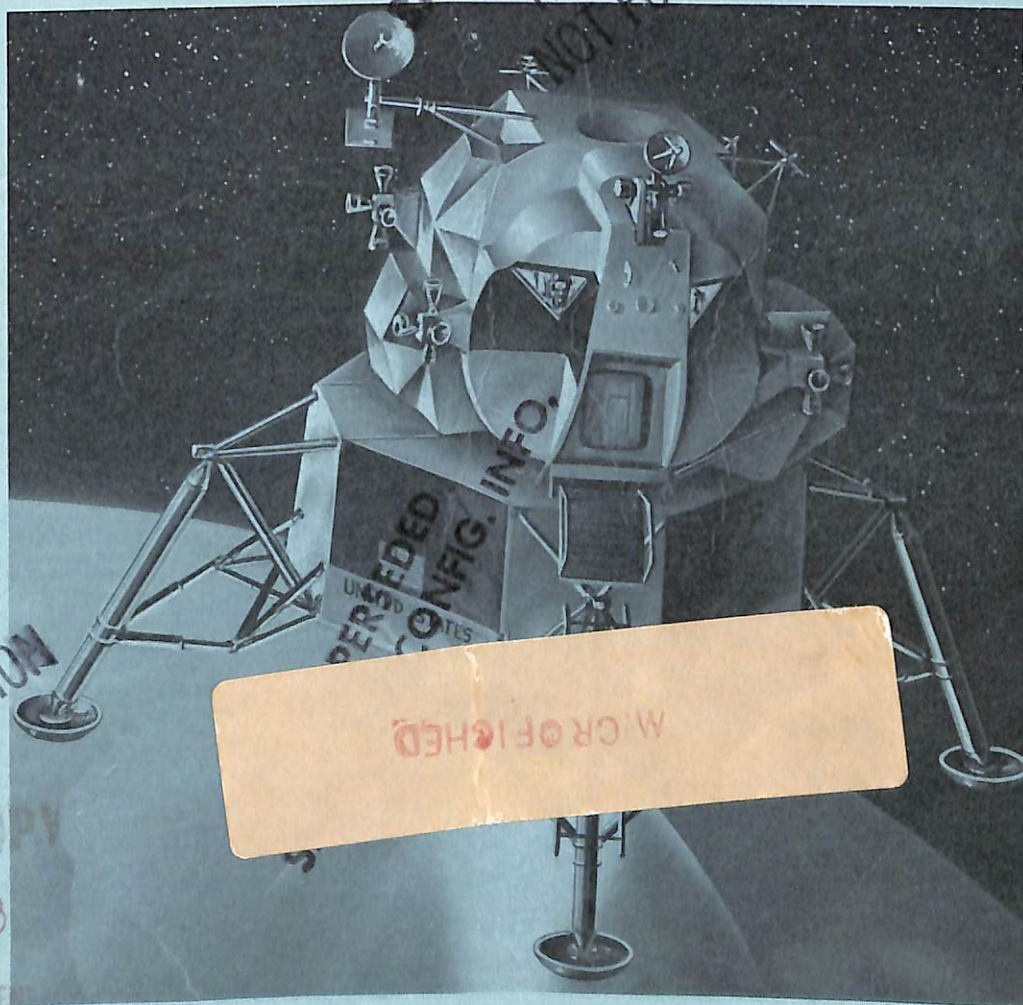


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LUNAR MODULE 3

VOLUME II OPERATIONAL PROCEDURES

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NAS 9-1100

Exhibit E

Paragraph 10.4

Prepared under direction of
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SPACECRAFT SYSTEMS BRANCH / FLIGHT CREW SUPPORT DIVISION



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5-1 thru 5-8.	Basic
D-1 thru D-8	Basic
E-1 thru E-6	Basic

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Appendices A, B, and C are contained in
Volume I of the Apollo Operations Handbook.

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GUIDANCE AND CONTROL SOURCE DATA

Paragraph	Title	Reference
4.2.10	AGS Power Up	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
4.3.5	APS Burn to Depletion	Sundance Program (P42), Revision 15, dated October 20, 1967
4.5.12	ORDEAL Initialization	U. S. Gov't Memo CF 221-7M-235, 7 July 1967
4.5.13	AGS Calibration	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
4.5.14	AGS Manual Absolute Time Initialization	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
4.5.15	AGS Manual State Vector Update	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
4.7.3	AGS Alignment With PGNC (IMU Align)	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
4.9.5 4.9.6	Rendezvous Alternate Rendezvous Method	1. Manual Lunar Orbit Rendezvous Analysis, R. J. Adornato and R. Fleisig-GAEC, and V. V. Asbedian-TRW Systems. Paper presented at the 2nd International Federation of Automatic Control Symposium on Automatic Control in Space. September 4-8, 1967; Vienna, Austria. 2. Simulated Study of Manual Control Techniques For The Concentric Flight Plan of Lunar Orbit Rendezvous. MSC Internal Note 66-EG-13, March 18, 1966. 3. Simulated Study of Manual Control Techniques For Lunar Orbit Rendezvous. MSC Internal Note 65-EG-33, August 2, 1965.
4.11.6	RCS Staging	Sundance Program (P47), Revision 04, dated August 15, 1947
4.11.7	AGS FITH	1. LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B. 2. Sundance Program (P42), Revision 15, dated October 20, 1967

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GUIDANCE AND CONTROL SOURCE DATA (cont)

Paragraph	Title	Reference
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4.2.11	PGNCS Startup Program (P05)	Revision 03 dated October 20, 1967
4.4.1	Program List	Revision 19, dated November 1, 1967
4.4.2	Routine List	Revision 19, dated November 1, 1967
4.4.3	Verb List	Revision 02, dated August 10, 1967
4.4.4	Noun List	Revision 02, dated August 10, 1967
4.4.5	Checklist Reference Codes (V50 N25)	Basic, dated July 21, 1967
4.4.6	Option Codes (V50 N06)	Basic, dated July 21, 1967
4.4.7	Alarm Codes (V50 N09)	Basic, dated July 21, 1967
4.4.8	Star Codes	Basic, dated July 12, 1967
4.4.9	AOT Detent Codes	Revision 09, dated October 20, 1967
4.4.10	AGS Selector Logic List	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
4.4.11	DEDA Input List	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
4.4.12	DEDA Output List	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
4.4.13	DEDA Accessible Constants List	LM AGS Operating Manual, April 1967, 05952-6141-T000, Revision B; subsequent changes auth per conf, AVO's & Tel Comm - TRW & GAEC
		<u>Sundance Program:</u>
4.5.4	Final Automatic Request Terminate Routine (R00)	Revision 01, dated August 7, 1967
4.5.5	LGC Idling Program (P00)	Revision 03, dated October 20, 1967
4.5.6	AGS Initialization Routine (R47)	Revision 09, dated October 20, 1967
4.5.9	Target ΔV Routine (R32)	Revision 02, dated August 15, 1967
4.5.11	Downlink Octal Dump (V74)	Revision 01, dated November 24, 1967
4.5.19	LGC/CMC Clock Synchronization Routine (R33)	Revision 05, dated August 15, 1967

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GUIDANCE AND CONTROL SOURCE DATA (cont)

Paragraph	Title	Reference
		<u>Sundance Program:</u>
4.5.20	PGNCS Power Down Program (P06)	Revision 04, dated October 20, 1967
4.6.1	Rendezvous Navigation Program (P20)	Revision 09, dated October 20, 1967
4.6.2	Ground Track Determination Program (P21)	Revision 06, dated October 20, 1967
4.6.3	Preferred Tracking Attitude Program (P25)	Revision 08, dated October 25, 1967
4.6.5	Digital Autopilot Data Load Routine (R03)	Revision 06, dated August 15, 1967
4.6.6	LGC Update Program (P27)	Revision 03, dated October 20, 1967
4.6.7	Crew Defined Maneuvers Routine (R62)	Revision 04, dated August 15, 1967
4.6.8	Rendezvous Final Attitude Routine (R63)	Revision 02, dated October 20, 1967
4.6.10	Rendezvous Parameter Display Routine (R31)	Revision 03, dated August 15, 1967
4.7.1	IMU Orientation Determination Program (P51)	Revision 11, dated September 15, 1967
4.7.2	IMU Realign Program (P52)	Revision 13, dated September 15, 1967
4.8.1	External ΔV Program With AGS Follow Up (P30)	Revision 04, dated October 20, 1967
4.8.2	CSI Program With AGS Follow Up (P32 or P72)	(P32) Revision 06, dated October 26, 1967 (P72) Revision 06, dated November 1, 1967
4.8.3	CDH Program With AGS Follow Up (P33 or P73)	(P33) Revision 11, dated November 1, 1967 (P73) Revision 06, dated October 20, 1967
4.8.4	TPI Program With AGS Follow Up (P34 or P74)	(P34) Revision 05, dated August 17, 1967 (P74) Revision 03, dated August 12, 1967
4.8.5	TPM Program (P35 or P75)	(P35) Revision 04, dated August 12, 1967 (P75) Revision 05, dated August 15, 1967
4.9.1	DPS Program (Docked & Separated) With AGS Follow Up/In Control (P40)	Revision 15, dated October 20, 1967

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GUIDANCE AND CONTROL SOURCE DATA (cont)

Paragraph	Title	Reference
		<u>Sundance Program:</u>
4.9.2	RCS Program With AGS Follow Up/In Control (P41)	Revision 12, dated October 20, 1967
4.9.3	APS Program With AGS Follow Up/In Control (P42)	Revision 15, dated October 20, 1967
4.9.4	Thrust Monitor Program (P47)	Revision 04, dated August 15, 1967
4.10.8	RR/LR Self Test Routine (R04)	Revision 05, dated November 1, 1967

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APOLLO OPERATIONS HANDBOOK

FOREWORD

Volume II of the Apollo Operations Handbook contains the flight crew operational procedures for LM 3. Change or revisions to this publication will be issued as required. A similar publication will be prepared for each manned Lunar Module.

Volume II consists of Normal/Backup, Abort, Malfunction, and Emergency procedures. Normal procedures are used when all subsystems are operating normally. Backup procedures are used to accomplish the objectives of the normal procedures, when equipment failure or other anomaly prevents use of the normal procedures. Abort procedures cover crew activity for abort modes. Malfunction procedures provide symptoms diagnoses, and corrective actions for subsystem malfunctions. Emergency procedures deal with situations that require immediate action to avoid or alleviate a hazardous condition.

Volume I of the Apollo Operations Handbook is bound separately. It describes the LM-3 subsystems and equipment.

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APOLLO OPERATIONS HANDBOOK

PRELAUNCH CLOSEOUT CHECK

TRANSFER TO LM & SUBSYSTEM ACTIVATION

TRANSFER TO CSM & SUBSYSTEM DEACTIVATION

G & N GENERAL

GUIDANCE & CONTROL

COAST

ALIGNMENT

PRETHRUST

THRUST

SEPARATION & DOCKING

STAGING

SUBSYSTEM MANAGEMENT

SECTION 4

NORMAL/BACKUP PROCEDURES

INTRODUCTION.

The tasks in this section are presented in numerical sequence. They are further organized, by subgroups, into related functions. The following paragraphs explain the tabular format.

The "CREWMAN" column indicates which crewmember is assigned to perform the specific procedure. The following abbreviations are used in this column: CDR (Commander), LMP (LM Pilot), and CMP (Command Module Pilot).

The "PNL" column indicates the location of a particular control or display, by panel number or equipment designation. The following equipment designations are used in this column: ECS (ECS module), PGA (pressure garment assembly), AOT (alignment optical telescope), ACA (attitude controller assembly), and TTCA (thrust/translation controller assembly). (The panels and ECS module are shown in figures E-1 and E-2.)

The "PROCEDURES" column contains groups of steps, or overall tasks, involved in performing a complete operation.

The "REMARKS" column provides the rationale that supports the adjacent step and the operational procedure. The scope of the rationale will increase as the operational procedures are refined through continued application by the Flight Crew during mission simulation, using Apollo evaluators and simulators.

Controls and displays are identified by their respective placards. Lengthy placards have been shortened herein. The following abbreviations are used for controls and displays:

caut lt	caution annunciators
CB	d-c circuit breakers
CB/AC	a-c circuit breakers
comp caut lt	component caution lights
cont.	continuous rotary controls
ind	all meters, gages, and digital displays
ind pwr fail lt	indicator power failure light
ind pwr/sig fail lt	indicator power/signal failure light
lt	lights
pb	pushbutton switches (except pushbutton lights)
pb/lt	pushbutton lights
sel	detent rotary switches
sw	toggle switches
tb	status flags
tw	thumbwheel controls
vlv	manually operated valves
warn lt	warning annunciators

Basic Date 1 Jan 1968

Change Date

Page 4-3

CREW-MAN	PNL	PROCEDURES	REMARKS
		4.1 PRELAUNCH CLOSEOUT CHECK Prelaunch procedures consist of checks performed by a backup flight crew before the prime crew enters. It is assumed that a complete prelaunch checkout, including stowage of loose gear, has been performed by ground support personnel before the backup flight crew enters the LM and that all subsystems are in an active configuration at the time of entry.	
	11	1. All panel 11 CB's open except: CB LTG: ANUN/DOCK/COMPNT - close CB HTR: RNDZ RDR STBY - close LDG RDR - close CB PGNS: IMU STBY - close CB EPS: BAT FEED TIE (2) - close CROSS TIE BAL LOADS - close DES ECA CONT - close DES ECA - close DC BUS VOLT - close EARTH ORBIT: C BAND PWR sw - OFF R/D TLM CAL sw - OFF 2. ORDEAL Panel: FDAI 1 sw - INRTL FDAI 2 sw - INRTL EARTH/LUNAR sw - PWR OFF LTG sw - OFF MODE sw - HOLD/FAST SLEW sw - center ALT SET cont - TBD nm	All tb's indicate no power condition.
	8	3. DES PROPUL: FUEL VENT sw - center; tb - bp OXID VENT sw - center; tb - bp ED: DES PRPLNT ISOL VLV sw - SAFE LDG GEAR DEPLOY tb - bp MASTER ARM sw - OFF DES VENT sw - SAFE ASC He SEL sw - BOTH LDG GEAR DEPLOY sw - SAFE RCS He PRESS sw - SAFE DES START He PRESS sw - SAFE	

4.1 PRELAUNCH CLOSEOUT CHECK

PRELAUNCH
CLOSEOUT

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CREW-MAN	PNL	PROCEDURES	REMARKS
	8	ASC He PRESS sw - SAFE STAGE sw - SAFE (guarded) STAGE RELAY sw - OFF AUDIO: S BAND T/R sw - OFF ICS T/R sw - OFF RELAY ON sw - RELAY OFF S band VOL tw - TBD* ICS VOL tw - TBD* VOX sw - ICS CONT sw - NORM VHF A sw - OFF VHF B sw - OFF VOX SENS tw - TBD* VHF A VOL tw - TBD* VHF B VOL tw - TBD* MASTER VOL tw - TBD* COAS sw - OFF	* Levels to be determined during OCP activities and left in optimum position during closeout.
	TTCA	4. THROTTLE/JETS cont (CDR) - JETS Throttle friction cont (CDR) - TBD*	
	5	5. DES RATE sw - center Eng STOP pb/lt - reset (flush) Eng START pb/lt - reset (flush) +X TRANSL pb - reset (flush) MSN TMR: TMR CONT sw - STOP SLEW CONT HOURS sw - center SLEW CONT MIN sw - center SLEW CONT SEC sw - center	
	5	LTG: OVERRIDE ANUN sw - OFF OVERRIDE NUM sw - OFF OVERRIDE INTEGRAL sw - OFF SIDE PANELS sw - OFF FLOOD cont (CDR) - DIM ANUN/NUM cont - DIM INTEGRAL cont - DIM	
	ACA	6. PTT pb (CDR) - not depressed	

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CREW-MAN	PNL	PROCEDURES	REMARKS
	1	7. X POINTER SCALE sw (CDR) - HI MULT MASTER ALARM pb/lt - reset (flush) RATE/ERR MON sw - LDG RDR/CMPTR ATTITUDE MON sw - PGNS SHFT/TRUN ✕ sw - +50° RATE SCALE sw - 25°/SEC IMU CAGE sw - OFF ENG THR CONT: THR CONT sw - AUTO MAN THROT sw - CDR ENG ARM sw - OFF X TRANSL sw - 2 JETS BAL CPL sw - ON ASC He REG 1 sw - center; tb - gray ASC He REG 2 sw - center; tb - gray DES He REG 1 sw - center; tb - gray DES He REG 2 sw - center; tb - bp PRPLNT QTY MON sw - OFF PRPLNT TEMP/PRESS MON sw - DES 1 HELIUM MON sel - OFF ABORT pb - reset (flush guarded) ABORT STAGE pb - reset (flush guarded) RNG/ALT MON sw - RNG/RNG RT MODE SEL sw - PGNS GUID CONT sw - PGNS	
	3	8. ENG GMBL sw - OFF DES ENG CMD OVRD sw - OFF RADAR: LDG ANT sw - AUTO TEST sw - OFF TEST MON sel - ALT XMTR RNDZ RDR: SLEW RATE sw - HI SLEW sw - center RNDZ RADAR sel - AUTO TRACK S/C: DEAD BAND sw - MIN GYRO TEST ROLL sw - ROLL GYRO TEST POS RT sw - OFF ROLL sw - MODE CONT PITCH sw - MODE CONT YAW sw - MODE CONT MODE CONTROL sel - ATT HOLD	

4.1 PRELAUNCH CLOSEOUT CHECK (cont)

PRELAUNCH
CLOSEOUT

CREW-MAN	PNL	PROCEDURES	REMARKS
	3	HTR CONT: TEMP MON sel - RNDZ RADAR RCS SYS A/B 2 QUAD 1 sw - AUTO RCS SYS A/B 2 QUAD 2 sw - AUTO RCS SYS A/B 2 QUAD 3 sw - AUTO RCS SYS A/B 2 QUAD 4 sw - AUTO EVNT TMR: RESET/COUNT sw - DOWN TMR CONT sw - center SLEW CONT MIN sw - center SLEW CONT SEC sw - center LTG: SIDE PANELS sw - OFF FLOOD sw - OFF FLOOD cont (LMP) - DIM EXTERIOR LTG sel - OFF LAMP/TONE TEST sel - OFF (ccw) X POINTER SCALE sw (LMP) - HI MULT	
	4	9. ACA/4 JET sw (CDR) - DISABLE TTCA/TRANSL sw (CDR) - DISABLE ACA/4 JET sw (LMP) - DISABLE TTCA/TRANSL sw (LMP) - DISABLE	
	AOT	10. Azimuth cont - CL Eye guard assembly and density filter - removed MARK X pb - not depressed MARK Y pb - not depressed REJECT pb - not depressed	
	2	11. RCS: SYS A ASC FEED 1 sw - center; tb - bp SYS A ASC FEED 2 sw - center; tb - bp SYS B ASC FEED 1 sw - center; tb - bp SYS B ASC FEED 2 sw - center; tb - bp SYS A QUAD 1 sw - center; tb - gray SYS A QUAD 4 sw - center; tb - gray SYS B QUAD 1 sw - center; tb - gray SYS B QUAD 4 sw - center; tb - gray SYS A QUAD 2 sw - center; tb - gray SYS A QUAD 3 sw - center; tb - gray SYS B QUAD 2 sw - center; tb - gray SYS B QUAD 3 sw - center; tb - gray CRSFD sw - center; tb - pb	

4.1 PRELAUNCH CLOSEOUT CHECK (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	2	SYS A MAIN SOV sw - center; tb - gray SYS B MAIN SOV sw - center; tb - gray TEMP/PRESS MON sel - He RCCA sw - OFF/RESET MASTER ALARM pb/lt - reset (flush) RATE/ERR MON sw - LDG RDR/COMPTR ATTITUDE MON sw - AGS GLYCOL sel - INST (SEC) SUIT FAN sel - OFF O2/H2O QTY MON sel - DES	
	TTCA	12. THROTTLE/JETS cont (LMP) - JETS Throttle friction cont (LMP) - TBD*	
	6	13. Eng STOP pb/lt - reset (flush) AGS STATUS sw - OFF	
	ACA	14. PTT pb (LMP) - not depressed	
	16	15. All panel 16 CB's open except: CB LTG: FLOOD - close ANUN/DOCK/COMPNT - close CB S/C: ASA - close CB HTR: S BD ANT - close CB EPS: DC BUS VOLT - close DES ECA - close DES ECA CONT - close CROSS TIE BAL LOADS - close BAT FEED TIE (2) - close	
	14	16. EPS: ED VOLTS sw - OFF POWER/TEMP MON sel - ED/OFF INVERTER sw - OFF SE BAT 1 HI & LOW VOLT sw - center; tb - bp SE BAT 2 HI & LOW VOLT sw - center; tb - bp CDR BAT 3 HI & LOW VOLT sw - center; tb - bp CDR BAT 4 HI & LOW VOLT sw - center; tb - bp DES BATS sw - center; tb - bp BAT 5 NORMAL SE FEED sw - center; tb - bp BAT 5 BACK UP CDR FEED sw - center; tb - bp BAT 6 NORMAL CDR FEED sw - center; tb - bp BAT 6 BACK UP SE FEED sw - center; tb - bp	

4.1 PRELAUNCH CLOSEOUT CHECK (cont)

PRELAUNCH
CLOSEOUT

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CREW-MAN	PNL	PROCEDURES	REMARKS
	12	17. AUDIO: CONT sw - NORM S BAND T/R sw - OFF ICS T/R sw - OFF RELAY ON sw - RELAY OFF S band VOL tw - TBD* ICS VOL tw - TBD* VOX sw - ICS VHF A sw - OFF VHF B sw - OFF VOX SENS tw - TBD* VHF A VOL tw - TBD* VHF B VOL tw - TBD* MASTER VOL tw - TBD* COMM: S BAND MODULATE sw - PM S BAND XMTR/RCVR sw - OFF S BAND PWR AMPL sw - OFF S BAND VOICE sw - OFF S BAND PCM sw - OFF S BAND RANGE sw - OFF/RESET VHF A XMTR sw - OFF VHF A RCVR sw - OFF VHF B XMTR sw - OFF VHF B RCVR sw - OFF TLM BIOMED sw - OFF TLM PCM sw - LO VHF A SQUELCH tw - TBD* VHF B SQUELCH tw - TBD* RECORDER sw - OFF RECORDER TAPE tb - bp COMM ANT: VHF sel - 1/PLSS TEST TRACK MODE sw - OFF PITCH cont - +255° YAW cont - -30° S BAND sel - 2 Ovhd floodlights (CDR & LMP) - rotate aft 18. ECS Module: SUIT GAS DIVERTER vlv - PULL EGRESS CABIN REPRESS vlv - CLOSE PLSS FILL vlv - CLOSE PRESS REG A vlv - CLOSE	*Levels to be determined during OCP activities and left in optimum position during closeout.

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CREW-MAN	PNL	PROCEDURES	REMARKS
	12	PRESS REG B vlv - CLOSE DES O2 vlv - CLOSE #1 ASC O2 vlv - CLOSE #2 ASC O2 vlv - CLOSE SUIT ISOL vlv (CDR) - SUIT FLOW SUIT ISOL vlv (LMP) - SUIT FLOW ASC H2O vlv - CLOSE SEC EVAP FLOW vlv - CLOSE PRIM EVAP FLOW NO. 2 vlv - CLOSE DES H2O vlv - OPEN WATER TANK SELECT vlv - DES SUIT TEMP vlv - COLD Cabin temp vlv - NORM PRIM EVAP FLOW sw - center (closed) CABIN GAS RETURN vlv - EGRESS SUIT CIRCUIT RELIEF vlv - AUTO CO2 CANISTER SEL vlv - PRIM PRIM CO2 CANISTER - CLOSE SEC CO2 CANISTER - CLOSE WATER SEP SEL vlv - PUSH SEP 1 Cabin relief and dump vlv (ovhd) - AUTO Cabin relief and dump vlv (fwd) - AUTO Primary evap flow solenoid vlv - close Crossover solenoid vlv - open	Closing the primary evap flow and crossover solenoid vlv must be confirmed via GSE; there is no indication in cabin.

4.1 PRELAUNCH CLOSEOUT CHECK (cont)



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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.2 <u>TRANSFER TO LM & SUBSYSTEM ACTIVATION</u> Transfer to LM and Subsystem Activation consists of tasks performed by the crew to enter the LM and to turn on and check the LM subsystems. 4.2.1 LMP INTRAVEHICULAR TRANSFER TO LM	
LMP		1. Cabin relief and dump vlv (topside of docking hatch) - DUMP 2. Verify that CSM, tunnel, and LM pressures have equalized. 3. Docking hatch handle - UNLOCK 4. Hatch - fully open 5. Verify LM cabin overhead floodlights are on with hatch open. 6. Read relative roll indication on docking ring and transmit reading to CSM. 7. Enter LM cabin, head first and facing forward. 8. Maneuver into cabin above ascent engine cover, grasp assist bar forward of hatch fitting in LM ceiling, pull self into cabin and walk backward down open hatch, ascent engine cover, and midsection bulkhead until feet are on cabin floor. 9. Unstow radiation survey meter. 10. Scan entire cabin interior with radiation survey meter and verify normal radiation level. 11. Stow meter.	Assumptions: (1) Probe and drogue in CSM; (2) CSM, LM, and docking tunnel pressurized; (3) crewman wearing helmet and gloves; and (4) transfer umbilical connected to left side of PGA. Only one crewman at a time can transfer, because there is only one transfer umbilical.
	PGA	12. Face forward and attach both inboard restraint lines to PGA.	

4.2.1 LMP INTRAVEHICULAR TRANSFER TO LM

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CREW-MAN	PNL	PROCEDURES	REMARKS
	PGA	13. Overhead floodlights - adjust for forward illumination	
		14. Remove front panel protective cover, fold and stow.	
		15. Unstow water nozzle.	
	ECS	16. DES H2O vlv - CLOSE	
	Heat ex-changer	17. Connect water nozzle to water hose quick-disconnect	
	ECS	18. DES H2O vlv - OPEN	
		4.2.2 INITIAL ENTRY STATUS CHECK	All tb's indicate no power condition.
LMP	11	1. All panel 11 CB's open except: CB HTR: RNDZ RDR STBY - close LDG RDR - close CB LTG: ANUN/DOCK/COMPNT - close CB PGNS: IMU STBY - close CB EPS: BAT FEED TIE (2) - close CROSS TIE BAL LOADS - close DES ECA CONT - close DES ECA - close DC BUS VOLT - close EARTH ORBIT: C BAND PWR sw - OFF R/D TLM CAL sw - OFF	
	16	2. All panel 16 CB's open except: CB LTG: FLOOD - close ANUN/DOCK/COMPNT - close CB S/C: ASA - close CB HTR: S BD ANT - close CB EPS: DISP - close* DC BUS VOLT - close DES ECA - close DES ECA CONT - close CROSS TIE BAL LOADS - close BAT FEED TIE (2) - close	* This CB is left open during Prelaunch Closeout Check.

4.2.2 INITIAL ENTRY STATUS CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	14	3. EPS: SE BAT 1 & 2 tb - bp CDR BAT 3 & 4 tb - bp 4.2.3 EPS ACTIVATION & CHECKOUT 1. Transfer power from CSM to LM:	CSM crewman verifies CSM LM PWR sw - LM PWR. Lights may go out briefly due to momentary interruption of power as result of transfer. However, on-line equipment should suffer no degradation. All 10 indicator power fail lights go on. CB INST: CWEA - open, until end of step 7.
	16	CB EPS: XLUNAR BUS TIE - close	
	11	CB INST: SIG SENSOR - close PCM/TE - close SIG CONDR 2 - close	
		CB EPS: XLUNAR BUS TIE - close CB INST: SIG CONDR 1 - close	
	14	EPS: SE BAT 1 & 2 tb - LO CDR BAT 3 & 4 tb - LO DES BATS tb - gray BAT 5 NORMAL SE FEED tb - bp BAT 5 BACK UP CDR FEED tb - bp BAT 6 NORMAL CDR FEED tb - bp BAT 6 BACK UP SE FEED tb - bp	
	3	2. Turn on floodlights: LTG: FLOOD sw - ALL	
	14	3. Check d-c bus voltage: EPS: POWER/TEMP MON sel - CDR BUS VOLTS ind - 25.0 to 32.5 vdc	
	3	4. Activate RCS heaters: HTR CONT: RCS SYS A/B 2 QUAD 1, 2, 3, 4 sw - AUTO	
	11	CB HTR RCS SYS A/B 1: QUAD 1, 2, 3, 4 - close	
	16	CB HTR RCS SYS A/B 2: QUAD 1, 2, 3, 4 - close	

4.2.3 EPS ACTIVATION & CHECKOUT

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CREW- MAN	PNL	PROCEDURES	REMARKS
LMP		CAUTION Do not proceed to step 5 if voltage > 27 vdc. 5. Turn on high voltage: CAUTION High voltage of all four descent batteries should be turned on in rapid sequence to avoid possible reverse-current situation and triggering of BATTERY caution light.	
	14	EPS: SE BAT 1 LOW VOLT sw - OFF/RESET; tb - bp SE BAT 1 HI VOLT sw - ON; tb - gray Repeat for SE BAT 2, CDR BAT 3, & CDR BAT 4 VOLTS ind - 28.0 to 32.5 vdc (each battery)	
	11	6. Complete EPS activation: CB/AC BUS A: AC BUS VOLT - close CB/AC BUS B: BUS TIE INV 2 - close CB/AC BUS B: BUS TIE INV 1 - close CB/AC BUS A: BUS TIE INV 2 - close CB/AC BUS A: BUS TIE INV 1 - close CB EPS; INV 1 - close ASC ECA - close ASC ECA CONT - close	CB EPS: INV 1 is closed for checkout. Inverter draws power while this circuit breaker is closed.
	16	CB ED: LOGIC PWR A - close CB EPS: INV 2 - close ASC ECA - close ASC ECA CONT - close CB ED: LOGIC PWR B - close	
		7. Initial EPS check: Check descent batteries: EPS: POWER/TEMP MON sel - BAT 1 VOLTS ind - 28.0 to 32.5 vdc AMPS ind - TBD amp Repeat for BAT 2, BAT 3, and BAT 4.	

4.2.3 EPS ACTIVATION & CHECKOUT (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	16	Check d-c bus voltage & a-c power:	
	14	CB EPS: CROSS TIE BAL LOADS - open	
		EPS:	
		POWER/TEMP MON sel - CDR BUS	
		VOLTS ind - 28.0 to 32.5 vdc	
		POWER/TEMP MON sel - SE BUS	
		VOLTS ind - 28.0 32.5 vdc	
		POWER/TEMP MON sel - AC BUS	
		INVERTER sw - 1	
		VOLTS ind - green band	Green band represents 112 to 118 vac.
		INVERTER sw -2	
		VOLTS ind - green band	
	11	CB EPS: INV 1 - open	Opening CB EPS: INV 1 provides unnecessary power consumption.
	16	CB INST: CWEA - close	CWEA status indications are:
			CES AC warn lt - on
			CES DC warn lt - on
			PRE AMPS caut lt - on
			HEATER caut lt - on (quad temp < 120° F)
			H2OSEP comp caut lt - on
			GLYCOL comp caut lt - on
			GLYCOL caut lt - on (temp > 50° F)
			MASTER ALARM pb/lt - off (because CB LTG: MASTER ALARM is not closed)
			ECS caut lt - on (assuming ECS has not yet been activated)
	16	CB EPS: CROSS TIE BAL LOADS - close	
	14	8. Check ED batteries:	
		EPS:	
		POWER/TEMP MON sel - ED/OFF	
		ED VOLTS sw - BAT A	
		VOLTS ind - 35.0 to 37.1 vdc	
		ED VOLTS sw - BAT B	
		VOLTS ind - 35.0 to 37.1 vdc	
		4.2.4 CIRCUIT BREAKER ACTIVATION	
LMP	11	1. Verify following:	
		X pointer ind pwr fail lt - on	
		THRUST ind pwr fail lt - on	
		MPS: PRESS ind pwr fail lt - on	
		RNG/ALT ind pwr/sig fail lt - on	

4.2.3 EPS ACTIVATION & CHECKOUT/4.2.4 CIRCUIT BREAKER ACTIVATION

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	2	RCS: PRESS ind pwr fail lt - on QUANTITY ind pwr fail lt - on ECS: PRESS ind pwr fail lt - on GLYCOL ind pwr fail lt - on QUANTITY ind pwr fail lt - on X pointer ind pwr fail lt - on	
	11	2. Close all panel 11 CB's, except: CB/AC BUS B: S BD ANT - open AOT LAMP - open CB/AC BUS A: AOT LAMP - open RNDZ RDR - open CB ECS: GLYCOL PUMP 2 - open GLYCOL PUMP 1 - open GLYCOL PUMP AUTO TRNFR - open CB COMM: UP DATA LINK - open SEC S BD XMTR/RCVR - open SEC S BD PWR/AMPL - open CDR AUDIO - open CB PGNS: LDG RDR - open RNDZ RDR - open IMU OPR - open CB EPS: CROSS TIE BUS - open INV 1 - open	Closure order is left to right, top to bottom.
	8	3. Verify following: DES PROPUL: FUEL VENT tb - bp OXID VENT tb - bp ED: LDG GEAR DEPLOY tb - bp	
	1	THRUST ind pwr fail lt - off X pointer ind pwr fail lt - off MPS: PRESS ind pwr fail lt - off	Indicator power failure lights go off as circuit breaker for associated indicator power is closed.

4.2.4 CIRCUIT BREAKER ACTIVATION (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	16	4. Close all panel 16 CB's except: CB LTG: MASTER ALARM - open CB ECS: SUIT FLOW CONT - open SUIT/CABIN REPRESS - open CB COMM: SE AUDIO - open PRIM S BD PWR AMPL - open S BD ANT - open TV - open CB ECS: GLYCOL PUMP SEC - open CABIN REPRESS - open CB CAMR: SEQ - open CB EPS: CROSS TIE BUS - open	SUIT FAN camp caut lt goes on when CB ECS: SUIT FAN ΔP is closed.
	1	5. Verify following: ASC He REG 1 tb - gray ASC He REG 2 tb - gray DES He REG 1 tb - gray DES He REG 2 tb - bp	
	2	X pointer ind pwr fail lt - off RCS: PRESS ind pwr fail lt - off QUANTITY ind pwr fail lt - off ECS: PRESS ind pwr fail lt - off GLYCOL ind pwr fail lt - off QUANTITY ind pwr fail lt - off SYS A ASC FUEL tb - bp SYS A ASC OXID tb - bp SYS B ASC FUEL tb - bp SYS B ASC OXID tb - bp SYS A QUAD 1 tb - bp SYS A QUAD 4 tb - bp SYS A QUAD 2 tb - bp SYS A QUAD 3 tb - bp SYS B QUAD 1 tb - bp SYS B QUAD 4 tb - bp SYS B QUAD 2 tb - bp SYS B QUAD 3 tb - bp SYS A MAIN SOV tb - gray SYS B MAIN SOV tb - gray CRSFD tb - bp	RNG/ALT ind pwr/sig fail lt remains on due to lack of synchronization.

4.2.4 CIRCUIT BREAKER ACTIVATION (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR 11	LMP AOT	4.2.5 AOT LIGHTING CHECK 1. CB/AC BUS A: AOT LAMP - close 2. RETICLE BRIGHTNESS cont - decr, then incr, then adjust as desired	AOT RETICLE BRIGHTNESS control is on AOT housing. Lights are internal to AOT. The reticle seen through the AOT optics should light. In addition, the legends on the Computer Control & Reticle Dimmer (CCRD) box and the angle counter should illuminate. The AOT is now lighted and ready for immediate use. If immediate use is not planned: CB/AC BUS A: AOT LAMP - open
CDR 8		4.2.6 COAS LIGHTING CHECK 1. COAS sw - OVHD 2. COAS brightness cont - dim, then bright 3. COAS sw - OFF CAUTION Be careful when moving the COAS and mating connectors. The COAS is a fragile optical instrument. 4. Remove COAS from overhead position. 5. Set COAS detent for forward (left window) position. 6. Install COAS in forward position. 7. COAS sw - FWD 8. COAS brightness cont - dim, then bright 9. COAS sw - OFF 10. Remove COAS from forward position. 11. Set COAS detent for overhead position. 12. Install COAS in overhead mounting position.	

4.2.5 AOT LIGHTING CHECK/4.2.6 COAS LIGHTING CHECK

CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	3	4.2.7 LIGHTING ACTIVATION & CHECKOUT 1. LTG: SIDE PANELS sw - ON FLOOD sw - OVHD/FWD, then OFF, then ALL FLOOD cont (LMP) - BRIGHT, then DIM, then adjust as desired EXTERIOR LTG sel - TRACK, then DOCK, then OFF	LMP side panel light may be turned off after check, if desired.
CDR	5	2. LTG: FLOOD cont (CDR) - BRIGHT, then DIM, then adjust as desired ANUN/NUM cont - BRIGHT, then DIM OVERRIDE ANUN sw - ON, then OFF OVERRIDE NUM sw - ON, then OFF ANUN/NUM cont - adjust as desired INTEGRAL cont - BRIGHT, then DIM OVERRIDE INTEGRAL sw - ON, then OFF INTEGRAL cont - adjust as desired SIDE PANELS sw - ON	CDR's side panel light may be turned off after check, if desired.
LMP	16	4.2.8 CAUTION & WARNING ARRAY CHECKOUT 1. CB INST: CWEA - open 2. CB LTG: MASTER ALARM - close MASTER ALARM pb/lt (2) & tone - on 3. MASTER ALARM pb/lt - reset MASTER ALARM pb/lt (2) & tone - off 4. LTG: LAMP/TONE TEST sel - C/W 1 Left bank warn lt - on 5. LTG: LAMP/TONE TEST sel - ENG PB C/W 2 Left bank warn lt - off Right bank warn lt - on Eng START pb/lt - on Eng STOP pb/lt (2) - on	Passing through ALARM TONE position causes MASTER ALARM pb/lt and tone to go on, and then go off when C/W 1 position is reached.

4.2.7 LIGHTING ACTIVATION & CHECKOUT/4.2.8 CAUTION & WARNING ARRAY CHECKOUT

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	3	6. LTG: LAMP/TONE TEST sel - C/W 3	
	1	Right bank warn lt - off	
	2	Left bank caut lt - on	
	5	Eng START pb/lt - off	
	5 & 6	Eng STOP pb/lt (2) - off	
	3	7. LTG: LAMP/TONE TEST sel - C/W 4	
	2	Left bank caut lt - off	
		Right bank caut lt - on	
	3	8. LTG: LAMP/TONE TEST sel - COMPNT	
	2	Right bank caut lt - off	
	14	EPS: BAT FAULT comp caut lt - on	
	2	SUIT FAN comp caut lt - on	
		GLYCOL comp caut lt - on	
		CO2 comp caut lt - on	
	2	H2OSEP comp caut lt - on	
	3	RADAR: NO TRACK lt - on	
		LUNAR CONTACT lt (2) - on	
	2 & 3	9. LTG: LAMP/TONE TEST sel - OFF (cw)	
	& 14	All comp caut lt - off	
	16	10. CB INST: CWEA - close	
	1	CES AC warn lt - on	
		DES DC warn lt - on	
	2	PRE AMPS caut lt - on	
		ECS caut lt - on	
		GLYCOL caut lt - on (if glycol temp > 50°F)	
		HEATER caut lt - on (if quad temp < 120°F)	
		GLYCOL comp caut lt - on	
		H2OSEP comp caut lt - on	
		SUIT FAN comp caut lt - on	
		4.2.9 SET MISSION TIMER	
CDR	5	1. MSN TMR: TMR CONT sw - RESET SLEW CONT HOURS sw - TENS SLEW CONT HOURS sw - UNITS	

4.2.8 CAUTION & WARNING ARRAY CHECKOUT/4.2.9 SET MISSION TIMER

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR		2. Repeat step 1 for MSN TMR: SLEW CONT MIN & SLEW CONT SEC sw 3. MSN TMR: TMR CONT sw - START 4.2.10 AGS POWER UP 1. Set controls - G&C basic	20 seconds after CB S/C: AEA is closed the AEA can accept the CDU zero discrete and accumulate PGNCs Euler angle pulses.
LMP	1 & 2	2. AGS STATUS sw - STAND BY CAUTION Note time (or start EVENT TIMER) so that step 3 can be $\geq$ 25 minutes later. Degraded ASA performance if used without 25 minutes in STAND BY or OPERATE. 3. AGS STATUS sw - OPERATE MASTER ALARM pb/lt - reset 4. Key DEDA - Self test C 412R If +10000 not displayed Key DEDA C 412+00000E (repeat address 412 readout after 5 seconds. If +10000 not displayed, AGS operations are not recommended) 5. Key DEDA - Earth orbital altitude rate scaling C 455+10000E 6. Key DEDA - Descent section staging flag status C 574R Negative number = staged Positive number = unstaged If incorrect, key in appropriate discrete 7. Key DEDA - Lunar surface flag status C 604R Negative number = lunar surface Positive number = not lunar surface If incorrect, key in appropriate number	

4.2.9 SET MISSION TIMER/4.2.10 AGS POWER UP

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP		8. Key DEDA - Staging sequence counter status C 612R If +00000 not displayed Key DEDA C 612 +0000E 4.2.11 PGNCS STARTUP PROGRAM (P05)	
	11	1. CB PGNS: IMU STBY - close LGC/DSKY - close 2. If LGC is not in standby (STBY lt - out), proceed to step 4. 3. Set LGC to operate mode Key PRO STBY lt - out Previous program displayed (P06) RSET pb - push 4. Key V37E 05E 5. FL V50 N25 - Checklist R1 00060 - Turn ISS on R2 ----- R3 ----- Accept: CB PGNS: IMU OPR - close NO ATT lt - on (for 90 seconds) NO ATT lt - out Wait 4 seconds Key PRO Reject: Key ENTR	
	11	6. Set controls - G&C basic 7. FL V50 N07 - Perform program change CAUTION If it is necessary to power up the IMU with the LGC in standby or off: CB PGNS: IMU OPR - close; wait 90 seconds, then set IMU CAGE sw - ON for 5 seconds.	

