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APOLLO 16

APOLLO OPERATIONS HANDBOOK

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J-SERIES MISSIONS
CSM 112 THRU 115**

**Volume 2
Operational Procedures**

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FOREWORD

This handbook contains the flight crew operational procedures for all active J-series spacecraft.

Volume II constitutes the crew Normal/Backup, Abort, Malfunction and Emergency procedures. Normal procedures are defined as those used if all systems are operating normally. Backup procedures are those used to accomplish the objective of the normal procedures when system failure or some other anomaly prevents use of the normal procedures. Malfunction and Emergency procedures encompass the recognition, diagnosis, and corrective action for system malfunctions or failure.

Spacecraft Page Identification

Pages of this handbook which are usable only on a single J-series vehicle are identified by including the spacecraft number parenthetically as a part of the page number.

Pages applicable to a specific series of vehicles are identified by including the spacecraft number and the letter S parenthetically as a part of the page number. The "S" indicates the page is applicable to the spacecraft number shown and to subsequent vehicles as well.

Common pages (pages with no spacecraft identification in the page number) are used for all J-series spacecraft.

Some pages have been repeated in order to satisfy page requirements for all spacecraft covered by the current handbook.

Utilization and Updates

This handbook concept requires the use of specific pages to provide specific vehicle coverage. It is suggested that the list of effective pages in the front of the handbook be used when changes to the book are made or to verify a specific vehicle configuration of the manual.

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To prepare the manual for use on a particular vehicle, select the complete set of common pages and those pages indicated for a particular vehicle as indicated on the list of effective pages.

When pages identified as applicable only to other vehicles have been removed in preparation of a manual for a specific vehicle, redundant pages will have been eliminated. Do not discard the removed pages. These pages are current for other vehicles until superseded by subsequent change.

Volume 1 - Spacecraft Description, SM2A-03-BLOCK II-(1), is bound separately and contains the description portion of the spacecraft systems and equipment. User of Volume 2 procedures should be thoroughly familiar with spacecraft and system descriptions in Volume 1.

Comments or suggested change to this handbook should be addressed to the Spacecraft Systems Branch, FCSD, MSC, Office Code CF22, Telephone HU3-5558.

INTRODUCTION

PROCEDURE COLUMNS

Procedural steps in this section are presented in tabular form and in numerical sequence. Steps are further organized by subgroups into related functions. Column headings of the Normal/Backup procedures consist of STATION/TIME (STA/T), STEP, PROCEDURE, PANEL and REMARKS. An explanation of each of these column headings is provided as follows:

<u>STA/T</u>	The station is equivalent to the crewmember assigned to the spacecraft location where a procedure or step is performed. Station CDR (commander), CMP (command module pilot) and LMP (lunar module pilot) correspond to the left, middle, and right crew couch positions, respectively. The CMP also pertains to the lower equipment bays inaccessible to the other crewmembers. The time column (T) will contain mission time, event time or altitudes.
<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 overall task involved in performing a complete function or operation. If a perimeter of Xs are around a procedure, it constitutes a backup procedure relative to the preceding step.
<u>PANEL</u>	The panel location is the location of a particular control or display by panel number. The main display console (MDC) panels are numbered 1 through 12; the lower equipment bay (LEB), 100 through 181; the right-hand equipment bay (RHEB), 225 through 278; the left-hand equipment bay (LHEB), 325 through 382; the left-hand forward equipment bay (LHFEB), 300 through 306; and the upper equipment bay (UEB), 600 through 604 and 13 - ORDEAL BOX. (See figure B-1 for panel locations.)

REMARKS

This column provides the rationale supporting the adjacent step and the operational procedure. Rationale will grow in scope as the operational procedures are refined through continued application by the Flight Crew as applied during mission simulation using Apollo evaluators and simulators. As the Flight Crew becomes more familiar with the spacecraft and increases its proficiency, the Abbreviated Checklist is expected to diminish in overall coverage. Volume 2, however, with its supporting rationale will become a repository of comprehensive data providing a reference baseline to the Abbreviated Checklist and for use by support personnel more recently assigned to the program.

SHORT-FORM NOMENCLATURE AND ABBREVIATIONS

Spacecraft controls and displays and their relative positions and indications are called out by their respective placard titles. Exceptions have been taken, where titles are lengthy by adoption of short-form nomenclature.

Whenever a designated callout refers to a control or display, it is identified by one of the following:

Light	lt
Switch	sw
Rotary type switch	sel
Circuit breaker	cb
Talkback indicator	tb
Valve	vlv
Indicator	ind
Pushbutton	pb
Potentiometer or rheostat	cont
Thumbwheel	tw

For Symbols and Definitions, refer to Appendix A in the Apollo Operations Handbook, Block II Spacecraft, Volume 1 - Spacecraft Description (SM2A-03-BLOCK II-(1) (H&J).

SECTION 4

NORMAL/BACKUP PROCEDURES

Normal/backup procedures consist of detail control actions and anticipated displays for accomplishing CSM systems management, flight control, navigation, and experimental procedures under nominal mission operating conditions. Approved alternate operating methods and backup systems procedures are included, and options indicated where applicable to provide maximum vehicle capability and operational flexibility. As an aid to the user, supporting rationale, system operating limitations, and remarks clarifying unique or obscure operating methods are provided adjacent to or keyed to affected locations in the procedures.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.1	BACKUP CREW PRELAUNCH CHECKS		
	<p>Prelaunch procedures consist of operational and configuration checks performed by backup flight crew prior to ingress of prime crew. Procedures have been sequenced so they can be more easily compared with other prelaunch documents. In order to keep them closely aligned, redundant switch settings may appear in more than one area and GDC align procedures have been repeated wherever necessary. It is assumed that a complete prelaunch checkout, including loose gear stowage, has been performed by ground support personnel, prior to backup crew ingress into command module, and that all systems are in an active configuration as required at time of ingress. Spacecraft suit circuit shall have been purged and oxygen content verified to be 95% minimum. Backup crew will utilize facility headsets until service structure is clear of vehicle, as there will be no VHF AM or S BAND transmission until that time. Refer to Appendix B for cabin switch/control position prior to backup crew cabin ingress.</p>		
4.1.1	C&WS STATUS CHECK		
CMP	C/W NORM - NORM	2	
	C/W CSM - CSM		
	C/W PWR - 2 [pause at off (ctr) at least 1 sec]		Excessive switching speed will cause temporary loss of both power supplies, and alarm reset capability.
ALL	MASTER ALARM pb/lt (3) - on, push	1,3,122	
CMP	C/W PWR - 1 [pause at off (ctr) at least 1 sec]	2	Excessive switching speed will cause temporary loss of both power supplies, and alarm reset capability.
ALL	MASTER ALARM pb/lt (3) - on, push	1,3,122	
CMP	C/W LAMP TEST - 1 (hold)	2	1 position is momentary.
CDR	MASTER ALARM pb/lt - on	1	
CMP	1h C/W lt (15) - on	2	
	C/W NORM - BOOST		
CDR	MASTER ALARM pb/lt - out	1	
CMP	C/W NORM - NORM	2	
CDR	MASTER ALARM pb/lt - on	1	

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 APOLLO OPERATIONS HANDBOOK

4.1.1

C&WS STATUS CHECK

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	C/W LAMP TEST - 2 (hold)	2	2 position is momentary.
CDR	MASTER ALARM pb/lt - out	1	
CMP	lh C/W lt (15) - out	2	
LMP	MASTER ALARM pb/lt - on	3	
CMP	rh C/W lt (20) - on	2	
	C/W LAMP TEST - rel		
LMP	MASTER ALARM pb/lt - out	3	
CMP	rh C/W lt (19) - out	2	SUIT COMPR C/W light will remain on until compressor is activated.
	C/W NORM - ACK		
	4.1.2 EMS PRELAUNCH TESTS		
	1 Initial EMS Prep		
CDR	EMS FUNC - OFF	1	
	<u>CAUTION</u>		
	If SPS THRUST lt on, a grd exists on one or both ΔV THRUST sws.		
	cb EMS (2) - close	8	
	Open EMS GTA cover	1	A 5/32-inch hex driver is required.
	GTA sw - on (up)		GTA switch is used during ground operations only. Setting switch on (up) allows EMS calibration for zero G condition. Switch must be set off (down) and door closed before flight.
	EMS MODE - STBY		

APOLLO OPERATIONS HANDBOOK

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EMS PRELAUNCH TESTS

STA/T STEP	PROCEDURE	PANEL	REMARKS												
CDR 2	EMS FUNC - ΔV Adj alphanumeric brightness (option) Wait 5 sec	1	ΔV/EMS SET switch used both for slewing G-V scroll and for setting ΔV/RNG indicator. Slew speeds executed by ΔV/EMS SET switch are as follows: <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>G-V Display Ft/Sec</th> <th>ΔV RNG Indicator Ft/Sec or Nautical Miles</th> </tr> </thead> <tbody> <tr> <td></td> <td>1827 Ft/Sec = 1 In. of Scroll</td> <td></td> </tr> <tr> <td>Slow (soft stop) INCR or DECR</td> <td>30 ft/sec/sec = 0.0164 in./sec</td> <td>0.25/sec</td> </tr> <tr> <td>Fast (hard stop) INCR or DECR</td> <td>480 ft/sec/sec = 0.263 in./sec</td> <td>127.5/sec</td> </tr> </tbody> </table>		G-V Display Ft/Sec	ΔV RNG Indicator Ft/Sec or Nautical Miles		1827 Ft/Sec = 1 In. of Scroll		Slow (soft stop) INCR or DECR	30 ft/sec/sec = 0.0164 in./sec	0.25/sec	Fast (hard stop) INCR or DECR	480 ft/sec/sec = 0.263 in./sec	127.5/sec
	G-V Display Ft/Sec	ΔV RNG Indicator Ft/Sec or Nautical Miles													
	1827 Ft/Sec = 1 In. of Scroll														
Slow (soft stop) INCR or DECR	30 ft/sec/sec = 0.0164 in./sec	0.25/sec													
Fast (hard stop) INCR or DECR	480 ft/sec/sec = 0.263 in./sec	127.5/sec													
3	GTA Null Adj EMS MODE - NORM Adj GTA null adj until ΔV/RNG least significant digit changes <1 per 10 sec														
4	EMS FUNC - ΔV SET Slew ΔV ind to +1586.8														
5	EMS FUNC - ΔV TEST SPS THRUST lt - on ΔV ind - decr (10 sec)		For negative numbers ΔV/RNG indicator will display a minus sign. No sign will appear for positive numbers.												

4.1.2

EMS PRELAUNCH TESTS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	SPS THRUST lt - out (at ΔV -0.1 fps) ΔV ind - stops at -20.8 ± 20.7 fps EMS MODE - STBY	1	Test 1 checks lower trip point of .05 G comparator. Ten seconds should be allowed to verify no malfunctions. No other light should come on before or after 10 seconds.
6	EMS FUNC - EMS TEST 1 (CCW) (wait 5 sec) EMS MODE - NORM (wait 10 sec) .05 G lt - out SPS THRUST lt - out Lift vctr dn lt - out Lift vctr up lt - out RNG ind - 0.0 NM Slew scroll until disp index superimposed upon notch at start of <u>next</u> self-test pattern		EMS scroll reverse slew capability is limited to one inch.
7	EMS FUNC - EMS TEST 2 Wait 10 sec .05 G lt - on (all others out)		Test 2 checks upper trip point of .05 G comparator. No other light should come on before or after 10 seconds.
8	EMS FUNC - EMS TEST 3 .05 G lt - on Lift vctr dn lt - on (10 sec after .05 G lt) Set RNG ind to 58.0 ± 0.0 NM		Test 3 checks corridor verification circuitry associated with lift vector down light ($G < .2$). For negative numbers RNG indicator will display minus sign in most significant digit. No sign will appear for positive numbers.

EMS PRELAUNCH TESTS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 9	EMS FUNC - EMS TEST 4 .05 G lt - on (all others out) G-V trace (during 10-sec period) within test pattern After 10 sec, G-V trace stops at lower right corner of test pattern RNG ind (during 10-sec period) counts toward zero After 10 sec, stops at 0.0+0.2	1	Test 4 checks range-to-go integrator circuits, range-to-go indicator, G-servo circuits, and G-V plotter.
10	EMS FUNC - EMS TEST 5 .05 G lt - on Lift vctr up lt - on (10 sec after .05 G lt) RNG ind - resets to 0.0 NM Scribe traces vert line ≈ 9 G to 0.28+0.1 G & stops (trace within test pattern)		Test 5 checks corridor verification circuitry associated with lift vector up light ($G > .2$). Enables slewing scroll to start of entry pattern. After scroll is set to <37K fps, it is not permissible to return EMS FUNC switch to EMS TEST 5 position (range integrator and scroll sync would be lost).
11	Slew scroll until stylus is at 0.28 G tol step of grd test pattern 1 & verify ΔV instructions are visible		

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 12	EMS FUNC - RNG SET EMS MODE - STBY Scribe traces vert line from 0.28 G to 0.0+0.1 G & stops All lt - out	1	
13	EMS FUNC - OFF		
	<u>WARNING</u> GTA sw is for grd tests only & must be set off (down) & door closed for proper flt oper of EMS. GTA sw - off (down) Close GTA cover		A 5/32-inch hex driver is required.
	4.1.3 GLYCOL LOOP CHECKS		
	Sec Gly Loop Check		
CMP	GLY TO RAD SEC vlv - NORM	377	
	ECS IND sel - SEC	2	
	SEC COOL PUMP - AC1		
	RAD SEC IN TEMP ind - 60°-97°F		
	RAD SEC OUT TEMP ind - 60°-70°F (pegged)		
	SEC GLY EVAP OUT TEMP ind - 60°-75°F (pegged)		
	SEC GLY EVAP STM PRESS ind - 0.25 psia (pegged)		
	SEC GLY DISCH PRESS ind - 39-51 psig		
	SEC ACCUM QTY ind - 30-50%		

GLYCOL LOOP CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	SEC COOL PUMP - AC2 SEC GLY DISCH PRESS ind - 39-51 psig SEC COOL PUMP - off (ctr) ECS IND sel - PRIM GLY TO RAD SEC vlv - BYP	2 377	
	Prim Gly Loop Activation		
LMP	GLY PUMPS - 2 AC1	4	
CMP	PRIM GLY DISCH PRESS ind - 37-50 psig	2	GSE flow must be temporarily interrupted (3 minutes maximum) for this check.
	PRIM ACCUM QTY ind - 25-50%		
LMP	GLY PUMPS - 1 AC1	4	
CMP	PRIM GLY DISCH PRESS ind - 37-50 psig	2	
	RAD FLOW CONT PWR - PWR		
	RAD FLOW CONT AUTO - 2		
	ECS RAD tb - 2		2 indicates No. 2 flow proportioning valve controlling flow.
	RAD FLOW CONT AUTO - AUTO		
	ECS RAD tb - gray		Gray indicates No. 1 flow proportioning valve controlling flow.
	RAD FLOW CONT PWR - off (ctr)		
CDR	DIRECT O2 vlv - OPEN (CCW), adj for	7	
CMP	O2 FLOW ind - 0.4+0.1 lb/hr	2	
	4.1.4 STANDBY INVERTER (NO. 3) CHECK		
LMP	AC2 RSET - OFF	3	
	INV 3 - MNB		
	INV 2 AC2 - OFF		
	INV 3 AC2 - on (up)		Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when alternate inverter is connected to bus.

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	AC2 RSET - RSET	3	RSET position is momentary. Positioning AC1 or 2 RSET switches to RSET and releasing ensures a MASTER ALARM light and tone. Positioning AC1 or 2 RSET switches to center will cause random activation of MASTER ALARM lights and tone.
CMP,LMP	MASTER ALARM pb/lt (2) - on (push)	3,122	
CMP	C/W lts (34) - out	2	
LMP	AC IND sel - BUS 2, ØA, B, C	3	
	AC VOLTS ind - 113-117 vac		
	AC2 RSET - OFF		
	INV 3 AC2 - OFF		
	INV 2 AC2 - on (up)		
	AC2 RSET - RSET		Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when alternate inverter connected to bus.
			RSET position is momentary. Positioning AC1 or 2 RSET switches to RSET and releasing ensures a MASTER ALARM light and tone. Positioning AC1 or 2 RSET switches to center will cause random activation of MASTER ALARM lights and tone.
LMP,CMP	MASTER ALARM pb/lt (2) - on (push)	3,122	
CMP	C/W lts (34) - out	2	
LMP	INV 3 - OFF	3	Inverter 1 powering a-c bus No. 1 and inverter 2 powering a-c bus No. 2.
	AC IND sel - BUS 1 & 2, ØA, B, C		
	AC VOLTS ind - 113-117 vac		
4.1.5 FC RADIATOR & FLOAT BAG CHECKS			
	FC Rad Check		
CMP	cb FC RAD (all) - close	226	
LMP	FC RAD tb (all) - gray	3	Gray indicates fuel cell radiator panels not bypassing flow.
CMP	cb FC RAD (all) - open	226	

RC RADIATOR & FLOAT BAG CHECKS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	Float Bag Check FLOAT BAG (all) - OFF cb FLOAT BAG (all) - close FLOAT BAG (all) - VENT cb FLOAT BAG (all) - open	8	Lever lock. Lever lock.
4.1.6 LHEB ECS VALVE STATUS			
CMP	GLY TO RAD SEC vlv - BYP (verify) PRIM ACCUM FILL vlv - OFF PRIM GLY ACCUM vlv - open (CCW) Y-Y strut - retract	377 379 378	Y-Y strut to be retracted to provide attenuation panel access.
	Open cool cont atten pnl SUIT HT EXCH PRIM GLY - FLOW (CCW)	382	Covers panel 382.
	<u>WARNING</u>		
	SUIT FLOW RELF vlv must remain OFF throughout msn or swelling of CO2-odor absorber filters may result.		
	SUIT FLOW RELF vlv - OFF GLY EVAP IN TEMP vlv - MIN (CCW) SUIT HT EXCH SEC GLY - FLOW EVAP H2O CONT (2) - AUTO H2O ACCUM (both) - RMTE		
	Close cool cont atten pnl Y-Y strut - extd & lock in place		

4.1.6

LHEB ECS VALVE STATUS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Open CO2 cstr atten pnl		Covers CO2 canisters.
	CO2 CSTR DIVERT vlv - ctr	350	
	Close CO2 cstr atten pnl		
	MN REG (2) - open	351	
	H2O/GLY TK sel (2) - BOTH		
	EMER CAB PRESS sel - OFF		
	CAB REPRESS vlv - OFF (CCW)		
	WASTE TK SERV vlv - CLOSE	352	Servicing fitting is plugged.
	PRESS RELF sel - 2		
	POT TK IN vlv - CLOSE		Potable water chlorination port capped.
	WASTE TK IN vlv - AUTO		
	PRESS EQUAL vlv - CLOSE	Fwd Hatch	
	AC UTIL PWR - OFF	201	
	TUNL VENT vlv - LM/CM ΔP	12	
	LM/CM ΔP ind - 0.0 psid		
	SUIT FLOW vlv (3) - FULL FLOW	300,301,302	
	PRIM CAB TEMP vlv - COLD (CW)	303	
	SEC CAB TEMP vlv - MAX COOL (CW)		
DRINK H2O SUP vlv - OFF	304	Drinking water unavailable during launch hold periods.	
4.1.7 LEB & TIMER PANEL 306			
UTIL PWR - OFF	100	Connector covered.	
FLOOD DIM - 1			
FLOOD FIXED - OFF			
G/N OPT PWR - OFF			
G/N IMU PWR - on (up)		Guarded.	
RNDZ XPNDR PWR - HTR			
NUMERICS LTS - as desired			
INTGL LTS - as desired			
FLOOD LTS - OFF (CCW)			

LEB & TIMER PANEL 306

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	MSN TMR - RSET MSN TMR ind - zero MSN TMR - START	306	RSET position is momentary. Mission timer will reset to zero and count up at launch.
	MSN TMR ind - counting up (verify) EVNT TMR START - STOP, then ctr EVNT TMR RSET - RSET SYS TEST (2) - 5A SYS TEST ind - 1.1-1.9 vdc	101	RSET position is momentary. Equivalent to +45° to +75°F nominal SPS oxidizer engine feedline temperature. Monitors battery relay bus voltage during launch.
	SYS TEST (2) - 5B RNDZ XPNDR TEST - OPR CM RCS HTRS - OFF WASTE H2O DUMP - HTR A URINE DUMP - HTR A <u>CAUTION</u> OPT ZERO sw must not be moved during prelaunch or inadvertent jett of opt covers could occur.	122	
	OPT ZERO - ZERO OPT TELTRUN - SLAVE TO SXT OPT MODE - MAN OPT COUPLING - DIR OPT SPEED - LO COND LAMPS - ON UP TLM - ACPT RETCL BRT tw - as req		

4.1.7

LEB & TIMER PANEL 306

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	SCI/UTIL PWR - OFF	163 162	Switches are located behind closeout panel and will be set at panel closeout.
	SCI PWR - OFF		
	S1 - OFF	164 181	Connector covered.
	CRYO AC PWR - on (up)		
	H2 FAN - AUTO	Supplies ac/dc power to cameras and EM sounder and heater power to pan camera.	
	O2 FAN - AUTO		
	SM/AC PWR - on (up)		
	DOOR JETT - off (down)		
	LOGIC PWR - OFF	Guarded.	
	cb pnl 181 - all closed		
4.1.8 RHEB & PANEL 601			
cb pnl 225 - all closed except cb HI GAIN ANT (2) - open	225		
cb FC REACS (all) - open			Fuel cell reactant valve circuit breakers are opened after fuel cell start-up to preclude inadvertent valve closure.
cb COAS/TUNL LTG MNB - open	229		
cb pnl 229 - all closed except			
cb MN REL (2) - open			
cb O2 VAC ION PUMPS (2) - open	230		
MAP CAMR ON tb - gray			
MAP CAMR TRACK tb - gray			

RHEB & PANEL 601

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	MAP CAMR ON - STBY	230	Map camera must be in standby during boost, TLI, and SPS thrusting periods.
	MAP CAMR TRACK - off (ctr)		
	MAP CAMR IMAGE MTN - OFF		
	GAMMA RAY BOOM DPLY tb - gray		Gray indicates boom retracted.
	GAMMA RAY BOOM JETT tb - gray		Gray indicates boom retracted and tie-down engaged.
	GAMMA RAY BOOM DPLY - off (ctr)		
	GAMMA RAY BOOM JETT - off (down)		
	GAMMA RAY EXP - OFF		
	GAMMA RAY GAIN - SHLD OFF		
	MASS SPECT BOOM DPLY tb - gray		Gray indicates boom retracted.
	MASS SPECT BOOM JETT tb - gray		Gray indicates boom retracted and tie-down engaged.
	MASS SPECT BOOM DPLY - off (ctr)		
	MASS SPECT BOOM JETT - off (down)		
	MASS SPECT EXP - off (ctr)		
	MASS SPECT ION SOURCE - OFF		
	MASS SPECT MULT - LO		
	MASS SPECT DSCRM - LO		
	DATA SYS CAL - off (down)		
	DATA SYS ON - OFF		
	SUB SAT tb - gray		Gray indicates TBD.
	SUB SAT - off (ctr)		
	PAN CAMR OPR tb - gray		Gray indicates TBD.
	PAN CAMR SELF TEST - off (ctr)		
	PAN CAMR MODE - STBY		Pan camera must be in standby during boost, TLI, and SPS thrusting periods.
	PAN CAMR PWR - BOOST		
	X RAY DR DPLY - off (ctr)		
	X RAY EXP - off (ctr)		
	ALPHA RAY - OFF		
	LASER ALTM - OFF		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	cb pnl 250 - all closed except <u>CAUTION</u> cbs BAT BUS A&B TO PYRO BUS (2) should never be closed when cb PYRO A&B/SEQ A&B (2) are closed. Loss of pyro bat pwr could result. cb BAT BUS A&B TO PYRO BUS (2) - open cb BAT C TO BAT BUS A&B (2) - open OVBD DRAIN vlv - OFF BAT VENT vlv - CLOSE WASTE STOW vlv - VENT REPRESS O2 - CLOSE	250 251 252 601	
	4.1.9 ORDEAL SWITCH POSITION CHECK <u>CAUTION</u> Before ORDEAL is stowed, or when not being used (whether EARTH/LUNAR sw is in PWR OFF or not), FDAI 1 & 2 sw must be at INRTL. Otherwise, pitch inertial att cannot be displayed by FDAI ball.		Assumes that ORDEAL box has been interconnected between FDAIs and EDA during installation, and that prime or backup crews will not be required to connect or disconnect ORDEAL cables to stow or unstow ORDEAL.
CDR	FDAI sw (both) - INRTL EARTH/LUNAR - PWR OFF ALT SET cont - as desired	13	This value to be determined from planned nominal insertion altitudes for each particular mission.

ORDEAL SWITCH POSITION CHECK

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	LTG - OFF MODE - HOLD/FAST SLEW - ctr	13	
	4.1.10 LH COUCH CHECKS		
	THC & RHC - LOCKED		It is possible to actuate THC clockwise or counter-clockwise while locked.
	LH ECS Vlv Stat		
CMP	SRG TK RELF vlv - open (CW)	375	
	PLVC sw - NORM	376	
	DEMAND REG sel - BOTH	380	
	SUIT TEST vlv - OFF		
	SUIT RETURN vlv - close (push)		
	PRIM GLY TO RAD - NORM	325	
	CAB PRESS RELF vlv (2) - BOOST/ENTR (safety latch off)		For ground checks, CAB PRESS is the equivalent of flight term CAB PRESS RELF.
	GLY RSVR IN vlv - OPEN	326	
	GLY RSVR OUT vlv - OPEN		
	GLY RSVR BYP vlv - CLOSE		
	SM O2 SUP vlv - ON		
	SRG TK O2 vlv - ON		
	REPRESS PKG vlv - ON		
	LH Side Pnls		
CDR	COAS PWR - OFF	15	Connector covered.
	UTIL PWR - OFF		
	PL BCN LT - off (ctr)		
	DYE MARKER - off (down)		Guarded. Verify safety removed.
	PL VENT - OFF		

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LH COUCH CHECKS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	AUTO RCS (16) - OFF FLOOD DIM - 1 FLOOD FIXED - OFF NUMERICS LTS - as desired FLOOD LTS - as desired INTGL LTS - as desired SECS LOGIC (both) - OFF SECS PYRO ARM (2) - SAFE cb pnl 8 - all closed except cb CM RCS HTRS (both) - open cb FLOAT BAG (all) - open cb SECS LOGIC (2) - open cb SECS ARM (2) - open EDS PWR - OFF	8	Lever lock. Lever lock with key lock guard.
	<p style="text-align: center;"><u>CAUTION</u></p> More than 1 hr of contin on-time for TVC SERVO PWR 1 or 2 sw may be detrimental to SPS gmb1 actuators.	7	
	TVC SERVO PWR (both) - OFF FDAI/GPI PWR - BOTH LOGIC 2/3 PWR - on (up) ELEC PWR - GDC/ECA SIG CONDR/DR BIAS PWR (both) - AC1 or AC2		Powers RJEC -4 vdc bias power supplies. To provide increased reliability, switches should not be set on same bus.
	BMAG PWR (both) - WARMUP		
	LH MDC & Pnls 600, 602, 603, & 604 Set ALT index - 3300	1	Value obtained from LCC.

LH COUCH CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	CMC ATT - IMU	1	<p>Normally left at IMU position throughout mission. Selection of GDC position causes total attitude display to be lost on both balls. GDC damage will result if GDC position selected and pitch or yaw rate is $>5^\circ/\text{sec}$, or if GDC yaw Euler angle is $>80^\circ$ and $<280^\circ$.</p> <p>For ground checks, TRANS CONTR PWR, ROT CONTR PWR NORM, and ROT CONTR PWR DIR are the equivalent of flight terms THC PWR, RHC PWR NORM, and RHC PWR DIR respectively.</p> <p>Lever lock. Guarded.</p> <p>Provides reduced gain for SPS thumbwheel control of SCS auto mode IV abort.</p>
	<p>ACCEL - check (+1 G) FDAI SCALE - 5/1 FDAI SEL - 1/2 FDAI SOURCE - CMC ATT SET - GDC MAN ATT ROLL - RATE CMD MAN ATT PITCH - ACCEL CMD MAN ATT YAW - RATE CMD LIM CYCLE - OFF ATT DBD - MIN RATE - HI THC PWR - on (up) RHC PWR NORM (both) - AC/DC RHC PWR DIR (both) - OFF</p> <p>SC CONT - SCS CMC MODE - FREE BMAG MODE (3) - RATE 2 SPS THRUST - NORM ΔV THRUST (2) - OFF SPS GMBL tw (2) - 0 ATT SET tw (3) - R 162°, P 90°, Y 0° SCS TVC (2) - RATE CMD GMBL MOT (4) - OFF ΔV CG - LM/CSM</p>		

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LH COUCH CHECKS



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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	ELS LOGIC - OFF ELS AUTO - AUTO CM RCS LOGIC - OFF CM PRPLNT DUMP - OFF CM PRPLNT PURG - off (down) IMU CAGE - off (down) EMS ROLL - OFF .05 G sw - OFF α/Pc IND sw - α α/Pc ind - zero LV IND/GPI sw - GPI TVC GMBL DR (2) - AUTO EVNT TMR START - ctr EVNT TMR RSET - up (ctr)	1	Guarded. Guarded. Guarded. Guarded. Required at OFF position until .05 G during entry. OFF position powered by LOGIC 2/3 PWR switch. Event Timer not counting. Timer resets and starts counting automatically when lift-off occurs. Resets and starts counting up in event of abort initiation.
CMP	SUIT CAB ΔP ind - >+2.0 in. H2O O2 FLOW ind - 0.4+0.1 lb/hr (not pegged) PROBE EXTD/REL tb (2) - gray PROBE (3) - OFF EXT RUN/EVA LTS - OFF EXT RNDZ LTS - off (ctr) TUNL LTS - OFF LM PWR - OFF UP TLM CM - ACPT UP TLM IU - BLOCK	2	DIRECT O2 valve partially open. Gray indicates probe fully extended or fully retracted. PROBE EXTD/REL switch guarded. UP TLM CM and UP TLM IU switches should be placed to ACPT only as required during updates.

LH COUCH CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	CM RCS PRESS - off (down) SM RCS IND sw - PRPLNT QTY RCS Status Check SM RCS He 1 tb (4) - bp SM RCS He 2 tb (4) - bp SM RCS PRIM PRPLNT tb (4) - bp SM RCS SEC PRPLNT tb (4) - bp SM RCS SEC FUEL PRESS (4) - OPEN RCS IND sel - SM A, B, C, D SM RCS PKG TEMP ind - amb SM RCS He PRESS ind - 4000-4350 psia SM RCS SEC FUEL PRESS ind - 192-207 psia	2	Guarded. Barber pole indicates helium isolation valves for system 1 are closed. Barber pole indicates helium isolation valves for system 2 are closed. Barber pole indicates at least one primary propellant isolation valve (fuel or oxidizer) in each quad is closed. Barber pole indicates at least one secondary propellant isolation valve (fuel or oxidizer) in each quad is closed. OPEN position is momentary. There is no position indicator talkback. Valve opening can be confirmed by ACE. SM RCS heaters are not operated on pad and during ascent to reduce effects of boost heating on package temperature. Ambient temperature <75° or >205°F will illuminate SM RCS status lights. Nominal He load is 4150 psig at 70°F. Pressure and temperature excursions are due to ambient conditions.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p> SM RCS IND sw - He TK TEMP SM RCS He TK TEMP ind - 60°-80°F SM RCS IND sw - PRPLNT QTY SM RCS PRPLNT QTY ind - 100% SM RCS HTRS (4) - OFF CM RCS PRPLNT (both) - on (up) CM RCS PRPLNT tb (both) - gray RCS IND sel - CM 1, CM 2 CM RCS He TEMP ind - 60°-90°F CM RCS He PRESS ind - 4000-4450 psia CM RCS MANF PRESS ind - 80-105 psia RCS CMD - ctr RCS TRNFR - SM EDS AUTO - OFF CSM/LM FNL SEP (both) - off (down) CM/SM SEP (2) - off (down) SIVB/LM SEP - off (down) PRPLNT DUMP - AUTO 2 ENG OUT sw - AUTO LV RATES sw - AUTO TWR JETT (both) - AUTO </p>	<p>2</p>	<p> On position is momentary. Gray indicates propellant isolation valves are open. GSE servicing pressure monitored until system activated. Pressure varies with temperature and ullage. If manifold pressure drops suddenly (indicates a ruptured burst diaphragm), close CM RCS propellant isolation valves and then preheat jets, 4.15.4, for 15 minutes after orbit insertion. Preheating open vents to vent any propellant trapped between propellant isolation valves and jets by energizing jet valve direct coils. Switch last set to OFF (momentary position) prior to backup crew ingress. SM position is momentary. Guarded. Guarded. Guarded. Guarded. </p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	LV GUID sw - IU	2	Guarded.
	LV STAGE - OFF		Guarded.
	XLUNAR INJECT - INJECT		
	MN REL - off (down)		Guarded.
	EMER O2 - CLOSE	600	
	REPRESS O2 RELF - open (CW)	602	
	REPRESS O2 PRESS ind - >865 psig		
	EVA STA O2 SUP - OFF	603	
SUIT PRESS ALARM - OFF	604		
4.1.11 RH COUCH CHECKS			
LMP	RHEB & Pnl 16		
	SCI PWR - OFF	227	Connector covered.
	DOCK TRGT - OFF	16	Connector covered.
	UTIL PWR - OFF		Connector covered.
	COAS PWR - OFF		
	cb pnl 275 - all closed except	275	
	cb MNA & B BAT C (2) - open		
	cb FLT/PL BAT BUS A, B, & BAT C (3) - open		
	cb pnl 276 - all closed	276	
	cb pnl 278 - all closed except	278	
cb UPR SYS COMPR (both) - open			
RH Side Pnls			
FC 1 PUMPS - AC1	5		
FC 2 & 3 PUMPS - AC2			
G/N PWR - AC1			
MN BUS TIE (2) - OFF			
BAT CHGR - AC1			

4.1.11

RH COUCH CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	<p>NONESS BUS - OFF INTGL LTS - OFF FLOOD LTS - OFF FLOOD DIM - 1 FLOOD FIXED - OFF cb pnl 5 - all closed except</p> <p>cb NONESS INST - open cb WASTE DUMP HTRS (2) - open</p>	5	<p>If circuit breaker RAD HTRS OVLD BAT A and/or BAT B trip, or are opened in flight, they should not be closed unless batteries are tied to main bus [MN BUS TIE (2) - on (up)]. This prevents possible disconnect of ECS radiator heaters by false overload signal.</p>
	<p>SPS GAUGING - AC1 TELCOM GRP 1 - AC1 TELCOM GRP 2 - AC2 GLY PUMPS - 1 AC1 (verify) SUIT COMPR (both) - OFF cb pnl 4 - all closed</p>	4	
	<p>RH MDC Pnls FC RAD (all) - off (ctr) FC RAD tb (all) - gray</p>	3	<p>Gray does not indicate status of fuel cell radiator bypass valves as talkback circuits are not powered at this time.</p>
	<p>FC HTRS (all) - on (up) FC PURG (all) - OFF FC REACS (all) - ctr FC REACS tb (all) - gray</p>		<p>Gray indicates fuel cell reactants valves open.</p>
	<p>FC MNA 1 & 3 - OFF, 2 - ctr</p>		<p>Fuel cell management will be monitored by ground crew until the gimbal drive and trim check at which time they will be verified on the main buses by the crew.</p>

RH COUCH CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	<p>FC MNA 1 & 3 tb - bp, 2 tb - gray</p> <p>MNA RSET - ctr FC MNB (all) - OFF FC MNB tb (all) - bp</p> <p>MNB RSET - ctr FC IND sel - 1, 2, 3 FC H2 FLOW ind - 0.01-0.05 lb/hr FC O2 FLOW ind - 0.1-0.4 lb/hr</p> <p>FC SKIN TEMP ind - 390°-450°F FC COND EXH TEMP ind - 150°-175°F FC tb (2) - gray</p> <p>FC IND sel - 2 BAT CHG - OFF DC IND sel - FC 1, 2, 3 DC AMPS ind - 5-20 amps DC IND sel - MNA, B DC VOLTS ind - 26.5-31 vdc DC IND sel - BAT BUS A, B, BAT C DC VOLTS ind - 35-37.5 vdc DC AMPS ind - <3.0 amps</p>	3	<p>Barber pole indicates fuel cells 1 and 3 disconnected from main bus A, gray indicates fuel cell 2 connected to main bus A.</p> <p>Barber pole indicates all fuel cells disconnected from main bus B.</p> <p>Flow limits are proportional to individual fuel cell currents and can be approximated by fuel cell H2 flow $\approx(\text{amps} \times 2.5)/1000$, and fuel cell O2 flow $\approx(\text{amps} \times 2.0)/100$. GSE is supplying most of the SC power.</p> <p>Gray indicates normal pH factor and normal fuel cell radiator temperature.</p>

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RH COUCH CHECKS



STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	<p style="text-align: center;"><u>CAUTION</u></p> <p>Do not leave DC IND sel at PYRO BAT A (B) position any longer than req to read DC VOLTS, or PYRO bat chg will be depleted.</p> <p>DC IND sel - PYRO BAT A, B DC VOLTS ind - 36.0-37.5 vdc DC IND sel - MNA</p> <p>Dual Inv Stat Check</p> <p>INV 1 - MNA INV 2 - MNB INV 3 - OFF INV 1 AC1 - on (up) INV 2 AC1 - OFF INV 3 AC1 - OFF INV 1 AC2 - OFF INV 2 AC2 - on (up) INV 3 AC2 - OFF AC IND sel - BUS 1 & 2, ØA, B, C AC VOLTS ind - 113-117 vac</p> <p>SPS Stat Checks SPS PRPLNT TEMP ind - 100°F max</p> <p>SPS FUEL PRESS ind - 170-195 psia SPS OXID PRESS ind - 170-195 psia</p>	3	<p>Switch position verification only. If switch positions must be changed, refer to 4.5.3.9, step a.</p> <p>Normal operating temperature is +45° to +75°F. Redline is +27 and +100°F.</p> <p>Normal operating pressure after fuel and oxidizer tank is pressurized with He (after He valve is actuated) is 170-195 psia. GSE servicing pressure is 110 psia.</p>

RH COUCH CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	<p>SPS PRESS IND sw - He, N2A, N2B SPS He PRESS ind - 3300-3900 psia SPS N2 PRESS ind - 2200-2800 psia SPS INJ VLV ind (4) - CLOSE SPS OXID VLV upper tb - MAX (verify) SPS OXID VLV lower tb - gray (verify)</p> <p>OXID FLOW VLV INCR - INCR (verify)</p> <p>OXID FLOW VLV PRIM - PRIM PUG MODE - NORM SPS He VLV tb (both) - bp</p> <p>SPS He VLV (both) - AUTO SPS LINE HTRS - off (ctr) SPS PRESS IND sw - He</p> <p>VHF ANT - SM LEFT S BD XPNDR - OFF S BD PWR AMPL PRIM - PRIM S BD PWR AMPL HI - off (ctr) S BD MODE VOICE - VOICE S BD MODE PCM - PCM S BD MODE RNG - RNG S BD AUX TAPE - ctr S BD AUX TV - ctr UP TLM DATA - DATA UP TLM CMD - RSET, then OFF PWR AMPL tb - bp</p> <p>TAPE MOTION tb - bp</p>	3	<p>GSE servicing pressure is 3600+50 psia.</p> <p>Upper talkback MAX and lower talkback gray indicates propellant utilization valve positioned for maximum oxidizer flow.</p> <p>Valve positioned to INCR by GSE during hypergolic landing.</p> <p>Barber pole indicates both helium isolation valves closed.</p> <p>Barber pole indicates power is not applied to S-band power amplifier.</p> <p>Barber pole indicates no tape motion.</p>

4.1.11

RH COUCH CHECKS



STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	S BD ANT OMNI A - B S BD ANT OMNI - OMNI VHF AM SQLCH tw (2) - noise +1 VHF AM (2) - off (ctr) VHF AM RCV - off (ctr) VHF BCN - OFF VHF RNG - OFF S BD SQLCH - ENBL FC REAC VLV - NORM H2 PURG LINE HTR - OFF TAPE RCDR PCM - PCM/ANLG TAPE RCDR RCD - RCD TAPE RCDR FWD - REWIND TAPE RCDR FWD - off (ctr) SCE PWR - NORM PMP PWR - NORM PCM BIT RATE - HI	3	Power to switch is provided by the up-data link or the TAPE RCDR FWD switch in FWD position. Allow tape to completely rewind before proceeding. TAPE MOTION talkback is gray when tape is in motion.
CMP	MSN TMR - RSET MSN TMR ind - zero MSN TMR - START MSN TMR ind - counting up C/W NORM - ACK C/W CSM - CSM C/W PWR - 1 (verify) C/W LAMP TEST sw - ctr PL VENT VLV - push (lock) CRYO H2 PRESS ind (both) - 225-260 psia	2	RSET position is momentary. Will reset to zero and count up at lift-off, but not abort initiation.

RH COUCH CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	02 PRESS IND sw - SURGE TK CRYO 02 PRESS 1 ind - 865-935 psia 02 PRESS IND sw - TK 1 CRYO 02 PRESS ind (both) - 865-935 psia CRYO H2 QTY ind (both) - 100% CRYO 02 QTY ind (both) - 100% CAB FAN (both) - OFF H2 HTRS (both) - AUTO 02 HTRS (both) - AUTO 02 PRESS IND sw - SURGE TK H2 FANS (both) - AUTO 02 FANS (both) - AUTO ECS IND sel - PRIM RAD PRIM IN TEMP ind - 60°-97°F RAD PRIM OUT TEMP ind - 35°-50°F PRIM GLY EVAP OUT TEMP ind - 35°-50°F PRIM GLY EVAP STM PRESS ind - 0.25 psia (pegged) PRIM GLY DISCH PRESS ind - 60 psig max SUIT TEMP ind - 45°-55°F CAB TEMP ind - 70°-80°F SUIT PRESS ind - ≈14.9 psia CAB PRESS ind - ≈14.7 psia CO2 PP ind - 0.0 mm Hg RAD FLOW CONT AUTO - AUTO ECS RAD tb - gray RAD FLOW CONT PWR - off (ctr) RAD MAN SEL - RAD 1	2	Gray indicates No. 1 flow proportioning valve controlling flow. When switch is powered, by placing RAD FLOW CONT PWR switch to MAN SEL, center position will close all isolation valves.

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RH COUCH CHECKS



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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>RAD PRIM HTR - off (ctr) RAD SEC HTR - OFF SUIT COMPR ΔP ind - 0.0 psid</p> <p>PRIM ACCUM QTY ind - 25-50% min H2O QTY IND sw - WASTE WASTE H2O QTY ind - <80% H2O QTY IND sw - POT POT H2O QTY ind - 80% POT H2O HTR - OFF SUIT H2O ACCUM AUTO - ctr SUIT H2O ACCUM ON - ctr SUIT HT EXCH - ON for 20 sec then off (ctr)</p> <p>SEC COOL EVAP - RSET for 58 sec min, then off (ctr) SEC COOL PUMP - off (ctr) GLY EVAP IN TEMP - MAN Position prim loop stm press vlv GLY EVAP STM AUTO - MAN GLY EVAP STM INCR - INCR for 58 sec min, then DECR for 8.5±0.5 sec</p> <p>GLY EVAP H2O FLOW - off (ctr) CAB TEMP - MAN CAB TEMP tw - max decr HI GAIN ANT PWR - OFF HI GAIN ANT TRACK - AUTO HI GAIN ANT BEAM - WIDE</p>	2	<p>SUIT COMPR C/W light remains on as long as compressors are not operating.</p> <p>Unless SUIT HT EXCH control switch is positioned to off (center), continuous power will be applied to motor valve.</p> <p>Ensures secondary loop steam pressure valve closed.</p> <p>INCR and DECR positions are momentary. Steam pressure valve requires 58 seconds from full close to full open.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	HI GAIN ANT PITCH ind - +90° HI GAIN ANT YAW ind - 0° HI GAIN ANT PITCH cont - 0° HI GAIN ANT YAW cont - 180° HI GAIN ANT SERVO - PRIM CAB PRESS DUMP vlv - close (CW)	2 Side hatch	Power off indicator reading. Power off indicator reading. Stow position. Stow position.
4.1.12 COMMUNICATIONS CHECK			
1 Comm Activation			
LMP	S BD XPNDR - PRIM S BD PWR AMPL HI - HI PWR AMPL tb - gray (after 90 sec)	3	Gray indicates power applied to S-band power amplifier.
CMP ALL	VHF AM B - DUPLEX S BD ANT ind - >1/3 scale MODE (3) - INTERCOM/PTT PAD COMM (3) - T/R PAD COMM VOL tw (3) - 5 PWR (3) - AUDIO/TONE MASTER VOL tw (3) - 5 SUIT PWR (3) - on (up) INTERCOM (3) - T/R INTERCOM VOL tw (3) - 5 VHF AM (3) - T/R VHF AM VOL tw (3) - 5 S BD (3) - T/R S BD VOL tw (3) - 5 AUDIO CONT (3) - NORM	2 9,10,6	
CDR	VHF RNG - NORM	9	

4.1.12

COMMUNICATIONS CHECK

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STA/T STEP	PROCEDURE	PANEL	REMARKS
2	Comm Checks		
CDR, LMP	Replace facility headsets with CM headsets		CM headsets and CWG adapters have been connected to communication control head prior to backup crew ingress at which time PWR and SUIT PWR switches were OFF (panels 6, 10, and 9).
	Perform comm checks (pad comm, S-band, & VHF AM)		
CDR LMP	Return to facility headset Don CMP headset & perform S-band & VHF AM comm checks		Ground will switch communication channel such that S-band modes and VHF AM may be verified.
	UP TLM DATA - UP VOICE BU	3	
	Establish 2-way comm on S-band		
	UP TLM DATA - DATA		
	S BD AUX TAPE - DN VOICE BU		
	Establish 2-way comm on S-band		
	S BD AUX TAPE - ctr		
	Return to facility headset		
3	At Completion of Comm Checks		
ALL	SUIT PWR (3) - OFF	9,10,6	
	PWR (3) - OFF		
CMP	MASTER VOL tw - 6	10	
	INTERCOM VOL tw - 6		
	S BD VOL tw - 6		
	VHF AM VOL tw - 7		
ALL	Disconnect CM headset & CWG adapter from comm cont head		
CMP	C/W PWR - off (ctr)	2	
LMP	cb C/W (2) - open	5	
	CDR & LMP egress CM		

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COMMUNICATIONS CHECK

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.1.13	VERIFY COUCH CONFIGURATION		
BCMP	MDC assist bar - extd & locked Headrests - soft suit position THC armrest in launch position & locked Inbd arm rests - stowed & contr locked Couches - launch/entry position (Y-Y struts extd & locked) Seat pans - 85° position & locked O2/comm umb - stowed Harnesses & restraints - extd & laid aside Couch stab brace - stowed Egress CM		Backup CMP (BCMP) accomplishes all tasks in 4.1.13 and 4.1.14. To eliminate confusion, station callouts for CDR and LMP locations have not been included.
4.1.14	PRIME CREW PRE-INGRESS PROCEDURE		
	Ingress CM		Backup CMP re-enters CM.
	S BD PWR AMPL HI - OFF	3	The S-band is powered down to allow GMIL station S-band antenna alignment.
	S BD XPNDR - OFF		
	cb C/W (2) - close	5	
	C/W PWR - 1	2	
	MASTER ALARM pb/lt - on, push	1,3,122	
	Perform Pot Water Chlor		Performed following launch vehicle propellant loading.
	POT TK IN vlv - OPEN	352	
	Attach needle assy to inj port		Use carry-on sterilization kit for chlorination.
	Insert chlor ampoule into casing		
	Conn knob assy & rot (CW) until piston contacts ampoule		
	Install ampoule assy on needle assy (push & turn CW)		

4.1.14

PRIME CREW PRE-INGRESS PROCEDURE

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STA/T STEP	PROCEDURE	PANEL	REMARKS
BCMP	<p>Rot knob (CW) until ampoule is empty (piston bottoms out)</p> <p>Disconnect ampoule assy from needle assy (push & turn CCW)</p> <p>Rot knob (CCW), remove used ampoule</p> <p>Repeat chlor inj steps using buffer ampoule (do not remove empty ampoule after inj)</p> <p>Wait 10 min. Then rot inj barrel (CCW) four turns while holding bayonet section in locked position (CW)</p> <p>Rot knob (CCW), remove filled ampoule</p> <p>Remove needle assy from inj port</p> <p>Wait 30-45 min. Then withdraw water as follows</p> <p>Attach H2O sampling container to food prep unit H2O probe</p> <p>FOOD PREP HOT H2O vlv - push, rel</p> <p>until 40 oz water withdrawn</p> <p>FOOD PREP COLD H2O vlv - push, rel</p> <p>until 20 oz water withdrawn</p> <p>Remove H2O sampling container from food prep unit & attach to drink gun nozzle</p> <p>DRINK H2O SUP vlv - ON</p> <p>Actuate drink gun cont until</p> <p>2-4 oz water withdrawn</p> <p>DRINK H2O SUP vlv - OFF</p> <p>Remove H2O sampling container from drink gun nozzle</p> <p>Remove sterilization kit from CM</p>	<p>352</p> <p>305</p> <p>304</p>	<p>Requires $\approx 5-1/2$ turns.</p> <p>Needle assembly to remain on inject port.</p> <p>Withdraws one ampoule of water.</p>

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PRIME CREW PRE-INGRESS PROCEDURE

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STA/T STEP	PROCEDURE	PANEL	REMARKS
BCMP	DIRECT O2 vlv - OPEN (CCW), adj for O2 FLOW ind - 0.6-0.8 lb/hr SUIT COMPR 1 - AC1 SUIT COMPR 1t - out SUIT COMPR ΔP ind - 0.7-0.9 psid SUIT CAB ΔP ind - >+2.0 in. H2O Verify PO2 SECS PYRO ARM (2) - SAFE (unlocked) RNDZ XPNDR PWR - OFF S BD XPNDR - PRIM S BD PWR AMPL HI - HI Ingress LEB for prime crew ingress support	7 2 4 2 8 100 3	Pad safety officer provides key to remove guard from lever lock SECS PYRO ARM switches.

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4.1.14

PRIME CREW PRE-INGRESS PROCEDURE



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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.2	PRIME CREW PRELAUNCH CHECKS		
4.2.1	INGRESS & STATUS CHECKS		
BCMP	SEC COOL PUMP - may be cycled from AC1 to off (ctr) during crew ingress & checkout to maintain crew comfort	2	Activation of secondary loop will warm suit circuit $\approx 10-15^{\circ}\text{F}$. Secondary pump may be selected on or off at option of flight crew for their comfort. Crew may be cold as vehicle is being prechilled by GSE coolant at this time.
4.2.1.1	<u>CDR Ingress LH Couch</u>		
CDR	Ingress LH couch CDR comm umb - conn to PGA SUIT PWR - on (up) PWR - AUDIO/TONE	9	
BCMP	1h SUIT FLOW vlv - OFF CDR O2 umb - conn to PGA	301	Connect red to red and blue to blue. Suit hose interconnect removed from CM.
	1h SUIT FLOW vlv - FULL FLOW CDR O2 vent - shut off & disconnect		PGA gas connector plugs installed. Ventilator removed from CM.
	Assist CDR in position; connections & adjustments completed		Restraints connected and tightened, and arm rests, torso and life vest adjusted. Helmet protector removed from CM.
	Verify sw positions as follows:		
	CAB FAN (both) - on (up)	2	
CDR	FLOAT BAG (3) - VENT	8	Lever lock.
	THC - neutral (locked)		
	MAN ATT ROLL - RATE CMD	1	
	MAN ATT PITCH - ACCEL CMD		

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4.2.1.1

INGRESS & STATUS CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	MAN ATT YAW - RATE CMD SCS TVC (2) - RATE CMD ΔV CG - LM/CSM ELS AUTO - AUTO	1	
	<u>4.2.1.2 LMP Ingress RH Couch</u>		
LMP	Ingress RH couch LMP comm umb - conn to PGA SUIT PWR - on (up) PWR - AUDIO/TONE	6	
BCMP	rh SUIT FLOW vlv - OFF LMP O2 umb - conn to PGA	300	Connect red to red and blue to blue. Suit hose interconnect removed from CM.
	rh SUIT FLOW vlv - FULL FLOW LMP O2 vent - shut off & disconnect		PGA gas connector plugs installed. Ventilator removed from CM.
	Assist LMP in position; connections & adjustments completed Verify the following		Restraints connected and tightened, and arm rests, torso and life vest adjusted.
LMP	SPS GAUGING - AC1 GLY PUMPS - 1 AC1 VHF ANT - SM LEFT OXID FLOW VLV INCR - NORM MNA RSET - ctr MNB RSET - ctr SPS He VLV (both) - AUTO S BD ANT OMNI A - B S BD ANT OMNI - OMNI VHF BCN - OFF SCE PWR - NORM AC 1 RSET - ctr AC 2 RSET - ctr	4 3	

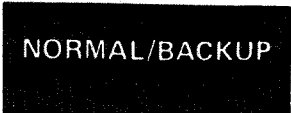
INGRESS & STATUS CHECKS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.2.1.3 <u>CMP Ingress Center Couch</u>			
CMP	Ingress ctr couch		
	CMP comm umb - conn to PGA		
BCMP	SUIT PWR - on (up)	10	
	PWR - AUDIO/TONE		
	ctr SUIT FLOW vlv - OFF	302	
	CMP 02 umb - conn to PGA		Connect red to red and blue to blue. Suit hose interconnect removed from CM.
	ctr SUIT FLOW vlv - FULL FLOW		
	CMP 02 vent - shut off & disconnect		PGA gas connector plugs installed. Ventilator removed from CM.
	Assist CMP in position; connections & adjustments completed		Restraints connected and tightened, and arm rests, torso and life vest adjusted. Helmet protector removed from CM.
	Perform fml crew verification		Helmets, umbilicals, PGA diverter valves and wrist disconnects, foot restraints, and life vests rechecked.
	Verify the following		
CMP	PRPLNT DUMP - AUTO	2	
	C/W NORM - BOOST		
	MSN TMR - START		
	SUIT H2O ACCUM AUTO - 1		
	SUIT COMPR ΔP ind - 0.7-0.9 psid		
All	VHF AM VOL tw (3) - as desired	6,10,9	
	S BD VOL tw (3) - as desired		
LMP	UP TLM CMD - NORM	3	
CMP	UP TLM CM - BLOCK	2	
BCMP	PAD COMM - OFF	10	PAD COMM can be used after launch for intercom backup with PAD COMM VOL thumbwheel decreased.
	Egress CM		

4.2.1.3

INGRESS & STATUS CHECKS



STA/T STEP	PROCEDURE	PANEL	REMARKS
4.2.1.4 <u>EDS Checkout & Countdown Test</u>			Crew participation in EDS test is directed by ground personnel. Test requires ≈30 minutes.
CDR	cb EDS (3) - close (verify)	8	
	EDS PWR - on (up)	7	CDR will verify ABORT light operation as it is activated by ground.
CMP	EDS AUTO - on (up)	2	
CDR	ABORT lt oper - verify	1	CDR will participate in EDS test on PAD COMM.
LMP	UP TLM CMD - OFF	3	
CDR	S BD - OFF	9	LMP will verify ABORT light operation as it is activated by ground.
	INTERCOM - OFF		
	VHF AM - OFF		Squeeze handle to unlock.
LMP	PAD COMM - OFF	6	
4.2.1.5 <u>Cabin Closeout</u>			
-01:40:00			
CMP	Side hatch closing Side hatch	Side hatch	
	Verify external tool stowed on outside of hatch (tech)		
	Remove hatch seal protector (tech)		
	Verify safety pin has been removed from actr handle sel (tech)		
	Gear box sel - N (neut) (tech)		
	Actr handle sel - N (neut) (tech)		
	GN2 vlv handle - push (outbd) (tech)		
	Verify piston chamber pressurized		
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
	If piston chamber is not pressurized GN2 charge No. 1 - CW (tech)		
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			

INGRESS & STATUS CHECKS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Hatch open lock - rel (tech) Push hatch to near closed position (tech) Lock pin rel knob - UNLOCK (verify) Hold hatch closed Insert tool B (handle in 9 o'clock position) into external hatch actuation socket, rot CW to stops & hold (tech) Press & hold LOCK PIN reset button Relax torque & remove tool B (tech)</p> <p>LOCK PIN reset button - rel LOCK PIN ind - not extd (rh couch) &/or white ind is opposite white mrk (ctr & lh couch)</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If lock pin is not engaged Insert tool B into external hatch actuation socket & slowly rot CCW until LMP verifies lock pin engagement (tech)</p> <p>X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p style="text-align: center;"><u>NOTE</u></p> <p>If RED lock pin is extd ≈0.5 inch, lock pin has been sheared.</p> <p>GN2 press ind - green (verify)</p>	Side hatch	<p>Obtains lock pin engagement. Mechanism should rotate ≈14 inches CCW due to spring pressure.</p>

4.2.1.5

INGRESS & STATUS CHECKS



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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Configure hatch for rapid egress Gear box sel - UNLATCH Actr handle sel - U (unlatch) BPC JETT knob - arrow on knob pointing to BPC JETT decal	Side hatch	
-01:35:00	If rapid hatch opening req, refer to 5.3.1.1		
	Strut unlock lanyard (2) - unstow & attach handle ends to MDC		
	Grd performs cab purge & hatch leak test Cab purge to 60% O ₂ /40% N ₂ (launch atmosphere) Grd performs hatch leak test		GSE verifies 60/40 ratio.
	<p style="text-align: center;"><u>CAUTION</u></p> During this check, established SUIT/CAB ΔP should be maintained by DIRECT O ₂ vlv.		Requires ≈20 minutes.
	4.2.1.6 <u>Change Launch Azimuth</u> (if necessary)		
	Key V78E FL V06 N29 X SM launch azimuth XXX.XX DEG Key V21E, load new azimuth PRO CAB FAN (both) - OFF	2	

INGRESS & STATUS CHECKS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.2.1.7 <u>EDS Test Complete</u>			
	-01:21:00		
	Set cont after test		
CDR	INTERCOM - T/R	9	
	VHF AM - T/R		
	S BD - T/R		
LMP	PAD COMM - T/R	6	
CDR	EDS PWR - OFF	7	
CMP	EDS AUTO - OFF (verify)	2	
	2 ENG OUT sw - AUTO (verify)		
	LV RATES sw - AUTO (verify)		
CDR	α/Pc ind - _____%	1	
	-01:13:00		
CMP	UP TLM IU - BLOCK	2	
4.2.2 FINAL VERIFICATION & SYSTEMS CHECKS			
4.2.2.1 <u>G&C Verification</u>			
1 Gyro Pwr Up			
	C/W NORM - NORM		
	BMAG TEMP 1t (both) - out		
CDR	FDAI/GPI PWR - OFF	7	If FDAIs are powered when BMAGs come up to speed, rate needles will oscillate full scale.
	ELEC PWR - GDC/ECA		
	BMAG PWR (both) - ON		
	FDAI/GPI PWR - BOTH		
CMP	C/W NORM - ACK	2	
2 GDC Align			
CDR	FDAI SEL - 1	1	
	FDAI SOURCE - ATT SET		

4.2.2.1

FINAL VERIFICATION & SYSTEMS CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	ATT SET tw (3) - R 162°, P 90°, Y 0°	1	These are nominal angles for a 72° launch azimuth and agree with prelaunch TCP. Only roll is affected by a variable launch azimuth.
	GDC ALIGN pb - push		
	FDAI 1 - err null		
	ATT SET tw (3) - R 168°, P 81°, Y 355°		
	FDAI 1 - full scale err (verify)		
	R right, P up, Y right		
	FDAI SEL - 2		
CMP	FDAI 2 - ind same as FDAI 1 (verify)	2	
CDR	GDC ALIGN pb - push	1	
CMP	FDAI 2 - err null	2	
CDR	ATT SET tw (3) - R 162°, P 90°, Y 0°	1	
CMP	FDAI 2 - full scale err (verify)	2	
	R left, P down, Y left		
CDR	FDAI SEL - 1	1	
	FDAI 1 - ind same as FDAI 2 (verify)		
	GDC ALIGN pb - push		
	FDAI 1 - total att (verify)		
	R 162°, P 90°, Y 0°		
	<u>WARNING</u>		
	Sequencers in SECS should be deactivated to preclude an inadvertent abort.		
	SECS PYRO ARM (2) - SAFE (verify)	8	Lever lock.
	SECS LOGIC (both) - OFF (verify)		Lever lock.

