
20	FL V50 N07 R1-00061		
6.7.1.4	<u>P42 - Thrusting - Return to Earth</u> <u>Program (RCS).</u>		
1	Set controls G&C BASIC, except: LIMIT CYCLE - ON AME - ATTITUDE FDAI BRIGHTNESS - adjust	8	

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STA/T	Step	PROCEDURES	Panel	REMARKS
	2	Pre-ignition preparation: PHASE LOCK - ON AC BUS 2 RESET - OFF INVERTER 2 - MNB INVERTER 1 - AC BUS 2 - OFF INVERTER 2 - AC BUS 2 - ON AC BUS 2 RESET - CENTER	208 18	
	3	Key V37E 42E		
	4	FL V16 N20 - present ICDU angles Roll, pitch, yaw XXX.XX DEG SET ATT SET DIALS V33E (R31 - Backup ΔV Counter)		
	5	FL V06 N14 R1 = VG XXXXX. FT/SEC TVC 1 POWER - AC1 MNA SET ΔV counter V33E		
	6	V06 N51 TTI XXBXX MIN-SEC VG XXXXX. FT/SEC ΔVM XXXXX. FT/SEC (=0) Update DET Test C/W lamps Check sight on boresight star using pitch angle and X-axis deflection		

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
-06:00 7	Key in VO6 N7OE (optional) P TRIM XXX.XX DEG Y TRIM XXX.XX DEG KEY RELEASE (R02 - Thrust Control Mode Check)		
-05:00 8	FL V50 N25 R1-00002 (G&N ΔV) SET ATT SET PITCH dial to pitch trim THC - CW Maneuver to pitch trim ΔV sw - ON G&N/SCS - SCS PDAI ALIGN - PRESS G&N/SCS - G&N ENTER	8 6 8	
9	VO6 N51 TTI XXBXX MIN-SEC VG XXXXX. FT/SEC ΔVM XXXXX. FT/SEC		
-02:00 10	Report TTI = 2 min LIMIT CYCLE - OFF Prim. THC - ARMED (R37 - SPS Engine Ignition Average G ON)		
-00:30 11	Check ΔVM for PIPA bias		
-00:05 12	FL V50 N11 (thrust on enable)		
-00:02 13	ENTER		

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STA/T	Step	PROCEDURES	Panel	REMARKS
00:00	14	THC - +X		
	15	V06 N52 (at thrust ON) TG VG TFF	XXBXX MIN-SEC XXXXX. FT/SEC XXBXX. MIN-SEC	
+00:10	16	FL V50 N11 (thrust on enable) V33E		
	17	Pitch S/C + at 4°/MIN (R34 - orbit parameter display)		
	18	FL V16 N47 GAMMA (300k) Δ R VI (300k) Key N42E	XXX.XX DEG XXXX.X NM XXXXX. FT/SEC	
	19	FL V16 N42 Δ R HP TFF Key N51E	XXXX.X NM XXXX.X NM XXBXX MIN-SEC	
	20	FL V16 N51 TTI VG Δ VM	XXBXX MIN-SEC XXXXX. FT/SEC XXXXX. FT/SEC	
	21	Set controls after +x off: Δ V sw - OFF TVC 1 POWER - OFF	8 24	
	22	Select P61 checklist		

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
6.7.1.5	<u>P61 - Maneuver to C/M-S/M Separation Attitude Program.</u>		
1	Key V37E 61E		
2	FL V16 N53 (30 sec display) G max. XXX.XX G Gamma (300k) XXX.XX DEG TFF XXBXX MIN/SEC DET-SET FOR TFF V33E (to proceed prior to 30 sec) (R21 - Attitude Maneuver)		
3	FL V06 N17 - final ICDU angles ROLL XXX.XX DEG(180) PITCH XXX.XX DEG(327) YAW XXX.XX DEG(0) SET ATT SET dials DIRECT RCS - ON	8	
a.	G&N maneuver: V33E ATT DEADBAND - MIN		
b.	Manual maneuver: (1) Note OG angle THC - CW Maneuver to final ICDU angles V70E ATT DEADBAND - MIN FL V50 N25 R1-00007 (att trim) Maneuver complete		

G&N DEORBIT AND ENTRY

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>ENTER</p> <p>THC - center (when att error nulled and P62)</p> <p>or (2) THC - CW</p> <p>V33E</p> <p>ATT DEADBAND - MIN</p> <p>Maneuver to final ICDU angles</p> <p>THC-CENTER (when att error nulled and P62)</p> <p>LIMIT CYCLE - ON</p>	8	
4	P62		
6.7.1.6	<u>P62 - C/M-S/M Separation and Pre-Entry Maneuver Program</u>		
1	<p>Manually select P62 (if required)</p> <p>Set controls to G&C_BASIC except:</p> <p>LIMIT CYCLE - ON</p> <p>AME - ATTITUDE</p> <p>Key V37E 62E</p> <p>(R03 - Entry Control Mode Check)</p>	8 14	
2	<p>FL V50 N25</p> <p>R1-00004 (SCS att cont)</p> <p>Accept:</p> <p>G&N/SCS - SCS</p> <p>FDAI ALIGN - PRESS</p> <p>ENTER</p>	8	

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	Reject: THC - CW V33E		
3	FL V50 N25 R1-00003 (G&N entry mode) Set: AME - MONITOR ATT. ERRORS - ZERO G&N/SCS - G&N AME - entry Accept: (discrete monitor) ENTER Reject: (discrete monitor) V33E	8	
4	FL V50 N25 R1-00041 (CM/SM sep) Set: MAIN BUS TIE (2) - ON F/C, MAIN BUS, A&B - (6) OFF F/C, REACTANTS - (3) OFF F/C, PUMPS - (3) OFF CB MESC ARM BAT A&B - CLOSED CB MESC LOGIC BAT A&B - CLOSED MESC LOGIC ARM (2) - ARM CB A&C ROLL MNA & B - OPEN CB B&D ROLL MNB - OPEN CB PITCH MNA - CLOSED CB PITCH MNB - OPEN CB YAW MNA - CLOSED	MDC-22 18 22 25	

G&N DEORBIT AND ENTRY

STA/T Step	PROCEDURES	Panel	REMARKS
	CB ELS BAT A&B - CLOSED	25	
	MESC PYRO ARM (2) - ARM	24	
	C/M RCS PRPLNT A&B - ON	15	
	OX DUMP - RCS CMD-AUTO	16	
	RCS C/M PRESS - PRESS	8	
	RCS INDICATORS - C/M A then B	12	
	RCS TRANS - CM	16	
	Test C/M jets - roll, yaw only		
	C/M-S/M SEP (2) - SEP	15	
	C&W mode sw - C/M	11	
	FLT QUAL RCDR - RCDR	19	
	USBE MODE - HBR with HIGH POWER	20	
	VHF-FM - ON		
	TAPE RECORDER - RECORD		
	FWD/REV - FWD (from beginning)		
	TAPE SPEED - NORMAL		
	VHF ANTENNA - UPPER		
	S-BAND ANTENNA - UPPER		
5	After satisfactory separation: Maneuver to initial entry attitude (heads up) (R= P= Y=)		
	a. G&N maneuver: ENTER		
	b. Manual maneuver: THC - CW ENTER Maneuver to entry attitude		

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
	<p>Backup: If V50 N25 still FL (no sep discrete to AGC): V33E</p> <p>6 FL V06 N62 Lat correct for RCS deorbit XXX.XX DEG Long correct for RCS deorbit XXX.XX DEG Heads UP/DN +00001/-00001</p> <p>Accept: V33E</p> <p>Reject: Load desired parameters (Final entry att maneuver)</p> <p>7 V06 N17 - final ICDU angles Roll, pitch, yaw XXX.XX DEG SET ATT SET dials Maneuver to final ICDU angles G&N/SCS - SCS FDAI ALIGN - PRESS. G&N/SCS - G&N THC - Center when att error nulled and P63 (P63 auto when CDU drive completed) Press ERROR RESET</p>	<p>6</p> <p>8</p> <p>6</p> <p>8</p>	

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STA/T	Step	PROCEDURES	Panel	REMARKS
		6.7.1.7 <u>P63 - Entry Initialization Program.</u>		
1	V16 N54	Beta XXX.XX DEG G XXX.XX G Rto targ XXXX.X NM (Key N64 for present lat, long, alt)		
		6.7.1.8 <u>P64 - Post 0.05G Program.</u>		
1	.05G ENTRY - ON		8	
2	ATT DEADBAND - MAX			
3	THC - CW			
4	V16 N54 -	Beta XXX.XX DEG G XXX.XX G Rto targ XXXX.X NM		
		6.7.1.9 <u>P67 - Final Phase Program (G = .2).</u>		
1	V16 N71	Beta XXX.XX DEG G XXX.XX G Rpred-Rtarg XXXX.X NM Fly roll CMD		
2	FL V16 N71 when $V_{rel} = 1000$ ft/sec (65,000 ft) If R3 = -, L up, If R3 = +, L down:			

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T	Step	PROCEDURES	Panel	REMARKS
50Kft	3	ELS LOGIC - LOGIC ELS AUTO - AUTO PANEL 5 - UNLOCK Backup:	8 16	
45Kft		CM unstable RCS CMD - OFF APEX COVER JETT PB - press DROGUE DEPLOY PB - press (2 sec after apex cover jett) CM STABLE	5	
24Kft	4	RCS CMD - OFF SCS CHANNELS (4) - OFF APEX COVER PB - JETT DROGUE DEPLOY PB - PRESS (2 sec after apex cover jett)	16 8 5	
10Kft	5	MAIN DEPLOY PB - PRESS CABIN PRESS RELIEF (2) - CLOSE C/M PROP JETT DUMP - DUMP Backup: Rotation controls (2) - one rotation control is positioned to command plus yaw and roll (excluding plus pitch). The other rotation control is positioned to command minus pitch yaw and roll.	307 8	

G&N DEORBIT AND ENTRY

STA/T Step	PROCEDURES	Panel	REMARKS
00:00	DET-RESET-START		The LOCKED placard on each strut is covered when the strut is unlocked.
+02:40	COUCH UNLOCK - UNLOCK (Check for unlock or pull 4 pins) C/M PROP JETT PURGE - PURGE Backup: C/M RCS He DUMP - DUMP The two rotation controls must also be used (excluding plus pitch) if they were used for the dump operation.	8	
+03:00	C/M RCS-PRESS-He-ZERO CABIN PRESSURE RELIEF (2) - BOOST ENTRY C/M PROP JETT-LOGIC - OFF C/M RCS PRPLNT (2) - OFF S-BAND XPONDER - OFF C-BAND - OFF VHF/FM - OFF RECOVERY VHF-BCN - ON VHF ANTENNA - RECOVERY CB-POST LDG-BAT BUS A & B, BAT C - CLOSED MAIN BUS TIE (2) - OFF DIRECT O2 - OPEN (CCW) SPLASHDOWN	12 307 8 15 20 203 22 24	

G&N DEORBIT AND ENTRY

NORMAL/BACKUP

STA/T	Step	PROCEDURES	Panel	REMARKS
	6.8	POSTLANDING AND WATER EGRESS PROCEDURES.		
	1	Touchdown and stabilization		
C		MAIN CHUTE - RELEASE	8	
		CABIN PRESSURE RELIEF - CLOSED	307	
P		TAPE RECORDER MODE - OFF		
		CB VENT FAN-PL BUS - CLOSED	25	
C		Floating inverted:		
		POST LANDING FLOAT BAG (3) - FILL (off when upright)		
	2	Poststabilization and ventilation		
C		PLV lock pins - pull		
		PLV duct lanyard - pull and secure		
		POST LANDING-VENT FAN - HIGH	25	
		POST LANDING-BEACON lights - ON		
		POST LANDING-ANTENNA (2) - DEPLOY		
		MESC LOGIC ARM (2) - OFF		
		MESC PYRO ARM (2) - SAFE	24	
P		RECOVERY HF - ON	13,23,26	
CSP		HF - T/R	20	
P		RECOVERY-HF MODE - SSB, BCN, or AM		
		POST LANDING switch - Checklist,		
		PG - complete		
	3	Stable I water egress checklist		
		POST LANDING-VENT FAN - OFF	25	
		VHF/AM - OFF	20	
		Audio center power off	13,23,26	

POSTLANDING AND WATER EGRESS PROCEDURES

NORMAL/BACKUP

STA/T Step	PROCEDURES	Panel	REMARKS
S P S S	Center couch - 276° position Right couch - 212° position Armrests, center couch - removed Headrest, center couch - lowered		
	<u>CAUTION</u> When the survival kit retainer bar is released, the two containers will fall down onto the pilot's couch.		
CSP	Survival kits - removed Hinge pins - removed Inner hatch - removed and stowed Outer hatch - released and removed Neck dams - on Connect red raft green lanyard with white snap to S/C unless S/C is sinking Attach one provisions kit white lanyard to white raft Attach yellow lanyard to senior pilot Inflate white raft Attach second provisions kit white lanyard to blue raft Attach yellow lanyard to pilot Inflate blue raft Attach red raft yellow lanyard to command pilot Inflate red raft		

POSTLANDING AND WATER EGRESS PROCEDURES

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STA/T	Step	PROCEDURES	Panel	REMARKS
	4	Stable II egress		
		POST LANDING-VENT FAN - OFF	25	
		VHF/AM - OFF	20	
		Audio center power (3) - OFF	26,13,23	
C		DIRECT O ₂ - on full		
CSP		Loosen foot restraints		
CSP		Unstrap		
S		Center and right couch 276° position		
		Neck dams - on		
P		Remove survival equipment from stowage		
S		Unlock tunnel hatch		
		NOTE The next step will flood the tunnel, so be prepared for a large pressure change within the C/M.		
C		PLVC sw - OPEN		
S		Remove and stow tunnel hatch		
		Connect red liferaft yellow lanyard to senior pilot		
		Pull out green lanyard with white snap from red liferaft and give to command pilot		
		Senior pilot exit with raft rucksack.		
P		Pilot connect hardware yellow lanyard to suit and exit with rucksack		
C		Connect yellow lanyard from water rucksack to suit		
		Connect green lanyard from red raft to suit		
		Exit with water rucksack		

POSTLANDING AND WATER EGRESS PROCEDURES

NORMAL/BACKUP

STA/T Step	PROCEDURES	REMARKS
5 CPS S P S CSP	Emergency water egress Unstrap and disconnect Neck dams - on Lower right seat (couch) Remove inner hatch Remove survival gear from stowage Each crewman take a rucksack and egress - Inflate waterwings	

POSTLANDING AND WATER EGRESS PROCEDURES

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MALFUNCTION PROCEDURES

SECTION 7

MALFUNCTION PROCEDURES

INTRODUCTION

Malfunction procedures consist of operational and trajectory analysis for situations other than normal that may occur during all mission phases. This will provide the crew with decision-making guidance as to aborting the mission, selecting and implementing an alternate mission, or continuing the mission under degraded conditions. The procedures include the corrective action that must be taken and the limitations that may be imposed. The malfunction procedures consist of the following:

- Malfunction procedures
- Abort procedures
- Emergency procedures.