4.2.10 AGS POWER UP/4.2.11 PGNCS STARTUP PROGRAM (P05)

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP		4.2.12 ECS ACTIVATION & CHECKOUT 1. Via communications hardline, request verification of the following: Crossover solenoid vlv - open Primary evap flow solenoid vlv - close 2. O2/H2O QTY MON sel - DES ECS: O2 QUANTITY ind - 100% H2O QUANTITY ind - 100% 3. O2/H2O QTY MON sel - ASC 1 ECS: O2 QUANTITY ind - 100% H2O QUANTITY ind - 100% 4. O2/H2O QTY MON sel - ASC 2 ECS: O2 QUANTITY ind - 100% H2O QUANTITY ind - 100% 5. O2/H2O QTY MON sel - DES 16 6. CB ECS: GLYCOL PUMP SEC - close CAUTION Primary pumps should not be off for longer than 2 minutes while primary sublimator is activated or primary sublimator could freeze and fail. 7. CB ECS: GLYCOL PUMP SEC - open 11 8. CB ECS: GLYCOL PUMP 1 - close 2 9. GLYCOL sel - PUMP 1 ECS: GLYCOL press ind - 15 to 45 psia GLYCOL comp caut lt - off ECS: GLYCOL temp ind - TBD 11 10. CB ECS: GLYCOL PUMP 2 - close 11. CB ECS: GLYCOL PUMP AUTO TRNFR - close	SEC GLYCOL PUMP must be checked by having MSFN monitor rpm. Monitoring secondary HTS necessitates turning off primary HTS pumps. Activation of primary HTS is initiated. This temperature should be high enough to ensure safe operation.

4.2.12 ECS ACTIVATION & CHECKOUT

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	11	12. CB ECS: GLYCOL PUMP 1 - open	This simulates pump No. 1 failure.
	1 & 2 2	13. MASTER ALARM pb/lt - on GLYCOL comp caut lt - on	
		14. MASTER ALARM pb/lt - reset	This temperature should be high enough to ensure safe operation.
		15. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp - ind - TBD	
		16. GLYCOL sel - PUMP 2	
		17. GLYCOL comp caut lt - off	
		18. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - TBD	MASTER ALARM pb/lt and GLYCOL comp caut lt may go on momentarily. If this occurs, reset MASTER ALARM pb/lt.
	11	19. CB ECS: GLYCOL PUMP AUTO TRNFR - open GLYCOL PUMP 1 - close	
	2	20. GLYCOL sel - PUMP 1	
		21. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - TBD	
	11	22. CB ECS: GLYCOL PUMP AUTO TRNFR - close	Activation of water management section.
ECS		23. CABIN GAS RETURN vlv - AUTO	
		24. PRIM EVAP FLOW sw - OPEN (momentarily)	
		25. Via communications hardline, verify: Primary evap flow solenoid vlv - open	
	2	26. ECS: GLYCOL temp ind - 32° to 50° F	
ECS		27. On SUIT ISOL vlv (LMP): ACTUATOR OVRD - PULL ACT	

4.2.12 ECS ACTIVATION & CHECKOUT (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	ECS	28. SUIT ISOL vlv (LMP) - SUIT DISCONN 29. On SUIT ISOL vlv (CDR): ACTUATOR OVRD - PULL ACT 30. SUIT ISOL vlv (CDR) - SUIT DISCONN 31. DES O2 vlv - OPEN 32. PRESS REG A vlv - EGRESS 33. PRESS REG B vlv - EGRESS	
	2	34. ECS: SUIT press ind - 5 ± 0.2 psia 35. SUIT FAN sel - 1 36. ECS: PART PRESS CO2 ind - 0 mm Hg 37. SUIT FAN comp caut lt - off 38. H2O SEP comp caut lt - off 39. ECS caut lt - off 4.2.13 LMP CONNECT TO LM ECS	CSM O2 supply is 5 ± 0.2 psia. ECS caut lt and H2O SEP comp caut lt go off when SEP comes up to speed. Time is approximately 1 minute when dry; approximately 15 minutes when wet.
LMP	ECS	1. Unstow O2 umbilical. 2. Remove plugs from PGA and stow.	
	PGA	3. Connect O2 umbilical to right side of PGA.	
	ECS	4. SUIT ISOL vlv (LMP) - SUIT FLOW 5. Request CSM shut off O2 flow in transfer umbilical. 6. Verify O2 flow to PGA from LM ARS.	

4.2.12 ECS ACTIVATION & CHECKOUT/4.2.13 LMP CONNECT TO LM ECS

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP		4.2.14 LMP VHF ACTIVATION & CHECKOUT 1. Request CSM set LMP Audio Panel Suit PWR sw - OFF 2. When headset sounds cease, disconnect transfer umbilical comm cable from PGA and connect LM comm cable to PGA. 16 2. CB COMM: SE AUDIO - close 12 4. COMM: VHF A XMTR sw - ON VHF A RCVR sw - ON VHF B XMTR sw - DATA RECORDER sw - as desired 5. COMM ANT: VHF sel - 1/PLSS TEST or 2, as required 6. Unstow LMP outboard armrest. 12 7. AUDIO: VHF A sw - T/R 8. Perform comm check with CSM, using PTT on ACA. 9. Request verification of CSM reception of LM LBR data. 10. Perform comm check with CSM, using PTT/keyer on umbilical. 12 11. AUDIO: VOX sw - ICS/XMTR 12. Perform comm check with CSM, using VOX. 13. AUDIO: VOX sw - ICS	Assumptions: (1) ECS Initial Activation and checkout was completed and (2) crewman is connected to LM ECS. Immediately after VHF Activation & Checkout, crewman must disconnect from transfer O2 umbilical. CSM removes transfer umbilical comm cable power, and enables VHF-AM Simplex A. CSM prepare to record LBR data from LM. VHF transceiver warmup time - fractions of a second. VHF 1/PLSS TEST selects aft antenna and VHF 2 selects forward antenna. Selection of 1 or 2 depends upon which antenna has the better view of the CSM. MSFN may also receive LM crewman's voice via VHF when in LOS. CSM reception of LM LBR data is verified as follows: CSM receives data via VHF B, data is recorded on DSE, recorded data is dumped to MSFN, where it is again recorded and then played back. (CSM has no onboard verification capability.) Audio volume and squelch control settings should be adjusted, as necessary, for best results under mission conditions.

4.2.14 LMP VHF ACTIVATION & CHECKOUT

CREW-MAN	PNL	PROCEDURES	REMARKS
LMP		4.2.15 LMP DISCONNECT TRANSFER UMBILICAL 1. Disconnect transfer umbilical O2 connectors from PGA. 2. Remove PGA O2 receptacle plugs from LMP's O2 umbilical stowage mounting plate and insert in left side PGA O2 receptacles. 3. Release restraints from PGA. 4. Return transfer umbilical to CSM. 5. Return to flight station and attach restraints to PGA.	
CDR		4.2.16 CDR INTRAVEHICULAR TRANSFER TO LM 1. Enter LM cabin, head first and facing forward. 2. Maneuver into cabin above ascent engine cover, grasp assist bar forward of hatch fitting in LM ceiling, pull self into cabin and walk backward down open hatch, ascent engine cover, and mid-section bulkhead until feet are on cabin floor. 3. Stand in flight station, face forward, and attach restraints. 4. Unstow O2 umbilical. 5. Remove plugs from right side O2 receptacles and stow in CDR's O2 umbilical stowage mounting plate. 6. Connect O2 umbilical to right side of PGA. 7. SUIT ISOL vlv (CDR) - SUIT FLOW 8. Request CSM shut off O2 flow in transfer umbilical. 9. Verify O2 flow to PGA from LM ARS.	

4.2.15 LMP DISCONNECT TRANSFER UMBILICAL/4.2.16 CDR INTRAVEHICULAR TRANSFER TO LM

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.2.17 CDR VHF ACTIVATION & CHECKOUT	Assumption: crewman is connected to LM ECS. Immediately after activation and checkout, crewman must disconnect from transfer O2 umbilical.
CDR		1. Request CSM set LMP Audio Panel Suit PWR sw - OFF	CSM removes transfer umbilical comm cable power.
		2. When headset sounds cease, disconnect transfer umbilical comm cable from PGA and connect LM comm cable to PGA.	
LMP	11 8 12	3. CB COMM: CDR AUDIO - close AUDIO: ICS sw - ICS T/R AUDIO: ICS sw - ICS T/R	Use PTT/keyer on umbilical for part of check and PTT on ACA for remainder of check, to ensure complete comm check.
CDR		4. Unstow CDR's inboard armrest.	
CDR LMP		5. Perform intercom check.	Audio volume and squelch control settings should be adjusted, as necessary, for best results under mission conditions.
CDR	8	AUDIO: VHF A sw - T/R	
		6. Perform VHF comm check with CSM, using PTT.	MSFN may also receive LM crewman's voice v' a VHF when in LOS.
	8	7. AUDIO: VOX sw - ICS/XMTR	
		8. Perform comm check with CSM, using VOX	
	8	9. AUDIO: VOX sw - ICS	
		4.2.18 CDR DISCONNECT TRANSFER UMBILICAL	
CDR		1. Disconnect transfer umbilical O2 connectors from PGA.	
		2. Remove PGA O2 receptacle plugs from CDR's O2 umbilical stowage mounting plate and insert in left side PGA O2 receptacles.	
		3. Release restraints from PGA.	
		4. Return transfer umbilical to CSM.	
		5. Return to flight station and attach restraints to PGA.	

4.2.17 CDR VHF ACTIVATION & CHECKOUT/4.2.18 CDR DISCONNECT TRANSFER UMBILICAL

CREW-MAN	PNL	PROCEDURES	REMARKS
		4.2.19 ARS/PGA PRESSURE INTEGRITY CHECK CAUTION To prevent overheating of the suit circuit fan and/or breakthrough in the primary heat transport section sublimator, the ARS/PGA shall not be maintained at elevated pressure for more than 5 minutes.	ARS/PGA pressure integrity check verifies no gross leaks in ARS or either PGA/EMU. On-board instrumentation (ECS: SUIT PRESS indicator and PGA pressure gage) is too coarse to determine exact leak rates. Crewman must remain stationary while monitoring pressure decay to preclude PGA cuff gage fluctuation.
LMP	ECS	1. SUIT GAS DIVERTER vlv - PULL EGRESS	
		2. CABIN GAS RETURN vlv - EGRESS	
		3. SUIT CIRCUIT RELIEF vlv - CLOSE	
	2	4. O2/H2O QTY MON sel - DES	
		5. ECS: O2 QUANTITY ind - monitor	If ECS: O2 QUANTITY ind reads < 30%, set PRESS REG A vlv to DIRECT O2 to limit time to pressurize to 2 minutes. Both regulators should then be set to CLOSE at step 8. If ECS: O2 QUANTITY ind is < 17%, do not depressurize cabin.
	ECS	6. PRESS REG A vlv - CLOSE	
		7. PRESS REG B vlv - DIRECT O2	PRESS REG B vlv may be cycled between CABIN and DIRECT O2 to permit comfortable buildup of pressure.
	PGA ECS	8. When PGA cuff gage reads 3.7 to 4.0 psig: PRESS REG B vlv - CLOSE	
	PGA	9. Monitor PGA cuff gage for 60 seconds and verify decay < 0.1 psi.	If suit pressure decay is excessive: SUIT CIRCUIT RELIEF vlv - AUTO CABIN GAS RETURN vlv - AUTO PRESS REG A vlv - EGRESS PRESS REG B vlv - EGRESS
	ECS	10. CO2 CANISTER SEL vlv - SEC	CO2 comp caut It goes on when CO2 CANISTER SEL vlv is in SEC position. Pressure drop can be expected when switching between CO2 canisters, due to volume change.
		11. Repeat steps 7 and 8 if pressure falls below 3.7 psig.	
		12. Repeat step 9.	

4.2.19 ARS/PGA PRESSURE INTEGRITY CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	ECS	13. CO2 CANISTER SEL vlv - PRIM	CO2 comp caut lt goes off when CO2 CANISTER SEL vlv is returned to PRIM.
		14. SUIT CIRCUIT RELIEF vlv - AUTO	
	2	15. Monitor ECS: SUIT PRESS ind decay to cabin pressure.	CSM O2 supply makeup is 5.0±0.2
	ECS	16. CABIN GAS RETURN vlv - AUTO	
		17. PRESS REG A vlv - EGRESS	
		18. PRESS REG B vlv - EGRESS	PRESS REG A & B vlv will be returned to CABIN position if ARS/PGA Pressure Integrity Check is performed in undocked configuration.
		4.2.20 SUIT FAN CHECK	
	2	1. SUIT FAN sel - 1	
	16	2. CB ECS: SUIT FAN 2 - open	
	11	3. CB ECS: SUIT FAN 1 - open	MASTER ALARM pb/lt goes on and circulation of O2 to PGA's stops.
	2	4. MASTER ALARM pb/lt - on ECS caut lt - on H2OSEP comp caut lt - on SUIT FAN comp caut lt - on MASTER ALARM pb/lt - reset SUIT FAN sel - 2	ECS caut lt and SUIT FAN and H2O SEP comp caut lt remain on.
	1	5. MASTER ALARM pb/lt - on SUIT/FAN warn lt - on MASTER ALARM pb/lt - reset	
	16	6. CB ECS: SUIT FAN 2 - close	O2 flow to PGA starts.
	1	7. SUIT/FAN warn lt - off ECS caut lt - off SUIT FAN comp caut lt - off H2OSEP comp caut lt - off	

4.2.19 ARS/PGA PRESSURE INTEGRITY CHECK/4.2.20 SUIT FAN CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	11	8. CB ECS: SUIT FAN 1 - close	MASTER ALARM pb/lt, ECS caut lt, H2O SEP and/or SUIT FAN comp caut lt may go on momentarily until suit fan No. 1 comes up to speed. If this occurs, reset MASTER ALARM pb/lt.
	2	9. SUIT FAN sel - 1	
		4.2.21 GLYCOL PUMP CHECK	
LMP	16	1. CB ECS: GLYCOL PUMP SEC - close CAUTION Primary pumps should not be turned off for longer than 2 minutes while primary sublimator is activated or primary sublimator could freeze and fail.	SEC GLYCOL PUMP must be checked by having MSFN monitor RPM. Monitoring secondary HTS necessitates turning off primary HTS pumps.
	2	2. GLYCOL sel - INST (SEC) MASTER ALARM pb/lt - on ECS caut lt - on GLYCOL comp caut lt - on MASTER ALARM pb/lt - reset	If GLYCOL PUMP SEC is not checked, omit steps 1 thru 3 and step 5.
	16	3. CB ECS: GLYCOL PUMP SEC - open	
	2	4. GLYCOL sel - PUMP 1 5. ECS caut lt - off GLYCOL comp caut lt - off	
CDR	11	6. CB ECS: GLYCOL PUMP 2 - close GLYCOL PUMP 1 - close GLYCOL PUMP AUTO TRNFR - close	
LMP	2	7. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - 32° to 50° F	
	11	8. CB ECS: GLYCOL PUMP 1 - open	This simulates pump No. 1 failure.

4.2.20 SUIT FAN CHECK/4.2.21 GLYCOL PUMP CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	2	9. MASTER ALARM pb/lt - on ECS caut lt - on (momentarily) GLYCOL comp caut lt - on MASTER ALARM pb/lt - reset ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - 32° to 50° F GLYCOL sel - PUMP 2 GLYCOL comp caut lt - off ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - 32° to 50° F	
CDR	11	10. CB ECS: GLYCOL PUMP AUTO TRNFR - open GLYCOL PUMP 1 - close	
LMP	2	11. GLYCOL sel - PUMP 1	MASTER ALARM pb/lt, ECS caut lt, and GLYCOL comp caut lt may go on momentarily. If this occurs, reset MASTER ALARM pb/lt.
		12. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - 32° to 50° F	
CDR	11	13. CB ECS: GLYCOL PUMP AUTO TRNFR - close	
		4.2.22 WATER SEPARATOR CHECK	
LMP	ECS	1. WATER SEP SEL vlv - PULL SEP 2	
	1 & 2	2. MASTER ALARM pb/lt - on	
	2	ECS caut lt - on	
		H2OSEP comp caut lt - on	
CDR		MASTER ALARM pb/lt - reset	
		ECS caut lt - off	
		H2OSEP comp caut lt - off	
LMP	ECS	3. WATER SEP SEL vlv - PUSH SEP 1	ECS caut lt and H2O SEP comp caut lt go off when selected water separator comes up to speed at approximately 1 minute when dry and approximately 15 minutes when wet.

4.2.21 GLYCOL PUMP CHECK/4.2.22 WATER SEPARATOR CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	2	4. MASTER ALARM pb/lt - on ECS caut lt - on H2OSEP comp caut lt - on MASTER ALARM pb/lt - reset ECS caut lt - off H2OSEP comp caut lt - off	
CDR			
		4.2.23 VHF B SIMPLEX CHECK	Communications checkout should be performed in the given sequence to maximize efficiency and end up with the communications basic configuration.
LMP		1. Request CSM switch to VHF-AM Simplex B (on mark).	MSFN may also receive LM crewman's voice via VHF when in LOS.
	16	2. Verify CB COMM: VHF B RCVR - close	
	12	3. COMM: VHF A XMTR sw - OFF VHF A RCVR sw - OFF VHF B XMTR sw - VOICE VHF B RCVR sw - ON	
CDR & 8 & 12 LMP		4. AUDIO: VHF A sw - OFF VHF B sw - T/R	
		5. Perform comm check with CSM.	Adjust volume and squelch controls as necessary.
LMP		6. CSM return to VHF AM Simplex A (on mark).	
CDR & 8 & 12 LMP		7. AUDIO: VHF A sw - T/R VHF B sw - OFF	
LMP	12	8. COMM: VHF A XMTR sw - ON VHF A RCVR sw - ON VHF B XMTR sw - DATA VHF B RCVR sw - OFF	
CDR & LMP		9. Perform comm check with CSM.	

4.2.22 WATER SEPARATOR CHECK/4.2.23 VHF B SIMPLEX CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	12	4.2.24 S-BAND ACTIVATION & CHECKOUT, USING OMNI ANTENNA 1. COMM ANT: S BAND sel - 1 or 2	S-BAND 1 selects forward antenna and S-BAND 2 selects aft antenna. Selection of 1 or 2 position is dependent upon vehicle attitude with respect to earth.
CDR & LMP	8 & 12	2. AUDIO: S-BAND T/R sw - S BAND T/R	
	12	3. COMM: S BAND XMTR/RCVR sw - PRIM S BAND VOICE sw - VOICE S BAND PCM sw - PCM TLM PCM sw - HI	S-band transceiver warmup time is 30 seconds after power on.
CDR & LMP		4. Perform S-band voice and data check with MSFN.	SIGNAL STRENGTH ind is applicable as indication of uplink phase lock.
LMP	12	5. AUDIO: VHF B XMTR sw - OFF 6. Inform CSM of VHF B data transmission deactivation.	Adjust volume and squelch controls as necessary. CSM will deactivate LBR data recording.
		4.2.25 S-BAND RANGING CHECK	
LMP	12	1. COMM: S BAND RANGE sw - RANGE 2. Verify range check complete with MSFN. 3. When directed by MSFN: COMM: S BAND RANGE sw - OFF/RESET	Ranging checks are performed at MSFN direction. Check consists of transmission of PRN range code from MSFN and receipt of turnaround signal.
		4.2.26 SECONDARY S-BAND TRANSCEIVER & POWER AMPLIFIER CHECK	
CDR	11	1. CB COMM: SEC S BD XMTR/RCVR - close SEC S BD PWR/AMPL - close	
LMP	16	2. CB COMM: PRIM S BD PWR AMPL - close	

4.2.24 S-BAND ACTIVATION & CHECKOUT, USING OMNI ANTENNA/4.2.25 S-BAND RANGING CHECK/
4.2.26 SECONDARY S-BAND TRANSCEIVER & POWER AMPLIFIER CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	12	3. COMM: S BAND XMTR/RCVR sw - SEC 4. Perform S-band voice and HBR data check with MSFN. 5. COMM: S BAND PWR AMPL sw - SEC 6. Perform S-band voice and HBR data check with MSFN. 7. COMM: S BAND PWR AMPL sw - PRIM 8. Perform S-band voice and HBR data check with MSFN. 9. COMM: S BAND PWR AMPL sw - OFF TLM PCM sw - LO 10. Perform S-band voice and LBR data check with MSFN. 11. COMM: S BAND XMTR/RCVR sw - PRIM 4.2.27 S-BAND FM CHECK	S-band transceivers require 30-second warmup time. S-band power amplifiers require 60-second warmup time and 0.5 second to lockup. MSFN verify power increase with PWR AMPL in operation.
LMP	12	1. COMM: S BAND MODULATE sw - FM 2. Perform S-band voice and LBR data check with MSFN. 3. COMM: TLM PCM sw - HI 4. Perform S-band voice and HBR data check with MSFN. 5. COMM: S BAND MODULATE sw - PM 6. Perform S-band voice and HBR data check with MSFN.	S-band transceiver warmup time is 5 seconds after change of modulation.

4.2.26 SECONDARY S-BAND TRANSCEIVER & POWER AMPLIFIER CHECK/4.2.27 S-BAND FM CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	12	4.2.28 S-BAND BACKUP VOICE & KEYING CHECK - COMM: S BAND VOICE sw - VOICE BU S BAND PCM sw - OFF TLM BIOMED sw - OFF - Perform S-band voice check with MSFN. - COMM: S BAND PCM sw - KEY - Perform code check with MSFN, using PTT/keyer on umbilical. - COMM: S BAND PCM sw - PCM TLM PCM sw - LO - Perform S-band voice and LBR data check with MSFN. - COMM: S BAND VOICE sw - VOICE TLM PCM sw - HI TLM BIOMED sw - as required - Perform S-band voice and HBR data check with MSFN. 4.2.29 ASCENT BATTERY ACTIVATION & CHECKOUT	
LMP	14	Place both ascent batteries on line: CAUTION Verify that high-voltage tap of descent batteries has been selected before placing ascent batteries on line. EPS: BAT 5 NORMAL SE FEED sw - ON; tb - gray POWER/TEMP MON sel - BAT 5 VOLTS ind - 28.0 to 32.5 vdc AMPS ind - TBD amp BAT 6 NORMAL CDR FEED sw - ON; tb - gray	Load of 40 amperes should be on line before performing this task.

4.2.28 S-BAND BACKUP VOICE & KEYING CHECK/4.2.29 ASCENT BATTERY ACTIVATION & CHECKOUT

CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	1	3. HELIUM MON sel - SUPCRIT PRESS 4. MPS: HELIUM ind - 624 to 1120 psia 5. HELIUM MON sel - TEMP 1 6. MPS: HELIUM ind - 70° F 7. HELIUM MON sel - TEMP 2 8. MPS: HELIUM ind - 70° F 9. HELIUM MON sel - PRESS 1 10. MPS: HELIUM ind - 3020 psia 11. HELIUM MON sel - PRESS 2 12. MPS: HELIUM ind - 3020 psia 13. HELIUM MON sel - AMB PRESS 14. PRPLNT TEMP/PRESS MON sw - DES 1 MPS: FUEL TEMP ind - 70° F OXID TEMP ind - 70° F FUEL PRESS ind - 150 psia OXID PRESS ind - 150 psia	This pressure range is based upon supercritical helium loading temperature of -453° F and mass of 48 pounds at 80 psia. The specific pressure before pressurization is function of total elapsed time from tank loading to pressurization, multiplied by expected pressure rise of 6 to 10 psia/hr. For other tank pressures, refer to table 4-2. Ascent helium tank operating temperature range is +30° to +140° F. Ascent helium tank pressure values, as a function of time, will remain approximately the same as initial tank loading conditions. For expected tank pressure values, as a function of tank temperature and initial loading condition, refer to table 4-3. ASC PRESS warn lt goes on at helium tank pressure of 2773 psia. Nominal propellant tank pressure, before pressurization, is expected to be approximately 150 psia at +70° F.

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	1	15. PRPLNT TEMP/PRESS MON sw - DES 2 MPS: FUEL TEMP ind - 70° F OXID TEMP ind - 70° F FUEL PRESS ind - 150 psia OXID PRESS ind - 150 psia 16. PRPLNT TEMP/PRESS MON sw - ASC MPS: FUEL TEMP ind - 70° F OXID TEMP ind - 70° F FUEL PRESS ind - 134 psia OXID PRESS ind - 145 psia 17. PRPLNT TEMP/PRESS MON sw - DES 1 18. PRPLNT QTY MON sw - DES 2 MPS: OXID QUANTITY ind - 95% FUEL QUANTITY ind - 95% 19. PRPLNT QTY MON sw - DES 1 MPS: OXID QUANTITY ind - 95% FUEL QUANTITY ind - 95% 20. PRPLNT QTY MON sw - OFF 21. DES He REG 1 tb - gray 22. DES He REG 2 tb - bp	Propellant tank operating temperature range is +50° to +90° F. The corresponding tank pressure range is 100 to 205 psia. The overall PQGS uncertainty during DPS operation, excluding any ground station telemetry error for an earth orbital mission will be ±1.3% of full tank capacity, except in the range of 8% to 25% propellant quantities, where the overall uncertainty is reduced to ±1.0%.
CDR	8	23. DPS pressurization: ED: MASTER ARM sw - ON DES PRPLNT ISOL VLV sw - FIRE DES START He PRESS sw - FIRE MASTER ARM sw - OFF	
LMP	1	HELIUM MON sel - AMB PRESS HELIUM ind - 350 to 1750 psia	If propellant tank ullage pressure is low just prior to ambient helium pressurization, pressure reading for ambient helium tank should drop in proportion to propellant tank pressure increase.

4.2.30 DPS/APS TEMP/PRESS CHECK & DPS PRESS CHECK (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	1	HELIUM MON sel - SUPCRIT PRESS MPS: HELIUM ind - 624 to 1750 psia PRPLNT TEMP/PRESS MON sw - DES 1 MPS: FUEL TEMP ind - 70° F OXID TEMP ind - 70° F FUEL PRESS ind - 252 psia OXID PRESS ind - 252 psia PRPLNT TEMP/PRESS MON sw - DES 2 MPS: FUEL TEMP ind - 70° F OXID TEMP ind - 70° F FUEL PRESS ind - 252 psia OXID PRESS ind - 252 psia PRPLNT TEMP/PRESS MON sw - DES 1	Propellant tank operating pressure range is 242 to 252 psia.

Table 4-1. Theoretical Descent Ambient Helium Bottle Loading

He Tank Loading (Prepress)	He Tank Temp (° F)	Expected He Tank Press (psia)
Minimum 1.00 lb (mass)	30	1310
	50	1400
	70	1470
	100	1600
Nominal 1.06 lb (mass)	30	1440
	50	1500
	70	1570
	100	1670
Maximum 1.12 lb (mass)	30	1550
	50	1610
	70	1670
	100	1750

Table 4-2. Supercritical Helium Pressure Before Pressurization

	Nominal Mission (psi)	Maximum Mission (psi)
Maximum (10 psi/hr)	760	1380
Nominal (8 psi/hr)	624	1120
Minimum (6 psi/hr)	488	860

Table 4-3. Ascent Helium Loading

Ascent He Tank Loading	He Tank Temp (° F)	Expected He Tank Press (psia)
Nominal 6.5 lb (mass)	30	2800
	40	2860
	60	2970
	70	3020
	90	3130
	110	3240
	120	3300
	140	3400

CREW-MAN	PNL	PROCEDURES	REMARKS
		4.2.31 RCS COLD FIRING CHECK OF PRIMARY COILS 1. Set controls G&C basic except: GUID CONT sw - AGS ENG THR CONT: X TRANSL sw - 4 JETS S/C: ROLL sw - MODE CONT PITCH sw - MODE CONT YAW sw - MODE CONT MODE CONTROL sel - ATT HOLD THROTTLE/JETS cont (CDR) - JETS 2. ACA (CDR) - Yaw right to soft stop for 1 second, release 3. ACA (CDR) - Yaw left to soft stop for 1 second, release 4. ACA (CDR) - Pitch up to soft stop for 1 second, release 5. ACA (CDR) - Pitch down to soft stop for 1 second, release 6. ACA (CDR) - Roll right to soft stop for 1 second, release 7. ACA (CDR) - Roll left to soft stop for 1 second, release 8. TTCA (CDR) - Move up for 1 second, release 9. TTCA (CDR) - Move down for 1 second, release 10. TTCA (CDR) - Move right for 1 second, release 11. TTCA (CDR) - Move left for 1 second, release 12. TTCA (CDR) - Push forward for 1 second, release 13. TTCA (CDR) - Pull aft for 1 second, release 14. Verify MSFN receipt of telemetry data 15. Repeat steps 2 through 13 with ACA (LMP) and TTCA (LMP)	This procedure must be performed during LM communications, LOS with MSFN tracking stations, to verify electrical continuity between the ACA's, TTCA's and jet driver output commands via telemetry data. This procedure is performed before RCS pressurization tasks.

4.2.31 RCS COLD FIRING CHECK OF PRIMARY COILS

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CREW-MAN	PNL	PROCEDURES	REMARKS
		16. Verify MSFN receipt of telemetry data 17. Return controls to G&C basic 4.2.32 RCS PRESSURIZATION	Warm-up time for RCS thrusters prior to firing is approximately 1 hour following a 5 hour cold soak with both sets of heaters operating and 3.2 hours if only one set is operating.
	3	1. HTR CONT: TEMP MON sel - RCS QUAD 1, 2, 3, 4 TEMP ind - 120° to 190° F (for each quad)	
	2	2. RCS: A QUANTITY ind - 100% B QUANTITY ind - 100% 3. RCS: TEMP/PRESS MON sel - He A and B PRESS ind - 2775 to 3325 psia 4. RCS: TEMP/PRESS MON sel - PRPLNT A and B TEMP ind - 40° to 100° F A and B PRESS ind - 25 to 30 psia 5. RCS: TEMP/PRESS MON sel - FUEL MANF A and B PRESS ind - 28 to 130 psia 6. RCS: TEMP/PRESS MON sel - OXID MANF A and B PRESS ind - 28 to 130 psia 7. RCS: TEMP/PRESS MON sel - FUEL MANF A PRESS ind - record initial pressure indication 8. RCS: TEMP/PRESS MON sel - OXID MANF A PRESS ind - record initial pressure indication	CB RCS: PQGS must be closed for approximately 1 minute before reading, to obtain valid reading. The quantity display will remain at 100% until the propellants in the lines are used. The overall quantity accuracy (including the Propellant Quantity Measuring Device accuracy) is <u>+9%</u>. Record pressures from steps 7 thru 10 in table A-4.

4.2.31. RCS COLD FIRING CHECK OF PRIMARY COILS (cont)/4.2.32 RCS PRESSURIZATION

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CREW-MAN	PNL	PROCEDURES	REMARKS
		9. RCS: SYS A QUAD 1 sw - OPEN; tb - gray A PRESS ind - check decrease	Pressure should decrease (approximately 7 psi) as each thruster pair isolation valve is opened. A false position indication occurs whenever a redundant command is given to the Parker Latching Solenoid Valve. For example, a close command to a closed valve, results in an open indication until the removal of the command.
		10. RCS: TEMP/PRESS MON sel - FUEL MANF A PRESS ind - check decrease	
		11. Repeat steps 7 thru 10 for RCS: SYS A QUAD 2, QUAD 3, and QUAD 4.	When all fuel isolation valves for system A have been opened, pressure should be approximately 28 psia below value recorded in step 7.
		12. Repeat steps 7 thru 11 for RCS: SYS B QUAD 1, QUAD 2, QUAD 3, and QUAD 4, reading RCS: B PRESS ind.	
		13. Verify FUEL MANF pressure A & B is approximately 28 psi below initial value of step 7.	
		14. RCS: TEMP/PRESS MON sel - OXID MANF	
		15. Verify OXID MANF pressure A & B is approximately 24.5 psi below reading of step 8.	
	8	16. ED: MASTER ARM sw - ON RCS He PRESS sw - FIRE MASTER ARM sw - OFF	RCS pressurization.
	2	17. RCS: TEMP/PRESS MON sel - OXID MANF A & B PRESS ind - 181 ± 3 psia	Nominal fuel and oxidizer operating pressure ranges are 178 to 188 psia.
		18. RCS: TEMP/PRESS MON sel - FUEL MANF A & B PRESS ind - 181 ± 3 psia	
		19. RCS: TEMP/PRESS MON sel - PRPLNT A & B TEMP ind - 40° to 100° F A & B PRESS ind - 181 ± 3 psia	

4.2.32 RCS PRESSURIZATION (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS																																																													
	2	20. RCS: TEMP/PRESS MON sel - He A & B PRESS ind - 2925 to 3175 psia Table 4-4. RCS Pressurization Record <table><tr><th rowspan="3"></th><th colspan="4">FUEL MANF</th><th colspan="4">OXID MANF</th></tr><tr><th colspan="2">Initial Pressure</th><th colspan="2">Pressure Decrease</th><th colspan="2">Initial Pressure</th><th colspan="2">Pressure Decrease</th></tr><tr><th>A</th><th>B</th><th>A</th><th>B</th><th>A</th><th>B</th><th>A</th><th>B</th></tr><tr><td>QUAD 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>QUAD 2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>QUAD 3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>QUAD 4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>		FUEL MANF				OXID MANF				Initial Pressure		Pressure Decrease		Initial Pressure		Pressure Decrease		A	B	A	B	A	B	A	B	QUAD 1									QUAD 2									QUAD 3									QUAD 4									Nominal He tank pressure reading before pressurization is 3050 psia at +70° F.
	FUEL MANF				OXID MANF																																																											
	Initial Pressure			Pressure Decrease		Initial Pressure		Pressure Decrease																																																								
	A	B	A	B	A	B	A	B																																																								
QUAD 1																																																																
QUAD 2																																																																
QUAD 3																																																																
QUAD 4																																																																
	3	4.2.33 RCS HOT FIRING CHECK OF PRIMARY COILS 1. Set controls to G&C basic except: S/C: MODE CONTROL sel - ATT HOLD	This task is performed to check functional continuity of ACA, TTCA, primary coils, and RCS thrusters. Caution and Warning array checkout completed. Task occurs before LM/CSM separation; and after RCS pressurization completed.																																																													
		2. Verify CSM has attitude control disabled																																																														
	11	3. CB RCS SYS A: QUAD 4 TCA - open QUAD 3 TCA - open QUAD 2 TCA - open 4. Verify CB RCS SYS A: QUAD 1 TCA - close																																																														

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CREW-MAN	PNL	PROCEDURES	REMARKS
	16	5. CB RCS SYS B: QUAD 1 TCA - open QUAD 3 TCA - open QUAD 4 TCA - open	
		6. Verify CB RCS SYS B: QUAD 2 TCA - close	
		7. ACA (CDR) - Yaw left to soft stop for 1 second, release	
1 & 2		8. Verify MASTER ALARM pb/lt - off Verify alarm tone - off Verify RCS TCA warn lt - off	
		CAUTION If any jet fails to fire upon command, the MASTER ALARM lts, tone and RCS TCA warn lt will come on. The malfunctioning quad pair will be indicated by red flag.	
	11	9. CB RCS SYS A: QUAD 1 TCA - open QUAD 2 TCA - close	
	16	10. CB RCS SYS B: QUAD 2 TCA - open QUAD 1 TCA - close	
		11. ACA (CDR) - Yaw right to soft stop for 1 second, release	
1 & 2		12. Repeat step 8	
	11	13. CB RCS SYS A: QUAD 2 TCA - open QUAD 4 TCA - close	
	16	14. CB RCS SYS B: QUAD 1 TCA - open QUAD 3 TCA - close	
		15. Repeat step 7	
1 & 2		16. Repeat step 8	

4.2.33 RCS HOT FIRING CHECK OF PRIMARY COILS (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	11	17. CB RCS SYS A: QUAD 4 TCA - open QUAD 3 TCA - close	
	16	18. CB RCS SYS B: QUAD 3 TCA - open QUAD 4 TCA - close	
		19. Repeat step 11	
1 & 2		20. Repeat step 8	
	11	21. CB RCS SYS A: QUAD 3 TCA - open	
		22. Verify CB RCS SYS A: QUAD 1 TCA - open	
		23. CB RCS SYS A: QUAD 4 TCA - close QUAD 2 TCA - close	
	16	24. CB RCS SYS B: QUAD 4 TCA - open	
		25. Verify CB RCS SYS B: QUAD 2 TCA - open	
		26. CB RCS SYS B: QUAD 1 TCA - close QUAD 3 TCA - close	
		27. Load DAP (R03)	DAP loading configuration is 51101
		28. TTCA (CDR) - Move up for 1 second, release	
1 & 2		29. Repeat step 8	
	11	30. CB RCS SYS A: QUAD 4 TCA - open QUAD 2 TCA - open	
		31. CB RCS SYS A: QUAD 3 TCA - close QUAD 1 TCA - close	

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CREW-MAN	PNL	PROCEDURES	REMARKS
	16	32. CB RCS SYS B: QUAD 1 TCA - open QUAD 3 TCA - open	
		33. CB RCS SYS B: QUAD 2 TCA - close QUAD 4 TCA - close	
		34. TTCA (CDR) - Move down for 1 second, release	
1 & 2		35. Repeat step 8	
11		36. CB RCS SYS A: QUAD 4 TCA - close QUAD 2 TCA - close	
16		37. CB RCS SYS B: QUAD 1 TCA - close QUAD 3 TCA - close	
		38. Request CSM return to attitude hold mode	
2		39. RCS: A QUANTITY ind - record % remaining B QUANTITY ind - record % remaining	
		40. Set controls - G&C basic	
		4.2.34 RCS IN-FLIGHT CHECK OF SECONDARY COILS	The purpose of this task is to check functional continuity of the ACA's, secondary coils, and RCS thrusters. Check occurs prior to LM/CSM separation and during communications' LOS with MSFN tracking stations. MSFN evaluates thrust chamber pressure switch readouts to determine that all thrusters fired. RCS pressurization completed.
		1. Verify CSM has attitude control disabled	
		2. Set controls to G&C basic except: S/C MODE CONTROL sel - OFF	
3		3. ACA (CDR) - Pitch up, hardover for 1 second	Refer to Table 4-5, RCS jet Select Logic - Secondary coils for identification of appropriate jets fired to perform pitch, roll,

4.2.33 RCS HOT FIRING CHECK OF PRIMARY COILS/4.2.34 RCS IN-FLIGHT CHECK OF SECONDARY COILS

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4. ACA (CDR) - Pitch down hardover for 1 second 5. ACA (CDR) - Roll right hardover for 1 second 6. ACA (CDR) - Roll left hardover for 1 second 7. ACA (CDR) - Yaw left hardover for 1 second 8. ACA (CDR) - Yaw right hardover for 1 second 9. Verify MSFN receipt of telemetry data 10. Repeat steps 3 through 8 with ACA (LMP) 11. Verify MSFN receipt of telemetry data 12. Request CSM return to attitude hold mode	and yaw maneuvers when the attitude controller is displaced to the hardover position.
	2	13. RCS: - A QUANTITY ind - record % remaining - B QUANTITY ind - record % remaining 14. Return controls to G&C basic	

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CREW-MAN	PNL	PROCEDURES	REMARKS															
		Table 4-5. RCS Jet Select Logic - Secondary Coils																
			B 4 U	A 4 D	B 4 F	A 4 R	A 3 U	B 3 D	B 3 A	A 3 R	B 2 U	A 2 D	A 2 A	B 2 L	A 1 U	B 1 D	A 1 F	B 1 L
		Maneuver																
		Yaw left							X								X	
		Yaw right				X				X				X				X
		Pitch up			X								X			X		
		Pitch down		X							X							
		Roll left	X						X			X						
		Roll right		X							X							
			X									X						

4.2.34 RCS IN-FLIGHT CHECK OF SECONDARY COILS (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		4.2.35 AGS CHECKOUT 1. Key DEDA - EL lamp check C6666 2. OPR ERR lt - on 3. Key DEDA - EL lamp check C 111 +88888 OPR ERR lt - off 4. Key DEDA - CLR 5. Key DEDA - EL lamp check complete C123 - 45679C 6. Key DEDA - Self test status C412R + X0000 X = 1 - Test successfully completed X = 3 - Logic test failure X = 4 - Memory test failure X = 7 - Logic test and memory test failure 7. If +100000 not displayed Key DEDA C412 + 00000E, after 5 seconds Key DEDA C412R CAUTION If +10000 not displayed, self test failed. AGS operations are not recommended. 8. Key DEDA - Descent section staging flag status C574R If +00000 not displayed Key DEDA C574 + 00000E	Assumption: AGS power-up completed Upper windows 666 Upper windows 111 Lower windows +88888 All display windows blank Upper windows 123 Lower windows - 45679