FINAL VERIFICATION & SYSTEMS CHECKS

STA/T STEP	PROCEDURE	PANEL	REMARKS										
<p>4.2.2.2 <u>Gimbal Drive & Trim Check</u></p> <p>1 Initialization FC on mn buses (verify)</p> <p>LMP FC MNA 1 & 2 - ctr, 3 - OFF FC MNA 1 & 2 tb - gray, 3 tb - bp</p> <p>FC MNB 1 & 2 - OFF, 3 - ctr FC MNB 1 & 2 tb - bp, 3 tb - gray</p> <p>MN BUS TIE (2) - on (up) 5 CDR SCS TVC (2) - RATE CMD (verify) 1</p>			<p>Verifies trim control and manual (MTVC) control capability of primary and secondary gimbal control system. SPS gimbal angle settings based on CSM c.g. and vary with propellant loading.</p> <p>PITCH and YAW GMBL caution/warning lights (panel 2) indicate overcurrent to gimbal motors. Otherwise, no indication to crew, except for switch selection, that a gimbal motor not operating or auto switchover (THC-CW) has taken place.</p> <p>GMBL POS indicator response opposite to RHC commands as follows:</p> <table border="0"> <thead> <tr> <th style="text-align: center;"><u>RHC</u></th> <th style="text-align: center;"><u>IND</u></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">+ Pitch</td> <td style="text-align: center;">- Pitch</td> </tr> <tr> <td style="text-align: center;">- Pitch</td> <td style="text-align: center;">+ Pitch</td> </tr> <tr> <td style="text-align: center;">+ Yaw</td> <td style="text-align: center;">- Yaw</td> </tr> <tr> <td style="text-align: center;">- Yaw</td> <td style="text-align: center;">+ Yaw</td> </tr> </tbody> </table> <p>Fuel cells are placed on main buses by crew prior to primary TVC check per ground crew instructions.</p> <p>Gray indicates fuel cells 1 and 2 connected to main bus A; barber pole indicates fuel cell 3 disconnected from main bus A.</p> <p>Barber pole indicates fuel cells 1 and 2 disconnected from main bus B; gray indicates fuel cell 3 connected to main bus B.</p>	<u>RHC</u>	<u>IND</u>	+ Pitch	- Pitch	- Pitch	+ Pitch	+ Yaw	- Yaw	- Yaw	+ Yaw
<u>RHC</u>	<u>IND</u>												
+ Pitch	- Pitch												
- Pitch	+ Pitch												
+ Yaw	- Yaw												
- Yaw	+ Yaw												

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>CAUTION</u>		
	More than 1 hr of contin on-time for TVC SERVO PWR 1 or 2 sw may be detrimental to SPS gmb1 actuators.		
CDR	TVC SERVO PWR 1 - AC1/MNA	7	
	TVC SERVO PWR 2 - AC2/MNB		
	LV IND/GPI sw - GPI (verify)	1	
	RHC 2 - ARMED		
2	Prim TVC Check GMBL MOT P1, Y1 - START		START position is momentary. Start SPS gimbal motors sequentially at ≈1-second intervals to avoid power surge. For ground checks, GMBL MOT PITCH or YAW are the equivalent of flight terms GMBL MOT P or Y.
	Confirm trim cont on inds SPS GMBL tw (2) - + & -		Gimbals drive in response to SPS pitch and yaw thumb-wheel movement. Verifies primary gimbal trim control.
	RHC 2 - perform MTVC check		Gimbals drive in response to RHC movement, and return to set-in values when RHC is neutral. Verifies primary MTVC loops.
3	Sec TVC Check SCS TVC (2) - AUTO GMBL MOT P2, Y2 - START THC - CW		
	Confirm trim cont on inds SPS GMBL tw (2) - + & -		Verifies secondary gimbal trim control.
	RHC 2 - perform MTVC check		Verifies secondary MTVC loops.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	<p>4 Auto Switchover Check</p> <p>GMBL MOT P2, Y2 - OFF</p> <p>Verify no MIVC THC - neut SPS GMBL tw (2) - P ___°, Y ___°</p> <p>GMBL MOT P1, Y1 - OFF RHC PWR NORM 2 - AC/DC RHC 2 - LOCKED</p> <p>LMP MN BUS TIE (2) - OFF, then AUTO CDR TVC SERVO PWR (both) - OFF LV IND/GPI sw - SII/SIVB</p>	<p>1</p> <p>5</p> <p>7</p> <p>1</p>	<p>Shut off gimbal motors sequentially to avoid a power surge.</p> <p>Gimbals are trimmed to thrusting values. These values are derived from Operational Trajectory, Table VIIIa, and include gimbal offset of ___ in pitch and ___ in yaw from spacecraft axis.</p>
	<p>4.2.2.3 <u>FDAI Verification</u></p> <p>FDAI SEL - 1/2 FDAI SOURCE - CMC FDAI 1 - total att R X°; P 90°; Y 0°</p>		<p>FDAI 2 is drifting as a function of earth rate.</p>
	<p>4.2.2.4 <u>RSI Test & Setup</u></p> <p>EMS ROLL - on (up) GDC ALIGN pb - push & hold ATT SET YAW tw - adj thru 45° angle, observe RSI tracks ≈45°, then adj until RSI points up GDC ALIGN pb - rel EMS ROLL - OFF</p>		<p>For ground checks, EMS RAI is the equivalent of flight term RSI.</p> <p>Avoid FDAI gimbal lock region.</p>

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4.2.2.4

FINAL VERIFICATION & SYSTEMS CHECKS



STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	Align GDC to IMU		Ensures that GDC is aligned to actual IMU angles, rather than calculated values. Attitude reference comparison (in orbit) will be more accurate.
	FDAI SEL - 1	1	
	FDAI SOURCE - ATT SET		Constraint: If CMC is on, an overload in IMU resolver circuitry may cause an ICDU oscillation and trigger ISS warning light. (Reference ICD MH01-01325-216.) FDAI must be used as a null meter in this mode of operation. If not, large errors will result because of impedance mismatch.
	ATT SET - IMU		
	ATT SET tw (3) - null FDAI 1 err		
	ATT SET - GDC		
	GDC ALIGN pb - push		
	FDAI SOURCE - CMC		
	FDAI SEL - 1/2		
	4.2.2.5 <u>EMS Prep</u>		
	Set EMS ΔV		
	EMS MODE - STBY (verify)		
	EMS FUNC - ΔV SET		
	Set ΔV ind - 6999.9 fps		
	EMS FUNC - ΔV		
-55:00			
CMP	C/W NORM - BOOST	2	Inhibits master alarm light on panel 1.
LMP	Cont head sw - XMIT, hold until advised to rel		
	UP TLM CMD - NORM	3	

FINAL VERIFICATION & SYSTEMS CHECKS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.2.2.6	<u>Pad Abort Enable</u>		
	<u>WARNING</u>		
	After pad abort enbl, oper of THC - CCW will init an abort.		
-44:00 CDR CMP	EDS PWR - on (up) Gear box sel - LATCH Actr handle sel - U (unlatch) (verify)	7 Side hatch	
ALL CDR	Shoulder harness - locked CM RCS LOGIC - on (up) cb SECS ARM (2) - close cb SECS LOGIC (2) - close SECS LOGIC (both) - on (up) Report logic arm After GO from STC SECS PYRO ARM (2) - on (up)	1 8	Lever lock. Both lever lock pyro arm switches must be operated. LES pad abort capability enabled; SECS LOGIC and PYRO buses are armed.
-28:00 CMP	H2 FANS (both) - off (ctr) O2 FANS (both) - off (ctr)	2	
4.2.2.7	<u>SM RCS Activation</u>		
-25:00	SM RCS He 1 (4) - OPEN SM RCS He 1 tb (4) - gray SM RCS He 2 (4) - OPEN SM RCS He 2 tb (4) - gray		OPEN position is momentary. Gray indicates primary He isolation valves open. OPEN position is momentary. Gray indicates secondary He isolation valves open.

4.2.2.7

FINAL VERIFICATION & SYSTEMS CHECKS



STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	RCS IND sel - SM A, B, C, D SM RCS SEC FUEL PRESS ind - 192-207 psia	2	Check pressure with RCS IND selector positioned at SM A, B, C, and D (in turn).
	SM RCS SEC FUEL PRESS (4) - CLOSE		CLOSE position is momentary. No talkbacks. ACE can confirm valves closed.
	SM RCS PRPLNT (4) - OPEN		OPEN position is momentary. Opens 16 isolation valves.
	SM RCS PRIM PRPLNT tb (4) - gray		Gray indicates primary fuel and oxidizer isolation valves open.
	SM RCS SEC PRPLNT tb (4) - gray		Gray indicates secondary fuel and oxidizer isolation valves open.
	4.2.2.8 <u>SM RCS Status Check</u>		
	RCS IND sel - SM A, B, C, D SM RCS PKG TEMP ind - amb		SM RCS heaters are not operated on pad or during ascent to reduce effects of boost heating on package temperature. Ambient temperature <75° or >205°F will cause SM RCS status lights to come on.
	SM RCS He PRESS ind - 4000-4350 psia		Nominal He load 4150 psig at 70°F. Pressure and temperature excursions are due to ambient conditions.
	SM RCS SEC FUEL PRESS ind - 192-207 psia		Primary fuel pressure initially shown for each quad until momentary OPEN position of SM RCS A (B, C, D) SEC FUEL PRESS switch selected.
	SM RCS IND sw - He TK TEMP SM RCS He TK TEMP ind - 60°-80°F		
	SM RCS IND sw - PRPLNT QTY		
	SM RCS PRPLNT QTY ind - 100%		
	RCS IND sel - CM 2		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.2.3 LAUNCH PREPARATION			
-20:00			
CMP	Change launch azimuth (if necessary) Key V78E FL V06 N29 X SM launch azimuth XXX.XX DEG Key V21E, load new azimuth PRO	2	
	Align GDC to IMU, 4.7.3		Ensures that GDC is aligned to actual IMU angles, rather than calculated values. Attitude reference comparison (in orbit) will be more accurate.
CDR	FDAI SEL - 1 FDAI SOURCE - ATT SET	1	Constraint: If CMC is on, an overload in IMU resolver circuitry may cause an ICDU oscillation and trigger ISS warning light. (Reference ICD MH01-01325-216.) FDAI must be used as a null meter in this mode of operation. If not, large errors will result because of impedance mismatch.
	ATT SET - IMU		
	ATT SET tw (3) - null FDAI 1 err		
	ATT SET - GDC		
	GDC ALIGN pb - push		
	FDAI SOURCE - CMC		
	FDAI SEL - 1/2		
	AUTO RCS A/C ROLL (4) - OFF (verify)	8	
	AUTO RCS B/D ROLL B1 & B2 - MNA		
	AUTO RCS B/D ROLL D1 & D2 - MNB		
	AUTO RCS PITCH A3 & C4 - MNB		
	AUTO RCS PITCH C3 & A4 - MNA		
	AUTO RCS YAW B3 & D4 - MNA		
	AUTO RCS YAW D3 & B4 - MNB		

4.2.3

LAUNCH PREPARATION

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	BAT C voltage - ___ vdc	3	
	DC IND sel - MNA		
CDR	FDAI 1 - total att	1	FDAI 2 is drifting as function of earth rate.
	R ___°, P ___°, Y ___°		
	BMAG MODE (3) - RATE 1		This position provides most reliable configuration in event a rate gyro fails during boost.
	FDAI SCALE - 5/5		Roll attitude error is scaled in P11 assuming FDAI is in 50/15/50/10 position. Until this position is selected at +01:50, roll full scale deflection will be 20°, not 5° as position indicates.
	RATE - HI		
	RHC (both) - ARMED		
	RHC PWR DIR (both) - MNA/MNB		
	CMC MODE - FREE		
	THC PWR - on (up)		
LMP	S BD - OFF	6	
CDR	VHF AM - OFF	9	
ALL	Perform air-to-grd voice check with MCCH		
LMP	S BD - T/R	6	
CDR	VHF AM - T/R	9	
	SPS THRUST - NORM	1	Lever lock.
	ΔV THRUST (2) - OFF		Guarded.
	α/Pc IND sw - α		
CMP	EDS AUTO - on (up)	2	
	LV RATES sw - AUTO		
	2 ENG OUT sw - AUTO		
	RCS CMD - OFF		OFF position is momentary.
CDR	TVC SERVO PWR 1 - AC1/MNA	7	
	TVC SERVO PWR 2 - AC2/MNB		
-10:00			
LMP	FC REAC VLVS - LATCH	3	

LAUNCH PREPARATION

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STA/T STEP	PROCEDURE	PANEL	REMARKS
-08:30 CMP	SEC COOL PUMP - off (ctr)	2	Crew option may have been exercised to turn SEC COOL PUMP on for crew comfort.
-08:00	Sys stat report		
-06:00	Sys GO/NO GO for launch		
-04:00 CDR CMP	LV ENG lts (5) - on PO2 (verify)	1 2	Launch vehicle engine lights on T -04:00 minutes.
	<u>CAUTION</u>		
	Do not press ENTR after keying V75. If ENTR is pressed, G&C sys will receive incorrect liftoff time.		
	Key V75		
-03:00 LMP	TAPE RCDR FWD - FWD TAPE MOTION tb - gray	3	Gray display indicates tape is in motion.
-02:15 CDR	PRIM GLY TO RAD - BYP (pull)	325	
CMP	PRIM GLY DISCH PRESS ind - 37-50 psig PRIM ACCUM QTY ind - 25-50%	2	Accomplished immediately after GSE water-glycol pump deactivated (T -02:15).
-01:15 LMP	MN BUS TIE (2) - on (up)	5	
-01:00 CDR,LMP	PAD COMM (2) - OFF	9,6	PAD COMM can be used after launch for intercom backup with PAD COMM VOL thumbwheel decreased.

4.2.3

LAUNCH PREPARATION



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STA/T STEP	PROCEDURE	PANEL	REMARKS
-00:45	CDR GDC ALIGN pb - push, hold	1	
CMP	FDAI 2 total att - no motion	2	
CDR	GDC ALIGN pb - rel	1	
	READY FOR IGNITION		
	Refer to Appendix B for cab sw/cont position at veh liftoff.		

LAUNCH PREPARATION

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.3 BOOST AND INSERTION	4.3.1 BOOST		
-00:09	Ignition		LV engines lights (5) go on at T -4 min when S-IC indicating circuits are armed.
CDR -00:01	LV ENG lts (5) - out	1	Indicates all five engines have achieved over 90 percent of rated thrust.
00:00	LIFT OFF lt - on & NO AUTO ABORT lt - out	00:00 MODE 1A	Additional lift-off cues: Event Timer start Voice communications from MSFN DSKY displays Program 11
	<p style="text-align: center;"><u>WARNING</u></p> <p>Do not press LIFT OFF/NO AUTO ABORT pb if LV RATE or any LV ENG lts on.</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X Liftoff verified If LIFTOFF lt off - push If NO AUTO ABORT lt on - push X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>	<p style="text-align: center;">↑ MODE 1A ↓ RATES +4°/sec P,Y +20°/sec R ↓</p>	Manual abort initiation may be required. (Refer to mission rules.)
CDR, CMP	Verify EVNT TMR ind resets to zero & starts counting up		Guarded. Guarded.

4.3.1

BOOST

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	XXXXXXXXXXXXXXXXXXXXX X EVNT TMR START - START X XXXXXXXXXXXXXXXXXXXXX X	1	START position is momentary.
CMP	Verify MSN TMR ind resets to zero & starts counting up	2	
	XXXXXXXXXXXXXXXXXXXXX X MSN TMR - RSET/START X XXXXXXXXXXXXXXXXXXXXX X		RSET position is momentary.
	Verify P11 (auto)		
	XXXXXXXXXXXXXXXXXXXXX X No P11 - Key ENTR X XXXXXXXXXXXXXXXXXXXXX X	MODE 1A	V75 inserted in P02 prior to lift-off.
	V06 N62 VI XXXXX. FPS H dot XXXXX. FPS H pad XXXX.X NM		These parameters will be displayed throughout ascent. VI = Inertial velocity. H dot = Altitude rate. H pad = Altitude above pad radius.
CDR	If LV RATE & LV GUID lts - on, from T +0 to T +2 min	1	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	LV GUID sw - CMC If man cont req Key 46E	2	Allows CMC automatic steering, all stages.
CDR	+00:12 Roll prog report Pitch prog - report +00:30 Roll prog - complete		
CMP	+00:42 PRPLNT DUMP - RCS CMD MODE 1B - report	00:42 MODE 1B	
CDR	+00:50 Mon α /Pc ind > to T +02:00	RATES +4°/sec P,Y +20°/sec R	1
CMP	13K' to CAB PRESS ind - starts 15K' decr	2	Relieves high CM-to-atmosphere ΔP . Assuming that cabin pressure at lift-off is 14.47 to 14.87 psia, the cabin pressure relief valve could begin modulating at 13K'.
CDR	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX If no decr by 25K' rh CAB PRESS RELF vlv - DUMP (safety latch off) until	ATT ERROR +5° P,Y	325

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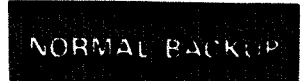
STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	CAB PRESS ind - 8 psia, then NORM (safety latch on)	2	
CMP	If still no decr CAB PRESS DUMP vlv - open (CCW) until CAB PRESS ind - 8 psia, then close (CW)	Side hatch 2	
XXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
+01:21	MAX Q		
<div style="border: 1px solid black; padding: 5px; display: inline-block;"> 100% AOA 5° ROLL error </div>			
CDR +01:56	MODE 1C - report (R3 = 16.5 NM)		
CMP +02:00	EDS AUTO - OFF 2 ENG OUT sw - OFF LV RATES sw - OFF		
CDR	α/Pc IND sw - Pc LV RATE lt disabled as platform failure cue & limits changed to 9.2° in P&Y	1	
+02:10	Report GO/NO GO for staging		
+02:15	CECO (LV ENG 5 lt - on) LIFT OFF lt - out (CECO +0.6 sec)		Center engine cutoff.

BOOST

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR +02:42	OECO (LV ENG 1, 2, 3 & 4 lts - on)	1	Outboard engine cutoff.
+02:43	All eng lts - out SII/SIVB staging capability armed (OECO +1.4 sec)		S-IC/SII separation.
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	If early SII/SIVB staging req, LV STAGE - on (up)		
CMP	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X	2	Guarded.
		MODE 1C	
CDR +02:44	LV ENG 1, 2, 3, 4 & 5 lts - on	1	SII engine ignition.
+02:45	SII SEP 1t - on		SII 2nd plane separation circuitry armed.
+02:45	All eng lts - out		SII engines 65 percent rated thrust.
CMP	GLY EVAP STM AUTO - AUTO GLY EVAP H2O FLOW - AUTO	2	
CDR +03:13	SII SEP 1t - out	1	SII interstage jettisoned.
CMP +03:18	TWR JETT (both) - on (up) (TFF >1+20) TWR JETT & MODE II report	2	Guarded. On position is momentary.
		03:16 MODE II	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	No tower jett Go to EMER PROCEDURES, 5.3.2.6		
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		

4.3.1

BOOST



STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	If LV GUID sw - CMC Key V46E for man cont	2	Activates Saturn DAP; provides steering commands to the IU for booster control. These stick commands are discrete rate commands. Attitude error needles are not designed to provide meaningful "fly to" information in manual mode.
MODE II			
CDR	MAN ATT PITCH - RATE CMD	1	
+03:23	LV guidance init (OECO +41 sec)		
+03:53	Guidance good		
+04:00	Report status		
LMP			
+05:00	Report status		
CMP			
+05:40	Upstage capability to COI		
+05:50	SIVB to orb capability		
CDR			
+06:00	Report status		
	LV IND/GPI sw - GPI		
CMP	Mon main bus voltages during gmb1 mot start	3	
CDR	GMBL MOT (4) - START	1	START position is momentary. Start SPS gimbal motors sequentially at ≈1-second intervals to avoid power surge.
	LV IND/GPI sw - SII/SIVB		
LMP			
+06:15	If AZ <96° S BD ANT OMNI - D	3	
	If AZ >96° S BD ANT OMNI A - C		
MODE II			

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP +07:00	Report status	MODE II	
+07:42	CECO (LV ENG 5 lt - on)	1	SII center engine cutoff.
LMP +08:00	Report status		
CDR +09:00	MODE IV report	09:00 MODE IV	SII outboard engines cutoff.
+09:11	OECO (LV ENG 1, 2, 3 & 4 lts - on)		SII/SIVB separation.
+09:12	All eng lts - out		
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
CMP	If no SII/SIVB staging LV STAGE - on (up)	2	Guarded.
	X XXXXXXXXXXXXXXXXXXXXXXXXXXXXX		
CDR +09:13	LV ENG 1 lt - on	1	SIVB ignition.
+09:16	LV ENG 1 lt - out		SIVB thrust to 65 percent.
CMP +10:00	Report/confirm COI MODE IV		Coast orbital insertion.
		10:08 MODE III	
+11:00	Report status If CMC takeover exercised during thrusting go to backup for SECO	MODE IV	SIVB cutoff must be manually initiated at a TBD time calculated during the boost.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR +11:29	SECO LV ENG 1 lt - on	1	SIVB engine cutoff (auto).
CMP	Begin TB5		Time base 5.
	MODE IV		
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
+TBD	If late SECO or LV GUID sw - CMC LV STAGE sw - on (up)	2	Guarded.
CDR	SECO LV ENG 1 lt - on Begin TB5 If still no SECO	1	
	<u>WARNING</u>	MODE III	
	THC must be returned from CCW position before 3.0 sec or CSM SLA sep will occur.		
	THC - CCW, return within 1 sec		
	SECO LV ENG 1 lt - on Begin TB5		
	X XXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
+11:39	INSERTION	INSERTION	

BOOST

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	LV ENG 1 lt - out (SECO +10 sec)	1	<p>VI = Inertial velocity. H dot = Altitude rate.</p> <p>H pad = Altitude above pad radius. V82 should not be selected during P02 or P11 within 5 seconds of liftoff time (this applies to any extended verb which sets bit 1 of flagword 4).</p> <p>Displays orbital parameters (N44). A meaningful display of N32 and N50 is available only during R30.</p> <p>Ha = Apogee altitude. Hp = Perigee altitude. TFF = Time of free fall to 49.4 NM (300,000 feet).</p> <p>Negative for undershoot, positive for overshoot.</p> <p>If TFF = -59B59, TF perigee is available by keying N32E.</p>
	Rcd from DSKY	2	
	VI	XXXXX. FPS	
	H dot	XXXXX. FPS	
	H pad	XXXX.X NM	
	(R30, Orbital Parameters)		
	Key V82E		
	FL V16 N44		
	Ha	XXXX.X NM	
	Hp	XXXX.X NM	
TFF	XXBXX MIN-SEC		
Key N50E			
Splash err	XXXX.X NM		
Hp	XXXX.X NM		
TFF	XXBXX MIN-SEC		
KEY REL			
FL V16 N44			
Ha	XXXX.X NM		
Hp	XXXX.X NM		
TFF	XXBXX MIN-SEC		
PRO			

4.3.1

BOOST

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	V06 N62 VI XXXXX. FPS H dot XXXXX. FPS H pad XXXX.X NM SAFE ORBIT Key V37E 00E	2	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.3.2 POSTORBITAL INSERTION CHECK		
	4.3.2.1 <u>Status Checklist</u>		
CDR	GMBL MOT (4) - OFF	1	Shut off gimbal motors sequentially to avoid power surge. Setting No. 2 motors off first minimizes switching in servo logic.
LMP	MN BUS TIE (2) - OFF	5	
CDR	AV THRUST (2) - OFF (verify)	1	Guarded.
	RHC PWR DIR (both) - OFF		
	ELS AUTO - MAN		
	CM RCS LOGIC - OFF		
	cb ELS (2) - open	8	Lever lock.
	SECS PYRO ARM (2) - SAFE		Lever lock.
	SECS LOGIC (both) - OFF		
	cb SECS ARM (2) - open		
	AUTO RCS (16) - OFF		
	EDS PWR - OFF	7	
	TVC SERVO PWR (both) - OFF		
LMP	PAN CAMR PWR - off (ctr)	230	
	PCM BIT RATE - LO	3	
	FC REAC VLVS - NORM		Setting switch to NORM removes holding voltage from open side of FC reactant valves.
CMP	UP TLM IU - as req	2	
	SM RCS HTRS (4) - PRIM		
	C/W NORM - NORM		

4.3.2.1

POSTORBITAL INSERTION CHECK

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>WARNING</u>		
	If BPC JETT knob cannot be positioned 180° away from the BPC JETT position before opening side hatch, a pin in the plunger may be sheared possibly allowing press seal to be broken. Cabin repressurization may not be possible due to overboard venting around the BPC plunger.		
CMP	BPC JETT knob - turn arrow on knob 180° away from BPC JETT decal Actr handle sel - N (neut) Vent piston chamber GN2 handle - pull (inbd) GN2 press ind - min	Side hatch	Disarms boost cover hatch release mechanism, preventing BPC JETT plunger from actuating during inflight operation of hatch.
ALL CMP	MODE (3) - as desired Crew couch strut unlock lanyards (2) - stow Couch to docking position Rcd 2-1 data from grd Lat _____ Long _____ GETI _____ ΔV _____	9,10,6	This data defines landing site and thrusting parameters for a first orbit, deorbit, and entry.
CDR	Mon LV TK PRESS ind (4) from orb insertion to CSM/SIVB sep for the following limits ΔP <36 psid (oxid > fuel) ΔP <26 psid (fuel > oxid) LV TK PRESS <50 psia	1	Refer to mission rules concerning SIVB fuel and oxidizer tank pressures.

POSTORBITAL INSERTION CHECK

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.3.2.2	<u>SCS Attitude Reference Comparison Check, 4.8.2.7</u>		Check must be performed as near to orbit injection as possible to prevent additional drift in attitude reference systems.
4.3.2.3	<u>SCT/SXT Dust Cover Jett Procedure</u>		
	<u>WARNING</u>		
	Until optics are to be used, the OPT ZERO (pnl 122), should be kept at ZERO to prevent inadvertent jett of optics covers.		
CMP 1	OPT PWR - on (up) OPT ZERO - OFF OPT MODE - MAN OPT COUPLING - DIR OPT SPEED - HI	100 122	Optics zero switch to OFF enables function of OPT MODE and OPT SPEED switches.
2	OHC - max right Observe ejection thru optics		Shaft angles for dust cover jettison are SCT = 150° and SXT = 40°. The optics shaft should be driven and maintained at full rate through these angles until covers are jettisoned.
4.3.2.4	<u>ECS Postinsertion Configuration</u>		
	Sec rad leak check Mon SEC ACCUM QTY ind GLY TO RAD SEC vlv - NORM for 30 sec, then BYP	2 377	Provides rapid postinsertion pressure integrity check of secondary radiator circuit - verification system has not opened during boost phase. This does not verify coolant loop heat rejection capability as defined in 4.5.4.2, step 7.

4.3.2.4

POSTORBITAL INSERTION CHECK

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	cb PL VENT FLT/PL - open	8	Prevents inadvertent opening of postlanding vent valves.
	CAB PRESS RELF vlv (2) - NORM (safety latch on)	325	
LMP	PRIM GLY EVAP STM PRESS ind - 0.09-0.14 psia PRIM GLY EVAP OUT TEMP ind - 38-43°F Init rad flow	2	
CDR	GLY RSVR BYP vlv - OPEN GLY RSVR OUT vlv - CLOSE GLY RSVR IN vlv - CLOSE	326	Water-glycol flow through primary loop radiators to commence no sooner than T +30:00 or later than T +55:00. After 2-1/2 minutes of flow, radiator outlet temperature should be less than inlet temperature.
LMP	PRIM ACCUM QTY ind - 25-50%	2	
CMP,LMP	PRIM ACCUM FILL vlv - ON, until 50% is reached	379,2	Primary accumulator quantity reading must be increased by at least 5% to provide ullage in glycol reservoir for temperature excursion.
LMP	RAD FLOW CONT PWR - PWR	2	
CDR	PRIM GLY TO RAD - NORM	325	
LMP	RAD PRIM HTR - 1 RAD PRIM OUT TEMP ind - below RAD PRIM IN TEMP ind	2	ECS primary loop radiators again isolated. In 10 minutes, flow through radiators is attempted once more by repeating procedure.
CDR	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X Outlet temp > than inlet after 5 min PRIM GLY TO RAD - BYP (pull), recheck in 10 min XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X	325	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	DRINK H2O SUP vlv - ON (CCW)	304	
LMP	ECS RAD tb - gray	2	Gray indicates No. 1 flow proportioning valve controlling flow.
	POT H2O HTR - MNA		
	GLY EVAP IN TEMP - AUTO		
	cb WASTE DUMP HTRS (2) - close	5	
CDR	REPRESS PKG vlv - FILL for 10 sec, then OFF	326	
CMP	REPRESS O2 PRESS ind - >865 psia	602	
<u>4.3.2.5 Systems Verification and Monitoring</u>			
	1 Mount ORDEAL BOX	13	
	Perform ORDEAL Initialization, 4.8.4.8		
	2 Perform C&WS Oper Check, 4.5.5.1		
	3 Perform SM RCS Mon Check, 4.5.2.2		
	4 Perform CM RCS Mon Check, 4.5.2.3		
CMP, LMP	5 Perform EPS Checks, 4.5.3.1 thru 4.5.3.4		
	6 Perform ECS Mon Check, 4.5.4.1		
LMP	7 Perform SPS Mon Check, 4.5.2.1		
	8 cb FC REACS (3) - open (verify)	226	
	cb COAS/TUNL LTG MNB - close		Provides power for right COAS six tunnel lights, and docking spotlight door indicator.

4.3.2.5 POSTORBITAL INSERTION CHECK



STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.3.2.6 <u>Cabin Atmosphere Verification</u>		
LMP 1	CAB PRESS ind - 5.6-6.2 psia & decr	2	Cabin pressure will be 5.6-6.2 psia after launch and continuously decrease until cabin pressure regulator activates and controls pressure to 4.7-5.3 psia. After 16-second time delay.
CDR 2	DIRECT O2 vlv - close (CW)	7	
LMP 3	O2 FLOW ind - 0.2 lb/hr	2	
CMP 4	EMER CAB PRESS sel - BOTH	351	
	SUIT RETURN vlv - open (pull)	380	
ALL 6	Gloves & helmet removed		
CMP 7	When CAB PRESS ind <5.3 psia O2 FLOW ind - 1.0 lb/hr O2 FLOW HI lt - on	2	
ALL	MASTER ALARM pb/lt - on, push	1,3,122	
	<u>CAUTION</u>		
	Opening cb ECS PRESS XDUCER 2 MNB to extinguish O2 FLOW HI lt is a crew option. If exercised, the following redundant functions will be lost.		
	CO2 PP ind & C/W circuit CAB PRESS ind O2 reg out press (PCM only) GLY EVAP STM PRESS ind O2 FLOW ind		

POSTORBITAL INSERTION CHECK

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP 8	cb ECS PRESS XDUCER 2 MNB - open	5	
9	60/40 cab purge complete at 8 hrs after LM isolation following transposition & docking. For 24 hrs after LM isolation following T & D, LM press will be monitored at ≈8-hr intervals using tunl vent vlv in the LM/CM ΔP position. At 24 hrs after LM isolation, it will be determined if a Δ cabin purge is req & the length of this purge.		
CMP	WASTE STOW vlv - CLOSE	252	
LMP	cb ECS PRESS XDUCER 2 MNB - close	5	
	O2 FLOW HI lt - out	2	

4.3.2.6

POSTORBITAL INSERTION CHECK



STA/T STEP	PROCEDURE	PANEL	REMARKS
4.4	INJECTIONS		
4.4.1	TRANSLUNAR INJECTION (TLI)		
4.4.1.1	<u>Thrusting Preparation</u>		
	CMC - on (req), 4.8.1.3		Circuit breakers assumed closed except as defined in LIMITED USE CIRCUIT BREAKER list, 4.5.1.2. Alignment to pad orientation unless discrepancy between SIVB IU data and CSM G/N data.
	ISS - on and orient known (req), 4.8.1.3 & 4.14		
	SCS - on (req), 4.8.4.2		
	DAP - load & activate (desired), 4.8.2.1		
	Comm Mode - as desired		
CMP	1 XLUNAR INJECT - INJECT (verify) If TLI inhibit desired XLUNAR INJECT - SAFE	2	TLI inhibit at this point will prevent start of Time Base 6 (TB6).
	2 If SIVB att cont desired, perform 4.7.1.7		SIVB attitude control not affected by TLI inhibit signal.
	3 Receive IU grd update - _____ UP TLM IU - as req		
	4 If req, IMU Realign (P52), 4.14.2		
CDR	5 LM Docking Sys Probe Extension & Stat Check Extd probe cb DOCK PROBE (2) - close (verify)	8	

4.4.1.1

TRANSLUNAR INJECTIONS (TLI)

STA/T STEP	PROCEDURE	PANEL	REMARKS														
	<p><u>CAUTION</u></p> <p>PROBE EXTD/REL should not be held in EXTD/REL position longer than 20 sec if probe has not extended. Capability of capture latch rel mots may be degraded.</p>																
CMP	<p>PROBE EXTD/REL - EXTD/REL & hold until probe fully extd</p> <p>PROBE EXTD/REL tb (2) - gray to bp to gray</p> <p>PROBE RETR (2) - OFF (verify)</p> <p>PROBE EXTD/REL - RETR</p> <p>PROBE EXTD/REL tb (2) - gray (verify)</p>	2	<p>Momentary up and guarded. Probe extended by compression spring and attenuator airhead forces. Crew should readily sense by auditory cues that probe has extended when probe bangs against stops. May not see talkbacks go to barber pole because of rapid motion of probe. Barber pole indicates power to talkback through probe circuitry. Return to gray indicates full extension of probe.</p> <p>Guarded.</p> <p>Verifies capture latches not locked and probe has started to extend.</p>														
	<table border="1" style="width: 100%; border-collapse: collapse; margin-top: 20px;"> <thead> <tr> <th rowspan="2" style="width: 15%;">PROBE POSITION</th> <th colspan="2" style="width: 85%;">PROBE EXTD/REL sw & tb positions</th> </tr> <tr> <th style="width: 35%;">EXTD/REL</th> <th style="width: 50%;">RETR</th> </tr> </thead> <tbody> <tr> <td>FULL EXTD</td> <td style="text-align: center;">gray</td> <td style="text-align: center;">gray</td> </tr> <tr> <td>FULL RETR</td> <td style="text-align: center;">bp</td> <td style="text-align: center;">bp</td> </tr> <tr> <td>PARTIAL EXTD</td> <td style="text-align: center;">bp</td> <td style="text-align: center;">gray</td> </tr> </tbody> </table>			PROBE POSITION	PROBE EXTD/REL sw & tb positions		EXTD/REL	RETR	FULL EXTD	gray	gray	FULL RETR	bp	bp	PARTIAL EXTD	bp	gray
PROBE POSITION	PROBE EXTD/REL sw & tb positions																
	EXTD/REL	RETR															
FULL EXTD	gray	gray															
FULL RETR	bp	bp															
PARTIAL EXTD	bp	gray															

TRANSLUNAR INJECTIONS (TLI)

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STA/T STEP	PROCEDURE	PANEL	REMARKS
6	Perform Att Err Disp - Att Set Source, 4.7.2.4		
CDR	FDAI/GPI PWR - BOTH	7	
7	Perform EMS ΔV Test & Null Bias Check, 4.7.6.1, & EMS ΔV Setup, 4.7.6.2		
8	Set up for CSM/SIVB sep capability		This step is essentially a return to G&C lift-off configuration for an abort capability.
	Verify/set controls		
CDR, CMP	RHC (both) - ARM		
CDR	cb SECS ARM (2) - close	8	
	After MSFN AOS		
	SECS LOGIC (both) - on (up)		Lever lock.
	Report logic arm after GO from MSFN		
	SECS PYRO ARM (2) - on (up)		Lever lock.
	EDS PWR - on (up)	7	
CMP	BMAG TEMP 1t (2) - out	2	
CDR	BMAG PWR (both) - ON	7	
	FDAI SCALE - 5/5	1	
	FDAI SEL - 1/2		
	THC PWR - on (up)		
	RHC PWR NORM (both) - AC/DC		
	RHC PWR DIR (both) - MNA/MNB		
	BMAG MODE (3) - RATE 1		
	SC CONT - SCS		
	AUTO RCS A/C ROLL (4) - OFF	8	
	AUTO RCS B/D ROLL (4) - MNA		
	AUTO RCS PITCH (4) - MNA		
	AUTO RCS YAW (4) - MNA		
	LV IND/GPI sw - SII/SIVB (verify)		
CMP	LV GUID sw - IU	2	

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TRANSLUNAR INJECTIONS (TLI)

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	UP TLM CM - BLOCK	2	
	UP TLM IU - as req		
CDR	Monitor LV TK PRESS ind (4)	1	Refer to mission rules concerning SIVB fuel and oxidizer tank pressure.
	ΔP <36 psid (oxid > fuel)		
	ΔP <26 psid (fuel > oxid)		
	LV TK PRESS <50 psia		
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	If ΔP or LV tank press exceeded		
	TVC SERVO PWR 1 - AC1/MNA	7	
	TVC SERVO PWR 2 - AC2/MNB		
00:00	THC - CCW (4 sec)		CSM/LV separation.
LMP	MN BUS TIE (2) - on (up)	5	
CDR	BMAG MODE (3) - ATT 1/RATE 2	1	
	GMBL MOT P1 & Y1 - START		START position is momentary. Start SPS gimbal motors sequentially at ≈1-second intervals to avoid power surge.
	GMBL MOT P2 & Y2 - START		
00:04	THC - neut & +X		
	ΔV THRUST A - NORM		
00:06	THRUST ON pb - push		SPS ignition.
	THC - rel (+X off)		
00:11	ΔV THRUST A - OFF		Guarded.
	X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
+02:37:42	Monitor for SIVB TB6		TB6 may begin after GET 02:34:00.
CMP	TB6 strt via CMC		
	V37E 15E	2	Configures CMC for TB6 initiation backup.

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TRANSLUNAR INJECTIONS (TLI)

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	FL V16 N35 Time to evnt OOOXX. HRS OOOXX. MIN OXX.XX SEC	2	Time from now to TB6 initiation. Display negative and counts to zero.
	EVNT TMR START - STOP Set evnt tmr to 50:59		Prepares Event Timer to count up.
	SII SEP 1t - on (TIG -9 min 38 sec) UPLINK ACTY 1t - on		Indicates start of TB6. Indicates CMC TB6 initiation discrete set.
	<pre> XXXXXXXXXXXXXXXXXXXXXXXXX X SII SEP 1t not on LV GUID - CMC SII SEP 1t - on X XXXXXXXXXXXXXXXXXXXXXXXXX </pre>		Applies CMC TB6 discrete to IU.
	FL V16 N35 Time from evnt OOOXX. HRS OOOXX. MIN OXX.XX SEL		Display positive and counts from zero.
	UPLINK ACTY 1t - out FL V37 Key XXE		Goes out when N35 = 10 seconds. ROO.
	If TLI inhibit desired XLUNAR INJECT - SAFE		If switching is done between start of TB6 and TB6 +41 seconds. Switching after TB6 +41 seconds will be honored at TB6 +8 minutes 17 seconds. Inhibiting will cause recycle back into TB5 for countdown to point of second opportunity.

4.4.1.1

TRANSLUNAR INJECTIONS (TLI)



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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>CAUTION</u>		State of XLUNAR INJECT switch automatically transfers from SAFE to INJECT at CSM/SIVB separation.
	If emer CSM/SIVB sep desired after strt of TB6, without restrt of SIVB, XLUNAR INJECT sw must be in SAFE & read by the LVDC at either TB6 +41 sec or at anytime from TB6 +8 min 17 sec to TB6 +9 min 20 sec before physical CSM/SIVB sep.		
CDR 50:59	SII SEP 1t - out (TIG -9 min 1 sec) EVNT TMR START - START	1	
LMP	9 Perform GDC ALIGN, 4.7.3 Perform Cryo O2 & H2 Man Fan Oper, 4.5.3.10 PCM BIT RATE - HI TAPE RCDR FWD - FWD UP TLM CMD - RSET	3	
58:00 CMP 10	Key V37E 47E (thrust mon)	2	
	Poss PROG alarm (4.8.1.16)		R02.
	FL V16 N83 ΔVX, Y, Z (cont) XXXX.X FPS		
	Key N62E VI XXXXX. FPS H dot XXXXX. FPS H pad XXXX.X NM		

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TRANSLUNAR INJECTION (TLI)

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 58:36	SII SEP lt - on (TIG -1 min 24 sec)	1	
58:38	SIVB ullage begins (TIG -1 min 22 sec)		
	<u>WARNING</u>		
	TLI inhibit signals will not be honored after 59:42 (TB6 +9 min 20 sec).		
59:16 CMP	If TLI inhibit desired XLUNAR INJECT - SAFE	2	TLI inhibit signals received between TB6 +8 minutes 17 seconds and TB6 +9 minutes 20 seconds will be honored ≈1 second after receipt. If inhibit signal received during this time, recycle back into TB5 will occur and countdown to point of second opportunity will commence.
	11 Activate TVC		
CDR 59:42	TVC SERVO PWR 1 - AC1/MNA SII SEP lt - out (TIG -18 sec)	7	SII SEP light off at this point indicates 18 seconds from SIVB restart. TLI inhibit is ignored from this point on.
	<u>WARNING</u>		
	If emer CSM/SIVB sep is performed after SII SEP lt - out (59:42), TB6 will continue to run with SIVB restrt occurring at 00:00.		
ALL 12	Ready for TLI		

4.4.1.1

TRANSLUNAR INJECTIONS (TLI)



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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 13	EMS MODE - NORM	1	
59:52	SIVB fuel lead		
59:55	SIVB ullage discontinues		
59:59	LV ENG 1 lt - on		
	4.4.1.2 <u>TLI Thrusting</u>		
00:00	SIVB restrt (TB6 +9 min 38 sec)		SIVB engine ignition.
00:02	LV ENG 1 lt - out Mon SIVB burn LV TK PRESS ind (4) ΔP <36 psid (oxid > fuel) ΔP <26 psid (fuel > oxid)		SIVB engine 65 percent rated thrust.
	If CMC takeover exercised during thrusting, go to backup for SECO		SIVB engine cutoff must be manually initiated at a TBD time calculated during boost.
05:45	Mon SECO LV ENG 1 lt - on Report cutoff		SIVB engine cutoff. TB7 begins.
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	If late SECO or LV GUID sw - CMC LV STAGE sw - on (up) SECO LV ENG 1 lt - on Report cutoff		Guarded.

TRANSLUNAR INJECTIONS (TLI)

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	<p>If still no SECO</p> <p style="text-align: center;"><u>WARNING</u></p> <p>THC must be returned from CCW position before 3.0 sec or CSM SLA sep will occur.</p> <p>THC - CCW, return within 1 sec SECO LV ENG 1 lt - on Report cutoff</p> <p style="text-align: center;">XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>	1	
05:55	LV ENG 1 lt - out (SECO +10 sec)		
	4.4.1.3 <u>Post-TLI Activities</u>		
	1 EMS MODE - STBY		
CMP	2 Record ΔV		
CDR	3 EMS FUNC - OFF		
LMP	4 TAPE RCDR FWD - off (ctr) PCM BIT RATE - LO	3	
CMP	5 Check orb param (R30) Key V82E	2	

4.4.1.3

TRANSLUNAR INJECTIONS (TLI)



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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	FL V16 N44 Ha Hp TFF PRO (exit R30)	2	Altitude above launch pad radius. TFF = Time of free fall to 49.4 NM (300,000 ft) above launch pad radius.
6	FL V16 N83 ΔVX, Y, Z (cont) XXXX.X FPS PRO FL V37 Key XXE		P47 display. To exit P47 when desired.
7	Perform Postorb Insertion Status Checklist, 4.3.2.1		
LMP	8 Pan & Map Camr Stby Mode off PAN CAMR PWR - off (ctr)	230	
CMP	MAP CAMR ON - OFF SM/AC PWR - OFF	181	

TRANSLUNAR INJECTIONS (TLI)

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.4.2 LUNAR ORBIT INSERTION (LOI) For LOI go to Thrusting, 4.13 4.4.3 TRANSEARTH INJECTION (TEI) For TEI go to Thrusting, 4.13		

4.4.3

LOI AND TEI



4.5 SYSTEMS MANAGEMENT

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

4.5.1 GENERAL DATA

This paragraph contains information of a general nature that closely relates with Systems Management procedures.

4.5.1.1 Systems Test Indicator Readouts

A SYS TEST indicator and two selector switches (panel 101) provide the crew with the capability of monitoring some systems measurements telemetered to MSFN. A chart (figure 4.5-1) for converting the SYS TEST indicator readings to measurement parameters is included in this paragraph. Measurements consist of the following:

- Fuel cells 1, 2, and 3 regulated O₂ and H₂ pressures
- Fuel cells 1, 2, and 3 radiator outlet temperatures
- O₂ and H₂ tank 3 quantities and pressures
- Battery compartment manifold pressure
- Battery relay bus voltage
- CSM to LM current
- SPS oxidizer line temperature
- CM/RCS jet injector temperature
- Rendezvous radar transponder voltages and frequency lockup.

The systems test indicator conversion chart (figure 4.5-1) lists positions of the SYS TEST switches (2), and pertinent data available for each indicator readout.

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- Fuel cells 1, 2, and 3 regulated N2, O2, and H2 pressures
- Fuel cells 1, 2, and 3 radiator outlet temperatures
- O2 and H2 tank 3 quantities and pressures
- Battery compartment manifold pressure
- Battery relay bus voltage
- CSM to LM current
- SPS oxidizer line temperature
- CM/RCS jet injector temperature
- Rendezvous radar transponder voltages and frequency lockup.

The systems test indicator conversion chart (figure 4.5-1) lists positions of the SYS TEST switches (2), and pertinent data available for each indicator readout.

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SYS TEST Sel Sw (2)	SYS TEST Ind				
	System		Sensor Range	Nominal Range	
	Position	Function		Measurement No.	System
1D	FC 1 O2 REG PRESS	SC 2066 P	Zero/75 psia	58 - 69 psia	3.9 - 4.6
2A	FC 2 O2 REG PRESS	SC 2067 P	Zero/75 psia	58 - 69 psia	3.9 - 4.6
2B	FC 3 O2 REG PRESS	SC 2068 P	Zero/75 psia	58 - 69 psia	3.9 - 4.6
2C	FC 1 H2 REG PRESS	SC 2069 P	Zero/75 psia	57 - 67 psia	3.8 - 4.5
2D	FC 2 H2 REG PRESS	SC 2070 P	Zero/75 psia	57 - 67 psia	3.8 - 4.5
3A	FC 3 H2 REG PRESS	SC 2071 P	Zero/75 psia	57 - 67 psia	3.8 - 4.5
3B	FC 1 RAD OUT TEMP	SC 2087 T	-50/+300°F	-10 - +90°F	0.6 - 2.0
3C	FC 2 RAD OUT TEMP	SC 2088 T	-50/+300°F	-10 - +90°F	0.6 - 2.0
3D	FC 3 RAD OUT TEMP	SC 2089 T	-50/+300°F	-10 - +90°F	0.6 - 2.0
4A	O2 TK 3 QTY	SC 0051 Q	Zero/100%	0 - 100%	0.0 - 5.0
4B	O2 TK 3 PRESS	SC 0053 P	50 - 1050 psia	865 - 935 psia	4.1 - 4.4
4C	H2 TK 3 QTY	SC 0050 Q	Zero/100%	0 - 100%	0.0 - 5.0
4D	H2 TK 3 PRESS	SC 0052 P	Zero/350 psia	225 - 265 psia	3.2 - 3.8
5A	SPS OXID LINE TEMP	SP 0049 T	Zero/+200°F	+45 - +75°F	1.1 - 1.9

Figure 4.5-1. Systems Test Indicator Conversion Chart (Sheet 1 of 3)

GENERAL DATA

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SYS TEST Sel Sw (2)	SYS TEST Ind				
	System		Sensor Range	Nominal Range	
	Position	Function		Measurement No.	System
1A	FC 1 N2 REG PRESS	SC 2060 P	Zero/75 psia	50 - 58 psia	3.3 - 3.9
1B	FC 2 N2 REG PRESS	SC 2061 P	Zero/75 psia	50 - 58 psia	3.3 - 3.9
1C	FC 3 N2 REG PRESS	SC 2062 P	Zero/75 psia	50 - 58 psia	3.3 - 3.9
1D	FC 1 O2 REG PRESS	SC 2066 P	Zero/75 psia	58 - 69 psia	3.9 - 4.6
2A	FC 2 O2 REG PRESS	SC 2067 P	Zero/75 psia	58 - 69 psia	3.9 - 4.6
2B	FC 3 O2 REG PRESS	SC 2068 P	Zero/75 psia	58 - 69 psia	3.9 - 4.6
2C	FC 1 H2 REG PRESS	SC 2069 P	Zero/75 psia	57 - 67 psia	3.8 - 4.5
2D	FC 2 H2 REG PRESS	SC 2070 P	Zero/75 psia	57 - 67 psia	3.8 - 4.5
3A	FC 3 H2 REG PRESS	SC 2071 P	Zero/75 psia	57 - 67 psia	3.8 - 4.5
3B	FC 1 RAD OUT TEMP	SC 2087 T	-50/+300°F	-10 - +90°F	0.6 - 2.0
3C	FC 2 RAD OUT TEMP	SC 2088 T	-50/+300°F	-10 - +90°F	0.6 - 2.0
3D	FC 3 RAD OUT TEMP	SC 2089 T	-50/+300°F	-10 - +90°F	0.6 - 2.0
4A	O2 TK 3 QTY	SC 0051 Q	Zero/100%	0 - 100%	0.0 - 5.0
4B	O2 TK 3 PRESS	SC 0053 P	50 - 1050 psia	865 - 935 psia	4.1 - 4.4
4C	H2 TK 3 QTY	SC 0050 Q	Zero/100%	0 - 100%	0.0 - 5.0
4D	H2 TK 3 PRESS	SC 0052 P	Zero/350 psia	225 - 265 psia	3.2 - 3.8
5A	SPS OXID LINE TEMP	SP 0049 T	Zero/+200°F	+45 - +75°F	1.1 - 1.9

Figure 4.5-1. Systems Test Indicator Conversion Chart (Sheet 1 of 3)

GENERAL DATA

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SYS TEST Sel Sw (2)	SYS TEST Ind				
	System		Sensor Range	Nominal Range	
	Position	Function		Measurement No.	System
5B	BAT RLY BUS VOLT	CC 0232 V	Zero/+45 vdc	30.5-37 vdc	3.4 - 4.1
5C	CM RCS INJ TEMP 24	CR 2110 T	-50/+50°F	>28°F	>3.9
5D	CM RCS INJ TEMP 25	CR 2116 T	-50/+50°F	>28°F	>3.9
6A	CM RCS INJ TEMP 12	CR 2114 T	-50/+50°F	>28°F	>3.9
6B	CM RCS INJ TEMP 14	CR 2100 T	-50/+50°F	>28°F	>3.9
6C	CM RCS INJ TEMP 16	CR 2103 T	-50/+50°F	>28°F	>3.9
6D	CM RCS INJ TEMP 21	CR 2119 T	-50/+50°F	>28°F	>3.9
7A	BAT COMPT PRESS	CC 0188 P	Zero/20 psia	<1 psia	<0.2
7D	CSM TO LM CURRENT	CC 2962 C	Zero/10 amps	1.0-6.4 amp	0.5 - 3.2
XPNDR A	PWR OUTPUT	ST 0711 V	0 - 0.48W	>0.24W	>1.0
XPNDR B	AGC SIGNAL	ST 0710 V	STIMULUS -115 -25 DBM	TEST OPERATE	>1.0 0.0 - 4.5
XPNDR C	PHASE LOCKUP	ST 0712 X	4.0 - 5.0V 0.0 - 0.8V	LOCKED UNLOCKED	>4.0 <0.8
XPNDR D	OPEN	NONE			

Figure 4.5-1. Systems Test Indicator Conversion Chart (Sheet 2 of 3)

4.5.1.1

GENERAL DATA

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SYS TEST Ind Display	N2*, O2, H2 Press (psia)	EPS Rad Out Temp (°F)	O2, H2 Tk 3 Qty (%)	O2 Tk 3 Press (psia)	H2 Tk 3 Press (psia)	SPS Oxid Line Temp (°F)	Bat Rly Bus (vdc)	CM RCS Inj Temp (°F)	Bat Compt Manf Press (psia)	LM Power (amps)
0.0	0	-50	0	50	0	0	0.0	-50	0.0	0.0
0.2	3	-36	4	90	14	8	1.8	-46	0.8	0.4
0.4	6	-22	8	130	28	16	3.6	-42	1.6	0.8
0.6	9	-8	12	170	42	24	5.4	-38	2.4	1.2
0.8	12	+6	16	210	56	32	7.2	-34	3.2	1.6
1.0	15	+20	20	250	70	40	9.0	-30	4.0	2.0
1.2	18	+34	24	290	84	48	10.8	-26	4.8	2.4
1.4	21	+48	28	330	98	56	12.6	-22	5.6	2.8
1.6	24	+62	32	370	112	64	14.4	-18	6.4	3.2
1.8	27	+76	36	410	126	72	16.2	-14	7.2	3.6
2.0	30	+90	40	450	140	80	18.0	-10	8.0	4.0
2.2	33	+104	44	490	154	88	19.8	-6	8.8	4.4
2.4	36	+118	48	530	168	96	21.6	-2	9.6	4.8
2.6	39	+132	52	570	182	104	23.4	+2	10.4	5.2
2.8	42	+146	56	610	196	112	25.2	+6	11.2	5.6
3.0	45	+160	60	650	210	120	27.0	+10	12.0	6.0
3.2	48	+174	64	690	224	128	28.8	+14	12.8	6.4
3.4	51	+188	68	730	238	136	30.6	+18	13.6	6.8
3.6	54	+202	72	770	252	144	32.4	+22	14.4	7.2
3.8	57	+216	76	810	266	152	34.2	+26	15.2	7.6
4.0	60	+230	80	850	280	160	36.0	+30	16.0	8.0
4.2	63	+244	84	890	294	168	37.8	+34	16.8	8.4
4.4	66	+258	88	930	308	176	39.6	+38	17.6	8.8
4.6	69	+272	92	970	322	184	41.4	+42	18.4	9.2
4.8	72	+286	96	1010	336	192	43.2	+46	19.2	9.6
5.0	75	+300	100	1050	350	200	45.0	+50	20.0	10.0

*N2 measurements not applicable to CSM 112.

Figure 4.5-1. Systems Test Indicator Conversion Chart (Sheet 3 of 3)

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4.5.1.2 Limited Use Circuit Breakers

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.

Circuit Breakers	Panel Location	When Opened	When Closed	Remarks
NONESS INST	5	Prelaunch	When required	No requirements are defined for use of this circuit breaker at the present time.
RAD HTRS OVLD (2)	5	CM/SM separation	Prelaunch	If opened in flight, do not reset unless batteries are tied to main buses. This prevents possible disconnect of ECS radiator heaters by a false overload signal.
FLOAT BAG (all)	8	Prelaunch	After splashdown	Opened to ensure against inadvertent activation of float bag compressors and sea dye marker.
CM RCS HTRS (both)	8	Prelaunch	Prior to deorbit and entry if heating required	Opened to ensure against inadvertent CM RCS jet activation. Heating probably not required.
ELS/CM SM SEP (2)	8	Postorbital insertion check	Prior to deorbit and entry	Opened to isolate ELS and CM SM SEP function until needed.
PL VENT FLT/PL	8	Postorbital insertion check	After splashdown	Opened to ensure against inadvertent activation of postlanding vents.

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Circuit Breakers	Panel Location	When Opened	When Closed	Remarks
SECS ARM (2)	8	Postorbital insertion check	During prelaunch, launch, docking, deorbit and entry procedures	Opened to ensure against inadvertent activation of SECS functions.
RCS LOGIC (2)	8	Post S-IVB separation check	During prelaunch, launch, deorbit, and entry procedures	Opened to ensure against inadvertent CM/SM RCS transfer and/or CM RCS activation.
EDS (all)	8	Post separation panel configuration (CSM/SLA separation)	Prelaunch	No further use after CSM/SLA separation.
SPS PITCH 1 BAT A	8	When SCS powered down after first SPS thrust	From launch through first SPS thrust and during subsequent SPS thrusts	Opened to prevent power drain through SCS TVC fail sensor.
SPS YAW 1 BAT A	8	When SCS powered down after first SPS thrust	From launch through first SPS thrust and during subsequent SPS thrusts	Opened to prevent power drain through SCS TVC fail sensor.
FC REACS (all)	226	Prelaunch after FC startup	Only when required to shut down fuel cell	Opened to ensure against inadvertent fuel cell shutdown.
FC RAD (all)	226	Prelaunch	Only when required to activate FC radiator bypass function	Bypass is only used in event of fuel cell failure.
MN REL (2)	229	Prelaunch	Only after splashdown	Opened to prevent premature main parachute release.

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Circuit Breakers	Panel Location	When Opened	When Closed	Remarks
O2 VAC ION PUMPS (2)	229	Prelaunch	When required	No requirements are defined for use of these circuit breakers at the present time.
PYRO A&B BAT BUS A&B (2)	250	Prelaunch	Only when required, if pyro bats indicate <3> vdc during bat check	Connects battery buses to pyro buses in event of pyro battery(s) failure.
BAT C TO BAT BUS A&B (2)	250	Prelaunch	When required to connect bat C to bat bus A or B	Connected when battery C is used to back up failed battery A or B.
MN A&B BAT C (2)	275	Prelaunch	Prior to deorbit and as required for bat A or B backup	Opened to isolate battery C from main buses.
FLT/PL BAT BUS A&B & BAT C (3)	275	Prelaunch	Prior to splashdown	Opened to isolate battery bus A & B and battery C from flight and post-landing bus.
UPR SYS COMPR (both)	278	Prelaunch	After splashdown	Opened to ensure against inadvertent activation of float bag compressors.
SIVB/LM SEP (2)	278	Following LM extraction	Prelaunch	No further use after LM is extracted from SIVB.