Malfunction procedures encompass the recognition, diagnosis, and corrective action for system malfunctions. In most cases, the crew is alerted to a malfunction condition by C&WS panel lights and indicators, or by the absence of a scheduled function or event. The crew will then locate, correct, or isolate the malfunction and determine its effect on the scheduled mission. These procedures are presented in tabular form and arranged by S/C systems. In most cases, malfunctions are identified by lights and indicators. Crew isolation or corrective action includes switch settings, indicator readings, and positioning of various controls. Malfunctions which cause systems status lights on MDC-10 or -11 to illuminate will also illuminate the MASTER ALARM lights on MDC-3, -18, and LEB-103. Simultaneously, an audio tone will be heard in all three headsets. Pressing the MASTER ALARM switch-light on MDC-3 or -18 will extinguish all three MASTER ALARM lights and cut off the audio tone in the headsets. However, the system status lights will remain illuminated as long as the malfunction exists. This will enable the master alarm circuit to function again should another malfunction occur.

To eliminate lengthy or repeated procedures, certain assumptions have been established with the malfunction procedures. These assumptions are as follows:

- Abnormal readings and indications will be verified with MSFN where practical.

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MALFUNCTION PROCEDURES

- At the first indication of a malfunction, the crew will check for tripped circuit breaker(s) in applicable circuit or system.
- Depth of coverage does not include malfunction isolation steps relative to failure within the sensor/indicator circuitry for the indicator (meter, status lights, talk-back) giving the primary malfunction indication.

Abort and emergency procedures consist of those instant-reaction procedures required where safety of the flight crew is concerned and time is a critical factor.

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MALFUNCTION PROCEDURES

MALFUNCTION

7.1 MALFUNCTION PROCEDURES

NOTE Malfunction Procedures will
be incorporated into this section
at a later date.

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ABORT PROCEDURES

7.2 ABORT PROCEDURES

ABORT

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ABORT PROCEDURES

7.2 ABORT PROCEDURES

During the ascent phase, an abort can be accomplished in an LES or SPS mode. An abort in the LES mode is accomplished by utilizing the launch escape system which has solid propellant motors mounted on a tower above the command module. During a normal mission, the launch escape tower is jettisoned approximately 30 seconds after second-stage booster ignition. After the launch escape tower is jettisoned, an abort can be accomplished in the SPS mode by utilizing the service propulsion engine in the service module.

7.2.1 LES ABORT MODES.

An abort may be initiated automatically by the emergency detection system (EDS) when two L/V engines fail, L/V excessive rates detected, breakup between IU and C/M, or manually when the commander's translation control is rotated to the full CCW position. Upon receipt of an abort signal, regardless of its source, the booster is cut off (if after T + 40 seconds), the C/M is separated from the S/M, and simultaneous ignition of the launch escape and pitch control motors takes place. Firing of the pitch control motor is inhibited 61 seconds after lift-off. Cutoff of the booster engines is inhibited for the first 40 seconds after lift-off by circuitry in IU because of range safety restrictions. The LES motors provide thrust to propel the command module away from the launch pad or trajectory of the launch vehicle.

Certain events that occur during an abort are controlled automatically by controllers in the sequential events control system (SECS). Refer to section 2 for a description of the SECS. The earth landing sequence controller (ELSC) contains high-altitude and low-altitude baroswitches. The opening of these baroswitches inhibit ELS operations and the closing initiates the operations. The high-altitude baroswitch controls automatic LES tower jettison, apex cover jettison, and drogue parachute mortar fire. The high-altitude baroswitch is designed to open at 38,500 feet and close at 24,000 feet. Because of venting lag, the high-altitude baroswitch will not open until 40,500 feet during ascent. An abort initiated under 30,000 feet (1 minute, 10 seconds) will allow sufficient time for automatic deployment of the canard, LES tower jettison, apex cover jettison, and drogue parachute deployment on a timed sequence controlled by time-delay relays. On an abort initiated between 1 minute 10 seconds and 3 minutes, automatic LES tower jettison, apex cover jettison, and drogue parachute deployment are delayed until the command module descends to the closing altitude of the high-altitude baroswitch (24,900 to 21,500 feet).

LES ABORT MODES

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The low-altitude (10K') baroswitch is closed 10,000 feet, open 18,000 feet. Opening of the low-altitude baroswitch will delay automatic deployment of the pilot-main parachutes until the command module descends to the closing altitude (10,950 to 9100 feet). During a pad to 1 minute 1 second after lift-off abort, release of the drogue parachutes and deployment of the main parachutes will be manually controlled. The RCS oxidizer and purging helium are automatically dumped overboard through a hole in the aft heat shield during a pad to 61-second abort, and the high-pressure helium is dumped into the aft compartment of the C/M. The oxidizer dump time is approximately 11 seconds. Helium dump is automatically initiated 18 seconds after abort initiation. The RCS fuel is retained in the supply tanks of the command module. The crew couches X-X attenuators (4) are not unlocked during a pad to 61-second abort as the crew would not have time to visually check and manually unlock struts, in the event they failed to unlock electromechanically. A mechanical override provides automatic breakout of approximately 20 g's upon landing.

The LES abort mode includes low-altitude abort, medium-altitude abort, and high-altitude abort as follows:

- Low-altitude abort - launch pad to 1 minute 1 second (Mode I-A).
- Medium-altitude abort - 1 minute 1 second to 2 minutes (Mode I-B).
- High-altitude abort - 2 minutes to LES tower jettison (Mode I-C).

See figure 7.2-1 for LES abort sequence of events, and figures 7.2-2 and 7.2-3 for low-, medium-, and high-altitude LES aborts. During a medium- or high-altitude abort, the C/M RCS propellants are burned through 10 RCS engines after the main parachutes disreef, and then the system is purged. The two engines out and L/V rates auto abort capability is switched off prior to S-IB/S-IVB staging and the crew must be ready to manually initiate an abort if those conditions arise. The crew couch attenuators are unlocked during the medium- and high-altitude aborts because the crew has plenty of time to visually check each of the four X-X struts and pull the unlock pins if necessary. The LOCKED placard on each strut will be covered when the strut is unlocked. All four struts must be either locked or unlocked to provide even attenuation at touchdown impact.

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Positioning of the following controls enables the sequential system to perform an automatic LES abort after lift-off.

1. ELS sw - AUTO
2. ABORT SYSTEM switches
 - OX DUMP sw - AUTO
 - 2 ENG OUT sw - AUTO
 - L/V RATES sw - AUTO
 - MODE 1&2 sw - LES MODE
3. EDS sw - AUTO
4. C/M PROP JETT switches
 - LOGIC sw - on (up)
 - DUMP sw - OFF
 - PURGE sw - OFF
5. MESC-LOGIC ARM sw (2) - on (up)
6. EDS POWER sw - ON
7. MASTER EVENT SEQ CONT-PYRO ARM sw (2) - on (up)
8. DIRECT RCS sw - on (up)

During ascent:

1. ABORT SYSTEM-OX DUMP sw - RCS CMD-AUTO (at 61 seconds after lift-off)
2. C/M RCS PRPLNT-A & B sw (2) - ON (at 61 seconds after lift-off)

ABORT

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STA/T Step	PROCEDURES	Panel	REMARKS
7.2.1.1	<u>Low Altitude (Mode I-A).</u> (PAD TO 01 MIN 01 SEC) 00:00C 1 ABORT (Automatic or Manual) a. BECO (if after lift-off + 40 seconds) b. Event timer reset and counting up - check c. 11-second time delay started d. C/M-S/M deadfaced e. 0.1-second time delay started f. Entry batteries (3) connected to d-c main buses g. 1.0-second time delay started h. 18-second time delay started i. C/M RCS pressurized j. RCS control transferred (S/M to C/M)		Backup: Translation control - rotate CCW into detent and leave. NOTE A LES abort can also be initiated by setting the C/M-S/M SEP switches 1 and 2 to the up position (momentary) (MDC-15). Backup: DIGITAL EVENT TIMER sw (2) (MDC-8) (1) RESET sw - RESET (momentary) (2) START/STOP sw - START Backup: C/M-S/M SEP sw (2) - up (momentary) (MDC-15) NOTE This is automatic backup. The batteries were connected to the d-c main buses at prelaunch with MAIN BUS TIE switches. Backup: REACTION CONTROL SYS-C/M PRESS/OFF sw - C/M PRESS (MDC-16) Backup: REACTION CONTROL SYS - TRANS sw - C/M (MDC-16)

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STA/T Step	PROCEDURES	Panel	REMARKS
C	k. C/M RCS oxidizer dump		No backup: Verify ABORT SYSTEM - OX DUMP sw in AUTO position. (MDC-16)
	l. C/M-S/M separation (guillotine and tension ties)		Backup: C/M-S/M SEP sw (2) - up (momentary) (MDC-15)
	m. DSKY PROGRAM changed - 17		
	n. LE and PC motors fire - check		Backup: (1) Panel lock control - UNLOCK (2) LES MOTOR FIRE sw - press (MDC-5)
+10"	2 Panel lock control - UNLOCK	5	
00:11	3 Canard deployed		Backup: CANARD DEPLOY sw - press (MDC-5)
	a. 3-second time delay started		
00:14	ELS logic arm		Backup: ELS LOGIC sw - LOGIC (MDC-8)
P	4 MASTER ALARM switch-light - press		
	5 CAUT/WARN-MODE sw - C/M		
C	6 LES tower jettisoned - check		Backup: ABORT SYSTEM-MODE sw (2) - TWR JETT SPS MODE (MDC-16)
	a. LES tower attach nuts detonated		
	b. Tower jettison motor ignited		
	c. 0.4-second time delay started		
	d. SCS/RCS disable signal		
	e. 2-second time delay started		
	f. 14-second time delay started		

LES ABORT MODES

ABORT

STA/T	Step	PROCEDURES	Panel	REMARKS
	7	Apex cover jettisoned - check		Backup: APEX COVER JETT sw - press (MDC-5)
00:16	8	Drogue parachute deployed - check		Backup: DROGUE DEPLOY sw - press (MDC-5)
	9	ALTIMETER reading - check	1	
	a.	If 3300 feet or below, MAIN DEPLOY sw - press	5	
	b.	If above 3300 feet:		
	(1)	ELS sw - MAN	16	
	(2)	At 3300 feet, MAIN DEPLOY sw - press		
	(3)	ELS sw - AUTO		The ELS switch must be repositioned to AUTO to allow a 14-second timer to enable main parachute release after touchdown.
	10	RECOVERY-VHF BCN sw - ON	20	
	11	VHF ANTENNA sw - RECOVERY	20	
00:18	12	RCS helium dump - check C/M RCS-PRESS He ind	12	No backup.
	13	C/M PROP JETT-LOGIC sw - OFF	8	
	14	C/M RCS PRPLNT-A and B sw - OFF	15	
	15	POST LANDING-BAT BUS A, B, and BAT C circuit breakers - close	203	
	16	MAIN BUS TIE sw (2) - OFF	22	
	17	DIRECT O ₂ valve - OPEN (CCW)	24	
		Postlanding check		

LES ABORT MODES

STA/T Step	PROCEDURES	Panel	REMARKS
7.2.1.2	<u>Medium Altitude (Mode I-B).</u> (01 MIN 01 SEC TO 02 MIN) -0°C 1 ABORT (Automatic or Manual) a. BECO b. Event timer reset and counting up c. 11-second time delay started d. C/M-S/M deadfaced e. 0.1-second time delay started f. Entry batteries (3) connected to d-c main buses g. 1.0-second time delay started h. C/M RCS pressurized - check i. RCS control transferred (S/M to C/M)	12	Backup: Translation control - rotate CCW into detent and leave NOTE A LES abort can also be initiated by setting the C/M-S/M SEP switches 1 and 2 to the up position (momentary) (MDC-15). Backup: DIGITAL EVENT TIMER sw (2) (MDC-8) (1) RESET sw - RESET (momentary) (2) START/STOP sw - START Backup: C/M-S/M SEP sw (2) - up (momentary) (MDC-15) NOTE This is automatic backup. The batteries were connected to the d-c main buses at prelaunch with MAIN BUS TIE switches. Backup: REACTION CONTROL SYS - C/M PRESS/OFF sw - C/M PRESS (MDC-16) Backup: REACTION CONTROL SYS-TRANS sw - C/M (MDC-16)