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CREW-MAN	PNL	PROCEDURES	REMARKS												
		9. Key DEDA - Lunar surface flag status C604R If +00000 not displayed Key DEDA C604 + 00000E 10. Key DEDA - Staging sequence number status C612R If +00000 not displayed Key DEDA C612 + 00000E 4.2.36 DOCKED IMU MANUAL TRANSFER COARSE ALIGNMENT 1. Request CSM into narrow deadband attitude hold mode in a convenient attitude for manual transfer alignment. 2. Request docking interface roll calibration angle ($\Delta\theta$). 3. Request and record present CSM ICDU angles 4. Calculate and record LM ICDU angles <table><tr><td><u>LM</u></td><td></td><td><u>CSM</u></td></tr><tr><td>OG</td><td>=</td><td>$\pm\Delta\theta - OG - 60^\circ$</td></tr><tr><td>IG</td><td>=</td><td>IG $\pm 180^\circ$</td></tr><tr><td>MG</td><td>=</td><td>-MG</td></tr></table> 5. Key V41 N20E - Coarse align ICDU's 6. FL V21 N22 XXX.XX⁰ E - Enter LM OG 7. FL V22 N22 XXX.XX⁰ E - Enter LM IG 8. FL V23 N22 XXX.XX⁰ E - Enter LM MG 9. NO ATT lt - on 10. Optional: Key V16 N20E - Monitor coarse alignment of ICDU's Record final ICDU angles Key KEY REL	<u>LM</u>		<u>CSM</u>	OG	=	$\pm\Delta\theta - OG - 60^\circ$	IG	=	IG $\pm 180^\circ$	MG	=	-MG	
<u>LM</u>		<u>CSM</u>													
OG	=	$\pm\Delta\theta - OG - 60^\circ$													
IG	=	IG $\pm 180^\circ$													
MG	=	-MG													

4.2.35 AGS CHECKOUT/4.2.36 DOCKED IMU MANUAL TRANSFER COARSE ALIGNMENT

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CREW-MAN	PNL	PROCEDURES	REMARKS
		11. Optional: To extinguish NO ATT lt Key V01 N01E 760E R1 ABCDE R2 ----- R3 ----- Verify D = 1 If A $\geq$ 4 wait until A < 4 then Key V21E 760E Key (A + 4) BC (D - 1) E Key ENTR NO ATT lt - off 12. Request and record 18 REFSMMAT values from CSM 13. Key V21 N01E 1262E Key first component -----E Key N15E, second component -----E Key third component -----E Key fourth through eighteenth component -----E 14. Key V01 N01E 77E R1 ABCDE R2 ----- R3 ----- Record ABCDE 15. Key V21E Key (A + 1) BCDE Key ENTR	D = 1, NO ATT lt - on A < 4, coarse align completed

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.3 TRANSFER TO CSM & SUBSYSTEM DEACTIVATION Transfer to CSM and Subsystem Deactivation consists of tasks performed by the crew to transfer from the LM to the CSM and to place LM subsystems into a powered-down condition that reproduces, to the extent practicable, LM prelaunch closeout status.	
CDR		4.3.1 CDR INTRAVEHICULAR TRANSFER TO CSM 1. Verify CSM has pressurized docking tunnel 2. Cabin relief and dump vlv (ovhd) - DUMP 3. Ovhd hatch - open 4. Verify tunnel is clear	Assumptions: equipment transfer to CSM, if required, must be accomplished prior to CDR connecting to transfer umbilical. If probe and drogue are in tunnel, crew must remove and stow in LM. CSM crewman may connect CSM/LM electrical umbilical during this time. LM crewman may reach transfer umbilical stowage himself.
		5. Receive transfer umbilical from CSM 6. Verify no oxygen flow in transfer umbilical 7. Remove plugs from left side PGA O2 connectors and stow 8. Connect transfer umbilical oxygen hoses to PGA (left side) 9. Coordinate with CSM - application of power to transfer umbilical comm cable.	Power is supplied by CSM, to be turned on after transfer comm cable is connected to PGA.
LMP	11	10. CB COMM: CDR AUDIO - open	
	12	11. COMM: TLM BIOMED - RIGHT	
CDR		12. Disconnect LM comm cable from PGA and connect transfer umbilical comm cable to PGA 13. Request CSM start oxygen flow thru transfer umbilical	This constitutes a comm check via transfer umbilical comm cable.
	ECS	14. SUIT ISOL vlv (CDR) - SUIT DISCONN 15. Verify O2 flow to PGA thru transfer umbilical 16. Disconnect LM umbilical O2 hoses from PGA	

4.3.1 CDR INTRAVEHICULAR TRANSFER TO CSM

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR	ECS	17. Remove plugs from stowage and place in PGA right side 18. Stow LM umbilical 19. Transfer into CSM 4.3.2 VEHICLE POWER DOWN	This task is performed prior to the crew sleep period. The CDR has transferred to the CSM and the LMP is connected to the CM ECS and COMM via the transfer umbilical. CB deactivation to be performed at end of procedure, just prior to transfer of power from LM to CSM. Controls omitted from this checklist are not applicable to a powerdown configuration.
LMP	ECS	1. Perform ECS power down: Overhead floodlight (LMP) - rotate aft SUIT GAS DIVERTER vlv - PULL EGRESS CABIN REPRESS vlv - CLOSE PLSS FILL vlv - CLOSE PRESS REG A vlv - CLOSE PRESS REG B vlv - CLOSE DES O2 vlv - CLOSE #1 ASC O2 vlv - CLOSE #2 ASC O2 vlv - CLOSE SUIT ISOL vlv (LMP) - SUIT DISCONN SUIT ISOL vlv (CDR) - SUIT DISCONN ASC H2O vlv - OPEN SEC EVAP FLOW vlv - CLOSE PRIM EVAP FLOW NO. 2 vlv - CLOSE DES H2O vlv - CLOSE WATER TANK SELECT vlv - DES Cabin temp vlv - NORM PRIM EVAP FLOW sw - center CABIN GAS RETURN vlv - AUTO CO2 CANISTER SEL vlv - PRIM SUIT CIRCUIT RELIEF vlv - AUTO PRIM CO2 CANISTER - CLOSE SEC CO2 CANISTER - CLOSE WATER SEP SEL vlv - PUSH SEP 1 Overhead floodlight (LMP) - rotate forward SUIT FAN sel - OFF GLYCOL sel - PUMP 1 ECS: GLYCOL temp ind - TBD ° F (stabilized) Cabin relief and dump vlv (fwd) - AUTO	
	2		
	ECS		

4.3.1 CDR INTRAVEHICULAR TRANSFER TO CSM/4.3.2 VEHICLE POWER-DOWN

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR & LMP	11	2. Perform PGNC Power-Down Program (P06): a. Set controls - G&C basic b. Key V37E 06E c. If IMU is operating: FL V50 N25 - Checklist Reference R1 00061 - Request IMU power down R2 ----- R3 ----- Accept: CB PGNS: IMU OPER - open Key PRO Reject: Key ENTR d. FL V50 N25 - Checklist Reference R1 00062 - Request LGC power down R2 ----- R3 ----- Accept: Key PRO and hold for 3 seconds STBY lt - on (after 3 sec delay) All EL numerics on DSKY - off Reject: Key ENTR e. FL V50 N07 - Perform program change	The purpose of Program 06 is to transfer the ISS/LGC from operate to standby.
LMP	8	3. ORDEAL Panel FDAI 1 sw - INRTL FDAI 2 sw - INRTL EARTH/LUNAR sw - PWR OFF LTG sw - OFF MODE sw - HOLD/FAST SLEW sw - center ALT SET cont - TBD nm 4. DES PROPUL: FUEL VENT sw - center; tb - bp OXID VENT sw - center; tb - bp ED: DES PRPLNT ISOL VLV sw - SAFE LDG GEAR DEPLOY tb - bp MASTER ARM sw - OFF DES VENT sw - SAFE	The LGC should be transferred to operate at least every 23 hours to preserve accurate GET accumulation.

4.3.2 VEHICLE POWER-DOWN (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	8	ASC He SEL sw - BOTH LDG GEAR DEPLOY sw - SAFE RCS He PRESS sw - SAFE DES START He PRESS sw - SAFE ASC He PRESS sw - SAFE STAGE sw - SAFE (guarded) STAGE RELAY sw - OFF AUDIO: S BAND T/R sw - OFF ICS T/R sw - OFF RELAY ON sw - RELAY OFF VOX sw - ICS CONT sw - NORM VHF A sw - OFF VHF B sw - OFF COAS sw - OFF TTCA 5. THROTTLE/JETS cont (CDR) - JETS Throttle friction cont (CDR) - TBD 6. DES RATE sw - center Eng STOP pb/lt - reset (flush) Eng START pb/lt - reset (flush) +X TRANSL pb - reset (flush) MSN TMR: TMR CONT sw - STOP SLEW CONT HOURS sw - center SLEW CONT MIN sw - center SLEW CONT SEC sw - center LTG: OVERRIDE ANUN sw - OFF OVERRIDE NUM sw - OFF OVERRIDE INTEGRAL sw - OFF SIDE PANELS sw - OFF FLOOD cont (CDR) - DIM ANUN/NUM cont - DIM INTEGRAL cont - DIM ACA 7. PTT pb (CDR) - not depressed	

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	1	8. X POINTER SCALE sw (CDR) - HI MULT MASTER ALARM pb/lt - reset (flush) RATE/ERROR MON sw - LDG RDR/CMPTR ATTITUDE MON sw - PGNS SHFT/TRUN X sw - $\pm 50^{\circ}$ RATE/SCALE sw - 25°/SEC IMU CAGE sw - OFF ENG THR CONT: THR CONT sw - AUTO MAN THROT sw - CDR ENG ARM sw - OFF X TRANSL sw - 2 JETS BAL CPL sw - ON ASC He REG 1 sw - center; tb - gray ASC He REG 2 sw - center; tb - gray DES He REG 1 sw - center; tb - gray DES He REG 2 sw - center; tb - bp PRPLNT QTY MON sw - OFF PRPLNT TEMP/PRESS MON sw - DES 1 HELIUM MON sel - OFF ABORT pb - reset (flush) ABORT STAGE pb - reset (flush) RNG/ALT MON sw - RNG/RNG RT MODE SEL sw - PGNS GUID CONT sw - PGNS	
	3	9. ENG GMBL sw - OFF DES ENG CMD OVRD sw - OFF RADAR: LDG ANT sw - AUTO TEST sw - OFF TEST MON sel - ALT XMTR SLEW RATE sw - HI RNDZ RDR: SLEW sw - center RNDZ RDR sel - AUTO TRACK S/C: DEAD BAND sw - MIN GYRO TEST ROLL sw - ROLL GYRO TEST POS RT sw - OFF ROLL sw - MODE CONT PITCH sw - MODE CONT YAW sw - MODE CONT MODE CONTROL sel - ATT HOLD	

4.3.2 VEHICLE POWER-DOWN (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	3	HTR CONT: TEMP MON sel - RNDZ RADAR EVNT TMR: RESET/COUNT sw - DOWN TMR CONT sw - center SLEW CONT MIN sw - center SLEW CONT SEC sw - center HTR CONT: RCS SYS A/B 2 QUAD 1 sw - AUTO RCS SYS A/B 2 QUAD 2 sw - AUTO RCS SYS A/B 2 QUAD 3 sw - AUTO RCS SYS A/B 2 QUAD 4 sw - AUTO LTG: SIDE PANELS sw - OFF FLOOD sw - OFF FLOOD cont (LMP) - DIM EXTERIOR LTG sel - OFF LAMP/TONE TEST sel - OFF (ccw) X POINTER SCALE sw (LMP) - HI MULT	
	4	10. ACA/4 JET sw (CDR) - DISABLE TTCA/TRANSL sw (CDR) - DISABLE ACA/4 JET sw (LMP) - DISABLE TTCA/TRANSL sw (LMP) - DISABLE	
AOT	11.	Azimuth cont - CL Verify eye guard assembly and density filter removed MARK X pb - not depressed MARK Y pb - not depressed REJECT pb - not depressed	
	2	12. RCS: SYS A ASC FEED 1 sw - center; tb - bp SYS A ASC FEED 2 sw - center; tb - bp SYS B ASC FEED 1 sw - center; tb - bp SYS B ASC FEED 2 sw - center; tb - bp SYS A QUAD 1 sw - center; tb - gray SYS A QUAD 4 sw - center; tb - gray SYS B QUAD 1 sw - center; tb - gray SYS B QUAD 4 sw - center; tb - gray SYS A QUAD 2 sw - center; tb - gray SYS A QUAD 3 sw - center; tb - gray SYS B QUAD 2 sw - center; tb - gray SYS B QUAD 3 sw - center; tb - gray CRSFD sw - center; tb - bp	

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	2	SYS A MAIN SOV sw - center; tb - gray SYS B MAIN SOV sw - center; tb - gray TEMP/PRESS MON sel - He RCCA sw - OFF/RESET MASTER ALARM pb/lt - reset (flush) RATE/ERR MON sw - LDG RDR/CMPTR ATTITUDE MON sw - AGS O2/H2O QTY MON sel - DES	
	TTCA 13.	THROTTLE/JETS cont (LMP) - JETS Throttle friction cont (LMP) - TBD	
	6	14. Eng STOP pb/lt - reset (flush) AGS STATUS sw - OFF	
	ACA	15. PTT pb (LMP) - not depressed	
	12	16. AUDIO: CONT sw - NORM S BAND T/R sw - OFF ICS T/R sw - OFF RELAY ON sw - RELAY OFF VOX sw - ICS VHF A sw - OFF VHF B sw - OFF COMM: S BAND MODULATE sw - PM S BAND XMTR/RCVR sw - OFF S BAND PWR AMPL sw - OFF S BAND VOICE sw - OFF S BAND PCM sw - OFF S BAND RANGE sw - OFF/RESET VHF A XMTR sw - OFF VHF A RCVR sw - OFF VHF B XMTR sw - OFF VHF B RCVR sw - OFF TLM BIOMED sw - OFF TLM PCM sw - LO RECORDER sw - OFF RECORDER TAPE tb - bp	

4.3.2 VEHICLE POWER-DOWN (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	12	COMM ANT: VHF sel - last setting TRACK MODE sw - OFF PITCH cont - last setting YAW cont - last setting S BAND sel - last setting	
	14	17. Perform EPS Power Down EPS: ED VOLTS sw - OFF POWER/TEMP MON sel - ED/OFF INVERTER sw - OFF	
	16	Open all panel 16 CB's except: CB LTG: FLOOD - close CB S/C: ASA - close CB HTR RCS SYS A/B 2: QUAD 1, 2, 3, 4 - close S BD ANT - close CB EPS: DISP - close DES ECA - close DES ECA CONT - close CROSS TIE BAL LOADS - close BAT FEED TIE (2) - close	
	11	Open all panel 11 CB's except: CB HTR: RNDZ RDR STBY - close LDG RDR - close CB HTR RCS SYS A/B 1: QUAD 4, 3, 2, 1 - close CB PGNS: IMU STBY - close CB EPS: BAT FEED TIE (2) - close CROSS TIE BAL LOADS - close DES ECA - close DES ECA CONT - close EARTH ORBIT: C BAND PWR sw - OFF R/D TLM CAL sw - OFF	Prior to opening CB LTG: ANUN/DOCK/COMPNT, check that all 10 indicator power failure lights are on.

CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	14	EPS: SE BAT 1 HI VOLT sw - OFF/RESET; tb - bp SE BAT 1 LOW VOLT sw - ON; tb - LO SE BAT 2 HI VOLT sw - OFF/RESET; tb - bp SE BAT 2 LOW VOLT sw - ON; tb - LO CDR BAT 3 HI VOLT sw - OFF/RESET; tb - bp CDR BAT 3 LOW VOLT sw - ON; tb - LO CDR BAT 4 HI VOLT sw - OFF/RESET; tb - bp CDR BAT 4 LOW VOLT sw - ON; tb - LO CB EPS: DISP - open	
	16	Transfer power from LM to CSM	CSM Panel: CSM-LM PWR sw - CSM PWR ON Lights may go out briefly as a momentary interruption of power results from the transfer. However, on-line equipment should suffer no degradation. Equipment remaining on line via XLUNAR BUS: S BD STEERABLE ANT HTR LDG RDR HTR RNDZ RDR HTR IMU HTR ASA HTR DES ECA OVHD FLD LTS remain on while ovhd hatch is open.
LMP		4.3.3 LMP CONNECT TO TRANSFER UMBILICAL 1. Receive transfer umbilical from CSM 2. Verify no oxygen flow in transfer umbilical 3. Remove plugs from left side PGA O2 connectors and stow 4. Connect transfer umbilical oxygen hoses to PGA (left side) 5. Coordinate with CSM - application of power to transfer umbilical comm cable.	
	16	6. CB COMM: SE AUDIO - open	Power is supplied by CSM, to be turned on after transfer comm cable is connected to PGA.

4.3.2 VEHICLE POWER-DOWN/4.3.3 LMP CONNECT TO TRANSFER UMBILICAL

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	12	7. COMM: TLM BIOMED sw - OFF 8. Disconnect LM comm cable from PGA and connect transfer umbilical comm cable to PGA 9. Request CSM start oxygen flow thru transfer umbilical	This constitutes a comm check via transfer umbilical comm cable.
	ECS	10. SUIT ISOL vlv (LMP) - SUIT DISCONN 11. Verify O2 flow to PGA thru transfer umbilical 12. Disconnect LM umbilical O2 from PGA 13. Remove plugs from stowage and place in PGA right side 14. Stow LM umbilical	
LMP		4.3.4 LMP INTRA-VEHICULAR TRANSFER TO CSM 1. Unstow and install front panel protective cover 2. Overhead floodlights - rotate aft 3. Release overhead hatch from ascent engine cover 4. Cabin relief and dump vlv (ovhd) - AUTO 5. Transfer to CSM, closing and securing LM hatch	
		4.3.5 APS BURN TO DEPLETION PREPARATION 1. Target LGC, using data provided by MSFN, for a great enough magnitude of burn to prevent engine shutdown by the LGC and to ensure ascent propellant depletion to begin about 25 minutes after LM jettison. 2. Select P42, load DAP and select PGNC automatic mode (P42, steps 1 through 21) but do not key PRO. Perform DCA Enable procedure.	MSFN will provide an external ΔV and time-of-ignition for use with Program 30. MSFN can perform all of P42 via digital uplink or continue orientation maneuver by keying PRO after LM jettison.

4.3.3 LMP CONNECT TO TRANSFER UMBILICAL/4.3.4 LMP INTRA-VEHICULAR TRANSFER TO CSM/4.3.5 APS BURN TO DEPLETION

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CREW- MAN	PNL	PROCEDURES	REMARKS
	2		The following should be performed before continuing this task: Equipment transferred to CSM Intravehicular transfer (CDR) to CSM LMP connected to transfer umbilical
	1	3. GUID CONT sw - PGNS	Positions of switches not constrained by the requirements of this task, and positions of momentary contact switches are not listed.
	1	4. MPS: ASC He REG 1 tb - gray ASC He REG 2 tb - gray	
	2	5. RCS: CRSFD tb - bp SYS A ASC FUEL tb - bp SYS A ASC OXID tb - bp SYS A QUAD 1 tb - gray SYS A QUAD 2 tb - gray SYS A QUAD 3 tb - gray SYS A QUAD 4 tb - gray SYS A MAIN SOV tb - gray SYS B MAIN SOV tb - gray SYS B ASC FUEL tb - bp SYS B ASC OXID tb - bp SYS B QUAD 1 tb - gray SYS B QUAD 2 tb - gray SYS B QUAD 3 tb - gray SYS B QUAD 4 tb - gray	
	2	6. RCCA sw - ENABLE	
	2	7. GLYCOL sel - PUMP 1 SUIT FAN sel - OFF	
			The RCCA switch can be placed to OFF/RESET to permit the ascent engine to burn, even though unstable operation may occur, in order to obtain data. Because the CSM may come in close range of the unmanned LM ascent stage, the RCCA switch is at ENABLE to protect the crew against a possible LM ascent stage-engine explosion. The LM ascent engine will be off in event of combustion from rough occurrences.

4.3.5 APS BURN TO DEPLETION (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
	3	8. S/C: ROLL sw - MODE CONT PITCH sw - MODE CONT YAW sw - MODE CONT MODE CONTROL sel - AUTO	Turn flood lighting sw OFF when no longer required. OVHD/FWD flood lights will remain on while docking hatch is open, and will turn off at closing of hatch.
	3	9. LTG: FLOOD sw - ALL EXTERIOR LTG sel - TRACK	
	4	10. ACA/4 JET sw (CDR) - DISABLE ACA/4 JET sw (LMP) - DISABLE TTCA/TRANSL sw (CDR) - DISABLE TTCA/TRANSL sw (LMP) - DISABLE	
	5	11. Eng STOP pb/lt - reset	
	6	12. Eng STOP pb/lt - reset	
	12	13. COMM: S BAND MODULATE sw - PM S BAND XMTR/RCVR sw - PRIM S BAND PWR AMPL sw - OFF S BAND VOICE sw - OFF S BAND PCM sw - PCM S BAND RANGE sw - OFF/RESET VHF A XMTR sw - OFF VHF A RCVR sw - OFF VHF B XMTR sw - OFF VHF B RCVR sw - OFF TLM BIOMED sw - OFF TLM PCM sw - HI RECORDER sw - OFF	Depends on LM orientation relative to MSFN station.
	12	14. COMM ANT: S BAND sel - 1 or 2	
	14	15. EPS: POWER TEMP/MON sel - ED/OFF INVERTER sw - 1	

CREW-MAN	PNL	PROCEDURES	REMARKS
	11	16. All panel 11 CB's open except: CB/AC BUS B: BUS TIE INV 2 - close BUS TIE INV 1 - close CB/AC BUS A: BUS TIE INV 2 - close BUS TIE INV 1 - close AC BUS VOLT - close CB RCS SYS A: QUAD 4 TCA - close QUAD 3 TCA - close QUAD 2 TCA - close QUAD 1 TCA - close CB INST: SIG CONDR 1 - close CB S/C: ATCA PGNS - close AELD - close CB HTR RCS SYS A/B 1: QUAD 4 - close QUAD 3 - close QUAD 2 - close QUAD 1 - close CB ECS: GLYCOL PUMP 2 - close GLYCOL PUMP 1 - close GLYCOL PUMP AUTO TRNFR - close CB PGNS: LGC/DSKY - close IMU STBY - close IMU OPR - close CB EPS: BAT FEED TIE (2) - close CROSS TIE BUS - close ASC ECA CONT - close ASC ECA - close INV 1 - close DC BUS VOLT - close CB EARTH ORBIT: ANT TRNFR B - close ANT TRNFR A - close R/D INST A - close R/D INST B - close EARTH ORBIT: C BAND PWR sw - ON CB COMM: UP DATA LINK - Close	

4.3.5 APS BURN TO DEPLETION (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	16	17. All panel 16 circuit breakers open except: CB RCS SYS B: QUAD 1 TCA - close QUAD 2 TCA - close QUAD 3 TCA - close QUAD 4 TCA - close PQGS/DISP - close CB LTG: TRACK - close FLOOD - close CB S/C: ENG ARM - close AELD - close ATCA - close CB INST: SIG SENSOR - close PCM/TE - close SIG CONDR 2 - close CB COMM: PRIM S BD XMTR/RCVR - close PMP - close CB HTR RCS SYS A/B 2: QUAD 1 - close QUAD 2 - close QUAD 3 - close QUAD 4 - close CB EPS: DC BUS VOLT - close ASC ECA - close ASC ECA CONT - close CROSS TIE BUS - close BAT FEED TIE (2) - close 18. Perform LMP intravehicular transfer to CSM	RCS and MPS display circuit breakers must not be opened until status of RCS and ascent solenoid valves have been verified. Refer to paragraph 4.3.4 Preparation for jettison, and jettison, are controlled from CSM. Post jettison coast and initial APS burn can be monitored visually from CSM. Control of LM is exercised by MSFN via uplink commands to DCA. APS burn to begin about 25 minutes after jettison at initial range of about 1000 feet.

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.4 <u>G&N GENERAL</u> 4.4.1 PROGRAM LIST <u>NO.</u> 00 LGC Idling 05 PGNCs Start Up 06 PGNCs Power Down 20 Rendezvous Navigation 21 Ground Track Determination 25 Preferred Tracking Attitude 27 LGC Update 30 External ΔV 32 Co-elliptic Sequence Initiation (CSI) 33 Constant Δ Altitude (CDH) 34 Transfer Phase Initiation (TPI) 35 Transfer Phase Midcourse (TPM) 40 DPS Thrust 41 RCS Thrust 42 APS Thrust 47 Thrust Monitor 51 IMU Orientation Determination 52 IMU Realign 72 CSM-CSI Targeting 73 CSM-CDH Targeting 74 CSM-TPI Targeting 75 CSM-TPM Targeting	<u>PHASE</u> Service Service Service Coast Coast Coast Coast Prethrust Prethrust Prethrust Prethrust Prethrust Prethrust Prethrust Prethrust Prethrust Alignment Alignment CSM Backup CSM Backup CSM Backup CSM Backup

4.4.1 PROGRAM LIST

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CREW- MAN	PNL	PROCEDURES	REMARKS
		4.4.2 ROUTINE LIST <u>NO.</u> 00 Final Automatic Request Terminate 02 IMU Status Check 03 DAP Data Load 04 RR/LR Self Test 21 RR Designate 22 RR Data Read 23 RR Manual Acquisition 24 RR Search 25 RR Monitor 30 Orbit Parameter Display 31 Rendezvous Parameter Display 32 Target ΔV 33 LGC/CMC Clock Synchronization 36 Out-of-Plane Rendezvous Display 47 AGS Initialization 50 Course Align 51 Inflight Fine Align 52 Automatic Optics Positioning 53 Inflight Sighting Mark 54 Sighting Data Test 55 Gyro Torquing 60 Attitude Maneuver 61 Preferred Tracking Attitude 62 Crew Defined Maneuver 63 Rendezvous Final Attitude 77 LR Spurious Test	

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.4.3 VERB LIST <u>NO.</u> <u>Regular Verbs</u> 01 Display octal component 1 in R1 02 Display octal component 2 in R1 03 Display octal component 3 in R1 04 Display octal components 1, 2 in R1, R2 05 Display octal components 1, 2, 3 in R1, R2, R3 06 Display decimal in R1 or R1, R2 or R1, R2, R3 07 Display double precision decimal in R1, R2 11 Monitor octal component 1 in R1 12 Monitor octal component 2 in R1 13 Monitor octal component 3 in R1 14 Monitor octal components 1, 2 in R1, R2 15 Monitor octal components 1, 2, 3 in R1, R2, R3 16 Monitor decimal in R1 or R1, R2 or R1, R2, R3 17 Monitor double precision decimal in R1, R2 21 Load component 1 into R1 22 Load component 2 into R2 23 Load component 3 into R3 24 Load components 1, 2 into R1, R2 25 Load components 1, 2, 3 into R1, R2, R3 27 Display fixed memory 30 Request Executive 31 Request Waitlist 32 Recycle program 33 Proceed without DSKY inputs 34 Terminate function 35 Test lights 36 Request fresh start 37 Change program <u>Extended Verbs</u> 40 Zero CDU's 41 Coarse align CDU's 42 Fine Align IMU 43 Load FDAI error needles 46 Establish PGNCs control 47 Initialize AGS (R47)	

4.4.3 VERB LIST

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CREW- MAN	PNL	PROCEDURES	REMARKS
		<u>NO.</u> 48 Load DAP data (R03) 49 Start crew defined maneuver (R62) 50 Please perform 52 Mark X reticle 53 Mark Y reticle 54 Mark X or Y reticle 55 Increment LGC time (decimal) 56 Terminate tracking (P20 and P25) 61 Command LR to position 2 62 Start RR/LR self test (R04) 64 Start S-band antenna routine (R05) 69 Restart 70 Update liftoff time (P27) 71 Universal update, block address (P27) 72 Universal update, single address (P27) 73 Update LGC time (octal) (P27) 74 Initialize erasable dump via downlink 76 Minimum impulse command mode 77 Rate command and attitude hold mode 78 Start LR spurious test (R77) 79 Stop LR spurious test (R77) 80 Update LM state vector 81 Update CSM state vector 82 Request orbit parameter display (R30) 83 Request rendezvous parameter display (R31) 84 Start target ΔV (R32) 89 Start rendezvous final attitude maneuver (R63) 90 Request rendezvous out-of-plane display (R36) 91 Temporary for hybrid and systems test 92 Start IMU performance test (P07) 93 Reset RFNDW flag 95 No update of either state vector 99 Enable engine ignition	

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CREW-MAN	PNL	PROCEDURES	REMARKS																																																																																																			
		4.4.4 NOUN LIST																																																																																																				
		<table><tr><th>NO.</th><th>Description/Component</th><th>Scale</th></tr><tr><td>01</td><td>Specify address (fraction)</td><td></td></tr><tr><td></td><td>R1</td><td>.XXXXXX</td></tr><tr><td></td><td>R2</td><td>.XXXXXX</td></tr><tr><td></td><td>R3</td><td>.XXXXXX</td></tr><tr><td>02</td><td>Specify address (whole)</td><td></td></tr><tr><td></td><td>R1</td><td>XXXXXX</td></tr><tr><td></td><td>R2</td><td>XXXXXX</td></tr><tr><td></td><td>R3</td><td>XXXXXX</td></tr><tr><td>03</td><td>Specify address (degree)</td><td></td></tr><tr><td></td><td>R1</td><td>XXX.XX°</td></tr><tr><td></td><td>R2</td><td>XXX.XX°</td></tr><tr><td></td><td>R3</td><td>XXX.XX°</td></tr><tr><td>05</td><td>Angular error/difference</td><td></td></tr><tr><td></td><td>R1</td><td>XX.XXX°</td></tr><tr><td></td><td>R2</td><td>-----</td></tr><tr><td></td><td>R3</td><td>-----</td></tr><tr><td>06</td><td>Option code</td><td></td></tr><tr><td></td><td>R1 Code</td><td>Octal</td></tr><tr><td></td><td>R2 Desired option</td><td>Octal</td></tr><tr><td></td><td>R3</td><td>-----</td></tr><tr><td>08</td><td>Alarm data</td><td></td></tr><tr><td></td><td>R1</td><td>Octal</td></tr><tr><td></td><td>R2</td><td>Octal</td></tr><tr><td></td><td>R3</td><td>Octal</td></tr><tr><td>09</td><td>Alarm codes</td><td></td></tr><tr><td></td><td>R1</td><td>Octal</td></tr><tr><td></td><td>R2</td><td>Octal</td></tr><tr><td></td><td>R3</td><td>Octal</td></tr><tr><td>14</td><td>Checklist</td><td></td></tr><tr><td></td><td>R1</td><td>XXXXXX</td></tr><tr><td></td><td>R2</td><td>-----</td></tr><tr><td></td><td>R3</td><td>-----</td></tr></table>	NO.	Description/Component	Scale	01	Specify address (fraction)			R1	.XXXXXX		R2	.XXXXXX		R3	.XXXXXX	02	Specify address (whole)			R1	XXXXXX		R2	XXXXXX		R3	XXXXXX	03	Specify address (degree)			R1	XXX.XX°		R2	XXX.XX°		R3	XXX.XX°	05	Angular error/difference			R1	XX.XXX°		R2	-----		R3	-----	06	Option code			R1 Code	Octal		R2 Desired option	Octal		R3	-----	08	Alarm data			R1	Octal		R2	Octal		R3	Octal	09	Alarm codes			R1	Octal		R2	Octal		R3	Octal	14	Checklist			R1	XXXXXX		R2	-----		R3	-----	
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	R3	Octal																																																																																																				
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	R1	Octal																																																																																																				
	R2	Octal																																																																																																				
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CREW- MAN	PNL	PROCEDURES			REMARKS
		NO.	Description/Component	Scale	
		15	Increment address R1 R2 R3	Octal ----- -----	
		16	Time of event R1 R2 R3	00XXX hr 000XX min 0XX.XX sec	
		17	Astronaut total attitude R1 Roll R2 Pitch R3 Yaw	XXX.XX° XXX.XX° XXX.XX°	
		18	Desired automatic maneuver FDAI angles R1 Roll R2 Pitch R3 Yaw	XXX.XX° XXX.XX° XXX.XX°	
		19	Bypass attitude trim maneuver (Desired FDAI angles) R1 Roll R2 Pitch R3 Yaw	XXX.XX° XXX.XX° XXX.XX°	
		20	ICDU angles R1 Outer gimbal R2 Inner gimbal R3 Middle gimbal	XXX.XX° XXX.XX° XXX.XX°	
		21	PIPAS R1 X R2 Y R3 Z	XXXXXX pulses XXXXXX pulses XXXXXX pulses	
		22	New ICDU angles R1 Outer gimbal R2 Inner gimbal R3 Middle gimbal	XXX.XX° XXX.XX° XXX.XX°	

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CREW- MAN	PNL	PROCEDURES			REMARKS
		<u>NO.</u>	<u>Description/Component</u>	<u>Scale</u>	
		24	ΔLGC clock time R1 R2 R3	00XXX hr 000XX min 0XX. XX sec	
		25	Checklist reference code (Used with V50) R1 Code R2 R3	XXXXX ----- -----	
		26	Priority/Delay, address, BBCON R1 R2 R3	Octal Octal Octal	
		27	Self test switch (on/off) R1 R2 R3	XXXXX ----- -----	
		30	TIG (CSI) R1 R2 R3	00XXX hr 000XX min 0XX. XX sec	
		31	TIG (CDH) R1 R2 R3	00XXX hr 000XX min 0XX. XX sec	
		32	Time to perigee R1 R2 R3	00XXX hr 000XX min 0XX. XX sec	
		33	TIG R1 R2 R3	00XXX hr 000XX min 0XX. XX sec	

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CREW-MAN	PNL	PROCEDURES			REMARKS
		<u>NO.</u>	<u>Description/Component</u>	<u>Scale</u>	
		34	Time of event R1 R2 R3	00XXX hr 000XX min 0XX.XX sec	
		35	Time to go to event R1 R2 R3	00XXX hr 000XX min 0XX.XX sec	
		36	Time of LGC clock R1 R2 R3	00XXX hr 000XX min 0XX.XX sec	
		37	TIG (TPI) R1 R2 R3	00XXX hr 000XX min 0XX.XX sec	
		40	R1 TFI R2 VG R3 ΔV_m	XXBXX min-sec XXXXX.X fps XXXXX.X fps	
		42	R1 Ha R2 Hp R3 ΔV (required)	XXXXX.X nm XXXXX.X nm XXXXX.X fps	
		43	R1 Latitude R2 Longitude R3 Altitude	XXX.XX° XXX.XX° XXXXX.X nm	A + display indicates North A + display indicates East
		44	R1 Ha R2 Hp R3 TFF	XXXXX.X nm XXXXX.X nm XXBXX min-sec	
		45	R1 Marks R2 TFI R3 MGA	XXXXXX XXBXX min-sec XXX.XX°	

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CREW-MAN	PNL	PROCEDURES			REMARKS
		NO.	Description/Component	Scale	
		46	DAP Configuration		
			R1	Octal	
			R2	-----	
			R3	-----	
		47			
			R1 LM weight	XXXXXX lbs	
			R2 CSM weight	XXXXXX lbs	
			R3	-----	
		48			
			R1 Gimbal pitch trim	XXX.XX°	
			R2 Gimbal roll trim	XXX.XX°	
			R3	-----	
		49			
			R1 ΔR	XXXXX.X nm	
			R2 ΔV	XXXXXX fps	
			R3	-----	
		50			
			R1 ΔH (CDH)	XXXXX.X nm	
			R2 ΔT (CDH-CSI or TPI-CSH)	XXBXX min-sec	
			R3 ΔT (TPI-CDH or TPI nom TPI)	XXBXX min-sec	
		54			
			R1 Range	XXXXX.X nm	
			R2 Range rate	XXXXX.X fps	
			R3 θ	XXX.XX°	
		55			
			R1 N(Apsidal crossings)	XXXXXX	
			R2 E	XXX.XX°	
			R3 Central angle	XXX.XX°	
		58			
			R1 Hp (TPI)	XXXXX.X nm	
			R2 ΔV (TPI)	XXXXX.X fps	
			R3 ΔV (TPF)	XXXXX.X fps	

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CREW-MAN	PNL	PROCEDURES			REMARKS
		NO.	Description/Component	Scale	
		59	R1 ΔV (LOS) R2 R3	XXXX.X fps XXXX.X fps XXXX.X fps	
		65	Sampled LGC time R1 R2 R3	00XXX hr 000XX min 0XX.XX sec	Fetches in interrupt
		66	R1 LR slant range R2 LR position R3	XXXXXX ft 0000X -----	X = 1 or 2
		67	LR velocities R1 VX R2 VY R3 VZ	XXXX.X fps XXXX.X fps XXXX.X fps	
		70	R1 AOT detent/star code (Before mark) R2 R3	Octal ----- -----	
		71	R1 AOT detent/star code (After mark) R2 R3	Octal ----- -----	
		72	RR angles R1 Trunnion R2 Shaft R3	XXX.XX° XXX.XX° -----	
		73	New RR Angles R1 Trunnion R2 Shaft R3	XXX.XX° XXX.XX° -----	

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CREW- MAN	PNL	PROCEDURES			REMARKS
		<u>NO.</u>	<u>Description/Component</u>	<u>Scale</u>	
		74	R1 LR altitude/slant range R2 LR time R3	XXXXXX ft XXX.XX sec -----	
		75	R1 LR VX/slant range R2 LR time R3	XXXXXX fps XXX.XX sec -----	
		76	R1 LR VY/slant range R2 LR time R3	XXXXXX fps XXX.XX sec -----	
		77	R1 LR VZ/slant range R2 LR time R3	XXXXXX fps XXX.XX sec -----	
		78	R1 RR range R2 RR trunnion angle R3 RR shaft angle	XXX.XX nm XXX.XX° XXX.XX°	
		80	R1 Data indicator R2 Ω R3	XXXXXX XXX.XX° -----	
		82	R1 ΔV_X (LV) R2 ΔV_Y (LV) R3 ΔV_Z (LV)	XXXXX.X fps XXXXX.X fps XXXXX.X fps	
		83	R1 ΔV_X (LM) R2 ΔV_Y (LM) R3 ΔV_Z (LM)	XXXXX.X fps XXXXX.X fps XXXXX.X fps	

4.4.4 NOUN LIST (cont)

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CREW- MAN	PNL	PROCEDURES			REMARKS
		<u>NO.</u>	<u>Description/Component</u>	<u>Scale</u>	
		84	R1 ΔVX (CSM) R2 ΔVY (CSM) R3 ΔVZ (CSM)	XXXX.X fps XXXX.X fps XXXX.X fps	
		85	R1 VGX (LM) R2 VGY (LM) R3 VGZ (LM)	XXXX.X fps XXXX.X fps XXXX.X fps	
		86	R1 VGX (LV) R2 VGY (LV) R3 VGZ (LV)	XXXX.X fps XXXX.X fps XXXX.X fps	
		87	Backup optics LOS R1 Azimuth R2 Elevation R3	XXX.XX° XXX.XX° -----	
		88	Planet vector R1 X R2 Y R3 Z	.XXXXXX .XXXXXX .XXXXXX	
		89	R1 Latitude R2 Longitude R3 Altitude	XX.XXX° XX.XXX° XXX.XX nm	
		90	Rendezvous out-of-plane parameters R1 Y R2 Y rate R3 PSI	XXX.XX nm XXXX.X fps XXX.XX°	
		93	Δgyro angles R1 X R2 Y R3 Z	XXX.XX° XXX.XX° XXX.XX°	

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CREW-MAN	PNL	PROCEDURES			REMARKS
		<u>NO.</u>	<u>Description/Component</u>	<u>Scale</u>	
		95	Preferred Attitude ICDU angles		
			R1	XXX.XX°	
			R2	XXX.XX°	
			R3	XXX.XX°	
		96	+X axis ICDU angles		
			R1	XXX.XX°	
			R2	XXX.XX°	
			R3	XXX.XX°	
		97	System test inputs		
			R1	XXXXXX	
			R2	.XXXXXX	
			R3	XXXXXX	
		98	System test results		
			R1	XXXXXX	
			R2	XXXXXX	
			R3	XXXXXX	
		4.4.5 CHECKLIST REFERENCE CODES (V50 N25)			
		<u>R1 Display</u>			
		00011	Key in automatic optics positioning data		
		00012	Key is target data		
		00014	Key in fine alignment option		
		00015	Perform star acquisition		
		00016	Key in terminate mark option		
		00017	Perform additional sightings		
		00026	Continue marking		
		00031	Key in engine on option		
		00035	Perform LGC thrusting preparation		
		00036	Perform thrust termination		
		00037	Continue interrupted program		
		00062	Switch LGC power down		
		00200	Key in zero AEA clock option		
		00201	Switch RR mode to automatic		
		00202	Key in sighting check option		
		00203	Switch to PGNCs automatic mode		

4.4.4 NOUN LIST/4.4.5 CHECKLIST REFERENCE CODES (V50 N25)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		<u>R1 Display</u> 00204 Key in enable gimbal trim option 00205 Perform manual acquisition of CSM 00401 Switch LM control to G&N 00403 Switch optics to manual or zero	Switch denotes position change of a panel switch. Perform denotes start or end of a task. Key in denotes data entry through the DSKY.
		4.4.6 OPTION CODES (V50 N06) <u>R1 Display</u> 00001 - Specify IMU orientation 00002 - Specify vehicle 00003 - Specify tracking attitude 00004 - Specify radar <u>R2 Load</u> 1 = Preferred 2 = Nominal 3 = REFSMMAT 4 = Land site 1 = LM 2 = CSM 1 = Preferred 2 = Other 1 - RR 2 = LR	The option code is displayed in R1 in conjunction with V50 N06. The astronaut keys the desired option into R2
		4.4.7 ALARM CODES (V05 N09) <u>R1, 2, 3</u> 00105 AOT mark system in use 00107 More than 7 mark pairs 00110 No mark since last mark reject 00111 Mark missing 00112 Mark reject not being accepted 00113 No inbits 00114 Mark made but not desired 00115 No marks in last pair to reject	Up to 3 alarm codes may be displayed simultaneously. R1 first alarm to occur after last reset, R2 second alarm to occur after last reset, R3 last alarm.