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4.5.1.2

GENERAL DATA

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NORMAL BACKUP

4.5.1.3 Non-Dioded/Non-Switchable Loads

MAIN BUS A

EPS/CRYO

Tk 1 H2 & O2 Htrs
 Inv 1 Pwr
 Util Outlets (pnl 15 & 16)
 Tk 1 O2 Vac-Ion Pump

ECS

CO2 PP ind C/W lt & PCM
 Prim 2 Rad Htr Cont
 Rad Flow Contr 1 & Auto Sel
 Rad Isol vlv Man Sel
 H2O Accum 1 Auto & Man Cont
 Urine & Waste H2O Dump Htr A
 Steam Duct Htr A
 Sec Rad Htr Cont
 Sec Rad In & Out Temp ind
 & PCM

RCS

CM Sys 1 Htrs
 CM Sys 1 Fuel & Oxid Purge
 CM Oxid Interconnect
 CM Fuel/He Interconnect
 CM Sys 1 Prplnt Dump 42 Sec TD
 CM Sys 1 Prplnt Isol vlv & tb
 SM B & D Htrs
 SM B & D He 1 & 2 Isol vlv
 & tb
 SM B & D Prim/Sec Prplnt Isol
 vlv & tb

SM B & D Sec Fuel Press Isol vlv
 Trnfr Mot sw 1

SPS

P & Y (Prim) Gmb1 Mots
 Enbl Pwr Sol Driver 1
 He 1 vlv & tb
 Pilot 1 & 2 vlv
 Prim Pilot Pre vlv
 Line Htrs A
 PUGS Test

SCS

FDAI 1 Total Att
 GDC (except RSI)
 BMAG 1 Htr & C/W Temp lt
 (eventually lose BMAG 1 as
 temp decr)
 Auto coils CM RCS 1 (if
 prior to CM/SM sep)
 Dir Ull Pitch C3 & A4
 Auto ΔV
 Auto Att Hold
 Rate 1 MTVC
 Rot Contr Pwr Dir 1
 a. MNA/MNB to half of jets
 b. MNA to all jets
 Rot Contr Pwr Dir 2, MNA/MNB
 to half of jets

LIGHTING

RH Girth Shelf Flood (Fixed
 Mode)
 RH Couch Flood (Fixed Mode)
 LH Girth Shelf Flood (Var Mode)
 LH Couch Flood (Var Mode)
 LH & RH Strut Flood (Var Mode)
 LH Opt Align Sight
 Rndz lt
 Sys A Tunl lts (6 elements)

DISPLAYS & CONTROLS

Msn Elapsed Tmr (pnl 2)

DOCKING

Sys A Probe conn (however A & B
 conn may be switched)

GENERAL DATA

MAIN BUS B

EPS/CRYO

Tk 2 H2 & O2 Htrs
 Inv 2 Pwr
 Util Outlet (pnl 100)
 LM Pwr
 Tk 2 O2 Vac-Ion Pump

ECS

O2 High Flow C/W lt
 Prim 1 Rad Htr Cont
 Rad Flow Contr 2
 Prim Rad In Temp ind & PCM
 H2O Accum 2 Auto & Man Cont
 Urine & Waste Dump Htr B
 Steam Duct Htr B

RCS

CM Sys 2 Htrs
 CM Sys 2 Fuel & Oxid Purge
 CM Fuel Interconnect
 CM Oxid/He Interconnect
 CM Sys 2 Prplnt Dump 42 Sec TD
 CM Sys 2 Prplnt Isol vlv & tb
 SM A & C Htrs
 SM A & C He 1 & 2 Isol vlv
 & tb
 SM A & C Prim/Sec Prplnt Isol
 vlv & tb

SM A & C Sec Fuel Press Isol vlv
 Trnfr Mot sw 2

SPS

P & Y (Sec) Gmbl Mots
 Enbl Pwr Sol Driver 2
 He 2 vlv & tb
 Pilot 3 & 4 vlv
 Sec Pilot Pre vlv
 Line Htrs B

SCS

FDAI 2 Total Att
 GDC
 BMAG 2 Htr & C/W Temp lt
 (eventually lose BMAG 2 as
 temp decr)
 Auto Coils CM RCS 2 (if prior to
 CM/SM sep)
 Dir Ull Yaw D3 & B4
 Auto ΔV (may be degraded)
 Min Imp Incr to ≈42 MS
 RSI
 ORDEAL
 Rot Contr Pwr Dir 1, MNA/MNB to
 half of jets
 Rot Contr Pwr Dir 2
 a. MNA/MNB to half of jets
 b. MNB to all jets

LIGHTING

LH Girth Shelf Flood (Fixed
 Mode)
 LH Couch Flood (Fixed Mode)
 LH & RH Strut Flood (Fixed Mode)
 RH Couch Flood (Var Mode)
 RH Girth Shelf Flood (Var Mode)
 RH Opt Align Sight
 Sys B Tunl lts (6 elements)
 Spotlight Door Initiator

DISPLAYS & CONTROLS

Msn Elapsed Tmr (pnl 306)

DOCKING

Sys B Probe conn (however A & B
 conn may be switched)

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BAT BUS A	BAT BUS B	BAT RELAY BUS
EPS/CRYO Mn Bus Tie A/C Mot sw ECS Prim Rad 1 Htr Ovld Snsr RCS SECS Auto RCS Trnfr to Trnfr Mot sw 1 SPS P & Y 1 (Prim) Gmbl Mot Cont SCS Auto RCS Sel MNA (if not previously enabled) SECS SECS & ELS Sys A Float Bag Compr 1 Float Bag 1 Mot sw & Cont vlv EDS Voting Logic 1	EPS/CRYO Mn Bus Tie B/C Mot sw ECS Prim Rad 2 Htr Ovld Snsr Sec Rad Htr Ovld Snsr RCS SECS Auto RCS Trnfr to Trnfr Mot sw 2 SPS P & Y (Sec) Gmbl Mot Cont SCS Auto RCS Sel MNB (if not previously enabled) SECS SECS & ELS Sys B Float Bag Compr 2 Float Bag 2 Mot sw & Cont vlv EDS Voting Logic 3	EPS/CRYO FC 1, 2, 3, Reacs vlvs, Latch Ckt & tbs FC 1, 2, 3 Rad Byp vlvs & tbs FC 1, 2, 3 to Mn Bus A & B Switching & tbs Mn Bus A & B UV Sensing & UV C/W lt (if C/W NORM sw in ACK) Inv 1, 2, 3 to AC Bus 1 & 2 & DC Bus Switching AC Over/UV Sensing & C/W lt AC Ovld C/W lt (if C/W NORM sw in ACK)
	BATTERY C	
	EDS Voting Logic 2	

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GENERAL DATA

<p>AC BUS 1</p>	<p>LIGHTING</p> <p>FDAI 1 EMS Num & Grid Msn Tmr Num (pnl 2) DSKY Num (pnl 2) EL for pnls 1-9, 15, 16, 229, 275 Sys 1 SM Run lts (6 elements) & EVA lt (1 element)</p>	<p>ORDEAL</p> <p>No. 2 Pitch & Yaw Needles on GPI (ØA) SII Fuel & SIVB Fuel & Oxid Press for ind No. 2 (ØA)</p>
<p>EPS/CRYO</p> <p>Tk 1 H2 & O2 Fans Tk 1 H2 & O2 Qty & Temp Sig Condr (ØC)</p> <p>ECS</p> <p>Cab Fan 1 Man Cont Prim Evap Stm vlv (ØC) Auto Cont Prim Gly Cont vlv (ØA) Sec Loop Evap Cool (ØA) Elect Cont Suit Ht Exch Gly Byp vlv (ØB) Rad Flow Contr 1 & Rad Isol vlvs (ØC)</p>	<p>AC BUS 2</p>	<p>LIGHTING</p> <p>EMS Roll Att & Scroll lts Msn Tmr Num (pnl 306) DSKY Num (pnl 140) EL for pnls 10, 100, 101, 122, 225, 226, 306 Sys 2 SM Run lts (8 elements) & EVA lt (1 element) Dock Trgt & Spot lt</p>
<p>SCS</p> <p>GDC (all modes except RSI) FDAI 1 BMAG 1 (ATT HOLD, RATE CMD) Min Imp (ØA) RHC 1 MTVC (ØA) Rate Cmd Prplnt Att Cont (ØA) Auto ΔV (ØA) No. 1 Pitch & Yaw Needles on GPI (ØA) SII Fuel & SIVB Fuel & Oxid Press for ind No. 1 (ØA)</p>	<p>EPS/CRYO</p> <p>Tk 2 H2 & O2 Fans Tk 2 H2 & O2 Qty & Temp Sig Condr (ØC)</p> <p>ECS</p> <p>Cab Fan 2 Prim Evap Temp Cont Unit (ØA) Auto Cab Temp Cont Unit (ØC) Rad Flow Contr 2 & Rad Isol vlvs (ØC)</p>	<p>PYRO BUS A</p>
<p>SCS</p> <p>MTVC (RATE CMD, ACCEL CMD) Proportional RATE CMD (TVC, ATT CONT) FDAI 2 BMAG 2 RSI (ØA) GDC (ØA) Auto ΔV (TVC) (ØA)</p>	<p>SCS</p> <p>MTVC (RATE CMD, ACCEL CMD) Proportional RATE CMD (TVC, ATT CONT) FDAI 2 BMAG 2 RSI (ØA) GDC (ØA) Auto ΔV (TVC) (ØA)</p>	<p>Fuel/He Interconnect Ox Interconnect CM RCS 1 Purge vlvs Seq Sys A Func (pyros)</p>
<p>SCS</p> <p>MTVC (RATE CMD, ACCEL CMD) Proportional RATE CMD (TVC, ATT CONT) FDAI 2 BMAG 2 RSI (ØA) GDC (ØA) Auto ΔV (TVC) (ØA)</p>	<p>SCS</p> <p>MTVC (RATE CMD, ACCEL CMD) Proportional RATE CMD (TVC, ATT CONT) FDAI 2 BMAG 2 RSI (ØA) GDC (ØA) Auto ΔV (TVC) (ØA)</p>	<p>PYRO BUS B</p> <p>Ox/He Interconnect Fuel Interconnect CM RCS 2 Purge vlv Seq Sys B Func (pyros)</p>

4.5.1.4 Powerdown Electrical Loads

The following electrical loads list may be utilized to effect a powerdown if main buses should indicate less than 26 vdc with no short circuit verification. Three types of loads are provided to permit most rapid and effective selection for a given mission phase. A return to normal configuration should be established when main buses reach 26.5 vdc.

Use of list assumes that entry batteries A and B (battery C when applicable) have been tied to main buses before powerdown selections are made.

Load Control	LAUNCH	FLIGHT	ENTRY	SPS Burns	Remarks
	Liftoff to Orbit Insertion	Orbit Insertion to Entry Preparation	Entry Preparation to 50K'		
CONTINUOUS LOADS					
cb G/N (10) - open			9.50 amp		After 0.05 G
FC PUMPS (all) - OFF	8.73 amp	8.73 amp	8.73 amp	8.73 amp	Until CM/SM sep
IMU to stby	6.33 amp				
cb ESS INST (2) - open	4.85 amp	4.80 amp	1.10 amp	4.80 amp	MNA & B
S BD PWR AMPL HI - off (ctr)	4.00 amp	4.00 amp	4.00 amp	4.00 amp	
SUIT COMPR 1 (or 2) - OFF		4.00 amp/compr	4.00 amp/compr	4.00 amp/compr	Unsuited only
TELCOM (both) - OFF	1.76 amp	3.71 amp	1.80 amp	3.71 amp	Group 1 & 2
cb G/N OPT (2) - open			3.10 amp		
GLY PUMPS - OFF	2.57 amp	2.57 amp	2.57 amp	2.57 amp	OFF no longer than 15 min
CMC to stby	1.96 amp				
G/N PWR - OFF	1.50 amp	1.50 amp	1.50 amp	1.50 amp	
cb RAD CONT/HTRS (2) - open	1.05 amp	1.05 amp	1.05 amp	1.05 amp	Until CM/SM sep
SCE PWR - off (ctr)	0.65 amp	0.65 amp	0.65 amp	0.65 amp	

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Load Control	LAUNCH	FLIGHT	ENTRY	SPS Burns	Remarks
	Liftoff to Orbit Insertion	Orbit Insertion to Entry Preparation	Entry Preparation to 50K'		
MANUALLY CYCLED LOADS					
GMBL MOT PITCH & YAW 2 - OFF	10.0 amp				At crew discretion
SPS LINE HTRS - off (ctr)		3.09 amp/bus		3.09 amp/bus	
SPS GAUGING - OFF				2.96 amp	
Min CM lighting	1.57 amp	1.57 amp	1.57 amp	1.57 amp	
TAPE RC DR FWD - off (ctr)	1.57 amp	1.57 amp	1.57 amp	1.57 amp	
AUTOMATICALLY CYCLED LOADS					
02 HTRS (both) - off (ctr)	11.05 amp	11.05 amp	11.05 amp	11.05 amp	Until CM/SM sep
02 FANS (both) - off (ctr)		5.40 amp	5.40 amp	5.40 amp	Until CM/SM sep
SM RCS HTRS (4) - OFF		2.09 amp/quad	2.09 amp/quad	2.09 amp/quad	Until CM/SM sep
POT H2O HTR - OFF		1.62 amp		1.62 amp	
H2 HTRS (both) - off (ctr)	1.43 amp	1.43 amp	1.43 amp	1.43 amp	Until CM/SM sep
H2 FANS (both) - off (ctr)		0.72 amp	0.72 amp	0.72 amp	Until CM/SM sep

4.5.1.3

GENERAL DATA

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.5.2	PROPULSION SYSTEMS		
	<p>Specific functions of the SPS and RCS must be monitored to assure operational readiness and capability. SPS and SM RCS monitoring checks are performed during post-orbital insertion check and at 4-hour intervals and after each SPS burn. In addition, the SM RCS monitoring check is performed prior to each SPS burn. The CM RCS monitoring check is performed during post-orbital insertion check and at 12-hour intervals and prior to entry.</p>		
	4.5.2.1 <u>SPS Monitoring Check</u>		
LMP	<p>SPS PRPLNT TEMP ind - +45° to +75°F If <45°F, SPS LINE HTRS - A If >75°F, SPS LINE HTRS - off (ctr) SPS PRESS IND sw - He, N2A, & N2B SPS He/N2 PRESS ind SPS He PRESS - 3900 psia max SPS N2 A PRESS - 2900 psia max SPS N2 B PRESS - 2900 psia max SPS PRESS IND sw - He SPS FUEL PRESS ind - 170-195 psia SPS OXID PRESS ind - 170-195 psia</p>	3	<p>Use A/B position if double heater operation required for temperature control.</p> <p>3600+50 psia at launch, decreases with each burn. 2900 psia at 130°F, decreases with each burn. 2900 psia at 130°F, decreases with each burn.</p> <p>Fuel and oxidizer tanks pressurized with helium prior to launch.</p>
	<u>CAUTION</u>		
	<p>If ΔP between fuel & oxid is >20 psi prior to a critical SPS burn, repressurize prplnt tks manually by placing SPS He VLV (both) - ON. ΔP between tks >20 psi during a burn may result in degraded performance, rough combustion, &/or eng failure. Refer to SPS malfunction symptom, 5.2.2.</p>		

PROPULSION SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	<p>SPS INJ VLV ind (4) - CLOSE</p> <p>SPS OXID QTY ind - record SPS FUEL QTY ind - record SPS OXID UNBAL ind - record OXID FLOW VLV PRIM - PRIM</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>Do not sw to sec oxid flow vlv with prim vlv functioning properly. Failure of sec vlv could result in loss of prplnt management capability. If OXID FLOW VLV PRIM sw inadvertently set to SEC when no failure exists, return to PRIM before repositioning OXID FLOW VLV INCR sw.</p> <p>SPS He VLV (both) - AUTO SPS He VLV tb (both) - bp</p> <p>4.5.2.2 <u>SM RCS Monitoring Check</u></p>	3	<p>Each CLOSE indicates two propellant ball valves closed.</p> <p>Quantity and unbalance indications may not be accurate subsequent to SPS burns of less than 25 seconds.</p> <p>Barber pole indicates helium isolation valve closed.</p> <p>In addition to normal monitoring checks, all helium and propellant talkbacks (16) should be verified gray after any mechanical shock to CSM.</p>
CMP	<p>SM RCS He tb (8) - gray</p> <p>SM RCS PRIM PRPLNT tb (4) - gray SM RCS SEC PRPLNT tb (4) - gray RCS IND sel - SM A, B, C, D</p>	2	<p>Gray indicates helium systems 1 & 2 isolation valves open.</p> <p>Gray indicates primary and secondary fuel and oxidizer isolation valves open.</p>

4.5.2.2

PROPULSION SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Check Quads A, B, C, D SM RCS PKG TEMP ind - 115°-175°F</p> <p>SM RCS He PRESS ind - record SM RCS IND sw - He TK TEMP SM RCS He TK TEMP ind - record SM RCS IND sw - PRPLNT QTY SM RCS PRPLNT QTY ind - record SM RCS SEC FUEL PRESS ind - 178-192 psia (192-207 psia until jets fired after orb insertion)</p> <p>When SM RCS SEC FUEL PRESS ind - <150 psia SM RCS A (B,C,D) SEC FUEL PRESS - OPEN</p> <p><u>4.5.2.3 CM RCS Monitoring Check</u></p> <p>CM RCS PRPLNT tb (both) - gray RCS IND sel - CM 1, 2 CM RCS He TEMP ind - 60°-90°F Prior to CM RCS activation CM RCS He PRESS ind - 4100-4200 psia CM RCS MANF PRESS ind - 80-105 psia</p> <p>After CM RCS activation CM RCS He PRESS ind - stab at 3300-3500 psia ≈15 min after activation CM RCS MANF PRESS ind - 287-302 psia</p>	2	<p>Temperature maintained between 115° and 134°F by thermostatically controlled heaters.</p> <p>Primary fuel pressure readout for each quad until momentary OPEN position of RCS A (B,C,D) SEC FUEL PRESS switch selected.</p> <p>Decrease in fuel pressure indicates primary fuel low. OPEN position is momentary.</p> <p>Gray indicates propellant isolation valves open.</p> <p>GSE servicing pressure monitored until system activated. Pressure varies with temperature and ullage. If manifold pressure drops suddenly, indicating a ruptured burst diaphragm, close CM RCS propellant isolation valves and then preheat jets (4.15.1.4) for 15 minutes. Preheating procedure vents any propellant trapped between propellant isolation valves and jets by energizing jet valve direct coils.</p>

PROPULSION SYSTEMS

4.5.3 ELECTRICAL POWER SYSTEM

EPS Management

The normal EPS configuration will be with two fuel cells on main bus A and one on main bus B, e.g., FC 1 and 2 on MNA and FC 3 on MNB. If one fuel cell is to be removed from buses, one of two configurations may be assumed. The prime configuration is one fuel cell per bus; for example, fuel cell 1 to main bus A and fuel cell 3 to main bus B. This configuration requires a dual inverter configuration and subsequent load balancing after fuel cell configuration has been established. The second configuration is to have two fuel cells paralleled to buses. This configuration should not be assumed unless equipment malfunction does not permit load balancing or one of the remaining fuel cells performance is degraded.

Standby operation (in-line heaters, reactants and pumps remain on) may be used when powering down spacecraft, as a corrective action for fuel cell malfunctions, or in the event it is desired to hold a fuel cell in reserve for future use. Batteries and remaining fuel cells should be normal when a fuel cell is placed on standby operation (open circuit). Inline heaters and pumps should not be turned off unless fuel cell is to be shut down. If, during the mission, it becomes necessary to conserve cryogenics, electrical loads should be reduced which will in turn decrease flow of cryogenics to fuel cells. In an emergency situation, consideration may be given to deactivate a fuel cell (inline heaters, pumps, and loads off) to conserve cryogenics. During deactive period, continuous monitoring of the fuel cell system will not necessarily assure a reactivation capability and there exists a possibility of complete loss of the fuel cell.

The prime inverter configuration is to have inverter 1 powering ac bus 1 and inverter 2 powering ac bus 2, with inverter 3 as backup. This configuration permits optimum bus isolation; however, reliability of the inverter permits single inverter operation to both ac buses if cryogenics are to be conserved.

Entry batteries A and B will normally supply main bus A and main bus B respectively with battery C as backup. The batteries (2) should be on during countdown, lift-off, and all delta V maneuvers. Battery C will supply the buses prior to deorbit burn and as required throughout the mission.

Battery C will be connected to buses as required to provide two-battery configuration for delta V maneuvers. All three batteries are to be used during final deorbit burn.

The battery charging cycle should be terminated when either the battery bus voltage indicated on PCM exceeds 39.5 vdc or when 100 percent of the expended energy has been replaced. This presumes charger current PCM data availability, and integration of charge current on the ground with MSFN advice to crew when 100 percent of charge is returned. If PCM link is lost, voice readouts of the onboard charger DC AMPS indicator will be required at intervals of 20 to 30 minutes for integration on the ground. Charging may be resumed if interrupted before achieving terminal conditions previously listed. Normal practice is to continue any charge to completion.

Batteries will be checked prior to each GO/NO-GO flight decision, prior to deorbit burn, and in routine periodic checks as required.

The onboard readout will be prime readout throughout EPS checks.

Fuel cell periodic verification consists of updating onboard data and comparing respective fuel cell performance for a particular phase, with established history of the powerplant.

Normal fuel cell purge requirements will be established in flight on the basis of prelaunch purity tests and elapsed amp-hours since previous purge. Purging will also be required just prior to GO/NO-GO flight decisions. Purging is accomplished by sequentially purging O2 (for 120 seconds) then H2 (for 80 seconds).

The time required for the H2 vent line heater activation prior to H2 purge has been set at 20 minutes. This time is flexible in that a purge may be attempted with less heater time (for example, a contingency corrective action) with no immediate adverse effect on the powerplant.

Cryogenic System Operational Regions

There are four basic cryogenic system operational regions based on control requirements. Quantity balance should be obtained by end of Region I to assure optimum fluid quantity remaining in Regions III and IV. These regions and their respective quantity balance requirements are:

Region I - Automatic Control Region

Quantity balance correction is to be implemented at a 3-percent differential for hydrogen and for oxygen a differential from 2 percent to 4 percent. Unbalanced conditions of 5 percent for O2 and 4 percent for H2 should be avoided.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	Region II - Minimum dq/dm Region Quantity balancing procedures should not be implemented in this region.		
	Region III - Post Minimum dq/dm Region Quantity balancing correction should be implemented on the same basis as in Region I. Heater switches may be in either manual or AUTO and fan switches should be operated manually, depending on balancing requirements.		
	Region IV - Terminal Region Quantity balancing procedures should not be implemented.		
	<u>4.5.3.1 Cryogenic Pressure-Quantity Check</u>		
CMP	CRYO H2 PRESS ind (both) - 225-260 psia O2 PRESS IND sw - SURGE TK CRYO O2 PRESS 1 ind - 865-935 psia O2 PRESS IND sw - TK 1 CRYO O2 PRESS ind (both) - 865-935 psia	2	Indicates H2 tank 1 and 2 pressure. Indicates surge tank O2 pressure. Indicates O2 tank 1 and 2 pressure.
	CRYO H2 QTY ind (both) - record		Nominal per mission profile curve, 100 percent maximum indicates full tank (28 pounds each tank).
	CRYO O2 QTY ind (both) - record		Nominal per mission profile curve, 100 percent maximum indicates full tank (320 pounds each tank).
	SYS TEST (2) - 4B SYS TEST ind - 4.1-4.4 vdc	101	Indicates O2 tank 3 pressure (865-935 psia).
	SYS TEST (2) - 4D SYS TEST ind - 3.2-3.8 vdc		Indicates H2 tank 3 pressure (225-265 psia).

4.5.3.1

ELECTRICAL POWER SYSTEM



STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	SYS TEST (2) - 4A SYS TEST ind - record SYS TEST (2) - 4C SYS TEST ind - record	101	Indicates O2 tank 3 quantity. Indicates H2 tank 3 quantity.
	<u>4.5.3.2 FC Power Plant Check</u>		
LMP	FC HTRS (all) - on (up) FC REACS tb (all) - gray FC IND sel - 1, 2, 3 FC H2 FLOW ind - 0.03-0.15 lb/hr FC O2 FLOW ind - 0.25-1.2 lb/hr FC SKIN TEMP ind - 390°-450°F FC COND EXH TEMP ind - 150°-175°F FC pH HI tb - gray FC RAD TEMP LO tb - gray	3	Enables electronic switches which automatically apply or remove power to fuel cell heaters. Gray indicates fuel cell reactant valves open. Flow limits are proportional to individual fuel cell currents and can be approximated by fuel cell O2 flow $\approx(\text{amps} \times 2.0)/100$, and fuel cell H2 flow $\approx(\text{amps} \times 2.5)/1000$. Gray indicates pH factor normal. Gray indicates fuel cell radiator temperatures normal.
	<u>4.5.3.3 D-C Voltage-Amperage Check</u>		
	MN BUS TIE (2) - OFF (verify) FC 1 & 2 MNA tb (2) - gray FC 3 MNA tb - bp	5 3	Gray indicates fuel cells 1 and 2 connected to main bus A. Barber pole indicates fuel cell 3 disconnected from main bus A.
	FC 1 & 2 MNB tb - bp FC 3 MNB tb (2) - gray		Barber pole indicates fuel cells 1 and 2 disconnected from main bus B. Gray indicates fuel cell 3 connected to main bus B.

ELECTRICAL POWER SYSTEM

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	DC IND sel - FC 1, 2, 3 DC AMPS ind - record amps DC IND sel - MNA, B DC VOLTS ind - 26.5-31 vdc (record) DC IND sel - BAT BUS A, B, & BAT C DC VOLTS ind - 31.5-38.0 vdc DC AMPS ind - <3.0 amps	3	Record dc amps for each fuel cell. Record dc volts for main buses A and B. Voltage indication may be different than shown when charging battery.
CMP	SYS TEST (2) - 5B SYS TEST ind - 3.4-4.1 vdc	101	Verifies battery relay bus voltage 30.5 to 37.0 vdc and verifies system test indicator. Perform if convenient.
	If LM PWR - CSM SYS TEST (2) - 7D SYS TEST ind - 0.5-3.2 vdc	2 101	Verifies LM heater current is 1 to 6.4 amps.
	<u>CAUTION</u> Do not leave DC IND sel at PYRO BAT A (B) position any longer than req to read DC VOLTS ind, or pyro bat chg will be depleted.		
LMP	DC IND sel - PYRO BAT A, B DC VOLTS ind - 36.5-37.5 vdc DC IND sel - MNA	3	Check pyro batteries A and B once every 24 hours.
	4.5.3.4 <u>A-C Voltage Check</u> AC IND sel - BUS 1, 2, ϕ A, B, C AC VOLTS ind - 113-117 vac		

4.5.3.4

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>4.5.3.5 Battery Charging</u>		
LMP	MN BUS TIE (2) - OFF	5	Placing MN BUS TIE switches at OFF completes circuit from charger to selected battery and disconnects battery from main bus.
	cb PYRO A & B BAT BUS A & B (2) - open	250	
	cb BAT C TO BAT BUS A & B - open		
	cb BAT RLY BUS BAT A (B) - open	5	
	DC IND sel - BAT CHGR	3	
	BAT CHG - A, B, or C		
	<u>CAUTION</u>		
	If bat chg is started immediately after discharge, chgr current may be high &/or chgr voltage may be low. Current & voltage should be within specified limits 45 min after initiation of chg, otherwise trnfr chgr to remaining bats. After remaining bats are charged, return chgr to affected bat.		
	DC VOLTS ind - 37.5-39.5 vdc		
	BAT CHG - OFF (at MSFN request or when DC VOLTS ind reads 39.5 vdc for bat bus A, B or bat C)		
	cb BAT RLY BUS BAT A (B) - close	5	
	DC IND sel - MNA	3	
CMP	SYS TEST (2) - 7A	101	
	SYS TEST ind - <1.5 vdc		
	(After sea level amb press ≈ 14 psia has been vented)		

ELECTRICAL POWER SYSTEM

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	If >1.5 vdc BAT VENT vlv - VENT (for 5 sec) then CLOSE	252	Battery vent manifold pressure >6 psia (1.5 vdc) indicates a gross battery malfunction which should have become apparent prior to manifold pressure increase. If manifold pressure \approx cabin pressure, leakage into battery case(s) is indicated which will have no effect on battery performance. Battery vent valve should not be opened if waste water tank is full or is being manually dumped overboard, or if OVBD DRAIN valve is open with urine dump line inter-connected to waste water dump line.
	SYS TEST (2) - 5B	101	Monitors battery relay bus voltage.
4.5.3.6 <u>FC Power Plant Purging</u>			
LMP	1 O2 purging FC IND sel - 1, 2, or 3 FC 1, 2, or 3 PURG - O2 (2 min)	3	Refer to purge information at beginning of 4.5.3. Purging is performed as determined by real time decision.
	FC O2 FLOW ind - flow incr 0.6 lb/hr		O2 flow rate will increase by 0.6 lb/hr. This may cause FC O2 FLOW indicator to exceed its normal limits and activate MASTER ALARM pb/lt (3) and FC 1 (2 or 3) light. Alarm limits may be checked by monitoring FC O2 FLOW indicator at the moment C/W light comes on.
	FC 1, 2, or 3 PURG - OFF		<ul style="list-style-type: none"> If normal O2 flow is at lowest limits, purging O2 side of fuel cell will not cause MASTER ALARM pb/lt to come on.
	2 H2 purging H2 PURG LINE HTR - on (up), 20 min prior to purge		Refer to purge information at beginning of 4.5.3. Purging is performed as determined by real time decision.

4.5.3.6

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	FC IND sel - 1, 2, or 3 FC 1, 2, or 3 PURG - H2 (1 min, 20 sec) FC H2 FLOW ind - flow incr 0.67 lb/hr	3	H2 flow rate will increase by 0.67 lb/hr. This will cause FC H2 FLOW indicator to exceed its normal limits, and activate MASTER ALARM pb/lt (3) and FC 1 (2 or 3) light.
ALL	MASTER ALARM pb/lt (3) - on MASTER ALARM pb/lt - push MASTER ALARM pb/lt (3) - out	1,3,122	
CMP	FC 1, 2, or 3 lt - on (until norm flow restored)	2	
LMP	FC 1, 2, or 3 PURG - OFF After ≈10 min H2 PURG LINE HTR - OFF	3	
	<u>4.5.3.7 H2 or O2 Quantity Balance Correction</u>		Refer to quantity balance information at beginning of 4.5.3.
CMP	On low qty tk H2 or O2 HTRS 1 (2) - off (ctr) When tk qty balanced H2 or O2 HTRS 1 (2) - AUTO	2	
	<u>4.5.3.8 FC Load Disconnect</u> (Example using FC 2)		This procedure is presented with the following assumptions: Fuel cells 1 and 2 powering dc main bus A. Fuel cell 3 powering dc main bus B. Requires load balancing. Fuel cell 2 is now disconnected from both dc main buses.
LMP	a. Prior to Disconnect Ensure that at least one FC is powering each mn bus FC disconnect (1) Prime configuration		
	FC 2 MNA - OFF FC 2 MNB - OFF (verify)	3	

ELECTRICAL POWER SYSTEM

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	FC 2 MNA & B tb (2) - bp	3	Barber poles indicate fuel cell 2 is disconnected from main bus A and main bus B.
	FC 1 MNA tb - gray		Gray indicates fuel cell 1 is connected to main bus A.
	FC 1 MNB tb - bp		Barber pole indicates fuel cell 1 is disconnected from main bus B.
	FC 3 MNA tb - bp		Barber pole indicates fuel cell 3 is disconnected from main bus A.
	FC 3 MNB tb - gray		Gray indicates fuel cell 3 is connected to main bus B.
	(2) Sec configuration		This configuration is assumed if load balancing cannot be obtained.
	FC 1 MNB - on (up)		On position is momentary. When fuel cell main bus switches are placed from OFF to momentary on position, MASTER ALARM and FC BUS DISC lights are energized.
	FC 3 MNA - on (up)		
	FC 2 MNA - OFF		Fuel cell 2 disconnected from both dc main buses.
	FC 2 MNB - OFF (verify)		Fuel cells 1 and 3 paralleled to both dc main buses.
ALL	MASTER ALARM pb/lt (3) - on	1,3,122	
CMP	FC BUS DISC lt - on (mom)	2	
ALL	MASTER ALARM pb/lt - push, out	1,3,122	
CMP	C/W lts (all) - out	2	
LMP	FC 1 MNA & B tb (2) - gray	3	Gray indicates fuel cell 1 connected to main bus A and B.
	FC 3 MNA & B tb (2) - gray		Gray indicates fuel cell 3 connected to main bus A and B.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	FC 2 MNA & B tb (2) - bp	3	Barber poles indicate fuel cell 2 disconnected from main bus A and B.
	b. Conn Desired FC to Desired Mn Bus FC to bus conn		
	FC 2 MNA - on (up)		On position is momentary. When fuel cell main bus switches placed from OFF to momentary on position, MASTER ALARM and FC BUS DISC lights are energized.
	FC 1 MNB - OFF		
	FC 3 MNA - OFF		
ALL	MASTER ALARM pb/lt (3) - on	1,3,122	
CMP	FC BUS DISC lt - on (mom)	2	
ALL	MASTER ALARM pb/lt - push, out	1,3,122	
CMP	C/W lts (all) - out	2	
LMP	FC 2 MNA tb - gray	3	Gray indicates fuel cell 2 connected to main bus A, barber pole indicates fuel cell 2 disconnected from main bus B.
	FC 2 MNB tb - bp		
	FC 1 MNA tb - gray		Gray indicates fuel cell 1 connected to main bus A.
	FC 1 MNB tb - bp		Barber pole indicates fuel cell 1 disconnected from main bus B.
	FC 3 MNA tb - bp		Barber pole indicates fuel cell 3 disconnected from main bus A.
	FC 3 MNB tb - gray		Gray indicates fuel cell 3 connected to main bus B.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.5.3.9	<u>Inverter Changeover</u>		Normal operation throughout mission will be with 2 inverters operating. During drifting flight, a single inverter is adequate to power both ac buses; however, two-inverter operation is assumed, providing maximum bus isolation.
	<u>WARNING</u>		
	Ensure at least one inv on each ac bus at all times (if available).		If 3 inverters are switched onto one ac bus, loss of ac power to that bus will result.
LMP	a. Dual Inv (No. 1 & 2) Oper AC2 RSET - OFF	3	This procedure is presented with the assumption that inverter 1 is powering ac bus 1 and 2.
	INV 2 - MNB		During dual inverter operation, inverter connected to dc main bus A should always power ac bus 1 and inverter connected to dc main bus B should always power ac bus 2, to preclude loss of all ac and dc power to SCS in event of single dc main bus failure.
	INV 1 AC2 - OFF		S-band phaselock will be lost upon switching inverters.
	INV 2 AC2 - on (up)		Inverter 1 now powering ac bus 1 and inverter 2 powering ac bus 2. Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when inverter is connected to bus.
	AC2 RSET - RSET		RSET position is momentary.
ALL	MASTER ALARM pb/lt (3) - on MASTER ALARM pb/lt - push	1,3,122	Placing AC1 or 2 RSET switch to RSET and releasing ensures a MASTER ALARM pb/lt - on. Placing AC1 or 2 RSET to center will cause random activation of
CMP	MASTER ALARM pb/lt (3) - out C/W lts (all) - out	2	MASTER ALARM pb/lt.

4.5.3.9

ELECTRICAL POWER SYSTEM

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	Perform AC Voltage Check, 4.5.3.4		
	b. Single Inv Oper		
	AC2 RSET - OFF	3	This procedure is presented with the assumption that inverter 1 is powering ac bus 1 and inverter 2 is powering ac bus 2.
	INV 2 - OFF		
	INV 2 AC2 - OFF		S-band phaselock will be lost upon switching inverters.
	INV 1 AC2 - on (up)		Inverter 1 now powering ac bus 1 and ac bus 2. Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when inverter is connected to bus.
	AC2 RSET - RSET		RSET position is momentary.
ALL	MASTER ALARM pb/lt (3) - on	1,3,122	Placing AC1 or 2 RSET switch to RSET and releasing ensures a MASTER ALARM pb/lt - on. Placing AC1 or 2 RSET to center will cause random activation of
	MASTER ALARM pb/lt - push		
	MASTER ALARM pb/lt (3) - out		
CMP	C/W lts (all) - out	2	MASTER ALARM pb/lt.
LMP	Perform AC Voltage Check, 4.5.3.4		
	c. Stby Inv (No. 3) Check or Oper		
	AC2 RSET - OFF	3	This procedure is presented with the assumption that inverter 1 is powering ac bus 1 and inverter 2 is powering ac bus 2.
	INV 2 - OFF		
	INV 3 - MNB		When switching inverter 3 from one main dc bus to the other, pause momentarily in OFF position.
	INV 2 AC2 - OFF		S-band phaselock will be lost upon switching inverters.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	INV 3 AC2 - on (up) AC2 RSET - RSET	3	Rapid performance of inverter switching sequence may initiate MASTER ALARM pb/lt when inverter is connected to bus. RSET position is momentary.
ALL	MASTER ALARM pb/lt (3) - on MASTER ALARM pb/lt - push MASTER ALARM pb/lt (3) - out	1,3,122	Placing AC1 or 2 RSET switch to RSET and releasing ensures a MASTER ALARM pb/lt - on. Placing AC1 or 2 RSET to center will cause random activation of
CMP	C/W lts (all) - out	2	MASTER ALARM pb/lt.
LMP	Perform AC Voltage Check, 4.5.3.4 If stby inv check Go to dual inv (No. 1 & 2) oper, 4.5.3.9a, & set INV 3 - OFF	3	Standby inverter (No. 3) check should be performed every 24 hours.
	4.5.3.10 <u>Cryo O2 & H2 Manual Fan Operation</u> <u>CAUTION</u> In the following step, if CRYO PRESS lt illuminates, do <u>not</u> set H2 & O2 FANS - off (ctr) or proceed to next step until lt extinguishes. Procedures to be determined.		Manual fan operation should be used during flight to prevent possible cryo pressure control motor switch arcing, which may cause a-c inverter a-c bus disconnect.

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4.5.4 ENVIRONMENTAL CONTROL SYSTEM

ECS systems management procedures are divided into two categories. The first category consists of five procedures, described in steps 1 through 5, that are conducted at specific time intervals.

1. An ECS monitoring check is recommended every hour from time the SC attains orbit until CSM separation. This check provides crew with latest status of the ECS.
2. A redundant component check is accomplished at 24-hour intervals to determine operational status of certain ECS redundant components and secondary water-glycol loop. The test will reveal any inoperative or malfunctioning components that might have been selected for use later in the mission. Several redundant components are not checked, however, because of excessive use of oxygen, a means of selection not incorporated, or lack of direct indication.
3. Replacement of one CO₂-odor absorber filter is required on an alternate basis, at 12-hour intervals, for the ECS to remain within prescribed metabolic limit. Filters are also changed if CO₂ partial pressure exceeds 7.6 mm Hg.
4. It is recommended that at 24-hour intervals the debris screen on suit circuit return valve be checked and cleaned as necessary.
5. It is recommended that chlorine and a buffer chemical be individually injected into potable water supply every 24 hours to maintain potability. There is a 10-ampoule supply of each chemical on the CM. Should a condition exist where either glycol evaporator is in use and waste water tank is empty, chlorine and buffer injections should be postponed.

The second category consists of procedures, described in steps 1 through 15, that are accomplished at random intervals or only as required.

1. PGA/shirtsleeve mode changes require certain precautions to be taken regarding suit power switch settings, communication functions and ECS adjustments. This applies whether the mode change is from PGA-to-shirtsleeve, shirtsleeve-to-PGA, or full PGA to partially suited mode. Also specified is a configuration for extravehicular and intravehicular transfer (EVT/IVT).

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2. Waste management procedures provide the steps necessary for collection, removal, and disposition of waste products (except perspiration and respiration) resulting from normal body functions. Collection and disposition of emesis within the CM is also covered.
3. Procedures are provided to repressurize the CM cabin to 5 psia following depressurization for any reason.
4. A verification of the PGA is carried out each time a crewman dons his suit. Although only one crewman may be returning to the suited mode, all those already suited will be subjected to PGA verification. The verification is also performed prior to S-IVB separation, SPS burns, cabin pressure dumping, EVT, IVT, and deorbit.
5. The CM oxygen supply, represented by the surge tank and repressurization tanks (3), requires replenishment after cabin repressurization.
6. The CM pressure dump procedure is utilized for extravehicular transfer (EVT).
7. The suit circuit, when isolated from the cabin, will be purged of accumulated hydrogen at the discretion of flight crew.
8. The cabin cold-soak operation is recommended for any period for which a cooler cabin is desirable, provided water consumption is compatible with water management, and radiator outlet temperature is greater than 0°F. The procedure may commence 8 to 12 hours prior to entry if a safety margin for entry is deemed advisable. Primary and secondary radiator loops are not to be operated simultaneously.
9. The CM/LM pressure equalization procedure will normally be performed to support initial hard docking and LM withdrawal, and intravehicular crew transfer from either CM or LM.
10. A procedure is provided for donning and doffing of emergency oxygen masks.
11. A procedure is provided to manually dump waste water overboard. This procedure is required approximately once per day to maintain waste water tank quantity level between 85 and 25 percent.

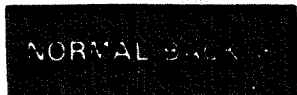
STA/T STEP	PROCEDURE	PANEL	REMARKS
	12. Data for servicing the gas separator cartridges is provided. The separators are used as a backup for separating H2 from H2O in the normal system.		
	13. The steps required to activate or deactivate the primary glycol evaporator are provided, if such action becomes necessary for lunar orbital path perturbations due to steam venting or for any other reason.		
	14. Prior to CM/LM rendezvous, the command module pilot should install the lunar dust filter over the cabin fan outlet. The filter should remain in place for 4 hours of cabin fan operation, starting when the CM and LM hatches are removed. This will ensure adequate lunar dust removal from the CM.		
	15. A procedure is provided for the use of the lunar dust vacuum cleaner following CM/LM rendezvous. Although this component is stowed in and is powered from the CM, its use within the LM is permitted by the length of the power cable.		
	4.5.4.1 <u>ECS Monitoring Check</u>		
LMP	SUIT CAB ΔP ind - -1.0 to -3.5 in. H2O O2 FLOW ind - 0.2-0.45 lb/hr	2	O2 flow may be as high as 1.0 lb/hr (pegged) prior to completion of cabin purge.
	O2 PRESS IND sw - SURGE TK CRYO O2 PRESS 1 ind - 865-935 psia		
CMP	O2 PRESS IND sw - TK 1 REPRESS O2 PRESS ind - >865 psia	602	Gray indicates No. 1 flow proportioning valve controlling flow.
LMP	ECS RAD tb - gray	2	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	If ECS RAD tb - 2 RAD FLOW CONT AUTO - 1 until tb gray, then AUTO		Attempt resetting talkback before assuming radiator proportioning malfunction.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	<p>If tb cannot be reset RAD FLOW CONT AUTO - 1 RAD PRIM OUT TEMP ind - within correct rng</p> <p>RAD FLOW CONT AUTO - AUTO RAD PRIM OUT TEMP ind - outside correct rng Refer to ECS Malfunction Proced, PRIM ECS RAD OUT TEMP HIGH, Symptom 15</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>ECS IND sel - PRIM RAD PRIM IN TEMP ind - 67°-97°F RAD PRIM OUT TEMP ind - -20° to 63°F (-20° to 97°F for lunar orb) PRIM GLY EVAP OUT TEMP ind - 38°-50.5°F PRIM GLY EVAP STM PRESS ind When boiling - 0.09-0.14 psia Not boiling - >0.14 psia PRIM GLY DISCH PRESS ind - 40-52 psig SUIT TEMP ind Without evap - 45°-70°F With evap - 45°-55°F CAB TEMP ind - 70°-80°F SUIT PRESS ind - ≈CAB PRESS ind CAB PRESS ind - 4.7-5.3 psia</p>	2	<p>Correct range indicates talkback malfunction only, with both proportioning systems and failure detection circuit operable.</p> <p>Cabin pressure will be 5.6 to 6.2 psia after launch and continuously decrease until cabin pressure regulator activates and controls to 4.7 to 5.3 psia.</p>

4.5.4.1

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	C02 PP ind - <7.6 mm Hg SUIT COMPR ΔP ind - 0.3-0.4 psid PRIM ACCUM QTY ind - 30-65% If qty <30%	2	
CMP,LMP	PRIM ACCUM FILL vlv - ON until 40-55% is reached	379,2	
LMP	H2O QTY IND sw - POT POT H2O QTY ind - 10-100% H2O QTY IND sw - WASTE WASTE H2O QTY ind - 25-85% If >85% - dump per 4.5.4.16	2	
	<u>4.5.4.2 ECS Redundant Component Check</u>		
	1 Suit compr SUIT COMPR (both) - redundant compr SUIT COMPR ΔP ind - 0.3-0.4 psid	4 2	
CDR	2 Suit demand regs DEMAND REG sel - 1 Close demand reg cab bleed port with finger	380	Obstruct bleed flow only long enough to obtain momentary high flow.
LMP	O2 FLOW ind - mom incr	2	
CDR	DEMAND REG sel - 2 Close demand reg cab bleed port with finger	380	Obstruct bleed flow only long enough to obtain momentary high flow.
LMP	O2 FLOW ind - mom incr	2	
CDR	DEMAND REG sel - BOTH	380	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
3 CMP	Main O2 regs MN REG B - close EMER CAB PRESS sel - 1 EMER CAB PRESS TEST pb - push	351	Press-to-test pushbutton held only long enough to obtain momentary high flow.
LMP CMP	O2 FLOW ind - pegged hi MN REG B - OPEN MN REG A - close EMER CAB PRESS sel - 2 EMER CAB PRESS TEST pb - push	2 351	
LMP CMP	O2 FLOW ind - pegged hi MN REG A - OPEN EMER CAB PRESS sel - BOTH (OFF if all crewmen suited)	2 351	Press-to-test pushbutton held only long enough to obtain momentary high flow.
4 LMP	H2O accum SUIT H2O ACCUM AUTO - redundant accum O2 FLOW ind - mon for momentary (10 sec) incr	2	
5 CMP	Urine dump nozzle htrs WASTE H2O DUMP - redundant htr URINE DUMP - redundant htr MSFN reports no significant change in urine & water dump nozzle temps	101	Nozzle temperatures are telemetered only. Temperature decrease indicates heater failure; however, if nozzles are facing sun, decrease may not be immediate.
6	Open cool cont atten pnl		Covers panel 382. Opened to perform part of secondary glycol loop check.

4.5.4.2

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p style="text-align: center;"><u>WARNING</u></p> <p>SUIT FLOW RELF vlv must remain OFF throughout msn or swelling of CO2 odor absorber filters may result.</p> <p>7 Sec gly loop</p>	382	<p>Coldplates are not provided in secondary glycol loop for DSE and G&N. Usage time for noncoldplated items is as follows: DSE: 2 hours ON, 1 hour OFF. G&N: 1.9 hours ON, 9.2 hours OFF.</p>
LMP	<p style="text-align: center;"><u>CAUTION</u></p> <p>Simultaneous oper of cryo 02 htrs & sec loop rad htrs will result in low mn bus voltage (<26.5 vdc). This will be precluded if the following precautions are observed.</p> <p>If RAD PRIM OUT TEMP ind - <48°F preceding sec loop activation, or if RAD SEC OUT TEMP ind - <45°F following sec loop activation:</p> <ul style="list-style-type: none"> • Inhibit cryo 02 htrs whenever cryo tk press <900 psia [02 HTRS (both) - off (ctr)]. Enbl cryo htrs when RAD SEC OUT TEMP ind - >48°F. • Enbl sec loop rad htrs when mn bus A & B >28.25 vdc with 3 FC oper or >28.5 vdc with 2 FC oper. 	2	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	SEC EVAP H2O CONT - AUTO	382	
LMP	ECS IND sel - SEC	2	
	GLY EVAP STM AUTO - MAN		
	GLY EVAP STM INCR - INCR for 58 sec min		Steam pressure valve requires 58 seconds from full open to full closed. INCR position is momentary.
CMP	GLY TO RAD SEC vlv - NORM	377	
LMP	RAD PRIM HTR - off (ctr)	2	
	GLY PUMPS - OFF	4	
	SEC COOL PUMP - AC1	2	
	SEC GLY DISCH PRESS ind - 39-51 psig		
	SEC ACCUM QTY ind - 30-55%		
	RAD SEC HTR - on (up)		
	SEC COOL EVAP - EVAP		
	SEC GLY EVAP STM PRESS ind		
	When boiling - 0.09-0.14 psia		
	Not boiling - >0.14 psia		
	After 20-30 min		
	RAD SEC IN TEMP ind - 60°-97°F		Allow 20 to 30 minutes of glycol circulation before reading temperature indicators.
	RAD SEC OUT TEMP ind - 40°-70°F (pegged)		75°F (actual) with high loads and worst case orientation, or >75°F (actual) during the subsolar point of lunar orbit.
	SEC GLY EVAP OUT TEMP ind - 40°-50.5°F		
	SEC COOL PUMP - AC2		
	SEC GLY DISCH PRESS ind - 39-51 psig		
	SEC COOL EVAP - RSET for 58 sec min, then off (ctr)		RSET closes steam pressure control valve. Steam pressure valve requires 58 seconds from full open to full close.
	RAD SEC HTR - OFF		
CMP	GLY TO RAD SEC vlv - BYP	377	
LMP	ECS IND sel - PRIM	2	
	SEC COOL PUMP - off (ctr)		
CMP	SEC EVAP H2O CONT - OFF	382	

4.5.4.2

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STA/T STEP	PROCEDURE	PANEL	REMARKS					
CMP 8	Close cool cont atten pnl	382	Covers panel 382.					
LMP 9	Prim gly pumps		Switch to pump opposite that on at beginning of test. This verifies primary loop pump operation.					
	GLY PUMPS - redundant pump	4						
	PRIM GLY DISCH PRESS ind - 40-52 psig PRIM ACCUM QTY ind - 30-65% GLY EVAP STM AUTO - AUTO	2						
10	Rad htrs RAD PRIM HTR - redundant htr		Switch to heater opposite that on at beginning of test. "On" time of heater is function of radiator outlet temperature and is cyclic in nature. Verification requires radiator outlet temperature at -15°F.					
4.5.4.3 <u>CO2 Absorber Filter Replacement</u>								
<u>CAUTION</u>								
Conn grd wire when removing or replacing filters from cstr or stowage.								
CMP	Obtain unused filter		Filter No.	Stowage Container	Filter No.	Stowage Container	Filter No.	Stowage Container
			1	Cstr A	12	A9	23	A4
			2	Cstr B	13	A9	24	A4
			3	B5	14	A9	25	A5
			4	B5	15	A1	26	A5
			5	B5	16	A1	27	A5
			6	B5	17	A3	28	A5
			7	B6	18	A3	29	A6
			8	B6	19	A3	30	A6
			9	B6	20	A3	31	A6
			10	B6	21	A4	32	A6
			11	A9	22	A4		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Open CO2 cstr atten pnl CO2 CSTR DIVERT vlv - up (or dn)	2 350	Handle placed up for canister B filter change, down for canister A filter change.
	<u>CAUTION</u> Apply press to latching handle to allow press interlock pin to withdraw, otherwise latching handle may not disengage. Cstr man bleed vlv - press Cover latching handle - unlock Replace used filter Cover latching handle - lock CO2 CSTR DIVERT vlv - ctr Close CO2 cstr atten pnl Stow used filter Stow excess shims in volume B5 or B6		Space is available for four shims at each end of volume B5 and B6.
4.5.4.4	<u>Debris Screen Check</u>		Lint or other debris on screens may reduce flow substantially.
a.	SUIT RETURN vlv screen Open cool cont atten pnl	380	Covers panel 382 and SUIT RETURN valve screen.
	<u>WARNING</u> SUIT FLOW RELF vlv must remain OFF throughout msn or swelling of CO2 odor absorber filters may result.	382	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR CMP	If debris is present SUIT RETURN vlv - close (push)	380	
CDR CMP	Clean screens SUIT RETURN vlv - open (pull)		
	Close cool cont atten pnl		
	b. Cab ht exch inlet screen CAB FAN (both) - OFF (verify)	2	
	Check cab ht exch inlet screen If debris present - clean screen		
4.5.4.5	<u>Potable Water Chlorination</u>		Chlorine concentration must not exceed 6 ppm.
	<u>CAUTION</u>		
	If waste water qty is approaching empty (reads <15%) & either gly evap is in oper, chlor procedure will not be performed, as impairment of evap efficiency may result.		
1	Check POT H2O QTY ind - if >90%, withdraw 8 oz of water		It is necessary to withdraw water to allow space for water flow into the tank after chlorine and buffer injection.
2	Retrieve chlor unit		Stowed in compartment B4.
3	Remove chlor port cap		
4	Attach needle assy to inj port		
5	Insert chlor ampoule into casing		Chlorine ampoules color-coded red.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 6	Conn knob assy & rot (CW) until piston contacts ampoule		
7	Install ampoule assy on needle assy (push & turn CW)	352	
<u>CAUTION</u>			
If potable water qty is <50%, inj half the contents of each ampoule (chlor & buffer) by rotating knob three turns (CW).			
8	Rot knob (CW) until ampoule is empty (piston bottoms out)		Requires ≈5-1/2 turns.
9	Disconnect ampoule assy from needle assy (push & turn CCW)		
10	Rot knob (CCW), remove & stow used ampoule		Place used ampoule in chlorination unit stowage bag.
11	Repeat steps 5 thru 8 using buffer ampoule		Buffer ampoules color-coded brown.
12	Wait 10 min, remove ampoule of H2O by rotating inj barrel (CCW) four turns while holding bayonet section in locked position (CW)		
13	Rot knob (CCW), remove & stow used ampoule		

4.5.4.5

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 14	Stow chlor unit		
15	Replace chlor port cap		
	<u>CAUTION</u>		
	Wait 30 min before withdrawing water from water use ports.		
	4.5.4.6 <u>PGA Mode Changes</u>		
	a. PGA to Shirtsleeve		Two flow paths exist for returning cabin atmosphere to suit circuit for scrubbing.
	CAB PRESS ind - >4.7 psia (verify)	2	
	EMER CAB PRESS sel - BOTH	351	
ALL	Doff & stow gloves & helmet		
	If suit return vlv is used		
CDR	SUIT RETURN vlv - open (pull)	380	
ALL	Retrieve inflight coveralls		
	SUIT PWR - OFF	9,10,6	
	PWR - OFF		
	AUDIO CONT - NORM		
	<u>WARNING</u>		
	If comm umb is to be discon- nected at bulkhead or cont head, VHF AM sw on associated pnl must be placed OFF & S BD MODE PCM sw must be in PCM or ctr.		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	Disconnect O2 & comm umb at PGA & insert interconnect in O2 return hose If suit return vlv is <u>not</u> used Retrieve inflight coveralls SUIT PWR - OFF PWR - OFF AUDIO CONT - NORM	9,10,6	
CDR	DEMAND REG sel - OFF <u>WARNING</u>	380	Screens plus hose causes increased pressure drop in suit circuit causing O2 demand flow.
	If comm umb is to be disconnected at bulkhead or cont head, VHF AM sw on associated pnl must be placed OFF & S BD MODE PCM sw must be in PCM or ctr.		
ALL	Disconnect O2 & comm umb at PGA & install suit return hose screen cap SUIT FLOW vlv - CAB FLOW (for unsuited crewmen) Disconnect UTCA, comm & biomed conn Doff & stow UTCA & PGA Don inflight coveralls Retrieve & conn CWG adapter to comm & biomed conn	300,301,302	Suit donning and suit loop isolation requires additional time for repositioning suit flow valves (inaccessible from couches) in addition to normal suiting time.
	Audio pnl sw (all) - as desired	9,10,6	Adjust suit flow valve between CAB FLOW and FULL FLOW to maintain adequate flow for suited crewman. Comm and biomed integrity should be verified.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	b. Shirtsleeve to PGA SUIT PWR - OFF PWR - OFF AUDIO CONT - NORM <u>WARNING</u> If comm umb is to be disconnected at bulkhead or control head, VHF AM sw on associated pnl must be placed OFF & S BD MODE PCM sw must be in PCM or ctr. Disconnect & stow CWG adapter Doff & stow inflight coveralls Retrieve & don UTCA & PGA, conn UTCA, comm & biomed conn If suit return vlv is used Remove O2 umb interconnect & conn O2 & comm umb to PGA	9,10,6	Two flow paths exist for returning cabin atmosphere to suit circuit for scrubbing.
CDR	SUIT RETURN vlv - close (push) (if all suited)	380	
ALL	If suit return vlv is <u>not</u> used Remove suit ckt return hose screen cap & conn O2 & comm umb		Suit donning and suit loop isolation requires additional time for repositioning suit flow valves (inaccessible from couches) in addition to normal suiting time.
CDR	DEMAND REG sel - BOTH		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	SUIT FLOW vlv - FULL FLOW (for suited crewman)	300,301,302	
	Audio pnl sw (all) - as desired	9,10,6	Comm and biomed integrity should be verified.
CMP	Retrieve & don helmet & gloves EMER CAB PRESS sel - OFF (if all suited)	351	
	c. PGA to Partial PGA		Two flow paths exist for returning cabin atmosphere to suit circuit for scrubbing.
	CAB PRESS ind - >4.7 psia (verify)	2	
ALL	EMER CAB PRESS sel - BOTH Doff & stow gloves & helmet If suit return vlv is used		
CDR ALL	SUIT RETURN vlv - open (pull) Reverse O2 umb conn at PGA	380	O2 umbilicals reversed for optimum flow distribution within PGA.
	Supply hose to outlet conn Return hose to inlet conn If suit return vlv is <u>not</u> used		
CDR	DEMAND REG sel - OFF		Screens plus hose cause increased pressure drop in suit circuit causing O2 demand flow.
ALL	Disconnect return hose from PGA & install suit return hose screen cap Conn supply hose to outlet conn		
	d. Shirtsleeve to EVT/IVT		Two flow paths exist for returning cabin atmosphere to suit circuit for scrubbing.
CDR,LMP	SUIT PWR - OFF PWR - OFF AUDIO CONT - NORM	9,6	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>WARNING</u>		
	If comm umb is to be disconnected at bulkhead or cont head, VHF AM sw on associated pnl must be placed OFF & S BD MODE PCM sw must be in PCM or ctr.		
CDR,LMP	Disconnect & stow CWG adapter Doff & stow inflight coveralls Doff CWG Don fecal containment system Don CWG		Stow LMP CWG.
CDR LMP CDR,LMP	Retrieve & don LCG Don comm carrier/moulded earpiece adapters Retrieve & don UCTA & PGA, conn UCTA, comm, & biomed conn If suit return vlv is used Remove O2 umb interconnect & conn O2 & comm umb		
CDR	SUIT RETURN vlv - close (push) (if all suited)	380	
CDR,LMP	If suit return vlv is <u>not</u> used Remove suit return hose screen cap & conn O2 & comm umb		Suit donning and suit loop isolation requires additional time for repositioning suit flow valves (inaccessible from couches) in addition to normal suiting time.
	SUIT FLOW vlv (2) - FULL FLOW Audio pnl sw (all) - as desired	300,301 9,6	Comm and biomed integrity should be verified.
CMP	Retrieve & don helmet & gloves EMER CAB PRESS sel - OFF (if all suited)	351	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.5.4.7	<p><u>Waste Management Procedures</u></p> <p><u>WARNING</u></p> <p>If germicide pouch is accidentally ruptured, proceed as follows:</p> <ul style="list-style-type: none"> ● Germicide on CM surface or hardware; wipe up with tissue. ● Germicide on crewman's skin; blot with tissue and flush with water. ● Germicide in crewman's eyes; irrigate with water from water gun or soaked tissue. ● Germicide ingested; take magnesium compound and/or high protein food - do not induce vomiting. <p>a. Urine Dump Modes</p> <p>(1) PGA urine collection bag Conn urine line filter to urine trnfr hose Conn urine trnfr hose/filter to urine/feces QD Remove cap from PGA thigh QD & stow</p>		<p>Filter stowed in R-5, hose under A-6.</p> <p>Temporary stowage.</p>
ALL			