LES ABORT MODES

ABORT

STA/T Step	PROCEDURES	Panel	REMARKS
	j. C/M-S/M separation (guillotine and tension ties)		Backup: C/M-S/M SEP sw (2) - up (momentary) (MDC-15)
	k. DSKY PROGRAM changed - 17		
	l. LE motor fire	5	Backup: (1) Panel lock control - UNLOCK (2) LES MOTOR FIRE sw - press
00:01	m. SCS/RCS enabled		Backup: REACTION CONTROL SYS - CMD sw - ON (MDC-16)
00:10	2 Panel lock control - UNLOCK	5	
00:11	3 Canard deployed		Backup: CANARD DEPLOY sw - press (MDC-5)
	a. 3-second time delay started		
	4 DSKY - monitor as required		
	R1 - Inertial flight path angle		
	R2 - Inertial velocity (ft/sec)		
	R3 - Vehicle altitude (0.1 NM)		
	5 Rotation control - CW into detent and leave		
	6 .05 G ENTRY sw - ON	8	
	7 ATTITUDE/MONITOR/ENTRY sw - ENTRY	8	
	8 SCS CHANNEL-PITCH sw - OFF	8	
00:14"	ELS logic arm		Backup: ELS LOGIC sw - LOGIC (MDC-8)
P	9 MASTER ALARM switch-light - press	18	

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STA/T	Step	PROCEDURES	Panel	REMARKS
	10	CAUT/WARN-MODE sw - C/M	11	
TJC	11	24,900 to 21,500 feet, LES tower jettisoned - check a. LES tower attach nuts detonated b. Tower jettison motor ignited c. 0.4-second time delay started d. SCS/RCS disable signal e. 2-second time delay started f. 14-second time delay started		Backup: ABORT SYSTEM-MODE sw (2) - TWR JETT SPS MODE (MDC-16) Backup: REACTION CONTROL SYS-CMD sw - OFF (MDC-16)
	12	Apex cover jettisoned (TJ + 0.4")		Backup: APEX COVER JETT sw - press (MDC-5)
+2.0"	13	Drogue parachute deployed - check NOTE The C/M may be very unstable until drogue parachutes disreef.		Backup: DROGUE DEPLOY sw - press (MDC-5)
	14	10,950 to 9,100 feet, main parachutes deployed - check	5	Backup: MAIN DEPLOY sw - press (MDC-5)
	15	Main parachutes disreef - check		
	16	CABIN PRESSURE RELIEF controls (2) - CLOSE	131	
	17	CM PROP JETT-DUMP sw - DUMP	8	Backup: One rotation control positioned to command plus yaw and roll (excluding plus pitch). The other rotation control positioned to command minus yaw, pitch, and roll.

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STA/T	Step	PROCEDURES	Panel	REMARKS
00:00	18	DIGITAL EVENT TIMER - RESET - START	8	
	19	COUCH UNLOCK sw - UNLOCK	8	Backup: Attenuator unlock pins (4) - pull
	20	RECOVERY-VHF BCN sw - ON	20	
	21	VHF ANTENNA sw - RECOVERY	20	
02:40	22	CM PROP JETT-PURGE sw - PURGE	8	Backup: C/M He RCS He DUMP sw - He DUMP (MDC-26). The two rotation controls must also be used if they were used for the dump operation in step 17. One control is positioned to command plus yaw and roll (excluding plus pitch). The other control is positioned to command minus yaw, pitch, and roll.
03:00	23	CABIN PRESSURE RELIEF controls (2) - BOOST ENTRY	131	
	24	C/M RCS-PRESS-He ind - zero	12	
	25	C/M PROP JETT-LOGIC sw - OFF	8	
	26	C/M RCS PRPLNT-A and B sw (2) - OFF	15	
	27	POST LANDING-BAT BUS A, B and BAT C - close	203	
	28	MAIN BUS TIE (2) - OFF	22	
		DIRECT O ₂ valve - OPEN (CCW)	24	
		Postlanding check		

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STA/T Step	PROCEDURES	Panel	REMARKS
7.2.1.3	High Altitude (Mode I-C)		
	(02 MIN 00 SEC TO 03 MIN 02 SEC)		
-0°C	1 ABORT (Automatic or Manual)		Backup: Translation control - rotate CCW into detent and leave.
	a. BECO		NOTE A LES abort can also be initiated by setting the C/M-S/M SEP switches A and B to the up position (momentary) (MDC-15).
	b. Event timer reset and counting up		Backup: DIGITAL EVENT TIMER sw (2) (MDC-8) (1) RESET sw - RESET (2) START/STOP sw - START
	c. 11-second time delay started		
	d. C/M-S/M deadfaced		Backup: C/M-S/M SEP sw (2) - up (momentary) (MDC-15)
	e. 0.1-second time delay started		NOTE This is auto backup. The batteries were connected to the d-c main buses at prelaunch with MAIN BUS TIE switches.
	f. Entry batteries (3) connected to d-c main buses		
	g. 1.0-second time delay started		
	h. C/M RCS pressurized	12	Backup: REACTION CONTROL SYS-C/M PRESS/OFF sw - C/M PRESS (MDC-16)
	i. RCS control transferred (S/M to C/M)		Backup: REACTION CONTROL SYS-TRANS sw - C/M (MDC-16)

LES ABORT MODES

ABORT

STA/T Step	PROCEDURES	Panel	REMARKS
+0.1"	j. C/M-S/M separation (guillotine and tension ties) k. DSKY PROGRAM changed - 17 l. LE motor fire		Backup: C/M-S/M SEP sw (2) - up (momentary) (MDC-15) Backup: (1) Panel lock control - UNLOCK (MDC-5) (2) LES MOTOR FIRE sw - press
+1.0"	m. SCS/RCS enabled		Backup: REACTION CONTROL SYS-CMD sw - ON (MDC-16)
+10"	2 Panel lock control - UNLOCK	5	
+11"	3 Canard deployed sw a. 3-second time delay started 4 DSKY - monitor as required R1 - Inertial flight path angle R2 - Inertial velocity (ft/sec) R3 - Vehicle altitude (0.1 NM) 5 Rotation control - CW into detent and leave 6 .05G ENTRY sw - ON 7 ATTITUDE/MONITOR/ENTRY sw - ENTRY 8 SCS CHANNEL-PITCH sw - OFF 9 Positive pitch rate in excess of 5 deg/sec - establish and maintain with rotation control	5 8 8 8	Backup: CANARD DEPLOY sw - press (MDC-5)

LES ABORT MODES

STA/T	Step	PROCEDURES	Panel	REMARKS
+14"		ELS logic arm		Backup: ELS LOGIC sw - LOGIC (MDC-8)
P	10	MASTER ALARM switch-light - press	18	
	11	CAUT/WARN-MODE sw - C/M	11	
TJC	12	24,900 to 21,500 feet, LES tower jettisoned - check		Backup: ABORT SYSTEM-MODE sw (2) - TWR JETT SPS MODE (MDC-16)
	a.	LES tower attach nuts detonated		
	b.	Tower jettison motor ignited		
	c.	0.4-second time delay started		
	d.	SCS/RCS disable signal		Backup: REACTION CONTROL SYS-CMD sw - OFF (MDC-16)
	e.	2-second time delay started		
	f.	14-second time delay started		
	13	Apex cover jettisoned (TJ + 0.4")		Backup: APEX COVER JETT sw - press (MDC-5)
+2.0"	14	Drogue parachute deployed - check		Backup: DROGUE DEPLOY sw - press (MDC-5)
		NOTE The C/M may be very unstable until drogue parachutes disreef.		
	15	10,950 to 9,100 feet, main parachutes deployed - check		Backup: MAIN DEPLOY sw - press (MDC-5)
	16	Main parachutes disreef - check		
	17	CABIN PRESSURE RELIEF controls (2) - CLOSE	131	

LES ABORT MODES

ABORT

STA/T Step	PROCEDURES	Panel	REMARKS
18	CM PROP JETT-DUMP sw - DUMP	8	Backup: One rotation control positioned to command plus yaw and roll (excluding plus pitch). The other rotation control positioned to command minus yaw, pitch, and roll.
19	DIGITAL EVENT TIMER - reset	8	
20	COUCH UNLOCK sw - UNLOCK	8	Backup: Attenuator unlock pins (4) - pull
21	RECOVERY-VHF BCN sw - ON	20	
22	VHF ANTENNA sw - RECOVERY	20	
02:40 23	CM PROP JETT-PURGE sw - PURGE	8	Backup: C/M He RCS He DUMP sw - He DUMP (MDC-26) The two rotation controls must be used if they were used for the dump operation in step 18. One control is positioned to command plus yaw and roll (excluding plus pitch). The other control is positioned to command minus yaw, pitch, and roll.
03:00 24	CABIN PRESSURE RELIEF controls (2) - BOOST ENTRY	131	
25	C/M RCS-PRESS-He ind - zero	12	
26	C/M PROP JETT-LOGIC sw - OFF	8	
27	C/M RCS PRPLNT - A and B sw (2) - OFF	15	

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STA/T Step	PROCEDURES	Panel	REMARKS
28	POST LANDING-BAT BUS A, B and BAT BUS C circuit breakers - close	203	
29	MAIN BUS TIE (2) - OFF	22	
30	DIRECT O ₂ valve - OPEN (CCW)	24	
	Postlanding check		
7.2.2	SPS ABORT MODES (POST-LET JETTISON)		
	<p>An abort in the SPS mode is accomplished by utilizing the SPS engine and must be initiated manually with the translation control. The Apollo Guidance Computer (AGC) will be notified of the abort by the CSM/S-IVB separation (abort) signal and display PROGRAM 71 on the DSKY. A short duration SPS burn, to increase separation between the CSM and S-IVB, will be initiated manually.</p>		
7.2.2.1	<u>SPS Abort (Mode II).</u>		
	TBD		
7.2.2.2	<u>SPS Abort (Mode III).</u>		
	TBD		
7.2.2.3	<u>SPS Abort (Mode IV).</u>		
	TBD		

LES ABORT MODES - SPS ABORT MODES (POST-LET JETTISON)