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CREW-MAN	PNL	PROCEDURES	REMARKS
		<u>RI, 2, 3</u>	
		00205 Preferred orientation selected but not specified	
		00206 Zero encode not allowed with coarse align to gimbal lock	
		00207 ISS turn on request not present for 90 seconds	
		00210 IMU not operating	
		00211 Coarse align error	
		00212 PIPA fail but PIPA not in use	
		00213 IMU not operating with turn on request	
		00214 Program using IMU when IMU turned off	
		00215 Orientation not specified	
		00216 Band PIPA reading	
		00217 Band return from stall routines	
		00220 Bad REFSMMAT	
		*00401 Desired gimbal angles yield gimbal lock ($>70^\circ$)	
		00404 Target out of view	
		00405 Two stars not available	
		00406 Rendezvous navigation not operating	
		00420 Third call to orbital integration	
		00421 W-matrix overflow	
		00501 Radar antenna out of limits	
		00502 Bad radar gimbal angle input	
		00503 Radar antenna designate fail	
		00510 Radar automatic discrete not present	
		00514 Radar goes out of automatic mode while in use	
		00515 RR CDU fail discrete present	
		00520 RADARUPT not expected at this time	
		00521 Cannot read radar	
		00525 $\Delta\theta > 3^\circ$	
		00526 Range > 400 nm	
		00527 RR out of limits in R23	
		00600 Imaginary roots on first iteration	
		00601 Hp (CSI) < 85 nm	
		00602 Hp (CDH) < 85 nm	
		00603 CSI to CDH time < 10 minutes	
		00604 CDH to TPI time < 10 minutes	
		00605 Number of iterations exceeds loop maximum	
		00606 ΔV exceeds maximum	
		00610 Computed CDH time greater than input TPI time	
		00611 No TIG for given elevation angle	
		01102 LGC self-test error	
		*01103 Unused CCS branch executed	

4.4.7 ALARM CODES (V05 N09) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS																					
		<u>RI, 2, 3</u> *01104 Delay routine busy 01105 Downlink too fast 01106 Uplink too fast 01107 Phase table failure. Assume erasable memory destroyed 01110 Restart with no active phase 01111 Restart with active phase *01201 Executive overflow, no VAC areas *01202 Executive overflow, no core sets *01203 Waitlist overflow, too many tasks *01206 Second job attempts to go to sleep via DSKY program *01207 No VAC area for marks *01210 Two programs using device at the same time 01211 Illegal interrupt of extended verb *01301 ARCSIN-ARCCOS input angle too large *01302 SQRT called with negative argument 01406 Thrust misalign > 90° 01407 VG increasing 01411 CDU does not agree with command within one degree *01501 DSKY alarm during internal use *01502 Illegal flashing display 01520 V37 request not permitted at this time 01550 V46 inoperative when TVC DAP is on 01600 Overflow and drift test *01601 Bad IMU torque 01703 <45 seconds to ignition 01704 PGNCS automatic mode not selected 01705 DAP hold flag not set 01706 Stage verify discrete does not agree with N46 01707 Checklist 00203 not performed 4.4.8 STAR CODES <table><tr><td></td><td></td><td><u>No.</u></td></tr><tr><td>Acamar</td><td>(θ Eridani)</td><td>6</td></tr><tr><td>Achernar</td><td>(α Eridani)</td><td>4</td></tr><tr><td>Acrux</td><td>(α Crucis)</td><td>25</td></tr><tr><td>Aldebaran</td><td>(α Tauri)</td><td>11</td></tr><tr><td>Alkaid</td><td>(η Ursae Majoris)</td><td>27</td></tr><tr><td>Alphard</td><td>(α Hydrae)</td><td>21</td></tr></table>			<u>No.</u>	Acamar	(θ Eridani)	6	Achernar	(α Eridani)	4	Acrux	(α Crucis)	25	Aldebaran	(α Tauri)	11	Alkaid	(η Ursae Majoris)	27	Alphard	(α Hydrae)	21	 <
		<u>No.</u>																						
Acamar	(θ Eridani)	6																						
Achernar	(α Eridani)	4																						
Acrux	(α Crucis)	25																						
Aldebaran	(α Tauri)	11																						
Alkaid	(η Ursae Majoris)	27																						
Alphard	(α Hydrae)	21																						

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CREW-MAN	PNL	PROCEDURES	REMARKS
		No. Alphecca (α Coronae Borealis) 32 Alpheratz (α Andromedae) 1 Altair (α Aquilae) 40 Antares (α Scorpii) 33 Arcturus (α Bootis) 31 Atria (α Trianguli Austrinus) 34 Canopus (α Carinae) 14 Capella (α Aurigae) 13 Dabih (β Capricorni) 41 Deneb (α Cygni) 43 Denebola (β Leonis) 23 Diphda (β Ceti) 2 Dnoces (δ Ursae Majoris) 20 Enif (ε Pegasi) 44 Fomalhaut (α Piscis Austrinus) 45 Gienah (γ Corvi) 24 Menkar (α Ceti) 7 Menkent (θ Centauri) 30 Mirfak (α Persei) 10 Navi (γ Cassiopeiae) 3 Nunki (σ Sagittarii) 37 Peacock (α Pavonis) 42 Polaris (α Ursae Minoris) 5 Procyon (α Canis Minoris) 16 Rasalhague (α Ophiuchi) 35 Regor (γ Velorum) 17 Regulus (α Leonis) 22 Rigel (β Orionis) 12 Sirius (α Canis Majoris) 15 Spica (α Virginis) 26 Vega (α Lyrne) 36 4.4.9 AOT DETENT CODES F - Front (AB2DE) L - Left (AB1DE) R - Right (AB3DE) RR - Rear right (AB4DE) RL - Rear left (AB4DE) CL - Close (AB4DE) COAS (AB5DE)	

4.4.8 STAR CODES/4.4.9 AOT DETENT CODES

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CREW- MAN	PNL	PROCEDURES	REMARKS																														
		Alternate LOS definition values N41 COAS (overhead window) R1 Azimuth 000.00° R2 Elevation 090.00° R3 ----- COAS (foreward window) R1 Azimuth 000.00° R2 Elevation 000.00° R3 ----- AOT (RR) R1 Azimuth 120.00° ±Δ R2 Elevation 45.00° ±Δ R3 ----- AOT (RL) R1 Azimuth 240.00° ±Δ R2 Elevation 45.00° ±Δ R3 ----- AOT (CL) R1 Azimuth 180.00° ±Δ R2 Elevation 45.00° ±Δ R3 ----- 4.4.10 AGS SELECTOR LOGIC LIST <table><tr><th>Address</th><th>Entry</th><th></th></tr><tr><td>400</td><td>+00000</td><td>Attitude hold</td></tr><tr><td></td><td>+10000</td><td>Guidance Steering</td></tr><tr><td></td><td>+20000</td><td>Acquisition steering</td></tr><tr><td></td><td>+30000</td><td>IMU align</td></tr><tr><td></td><td>+40000</td><td>Lunar align</td></tr><tr><td></td><td>+50000</td><td>Body axis align</td></tr><tr><td></td><td>+60000</td><td>Gyro and accelerometer calibration</td></tr><tr><td></td><td>+70000</td><td>Accelerometer only calibration</td></tr><tr><td>407</td><td>+10000</td><td>Freeze external ΔV in inertial space</td></tr></table>	Address	Entry		400	+00000	Attitude hold		+10000	Guidance Steering		+20000	Acquisition steering		+30000	IMU align		+40000	Lunar align		+50000	Body axis align		+60000	Gyro and accelerometer calibration		+70000	Accelerometer only calibration	407	+10000	Freeze external ΔV in inertial space	
Address	Entry																																
400	+00000	Attitude hold																															
	+10000	Guidance Steering																															
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	+30000	IMU align																															
	+40000	Lunar align																															
	+50000	Body axis align																															
	+60000	Gyro and accelerometer calibration																															
	+70000	Accelerometer only calibration																															
407	+10000	Freeze external ΔV in inertial space																															

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CREW-MAN	PNL	PROCEDURES		REMARKS
		<u>Address</u>	<u>Entry</u>	
		410	+00000 +10000 +20000 +30000 +40000 +50000	Orbit insertion CSI CDH TPI search TPI execute External ΔV
		411	+00000 +10000	DPS or RCS computation selection APS computation selection
		412	+00000	Reinitiate AGS self test
		413	+10000	Reset Lunar surface flag and store azimuth
		414	+00000 +10000 +20000 +30000	Navigation initialization complete LM and CSM navigation initialization via PGNCs downlink LM navigation initialization via DEDA CSM navigation initialization via DEDA
		415	+00000 +10000	Program reset. Normal value of the store Z-axis direction cosines command Store Z-axis direction cosines
		416	+00000 +10000 +20000	Select CDH at first apsidal crossing Select CDH at second apsidal crossing Select CDH at third apsidal crossing
		417	+00000 +10000	Select CDH at apsidal crossing Select CDH from $+180^\circ$ to 360° CSI per address 416
		455	+00000 +10000	Lunar scaling for RANGE RATE: ALT RATE meter Earth scaling for RANGE RATE: ALT RATE meter
		456	+00000 +10000	Normal TPI Create node 90° down range from TPI
				Guidance routines
				Allows coplanar burn at midcourse if done at 90° .

4.4.10 AGS SELECTOR LOGIC LIST (cont)

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CREW- MAN	PNL	PROCEDURES			REMARKS
		4.4.11 DEDA INPUT LIST			
		<u>Address</u>	<u>Quantization</u>		
		047	-	Sine of landing azimuth angle	
		053	-	Cosine of landing azimuth angle	
		147	-	Target of LOS between LM and CSM at desired TPI time	
		231	1000 ft	Radial distance of launch site from center of Earth	
		232	1000 ft	Targeted injection altitude at orbit insertion	
		233	1000 ft	Vertical pitch steering altitude threshold	
		240	1000 ft	X component of LM position	
		241	1000 ft	Y component of LM position	
		242	1000 ft	Z component of LM position	
		244	1000 ft	X component of CSM position	
		245	1000 ft	Y component of CSM position	
		246	1000 ft	Z component of CSM position	
		254	0.1 min	Epoch time of LM emphemeris data	
		260	1 fps	X component of LM velocity	
		261	1 fps	Y component of LM velocity	
		262	1 fps	Z component of LM velocity	
		264	1 fps	X component of CSM velocity	
		265	1 fps	Y component of CSM velocity	

4.4.11 DEDA INPUT LIST

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CREW-MAN	PNL	PROCEDURES			REMARKS
		<u>Address</u>	<u>Quantization</u>		
		266	1 fps	Z component of CSM velocity	
		272	0.1 min	Epoch time of CSM ephememeris data	
		275	0.1 min	AGS computer time of CSI maneuver (tigA)	
		300	0.1 min	TPI time	
		310	0.01 min	Rendezvous offset time	
		311	0.01 min	Time from TPI to rendezvous	
		313	0.01 min	Time increment in TPI search routine (Δt)	Valid in CSI, CDH, or TPI.
		316	0.1 nm	Radar range	
		373	0.1 min	AGS computer time of TPI maneuver (tigC)	
		377	0.1 min	AGS computer time (t)	
		450	1 fps	External ΔV component in horizontal direction parallel to CSM orbit plane.	A + display indicates VG in posigrade direction.
		451	1 fps	External ΔV component in horizontal direction perpendicular to CSM orbit plane. (ΔV_y)	A + display indicates VG opposite to LM angular momentum vector.
		452	1 fps	External ΔV component in radial direction.	A + display indicates VG toward Earth.
		503	1 fps	Radar range rate	
		504	1 fps	Vertical pitch steering altitude rate threshold	
		505	1 fps	Target radial rate at orbit insertion	
		506	1 fps	Targeted horizontal velocity at orbit insertion	

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CREW-MAN	PNL	PROCEDURES			REMARKS
		<u>Address</u>	<u>Quantization</u>		
		540	-	X axis accelerometer bias	
		541	-	Y axis accelerometer bias	
		542	-	Z axis accelerometer bias	
		544	0.01°/hr	X gyro drift compensation constant	
		545	0.01°/hr	Y gyro drift compensation constant	
		546	0.01°/hr	Z gyro drift compensation constant	
		547	-	Lunar align azimuth correction	
		4.4.12 DEDA OUTPUT LIST			
		<u>Address</u>	<u>Quantization</u>		
		172	0.1 nm	Perigee altitude of predicted LM trajectory (q1)	
		211	1000 ft	Out-of-plane position	
		263	1 fps	Out-of-plane velocity (Vpy)	
		270	1 fps	LM velocity normal to CSM orbit plane (Vyo)	
		274	0.1 min	Time from CDH to TPI (TC)	
		275	0.1 min	AGS computer time of CSI maneuver (tigA)	
		300	0.1 min	TPI time	
		304	0.01°	Angle between Z body axis and local horizon (ξ)	
		305	0.01°	CSI iteration error (Co)	

4.4.11 DEDA INPUT LIST/4.4.12 DEDA OUTPUT LIST

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CREW- MAN	PNL	PROCEDURES			REMARKS
		Address	Quantization		
		306	0.01°	Predicted LOS angle at TPI time (θ LOS)	Valid in TPI only
		311	0.01 min	Time from TPI to rendezvous	
		313	0.01 min	Time to CDH in CSI mode ($T\Delta$)	
		314	0.01 min	Time to rendezvous (Tr)	Valid in TPI only
		317	0.1 nm	LM to CSM range (R)	
		337	0.1 nm	LM altitude (h)	
		340	1000 ft	X component of LM position (rx)	
		341	1000 ft	Y component of LM position (ry)	
		342	1000 ft	Z component of LM position (rz)	
		343	0.1 nm	Perigee altitude of LM trajectory (q)	
		344	1000 ft	X component of CSM position (rcx)	
		345	1000 ft	Y component of CSM position (rcy)	
		346	1000 ft	Z component of CSM position (rcz)	
		347	1000 ft	Predicted orbit insertion burnout radius (rf)	
		360	1 fps	X component of LM velocity (Vx)	
		361	1 fps	Y component of LM velocity (Vy)	
		362	1 fps	Z component of LM velocity (Vz)	
		364	1 fps	X component of CSM velocity (Vcx)	
		365	1 fps	Y component of CSM velocity (Vcy)	
		366	1 fps	Z component of CSM velocity (Vcz)	

4.4.12 DEDA OUTPUT LIST (cont)

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CREW-MAN	PNL	PROCEDURES			REMARKS
		<u>Address</u>	<u>Quantization</u>		
		367	1 fps	LM altitude rate	
		370	1 fps	Magnitude of LM velocity to be gained (VG)	
		371	1 fps	CDH maneuver ΔV (Vpo)	Valid in CSI guidance mode
		371	1 fps	Velocity to rendezvous (VT)	Valid during direct intercept only
		373	0.1 min	Time from CSI to CDH	
		377	0.1 min	AGS computer time (t)	
		402	0.1 nm	Differential altitude in coelliptic orbit (Δh)	
		404	1 fps	Minus descent stage capability + ΔV expended (Vdx)	
		423	1 fps	Desired final altitude rate	
		433	1 fps	Magnitude of LM velocity (V)	
		440	1 fps	Range rate between LM and CSM	A - display indicates LM closing on CSM
		441	1 fps	LM velocity normal to CSM orbit plane (Vy)	
		463	1 fps	Rate of predicted radial velocity at CSI	
		470	1 fps	Plus ΔV expended since AGS turn on (VDx)	
		500	1 fps	ΔV in X direction (ΔV_{gx})	
		501	1 fps	ΔV in Y direction (ΔV_{gy})	
		502	1 fps	ΔV in Z direction (ΔV_{gz})	
		507	1 fps	ΔV for CSI maneuver (VO)	

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CREW- MAN	PNL	PROCEDURES		REMARKS
		<u>Address</u>	<u>Quantization</u>	
		574	-	Descent section staging flag
		604	-	Lunar surface flag
		611	1 fps	Predicted value of altitude rate
		612	-	Staging sequence counter
		4.4.13 DEDA ACCESSIBLE CONSTANTS LIST		
		<u>Address</u>	<u>Quantization</u>	
		217	1000 ft	Initial p perturbation
		223	1000 fps	Constant in linear expression for final altitude rate as a function of final altitude
		230	1000 ft	(Δp) limiter
		454	1 fps	VG threshold on engine cutoff computations
		473	1 fps	Descent stage ΔV bias
		526	Octal	Set value of VT
		527	Octal	Upper limit on final altitude rate
		534	Octal	Compensation and scale factor constant for X axis accelerometer
		535	Octal	Compensation and scale factor constant for Y axis accelerometer
		536	Octal	Compensation and scale factor constant for Z axis accelerometer
		537	Octal	Compensation constant for X gyro spin axis mass unbalanced drift

4.4.12 DEDA OUTPUT LIST/4.4.13 DEDA ACCESSIBLE CONSTANTS LIST

CREW- MAN	PNL	PROCEDURES		REMARKS
		<u>Address</u>	<u>Quantization</u>	
		540	Octal	Compensation constant for X axis accelerometer bias
		541	Octal	Compensation constant for Y axis accelerometer bias
		542	Octal	Compensation constant for Z axis accelerometer bias
		544	0.01°/hr	X gyro drift compensation
		545	0.01°/hr	Y gyro drift compensation
		546	0.01°/hr	Z gyro drift compensation
		550	Octal	X gyro attitude rate scale factor error compensation
		551	Octal	Y gyro attitude rate scale factor error compensation
		552	Octal	Z gyro attitude rate scale factor error compensation
		555	Octal	Limit on derivative of yaw acceleration
		556	Octal	Lower limit on derivative of radial acceleration
		564	Octal	Lower limit on $\Delta 6$
		565	Octal	Initial value and limit of $\Delta 6$
		566	Octal	Engine cant angle in pitch plane
		602	Octal	Engine cant angle in yaw plane
		616	Octal	Number of 2-sec cycles for ullage test delay
		617	Octal	Gyro calibrate duration

4.4.13 DEDA ACCESSIBLE CONSTANTS LIST (cont)

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CREW- MAN	PNL	PROCEDURES			REMARKS
		Address	Quantization		
		620	Octal	Controls iterations of p iterator	
		621	Octal	Accelerometer calibrate time	
		622	Octal	Staging times (1 count per 40 msec) to maintain attitude hold momentarily after staging	
		624	Octal	Constant in altitude and altitude rate 200 msec readout	
		625	Octal	FDAI computation singularity region	
		626	Octal	X axis alignment gain	
		627	Octal	Lunar align	
		630	Octal	Lunar align	
		631	Octal	Lunar align stop, error criterion	
		632	Octal	Calibrate gain	
		633	Octal	Calibrate gain	
		634	Octal	Navigation sensed velocity threshold	
		635	Octal	Accelerometer calibrate gain	
		636	Octal	Gravitational constant	
		637	Octal	Gravitational constant reciprocal	
		641	Octal	Filter velocity uncertainty term	
		642	Octal	Coefficient in linear expression for final altitude rate as a function of final altitude	
		643	Octal	Coefficient in evaluation of cost	

4.4.13 DEDA ACCESSIBLE CONSTANTS LIST (cont)

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CREW- MAN	PNL	PROCEDURES			REMARKS
		<u>Address</u>	<u>Quantization</u>		
		644	Octal	Decrease $\Delta 6$ factor	
		645	Octal	Increase $\Delta 6$ factor	
		646	Octal	Error term in radar filter	
		647	Octal	Velocity to be gained threshold	
		651	Octal	Initial position error variance	
		652	Octal	Initial velocity error variance	
		653	Octal	Radar error model	
		654	Octal	TB computation factor	
		655	Octal	TB computation factor	
		657	Octal	Ascent engine cutoff impulse compensation	
		660	Octal	Lower limit on aT	
		661	Octal	Ullage threshold	
		666	Octal	Body attitude error limit	
		673	Octal	Product of lunar rotation rate and 20 msec compute cycle period	Readout is 00000 for Earth-orbital missions

4.5 GUIDANCE AND CONTROL

4.5.1 GENERAL INSTRUCTIONS

The following conditions and restrictions apply to the guidance and control procedures. Failure to establish these conditions or observe the restrictions could adversely affect crew safety, subsystem operation, and completion of the mission. The reasons given for conditions are valid unless a particular procedure specifies otherwise.

- The ENG THR CONT: BAL CPL sw should be set to ON during all mission phases, except during APS engine burns. This permits the RCS to aid in APS engine thrust if under AGS control.
- The X POINTER SCALE sw should be set to HI MULT if the associated RATE/ERR MON sw is set to RNDZ RADAR during manual slewing of the rendezvous radar. This prevents damage to the X-pointer ind needles.
- The DES ENG CMD OVRD sw should be set to ON during DPS engine thrust. This prevents premature DPS engine shutdown if DECA power is lost.
- The S/C: DEAD BAND sw provides narrow deadband when set to MIN during MPS thrusting. This switch is not functional when PGNCS is in control.
- Use of the DSKY is restricted as follows:

For display verbs 01 through 07, monitor verbs 11 through 17, and load verbs 21 through 25, the number of components of the verb must not exceed the number of components of the noun being used. If this restriction is not observed, the OPR ERR lt goes on.

Mixing of octal and decimal data in multicomponent load verbs is not permitted. Data components must be all decimal or all octal.

Machine addresses loaded must be in octal form.

The magnitude of data being loaded should not exceed that of the noun being used. If this restriction is not observed, the OPR ERR lt goes on.

Decimal data must be preceded by a sign (+ or -) and the data word must contain five digits. If the data word does not have five digits, zeroes must be entered before the most significant digits.

For displays of time only, three data words must be loaded (for hours, minutes, and seconds).

All data loads must be verified before pressing the ENTR pb for last register being loaded. If any data are incorrect, the register can be cleared by pressing the CLR pb. Each successive pressing of the CLR pb clears the preceding register. This backing-up action occurs only on components called by the load verb.

4.5.1 GENERAL INSTRUCTIONS

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CREW-MAN	PNL	PROCEDURES	REMARKS
		Flashing VERB/NOUN requires operator action. The program in progress is halted until appropriate action is taken. Use of the DEDA is restricted as follows: The CLR pb must be pressed before every DEDA entry. All addresses are in octal form. They must not exceed the number 704 (highest numbered address). A sign (+ or -) must be entered after the address when loading data. An octal quantity with a digit greater than 7 or a number greater than the allowable range of the address, must not be entered.	
	11	4.5.2 G&C BASIC 1. CB/AC BUS B: ORDEAL - close AGS - close AOT LAMP - open SE FDAI - close NUM LTG - close CB/AC BUS A: AOT LAMP - open RNDZ RDR - open DECA GMBL - close CB FLT DISP: THRUST - close MISSION TIMER - close CDR X PNTR - close RNG/RNG RT - close GASTA - close CDR FDAI - close COAS - close ORDEAL - close CB/AC BUS A: RNG/RNG RT - close GASTA - close CDR FDAI - close	

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CREW- MAN	PNL	PROCEDURES	REMARKS
	11	CB HTR: RNDZ RDR STDBY - close RNDZ RDR OPR - close LDG RDR - close AOT - close CB S/C: ABORT STAGE - close ATCA PGNS - close AELD - close ENG CONT - close ATT DIR CONT - close ENG START OVRD - close DECA PWR - close CB PGNS: SIG STR DISP - close LDG RDR - open RNDZ RDR - open LGC/DSKY - close IMU STBY - close IMU OPR - close 2. (ORDEAL) FDAI 1 sw - INRTL FDAI 2 sw - INRTL EARTH/LUNAR sw - PWR OFF LTG sw - OFF MODE sw - HOLD/FAST SLEW sw - center 8 3. COAS sw - OFF 5 4. MSN TMR: TMR CONT sw - START Eng START pb/lt - off Eng STOP pb/lt - reset/off 1 5. X POINTER SCALE sw - HI MULT RATE/ERR MON sw - LDG RDR/CMPTR ATTITUDE MON sw - PGNS GUID CONT sw - PGNS MODE SEL sw - AGS RNG/ALT MON sw - RNG/RNG RT	

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CREW-MAN	PNL	PROCEDURES	REMARKS
	1	SHAFT TRUN X sw - $\pm 50^\circ$ RATE SCALE sw - $25^\circ/\text{SEC}$ IMU CAGE sw - OFF ENG THR CONT: THR CONT sw - AUTO MAN THROT sw - CDR ENG ARM sw - OFF X TRANSL sw - 2 JETS BAL CPL sw - ON ABORT pb - reset (flush) ABORT STAGE pb - reset (flush)	
	2	6. RATE/ERR MON sw - RNDZ RADAR ATTITUDE MON sw - AGS RCCA sw - OFF/RESET	
	3	7. ENG GMBL sw - ENABLE DES ENG CMD OVRD sw - OFF RADAR: LDG ANT sw - AUTO RADAR TEST sw - OFF RADAR: TEST MON sel - AGC RNDZ RADAR sel - LGC RADAR: SLEW RATE sw - HI S/C: DEAD BAND sw - MIN GYRO TEST ROLL sw - ROLL GYRO TEST POS RT sw - OFF PITCH sw - MODE CONT ROLL sw - MODE CONT YAW sw - MODE CONT MODE CONTROL sel - AUTO X POINTER SCALE sw (LMP) - HI MULT	
	4	8. ACA/4 JET sw (CDR) - ENABLE TTCA/TRANSL sw (CDR) - ENABLE ACA /4 JET sw (LMP) - ENABLE TTCA/TRANSL sw (LMP) - ENABLE	
	6	9. AGS STATUS sw - OPERATE ENG STOP pb/lt - reset/off	
	16	10. CB FLT DISP: EVNT TMR/SE FDAI - close SE X PNTR - close	

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CREW- MAN	PNL	PROCEDURES	REMARKS
	16	CB S/C: - AEA - close - ENG ARM - close - ASA - close - AELD - close - ATCA - close - ABORT STAGE - close - ATCA (AGS) - close - DES ENG OVRD - open - CB HTR: DISP - close 11. (TTCA) - THROTTLE/JETS cont (CDR) - THROTTLE - TTCA (CDR) - minimum - THROTTLE/JETS cont (LMP) - JETS 12. Crew Optical Alignment Sight (COAS) - left window 13. (AOT) - AOT ind - 000.0° - Azimuth control - CL 4.5.3 THRUSTER GEOMETRY Table 4-6 is a general listing of the basic RCS engine logic for the translation and rotation maneuvers of the LM. Under DAP control the jets selected for a particular maneuver are arranged so that the first entry is the optimum selection for the specified maneuver. Figure 4-1 illustrates the RCS thruster geometry.	

Table 4-6. RCS Jet Select Logic

Maneuver	B 4 U	A 4 D	B 4 F	A 4 R	A 3 U	B 3 D	B 3 A	A 3 R	B 2 U	A 2 D	A 2 A	B 2 L	A 1 U	B 1 D	A 1 F	B 1 L
A. AUTO DAP CONTROL																
Pitch up (+ θ)		X			X				X					X		
		X			X					X					X	
			X			X								X		
Pitch down (- θ)		X				X				X				X		
		X					X				X			X		
		X						X				X		X		
Roll right (+ ψ)		X			X		X			X					X	
		X				X					X			X		
		X				X					X					
Roll left (- ψ)			X			X			X			X		X		
			X			X			X					X		
			X				X			X					X	
Roll right, pitch up					X									X	X	
															X	
Roll left, pitch down					X		X							X		
						X										
	X									X						
	X									X						
Roll left, pitch up			X						X							
			X													
+ X Translation & Ullage			X			X				X					X	
						X									X	
- X Translation	X		X		X				X				X			
	X				X				X				X			

Maneuver	B 4 U	A 4 D	B 4 F	A 4 R	A 3 U	B 3 D	B 3 A	A 3 R	B 2 U	A 2 D	A 2 A	B 2 L	A 1 U	B 1 D	A 1 F	B 1 L
B. MANUAL CONTROL, PGNCs MODE (ACA & TTCA)																
Pitch up (+ θ)			X		X											
Pitch down (- θ)	X					X										
Roll right (+ ψ)	X					X									X	
Roll left (- ψ)							X			X						
Yaw right (- θ)											X					X
Yaw left (+ θ)				X				X				X			X	
+ X Translation (4 jets)				X				X			X				X	
+ X Translation (2 jets)			X				X								X	
- X Translation (4 jets)	X					X				X				X		
- X Translation (2 jets)						X								X		
+ Y Translation												X				X
- Y Translation				X				X								
+ Z Translation								X			X					
- Z Translation				X											X	
C. MANUAL CONTROL, AGS MODE (ACA & TTCA)																
Pitch up (+ θ)										X					X	
Pitch down (- θ)											X			X		
Roll right (+ ψ)						X					X					
Roll left (- ψ)							X			X						
Yaw right (- θ)				X								X				X
Yaw left (+ θ)					X			X					X		X	
+ X Translation (4 jets)			X					X			X				X	
+ X Translation (2 jets)								X							X	
- X Translation (4 jets)	X					X				X				X		
- X Translation (2 jets)						X								X		
+ Y Translation												X				X
- Y Translation				X				X								
+ Z Translation								X			X					
- Z Translation				X											X	

4.5.3 THRUSTER GEOMETRY (cont)

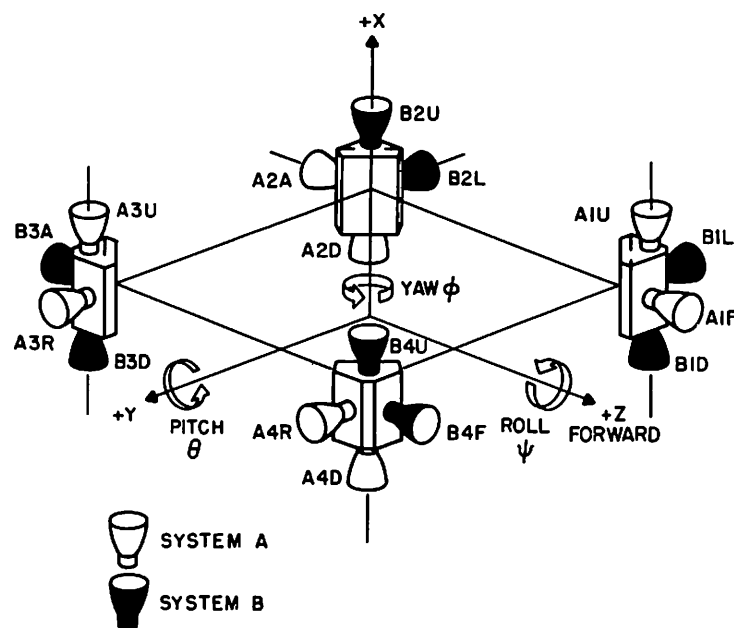


Figure 4-1. RCS Thrust Geometry

4.5.3 THRUSTER GEOMETRY (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		4.5.4 FINAL AUTOMATIC REQUEST TERMINATE ROUTINE (R00) 1. Routine selected by program being terminated 2. FL V50 N07 - Please perform program change 3. Key V37E XXE - Desired program 4. R00 exits to selected program 4.5.5 LGC IDLING PROGRAM (P00) 1. Key V37E 00E 2. PGNCS attitude control is available by standard RCS DAP procedures 3. Orbit parameters will be displayed by selecting R30 4. PGNCS data will be displayed by using standard DSKY procedures 5. To review LGC erasable memory, proceed as follows: a. V01 N01E Key octal identifier of desired register ENTR R1 Register content R2 ----- R3 Register address b. N15E for next register c. ENTR for each successive register 6. To change LGC erasable memory, proceed as follows: a. V21 N01E Key octal identifier of desired register ENTR R1 Loaded data R2 ----- R3 Register address Key data (R1 content) ENTR	Routine 00 provides a standard exit for programs and an option to select any desired program. Program 00 provides an indication to the crew that the LGC is engaged in no control or computational operations which might require consideration for coordination with other crew tasks in progress. The LGC is maintained in a condition of readiness for entry into any other program. Ref para 4.6.5.

4.5.4 FINAL AUTOMATIC REQUEST TERMINATE ROUTINE (R00)/4.5.5 LGC IDLING PROGRAM (P00)

4.5.5 LGC IDLING PROGRAM (P00)/4.5.6 AGS INITIALIZATION ROUTINE (R47)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		6. Key DEDA - AGS computer time C 377 + 00000 (Do not enter) 7. Key ENTR on DSKY and DEDA simultaneously 8. FL V06 N-- - GET at AEA clock zero (K) R1 00XXX hr R2 000XX min R3 0XX.XX sec Accept: Record K PRO Reject: Use MSFN value of time or use time from last P02, record and V25E - Load value 9. Key DEDA - AGS update C 414R (Displays 00000 when AGS initialization complete) 4.5.7 AGS INITIALIZATION (SUPPLEMENTARY) 1. Receive and record Wb vector if available from MSFN; go to step 5. If Wb vector not available, go to step 2 2. Key DEDA - Wcx C 054R (1 fps) Record Wcx 3. Key DEDA - Wcy C 055R (1 fps) Record Wcy 4. Key DEDA - Wcz C 056R (1 fps) Record Wcz 5. Key DEDA - Wbx C 124 ± XXXXXE (1 fps) 6. Key DEDA - Wby C 125 ± XXXXXE (1 fps) 7. Key DEDA - Wbz C 126 ± XXXXXE (1 fps)	DSKY displays K for approximately 20 seconds. The AGS initialization supplementary procedure can be used following update of CSM state vector in AGS (manual or PGNCs downlink), first update after standby, or if CSM thrusts to change orbit.

4.5.6 AGS INITIALIZATION ROUTINE (R47)/4.5.7 AGS INITIALIZATION (SUPPLEMENTARY)

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CREW-MAN	PNL	PROCEDURES	REMARKS																																				
		4.5.8 LGC SELF TEST 1. Zero SCOUNT and ERCOUNT registers Key V21 E N01E 1765E 00000E - ERCOUNT N15E 00000E - SCOUNT N15E 00000E - SCOUNT + 1 N15E 00000E - SCOUNT + 2 2. Key V21 N27 E AAAAAE where AAAAA = Repeated <table><thead><tr><th>One cycle</th><th>Cycles</th><th>Check</th></tr></thead><tbody><tr><td>00001</td><td>77776</td><td>Internal computer</td></tr><tr><td>00002</td><td>77775</td><td>Internal computer</td></tr><tr><td>00003</td><td>77774</td><td>Internal computer</td></tr><tr><td>00004</td><td>77773</td><td>Erasable memory</td></tr><tr><td>00005</td><td>77772</td><td>Fixed memory</td></tr><tr><td>00006</td><td>77771</td><td>Internal computer</td></tr><tr><td>00007</td><td>77770</td><td>Internal computer</td></tr><tr><td>00010</td><td>77767</td><td>Internal computer</td></tr><tr><td>00011</td><td>77766</td><td>Backup idle mode</td></tr><tr><td>00000</td><td>-</td><td>Backup idle mode</td></tr><tr><td>-</td><td>77777</td><td>Internal computer</td></tr></tbody></table> 3. Key V15 N01E 1366E SCOUNT register XXXXX SCOUNT +1 register XXXXX SCOUNT +2 register XXXXX LGC self check (00010, 77767, 77777) successfully completed: R3 increments + 1 Key V21 N27E 00010E Key V37E 00E - P00 LGC self-check error: PROG It - on Key V15 N01E 1363E (Failure register) R1 01102 - Self-check error Key V15 N01E 1364E (Failure address) R1 XXXXX - Address +1 of where last error occurred Determine next step with MSFN	One cycle	Cycles	Check	00001	77776	Internal computer	00002	77775	Internal computer	00003	77774	Internal computer	00004	77773	Erasable memory	00005	77772	Fixed memory	00006	77771	Internal computer	00007	77770	Internal computer	00010	77767	Internal computer	00011	77766	Backup idle mode	00000	-	Backup idle mode	-	77777	Internal computer	If the LGC detects an error during one cycle selection, the computer goes to idle, otherwise, it repeats test. If the LGC detects an error during repeated cycles, the computer tries test again, otherwise, it repeats test. Appropriate alarm lights go on and LGC completes self check.
One cycle	Cycles	Check																																					
00001	77776	Internal computer																																					
00002	77775	Internal computer																																					
00003	77774	Internal computer																																					
00004	77773	Erasable memory																																					
00005	77772	Fixed memory																																					
00006	77771	Internal computer																																					
00007	77770	Internal computer																																					
00010	77767	Internal computer																																					
00011	77766	Backup idle mode																																					
00000	-	Backup idle mode																																					
-	77777	Internal computer																																					

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR	4	4.5.9 TARGET ΔV ROUTINE (R32) 1. Key V84E 2. FL V06 N84 - ΔV (OV) R1 X XXXX. X fps R2 Y XXXX. X fps R3 Z XXXX. X fps Accept: PRO Reject: V25E - Load correct value of ΔV (OV) 3. FL V06 N34 - TIG (OV) R1 00XXX hr R2 000XX min R3 0XX. XX sec Accept: PRO Reject: V25E - Load correct value of TIG (OV)	The purpose of Routine 03 is to notify the LGC of orbital parameter changes by the CSM and to provide the ΔV for a CSM state vector update in the LGC. Routine 32 should be performed before a CSM maneuver with calculated data and after the maneuver with actual data.
	1&2 1 2	4.5.10 DSKY LIGHTS TEST (V35) 1. Key V35E - DSKY lights test 2. MASTER ALARM pb/lt - on LGC warn lt - on ISS warn lt - on PGNS caut lt - on 3. UPLINK ACTY lt - on NO ATT lt - on STBY lt - on KEY REL lt - on OPR ERR lt - on TEMP lt - on GIMBAL LOCK lt - on PROG lt - on RESTART lt - on TRACKER lt - on PROG ind - 88 VERB ind - 88 flashes NOUN ind - 88 flashes	

4.5.9 TARGET ΔV ROUTINE (R32)/4.5.10 DSKY LIGHTS TEST (V35)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	1 & 2	R1 +88888 R2 +88888 R3 +88888 4. MASTER ALARM pb/lt - reset 5. After 5 seconds MASTER ALARM pb/lt - off LGC warn lt - off ISS warn lt - off PGNS caut lt - off UPLINK ACTY lt - off NO ATT lt - off STBY lt - off KEY REL lt - off OPR ERR lt - off TEMP lt - off GIMBAL LOCK lt - off PROG lt - off RESTART lt - off TRACKER lt - off PROG ind - 00 VERB ind - -- NOUN ind - -- R1 ---- R2 ---- R3 ---- 4.5.11 DOWNLINK OCTAL DUMP 1. LGC operating 2. Key V21 N01E 1120E Key 40000E for one complete downlink dump Key 10000E for two complete downlink dumps Key 20000E for four complete downlink dumps 3. Key V74E	One complete downlink dump $\approx$ 20.8 sec Two complete downlink dumps $\approx$ 41.6 sec Four complete downlink dumps $\approx$ 83.2 sec

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR		4.5.12 ORDEAL INITIALIZATION - Set controls G&C basic except Ordeal: FDAI 1 or FDAI 2 sw - ORB RATE EARTH/LUNAR sw - EARTH - If not previously selected, V46E - PGNCs control, maximum deadband - Obtain altitude setting by selecting one of the following: R30 - Orbit Parameter Display Routine P21 - Ground Track Determination Program Obtain altitude setting from MSFN - ALT SET cont - adjust to setting determined in step 3 - Load DAP data (R03) V48E, select minimum deadband Go to step 6 if under AGS control - If under AGS control, S/C: DEAD BAND sw - MIN - Key V83E (R31 - Request Rendezvous Parameter Display Routine.) Go to step 9 if under AGS control - FL V06 N54 R1 Range XXXX.XX nm R2 Range rate XXXX.X fps R3 θ XXX.XX° V34E - Terminate R31 when finished - If under AGS control, Key DEDA - ζ C 307R (.01°)	The purpose of this procedure is to align one or both FDAI's to local vertical coordinates. Ref para 4.6.2. θ (LGC) and ζ (DEDA) is the angle between the + Z axis and the local horizontal plane. Positive display indicates + Z axis above the plane.

4.5.12 ORDEAL INITIALIZATION

G&C

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4.5.12 ORDEAL INITIALIZATION/4.5.13 AGS CALIBRATION

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CREW- MAN	PNL	PROCEDURES	REMARKS
LMP		7. Key DEDA - Accelerometer calibration C 400 + 70000E 8. Key DEDA - Accelerometer calibration status C 400R (+00000 = Calibration complete) 9. Key DEDA - Accelerometer bias compensation C 540R (octal) - X accelerometer C 541R (octal) - Y accelerometer C 542R (octal) - Z accelerometer Compare accelerometer bias compensation values of step 2 with those of step 9. Nominal variation <u>TBD</u> 4.5.14 AGS MANUAL ABSOLUTE TIME INITIALIZATION 1. Key DEDA - AGS computer time C 377 + 00000E 2. Receive and record AGS time bias from MSFN 3. Receive and record LM and CSM state vectors for navigation initialization 4.5.15 AGS MANUAL STATE VECTOR UPDATE 1. Set controls - G&C basic 2. Record LM and CSM state vectors and epoch times from MSFN. 3. Key DEDA - X component of CSM position C 244 ± XXXXXE (1000 ft) 4. Key DEDA - Y component of CSM position C 245 ± XXXXXE (1000 ft) 5. Key DEDA - Z component of CSM position C 246 ± XXXXXE (1000 ft) 6. Key DEDA - X component of CSM velocity C 264 ± XXXXXE (1 fps)	Accelerometer only calibration. CSM state vectors must be updated after any CSM maneuver.