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	Conn urine trnfr hose/filter QD to thigh QD OVBD DRAIN vlv - DUMP When PGA bag empty, discon- nect urine trnfr hose/ filter QD at PGA thigh QD Replace cap on PGA thigh QD Conn UTS to urine trnfr hose/ filter QD UTS vlv - open Purge until particles cease exhausting vent line (1 to 2 min), then OVBD DRAIN vlv - OFF UTS vlv - close Disconnect UTS from urine trnfr hose & stow Disconnect urine trnfr hose from urine/feces QD & stow	251	Stowed in R-11.
	(2) UTS (collection)		Used when inconvenient for simultaneous urination and overboard dumping.
	Obtain UTS & verify vlv closed Roll cuff - affixed UTS vlv - open Perform task		Stowed in R-11.
	UTS vlv - close Roll cuff - removed		Six spare roll-on cuffs stowed in medical accessory kit (B2), and one spare receiver assembly stowed in R-11.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	<p>Free urine in cuff absorbed with tissue UTS - stow (temporary) When convenient, dump urine by UTS (dump) proced</p> <p>(3) UTS (dump) Conn urine line filter to urine trnfr hose Conn urine trnfr hose/filter to urine/feces QD Obtain UTS & verify vlv closed Attach UTS to urine trnfr hose Perform UTS (collection) (if req), 4.5.4.7a (2) OVBD DRAIN vlv - DUMP When UTS bag empty, UTS vlv - open Purge 30 sec (min), then OVBD DRAIN vlv - OFF UTS vlv - close Disconnect UTS from urine trnfr hose & stow Disconnect urine trnfr hose from urine/feces QD & stow</p> <p>(4) Urine Receptacle Assy (URA) Conn urine line filter to urine trnfr hose Conn urine trnfr hose/filter to urine feces QD Conn urine receptacle to urine trnfr hose URA vlv - VENT</p>	251	<p>Filter in R-5, hose under A-6.</p> <p>Stowed in R-11.</p> <p>Stow in R-11.</p> <p>Stow filter in R-5, hose under A-6.</p> <p>GFE assembly.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	<p>Remove receptacle cover OVBD DRAIN vlv - DUMP Perform task</p> <p>Flush screen & honeycomb with water gun Replace receptacle cover after liquid has cleared from URA URA vlv - CLOSE (CW) Stow URA for next use with urine trnfr hose conn & OVBD DRAIN vlv - DUMP For storage prior to entry OVBD DRAIN vlv - OFF Remove & stow URA, urine trnfr hose & urine filter</p> <p>b. Defecation Remove fecal collection assy from stowage Obtain defecation collection device from assy Remove germicide pouch Insert germicide pouch (protective cover removed) into inner fecal bag Remove protective covering from lip of inner fecal bag & place into bag Affix inner fecal bag Perform task</p>	251	<p>Direct urine stream parallel to honeycomb to prevent splashback. Avoid accelerations to URA during use. Remove last drop by touching screen at top of URA.</p> <p>Allows URA to vacuum dry between uses.</p> <p>Stow in A-8.</p> <p>Assemblies stowed in compartment R-10.</p> <p>Lip of inner fecal bag covered with adhesive.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	<p>Seal inner fecal bag Rupture germicide pouch Knead contents for 4 min Insert into outer fecal bag Only subsequent to initial odor detection will waste stowage compartment be vented prior to each waste deposit WASTE STOW vlv - VENT for 30 sec, then CLOSE Stow fecal bag</p> <p>c. Emesis Obtain fecal/emesis (F/E) bag Perform task Insert germicide pouch (protective cover removed) into inner F/E bag Seal inner F/E bag Rupture germicide pouch Insert inner F/E bag into outer F/E bag & seal Only subsequent to initial odor detection will waste stowage compartment be vented prior to each waste deposit WASTE STOW vlv - VENT for 30 sec, then CLOSE Stow outer F/E bag</p>	252	<p>Remove air prior to sealing.</p> <p>Fecal matter stowed in waste stowage compartment.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
<p>d. Side Hatch Urine/Water Dump</p> <p>CMP</p>	<p>Remove dump nozzle conn cover</p> <p>Remove plug & stow Withdraw wire guard & wires from slot Install male QD on dump nozzle (finger-tight) Conn cable to htr conn (if req)</p> <p>UTIL PWR - OFF (verify) Conn cable to outlet UTIL PWR - on (up) If urine ovbd dump req Conn urine dump hose to dump nozzle QD If waste H2O ovbd dump req Install female QD on waste H2O servicing conn Conn urine dump hose to servicing conn & dump nozzle H2O QTY IND sw - WASTE WASTE TK SERV vlv - OPEN until WASTE H2O QTY ind - ≈25%, then CLOSE</p>	<p>Side hatch</p> <p>16</p> <p>352</p> <p>2</p> <p>352</p>	<p>Cable and quick-disconnects stowed in Volume R-10.</p> <p>Use tool E. Rotate cover as necessary to permit removal of electrical connector. Connector lock pins must be aligned with slots (3) in threaded portion of cover.</p> <p>Use tool E. Plug stowed in Volume R-10. Wire guard to hang loose on wiring.</p> <p>The side hatch dump nozzle heater need not be connected (crew option). CM orientation and previous cold soak should be considered when electing not to connect heater. If nozzle freezes, connect and use heater to thaw nozzle.</p> <p>Cabin to ambient ΔP will provide for urine flow.</p> <p>Use tool F to remove connector cap.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p style="text-align: center;"><u>CAUTION</u></p> <p>Depletion of all waste water may damage suit heat exchanger water separator.</p> <p>e. Water Collection Conn urine trnfr hose-filter to urine/feces QD Conn cab purge QD to urine trnfr hose OVBD DRAIN vlv - DUMP Collect water After collection is complete Purge until particles cease exhausting vent line (1 to 2 min) OVBD DRAIN vlv - CLOSE</p> <p>f. Vac Oper Using O2 Umb</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>Not to be used for H2O collection. Ingestion of H2O will cause swelling of CO2 cstr element.</p>	251	
CDR ALL	<p>DEMAND REG sel - OFF SUIT RETURN vlv - close (push) Install one screen & one inter-connect to two return hoses Install vac brush to third return hose</p>	380	Screens plus hose cause increased pressure drop in suit circuit causing O2 demand flow.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	SUIT FLOW vlv (3) - FULL FLOW	300,301,302	
CDR	At completion of vac SUIT RETURN vlv - open (pull)	380	
ALL	DEMAND REG sel - BOTH SUIT FLOW vlv (3) - CAB FLOW	300,301,302	
LMP	Remove vac brush & install screen cap on return hose		
4.5.4.8 <u>CM Repressurization</u>			
a. Norm Mode (time ≈21 min)			
CDR	CAB PRESS RELF vlv (2) - NORM (safety latch on)	325	
CMP	CAB PRESS DUMP vlv - close (CW) (verify)	Side hatch	
LMP	O2 PRESS IND sw - SURGE TK	2	
CDR	REPRESS PKG vlv - FILL	326	
LMP	REPRESS O2 - OPEN CRYO O2 PRESS 1 ind - 150 psia min	601 2	Guarded. Minimum surge tank pressure.
CDR	REPRESS PKG vlv - OFF	326	
LMP	CAB PRESS ind - 3.0 psia (in 1 min)	2	
CDR	REPRESS O2 PRESS ind - 0.0 psig	602	
CMP	REPRESS O2 - CLOSE	601	Guarded.
LMP	CAB REPRESS vlv - open (CW)	351	Maintain 150 psia minimum in surge tank.
LMP	CAB PRESS ind - 4.7-5.3 psia	2	
CMP	O2 PRESS IND sw - TK 1 CAB REPRESS vlv - OFF (CCW)	351	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	b. Alternate Mode (time ≈ 48 min) CAB PRESS RELF vlv (2) - NORM (safety latch on)	325	
CMP	CAB PRESS DUMP vlv - close (CW) (verify)	Side hatch	
LMP	EMER CAB PRESS sel - BOTH CAB REPRESS vlv - open (CW) 02 PRESS IND sw - SURGE TK CRYO 02 PRESS 1 ind - 150 psia min	351 2	Minimum surge tank pressure.
CMP	EMER CAB PRESS sel - OFF CAB REPRESS vlv - adj to 150 psia min	351	
LMP	CAB PRESS ind - 4.7-5.3 psia 02 PRESS IND sw - TK 1	2	
CMP	CAB REPRESS vlv - OFF (CCW)	351	
4.5.4.9 <u>Pressure Suit Circuit & PGA Check at 5.0 psia</u>			
a. Gross Suit Ckt Verification			This procedure may be used in lieu of step b, PGA Check Only, to ascertain complete suit loop integrity.
CDR	DIRECT 02 vlv - close (CW)	7	
CMP	SUIT PRESS ind - 4.7-5.3 psia 02 FLOW ind - 0.2-0.4 lb/hr	2	
<u>CAUTION</u>			
● SUIT TEST vlv should remain in PRESS position until suit ckt press is stab to preclude seal scarring.			
...continued			

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	<ul style="list-style-type: none"> • If repositioning of SUIT TEST vlv from PRESS is req prior to suit press stabilization, perform the following: <ul style="list-style-type: none"> a. DEMAND REG sel - OFF b. Allow 15 sec (min) stabilization time c. Reposition SUIT TEST vlv - DEPRESS or OFF as applicable d. When suit press stabilized, DEMAND REG sel - BOTH <p>SUIT TEST vlv - PRESS</p>	380	All crewmen exercise PGA joints during pressurization period. DIRECT O2 valve may be slightly opened to reduce suit loop pressurization time, but must be fully closed (CW) at 4.0 psig suit pressure.
CMP	O2 FLOW ind - 1.0 lb/hr (pegged)	2	After 16-second delay.
ALL	O2 FLOW HI lt - on		
CDR	MASTER ALARM pb/lt (3) - on, push	1,3,122	
CDR	Cycle SUIT RETURN vlv - open (pull) & close (push) when PGA press ind - 1.5-2.0 psig	380	Continue suit circuit pressurization until O2 flow starts to decrease.
CMP	SUIT PRESS ind - 8.8-9.8 psia	2	Crewmen remain inactive while monitoring suit circuit pressure and O2 flow indicator to preclude fluctuations in O2 flow. Monitoring should not be scheduled during H2O accumulator stroking (or 30 seconds thereafter), or accumulators should be temporarily disabled during test (SUIT H2O ACCUM AUTO - center, then back to previous position).

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL CMP	PGA press ind (3) - 4.1-4.5 psig O2 FLOW HI lt - out O2 FLOW ind - stab for 15 sec, & remain <0.8 lb/hr for 30 sec after stabilization	PGA 2	
CDR CMP	SUIT TEST vlv - DEPRESS O2 FLOW ind - 0.2-0.4 lb/hr SUIT PRESS ind - slightly >CAB PRESS ind	380 2	In ≈75 seconds.
CDR	SUIT TEST vlv - OFF DEMAND REG sel - BOTH (verify)	380	
	b. PGA Check Only		This procedure is performed only if individual or collective PGA verification is required.
CMP	DIRECT O2 vlv - close (CW) SUIT PRESS ind - 4.7-5.3 psia O2 FLOW ind - 0.2-0.4 lb/hr	7 2	
	<u>CAUTION</u> SUIT TEST vlv should remain in PRESS position until suit ckt press is stab to preclude seal scarring.		
CDR	SUIT TEST vlv - PRESS	380	All crewmen exercise PGA joints during pressurization period. DIRECT O2 valve may be slightly opened to reduce suit loop pressurization time, but must be fully closed (CW) at 4.0 psig suit pressure.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	O2 FLOW ind - 1.0 lb/hr (pegged)	2	
ALL	O2 FLOW HI lt - on		
CMP	MASTER ALARM pb/lt (3) - on,	1,3,122	
ALL	push		
CMP	SUIT PRESS ind - 8.8-9.8 psia	2	After ≈75 seconds.
ALL	PGA press ind (3) - 4.1-4.5 psig	PGA	
	<u>WARNING</u>		
	Suit flow vlv(s) may remain in OFF position for no longer than one min or asphyxiation may result.		
	<u>CAUTION</u>		
	If all suit flow vlvs are closed simultaneously, suit comprs must be shut off to prevent compr damage due to deadheading of suit loop.		
CMP	SUIT FLOW vlv (suited crew-	300,301,302	
ALL	men) - OFF		
CMP	PGA press ind (suited crew-	PGA	Crewmen hold breath and remain inactive while monitoring PGA pressure decay to preclude pressure drop or fluctuation on PGA pressure indicators.
ALL	men) - <0.5 psi/min press decay		
CMP	SUIT FLOW vlv (suited crew-	300,301,302	
ALL	men) - FULL FLOW		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>CAUTION</u>		
	If repositioning of SUIT TEST vlv from PRESS is req prior to suit press stabilization, perform the following:		
CDR	a. DEMAND REG sel - OFF	380	
	b. Allow 15 sec (min) stabilization time		
	c. Reposition SUIT TEST vlv - DEPRESS or OFF as applicable		
	d. When suit press stabilization, DEMAND REG sel - BOTH		
CMP	SUIT TEST vlv - DEPRESS 02 FLOW HI lt - out 02 FLOW ind - 0.2-0.4 lb/hr SUIT PRESS ind - slightly >CAB PRESS ind	2	In ≈75 seconds.
CDR	SUIT TEST vlv - OFF	380	
	4.5.4.10 <u>CM O2 Supply Refill</u>		
LMP	02 PRESS IND sw - SURGE TK CRYO O2 PRESS 1 ind - 400 psia	2	
CMP	CAB REPRESS vlv - OFF (CCW)	351	
CDR	REPRESS O2 - CLOSE REPRESS PKG vlv - FILL	601 326	Guarded.
CMP	CRYO O2 PRESS 1 ind - 865-935 psia	2	Monitor pressure to assure no decrease below 150 psia.
CDR	02 PRESS IND sw - TK 1 REPRESS PKG vlv - OFF	326	Upon completing refill operation.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.5.4.11 <u>CM Pressure Dump</u>		
	a. Using Cab Press Relf Vlv		
CMP	CAB FAN (both) - OFF (verify)	2	
CDR	DIRECT O2 vlv - close (CW)	7	
	rh CAB PRESS RELF vlv - DUMP (safety latch off)	325	Valve in DUMP position long enough for cabin pressure to decrease to ≈ 3.25 psia.
CMP	CAB PRESS ind - 3.0-3.25 psia	2	
CDR	rh CAB PRESS RELF vlv - BOOST/ENTR	325	
CMP	O2 FLOW ind - ≈ 0.24 lb/hr	2	Verifies cabin pressure regulator lockout.
	SUIT PRESS ind - 3.5-4.0 psia		Verifies suit demand pressure regulator aneroid function.
CDR	rh CAB PRESS RELF vlv - DUMP	325	
CMP	CAB PRESS ind - 0.0 psia (within 6 min)	2	Cabin at 0.01 psia within 4.5 minutes.
CDR	CAB PRESS RELF vlv (2) - NORM (safety latch on)	325	
	b. Using Side Hatch Cab Press Dump Vlv		
LMP	CAB FAN (both) - OFF (verify)	2	
CMP	EMER CAB PRESS sel - OFF	351	
CDR	REPRESS PKG vlv - OFF	326	
	If lone crewman oper REPRESS PKG vlv - FILL		REPRESS PKG valve should be in FILL position for lone crewman activities, as leaving valve in OFF reduces immediate repressurization capability to ≈ 1.8 psia, less than amount required to sustain life if suit ruptures.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	REPRESS 02 vlv - CLOSE	601	
CDR	DIRECT 02 vlv - close (CW) (verify)	7	
LMP	CAB PRESS DUMP vlv - open (CCW - one turn)	Side hatch	Valve in open position long enough for cabin pressure to decrease to ≈ 3.25 psia.
	CAB PRESS ind - 3.0-3.25 psia	2	
	CAB PRESS DUMP vlv - close (CW)	Side hatch	
	02 FLOW ind - < 0.5 lb/hr	2	Verifies cabin pressure regulator lockout and that EMER CAB PRESS selector is OFF.
	SUIT PRESS ind - 3.5-4.0 psia		Verifies suit demand pressure regulator aneroid function.
	CAB PRESS DUMP vlv - open (CCW)	Side hatch	Full open.
	CAB PRESS ind - ≈ 0 psia	2	
	CAB PRESS DUMP vlv - close (CW)	Side hatch	
4.5.4.12 <u>Suit Circuit Purge of H2</u>			
CDR	DIRECT 02 vlv - OPEN (CCW) for 1 min	7	Suit circuit pressure relief valve dumps hydrogen into cabin.
CMP	02 FLOW ind - 1.0 lb/hr (pegged)	2	
	02 FLOW HI lt - on		After 16-second time delay.
ALL	MASTER ALARM pb/lt (3) - on, push	1,3,122	
CDR	DIRECT 02 vlv - close (CW)	7	
CMP	02 FLOW HI lt - out	2	
	02 FLOW ind - 0.2 lb/hr (pegged)		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.5.4.13	<u>Cabin Cold-Soak Operation</u>		Secondary glycol loop placed in evaporative cooling mode, and routed only to suit circuit heat exchanger.
CMP	a. Activate Cold Soak Open cool cont atten pnl		Covers panel 382.
	<u>WARNING</u>		
	SUIT FLOW RELF vlv must remain OFF throughout mission or swelling of CO2 odor absorber filters may result.	382	
LMP	SUIT HT EXCH SEC GLY - FLOW SEC EVAP H2O CONT vlv - AUTO Close cool cont atten pnl		
CMP	CAB TEMP - MAN	2	
CMP	PRIM CAB TEMP vlv - COLD (CW)	303	Maximum cold position.
LMP	SEC CAB TEMP vlv - OFF (CCW)		Bypass cabin heat exchanger.
LMP	SUIT HT EXCH - BYP for 20 sec, then off (ctr)	2	
	ECS IND sel - SEC		
	SEC COOL PUMP - AC1		
	SEC GLY DISCH PRESS ind - 39-51 psig		
	SEC ACCUM QTY ind - 30-55%		
	SEC COOL EVAP - EVAP		
	SEC GLY EVAP OUT TEMP ind - 38°-50.5°F		
	SEC GLY EVAP STM PRESS ind		
	When boiling - 0.09-0.14 psia		
	Not boiling - >0.14 psia		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	ECS IND sel - PRIM RAD PRIM OUT TEMP ind - >-20°F If <-20°F SEC COOL EVAP - RSET for 58 sec min, then off (ctr) SEC COOL PUMP - off (ctr) SUIT HT EXCH - ON for 20 sec, then off (ctr)	2	Cold soak operation is stopped until RAD PRIM OUT TEMP indicator - >0°F.
CMP LMP	b. Deactivate Cold Soak SEC CAB TEMP vlv - MAX COOL (CW) CAB TEMP - AUTO SUIT HT EXCH - ON for 20 sec, then off (ctr) SEC COOL EVAP - RSET for 58 sec min, then off (ctr)	303 2	RSET closes steam pressure control valve. Steam pressure valve requires 58 seconds from full open to full close.
CMP	SEC COOL PUMP - off (ctr) Open cool cont atten pnl		
	<u>WARNING</u> SUIT FLOW RELF vlv must remain OFF throughout msn or swelling of CO2 odor absorber filters may result.	382	
	SEC EVAP H2O CONT vlv - OFF Close cool cont atten pnl		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>4.5.4.14 CM/LM Pressure Equalization</u>		
ALL	a. Vented LM PGAs donned & checked (refer to PGA Mode Changes, 4.5.4.6, & Pressure Suit Circuit & PGA Check at 5.0 psia, 4.5.4.9)		LM overhead hatch pressure dump valve open at launch. This procedure requires ≈30 minutes to complete.
CMP	WASTE STOW vlv - CLOSE	252	Required for transposition, docking, and LM ejection only.
LMP	02 PRESS IND sw - SURGE TK CRYO 02 PRESS 1 ind & REPRESS 02 PRESS ind - 865-935 psia (verify)	2	
CMP	EMER CAB PRESS sel - OFF (verify)	351	At reduced cabin pressure, unnecessary O2 consumption will occur if EMER CAB PRESS selector is not OFF.
CDR	REPRESS PKG vlv - OFF	326	
	<u>CAUTION</u>		
	Do not exceed cab press of 5.7 psia or cab press relf vlv will actuate.		
LMP	DIRECT O2 vlv - OPEN (CCW) O2 FLOW ind - 1.0 lb/hr (pegged) O2 FLOW HI lt - on	7 2	
ALL	MASTER ALARM pb/lt (3) - on, push	1,3,122	
LMP	SUIT CAB ΔP ind - >+2.0 in. H2O CAB PRESS ind - ≈5.7 psia	2	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	DIRECT O2 vlv - close (CW)	7	Cabin pressure should increase to ≈ 5.7 psia in ≈ 2 minutes. Surge tank pressure will decrease to ≈ 550 psia.
CMP	TUNL VENT vlv - LM/CM ΔP (verify) LM/CM ΔP ind - +4 psid (pegged) after 27.5 min	12	
LMP	CRYO O2 PRESS ind - 850 psia	2	Surge tank pressure will increase from 550 psia to 850 psia in ≈ 27.5 minutes after DIRECT O2 valve is closed.
CMP	PRESS EQUAL vlv - OPEN Fwd hatch		
	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>If unable to open PRESS EQUAL vlv, inform MSFN</p> <p>CM Pressure Dump, 4.5.4.11a Continue prep for LM ejection using pressurized PGAs CM Repressurization, 4.5.4.8a</p> <p>or TUNL VENT vlv - LM PRESS</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p>		Applicable to transposition, docking, and LM ejection. SIVB life limit does not permit alternate pressure equalization through TUNL VENT valve.
		12	
LMP	CAB PRESS ind - 4.5 psia	2	TUNL VENT valve requires ≈ 10 hours to pressurize tunnel and LM.
	PRESS EQUAL vlv - CLOSE Fwd hatch		
CMP	LM/CM ΔP ind - ≈ 3.1 psid Mon LM/CM ΔP ind for 3 min & verify ΔP stable	12	
LMP	PRESS EQUAL vlv - OPEN Fwd hatch		
	CAB PRESS ind - 4.0 psia	2	
CMP	REPRESS O2 - OPEN	601	
LMP	CAB PRESS ind - 5.7 psia (max)	2	Anticipated cabin pressure will be ≈ 5.0 psia.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Cycle REPRESS O2 as req between 4.0 & 5.7 psia limits until REPRESS O2 PRESS ind - ≈0.0 psia REPRESS O2 - CLOSE	601	LM and CM cabin should be equalized in pressure when REPRESS O2 bottles are empty. If not, excessive tunnel or LM cabin leakage is indicated.
LMP	CAB PRESS ind - >4.0 psia	2	
CMP	LM/CM ΔP ind - ≈0.0 psid	12	Permissible to proceed with hatch removal.
LMP	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX CAB PRESS ind does not stab above 4.0 psia & LM/CM ΔP ind - >0.0 psid	2	Pressure will continue to increase automatically through cabin pressure regulator.
CMP	PRESS EQUAL vlv - CLOSE PRESS EQUAL vlv opened periodically as CM press incr thru cab press until press is equalized at or above 4.0 psia XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Fwd hatch	
LMP	CRYO O2 PRESS 1 ind - 400 psia	2	
CDR	REPRESS PKG vlv - FILL until	326	
LMP	CRYO O2 PRESS 1 ind &	2	
CMP	REPRESS O2 PRESS ind - 865-935 psia	602	
CDR	REPRESS PKG vlv - OFF	326	
CMP	EMER CAB PRESS sel - BOTH	351	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>CAUTION</u>		
	TUNL VENT vlv should not be inadvertently left in LM PRESS position when CM & LM are separated, as O2 would be vented to amb thru a 1/4-inch line.		
CMP	TUNL VENT vlv - OFF WASTE STOW vlv - VENT	12 252	Required for transposition, docking, and LM ejection only.
	b. Pressurized LM		
	PGA donned & checked (refer to PGA Mode Changes, 4.5.4.6, & Pressure Suit Circuit & PGA Check at 5.0 psia, 4.5.4.9)		
LMP	O2 PRESS IND sw - SURGE TK CRYO O2 PRESS 1 ind - 865-935 psia (verify)	2	
CMP	EMER CAB PRESS sel - OFF (verify)	351	At reduced cabin pressure, unnecessary O2 consumption will occur if EMER CAB PRESS selector is not OFF.
CDR	REPRESS PKG vlv - OFF	326	
	DIRECT O2 vlv - OPEN (CCW)	7	
LMP	CAB PRESS ind - 5.5 psia	2	
CDR	DIRECT O2 vlv - close (CW) until	7	
LMP	O2 FLOW ind - <0.5 lb/hr	2	
CDR	DIRECT O2 vlv - OPEN (CCW) until O2 flow - 0.6 lb/hr	7	
CMP	TUNL VENT vlv - LM/CM ΔP LM/CM ΔP ind - +4 psid (pegged) PRESS EQUAL vlv - OPEN	12 Fwd hatch	

4.5.4.14

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX If unable to open PRESS EQUAL vlv TUNL VENT vlv - LM PRESS XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>	12	
	<p>LM/CM ΔP ind - ≈3 psid PRESS EQUAL vlv - CLOSE LM/CM ΔP ind - mon for 3 min & verify ΔP stable PRESS EQUAL vlv - OPEN LM/CM ΔP ind - 0.0 psid PRESS EQUAL vlv - CLOSE EMER CAB PRESS sel - BOTH</p>	<p>Fwd hatch 12 Fwd hatch 12 Fwd hatch 351</p>	
	<p><u>CAUTION</u></p> <p>TUNL VENT vlv should not be inadvertently left in LM PRESS position when CM & LM are separated, as O2 would be vented to amb thru a 1/4-inch line.</p>		
CDR	<p>TUNL VENT vlv - OFF DIRECT O2 vlv - close (CW) immediately after hatch close-out</p>	<p>12 7</p>	
	<p>4.5.4.15 <u>Operation of Emergency O2 Masks</u></p>		
LMP	EMER O2 - OPEN	600	Masks stowed on aft bulkhead aft of emergency O2 unit.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	Don emer O2 masks	AESB	Push mask pushbutton for continuous flow, otherwise mask is demand flow.
LMP	Doff emer O2 masks EMER O2 - CLOSE	600	
	<u>4.5.4.16 Waste Water Tank Drain</u>		
	H2O QTY IND sw - WASTE	2	
CMP	PRESS RELF sel - DUMP A	352	
LMP	Mon WASTE H2O QTY ind - decr WASTE H2O QTY ind - ~25%	2	
	<u>CAUTION</u>		
	Depletion of all waste water may damage suit heat exchanger water separator.		
CMP	PRESS RELF sel - 2	352	
	<u>4.5.4.17 Gas Separator Cartridge Servicing</u>		
	a. Remove separator cartridge from stowage		Stowed in volume A1.
	b. Attach separator to water pistol		Female port of separator will fit on water pistol probe.
	c. Trigger water pistol in short pulses until water is observed at separator outlet port		
	d. Wait 10 min		Allow 10 minutes for membrane wetting.

4.5.4.17

ENVIRONMENTAL CONTROL SYSTEM

STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>CAUTION</u>		
	Membrane can be damaged by pencils, screwdrivers, & other pointed objects.		
CMP	e. Use separator on water pistol or food prep unit as req	305	
4.5.4.18	<u>Primary Glycol Evaporator Operation</u>		
1	Activate prim evap GLY EVAP H2O FLOW - AUTO GLY EVAP STM AUTO - AUTO	2	
2	Deactivate prim evap GLY EVAP H2O FLOW - off (ctr) GLY EVAP STM AUTO - MAN GLY EVAP STM INCR - INCR for 58 sec min		INCR position is momentary. Steam pressure valve requires 58 seconds from full open to full close.
4.5.4.19	<u>Cabin Fan Lunar Dust Filter</u>		
1	Filter installation before LM/CM rndz Unstow filter & install over cab fan outlet (louvers full open) Place filter bellows in extd position CAB FAN (2) - on (up)	UEB 2	As close as is practical to LM/CM rendezvous. Filter stowage bag to remain in position in upper equipment bay adjacent to repress O2 panel. Activated when CM and LM hatches are removed.
2	Filter removal after LM/CM rndz		Cabin fans, with filter in place, to remain in operation for 4 hours after CM and LM hatches removed.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	After 4 hours CAB FAN (2) - OFF Place filter bellows in compressed position Position filter stowage bag over filter Loosen filter mounting snaps (2) & carefully remove & seal filter in stowage bag Secure filter stowage bag to top of stowage locker A13	2	The vacuum cleaner assembly may be used in LM as well as CM, because of length of power cable.
4.5.4.20	<u>Lunar Dust Vacuum Cleaner Operation</u>		
	Unstow vac cleaner & associated cmpnts (pwr cable, bag, hose, & brush)	AEB	
	AC UTIL PWR - OFF (verify)	201	
	Assemble cmpnts & conn pwr cable to pnl		
	AC UTIL PWR - on (up)		
	Vac cleaner pwr sw - ON		
	At completion of vac cleaner use		
	Vac cleaner pwr sw - OFF		
	AC UTIL PWR - OFF		
	Disconnect pwr cable & disassemble cmpnts		
	Stow vac cleaner & associated cmpnts	AEB	

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4.5.4.20

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4.5.5 CAUTION AND WARNING SYSTEM

CAUTION

Any or all of the system status lights should not be left illuminated for more than 10 minutes or overheating of the matrix will occur.

System management procedures for the C&WS consist of the following:

1. A procedure is provided for an operational test of the detection unit, system status lights, and MASTER ALARM pb/lt and tone. The test may be conducted at any time during the mission at discretion of crew.
2. An adjustment may be made at each orbital sunset to facilitate dark adaptation during period of orbital darkness.
3. Acknowledgement of system status light illumination and resetting of master alarm circuit is required. The procedures apply during prelaunch or any flight phase of the mission.
4. A procedure is provided for inhibiting master alarm tone in each headset, at discretion of the crew.
5. If one or more of the C&WS status lights are illuminated for more than 10 minutes, the status light matrix will become hot to the touch. The Acknowledge Mode may be used to prevent excessive on-time of status lights.
6. Installation procedures and an operational check for stowable C/W tone booster is presented.
7. During normal operations some C/W master alarms may illuminate. These alarms are listed, accompanied by information on what action should be taken to return C/W system to normal.

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.5.5.1 <u>C&WS Operational Check</u>			
CMP	C/W LAMP TEST - 1 (hold)	2	Position 1 is momentary. Lamp test of MASTER ALARM light on panel 122 accomplished when G&N condition lights on that panel tested. Master alarm tone not activated by this test.
CDR	MASTER ALARM pb/lt - on	1	
CMP	lh C/W lts (15) - on	2	Position 2 is momentary.
CMP	C/W LAMP TEST - 2 (hold)	2	
CDR	MASTER ALARM pb/lt - out	1	
CMP	lh C/W lts (15) - out	2	
LMP	MASTER ALARM pb/lt - on	3	
CMP	rh C/W lts (20) - on	2	
	C/W LAMP TEST - rel		
LMP	MASTER ALARM pb/lt - out	3	
CMP	rh C/W lts (20) - out	2	Master alarm tone activated by this test. Systems 1 and 2 status lights.
	C/W CSM - CM		
	CM RCS lt (both) - on		
ALL	MASTER ALARM pb/lt (3) & tone - on	1,3,122	MASTER ALARM light on MDC-1 will not come on if C/W NORM switch is in BOOST position.
	MASTER ALARM pb/lt - push		
	MASTER ALARM pb/lt (3) & tone - out		
CMP	C/W CSM - CSM	2	
	CM RCS lt (both) - out		
4.5.5.2 <u>Dark Adaptation Adjustment</u>			
	C/W NORM - ACK (at sunset)		
	C/W NORM - NORM (at sunrise)		

4.5.2.2

CAUTION AND WARNING SYSTEM

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.5.5.3 <u>Acknowledge/Reset Master Alarm Indication</u>		
ALL	a. Norm Mode MASTER ALARM pb/lt (3) & tone - on MASTER ALARM pb/lt (3) - push	1,3,122	All MASTER ALARM lights have reset capability. Pushing any light will reset alarm circuit unless C/W NORM switch in BOOST position. In this case, there is no reset capability with MASTER ALARM light on MDC-1.
CMP	MASTER ALARM pb/lt (3) & tone - out Applicable C/W lt - remains on	2	
ALL	b. Acknowledge Mode (C/W NORM in ACK) MASTER ALARM pb/lt (3) & tone - on	1,3,122	MASTER ALARM light on panel 122 does not have acknowledge capability.
CDR,LMP	MASTER ALARM pb/lt (2) - push & hold	1,3	
ALL	MASTER ALARM pb/lt (3) & tone - out	1,3,122	
CMP	Applicable C/W lt - on, for malfunction indication	2	
CDR,LMP CMP	MASTER ALARM pb/lt (2) - rel Applicable C/W lt - out	1,3 2	
	4.5.5.4 <u>Master Alarm Tone Headset Control</u>		
ALL	a. Inhibit Tone PWR (3) - AUDIO	9,10,6	Inhibit function may be selected individually or in any combination.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
ALL	b. Permit Tone PWR (3) - AUDIO/TONE	9,10,6	
	4.5.5.5 <u>Stowable C/W Tone Booster</u>		Provided for crew use during sleep cycle and is stowed during Boost and Entry under locker A3.
CDR,LMP	a. Installation UTIL PWR - OFF Install conn of tone booster Place light snsr over MASTER ALARM lt	15,16 1,3	Removes power from connector on panel 15(16). Velcro attached.
	UTIL PWR - on (up) Install tone beeper on LH (RH) girth shelf as req		Velcro attached.
CMP	b. Operational Check C/W LAMP TEST - 1(2) (hold, rel)	2	Activates tone beeper as long as switch is held in position 1(2).
	4.5.5.6 <u>Normal Operation C/W Master Alarms</u>		
<p>The following list denotes those C/W lamps which may illuminate during normal operation. In all cases except SM C/W lights at CM/SM separation, push MASTER ALARM pb/lt to clear MASTER ALARM before proceeding to corrective action.</p>			

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C/W Lamp (MDC-2)	Remarks	Corrective Action
FC BUS DISC	Occurs momentarily when connecting fuel cell to bus.	None
SM RCS A, B, C, & D SPS PRESS	Occurs at CM separation from SM because C/W CSM switch at CSM position.	C/W CSM - CM; MASTER ALARM pb/lt - push
SM RCS A, B, C, & D	High temperature may illuminate light during (1) boost heating, (2) ΔVs using SM RCS extensively with SIVB attached, or (3) transposition and docking using SM RCS extensively. During phase (1), MASTER ALARM on panel 1 inactive. During phases (2) or (3), normal operating ranges on indicators should be utilized.	None
O ₂ FLOW HI	Occurs (1) during cabin purge, and (2) if urine dump valve left open. May occur during urine dump.	Open cb ECS PRESS XDUCER 2 MNB (MDC-5).
CRYO PRESS	Limits may shift under flight conditions and cause low-limit warning during sleep periods.	Reference 4.5.3.7 & 4.5.3.10
FC 1, 2, & 3	Could occur when an H ₂ or O ₂ purge conducted.	None
BMAG 1 & 2	Occurs during power up.	BMAG PWR switch(es) should be left in WARMUP until light extinguished.

CAUTION AND WARNING SYSTEM

4.5.6 TELECOMMUNICATIONS

The T/C system will be in operation throughout entire mission. The information and procedures included here consist of normal and backup procedures that will be utilized to accomplish mission requirements and satisfy test objectives. Some of these procedures will only be required during tests or contingencies.

Most orbital paths will involve passage over several MSFN ground stations within acceptable slant ranges for S-band voice and data communications. Equipment necessary for voice communications, PCM, and TLM transmission will be activated and operating at all times. The UDL will also remain activated and capable of receiving up-data when required.

Action required of 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 SC attitude such that selected antenna is directed toward MSFN station or by changing antennas or antenna attitude with S-band antenna controls. Also, audio control panels (MDC-6, -9, and -10) must be set up in accordance with requirements of individual crewman for control of voice transmission and reception.

The reception of up-data for updating the CTE and receiving real-time commands (RTCs) will require no action on part of crew since the UDL will normally remain activated and will utilize the same antenna as that used for S-band voice and data operations. For updating command module computer, however, up-telemetry switches (panels 2 and 122) must be set to ACPT position.

The following procedures are presented with the assumption that appropriate electrical buses are powered and that proper circuit breakers are closed.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.5.6.1 <u>Basic Switch Configuration</u>		
LMP 1	Apply A-C pwr TELCOM GRP 1 - AC1 TELCOM GRP 2 - AC2	4	
ALL 2	Audio pnl (3) MODE (3) - INTERCOM/PTT S BD (3) - T/R SUIT PWR (3) - on (up) AUDIO CONT (3) - NORM PWR (3) - AUDIO/TONE VHF AM (3) - T/R INTERCOM (3) - T/R PAD COMM (3) - OFF VHF RNG - NORM	9,10,6	Each crewman's individual audio panel must be activated to enable him to receive or transmit voice signals. T/R position enables voice transmission and reception over selected audio channel. RCV position permits reception only.
CDR		9	
LMP 3	S band norm S BD XPNDR - PRIM	3	Whenever S BD XPNDR switch positioned from PRIM to SEC or from SEC to PRIM, hesitate momentarily in OFF position to allow relay actuation to follow switch action. S-band phaselock will be lost upon switching to alternate transponder. Phaselock must be re-established.
	S BD PWR AMPL PRIM - PRIM S BD PWR AMPL HI - HI S BD MODE VOICE - VOICE S BD MODE PCM - PCM S BD MODE RNG - RNG		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	4 S band aux S BD AUX TAPE - off (ctr) S BD AUX TV - off (ctr)	3	
	5 Up TLM UP TLM DATA - DATA UP TLM CMD - NORM PWR AMPL tb - gray TAPE MOTION tb - gray		Gray indicates power applied to S-band power amplifier. Gray indicates tape in motion.
	6 S band ant S BD ANT OMNI A - A S BD ANT OMNI - OMNI		If OMNI D is selected by crewman, ground switching capability will be lost. Since MSFN has the capability only to command OMNI D or to reset, manual selection of OMNI D essentially disables antenna command capability.
	7 VHF AM VHF AM A - SIMPLEX VHF AM B - off (ctr) VHF AM RCV - off (ctr) VHF AM SQLCH tw (2) - noise + 1		In the event marginal VHF voice communications is experienced and VHF voice communications is required, VHF receiver squelch may be disabled by setting the appropriate thumbwheel to 1. This will allow weak-signal reception, but will severely degrade DSE recorded voice.

4.5.6.1

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP 8	VHF BCN - OFF VHF RNG - OFF	3	
9	Tape rcdr TAPE RCDR PCM - PCM/ANLG TAPE RCDR RCD - RCD TAPE RCDR FWD - FWD		
10	Pwr SCE PWR - NORM PMP PWR - NORM		
11	TLM inputs PCM BIT RATE - LO		
12	VHF ANT - SM LEFT		
CMP 13	RNDZ XPNDR PWR - OFF	100	
14	RNDZ XPNDR TEST - OPR	101	
LMP 15	S BD SQLCH - ENBL	3	
4.5.6.2 <u>High Gain Antenna Operation</u>			
CMP	cb HI GAIN ANT (2) - close	225	
	HI GAIN ANT TRACK - MAN	2	
	HI GAIN ANT SERVO - PRIM		
	HI GAIN ANT BEAM - WIDE		
	HI GAIN ANT PWR - on (up)		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Determine req ant coordinates If IMU aligned, 4.8.1.16 If G&N not available, trial & error method must be used</p> <p>Verify that req coordinates are within full coverage region</p>		<p>Refer to CSM DATA BOOK, section 4.7, HGA Scan and Warning Limit, Yaw-Pitch Coordinates. Reliable acquisition can be accomplished with YAW-PITCH coordinates in full coverage region. In the CSM skin interference zone, RF reflections will cause no problems when operating in MANUAL, AUTO or REACQ mode, when in WIDE BEAM. After acquisition, the antenna will track through CSM skin interference zone and scan limit zone while in NARROW beam and in either AUTO or REACQ modes without incurring an interference problem.</p> <p>Should acquisition be attempted in the CSM skin interference zone in either NARROW or MEDIUM beam while in AUTO or REACQ mode, acquisition problems may be encountered. MSFN and SC will experience (a) low signal strength indicating lockup on a side lobe or (b) varying signal strength caused by antenna alternately switching between wide and narrow beamwidth. SC antenna pitch and yaw indicator will also provide visual indication of condition (b). Other indicators of the interference condition include noise or loss of voice or track loss.</p> <p>Upon detection of this situation, attempt one of the following.</p> <ol style="list-style-type: none"> a. Change CSM attitude to provide antenna coordinates in the full coverage region.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	HI GAIN ANT PITCH & YAW cont (2) - set in req coordinates	2	b. Allow up to 60 seconds for the expected CSM attitude variation to alleviate the condition. c. In attitude hold condition, operate in wide beam mode. d. Transfer to narrow beam and acquire earth manually.
LMP	If in earth orb S BD PWR AMPL HI - off (ctr)	3	
CMP	S BD ANT OMNI - HI GAIN S BD ANT ind - >1/2 scale HI GAIN ANT TRACK - AUTO or REACQ	2	With TRACK switch in REACQ, antenna will reposition to position control settings when the antenna reaches the scan limit. To prevent acquisition problems, predicted earth-rise should be set in the full coverage region.
	HI GAIN ANT BEAM - as desired S BD ANT ind - >1/2 scale When omni ant oper is desired HI GAIN ANT TRACK - MAN HI GAIN ANT PITCH cont - -52° HI GAIN ANT YAW cont - 270°		
	4.5.6.3 <u>S-Band Xponder Modes</u>		
LMP	Voice, RT-HBR Data, Ranging Sel BASIC except PCM BIT RATE - HI	3	
	Voice, RT-LBR Data, Ranging Sel BASIC		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	Voice, RT-HBR Data Sel BASIC except S BD MODE RNG - OFF PCM BIT RATE - HI Voice, RT-LBR Data Sel BASIC except S BD MODE RNG - OFF Voice & Ranging Sel BASIC except S BD MODE PCM - ctr Voice Sel BASIC except S BD MODE PCM - ctr S BD MODE RNG - OFF Voice & LBR PCM with Apollo/Recovery Instrumented Aircraft (A/RIA) Sel BASIC except S BD MODE RNG - OFF 4.5.6.4 <u>FM Xmtr Modes</u> Dump PCM/Analog Sel BASIC except TAPE RCDR FWD - REWIND S BD AUX TAPE - TAPE TAPE RCDR RCD - PLAY TAPE RCDR FWD - FWD (after rewind complete)	3	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	<p>TAPE MOTION tb - gray Rewind & return to BASIC</p> <p>Dump LM PCM Sel BASIC except TAPE RCDR FWD - REWIND S BD AUX TAPE - TAPE TAPE RCDR PCM - LM PCM TAPE RCDR RCD - PLAY TAPE RCDR FWD - FWD (after rewind complete) TAPE MOTION tb - gray Rewind & return to BASIC</p> <p>TV Camr Oper (black & white)</p> <p><u>WARNING</u></p> <p>Ensure that S BD AUX TV sw is off (ctr) prior to conn or disconnecting TV camr.</p> <p>Unstow camr, opt sight, lens, light atten, & cables S BD AUX TAPE - ctr, or DN VOICE BU</p> <p>S BD AUX TV - off (ctr) Conn pwr & RF cables Install proper lens (telephoto out of focus at <143 ft) (wide angle out of focus at <18 in.) Attach light atten to camr lens (atten clamps around barrel)</p>	3	<p>Gray indicates tape in motion.</p> <p>Gray indicates tape in motion.</p> <p>Positioning S BD AUX TAPE - TAPE, disables TV function.</p> <p>Camera is stowed with wide angle lens attached.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Mon pwr sw - on (up) Adj mon cont for best image (VER, HOR, BRT & CONT cont knobs) Adj cab lighting to max	Camr	
ALL	FLOOD LTS - OFF (CCW) FLOOD DIM - 1 FLOOD FIXED - OFF FLOOD LTS - full BRT (CW)	5,8,100	
CMP	Using mon, adj camr cont Lens aperture Zoom cont Focus cont To xmit to MSFN Camr xmit/stby sw - XMITT (up)	Camr	Transmission will begin immediately if power amplifier warmup time has been satisfied.
LMP	When TV oper is complete S BD AUX TV - ctr	3	
CMP	Disassemble & stow camr, mon, & cables		
ALL	Adj cab lighting as desired, 4.5.8		
	4.5.6.5 <u>VHF/AM Modes</u>		BASIC switch configuration provides CSM-MSFN voice, CSM-IM voice, and CM-recovery voice.
	Simplex A Select BASIC		
	Duplex A		
LMP	Sel BASIC except VHF AM A - DUPLEX		PLSS operation. Should not be used until after CSM/SIVB separation as MSFN transmission on VHF AM B will interfere with booster TM.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	Simplex B Sel BASIC except VHF AM B - SIMPLEX VHF AM A - off (ctr)	3	CM-recovery backup voice. Should not be used until after CSM/SIVB separation as MSFN transmission on VHF AM B will interfere with booster TM.
	Duplex B Sel BASIC except VHF AM B - DUPLEX VHF AM A - off (ctr)		PLSS backup operation.
	RCV ONLY A Sel BASIC except VHF AM RCV - A VHF AM A - off (ctr)		Provides capability to monitor recovery VHF voice transmissions.
	4.5.6.6 <u>VHF AM Ranging Mode</u>		Activation of VHF ranging significantly reduces voice capability. In the event marginal VHF voice communications is experienced and voice communications is required, both CSM and LM VHF ranging equipment (DRG and RTTA) may be turned off during the communication period to provide increase voice margin.
CMP	VHF AM A - off (ctr) VHF AM B - DUPLEX VHF RNG - on (up) If P20 operating & VHF AM ranging option selected TRACKER lt - on	2,140	The CMC will activate TRACKER light and wait for a "data good" signal from digital ranging generator.
CDR	EMS FUNC - VHF RNG EMS MODE - VHF RNG	1	

4.5.6.6

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>CAUTION</u>		
	There must be no VHF AM voice transmission by LM, CSM or MSFN for ≈12 sec after VHF RNG - RSET.	9	Voice transmission at this time could interfere with accuracy of ranging signal.
CDR	VHF RNG - RSET (1 sec min) RNG ind - B00000	1	Momentary up, hold for 1 second minimum. When VHF RNG switch is placed to RSET, RNG indicator will reset to zero, and operator will hear mid tone (3.95 kHz) and then low tone (2.47 kHz).
	If P20 operating & VHF AM ranging option selected		
CMP	TRACKER lt - out	2,140	TRACKER light - out (no OCDU failure) and RNG indicator starts counting up ≈4 seconds after termination of low tone. RNG indicator is interpreted as range in nautical miles to nearest .XXNM.
CDR	RNG ind - BXXXXX	1	
	4.5.6.7 <u>DSE Record Modes</u>		
	Record HBR CM Data, CM/IC, LM/IC, LM/PCM Sel BASIC except PCM BIT RATE - HI VHF AM RCV - B DATA	3	Under nominal conditions MSFN will control tape recorder operation. In order to dump LM PCM when recorded with CM PCM, two dumps are required.
LMP	Record LBR CM Data, CM/IC, LM/PCM, EVA/LM/IC Sel BASIC except VHF AM RCV - B DATA		In order to dump LM PCM when recorded with CM PCM, two dumps are required.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	Record HBR CM Data, EVA/LM/IC, CM/IC Sel BASIC except VHF AM A or B - DUPLEX PCM BIT RATE - HI	3	
	Record LBR CM Data, EVA/LM/IC, CM/IC Sel BASIC except VHF AM A or B - DUPLEX		
	4.5.6.8 <u>Relay Mode (LM Voice to MSFN)</u>		
	Voice Relay (With VHF Ranging)		
CMP	Sel BASIC except MODE - VOX VOX SENS tw - 5 S BD - OFF INTERCOM - OFF AUDIO CONT - BU	10	
CDR	MODE - VOX VOX SENS tw - as req	9	When operating in VOX mode, LM reply should be delayed 2 seconds to allow for VOX release time.
LMP	S BD MODE VOICE - RELAY VHF AM A - off (ctr) VHF AM B - DUPLEX VHF RNG - on (up)	3	
	Voice Relay (with LM LBR PCM record)		
CMP	Sel BASIC except MODE - VOX VOX SENS tw - 5	10	

4.5.6.8

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	S BD - OFF	10	
	INTERCOM - OFF		
	AUDIO CONT - BU		
CDR	MODE - VOX	9	When operating in VOX mode, LM reply should be delayed 2 seconds to allow for VOX release time.
	VOX SENS tw - as req		
LMP	S BD MODE VOICE - RELAY	3	
	VHF AM RCV - B DATA		
4.5.6.9 <u>Rendezvous Transponder Activation and Self Test</u>			
	RNDZ XPNDR PWR - HTR for 24 min, then on (up)	100	One minute warmup is required if self-test only is to be performed.
	SYS TEST (LH) - XPNDR	101	
	SYS TEST (RH) - A (RRT XMTR OUT PWR)		
	SYS TEST ind - >1.0 vdc		
	SYS TEST (RH) - B (RRT AGC SIG)		
	RNDZ XPNDR TEST - on (up)		On (up) position is momentary.
	SYS TEST ind - >1.0 vdc (self-test)		
	RNDZ XPNDR TEST - OPR		
	SYS TEST ind - 0-4.5 vdc (opr)		Indicates relative received signal strength, (preferred position during rendezvous).
	SYS TEST (RH) - C (RRT FREQ LOCK)		
	SYS TEST ind		
	Unlocked - <0.8 vdc		
	Locked - >4.0 vdc		RF lockup indicated by 4.0 vdc in OPR with LM interrogation.
	SYS TEST (RH) - B (RRT AGC SIG opr)		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.5.6.10 <u>Backup Modes</u>	<p>LMP</p> <p>Up Voice Backup Sel BASIC except UP TLM DATA - UP VOICE BU</p> <p>Down Voice Backup Sel BASIC except S BD MODE PCM - ctr S BD AUX TAPE - DN VOICE BU S BD MODE RNG - OFF PCM BIT RATE - HI</p> <p>Down Voice & LBR RT Data Backup Sel BASIC except S BD AUX TAPE - DN VOICE BU S BD MODE RNG - OFF</p> <p>Key Sel BASIC except S BD MODE PCM - KEY S BD MODE RNG - OFF</p> <p>Down Data Backup Sel BASIC except PMP PWR - AUX</p>	3	Requires coordination with MSFN. Udata signal (noise) will be present in headsets until MSFN reconfigures for this mode.
4.5.6.11 <u>Pad Communications</u>	<p>ALL</p> <p>Sel BASIC except TAPE RCDR FWD - off (ctr) Prior to launch PAD COMM (3) - T/R (or RCV) PAD COMM VOL tw (3) - as desired Launch -10:00 PAD COMM (3) - OFF</p>	9,10,6	PAD COMM switch can be used after launch for intercom backup with PAD COMM VOL thumbwheel decreased.

4.5.6.11

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STA/T STEP	PROCEDURE	REMARKS
	<p>4.5.7 MECHANICAL SYSTEMS</p> <p>Procedures for opening and closing side and forward hatches are presented in the following paragraphs, as well as procedure for operation of side hatch counterbalance mechanism. The procedures include operational performance from the interior and exterior of the CM.</p> <p>4.5.7.1 <u>Opening Side Hatch for EVT</u></p> <p>a. Opening Side Hatch From CM Interior Without Utilizing Counterbalance Mechanism</p> <p>PGAs donned & checked, 4.5.4.9 Procure tether & tool B & fasten to arm Dump CM press, 4.5.4.11</p> <p style="text-align: center;"><u>WARNING</u></p> <p>Counterbalance piston chamber must be vented prior to opening hatch in zero G.</p> <p>Deactivate counterbalance mechanism, 4.5.7.3, step a</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>To prevent shearing lock pin, set lock pin rel knob to UNLOCK prior to operating actr handle.</p>	<p>Tool B stowed in volume A1.</p>

MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Lock pin rel knob - UNLOCK [check that red shear pin is extd ≈0.5 inch (rh couch) &/or white ind is opposite yellow mark (ctr/lh couch)]</p> <p>Gear box sel - UNLATCH</p> <p>Actr handle sel - U (unlatch)</p> <p>Actr handle rel - push or squeeze</p> <p>Actr handle - opr (until hatch can be opened)</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>If hatch does not open normally & there are no crewmen EVA, do not proceed with attempt to open hatch.</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>If unable to open hatch & crewmen are EVA</p> <p>Recheck position of conts</p> <p>Ensure no foreign objects caught in hatch assy (latches, latch linkage, gear box linkage or hinges)</p> <p>Actr handle - opr (incr load)</p> <p>If still unable to open hatch</p> <p>Remove clevis pins (4 places) with tool B</p> <p>Move latches to unlatch position with tool F</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>	Side hatch	<p>Pin can be sheared if left in LOCK position.</p> <p>Push (button) or squeeze (bar) releases actuator handle for operation.</p> <p>Wrench flats are on each latch assembly.</p>

4.5.7.1

MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Actr handle sel - L Stow actr handle Gear box sel - LATCH	Side hatch	
ALL CMP	b. Open Side Hatch From CM Interior Using Counterbalance Mechanism PGAs donned & checked, 4.5.4.9 Dump CM press, 4.5.4.11 Vent piston chamber GN2 vlv handle - pull (inbd) GN2 press ind - min		
	<p style="text-align: center;"><u>CAUTION</u></p> To prevent shearing lock pin, set lock pin rel knob to UNLOCK prior to operating actr handle.		
	Lock pin rel knob - UNLOCK [check that red shear pin extd ≈0.5 inch (rh couch) &/or white ind opposite yellow mark (ctr/lh couch)] Gear box sel - UNLATCH Actr handle sel - U (unlatch) Actr handle rel - push or squeeze Actr handle - opr (until hatch latches are unlatched)		Pin can be sheared if left in LOCK position.
			Push (button) or squeeze (bar) releases actuator handle for operation.

MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>CAUTION</u>		
	If latches do not open normally, do not proceed with attempt to open hatch.		
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
CMP	If unable to open latches & return trnfr cannot be performed through CM/LM tunl Recheck position of conts Vent piston chamber GN2 vlv handle - pull (inbd) GN2 press ind - min Insure no foreign objects caught in hatch assy (latches, latch linkage, gear box linkage) Actr handle - opr (incr load) If still unable to open hatch Remove clevis pins (4 places with tool B Move latches to unlatch position with tool F	Side hatch	Wrench flats are on each latch assembly.
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	Actr handle sel - L Stow actr handle Gear box sel - LATCH		Prepares hatch for closing.

4.5.7.1

MECHANICAL SYSTEMS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<p><u>CAUTION</u></p> <p>Do not puncture second press bottle to open hatch. This press bottle is in reserve for postlanding.</p>		
CMP	<p>Pressurize piston chamber GN2 vlv handle - push slowly until hatch is open & locked</p>	<p>Side hatch</p>	
	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If unable to open hatch Insure no foreign objects caught in hatch hinges or counter- balance mechanism X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>		
	<p><u>CAUTION</u></p> <p>Do not disconnect hatch bellcrank with hatch in open position.</p> <p>Depressurize piston chamber GN2 vlv handle - pull inbd until GN2 press ind - min</p>		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If piston chamber will not vent Disengage counterbalance Tool B - insert into counterbalance locking pin Rot tool B (CCW) to stop (4-1/2 turns)</p> <p>X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>c. Opening Side Hatch From CM Exterior PGAs donned & checked, 4.5.4.9 Dump CM press CAB PRESS DUMP vlv - insert tool B, depress & rot (CW) to stop</p> <p style="text-align: center;"><u>WARNING</u></p> <p>Counterbalance piston chamber must be vented prior to opening hatch in zero G.</p> <p>Deactivate counterbalance mechanism, 4.5.7.3, step a Wait 70 sec min, then insert tool B in hatch actuation socket Rot CCW (368°) until hatch can be opened</p>	<p>Side hatch</p>	<p>Disengages piston bellcrank. Tool F may also be used. Counterbalance assist of hatch opening will not be available for postlanding.</p> <p>Depressing pressure equalization valve with tool B will release inside actuating handle from stowed position, and rotating to stop will open valve.</p> <p>Releases hatch latches.</p>

4.5.7.1

MECHANICAL SYSTEMS



STA/T STEP	PROCEDURE	PANEL	REMARKS
4.5.7.2	<u>Closing Side Hatch for EVT</u>		
CMP	<p>a. Closing Side Hatch From CM Interior</p> <p>Check EVT equip clear of hatch & hatch frame</p> <p>Actr handle sel - L (latch)</p> <p>Gear box sel - LATCH</p> <p>Open door rel handle - pull</p> <p>Verify latches are in open position</p> <p>Close hatch</p> <p>Open door rel handle - stow</p> <p>Actr handle rel - push or squeeze</p> <p>Actr handle - opr (while holding hatch closed)</p> <p>Verify hatch fully latched</p>	Side hatch	D-ring.
	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>If hatch does not latch</p> <p>Recheck position of conts</p> <p>Check latches for unlatch position</p> <p>Insure hatch is closed sufficiently for latches to engage</p> <p>Insure no foreign objects caught in hatch assy</p> <p>Actr handle - opr (incr load)</p> <p>If hatch still does not latch</p> <p>Install jackscrews (3) to restrain hatch in closed position</p> <p>Disconnect gearbox from linkage</p> <p>Remove clevis pins (4 places) with tool B</p>		<p>Left bank of latches (looking outboard) cannot be closed if gearbox fails in extreme open position but can be closed if actuator handle can be operated for one complete stroke towards closure.</p>

MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Move latches to latch position with tool F</p> <p>Install (2) clevis pins in threaded holes in linkage bell cranks of upper gearbox side & lower hinge side (clevis pins installed when ≈ half the threads are visible)</p>	Side hatch	Wrench flats are on each latch assembly.
	<p>If hatch still will not latch, tighten jackscrews (3) to close hatch</p>		<p>Four latches have kickers to force latch open during unlatch cycle. If one is jammed open, jackscrews will not close hatch to pressure seal and there will be ≈0.6 inch between hatch and seal. Latch must be unjammed or removed (using torque set screwdriver) to close hatch completely.</p>
	<p>Lock pin rel knob - LOCK (auto)</p> <p>LOCK PIN ind - not extd (rh couch) and/or that white ind is opposite white mark (ctr/lh couch)</p>		<p>Verifies lock pin has automatically engaged. Indicates lock pin is engaged.</p>
	<p>If hatch was opened from CM exterior & lock pin rel knob does not lock, LOCK PIN rset - RSET (push)</p>		
	<p>Actr handle - stowed position</p> <p>Actr handle sel - N (neut)</p> <p>Repressurize CM, 4.5.4.8</p>		

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4.5.7.2

MECHANICAL SYSTEMS



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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	b. Closing Side Hatch From CM Exterior Check EVT equip clear of hatch & hatch frame Actr handle sel - N (neut) Gear box sel - N (neut)	Side hatch	
LMP	Open door rel handle - pull		D-ring.
CMP	Close hatch		
LMP	Open door rel handle - stow		
LMP	Hatch actuation socket - insert tool B Rot CW (382°) to stop		Engages hatch latches.
CMP	Tool B - remove from socket LOCK PIN rset - RSET (push)		Engages lock pin. Mechanism will automatically return 14° (CCW) when tool B is removed.
	<p style="text-align: center;">XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If mechanism does not auto return 14° (CCW) when tool B is removed, reinsert tool B & man rot 14° (CCW) X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>		
	Lock pin rel knob - LOCK LOCK PIN ind - not extd (rh couch) and/or white ind opposite white mark (ctr/lh couch)		
LMP	If PRESS EQUAL VLV is open PRESS EQUAL VLV - insert tool B & rot (CCW) to stop Remove tool B Repressurize CM, 4.5.4.8		Seals CM pressure equalization valve.

MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>4.5.7.3 <u>Side Hatch Counterbalance Operation</u></p> <p>a. Deactivate Counterbalance Mechanism</p> <ol style="list-style-type: none"> 1. Vent piston chamber GN2 vlv handle - pull (inbd) GN2 press ind - min 2. Disengage counterbalance (crew option) <ol style="list-style-type: none"> (A) Counterbalance locking pin Tool B - insert into counterbalance locking pin Rot tool B (CCW) to stop (4-1/2 turns) or (B) Pip pin on counterbalance arm Pull pip pin connecting roller track fitting & bell crank Stow pip pin Push roller track fitting to end of track & check if roller will come off - stow roller(s) that can be removed <p>b. Activate Counterbalance Mechanism</p> <ol style="list-style-type: none"> 1. Engage counterbalance (if disengaged) <ol style="list-style-type: none"> (A) Counterbalance locking pin Tool B - insert into counterbalance locking pin 	<p>Side hatch</p> <p>R-10</p>	<p>Squeeze handle to unlock.</p> <p>Use either the pip pin or counterbalance locking pin to disengage counterbalance. Do not use both methods.</p> <p>Disengages piston bellcrank from hatch bellcrank. Tool F may also be used.</p> <p>Engage counterbalance by method used to disengage counterbalance: pip pin or counterbalance locking pin.</p>

4.5.7.3

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p style="text-align: center;"><u>CAUTION</u></p> <p>Do not continue torquing after locking nut has bottomed or roll pin may shear causing locking pin cap to become a loose part.</p>	Side hatch	<p>When installing counterbalance locking pin, verify that locking pin is aligned with hole in crank. After seating roll pin, do not apply any additional torque. Excessive torque will shear roll pin and cause locking pin cap to become a loose part. If this should happen, stow loose cap. This is not detrimental to operation of system. Once locking pin is engaged and cap has separated, counterbalance disconnect may be accomplished by pulling pip-pin or removing locking pin using tool F.</p>
LMP	<p>or (B) Pip-pin on counterbalance arm Remove roller(s) from stowage (if removed) & re-install on track fitting Remove pip-pin from stowage Conn counterbalance to track fitting with pip-pin</p> <p>2. Pressurize piston chamber GN2 vlv handle - push (outbd)</p> <p>GN2 press ind - green</p>		<p>Squeeze handle to unlock.</p> <p>GN2 pressure indicator will display charge bottle pressure when GN2 valve handle in charge position (outboard). To provide maximum assist, GN2 valve handle will be left in charge position through time counterbalance activated.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	<p style="text-align: center;">XXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If GN2 press ind - below green GN2 ratchet handle - opr XXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p>	Side hatch	
	4.5.7.4 <u>Opening Fwd Hatch</u>		
	a. Opening Fwd Hatch From CM Interior Equalize CM/LM press, 4.5.4.14		If required. Tunnel pressure integrity check is incorporated into these procedures.
	Actr handle rel - PULL & ROTATE	Tunl	To free actuator handle for operation, release is rotated to stop.
	Actr handle - pull to stop Actr handle sel - U (unlatch) Actr handle - push to stop Gearbox disconnect socket - U (verify) Actr handle sel - STOW Actr handle - push to stowed position		Actuator handle should move ≈80°.
	Remove & stow fwd hatch		Actuator handle should move ≈60° to release latches.
	b. Opening Fwd Hatch From CM Exterior PGAs donned & checked, 4.5.4.9		Actuator handle release automatically locks handle in stowed position.
ALL CDR	PRESS EQUAL vlv - OPEN	Fwd hatch	
	Tool B - insert, hold depressed & rot (CW)		
CMP	TUNL VENT vlv - LM/CM ΔP	12	Hatch should be stowed in LHEB.

4.5.7.4

MECHANICAL SYSTEMS



STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	LM/CM ΔP ind - 0.0 psid XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If CMP is unable to mon LM/CM ΔP ind when PRESS EQUAL vlv is positioned to OPEN, wait min of 60 sec before attempting to opr hatch actuation socket XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X	12	Report indication to CDR. Accuracy of gauge is +0.1 psi at -1.0 to +1.0 psid and 70°F, +0.2 psi at +1.0 to +4.0 psid and 70°F. LM pressure is normally 0.2 psia below that of CM.
CDR	Hatch actuation socket - insert tool B & rot (CCW) Remove & stow fwd hatch in LHEB 4.5.7.5 <u>Closing Fwd Hatch</u>	Tun1	Disconnects gear box and releases hatch latches.
LMP or CMP	Closing Fwd Hatch From CM Interior Obtain fwd hatch from stowage Position hatch against sealing surface Actr handle rel - PULL & ROTATE Actr handle - pull to stop Actr handle sel - L (latch) Actr handle - push to stop Verify gearbox disconnect socket is opposite L mark on hatch	Fwd hatch	Performed by LMP or CMP. Forward hatch stowed in LHEB. Align equivalent colored arrows. To free actuator handle for operation, release rotated to stop. Actuator handle should move ≈80°. Actuator handle should move ≈60° to engage latches.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP or CMP	Actr handle sel - STOW Actr handle - push to stowed position	Fwd hatch	Actuator handle release automatically locks handle in stowed position.
CDR	Push man gearbox lock (chrome tab) PRESS EQUAL vlv - CLOSE (CW)		Verifies that gear box lock is engaged. Yellow indicator pin must be in green zone and valve handle must be in yellow-band area (indicates valve is fully closed).
	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>X</p> <p>Cannot close PRESS EQUAL vlv Remove fwd hatch, 4.5.7.4 Insert Tool B in external tool interface for additional lever- age, hold depressed & rot (CCW) Install fwd hatch</p> <p>X</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>		
	Repressurize CM, 4.5.4.8		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.5.8 FLOODLIGHT OPERATING MODES			
4.5.8.1 <u>Prim Floodlight Mode</u>			
ALL	FLOOD LTS - OFF (CCW) FLOOD DIM - 1 FLOOD LTS - full dim or full BRT	5,8,100	
4.5.8.2 <u>Sec Floodlight Mode</u>			
	FLOOD LTS - OFF (CCW) FLOOD DIM - 2 FLOOD LTS - full BRT (CW)		Operation in secondary mode is a backup only to be used in the event of DIM-1 circuitry in-flight failure. The DIM-2, dimmed floodlight predicted operating life is ≈100 hours.

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APOLLO OPERATIONS HANDBOOK

FLOODLIGHT OPERATING MODES

4.6 G&C REFERENCE DATA

This section provides data which generally apply to all G&C procedures in sections 4.7 through 4.16 and 5.1 through 5.3. The data do not include procedures but contains information which may be referenced in various procedures, may contain application of procedures, or may be helpful in applying the procedures.

4.6.1 G&C OPERATING NOTES

G&C operating notes are separated into three categories: G&C operations, SCS operations, and G&N operations. Notes for G&C operations provide data associated with guidance and control functions in general while notes for SCS and G&N operations are more specific to their systems.

4.6.1.1 G&C Operations

1. ULLAGE: For ullage switch setup with or without attitude control, see figure 4.6-1. Normally, the setup should include attitude control.
2. RCS JET, VENT, RADIATOR, AND ANTENNA LOCATIONS: SM and CM RCS jets, vent, and radiator locations are illustrated in figure 4.6-2.
3. SCS LOGIC BUS POWER DISTRIBUTION: SCS logic bus circuit breakers on panel 8 provide MNA and MNB power to four SCS logic buses. Figure 4.6-3 delineates power source and power distribution for SCS controls (pushbuttons, functions, and switches).

Main bus power to SCS logic buses 1 and 4 is controlled only by the SCS logic bus circuit breakers on panel 8. Power to SCS logic buses 2 and 3 is controlled by SCS logic bus circuit breakers on panel 8 and the LOGIC 2/3 PWR switch on panel 7. Other than SCS TVC, equipment loads can only be removed from a specific logic bus by selecting acceptable control positions not powered by that bus. (See figure 4.6-3.)

Type of Ullage Desired		Required AUTO RCS Switch Positions (Jets Firing*)								RCS Jets* Providing Attitude Hold Capability	
		Pitch				Yaw				Pitch	Yaw
		A3	C3	A4	C4	B3	D3	B4	D4		
2 Jet-Quad A/C Pitch Jets C3 and A4	Without Attitude Control	OFF	MNA or MNB	MNA or MNB	OFF	MNA or MNB	OFF	OFF	MNA or MNB	None	B3 and D4
	With Attitude Control	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	OFF	OFF	MNA or MNB	A3 and C4	B3 and D4
2 Jet - Quad B/D Yaw Jets D3 and B4	Without Attitude Control	MNA or MNB	OFF	OFF	MNA or MNB	OFF	MNA or MNB	MNA or MNB	OFF	A3 and C4	None
	With Attitude Control	MNA or MNB	OFF	OFF	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	A3 and C4	B3 and D4
4 Jet - Quad ABCD Jets A4, B4, C3, D3	Without Attitude Control	OFF	MNA or MNB	MNA or MNB	OFF	OFF	MNA or MNB	MNA or MNB	OFF	None	None
	With Attitude Control	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	MNA or MNB	A3 and C4	B3 and D4

*See figure 4.6-2 for explanation of jet code.

Figure 4.6-1. SCS Ullage Setup

G&C OPERATIONS

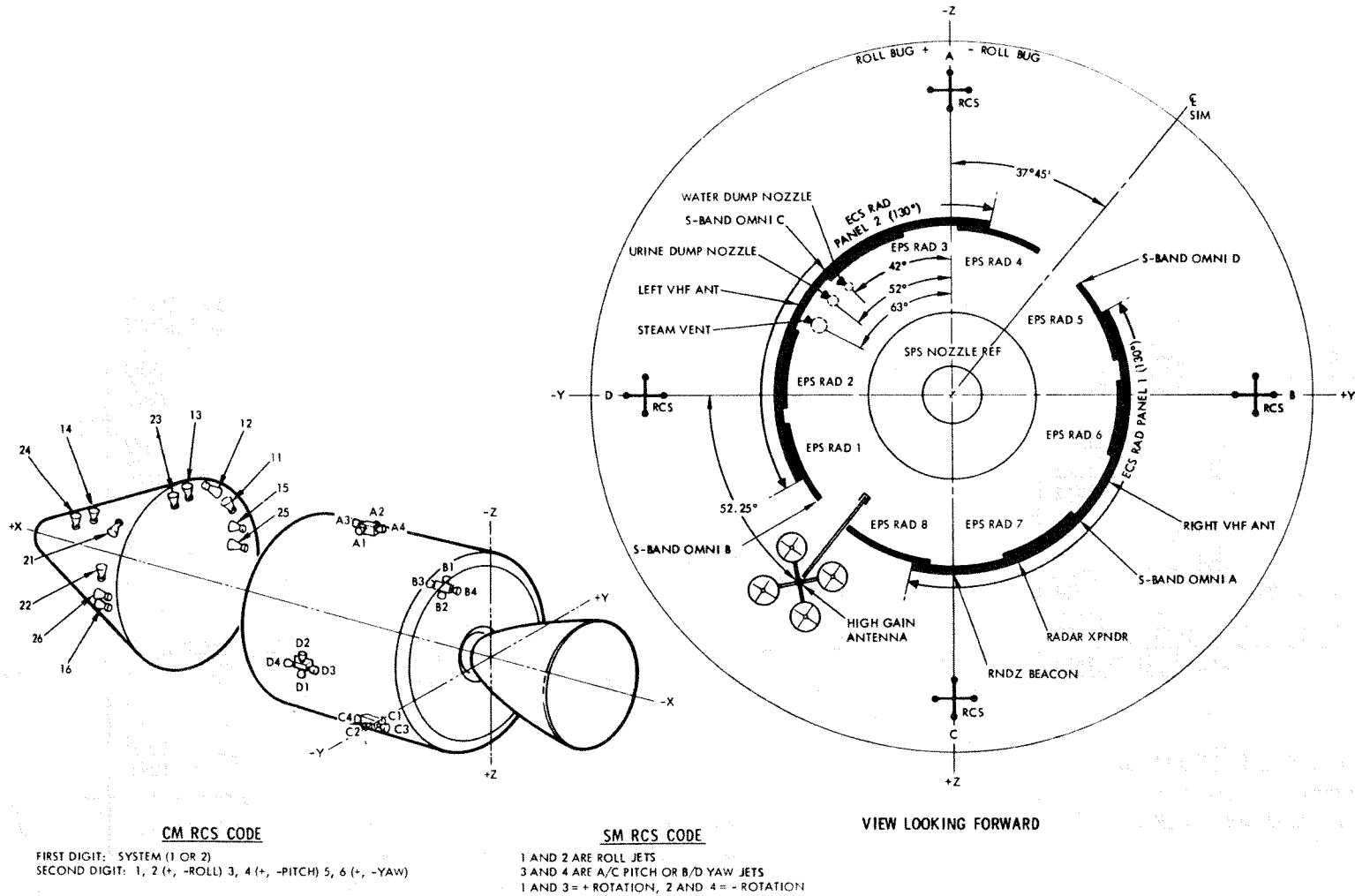


Figure 4.6-2. RCS Jet, Vent, Radiator, and Antenna Locations

SM-2A-2212

4.6.1.1

G&C OPERATIONS

CONTROLS		POWER SOURCE				POWER OFF	
		BUS 1 (cb direct)	BUS 2 (LOGIC 2/3 PWR sw)	BUS 3 (LOGIC 2/3 PWR sw)	BUS 4 (cb direct)	OPEN CIRCUIT	SWITCHED OFF BY
TITLE	POSITIONS						
CMC ATT	IMU	X			X		cb SCS LOGIC 1/2, 1/4, & 3/4
	GDC					X	
FDAI SCALE	5/1					X	
	5/5		X				LOGIC 2/3 PWR
	50/15/50/10				X		cb SCS LOGIC 1/4 & 3/4
FDAI SEL	1/2				X		cb SCS LOGIC 1/4 & 3/4
	1			X			LOGIC 2/3 PWR
	2			X			LOGIC 2/3 PWR
FDAI SOURCE	CMC		X				LOGIC 2/3 PWR
	ATT SET			X			LOGIC 2/3 PWR
	GDC			X			LOGIC 2/3 PWR
ATT SET	IMU		X				LOGIC 2/3 PWR
	GDC				X		cb SCS LOGIC 1/4 & 3/4
MAN ATT (3)	ACCEL CMD	X					cb SCS LOGIC 1/2 & 1/4
	RATE CMD					X	
	MIN IMP	X					cb SCS LOGIC 1/2 & 1/4
LIM CYCLE	on (up)					X	
	OFF	X					cb SCS LOGIC 1/2 & 1/4
ATT DBD	MAX					X	
	MIN	X					cb SCS LOGIC 1/2 & 1/4
RATE	HI	X					cb SCS LOGIC 1/2 & 1/4
	LO					X	

Figure 4.6-3. SCS Logic Bus Power Distribution (Sheet 1 of 2)

G&C OPERATIONS

CONTROLS		POWER SOURCE				POWER OFF	
		BUS 1 (cb direct)	BUS 2 (LOGIC 2/3 PWR sw)	BUS 3 (LOGIC 2/3 PWR sw)	BUS 4 (cb direct)	OPEN CIRCUIT	SWITCHED OFF BY
TITLE	POSITIONS						
SC CONT	CMC		X			LOGIC 2/3 PWR	
	SCS			X		LOGIC 2/3 PWR	
BMAG MODE	RATE 2		(R)	(P & Y)		LOGIC 2/3 PWR	
	ATT 1/RATE 2		(R)	(P & Y)		LOGIC 2/3 PWR	
	RATE 1	(R,P,Y)				cb SCS LOGIC 1/2 & 1/4	
DIR ULL	pb	X				cb SCS LOGIC 1/2 & 1/4	
THRUST ON	pb	X				cb SCS LOGIC 1/2 & 1/4	
GDC ALIGN	pb				X	cb SCS LOGIC 1/4 & 3/4	
SCS TVC (2)	AUTO			X		LOGIC 2/3 PWR	
	RATE CMD			X		LOGIC 2/3 PWR	
	ACCEL CMD			X		LOGIC 2/3 PWR	
ΔV CG	LM/CSM			X		LOGIC 2/3 PWR	
	CSM				X	LOGIC 2/3 PWR	
EMS ROLL	on (up)				X	cb SCS LOGIC 1/4 & 3/4	
	OFF				X		
.05 G sw	on (up)				X	cb SCS LOGIC 1/4 & 3/4	
	OFF		X			LOGIC 2/3 PWR	
TVC GMBL DR (2)	1				X		
	AUTO	X				cb SCS LOGIC 1/2 & 1/4	
	2			X		LOGIC 2/3 PWR	
THC	CW sw		X			LOGIC 2/3 PWR	

Figure 4.6-3. SCS Logic Bus Power Distribution (Sheet 2 of 2)

CAUTION

SCS logic bus power must not be removed from CMC ATT switch if (1) pitch or yaw rate $>5^\circ$ /second, or (2) GDC yaw Euler angle $>80^\circ$ and $<280^\circ$. Removing power when either of these conditions exist will result in GDC damage.

4. LIMITED USE CONTROLS: G&C circuit breakers, required for G&C operation, are to be closed during the entire mission except in event of malfunctions. (See figure 4.6-4.) If a malfunction occurs, some circuit breakers may be operated in order to isolate problem areas. Refer to malfunction procedures, section 5.2.

Figure 4.6-5 defines switches which will remain in same position during major portion of orbital flight time because of functional requirements. Other considerations are to maintain maximum crew safety, increase equipment reliability, and minimize power consumption.

5. ATT SET - IMU FUNCTION: If CMC is on, an overload in IMU resolver circuitry may cause an ICDU oscillation and trigger the ISS warning light (Reference ICD MH01-01325-216). FDAI must be used only as a null meter in this mode of operation. If not, large errors will result because of impedance mismatch. ATT SET switch should be left at GDC when not in use.

A polarity reversal occurs when ATT SET - IMU option is selected, and roll gimbal angle $>+90^\circ$. The pitch and yaw attitude error needles become "fly from" indicators rather than "fly to" indicators in this instance.

6. LOGIC 2/3 PWR switch: Required "on" for proper control/display functions (G&N or SCS modes). See figure 4.6-3 for switches whose positions are dependent on this switch being on for proper system operation.
7. MANEUVER $>17^\circ$: For CMC maneuvers $>17^\circ$ and during SIVB maneuvers, the BMAGs should be caged to prevent them from hitting their stops.

G&C OPERATIONS

The G&C circuit breakers listed in this chart must be closed throughout the mission except when necessary to correct a malfunction.

<p>Panel 8</p> <p>SCS</p> <p>TVC AC1</p> <p>AC (both)</p> <p>ECA/TVC AC2</p> <p>DIR ULL (2)</p> <p>CONTR DIR (4)</p> <p>CONTR AUTO (2)</p> <p>LOGIC (all)</p> <p>SYS (2)</p> <p>A/C ROLL (2)</p> <p>B/D ROLL (2)</p> <p>PITCH (2)</p> <p>YAW (2)</p> <p>ORDEAL (2)</p> <p>EMS (2)</p> <p>RCS</p> <p>SM HTRS (4)</p> <p>PRPLNT (2)</p> <p>SPS (12)</p>	<p>Panel 5</p> <p>G/N</p> <p>PWR AC (both)</p> <p>IMU (2)</p> <p>IMU HTR (2)</p> <p>CMPTR (2)</p> <p>OPT (2)</p> <p>Panel 229</p> <p>EPS</p> <p>GRP 1 (both)</p> <p>GRP 2 (both)</p> <p>GRP 3 (both)</p> <p>GRP 4 (both)</p> <p>GRP 5 (both)</p>
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Figure 4.6-4. Limited Use G&C Circuit Breakers

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Switch	Location	Position Major Portion of Mission	When Required	Remarks
CMC ATT	MDC-1	IMU	Normally not touched	Selection of GDC position causes total attitude display to be lost on both balls. Must not be moved to GDC position if (1) pitch or yaw rate is >5 deg/sec, or (2) GDC yaw Euler angle >80° and <280°. GDC damage will result if this is done.
IMU CAGE (guarded)	MDC-1	off (down)	To establish an inertial reference in event of CSS failure or IMU tumbling.	Cage mode zeros the IMU gimbals in a coarse alignment.
EMS ROLL	MDC-1	OFF	Prior to entry	Refer to Entry and Entry Preparation Procedures.
.05 G sw	MDC-1	OFF	At .05 G during entry	Except for entry, on (up) position not desirable (cages BMAGs). Off position powered by LOGIC 2/3 PWR - on (up).
α/Pc IND sw	MDC-1	Pc	Following launch tower jettison	Left in Pc position after tower jettison.
LV IND/GPI sw	MDC-1	GPI	Prior to SPS thrusting	Placed in SII/SIVB position during Prime Crew Prelaunch. Temporarily placed in GPI position for SPS gimbal check at lift off +6 minutes.
LV GUID	MDC-2	IU	If manual inputs to the SIVB control system are required	Nonfunctional after separation from SIVB.
UP TLM	LEB-122	ACPT	Not normally changed	Both UP TLM switches (MDC-2, LEB 122) must be in ACPT position for CMC to accept telem data. MDC-2 switch normally used as control.

Figure 4.6-5. Limited Use Controls

G&C OPERATIONS

8. ACCEL CMDs: Acceleration commands are available, via RHCs, any time MAN ATT switches are at ACCEL CMD (SC CONT - CMC or SCS). However, ACCEL CMD position inhibits any CMC outputs to RCS jets.
9. EMS MODE switch: EMS MODE switch should be placed to NORM <30 seconds prior to thrusting to minimize buildup of ΔV indicator errors, caused by accelerometer bias. Errors also minimized if set to STBY immediately after thrusting. Otherwise, ΔV ind continues counting.
10. MAN ATT/BMAG MODE switches: Switches may be set by axis, as desired.
11. SPS GMBL MOTORS: Start motors sequentially at ≈ 1 -second intervals to avoid electrical overload. Turn GMBL MOT switches OFF sequentially to avoid power surge. Turning servo 2 off first minimizes switching in the logic.
12. (R02) IMU STATUS check: Procedure prerequisites signify when ISS should be on and a known orientation required. Assuming that prerequisites have been complied with, program alarm for R02 should not occur. If prerequisites are not complied with, program alarm for ISS not on and/or IMU orientation unknown is treated as shown in 4.8.1.16.
13. CMC ATT switch: Normally left at IMU position throughout mission. Selection of GDC position causes total attitude display to be lost on both balls. GDC damage will result if GDC position selected and pitch or yaw rate is > 5 deg/sec, or if GDC yaw Euler angle is $> 80^\circ$ and $< 280^\circ$.

4.6.1.2 SCS Operations

1. SCS RATE/DEADBAND: During SCS attitude control modes (4.7.1), ATT DBD and RATE switch positions establish rate and deadband response. (See figure 4.6-6.) For FDAI scaling, see figure 4.6-7. Refer to 4.8.2.1 for selection of CMC controlled rate and deadband.
2. SCS JET SEL: Sixteen AUTO RCS switches, consisting of four switch groups titled A/C ROLL, B/D ROLL, PITCH, and YAW with four switches each, enable CM and/or SM jets. Panel nomenclature for AUTO RCS switches summarizes jet characteristics for both SM and CM RCS jets. See figure 4.6-8. Refer to 4.6.1.3, note 1d, and 4.8.2.1 for CMC jet selection.
3. INADVERTENT JET FIRINGS: When powering up SCS, BMAGs should be caged to prevent inadvertent firings of RCS jets.
4. PSEUDO RATE: The pseudo rate function, controlled by LIM CYCLE switch, is used only during SCS attitude hold mode to conserve RCS propellants. However, manual SCS maneuvers with LIM CYCLE switch on cause excessive RCS injector valve cycling and increased propellant consumption. Switch does not function when in computer (CMC) mode. Also refer to note 6.
5. SIG CONDR/DR BIAS PWR switch: Powers RJEC -4 vdc bias power supplies and various SCS signal conditioners for telemetry. To provide increased reliability, switches should not be set on same bus.
6. LIM CYCLE switch: For SCS modes, LIM CYCLE switch should be configured as follows in order to conserve RCS propellant:
 - OFF - Manual proportional rate command.
 - OFF - Automatic rate damping.
 - on (up) - Attitude hold.
7. BMAG PWR switch: When BMAG PWR switches set to OFF, 40-minute warmup may be required (BMAG 1 & 2 TEMP lights out when operating temperature reached) before normal operation of BMAGs. If set from ON to WARMUP, BMAG TEMP lights should remain out.

SCS OPERATIONS

Control Parameter		SWITCH POSITIONS			
		RATE - LOW*		RATE - HIGH	
		ATT DBD:		ATT DBD:	
		MIN	MAX*	MIN	MAX
Attitude Deadband		<u>+0.2°</u>	<u>+4.2°</u>	<u>+4.0°</u>	<u>+8.0°</u>
Commanded Rates	Pitch & Yaw	<u>+0.7°/sec</u>		<u>+7.0°/sec</u>	
	Roll			<u>+20.0°/sec</u>	
Rate Deadband		<u>+0.2°/sec</u>		<u>+2.0°/sec</u>	
*Recommended position to minimize fuel consumption during attitude hold.					

Figure 4.6-6. SCS Rate and Deadband Select Logic

FDAI SCALE SW POS	ATT ERROR			
	FLIGHT PHASE	CMC	SCS	SCS RATES
5/1	Boost & entry	R 20° P&Y 5°	RP&Y 5°	RP&Y 1°/sec
	All other	RP&Y 5°	RP&Y 5°	RP&Y 1°/sec
5/5	Boost & entry	R 20° P&Y 5°	RP&Y 5°	RP&Y 5°/sec
	All other	RP&Y 5°	RP&Y 5°	RP&Y 5°/sec
50/15, 50/10	Boost & entry	R 50°	R 50°	R 50°/sec
		P&Y 15°	P&Y 15°	P&Y 10°/sec
	All other	R 12.5°	R 50°	R 50°/sec
		P&Y 15°	P&Y 15°	P&Y 10°/sec

Figure 4.6-7. FDAI Scaling

SCS OPERATIONS

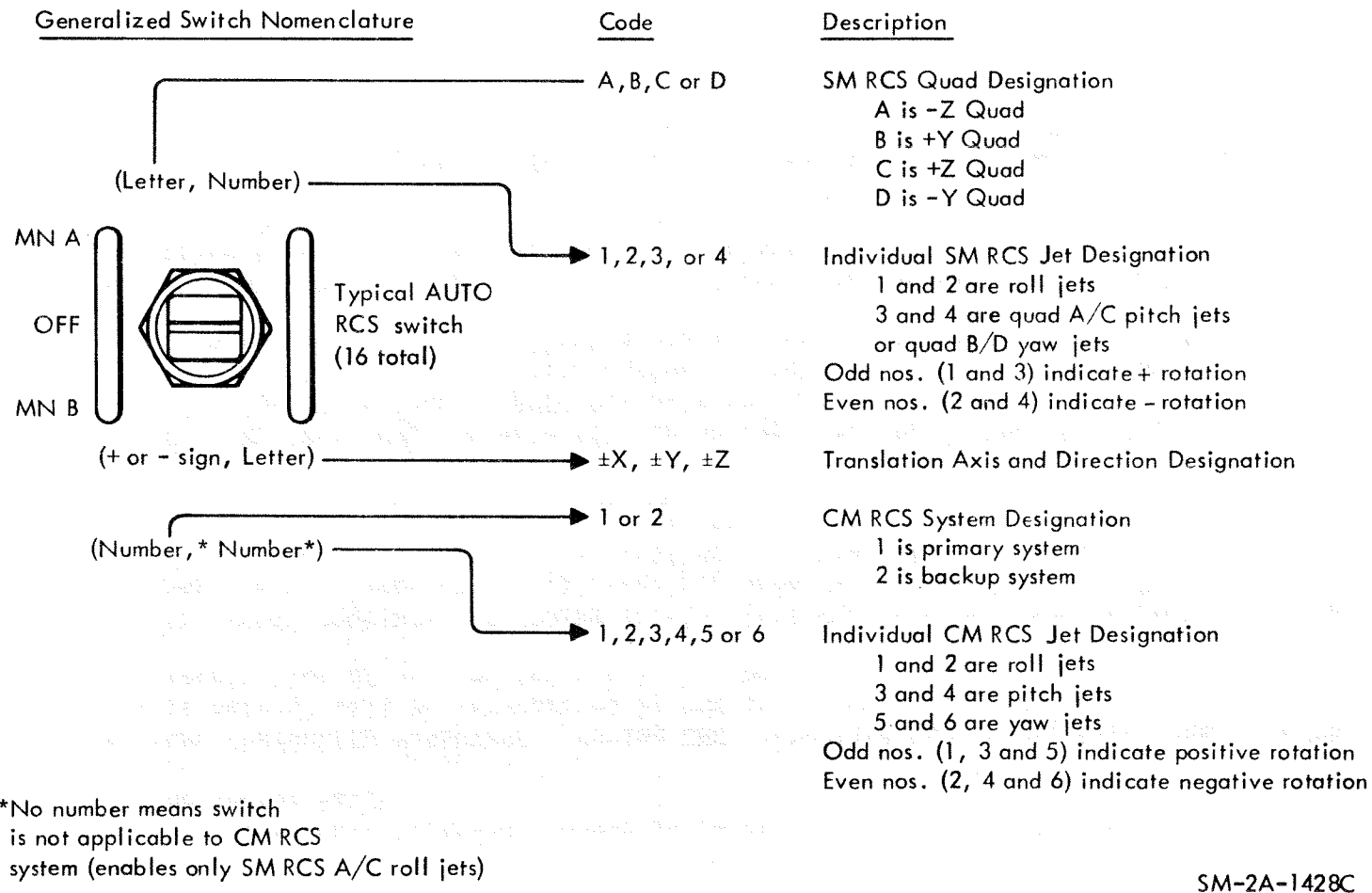


Figure 4.6-8. SCS Jet Select Logic: MDC-8 Nomenclature

4.6.1.3 G&N Operations

1. GENERAL:

- a. IMU STBY PWR: If standby power is removed for more than 20 minutes, ISS calibration is no longer valid.
- b. CMC CONTROLLED MANEUVERS: During CMC controlled maneuvers, any input from RHC (RHC out of detent) will be interpreted by CMC as a manual override and will cause immediate termination of auto maneuver calculation.
- c. VEC POINT ROUTINE: VEC POINT routine (all CMC auto maneuvers except in P23 and R62) may compute large OGA (roll) required when +X must be rotated $\approx 180^\circ$. Sensitivity to such changes gets greater as magnitude increases toward 180° . If desired, a manual maneuver in pitch $\approx 30^\circ$ is performed and the solution is then recomputed by keying PRO on FL V50 N18 while not in CMC/AUTO.
- d. CMC JET SEL: CMC jet selection is accomplished by performing procedure 4.8.2.1, V48 (R03, DAP Data Load). AUTO RCS switches should correspond to RCS DAP configuration. During SPS thrusting, configuration for AUTO RCS roll enable should agree with RCS DAP load to reduce SPS propellant slosh in event of a failed-on roll jet.
- e. IMU GMBL LOCK: If non-G&N controlled attitude maneuvers are made by crew, care must be taken to avoid IMU gimbal lock. IMU gimbal angles may be monitored by observing ICDUs (V16 N20) or by monitoring FDAI ball.
- f. CMC PWR: If computer power is switched off, it will be necessary to perform a computer fresh start (V36E) to initialize erasable storage. CMC update program (P27) would have to be done to update the state vector and computer clock time.
- g. CLOCK TIME (GET): CMC is capable of maintaining an accurate value of ground elapsed time (GET) for only 23 hours when in standby mode. If CMC is not brought out of standby condition to running condition at least once within 23 hours, CMC value of GET must be updated.

G&N OPERATIONS

- h. IMU ORIENTATION (P51): Time and RCS prplnt may be saved, and subsequent IMU alignment decisions greatly simplified if P51 is performed in such a way as to leave IMU inertially stabilized at an orientation as close as possible to optimum orientation required by future CMC programs.
2. CSS/ISS INTERFACE: Normally the CMC must be ON before the IMU can be operated. However, the IMU may be powered up while the CMC is at STBY. In this condition, the IMU is caged (if powered up) and remains in a coarse align mode. Caging is accomplished internally and does not require any panel switching. However, if the CMC is at STBY, the IMU can be uncaged by placing the IMU CAGE switch to on (up) for ≈ 5 seconds. V37 should not be called for 15 seconds after NO ATT light goes out. If V37 is called prior to 15 seconds, the PIPA FAIL bit will not be reset and a PIPA FAIL will go undetected.
3. DSKY OPERATIONS: DSKY operations (MDC-2 and LEB-140) require certain restrictions to operation, loading of data, and display of data which are necessary to proper operation. Some general restrictions are listed below. Detailed information relative to DSKY operations is contained in MIT Report E-2129, "Keyboard and Display Program and Operation."
- a. DISPLAY/MONITOR VERBS: For display verbs (01-07), monitor verbs (11-17), 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 beginning with noun 04. Noun 01, 02, and 03 may be used with any verb regardless of number of components. If an attempt is made to violate this restriction, the OPR ERR indicator will illuminate when ENTR is pressed to execute the verb/noun action.
- b. OCTAL/DECIMAL MIXING: 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 OPR ERR indicator will illuminate when ENTR is pressed for the last entry.
- c. DECIMAL/OCTAL LOADS: Octal data loads require only significant digits be keyed (e.g., 5, 4, ENTR). Loading decimal data requires each complete entry be made with a sign (+, -), followed by significant digits. Decimal load of less than 5 digits will be

accepted, just as an octal load. Zeros need not be entered ahead of most significant digit. (E.g., for a data load of +925, entry will be made by pressing DSKY keys +, 9, 2, 5, ENTR, and +, ENTR rather than +, 0, 0, 0, 0, 0, ENTR.) When loading decimal data, ENTR sometimes changes last digit of loaded value.

- d. MACHINE ADDRESSES: Machine addresses must be loaded in octal.
- e. DATA LOAD: If an attempt is made to load a data word which is too large in magnitude for the noun being used, the OPR ERR indicator will illuminate.

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

- f. VERB/NOUN FLASHES: All VERB/NOUN flashes require operator action and the program in progress is halted until appropriate action is taken.
- g. PROGRAM SELECTIONS: At times when program selection is not allowable by astronaut action (V37E XXE), ROO will issue a program alarm (01520) and interrupted activity will resume. Attempts to select nonexistent programs will result in an operator error light and return to interrupted program activity and display.
- h. PROGRAM TERMINATION: Any program can be terminated at a flashing display via V34E except:
- When P20 is running in background of another program, a V34E on a P20 display (R60 or N49 in R22) will terminate P20 only. Conversely, a V34E on a prethrust program will turn off that program but not P20.
 - V34E with an extended verb running will terminate the extended verb only.
 - V34E is ignored in P06.

G&N OPERATIONS

- i. V96E: V96E may cause significant loss of W-matrix correlation if keyed in:
- After a V37E XXE from a program using average G and before XX appears in PROG lights.
 - During a permanent state vector integration in P20 during mark processing.

To recover, V93E is keyed at some time prior to next navigation marks or VHF range input. In all other cases, use of V96E will cause no ill effects providing next program selected is P00.

- j. V82E: After V82E, meaningful information in N50 (splash error) is available only during P11 and P00.
- k. EXTENDED VERBS: Extended verbs are not restart-protected. If RESTART light goes on during an extended verb, or if software restart occurs (no RESTART light), the verb should be reselected.
- l. VG/ Δ V DISPLAYS: VG or Δ V displays in control coordinates, N85 or N83, are based on reading accelerometers every 2 seconds. Displays, however, are asynchronous 1-second monitors. Result is a possible 1/2- to 1-1/2-second delay between application of Δ V and visible result.
- m. PRO KEY: A PRO key input is rejected if verb windows show a V21, V22, or V23. V33E must be used for these cases, e.g., a V21 PRO (or V25E PRO) will be rejected; a V25 PRO will not. For the V21, V22, V23 and PRO cases, PRO lights OPR ERR light.
- n. KEY REL pb/KEY REL lt: Normal and special cases of KEY REL light and KEY REL push-button use are discussed in the following notes.

KEY REL lt - on

- When internal display comes up while operator has DSKY.
- When internal flashing display is currently on DSKY and keystroke is made except for PRO, ENTR, and ERR RSET.

- Suspended monitor: When operator makes keystroke on top of (his own) monitor verbs (verbs 11-17).
 - Remains on after V37 until new program is started. Operator should not use keyboard until KEY REL light is out and new program number is displayed.
- o. KEY REL lt - out
- When operator relinquishes DSKY by pressing KEY REL.
 - When operator terminates his current sequence normally by:
 - Final ENTR of load sequence
 - or ENTR, after a response to a flashing display (V34E)
 - or ENTR, after an extended verb request (V49E).
- p. Special cases of KEY REL
- If operator selects a nonmonitor verb display on top of his own previously selected monitor verb, the KEY REL light will flash. Pressing KEY REL will bring back (unsuspend) the monitor and extinguish light. However, if these sequences are performed on top of an internal display, the KEY REL light will not go out when KEY REL is pressed. One more KEY REL operation (total of two) is required to extinguish KEY REL light, and bring back the internal display.
 - If operator selects a verb-noun combination (i.e., V16 monitor) on top of an internal flashing display, the internal display can still be answered with V32E, PRO, or V34E, which wipes everything from the DSKY until the next internal display. However, an operator-selected monitor should, as a rule, never be terminated with V34E. V34E may not be the desired response to the internal flashing display. KEY REL should be used instead. KEY REL need not be used if a data load is interrupted by a priority display.

4. OPTICS MECHANIZATION: Operation of the SCT and SXT requires adherence to certain constraints which are described as follows:
- a. To avoid sun interference, the sun position must be more than 10 degrees from optics shaft-drive axis and more than 15 degrees from star LOS for SXT, and more than 55 degrees from shaft-drive axis for SCT. Within these limits it is possible to use SXT even when sun position is between the SLOS and LLOS. The constraints given, however, do not take into account light scattering which can occur from actual spacecraft configuration.
 - b. An adequate portion of the star field must be visible through SCT in order that navigational stars can be recognized. The optics shaft-drive axis thus must be pointed at least 30 degrees above local sunlit earth horizon and at least 20 degrees above local dark earth horizon.
 - c. Maximum SXT LOS drive rates are 10 deg/sec for trunnion and 19.5 deg/sec for shaft, with a +20 percent tolerance. During landmark tracking from a 100-nautical mile earth orbit, in order to be able to maintain optics LOS within the capability of shaft-drive rate, optics LOS to the landmark must be >8.5 degrees from optics shaft-drive-axis ground track at closest point of approach of landmark to shaft-drive-axis ground track. Within this constraint, landmarks on spacecraft ground track can be used by simply rolling CSM so that optic LOS is >8.5 degrees from optics shaft-drive-axis LOS.
 - d. TRACKER caution light should be ignored during TVC. Optics CDU fail during TVC, sets TRACKER light which will stay on (even with fail removed) until end of TVC or keying RSET.
 - e. During auto optics, computation lag between sampling IMU CDUs and driving optics causes optics to lag behind target. Amount of offset is proportional to CSM angular rate. At usual rate of 4 deg/min, maximum offset would be 0.133°. This will not cause an error during manual tracking and marking.
 - f. After a fresh start, or restart, or after turning optics power on, optics must be taken out of zero and returned to zero to perform an optics zero since it is not position of switch but change to zero position that triggers zeroing program.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.6.2	VERB LIST		
	Regular Verbs		
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 (R1, R2, R3)		
06	Disp dec (R1 or R1, R2 or R1, R2, R3)		
07	Disp DP dec - test only (R1, R2)		
11	Mon oct compnt 1 (R1)		
12	Mon oct compnt 2 (R1)		
13	Mon oct compnt 3 (R1)		
14	Mon oct compnt 1, 2 (R1, R2)		
15	Mon oct compnt 1, 2, 3 (R1, R2, R3)		
16	Mon dec (R1 or R1, R2 or R1, R2, R3)		
17	Mon DP dec - test only (R1, R2)		
21	Load compnt 1 (R1)		
22	Load compnt 2 (R2)		
23	Load compnt 3 (R3)		
24	Load compnt 1, 2 (R1, R2)		
25	Load compnt 1, 2, 3 (R1, R2, R3)		
27	Disp fixed memory		
30	Request exec		
31	Request waitlist		
32	Recycle		
33	Proceed		
			V33E must be used for accept option if V21, V22, or V23 is in verb window. PRO is not accepted and turns on OPR ERR light.
			Use in P00 only.
			Use in P00 only.

VERB LIST

STA/T STEP	PROCEDURE	PANEL	REMARKS
34	Terminate		
35	Test lights		Use in P00 only.
36	Req fresh strt		Blanks DSKY displays. May compromise stored state vector requiring a P27 update and IMU orientation determination.
37	Change prog (major mode)		
	Extended Verbs		
*40	Zero CDU (with N20)		Ensures sync between ISS CDU counters and CDU counters in CMC. Terminates coarse align and enters fine align.
41	Coarse align CDU (with N20 & N91)		N20 - Aligns IMU to gimbal angles specified by crew. To coarse align to 0, 0, 0 when GMBL LOCK and coarse align. N91 - To drive optics to shaft and trunnion angles specified by crew (V41 N91 from P00 only).
42	Pulse torque gyro		Fine align IMU.
43	Load FDAI att err needles (test only)		P00 only.
*44	Set surface flag		
*45	Rset surface flag		
*46	Activate DAP		
*47	Set LM state vctr into CSM state vctr		
48	Strt DAP data load (R03)		Calls up routine 03.
49	Strt crew defined mnvr (R62)		P00 only.
50	Please perform		
51	Please mrk		
	*Callable with another extended verb in use & does not lock out other extended verbs.		

4.6.2

VERB LIST

STA/T STEP	PROCEDURE	PANEL	REMARKS
*52	Marked on offset ldg site (P22)		
53	Please mrk alternate LOS		
54	Strt rndz backup sighting mrk (R23)		
55	Increment CMC time (dec)		
*56	Term tracking (P20)		
57	Strt rndz sighting mrk (R21)		
*58	Rset stick flag, set V50 N18 flag		Allows auto maneuvers.
59	Please mrk (opt calib)		
*60	Set att err ref to present att		
*61	Sel mode 1 (disp DAP att err)		Mode 1. FDAI error needles show difference between current and DAP commanded ICDU angles.
*62	Sel mode 2 (disp tot att err)		Mode 2. Display difference between desired final ICDUs (N22) and present ICDUs (N20) resolved into CSM control axes.
*63	Disp tot astronaut att err		Mode 3. Display difference between astronaut total attitude (N17) and present ICDUs (N20) resolved into CSM control axes.
64	Strt S-bd ant routine (R05)		
*65	Strt opt verif of prelaunch align - P03		V65E calls for P03 (during P02 only).
*66	Set CSM state vctr into LM state vctr		
67	Strt W matrix RSS err disp		
*69	Restrt		
70	Strt CMC update - liftoff time (P27)		V70 through V73 are allowed only during P00 or P02.
71	Strt CMC update - block ADR (P27)		
72	Strt CMC update - single ADR (P27)		
73	Strt CMC update - CMC time (P27)		
	*Callable with another extended verb in use & does not lock out other extended verbs.		

VERB LIST

STA/T STEP	PROCEDURE	PANEL	REMARKS
*74	Init erasable dump via downlink		
*75	Backup liftoff		
*76	Set pref att flag		
*77	Rset pref att flag		
*78	Update prelaunch az		
79	Req orbrate/PTC (BBQ mode - R64)		
*80	Enbl LM state vctr update		
*81	Enbl CSM state vctr update		
82	Req orb param disp (R30)		V82E calls R30.
83	Req rndz param disp #1 (R31)		V83E calls R31. V83 and V85 displays will be meaningless at altitudes >432 NM for both earth and moon if exercised during periods of precision vector integration.
85	Req rndz param disp #2 (R34)		V85E calls R34.
*86	Reject rndz backup sighting mrk		
*87	Set VHF range flag		
*88	Rset VHF range flag		
89	Strt rndz fnl att routine (R63)		V89E calls R63 from P00 only.
90	Req rndz out of plane disp (R36)		V90E calls R36.
91	Banksum		P00 only.
*93	Enbl W matrix init		
*94	Enbl cislunar tracking recycle (P23)		
*96	Term integration & go to P00.		
97	SPS thrust fail (R40)		
99	Enbl eng ign		
*Callable with another extended verb in use & does not lock out other extended verbs.			

4.6.2

VERB LIST

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.6.3	NOUN LIST		All nouns may be loaded via DSKY entry. However, registers containing units of XXBXX cannot be loaded and nouns containing such register data cannot be loaded by V2 ⁴ or V25.
01	Specify address (fract)	.XXXXX .XXXXX .XXXXX	
02	Specify address (whole)	XXXXX. XXXXX. XXXXX.	
03	Specify address (deg)	XXX.XX XXX.XX XXX.XX	
+05	Angular err/diff	XXX.XX DEG	
+06	Option code ID	OCT	
	Option code	OCT	
+07	Flagword	ECADR OCT BIT ID OCT ACTION OCT	ECADR <30 (octal) will select appropriate channel (except that channel 7 attempts will be ignored).
08	Alarm data	ADRES OCT BBCON OCT ERCOUNT OCT	
09	Alarm codes	FIRST OCT SECOND OCT LAST OCT	
10	Chan to be specified	OCT	
11	GETI (CSI)	OOXXX. HRS OOOXX. MIN OXX.XX SEC	
	+Nouns not manually callable with valid data at any time.		

NOUN LIST

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STA/T STEP	PROCEDURE	PANEL	REMARKS
+12	Option code	OCT	Used only with extended verbs.
		OCT	
13	GETI (CDH)	00XXX. HRS 000XX. MIN OXX.XX SEC	
15	Increment address	OCT	Used with N01, N02, and N03.
+16	Time of event	00XXX. HRS 000XX. MIN OXX.XX SEC	Used by extended verb only.
17	Astronaut tot	R XXX.XX DEG	Used in Mode 3 needles (V63).
	att	P XXX.XX DEG	
		Y XXX.XX DEG	
18	Auto mnvr	R XXX.XX DEG	
		P XXX.XX DEG	
		Y XXX.XX DEG	
20	ICDU angles	OG-R XXX.XX DEG	
		IG-P XXX.XX DEG	
		MG-Y XXX.XX DEG	
21	PIPAS	X XXXXX. Pulses	
		Y XXXXX. Pulses	
		Z XXXXX. Pulses	
22	New ICDU angles	OG-R XXX.XX DEG	
		IG-P XXX.XX DEG	
		MG-Y XXX.XX DEG	
+24	Δ time for CMC clock	00XXX. HRS 000XX. MIN OXX.XX SEC	V25 N24 display initiated by V55E.
+25	Checklist	XXXXX.	Used with V50.
+26	Prio/delay	OCT	Used with V30, V31.
	ADRES	OCT	
	BBCON	OCT	
+Nouns not manually callable with valid data at any time.			

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NOUN LIST



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STA/T STEP	PROCEDURE	PANEL	REMARKS
27	Self-test on/off sw	XXXXX.	
+29	X SM launch az	XXX.XX DEG	
+30	Trgt code (gyro com- passing verif)	XXXXX. XXXXX. XXXXX.	
32	TF perigee	00XXX. HRS 000XX. MIN 0XX.XX SEC	Time from perigee/perilune.
33	GETI	00XXX. HRS 000XX. MIN 0XX.XX SEC	GETI - ground elapsed time of ignition.
+34	Time of evnt	00XXX. HRS 000XX. MIN 0XX.XX SEC	
35	Time from evnt	00XXX. HRS 000XX. MIN 0XX.XX SEC	
36	Time of CMC clock	00XXX. HRS 000XX. MIN 0XX.XX SEC	
37	GETI (TPI)	00XXX. HRS 000XX. MIN 0XX.XX SEC	
38	Time of state vctr	00XXX. HRS 000XX. MIN 0XX.XX SEC	
39	ΔT for trnfr	00XXX. HRS 000XX. MIN 0XX.XX SEC	
40	TF GETI/TFC VG ΔV (accum)	XXBXX MIN-SEC XXXX.X FPS XXXX.X FPS	This is a no load noun (OPR ERR).
+Nouns not manually callable with valid data at any time.			

NOUN LIST

STA/T STEP	PROCEDURE	PANEL	REMARKS	
+41	Trgt	Az Elev ID	XXX.XX DEG XX.XXX DEG 0000X.	N41 - 2 component noun.
42	Ha Hp ΔV (req)		XXXX.X NM XXXX.X NM XXXX.X FPS	Apogee/apolune altitude. Perigee/perilune altitude.
43	Lat (+N) Long (+E) Alt		XXX.XX DEG XXX.XX DEG XXXX.X NM	
44	Ha Hp		XXXX.X NM XXXX.X NM	Apogee altitude. This is a no load noun (OPR ERR). Perigee altitude.
	TFF	XXBXX	MIN-SEC	Time of freefall to 49.4 NM (300,000 ft) above launch pad radius for earth orbit, or for lunar orbit, 5.8 NM (35,000 ft) above lunar radius at most recently defined lunar landing site.
45	Mrks (VHF/opt) TF GETI (next burn) MGA	XXBXX XXBXX XXX.XX	MKS MIN-SEC DEG	This is a no load noun (OPR ERR).
46	DAP config	OCT		Loads configuration for use by DAPS.
47	CSM wt LM wt	XXXXX.	LB LB	Loads vehicle weights for use by DAPS.
48	Pitch trim Yaw trim	XXX.XX	DEG DEG	Loads pitch and yaw trim angles.
49	ΔR ΔV Code	XXXX.X XXXX.X 0000X.	NM FPS	
+Nouns not manually callable with valid data at any time.				

4.6.3

NOUN LIST

STA/T STEP	PROCEDURE	PANEL	REMARKS
50	Splash err	XXXX.X NM	Negative for undershoot, positive for overshoot. This is a no load noun (OPR ERR).
	Hp	XXXX.X NM	
	TFF	XXBXX MIN-SEC	Time of freefall.
51	Rho	XXX.XX DEG	
	Gamma	XXX.XX DEG	
52	CENTANG (active veh)	XXX.XX DEG	Central angle of active vehicle.
53	Range	XXX.XX NM	
	Range rate	XXXX.X FPS	
	Phi (lcl horiz/SLOS)	XXX.XX DEG	0 to 180° = SLOS above plane.
54	Range	XXX.XX NM	Range to LM.
	Range rate	XXXX.X FPS	
	Theta (lcl horiz/ CSM +X)	XXX.XX DEG	0 to 180° = +X above plane.
55	NN	0000X.	Display definition depends on using program/routine. Elevation.
	E	XXX.XX DEG	
	CENTANG (passive veh)	XXX.XX DEG	Central angle of passive vehicle.
56	Reentry angle	XXX.XX DEG	
	ΔV	XXXXX. FPS	
58	Hp (post TPI)	XXXX.X NM	Perigee alt (post TPI).
	ΔV (TPI)	XXXX.X FPS	
	ΔV (TPF)	XXXX.X FPS	
59	ΔV LOS 1	XXXX.X FPS	
	ΔV LOS 2	XXXX.X FPS	
	ΔV LOS 3	XXXX.X FPS	
60	G max	XXX.XX G	
	V pred	XXXXX. FPS	
	Gamma EI [lcl horiz/VI (+up)]	XXX.XX DEG	
61	Impact Lat (+N)	XXX.XX DEG	
	Impact Long (+E)	XXX.XX DEG	
	Hds up/down (+Hds up)	+/-00001.	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
62	VI H dot H pad	XXXXX. FPS XXXXX. FPS XXXX.X NM	Inertial velocity. Altitude rate. Altitude above pad radius (earth orbit) or landing site radius (lunar orbit).
63	RTOGO (.05 G to splash)	XXXX.X NM	One shot display, should always be positive. .05 G represents pad loaded altitude. This is a no load noun (OPR ERR).
64	VIO (at .05 G) TFE (time from .05 G) Drag accel VI Range to splash	XXXXX. FPS XXBXX MIN-SEC XXX.XX G XXXXX. FPS XXXX.X NM	Predicted inertial velocity. Inertial velocity. Negative and counting down when approaching target; positive and counting up when leaving target.
65	Sampled CMC time	00XXX. HRS 000XX. MIN 0XX.XX SEC	Fetches in interrupt.
66	Beta CRSRNG ERR	XXX.XX DEG XXXX.X NM	Commanded bank angle. Positive to right of plane (LATANG +South); negative to left of plane (-North).
	DNRNG ERR	XXXX.X NM	Negative for undershoot (PREDANGLE -θ); positive for overshoot.
67	Range to splash Lat [Present pos (+N)] Long [Present pos (+E)]	XXXX.X NM XXX.XX DEG XXX.XX DEG	Negative counting down for approaching target; positive counting up for leaving target.

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NOUN LIST

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STA/T STEP	PROCEDURE	PANEL	REMARKS
68	Beta VI H dot	XXX.XX DEG XXXXX. FPS XXXXX. FPS	Commanded bank angle. Inertial velocity. Altitude rate.
69	Beta DL VL	XXX.XX DEG XXX.XX G XXXXX. FPS	Beta - commanded bank angle. DL - drag acceleration at end of up-control. VL - velocity at end of up-control.
70	Star code (before mrk) Lmk data Horiz data	OCT OCT OCT	
71	Star code (after mrk) Lmk data Horiz data	OCT OCT OCT	
73	Alt/10 VI Gamma	XXXXX. NM XXXXX. FPS XXX.XX DEG	On call in P21.
74	Beta VI Drag accel	XXX.XX DEG XXXXX. FPS XXX.XX G	
75	Δ alt (CDH) Δ T (CDH -CSI or TPI -CDH) Δ T (TPI -CDH or TPI -NOM TPI)	XXXX.X NM XXBXX MIN-SEC XXBXX MIN-SEC	
79	Rate DBD Axis option (X or Y)	X.XXXX DEG/SEC XXX.XX DEG 0000X.	Used with V79. 0 = X (PTC), non-zero = Y (orbrate).
80	Time to ign (cutoff) VG Δ V (accum)	XXBXX MIN-SEC XXXXX. FPS XXXXX. FPS	
81	Δ VX (lcl vert) Δ VY (lcl vert) Δ VZ (lcl vert)	XXXX.X FPS XXXX.X FPS XXXX.X FPS	(Δ V components).