ABORT

ABORT PROCEDURES

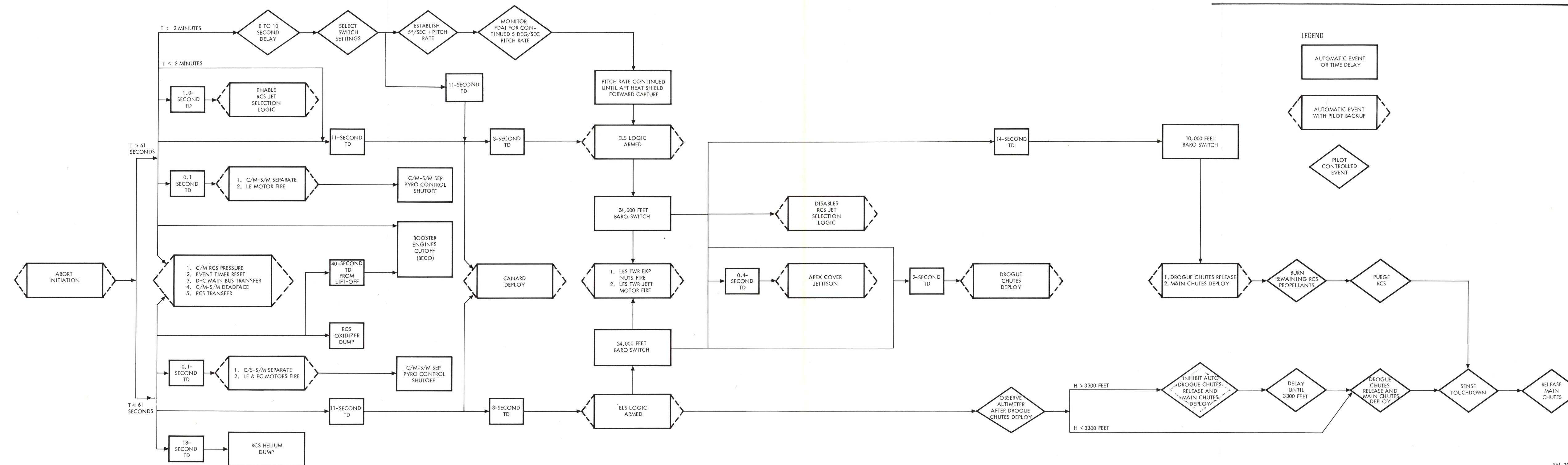
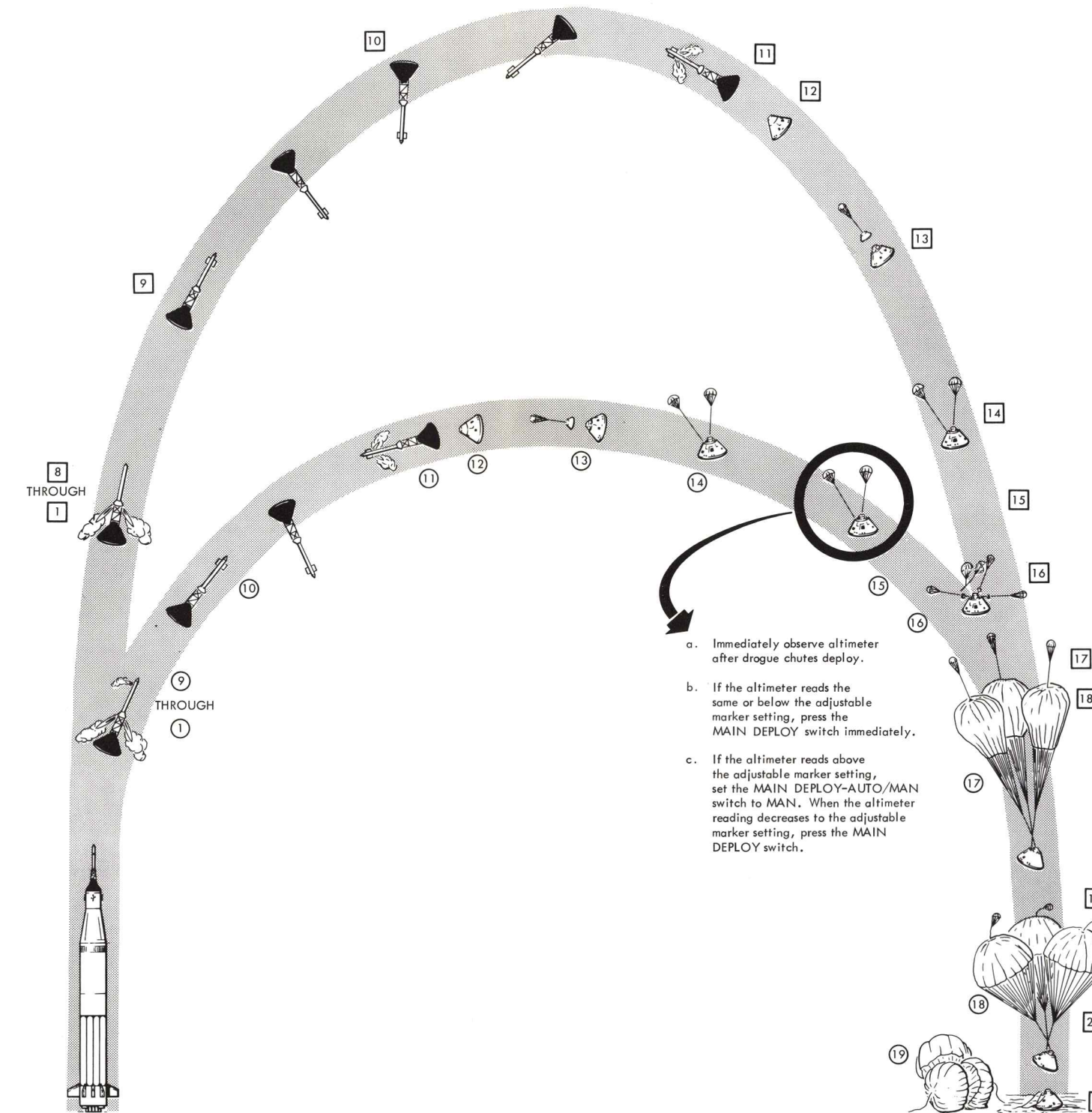


Figure 7.2-1. LES Abort Sequence of Events

ABORT PROCEDURES

PAD TO 61 SECONDS ABORT

T-0"	1 ABORT INITIATED	(TLM)
	2 BOOSTER ENGINES CUTOFF (IF LIFT-OFF + 40 SECONDS)	(TLM)
	3 EVENT TIMER RESET	
	4 C/M-S/M UMBILICAL DEADFACE	
	5 C/M RCS PRESSURIZE	(TLM)
T+0.1	6 START C/M RCS OXIDIZER DUMP	(TLM)
	7 C/M-S/M SEPARATION	(TLM)
	8 LAUNCH ESCAPE AND PITCH MOTORS IGNITED	
T+1.8"	9 C/M-S/M SEPARATION PYRO CONTROL CUTOFF	
T+11"	10 CANARD DEPLOYED	(TLM)
T+14"	11 ELS LOGIC ARMED	
T+14"	12 BPC AND LES TWR JETTISONED	(TLM)
T+14.4"	13 APEX COVER JETTISONED	(TLM)
T+16"	14 DROGUE PARACHUTES DEPLOYED (reefed for 8 seconds)	(TLM)
T+18"	15 C/M RCS HELIUM DEPRESSURIZATION	
	16 DROGUE PARACHUTES RELEASE AND PILOT PARACHUTES DEPLOYED (MANUAL SEL)	(TLM)
	17 MAIN PARACHUTES REEFED FOR 8 SECONDS	
	18 MAIN PARACHUTES DISREEF	
	19 MAIN PARACHUTES RELEASED AFTER TOUCHDOWN (MANUAL SEL)	



61 SECONDS TO 1 MINUTE-10 SECOND ABORT

T-0"	1 ABORT INITIATED	(TLM)
	2 BOOSTER ENGINE CUTOFF (BECO)	(TLM)
	3 EVENT TIMER RESET	
	4 C/M-S/M UMBILICAL DEADFACE	
	5 C/M-S/M PRESSURIZE	(TLM)
T+0.1"	6 C/M-S/M SEPARATION	(TLM)
	7 LAUNCH ESCAPE MOTOR IGNITED	(TLM)
T+1.8"	8 C/M-S/M SEPARATION PYRO CONTROL CUTOFF	
T+11"	9 CANARD DEPLOYED	(TLM)
	10 CANARD CONTROLS C/M IN TURNAROUND MANEUVER	
T+14"	11 ELS LOGIC ARMED	
T+14"	12 BPC AND LES TWR JETTISONED	(TLM)
T+14.4"	13 APEX COVER JETTISONED	(TLM)
T+16"	14 DROGUE PARACHUTES DEPLOYED (reefed for 8 seconds)	(TLM)
	15 10,000 FEET BARO SWITCH CLOSURE	
	16 DROGUE PARACHUTES RELEASE AND PILOT PARACHUTES DEPLOY	(TLM)
	17 MAIN PARACHUTES REEFED FOR 8 SECONDS	
	18 BURN RCS PROPELLANTS (MANUAL SEL)	
	19 MAIN PARACHUTES DISREEF	
	20 PURGE RCS (MANUAL SEL)	
	21 MAIN PARACHUTES RELEASE AFTER TOUCHDOWN (MANUAL SEL)	

Figure 7.2-2. Low-Altitude Abort Profiles

ABORT PROCEDURES

ABORT PROCEDURES

MEDIUM-ALTITUDE LES ABORT		
T - 0"	1 ABORT INITIATED	(TLM)
	2 BOOSTER ENGINE CUTOFF (BECO)	(TLM)
	3 DIGITAL EVENT TIMER RESET	
	4 C/M-S/M UMBILICAL DEADFACED	
	5 C/M RCS PRESSURIZED	(TLM)
	6 RCS CONTROL TRANSFERRED	
T + 0.1"	7 C/M-S/M SEPARATION	(TLM)
	8 LAUNCH ESCAPE MOTOR IGNITED	(TLM)
T + 1.8"	9 C/M RCS/SCS ENABLED	
T + 14"	10 C/M-S/M SEPARATION PYRO CONTROL CUTOFF	
T + 14"	11 CANARD DEPLOYED	(TLM)
	12 ELS LOGIC ARMED	
	13 CANARD CONTROLS C/M IN TURNAROUND MANEUVER	
	14 LES TWR & CANARD TRAILS C/M DURING DESCENT	
	15 AT APPROXIMATELY 24,000 FEET	
	a. 24K' BARO SWITCH LOCK-IN	(TLM)
	b. C/M RCS/SCS DISABLED	(TLM)
	c. LES TOWER JETTISONED	(TLM)
TWR JETT +0.4"	16 APEX COVER JETTISONED	(TLM)
TWR JETT +2"	17 DROGUE PARACHUTES DEPLOY REEFED (DISREEF IN 8 SECONDS)	(TLM)
	18 10,000 FEET BARO SWITCH CLOSURE	
	a. DROGUE PARACHUTES RELEASED	(TLM)
	b. PILOT PARACHUTES DEPLOYED	
	19 BURN RCS PROPELLANTS (MANUAL SEL)	
	20 MAIN PARACHUTES REEFED FOR 8 SECONDS	
	21 PURGE RCS (MANUAL SEL)	
	22 MAIN PARACHUTES RELEASED (MANUAL SEL)	



HIGH-ALTITUDE LES ABORT		
T - 0"	1 ABORT INITIATED	(TLM)
	2 BOOSTER ENGINE CUTOFF (BECO)	(TLM)
	3 DIGITAL EVENT TIMER RESET	
	4 C/M-S/M UMBILICAL DEADFACED	
	5 C/M RCS PRESSURIZED	(TLM)
	6 RCS TRANSFERRED	
T + 0.1"	7 C/M-S/M SEPARATION	(TLM)
	8 LAUNCH ESCAPE MOTOR IGNITED	(TLM)
T + 1.8"	9 C/M RCS/SCS ENABLED	
T + 11"	10 C/M-S/M SEPARATION PYRO CONTROL SHUTOFF	
T + 11"	11 CANARD DEPLOYED	(TLM)
T + 14"	12 ELS LOGIC ARMED	
	13 5°/SEC + PITCH RATE ESTABLISHED	
	14 LES TWR & CANARD TRAILS C/M AFTER DESCENDING TO LOWER ALTITUDE	
	15 AT APPROXIMATELY 24,000 FEET	
	a. 24K' BARO SWITCH LOCK-IN	(TLM)
	b. C/M RCS/SCS DISABLED	(TLM)
	c. LES TOWER JETTISONED	(TLM)
BARO-SWITCH CLOSURE + 0.4"	16 APEX COVER JETTISONED	(TLM)
BARO-SWITCH CLOSURE +2"	17 DROGUE PARACHUTES DEPLOYED REEFED (DISREEF IN 8 SECONDS)	(TLM)
	18 10,000 FEET BARO SWITCH CLOSURE	
	a. DROGUE PARACHUTES RELEASED	(TLM)
	b. PILOT PARACHUTES DEPLOYED	
	19 BURN RCS PROPELLANTS (MANUAL SEL)	
	20 MAIN PARACHUTES REEFED FOR 8 SECONDS	
	21 PURGE RCS (MANUAL SEL)	
	22 MAIN PARACHUTES RELEASED (MANUAL SEL)	

EMERGENCY PROCEDURES

7.3 EMERGENCY PROCEDURES

STA/T Step	PROCEDURES	Panel	REMARKS
7.3 EMERGENCY PROCEDURES			
7.3.1 FIRE/SMOKE IN C/M.			
CSP	1 PGSSs - don		
C	2 DIRECT O ₂ valve - OPEN (CCW)	24	Suit circuit isolated from cabin atmosphere by differential pressure; also, commences purge of suit circuit.
S	3 EMERGENCY CABIN PRESSURE valve - OFF	314	
	4 CABIN REPRESS valve - close (CCW)		
C	5 CABIN PRESSURE RELIEF cont (lower) - DUMP	307	Approximately 2 minutes required to dump cabin
7.3.2 CONTAMINATION IN C/M			
			Crew may become physically aware of contamination, but if undetected, may be brought to their attention by MSFN upon receipt of TLM data. Types, sources, and amounts are not defined; therefore, the very existence of contamination in the C/M is treated as an emergency.
CSP	1 PGAs - don		
C	2 DIRECT O ₂ valve - OPEN	24	Suit circuit isolated from cabin atmosphere by differential pressure, also commences purge of suit if contamination originates in cabin.
			NOTE Contamination originates in cabin if no longer detectable, or in suit if still noticeable.

EMERGENCY PROCEDURES

EMERGENCY

STA/T	Step	PROCEDURES	Panel	REMARKS
	3	Cabin contamination - cabin dump unnecessary		
		Remove attenuation panel		
S		SUIT CIRCUIT RETURN SHUT-OFF valve - C (close) (CCW)	319	Mechanically isolates suit circuit from cabin atmosphere and shuts off excessive oxygen flow.
		Replace attenuation panel		
C		DIRECT O ₂ valve - close (CW)	24	
	4	Cabin contamination - cabin dump necessary		
		Remove attenuation panel		
		SUIT CIRCUIT RETURN SHUT-OFF valve - C (close) (CCW)	319	Mechanically isolates suit circuit from cabin atmosphere and shuts off excessive oxygen flow.
		Replace attenuation panel		
C		DIRECT O ₂ valve - close (CW)	24	
S		EMERGENCY CABIN PRESSURE valve - OFF	314	
		CABIN REPRESS - close (CCW)		
C		CABIN PRESSURE RELIEF cont (lower) - DUMP	307	
	7.3.3	SUIT CONTAMINATION.		
C	1	DIRECT O ₂ valve - OPEN (CCW)	24	
P	2	SUIT COMPRESSOR switch - OFF	21	

STA/T Step	PROCEDURES	Panel	REMARKS
	7.3.4 CABIN DECOMPRESSION.		An emergency condition exists if any crewman is unsuited during cabin decompression.
CSP	1 PGAs - don		
S	EMERGENCY CABIN PRESSURE valve - OFF CABIN REPRESS - close (CCW)	314	After last crewman is suited.
	7.3.5 PAD EMERGENCY EGRESS.		To be used from T-30:00 to T-02:00 when an LES abort is not required. Crew will be notified of emergency condition and when to commence procedure.
C	1 CABIN PRESSURE RELIEF control (lower) - DUMP	307	
CSP	2 Release couch restraints		
S	3 Drop center couch headrest		
P	4 MAIN BUS TIE-BAT A & C, BAT B & C switches (2) - OFF	22	
C	5 Remove R/H rotational control		
	6 Verify access arm in position		
CSP	7 Disconnect O ₂ and electrical umbilicals		
S	8 Remove airlock cover and inner hatch		
	9 Hit striker plate		Unlocks boost protective cover access.
	10 Release and push out ablative cover and boost protective cover		
SCP	11 Egress to access arm		

EMERGENCY PROCEDURES

EMERGENCY

SECTION 8

EXPERIMENTS PROCEDURES

INTRODUCTION.