4.5.13 AGS CALIBRATION/4.5.14 AGS MANUAL ABSOLUTE TIME INITIALIZATION/4.5.15 AGS MANUAL STATE VECTOR UPDATE

CREW-MAN	PNL	PROCEDURES	REMARKS
LMP		7. Key DEDA - Y component of CSM velocity C 265 ± XXXXXE (1 fps) 8. Key DEDA - Z component of CSM velocity C 266 ± XXXXXE (1 fps) 9. Key DEDA - CSM epoch time C 272 ± XXXXXE (0.1 min) 10. Key DEDA - Update CSM state vector C 414 ± 30000E 11. Key DEDA - Update status C 414R (+00000 = Update complete within 2 seconds) 12. Key DEDA - X component of LM position C 240 ± XXXXXE (1000 ft) 13. Key DEDA - Y component of LM position C 241 ± XXXXXE (1000 ft) 14. Key DEDA - Z component of LM position C 242 ± XXXXXE (1000 ft) 15. Key DEDA - X component of LM velocity C 260 ± XXXXXE (1 fps) 16. Key DEDA - Y component of LM velocity C 261 ± XXXXXE (1 fps) 17. Key DEDA - Z component of LM velocity C 262 ± XXXXXE (1 fps) 18. Key DEDA - LM epoch time C 254 ± XXXXXE (0.1 min) 19. Key DEDA - Update LM state vector C 414 ± 20000E 20. Key DEDA - Update status C 414R (+00000 = Update complete within 2 seconds)	CSM epoch time must be a valid AGS time. State vector is invalid if LM thrust occurs after step 2 or if 8191 seconds elapse after step 2. LM epoch time must be a valid AGS time.

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR		4.5.16 RATE OF DESCENT INTERFACE CHECK 1. Key V11 N10E 16E - Channel 16 specified R1 ABCDE - Inbit channel, 16-bit configuration R2 ----- R3 -----	
	5	2. DESCENT RATE sw - center Verify C = 0 and D < 4 3. DESCENT RATE sw - + Verify D > 3 4. DESCENT RATE sw - - Verify C = 1	
		4.5.17 RENDEZVOUS RADAR DEACTIVATION	
	11	1. CB/AC BUS A: RNDZ RDR - open CB PGNS: RNDZ RDR - open	
		4.5.18 LANDING RADAR DEACTIVATION	
	11	1. CB PGNS: LDG RDR - open	
		4.5.19 LGC/CMC CLOCK SYNCHRONIZATION ROUTINE (R33)	
		1. Verify P00 is displayed 2. If a precise value for the difference between the LGC and CMC clocks is available from MSFN, go to step 13. 3. Key V06 N65 (do not enter) 4. Confirm selection of Routine 33 in CSM.	The purpose of Routine 33 is to synchronize the LGC clock with the CMC clock. Program 00 must be displayed before selecting R33. Program 05 - PGNCS startup is performed before entry to this task. The ISS is not required for R33.

4.5.16 RATE OF DESCENT INTERFACE CHECK/4.5.17 RENDEZVOUS RADAR DEACTIVATION/
4.5.18 LANDING RADAR DEACTIVATION/4.5.19 LGC/CMC CLOCK SYNCHRONIZATION ROUTINE (R33)

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR/ LMP		5. Perform countdown with CMP to insure simultaneous enter of Routine 33 in LGC and CMC. 6. Key ENTR 7. V06 N65 - LGC clock time R1 00XXX hr R2 000XX min R3 0XX.XX sec Record LGC clock time 8. Obtain CMC clock time from CMP 9. Compute LGC and CMC clock difference 10. Repeat steps 3 through 9 if more LGC and CMC clock difference data points are desired. 11. Average all LGC and CMC clock difference data points 12. Key V55E - increment LGC time 13. FL V21 N24 Key clock hr difference 14. FL V22 N24 Key clock min difference 15. FL V23 N24 Key clock sec difference 16. If clock check is desired, repeat steps 4 through 7 4.5.20 PGNCS POWER-DOWN PROGRAM (P06) 1. Set controls - G&C basic 2. Key V37E 06E	The purpose of Program 06 is to transfer the ISS/LGC from operate to standby.

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CREW-MAN	PNL	PROCEDURES	REMARKS
	11	3. If IMU is operating: FL V50 N25 - Checklist Reference R1 00061 - Request IMU power down R2 ----- R3 ----- Accept: CB PGNS: IMU OPR - open Key PRO Reject: Key ENTR 4. FL V50 N25 - Checklist Reference R1 00062 - Request LGC power down R2 ----- R3 ----- Accept: Key PRO and hold for 3 seconds STBY lt - on (after 3 sec delay) All EL numerics on DSKY - off Reject: Key ENTR 5. FL V50 N07 - Perform program change	
LMP	3	4.5.21 SET EVENT TIMER 1. EVNT TMR: RESET/COUNT sw - RESET 2. EVNT TMR: SLEW CONT MIN sw - TENS 3. EVNT TMR: SLEW CONT MIN sw - UNITS 4. Repeat steps 2 and 3 for EVNT TMR: SLEW CONT SEC sw 5. EVNT TMR: RESET/COUNT sw - UP or DOWN 6. EVNT TMR: TMR CONT sw - START	
	11	4.5.22 DCA ENABLE 1. Communicate with MSFN and coordinate uplink enabling requirements. 2. CB COMM: UP DATA LINK - close	The LGC should be transferred to operate at least every 23 hours to preserve accurate GET accumulation. To enable DCA the LGC must be operating in P00.

4.5.20 PGNS POWER DOWN PROGRAM (P06)/4.5.21 EVENT TIMER ACTIVATION/4.5.22 DCA ENABLE

CREW-MAN	PNL	PROCEDURES	REMARKS
	11	3. Key V21 N01E 00045E 00000E - clears Inlink Counter before initial MSFN uplink transmission 4.5.23 DCA DISABLE 1. CB COMM: UP DATA LINK - open 2. Key RSET. 4.5.24 PIPA BIAS MEASUREMENT AND LOADING 1. Set EVENT TIMER - 00:00 2. S/C: MODE CONTROL sel - OFF 3. Key V25 N21E Key V06 N21 (do not enter) Key ENTR and start EVENT TIMER simultaneously Display initial PIPA counts R1 X ----- pulses R2 Y ----- pulses R3 Z ----- pulses 4. Key ENTR Display final PIPA counts R1 X ----- pulses R2 Y ----- pulses R3 Z ----- pulses 5. Calculate PIPA bias $\frac{\text{Final} - \text{Initial}}{100} = \text{PIPA bias}$ 6. If measured and present PIPA bias differ by more than 26400, adjust PIPA bias correction, step 7. 7. Key V21 N01E 17XXE - Applicable PIPA XXXXXE - Measured value 8. Select P00.	MSFN also has the capability of clearing and resetting the Inlink Counter before transmitting uplink data. Resets alarms that may be generated during DCA power down. Altitude rates should $\approx 0^\circ/\text{sec}$ Bias identification: X - 1727 Y - 1731 Z - 1733

4.5.22 DCA ENABLE/4.5.23 DCA DISABLE/4.5.24 PIPA BIAS MEASUREMENT AND LOADING

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.6 <u>COAST</u>	
		4.6.1 RENDEZVOUS NAVIGATION PROGRAM (P20)	Program 20 controls LM attitude and the RR to acquire and track the CSM while coasting, updates either the LM or CSM state vectors from RR tracking data, and points the LM tracking beacon at the CSM. Rendezvous Radar Activation, ref para 4.10.4 and Rendezvous Radar Checkout, ref para 4.10.5 completed before selecting P20.
	11	1. Set controls - G&C basic except: CB/AC BUS A: RNDZ RDR - close CB PGNS: RNDZ RDR - close	Ref para 4.5.2
	1	RATE/ERR MON sw - RNDZ RDR	
	3	HTR CONT: TEMP MON sel - RNDZ RADAR	
	3	2. If manual RR selection is desired RNDZ RADAR sel - SLEW	
		3. Key V37E 20E	
		4. Routine 02 - IMU status check is performed, step 5	
		5. POSS FL V50 N07 - Perform program change R1 00005 - PGNCs startup 00051 - IMU Orientation Determination R2 ----- R3 ----- Key V37E 05E or 51E Exit R02	
	1 & 2	6. POSS FL V05 N09 - Alarm PROG lt - on MASTER ALARM pb/lt - on PGNS caut lt - on R1 00526 - Range > 400 nm R2 ----- R3 ----- Alternatives to alarm: a. Wait until range < 400 nm, key V32, go to step 7. b. Key V83E - Rendezvous Parameter Display Routine (R31): FL V06 N54 R1 Range XXXXX.X nm R2 Range rate XXXXX.X fps	

4.6.1 RENDEZVOUS NAVIGATION PROGRAM (P20)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		R3 0 XXX.XX° Key PRO when finished, go to step 7. Exit R31 c. Key V56E - Terminate P20, exit to other program in process or P00. 7. Routine 61 - Preferred Tracking Attitude may be called at this time. If R61 is called, Routine - 60 Attitude Maneuver will follow, steps 8 through 12. 8. FL V50 N25 - Checklist Reference R1 00203 - Switch to PGNC automatic mode R2 ----- R3 ----- Accept: 1 GUID CONT sw - PGNS 3 S/C: MODE CONTROL sel - AUTO Key PRO Reject: 1 GUID CONT sw - PGNS 3 S/C: MODE CONTROL sel - ATT HOLD Key ENTR 9. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° 10. POSS PROG lt - on Key V05 N09E - Call alarm R1 00401 - Final attitude yields gimbal lock R2 ----- R3 ----- Change IMU orientation or vehicle attitude to avoid gimbal lock. If alarm is not 00401: Key KEY REL and RSET 11. Monitor FDAI to avoid gimbal lock. If manual completion of maneuver is desired: S/C: MODE CONTROL sel - ATT HOLD ACA - Maneuver manually Attitude maneuver complete.	

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CREW-MAN	PNL	PROCEDURES	REMARKS
		12. FL V50 N19 - Trim enable R1 Roll XXX.XX⁰ R2 Pitch XXX.XX⁰ R3 Yaw XXX.XX⁰ Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Manual trim can be provided via the ACA Key ENTR Exit R60	
	1 3		
	1 3		
	3	13. POSS FL V50 N25 - Checklist reference R1 00201 - RR automatic mode R2 ----- R3 ----- RNDZ RADAR sel - LGC Key PRO after CSM lock on, go to step 27 Alternate: Manual acquisition may be selected Key ENTR - RR Manual Acquisition Routine (R23), steps 14 through 24.	This display is called only when RNDZ RADAR sel is not set to LGC.
		14. Routine 61 - Preferred Tracking Attitude followed by Routine 60 - Attitude Maneuver is called by R23, steps 15 through 19.	
		15. FL V50 N25 - Checklist Reference R1 00203 - Switch to PGNCS automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR	
	1 3		
	1 3		

4.6.1 RENDEZVOUS NAVIGATION PROGRAM (P20) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		16. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX°	
		17. POSS PROG lt - on Key V05 N09E - Call alarm R1 00401 - Final attitude yields gimbal lock R2 ----- R3 ----- Change IMU orientation or vehicle attitude to avoid gimbal lock. If alarm is not 00401: Key KEY REL and RSET	
	3	18. Monitor FDAI to avoid gimbal lock. If manual completion of maneuver is desired: S/C: MODE CONTROL sel - ATT HOLD ACA - Maneuver manually Attitude maneuver complete.	Go to step 20 for alternate procedure.
	1	19. FL V50 N19 - Trim enable	
	3	R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO	
	1	Reject:	
	3	GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Manual trim can be provided via the ACA Key ENTR Exit R60	
	1	20. Alternate procedure for pointing LM +Z axis at CSM $\leq 30^\circ$ to LOS:	
	3	GUID CONT sw - AGS S/C: MODE CONTROL sel - AUTO Key DEDA - Acquisition steering C 400 + 20000E	
	1	Monitor FDAI, when stable GUID CONT sw - PGNS	

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CREW- MAN	PNL	PROCEDURES	REMARKS
		21. FL V50 N25 R1 00205 - Perform manual acquisition of CSM R2 ----- R3 ----- RADAR: SLEW RATE sw - HI RNDZ RADAR: SLEW sw - slew to maximum signal strength RNDZ RADAR: SIGNAL STRENGTH ind - peaked If acquisition cannot be accomplished with present attitude, key ENTR or V34E - go to step 26 FDAI - observe shaft and trunnion angles RANGE/RANGE RATE ind - observe range rate RADAR: SLEW RATE sw - LO RNDZ RADAR: SIGNAL STRENGTH ind - peaked	
	3		
	1		With RR in mode 2, FDAI does not display shaft and trunnion angles.
	3		
		22. Sidelobe check: RNDZ RADAR: SLEW sw - LEFT FDAI yaw error needle - -20° RNDZ RADAR: SLEW sw - RIGHT FDAI yaw error needle - $+20^{\circ}$ RNDZ RADAR: SIGNAL STRENGTH ind - varies from maximum to minimum. Position RR to maximum signal strength	
	3		
	1		
	3		
	1		
	3		
		23. RNDZ RADAR sel - LGC Key PRO - Exit R23	
	1 & 2	24. POSS FL V05 N09 - Alarm R1 00527 - CSM outside allowable limits of present RR mode R2 ----- R3 ----- MASTER ALARM pb/lt - on PGNS caut lt - on MASTER ALARM pb/lt - reset Key V32E - recycle to step 14 to maneuver again to preferred tracking attitude or Key V34E - Exit R23 and P20.	
	1 & 2		
	2		
			Attitude maneuver, RR designate, RR track, RR Mark, and state vector update processes are now automatic. LGC - astronaut communications hereafter are not necessarily sequential.

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CREW-MAN	PNL	PROCEDURES	REMARKS
		25. Key V16 N45E R1 N XXXXX Marks R2 TFI XXXBXX min - sec R3 MGA XXX.XX⁰ Key KEY REL 26. To terminate Program 20, perform the following: a. If no other program is in process Key V37E 00E - P00 b. If another program is in process Key V56E - R00 27. Routine 21 - RR Designate, step 28. 28. POSS FL V05 N09 - Alarm R1 00503 - RR cannot acquire CSM R2 ----- R3 ----- 1 & 2 MASTER ALARM pb/lt - on 1 PGNS caut lt - on PROG lt - on 1 & 2 MASTER ALARM pb/lt - reset Alternates to alarm: a. Key PRO - exit R21 to Routine 24 - RR search, steps 29 to 36 b. Key V34E - Terminate, exit R21 and P20. Reselect P20 c. Key V32E - Recycle to step 27 29. Routine 24 - RR Search Routine calls Routine 61 - Preferred Tracking Attitude followed by Routine 60 - Attitude Maneuver, steps 30 through 34. 30. FL V50 N25 - Checklist Reference R1 00203 - switch to PGNCS automatic mode R2 ----- R3 ----- Accept: 1 GUID CONT sw - PGNS 3 S/C: MODE CONTROL sel - AUTO Key PRO	TFI and MGA displays meaningless unless engine burn is defined. Recycles to beginning of Routine 21.

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CREW-MAN	PNL	PROCEDURES	REMARKS
	1 3	Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR	
		31. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX°	
		32. POSS PROG lt - on Key V05 N09E - Call alarm R1 00401 - Final attitude yields gimbal lock R2 ----- R3 ----- Change IMU orientation on vehicle attitude to avoid gimbal lock. If alarm is not 00401 Key KEY REL and RSET	
	3	33. Monitor FDAI to avoid gimbal lock. If manual completion of maneuver is desired: S/C: MODE CONTROL sel - ATT HOLD ACA - Maneuver manually Attitude maneuver complete.	Step 20 is an alternate maneuver procedure.
		34. FL V50 N19 - Trim enable R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX°	
	1 3	Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO	
	1 3	Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Manual trim can be provided via the ACA. Key ENTR Exit R60	

4.6.1 RENDEZVOUS NAVIGATION PROGRAM (P20) (cont)

COAST

CREW-MAN	PNL	PROCEDURES	REMARKS
	3 1 3 1	35. FL V16 N80 R1 ----- R2 Ω XXX, XX^o R3 ----- R1 will display 11111 when discrete from RR is received indicating that search is successful. Recycle to step 30 if $\Omega > 30^o$ If 11111 is not displayed in R1 and search is to be terminated key V34E - Exit R24 and P20 36. Sidelobe check: RNDZ RADAR: SLEW sw - LEFT FDAI yaw error needle - -20^o RNDZ RADAR: SLEW sw - RIGHT FDAI yaw error needle - +20^o RNDZ RADAR: SIGNAL STRENGTH ind - varies from maximum to minimum Position RR to maximum signal strength Key PRO - Recycle to step 6. Exit R24 37. Routine 22 - RR Data Read, steps 38 through 49. 38. POSS FL V50 N07 - Change Program Terminate R22. 39. POSS PROG It - on TRACKER It - on Key V05 N09E - Call alarm R1 00521 - Radar antenna out of limits R2 ----- R3 ----- KEY REL It - on Key KEY REL and RSET - Recycle to step 25.	

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CREW-MAN	PNL	PROCEDURES	REMARKS
	2 1 & 2	40. POSS FL V05 N09 - Alarm R1 00525 - $\Delta\theta > 3^\circ$ R2 ----- R3 ----- PROG lt - on PGNS caut lt - on MASTER ALARM pb/lt - on MASTER ALARM pb/lt - reset Key RSET PRO If no alarm, go to step 43. 41. FL V06 N05 R1 $\Delta\theta$ XXX.XX$^\circ$ R2 ---- R3 ----- Accept $\Delta\theta$: Key PRO Reject $\Delta\theta$: Key V32E - Perform step 42. 42. Sidelobe check: RNDZ RADAR: SLEW sw - LEFT FDAI yaw error needle - -20° RNDZ RADAR: SLEW sw - RIGHT FDAI yaw error needle - $+20^\circ$ RNDZ RADAR: SIGNAL STRENGTH ind - varies from maximum to minimum Position RR to maximum signal strength 43. Routine 61 - Preferred Tracking Attitude followed by Routine 60 may be called at this time, steps 44 through 48. 44. FL V50 N25 - Checklist Reference R1 00203 - switch to PGNC automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO	LM can be maneuvered manually during this period, but state vector update data will be degraded.
	3 1		
	1 3		

4.6.1 RENDEZVOUS NAVIGATION PROGRAM (P20) (cont)

4.6.1 RENDEZVOUS NAVIGATION PROGRAM (P20) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		Accept: Key PRO Reject: Choose one of the following: Key V32E - Recycle to step 37 Key V34E - Terminate R22 and P20 Key V37E 20E - Reselect P20 Reselect another program Exit R22. 50. Routine 25 - RR Monitor is automatically called every 0.48 second whenever the LGC is on, steps 51 and 52 51. POSS FL V05 N09 - Alarm R1 00515 - RR CDU fail R2 ----- R3 ----- PROG lt - on MASTER ALARM pb/lt - on PGNS caut lt - on TRACKER lt - on MASTER ALARM pb/lt - reset Key KEY REL and RSET 52. POSS FL V05 N09 - Alarm R1 00501 - Antenna angles exceed mode limits R2 ----- R3 ----- Prog lt - on MASTER ALARM pb/lt - on PGNS caut lt - on MASTER ALARM pb/lt - reset Alternatives: Key KEY REL and RSET, select P00 Reselect P20. Recycle to step 50. 4.6.2 GROUND TRACK DETERMINATION PROGRAM (P21) 1. Key V37E 21E	
	1 & 2 2		
	1 & 2 2		
			The purpose of Program 21 is to provide the astronaut with details of his ground track without the need of ground communication.

4.6.1 RENDEZVOUS NAVIGATION PROGRAM (P20)/4.6.2 GROUND TRACK DETERMINATION PROGRAM (P21)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		2. FL V04 N06 R1 <u>TBD</u> - Option code for assumed vehicle R2 0000X - LGC assumed option R3 ----- X = 1 - LM X ≥ 2 - CSM Accept: Key PRO Reject: Key V22E - Load desired option 3. FL V06 N34 - GET of desired latitude and longitude position R1 00XXX hr R2 000XX min R3 0XX.XX sec Accept: Key PRO Reject: V25E - Load desired GET time 4. FL V06 N43 - Parameters at GET R1 - Latitude XXX.XX⁰ (+ = North) R2 - Longitude XXX.XX⁰ (+ = East) R3 - Altitude XXXX.X nm Alternatives: V32E - Recycle for N43 at GET of 10 min later or, V34E - Terminate P21 5. FL V50 N07 - Change program 4.6.3 PREFERRED TRACKING ATTITUDE PROGRAM (P25) 1. Key V37E 25E 2. Routine 02 - IMU status check is called at this time, step 3. 3. POSS FL V50 N07 R1 00005 - Select PGNCs Startup 00051 - Select IMU Orientation R2 ----- R3 ----- Select P05 or P51 Exit R02 and P25	The purpose of Program 25 is to compute the preferred tracking attitude of the LM which enables CSM to track the LM tracking light, and maneuver to preferred tracking attitude.

4.6.2 GROUND TRACK DETERMINATION PROGRAM (P21)/4.6.3 PREFERRED TRACKING ATTITUDE PROGRAM (P25)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4. POSS FL V50 N25 - Checklist Reference R1 00203 - Select PGNC automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR	
	1 3		
	1 3		
		5. Routine 61 - Preferred Tracking Attitude is called at this, step 6.	
	2 1 & 2	6. POSS PROG lt - on PGNS caut lt - on MASTER ALARM pb/lt - on FL V05 N09 - Alarm R1 01707 - PGNC automatic mode not selected R2 ----- R3 ----- MASTER ALARM pb/lt - reset GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO If PGNC automatic mode previously selected Key PRO	This alarm should not occur in P25 because it is redundant. Checklist Reference Code displayed in step 4.
		7. R60 - Attitude Maneuver is called by Routine 61, steps 8 through 12. Exit R61.	
		8. FL V50 N25 - Checklist Reference R1 00203 - Select PGNC automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR	
	1 3		
	1 3		

4.6.3 PREFERRED TRACKING ATTITUDE PROGRAM (P25) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		9. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° 10. POSS PROG It - on Key V05 N09E - Call alarm R1 00401 - Final attitude yields gimbal lock R2 ----- R3 ----- Change IMU orientation or vehicle attitude to avoid gimbal lock If alarm is not 00401: Key KEY REL and RSET 11. Monitor FDAI to avoid gimbal lock. If manual completion S/C: MODE CONTROL sel - ATT HOLD ACA - Maneuver manually Attitude maneuver complete 12. FL V50 N19 - Trim enable R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Manual trim can be provided via the ACA Key ENTR Exit R60 13. To terminate P25: Select P00 or Key V56E, if another program is in progress. 4.6.4 MANUAL AGS RENDEZVOUS RADAR NAVIGATION UPDATING 1. Set RR antenna - mode 1	
	1		
	3		
	1		
			Ref para 4.10.5

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CREW- MAN	PNL	PROCEDURES	REMARKS
	1	2. Set controls to G&C basic except: GUID CONT sw - AGS SHFT/TRUN 4 sw - $\pm 5^\circ$ RNDZ RADAR sel - SLEW	If RR is locked onto CSM go to step 12, RNDZ RADAR sel is set to LGC.
	3		
	5	3. Eng STOP pb/lt - push	Inhibits engine on commands.
		4. Key DEDA - Acquisition steering C 400 + 20000E Wait for vehicle rotation to stop	
	3	5. RNDZ RADAR: SLEW sw - drive antenna to null one axis at a time	Any later state vector update via DEDA or PGNCS downlink supersedes this radar update. If time between RR data points >17 minutes, radar filtering is restarted. RR information should not be entered in AGS if RR range >100 nm.
1 & 2	6.	Observe FDAI shaft and trunnion needles for null	
3	7.	When second axis approaches null observe RNDZ RADAR: SIGNAL STRENGTH ind - determine and lock on strongest lobe	
	8.	RNDZ RADAR: SLEW sw - check first axis for strongest lobe	
	9.	RNDZ RADAR sel - AUTO TRACK	
	10.	S/C: MODE CONTROL sel - ATT HOLD	
	11.	S/C: DEAD BAND sw - MAX	
	12.	The following steps are to be repeated every 3 minutes for 5 or more data points.	
	13.	Key DEDA - Store Z axis direction cosines C 415 + 10000 (do not ENTR)	
3	14.	S/C: DEAD BAND sw - MIN	
1	15.	ACA - null shaft and trunnion angles on FDAI	
	16.	Note RR range at shaft and trunnion null (If null not acceptable, repeat steps 12, 16, 17) Key DEDA - ENTR (at null)	

4.6.4 MANUAL AGS RENDEZVOUS RADAR NAVIGATION UPDATING (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	3	17. Key DEDA - Radar range C 316 +XXXXXE (0.1 nm) (perform this step within 30 seconds of step 16) 18. S/C: DEAD BAND sw - MAX 19. Note RR range rate speed of change 20. Select value of range rate that occurs in about 15 seconds and insert value via DEDA Key DEDA - Radar range rate C 503 + XXXXX (1 fps) (Do not ENTR) 21. When RR range rate = value loaded in DEDA Key DEDA - ENTR 4.6.5 DIGITAL AUTOPILOT DATA LOAD ROUTINE (R03) 1. Key V48E 2. FL V06 N46 - DAP configuration R1 ABCDE R2 ----- R3 ----- A - Ascent Stage 0 = LM Alone 1 = Ascent & descent stage plus docked CSM B - X-Axis Acceleration 0 = 2-jet acceleration RCS System A 1 = 2-jet acceleration RCS System B 2 = 4-jet acceleration C - Scaling 0 = Fine ACA maximum 4°/sec 1 = Normal ACA maximum 20°/sec D - Attitude Deadband 0 = 0.3° 1 = 5.0°	Enter range rate after last radar range and angle update and prior to midcourse. Keep RR range rate read-enter time to a minimum. Purposes of Routine 03 are as follows: Load and verify DAP data, and DPS trims Provide a means for selecting desired DAP response Perform engine gimbal trim

4.6.4 MANUAL AGS RENDEZVOUS RADAR NAVIGATION UPDATING/4.6.5 DIGITAL AUTOPILOT DATA LOAD ROUTINE (R03)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		E - KALCMANU Rate 0 = 0.20/sec 1 = 0.50/sec 2 = 2.00/sec 3 = 10.00/sec Accept: Key PRO Reject: V21 - Load desired DAP data code 3. POSS FL V05 N09 - Alarm R1 01706 - DAP data code does not agree with stage verify R2 ----- R3 ----- V32E - Recycle to step 2 and load correct data or V34E - Terminate (Exit R03) 4. FL V06 N47 R1 LM Weight XXXXXX lbs x 10 R2 CSM Weight XXXXXX lbs x 10 R3 ----- Accept: Key PRO Reject: V24E - Load desired parameters 5. If descent stage is attached, proceed to step 6 If descent stage not attached, exit R03 6. FL V06 N48 - Trim parameters R1 Pitch XXX.XX⁰ R2 Roll XXX.XX⁰ R3 ----- Accept: Key PRO (Drive gimbals to trim position) Reject: V24E - Load desired trim parameters 7. FL V50 N25 - Checklist Reference R1 00037 - Switch to interrupted program R2 ----- R3 ----- Resume interrupted program: Key PRO Terminate: V34E - LGC automatically goes to PRO	

4.6.5 DIGITAL AUTOPILOT DATA LOAD ROUTINE (R03) (cont)

CREW-MAN	PNL	PROCEDURES	REMARKS
		4.6.6 LGC UPDATE PROGRAM (P27) - Set controls - G&C basic - If update will be automatic UPLINK ACTY It - on, go to step 8. If update will be manual receive and record data. - Select desired update: Key V70E - Update liftoff time or Key V71E - Load sequential data block or Key V72E - Load singular data or Key V73E - Octal time increment - If OPR ERR It - on or UPLINK ACTY It - off update is not allowed. Select P00 and repeat step 4. - FL V21 N01 (if V71 or V72 entered) R1 ----- R2 Unchanged XXXXX R3 UPBUFF Octal Accept: Key XXXXXE index word (displayed in R1) Reject V34E - Terminate	Purpose of Program 27 is to insert information into the LGC via digital uplink from MSFN or via DSKY input. The LGC must be in Program 00 before selecting P27. DCA Enable procedure must be accomplished if update is to be via uplink from MSFN. Load octal index word and display UPBUFF. UPBUFF is address of erasable memory location used for temporary storage of block. Twenty locations are available for V71 and V72. The index word indicates how many of these locations are required (including location identifier for index word, addresses, and data). For V71 3 (octal) $\leq$ index word $\leq$ 24 (octal). For V72 3 (octal) $\leq$ index word $\leq$ 23 (octal) and the index word must be an odd number. Since with V71 a single address describes where the block of data will go, 18 locations are available for data with the block consisting of index word followed by block address and data. With V72 a separate address is needed for each data word and the block consists of index word, in successive even and odd numbered locations, with up to nine pairs of address and data words.

4.6.6 LGC UPDATE PROGRAM (P27)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		6. FL V21 N01 - Data load request R1 ----- R2 Unchanged R3 AAAAA Accept: Key in data for update Reject: V34E - Terminate 7. FL V21 N02 R1 ----- R2 Unchanged R3 000XX Key PRO to use data or key in octal identifier for data to be correct and return to step 5. 8. UPLINK ACTY It - out 9. If LGC update was via uplink from MSFN, DSKY may indicate alarm because of transient conditions. perform DCA Disable Key RSET 10. Exit P27 and P00 is selected 11. Set controls - G&C basic 4.6.7 CREW-DEFINED MANEUVER ROUTINE (R62) 1. Key VTBD E 2. FL V06 N22 - Gimbal angles R1 OG XXX.XX⁰ R2 IG XXX.XX⁰ R3 MG XXX.XX⁰ Accept: Key PRO Reject: Key V25E - Load new gimbal angles 3. Routine 60 - Attitude Maneuver is performed at this time	AAAAA is calculated machine address in temporary storage block. Flashing continues until all data components are loaded. R3 contains the UPTMP address which is an erasable location octal identifier. Refer para 4.5.23 Routine 62 provides the astronauts with the ability to specify a final vehicle attitude for use by an LGC-controlled attitude maneuver. Routine 62 can only be entered from P00.

4.6.6 LGC UPDATE PROGRAM (P27)/4.6.7 CREW-DEFINED MANEUVER ROUTINE (R62)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4. FL V50 N25 - Checklist Reference R1 00203 - Switch to PGNC automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR	
	1 3		
	1 3		
		5. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX°	
		6. POSS PROG It - on Key V05 N09E - Call alarm R1 00401:- Final attitude yields gimbal lock R2 ----- R3 ----- Change IMU orientation or vehicle attitude to avoid gimbal lock. If alarm is not 00401: Key KEY REL and RSET	
		7. Monitor FDAI to avoid gimbal lock. If manual completion of maneuver is desired: S/C: MODE CONTROL sel - ATT HOLD ACA - Maneuver manually Attitude maneuver complete	
		8. FL V50 N19 - Trim enable R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO	
	1 3		

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CREW- MAN	PNL	PROCEDURES	REMARKS
		Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Manual trim can be provided via the ACA Key ENTR Exit R60 4.6.8 RENDEZVOUS FINAL ATTITUDE ROUTINE (R63) 1. Key V89E If: OPR ERR lt - on Key RSET 2. IMU Status check Routine 02 POSS FL V50 N07 R1 00005 - Perform PGNCs startup 00051 - Perform IMU orientation determination R2 ----- R3 ----- Key V37E 05E or 51E Exit R02 3. FL V04 N06 - Option R1 0000X option code R2 0000X option axis R3 ----- R2 00001 = +Z axis (preferred) 00002 = +X axis Accept: Key PRO Reject: Key V22E - Load desired code 4. FL V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX°	The purpose of Routine 63 is to calculate and display final FDAI angles required to point +Z or +X axis at CSM; and to call the attitude maneuver routine (R60) for automatic maneuver capability This routine is selected only during the LGC idling program (P00) OPR ERR lt - on if LGC idling, Program 00 is not in process.

4.6.7 CREW-DEFINED MANEUVER ROUTINE (R62)/4.6.8 RENDEZVOUS FINAL ATTITUDE ROUTINE (R63)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		Accept: Key PRO Reject: Key V32E - Recycle to update data, or key V34E - Terminate	
		5. Attitude Maneuver Routine 60 - steps 6 through 11	
		6. FL V50 N25 - Checklist Reference	
		R1 00203 - Select PGNCs automatic mode	
		R2 -----	
		R3 -----	
		Accept:	
1		GUID CONT sw - PGNS	
3		S/C: MODE CONTROL sel - AUTO	
		Key PRO	
		Reject:	
1		GUID CONT sw - PGNS or AGS	
3		S/C: MODE CONTROL sel - ATT HOLD	
		Key ENTR	
		PGNCs capability to perform maneuver automatically will be compromised if the vehicle attitude is changed by manual inputs after this time	
		7. Key V06 N94 - FDAI angles	
		R1 Roll XXX.XX°	
		R2 Pitch XXX.XX°	
		R3 Yaw XXX.XX°	
		8. If automatic mode selected:	
		POSS MASTER ALARM pb/lt - on	
		PGNS caut lt - on	
		PROG lt - on	
		MASTER ALARM pb/lt - reset	
		Key V05 N09 - Call alarm	
		R1 00401 - Calculated gimbal angles yield gimbal lock	
		R2 -----	
		R3 -----	
		Key REL lt - on	
		Key KEY REL	
		Key RSET	
		Determine remainder of maneuver with MSFN	
		If alarm not 00401 attend alarm and continue if possible	
			If not ready, crew may wait before responding.

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CREW-MAN	PNL	PROCEDURES	REMARKS
	1 3	9. If automatic mode selected, maneuver will start Monitor attitude maneuver by reference to FDAI needles 10. If automatic mode not selected, perform maneuver manually with ACA using visual cues and the FDAI 11. FL V50 N19 - Perform attitude trim enable R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° Accept: (Automatic Attitude Trim) GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Return to step 7 Reject: GUID CONT sw - PGNS or AGS S/C: MODE CONTROL sel - ATT HOLD or AUTO Key ENTR Exit R60 and R63. 4.6.9 MONITOR AGS VALUES OF OUT-OF-PLANE POSITION AND VELOCITY 1. Key DEDA - Y C 211R (1000ft) 2. Key DEDA - Vyo C 270R (1 fps) 4.6.10 RENDEZVOUS PARAMETER DISPLAY ROUTINE (R31) 1. Key V83E - Request R31 2. FL V06 N54 R1 Range XXXX.X nm R2 Range rate XXXX.X fps R3 0XXX.XX° Display update every 2 seconds Key PRO to terminate display	R1, R2 and R3 retain FDAI angle (N94) displays. Plane changes are most efficient at a mode (Y = 0) The purpose of Routine 31 is to display, at astronaut request, LGC - calculated rendezvous parameters.

4.6.8 RENDEZVOUS FINAL ATTITUDE ROUTINE (R63)/4.6.9 MONITOR AGS VALUES OF OUT-OF-PLANE POSITION AND VELOCITY/
4.6.10 RENDEZVOUS PARAMETER DISPLAY ROUTINE (R31)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	11	4.7 <u>ALIGNMENT</u> 4.7.1 IMU ORIENTATION DETERMINATION PROGRAM (P51) - Set controls - G&C basic except: CB/AC BUS B: AOT LAMP - close AOT: Azimuth cont - F - CB HTR: AOT - close - Under control of AGS, when DAP minimum impulse mode is used, set applicable S/C: PITCH, ROLL, YAW sw - PULSE. - Key V37E 51E - POSS FL V50 N07 R1 00005 - PGNS startup R2 ----- R3 ----- Key V37E 05E Reselect P51 after completion of P05 - FL V50 N25 - Checklist Reference R1 00015 - Perform star acquisition R2 ----- R3 ----- - Maneuver vehicle so that two stars are visible in AOT field and avoid gimbal lock and position pitch axis in preferred direction. - If coarse alignment is not required, go to step 8 - Key ENTR to coarse align IMU gimbal angles to zero degrees and prevent gimbal lock - V41 N22 - Coarse align CDU's R1 Yaw XXX.XX° R2 Pitch XXX.XX° R3 Roll XXX.XX°	The purpose of Program 51 is to determine the inertial orientation of the IMU using sightings on two celestial bodies using the AOT or COAS. A yaw maneuver > 90° will cause the pitch and roll gimbals to flip 180° and gyrate for approximately 3 seconds.

4.7.1 IMU ORIENTATION DETERMINATION PROGRAM (P51)

ALIGNMENT

CREW- MAN	PNL	PROCEDURES	REMARKS
		NO ATT It - on FDAI - follows IMU gimbal movement NO ATT It - off CDU's coarse align complete 11. R53 - Inflight Sighting Mark Routine called at this time, steps 12 through 20. 12. FL V01 N71 R1 ABCDE - Star code, AOT detent code AB = blank C = AOT detent code DE - Star code R2 ----- R3 ----- Accept: Key PRO Reject: Key V21E - Load desired codes If target is not a planet, go to step 15 13. FL V06 N34 - GET R1 00XXX hr R2 000XX min R3 0XX.XX sec Use GET and time of launch to compute ephemeris time. Use on-board tables to compute target position vectors at GET. Key PRO 14. FL V06 NTBD - Planet position vectors R1 X .XXXXXX R2 Y .XXXXXX R3 Z .XXXXXX Accept: Key PRO Reject: Load correct vectors 15. If rear AOT detent or backup optical system in use FL V06 NTBD - Optical system LOS R1 Azimuth XXX.XX° R2 Elevation XXX.XX° R3 ----- Accept: Key PRO Reject: Load correct calibrations	

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CREW-MAN	PNL	PROCEDURES	REMARKS
	3	16. FL V54 (Mark X or Y) Key V76E - Minimum impulse mode S/C: MODE CONTROL sel - ATT HOLD Mark X or Y as appropriate	
1 1 & 2		17. POSS PROG lt - on PGNS caut lt - on MASTER ALARM pb/lt - on V05 N09E - Call alarm R1 XXXXX R2 XXXXX R3 XXXXX Possible alarms: 00111 - An enter/recycle entry when no complete star vector pair is stored in LGC. 00107 - A proceed entry when > mark pairs are already stored in LGC. 00112 - A mark entry when no marks are being requested by LGC. 00115 - A mark reject entry when a pair, or partial pair has already been rejected or when no unrejected marks are stored in LGC. 00114 - A mark X (or mark Y) entry when LGC is requesting a mark Y (or mark X). MASTER ALARM pb/lt - reset Key RSET	Alarm codes can appear in up to 3 registers.
1 & 2		18. FL V52 (or V53) - Mark X axis (or Y axis, depends on first mark.) Accept: Mark X or Y Reject: Key PRO (unpaired mark data on this star are discarded) Return to step 16	
		19. FL V50 N25 - Checklist Reference R1 00016 - Continue marking R2 ----- R3 ----- Accept: Key PRO - Recycle to step 16 Reject: Key ENTR	
		20. FL V50 N25 - Checklist Reference R1 00015 - Perform star acquisition R2 ----- R3 -----	

4.7.1 IMU ORIENTATION DETERMINATION PROGRAM (P51) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	3	Accept: Key PRO - Recycle to step 12. Reject: Key ENTR and V77E - Disables minimum impulse mode. S/C: MODE CONTROL sel - AUTO Exit R53 21. Repeat Routine 53 - Inflight Sighting Mark for star 2. 22. Routine 54 - Sighting Data Test is called at this time, step 23. 23. V06 N05 - Data good if display does not flash, not good if display flashes R1 Star angle difference XXX.XX° R2 ----- R3 ----- Accept (bad data): Key PRO, go to step 24 Reject: Key V32E - Recycle to step 6 Exit R54 24. FL V50 N07 - Change program R1 ----- R2 ----- R3 -----	Data good if difference <0.05. Data good display may last only 10 seconds and returns to P51, step 24.
	11	25. Set controls - G&C basic. 4.7.2 IMU REALIGN PROGRAM (P52)	The purpose of Program 52 is to align the IMU from a "known" orientation to one of four orientations selected by the astronaut based on sightings of two celestial bodies with the AOT or backup optical system. The ISS is on and has been aligned to a "known" orientation which is stored in the LGC (REFSMMAT).
	11 AOT	1. Set controls - G&C basic except: CB/AC BUS B: AOT LAMP - close AOT: azimuth cont - F 2. Key V37E 52E 3. FL V04 N06 R1 00005 option code R2 0000X assumed option R3 -----	

4.7.1 IMU ORIENTATION DETERMINATION PROGRAM (P51)/4.7.2 IMU REALIGN PROGRAM (P52)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		X = 00001 - preferred X = 00002 - nominal X = 00003 - REFSMMAT X = 00004 - landing site Accept: Key PRO Preferred: go to step 6 REFSMMAT: go to step 7 Reject: Load desired option	
	1 & 2	4. POSS FL V05 N09 - Alarm	
	2	MASTER ALARM pb/lt - on	
	4	PGNS caut lt - on	
		PROG lt - on	
		R1 00215 (preferred orientation selected but not specified)	
		R2 -----	
		R3 -----	
	1 & 2	MASTER ALARM pb/lt - reset	
		Choose nominal or REFSMMAT	
		Orientation V32E, RSET or:	
		Select Pre-Thrust program to define preferred orientation	
		Key PRO	
		Exit P52	
		5. If nominal or landing site orientation selected:	
		FL V06 N34 - GET (align)	
		R1 00XXX hr	
		R2 000XX min	
		R3 0XX.XX sec	
		Accept: Key PRO	
		Reject: Load desired GET (align)	
		6. If landing site orientation selected:	
		FL V06 N43 (landing site coordinates)	
		R1 - Latitude XXX.XX ^o	
		R2 - Longitude XXX.XX ^o	
		R3 - Altitude XXX.XX nm	
		Accept: Key PRO	
		Reject: Load correct coordinates	
			GET (align) will initially contain 00000, 00000, 00000. If this is accepted, the orientation will be defined for a GET (align) automatically selected by the present time.