NOUN LIST

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STA/T STEP	PROCEDURE	PANEL	REMARKS
82	ΔVX (lcl vert)	XXXX.X FPS	
	ΔVY (lcl vert)	XXXX.X FPS	
	ΔVZ (lcl vert)	XXXX.X FPS	
83	ΔVX (cont)	XXXX.X FPS	(ΔV components) control = CSM control axes.
	ΔVY (cont)	XXXX.X FPS	
	ΔVZ (cont)	XXXX.X FPS	
84	ΔVX (other veh)	XXXX.X FPS	(ΔV components).
	ΔVY (other veh)	XXXX.X FPS	
	ΔVZ (other veh)	XXXX.X FPS	
85	VGX (cont)	XXXX.X FPS	(VG vector components) control = CSM control axes.
	VGY (cont)	XXXX.X FPS	
	VGZ (cont)	XXXX.X FPS	
86	ΔVX (lcl vert)	XXXXX. FPS	
	ΔVY (lcl vert)	XXXXX. FPS	
	ΔVZ (lcl vert)	XXXXX. FPS	
87	Mrk data	Shft XXX.XX DEG	
		Trun XX.XXX DEG	
88	Planet	X .XXXXX	Unit position vector.
		Y .XXXXX	
		Z .XXXXX	
89	Lmk	Lat (+N) XX.XXX DEG	
		Long/2 (+E) XX.XXX DEG	
		Alt XXX.XX NM	
90	Rndz out of plane param	Y XXX.XX NM	
		Y Dot XXXX.X FPS	
		Psi XXX.XX DEG	
91	Present OCDU angles	Shft XXX.XX DEG	
		Trun XX.XXX DEG	
92	New OCDU angles	Shft XXX.XX DEG	
		Trun XX.XXX DEG	
93	Δ gyro angles	X Gyro XX.XXX DEG	
		Y Gyro XX.XXX DEG	
		Z Gyro XX.XXX DEG	

4.6.3

NOUN LIST



STA/T STEP		PROCEDURE	PANEL	REMARKS						
4.6.4 STAR LIST				Vis Mag, Right Ascension and Declination data are relative to the numerical list.						
NO.	STAR NAME	STAR NAME	NO.	Vis Mag	Right Ascension			Declination		
	(Numerical)	(Alphabetical)			(hr)	(min)	(sec)	(deg)	(min)	(sec)
1	Alpheratz	Acamar	6	2.1	0	06	49.9	+28	55	29
2	Diphda	Achernar	4	2.2	0	42	05.0	-18	09	04
3	Navi	Acrux	25	Var	0	54	53.0	+60	33	17
4	Achernar	Aldebaran	11	0.6	1	36	35.9	-57	23	20
5	Polaris	Alkaid	27	2.1	2	03	18.9	+89	07	34
6	Acamar	Alphard	21	3.4	2	57	07.4	-40	25	27
7	Menkar	Alphecca	32	2.8	3	00	42.5	+03	58	23
10	Mirfak	Alpheratz	1	1.9	3	22	10.3	+49	45	21
11	Aldebaran	Altair	40	1.1	4	34	11.8	+16	27	01
12	Rigel	Antares	33	0.3	5	13	05.7	-08	14	06
13	Capella	Arcturus	31	0.2	5	14	28.2	+45	58	10
14	Canopus	Atria	34	-0.9	6	23	17.1	-52	40	44
15	Sirius	Canopus	14	-1.6	6	43	49.6	-16	40	25
16	Procyon	Capella	13	0.5	7	37	43.9	+05	18	11
17	Regor	Dabih	41	1.9	8	08	36.4	-47	14	51
20	Dnoces	Deneb	43	3.1	8	57	09.7	+48	09	38
21	Alphard	Denebola	23	2.2	9	26	06.8	-08	31	40
22	Regulus	Diphda	2	1.3	10	06	46.5	+12	06	52
23	Denebola	Dnoces	20	2.2	11	47	31.8	+14	44	23
24	Gienah	Enif	44	2.8	12	14	15.6	-17	22	32
25	Acrux	Fomalhaut	45	1.0	12	24	54.9	-62	55	59
26	Spica	Gienah	24	1.2	13	23	36.6	-11	00	19
27	Alkaid	Menkar	7	1.9	13	46	21.6	+49	27	45

4.6.4

STAR LIST

STA/T STEP		PROCEDURE		PANEL	REMARKS					
<u>NO.</u>	<u>STAR NAME</u> (Numerical)	<u>STAR NAME</u> (Alphabetical)	<u>NO.</u>	Vis Mag	Right Ascension			Declination		
					(hr)	(min)	(sec)	(deg)	(min)	(sec)
30	Menkent	Menkent	30	2.3	14	04	54.6	-36	13	23
31	Arcturus	Mirfak	10	0.2	14	14	17.5	+19	20	16
32	Alphecca	Navi	3	2.3	15	33	25.0	+26	48	53
33	Antares	Nunki	37	1.2	16	27	33.9	-26	22	01
34	Atria	Peacock	42	1.9	16	45	28.3	-68	58	31
35	Rasalhague	Polaris	5	2.1	17	33	32.4	+12	34	50
36	Vega	Procyon	16	0.1	18	35	55.3	+38	45	17
37	Nunki	Rasalhague	35	2.1	18	53	24.3	-26	20	08
40	Altair	Regor	17	0.9	19	49	19.1	+08	47	16
41	Dabih	Regulus	22	3.2	20	19	19.6	-14	49	38
42	Peacock	Rigel	12	2.1	20	23	17.0	-56	50	58
43	Deneb	Sirius	15	1.3	20	40	24.4	+45	10	21
44	Enif	Spica	26	2.5	21	42	42.7	+09	44	12
45	Fomalhaut	Vega	36	1.3	22	55	59.7	-29	46	54

STAR LIST

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.6.5 CHECKLIST REFERENCE CODES (V50 N25)			
<u>Rl Code</u>	<u>ACTION</u>	<u>FUNCTION</u>	
00013	Perform	Coarse align or pulse torque	
00014	Perform	Fine align option	
00015	Perform	Trgt acq	
00016	Key in	Term mrk seq	
00041	Sw	CM/SM sep to up	
00062	Sw	CMC pwr down	
00202	Perform	G&N auto mnvr	
00204	Perform	Enbl gmb1 trim option	
			Target (celestial body) acquisition - Used in conjunction with N70, N71 and the following celestial body codes: 00 - Planet (any planet except Earth) 01 to 45 - Star 46 - Sun 47 - Earth 50 - Moon

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4.6.5

CHECKLIST REFERENCE CODES (V50 N25)

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.6.6 OPTION CODES (V04 N06 or V04 N12)			
<u>R1 Code</u>	<u>Purpose</u>	<u>Input for R2</u>	
00001	Specify IMU orientation	1 = PREF 2 = NOM 3 = REFSMMAT 4 = Ldg site	Specified option codes will be flashed in R1 in conjunction with V04 N06 or V04 N12. Requests desired option be loaded into R2.
00002	Specify veh	1 = This veh 2 = Other veh	
00003	Specify tracking att	1 = PREF 2 = +X axis	
00007	Specify propul sys	1 = SPS 2 = RCS	

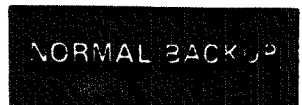
OPTION CODES (V04 N06 OR V04 N12)

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STA/T STEP	PROCEDURE	PANEL	REMARKS																				
4.6.7	<p>ALARM CODES (V05 N09)</p> <p>Codes starting with 2 signifies POODOO routine: generates software restart (if ave G running, same as BAILOUT; if not, goes to ROO). Will not turn on RESTART lt</p> <p>Codes starting with 3 signifies BAILOUT routine: generates software restart (returns to interrupted program). Does not turn on RESTART lt</p> <p>00110 Mrk reject has been entered but ignored (continue)</p> <p>00112 Mrk reject with no mrks being acctd (continue)</p> <p>00113 No inbits (chan 16) (continue)</p> <p>00114 More mrks made than desired (continue)</p> <p>00115 V41 N91 keyed with OPT MODE not in CMC</p> <p>00116 Opt sw altered before 15 sec zero time elapsed</p>		<p>Alarms for V05 N09 (ERR RSET zeros R1 and R2; leaves R3 alone)</p> <p>R1 - first alarm to occur R2 - second alarm to occur R3 - last alarm to occur (There is no indication as to whether 3, or more than 3, alarms have occurred)</p> <p>The following list shows general numbering logic for alarm codes excluding interfaces and exceptions:</p> <table border="0"> <tr><td>00100-00200</td><td>Optics subsystem</td></tr> <tr><td>00200-00300</td><td>IMU subsystem</td></tr> <tr><td>00400-00600</td><td>Rendezvous</td></tr> <tr><td>01100-01200</td><td>Computer hardware malfunctions</td></tr> <tr><td>01200-01300</td><td>List overflows (all aborts)</td></tr> <tr><td>01300-01400</td><td>Interpreter errors</td></tr> <tr><td>01400-01500</td><td>Display alarms</td></tr> <tr><td>01500-01600</td><td>Keyboard and display programs</td></tr> <tr><td>01600-01700</td><td>System test alarms</td></tr> <tr><td>01700-01800</td><td>DAP display alarms</td></tr> </table> <p>Either no marks have been received or there have been no marks since last mark reject.</p> <p>If alarm recurs, use MDC DSKY.</p> <p>Set OPT MODE - CMC and OPT ZERO - OFF. OPR ERR also lights.</p> <p>Set OPT ZERO - ZERO (≈15 sec to zero).</p>	00100-00200	Optics subsystem	00200-00300	IMU subsystem	00400-00600	Rendezvous	01100-01200	Computer hardware malfunctions	01200-01300	List overflows (all aborts)	01300-01400	Interpreter errors	01400-01500	Display alarms	01500-01600	Keyboard and display programs	01600-01700	System test alarms	01700-01800	DAP display alarms
00100-00200	Optics subsystem																						
00200-00300	IMU subsystem																						
00400-00600	Rendezvous																						
01100-01200	Computer hardware malfunctions																						
01200-01300	List overflows (all aborts)																						
01300-01400	Interpreter errors																						
01400-01500	Display alarms																						
01500-01600	Keyboard and display programs																						
01600-01700	System test alarms																						
01700-01800	DAP display alarms																						

4.6.7

ALARM CODES (V05 N09)



STA/T STEP	PROCEDURE	PANEL	REMARKS
00117	V41 N91 keyed but CMC has reserved OCDU		V41 N91 not yet available. May occur from start of drive test until end of burn.
00120	Opt torque has been req but opt have not been zeroed since last FRESH START or RESTART		Set OPT ZERO - OFF then ZERO (\approx 15 sec to zero).
00121	SC att rates of $>$ two-thirds deg per sec will result in auto reject of sighting mrks		Repeat mark.
00122	Marking not called for (continue)		Use SCS control. Refer to G&N malfunction procedures, symptom 12. While thrusting navigation (average G) is operating, a PIPA output in excess of 6399 pulses in a 2-second period has been detected.
00205	PIPA saturated		
00206	IMU zero routine has been entered with both GMBL LOCK lt and NO ATT lt on		Coarse align to 0, 0, 0. Reselect V40 N20E. IMU mode switching.
00207	ISS turn-on req not present for 90 sec		Redo IMU turn on. Refer to G&N malfunction procedures, symptom 12.
00210	ISS not on		Redo IMU turn on. If alarm recurs, perform fresh start (V36E). Consult MSFN. Refer to malfunction procedures, symptom 12. Used by IMU zero routine, R02, P51, and P53.
00211	Coarse align err		If P51, 53/P52, 54 in progress, record gyro torquing angles and perform fine align check in P52, 54. Otherwise, refer to V41 N20. Refer to G&N malfunction procedures, symptom 12. Following coarse align, an ICDU is found not to be within 2° of its desired value.

ALARM CODES (V05 N09)

STA/T STEP	PROCEDURE	PANEL	REMARKS
00212	PIPA fail, but PIPA not being used		PIPA BIAS check. Refer to G&N malfunction procedures, symptom 6, step 7. A PIPA fail signal has been received by CMC but PIPAs are not being used (average G not on); or CMC has just finished with PIPAs and finds a PIPA fail signal. For latter case, ISS warning light is extinguished.
00213	IMU not operating with turn-on req		Refer to 00210. CMC has detected an ISS turn-on request but finds ISS operate not present.
00214	Prog using IMU when turned off		Refer to 00210 or exit program. IMU not in use (IMUSE flag reset). IMU in use (IMUSE flag set).
00217	IMU coarse align or pulse torque difficulty has occurred		Reinitiate current program. If alarm recurs, terminate use of ISS. Refer to G&N malfunction procedures, symptom 12. This alarm is issued in alignment program, P5X, if coarse align or gyro torquing attempted during IMU turn-on, while a cage command is present or while IMU zeroing is taking place. It is also issued if coarse align failure has occurred (code 211) or if CMC detects ISS warning light on at end of a "successful" coarse alignment or gyro torquing process.
00220	IMU orient unknown		Align or if aligned, set REFSMMAT flag.
00401	Desired middle gmb1 angle excessive		Call N22 - maneuver if MGA 85° or realign IMU. Alarm will be generated if MGA >math>60^\circ</math> is calculated during: <ul style="list-style-type: none"> a. Realignment in P52/54 b. Entry attitude in P62, P66 display, and P64 (if velocity is <math>27\text{K FPS}</math> at .05 G point).

4.6.7

ALARM CODES (V05 N09)

STA/T STEP	PROCEDURE	PANEL	REMARKS
00404	Trgt out of view (90 deg test)		P52, P22 and P23. A trunnion angle $>90^\circ$ required to acquire star or landmark. This is a priority alarm and will be displayed by CMC with a flashing V05 N09.
00405	Acpt star pair not avail		In P52 and P54, CMC searches for pair of nav stars which are not $<30^\circ$ and not $>76^\circ$ apart. In addition, neither star may be occulted by earth, sun or moon, and each star must be within 38° of optics shaft axis. If no such pair can be found, alarm is displayed automatically by computer with a flashing V05 N09.
00406	Rndz nav not oper		Select P20 or continue. V54 or V57 has been entered but rendezvous tracking is not operating. CMC ignores request for marks and reinstates interrupted display, if any.
00421	W-matrix overflow		Notify MSFN but continue. W-matrix automatically reinitialized at next mark.
20430	Orb integration		Notify MSFN. Probable state vector uplink required. This may happen if CMC attempts to integrate a state vector that intersects earth or moon. A state vector update may be required.
00600	Imaginary roots on 1st iteration		P32, P72.
00601	Post CSI Hp <5.8 NM (85 NM for E.O.)		P32, P72.
00602	Post CDH Hp <5.8 NM (85 NM for E.O.)		P32, P72.
00603	CDH -CSI <10 min		P32, P72.
00604	TPI -CDH <10 min		P32, P72.
00605	No. of iterations exceeds loop max		P32, P72, P37.

ALARM CODES (V05 N09)

STA/T STEP	PROCEDURE	PANEL	REMARKS
00606	ΔV exceeds max		P32, P72.
20607	No solution from time θ or time radius		Reselect program. Vehicle will be in a hyperbolic orbit, or entry angle too steep.
20610	Lambda < unity		Reselect P37 and decrease TIG. Selected GETI yields a radius < entry interface radius.
00611	No TIG for given ELEV angle		P33, P34, P73, P74.
00612	State vctr in wrong sphere of influence		P37.
00613	Re-entry angle out of limits		P37.
00777	ISS warning caused by PIPA fail		Refer to G&N malfunction procedures, symptom 6.
01102	CMC self test err		Self check.
21103	Unused CCS branch executed		Copy N08, notify MSFN. Initiate V36 recovery. CMC has branched to an illogical point in its instruction sequence.
31104	Delay routine busy		Reselect extended verb or continue with program. Notify MSFN. An internal routine (DELAYJOB) used by CMC to cause variable time delays, has received requests from more than 4 jobs.
01105	Downlink too fast		Rset. If alarm recurs, DOWNLINK FAILURE. Refer to G&N malfunction procedures, symptom 12.
01106	Uplink too fast		Rset. If alarm recurs, UPLINK FAILURE. Refer to G&N malfunction procedures, symptom 12.

4.6.7

ALARM CODES (V05 N09)

STA/T STEP	PROCEDURE	PANEL	REMARKS
01107	Phase table failure - assume erasable memory is destroyed		Perform: 1. V74 CMC DOWNLINK 2. P27 as necessary 3. V48 as necessary (V46) 4. Re-establish REFSMMAT via P51 as necessary. If FRESH START recurs, CMC FAILURE. Refer to malfunction procedures, symptom SSR-3. During CMC restart, a phase table disagreement was found. CMC will perform an automatic fresh start if this condition exists.
31201	Exec overflow - no VAC area		Reselect extended verb and/or continue program. Refer to 31201. Refer to 31201.
31202	Exec overflow - no core sets		
31203	Waitlist overflow - too many tasks		
21204	Neg or zero waitlist call		If average G on, continue. Otherwise reselect program.
21206	Second job attempts to go to sleep via keyboard and disp prog		Refer to 21204.
31207	No VAC area for marks		Rset. Reselect program. If alarm recurs, consult MSFN.
21210	Second attempt is made to stall		Reselect program. Do not attempt use of device while CMC is using it. While performing certain IMU mode switching functions or while performing automatic attitude maneuvers CMC begins a function or maneuver and then "stalls" until appropriate job has been completed. If a second attempt is made to stall for the same reason (i.e., IMU mode switch or attitude maneuver), this alarm is generated.

ALARM CODES (V05 N09)

STA/T STEP	PROCEDURE	PANEL	REMARKS
31211	Illegal interrupt of extended verb		Reselect extended verb after optics marking completed. If an internal request for marks (SXTMARK or R57) made, CMC tests to see if mark system already busy or if an extended verb active. If either condition is discovered, alarm is generated.
01301	Arcsin or arccos input >1		Copy NO8, notify MSFN, continue.
21302	SQRT called with neg argument		Refer to 21103.
01407	VG incr		P40. Refer to G&N malfunction procedures, symptom 12. CMC has determined that last measured value of ΔV was in such a direction as to cause VG to increase rather than decrease. As long as this condition exists, value of time to go to cutoff is not recalculated (although R1 of N40 will continue to count down) and an automatic engine-off command will <u>not</u> be sent by CMC.
01426	IMU unsatisfactory		Realign or use SCS. Neither +Y stable member axis nor -Y stable member axis within 30° of $\underline{V} \times \underline{R}$ where \underline{V} and \underline{R} are present vehicle velocity and position vectors respectively. The test for this condition performed at beginning of P61 and P62.
01427	IMU reversed		Note FDAI operation is inverted. The -Y stable member axis is within 30° of $\underline{V} \times \underline{R}$ (cf. code 1426).
21501	Keyboard and disp alarm during internal use (NVSUB).		Refer to 21103.
21502	Illegal flashing disp		Refer to 21103.

STA/T STEP	PROCEDURE	PANEL	REMARKS
01520	V37 req not permitted at this time		Wait until COMP ACTY light not on continuously, reselect V37 or if P62/P67, select P00 and then desired program. Alarm will be generated if a V37 request made with IMU as follows: <ul style="list-style-type: none"> a. In its 90-second turn-on period b. Being caged c. Being zeroed. It will also be generated if V37 request is made for a program other than P00 after entry DAP has been started in P62, during P76 and P00 integration, in P06 and during optics zeroing.
21521	P01 or P07 illegally sel		Refer to 21204.
01600	Overflow in drift test		This is ground test alarm only.
01601	Bad IMU torque abort		Refer to 01600. Generated in P01, P02, or P07.
01602	Bad opt during verif		Refer to 01600. This alarm cannot be operated by the CMC.
01703	Insufficient time for integration		P40, P41. Will occur between TIG -42.5 and TIG -35 seconds.
03777	ISS warning caused by ICDU fail		Refer to G&N malfunction procedures, symptom 6.
04777	ISS warning caused by ICDU and PIPA fail		Refer to G&N malfunction procedures, symptom 6.
07777	ISS warning caused by IMU fail		Refer to G&N malfunction procedures, symptom 6.
10777	ISS warning caused by IMU and PIPA fail		Refer to G&N malfunction procedures, symptom 6.
13777	ISS warning caused by IMU and ICDU fail		Refer to G&N malfunction procedures, symptom 6.
14777	ISS warning caused by IMU, ICDU, and PIPA fail		Refer to G&N malfunction procedures, symptom 6.

ALARM CODES (V05 N09)

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.6.8	CMC PROGRAM - ROUTINE INDEX		
4.6.8.1	<u>Programs</u>		
		Contains Crew Interface Routines	
<u>Phase</u>	<u>Program No.</u>	<u>Program Title</u>	
Pre-Launch & Service	00	CMC idling	None
	01	Prelaunch or service init	None
	02	Prelaunch or service gyro compassing	None
	03	Prelaunch or service opt verif of gyro compassing	None
	06	CMC pwr down	R00
	07	Sys test	
Boost	11	Earth orb insertion mon	None
	15	CMC TB6 init	R00
Coast	20	Rndz nav	R02,R61,R52, R00,R22,R21
	21	Grd track determ	R00
	22	Orb nav	R02,R53,R52, R00
	23	Cislunar midcourse nav	R00,R53,R52
	24	Rate aided opt	R00,R53,R52
	27	CMC update	None

Do not select the following program sequences:

- a. P3X - P7X - P40/P41
P3X - P23 - P40/P41
(P3X computations are overwritten)
Redo P3X and then P40 or P41
- b. P40/P41 - P27 - P52
(P27 overwrites preferred attitude computations)
Redo P40/P41 up to V50 N18, then reselect P52
- c. P27 - P40/P41 - 52
Reload preferred REFSMMAT from ground.

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STA/T STEP		PROCEDURE	PANEL	REMARKS
			Contains Crew Interface Routines	
<u>Phase</u>	<u>Program No.</u>	<u>Program Title</u>		
Pre-Thrusting	30	External ΔV	R00	
	32	Co-elliptic seq init (CSI)	R00	
	33	Constant Δalt (CDH)	R00	
	34	Trnfr phase init (TPI)	R00,R22,R21	
	35	Trnfr phase (midcourse)	R00,R22,R21	
	37	Ret to Earth	R00	
Thrusting	40	SPS	R02,R60,R00	
	41	RCS	R02,R60,R00	
	47	Thrust mon	R02,R00	
Align-ment	51	IMU orient determ	R53,R54,R00	
	52	IMU realign	R02,R50,R00 R52, R53, R54, R55	
	53	Back-up IMU orient determ	R56, R54, R00	
	54	Back-up IMU realign	R02, R50, R00 R56, R54, R55	
Entry	61	Entry prep	R02	
	62	CM/SM sep and pre-entry mnvr	R02	
	63	Entry init	None	
	64	Post 0.05 G	None	

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STA/T STEP	PROCEDURE		PANEL	REMARKS
	<u>Phase</u>	<u>Program No.</u>	<u>Program Title</u>	<u>Contains Crew Interface Routines</u>
		65	Entry upcontrol	None
		66	Ballistic entry	None
		67	Fnl phase	R00
Abort		72	LM co-elliptic seq trgtg (CSI)	R00
		73	LM constant Δ alt trgtg (CDH)	R00
		74	LM trnfr phase init (TPI) trgtg	R22,R00,R21
		75	LM trnfr phase (midcourse) trgtg	R22,R00,R21
		76	Trgt Δ V	R00
4.6.8.2 <u>Routines</u>				
	<u>Routine</u>	<u>Routine Title</u>		
	00	Fnl auto req term		
	02	IMU stat check		
	03	DAP data load		Manually selected by crew (V48E).
	05	S bd ant		Manually selected by crew (V64E).
	21	Rndz tracking sighting mrk		Manually selected by crew (V57E).
	22	Rndz tracking data processing		
	23	Backup rndz tracking sighting mrk		Manually selected by crew (V54E).
	30	Orb param disp		May be called by crew (V82E).

4.6.8.2

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>Routine</u>	<u>Routine Title</u>	
31	Rndz param disp routine No. 1		Displays range, range rate, and the angle between CSM +X axis and local horizontal (theta). Selected by crew (V83E).
33	CMC/LGC clock sync		V06 N65.
34	Rndz param disp routine No. 2		Displays range, range rate, and angle between optics star line of sight and local horizontal (phi). Selected by crew (V85E).
36	Rndz out of plane disp		Selected by V90E.
40	SPS thrust fail		
41	State vctr integration (mid to ave)		
50	Coarse align		
52	Auto opt positioning		Automatically selected by P20, P22, P23 or P52. It is self-perpetuating and terminated by R53 for star or landmark sightings.
53	Sighting mrk		
54	Sighting data disp		
55	Gyro torquing		
56	Alternate LOS sighting mrk		Used to perform sighting marks for backup alignment programs P53 and P54.
57	Opt calib		
60	Att mnvr		
61	Tracking att		Orients CSM properly with respect to target vehicle during rendezvous tracking.
62	Crew defined mnvr		Selected by (V49E) via P00 only.
63	Rndz fnl att		Selected by (V89E) via P00 only.
64	Orbrate/PTC (BBQ mode - R64)		Selected by (V79E).

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EM2A-03-BLOCK II-J-(2)
APOLLO OPERATIONS HANDBOOK

STA/T STEP	PROCEDURE	PANEL	REMARKS																										
4.6.9	CMC PROGRAM - FLAG LISTING																												
	<p>The flags which are applicable to colossus programs are summarized in this section for information purposes only. Paragraph 4.6.9.1 shows the correlation between flag word numbers and erasable memory addresses while paragraph 4.6.9.2 lists the relationship between flags and programs.</p>																												
4.6.9.1	<u>Flag Word - Memory Location Correlation</u>																												
	<table border="1"> <thead> <tr> <th><u>Flag Word</u></th> <th><u>Memory Address</u></th> </tr> </thead> <tbody> <tr><td>0</td><td>00074</td></tr> <tr><td>1</td><td>00075</td></tr> <tr><td>2</td><td>00076</td></tr> <tr><td>3</td><td>00077</td></tr> <tr><td>4</td><td>00100</td></tr> <tr><td>5</td><td>00101</td></tr> <tr><td>6</td><td>00102</td></tr> <tr><td>7</td><td>00103</td></tr> <tr><td>8</td><td>00104</td></tr> <tr><td>9</td><td>00105</td></tr> <tr><td>10</td><td>00106</td></tr> <tr><td>11</td><td>00107</td></tr> </tbody> </table>	<u>Flag Word</u>	<u>Memory Address</u>	0	00074	1	00075	2	00076	3	00077	4	00100	5	00101	6	00102	7	00103	8	00104	9	00105	10	00106	11	00107		
<u>Flag Word</u>	<u>Memory Address</u>																												
0	00074																												
1	00075																												
2	00076																												
3	00077																												
4	00100																												
5	00101																												
6	00102																												
7	00103																												
8	00104																												
9	00105																												
10	00106																												
11	00107																												

4.6.9.1

CMC PROGRAM - FLAG LISTING

4.6.9.2 Flag - Program Listing

<u>No.</u>	<u>Title</u>	<u>Code</u>	<u>Flag Word</u>	<u>Bit</u>	<u>When Set</u>	<u>When Reset</u>
FLAGS						
1	Rndz	RNDVZFLG	0	7	P20 init	P20 term
2	Update	UPDATFLG	1	7	State vctr up-dating by marks allowed	State vctr up-dating by marks not allowed
3	Track	TRACKFLG	1	5	Rndz tracking allowed	Rndz tracking not allowed
4	Pref att	PFRATFLG	2	4	Preferred SC att computed	Preferred SC att not computed
5	Steer	STEERSW	2	11	Steering to be done	Steering omitted
6	IMU orient	REFSMFLG	3	13	REFSMMAT good	REFSMMAT not good
7	IMU	IMUSE	0	8	IMU in use	IMU not in use
8	State vctr	VEHUPFLG	1	8	CSM state vctr updated	LM state vctr updated
9	Term	TERMIFLG	7	15	Term R52 and R53	Do not term
11	Trgt 1	TARG1FLG	1	10	Sighting LM	Not sighting LM
12	Trgt 2	TARG2FLG	1	9	Sighting lmk	Sighting Star
13	W matrix (rndz)	RENDWFLG	5	1	W matrix for rndz nav valid	W matrix for rndz nav invalid
14	W matrix (orb nav)	ORBWFLAG	3	6	W matrix for orb nav valid	W matrix for orb nav invalid

CMC PROGRAM - FLAG LISTING

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<u>No.</u>	<u>Title</u>	<u>Code</u>	<u>Flag Word</u>	<u>Bit</u>	<u>When Set</u>	<u>When Reset</u>
15	3 axis	3AXISFLG	5	6	Mnvr specified by 3 axes	Mnvr specified by 1 axis
16	External ΔV	XDELVFLG	2	8	External ΔV VG computations	Lambert VG computations
17	Active veh	AVFLAG	2	5	LM active	CSM active
18	Final comp	FINALFLG	2	6	Fnl pass thru rndz prog comp	Interim pass thru rndz prog comp
19	Sighting mrk	R53FLAG	0	6	V51 initiated	V51 not initiated
20	Stick flag	STIKFLAG	1	14	RHC out of detent (auto mnvr not enabled)	RHC in detent (auto mnvr enabled)
21	Surface	SURFFLAG	8	8	LM on lunar surface	LM not on lunar surface
22	LM sphere	LMOONFLG	8	11	Permanent LM state in lunar sphere	Permanent LM state in earth sphere
23	CM sphere	CMOONFLG	8	12	Permanent CSM state in lunar sphere	Permanent CSM state in earth sphere
NON-FLAGS						
1	Mrk	MARKSTAT	1344*	10	After sighting mark	After mark reject
2	ISS zero	IMODES30	1334*	9	IMU opr bit present (set to 0)	IMU opr bit not present (reset to 1)
*Memory address						

4.6.9.2

CMC PROGRAM - FLAG LISTING

STA/T STEP	PROCEDURE	PANEL	REMARKS
	<p>4.7 G&C REFERENCE MODES</p> <p>This section provides information about basic G&C functions by defining them in terms of system operating prerequisites and switch positions which together represent reference modes. Their scope is limited to independent system functions. These reference modes are repeatable and are applicable to all G&C procedures and thus are referenced in all subsequent sections of G&C procedures. The modes, however, are NOT intended to be complete or self-contained procedures.</p> <p>Wherever a step in one of these G&C reference modes references another mode, the title and paragraph number of the referenced mode is shown and the recommended options in the mode, if any, are specified. Only those switches which are required to be in unique positions are shown in the affected step after the mode is referenced.</p> <p>During time-critical mission phases, reference to other sections of the handbook cannot be accommodated, and, therefore, all time-critical operations are self-contained. Modes similar to those shown in this section, however, are contained or repeated within the time-critical procedures.</p> <p>For general G&C operating data, refer to operating notes, 4.6.1.</p>		
	<p>4.7.1 ATTITUDE CONTROL</p> <p>4.7.1.1 <u>SCS Channel Selection</u></p> <p>1 Set pwr sw CDR LOGIC 2/3 PWR - on (up)</p> <p>SIG CONDR/DR BIAS PWR (both) - AC1 or AC2</p>	7	<p>Provides methods for enabling RCS auto coils without undesirable jet firings.</p> <p>Supplies 28 vdc to SC CONT switch, THC CW switch and ATT 1/RATE 2 and RATE 2 positions of BMAG MODE switches.</p> <p>4.6.1.2, note 5.</p>

4.7.1.1

ATTITUDE CONTROL

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	2 Enable auto coils		
	For CMC cont SC CONT - CMC CMC MODE - FREE	1	For post CM/SM separation, AUTO RCS A/C ROLL switches should be OFF, and DAP configured for B/D roll. Also refer to 4.6.1.1, note 7.
	MAN ATT (3) - MIN IMP or RATE CMD		4.6.1.1, note 8.
	AUTO RCS (16) - MNA or MNB or OFF (correspond to RCS DAP configuration)	8	Configure AUTO RCS roll enable to agree with RCS DAP load, to reduce SPS propellant slosh during ΔV thrusting in the event of a failed-on roll jet.
	For SCS cont		
	a. SC CONT - SCS	1	
	or SC CONT - CMC THC - CW		
	b. BMAG MODE (3) - RATE 2		BMAG MODE or MAN ATT switching cages BMAGs and prevents attitude error signals from causing jet firings.
	or MAN ATT (3) - MIN IMP or ACCEL CMD		
	c. AUTO RCS (16) - MNA or MNB	8	For SCS control, switches should be set by quad and rotation axis, as desired. Only one roll quad should be enabled for SCS control to optimize RCS propellant consumption. One exception is 3-axis translation when all quads are required.
	4.7.1.2 <u>SCS Minimum Impulse</u>		
	1 Set pwr sw ELEC PWR - GDC/ECA or ECA	7	Either position required for minimum impulse generator.

ATTITUDE CONTROL

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	LOGIC 2/3 PWR - on (up) SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 RHC PWR NORM (both) - AC/DC	7 1	Supplies 28 vdc to SC CONT switch, and THC CW switch. 4.6.1.2, note 5.
2	Sel min imp cont MAN ATT - MIN IMP SC CONT - SCS		Switches should be set by axis as desired.
or	SC CONT - CMC THC - CW		
3	Enable auto coils, 4.7.1.1		
4.7.1.3 <u>SCS Acceleration Command</u>			
1	Set pwr sw LOGIC 2/3 PWR - on (up) SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 RHC PWR NORM (both) - AC/DC	7 1	Supplies 28 vdc to SC CONT switch. 4.6.1.2, note 5.
2	Sel accel cmd cont MAN ATT - ACCEL CMD		Switches should be set by axis as desired.
3	Enable auto coils, 4.7.1.1		Either CMC or SCS control permissible.
4.7.1.4 <u>SCS Attitude Hold/Rate Command</u>			
1	Set pwr sw LOGIC 2/3 PWR - on (up) ELEC PWR - GDC/ECA or ECA	7	Supplies 28 vdc to SC CONT switch.

4.7.1.4

ATTITUDE CONTROL

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	SIG CONDR/DR BIAS PWR 1 - AC1 or AC2	7	Provides SCS signal conditioner power for RHC proportional rate command TLM. Also refer to 4.6.1.2, note 5.
	BMAG PWR (both) - ON		If rate damping only is desired, BMAG 1 need not be turned ON but should be set to WARMUP.
	RHC PWR NORM (1, 2 or BOTH) - AC/DC	1	If manual override of attitude hold desired.
2	Enable auto coils, 4.7.1.1		4.6.1.1, note 7.
3	Establish att hold MAN ATT - RATE CMD SC CONT - SCS		Switches may be set by axis as desired. Also refer to 4.6.1.2, note 6.
	or SC CONT - CMC THC - CW		
	BMAG MODE - ATT 1/RATE 2		
4.7.1.5	<u>CMC Minimum Impulse</u>		
1	The following are req CMC - on, 4.8.1.3 RCS DAP - load & activate, 4.8.2.1		CMC, ISS, and RCS DAP enable autopilot control. Minimum impulse controller (MIC), located on panel 122 in LEB, and RHC provides minimum impulse command capability in this mode. RHC will provide normal acceleration commands providing MAN ATT switches at ACCEL CMD.
	ISS - on (desired), 4.8.1.3		For display of ISS total attitude and errors.

ATTITUDE CONTROL

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 2	Set pwr sw LOGIC 2/3 PWR - on (up) SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 RHC PWR NORM (both) - AC/DC	7 1	Supplies 28 vdc to SC CONT switch. 4.6.1.2, note 5.
3	Establish CMC Cont SC CONT - CMC CMC MODE - FREE MAN ATT (3) - MIN IMP or MAN ATT (3) - RATE CMD BMAG MODE (3) - RATE 2		ACCEL CMD position cannot be used because it inhibits CMC outputs to jets.
4	Enable Auto Coils, 4.7.1.1		
4.7.1.6 <u>CMC Attitude Control - Auto/Hold</u>			
1	The following are req CMC - on, 4.8.1.3 ISS - on, 4.8.1.3 RCS DAP - load & activate, 4.8.2.1		CMC, ISS, and RCS DAP enable autopilot control.
2	Set pwr sw LOGIC 2/3 PWR - on (up) SIG CONDR/DR BIAS PWR (both) - AC1 or AC2	7	Supplies 28 vdc to SC CONT switch. 4.6.1.2, note 5.
3	Enable auto coils, 4.7.1.1		
4	Establish att cont MAN ATT (3) - RATE CMD or MIN IMP	1	

4.7.1.6

ATTITUDE CONTROL



STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	SC CONT - CMC CMC MODE - HOLD or AUTO	1	AUTO position must be selected when CMC automatic maneuver desired.
	4.7.1.7 <u>SIVB Attitude Control</u>		Describes condition required to enable RHC rate control of SIVB.
	1 The following are req CMC - on, 4.8.1.3 LOGIC 2/3 PWR - on (up)	7	Supplies power for caging BMAGs via BMAG MODE switches.
	ISS - on (desired), 4.8.1.3		For display of ISS total attitude and errors.
CMP	2 Enable att cont Saturn DAP activated, 4.8.2.1	2,140	Load 3 in configuration option of DAP activation procedure. Also refer to 4.6.1.1, note 7. AUTO RCS switches should be off to prevent SM jet firing.
	LV GUID sw - CMC	2	

ATTITUDE CONTROL

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.7.2	ATTITUDE DISPLAYS		
4.7.2.1	<u>Rate Display</u>		Provides methods for displaying rate information on rate needles of FDAI 1 or FDAI 2, or both, as desired.
CDR	1 Set pwr sw FDAI/GPI PWR - 1, 2 or BOTH	7	Provides power for display electronics. Position chosen depends on which FDAI(s) desired.
	LOGIC 2/3 PWR - on (up)		4.6.1.1, note 6.
	BMAG 2 PWR - ON (req if BMAG 2 desired)		Either BMAG 1 or BMAG 2 may be selected to provide information. BMAG 2 is normally used and BMAG 1 provides backup capability.
	BMAG 1 PWR - ON (req if BMAG 1 desired)		
	2 Sel desired rate source BMAG MODE - RATE 2 or ATT 1/RATE 2	1	Switches should be set by axis as desired. Selects BMAG 2.
	or BMAG MODE - RATE 1		Selects BMAG 1.
	3 Sel disp configuration FDAI SEL - 1		Displays rate from BMAG 1 or 2 on FDAI 1 only.
	or FDAI SEL - 2		Displays rate from BMAG 1 or 2 on FDAI 2 only.
	or FDAI SEL - 1/2		Displays rate from BMAG 1 or 2 on both FDAIs.
4.7.2.2	<u>Attitude Error Display - BMAG Source</u>		Provides methods for displaying BMAG 1 attitude error information on attitude error needles of FDAI 1 or FDAI 2. Needles display attitude excursion from point at which BMAGs are uncaged up to a maximum of 17°.

4.7.2.2

ATTITUDE DISPLAYS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	1 Set pwr sw FDAI/GPI PWR - 1, 2 or BOTH LOGIC 2/3 PWR - on (up) BMAG 1 PWR - ON	7	Provides power for display electronics. Position chosen depends on which FDAI(s) desired. Supplies power for caging BMAGs via BMAG MODE switches. Powers BMAGs in gyro assembly 1, the only BMAGs capable of providing attitude error information.
	2 Provide att err info MAN ATT - RATE CMD BMAG MODE - ATT 1/RATE 2 RHC - neut	1	Switches should be set by axis as desired. RATE CMD position required to uncage BMAG 1. However, RHC breakout and MAN ATT switches overridden by IGN 2 logic signal during thrusting to uncage BMAGs. If RHC breakout switches activated, BMAGs caged (by axis) and attitude hold lost.
	3 Sel disp configuration a. FDAI SEL - 1/2 or b. FDAI SEL - 1 or 2 FDAI SOURCE - GDC		Displays attitude error from BMAG 1 on FDAI 2. Displays attitude error from BMAG 1 on FDAI 1 or 2. This position required when only one FDAI selected.
	4.7.2.3 <u>Attitude Error Display - CMC Source</u>		Provides G&N computed attitude error in control axes. Information meaningful only when computer program defines desired attitude.
	1 The following are req CMC - on, 4.8.1.3 ISS - on, 4.8.1.3 2 Set pwr sw FDAI/GPI PWR - 1, 2 or BOTH	7	Required to compute error and mode CDUs. Required for attitude information. Provides power for display electronics. Position chosen depends on which FDAI(s) desired.

ATTITUDE DISPLAYS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	LOGIC 2/3 PWR - on (up)	7	Provides power for FDAI switches.
3	Select disp scaling FDAI SCALE - 5/5 or 5/1	1	Positions provide for compatible scaling between CMC and display electronics in roll axis during orbital flight. If 50/15, 50/10 position is chosen, roll scaling is 12.5° full scale.
4	Sel disp configuration		
	a. FDAI SEL - 1/2		Displays attitude error from CDUs on FDAI 1.
or	b. FDAI SEL - 1 or 2 FDAI SOURCE - CMC		Displays attitude error from CDUs on FDAI 1 or 2. This position required when only one FDAI selected.
4.7.2.4	<u>Attitude Error Display - Attitude Set Source</u>		Provides methods for displaying attitude difference between attitude set indicators and GDC (body error) or IMU gimbal angles (Euler error). Polarity reversal occurs when ATT SET - IMU option selected and roll gimbal angle >+90°. Pitch and yaw attitude error needles become "fly from" indicators rather than "fly to" indicators in this instance.
1	Set pwr sw & disp logic FDAI/GPI PWR - 1, 2 or BOTH	7	Provides power for display electronics. Position depends on which FDAI desired.
	LOGIC 2/3 PWR - on (up) FDAI SEL - 1 or 2 FDAI SOURCE - ATT SET	1	Display not available at 1/2 position. Required to enable attitude set input to FDAI.
2	Sel att ref		
	a. SCS		
	ELEC PWR - GDC/ECA BMAG 2 PWR - ON	7	Provides power to GDC electronics.

4.7.2.4

ATTITUDE DISPLAYS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	ATT SET - GDC BMAG MODE - RATE 2 or ATT 1/RATE 2	1	Switches should be set by axis as desired.
	b. ISS ISS - on, 4.8.1.3 ATT SET - IMU		4.6.1.1, note 5.
4.7.2.5	<u>Total Attitude</u>		Provides methods for displaying Euler angles on FDAI ball from GDC or IMU.
1	Set pwr sw & enable FDAI FDAI/GPI PWR - 1, 2 or BOTH	7	Provides power for display electronics. Position depends on which FDAI(s) desired.
	LOGIC 2/3 PWR - on (up)		Supplies power for FDAI, BMAG MODE switches and ATT SET switch (IMU position).
2	Sel disp & disp source		
	a. ISS disp ISS - on, 4.8.1.3 FDAI 1 disp		Enables IMU resolver outputs to FDAI 1 ball drive. There are three possible switch combinations.
	FDAI SEL - 1/2	1	This position also enables GDC total attitude to FDAI No. 2.
	or FDAI SEL - 1 FDAI SOURCE - CMC		
	or FDAI SOURCE - ATT SET ATT SET - IMU		4.6.1.1, note 5.
	FDAI 2 disp FDAI SEL - 2 FDAI SOURCE - CMC		Enables IMU resolver outputs to FDAI 2 ball drive. There are two possible switch combinations.

ATTITUDE DISPLAYS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	or FDAI SOURCE - ATT SET ATT SET - IMU	1	4.6.1.1, note 5.
	b. GDC disp		
	ELEC PWR - GDC/ECA	7	Provides power to GDC electronics.
	BMAG 2 PWR - ON		
	BMAG MODE - RATE 2 or ATT 1/RATE 2	1	Switches should be set by axis as desired.
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X BMAG 1 PWR - ON (if BMAG 2 fails) BMAG MODE - RATE 1	7 1	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	FDAI 2 disp FDAI SEL - 1/2		Enables GDC resolver outputs to FDAI 2 ball drive. There are three possible switch combinations.
	or FDAI SEL - 2 FDAI SOURCE - GDC		
	or FDAI SOURCE - ATT SET ATT SET - GDC		
	FDAI 1 disp FDAI SEL - 1 FDAI SOURCE - GDC		Enables GDC resolver outputs to FDAI 1 ball drive. There are two possible switch combinations.
	or FDAI SOURCE - ATT SET ATT SET - GDC		

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.7.2.6	<u>ORDEAL - Local Horizontal Attitude</u>		Provides methods for displaying local horizontal reference established by ORDEAL on FDAI 1 and/or FDAI 2 balls. Only pitch axis is affected.
1	Set pwr sw FDAI/GPI PWR - 1, 2 or BOTH	7	Provides power for display electronics. Position chosen depends on which FDAI(s) desired.
	EARTH/LUNAR - EARTH or LUNAR LTG - BRT or DIM	13	
2	Sel disp configuration		Reference system may be GDC or IMU, 4.7.2.5.
	FDAI 1 disp		
	FDAI SEL - 1 or 1/2	1	
	FDAI 1 sw - ORB RATE	13	
	FDAI 2 disp		
	FDAI SEL - 2 or 1/2	1	
	FDAI 2 sw - ORB RATE	13	
	FDAI 1 & 2 disp		
	FDAI SEL - 1/2	1	
	FDAI sw (both) - ORB RATE	13	
4.7.3	GDC ALIGN		Aligns GDC to ATT SET thumbwheels.
	ELEC PWR - GDC/ECA	7	Supplies power to GDC electronics.
	ATT SET - GDC	1	Enables att set inputs to GDC.
	Verify tw settings		
	GDC ALIGN pb - push		Enables attitude set inputs to GDC and disables BMAG inputs.

GDC ALIGN

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.7.4	SPS THRUST CONTROL		
4.7.4.1	<u>TVC Initialization</u>		Defines safe switch configuration required before initiation of thrusting procedures.
CDR	LOGIC 2/3 PWR - on (up) SIG CONDR/DR BIAS PWR (both) - AC1 or AC2	7	Provides power to SCS TVC switches. Required for RCS jet on-off and MTVC TLM.
	SPS THRUST - NORM	1	
	SCS TVC (2) - RATE CMD (if burn is G&N or MTVC)		
or	SCS TVC (2) - AUTO (SCS burn) TVC GMBL DR (2) - AUTO		The 1 or 2 positions may be used as backup if required.
	AV CG - LM/CSM or CSM		Required only for SCS/SPS auto thrusting. Position depends on whether LM attached or not.
	FDAI/GPI PWR - 1, 2 or BOTH	7	Position chosen depends on whether redundant GPI displays desired. To enable redundant GPI indicators, FDAI/GPI PWR switch must be set to BOTH.
	LV IND/GPI sw - GPI	1	
4.7.4.2	<u>SPS Gimbal Control</u>		
1	CMC Cont		
	ISS - on (req), 4.8.1.3		Provides attitude information and power to ECDUs.
	CMC - on (req), 4.8.1.3		
	Servo loop activated (step 4)		
	Gmb1 mot on		Operating time limited depending on operating conditions. MN BUS TIE (2) must be on before gimbal motors started.
	SC CONT - CMC		

4.7.4.2

SPS THRUST CONTROL

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	LOGIC 2/3 PWR - on (up) THC - neutral	7	Supplies power to SC CONT switch.
2	SCS Cont - AUTO Servo loop activated (step 4) Gmbl mot on	1	Operating time limited depending on operating conditions. MN BUS TIE (2) must be on before gimbal motors are started.
	LOGIC 2/3 PWR - on (up)	7	Supplies power to SC CONT, BMAG MODE, SCS TVC, .05 G switch (OFF position) and THC CW switches.
	ELEC PWR - ECA or GDC/ECA BMAG PWR (both) - ON		Supplies power to the control electronics. Rate and attitude sensors required.
	BMAG MODE - ATT 1/RATE 2	1	BMAGs in gyro assembly 1 will uncage if MAN ATT switches are at RATE CMD. If not, uncaging will occur when IGN 2 logic signal is present.
	SCS TVC (2) - AUTO IGN 2 logic sig present		Provided by thrust control logic at engine on until 1 second after engine off.
	SC CONT - SCS THC - neut		
	or SC CONT - CMC THC - CW		
3	MTVC cont - RATE CMD/ACCEL CMD		Stick integrator is enabled when IGN 2 logic signal is present. IGN 2 logic signal present at SPS on until 1 second after SPS - off, is provided by thrust control electronics.

SPS THRUST CONTROL

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	Servo loop activated (step 4) Gmbl mot on		Operating time limited depending on operating conditions. MN BUS TIE (2) must be on before gimbal motors started.
	LOGIC 2/3 PWR - on (up)	7	Provides power for SC CONT, BMAG MODE, SCS TVC and THC - CW switches.
	SIG CONDR/DR BIAS PWR (both) - AC1 or AC2		Required for RCS jet on-off and MIVC TLM.
	ELEC PWR - ECA or GDC/ECA BMAG 2 PWR - ON (for RATE CMD) BMAG MODE (3) - ATT 1/RATE 2 or RATE 2 RHC PWR NORM (both) - AC/DC	1	Supplies power to RHCs and control electronics. Rate information required for RATE CMD MIVC.
	Rate Cmd		
	a. SCS TVC (2) - AUTO SC CONT - SCS THC - CW		
	or b. SCS TVC (2) - RATE CMD SC CONT - SCS		
	or SC CONT - CMC THC - CW		
	Accel Cmd		
	a. SCS TVC (2) - ACCEL CMD SC CONT - SCS		
	or SC CONT - CMC THC - CW		

4.7.4.2

SPS THRUST CONTROL

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4	<p>Servo Loop Activation</p> <p>a. Servo loop No. 1</p> <p>CDR TVC SERVO PWR 1 - AC1/MNA</p> <p>TVC GMBL DR (2) - 1</p> <p>or TVC GMBL DR (2) - AUTO THC - neut GMBL MOT 1 - operating</p> <p>or TVC SERVO PWR 2 - OFF</p> <p>b. Servo loop No. 2</p> <p>TVC SERVO PWR 2 - AC2/MNB</p> <p>TVC GMBL DR (2) - 2</p> <p>or TVC GMBL DR (2) - AUTO LOGIC 2/3 PWR - on (up) THC - CW</p> <p>or TVC GMBL DR (2) - AUTO GMBL MOT 1 - not operating</p>	<p>7</p> <p>1</p> <p>7</p> <p>1</p> <p>7</p> <p>1</p>	<p>Provides power to clutches and servo drive electronics. Alternate position of this switch (AC2/MNB) should be used only in the event of an AC1 bus failure to provide additional redundancy. AC1/MNA position should be used in all other cases to be compatible with d-c power source for gimbals motors (DC MNA bus power).</p> <p>No. 1 gimbal motor must be on with no overcurrent failure sensed.</p> <p>Alternate position of this switch (AC1/MNA) should be used only in the event of an AC2 bus failure to provide additional redundancy. AC2/MNB position should be used in all other cases to be compatible with d-c power source for gimbal motors (DC MNB bus power).</p> <p>Provides power to THC - CW switch.</p> <p>If No. 1 gimbal motor is off or an overcurrent sensed, control transferred to No. 2 servo loop.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
<p>4.7.4.3 <u>Thrust On-Off Control</u></p> <p>1 CMC Cont ISS - on (req), 4.8.1.3 CMC - on (req), 4.8.1.3 SPS Gmbl Cont (desired), 4.7.4.2 SC CONT - CMC LOGIC 2/3 PWR - on (up) SPS THRUST - NORM</p> <p>ΔV THRUST A(B) - NORM</p> <p>Thrust on CMC eng on cmd (P40)</p> <p>Thrust off CMC eng off cmd (P40)</p> <p>or ΔV THRUST A &/or B - OFF</p> <p>2 SCS Cont SPS Gmbl Cont (desired), 4.7.4.2 SC CONT - SCS</p> <p>or SC CONT - CMC THC - CW</p> <p>LOGIC 2/3 PWR - on (up) SPS THRUST - NORM ΔV THRUST A(B) - NORM</p> <p>Thrust on ΔV ind - not zero THC - +X</p>		<p>7</p> <p>1</p> <p>7</p> <p>1</p>	<p>To satisfy CMC control, THC must not be CW. Supplies 28 vdc to SC CONT switch. DIR ON will override CMC thrust-on control.</p> <p>Guarded.</p> <p>Guarded.</p> <p>This option may establish SCS MTVC mode depending on position of SCS TVC switches.</p> <p>Supplies 28 vdc to SC CONT switch. DIR ON will override SPS thrust control. Guarded.</p> <p>Required only if EMS FUNC in ΔV or ΔV TEST.</p>

4.7.4.3

SPS THRUST CONTROL

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.7.5	OPTICS CONTROL		
4.7.5.1	<u>Auto Optics Positioning</u>		This procedure permits CMC control of optics.
1	The following are req ISS - on, & orient known, 4.8.1.3 & 4.14 CMC - on, 4.8.1.3 Opt - on, 4.8.1.4		
2	Establish CMC cont OPT ZERO - OFF OPT TELTRUN - SLAVE TO SXT OPT MODE - CMC	122	Required for SCT trunnion drive.
4.7.5.2	<u>Manual Optics Control</u>		Permits manual control of optics using optics hand control (OHC).
1	Opt - on, 4.8.1.4		
2	Establish man cont & sighting options OPT ZERO - OFF OPT COUPLING - DIR or RSLV OPT MODE - MAN OPT TELTRUN - SLAVE TO SXT		Permits desired image motion in FOV. In DIRECT mode, OHC left, right motion drives optics shaft, while up, down motion drives trunnion. RSLV mode provides motion resolved into SC body coordinates. Motion appears to be target motion corresponding to direction of OHC movement. Required for proper landmark tracking.
or	0°		Provides zeroing of SCT trunnion axis.
or	25°		Provides greater scanning capability for star sightings.
	OPT SPEED - HI, MED or LO		Set as desired.

4.7.5.2

OPTICS CONTROL



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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.7.5.3	<u>Manual Optics Drive</u>		Permits manual optics operation (no power) using optics tool.
LMP CMP	1 The following are req G/N PWR - AC1 or AC2 G/N OPT PWR - OFF	5 100	Supplies power for condition lamps and reticle.
	2 Obtain opt tool from tool kit		
	3 Perform man opt drive RETCL BRT tw - as req SHAFT - as desired TRUN - as desired	122 121	

OPTICS CONTROL

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.7.6	ENTRY MONITOR SYSTEM (EMS)		
4.7.6.1	<u>ΔV Test & Null Bias Check</u>		
CDR	1 Init EMS prep EMS FUNC - OFF (verify) cb EMS (2) - close EMS MODE - STBY	1 8 1	
	2 EMS FUNC - ΔV SET Adj alphanumeric brightness (option) EMS MODE - NORM Set ΔV ind to +1586.8 fps		Enables slewing of ΔV indicator. 4.6.1.1, note 9.
	3 EMS FUNC - ΔV TEST SPS THRUST lt - on ΔV ind decr (10 sec) SPS THRUST lt - out ≈ -0.1 fps on ΔV ind ΔV ind stops at -20.8±20.7 fps		ΔV TEST checks ΔV circuitry.
	4 EMS MODE - STBY		
	5 EMS FUNC - ΔV SET Slew ΔV ind to -100.0 fps		The ΔV indicator zeroed to start accelerometer null bias check.
	6 EMS FUNC - ΔV (wait 5 sec)		
T=0	7 EMS MODE - NORM		

4.7.6.1

ENTRY MONITOR SYSTEM



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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR T=100 sec 8	<p>EMS MODE - STBY Rcd ΔV ind If ΔV drift ≤ 1 fps, do not bias counter</p> <p>If ΔV drift > 1 fps but < 10 fps bias if desired</p> <p>If ΔV drift > 10 fps, EMS is no-go for all functions</p>	1	<p>Acceleration ≤ 0.01 fps².</p> <p>Acceleration > 0.01 fps² but < 0.1 fps². Counter bias not required for SPS ΔV.</p> <p>Acceleration > 0.1 fps².</p>
	<p style="text-align: center;"><u>CAUTION</u></p> <p>Do not turn EMS FUNC - OFF prior to ΔV, or null bias will be invalid.</p>		
4.7.6.2	<u>ΔV Setup</u>		Specifies required steps necessary to initialize EMS for monitoring ΔVs and to generate SPS engine cutoff signal for SCS controlled SPS ΔVs.
	ΔV TEST & NULL BIAS CHECK (desired),		
4.7.6.1	cb EMS (2) - close	8	
1	EMS MODE - STBY EMS FUNC - ΔV SET	1	
2	Set ΔV ind - req ΔV		
3	EMS FUNC - ΔV		4.6.1.1, note 9.

ENTRY MONITOR SYSTEM

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.8	G&C GENERAL PROCEDURES		<p>The procedures in this section involve both the G&N and SCS and are used most frequently during the orbital phase. Because they are fundamental to G&C operation, they are included or referenced in various forms in the more complex G&C procedures contained in sections 4.9 and 4.11 through 4.18.</p> <p>Applicable G&C Reference Modes, 4.7, have been referenced throughout these procedures.</p> <p>For general G&C operating data, refer to operating notes, 4.6.1.</p>

4.8

G&C GENERAL PROCEDURES

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.8.1 G&N GENERAL 4.8.1.1 <u>(P00) CMC Idling Program</u> CMP Key V37E 00E DSKY - P00		2,140	Indicates that CMC in operate condition but not performing control or computation operations requiring coordination with other crew tasks. Maintains CMC in readiness for entry into most programs. CSM and LM state vectors and W-matrices (orbital and rendezvous) are updated. (Refer to 5.6.12 of R-577, section 5.)
4.8.1.2 <u>CMC/IMU Power Down</u> <u>(P06) CMC Power Down</u> Perform DAP Activation, 4.8.2.1 Load 0 (no DAP) in left digit of R1 1 Key V37E 06E DSKY - P06 2 FL V50 N25 00062 (CMC pwr down) PRO (push till STBY lt - on) CMC blanks DSKY dis			Transfers CMC from operate to standby. V69E may be used to recover from an inadvertent entrance into P06. Otherwise, when P06 selected, CMC must be powered down to standby. Prevents inadvertent jet firing during power up.

G&N GENERAL

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>IMU Power Down</u>		Transfers IMU from operate to standby.
CDR 1	CMC MODE - FREE	1	
CMP 2	G/N IMU PWR - OFF	100	Guarded. Loss of IRIG wheel power will send IMU FAIL discrete to CMC.
CMP 3	If CMC operating Key V37E XXE	2,140	Select program not requiring IMU.
	<u>CAUTION</u>		
	Only in case of emer shall IMU be powered down beyond stby:		If standby power removed for >20 minutes, ISS calibration no longer valid.
LMP	cb IMU HTR (2) - open	5	
	4.8.1.3 <u>Startup</u>		Transfers ISS/CMC from standby to operate condition. Startup procedure will be first procedure selected after returning from standby, since time 2/time 1 is invalid until this is done.
	<u>CMC Startup</u>		
CMP	PRO - (push until STBY lt out) Poss CMC warning lt (20 sec max) Poss RESTART lt - on Poss PROG alarm RSET DSKY - P06 FL V37 Key 00E	2,140	When PRO released, CMC may revert to STBY mode. Repeat PRO until STBY light out. These alarms should be ignored if they can be reset.