This section contains the required crew procedures for the various experiments to be accomplished during orbit. Each crewman participating is identified in the procedure title. For a description of the experiment, refer to section 4, volume I.

The following list is a cross reference between the new and old experiments identification numbers. Experiment numbers followed by an asterisk do not require in-flight procedures.

<u>New No.</u>	<u>Old No.</u>
MO04	M-4A
MO05	M-5A
MO06*	M-6A
MO07*	M-7A
MO11*	M-11
MO12	M-12A
MO19	M-19
MO20	M-20
MO23*	M-23
SO05	S-5A
SO06	S-6A
SO15	S-15
SO16	S-16
SO17	S-17
SO18	S-18
TO04	S-14,T-4

8.1 OPERATING PROCEDURES.

Experiment procedures accomplished by the crew during noncritical periods of the mission include retrieving and stowing equipment, connecting equipment electrical cables, and operating valves and switches.

EXPERIMENTS

SM2A-03-SC014
APOLLO OPERATIONS HANDBOOK

Electrical power for scientific equipment is provided by the spacecraft nonessential bus No. 2 through the following crew compartments and outlets:

- Compartment A. Power to the outlet on the exterior of the compartment, and for experiments S017 (except the sensor door) and T004, is from the SCIEN EQUIP SEB-1 circuit breaker on MDC-22. The sensor door control panel on the exterior of the compartment receives power from the SCIEN EQUIP SEB-2 circuit breaker on MDC-22.
- Compartment C. The medical data acquisition system (MDAS) receives power through the octopus cable routed from the outlet on the exterior of compartment A. Power enters the MDAS through receptacle J101 and is distributed through J101 to the T-adapter, and through J102 and J104 for experiments M012 and M019, respectively. MDAS receptacles J103 and J105 are not utilized for experiments. The MDAS MAIN PWR switch operates the MDAS timer; the switch also controls power to the MDAS INST PWR switch, a J102 through J105 and T-adapter power and signal control as well as a recorder control.
- RH and LH Side Window Outlets (Panels 207 and 318). An electrical outlet, marked SCIENTIFIC EQUIPMENT, is located adjacent to each of the two crew compartment side windows. Power for these outlets is from the SCIEN EQUIP HATCH circuit breaker (MDC-22) and is controlled by an ON-OFF switch (on each outlet). The outlets are not utilized for experiments.

The octopus cable installation (paragraph 8.1.1) will be accomplished prior to starting the first experiment requiring data recording. The cable will be restowed (paragraph 8.11.1) prior to deorbit.

Prior to deorbit, after the experiments are completed, all experiment and associated equipment switches other than the S015 experiment should be turned off; loose equipment (temporarily stowed in the crew compartment) must be returned to the proper stowage areas.

EXPERIMENTS PROCEDURES

STA/T	Step	PROCEDURES	Panel	REMARKS
	8.1.1	OCTOPUS CABLE HOOKUP. (S)		
		<u>CAUTION</u> Two of the three octopus cable plugs are identically shaped. To prevent inadvertent reversal of cable during hookup, each plug and its proper mating receptacle are coded the same color.		
S	1	Egress couch and retrieve octopus cable from stowage.	(Compt F)	
	2	MDAS MAIN PWR sw - OFF	(Compt C)	
	3	MDAS INST PWR sw - OFF		
	4	Connect octopus cable plug to MDAS receptacle J101.	(Compt C)	Plug and receptacle are blue.
	5	Install octopus cable on LEB, LHEB, and LHFEB using integral Velcro sleeving and tabs.		Match shapes and colors of Velcro hook and pile.
	6	Connect octopus cable plug to T-adaptor of first crewman to be recorded.	300, 301, or 302	Plug and T-adaptor are orange-yellow. Only one crewman at a time can be connected to the octopus cable.
	7	Connect octopus cable plug to 28-vdc outlet.	(Compt A)	Plug and outlet are white.
	8	MDAS MAIN PWR sw - ON	(Compt C)	Switch remains on and octopus cable remains connected between compartments A and C for duration of flight to provide continuous timer operation.

OCTOPUS CABLE HOOKUP

STA/T Step	PROCEDURES	Panel	REMARKS
9	MDAS TIMER sw - RESET.	(Compt C)	Timer is reset on cue and MET is logged in experiments log.
8.1.2	IN-FLIGHT PHONOCARDIOGRAM (MOO4) (CSP).		
	Both the commander and senior pilot participate in the experiment. However, only one crewman at a time can be recorded on the MDAS.		It is assumed that the octopus cable was previously installed between compartments A and C.
1	TLM INPUTS-BLOMED sw - as required (position 1, 2 or 3)	20	Normally, the crewman preparing for an experiment will be monitored by telemetry. The position of the TLM INPUTS - BLOMED switch determines the crewman selected for operational readouts. These readouts can be transmitted at the same time in-flight recordings are being made.
2	MDAS INST PWR sw - OFF	(Compt C)	
	<u>WARNING</u> Switch is off to prevent possible electrical arcing during hookup of octopus cable.		
3	Connect octopus cable plug to T-adapter	300,301 or 302	Only one crewman at a time can be connected to the octopus cable. Plug and adapter are coded orange-yellow for identification.
4	MDAS INST PWR sw - ON	(Compt C)	
	NOTE In-flight periods for collecting data (including MDAS recording start and total times) will normally be established by NASA ground control personnel.		

OCTOPUS CABLE HOOKUP AND MOO4 EXPERIMENT

STA/T	Step	PROCEDURES	Panel	REMARKS
	5	Record MET (mission elapse time) on the voice recorder or in the log.		
	6	Ingress crew couch.		
	7	On completion of experiment, egress couch and turn MDAS INST PWR sw - OFF.	(Compt C)	
	8.1.3	BIOASSAYS BODY FLUID (MOO5) (SP).		
		Two crewmen are provided with USVMS units and associated equipment for participation in the experiment.		
	1	Egress crew couch and assemble USVMS for urine collection:		
		<p><u>WARNING</u> If there is any known or suspected tritium leakage from a USVMS unit injector cylinder (accumulator), the complete unit must be removed from operational use to prevent possible contamination of the crew cabin. Then, the unit is wrapped in paper towels, placed in a secondary stowage bag, and stowed in compartment S.</p> <p>a. Retrieve USVMS unit and collection bag from stowage.</p> <p>NOTE During boost and entry, the unit is stowed in compartment S; one mixing bag is in bioassay bag A and one is in bioassay bag B. During orbit, the unit with bag attached is stowed on Velcro in the LEB.</p>		

MOO4 AND MOO5 EXPERIMENTS

EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
	b. Secure mixing bag to unit.		
	c. Retrieve and attach roll-on cuff to unit receiver.	(Bioassay bag B)	
2	Rotate unit selector valve 360 degrees clockwise to URINATE position.		
	<p><u>CAUTION</u> This is a one-time operation for initial utilization of the USVMS. To avoid duplicate injection of tracer media, do not rotate selector over 360 degrees.</p>		
3	Attach open end of roll-on cuff to crewman for interface with USVMS.		
4	Urinate into USVMS unit.		
5	Detach cuff (when urination is complete) and clean receiver end of USVMS.		The individual roll-on cuffs are replaced daily.
6	Prepare USVMS unit for sample collection:		
	a. Retrieve sample bag from stowage.	(Bioassay bag A, B)	
	b. Mark crewman identity and ground-elapsed time on tag attached to sample bag.		

MO05 EXPERIMENT

STA/T Step	PROCEDURES	Panel	REMARKS
	<p>c. Attach and secure sample bag to sample valve port on USVMS unit.</p> <p><u>WARNING</u> Sample bag collar must be attached to sample valve port and rotated until secure or urine spillage will result.</p> <p>d. Rotate unit selector valve 90 degrees clockwise to SAMPLE position.</p> <p>e. Knead mixing bag about 20 seconds to mix urine with tracer chemical.</p>		<p>Tracer chemical is pumped whenever SAMPLE position is selected.</p>
7	Rotate sample injector lever 90 degrees clockwise to insert probe into sample bag.		Injector probe pierces sample bag rubber stopper to permit urine flow from mixing bag.
8	Squeeze and roll up mixing bag to fill sample bag.		About 75 cc of traced urine will flow into sample bag.
9	Rotate sample injector lever 90 degrees counterclockwise to retract injector probe		Retracted probe closes liquid flow line to sample valve port.
10	Remove filled sample bag from sample valve port.		
11	Stow sample bag:		
	<p>a. Retrieve secondary stowage bag.</p> <p>(Bioassay bag A, B)</p>		

MO05 EXPERIMENT

STA/T Step	PROCEDURES	Panel	REMARKS
	<ul style="list-style-type: none"> b. Insert and seal sample bag in secondary stowage bag. c. Place secondary stowage bag in available locker space. 		
12	Prepare USVMS unit for urine dump.		
	<ul style="list-style-type: none"> a. Attach unit to quick-disconnect on waste management dump line. 		The urine filter assembly on the fecal canister is connected to the waste management system (WMS) RHEB.
	<ul style="list-style-type: none"> b. WASTE MANAGEMENT - SELECTOR valve - URINE FECES. <p>NOTE Allow time for entrapped urine to drain from the USVMS unit. An internal bypass removes residual urine from the USVMS housing when the unit selector valve is at SAMPLE.</p>	201	
	<ul style="list-style-type: none"> c. WASTE MANAGEMENT - OVBD DRAIN valve - DUMP. 	201	
	<ul style="list-style-type: none"> d. Rotate unit selector valve - DUMP <p>NOTE Thirty seconds are required for spacecraft WMS to drain urine from mixing bag.</p>		
	<ul style="list-style-type: none"> e. WASTE MANAGEMENT valves (2) - OFF 	201	

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STA/T Step	PROCEDURES	Panel	REMARKS
	<p>NOTE The mixing bag can be squeezed to aid urine evacuation. It should be empty before the WMS valves are turned off.</p> <p>13 Disconnect USVMS unit from waste management dump line and secure to convenient velcro in LEB.</p> <p>8.1.4 EXERCISE ERGOMETER (MO12) (CSP).</p> <p>All crewmen will exercise twice on the 4th, 8th, and 12th day. One crewman (alternating) per day will record one exercise period on the MDAS.</p> <p>1 Record in the experiments log book.</p> <p>a. Crewman performing the experiment.</p> <p>b. TEMP CABIN indicator reading.</p> <p>2 Egress couch and reposition ergometer for use under RH couch.</p> <p>3 Remove visual monitor unit and attached cable from stowed position on ergometer.</p> <p>4 Secure monitor unit to footrest and attach cable to Velcro along structure of RH couch.</p>		<p>It is assumed that the octopus cable was previously installed between compartments A and C.</p>

MO05 EXPERIMENT AND MO12 EXPERIMENTS

EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
5	MDAS INST PWR sw - OFF <u>WARNING</u> Switch is off to prevent possible electrical arcing during power cable hookup.	(Compt C)	
6	Connect ergometer signal and power cable plug to MDAS receptacle J102.		Plug and receptacle are color-coded tan for identification
7	Connect octopus cable plug to crewman's T-adapter.	300, 301 or 302	Plug is color-coded orange-yellow.
8	Remove lap belt from stowage.	(Compt Y)	
9	Attach lap belt to seat on CO ₂ absorber container opposite RH couch.		
10	Place couch pad on container seat and sit facing ergometer.		
11	MDAS INST POWER sw - ON	(Compt C)	The switch starts the MDAS tape recorder and applies power to the ergometer.
12	Record MET on the voice recorder or in the crew log.		