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

CREW-MAN	PNL	PROCEDURES	REMARKS
		7. FL V06 N32 R1 MG XXX.XX⁰ R2 IG XXX.XX⁰ R3 OG XXX.XX⁰ Accept: Key PRO Reject: Maneuver vehicle with ACA to acceptable MGA (<TBD degrees) Key V32E or Terminate - Key V34E 8. Coarse Align Routine (R50) is called at this time Coarse align complete when NO ATT lt - out Exit R50 9. Inflight Fine Align Routine (R51) is called at this time FL V50 N25 R1 00015 - celestial body acquisition R2 ----- R3 ----- Maneuver vehicle to obtain two stars Key ENTR (bypass star selection routine) or: Key PRO 10. POSS FL V05 N09 - Alarm 1 & 2 MASTER ALARM pb/lt - on 2 PGNS caut lt - on 00405 (two stars not available) 1 & 2 MASTER ALARM pb/lt - reset Maneuver to obtain two stars Key PRO (bypass star selection routine) Key RSET Key V32E (repeat star selection routine) Key RSET R1 ----- R2 XXXXXX R3 XXXXXX 11. Automatic Optics Positioning Routine (R52) is called at this time. FL V01 N70 R1 ABCDE R2 ----- R3 -----	

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		AB - blank C - AOT detent DE - star/sun code AOT: azimuth cont - detent chosen Accept: Key PRO If target is not plane, go to step 11 Reject: Load desired AOT detent and/or star/sun code 12. FL V06 N34 - GET R1 XXXXX. hr R2 000.XX min R3 0XX.XX sec Use GET and time of launch to compute ephemeris time. Use on-board tables to compute target position vectors at present time Key PRO 13. FL V06 NTBD (Planet position vectors) R1 - X .XXXXXX R2 - Y .XXXXXX R3 - Z .XXXXXX Accept: Key PRO Reject: Load correct vectors 14. If rear AOT detent or backup optical system in use: FL V06 NTBD - Optical system LOS R1 Azimuth XXX.XX° R2 Elevation XXX.XX° R3 ----- Accept: Key PRO Reject: Load correct calibrations 15. Routine 60 - Attitude Maneuver followed by Routine 61 - Preferred Tracking Attitude is called at this time. 16. FL V50 N25 - Checklist Reference R1 00203 - Switch to PGNCS automatic mode R2 ----- R3 ----- Accept: GUID CONT - PGNS S/C: MODE CONTROL - AUTO Key PRO	
	3		
	1		
	3		

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

CREW- MAN	PNL	PROCEDURES	REMARKS
	1 3	Reject: GUID CONT - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR or select AGS	
		17. V06 N94 (final gimbal angles) R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° Monitor maneuver on FDAI	
	1 & 2 2 3 1 & 2	18. POSS: MASTER ALARM pb/lt - on PGNS caut lt - on PROG lt - on MASTER ALARM pb/lt - reset Key V05 N09E - Call alarm R1 - 00401 or R1 XXXXXX R2 XXXXXX R3 XXXXXX If R1 00401, consult backup procedures - change IMU orientation or final vehicle attitude Key REL Key RSET Go to step 14 If R1 XXXXXX attend to alarm Key KEY REL Key RSET	
		19. FL V50 N19 (perform trim maneuver) R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° Accept: GUID CONT - PGNS S/C: MODE CONTROL sel - AUTO Key PRO - return to step 12 Reject: GUID CONT - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR Exit R52 and R60 (R53 - in-flight sighting mark - star No. 1	

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		20. Routine 53 - Inflight Sighting Mark is called at this time FL V01 N71 R1 ABCDE R2 ----- R3 ----- AB - blank C - AOT detent DE - star/sun code Accept: Key PRO Reject: Load desired detent and/or star/sun code - if target is not a planet, go to step 23 21. FL V06 N34 - GET R1 XXXXX. hr R2 000XX. min R3 0XX.XX sec Use GET and the time of launch to compute ephemeris time. Use on-board tables to compute target position vectors at GET. Key PRO 22. FL V06 NTBD - Planet position vector R1 - X .XXXXXX R2 - Y .XXXXXX R3 - Z .XXXXXX Accept: Key PRO Reject: Load correct vectors 23. If any rear detent or backup optical system in use: FL V06 NTBD - optical system LOS R1 Azimuth XXX.XX° R2 Elevation XXX.XX° R3 ----- Accept: Key PRO Reject: Load correct calibrations 24. FL V54 (mark X or mark Y) POSS: PROG - on PGNS caut lt - on MASTER ALARM pb/lt - on	
	3		
	2		
	1 & 2		

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

CREW-MAN	PNL	PROCEDURES	REMARKS
		A program alarm will occur in the following cases (to identify alarm, Key V05 N09 and observe alarm codes in R1, R2 and R3) - An "enter/recycle" when no complete star vector pair is stored in the LGC (alarm code 00111) - A "proceed" when 7 mark pairs are already stored in the LGC (alarm code 00107) - A "mark X", "mark Y", or "mark reject" when no marks are being requested by the LGC (alarm code 00112) - A "mark reject" when a pair or partial pair has already been rejected, or when no unrejected marks are stored in the LGC (alarm code 00115) - A "mark X" when LGC is requesting a "mark y" or vice versa (alarm code 00114) If program alarm occurs: MASTER ALARM pb/lt - reset Key RSET V76E (for minimum impulse code) S/C: MODE CONTROL sel - ATT HOLD Mark X or Y as appropriate 25. FL V52 (mark X) or: FL V53 (mark Y) Accept: Mark X or mark Y as appropriate Reject: Key PRO (unpaired mark data on this star is discarded) Return to step 24 26. FL V50 N25 R1 00016 (continue marking) R2 ----- R3 ----- Accept: Key PRO Return to step 19 Reject: Key ENTR 27. FL V50 N25 R1 00015 (perform star acquisition) R2 ----- R3 ----- Accept: Key ENTR Return to step 15 Reject: Key ENTR, V77E to disable minimum impulse mode S/C: MODE CONTROL sel - AUTO Exit R53	
	1 & 2		
	3		
	3		

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		28. Routine 52 - Automatic Optics Position is called for second star FL V01 N70 R1 ABCDE R2 ----- R3 ----- AB - blank C - AOT detent DE - star/sun code Accept: Key PRO If target is not a planet, go to step 26 Reject: Load desired detent and/or star/sun code 29. FL V06 N34 - GET R1 XXXXX. hr R2 000XX. min R3 0XX.XX sec Use GET and time of launch to compute ephemeris time. Use on-board tables to compute target position vectors at present time. Key PRO 30. FL V06 N (Planet position vectors) R1 X .XXXXX R2 Y .XXXXX R3 Z .XXXXX Accept: Key PRO Reject: Load correct vectors 31. If rear AOT detent or backup optical system in use: FL V06 NTBD - optical system LOS R1 Azimuth XXX.XX⁰ R2 Elevation XXX.XX⁰ R3 ----- Accept: Key PRO Reject: Load correct calibrations 32. Routine 60 - Attitude Maneuver is called at this time FL V50 N25 R1 00203 - switch to PGNC automatic mode R2 ----- R3 -----	

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

ALIGNMENT

CREW-MAN	PNL	PROCEDURES	REMARKS
	1 3	Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO	
	1 3	Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR or - Select AGS	
		33. V06 N94 (final gimbal angles) R1 MG XXX.XX° R2 OG XXX.XX° R3 IG XXX.XX° Monitor maneuver on FDAI	
	1 & 2 2	34. POSS MASTER ALARM pb/lt - on PGNS caut lt - on PROG lt - on	
	1 & 2	MASTER ALARM pb/lt - reset Key V05 N09E - Call alarm R1 00401 or R1 XXXXXX R2 ----- R3 ----- If R1 00401 consult backup procedures If R1 XXXXXX, attend alarm Key KEY REL Key RSET Change IMU orientation or final vehicle attitude Key KEY REL Key RSET Go to step 28	
		35. FL V50 N19 (perform trim maneuver) R1 MG XXX.XX° R2 IG XXX.XX° R3 OG XXX.XX°	
	1 3	Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO	

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	1 3	Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR Exit R52, R60 (R53 - in-flight sighting mark - star No. II) 36. Routine 53 - Inflight Sighting Mark, second star is called at this time FL V01 N71 R1 ABCDE R2 ----- R3 ----- AB - blank C - AOT detent DE - star/sun code Accept: Key PRO Reject: Load desired detent and/or sun/star code If target is not a planet, go to step 33 37. FL V06 N34 - GET R1 XXXXX. hr R2 000.XX min R3 0XX.XX sec Use GET and the time of launch to compute ephemeris time. Use on-board tables to compute target position vectors at GET Key PRO 38. FL V06 NTBD (Planet position vectors) R1 X .XXXXX R2 Y .XXXXX R3 Z .XXXXX Accept: Key PRO Reject: Load correct vectors 39. If any rear detent or backup optical system in use: FL V06 NTBD - optical system LOS R1 Azimuth XXX.XX^o R2 Elevation XXX.XX^o R3 ----- Accept: Key PRO Reject: Load correct calibrations	

4. 7. 2 IMU REALIGN PROGRAM (P52) (cont)

CREW-MAN	PNL	PROCEDURES	REMARKS
	2 1 & 2	40. FL V54 (mark X or mark Y) POSS PROG lt - on PGNS caut lt - on MASTER ALARM pb/lt - on A program alarm will occur in the following cases (to identify alarm, Key V05 N09E and observe alarm codes in R1, R2 and R3): - An "enter/recycle" when no complete star vector pair is stored in LGC (alarm code 00111) - A "proceed" when 7 mark pairs are already stored in LGC (alarm code 00107) - A "mark X", "mark Y", or "mark reject" when no marks are being requested by LGC (alarm code 00112) - A "mark reject" when a pair or partial pair has already been rejected or when no unrejected marks are stored in LGC (alarm code 00115) - A "mark X" when LGC is requesting a "mark Y" or vice versa (alarm code 00114) If program alarm occurs: MASTER ALARM pb/lt - reset Key RSET V76E - for minimum impulse mode S/C: MODE CONTROL sel - ATT HOLD Mark X or mark Y as appropriate	
	3	41. FL V52 (mark X) or FL V53 (mark Y) Accept: Mark X or mark Y as appropriate Reject: Key PRO (unpaired mark data on this star is discarded) Return to step 40 42. FL V50 N25 R1 00016 (continue marking) R2 ----- R3 ----- Accept: Key PRO Return to step 40 Reject: Key ENTR 43. FL V50 N25 R1 00015 (perform star acquisition) R2 ----- R3 ----- Accept: Key ENTR Return to step 30	

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		Reject: Key ENTR V77E - to disable minimum impulse mode S/C: MODE CONTROL sel - AUTO Exit R53 44. R54 - Sighting Data Test is called at this time V06 N05 (10 seconds display) R1 star angle difference 000.XX⁰ R2 ----- R3 ----- (data good - difference < .15⁰) or: FL V06 N05 R1 - star angle difference XXX.XX⁰ R2 ----- R3 ----- (data bad - difference > .15⁰) Accept: Key PRO Go to step 46 Reject: Key V32E Exit R54 45. FL V50 N25 R1 00014 (fine align) R2 ----- R3 ----- Accept: Key PRO Go to step 7 Reject: Key ENTR Go to step 48 (R55 Gyro torquing) 46. Routine 55 - Gyro Torquing is called at this time FL V06 N93 - ΔGyro angles R1 X XX.XXX⁰ R2 Y XX.XXX⁰ R3 Z XX.XXX⁰ Accept: Key PRO Reject: Key V32E (gyros are not torqued) Exit R55	

4.7.2 IMU REALIGN PROGRAM (P52) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		47. FL V50 N25 R1 00014 (fine align check) R2 ----- R3 ----- Accept: Key PRO Return to step 9 Reject: Key ENTR Exit R51 R00 48. FL V50 N07 CB/AC BUS B: AOT LAMP - open AOT: Azimuth cont - CL 4.7.3 AGS ALIGNMENT WITH PGNC (IMU ALIGN) 1. Set controls - G&C basic 2. Key DEDA - IMU align C 400 + 30000E 3. Key DEDA - IMU align complete C 400R (displays 00000 when complete)	If IMU orientation is changed and AGS IMU alignment is to be performed, perform R47. Allow at least 20 seconds after R47 before starting AGS IMU alignment.

4.7.2 IMU REALIGN PROGRAM (P52)/4.7.3 AGS ALIGNMENT WITH PGNC (IMU ALIGN)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.8 PRETHRUST 4.8.1 EXTERNAL ΔV PROGRAM WITH AGS FOLLOW UP (P30)	
		AGS Selector Logic: 410 = + 50000	The purpose of Program 30 is to accept targeting parameters from source(s) external to the LGC, and to compute from these the required velocity as well as other initial conditions required by the LGC for a desired maneuver. The targeting parameters inserted into the LGC are: Time of ignition (TIG) Impulsive ΔV along LM local vertical axes at TIG.
11	1	1. Set controls - G&C basic except: CB/AC BUS A: RNDZ RDR - close CB PGNS: RNDZ RDR - close RATE/ERR MON sw - RNDZ RADAR 2. Key V37E 30E	To display to astronaut and ground the specific dependent variables associated with the maneuver for astronaut/ground approval. Assumptions: (1) PGNCs Start-up (2) P51 - IMU Orientation Determination should be completed before selection of this program.
		3. FL V06 N33 - TIG R1 00XXX hr R2 000XX min R3 0XX.XX sec Accept: Record TIG (ΔV) Key PRO Reject: V25E - Load desired TIG (ΔV)	To switch from PGNCs to AGS control, set G&C basic except: GUID CONT - AGS
		4. FL V06 N82 - ΔV (LV) R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps Accept: PRO Reject: V25E - Load desired ΔV (LV)	A + entry indicates V to be added in posigrade position. Separate procedure for out-of-plane ΔV at CSI, CDH.
		Key DEDA - Guidance steering C 400 + 10000E Key DEDA - ΔVX C 450 ± XXXXXE (1 fps) After CSI, CDH - to obtain velocity perpendicular to CSM orbit: Key DEDA - readout Vpy C 263R (1 fps) Determined desired proportion of Vpy to be entered in ΔVY	

4.8.1 EXTERNAL ΔV PROGRAM WITH AGS FOLLOW UP (P30)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		Key DEDA - ΔVY C 451 $\pm$ XXXXX (1 fps) Key DEDA - ΔVZ C 452 $\pm$ XXXXXE (1 fps) Key DEDA- External ΔV C 410 + 50000E 5. FL V06 N42 Ha XXXX.X nm Hp XXXX.X nm ΔV XXXX.X fps Coordinate data with MSFN Accept: Key PRO Reject: Reselect P30 or P27, load new parameters a. V37E 00E - LGC - Idling V37E 30E - External ΔV V25E - Load desired data b. V37E 00E - LGC Idling V37E 27E-LGC Update 6. FL V16 N35 - TFI R1 00XXX hr R2 000XX min R3 0XX.XX sec Set EVENT TIMER TO TFI Accept: Key PRO Reject: Select new program 7. R02 - IMU Status Check POSS FL50 N07 R1 00005 - PGNCS Startup 00051 - IMU Orientation Determination R2 ----- R3 ----- Key V37E 05E or 51E Exit R02	A + entry indicates V to be added opposite to LM angular momentum vector. A + entry indicates V to be added toward gravitational source. Reject options

4.8.1 EXTERNAL ΔV PROGRAM WITH AGS FOLLOW UP (P30) (cont)

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4.8.1 EXTERNAL ΔV PROGRAM WITH AGS FOLLOW UP (P30) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		15. FL V50 N07 - Perform new program Select propulsion program Exit P30 4.8.2 CSI PROGRAM WITH AGS FOLLOW UP (P32 or P72) AGS Selector Logic: 410 = + 10000	The purpose of Program 32 and Program 72 is to calculate parameters, based on maneuver data approved and keyed into the LGC by the astronaut, for the CSI and CDH; to display to, and receive approval from astronaut/ground, for the dependent variables; and to store the CSI target parameters for use by the desired thrusting program. RR used if within RR range. To switch from PGNCs to AGS control, G&C basic except: GUID CONT - AGS Ignore this column for P72
	11	1. Set controls - G&C basic except CB/AC BUS A: RNDZ RDR - close CB PGNS: RNDZ RDR - close HTR CONT: TEMP MON sel - RNDZ RADAR	
	3	2. Key V37E 32E or V37E 72E 3. FL V06 N30 - TIG (CSI) R1 00XXX hr R2 000XX min R3 0XX.XX sec Accept: Record TIG (CSI) PRO Reject: Key V25E - Load desired TIG (CSI) 4. FL V06 N55 R1 N 000XX R2 E XXX.XX° R3 ----- Accept: Record values	Receive targeting data from MSFN Key DEDA - Guidance Steering C 400 + 10000E Key DEDA - t_{igA} (CSI time) C 275 + XXXXXE (0.1 min) Key DEDA - Select Apsidal crossing for CDH R1 00001 = first Apsidal crossing at which TIG (CDH) should occur; 00002 = second etc.

4.8.1 EXTERNAL V PROGRAM WITH AGS FOLLOW UP (P30)/4.8.2 CSI PROGRAM WITH AGS FOLLOW UP (P32 or P72)

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CREW-MAN	PNL	PROCEDURES		REMARKS
		Key PRO Reject: Key V21E and/or V22E - Load desired CDH Apsis and/or E 5. FL V06 N37 - TIG (TPI) R1 00XXX hr R2 000XX min R3 0XX.XX sec Accept: Record TIG (TPI) Key PRO Reject: Key V25E - Load desired TIG (TPI) 6. FL V16 N45 R1 N XXXXXX -marks R2 TFI XXBXX min-sec R3 MGA 00000°	C 416 + X0000E X = 0 - 1st crossing X = 1 - 2nd crossing X = 2 - 3rd crossing Key DEDA - Select CDH at apsidal crossing or at fixed central angle C 417 + X0000E X = 0 - Select CDH at Apsis X = 1 - Select CDH at CSI + 180°, 360°, or 540° per address 416 Key DEDA - CSI C 410 + 10000E Key DEDA - Altitude rate at CSI C 463 (1 fps) If address 463 is <10 fps, Key DEDA - Select CDH at X radians after CSI (contents of address 416 + 1 times π C 417 + 10000E	Criterion for nearly circular orbit. -00000 is displayed at any time other than the last pass through the program.

4. 8.2 CSI PROGRAM WITH AGS FOLLOW UP (P32 or P72) (cont)

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CREW-MAN	PNL	PROCEDURES		REMARKS
			Key DEDA - Octal B2 Tan (LOS andle at TPI) C 147 + XXXXXE	Nominal value - 04003 Range - 03639 to 35667 <u>TANGENTS OF ANGLES IN OCTAL FORM WITH BINARY SHIFT (B2)</u> ANGLE (°)TANGENT (OCTAL B2) 20.05646 21.06111 22.06356 23.06625 24.07077 25.07354 26.07633 26.6.10006 Nominal angle between LOS-to-CSM and local horizontal at desired TPI time as used in the CSI computations. 27.10116 28.10404 29.10675 30.11172 31.11472 32.11777 33.12310 34.12626 35.13150 36.13500 37.14035 38.14400 39.14752 40.15332 41.15721 42.16320 43.16727 44.17347 45.20000 46.20443 47.21121 48.21512 49.22320 50.23043

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CREW-MAN	PNL	PROCEDURES		REMARKS
		Options: a. To continue the mark process - Key V32E - Recycle, go to step 7 b. To terminate the mark process, and do the final pass through the program: Key PRO	7. POSS FL V05 N09 - Alarm in up to 3 registers 00XXX 00XXX 00XXX	51 .23504 52 .24365 53 .25167 54 .26013 55 .26663 56 .27561 57 .30507 58 .31466 59 .32502 60 .33555 61 .34672 62 .36057 63 .37316 64 .40634 65 .42240 66 .43737 67 .45544 68 .47464 69 .51535 70 .53754 71 .56357 72 .61175 73 .64253 74 .67631 75 .73555

4.8.2 CSI PROGRAM WITH AGS FOLLOW UP (P32 or P72) (cont)

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CREW-MAN	PNL	PROCEDURES		REMARKS
		Possible alarms: 00600 00606 00605 00601 00602 00603 00604 Key RSET Key V32E - recycle to step 3, adjust input parameters 8. FL V06 N50 R1 XXXX.X NM - Δalt (CDH) R2 XXBXX min-sec ΔT (CSI/CDH) R3 XXBXX min-sec ΔT (CSH/TPI) Record values - Key PRO 9. FL V06 N81 - Display ΔV for CSI R1 XXXX.X fps - ΔVx (LV) R2 XXXX.X fps - ΔVy (LV) R3 XXXX.X fps - ΔVz (LV) Accept: Record values Key PRO Reject: Key V25E - Load desired data	Key DEDA - Vpo - ΔV for C 371R (1 fps), record value Key DEDA - Δro or Δh C 402R (0.01 min) - compare with R1 Key DEDA - TAO, CSI to CDH time C 373R (0.1 min) - compare with R2 Key DEDA - Tc - CDA to TPI time C 274R (0.1 min) - compare with R3 Key DEDA - Vo - ΔV CSI C 507R (1 fps)	See G&N GENERAL, 4.4.7 for alarm codes.

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CREW- MAN	PNL	PROCEDURES		REMARKS
		10. FL V06 N82 - Display ΔV for CDH R1 XXXX.X fps - ΔV_x (LV) R2 XXXX.X fps - ΔV_y (LV) R3 XXXX.X fps - ΔV_z (LV) Record values - Key PRO	If solutions are unsatisfactory, request new targeting data from MSFN and reinitialize CSI search routine Key DEDA - Reinitialize CSI search routine C 410 + 00000E Repeat CSI routine address 410 + 10000 and readout new parameters. Alternate method of eliminating unsatisfactory data - generate new TPI and reinitialize CSI search routine	A new value of ΔV_y based on use of R36 may be substituted to obtain out-of-plane corrections.
		11. FL V16 N45 R1 N XXXXX Marks R2 TFI XXBXX min-sec R3 MGA XXX.XX0 R3 will display: a. -00000, if this is not the last pass through the program b. -00001, if this is the last pass for P72, or if this is the last pass and the IMU is not aligned for P32 c. XXX.XX deg MGA with + X axis aligned with the thrust vector for P32	Key DEDA - Ti C 313R (0.01 min)	

4. 8. 2 CSI PROGRAM WITH AGS FOLLOW UP (P32 or P72) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		Options: a. If this was not the last pass through the program: (1) To determine the mark process and accomplish the final pass - Key PRO - return to step 7 (2) To continue the mark process - Key V32E, recycle to step 7 b. If this was the last pass through the program: Set EVENT TIMER to TFI (in R2) Key V47E - Perform R47 for AGS state update vector only 12. Transmit maneuver parameters to CSM, P32: Transmit ΔV (N82) to CSM P72: Transmit all maneuver Parameters to CSM Key PRO 13. FL V50 N07 - Perform change of program Key V37E --E - Select desired propulsion program (EXIT P32 P72)	Refer to paragraph 4.5.6 for R47. To update AGS-state vectors manually, refer to paragraph 4.5.15.

4.8.2 CSI PROGRAM WITH AGS FOLLOW UP (P32 or P72) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.8.3 CDH PROGRAM WITH AGS FOLLOW UP (P33 or P73) AGS Selector Logic: 410 = + 20000	The purpose of Program 33 is to calculate parameters, based upon maneuver data approved and keyed into the LGC by the astronaut, for use in the CDH; to display to, and receive approval from astronaut/ground, the dependent variables for the CDH maneuver; and to store the CDH target parameters for use by the desired thrusting program. The purpose of Program 73 is to calculate parameters for the maneuvers with the exception of co-elliptic sequence initiation (CSI) for CSM execution; these parameters to be approved, keyed and displayed in the same manner as for Program 33. To switch from PGNS to AGS control, set to G&C basic except: GUID CONT sw - AGS Disregard AGS column for P73
	11	1. Set controls G&C basic except: CB/AC BUS A: RNDZ RDR - close	
	11	CB PGNS: RNDZ RDR - close	
	3	HTR CONT: TEMP MON sel - RNDZ RADAR	
		2. Key V37E 33E or V37E 73E	
		3. FL V06 N31 - Display TIG (CDH) R1 00XXX hrs R2 000XX min R3 0XX.XX sec Accept: Record data Key PRO Reject: Key V25E - Load desired data	Key DEDA - Guidance steering C 400 + 10000E Enter CDH routine before LM passes through apogee or perigee, and before LM or CSM state vector update
		4. P33 - Go to step 5 P73 - Go to step 7	

4.8.3 CDH PROGRAM WITH AGS FOLLOW UP (P33 or P73)

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CREW- MAN	PNL	PROCEDURES		REMARKS
		5. P33 only: FL V16 N45 R1 N XXXXX Marks R2 TFI XXBXX min-sec R3 MGA 00000° Options: a. To continue the mark process: Key V32E, recycle b. To terminate the mark process, perform final pass through the program - Key PRO 6. P33 only: POSS FL V05 N09 - Alarm R1 00611 - no solution can reached R2 ----- R3 ----- PROG lt - on RSET pb - push Options: a. Key V32E - Recycle to step 3, readjust TIG b. Key PRO - proceed with inaccurate data c. Key V34E - Terminate 7. FL V06 N-- R1 Δalt (CDH) XXXX.X nm R2 ΔT (CDH/TPI) XXBXX min-sec R3 ΔT (TPI/TPI) XXBXX min-sec Record data Key PRO	If CSI is not performed immediately before CDH routine selection - Key DEDA TΔ, time to go to CDH (obtain from MSFN) C 313 + XXXXXE (0.01 min) Unless DEDA entry 417 + 10000 was made during CSI, the sign of altitude rate must not change beginning of CSI until selection of CDH Key DEDA - Δro or Δh C 402R (0.1 min) compare with R1	R3 - 00000 is displayed at any time other than the last pass through the program.

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CREW- MAN	PNL	PROCEDURES	REMARKS
		c. XXXX.XX° MGA with +X axis aligned with the thrust vector for P33 Options: If not the last pass through the program: a. To terminate the mark process perform the final pass Key PRO b. To continue the mark process - Key V32E - Recycle: P33 - Return to step 6 P73 - Return to step 7 If this was the last pass through the program - Set EVENT TIMER to TFI (in R2) Key V47E: Perform R47 (for AGS state vector only) 12. Transmit maneuver parameters to CSM: P33: transmit ΔV (N82) to CSM P73: transmit all maneuver parameters to CSM Key PRO 13. FL V50 N07 - perform change of program Select desired program (Exit P33, P73)	Refer to paragraph 4.5.6 for R47. To update AGS-state vectors manually, refer to paragraph 4.5.15
		4.8.4 TPI PROGRAM WITH AGS FOLLOW UP (P34 or P74) AGS Select Logic: 410 = + 40000	The purpose of Program 34 (or Program 74) is to calculate required ΔV and other initial conditions for TPI maneuver given TIG (TPI) or E (TPI) and ΔT TRANS. P74 is for a CSM maneuver, ignore backup column for this program.

4.8.3 CDH PROGRAM WITH AGS FOLLOW UP (P33 or P73) (cont)/4.8.4 TPI PROGRAM WITH AGS FOLLOW UP (P34 or P74)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		1. Set controls - G&C basic except: CB/AC BUS A: RNDZ RDR - close CB PGNS: RNDZ RDR - close RATE ERR MON sw - RNDZ RADAR HTR CONT: TEMP MON sel - RNDZ RADAR 2. Key V37E 34E or 74E 3. FL V06 N37 - TIG (TPI) R1 00XXX hr R2 000XX min R3 0XX.XX sec Accept: Record TIG (TPI) Key PRO Reject: Key V25E - Load desired TIG (TPI) 4. FL V06 N55 R1 ----- R2 E XXX.XX° R3 ----- Accept: Record E Key PRO Reject: Key V22E - Load desired E 5. FL V50 N06 - Option R1 00003 - Load TPI option R2 0000X - Assumed option R3 ----- X = 1 - Load TIG (TPI) X = 2 - Load E Accept: Key PRO Reject: V22E - Load desired option (1E or 2E)	To switch from PGNCs to AGS control GUID CONT sw - AGS Key DEDA - Guidance steering C 400 + 10000E

4.8.4 TPI PROGRAM WITH AGS FOLLOW UP (P34 or P74) (cont)

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CREW- MAN	PNL	PROCEDURES		REMARKS
		6. POSS FL V05 N09 - Alarm R1 00611 - No solution for TIG (TPI) or E R2 ----- R3 ----- PROG lt - on PGNS caut lt - on MASTER ALARM pb/lt - on MASTER ALARM pb/lt - reset Key RSET Key V32E - Recycle to step 3 7. If E load option is selected FL V06 N37 - TIG (TPI) R1 00XXX hr R2 000XX min R3 0XX.XX sec Accept: Record TIG (TPI) Key PRO Reject: Key V32E Recycle to step 3 8. If TIG (TPI) load option is selected FL V06 N55 - E R1 ----- R2 E XXX.XX° R3 ----- Accept: Record E Key PRO Reject: Key V32E Recycle to step 3 9. FL V06 N39 - ΔT TRANS R1 00XXX hr R2 000XX min R3 0XX.XX sec Accept: Record ΔT TRANS Key PRO Reject: V25 - Load desired T TRANS	To cause a node to be generated 90° downrange from TPI Key DEDA C 456 + 10000E For nominal TPI Key DEDA C 456 + 00000E Key DEDA - Time duration of transfer C 311 + XXXXXE (0.01 min) <u>Under PGNCs control:</u> Key DEDA - TPI execute C 410 + 40000E Key DEDA - tigC C 373 + XXXXXE (0.1 min)	To avoid indeterminant values at 0°, 180° and 360°, address 311 must not reflect the following: < 5 minutes 42 to <53 minutes 90 to <100 minutes >130 minutes

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CREW- MAN	PNL	PROCEDURES	REMARKS
		<u>Under AGS control:</u> Key DEDA - TPI search C 410 + 30000E Key DEDA - TΔ C 313 + XXXXXE (0.01 min) Key DEDA - θLOS C 306R (0.01°) When θLOS = Preselected value (approximately PGNCS E) Key DEDA - TPI execute C 410 + 40000E Key DEDA - TΔ C 313R (0.01 min) 10. P74 only: FL V06 N84 - ΔV CSM R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps Record ΔV CSM Key PRO 11. FL V06 N58 R1 ΔV (TPI) XXXX.X fps R2 Hp (TPI) XXXX.X nm R3 ΔV (TPF) XXXX.X fps Accept: Record values Key PRO Reject: Key V32E - Recycle to step 3 and adjust input parameters 12. FL V16 N35 - TFI R1 00XXX hr R2 000XX min R3 0XX.XX sec	

4.8.4 TPI PROGRAM WITH AGS FOLLOW UP (P34 or P74) (cont)

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4.8.4 TPI PROGRAM WITH AGS FOLLOW UP (P34 or P74) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		17. POSS FL V50 N07 R1 00005 - PGNCS startup 00051 - IMU Orientation Determination R2 ----- R3 ----- Select appropriate program Exit R02 and P34 or P74 18. P34 only: FL V16 N45 R1 N XXXXXX marks R2 TFI (TPI) XXBXX min-sec R3 MGA XXX.XX° Record N and MGA Key PRO 19. P34 only: Perform R47 - AGS Initialization 20. P34 only: Transmit ΔV parameters to CSM. 21. P34 only: FL V50 N07 - change Program Select propulsion program Exit P34 22. P74 only: Transmit maneuver param- eters to CSM 23. P74 only: FL V50 N07 - change program Exit P74	Reference paragraph 4.5.6 for R47 To update AGS manually refer to paragraph 4.5.14

4.8.4 TPI PROGRAM WITH AGS FOLLOW UP (P34 or P74) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.8.5 TPM PROGRAM WITH AGS FOLLOW UP (P35 or P75) AGS Select Logic: 410 = + 40000 1. Set control - G&C basic except: CB/AC BUS A: RNDZ RDR - close CB PGNS: RNDZ RDR - close RATE ERR MON sw - RNDZ RADAR HTR CONT: TEMP MON sel - RNDZ RADAR 2. Key V37E 35E or 75E 3. FL V16 N35 - TF INT R1 00XXX hr R2 000XX min R3 0XX.XX sec 4. Set EVENT TIMER to TF INT Key PRO 5. FL V16 N45 R1 N 000XX marks R2 TF INT XXBXX min-sec R3 00000 <u>No retargeting required:</u> Key DEDA - C 456 + 00000E Key DEDA - VG C 370R (1 fps) Null VG with TTCA at desired thrusting time <u>Retargeting required:</u> Determine targeted time of TPI burn and time duration of transfer Original time of rendezvous can be preserved by specifying a new targeted time of TPI burn	The purpose of Program 35 (or Program 75) is to calculate required ΔV and other initial conditions for TPM maneuver during LM rendezvous. P75 is for a CSM maneuver, ignore backup column for this program. ISS is on and precisely aligned. RR is on and locked on CSM To switch from PGNCS to AGS control GUID CONT sw - AGS R3 displays 00000 until tracking is terminated and Lambert problem is solved. Thereafter R3 displays MGA. To prevent changing node for midcourse burn not at node, retargeting is required.

4.8.5 TPM PROGRAM WITH AGS FOLLOW UP (P35 or P75)

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CREW-MAN	PNL	PROCEDURES		REMARKS
		6. P35 only: If TF INT ≤ 10 min, select Thrust Monitor Program (P47). 7. P75 only: If TF INT ≤ 10 min, advise CSM to select P47. 8. Check N increasing once per minute. When ready key PRO 9. P75 only: FL V06 N85 (ΔV CSM) R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps Record ΔV CSM Key PRO	Key DEDA - tig C C 373R (0.1 min) Record tig C Key DEDA C 311R + XXXXXE (0.01 min) Key DEDA - tig C C 373 + XXXXXE (0.1 min) Key DEDA - New time duration of transfer C 311 + XXXXXE (0.01 min) Key DEDA - Vpy C 263R (1 fps) Record Vpy Key DEDA - Vy C 451 + XXXXXE (1 fps) Key DEDA - VG C 370R (1 fps) Null VG with TTCA at desired thrusting time	Reference paragraph 4.9.4

4.8.5 TPM PROGRAM WITH AGS FOLLOW UP (P35 or P75) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		10. FL V06 N38 - TIG (MID) R1 00XXX hr R2 000XX min R3 0XX.XX sec Record TIG (MID) Key PRO 11. FL V06 N59 R1 ΔV (MID) XXXX.X fps R2 TFI (MID) XXBXX min-sec R3 ΔV (TPF) XXXX.X fps If midcourse burn is not required Key V32E - Recycle to step 4 If midcourse burn is required Key PRO 12. P75 only: Set EVENT TIMER to TFI (MID) 13. P75 only: Transmit all parameters to CSM 14. P75 only: FL V50 N07 - Change program Exit P75 15. P35 only: FL V16 N45 R1 N XXXXX marks R2 TFI XXBXX min-sec R3 MGA XXX.XX° 16. P35 only: Perform R47-AGS Initiation	Key DEDA-AGS update via downlink C 414 + 10000E Reference paragraph 4.9.4 for R47. To update AGS manually, refer to paragraph 4.5.14.

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CREW-MAN	PNL	PROCEDURES	REMARKS
		17. P35 only: FL V16 N45 R1 N XXXXX marks R2 TFI XXBXX min-sec R3 MGA XXX.XX° Set EVENT TIMER to TFI (MID) Record parameters Key PRO Transmit parameters to CSM 18. FL V50 N07 - Change program Exit P35 4.8.6 USE OF EXTERNAL ΔV for REMOVING OUT-OF-PLANE VELOCITY at CSI or CDH 1. After the CSI solution has converged and the solution checks have been made, or the CDH solution checks have been made: Key DEDA - Vpy C 263R (1 fps) 2. Determine proportion of Vpy to be entered in ΔV_y (obtain from MSFN or from (TBD) procedure) 3. Key DEDA - ΔV_y C 451 ± XXXXXE (1 fps) 4. Key DEDA - external ΔV C 410 + 50000E 5. Key DEDA - AGS update via downlink C 414 + 10000E	CSI is normally near a node ($Y = 0$, $V_y = \text{maximum}$) with respect to the CSM orbit and is an efficient time and location to remove out-of-plane velocity. Two components of ΔV for the external ΔV option are computed by the CSI and CDH routines. The other component is read out on the DEDA from one location and a (TBD) proportion is entered in the appropriate external ΔV location. The external ΔV option is used for the CSI or CDH burn. To update AGS manually, refer to paragraph 4.5.15

4.8.5 TPM PROGRAM WITH AGS FOLLOW UP (P35 or P75) (cont)/4.8.6 USE OF EXTERNAL ΔV for REMOVING OUT-OF-PLANE VELOCITY at CSI or CDH

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CREW- MAN	PNL	PROCEDURES	REMARKS
		4.9 <u>THRUST</u> 4.9.1 DPS PROGRAM (DOCKED & SEPARATED) WITH AGS FOLLOW UP/IN CONTROL (P40) 1. Set control - G&C basic 2. In docked configuration, execute P30. 3. If required load DAP (R03) 4. Key V37E 40E 5. POSS FL V05 N09 - Alarm R1 01706 - Stage verified discrete indicates DPS has been staged. R2----- R3----- PROG lt - on Key V34E and RSET Exit P40 6. Routine 02 - IMU Status check is performed at this time, step 7. 7. POSS FL V50 N07 R1 00005 - PGNCS startup 00051 - IMU orientation determination R2 ----- R3 ----- Select P05 or 51 Exit R02 and P40	The purpose of Program 40 is to compute a preferred IMU orientation and a LM attitude for a DPS thrusting maneuver. The following have been performed before selecting Program 40: MPS BASIC (Unstaged), paragraph 4.12.6 ECS BASIC (Staged & Unstaged) paragraph 4.12.1 EPS Preparation for DPS Burn, paragraph 4.12.4 Program 05, paragraph 4.2.11 Program 51, paragraph 4.7.1 DPS ambient helium pressurization Reference paragraph 4.8.1 Suggested DAP load for docked configuration is 1XXXXX and for separated configuration 0XXXXX. Reference paragraph 4.6.5 for DAP load logic.

4.9.1 DPS PROGRAM (DOCKED & SEPARATED) WITH AGS FOLLOW UP/IN CONTROL (P40)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		8. Manual selection of VG(LV) can be performed Key V06 N86E R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps 9. Routine 60 - Attitude maneuver is performed at this time, steps 10 through 14. 10. FL V50 N25 - Checklist Reference R1 00203 - switch to PGNS automatic mode R2----- R3----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR 11. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° 12. If PGNS automatic mode not selected, perform manual maneuver.	If IMU orientation changed since last state vector update, perform R47, paragraph 4.56, only if time is available. Complete AGS IMU align before LGC performs R60 to insure attitude rates $< 0.1^\circ/\text{sec}$ during AGS IMU align. Key C400 + 30000E Key DEDA - Guidance steering C 400 + 10000E Under AGS control: GUID CONT sw - AGS S/C: MODE CONTROL sel - AUTO If AGS automatic mode selected, when EVENT TIMER $\approx 02:00$ ENG THR CONT: THR CONT sw - MAN ENG THR CONT: MAN THROT sw - CDR

4.9.1 DPS PROGRAM (DOCKED & SEPARATED) WITH AGS FOLLOW UP/IN CONTROL (P40) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		13. If automatic maneuver, POSS PROG lt - on Key V09 N09E - Call alarm R1 00401 - Calculated gimbal angles yield gimbal lock R2----- R3----- If alarm is not 00401: Key KEY REL and RSET 14. FL V50 N10 - Enable trim R1 Roll XXX.XX⁰ R2 Pitch XXX.XX⁰ R3 Yaw XXX.XX⁰ Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR Exit R60 15. If PGNC automatic mode not selected, FL V50 N 25 - Checklist Reference R1 00203 - switch to PGNCS automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO ENG THR CONT: THR CONT - AUTO Key PRO Reject: Key ENTR	Key DEDA - ΔV_{gx} C 500R (1 fps)

4.9.1 DPS PROGRAM (DOCKED & SEPARATED) WITH AGS FOLLOW UP/IN CONTROL (P40) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		16. POSS FL V06 N09 - Alarm R1 01703 - TFI <45 sec R2----- R3----- Refer to EVENT TIMER and determine with MSFN whether to slip engine ignition 45 sec To slip TFI 45 sec: Key PRO and RSET To terminate: Key V34E and RSET Exit P40 17. If LR operating test is performed during DPS thrust, activate LR at least 1 minute before DPS burn and select Routine 77 - LR Spurious Test, step 18. 18. Key V78E Velocity and range beams are sampled once each second; To terminate R77: Key V79E Exit R77 19. V06 N40 R1 TFI XXBXX min-sec R2 VG XXXX.X fps R3 ΔVm XXXX.X fps Update EVENT TIMER if TFI slipped Verify CMD THRUST ind - 10% 20. If under PGNCS control: ENG THR CONT: ENG ARM sw - DES 21. If first DPS burn: EDS MASTER ARM sw - ON 22. Secure self and cabin	Reference paragraph 4.10.2 If CMD THRUST ind - >10%, reset throttle setting to minimum and increase friction setting. If CMD THRUST ind remains >10%, set ENG THR CONT: THR CONT sw - MAN

4.9.1 DPS PROGRAM (DOCKED & SEPARATED) WITH AGS FOLLOW UP/IN CONTROL (P40) (cont)

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CREW- MAN	PNL	PROCEDURES		REMARKS
		23. Verify $\Delta V_m < 0.5$ fps from TFI = -00B30 to 00B15 24. If $\Delta V_m > 0.5$ fps, GUID CONT sw - AGS ENG THR CONT: THR CONT sw - MAN 25. When TFI = - 00B07 (docked) configuration - 00B10, monitor start of ullage ΔV. 26. When TFI = -00B05, FL V50 N99 - Request engine on enable R1 TFI XXBXX min-sec R2 VG XXXX. X fps R3 ΔV_m >XXXX. X fps Accept: When $\Delta V_m > TBD$ fps key PRO Reject: Key V34E Exit P40. 27. To perform thrust with RCS, Key ENTR. Go to step 40. 28. Monitor thrust when TFI = 00B00 or when PRO is keyed. If no DPS burn, return to step 26. 29. V06 N40 R1 TG XXBXX min-sec R2 VG XXXX. X fps R3 ΔV_m XXXX. X fps TB and VG decreasing ΔV_m increasing Monitor FDAI attitude error and attitude rates	If under AGS control: When EVENT TIMER = -00:12, +X TRANSL pb - push and hold until DPS start Alternate procedure: When EVENT TIMER = -00:12, TTCA - move up until DPS start Monitor thrust when EVENT TIMER = 00:00. If no DPS burn START pb - push ΔV_{gx} decreasing	DSKY displays are blanked from TFI = -00B35 to -00B30. Displays reappear at beginning of average G integration.