4.8.1.3

G&N GENERAL



STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>If state vctr update</p> <p>Key V96E</p> <p>Perform CSM - (P27) CMC Update, 4.8.1.5</p> <p>Key V37E OOE</p> <p>Key V37E XXE</p> <p><u>ISS Startup</u></p> <p>If CMC on</p> <p>G/N IMU PWR - on (up)</p> <p>NO ATT lt - on (90 sec)</p> <p>NO ATT lt - out (wait 15 sec)</p> <p>Key V37E XXE</p> <p>If CMC not on</p> <p>G/N IMU PWR - on (up)</p> <p>Wait 90 sec</p> <p>IMU CAGE - on (up) ≈5 sec then off (down)</p>	<p>2,140</p> <p>100</p> <p>2,140</p> <p>100</p> <p>1</p>	<p>V96E suspends state vector integration.</p> <p>Re-enables POO integration suspended by V96E.</p> <p>Guarded.</p> <p>Select IMU alignment program desired.</p> <p>Guarded. IMU drives to 0,0,0.</p> <p>Guarded. Releases IMU.</p>
	<p>4.8.1.4 <u>Optics Power Control</u></p> <p>1 Opt pwr up</p>		
CMP	<p>G/N PWR - AC1 or AC2</p> <p>G/N OPT PWR - on (up)</p> <p>OPT ZERO - OFF</p> <p>OPT ZERO - ZERO (≈15 sec to zero)</p> <p>COND LAMPS - ON</p> <p>RETCL BRT tw - adj</p>	<p>5</p> <p>100</p> <p>122</p>	<p>Provides power to reticle and condition lights in LEB.</p> <p>OPT ZERO switch should be left at ZERO until optics use required. It is not position of this switch, but change to ZERO position that triggers zeroing routine.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	2 Opt pwr down OPT ZERO - ZERO G/N OPT PWR - OFF G/N PWR - OFF	122 100 5	Removes power from reticle and condition lights in LEB.
	4.8.1.5 <u>(P27) CSM - CMC Update</u>		P27 may be entered only from P00, P02. All uplinked or keyed in ΔVs and target vectors must be in same sphere of influence as CMC determined state at TIG and TIG -30.
	CMC - on (req), 4.8.1.3 Key V37E 00E	2,140	
	<u>Auto Update</u>		
1	UP TLM CM - ACPT UP TLM - ACPT UPLINK ACTY lt - on	2 122	
2	Update complete UPLINK ACTY lt - out UP TLM CM - BLOCK	2,122 2	PROG window on DSKY displays 00 or 02.
	or UP TLM - BLOCK	122	
3	Key V37E 00E	2,140	
	<u>Voice Transmission Update</u>		
1	Liftoff time - V70E		
	or Load data block - V71E		

4.8.1.5

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP or	Load singular data - V72E	2,140	If another extended verb active.
or	Oct time increment - V73E		
	Poss OPR ERR		
2	DSKY - P27		P27 may be terminated by responding to flashing display with V34E. Data will not be incorporated for use by CMC.
3	FL V21 N01 R1 Blank R2 Unchanged R3 AAAAA		
	Key in update data, XXXXXE (R1) CMC increments R3 by 1		
	Repeat 3 until all data loaded		
4	FL V21 N02 R1 Blank R2 Unchanged R3 00330		
	Accept update V33E		4.6.1.3, note 3m.
	P00 or P02 - sel auto		Data transferred from buffer storage to appropriate cells
	If V96 previously keyed Key V37E 00E		Reinstates periodic P00 integration.
	Reject update Load Oct ID (XXE) of word to be corrected Return to 3		

G&N GENERAL

STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>Time Update (Decimal)</u>		
CMP 1	Key V55E	2,140	
	Poss OPR ERR		If another extended verb active.
2	FL V21 N24 (V25) Δ time (CMC clock)	OOXXX. HRS OOOXX. MIN OXX.XX SEC	All registers initially blank. Delta time change must all be provided in decimal.
	Accept Load ΔT		CMC adds ΔT to CMC clock time.
	Reject V33E or V34E		4.6.1.3, note 3m. V33E or V34E does not update clock time.
3	Check Updated CMC Time Key V06 N65E Key V37E 00E		DSKY displays R1, R2, R3 for crew verification. CMC returns to P00.
	<u>Erasable Memory Update</u>		
1	Key V37E 00E		
2	For Seq Address V21 N01E Load first address XXXXE Load first data word XXXXXE		
	N15E Verify CMC increments address by one (R1)		

4.8.1.5

G&N GENERAL

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Load second data word XXXXXE,E Load third data word XXXXXE,E</p> <p>Continue until last address in seq filled</p> <p>3 For Non-seq Address V21 N01E Load first address XXXXE Load first data word XXXXXE,E Load second address XXXXE Load second data word XXXXXE,E</p> <p>4 To Verify Data Loaded in Seq Address V01 N01E Load first address XXXXE Check first data word in R1 N15E Check second data word in R1 ENTR Check third data word in R1 ENTR</p> <p>4.8.1.6 (P47) <u>G&N Thrusting Monitor Program</u></p> <p>CMC - on (req), 4.8.1.3 ISS - on & aligned (req), 4.8.1.3 & 4.14</p> <p>1 Key V37E 47E</p>	<p>2,140</p> <p>2</p>	<p>Monitors vehicle acceleration during non-G&N controlled thrusting maneuvers, and displays ΔV applied to vehicle by thrusting maneuver.</p> <p>G&N monitor of ΔV highly desirable, if available, but not a requirement. P47 should be called just prior to thrusting and terminated as soon as possible</p> <p style="text-align: right;">...continued</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	2 FL V16 N83 ΔVX, Y, Z (cont) XXXX.X FPS	2	<p>thereafter in order to minimize errors of bias and average G. P47 also normally used during rendezvous final phase. Any ΔV under G&N control during that phase would require P34, P40, or P41. Range, range rate, and theta may be displayed by using V83 (R31).</p> <p>Range, range rate, and phi may be displayed during P47 by using V85 (R34). Orbital parameters may be displayed by using V82 (R30). Also, an SCS orbit change can be monitored by P40 if properly combined with G&N Prethrusting and Thrusting Procedures, 4.12 and 4.13.</p> <p>N62 (VI, H dot, H) available during P47.</p> <p>R02.</p> <p>Displayed when average G turned on. CMC requires 12.5 seconds to turn on average G if integration required is < a time step plus 1.4 seconds (earth orbit) or 2.5 seconds (lunar orbit) for each additional time step. Time step = 240 seconds (earth orbit) or 350 seconds (lunar orbit).</p> <p>Provides capability to monitor another burn without going through R00.</p> <p>When P47 termination desired.</p>
	Poss PROG alarm (4.8.1.16)		
	(To rezero registers - V32E)		
	Mon for burn completion Rcd ΔV PRO (exit P47)		

4.8.1.6

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 3	FL V37 Key XXE	2	If average G on, R00 turns off average G, zeros rendezvous optics mark and VHF ranging mark counters. Otherwise, counters not zeroed. It also sets or resets RNDZ, TRACK, and UPDATE flags, depending on which programs in progress or called. It may also recycle into P20.
4.8.1.7	<u>CMC Self-Check Procedure</u>		
	CMC - on (req), 4.8.1.3		Procedure used to check CMC's ability to write into and read out of erasable memory and performs internal fixed memory banksum.
1	Key V25 N01E 1365E E, E, E	2,140	Zero self-check cells: ERCOUNT, SCOUNT, SCOUNT +1.
2	Key V15 N01E - establish mon of self-check 1365E		Begin monitor of self-check cells.
3	Key V21 N27E 10E - starts self-check		Starts complete self-check.
4	Mon R2 & PROG 1t		
	a. R2 becomes >3 Self-check has been successfully completed at least once Key V21 N27E OE term self-check		Turns off self-check.
	b. If PROG 1t comes on Coord with MSFN &/or perform malfunc SSR-1		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.8.1.8	<u>Measurement and Loading of PIPA Bias</u>		
	CMC - on (req), 4.8.1.3 ISS - on (req), 4.8.1.3 & 4.14		ISS should be on at least one hour prior to performing this procedure to allow PIPAs to stabilize.
CDR	SCS - on (desired), 4.8.4.2 LOGIC 2/3 PWR - on (up)	7	Provides display and SCS control capability.
1	Set Evnt Tmr 00:00	1	
2	Sel Att Cont desired, 4.7.1 Maintain SC Rates <0.1°/sec		
CDR,CMP	00:00 3 Key V25 N21E, E, E, E/start Evnt Tmr	2,140	Zeros noun 21 cells.
CMP	4 Key V06 N21 (do not ENTR)		
01:04	5 Key ENTR		
6	Rcd PIPA counts (X)R1____(Y)R2____(Z)R3____ XXXAB		
7	Key V21 N01E (adj PIPA bias) Load 1452E (calculated X bias) +ABXXE, E 1454E (calculated Y bias) +ABXXE, E 1456E (calculated Z bias) +ABXXE		

4.8.1.8

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	(If AB >99, CMC incapable of adj PIPA bias)		
CMP 8	Key V37E OOE	2,140	
	4.8.1.9 <u>(R33) CMC/LGC Clock Sync Routine</u>		Provides onboard method of determining difference between LGC and CMC clock time (ΔT).
	CMC - on (req), 4.8.1.3		
	1 Key V06 N65		
	2 Confirm sel of this routine in LM		
	3 Perform countdown with LM crew ENTR (simultaneously with LM)		
	4 V06 N65		
	CM clock time	00XXX. HRS 000XX. MIN 0XX.XX SEC	
	Rcd this time Obtain from LM the LM clock time of ENTR Compute ΔT If more data req, return to 3 Comp average of ΔT s		
	5 To incorporate ΔT into CMC clock Perform Time Update, 4.8.1.5		

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STA/T STEP	PROCEDURE	PANEL	REMARKS																															
	4.8.1.10 <u>AR and AV Threshold Change Procedure</u>																																	
	CMC - on (req), 4.8.1.3																																	
CMP	Key V24 N01E Key 2002E	2,140																																
	Load erasable value for desired AR (from following table)																																	
	R3 2003																																	
	Load erasable value for desired AV (from following table)																																	
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Desired AR NM</th> <th style="width: 25%;">Erasable Value</th> <th style="width: 25%;">Desired AV FPS</th> <th style="width: 25%;">Erasable Value</th> </tr> </thead> <tbody> <tr><td>0.00</td><td>77776</td><td>0.00</td><td>77776</td></tr> <tr><td>0.001</td><td>0</td><td>0.0001</td><td>0</td></tr> <tr><td>0.1</td><td>6</td><td>2.5</td><td>1</td></tr> <tr><td>0.2</td><td>14</td><td>5.12</td><td>2</td></tr> <tr><td>0.3</td><td>21</td><td>7.68</td><td>3</td></tr> <tr><td>0.4</td><td>27</td><td>10.24</td><td>4</td></tr> <tr><td>0.5</td><td>35</td><td></td><td></td></tr> </tbody> </table>	Desired AR NM	Erasable Value	Desired AV FPS	Erasable Value	0.00	77776	0.00	77776	0.001	0	0.0001	0	0.1	6	2.5	1	0.2	14	5.12	2	0.3	21	7.68	3	0.4	27	10.24	4	0.5	35			
Desired AR NM	Erasable Value	Desired AV FPS	Erasable Value																															
0.00	77776	0.00	77776																															
0.001	0	0.0001	0																															
0.1	6	2.5	1																															
0.2	14	5.12	2																															
0.3	21	7.68	3																															
0.4	27	10.24	4																															
0.5	35																																	
	4.8.1.11 <u>A or B Erasable Value Change Procedure</u>																																	
	CMC - on (req), 4.8.1.3 P35 & P75 not operating																																	
			Procedure ineffective if programs currently running.																															

4.8.1.11

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STA/T STEP	PROCEDURE	PANEL	REMARKS																		
CMP	Key V24 NO1E Key 2021E (2023E for B) Load 00000E (1:30 to 2:30) Load 00003E (10:00) Load 00004E (11:00 & 12:00) R3 2022 (2024 for B)	2,140	Addresses 2021 and 2023 used by programs P35 and P75 respectively.																		
	Load desired value (from following 2022/2024 table)		Addresses 2022 and 2024 used by programs P35 and P75 respectively.																		
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Desired A or B</th> <th style="width: 50%;">2022/2024</th> </tr> </thead> <tbody> <tr><td>1:30</td><td>21450</td></tr> <tr><td>1:45</td><td>24404</td></tr> <tr><td>2:00</td><td>27340</td></tr> <tr><td>2:15</td><td>32274</td></tr> <tr><td>2:30</td><td>35230</td></tr> <tr><td>10:00</td><td>25140</td></tr> <tr><td>11:00</td><td>00720</td></tr> <tr><td>12:00</td><td>14500</td></tr> </tbody> </table>	Desired A or B	2022/2024	1:30	21450	1:45	24404	2:00	27340	2:15	32274	2:30	35230	10:00	25140	11:00	00720	12:00	14500		
Desired A or B	2022/2024																				
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10:00	25140																				
11:00	00720																				
12:00	14500																				
	<p>4.8.1.12 <u>Flagword Monitor and Change Procedure</u></p> <p>Flagword Monitor</p> <p>Key V11 NO1E Key XXXE (flagword address)</p> <p>R1 XXXXX (flag bit) R3 00XXX (flagword address)</p> <p>Check flag bit in R1 KEY REL</p>		4.6.13.1 for flagword addresses.																		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	Flagword Change		
CMP	Key V25 N07E Key XXXE (flagword address)	2,140	ECADR ≤ 30 (octal) will select appropriate channel (except that channel 7 attempts will be ignored).
	Key XXXXE (bit ID) Key 1 or 0 (1 = set flag bit, 0 = reset flag bit)		Load code for bit to be changed as follows:
	Example:		
	To set REFSMMAT FLG (flagword 3, bit 13) Key V25 N07E 77E 10000E 1E		
	4.8.1.13 (V79) Orbrate/PTC (BBQ Mode - R64)		
	CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 (For orbrate, Ysm aligned to <u>V</u> x <u>R</u>) SCS - on (desired), 4.8.4.2 RCS DAP - Load & activate (req), 4.8.2.1		Allows orbital rate or PTC maneuver by astronaut selection of rate, deadband, and X or Y axis and sets DAP parameters to maintain chosen rate. For SCS passive thermal control procedures, refer to 4.8.4.9 and 10.
CDR	LOGIC 2/3 PWR - on (up)	7	Provides display and SCS control capability. 0.5° deadband and 0.2°/second rate recommended.
CMP	1 Perform (V49E) R62, 4.8.3.4 Load gmb1 angles for init of mnvr (orbrate or PTC)		MGA should be \approx zero for both cases.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 2	Disable two adjacent RCS quads For PTC, att hold for 20 min		Provides fuel conservation and lower rates (panel 8 switches, or R03, may be used to disable engines). To damp existing vehicle rates.
CDR	MAN ATT P&Y (2) - ACCEL CMD Enable all jets	1	Protects against a pitch or yaw jet firing between end of 20-minute wait period and PRO on N79.
CMP 3	Key V79E Poss OPR ERR If in P00, go to 5	2,140	If another extended verb active.
4	FL V06 N16 Time of event OOXX. HRS OOXX. MIN OXX.XX SEC Accept PRO Reject V25E Load desired data		Permits loading of GET for maneuver initiation. Initially 00000 (present time).
5	FL V06 N79 Rate DBD Axis option (X or Y) (0 = X axis, non-zero = Y axis)		+ for increasing CDU angles; - for decreasing CDU angles. X axis (PTC), Y axis (orbrate).
CDR	Accept SC CONT - CMC CMC MODE - AUTO	1	
CMP	PRO Reject Key V25E Load desired data	2,140	Initiates pitch rate (orbrate), or roll rate (PTC), as determined by N79 load. If GET specified (non-zero) in N16, UPLINK ACTY it will indicate maneuver initiation. KEY REL, ERR RSET or V37E XXE will extinguish light.

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STA/T STEP	PROCEDURE	PANEL	REMARKS																												
CDR	For PTC, MAN ATT ROLL - ACCEL CMD MAN ATT P&Y (2) - RATE CMD	1	Enables auto pitch and yaw attitude hold in N79 deadband.																												
6	If desired for PTC, AUTO RCS (16) - OFF RHC PWR DIR (both) - OFF	8 1																													
7	To term mnvr Orbrate Key V46E	2,140																													
CMP			Sets last specified R03 parameters in RCS DAP. In addition, the DAP established by this routine will be altered according to the following table:																												
CDR	PTC MAN ATT (3) - ACCEL CMD AUTO RCS (16) - MNA or MNB V46E or cycle SC CONT sw MAN ATT (3) - RATE CMD	1 8 1																													
			<table border="1"> <thead> <tr> <th>SWITCHING FUNCTION</th> <th>ZEROS COMMANDED RATES</th> <th>RETURNS TO (R03) SPECIFIED DEADBAND</th> <th>ZEROS DAP ATTITUDE ERROR</th> </tr> </thead> <tbody> <tr> <td>V46E</td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>SC CONT - Cycled, CMC/SCS/CMC</td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>CMC MODE - HOLD</td> <td>X</td> <td></td> <td>X</td> </tr> <tr> <td>RHC - out of detent</td> <td>X</td> <td></td> <td>X</td> </tr> <tr> <td>V37E XXE</td> <td>X</td> <td>X</td> <td></td> </tr> <tr> <td>KALCMANU</td> <td>*</td> <td></td> <td>X</td> </tr> </tbody> </table>	SWITCHING FUNCTION	ZEROS COMMANDED RATES	RETURNS TO (R03) SPECIFIED DEADBAND	ZEROS DAP ATTITUDE ERROR	V46E	X	X	X	SC CONT - Cycled, CMC/SCS/CMC	X	X	X	CMC MODE - HOLD	X		X	RHC - out of detent	X		X	V37E XXE	X	X		KALCMANU	*		X
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V37E XXE	X	X																													
KALCMANU	*		X																												
			*KALCMANU generates new commanded rates.																												

4.8.1.13

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STA/T STEP	PROCEDURE	PANEL	REMARKS	
4.8.1.14	<u>G&N Passive Thermal Control Procedure</u>		For SCS passive thermal control procedures, refer to 4.8.4.9 and 10.	
	CMC - on (req), 4.8.1.3			
	ISS - on & orient known (req), 4.8.1.3 & 4.14			
	RCS DAP - Load & activate (req), 4.8.2.1		0.5° deadband and 0.2°/second rate recommended.	
1	Perform (V49E) R62, 4.8.3.4 (PRO on auto mnvr req, FL V50 N18)		This option required to ensure erasable memory is properly set up.	
CDR CMP	2 Disable two adjacent RCS quads Att hold for 20 min	8	Provides fuel conservation and lower rates (panel 8 switches or RO3 may be used to disable engines).	
CDR	3 MAN ATT P&Y (2) - ACCEL CMD	1		
	Enable all RCS jets	8		
CMP	4 Set att hold Key V21 N01E 1013E, E (Set HOLD FLG zero)	2,140	Sets HOLD FLG zero and inhibits maneuver until after data load.	
	Establish desired rate			
	+0.1°/sec	-0.1°/sec	+0.3°/sec	-0.3°/sec
	V24 N01E 3125E 3E 24400E V21E 3176E 35101E	V24 N01E 3125E 77774E 53400E V21E 3176E 42676E	V24 N01E 3125E 12E 35400E V24E 3175E 2E 27303E	V24 N01E 3125E 77765E 42400E V24E 3175E 77775E 50474E

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 5	Start roll mvr Key V21 NO1E 1013E 70000E	2,140	Initiates maneuver.
CDR 6	MAN ATT ROLL - ACCEL CMD	1	Disables roll jets for duration of PTC.
CMP 7	Perform RCS DAP Att Dbd Change, 4.8.2.2		+30° deadband is recommended.
CDR 8	AUTO RCS (16) - OFF		
9	To term PTC MAN ATT (3) - ACCEL CMD (verify) AUTO RCS (16) - MNA or MNB V46E or Cycle SC CONT sw MAN ATT (3) - RATE CMD	8 1	Re-establishes attitude hold within attitude deadband selected in R03.
4.8.1.15 <u>Saturn Rate Change</u>			
CMC - on (req), 4.8.1.3			
CMP 1	Key V24 NO1E 3322E XXXE YYYYYE	2,140	

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4.8.1.15

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STA/T STEP	PROCEDURE	PANEL	REMARKS																					
	<table border="1"> <thead> <tr> <th></th> <th>SAT RATE +1 (3322)</th> <th>SAT RATE +2 (3323)</th> </tr> </thead> <tbody> <tr> <td>SIVB RATE</td> <td>XXX</td> <td>YYYYY</td> </tr> <tr> <td>0.05°/sec RPY</td> <td>161</td> <td>77616</td> </tr> <tr> <td>0.1°/sec RPY</td> <td>210</td> <td>77567</td> </tr> <tr> <td>0.2°/sec RPY</td> <td>266</td> <td>77511</td> </tr> <tr> <td>*0.3°/sec RPY</td> <td>344</td> <td>77433</td> </tr> <tr> <td>0.5°/sec R, 0.3°/sec P&Y</td> <td>476</td> <td>77301</td> </tr> </tbody> </table>		SAT RATE +1 (3322)	SAT RATE +2 (3323)	SIVB RATE	XXX	YYYYY	0.05°/sec RPY	161	77616	0.1°/sec RPY	210	77567	0.2°/sec RPY	266	77511	*0.3°/sec RPY	344	77433	0.5°/sec R, 0.3°/sec P&Y	476	77301		
	SAT RATE +1 (3322)	SAT RATE +2 (3323)																						
SIVB RATE	XXX	YYYYY																						
0.05°/sec RPY	161	77616																						
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*0.3°/sec RPY	344	77433																						
0.5°/sec R, 0.3°/sec P&Y	476	77301																						
	*Use for TLI																							
	4.8.1.16 (R02) IMU Status Check		Check whether IMU on and, if on, whether it is aligned to an orientation known by CMC. R02 automatically called by programs requiring ISS. Provides for program alarms if ISS not on and/or IMU orientation unknown.																					
	1 ISS not on (known orient not req)																							
CMP	PROG alarm FL V37 Key V05 N09E (to verify alarm) 00210 (ISS not on) Perform ISS turnon Key XXE	2,140	Occurs only if ISS not on. Alarm stored; must key V05 N09E to display alarm code. Return to PXX at completion of ISS turnon.																					

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STA/T STEP	PROCEDURE	PANEL	REMARKS
<p>2 ISS not on &/or orient unknown (known orient req)</p> <p>CMP</p>	<p>PROG alarm Key V05 N09E (to verify alarm) 00210 (ISS not on)</p> <p>or 00220 (IMU orient unknown)</p> <p>FL V37</p> <p>Key XXE</p> <p>4.8.1.17 <u>(V64) S-Band Antenna Routine (R05)</u></p> <p>CMC - on (req), 4.8.1.3</p> <p>ISS - on & orient known (req), 4.8.1.3 & 4.14</p> <p>1 Key V64E</p> <p>Poss OPR ERR</p>	<p>2,140</p>	<p>Alarm stored; must key V05 N09E to display alarm code.</p> <p>RSET and KEY REL pressed when nature of problem determined. When CMC regains control, program cycles through R00, which resets 3-AXIS flag and may set or reset RNDZ, TRACK, and UPDATE flags, depending on which programs are in progress or called.</p> <p>Perform ISS turnon and/or IMU orientation determination. Reinitiate desired program.</p> <p>Computes and displays two steerable S-band antenna gimbal angles required to point antenna toward center of earth.</p> <p>Required for valid angle displays.</p> <p>Selects R05. Uses permanent state vector for calculations and therefore, will be based on old values if average G on.</p> <p>If another extended verb active.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 2 FL V06 N51		2,140	S-band required gimbal angles. Rho - Pitch gimbal angle. Gamma - Yaw gimbal angle.
	Rho XXX.XX DEG Gamma XXX.XX DEG		
	Accept Rcd angles PRO		
	Reject Sel Att Cont mode desired, 4.7.1 Mnvr SC as req		Spacecraft maneuver will be required only if displayed angles do not provide an unobstructed view of earth. (Ref CSM Data Book, section 4.7, HGA Scan and Warning Limit, Yaw - Pitch Coord.)
	4.8.1.18 <u>DSKY 88888 Clear Procedure</u>		DSKY relay failure mode will cause an all-eights display on DSKY. Affects display capability of DSKY but will not affect input/output or control functions.
	Key V99 N99 Key V25 N01E 00000E +99999E +99999E +99999 CLR, CLR, CLR 00000E 00000E 00000E		
	If OPR ERR Start over		
	If DSKY does not clear Repeat proced		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.8.2 DIGITAL AUTOPILOT (DAP)		
	4.8.2.1 <u>(V48) CSM - DAP Data Load Procedure (R03)</u>		
	CMC - on (req), 4.8.1.3		For CMC control modes, DAP data load procedure is used to select rate, deadband, and quads. When under computer control, operating program will establish SC rates and attitude error deadbands, or crew may select other desired error deadbands via DSKY. In addition, crew has capability of selecting RCS quads for computer command of manual translation, attitude hold, or automatic and manual maneuvers.
CMP 1	Key V48E	2,140	Extended verb 48 program calls DAP data 1, 2, and 3 in sequential order. DAP data 1, 2, or 3 may also be displayed individually by using respective verb/noun combinations, i.e., V04 N46, V06 N47, or V06 N48.
	(Bit A of R1 configures TVC DAP for LM on-off)		
2	FL V04 N46 R1 - A B C D E R2 - A B C D E		
	Accept PRO Reject V24E load desired data		

4.8.2.1

DIGITAL AUTOPILOT (DAP)

STA/T STEP	PROCEDURE	PANEL	REMARKS										
R1	<table border="1"> <thead> <tr> <th>Vehicle Config.</th> <th>Quad A/C for \ddot{X}</th> <th>Quad B/D for \ddot{X}</th> <th>Err Deadband</th> <th>Rate Select</th> </tr> </thead> <tbody> <tr> <td>0 = No Dap 1 = CSM 2 = CSM & LM 3 = CSM & SIVB 6 = CSM & LM (Ascent Sig only)</td> <td>0 = Fail A/C 1 = Use A/C</td> <td>0 = Fail B/D 1 = Use B/D</td> <td>0 = $\pm 0.5^\circ$ 1 = $\pm 5.0^\circ$</td> <td>0 = 0.05°/sec 1 = 0.2°/sec 2 = 0.5°/sec 3 = 2.0°/sec</td> </tr> </tbody> </table>	Vehicle Config.	Quad A/C for \ddot{X}	Quad B/D for \ddot{X}	Err Deadband	Rate Select	0 = No Dap 1 = CSM 2 = CSM & LM 3 = CSM & SIVB 6 = CSM & LM (Ascent Sig only)	0 = Fail A/C 1 = Use A/C	0 = Fail B/D 1 = Use B/D	0 = $\pm 0.5^\circ$ 1 = $\pm 5.0^\circ$	0 = 0.05°/sec 1 = 0.2°/sec 2 = 0.5°/sec 3 = 2.0°/sec		If quads A/C and B/D (4 jets) desired for $\pm X$ translation, R1-B and R1-C may be set to 0,0, or 1,1.
Vehicle Config.	Quad A/C for \ddot{X}	Quad B/D for \ddot{X}	Err Deadband	Rate Select									
0 = No Dap 1 = CSM 2 = CSM & LM 3 = CSM & SIVB 6 = CSM & LM (Ascent Sig only)	0 = Fail A/C 1 = Use A/C	0 = Fail B/D 1 = Use B/D	0 = $\pm 0.5^\circ$ 1 = $\pm 5.0^\circ$	0 = 0.05°/sec 1 = 0.2°/sec 2 = 0.5°/sec 3 = 2.0°/sec									
R2	<table border="1"> <thead> <tr> <th>Roll Quad Select</th> <th>Quad A</th> <th>Quad B</th> <th>Quad C</th> <th>Quad D</th> </tr> </thead> <tbody> <tr> <td>0 = Use B/D 1 = Use A/C</td> <td>0 = Fail 1 = Use</td> <td>0 = Fail 1 = Use</td> <td>0 = Fail 1 = Use</td> <td>0 = Fail 1 = Use</td> </tr> </tbody> </table>	Roll Quad Select	Quad A	Quad B	Quad C	Quad D	0 = Use B/D 1 = Use A/C	0 = Fail 1 = Use	0 = Fail 1 = Use	0 = Fail 1 = Use	0 = Fail 1 = Use		If A is failed, CMC assumes C is good. If B is failed, CMC assumes D is good.
Roll Quad Select	Quad A	Quad B	Quad C	Quad D									
0 = Use B/D 1 = Use A/C	0 = Fail 1 = Use	0 = Fail 1 = Use	0 = Fail 1 = Use	0 = Fail 1 = Use									
CMP 3	FL V06 N47 CSM wt XXXXX. LBS LM wt XXXXX. LBS Accept PRO Reject Key V21E, V22E or V24E Load correct data	2,140	Value of mass used in non-DAP coding not updated unless vehicle configuration bit is 1, 2, or 6. During P40 TVC DAP reduces value for weight linearly, as function of SPS maneuver time. Maneuvers performed without using P40 could cause CMC's knowledge of weight to be compromised.										
4	FL V06 N48 P Trim XXX.XX DEG Y Trim XXX.XX DEG Accept PRO - Return to prog in progress Reject Key V21E, V22E or V24E Load correct data		If burn >0.42 second, trim values will be updated by CMC during burn. Do not load engine gimbal trim angles >9°.										
5	To activate DAP		To be done first time DAP started or after fresh start.										

DIGITAL AUTOPILOT (DAP)

STA/T STEP	PROCEDURE	PANEL	REMARKS														
CDR CMP	CMC MODE - FREE Key V46E	1 2,140	Prevents inadvertent jet firings. Activates DAP.														
4.8.2.2	<u>RCS DAP Attitude Deadband Change Procedure</u>		This procedure will change RCS DAP att deadband to +2.5, 10, 15, 20, 25, or 30°. Alternate method of establishing desired deadbands is to use V79 procedures, loading desired deadband, and specify zero rate.														
	CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 RCS DAP - activate (req), 4.8.2.1 SCS - on (desired), 4.8.4.2																
1	Sel CMC Att Cont - auto, 4.7.1.6																
2	Sel 5.0° dbd in RCS DAP, 4.8.2.1																
3	Key V21 NO1E 3255E Load D Band (see table)																
	<table border="1"> <thead> <tr> <th>Desired dbd</th> <th>D Band</th> </tr> </thead> <tbody> <tr> <td>+2.5°</td> <td>0343E</td> </tr> <tr> <td>+10°</td> <td>1616E</td> </tr> <tr> <td>+15°</td> <td>2525E</td> </tr> <tr> <td>+20°</td> <td>3434E</td> </tr> <tr> <td>+25°</td> <td>4343E</td> </tr> <tr> <td>+30°</td> <td>5252E</td> </tr> </tbody> </table>	Desired dbd	D Band	+2.5°	0343E	+10°	1616E	+15°	2525E	+20°	3434E	+25°	4343E	+30°	5252E		
Desired dbd	D Band																
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+20°	3434E																
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+30°	5252E																

4.8.2.2

DIGITAL AUTOPILOT (DAP)

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 4	To return to 5.0° dbd THC - CW, then neut		Center of deadband shifted.
	or Key V48E PRO PRO PRO	2,140	Center of deadband not affected.
	<p>4.8.2.3 <u>RCS DAP Orbital Rate Procedure</u></p> <p>CMC - on (req), 4.8.1.3</p> <p>ISS - on & orient known (req), 4.8.1.3 & 4.14</p> <p>SCS - on (desired), 4.8.4.2</p> <p>RCS DAP - load & activate (req), 4.8.2.1 (Use R03 to disable 2 adjacent RCS quads)</p> <p>Ysm aligned to <u>V</u> x <u>R</u> (If <u>R</u> x <u>V</u>, complement numbers for ZZZZZ)</p> <p>1 Perform (V49) R62, 4.8.3.4 Load gmb1 angles for init of orbrate</p> <p>2 If desired Key V37E XXE (non-att cont prog)</p>		<p>To minimize RCS propellant consumption.</p> <p>Gimbal angles loaded are those that are to be at initiation of orbital rate rotation. MGA should be zero.</p>

DIGITAL AUTOPILOT (DAP)

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 3	Establish orbrate For rates 0.1°/sec or less, load oct numbers corresponding to desired mnvr rate from following table For rate 0.5°/sec, go to 5	2,140	Sets HOLD FLG to zero and inhibits maneuver until after data load.
	Key V21 N01E 1013E,E (Set HOLD FLG zero)		
	Key V24 N01E 3127E VVVVVE WWWWWE		
	Key V24E 3131E XXXXXE YYYYYE		
	Key V21E 3200E ZZZZZE		
	Key V21 N01E 1332E 70000E (Set HOLD FLG negative)		Final ENTR initiates maneuver.
	Mnvr in progress		

STA/T STEP	PROCEDURE	PANEL				REMARKS
4 To term mnvr, go to 8						
ORBRATE deg/sec	CDUX					
	0 deg	+90 deg	+180 deg	+270 deg		
-0.100	VVVVV = 77774	00000	00003	00000		
	WWWWW = 54300	61300	23500	16500		
	XXXXX = 00000	00003	00000	77774		
	YYYYY = 61300	23500	16500	54300		
	ZZZZZ = 42676	42676	42676	42676		
-0.095	VVVVV = 77774	00000	00003	00000		
	WWWWW = 62200	62000	15600	16000		
	XXXXX = 00000	00003	00000	77774		
	YYYYY = 62000	15600	16000	62200		
	ZZZZZ = 44250	44250	44250	44250		
-0.090	VVVVV = 77774	00000	00003	00000		
	WWWWW = 70000	62600	10000	15200		
	XXXXX = 00000	00003	00000	77774		
	YYYYY = 62600	10000	15200	70000		
	ZZZZZ = 45622	45622	45622	45622		
-0.085	VVVVV = 77774	00000	00003	00000		
	WWWWW = 75600	63400	02200	14400		
	XXXXX = 00000	00003	00000	77774		
	YYYYY = 63400	02200	14400	75600		
	ZZZZZ = 47173	47173	47173	47173		
...continued						

DIGITAL AUTOPILOT (DAP)

STA/T STEP	PROCEDURE				PANEL	REMARKS
ORBRATE deg/sec	CDUX					
	0 deg	+90 deg	+180 deg	+270 deg		
-0.080	VVVVV = 77775 WWWWW = 43400 XXXXX = 00000 YYYYY = 64100 ZZZZZ = 50545	00000 64100 00002 34400 50545	00002 34400 00000 13700 50545	00000 13700 77775 43400 50545		
-0.075	VVVVV = 77775 WWWWW = 51300 XXXXX = 00000 YYYYY = 64700 ZZZZZ = 52117	00000 64700 00002 26500 52117	00002 26500 00000 13100 52117	00000 13100 77775 51300 52117		
-0.070	VVVVV = 77775 WWWWW = 57100 XXXXX = 00000 YYYYY = 65500 ZZZZZ = 53467	00000 65500 00002 20700 53467	00002 20700 00000 12300 53467	00000 12300 77775 57100 53467		
-0.065	VVVVV = 77775 WWWWW = 64700 XXXXX = 00000 YYYYY = 66300 ZZZZZ = 55041	00000 66300 00002 13100 55041	00002 13100 00000 11500 55041	00000 11500 77775 64700 55041		
...continued						

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4.8.2.3

DIGITAL AUTOPILOT (DAP)

STA/T STEP		PROCEDURE				PANEL	REMARKS
ORBRATE deg/sec	CDUX						
	0 deg	+90 deg	+180 deg	+270 deg			
-0.060	VVVVV = 77775 WWWWW = 72500 XXXXX = 00000 YYYYY = 67100 ZZZZZ = 56413	00000 67100 00002 05300 56413	00002 05300 00000 10700 56413	00000 10700 77775 72500 56413			
-0.055	VVVVV = 77776 WWWWW = 40300 XXXXX = 00000 YYYYY = 67600 ZZZZZ = 57765	00000 67600 00001 37400 57765	00001 37400 00000 10200 57765	00000 10200 77776 40300 57765			
-0.050	VVVVV = 77776 WWWWW = 46200 XXXXX = 00000 YYYYY = 70400 ZZZZZ = 61337	00000 70400 00001 31600 61337	00001 31600 00000 07400 61337	00000 07400 77776 46200 61337			
CMP 5 Ysm aligned to <u>V</u> <u>X</u> <u>R</u> 2,140 (If <u>R</u> x <u>V</u> , complement numbers for AAAAA and ZZZZZ)							
6 Key V21 NO1E 1013E,E (set HOLD FLG zero)							Sets HOLD FLG zero and inhibits maneuver until after data load.

DIGITAL AUTOPILOT (DAP)

STA/T STEP	PROCEDURE	PANEL	REMARKS																																								
CMP 7	Establish orbrate (0.5°/sec) Load oct numbers corresponding to mnvr rate from following table Key V24E 3127E VVVVVE WWWWWE Key V24E 3131E XXXXXE YYYYYE Key V24E AAAAAE ZZZZZE Key V21E 1013E 70000E (set HOLD FLG negative)	2,140	Final ENTR initiates maneuver.																																								
	<table border="1" style="margin: auto; border-collapse: collapse;"> <thead> <tr> <th></th> <th colspan="4">CDUX</th> </tr> <tr> <th></th> <th>0°</th> <th>180°</th> <th>7.25°</th> <th>187.25°</th> </tr> </thead> <tbody> <tr> <td>VVVVV</td> <td>77755</td> <td>00022</td> <td>77722</td> <td>00022</td> </tr> <tr> <td>WWWWW</td> <td>76077</td> <td>01700</td> <td>71351</td> <td>06426</td> </tr> <tr> <td>XXXXX</td> <td>77775</td> <td>00002</td> <td>---</td> <td>---</td> </tr> <tr> <td>YYYYY</td> <td>66367</td> <td>11410</td> <td>---</td> <td>---</td> </tr> <tr> <td>AAAAA</td> <td>77773</td> <td>77773</td> <td>77773</td> <td>77773</td> </tr> <tr> <td>ZZZZZ</td> <td>56272</td> <td>56272</td> <td>56272</td> <td>56272</td> </tr> </tbody> </table>				CDUX					0°	180°	7.25°	187.25°	VVVVV	77755	00022	77722	00022	WWWWW	76077	01700	71351	06426	XXXXX	77775	00002	---	---	YYYYY	66367	11410	---	---	AAAAA	77773	77773	77773	77773	ZZZZZ	56272	56272	56272	56272
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AAAAA	77773	77773	77773	77773																																							
ZZZZZ	56272	56272	56272	56272																																							

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 8	To term mnvr CMC MODE - HOLD	1	
CMP	or Key V49E, return to 1 or Key V46E or RHC - out of detent or Key V37E	2,140	

DIGITAL AUTOPILOT (DAP)

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.8.3	EXTENDED VERBS		
4.8.3.1	<u>(V35) DSKY Condition Light Test</u>		Procedure designed to test CMC/caution and warning, DSKY interface.
	CMC - on (req), 4.8.1.3		
CMP	1 Key V37E OOE (req)	2,140	Must be performed while in P00.
	2 Key V35E		
	3 Mon the following events		
	a. All DSKY condition lts - on		
	b. ISS warning lt - on CMC warning lt - on		
	c. All DSKY numerical windows disp 8 Sign positions in R1, R2, R3 show + V, N windows flash		
	Wait 5 sec		
	d. All DSKY warning lts - out		NO ATT will be left on if coarse align occurring.
	e. ISS lt - out CMC lt - out		
	f. Old PROG number will be disp Interrupted disp (if any) will be restarted		

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.8.3.2 (V42) Torque Gyros	CMC - on (req), 4.8.1.3 ISS - on (req), 4.8.1.3 & 4.14	2,140	Fine aligns stable member by torquing gyros (primarily for ground use).
CMP 1 Key V37E 00E	2 For Load <100° Key V42E	2,140	If another extended verb active, or IMU stall routine in use.
or For Load >99.999°	Key V21 N02E 2757E XXXXXE N15E XXXXXEE YYYYYEE YYYYYEE ZZZZZEE ZZZZZE Key V42E	2,140	Load >90 deg should not be performed during flight.
3 FL V21 N93 (request load)	Poss OPR ERR	2,140	If another extended verb active, or IMU stall routine in use.
3 FL V21 N93 (request load)	Poss OPR ERR	2,140	If SC CONT at CMC and CMC MODE at AUTO or HOLD, DAP will maneuver vehicle to follow the platform as it moves.

EXTENDED VERBS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Δ Gyro X, Y, Z XX.XXX DEG	2,140	Registers initially blank.
	Accept Load desired data DSKY displays V42 NO ATT lt - out		
	Reject V33E DSKY displays V42 NO ATT lt - out		Key V33E if gyro torquing registers loaded prior to keying V42E. Also refer to 4.6.1.3, note 3m.
	<u>4.8.3.3 (V43) Load FDAI Error Needles</u>		Loads crew specified angles into FDAI error needles (primarily for ground use).
	CMC - on (req), 4.8.1.3 ISS - on (req), 4.8.1.3		
	1 Key V37E 00E		V43E can be executed only from P00.
	2 Key V43E		
	Poss OPR ERR		V43E cannot be executed if CMC not in P00, IMU in coarse align or zero ICPU mode, or if another extended verb active. (Latter is constraint after liftoff.)
	3 FL V21 N22 (request load) R, P, Y XXX.XX DEG		Registers initially blank.
	Load desired err angles		Maximum effective angle which may be loaded is <u>+16.88</u> degrees.

4.8.3.3

EXTENDED VERBS

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.8.3.4 (V49) CSM Crew Defined Maneuver (R62)		Provides method of performing CMC controlled maneuver to crew defined attitude.
	CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2		
CMP 1	Key V37E 00E	2,140	Routine R62 may be called from P00 only.
2	Sel Tot Att (ISS) Disp, 4.7.2.5		Both FDAIs recommended so either reference system (IMU or GDC) may be monitored. (CMC attitude error and rate displays available.)
3	Key V49E		
	Poss OPR ERR		If another extended verb active.
4	FL V06 N22 (fml gmb1 angles) R, P, Y XXX.XX DEG		
	Accept PRO Reject V25E load desired gmb1 angles		
	(R60 - Attitude Maneuver Routine)		Provides for maneuver (automatically or manually) to specified attitude.
5	FL V50 N18 (auto mnvr request) R, P, Y XXX.XX DEG		Required gimbal angles.

EXTENDED VERBS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	Accept BMAG MODE (3) - RATE 2	1	
	Sel CMC Att Cont Auto, 4.7.1.6		
CMP	PRO	2,140	May be performed second time as attitude trim.
	V06 N18		Static display until completion of auto maneuver and reverts to FL V50 N18.
	R, P, Y XXX.XX DEG		
	Mon auto mnvr on FDAI		
	Reject Key V62E		Selects Mode 2, total attitude error on FDAI needles.
	RHC - Null FDAI needles		Any input from RHC (RHC out of detent) will be interpreted by CMC as a manual override and will cause immediate termination of auto maneuver calculation.
	When att satisfactory		
	ENTR		
	4.8.3.5 <u>(V67) Start W-Matrix RSS Error Display</u>		Provides display of RSS position and velocity errors, and opportunity to load new initialization values. However, initialization will not take place until next opportunity.
	CMC - on (req), 4.8.1.3		
	1 Key V67E		
	Poss OPR ERR		If another extended verb in process.
	Exit		
	2 FL V06 N99		
	POS ERR XXXXX. FT		RSS value of position error.
	VEL ERR XXXX.X FPS		RSS value of velocity error.

4.8.3.5

EXTENDED VERBS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Option code Accept PRO Reject Key V25E Load desired data (per following tables)	0000X 2,140	Option code: (initially 00000) 00001 - Rendezvous 00002 - Orbital 00003 - Cislunar R3 must be loaded for desired option. Otherwise, reinitialization will not occur. Bypasses reinitialization, if R3 = 00000. To initialize at new values. Initialization occurs next time a measurement is made. N99 values to be loaded to obtain desired POS ERR and VEL ERR elements with corresponding octal values for erasable.
W-MATRIX TABLE (V67)			
WRENDPOS	2000-P20	WRENDVEL	2001-P20
WORBPOS	2004-P22	WORBVEL	2005-P22
WMID POS	3000-P23	WMIDVEL	3001-P23
N99 R1	1000 ft	OCT	N99 R2 fps OCT
10000	10	137	10 10 762
08000	8	114	8 8 620
06000	6	71	6 6 453
04000	4	46	4 4 307
02000	2	23	2 2 144
01000	1	11	1 1 61
00800	.8	7	.8 .8 50
00600	.6	5	.6 .6 34
00400	.4	3	.4 .4 24
00300	.2	2	.2 .2 10
00100	.1	1	.1 .1 5

EXTENDED VERBS

STA/T STEP	PROCEDURE	PANEL	REMARKS
<p>4.8.3.6 (V74) <u>Initialize Erasable Dump Via Downlink</u></p> <p>CMC - on (req), 4.8.1.3</p> <p>CMP 1 Key V74E (V74 will deliver two complete dumps)</p>		2,140	Dumps all eight banks of erasable memory via downlink.
<p>4.8.3.7 (V91) <u>Display Banksum</u></p> <p>CMC - on (req), 4.8.1.3</p> <p>1 Key V37E 00E</p> <p>2 Key V91E</p> <p>Poss OPR ERR</p> <p>3 FL V05 N01</p> <p>Banksum XXXXX</p> <p>Bank No. XXXXX</p> <p>Bugger word XXXXX</p> <p>Accept V34E (halt summing)</p> <p>Reject PRO, recycle 3 (next bank)</p>			<p>Displays sum of each bank for comparison.</p> <p>Procedure must be performed in P00.</p> <p>If another extended verb active.</p> <p>Sum of bits of chosen bank.</p> <p>Number of bank being read.</p> <p>Factor required to make $R1 = R2$.</p> <p>Expected bank and banksum acceptable ($R1 = R2$).</p> <p>43 banks.</p>

4.8.3.7

EXTENDED VERBS

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.8.4	SCS GENERAL		
4.8.4.1	<u>SCS Power Down</u>		Describes safe power-down configuration.
CDR	1 Provide Safe Sys Configuration		
	EMS FUNC - OFF	1	
	EMS MODE - STBY		
	AUTO RCS (16) - OFF	8	
	BMAG MODE (3) - RATE 2	1	
	SPS THRUST - NORM		Normal position selected to prevent inadvertent SPS firing.
	2 Remove SCS Pwr		
	TVC SERVO PWR (both) - OFF	7	
	FDAI/GPI PWR - OFF		
	LOGIC 2/3 PWR - OFF		
	ELEC PWR - OFF		
	SIG CONDR/DR BIAS PWR (both) - OFF		
	BMAG PWR (both) - WARMUP		
	RHC PWR NORM (both) - OFF	1	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	For tot pwr down		
	W BMAG 1 PWR - OFF	7	When BMAG switches set to OFF, 40-minute warmup may be required (BMAG 1 and 2 TEMP lights extinguish when operating temperature is reached) before normal operation of BMAGs. If set from ON to WARMUP, BMAG TEMP lights should remain out.
	X XXXXXXXXXXXXXXXXXXXXXXXXXXXXX		
	3 Pwr Down ORDEAL		
	FDAI sw (both) - INRTL	13	
	EARTH/LUNAR - PWR OFF		
	LIG - OFF		

SCS GENERAL

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	4 Pwr Down COAS COAS PWR (2) - OFF	15,16	
CDR, CMP	5 Miscellaneous THC - neut, LOCKED RHC (both) - LOCKED		
CDR	6 Remove Logic Sw Pwr FDAI SCALE - 5/1 FDAI SEL - 1 or 2 ATT SET - GDC MAN ATT (3) - RATE CMD LIM CYCLE - on (up) ATT DBD - MAX RATE - LO EMS ROLL - OFF TVC GMBL DR (2) - 1	1	Optional step to place panel 1 switches on logic buses in their OFF position. Relationship between switch positions and logic buses described in 4.6.3. ATT SET switch should be left at GDC when not in use. Also refer to 4.6.1.1, note 5.
	4.8.4.2 <u>SCS Power Up</u>		Used to power up display and control electronics of SCS.
	1 Provide Safe Sys Configuration AUTO RCS (16) - OFF BMAG MODE (3) - RATE 2	8 1	Cages BMAGs and prevents attitude error signal, if any, from causing jet firings when RCS enabled.
	2 Set Pwr Switches LOGIC 2/3 PWR - on (up) ELEC PWR - GDC/ECA	7	Configures G&C for future command/control functions. Provides power for control and GDC electronics.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	SIG CONDR/DR BIAS PWR (both) - AC1 or AC2	7	Switch 1 also provides SCS signal conditioner power for the following TLM functions: rate and attitude error, SCS auto TVC, MTVC, gimbal position transducer and RHC proportional rate commands. Switch 2 provides SCS signal conditioner power for TVC pitch and yaw differential clutch current TLM. For increased reliability, switches should not be set on same bus. Also refer to 4.6.1.2, note 5.
CMP	BMAG TEMP 1t (2) - out	2	
CDR	FDAI/GPI PWR - OFF	7	If FDAIs are powered when BMAGs come up to speed, rate needles will oscillate full scale.
	BMAG PWR (both) - ON		Provides rate and attitude source for control and display functions.
	FDAI/GPI PWR - BOTH		Provides power for display electronics.
	RHC PWR NORM (both) - AC/DC	1	Provides power to RHC for manual control functions if needed.
	4.8.4.3 <u>Drift Rate Adjust</u>		Permits periodic adjustment of finite drift rates of <1 deg/sec. It is intended for use during long periods of drift such as in thermal control where high power consumption undesirable.
	1 Set up Pwr Sw		
	LOGIC 2/3 PWR - on (up)	7	Powers panel 1 controls for command/control functions.
	ELEC PWR - ECA		Powers control electronics.
CMP	BMAG TEMP 1t (2) - out	2	
CDR	FDAI/GPI PWR - OFF	7	If FDAIs are powered when BMAGs come up to speed, rate needles will oscillate full scale.

SCS GENERAL

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	BMAG 2 PWR - ON	7	Provides rate source for control and display functions.
	FDAI/GPI PWR - 1		Provides power for display electronics.
	SIG CONDR/DR BIAS PWR (both) - AC1 or AC2		4.6.1.2, note 5.
	RHC PWR NORM (both) - AC/DC	1	
2	Establish Rate Disp for Ball 1, 4.7.2.1 FDAI SEL - 1 BMAG MODE - RATE 2		
3	Establish SCS Min Imp, 4.7.1.2 MAN ATT (3) - MIN IMP SC CONT - SCS AUTO RCS - MNA or MNB	8	Single jet control in each axis preferred to allow fuel conservation.
4	Adj Veh Rates RHC - ARMED Adj rates using FDAI 1 RHC - LOCKED		FDAI SCALE - 5/1 recommended since expected rates will be <1 deg/sec.
4.8.4.4	<u>Minimum Power SCS Attitude Hold</u> <u>(Three or Two Axes)</u>		Provides attitude hold in two or three axes, as desired, for prolonged periods using low power consumption.
1	Set Pwr Sw LOGIC 2/3 PWR - on (up) ELEC PWR - ECA	7	If total attitude display desired, select GDC/ECA.

4.8.4.4

SCS GENERAL

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP CDR	BMAG TEMP 1t (2) - out FDAI/GPI PWR - OFF	2 7	If FDAIs powered when BMAGs come up to speed, rate needles will oscillate full scale.
	SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 BMAG PWR (both) - ON FDAI/GPI PWR - 1		4.6.1.2, note 5. Provides power for display electronics.
2	Establish SCS Att Hold/Rate Cmd, 4.7.1.4 MAN ATT (3 or 2) - RATE CMD LIM CYCLE - on (up) ATT DBD - MAX RATE - LO SC CONT - SCS BMAG MODE (3) - RATE 2 AUTO RCS - MNA or MNB BMAG MODE (3 or 2) - ATT 1/RATE 2	1 8 1	Selection by axis using these switches will determine axes in which attitude hold is enabled. Single jet control in each axis preferred to allow fuel conservation.
3	Sel Disp, 4.7.2.1 & 2 FDAI SEL - 1 FDAI SOURCE - GDC		
4	Mon FDAI 1 att err during limit cycling		

SCS GENERAL

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.8.4.5	<u>SCS Attitude Maneuver</u>		Provides options for performing SCS attitude maneuver during normal orbital operations or to satisfy specific mission requirements. Permits easy correlation to G&C Reference Modes, 4.7, and other G&C General Procedures, 4.8.
	1 The following are req ISS - on & orient known (for step 3a), 4.8.1.3 & 4.14 SCS - on, 4.8.4.2		
CDR	2 Obtain mnvr data from MSFN		
	a. Fnl mnvr angles R ___°, P ___°, Y ___°		
	or b. External ref cues		
	3 Maneuver		Select FDAI display as required. Also refer to 4.6.1.2, note 6.
	a. To specified mnvr angles If ISS avail Perform GDC align to IMU gmbl angles, 4.8.4.6 If ISS not avail Perform alternate SC Inertial Att Determination, 4.14.2.1 Set ATT SET tw - to desired values (step 2) Sel att cont mode, 4.7.1	1	Mode should be compatible with magnitude of maneuver - e.g., rate command, acceleration command or minimum impulse, and desired rates.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	RHC - mnvr		Use total attitude and/or attitude error displays as required to obtain final gimbal angles.
or b.	To external ref Sel att cont mode, 4.7.1 RHC - mnvr		Null rates at desired orientation.
4.8.4.6	<u>GDC Alignment to IMU Gimbal Angles</u>		Provides two methods for aligning GDC to IMU.
1	The following are req CMC - (on for step 3b), 4.8.1.3 ISS - on & orient known, 4.8.1.3 & 4.14 SCS - on, 4.8.4.2 FDAI 1 sw - INRTL (desired)	13	Provides easy comparison between FDAI and ATT SET values.
2	Establish Att Cont, 4.7.1 Damp veh rates		Selected to prevent drift error during alignment process.
3	Perform Att Err Disp - ISS Att Set Source, 4.7.2.4		4.6.1.1, note 5.
a.	FDAI SOURCE - ATT SET ATT SET - IMU FDAI SEL - 1 ATT SET tw - null FDAI 1 errors	1	Verify that ATT SET tw and FDAI 1 indicate same total attitude because false nulling of error needles could occur 180° from desired attitude.

SCS GENERAL

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	5 Perform ATT SET/IMU comparison, 4.7.2.4 FDAI SEL - 1 FDAI SOURCE - ATT SET ATT SET - IMU ATT SET tw (3) - set \approx to DSKY values, null FDAI 1 att err	1	4.6.1.1, note 5.
CMP	ENTR (when nulled) Rcd DSKY values R <u> </u> ^o , P <u> </u> ^o , Y <u> </u> ^o Rcd ATT SET values R <u> </u> ^o , P <u> </u> ^o , Y <u> </u> ^o	2,140	Error needle bias, if any, determined and may be subtracted from GDC drift in step 6 (postflight).
CDR	6 Perform ATT SET/GDC comparison ATT SET - GDC ATT SET tw (3) - null FDAI 1 att err	2,140	
CMP	ENTR (when nulled) Rcd DSKY values R <u> </u> ^o , P <u> </u> ^o , Y <u> </u> ^o Rcd ATT SET values R <u> </u> ^o , P <u> </u> ^o , Y <u> </u> ^o	1	
	4.8.4.8 <u>ORDEAL Initialization</u>		Aligns one or both FDAIs to local vertical coordinates.
	1 The following are req CMC - on (for steps 4a & 7a), 4.8.1.3 ISS - on & aligned, nom option (for step 7a), 4.8.1.3 & 4.14 SCS - on, 4.8.4.2		IMU and/or SCS attitude reference system must be aligned with +Y axis of reference along (<u>V</u> x <u>R</u>), where V is velocity vector and R is position vector from center of earth/moon.
	2 Sel Tot Att Disp, 4.7.2.5		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 3	Set ORDEAL cont, 4.7.2.6 FDAI 2 or 1 sw - ORB RATE EARTH/LUNAR - as req MODE - HOLD/FAST	13	Either or both FDAIs may be driven by ORDEAL.
	4 Obtain alt setting		
CMP	a. (R30) orb param disp routine Key V82E Record Ha and Hp Calculate ave	2,140	
	or b. (P21) ground track determination prog Key V37E 21E Record alt for 10-min intervals of present orb Calculate ave		
	or c. MSFN If CMC in STBY, obtain alt setting from MSFN		
CDR 5	ALT SET - adj to proper alt	13	
	6 Sel att cont mode, 4.7.1, & mnvr to place +Xsc in orb plane (0° yaw)		

4.8.4.8

SCS GENERAL



STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 7	Obtain θ - pitch angle to lcl horiz		θ is the angle included between +Xsc and local horizontal. Angle in range 0° to 180° indicates +Xsc above local horizontal plane. Total range 0° to 360° .
CMP	a. (R31) rndz param disp routine Key V83E	2,140	
CDR or b.	MSFN If CMC in STBY, obtain θ from MSFN based on +Xsc pointed at horiz Mnvr to point +Xsc at horiz, 4.8.4.5	13	θ based on +Xsc pointed at horizon dependent on present altitude.
8	Slew FDAI to θ		The CMC display of θ is from 0° to 360° .
9	MODE - OPR/SLOW Slew/adj FDAI precisely		FDAI may be more accurately adjusted using 1° marks if yaw angle is 0° and roll angle 0° or 180° . When momentary SLEW switch released, ORDEAL is in operate mode.
10	Repeat 7 thru 9 as req		FDAI sw (both) must be at INRTL (pwr OFF or not) to display pitch inertial attitude.
4.8.4.9	<u>SCS Passive Thermal Control Using Wobble Mode</u>		For G&N Passive Thermal Control Procedure, refer to 4.8.1.13 and 14.
1	Set up pwr sw LOGIC 2/3 PWR - on (up) ELEC PWR - ECA	7	If total attitude display desired, select GDC/ECA.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP CDR	BMAG TEMP 1t (2) - out FDAI/GPI PWR - OFF BMAG PWR (both) - ON FDAI/GPI PWR - 1 SIG CONDR/DR BIAS PWR (both) - AC1 or AC2 RHC PWR NORM (both) - AC/DC	2 7 1	If FDAIs powered when BMAGs come up to speed, rate needles will oscillate full scale. 4.6.1.2, note 5.
2	Establish SCS att hold/rate cmd MAN ATT (3) - RATE CMD LIM CYCLE - on (up) ATT DBD - MIN RATE - LO SC CONT - SCS BMAG MODE (3) - RATE 2 AUTO RCS A/C ROLL or B/D ROLL (4) - MNA or MNB AUTO RCS PITCH & YAW - set for single jet oper BMAG MODE (3) - ATT 1/RATE 2	 8 1	This switching assumes RCS not enabled or attitude error needles are nulled before this switching performed. Only one pair of roll quads should be enabled. Single jet control in PITCH and YAW provides reduced RCS authority for attainment of minimum rates.
3	Select Disp FDAI SEL - 1 FDAI SOURCE - GDC		
4	Mnvr SC to desired att		Maneuver should place desired wobble axis in CSM -Z+Y quadrant, _____° from X axis.

4.8.4.9

SCS GENERAL

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	5	Achieve pitch up & yaw right rates of 0.01-0.02°/sec		Allow CSM to deadband to these rates. Rate may be obtained manually if minimum impulse control used.
	6	MAN ATT ROLL - ACCEL CMD LIM CYCLE - OFF ATT DBD - MAX RATE - HI BMAG MODE (3) - RATE 2 AUTO RCS ROLL (8) - MNA or MNB Init _____°/sec roll rate	1 8	Full roll authority can be used to establish this rate with one RHC action.
	4.8.4.10	<u>SCS Passive Thermal Control Using BAR-B-Q Minimum Power Mode</u>		For G&N Passive Thermal Control Procedure, refer to 4.8.1.13 and 14.
	1	Set up pwr sw LOGIC 2/3 PWR - on (up) SCS ELEC PWR - ECA	7	If total attitude display desired, select GDC/ECA.
CMP		BMAG TEMP 1t (2) - out	2	
CDR		FDAI/GPI PWR - OFF	7	If FDAIs powered when BMAGs come up to speed, rate needles will oscillate full scale.
		BMAG PWR (both) - ON FDAI/GPI PWR - 1 SIG CONDR/DR BIAS PWR (both) - AC1 or AC2		4.6.1.2, note 5.
		RHC PWR NORM (both) - AC/DC	1	
	2	Sel Disp FDAI SEL - 1 FDAI SOURCE - GDC		

SCS GENERAL

STA/T STEP	PROCEDURE	PANEL	REMARKS															
CDR 3	Mnvr SC to desired att																	
4	Establish 2 axis SCS att hold/rate cmd MAN ATT P&Y (2) - RATE CMD MAN ATT ROLL - ACCEL CMD LIM CYCLE - on (up) or MIN IMP ATT DBD - MAX RATE - HI SC CONT - SCS AUTO RCS PITCH & YAW - set for single jet oper	1 8	Engine combinations available for single jet control are: <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="5">SINGLE JET CONTROL</th> </tr> </thead> <tbody> <tr> <td>PITCH</td> <td>A3-A4</td> <td>C3-C4</td> <td>A3-C4</td> <td>C3-A4</td> </tr> <tr> <td>YAW</td> <td>B3-B4</td> <td>D3-D4</td> <td>B3-D4</td> <td>D3-B4</td> </tr> </tbody> </table>	SINGLE JET CONTROL					PITCH	A3-A4	C3-C4	A3-C4	C3-A4	YAW	B3-B4	D3-D4	B3-D4	D3-B4
SINGLE JET CONTROL																		
PITCH	A3-A4	C3-C4	A3-C4	C3-A4														
YAW	B3-B4	D3-D4	B3-D4	D3-B4														
	AUTO RCS A/C ROLL or B/D ROLL (4) - MNA or MNB BMAG MODE (3) - ATT 1/RATE 2	1																
5	Init 0.1°/sec roll rate																	
6	Mon FDAI 1 att err during limit cycling																	

STA/T STEP	PROCEDURE	PANEL	REMARKS												
<p>4.10 LM INTERFACE & EVA ACTIVITIES</p> <p>4.10.1 MANEUVERS</p> <p>4.10.1.1 <u>CSM/SLA Separation, Transposition and Docking</u></p> <p>1 The following are req CMC - on, 4.8.1.3 COAS - installed & calib, 4.14.1.8 LM Docking Sys Probe Extension & Stat Check, 4.4.1.1 (step 5) SCS - on, 4.8.4.2 ISS - on & orient known, 4.8.1.3 & 4.14 RCS DAP load & activate, 4.8.2.1 R1 - 111XX } Noun 46 Disp R2 - X1111 }</p> <p>SIVB mnvrs to sep att</p> <p>CMP Key V16 N20E (N20) R <u> </u> P <u> </u> Y <u> </u> -60° +180° + to -</p> <p>(N22) R <u> </u>° P <u> </u>° Y <u> </u>°</p> <p>Load N22 (Docking att)</p>		<p>2</p>	<p>Provides G&N control capability.</p> <p>Provides SCS control capability.</p> <p>Establishes G&N control capability as follows: CSM configuration, 4 quad translation (quads A, B, C, D - on).</p> <p>CSM maneuver should be performed in the following attitude and rate deadbands in either the CMC or SCS control modes to simplify the control task during separation.</p> <table border="1"> <thead> <tr> <th></th> <th>CMC</th> <th>SCS</th> </tr> </thead> <tbody> <tr> <td>ATT DBD</td> <td>+0.5° (R03)</td> <td>+0.2° (MIN)</td> </tr> <tr> <td>RATE DBD</td> <td>+0.2°/sec (fixed)</td> <td>+0.2°/sec (LO)</td> </tr> <tr> <td>RATE CMD (RHC)</td> <td>+0.5°/sec (R03)</td> <td>+0.65°/sec</td> </tr> </tbody> </table>		CMC	SCS	ATT DBD	+0.5° (R03)	+0.2° (MIN)	RATE DBD	+0.2°/sec (fixed)	+0.2°/sec (LO)	RATE CMD (RHC)	+0.5°/sec (R03)	+0.65°/sec
	CMC	SCS													
ATT DBD	+0.5° (R03)	+0.2° (MIN)													
RATE DBD	+0.2°/sec (fixed)	+0.2°/sec (LO)													
RATE CMD (RHC)	+0.5°/sec (R03)	+0.65°/sec													

4.10.1.1

MANEUVERS



STA/T STEP	PROCEDURE	PANEL	REMARKS
	Pnl configuration per 4.3.2.1		Postorbital insertion status checklist.
CMP	2 Pnl reconfiguration & sep prep Key V60E	2	Nulls FDAI 1 error needles, N17 = N20.
	Key V63E		Permits display of error between present and astronaut loaded gimbal angles on FDAI 1, N20 and N17.
CDR	Verify SM RCS activation SM RCS PRPLNT tb (8) - gray Set pnl 1 SCS att cont	1	Enables direct RCS coils for contingency takeover.
	THC PWR - on (up)		
	RHC PWR DIR (both) - MNA/MNB		
	RHC PWR NORM (both) - AC/DC		
	SC CONT - SCS		
	CMC MODE - FREE		
	BMAG MODE (3) - RATE 2		Cages the BMAGs and prevents attitude maneuver signals from causing them to hit their stops.
	ATT DBD - MIN		
	RATE - LO		
	LIM CYCLE - OFF		
	LV IND/GPI sw - SII/SIVB (verify)	8	Jets enabled on MN bus A & B should be selected so that command will be maintained for the most critical maneuvers in case of either dc bus failure.
	AUTO RCS (16) - MNA or MNB		
	MAN ATT (3) - MIN IMP	1	Establishes proportional manual control with rate
	TVC SERVO PWR 1 - AC1/MNA	7	damping for SCS backup.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	Establish sep performance cues Perform EMS ΔV Test & Null Bias check, 4.7.6.1, & EMS ΔV Setup, 4.7.6.2, except set ΔV ind at -100 to avoid oper around the 0.0 fps settings GDC - align, 4.8.4.6 Establish displays FDAI SEL - 1/2	7	1 Enables G&N on FDAI 1, SCS on FDAI 2. 2 Integrates state vector forward. 1 RSET position is momentary.
CDR,CMP	Key V37E OOE EVNT TMR RSET - RSET EVNT TMR ind - 00:00	1	Provides power to sequencer and pyro circuits for separation.
3	Enbl sequencer logic cb SECS ARM (2) - close After MSFN AOS SECS LOGIC (both) - on (up) Report logic arm After GO from MSFN SECS PYRO ARM (2) - on (up) Perform fnl presep func	8	Lever lock. Lever lock.
CMP	V66E Key V37E 47E (thrust mon) FL V16 N83 ΔVX, Y, Z (cont) XXXX.X FPS	2	Transfer CSM state vector to LM storage. Permits display of velocity change during thrusting on DSKY. Perform ≈60 seconds prior to separation to minimize effective PIPA bias.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	RHC 2 - ARMED		
CMP	RCS CMD - ON	2	ON position is momentary. Enables RCS latching relay in SECS. This function also accomplished automatically by SECS.
CDR	RHC - RCS check (audible) SC CONT - CMC MAN ATT (3) - RATE CMD	1	
	4 Separation		
LMP	FC REAC VLVS - LATCH	3	
CDR	EMS MODE - NORM CMC MODE - HOLD or AUTO THC - ARMED	1	Perform 30 seconds prior to separation to minimize effective EMS drift.
-00:03	THC - +X & hold 3 sec prior to sep		Initiates pre-separation tension.
00:00	CSM/LV SEP pb - push & hold Start Evnt Tmr LV TK PRESS ind (4) - 0 LV ENG 1 lt - out CSM/LV SEP pb - rel		Guarded. Indicates physical separation.
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	No sep		
00:00	THC - CCW (leave in detent) Evnt Tmr rset & counting up (auto)		Activates automatic SECS separation and direct RCS ullage.
00:03	RCS dir ullage (auto) LV TK PRESS ind (4) - 0 LV ENG 1 lt - out		SECS delays separation for 3 seconds. Indicates physical separation.