MO12 EXPERIMENT

STA/T	Step	PROCEDURES	Panel	REMARKS
	13	Secure lap belt and place feet in foot pedals.		
	14	Remain inactive 2 minutes (during recording sessions only).		Provides biomedical data for the pre-exercise period.
	15	Select preflight exercise level on visual monitor unit.		
	16	Perform exercise to keep FT LBS/MIN indicator needle centered for 15 minutes.		
	17	Remain seated 3 minutes after exercise (during recording sessions only).		Provides biomedical data for the recovery period.
	18	MDAS INST PWR sw - OFF		
		NOTE The ergometer and lap belt will be stowed just prior to deorbit when all loose equipment is secured.		
CP	19	Log TEMP CABIN indicator reading.	13	

M012 EXPERIMENT

EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
8.1.5	<p>METABOLIC RATE MEASUREMENT (MO19) AND PULMONARY FUNCTION (MO20) (CSP).</p> <p>MO19 experiment duration will be about 10 to 20 minutes two or three times during each 24-hour period per crewman. M-20 experiment duration will be about 20 minutes two or three times during each 24-hour period per crewman including 5 minutes of air collection.</p> <p>Only one crewman at a time is connected to the gas meter and the MDAS. Procedures for MO20 only are coded in subsequent steps.</p>		
1	Egress crew couch to retrieve gas meter from stowage under left couch.	(Meter Container)	
2	Attach gas meter to Velcro on workshelf.		
3	MDAS INST PWR sw - OFF	(Compt C)	
	<p><u>WARNING</u> Switch is off to prevent possible electrical arcing when power cable is connected to MDAS.</p>		
4	Connect gas meter power cable plug to MDAS receptacle J104.		Plug and receptacle are color coded black for identification.
5	Retrieve experiment accessory equipment from stowage:	(Compt D)	

MO19 AND MO20 EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
	<ul style="list-style-type: none"> a. Mouthpiece b. Breathing valve c. Interconnecting hose d. Nose clip 		
6	Assemble mouthpiece, breathing valve, and interconnecting hose and connect to EXPIRED AIR INLET on gas meter.		
7	Attach sample bag to inlet and exhaust ports on top of gas meter.		M-19 sample bag has inlet and exhaust air ports that interface with fittings on top of gas meter.
8	MDAS INST PWR sw - ON	(Compt C)	
9	Log initial VOL LITERS indication shown on gas meter.		Initial reading of gas volume is necessary for determining crewman's capacity.
10	Sit on CO ₂ absorber container with back to LEB.		
11	Affix nose clip and breathe into mouthpiece.		
12	Verify air flow through VOL LITERS indicator and movement of air in sample bag.		
13	Continue to breathe through mouthpiece for 10 minutes or until sample bag is filled.		

MO19 AND MO20 EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
14	Remove mouthpiece and log VOL LITERS indication.		
15	Gas meter power sw - ON		
16	GAS VALVE knob - ON (CCW)		
17	SAMPLE SELECT knob - EXPIRED AIR		
18	Momentarily press SAMPLE PUMP pushbutton (3 times).		
19	INJECT VALVE knob - lower mark (90° CW)		
20	Observe O ₂ and CO ₂ indicator display numbers for one minute; then, log final display.		Each indicator should start at zero; count upward to a maximum; and present a final display.
21	Gas meter power sw - OFF		
22	Disconnect mouthpiece and breathing valve from interconnecting hose.		
23	Disconnect interconnecting hose from gas meter.		Loose equipment may be temporarily stowed on vacant couch.
24	GAS VALVE knob - OFF		
	NOTE Steps 25 through 35 are coded for experiment MO20.		
25	Remove MO19 sample bag and seal off gas meter ports (MO20).		

MO19 AND MO20 EXPERIMENTS

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STA/T Step	PROCEDURES	Panel	REMARKS
26	Retrieve 80-liter bag from stowage (MO20).	(Compt D)	
27	Connect mouthpiece and breathing valve to 80-liter bag (MO20).		
28	Perform predetermined exercises for 15 minutes (MO20).		
29	Continue exercise for an additional 5 minutes while exhaling into 80-liter bag (MO20).		
30	Disconnect mouthpiece from breathing valve on 80-liter bag (MO20).		
31	Log VOL LITERS indication shown on gas meter (MO20).		
32	Attach breathing valve outlet port to gas meter EXPIRED AIR INLET (MO20).		
33	Compress 80-liter bag to transfer trapped air into gas meter (MO20).		
34	Log final VOL LITERS indication shown on gas meter (MO20).		
35	MDAS INST PWR sw - OFF	(Compt C)	
36	Disconnect 80-liter bag from gas meter (MO20).		
	NOTE Other crewmen can start experiment at step 6.		

MO19 AND MO20 EXPERIMENTS

EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
37	On completion of individual tests, disassemble and stow equipment:		
	a. Stow mouthpiece, nose clip, breathing valve, hose, and 80-liter bag	(Compt D)	
	b. Disconnect gas meter power cable from MDAS receptacle J104.	(Compt C)	
	c. Stow meter.	(Meter Container)	
8.1.6	SYNOPTIC TERRAIN PHOTOGRAPHY (S005) OR SYNOPTIC WEATHER PHOTOGRAPHY (S006) (CSP) All three crewmen participate in the experiments. Targets-of-opportunity will be photographed by a crewmember occupying either the LH or RH crew couch.		
1	Egress couch and retrieve 70 mm camera, filter, and film pack from stowage.	(Compt A and B)	All 70 mm camera equipment except spare film packs is located in compartment A.
2	Prepare camera for photography:		
	a. Load desired film pack.		
	b. Attach appropriate filter to camera.		The ultraviolet (clear) filter is used with color film and the infrared (orange) filter is for color-shift infrared film.
	c. Check that ring sight is attached to camera.		
	d. Adjust camera settings.		
3	Ingress couch and temporarily stow camera on side hatch for operational accessibility.		Camera is attached by Velcro to access hatch opposite center couch until target is available.

M019, M020, S005 OR S006 EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
4	Fill out experiments log: a. Record mission-elapsed time. b. Identify target and crew photographer. c. Record picture frame and film pack number.		
5	Turn off all cabin lights.	8,23,26	
6	Draw opaque shades over sunlit windows.		
7	Remove camera from hatch and photograph target (s)-of-opportunity.		Camera handcrank must be used to clear camera for subsequent pictures.
8	Stow camera equipment prior to entry.	(Compt A, B)	
8.1.7	ZERO G SINGLE HUMAN CELL (S015) (S). <u>WARNING</u> The experiment package contains about 25 microcuries of radioactive tritium. If there is any known or suspected damage to the tritium sources, the experiment unit must be secured in the stowage case to prevent possible contamination in the crew compartment.		

S005 OR S006, AND S015 EXPERIMENTS

EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
	<p>NOTE Procedures for equipment retrieval and stowage only are provided in the following paragraphs. Procedures for accomplishing the experiment will be included when available.</p> <p>8.1.7.1 <u>Equipment Retrieval.</u></p>		
S	<p>1 Loosen lap belt and lower center couch seat pan to 170° position.</p> <p>2 Assume position on stomach in center couch, with legs restrained by lap belt.</p> <p>3 Lower center couch headrest.</p> <p>4 Thermal control power sw - OFF</p> <p>5 Disconnect power cable from experiment package</p> <p>6 Open stowage case.</p> <p>7 Remove experiment package from stowage case.</p> <p>8 Close and latch case.</p> <p>9 Secure package to top of case with MICROSCOPE SPECIMEN FEED switch nearest couch.</p>	(Stowage case)	<p>Stowage case is on aft bulkhead near center couch headrest.</p> <p>Cable connects switch to package.</p> <p>Velcro is provided on package and case.</p>

STA/T Step	PROCEDURES	Panel	REMARKS
10	Reconnect power cable to package.		
11	Thermal control power sw - ON		
12	Raise MICROSCOPE and install eyecup.		
	NOTE If experiment will be accomplished now, omit steps 13 through 16 and proceed at paragraph 8.1.7.2.		
13	Raise center couch headrest.		
14	Assume position on back in center couch.		
15	Raise center couch seat pan to 96° position.		
16	Adjust lap belt.		
8.1.7.2	<u>Equipment Operation</u>		
	Procedures will be provided when available.		

S015 EXPERIMENT

EXPERIMENTS

STA/T	Step	PROCEDURES	Panel	REMARKS
		8.1.7.3 <u>Equipment Stowage.</u>		
		NOTE If equipment will be stowed immediately after accomplishing experiment, omit steps 1 through 3.		
S	1	Loosen lap belt and lower center couch seat pan to 170° position.		
	2	Assume position on stomach in center couch, with legs restrained by lap belt.		
	3	Lower center couch headrest.		
	4	Remove eyecup and fold MICROSCOPE to stowage position.		
	5	Thermal control power sw - OFF	(Stowage case)	
	6	Disconnect power cable from experiment package.		
	7	Remove experiment package from top of stowage case.		
	8	Open stowage case.		
	9	Place package inside case		
	10	Place eyecup inside small compartment of case.		

S015 EXPERIMENT

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STA/T	Step	PROCEDURES	Panel	REMARKS
	11	Close and latch case.		
	12	Connect power cable to package.		
	13	Thermal control power sw - ON		
	14	Raise center couch headrest.		
	15	Assume position on back in center couch.		
	16	Raise center couch seat pan to 96° position and adjust lap belt.		
	8.1.8	<p>TRAPPED PARTICLE ASYMMETRY (S016) OR MICROMETEORITE COLLECTION (S018) (CS).</p> <p>Either experiment can be accomplished utilizing the following procedure. Steps applicable to only one experiment are coded as S016 or S018 only.</p> <p>Duration of each experiment will be 8 hours. The S016 experiment will be conducted during the last 24 hours prior to re-entry.</p> <p>The crewman in the center couch will conduct the experiment while assisted by the crewman in the left couch.</p>		

S015, S016 OR S018 EXPERIMENTS

EXPERIMENTS

STA/T	Step	PROCEDURES	Panel	REMARKS
		8.1.8.1 <u>Ablator Door Removal.</u>		
S	1	PRESSURE DOOR knob fully - CLOSE.	(Airlock)	Button in center of knob must be pressed to unlock knob.
SP	2	AIRLOCK PRESSURE ind - cabin pressure	(Airlock), 13	
C	3	Retrieve ablator door rod from stowage	(Compt A)	
S	4	Unlock and remove canister plug.	(Airlock)	The canister plug is attached to the canister by a lanyard.
	5	Press knob on HANDLE RELEASE lever and move handle forward 45 degrees to remove canister from airlock.		
	6	Insert ablator door rod through canister.		Ablator door rod can only be installed from inside of canister.
	7	Position rod shoulder against canister.		
	8	Install canister on airlock; press knob on HANDLE RELEASE lever and move handle aft 45 degrees to lock.		
	9	Airlock pressure valve - DE-PRESSURIZE		
	10	AIRLOCK PRESSURE ind - zero psia		
	11	PRESSURE DOOR knob - OPEN	(Airlock)	Button in center of knob must be pressed to unlock knob. Approximately 16 turns are required to open the pressure door.

SOL6 OR SOL8 EXPERIMENT

STA/T	Step	PROCEDURES	Panel	REMARKS
	12	Engage ablator door rod in ablator door lock.		
C	13	Retrieve in-flight tools E, J, and tether from stowage	(Tool-table)	
S	14	Interlock ablator door rod and ablator door using tools E and J.	(Airlock)	
	15	Retrieve tool B.	(Hatch)	
	16	Using tool B, unlock and pull ablator door into canister.		Approximately 36 degrees in a CCW direction are required to unlock door.
	17	PRESSURE DOOR knob - CLOSE		Approximately 16 turns are required to close the pressure door.
	18	Airlock pressure valve - PRESSURIZE		
SP	19	AIRLOCK PRESSURE ind - cabin pressure	(Airlock), 13	
S	20	Remove canister from airlock		
C	21	Remove ablator door and ablator door rod from inside canister		
	22	Temporarily stow canister on left-hand couch.		
	23	Stow tool B.	(Hatch)	
S	24	Stow ablator door with ablator door rod attached.	(Hatch)	

S016 OR S018 EXPERIMENT

Basic Date 17 Oct 1966

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STA/T	Step	PROCEDURES	Panel	REMARKS
	8.1.8.2	<u>Experiment Assembly and Deployment.</u>		
C	1	Retrieve standpipe collar from stowage.	(Compt D)	
	2	Retrieve standpipe from stowage.	(Compt A)	
	3	Retrieve canister from left-hand couch.		
	4	Insert standpipe through canister.	(Airlock)	
		<u>CAUTION</u> Standpipe is installed from inside of canister to avoid damage to o-rings.		
	5	Install collar on standpipe.		
	6	Retrieve extensions rods from stowage.	(Compt A)	
	7	Mate male end of short extension rod to long extension rod and tighten interlock screw.		
	8	Retrieve extension handle from stowage.	(Compt D)	
	9	Retrieve protractor from stowage (S016 only).	(Compt D)	
	10	Using tools E and J, install protractor on handle (S016 only).		
		<u>WARNING</u> In the following step, tighten only the screw indicated. If the jettison screw is inadvertently loosened (CCW), the rods separate from the handle with approximately 50 pounds of force and recoil.		
	11	Mate extension handle to extension rod and tighten interlock screw.		

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STA/T Step	PROCEDURES	Panel	REMARKS
12	<p>Retrieve applicable experiment package from stowage.</p> <p><u>CAUTION</u> The S016 package must be carefully handled to avoid damaging the aluminum foil. Also, do not apply hand pressure on the bottom 1.5-inch area of the package.</p> <ul style="list-style-type: none"> • S016 experiment • S018 experiment 	<p>(Compt E)</p> <p>(Compt T)</p>	
13	Insert extension rods through standpipe (S016 only).		
14	Position experiment on extension rod (S016 only).		
15	Position experiment on standpipe with index key aligned and hold during next step (S018 only).		
16	Insert extension rods into standpipe until standpipe is locked to experiment case (S018 only).		Ball locks on the standpipe are protruded when rods are inserted.
17	Rotate rod until hex engages; press experiment lock plunger until experiment seats; then, release plunger.		