4.9.1 DPS PROGRAM (DOCKED & SEPARATED) WITH AGS FOLLOW UP/IN CONTROL (P40) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		30. In docked configuration perform APS/RCS Propellant Interconnect procedure, steps 1, 2, and 3 of paragraph 4.12.23 31. Backup procedure: GUID CONT sw - AGS ENG THRU CONT: THR CONT-MAN TTCA - increase as desired 32. When EVENT TIMER = 59:34 ENG THRUST ind - 100% CMD THRUST ind - 100% Unless initial TG <95 seconds 33. POSS PROG lt - on Key V05 N09E - Call alarm R1 01407 - Angle between VG and $\Delta V > 45^\circ$ R2----- R3----- KEY REL lt - on Key KEY REL and RSET 34. In docked configuration at TG = -10 seconds, perform APS/RCS Propellant Interconnect procedure steps 4, 5, and 6 of paragraph 4.12.23 35. Monitor thrust cutoff when TG and VG = 00B00 and 0000.0 fps 36. If cutoff is early, return to return to step 26 37. If cutoff is late, STOP pb - push consult with MSFN 38. After thrust cutoff, ENG THR CONT: ENG ARM sw - OFF ED: MASTER ARM sw - OFF	When EVENT TIMER = 59:34 = TG + 26 seconds, throttle is commanded to maximum. If TG <95 seconds, no throttle flag is set to inhibit throttle command from going to maximum. The logic used assures accurate engine cutoff. ΔV_{gx} = TBD 10 seconds before engine cutoff. Monitor thrust cut off when $\Delta V_x = 00000$ fps If under AGS control, ABORT pb - reset

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CREW-MAN	PNL	PROCEDURES	REMARKS
		39. If LR operating test performed during thrust, CB PGNS: LDG RDR - open Key V79E 40. FL V16 N40 R1 TG XXBXX min-sec R2 VG XXXX.X fps R3 ΔV_m XXXX.X fps Record VG Key PRO 41. FL V16 N85 - VG (LM) R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps 42. If manual trim is desired: S/C: MODE CONTROL sel - ATT HOLD THROTTLE /JETS cont (CDR) - JETS TTCA - maneuver to null VGX, VGY, VGZ S/C: MODE CONTROL sel-AUTO 43. Receive orbital data from MSFN 44. Routine 30 - Orbital Display may be called at this time, steps 45 through 48 45. Key V82E	

4.9.1 DPS PROGRAM (DOCKED & SEPARATED) WITH AGS FOLLOW UP/IN CONTROL (P40) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		46. FL V06 N40 R1 0000X - option code for assumed vehicle R2 0000X - LGC assumed option R3 ----- R2 0000X = 1 - LM 0000X >1 CSM Accept: Key PRO Reject: Key V22E Load desired option 47. FL V06 N44 - Orbit parameters R1 Ha XXXX.X nm R2 Hp XXXX.X nm R3 TFF XXBXX min-sec When finished with display Key PRO 48. If Hp > 300,000 ft FL V06 N32 - T Perigee R1 00XXX hr R2 000XX min R3 0XX.XX sec Key PRO Exit R30 49. FL V50 N07 - Change program Exit P40 50. Load DAP (R03) wide deadband if no maneuvers are planned 4.9.2 RCS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P41)	If Hp $\geq 300,000$ ft (≈ 50 nm), TFF = 59B59 until Hp < 300,000 ft Orbit parameters can be recycled to display updated values if average g integration is in process by keying V32E. The purpose of Program 41 is to compute a preferred IMU orientation and a LM attitude for an RCS thrusting maneuver. The following have been performed: ECS Basic (Staged & Unstaged), paragraph 4.12.1 Communications Basic, paragraph 4.12.5 Program 05, paragraph 4.2.11 Program 51, paragraph 4.7.1

4.9.1 DPS PROGRAM (DOCKED & SEPARATED) WITH AGS FOLLOW UP/IN CONTROL (P40)/
4.9.2 RCS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P41)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		1. Set controls - G&C basic except: JETS/THROTTLE cont (CDR) - JETS 2. If required load DAP (R03) 3. Key V37E 41E 4. Routine 02 - IMU status check is performed at this time, step 5. 5. POSS FL V50 N07 R1 00005 - PGNCS startup 00051 - IMU Orientation Determination R2----- R3----- Select P05 or P51 Exit R02 and P41 6. Manual selection of VG (LV) can be performed Key V06 N86E R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps 7. Routine 60 - Attitude Maneuver is performed at this time, steps 8 through 12.	Suggested DAP load is X2102. Reference paragraph 4.6.5 for DAP load logic If IMU orientation changed since last state vector update, perform R47, paragraph 4.5.6, only if time is available. Complete AGS IMU align before LGC performs R60 to insure attitude rates $<0.5^{\circ}/\text{sec}$ during AGS IMU align.

4.9.2. RCS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P41) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		8. FL V50 N25 - Checklist Reference R1 00203 - switch to PGNCs automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR 9. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° 10. If PGNCs automatic mode not selected, perform manual maneuver. 11. If automatic maneuver, POSS PROG It-on Key V09 N09E - Call alarm R1 00401 - calculated gimbal angles yield gimbal lock R2----- R3----- If alarm is not 00401, Key Key KEY REL and RSET	Under AGS control: GUID CONT sw - AGS S/C: MODE CONTROL sel - AUTO Key DEDA - ΔV_{gx} C 500R (1 fps)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		12. FL V50 N19 - Enable trim R1 Roll XXXX.XX⁰ R2 Pitch XXX.XX⁰ R3 Yaw XXX.XX⁰ Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR Exit R60 13. Secure self and cabin 14. V16 N85 - VG (LM) R1 X XXXXX.X fps R2 Y XXXXX.X fps R3 Z XXXXX.X fps 15. At TFI = -00B00 FL V16 N85 - VG (LM) R1 X XXXXX.X fps R2 Y XXXXX.X fps R3 Z XXXXX.X fps TTCA and/or ACA - maneuver to null out VGX, VGY, VGZ. 16. Backup procedure: + X TRANSL pb - push and hold	DSKY displays are blanked at TIG = -00B35 to -00B30 To conserve RCS propellant during RCS thrust APS/RCS Propellant Interconnect, reference paragraph 4.12.23, can be performed.

4.9.2 RCS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P41) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		17. Receive orbital data from MSFN 18. Routine 30 - Orbital Display may be called at this time, steps 19 through 22 19. Key V82E 20. FL V04 N06 R1 0000X - Option code for assumed vehicle R2 0000X - LGC assumed option R3 ----- R2 00002 = 1 - LM 0000X = >1 - CSM Accept: Key PRC Reject: Key V22E - Load desired option 21. FL V06 N44 - Orbit parameters R1 Ha XXXX.X nm R2 Hp XXXX.X nm R3TFF XXBXX min-sec When finished with display Key PRO 22. If Hp >300,000 ft FL V06 N32 - T Perigee R1 00XXX hr R2 000XX min R3 0XX.XX sec Key PRO Exit R30 23. FL V50 N07 - Change program Exit P41 24. Load DAP (R03) wide dead-band if no maneuvers are planned.	If Hp $\geq 300,000$ ft (≈ 50 nm), TFF = 59B59 until Hp <300,000 ft. Orbit parameters can be recycled to display updated values if average g integration is in process by keying V32E.

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4.9.3 APS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P42)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		7. Manual selection of VG (LV) can be performed R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps 8. Routine 60 - Attitude Maneuver is performed at this time, steps 9 through 13. 9. FL V50 N25 - Checklist Reference R1 00203 - Switch to PGNC automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR 10. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° 11. If PGNC automatic mode not selected, perform manual maneuver.	If IMU orientation changed since last state vector update, perform R47, paragraph 4.5.6, only if time is available. Complete AGS IMU align before LGC performs R60 to insure attitude rates <0.1°/sec during AGS IMU align. Key DEDA - IMU align C 400 + 30000E Key DEDA - Guidance steering C 400 + 10000E Key DEDA - Canted thrust vector C 411 + 10000E Under AGS control: GUID CONT sw - AGS S/C: MODE CONTROL sel - AUTO

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CREW-MAN	PNL	PROCEDURES	REMARKS
		12. If automatic maneuver, POSS PROG It - on Key V05 N09E - Call alarm R1 00401 - Calculated gimbal angles yield gimbal lock R2 ----- R3 ----- If alarm is not 00401 Key KEY REL and RSET 13. FL V50 N19 - Enable trim R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° Accept: GUID CONT sw - AUTO S/C: MODE CONTROL sel - AUTO Key PRO Reject: GUID CONT sw - PGNS S/C: MODE CONTROL sel - ATT HOLD Key ENTR Exit R60 14. If PGNCs automatic mode not selected, FL V50 N25 - Checklist Reference R1 00203 - Switch to PGNCs automatic mode R2 ----- R3 ----- Accept: GUID CONT sw - PGNS S/C: MODE CONTROL sel - AUTO Key PRO Reject: Key ENTR	Key DEDA - ΔV_{gx} C 500R (1fps)

4.9.3 APS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P42) (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		15. POSS FL V05 N09 - Alarm R1 01703 - TFI <45 sec R2 ----- R3 ----- Refer to EVENT TIMER and determine with MSFN whether to slip engine ignition 45 sec To slip TFI 45 sec: Key PRO and RSET To terminate: Key V34E and RSET Exit P42 16. V06 N40 R1 TFI XXBXX min-sec R2 VG XXXX.X fps R3 ΔVm XXXX.X fps Under PGNCS control: ENG THR CONT: ENG ARM sw - ASC 17. Secure self and cabin 18. Verify ΔVm <0.5 fps from TFI = - 00B30 to -00B15 19. If ΔVm >0.5 fps, GUID CONT sw - AGS 20. When TFI = 00B05, FL V50 N99 - Request engine on enable R1 TFI XXBXX min-sec R2 VG XXXX.X fps R3 ΔVm XXXX.X fps Monitor start of ullage ΔV at TFI = -00B03. For manual staging under automatic APS firing (Modified FITH): ED: MASTER ARM sw - ON ED: STAGE sw - FIRE when ΔVm >TBD fps.	Under AGS control ABORT STAGE pb - push DSKY displays are blanked from TFI = - 00B35 to -00B30. If under AGS control: When EVENT TIMER = -00:12, +X TRANSL pb - push and hold until APS start Alternate procedure: When EVENT TIMER = -00:12, TTCA - move up until APS start Required ullage is a function of LM mass and ullage volume.

4.9.3 APS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P42) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		Accept: When $\Delta V_m > \text{TBD fps}$ - Key PRO Reject: Key V34E Exit P42 21. To perform thrust with RCS, Key ENTR - go to step 34 22. Monitor thrust when TFI = 00B00, If no APS burn return to step 20 23. V06 N40 R1 TG XXXBXX min-sec R2 VG XXXX.X fps R3 ΔV_m XXXX.X fps TG and VG decreasing ΔV_m in- creasing. 24. Perform APS/RCS Propellant Interconnect, steps 1, 2, and 3 of paragraph 4.12.23. 25. Monitor FDAI attitude error and attitude rates. 26. Backup procedure: GUID CONT sw - AGS 27. At TG = 10 seconds perform APS/RCS Propellant Interconnect, steps 4, 5, and 6 of paragraph 4.12.23 28. Monitor thrust cutoff when TG and VG = 00B00 and 0000.0 fps 29. If cutoff is early, return to step 20. 30. If cutoff is late, STOP pb - push consult with MSFN	Monitor thrust when EVENT TIMER = 00:00 if no APS burn, START pb - push ΔV_{gx} decreasing ENG THR CONT: BAL CPL sw - OFF Monitor thrust cutoff when $\Delta V_{gx} = 00000 \text{ fps}$

4.9.3 APS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P42) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		31. POSS PROG lt - on Key V05 N09E - Call alarm R1 01407 - Angle between VG and $\Delta V > 45^\circ$ R2 ----- R3 ----- KEY REL lt - on Key KEY REL and RSET 32. After thrust cutoff, ENG THR CONT: ENG ARM sw - OFF RCCA sw - OFF/RESET 33. FL V16 N40 R1 TG XXBXX min-sec R2 VG XXXXX.X fps R3 ΔV_m XXXXX.X fps Record VG Key PRO 34. FL V16 N85 - VG (LM) R1 X XXXXX.X fps R2 Y XXXXX.X fps R3 Z XXXXX.X fps 35. If manual trim is desired: S/C: MODE CONTROL sel - ATT HOLD TTCA - maneuver to null VGX, VGY, VGZ S/C: MODE CONTROL sel - AUTO	

4.9.3 APS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P42) (cont)

CREW-MAN	PNL	PROCEDURES	REMARKS
		36. Receive orbital date from MSFN 37. Routine 30 - Orbital Display may be called at this time, steps 38 through 41 38. Key V82E 39. FL V04 N06 R1 0000X - Option code for assumed vehicle R2 0000X - LGC assumed option R3 ----- R2 0000X = 1 - LM 0000X = >1 - CSM Accept: Key PRO Reject: Key V22E - load desired option 40. FL V06 N44 - Orbit parameters R1 Ha XXXX.X nm R2 Hp XXXX.X nm R3 TFF XXBXX min-sec When finished with display Key PRO 41. If Hp > 300,000 ft FL V06 N32 - T Perigee R1 00XXX hr R2 000XX min R3 0XX.XX sec Key PRO Exit R30 42. FL V50 N07 - Change program Exit P42 43. Load DAP (R03) wide deadband if no maneuvers are planned.	If Hp $\geq$ 300,000 ft ($\approx$50 nm), TFF = 59B59 until Hp < 300,000 ft. Orbit parameters can be recycled to display updated values if average g integration is in process by keying V32E.

4.9.3 APS PROGRAM WITH AGS FOLLOW UP/IN CONTROL (P42) (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.9.4 THRUST MONITOR PROGRAM (P47) - Load DAP (R03) narrow deadband (XXX0X) - Key V37E 47E - R02 - IMU status check POSS FL V50 N07 R1 00005 - PGNCS startup 00051 - IMU orientation determination R2 ----- R3 ----- Key V37E 05E or 51E Exit R02 - FL V16 N83 - ΔV (LM) R1 - X XXXXX.X (fps) R2 - Y XXXXX.X (fps) R3 - Z XXXXX.X (fps) S/C: MODE CONTROL sel - ATT HOLD Options: Perform desired thrusting maneuver, monitoring FDAI to avoid gimbal lock. To monitor another burn, zero N83: Key V32E - Recycle to step 3 Terminate monitoring: Key PRO - FL V50 N07 - Change program - Load DAP (R03) wide deadband if no maneuvers planned 4.9.5 RENDEZVOUS - Set controls - G&C basic except: S/C: MODE CONTROL sel - ATT HOLD THROTTLE/JETS cont (CDR) - JETS	The purpose of Program 47 is to monitor vehicle acceleration during a non-PGNCS controlled thrusting maneuver, and to display the ΔV applied to the vehicle by the maneuver.
	3 TTCA		

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CREW-MAN	PNL	PROCEDURES	REMARKS
	3 TTCA	2. Rendezvous is performed by one astronaut. 3. Key V37E 47E 4. Perform Routine 31 - Rendezvous Parameter Display, steps 5 and 6. 5. Key V83E 6. FL V06 N54 - Rendezvous parameters R1 Range XXX.XX nm R2 Range rate XXXX.X fps R3 θXXX.XX° When finished with display, Key PRO 7. Perform steps 8 through 14 at each of the following checkpoints: 30,000 ft ($\approx$4.9 nm) 15,000 ft ($\approx$2.5 nm) 5,000 ft ($\approx$0.8 nm) 1,000 ft ($\approx$0.2 nm) 8. If AGS control is desired: 1 GUID CONT sw - AGS 3 S/C: DEAD BAND sw - MIN 9. If required, load DAP (R03) 10. ACA - Yaw right or left, pitch up or down to null out azimuth and elevation angles on FDAI. 11. ACA - Roll left or right to null azimuth rate on X pointer ind.	Before entering this task, assure the following: CSM is in attitude hold mode Rendezvous radar is activated LM is staged Range to CSM is $\leq$30,000 ft The second astronaut provides no assistance unless it is necessary to assure equipment or crew safety. When range <5,000 ft or >30,000 ft Alternate Rendezvous Method, paragraph 4.9.6 is used. Suggested DAP load is 00X0X.

4.9.5 RENDEZVOUS (cont)

CREW-MAN	PNL	PROCEDURES	REMARKS
	1	12. X pointer ind - read elevation rate RANGE/RANGE RATE ind - read range rate Using nomogram, determine elevation angle for thrust maneuver.	An intersection above 45° on nomogram indicates X jets should be used for correction; below 45° indicates Z jets should be used for correction. Whether to pitch up or down and whether the correction is made in the plus or minus direction are determined by using the appropriate vector diagram shown in the nomogram. If the LM is going down with respect to the CSM (i.e., the displayed elevation rate is positive) use the vector diagram on the left. If the LM is going up with respect to the CSM (i.e., the displayed elevation rate is negative), use the diagram on the right. The vector diagram shows relative velocity of LM to CSM and approximate required vector to reduce these velocities.
	ACA	13. ACA - Pitch up or down to required elevation angle.	
		14. Thrust in required direction until elevation rate and range rate is reduced to lowest values given on the nomogram for current range checkpoint.	
		15. Load DAP (R03) - wide deadband	This alternate rendezvous method is designed to be accomplished using onboard instruments only.
	3	16. If under AGS control S/C: DEAD BAND sw - MAX	
		4.9.6 ALTERNATE RENDEZVOUS METHOD	
	3	1. Set controls - G&C basic except: S/C: MODE CONTROL set - ATT HOLD THROTTLE/JETS cont (CDR) - JETS	
	TTCA	2. Key V37E 47E	
		3. Perform Routine 31 - Rendezvous Parameter Display Routine, steps 4 and 5.	
		4. Key V83E	
		5. FL V06 N54 - Rendezvous parameters R1 Range XXX.XX nm R2 Range rate XXXX.X fps R3 θXXX.XX°	

4.9.5 RENDEZVOUS/4.9.6 ALTERNATE RENDEZVOUS METHOD

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CREW-MAN	PNL	PROCEDURES	REMARKS																																		
		6. Perform steps 7 through 11 at each of the range checkpoints in the CFP Rendezvous Maneuver Schedule, table 4-4. <table border="1"> <caption>Table 4-7 CFP Rendezvous Maneuver Schedule</caption> <thead> <tr> <th rowspan="2">Range</th><th colspan="2">Range Rate (ft/sec)</th><th rowspan="2">Elevation Rate (mrad/sec)</th></tr> <tr> <th>Max</th><th>Min</th></tr> </thead> <tbody> <tr> <td>120,000 ft (≈19.7 nm)</td><td>-170</td><td>-60</td><td>0.2</td></tr> <tr> <td>60,000 ft (≈ 9.9 nm)</td><td>-150</td><td>-50</td><td>0.2</td></tr> <tr> <td>30,000 ft (≈4.9 nm)</td><td>- 50</td><td>-30</td><td>0.2</td></tr> <tr> <td>15,000 ft (≈2.5 nm)</td><td>- 35</td><td>-15</td><td>0.2</td></tr> <tr> <td>5,000 ft (≈0.8 nm)</td><td>- 15</td><td>-10</td><td>0.2</td></tr> <tr> <td>1,000 ft (≈0.2 nm)</td><td>- 5</td><td>- 3</td><td>0.2</td></tr> <tr> <td>500 ft (≈0.1 nm)</td><td>- 5</td><td>0</td><td>0.2</td></tr> </tbody> </table> 7. Load DAP (R03) - narrow deadband ACA 8. ACA - Yaw right or left, pitch up or down to null out azimuth and 1 elevation angles on FDAI. ACA 9. ACA - Roll left or right to null azimuth rate on X-pointer ind. TTCA 10. TTCA - move up or down to reduce elevation rate on X-pointer to ± 0.2 mrad/sec: 11. TTCA - push forward or pull aft to adjust range rate to within rate limits listed in CFP Rendezvous Maneuver Schedule for current range checkpoint. 12. Load DAP (R03) - wide deadband	Range	Range Rate (ft/sec)		Elevation Rate (mrad/sec)	Max	Min	120,000 ft (≈19.7 nm)	-170	-60	0.2	60,000 ft (≈ 9.9 nm)	-150	-50	0.2	30,000 ft (≈4.9 nm)	- 50	-30	0.2	15,000 ft (≈2.5 nm)	- 35	-15	0.2	5,000 ft (≈0.8 nm)	- 15	-10	0.2	1,000 ft (≈0.2 nm)	- 5	- 3	0.2	500 ft (≈0.1 nm)	- 5	0	0.2	If elevation rate is positive, reduce rate to +0.2 mrad/sec; if elevation rate is negative, reduce rate to -0.2 mrad/sec.
Range	Range Rate (ft/sec)			Elevation Rate (mrad/sec)																																	
	Max	Min																																			
120,000 ft (≈19.7 nm)	-170	-60	0.2																																		
60,000 ft (≈ 9.9 nm)	-150	-50	0.2																																		
30,000 ft (≈4.9 nm)	- 50	-30	0.2																																		
15,000 ft (≈2.5 nm)	- 35	-15	0.2																																		
5,000 ft (≈0.8 nm)	- 15	-10	0.2																																		
1,000 ft (≈0.2 nm)	- 5	- 3	0.2																																		
500 ft (≈0.1 nm)	- 5	0	0.2																																		

4.9.6 ALTERNATE RENDEZVOUS METHOD (cont)

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LMA790-3-LM 3
 APOLLO OPERATIONS HANDBOOK

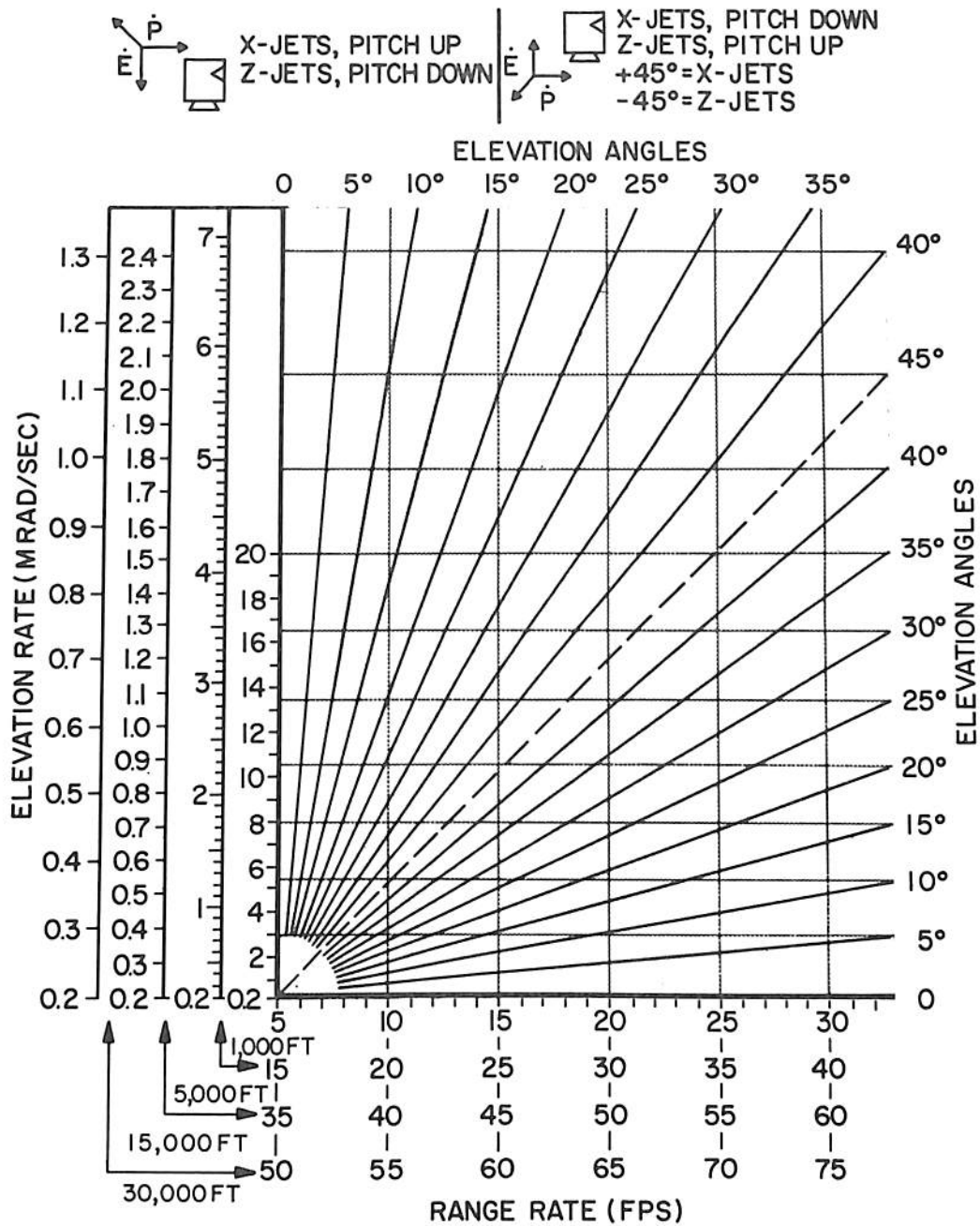


Figure 4-2. Rendezvous Nomogram

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.10 <u>SEPARATION & DOCKING</u>	
		4.10.1 LM ACTIVE SEPARATION	
		1. Install probe and drogue	
		2. Disconnect and stow LM electrical umbilical	
		3. Overhead hatch - close and secure	
		4. Cabin relief and dump vlv (ovhd) - AUTO	
		5. Perform ECS basic except: TBD	
	TTCA 3	6. Perform G&C basic except: THROTTLE/JETS cont (CDR)- JETS S/C: MODE CONTROL sel - OFF	
		7. Perform Heaters status check	Reference paragraph 4.12.27
		8. Verify CSM tunnel depressurized	
		9. Perform cabin leak check	Reference paragraph 4.12.17
		10. Verify ECS basic	
		11. Set EVENT TIMER to count down to separation	
		12. Verify LM/CSM probe preloaded and latches released	
	3	13. LTG: EXTERIOR LTG sel - DOCK	
		14. Install COAS (ovhd window)	
		15. Load DAP (R03)	Suggested DAP load is 10102, 0010X.
		16. Key V37E 47E - Thrust Monitor Program	
	3	17. FL V06 N83 - ΔV (LM) R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps	

4.10.1 LM ACTIVE SEPARATION

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4.10.1 LM ACTIVE SEPARATION/4.10.2 LANDING RADAR TURN-ON/4.10.3 LANDING RADAR CHECKOUT

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CREW- MAN	PNL	PROCEDURES	REMARKS
		3. Verify ALT/ALT RATE ind - 8193 to 8357 ft and -441 to -457 4. Verify X pointer ind FWD VEL and LAT VEL - off scale, to right and up 5. Perform Routine 04 - LR/RR Self Test, steps 6 through 20 6. Key V62E 7. FL V04 N06 R1 00004 - Option code for assumed radar test R2 0000X - LGC assumed option R3 ----- R2 0000X = 1 - RR 0000X = 2 - LR Accept: Key PRO Reject: V22E 2E (Load LR option) 8. FL V16 N66 R1 Range XXX.XX nm R2 LR position 0000X R3 ----- R2 0000X = 1 - LR position 1 0000X = 2 - LR position 1 Verify R1 is 081.56 to 084.18 nm Key PRO 9. FL V16 N67 - Simulated velocities R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps Verify R1 is -0022.6 to -0026.8 fps Verify R2 is +0093.4 to +0099.0 fps Verify R3 is +0063.0 to +0068.6 fps 10. Key V32E 11. FL V16 N66 R2 Range XXX.XX nm R2 LR position 0000X R3 ----- R2 0000X = 1 - LR position 1 0000X = 2 - LR position 2	self-test signal self-test signal LGC supplies LR parameters to MSFN via downlink. Self-test simulated slant range to lunar surface

4.10.3 LANDING RADAR CHECKOUT (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	3	12. RADAR: LDG ANT sw - AUTO R2 = 00001	
		13. RADAR: LDG ANT sw - DES R2 = 00001	
		14. RADAR: LDG ANT sw - HOVER R2 = 00002	
1		15. Verify RANGE ind - 7865 + 8023 ft	Self-test simulated altitude
		16. Verify RANGE RATE ind - -441 to -457 fps	Self-test simulated altitude rate
	3	17. RADAR: LDG ANT sw - DES R2 = 00002	
		18. RADAR: LDG ANT sw - AUTO R2 = 00001	
		19. RADAR TEST sw - OFF	
		20. To terminate R04 Key V34E.	
		4.10.4 RENDEZVOUS RADAR TURN-ON	
1	3	1. Set controls - G&C basic except: RATE/ERR MON sw - RNDZ RADAR HTR CONT: TEMP MON sel - RNDZ RADAR RADAR: TEST MON sel - XMTR PWR	
		2. HTR CONT: TEMP ind - $\geq +10^{\circ}\text{F}$	Wait until HTR CONT: TEMP ind - $\geq +10^{\circ}\text{F}$ before continuing.
11		3. CB/AC BUS A: RNDZ RDR - close CB PGNS: RNDZ RDR - close	
		4. RNDZ RADAR: NO TRACK lt - on	
1		5. RNG/ALT ind pwr/sig fail lt - on	RNG/ALT ind pwr/sig fail, lt indicates absence of a RR data good signal.
		6. Perform Program 20 for RR lock-on to CSM.	Reference paragraph 4.6.1

4.10.3 LANDING RADAR CHECKOUT/4.10.4 RENDEZVOUS RADAR TURN-ON

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.10.5 RENDEZVOUS RADAR ACTIVATION & CHECKOUT	
	1 3	1. Set controls G&C basic except: RATE/ERR MON sw - RNDZ RDR HTR CONT: TEMP MON sel - RNDZ RADAR RADAR: TEST MON sel - XMTR PWR	If RR previously activated omit steps 4, 7, 8, and 9 but bring RR to mode 1 (shaft and trunnion angles at 00°.
		2. Verify HTR CONT: TEMP ind - $\geq +10^{\circ}\text{F}$	
		3. RNDZ RADAR sel - SLEW	Data no good signal is inhibited.
		4. Release RR antenna restraining device	
	11	5. CB/AC BUS A: RNDZ RDR - close CB PGNS: RNDZ RDR - close	
	3 1	6. Verify RADAR: No TRACK lt - on RNG/ALT ind pwr/sig fail lt - on	
		CAUTION If RR is manually slewed, X POINTER SCALE sw should be set to HI MULT if the associated RATE/ERR MON sw is set to RNDZ RDR.	
	3	7. Hold RNDZ RADAR: SLEW sw - LEFT (Trunnion angle display on FDAI deflects to right and returns to 0°)	Steps 7, 8, and 9 bring RR antenna from restraint position in mode 2 to shaft and trunnion 00° in mode 1.
		8. RNDZ RADAR: SLEW RATE sw - LO	
		9. Hold RNDZ RADAR: SLEW sw - DOWN (Shaft angle display on FDAI reaches 0°)	
	1 & 2	10. Rndz radar sel - AUTO TRACK RNDZ RDR caut lt - on MASTER ALARM pb/lt - on	Data no good signal is enabled.
		11. MASTER ALARM pb - reset	
	3	12. RADAR TEST sw - RNDZ	RR antenna will oscillate and drift during self test.
		13. RADAR: SIGNAL STRENGTH ind - 2.9 to 4.1 vdc	

4.10.5 RENDEZVOUS RADAR ACTIVATION & CHECKOUT

CREW-MAN	PNL	PROCEDURES	REMARKS
	2	14. RADAR: NO TRACK lt - off RNDZ RDR caut lt - off RNG/ALT ind pwr/sig fail lt - off	
	1	15. RANGE/RANGE RATE ind - 189 to 198 nm/459 to 541 fps	
	3	16. Rndz radar sel - LGC	
		17. Perform Routine 04 - RR/LR Self Test, steps 18 through 23	
		18. Key V62	
		19. FL V04 N06 R1 00004 - Option code for assumed test R2 0000X - LGC assumed option R3 ----- R2 0000X = 1 - RR 0000X = 2 - LR Accept: Key PRO Reject: Key V22E 1E (RR test)	
		20. FL V16 N72 - RR CDU angles R1 Trunnion XXX.XX° R2 Shaft XXX.XX° R3 ----- Verify shaft and trunnion angles with FDAI	
		21. RNDZ RADAR sel - AUTO TRACK	This step is required only if LGC does not issue automatic track enable.
		22. Key PRO	
		23. FL V16 N78 R1 Range XXX.XX nm R2 Range rate XXXXXX fps R3 ----- Verify R1 - ≈ 020.00 nm Verify R2 - 00459 to 00541 fps Key V34E - Terminate Exit R04	
	3	24. RADAR: TEST MON sel - SHAFT ERR	

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CREW-MAN	PNL	PROCEDURES	REMARKS
		25. RADAR: SIGNAL STRENGTH ind - Verify smooth needle deflection left, from 0 to 2.5 vdc and right, from 1.5 to 3.5 vdc, at approximately 1 cps 26. RADAR: TEST MON sel - TRUN ERR 27. Repeat step 25	
	3	28. RNDZ RADAR sel - SLEW	Automatic track enable is lost.
	1	RNDZ RADAR: NO TRACK lt - on RNG/ALT ind pwr/sig fail lt - off	
	3	29. RNDZ RADAR: SLEW sw - Null shaft and trunnion angles	
		30. RNDZ RADAR sel - AUTO TRACK	Removes CWEA inhibit.
	2	31. RNDZ RDR caut lt - on	
	1 & 2	MASTER ALARM pb/lt - on MASTER ALARM pb/lt - reset	
		32. RNDZ RDR caut lt - off RNDZ RADAR: NO TRACK lt - off RNG/ALT ind pwr/sig fail lt - off	
		33. Allow ≈ 10 seconds for lock on Verify RR lock on.	
	1	34. Verify smooth transitions at approximately 1 cps of the following: FDAI - Shaft and trunnion 2° to 8° until beyond display range X pointer ind AZ RT and ELEV RT - Full scale until antenna drifts to stops	
		35. Key V21 N10E 12E R1 ABCDE R2 ----- R3 ----- Key ENTR	If P20 is used key V56E or select P00.
	2	36. RADAR TEST sw - OFF	
	1 & 2	MASTER ALARM pb/lt - on RNDZ RDR caut lt - on MASTER ALARM pb/lt - reset	

4.10.5 RENDEZVOUS RADAR ACTIVATION & CHECKOUT (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR LMP	3	37. Request CSM, to turn on RR transponder. Position LM for RR transponder tracking and verify transponder operation	
		38. RNDZ RADAR sel - LGC	
		39. Perform P20 for RR lock-on to CSM.	
CDR LMP	11 16 12	4.10.6 S-BAND STEERABLE ANTENNA CHECKOUT	Reference paragraph 4.12.5 S BAND sel setting depends upon vehicle attitude with respect to earth.
		1. Perform Communications Basic CB/AC BUS B: S BD ANT - close CB COMM: S BD ANT - close COMM ANT: S BAND sel - 1 or 2	
		2. Perform S-band voice and data check with MSFN	
CDR LMP	4 12	3. Operate DSKY for FDAI angles Key V16 N94E Monitor readout and transmit to MSFN for verification	Alternate to DSKY operation is to read FDAI display for attitude information.
		4. Request MSFN compute S-band steerable antenna pitch and yaw gimbal angles required to point antenna at MSFN station with LM at its present position and attitude	
		5. COMM ANT: PITCH cont - computed angle YAW cont - computed angle TRACK MODE sw - SLEW S BAND sel - SLEW	
LMP	12	6. COMM ANT: SIGNAL STRENGTH ind - verify >1 TRACK MODE sw - AUTO SIGNAL STRENGTH ind - remains >1	Greater than 1 indication denotes up-link phase lock.
		7. Perform S-band voice and data check with MSFN.	

4.10.5 RENDEZVOUS RADAR ACTIVATION & CHECKOUT/4.10.6 S-BAND STEERABLE ANTENNA CHECKOUT

CREW-MAN	PNL	PROCEDURES	REMARKS
CDR	1	4.10.7 LM ACTIVE DOCKING 1. Set controls - G&C basic except: THROTTLE/JETS sw (CDR) - JETS RATE/ERR MON sw - RNDZ RADAR SHFT/TRUN ✕ sw - $\pm 5^\circ$ RATE SCALE sw - $5^\circ/\text{sec}$	
LMP	8 3	2. COAS sw - FWD LTG: EXTERIOR LTG sel - DOCK 3. Program 47 is running, rendezvous radar is tracking CSM. 4. Load DAP (R03) 5. Radar technique: ACA - Yaw and pitch as required to null azimuth and elevation angles on FDAI. TTCA - Translate in X and Y body axes to null LOS rates on X pointer (X pointer is fly-to-display). Translate in Z body axes to bring range rate to -5 fps 6. Monitor: Between ranges of 500 and 110 ft maintain null of azimuth and elevation angles and LOS rates and maintain range rate at -5 fps. 7. TTCA - At range of 110 ft start translating to null range rate so that range rate is zero at range of 80 ft. 8. ACA and TTCA: Rotate and translate to acquire face-to-face orientation (LM Z axis aligned with CSM X - axis) and acquire null of LOS rates and range rate.	Suggested DAP load 0000X.
CDR	3 1 3 11	9. Prepare for docking: RNDZ RADAR sel - SLEW SHFT TRUN ✕ sw - $\pm 50^\circ$ RNDZ RADAR: SLEW sw - LEFT or RIGHT to null trunnion SLEW sw - DOWN until shaft angle = 50° CB/AC BUS A: RNDZ RDR - open CB PGNS: RNDZ RDR - open Install COAS in overhead window.	

4.10.7 LM ACTIVE DOCKING

CREW-MAN	PNL	PROCEDURES	REMARKS
LMP		10. ACA - pitch down 90° and view CSM through overhead window 11. ACA and TTCA - yaw left 120° translation required until COAS reticle is aligned with CSM standoff target 12. TTCA - Make final approach along + X axis at barely detectable closing rates (0.1 to 0.3 fps) 13. At contact, thrust until CSM verifies latch capture 14. Receive verification of soft docking from CSM 3 15. S/C: MODE CONTROL sel - AUTO 3 16. LTG: FLOOD sw - OVHD/FWD 17. Pressurize LM/CSM interlock 18. LTG: EXTERIOR LTG sw - OFF 19. Return to G&C basic. 4.10.8 RR/LR SELF TEST ROUTINE (R04) 1. Key V62E 2. FL V04 N06 - Option Code R1 TBD - Specify Radar R2 00004 - Assumed option R3 ----- <u>Options</u> X = 00001 - Rendezvous radar X = 00002 - Landing radar	A yaw maneuver > 90° causes FDAI pitch and roll gimbals to flip 180° and gyrate ≈ 3 sec. Absolute maximum contact velocity is 1.0 fps. Capture thrust must be applied within 1 second of contact. This prevents rebound after contact. LM RCS is used for attitude control to conserve CSM RCS propellant. The purpose of this routine is to provide DSKY displays and LGC downlink data to support RR/LR self tests. This routine will be performed as required in its entirety during the RR and LR checkouts. It is provided here for purposes of completeness only. RR/LR activation has been performed. This routine shall be called only during the LGC idling program (P00).

4.10.7 LM ACTIVE DOCKING/4.10.8 RR/LR SELF TEST ROUTINE (R04)

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CREW-MAN	PNL	PROCEDURES	REMARKS
	3	Accept: Code 00001 RADAR TEST sw - RNDZ Key PRO Go to step 3, or Code 00002 RADAR TEST sw - LDG Go to step 6 Reject: Key V22E - Load desired code	
	3	3. If 00001 - RR option code selected: POSS FL V50 N25 - Checklist reference R1 00201 - Perform selection of RR automatic mode R2 ----- R3 ----- RNDZ RADAR sel - LGC Key PRO	RR automatic mode must be selected to place the RR under LGC control. The LGC issues an auto track enable signal, permitting the RR to lock on the self-test signal.
	3	4. FL V16 N72 - Monitor RR CDU angles R1 XXX.XX° - Shaft R2 XXX.XX° - Trunnion R3 ----- Options: a. To monitor range and range rate - Key PRO b. To terminate radar self test - Key V34E - Terminate RADAR TEST sw - OFF	If desired, crew may wait before responding.
	3	5. FL V16 N78 - Monitor RR range and range rate R1 XXX.XX NM - Range R2 XXXXXX. FPS - Range rate R3 ----- Options: a. To terminate radar self test - Key V34E - Terminate RADAR TEST sw - OFF	
	3	b. To perform LR self test - RADAR TEST sw - LDG Key PRO Go to step 6	

4.10.8 RR/LR SELF TEST ROUTINE (R04) (cont)

CREW- MAN	PNL	PROCEDURES	REMARKS
		c. To monitor RR shaft and trunnion angles - Key V32E - Recycle to step 3	
	3	6. FL V16 N66 - Monitor LR range and antenna position R1 XXXXX. FT - Range R2 0000X - Antenna position R3 ----- X = 00001 - LR antenna position 1 X = 00002 - LR antenna position 2 Options: a. To monitor LR simulated velocities - Key PRO b. To terminate radar self test - Key V34E - Terminate RADAR TEST sw - OFF	
	3	7. FL V16 N67 - Monitor LR simulated velocities R1 XXXX.X fps - V (X) R2 XXXX.X fps - V (Y) R3 XXXX.X fps - V (Z) Options: a. To terminate radar self test - Key V34E - Terminate RADAR TEST sw - OFF	
	3	b. To monitor LR range and antenna position - Key V32E - Recycle to step 6	
	3	c. To perform RR self test - RADAR TEST sw - RNDZ Key PRO Return to step 3 Exit R04.	