MANEUVERS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR 00:07 max	THC - neut RCS dir ullage terminated (auto) Confirm $\Delta V \approx 1$ fps XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		Terminates automatic direct RCS ullage.
00:04 max	THC - neut $\Delta V \approx -100.8$ fps 5 Postsep pnl configuration		After ≈ 4 seconds of free thrusting. Based on CSM weight of 65,150 pounds an average separation ΔV as follows: In 4.4 seconds $\Delta V = -100.8$ fps In 5.0 seconds $\Delta V = -100.9$ fps Either EMS and/or DSKY may be used to read $\Delta V = -100.8$ fps which should be observed in 4.5 ± 0.5 seconds. ΔV and time should be monitored concurrently to determine which cue will prevail. The EMS should provide primary cue.
CMP	SM RCS PRPLNT tb (8) - gray (verify) SM RCS He tb (8) - gray (verify) SM RCS SEC FUEL PRESS (4) - CLOSE	2	During coast to transposition. Provides normal, safe, formation flight configuration.
LMP	FC REAC VLVS - NORM	3	Momentary.

4.10.1.1

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP 6	Transposition XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X No TLI or propulsive venting not inhibited Do <u>NOT</u> perform -X trans at 00:35 X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		If TLI not performed or propulsive venting not inhibited, minimum separation distance at completion of pitch maneuver will be ≈65 feet.
CDR 00:35	THC -X to ΔV = -100.3 fps MAN ATT PITCH - ACCEL CMD RHC - pitch up 2°/sec Visually acq SIVB & null pitch rate	1	Positive pitch at 2°/second followed by a negative pitch command to null rates at a total pitch maneuver of 180°. At completion of pitch maneuver, minimum separation distance will be ≈55 feet.
CMP	V62E	2	Permits display of error between present and docking attitude on FDAI 1, N20 and N22.
CDR	MAN ATT PITCH - RATE CMD RHC, THC - Null trans err & rates Perform auto roll mnvr to docking att, 4.8.3.4	1	
	or Perform man roll mnvr to docking att CMC MODE - FREE RHC - roll left 60° to null err needles		
7	HGA oper, 4.5.6.2		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	8 Set pnl 1 SCS att cont CMC MODE - FREE (verify) BMAG MODE (3) - ATT 1/RATE 2 SC CONT - SCS	1	
CMP	9 Verify cont stat for docking COAS PWR - on (up) EXT RNDZ LT - SPOT	15 2	
	10 PROBE EXTD/REL - RETR (verify) PROBE EXTD/REL tb (2) - gray (verify)		Guarded. Verifies capture latches not locked.
CDR	11 Init capture latch THC - translate to close at 0.25 to 0.5 fps maintain min lateral velocity RHC - maintain min relative align angles with SIVB At contact, apply +X thrust as req		Rate established visually. Use COAS and docking target for alignment cues. Contact will be indicated by audio cues, a slight disturbance in motion, and/or COAS observation.
CMP CDR	PROBE EXTD/REL tb (2) - bp SC CONT - CMC	1	Talkbacks barber pole indicate capture. Only one talkback required for indication. Failure to capture will also be indicated by no noticeable rebound tension load (deceleration) and separation from SIVB. If retraction initiated, it will not occur until capture.
CMP	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X Positive ind of no capture or divergent oscillations or abnormal motions PROBE EXTD/REL - EXTD/REL	2	Guarded. EXTD/REL position is momentary.

4.10.1.1

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	SC CONT - SCS THC - -X withdraw to formation flt distance	1	
CMP	PROBE EXTD/REL - EXTD/REL for 5 sec PROBE EXTD/REL - RETR PROBE EXTD/REL tb - gray (verify) Attempt redock as before	2	Guarded. EXTD/REL position is momentary. Guarded.
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
CDR	Allow probe to damp SC motions (≈10 sec) THC - null pitch & yaw align err to within +3° (min possible)		Alignment determined using COAS and docking target. Retraction loads may cause docking ring damage. Loads are minimum at zero misalignment during retraction.
	RHC - null roll align err to within +10°		Docking with roll angles >+10° may prohibit LM umbilical connection.
CMP	12 Init retraction & docking latch closure PROBE RETR PRIM - 1 Observe retraction movement between the two vehicles PROBE EXTD/REL tb (2) - gray		When capture latch alignment satisfactory. 10-inch retraction stroke should take ≈10 seconds. Talkback A will indicate only if docking latches 1, 5, and 9 close. Talkback B will indicate only if latches 3, 7, and 11 close. Audio and tactile cues will also indicate docking latch closure.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
CMP	PROBE EXTD/REL tb (2) - remain bp after 30 sec & docking latch closure cues (auditory & tac- tile) unsatisfactory PROBE RETR PRIM - 2 If docking still unsuccessful PROBE RETR SEC - 1 X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	2	
CDR	13 Safe docking sys SECS PYRO ARM (2) - SAFE SECS LOGIC (both) - OFF cb SECS ARM (2) - open EDS PWR - OFF cb EDS (3) - open	8 7 8	Lever lock. Lever lock.
CMP	PROBE EXTD/REL - OFF PROBE RETR (2) - OFF	2	Guarded.
CDR	cb DOCK PROBE (2) - open	8	
	14 Postdocking pnl configuration RATE - HI ATT DBD - MAX cb RCS LOGIC (2) - open	1 8	
CDR	TVC SERVO PWR (2) - OFF	7	
CMP	EXT RNDZ LT - off (ctr) PRO FL V37 Key OOE	2	

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4.10.1.1

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	COAS PWR - OFF	15	
	EMS MODE - STBY	1	
	EMS FUNC - OFF		
	BMAG MODE (3) - RATE 2		
CMP	TUNL LT - on (up)	2	
	Key V83E		Checks state vector.
	Key V47E		Moves LM state vector into CM state vector.
	4.10.1.2 <u>LM Ejection From SLA</u>		
	1 The following are req		
	Prep for LM withdrawal completed,		
	4.10.2.1		
	CMC - on, 4.8.1.3		
	SCS - on, 4.8.4.2		
	ISS - on & orientation known, 4.8.1.3		
	& 4.14		
	RCS DAP load & activated, 4.8.2.1		
	R1 - 21102		
	R2 - X1111		
	2 Pre-IM ejection		
CDR	cb DOCK PROBE (2) - close	8	
	Set Evnt Tmr 00:00	1	
	cb SECS ARM (2) - close	8	
	After MSFN AOS		
	SECS LOGIC (both) - on (up)		Lever lock.
	Report logic arm		
	After GO from MSFN		
	SECS PYRO ARM (2) - on (up)		Lever lock.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	3 Perform ejection		
LMP	cb SIVB/LM SEP (2) - close (verify)	278	Perform \approx 30 seconds prior to ejection to minimize EMS drift error.
CDR	TVC SERVO PWR 1 - AC1/MNA	7	
	EMS FUNC - Δ V SET	1	
	SLEW Δ V ind - -100.0		
	EMS FUNC - Δ V		
	EMS MODE - NORM		
CMP 00:00	SIVB/LM SEP - on (up) Start Evnt Tmr	2	Guarded. On (up) position is momentary. Spring system will provide a minimum separation velocity of \approx 0.7 fps (assumes four actuators operated).
CDR 00:05	THC -X & hold		Provides a minimum separation velocity of \approx 1.44 fps; or \approx 1.38 fps if TLI is not performed or propulsive venting is not inhibited. The following tables provide parameters for flight planning if the variables (SIVB propulsive vent, time of RCS burn, etc.) are changed for specific missions. (See figure 4.10-1.)
00:08	THC - neut		
00:14	CMC MODE - AUTO	1	
	4 Postejection		
	SECS PYRO ARM (2) - SAFE	8	Lever lock.
	SECS LOGIC (both) - OFF		Lever lock.
LMP	cb SECS ARM (2) - open		
	cb SIVB/LM SEP (2) - open	278	

4.10.1.2

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3 Sec CSM RCS Burn (400 Lb -X Translation)				
Configuration	SIVB Propulsive Vent Force (lbs)	Time to Translate 15 Ft (seconds)		SIVB and CSM Recontact Time (No Evasive Mnvr)
		RCS Burn at 5.0 to 8.0 Sec After Sep	RCS Burn at 8.0 to 11.0 Sec After Sep	
LM Ejection In Earth Parking Orbit	0.0	16.3 sec	17.6 sec	--
	8.0	16.8 sec	18.6 sec	1280 sec
	12.5	17.2 sec	19.0 sec	810 sec
	25.0	17.8 sec	20.2 sec	400 sec
LM Ejection After TLI	0.0	13.5 sec	14.4 sec	--
	8.0	14.0 sec	15.0 sec	375 sec
	12.5	14.4 sec	15.5 sec	235 sec
	25.0	15.6 sec	16.9 sec	115 sec
No CSM RCS -X Translation				
Configuration	SIVB Propulsive Vent Force (lbs)	Time to Translate 15 Ft (secs)		SIVB and CSM Recontact Time (No Evasive Mnvr)
		No RCS Burn		
LM Ejection In Earth Parking Orbit	0.0	27.4 sec		--
	8.0	36.3 sec		600 sec
	12.5	42.6 sec		362 sec
	25.0	61.3 sec		160 sec
LM Ejection After TLI	0.0	16.6 sec		--
	8.0	17.0 sec		237 sec
	12.5	17.5 sec		149 sec
	25.0	23.8 sec		62 sec

Figure 4.10-1. SIVB/CSM Separation Parameters

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	LV IND/GPI sw - GPI CMC MODE - FREE MAN ATT (3) - MIN IMP SC CONT - SCS	1	When clear of SIVB.
CMP	Reload DAP N46, R1 = 21111	2	
CDR	EMS MODE - STBY EMS FUNC - OFF THC PWR - OFF RHC PWR DIR (both) - OFF RHC, THC - LOCKED TVC SERVO PWR 1 - OFF	1 7	
4.10.1.3 <u>LM Undocking From CSM</u>			This procedure describes CSM activities required each time LM separates from CSM after docking except for final LM separation. These procedures as written are incomplete until properly integrated with corresponding LM procedures.
1 Perform prep for manned LM sep, 4.10.2.4			
2 Perform systems prep SCS - on, 4.8.4.2 Sel desired displays, 4.7.2 Sel SCS rate damping only, 4.7.1.4 cb DOCK PROBE (2) - close			
CMP	PROBE EXTND/REL - RETR PROBE EXTND/REL tb (2) - bp (verify) PROBE EXTND/REL - OFF	8 2	Guarded. Verifies redundant probe retract capability. Guarded.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	MAN ATT (3) - RATE CMD ATT DBD - MAX RATE - HI THC PWR - on (up) RHC PWR NORM (both) - AC/DC RHC PWR DIR (both) - MNA/MNB RHC, THC - ARMED SC CONT - SCS BMAG MODE (3) - RATE 2	1	
3	Verify spacecraft status with LM		CDR, LMP verify spacecraft status with CSM.
4	Mnvr to sep att		Per flight plan. Either vehicle may maintain attitude control.
5	Perform fnl prep pnl operations Set Evnt Tmrs EVNT TMR RSET - DOWN -XX:XX EVNT TMR START - START (on sig from CDR)		Timer will be set up to reach 00:00 at separation. START position is momentary.
6	Separation		CDR will count down to separation time.
a.	Undocking		
	<u>CAUTION</u> PROBE EXTD/REL should not be held in EXTD/REL position longer than 20 sec if probe has not extended. Capability of capture latch rel mots may be degraded.	2	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
<p>CMP 00:00</p>	<p>PROBE EXTD/REL - EXTD/REL & hold until 5 sec after LM sep</p> <p>PROBE EXTD/REL tb (2) - gray to bp to gray</p> <p>Mon LM sep</p> <p>b. Soft Undocking (alternate)</p> <p>PROBE EXTD/REL - EXTD/REL (mom)</p> <p>Probe extended & LM still attached (verify)</p> <p>Allow motions to dampen (5 sec)</p>	<p>2</p>	<p>Momentary up and guarded. Probe is extended by a compression spring and attenuator airhead forces. The 10-inch extension stroke working against CSM/LM inertia takes ≈5 seconds.</p> <p>Barber pole indicates power to talkback through the probe circuitry. Return to gray indicates full extension of probe.</p> <p>CDR will monitor CSM separation. The CSM and LM should attain a separation distance of 15 feet in 27 seconds with a separation velocity of 0.65 fps. Subsequent to 15-foot separation the LM may execute maneuvers with each vehicle configured as desired for attitude control.</p> <p>This procedure minimizes undocking ΔV.</p> <p>Releasing switch from EXTD/REL position should be done as fast as possible in order to ensure that capture latches relock before probe gets fully extended.</p> <p>LM motion should stop suddenly when probe gets fully extended resulting in both visual and tactile cues of probe extension and probe/drogue engagement.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<u>CAUTION</u>		
	PROBE EXTD/REL should not be held in EXTD/REL position longer than 20 sec. Capability of capture latch rel mots may be degraded.		
CMP 00:00	PROBE EXTD/REL - EXTD/REL & hold After 2 sec THC - -X (4 jet) for 1 sec PROBE EXTD/REL - OFF after probe/drogue disengagement verified	2	Guarded. EXTD/REL position is momentary. Guarded.
	7 Postundocking reconfiguration PROBE EXTD/REL - RETR		Guarded. Required to provide capture latch talkback signal during subsequent docking.
CDR	PROBE EXTD/REL tb (2) - gray (verify) PROBE EXTD/REL - OFF cb DOCK PROBE (2) - open	8	Verifies capture latches cocked. Guarded.
CMP	Prepare for contingency redocking EXT RUN/EVA LT - on (up) (verify) EXT RNDZ LT - RNDZ (verify) Activate rndz xpndr, 4.5.6.9	2	If required.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	<p>Confirm CSM status with LM PROBE EXTD/REL - RETR (verify) PROBE EXTD/REL tb (2) - gray (verify)</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>If PROBE EXTD/REL tb - bp PROBE EXTD/REL - EXTD/REL for 5 sec PROBE EXTD/REL - RETR PROBE EXTD/REL tb (2) - gray (verify)</p> <p>X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>3 Mon LM closing mnvrs</p> <p>4 Init capture latch & retraction PROBE EXTD/REL tb (2) - mon PROBE EXTD/REL tb (2) - bp</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>Positive ind of no capture Advise LM no capture THC - -X withdraw to formation flt distance PROBE EXTD/REL - EXTD/REL for 5 sec</p>	<p>2</p>	<p>Guarded. Verifies capture latches are not locked.</p> <p>Guarded. EXTD/REL position is momentary.</p> <p>Guarded.</p> <p>LM will make final approach along +X axis at closing rates of 0.25 to 0.5 fps.</p> <p>Talkbacks barberpole indicates capture. Only one talkback is required for indication. Failure to capture will also be indicated by separation from the LM. If retraction is initiated it will not occur until capture.</p> <p>Guarded. EXTD/REL position is momentary.</p>

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	COAS PWR - OFF cb DOCK PROBE (2) - open SECS PYRO ARM (2) - SAFE SECS LOGIC (both) - OFF cb SECS ARM (2) - open RNDZ XPNDR PWR - ORR	15 8 100	Lever lock. Lever lock.
6	Post docking operations prior to IVT CMC MODE - HOLD	1	LM will configure for inactive control status.
4.10.1.5	<u>CSM Active Docking With LM</u>		Describes CSM activities required each time CSM docks with LM. These procedures as written are incomplete until properly integrated with corresponding LM procedures.
1	The following is req COAS - installed & calib, 4.14.1.8		Range and range rate must be within docking limits.
2	Configure CSM for docking THC PWR - on (up) RHC PWR DIR (both) - MNA/MNB SC CONT - SCS CMC MODE - FREE AUTO RCS (16) - MNA or MNB MAN ATT (3) - RATE CMD EMAG MODE (3) - ATT 1/RATE 2 THC - ARMED RHC (both) - ARMED LIM CYCLE - OFF	8 1	SCS functions are for backup operation. Establishes SCS attitude hold.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	ATT DBD - MIN	1	
	RATE - LO		
	EXT RUN/EVA LT - on (up) (verify)	2	
	COAS PWR - on (up)	15	
	cb DOCK PROBE (2) - close	8	
	PROBE RETR (2) - OFF	2	
	cb SECS ARM (2) - close	8	
	After MSFN AOS		
	SECS LOGIC (both) - on (up)		Lever lock.
	Report logic arm		
	After GO from MSFN		
	SECS PYRO ARM (2) - on (up)		Lever lock.
	PROBE EXTD/REL - RETR (verify)	2	Guarded.
	PROBE EXTD/REL tb (2) - gray (verify)		Verifies capture latches not locked.
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		
	PROBE EXTD/REL tb (2) - bp		
	PROBE EXTD/REL - EXTD/REL for		Guarded. EXTD/REL position is momentary.
	5 sec		
	PROBE EXTD/REL - RETR		Guarded.
	PROBE EXTD/REL tb (2) - gray		
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		
3	Init capture latch & retraction		
	RHC, THC - align COAS with LM trgt		
	THC - init +X to close at 0.25 to		
	0.5 fps		Rate established visually. Use COAS and docking target for alignment cues.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	THC - maintain min lateral velocity RHC - maintain min relative align angles with LM At contact, provide cue to LM for thrusting PROBE EXTD/REL tb A and/or B - bp Confirm capture latch to LM XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X Positive ind of no capture THC - -X withdraw to formation flt distance PROBE EXTD/REL - EXTD/REL for 5 sec PROBE EXTD/REL - RETR PROBE EXTD/REL tb - gray (verify) Attempt redock as before XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X	2	Contact will be indicated by audio cues, slight disturbance in motion and/or COAS observation. LM will apply +X thrusting as required on cue from CSM or by tactile cue at contact. Talkbacks barberpole indicate capture. Only one talk- back required for indication. Failure to capture will also be indicated by separation from LM. If retrac- tion initiated it will not occur until capture. LM will terminate +X thrusting upon receipt of capture cue from the CSM.
	SC CONT - CMC Allow probe to damp SC motions (≈10 sec) THC - null pitch & yaw align to within <u>+3</u> ^o	1	Guarded. EXTD/REL position is momentary. Guarded. Alignment determined using COAS and docking target.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	PROBE RETR SEC - 1 Observe retraction movement between the two vehicles PROBE EXTD/REL tb (2) - gray	2	Initiates probe retraction. 10-inch retraction should require ≈5 seconds. Talkback A will indicate only if docking latches 1, 5, and 9 close. Talkback B will indicate only if latches 3, 7, and 11 close. Audio and tactile cues will also indicate docking latch closure.
	<pre>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X PROBE EXTD/REL tb (2) - remain bp & docking latch closure cues (auditory & tactile) unsatisfactory PROBE RETR PRIM - 2</pre>		
	<pre>X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX 4 Safe docking system PROBE EXTD/REL - OFF PROBE RETR (2) - OFF EXT RUN/EVA LT - OFF EXT RNDZ LT - off (ctr) COAS PWR - OFF cb DOCK PROBE (2) - open SECS PYRO ARM (2) - SAFE SECS LOGIC (both) - OFF cb SECS ARM (2) - open RNDZ XPNDR PWR - OFF</pre>	15 8 100	Guarded. Lever lock. Lever lock.
	<pre>5 Postdocking operations prior to IVT CMC MODE - HOLD</pre>	1	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.10.1.6	<u>LM Jettison and Separation</u>		
1	Perform fnl IVT to CSM, 4.10.2.3		
2	Perform auto mnvr to jett att, 4.8.3.4		R62.
or	Perform SCS att mnvr to jett att, 4.8.4.5		
3	Perform tunl depressurization & fwd hatch seat integrity check, 4.10.2.4, step 5		
4	Perform LM jett prep		
CMP CDR	LM PWR - OFF (verify) cb SECS ARM (2) - close After MSFN AOS	2 8	
	SECS LOGIC (both) - on (up) Report logic arm		Lever lock.
	After GO from MSFN SECS PYRO ARM (2) - on (up)		Lever lock.
	At jett att BMAG MODE (3) - ATT 1/RATE 2 SC CONT - SCS	1	
CMP	RCS DAP - load & actuate, 4.8.2.1 RI-11102 (N46 display)		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 5	LM jett CSM/LM FNL SEP (both) - on (up)	2	Guarded and momentary. Provides jettison of docking ring, with probe and LM attached, from CSM. Separation velocity of 0.4 ft/sec will be obtained with the use of the docking ring pyrotechnic separation device only (CM/LM tunnel depressurized). If four quads RCS firing is used to augment ΔV , 1.44 pounds of propellants are used for every second of firing. Any pressure in CM/LM tunnel at time of separation will impart an additional ΔV up to a maximum of 1.9 ft/sec.
CDR 6	Postjett pnl reconfiguration SECS PYRO ARM (2) - SAFE SECS LOGIC (both) - OFF cb SECS ARM (2) - open	8	Lever lock. Lever lock.
7	Separation Perform SCS att mnvr to sep att, 4.8.4.5 or Perform auto mnvr to sep att, 4.8.3.4 Mon G&N thrusting, 4.8.1.6 EMS MODE - NORM THC - +Z (2 jet) for 1.0 fps ΔV (5 sec min after pyro sep)	1	R62. P47.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.10.2	<p>IVT</p> <p>This section provides data which apply to all intervehicular crew transfers during the CSM mission. Because a transfer to the LM or to the CM is basically the same, only a few procedures are provided to cover all the intervehicular transfers involved in the mission. As is the practice throughout the J-Series Volume II AOH, the column heading STA/T refers to the spacecraft location where a procedure or step is performed except for those times when a crewman has transferred to the LM. In this case, the STA/T heading is used to refer directly to the corresponding crewman and not to the spacecraft location.</p>		
	<p>4.10.2.1 <u>Preparation for LM Ejection</u></p>		
ALL CMP	<p>1 Configure PGAs, 4.5.4.6b Retrieve & don helmet protective shield</p> <p>2 Configure couches as req</p> <p>3 Configure cont pnl LM PWR - OFF (verify) TUNL LT - on (up)</p> <p>4 Perform docking tunl operations Equalize CM/LM press, 4.5.4.14 Remove fwd hatch, 4.5.7.4a Verify docking latches Pull latch handle of each latch to ensure hook is engaged Pwr bungee parallel to +X axis (verify)</p>	2	<p>Tunnel pressure integrity incorporated in CM/LM pressure equalization procedure.</p> <p>Latch indicator button (red) may protrude through hole in latch handle if latch is not engaged.</p>

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>If hook(s) not engaged Attempt to engage latch handle prior to recocking latch If pwr bungee not parallel to +X axis Push on top of bungee fairing to obtain fml preload If hook(s) cannot be engaged or pwr bungee parallel to +X axis not attained Recock latch(es) & man trigger, 4.10.4.8, steps 2 & 4</p> <p>X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>Depress GN2 bleed button (red) at aft end of probe body & hold for 10 sec Connect LM umb conn (2) Open docking ring conn fairings (2) (orange) Disengage one conn from stowage receptacle in LM tunl Pull umb across docking interface Align index marks Push LM umb conn into pwr receptacle in docking ring & rot CW to lock</p>	tunl	<p>Required to bleed probe retract gas system for subsequent operation.</p> <p>One at a time.</p>

4.10.2.1

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Route LM umb thru slot in back of receptacle assy & close fairing (orange)	tun1	Fairing must be closed to install hatch.
	Repeat for sec umb		
	LM PWR - CSM	2	
	SYS TEST (2) - 7D	101	Test for integrity of electrical umbilical connection.
	SYS TEST ind - 0.5-3.2 vdc (1-6.4 amps)		
	Reinstall fwd hatch, 4.5.7.5		
ALL 5	Reconfigure couches as req		
	4.10.2.2 <u>IVT to LM</u>		Procedure describes general requirements for crew transfer to LM under normal conditions. Not all steps included here are necessarily required for every IVT; utilization depends on particular time in mission when transfer occurs. Procedures as written are incomplete until properly integrated with corresponding LM procedures.
1	The following are req		
CDR,LMP	PGAs configured, 4.5.4.6d		
CMP	PGA - configured, 4.5.4.6b		
	Retrieve & don helmet protective shield		
	Couches configured as req		
2	Clear tun1		
	TUNL LT - on (up)	2	
	Equalize CM/LM press, 4.5.4.14		Tunnel pressure integrity check included as part of CM/LM pressure equalization procedure.
	Remove fwd hatch, docking probe, & docking drogue, 4.5.7.4a, 4.10.4.1, & 4.10.4.4		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
3	Crew Transfer		LMP umbilical hoses used as transfer hoses. Transfer umbilical hoses must be hooked up to left PGA connectors before transferring.
LMP	Connect trnfr O2 hose to left PGA conn (2) rh SUIT FLOW vlv - FULL FLOW Connect protective plugs to right PGA conn (2) Trnfr to LM head first entering LM cabin facing fwd	300	Red to red, blue to blue.
CMP	Audio pnl sw (all) - as desired by LMP	6	LMP will perform initial entry status check, partial activation of systems and checkout.
CDR	LM PWR - OFF (upon coordination with LMP)	2	
CMP	rh SUIT FLOW vlv - OFF (upon request from LMP) Upon request from LMP PWR - OFF SUIT PWR - OFF AUDIO CONT - FORM	300	LMP will connect to LM ECS and perform VHF activation and checkout. LMP will disconnect transfer umbilicals.
CDR	Obtain umbs from LMP		
CMP	ctr SUIT FLOW vlv - CAB FLOW	302	
CDR	Connect O2 trnfr umb to left PGA conn (2) rh SUIT FLOW vlv - FULL FLOW Disconnect O2 hose from right PGA conn (2) Connect protective plugs to right PGA conn (2) Install interconnect on O2 hose (CDR's)	300	Red to red, blue to blue.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	PWR - OFF SUIT PWR - OFF AUDIO CONT - NORM	9	
CDR	Remove CCU from PGA conn		
CMP	Verify PWR & SUIT PWR sws on LMP's audio pnl are in OFF position	6	
CDR	Connect trnfr CCU to PGA		
CMP	Audio pnl sw (all) - as desired by CDR		
CDR	Trnfr to LM head first entering LM cab facing fwd		
CMP	Upon request from CDR rh SUIT FLOW vlv - OFF	300	CDR will hook up O2 umbilical.
	PWR - OFF SUIT PWR - OFF	6	CDR will verify O2 flow to PGA from LM ARS and perform VHF activation and checkout.
	Obtain trnfr umbs Install suit hose interconnect on O2 hoses Stow trnfr umbs		CDR will disconnect transfer umbilical comm cable from PGA and connect IM comm cable to PGA when headset sounds cease.
4	Close tunl (docking hardware stowage)		Step to be performed when other than temporary stowage in CM cabin required for mission phases such as DPS, docked burn, and EVA.
	Install docking drogue, docking probe, & fwd hatch, 4.10.4.6, 4.10.4.3 & 4.5.7.5		
	TUNL VENT vlv - LM/CM ΔP	12	

IVT

STA/T STEP	PROCEDURE	REMARKS
<p>4.10.2.3 <u>IVT to CSM</u></p> <p>ALL CMP</p>	<p>1 The following are req PGAs configured as req Retrieve & don helmet protective shield if req Couches configured as req</p> <p>2 Clear tunl a. Prior to LOD</p> <p>CM/LM Press Equalization, 4.5.4.14 Remove fwd hatch, docking probe, & docking drogue, 4.5.7.4a, 4.10.4.1, & 4.10.4.4 Equalize tunl/LM press & open LM hatch</p> <p>b. After LOD or emergency</p> <p>Equalize LM/tunl press from LM Remove docking drogue & docking probe, 4.10.4.5 & 4.10.4.2 Stow probe & drogue in LM as req CM/LM Press Equalization, 4.5.4.14, if req Remove fwd hatch, 4.5.7.4</p>	<p>This is the normal procedure for returning to the CSM prior to LOD.</p> <p>Normal procedure for returning to CSM after LOD and would be used for an emergency return without assistance from CSM.</p> <p>Procedure of 4.5.7.4b would be performed only if CMP could not perform 4.5.7.4a.</p>

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 3	Crew Transfer		
	a. From LM ECS		
	rh SUIT FLOW vlv - as desired (verify)	300	The procedure as written assumes that CDR normally makes transfer first. If LMP transfers first, it will be necessary for LMP and CDR to trade umbilicals. LM crewman will connect transfer 02 and comm umbilicals to PGA.
	Connect hose interconnect to trnfr umbs (verify)		
	PWR - OFF (verify)		
	SUIT PWR - OFF (verify)		
	AUDIO CONT - NORM (verify)		
	Pass trnfr umbs to LM		
	Upon request from LM crewman (via VHF)		
	rh SUIT FLOW vlv - FULL FLOW	300	
	PWR - AUDIO/TONE	6	
	SUIT PWR - on (up)		
CDR,LMP	Trnfr to CSM		Red to red, blue to blue.
	Remove protective plugs from right PGA conn (2)		
	Remove suit hose interconnect from 02 hoses (CDR's)		
	Connect 02 umb (CDR's) to right PGA conn (2)		
	lh SUIT FLOW vlv - FULL FLOW	301	
	rh SUIT FLOW vlv - OFF	300	

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR,LMP	Disconnect LMP's O2 hose from left PGA conns Connect protective plugs to left PGA conns Install suit hose interconnect on O2 hoses (trnfr)		
CMP	PWR - OFF SUIT PWR - OFF	6	
CDR,LMP CMP	AUDIO CONT - NORM (verify) Remove trnfr CCU from PGA conn Verify PWR & SUIT PWR sws on CDR's audio pnl are in OFF position & AUDIO CONT sw in NORM position	9	
CDR,LMP CMP CDR,LMP	Connect CDR's (left) CCU to PGA Audio pnl sw (all) - as desired rh SUIT FLOW vlv - OFF (verify) Connect hose interconnect to trnfr umbs (verify) PWR - OFF (verify) SUIT PWR - OFF (verify) AUDIO CONT - NORM (verify)	300	
CMP	Pass trnfr umbs to LM Upon request from LMP/CDR rh SUIT FLOW vlv - FULL FLOW PWR - AUDIO/TONE SUIT PWR - on (up)	300 6	LM crewman will connect transfer O2 and CCU umbilicals to PGA.
	LM/CSM pwr trnfr Upon request from LMP LM PWR - CSM	2	LM vehicle power down. If required.

4.10.2.3

IVT



STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP,CDR	Trnfr to CSM b. From PLSS/OPS & LM ECS		CDR and LMP are in LM, one crewman on LM ECS, one crewman on PLSS/OPS. LMP transferred first in these procedures because of operational considerations (i.e., amount of oxygen available in PLSS/OPS, etc.). It will be necessary for LMP and CDR to trade umbilicals once transfer completed.
CMP	rh SUIT FLOW vlv - OFF (verify) PWR - OFF (verify) SUIT PWR - OFF (verify) AUDIO CONT - NORM (verify) Pass trnfr umbs to LM rh SUIT FLOW vlv - as desired LM crewman Upon request from LM (via VHF) PWR - AUDIO/TONE SUIT PWR - on (up)	300 6	LM crewman will open LM hatch and secure. LM crewman on PLSS/OPS will connect transfer O2 and comm umbilicals to PGA.
LMP,CDR	1h SUIT FLOW vlv - OFF (verify) Remove protective plugs from left PGA conn (2) Connect O2 umb (CDR's) to left PGA conn (2) 1h SUIT FLOW vlv - FULL FLOW rh SUIT FLOW vlv - OFF Disconnect O2 trnfr umbs from right PGA conn (2)	301 300	LM crewman will transfer through tunnel to CM. Red to red, blue to blue.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP,CDR	Connect protective plugs to right PGA conns		
	Install interconnect on 02 hose		
CMP	PWR - OFF	6	
	SUIT PWR - OFF		
	AUDIO CONT - NORM (verify)		
	PWR - OFF (verify)	9	
	SUIT PWR - OFF (verify)		
	AUDIO CONT - NORM (verify)		
	Remove trnfr CCU from PGA		
	Audio pnl sw (all) - as desired		
	rh SUIT FLOW vlv - OFF (verify)	300	
	Connect hose interconnect to		
	trnfr umbs (verify)		
	PWR - OFF (verify)	6	
	SUIT PWR - OFF (verify)		
	AUDIO CONT - NORM (verify)		
	Pass trnfr umbs to LM		LM crewman will connect transfer 02 and CCU umbilicals to PGA.
	Upon request from CDR/LMP		
LMP,CDR	rh SUIT FLOW vlv - FULL FLOW	300	
CMP	PWR - AUDIO/TONE	6	
	SUIT PWR - on (up)		LM vehicle power down. If required.
	LM/CSM pwr trnfr		
	Upon request from LM crewman		
	LM PWR - CSM		

4.10.2.3

IVT



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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<p>Torque preload handle CW until load limiter releases Cock engaged docking latches, 4.10.4.8, steps 1-3 Master alarm tone does not sound Proceed with the procedure (step 5)</p> <p>or Master alarm tone sounds Install fwd hatch, 4.5.7.5 Proceed with the procedure deleting step 5 (secure tunl hatches & check integrity)</p>		Suit may balloon.
	<p>X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p>		
CMP	<p>5 Secure tunl hatches & check integrity Install fwd hatch, 4.5.7.5 Verify LM hatch is closed & vlv properly set CAB PRESS ind - 4.7-5.3 psia (verify) Read O2 FLOW ind TUNL VENT vlv - TUNL VENT for 30 sec, then LM/CM ΔP & check ΔP incr TUNL VENT vlv - TUNL VENT until ΔP >3.5 psi LM/CM ΔP ind - remains constant within +0.2 psi at least value read for 2 min (verify) O2 FLOW ind - no incr (verify)</p>	<p>2 12 2</p>	LM function.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP 6	Configure cab for sep Remove ctr couch & stow Install docking trgt & receive align- ment verification from LM Configure side hatch for unaided ingress Actr handle sel - N (neut) Vent counterbalance piston chamber GN2 vlv handle - pull (inbd) GN2 press ind - min		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
4.10.3	EXTRAVEHICULAR ACTIVITY (EVA)		
4.10.3.1	<u>CSM/LM EVA</u>		
1	CSM Prep		
	Configure PGA as desired, 4.5.4.6		
	Configure couches as req		
	Disable desired RCS jets (Quad A)		
CDR	AUTO RCS A/C ROLL A1, A2 (2) - OFF	8	
	AUTO RCS B/D ROLL (4) - OFF		
	AUTO RCS PITCH A3, A4 (2) - OFF		
	AUTO RCS YAW B3, D4 (2) - OFF		
CMP	Verify side hatch counterbalance mechanism is disengaged, 4.5.7.3a (if desired)		
	Reconfigure PGA, 4.5.4.6b		
	PLSS comm check if req on request by LM		
LMP	VHF AM A - DUPLEX	3	
	VHF AM B - off (ctr) (verify)		
	VHF RNG - OFF (verify)		
	Verify comm with		
	2 PLSS - CDR (EVCS #1) & LMP (EVCS #2)		
	or 1 PLSS - EVCS #1 or EVCS #2		
	Suit circuit & PGA integrity check, 4.5.4.9a		
	Dump CM press, 4.5.4.11		

4.10.3.1

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STA/T STEP	PROCEDURE	PANEL	REMARKS
2 Side Hatch Operation	<p style="text-align: center;"><u>WARNING</u></p> <p>The hatch should not remain in the open position and exposed to worst conditions for longer than 60 min as warpage may occur & make the hatch difficult to close.</p>		
CMP	<p>a. From CM Interior Open side hatch, 4.5.7.1a or b Close side hatch, 4.5.7.2a</p>		<p>The particular method and crewmen involved in opening the hatch optional (by crew coordination per flight plan).</p>
LMP	<p>or b. From CM Exterior Open side hatch, 4.5.7.1c</p>		
CMP, LMP	<p>or c. From CM Interior/Exterior Close side hatch, 4.5.7.2b</p>		
3 Vacuum Trnfr to CSM ECS	<p>a. From IM ECS Perform trnfr, 4.10.2.3-6</p>		<p>All crewmen in CM, CDR on OPS, LMP on PLSS/OPS. Although these procedures are written sequentially, actual transfers of CDR and LMP to CSM ECS may be performed concurrently depending upon operational considerations (i.e., amount of oxygen remaining in OPS and PLSS/OPS, other time constraints, etc.). CDR and LMP assist each other as required.</p>
	<p>b. From OPS & PLSS/OPS</p>		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR CMP	lh SUIT FLOW vlv - OFF (verify) PWR - OFF (verify) SUIT PWR - OFF (verify) AUDIO CONT - NORM (verify)	301 9	
CDR	Remove PGA conn thermal covers Connect O2 umb (CDR's) to right PGA conns lh SUIT FLOW vlv - FULL FLOW OPS O2 shutoff vlv - close Close purge vlv in left PGA outlet conn Connect CCU (CDR's) to PGA Audio pnl sw (all) - as desired	301 9	Red to red, blue to blue.
LMP	rh SUIT FLOW vlv - OFF (verify)	300	CDR positioned nearest suit flow valves.
CMP	PWR - OFF (verify) SUIT PWR - OFF (verify) AUDIO CONT - NORM (verify)	6	LMP may perform these operations depending upon his position in CM.
LMP	Remove PGA conn thermal covers Remove purge vlv from right PGA outlet conn OPS O2 shutoff vlv - close Disconnect OPS O2 hose from right PGA inlet conn Connect O2 umb (LMP's) to right PGA conns		This operation should be deferred until CM repressurized if operationally feasible.
CDR LMP	rh SUIT FLOW vlv - FULL FLOW PLSS FAN sw - OFF PLSS O2 SHUTOFF vlv - CLOSE PLSS PUMP sw - OFF PLSS MODE SELECTOR sw - OFF (position 3)	300 PLSS	Red to red, blue to blue.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	Disconnect PLSS elect umb from PGA Connect CCU (LMP's) to PGA Audio pnl sw (all) - as desired	PLSS 6	
ALL 4	CSM POST-EVA Reconfiguration Repressurize CM, 4.5.4.8a or 4.5.4.8b Reconfigure couches as req		
4.10.3.2	<u>Scientific Instrumentation</u> <u>Module (SIM) EVA</u>		These are integrated operations requiring coordination with OPS procedures.
1	System Prep CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.18.1.3 & 4.14 SCS - on (desired), 4.8.4.2 RCS DAP - load & activate (req), 4.8.2.1		Assumes all experiments have been deactivated and those requiring retraction have been retracted (4.18.3.2, 4.18.3.4, 4.18.3.6, & 4.18.4.2).
2	Mnvr to EVA att P ___ ° Y ___ ° R ___ °		Deadband recommended 5°. Select A/C for roll control to be compatible with step 12 jet disable configuration.
3	Configure couches as req		Provides best lighting on SIM.

SIM EVA

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP, CDR 4	Don PGAs with O2 umb conns reversed SUIT FLOW vlv - FULL FLOW	300,301	O2 umbilical reversed for optimum flow distribution within PGA.
CMP LMP 5	Configure PGA for EVA Don PGA SUIT PWR - OFF PWR - OFF AUDIO CONT - NORM Conn EVA O2/comm umb to CM IVA/EVA sta Conn EVA O2/comm umb to PGA Attach OPS & OPS PURGE vlv Attach SUIT CONT vlv Attach PRESS CONT vlv	10 603 PGA	LMP assist as required.
6	Configure audio ctr SUIT PWR - on (up) PWR - AUDIO MODE - INTERCOM/PTT S BD - T/R INTERCOM - T/R PAD COMM - OFF VHF AM - OFF	10	
CMP 7	Checkout OPS, PGA, & EVA O2 umb Don helmet & gloves OPS checkout per decal PGA & EVA O2 umb checkout		Refer to orbital EVA Procedures document prepared by EVA Branch FCSD, MSC.

4.10.3.2

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STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	EVA STA O2 SUP - ON SUIT PRESS ALARM - ON PCV - open SCU - open Mon suit tonal alarm	603 604 PGA	Automatic shutoff occurs at suit pressure indication of 3.1-3.4 psig.
	Mon PGA press incr SUIT PRESS ind - 3.5-4.0 psig Tonal alarm - off SUIT PRESS ind - stable at 3.5-4.0 psig	Cuff gage	
	<u>WARNING</u>		
	SCU vlv may remain in close position for no longer than one min or asphyxiation may result.		
	SCU - close Mon SUIT PRESS ind for <0.3 psi/min press decay SCU - open	PGA	
LMP, CDR CMP	8 Configure for CM Depressurization Configure PGA, 4.5.4.6b ctr SUIT FLOW vlv - OFF (EVA crewman only) Install O2 umb interconnect	302	
LMP	9 Activate prim evap GLY EVAP H2O FLOW - AUTO GLY EVAP STM AUTO - AUTO	2	To facilitate water removal in the suit circuit and preclude LMP and CDR face plate fogging.

SIM EVA

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP, 10 CDR	Perform suit ckt integrity check, 4.5.4.9		
CDR 11	Perform CM press dump, 4.5.4.11a (except rh CAB PRESS RELF vlv - DUMP at conclusion of dump)	325	To preclude pressure buildup in CM because of purge flow from returning EVA crewman, the CAB PRESS RELF vlv must remain open.
12	Deactivate SM RCS AUTO RCS A/C ROLL A1 & A2 - OFF AUTO RCS B/D ROLL B1 & B2 & D2 - OFF AUTO RCS PITCH A3 & A4 - OFF AUTO RCS YAW B3 & B4 - OFF	8	
13	Side Hatch Oper (open) <u>WARNING</u> The side hatch should not remain in open position & exposed to worst case conditions for longer than 60 min as warpage may occur & make hatch difficult to close.		
	Open side hatch, 4.5.7.1a		The particular method and crewman involved in open- ing hatch is optional. Flight plan coordination is required.
CMP 14	EVA to SIM		Use CM/SM handrails and Dutch slippers. Refer to orbital EVA Procedures document for approach to SM and film cassette removal.

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
CMP	If PGA press alarm tone sounds or loss of purge flow OPS shutoff vlv - open PURGE vlv - HI FLOW SUIT PRESS ind - >3.4 psig SCU - close PCV - close	PGA Cuff gage PGA	
	If SUIT PRESS ind - <3.4 psig SCU - open SUIT PRESS still <3.4 psig PURGE vlv - LO FLOW Ingress CM immediately Helmet & gloves can be removed at CM PRESS ind - 3.0 psi if req		
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
15	Side Hatch Oper (close) Close side hatch, 4.5.7.2a		
16	CM Post - EVA reconfiguration Repressurize CM, 4.5.4.8a Reconfigure couches as req		
ALL 17	Remove PGAs & stow		
CDR 18	Deactivate EVA sta EVA STA 02 SUP - OFF SUIT PRESS ALARM - OFF	603 604	

SIM EVA

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STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP 19	Deactivate prim evap GLY EVAP H2O FLOW - off (ctr) GLY EVAP STM AUTO - MAN GLY EVAP STM INCR - INCR for 58 sec min	2	INCR position is momentary. Steam pressure valve requires 58 seconds from full open to full close.

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4.10.3.2

SIM EVA

STA/T STEP	PROCEDURE	PANEL	REMARKS
	<p>4.10.4 TUNNEL MECHANICAL SYSTEMS</p> <p>4.10.4.1 <u>Docking Probe Removal (CM side)</u></p> <p>1 Pnl & tunl configuration CMP PROBE (3) - OFF cb DOCK PROBE (2) - open Fwd hatch removed, 4.5.7.4 Auto docking latches engaged (at least 3 engaged latches ≈120° apart)</p> <p>2 Extend latch engaged, ind (red) not visible (verify)</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If extd latch is not engaged, ind (red) not flush with latch housing Preload sel lever - rot CW (away from orange stripe) Preload handle - torque CCW until extd latch engages, ind (red) not visible X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>	<p>2 8 tunl</p>	<p>PROBE EXTD/REL switch is guarded.</p> <p>If probe is being removed after previously being installed for stowage, it will not be necessary to perform steps 2, 3, and 4. Step 2 should be performed only after TLD.</p>

TUNNEL MECHANICAL SYSTEMS

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<p>GN2 bleed button (red) - press for 10 sec</p> <p>Preload sel lever - rot CCW (parallel to orange stripe)</p> <p>Preload handle - torque CW until load is removed from support beams</p>	tun1	<p>GN2 bleed button (red) located under pyro components cover, depressurizes probe retract system when depressed.</p> <p>Support beams may become loose in docking ring sockets.</p>
3	<p>Preload sel lever - rot CW (away from orange stripe)</p> <p>Preload handle - torque CCW until extd latch engages, ind (red) not visible</p> <p>GN2 bleed button (red) - press for 10 sec</p>		<p>Step 3 should be performed only after LOD.</p>
4	<p>Disconnect & stow probe umbs</p> <p>Pull conn shell (yellow) & rot CCW to unlock</p> <p>Pull conn to remove, align yellow mark with stowage conn (yellow) & push to engage</p> <p>Rot conn shell CW to lock</p> <p>Repeat for sec prob umb (yellow)</p> <p>Close probe umb conn covers (2) (yellow)</p> <p>Position preload handle against stowed probe umb</p> <p>Preload sel lever - mid-position</p>		<p>GN2 bleed button (red), located under pyro components cover, depressurizes probe retract system when depressed.</p> <p>Stowage connector located on aft side of support beams.</p>

4.10.4.1

TUNNEL MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
5	<p>Fold probe</p> <p>Pull installation strut from clip on support beam, rot foot 180° & position against tunl wall between yellow marks</p> <p>Rot capture latch rel handle lock CCW to unlock (orange stripe visible)</p> <p>Depress ratchet handle rel button (gray) & pull ratchet handle aft to full extension</p> <p>Depress ratchet handle rel button (gray) & push ratchet handle to first detent (red band only visible)</p> <p>Push ratchet handle outbd 30° & hold allowing probe to fold</p>	tunl	<p>Ratchet handle release button (gray) is on aft end of ratchet handle.</p> <p>Probe fully folded when Teflon block on Z-support beam within 1/4 inch of ratchet housing.</p>
	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>Probe will not fold</p> <p>Using tool F, rot jam nut & hex bolt (ratchet handle stop) CCW to remove bolt</p> <p>Push ratchet handle outd until probe releases & hold until probe folds</p> <p>(Subsequent installations of probe must be done very carefully to avoid releasing ratchet & folding probe while attempting to install it)</p>		
	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p>		

TUNNEL MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Pull capture latch rel handle from recess & rot 150° CCW to cock capture latches Move probe into tunl</p> <p>3 Engage capture latches Push probe head into drogue until capture latches engage & lock</p> <p>Rot capture latch rel handle CCW 30° to lock capture latches & push fwd into recess Verify probe capture latch rel (LM side) button protrudes above probe head</p> <p>4 Engage probe in docking ring Pull installation strut from clip on support beam, rot foot 180° & position against tunl wall between yellow marks Depress ratchet handle rel button (gray) & pull ratchet handle aft to full extension (green & red bands visible) Push ratchet handle outboard 25° to stop & repeat until probe support beams (3) engage in docking ring sockets</p>	tunl	<p>Orange arrow on pyro cover should align with orange end at capture latch release handle. Do not force handle.</p> <p>A slight pull in aft direction will disengage capture latches if not fully engaged.</p> <p>Colored ends of capture latch release handle should match colors on probe collar. Do not force handle.</p> <p>LM crewman must make this verification. Probe capture latch release button on LM side of drogue when capture latches engaged.</p> <p>Yellow marks located on -Z axis. Probe support beam and corresponding docking ring socket color-coded yellow.</p> <p>Ratchet handle release button (gray) on aft end of ratchet handle.</p> <p>From this point ≈19 strokes required to install probe. An orange hash mark on collar conduit becomes visible when fully installed. Care should be exercised to ensure probe support beams (3) align with docking ring sockets and end of pitch arms do not interfere with docking latch fairings.</p>

TUNNEL MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>If pushing ratchet handle outbd does not advance support beams to engage docking ring sockets</p> <p>Depress ratchet handle rel button (gray) & push ratchet handle fwd to first detent (red band only visible)</p> <p>Slowly push ratchet handle outbd ≈25° until ratchet pawl engages (audible click) & repeat until 3 probe support beams engage in docking ring sockets</p> <p>(If ratchet handle is pushed outbd past point of pawl engagement, probe will rel)</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>Verify ratchet pawl ind (red) is flush with ratchet housing</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>If ratchet pawl ind is protruding above ratchet housing</p> <p>Push ratchet handle outbd 25° to stop & hold</p> <p>Press ratchet pawl ind (red) to seat pawl (ind flush)</p> <p>Return ratchet handle to full inbd position</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p>	tun1	<p>If ratchet pawl not audible, watch action of ratchet pawl indicator (red).</p>

4.10.4.3

TUNNEL MECHANICAL SYSTEMS



STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Depress ratchet handle rel button (gray) & with ratchet handle held inbd, push fully fwd to stow position</p> <p>Rot installation strut foot 180° to stow position & restow installation strut in clip on support beam</p>	tun1	<p>This step required only if probe installed in tunnel for stowage. Support beams may become loose in docking ring sockets. Rotate preload select lever CCW (parallel to orange stripe) to move extend latch aft (compress probe) and CW (away from orange stripe) to move extend latch forward (expand probe).</p>
5	<p>Adj preload handle in direction req to maintain support beams in an unloaded condition</p>		<p>Position provides clearance with forward hatch actuator handle.</p>
	<p>Position preload handle at a 45° angle to support beam (either side)</p>		
6	<p>Push preload shaft fwd into detent</p> <p>Push capture latch rel handle fwd into detent</p> <p>Rot capture latch rel handle lock CW to lock (orange stripe not visible)</p>		
7	<p>Connect probe umbs</p> <p>Pull probe umbs covers (2) (yellow) inbd & rot fwd to open</p>		<p>This step not required when installing probe for stowage.</p> <p>Probe umbilical covers located in docking ring.</p>

TUNNEL MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	<p>Pull conn shell (yellow) aft & rot CCW to unlock Pull conn to remove, align with docking ring conn (yellow) & push to engage Rot conn shell CW to lock Repeat for sec probe umb (yellow)</p> <p>4.10.4.4 <u>Docking Drogue Removal (CM side)</u></p> <p>Docking probe removal, 4.10.4.1 Pull & rot (CCW) drogue lock lever until flush against tunl wall Remove drogue</p> <p>Rot (CW) & push until 3 drogue lugs clear support fittings Rot toward CM & grasp any 2 handles Mnvr drogue past support fittings & stow in CM</p> <p>4.10.4.5 <u>Docking Drogue Removal (LM side)</u></p> <p>1 Verify auto docking latches engaged (at least 3 engaged latches $\approx 120^\circ$ apart)</p>	tunl	<p>Probe umbilical connectors stowed on probe support beams.</p> <p>Normally accomplished when all three crewmen are in CM prior to an IVT to LM and normally follows probe removal.</p> <p>Drogue outer ring should be grasped with both hands at opposite sides. Drogue lugs must move to left end of support fitting before drogue can be pushed free. Care must be taken not to strike LM hatch.</p> <p>Drogue must be canted and rotated to clear tunnel. Drogue stowed under LMP couch.</p> <p>Step 1 should be performed only after LOD. This could be visual verification or tactile verification using tool B if required.</p>

STA/T STEP	PROCEDURE	PANEL	REMARKS
	Push probe capture latch rel button tool B	tun1	Releases three probe capture latches and extend latch will engage automatically to prevent probe from re-extending.
	Probe head retracts from drogue (verify)		
	<pre> XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If probe head does not retract from drogue Remove probe from CM side, 4.10.4.1 Remove drogue, steps 2 & 4 or 4.10.4.4 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X </pre>		
	<pre> XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If capture latches will not rel Rel probe, 4.10.4.1, steps 1, 3, 2, 4, & 5 Rel drogue, step 2 Remove probe & drogue connected, & stow in LM XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X </pre>		This procedure requires a crewman in both LM and CM.
2	<p>Remove drogue</p> <p>Rot drogue lock lever inbd 90°</p> <p>Push drogue lock lever & rot 90° CW to unlock drogue</p> <p>Rot drogue CCW until drogue lugs (3) clear tun1 drogue supports (3)</p>		

TUNNEL MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
3	Depress capture latch rel button with tool B & hold Pull on drogue handle to rel capture latches	tun1	Step 3 should be performed only when probe and drogue were previously installed for stowage.
	<pre> XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If capture latches will not rel Rel probe, 4.10.4.1, steps 1, 3, 2, 4, & 5 Rel drogue, step 2 Remove probe & drogue connected, & stow in LM X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX </pre>		This procedure requires a crewman in both LM and CM.
4	Remove drogue from tun1 & stow in LM as req		Stowage for LM jettison provided in LM.
4.10.4.6	<u>Docking Drogue Installation (CM side)</u>		
	Procure drogue from stowage Install drogue Mnvr past support fitting in LM tun1		Drogue stowed under LMP couch.
	Align drogue lugs (3) with support fittings in LM tun1		Drogue must be held along outer diameter at opposite sides adjacent to drogue lugs. At this point drogue handles are facing IM hatch.

4.10.4.6

TUNNEL MECHANICAL SYSTEMS



STA/T STEP	PROCEDURE	PANEL	REMARKS
	Preload sel lever - Rot to mid-position Capture latch rel handle lock - locked position (orange stripe not visible) (verify)	tun1	
4.10.4.8	<u>Tunnel Latch Operations</u>		
1	Verify probe is preloaded, 4.10.4.7		
2	Cocking of latches		Any suitable tool may be used to trigger release lever if desired.
	<u>WARNING</u>		
	To avoid possible injury to fingers or damage to the PGA, care must be taken not to place fingers under or near a latch while cocking, nor under or near the latch hook of a cocked latch.		
	Depress rel button behind handle latch grip & pull latch handle down two complete strokes		This procedure disengages and cocks latch. It may take only one complete stroke to cock each latch.
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X		
	If latch handle cannot be pulled While pulling handle, depress rh no-back pawl on bottom until it disengages from ratchet tooth		

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STA/T STEP	PROCEDURE	PANEL	REMARKS
	<p>If latch handle pulls free, remove press from rh no-back pawl & complete cocking procedures</p>	tun1	
	<p>If latch handle still cannot be pulled While pulling handle, depress lh no-back pawl through fairing covering hole with tools E and R until ratchet tooth disengages & latch handle pulls free Remove press from lh no-back pawl & complete cocking procedure</p>		
	<p>If latch handle still cannot be pulled Remove fairing covering lh no-back pawl (using tools E and R) While pulling handle, depress both no-back pawls on the bottom until ratchet teeth are disengaged & latch handle pulls free Remove press from both no-back pawls & complete cocking procedure</p>		
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		
	<p>Verify hook rotates inbd to clear LM ring</p>		

TUNNEL MECHANICAL SYSTEMS

STA/T STEP	PROCEDURE	PANEL	REMARKS
	<p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X If latch hook does not rel from LM ring on first stroke Push top of AUX REL (yellow) button & proceed with sec stroke XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX X</p> <p>Verify/push latch handle outbd against latch hook</p> <p>3 Repeat step 2 until all 12 latches are disengaged & cocked</p> <p>4 Man triggering of latches Push man rel lever at side of latches located</p>	<p>tun1</p>	<p>Prevents latch handle sticking inboard which could prevent the latch primary trigger from resetting after undocking.</p> <p>Latches reset for subsequent docking operations.</p> <p>This procedure engages latch. Manual release lever located at lower right side of latch handle. Use tool L to push manual release lever.</p>