S016 OR S018 EXPERIMENT

EXPERIMENTS

STA/T	Step	PROCEDURES	Panel	REMARKS
S		<p><u>CAUTION</u> Verify experiment is locked to rod by attempting to pull rod from experiment. If not locked, experiment could be damaged, prevent airlock door operation, or be lost in space.</p>		
	18	Install canister on airlock.		
		<p><u>CAUTION</u> Check that experiment is completely inside canister to prevent damage to experiment when airlock door is opened.</p>		
	19	Airlock pressure valve - DE-PRESSURIZE.	(Airlock)	
	20	Airlock pressure ind - zero psia.		
	21	PRESSURE DOOR knob - OPEN		
	22	Extend standpipe and engage collar lock.		
C	23	Push extension rods through standpipe until extension handle seats against standpipe collar (S016 only).	(Airlock)	
	24	Turn extension handle CCW to release and push to open telescopic sections (S018 only).		
	25	Record degrees indicated by protractor (S016 only).		
		<p>NOTE If experiment deployment total time is accomplished in segments, orientation must be the same (S016 only).</p>		

S016 OR S018 EXPERIMENT

STA/T	Step	PROCEDURES	Panel	REMARKS
		8.1.8.3 <u>Experiment Retrieval.</u>		
S	1	Pull extension handle as far as possible (S016 only).		In this position, experiment is against standpipe.
	2	Pull extension handle to close experiment; then turn handle CW to lock telescopic sections (S018 only).		
	3	Release collar lock.		
	4	Pull standpipe and collar, and extension handle until experiment is completely in canister.		
		<p><u>CAUTION</u> Maintain rotational alignment of S018 experiment to avoid possible damage to ablator material, airlock, or experiment. If either experiment cannot be retrieved, the experiment, standpipe, and rods will have to be jettisoned. Refer to backup procedure.</p> <p>BACKUP PROCEDURE</p> <p>a. Withdraw collar lock and push extension handle into collar; then release collar lock.</p> <p>b. Verify handle is locked to collar.</p>		

S016 OR S018 EXPERIMENT

EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
SP S C	c. Using in-flight tools E and J, loosen (CCW) experiment jettison screw in extension handle.		Loosening the screw jettisons the experiment, standpipe, and extension rods into space.
	d. PRESSURE DOOR knob - CLOSE		
	e. Airlock pressure valve - PRESSURIZE		
	f. AIRLOCK PRESSURE ind - cabin pressure	(Airlock), 13	
	g. Remove canister from airlock.		
	h. Remove extension handle and collar from canister.		
	i. Remove collar from canister.		
	j. Remove protractor from handle (S016 only).		
	NOTE This completes the backup procedure. Proceed with normal procedures at paragraph 8.1.8.4, step 5.		

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STA/T	Step	PROCEDURES	Panel	REMARKS
	5	PRESSURE DOOR knob - CLOSE		
	6	Airlock pressure valve - PRESSURIZE.		
SP	7	AIRLOCK PRESSURE ind - cabin pressure.	(Airlock), 13	
S	8	Remove canister from airlock.	(Airlock)	
C	9	Remove experiment from canister by pressing experiment lock plunger and withdrawing extension rods.		
C	10	Stow applicable experiment package.		
		• S016 experiment	(Compt E)	
		• S018 experiment	(Compt T)	
		NOTE After accomplishing both experiments, or if second experiment will not be accomplished immediately, disassemble and stow equipment. (Paragraph 8.1.8.4)		
	8.1.8.4	<u>Equipment Disassembly.</u>		
C	1	Using tools E and J, disassemble two extension rods and handle by loosening interlock screws.		
	2	Remove protractor from handle (S016 only).		

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EXPERIMENTS

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STA/T Step	PROCEDURES	Panel	REMARKS
3	Remove standpipe and collar from canister.		
4	Stow standpipe and two extension rods.	(Compt A)	
5	Stow collar and extension handle.	(Compt D)	
6	Stow protractor (S016 only).	(Compt D)	
7	Retrieve ablator door (with ablator rod attached) from stowage on aft bulkhead.		
8	Insert ablator door rod through inside of canister until ablator door is nested in canister and TOP marks are aligned.		
S 9	Install canister on airlock	(Airlock)	
10	Airlock pressure valve - DE-PRESSURIZE		
11	AIRLOCK PRESSURE ind - zero psia		
12	PRESSURE DOOR knob - OPEN.		
13	Retrieve tool B from stowage.	(Hatch)	
14	Install tool B on ablator door rod.	(Airlock)	

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STA/T Step	PROCEDURES	Panel	REMARKS
15	Push ablator door rod outboard to position ablator door in outer hatch. NOTE Maintain rotational alignment while installing ablator door to avoid damaging mating edges of door and hatch.		
16	Using tool B, lock ablator door.		Approximately 36° CW turn required.
17	Remove tool B from rod.		
18	Stow tool B	(Hatch)	
19	Using tool E and J, loosen interlock screw (CCW) in ablator door rod.		
20	Install tool B on ablator door rod.		
21	Using tool B, pull rod as far as possible. NOTE Rod shoulder should be against canister to permit closing of pressure door.		
22	Remove tool B from rod.		
23	Stow tool B.	(Hatch)	
24	PRESSURE DOOR knob - CLOSE	(Airlock)	
25	Airlock pressure valve - PRESSURIZE		

SO16 OR SO18 EXPERIMENT

EXPERIMENTS

STA/T Step		PROCEDURES	Panel	REMARKS
SP	26	AIRLOCK PRESSURE ind - cabin pressure	(Airlock), 13	
	S	27 Remove canister from airlock.		
		28 Remove ablator door rod from canister.		
		29 Install canister on airlock.		
		30 Install and lock canister plug in canister.		
C	31	Stow tools E, J, and tether.	(Tool table)	
	32	Stow ablator door rod.	(Compt A)	
	8.1.9	X-RAY ASTRONOMY (S017) (CSP).		
		All three crewmen will be trained for the experiment. However, only one crewman will normally operate the equipment for determining X-ray sources in space.		
		Procedures will be provided when available.		
	8.1.10	ORBITAL OTOLITH FUNCTION (TOO4) (--).		
		Total time required to accomplish the experiment is about 45 minutes. Experiment time intervals will provided when available.		

S016 OR S018, S017, AND TOO4 EXPERIMENTS

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STA/T	Step	PROCEDURES	Panel	REMARKS
		8.1.10.1 <u>Experiment Activation.</u>		
	1	Open door.	(Compt A)	
	2	MAIN PWR sw - ON		
	3	Close door.		
		8.1.10.2 <u>Experiment Cycle.</u>		
	1	Open door.	(Compt A)	
	2	FROG PWR ON sw - press		
	3	RCDR READ IN sw - press		
	4	Ascertain frog cycle number by consulting experiments log.		
	5	VOICE sw - press and hold		
	6	Announce MET and frog cycle number.		
	7	VOICE sw - release		
	8	FROG CENT CYCLE sw - press		
	9	Record MET and frog cycle number in experiments log.		
	10	Wait approximately 5-1/2 minutes to complete experiment recording cycle.		

TOO4 EXPERIMENT

EXPERIMENTS

STA/T Step	PROCEDURES	Panel	REMARKS
11	Verify RCDR STOP sw - illuminated (4th cycle only).		After completion of four experiment cycles, the MDAS data recorder is allowed to run until end of tape is reached, as indicated by illumination of RCDR STOP switch (approximately two minutes of additional operation).
12	OFF sw - press		
13	Close door.		
14	Repeat experiment cycle at designated intervals until four cycles are completed.		
8.1.10.3	<u>Experiment Data Dump.</u>		
1	Open door.		Communication acquisition by ground tracking station is a prerequisite.
2	FROG PWR ON sw - ON	(Compt A)	
3	REAL TIME DATA sw - press		
4	Verify satisfactory acquisition at ground tracking station.		
5	RCDR READ OUT sw - press		
6	If tracking station indicates probable loss of acquisition before data dump completion:		
	a. OFF sw - press		

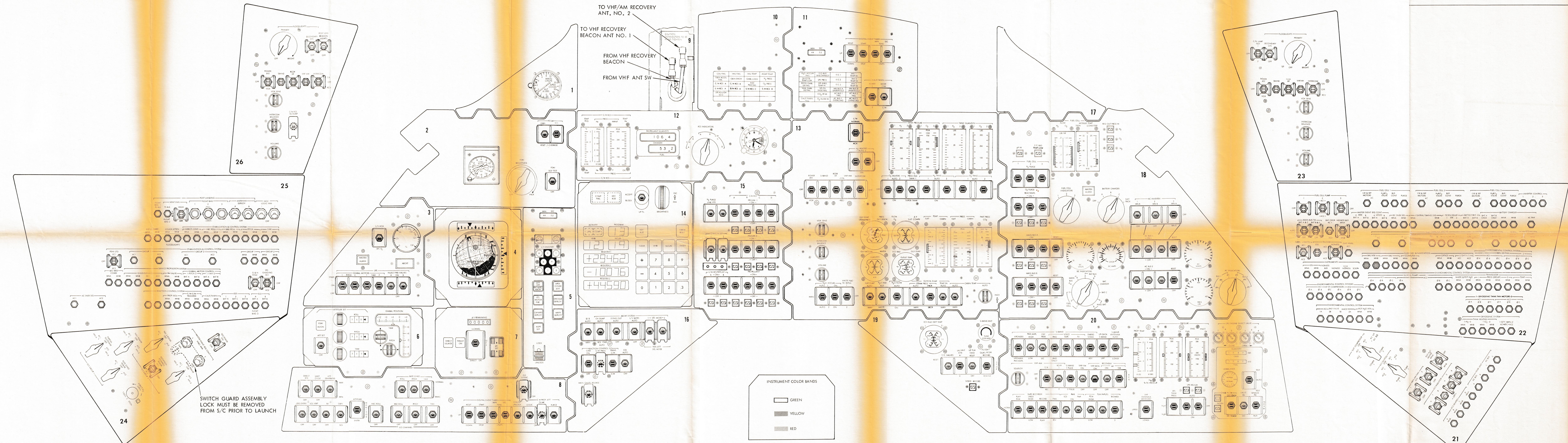
TOO4 EXPERIMENT

STA/T Step	PROCEDURES	Panel	REMARKS
	<p>NOTE When reacquisition is obtained by ground tracking station, proceed with the following steps.</p> <p>b. FROG PWR ON sw - press</p> <p>c. REAL TIME DATA sw - press</p> <p>d. Verify satisfactory acquisition at tracking station.</p>		
7	Verify RCDR STOP sw - illuminated		Illumination of switch indicates completion of data readout.
8	OFF sw - press		
9	Close door.		
8.1.10.4	<u>Experiment Deactivation.</u>		
1	Open door.		
2	FROG LIFE SUPPORT sw - OFF	(Compt A)	
3	Close door.		
8.1.11	OCTOPUS CABLE STOWAGE (S)		
S 1	When the medical data acquisition system (MDAS) is no longer required, the octopus cable is disconnected and stowed.		

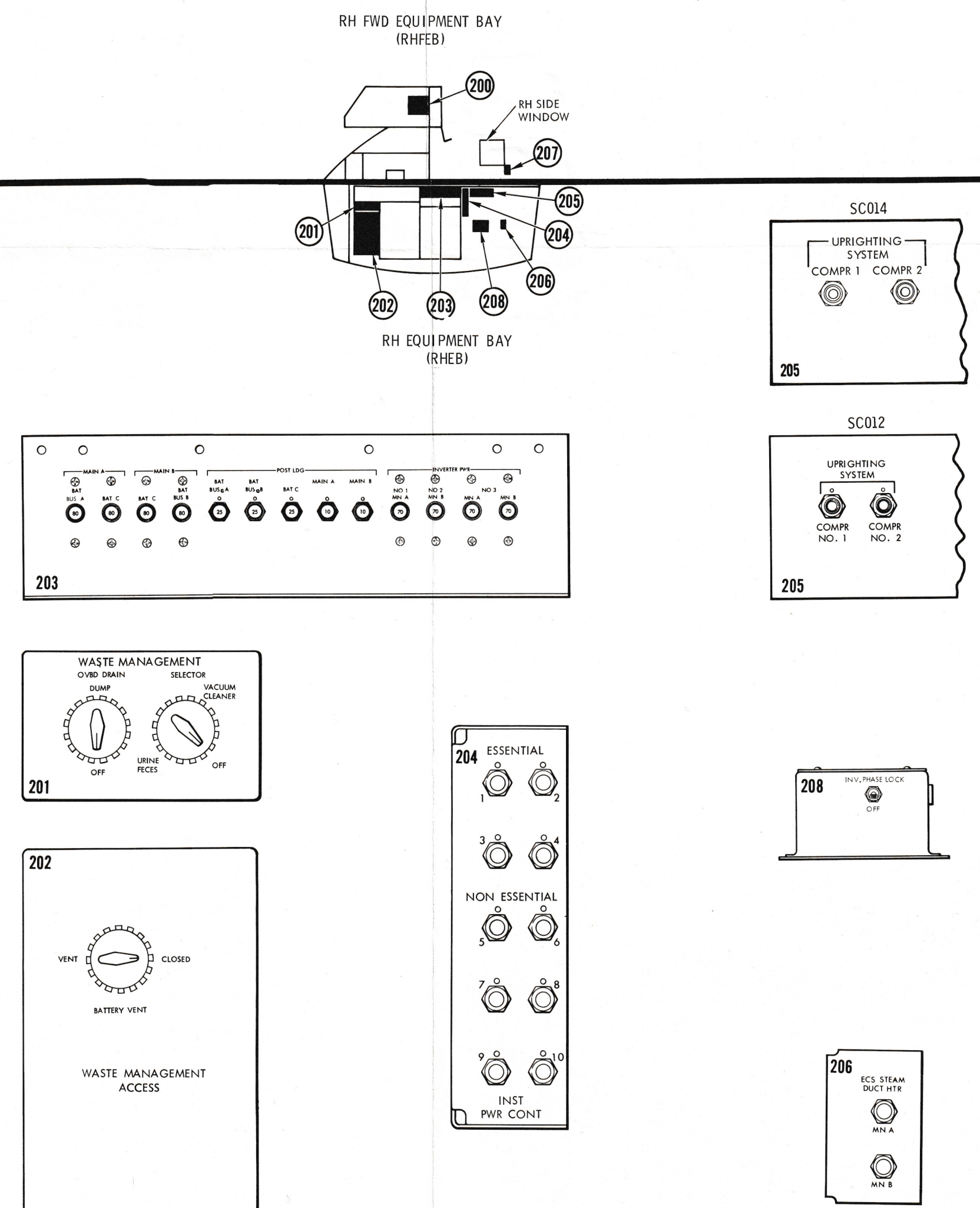
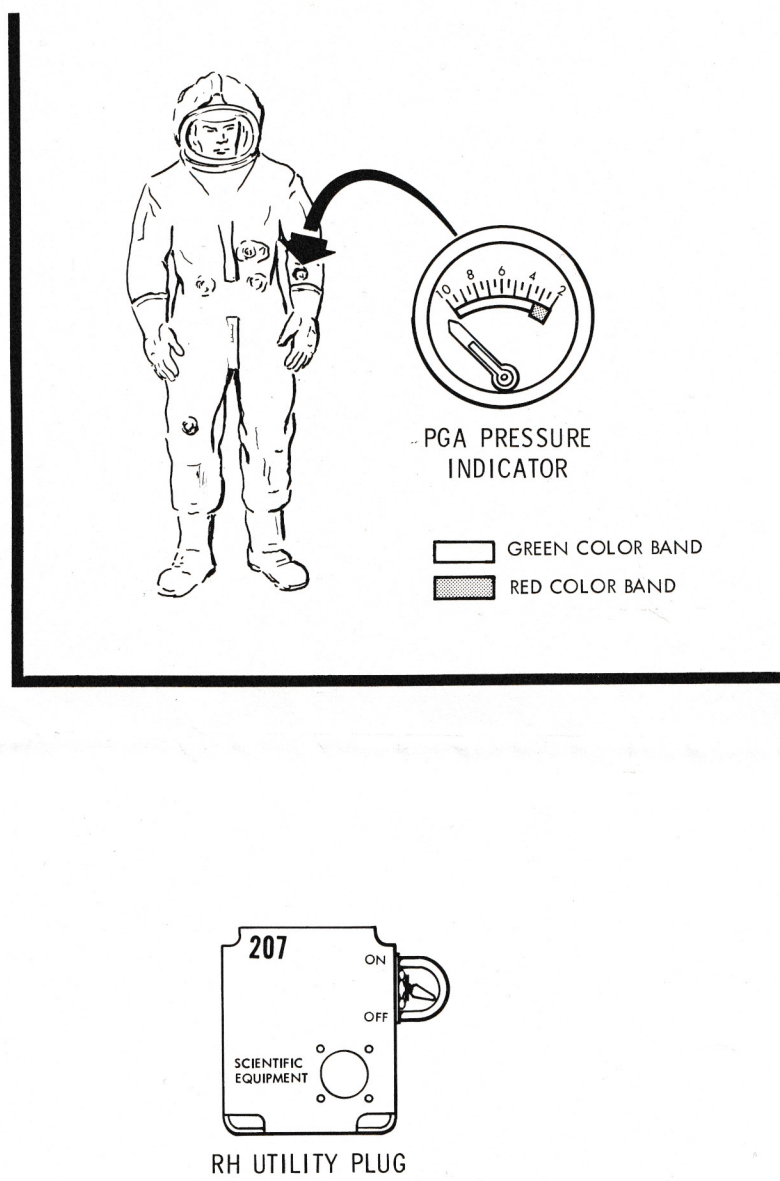
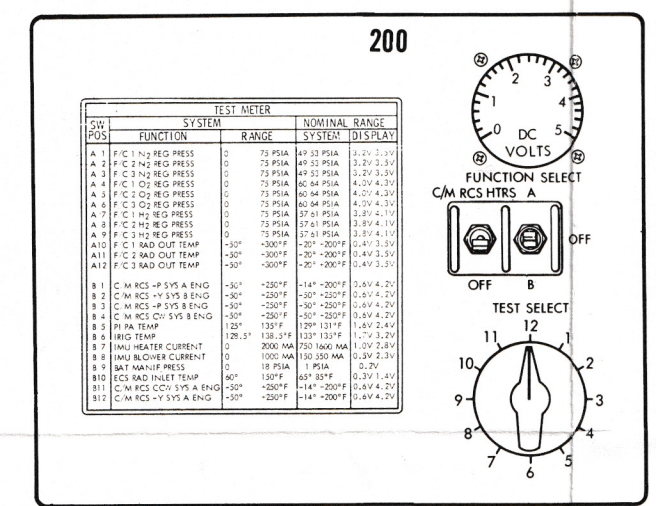
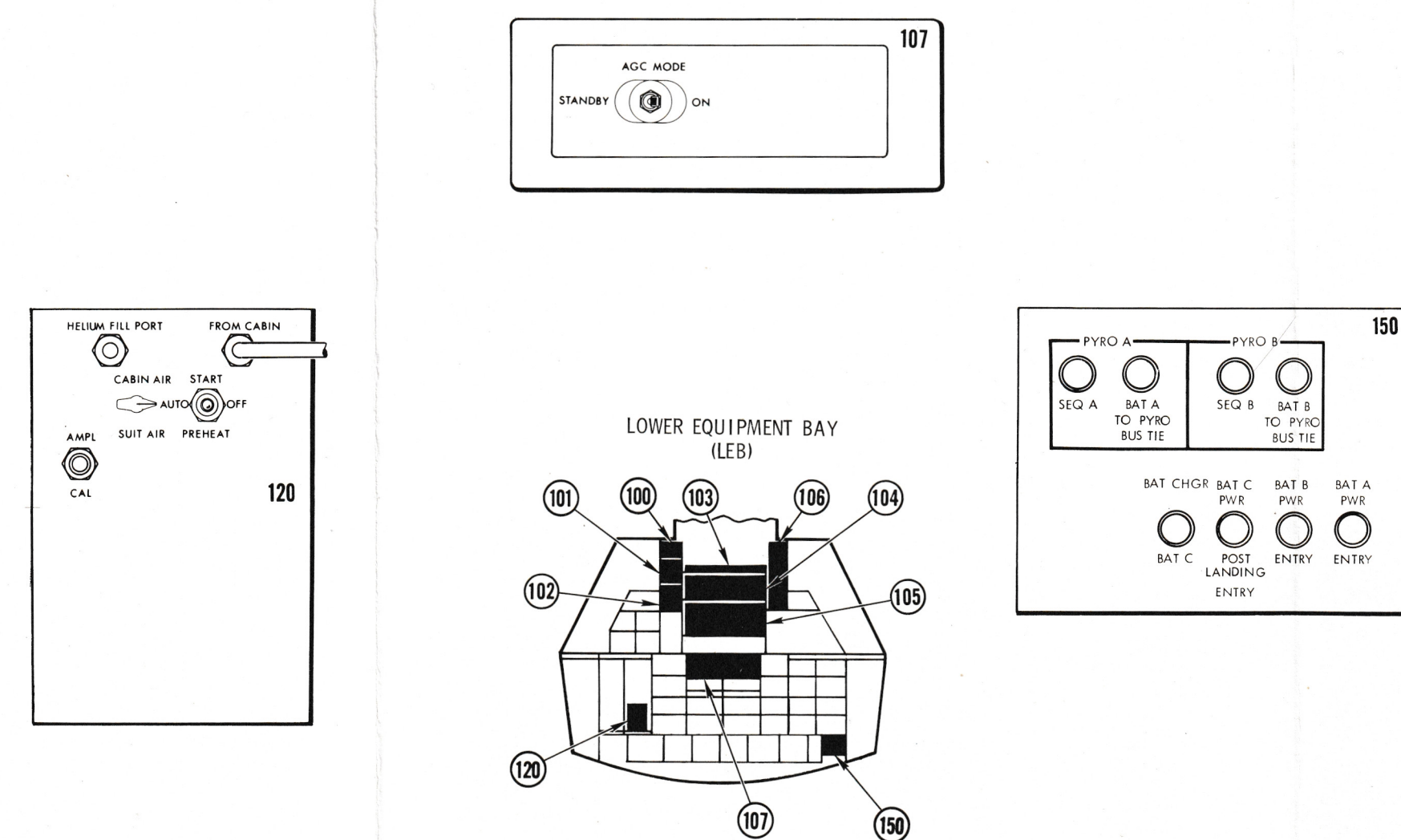
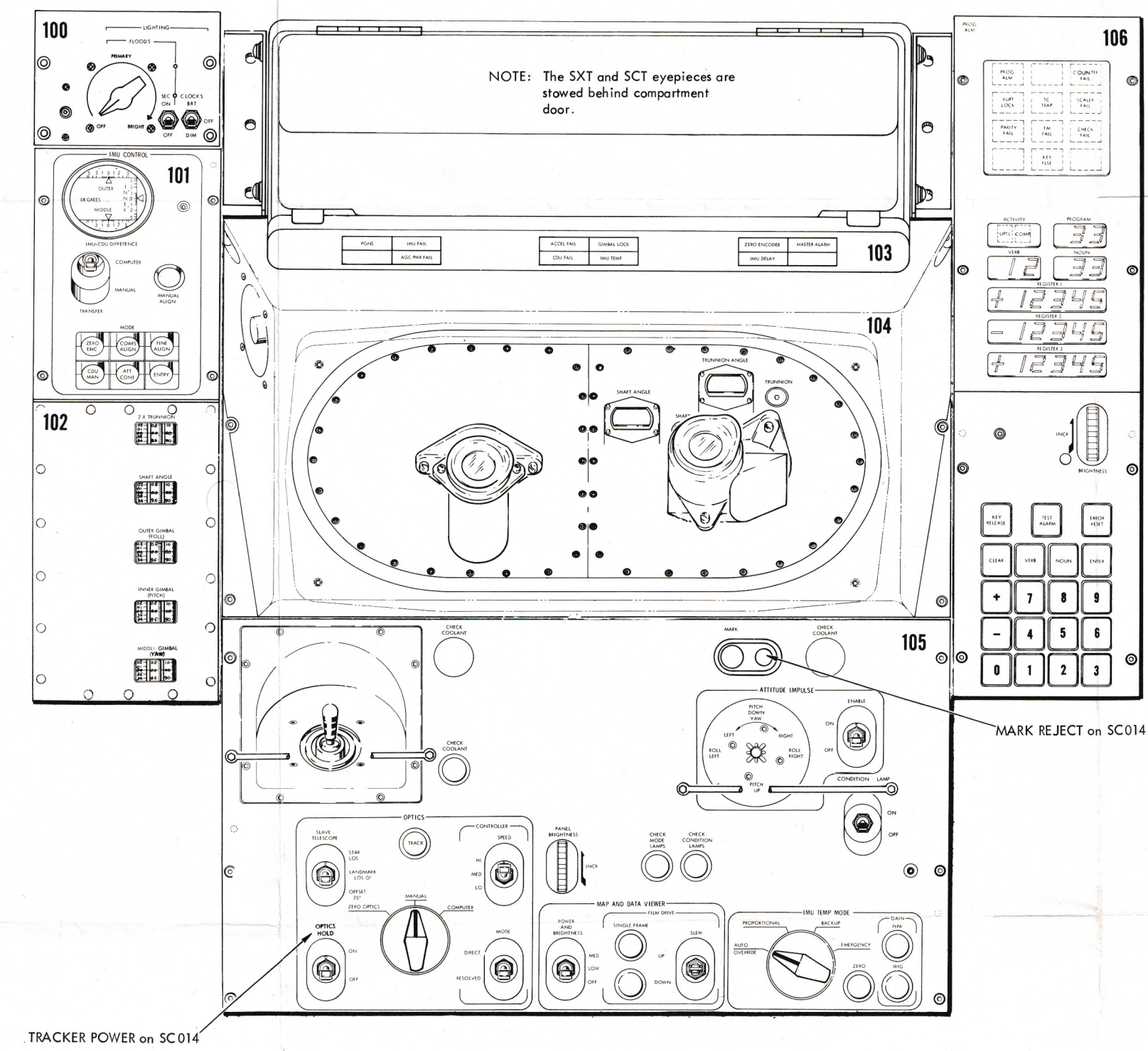
TOO4 EXPERIMENT - OCTOPUS CABLE STOWAGE

STA/T	Step	PROCEDURES	Panel	REMARKS
	2	MDAS MAIN PWR sw - OFF	(Compt C)	
	3	Disconnect octopus cable plug at 28-vdc outlet.	(Compt A)	
	4	Disconnect octopus cable plug at T-adapter.	300, 301, or 302	
	5	Starting at T-adapter, progressively separate Velcro while coiling octopus cable toward MDAS.		
	6	Disconnect octopus cable plug at MDAS receptacle J101.	(Compt C)	
	7	Stow octopus cable	(Compt F)	

OCTOPUS CABLE STOWAGE



SM-2A-1084A
Figure B-1. Crew Displays and Controls (Sheet 1 of 2)



SM-2A-1085A