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.11.2 APS PRESSURIZATION & CHECKOUT - HELIUM MON sel - TEMP 1 MPS: HELIUM ind - 30° to 140°F - HELIUM MON sel - TEMP 2 MPS: HELIUM ind - 30° to 140°F - HELIUM MON sel - PRESS 1 MPS: HELIUM ind - 2800 to 3400 psia Record pressure _____ psia - HELIUM MON sel - PRESS 2 MPS: HELIUM ind - 2800 to 3400 psia Record pressure _____ psia - PRPLNT TEMP/PRESS MON sw - ASC MPS: FUEL TEMP ind - 50° to 90°F OXID TEMP ind - 50° to 90°F FUEL PRESS ind - 100 to 205 psia OXID PRESS ind - 100 to 205 psia - ASC He REG 1 and 2 tb - gray - RCCA sw - ENABLE - ED: ASC He SEL sw - BOTH MASTER ARM sw - ON ASC He PRESS sw - FIRE MASTER ARM sw - OFF - PRPLNT TEMP/PRESS MON sw - ASC MPS: FUEL TEMP ind - 50° to 90°F OXID TEMP ind - 50° to 90°F FUEL PRESS ind - 100 to 205 psia OXID PRESS ind - 100 to 205 psia - HELIUM MON sel - PRESS 2 MPS: HELIUM ind - 2800 to 3400 psia HELIUM MON sel - PRESS 1 MPS: HELIUM ind - 2800 to 3400 psia	Ascent helium tank pressure values, as a function of time, will remain approximately the same as initial tank loading conditions. Refer to Table 4.3, Ascent Helium Loading or expected tank pressure values as a function of tank temperature and initial loading conditions. ASC PRESS warn lt goes on when helium tank pressure decreases to 2773 psia. Select TANK 1 or TANK 2 if pressure readings in steps 3 or 4 are below TBD, or a leak is suspected.

4.11.2 APS PRESSURIZATION & CHECKOUT

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.11.3 EPS PRESTAGING CHECK 1. EPS: BAT 5 NORMAL FEED sw - ON; tb - gray POWER/TEMP MON sw - BAT 5 VOLTS ind - 28.0 to 32.5 vdc AMPS ind - TBD 2. EPS: BAT 6 NORMAL FEED sw - ON; tb - gray POWER/TEMP MON sw - BAT 6 VOLTS ind - 28.0 to 32.5 vdc AMPS ind - TBD 3. CB/AC S/C: DECA GMBL - open CB PROPUL: DES He REG - open CB S/C: DECA PWR - open CB ED: LDG GEAR FLAG - open CB HTR: LDG RDR - open CB FLT DISP: THRUST DISP - open CB EPS: CROSS TIE BAL LOADS (2) - open CB PGNS: LDG RDR - open CB EPS: INV 1 - close 4. EPS: INVERTER sw - 1 POWER/TEMP MON sw - AC BUS VOLTS ind - green band 5. EPS: BAT 1, 2, 3, 4 HI VOLT sw - OFF/RESET; tb - bp 6. EPS: DES BATS sw - DEADFACE; tb - bp	Manual removal of descent batteries one at a time, at about three second intervals, will avoid transient. WARNING If power is lost on either bus: CB EPS: CROSS TIE BUS (2) - close EPS: DES BATS sw - CONNECT; tb - gray EPS: BAT 1, 2, 3, 4 HI VOLT sw - ON CB EPS: CROSS TIE BUS (2) - open

4.11.3 EPS PRESTAGING CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR/ LMP	11 & 16	7. EPS: POWER/TEMP MON sw - CDR Bus VOLTS ind 26.5 to 32.5 vdc	
		8. EPS: POWER/TEMP MON sw - SE BUS VOLTS ind - 26.5 to 32.5 vdc	
		9. EPS: POWER/TEMP MON sw - CDR BUS	
		10. EPS: BAT 1, 2, 3, 4 HI VOLT sw - ON; tb - gray	
		11. EPS: DES BATS sw - CONNECT; tb - gray	
		4.11.4 ECS PRESTAGING CHECK	
		1. Perform ECS Basic (staged)	Ref para 4.12.1
		2. Perform ECS Periodic Monitoring (staged)	Ref para 4.12.9
		4.11.5 EPS POSTSTAGING CHECK	
		1. Perform EPS Basic (staged)	Ref para 4.12.3
		2. EPS: POWER/TEMP MON sw - BAT 5 VOLTS ind - 28.0 to 32.5 vdc AMPS ind - TBD	Steps 2 and 3 determine that ascent batteries are supplying approximately the same current.
		3. EPS: POWER/TEMP MON sw - BAT 6 VOLTS ind - 28.0 to 32.5 vdc AMPS ind - TBD	
		4. EPS: POWER/TEMP MON sw - AC BUS VOLTS ind - green band	
		5. CB ED: LOGIC PWR A - open CB ED: LOGIC PWR B - open CB S/C: ABORT STAGE	

4.11.3 EPS PRESTAGING CHECK/4.11.4 ECS PRESTAGING CHECK/4.11.5 EPS POSTSTAGING CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.11.6 RCS STAGING - Set controls G&C basic except: THROTTLE/JETS cont (CDR) - JETS - Secure self and cabin - Set EVENT TIMER to stage time - If required, perform R47 - If required, load DAP (R03) - Key V37E 47E - POSS FL V50 N07 R1 00005 - PGNCS Startup 00051 - INV Orientation Determination R2 ----- R3 ----- Select P05 or P51 - FL V16 N83 - ΔV (LM) R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps S/C: MODE CONTROL sel - ATT HOLD - ACA - Rotate to desired thrusting attitude. Monitor FDAI to avoid gimbal lock. - Verify ED: MASTER ARM sw - ON	The following should be performed before entering this task: ECS Basic (unstaged & staged) paragraph 4.12.1 EPS Basic (staged), paragraph 4.12.3 Suggested DAP load XXX0X.
		Key DEDA - VDx C 470R (1 fps) To switch to AGS control GUID CONT sw - AGS	

4.11.6 RCS STAGING

STAGING

CREW-MAN	PNL	PROCEDURES	REMARKS
		11. When EVENT TIMER = 00:00 STAGE sw - FIRE 12. TTCA - move up for TBD see to obtain ΔV of TBD fps 13. Key PRO 14. ED: MASTER ARM sw - OFF 15. Load DAP (R03) wide deadband if no maneuvers are planned. 4.11.7 AGS FITH 1. Set controls - G&C basic except: THROTTLE/JETS cont (CDR) - JETS GUID CONT sw - AGS S/C: MODE CONTROL sel - ATT HOLD RCCA sw - ENABLE 2. Secure self and cabin 3. Set EVENT TIMER to FITH Key DEDA - Guidance steering C 400 + 10000E Receive targeting parameters from MSFN for AGS orbit insertion.	Programs 05 and 51 should be performed before entering this task. A PGNCs follow up/in control capability with AGS FITH is not available at this time since present P42 logic requires termination if staging has not occurred. It is assumed that P42 will be modified to include this capability and is offered for completeness. The following should be performed before entering this task: ECS Basic (Unstaged & Staged), paragraph 4.12.1 EPS Basic (Staged), paragraph 4.12.3 MPS Basic (Staged), paragraph 4.12.7

4.11.6 RCS STAGING/4.11.7 AGS FITH

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CREW- MAN	PNL	PROCEDURES		REMARKS
		4. Key V37E 42E 5. POSS FL V05 N09 - ALARM R1 01706 - stage verified discrete indicates DPS not staged R2 ----- R3 ----- PROG It - on Key V34E and RSET Probable exit from P42 6. Perform Routine 02 - IMU Status Check, step 7. 7. POSS FL V50 N07 R1 00005 - PGNCS startup 00051 - IMU Orientation Determination R2 ----- R3 ----- Select P05 or P51 Exit 42 and R02 8. Perform Routine 60 - Attitude Maneuver, steps 9 through 11.	Key DEDA - Injection altitude C 232 + XXXXXE (1000 ft) Key DEDA - Target radial rate C 505 + XXXXXE (1 fps) Key DEDA - Targeted horizontal velocity C 506 + XXXXXE (1 fps) Key DEDA - IMU align C 400 + 30000E	If IMU orientation changed since last state vector update, perform Routine R47 - AGS Initialization only if time is available. Complete AGS IMU align before LGC performs R60 to insure attitude rates $< 0.1^{\circ}/\text{sec}$.

4.11.7 AGS FITH (cont)

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CREW- MAN	PNL	PROCEDURES	REMARKS
		9. FL V50 N25 - Checklist reference R1 00203 - Switch to PGNC automatic mode R2 ----- R3 ----- Key ENTR 10. V06 N94 - FDAI angles R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° 11. FL V50 N19 - Enable trim R1 Roll XXX.XX° R2 Pitch XXX.XX° R3 Yaw XXX.XX° S/C; MODE CONTROL sel - AUTO Key ENTR Exit R60 12. FL V50 N25 - Checklist reference R1 00203 - Request PGNC automatic mode R2 ----- R3 ----- Key ENTR 13. POSS FL V05 N09 - Alarm R1 01703 - TFI <45 sec R2 ----- R3 ----- PROG lt - on PGNS caut lt - on MASTER ALARM pb/lt - on MASTER ALARM pb/lt - reset Refer to EVENT TIMER and determine with MSFN whether to slip engine ignition 45 sec. Slip TFI 45 sec: Key PRO Terminate: Key V34E and RSET	Key DEDA - APS computation C 411 + 10000E Key DEDA - ΔVgx C 500R (1 fps)

CREW-MAN	PNL	PROCEDURES	REMARKS
		14. V06 N40 R1 TFI XXBXX min-sec R2 VG XXXX.X fps R3 ΔV_m XXXX.X fps 15. Verify ΔV_m <0.5 fps from TFI = -00B30 to 00B15 16. If ΔV_m >0.5 fps, determine remainder of task with MSFN. 17. When TFI = 00B05 FL V50 N99 - Request engine on enable R1 TFI XXBXX min-sec R2 VG XXXX.X fps R3 ΔV_m XXXX.X fps To perform thrust with RCS: Key ENTR, go to step 28. 18. Monitor thrust when TFI = 00B00 If no APS burn, return to step 17. 19. V06 N40 R1 TG XXBXX min-sec R2 VG XXXX.X fps R3 ΔV_m XXXX.X fps TG and VG decreasing ΔV_m increasing 20. Perform APS/RCS Propellant Interconnect, steps 1, 2, and 3 of paragraph 4.12.23. 21. Monitor FDAI attitude error and attitude rates. 22. Backup procedure: GUID CONT sw - PGNS	ABORT STAGE pb - push When EVENT TIMER = -00:12, + X TRANSL pb - push and hold until APS start Alternate procedures when EVENT TIMER = -00:12: TTCA - move up until APS start Monitor thrust when EVENT TIMER = 00:00 If no APS burn START pb - push ΔV_{gx} decreasing ENG THR CONT: BAL CPL sw - OFF DSKY displays will blank between TFI = 00B35 to 00B30.

CREW-MAN	PNL	PROCEDURES	REMARKS
		23. At TG = 10 seconds perform APS/RCS Propellant Interconnect, steps 4, 5, and 6 of paragraph 4.12.23. 24. Monitor thrust cut off when TG & VG = 00B00 and 00000 25. RCCA sw - OFF/RESET 26. Backup procedures STOP pb - push 27. POSS PROG lt - on Key V05 N09E - Call alarm R1 01407 - Angle between ΔVG and $\Delta V-45^{\circ}$ R2 ----- R3 ----- Key REL lt - on Key KEY REL and RSET 28. FL V16 N40 R1 TG XXBXX min-sec R2 VG XXXX.X fps R3 ΔVm XXXX.X fps Record VG Key PRO 29. FL V16 N85 - VG (LM) R1 X XXXX.X fps R2 Y XXXX.X fps R3 Z XXXX.X fps 30. If manual trim is desired = S/C: MODE CONTROL sel - ATT HOLD TTCA - maneuver to null VGX, VGY, VGZ	Monitor thrust cutoff when $\Delta Vgx = 00000$ ENG THR CONT: BAL CPL sw - ON ABORT STAGE pb- reset Manual trim maneuver under AGS control: ENG THR CONT: X TRANSL sw - 2 JETS ΔVgx null TTCA - move up or down

CREW-MAN	PNL	PROCEDURES		REMARKS
			ΔV_{gy} null Key DEDA - V_{gy} C 501R (1 fps) TTCA - move left or right ΔV_{gz} null Key DEDA - ΔV_{gz} C 502R (1 fps) TTCA - push forward or pull aft If next maneuver is under PGNCS control, GUID CONT sw - PGNS	
		31. Receive orbital data from MSFN		
		32. Routine 30 - Orbital Display may be called at this time, steps 33 through 36.		
		33. Key V82E		
		34. FL V04 N06 R1 00002 - Option code for assumed vehicle R2 0000X - LGC assumed option R3 ----- R2 0000X = 1 - LM 0000X = 2 - CSM Accept: Key PRO Reject: Key V22E Load desired option		
		35. FL V06 N44 - Orbit parameters R1 Ha XXXX.X nm R2 Hp XXXX.X nm R3 TFF XXBXX min-sec When finished with display Key PRO	Key DEDA - q C 343 (0.1 nm) Compare q with Hp	If $H_p \geq 300,000$ ft (≈ 50 nm), TFF = 59B59 until $H_p < 30,000$ ft Orbit parameters can be recycled to display updated values if average g integration is in process by keying V32E.

CREW-MAN	PNL	PROCEDURES	REMARKS
		36. If Hp > 300,000 ft FL V06 N32 - T Perigee R1 00XXX hr R2 000XX min R3 0XX.XX sec Key PRO Exit R30	
	3	37. FL V50 N07 - Change Program Exit P42	

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CREW-MAN	PNL	PROCEDURES	REMARKS																																																																											
		4.12 <u>SUBSYSTEM MANAGEMENT</u> Subsystem management procedures are a compilation of procedures that are common to more than one mission phase. The procedures involve basic switch configurations, integrity and status checks, servicing and periodic monitoring. The procedures consist of the following: • Basic switch configurations of the ECS, EPS, MPS, and CS • Integrity checks of cabin pressure, glycol pump, water separator, communication relay modes, data transmission, TV operation, and heaters status check • Servicing of primary and secondary CO2 canisters • Periodic monitoring of DPS, APS and RCS. 4.12.1 ECS BASIC (UNSTAGED AND STAGED) <table><tr><td></td><td><u>Unstaged</u></td><td><u>Staged</u></td></tr><tr><td>ECS 1. SUIT GAS DIVERTER vlv</td><td>PUSH CABIN</td><td>PULL EGRESS</td></tr><tr><td> CABIN REPRESS vlv</td><td>AUTO</td><td>CLOSE</td></tr><tr><td> PLSS FILL vlv</td><td>CLOSE</td><td>CLOSE</td></tr><tr><td> PRESS REG A vlv</td><td>CABIN</td><td>CABIN</td></tr><tr><td> PRESS REG B vlv</td><td>CABIN</td><td>CABIN</td></tr><tr><td> DES O2 vlv</td><td>OPEN</td><td>CLOSE</td></tr><tr><td> #1 ASC O2 vlv</td><td>CLOSE</td><td>OPEN</td></tr><tr><td> #2 ASC O2 vlv</td><td>CLOSE</td><td>CLOSE</td></tr><tr><td> SUIT ISOL vlv (LMP)</td><td>SUIT FLOW</td><td>SUIT FLOW</td></tr><tr><td> SUIT ISOL vlv (CDR)</td><td>SUIT FLOW</td><td>SUIT FLOW</td></tr><tr><td> SEC EVAP FLOW vlv</td><td>CLOSE</td><td>CLOSE</td></tr><tr><td> PRIM EVAP FLOW NO. 2 vlv</td><td>CLOSE</td><td>CLOSE</td></tr><tr><td> WATER TANK SELECT vlv</td><td>DES</td><td>ASC</td></tr><tr><td> SUIT TEMP vlv</td><td>adjust</td><td>adjust</td></tr><tr><td> ASC H2O vlv</td><td>CLOSE</td><td>OPEN</td></tr><tr><td> DES H2O vlv</td><td>OPEN</td><td>CLOSE</td></tr><tr><td> PRIM EVAP FLOW sw</td><td>center</td><td>center</td></tr><tr><td> CABIN GAS RETURN vlv</td><td>AUTO</td><td>AUTO</td></tr><tr><td> CO2 CANISTER SEL vlv</td><td>PRIM</td><td>PRIM</td></tr><tr><td> SUIT CIRCUIT RELIEF vlv</td><td>AUTO</td><td>AUTO</td></tr><tr><td> PRIM CO2 CANISTER</td><td>CLOSE</td><td>CLOSE</td></tr><tr><td> SEC CO2 CANISTER</td><td>CLOSE</td><td>CLOSE</td></tr><tr><td> WATER SEP SEL vlv</td><td>PUSH SEP I</td><td>PUSH SEP I</td></tr><tr><td> Cabin temp vlv</td><td>NORM</td><td>NORM</td></tr></table>		<u>Unstaged</u>	<u>Staged</u>	ECS 1. SUIT GAS DIVERTER vlv	PUSH CABIN	PULL EGRESS	CABIN REPRESS vlv	AUTO	CLOSE	PLSS FILL vlv	CLOSE	CLOSE	PRESS REG A vlv	CABIN	CABIN	PRESS REG B vlv	CABIN	CABIN	DES O2 vlv	OPEN	CLOSE	#1 ASC O2 vlv	CLOSE	OPEN	#2 ASC O2 vlv	CLOSE	CLOSE	SUIT ISOL vlv (LMP)	SUIT FLOW	SUIT FLOW	SUIT ISOL vlv (CDR)	SUIT FLOW	SUIT FLOW	SEC EVAP FLOW vlv	CLOSE	CLOSE	PRIM EVAP FLOW NO. 2 vlv	CLOSE	CLOSE	WATER TANK SELECT vlv	DES	ASC	SUIT TEMP vlv	adjust	adjust	ASC H2O vlv	CLOSE	OPEN	DES H2O vlv	OPEN	CLOSE	PRIM EVAP FLOW sw	center	center	CABIN GAS RETURN vlv	AUTO	AUTO	CO2 CANISTER SEL vlv	PRIM	PRIM	SUIT CIRCUIT RELIEF vlv	AUTO	AUTO	PRIM CO2 CANISTER	CLOSE	CLOSE	SEC CO2 CANISTER	CLOSE	CLOSE	WATER SEP SEL vlv	PUSH SEP I	PUSH SEP I	Cabin temp vlv	NORM	NORM	
	<u>Unstaged</u>	<u>Staged</u>																																																																												
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PLSS FILL vlv	CLOSE	CLOSE																																																																												
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SUIT ISOL vlv (CDR)	SUIT FLOW	SUIT FLOW																																																																												
SEC EVAP FLOW vlv	CLOSE	CLOSE																																																																												
PRIM EVAP FLOW NO. 2 vlv	CLOSE	CLOSE																																																																												
WATER TANK SELECT vlv	DES	ASC																																																																												
SUIT TEMP vlv	adjust	adjust																																																																												
ASC H2O vlv	CLOSE	OPEN																																																																												
DES H2O vlv	OPEN	CLOSE																																																																												
PRIM EVAP FLOW sw	center	center																																																																												
CABIN GAS RETURN vlv	AUTO	AUTO																																																																												
CO2 CANISTER SEL vlv	PRIM	PRIM																																																																												
SUIT CIRCUIT RELIEF vlv	AUTO	AUTO																																																																												
PRIM CO2 CANISTER	CLOSE	CLOSE																																																																												
SEC CO2 CANISTER	CLOSE	CLOSE																																																																												
WATER SEP SEL vlv	PUSH SEP I	PUSH SEP I																																																																												
Cabin temp vlv	NORM	NORM																																																																												

4.12.1 ECS BASIC (UNSTAGED AND STAGED)

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CREW-MAN	PNL	PROCEDURES		REMARKS
			<u>Unstaged</u> <u>Staged</u>	
CDR	11	2. Cabin relief and dump vlv (ovhd)	AUTO	AUTO
		3. Cabin relief and dump vlv (fwd)	AUTO	AUTO
		4. CB ECS:		
		SUIT FAN 1	close	close
LMP	2	CABIN FAN 1	close	close
		GLYCOL PUMP 2	close	close
		GLYCOL PUMP 1	close	close
		GLYCOL PUMP AUTO TRNFR	close	close
		5. GLYCOL sel	PUMP 1	PUMP 1
		SUIT FAN sel	1	1
		O2/H2O QTY MON sel	DES	ASC 1
		ECS:		
	16	PRESS ind pwr fail lt	off	off
		GLYCOL ind pwr fail lt	off	off
		QUANTITY ind pwr fail lt	off	off
		GLYCOL comp caut lt	off	off
		SUIT FAN comp caut lt	off	off
		CO2 comp caut lt	off	off
		H2O comp caut lt	off	off
		6. CB ECS:		
		SUIT FLOW CONT	close	close
		SUIT/CABIN REPRESS	close	close
		DISP	close	close
		GLYCOL PUMP SEC	open	open
		PRIM GLYCOL EVAP FLOW	close	close
		CABIN FAN 2	close	close
		CABIN FAN CONT	close	close
		CABIN REPRESS	close	open
		SUIT FAN 2	close	close
		SUIT FAN ΔP	close	close
		DIVERT VLV	close	close
		CO2 SENSOR	close	close

CREW-MAN	PNL	PROCEDURES	REMARKS
CDR	11	4.12.2 EPS BASIC (UNSTAGED) 1. ALL EPS CB's closed except: CB EPS: INV 1 - open CROSS TIE BUS - open CROSS TIE BUS - open	
LMP	16		
	14	2. EPS: POWER/TEMP MON sel - CDR BUS INVERTER sw - 2 SE BAT 1 and 2 tb - gray CDR BAT 3 and 4 tb - gray DES BATS tb - gray BAT 5 NORMAL SE FEED tb - bp BAT 5 BACK UP CDR FEED tb - bp BAT 6 NORMAL CDR FEED tb - bp BAT 6 BACK UP SE FEED tb - bp	
CDR	11	4.12.3 EPS BASIC (STAGED) 1. All CB's closed, except: CB EPS: CROSS TIE BUS - open DES ECA CONT - open DES ECA - open INV 1 - open	
LMP	16	2. CB EPS: DES ECA - open DES ECA CONT - open CROSS TIE BUS - open	
	14	3. EPS: POWER/TEMP MON sel - CDR BUS INVERTER sw - 2 SE BAT 1 and 2 tb - bp CDR BAT 3 and 4 tb - bp DES BATS tb - bp BAT 5 NORMAL SE FEED tb - bp BAT 5 BACK UP CDR FEED tb - bp BAT 6 NORMAL CDR FEED tb - bp BAT 6 BACK UP SE FEED tb - bp	

4.12.2 EPS BASIC (UNSTAGED)/4.12.3 EPS BASIC (STAGED)

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR	11	4.12.4 EPS PREPARATION FOR DPS BURN	
LMP	16	1. Perform EPS basic (unstaged) except: CB EPS: INV 1 - close CROSS TIE BAL LOADS - open CROSS TIE BAL LOADS - open	
	14	2. Check AC voltage from Inverter 1: EPS: POWER/TEMP MON sel - AC BUS INVERTER sw - 1 VOLTS ind - green band	
		3. Place both ascent batteries on line: EPS: BAT 5 NORMAL SE FEED sw - ON; tb - gray BAT 6 NORMAL CDR FEED sw - ON; tb - gray	
		4. Check voltage of all six batteries: EPS: POWER/TEMP MON sel - BAT 1 VOLTS ind - 28.0 to 32.5 vdc Repeat measurement for BATS 2, 3, 4, 5, and 6.	
		5. Check dc voltage on both buses: EPS: POWER/TEMP MON sel - CDR BUS VOLTS ind - 26.5 to 32.5 vdc POWER/TEMP MON sel - SE BUS VOLTS ind - 26.5 to 32.5 vdc	
		6. EPS: POWER/TEMP MON sel - CDR BUS CAUTION To avoid transients, remove descent batteries individually at intervals of at least 3 seconds.	Set selector switch in advance to shorten measurement time.
LMP	14	7. Remove all four descent batteries from line, and deadface: EPS: SE BAT 1 and 2 HI VOLT sw OFF/RESET; tb - bp CDR BAT 3, and 4 HI VOLT sw - OFF/RESET; tb - bp DES BATS sw - DEADFACE; tb - bp	If power is lost on either bus: CB EPS: CROSS TIE BUS (2) - close EPS: SE BAT 1 and 2 HI VOLT sw - ON; tb - gray CDR BAT 3 and 4 HI VOLT sw - ON; tb - gray CB EPS: CROSS TIE BUS (2) - close

4.12.4 EPS PREPARATION FOR DPS BURN

CREW-MAN	PNL	PROCEDURES	REMARKS
		8. Check backup feed path from BAT 5 with BAT 6 taken off line: CAUTION There is no overcurrent protection for backup feed paths. Switch back to normal feed paths immediately after measuring voltage. EPS: BAT 5 BACK UP CDR FEED sw - ON; tb - gray BAT 6 NORMAL CDR FEED sw - OFF/RESET; tb - bp VOLTS ind - 26.5 to 32.5 volts 9. Return to normal ascent battery configuration EPS: BAT 6 NORMAL CDR FEED sw - ON; tb - bp BAT 5 BACK UP CDR FEED sw - OFF/RESET; tb - bp EPS: POWER/TEMP MON sel - SE BUS 10. Check backup feed path from BAT 6 with BAT 5 taken off line: CAUTION There is no overcurrent protection for backup feed paths. Switch back to normal feed paths immediately after measuring voltage. EPS: BAT 6 BACK UP SE FEED sw - ON; tb - gray BAT 5 NORMAL SE FEED sw - OFF/RESET; tb - bp VOLTS ind - 26.5 to 32.5 volts 11. Return to normal ascent battery configuration: EPS: BAT 5 NORMAL SE FEED sw - ON; tb - gray BAT 6 BACK UP SE FEED sw - OFF/RESET; tb - bp 12. Check voltage on SE BUS: EPS: POWER/TEMP MON sel - SE BUS VOLTS ind - 26.5 to 32.5 vdc	If power is lost on CDR BUS: EPS: BAT 6 NORMAL CDR FEED sw - ON; tb - gray BAT 5 BACK UP CDR FEED sw - OFF/RESET; tb - bp Set selector switch in advance to shorten measurement time. If power is lost on SE BUS: EPS: BAT 5 NORMAL SE FEED sw - ON; tb - gray BAT 6 BACK UP FEED sw - OFF/RESET; tb - bp

4.12.4 EPS PREPARATION FOR DPS BURN (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		13. Place all four descent batteries back on line: EPS: DES BATS sw - CONNECT; tb - gray SE BAT 1 & 2 HI VOLT sw - ON; tb - gray CDR BAT 3 & 4 HI VOLT sw - ON; tb - gray 4.12.5 COMMUNICATIONS BASIC	
	11	1. CB/AC BUS B: S BD ANT - open CB/AC BUS A: TAPE RCDR - close CB COMM: UP DATA LINK - open SEC S BD XMTR/RCVR - close SEC S BD PWR AMPL - close VHF A RCVR - close VHF B XMTR - close CDR AUDIO - close	This is communications switch configuration after all initial communications checks have been completed.
		2. CB EARTH ORBIT: ANT TRNFR A - close ANT TRNFR B - close R/D INST A - close R/D INST B - close C BAND PWR sw - ON R/D TLM CAL sw - OFF	
	8	3. AUDIO: S BAND T/R sw - S BAND T/R ICS T/R sw - ICS T/R RELAY ON sw - RELAY OFF VOX sw - ICS/XMTR AUDIO CONT sw - NORM VHF A sw - T/R VHF B sw - OFF	
	16	4. CB HTR: S BD ANT - close CB COMM: DISP - close SE AUDIO - close VHF A XMTR - close VHF B RCVR - close PRIM S BD PWR AMPL - close	

4.12.4 EPS PREPARATION FOR DPS BURN/4.12.5 COMMUNICATIONS BASIC

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CREW-MAN	PNL	PROCEDURES	REMARKS
	12	PRIM S BD XMTR/RCVR - close S BD ANT - open PMP - close TV - open CB CAMR: SEQ - open 5. AUDIO: S BAND T/R sw - S BAND T/R ICS T/R sw - ICS T/R RELAY ON sw - RELAY OFF VOX sw - ICS/XMTR AUDIO CONT sw - NORM VHF A sw - T/R VHF B sw - OFF 6. COMM: S BAND MODULATE sw - PM S BAND XMTR/RCVR sw - PRIM S BAND PWR AMPL sw - OFF S BAND VOICE sw - VOICE S BAND PCM sw - PCM S BAND RANGE sw - OFF VHF A XMTR sw - ON VHF A RCVR sw - ON VHF B XMTR sw - OFF VHF B RCVR sw - OFF TLM BIOMED sw - as required TLM PCM sw - HI RECORDER sw - OFF NOTE The recorder when enabled, records continuously when AUDIO: VOX sw is set to ICS. Total recording time is 10 hours. 7. COMM ANT: VHF sel - 1/PLSS TEST TRACK MODE sw - OFF PITCH cont - +255° (antenna lock position) YAW cont - -30° (antenna lock position) S BAND sel - 2	

4.12.5 COMMUNICATIONS BASIC (cont)

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.12.6 MPS BASIC (UNSTAGED)	
CDR	11	1. CB/AC BUS B: He/PQGS PROPUL DISP - close CB PROPUL: DES He REG/VENT - close	
LMP	16	2. CB PROPUL: ASC He REG - close TEMP/PRESS DISP FLAGS - close PQGS - open	
CDR	1	3. PRPLNT QTY MON sw - OFF HELIUM MON sel - SUPERCRIT PRESS PRPLNT TEMP/PRESS MON sw - DES 1 DES He REG 1 tb - gray DES He REG 2 tb - bp ASC He REG 1 tb - gray ASC He REG 2 tb - gray	
LMP	2	4. RCCA sw - OFF/RESET	
CDR	8	5. DES PROPUL: FUEL VENT tb - bp OXID VENT tb - bp	
		4.12.7 MPS BASIC (STAGED)	
CDR	11	1. CB/AC BUS B: He/PQGS PROPUL DISP - close CB PROPUL: DES He REG/VENT - open	
LMP	16	2. CB PROPUL: ASC He REG - close TEMP/PRESS DISP FLAGS - close PQGS - open	
CDR	1	3. PRPLNT QTY MON sw - OFF HELIUM MON sel - PRESS 2 PRPLNT TEMP/PRESS MON sw - ASC ASC He REG 1 tb - gray ASC He REG 2 tb - gray	
LMP	2	4. RCCA sw - ENABLE	

4.12.6 MPS BASIC (UNSTAGED)/4.12.7 MPS BASIC (STAGED)

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	2	4.12.8 ECS PERIODIC MONITORING (UNSTAGED) 1. ECS: CABIN TEMP ind - 70° to 80° F PRESS ind pwr fail lt - off SUIT PRESS ind - 4.6 to 5.0 psia CABIN PRESS ind - 4.6 to 5.0 psia PART PRESS CO2 ind - <7.6 mm Hg GLYCOL ind pwr fail lt - off GLYCOL TEMP ind - 32° to 50° F GLYCOL press ind - 15 to 45 psia GLYCOL comp caut lt - off SUIT FAN comp caut lt - off CO2 comp caut lt - off H2O SEP comp caut lt - off 2. O2/H2O QTY MON sel - DES ECS: QUANTITY ind pwr fail lt - off O2 QUANTITY ind - TBD% H2O QUANTITY ind - TBD% 3. O2/H2O QTY MON sel - ASC 1 ECS: O2 QUANTITY ind - 100% H2O QUANTITY ind - 100% 4. O2/H2O QTY MON sel - ASC 2 ECS: O2 QUANTITY ind - 100% H2O QUANTITY ind - 100% 5. O2/H2O QTY MON sel - DES	Assumption: ECS basic (Unstaged). The MASTER ALARM pb/lt ECS caut lt and CO2 comp caut lt go on when 2.274 ±.025 volts are sensed at the CWEA comparator. When CO2 partial pressure is being sensed at 5.0 psia, the actual CO2 partial pressure could range between 5.35 to 8.25 mm Hg. The ECS: PART PRESS CO2 ind will read approximately 8 mm Hg. When CO2 partial pressure is being sensed at 3.7 psia, actual CO2 partial pressure could be between 6.45 and 10 mm Hg when the MASTER ALARM pb/lt, ECS caut lt and CO2 comp caut lt go on. ECS: PART PRESS CO2 ind will read 7.6 mm Hg. To be certain that actual CO2 partial pressure is 8 mm Hg, ECS: PART PRESS CO2 ind should read 6 mm Hg. Quantity of consumables displayed is function of mission elapsed time.

4.12.8 PERIODIC MONITORING (UNSTAGED)

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	2	4.12.9 ECS PERIODIC MONITORING (STAGED) 1. ECS: CABIN TEMP ind - 70° to 80° F PRESS ind pwr fail lt - off SUIT PRESS ind - 4.6 to 5.0 psia CABIN PRESS ind - 4.6 to 5.0 psia PART PRESS CO2 ind - <7.6 mm Hg GLYCOL ind pwr fail lt - off GLYCOL TEMP ind - 32° to 50° F GLYCOL PRESS ind - 15 to 45 psia GLYCOL comp caut lt - off SUIT FAN comp caut lt - off CO2 comp caut lt - off H2O SEP comp caut lt - off 2. O2/H2O QTY MON sel - ASC 1 ECS: QUANTITY ind pwr fail lt - off O2 QUANTITY ind - TBD% H2O QUANTITY ind - TBD% 3. O2/H2O QTY MON sel - ASC 2 ECS: O2 QUANTITY ind - 100% H2O QUANTITY ind - TBD% 4. O2/H2O QTY MON SEL - ASC 1	Assumption: ECS Basic (Staged) MASTER ALARM pb/lt, ECS caut lt, and CO2 comp caut lt go on when 2.274 ±0.025 volts is sensed at CWEA comparator. When 5.0 psia CO2 partial pressure is sensed, actual CO2 partial pressure could be between 5.35 and 8.25 mm Hg. ECS: PART PRESS CO2 ind will read approximately 8 mm Hg. When 3.7 psia CO2 partial pressure is sensed actual CO2 partial pressure could be between 6.45 to 10 mm Hg when MASTER ALARM pb/lt, ECS caut lt and CO2 comp caut lt go on. The ECS: PART PRESS CO2 ind should read 6 mm Hg. Quantity of consumables displayed is function of mission elapsed time.

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	16	4.12.10 GLYCOL PUMP CHECK	
		1. CB ECS: GLYCOL PUMP SEC - close	SEC GLYCOL PUMP must be checked by having MSFN monitor RPM. Monitoring secondary HTS necessitates turning off primary HTS pumps.
		CAUTION	
		Primary pumps should not be turned off for longer than 2 minutes while primary sublimator is activated or primary sublimator could freeze and fail.	
	2	2. GLYCOL sel - INST (SEC)	If GLYCOL PUMP SEC is not checked, omit steps 1 thru 5 and step 7.
		3. MASTER ALARM pb/lt - on ECS caut lt - on GLYCOL comp caut lt - on	
		4. MASTER ALARM pb/lt - reset	
		5. CB ECS: GLYCOL PUMP SEC - open	
		6. GLYCOL sel - PUMP 1	
		7. ECS caut lt - off GLYCOL comp caut lt - off	
CDR	11	8. CB ECS: GLYCOL PUMP 2 - close GLYCOL PUMP 1 - close GLYCOL PUMP AUTO TRNFR - close	
LMP	2	9. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - 32° to 50° F	
	11	10. CB ECS: GLYCOL PUMP 1 - open	This simulates pump No. 1 failure.
LMP	1 & 2 2	11. MASTER ALARM pb/lt - on ECS caut lt - on (momentarily) GLYCOL comp caut lt - on	
		12. MASTER ALARM pb/lt - reset	

4.12.10 GLYCOL PUMP CHECK

CREW-MAN	PNL	PROCEDURES	REMARKS
		13. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - 32° to 50° F 14. GLYCOL sel - PUMP 2 15. GLYCOL comp caut lt - off 16. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - 32° to 50° F	
CDR	11	17. CB ECS: GLYCOL PUMP AUTO TRNFR - open GLYCOL PUMP 1 - close	
LMP	2	18. GLYCOL sel - PUMP 1	MASTER ALARM pb/lt, ECS caut lt, and GLYCOL comp caut lt may go on momentarily. If this occurs, reset MASTER ALARM pb/lt.
		19. ECS: GLYCOL press ind - 15 to 45 psia GLYCOL temp ind - 32° to 50° F	
CDR	11	20. CB ECS: GLYCOL PUMP AUTO TRNFR - close	
		4.12.11 SECONDARY HEAT TRANSPORT SECTION ACTIVATION CAUTION Activation of secondary heat transport section is nonreversible. This task should only be performed if primary heat transport section fails.	Activation of secondary heat transport section assumes either failure of both primary glycol pumps, loss of primary glycol/ or inability to maintain primary glycol loop temperature below +50° F. ECS caut lt and GLYCOL comp caut lt remain on after secondary heat transport section is activated.
	ECS	1. WATER TANK SELECT vlv - SEC	
LMP	16	2. CB ECS: GLYCOL PUMP SEC - close	
	2	3. GLYCOL sel - INST (SEC)	
	ECS	4. SEC EVAP FLOW vlv - open	
CDR	11	5. CB ECS: GLYCOL PUMP 2 - open	

4.12.10 GLYCOL PUMP CHECK/4.12.11 SECONDARY HEAT TRANSPORT SECTION ACTIVATION

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	ECS	6. CB ECS: GLYCOL PUMP 1 - open 7. CB ECS: GLYCOL PUMP AUTO TRNFR - open 8. PRIM EVAP FLOW sw - CLOSE (momentary) 9. PRIM EVAP FLOW NO 2 vlv - CLOSE 10. ASC H2O vlv - OPEN 11. DES H2O vlv - CLOSE	
LMP	16	12. CB ECS: CABIN FAN 2 - open	
CDR	11	13. CB ECS: CABIN FAN 1 - open.	
LMP	ECS	4.12.12 WATER SEPARATOR CHECK	
	1 & 2	1. WATER SEP SEL vlv - PULL SEP 2	
	2	2. MASTER ALARM pb/lt - on ECS caut lt - on H2O SEP comp caut lt - on	
CDR		3. MASTER ALARM pb/lt - reset	
		4. ECS caut lt - off H2O SEP comp caut lt - off	ECS caut lt and H2O SEP comp caut lt go off when selected water separator comes up to speed at approximately 1 minute when dry and approximately 15 minutes when wet.
LMP	ECS	5. WATER SEP SEL vlv - PUSH SEP 1	
	2	6. MASTER ALARM pb/lt - on ECS caut lt - on H2O SEP comp caut lt - on	
CDR		7. MASTER ALARM pb/lt - reset	
		8. ECS caut lt - off H2O SEP comp caut lt - off.	

4.12.11 SECONDARY HEAT TRANSPORT SECTION ACTIVATION/4.12.12 WATER SEPARATOR CHECK

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CREW-MAN	PNL	PROCEDURES	REMARKS
		4.12.13 PRIMARY Li OH CARTRIDGE REPLACEMENT	
LMP	ECS 2	1. CO2 CANISTER SEL vlv - SEC CO2 comp caut lt - on	Ascent engine cover must be cleared of stowed equipment to gain access to ECS Li OH cartridge.
CDR	1	2. ECS: PART PRESS CO2 ind - monitor	PART PRESS CO2 ind should indicate pressure decay to zero mm Hg.
LMP	ECS	3. PRIM CO2 CANISTER VENT pb - push	This step is required to vent ΔP pressure across canister.
		4. Rotate primary CO2 canister cover to OPEN and remove	
		5. Rotate and remove used Li OH cartridge from canister	
		6. Open netting flap over primary Li OH stowage container	
		7. Unscrew two fasteners, remove cover, and withdraw cartridge	
		8. Insert used cartridge into stowage container and secure cover in place	
		9. Align index marks on Li OH cartridge and canister, then insert cartridge and rotate it until properly seated.	
		10. Install CO2 canister cover and rotate to close	
		11. CO2 CANISTER SEL vlv - PRIM	
	2	12. CO2 comp caut lt - off	
		13. ECS: PART PRESS CO2 ind - monitor.	Perform ARS/PGA pressure integrity check. (Refer to paragraph 4.2.20.)
		4.12.14 SECONDARY Li OH CARTRIDGE REPLACEMENT	
LMP	ECS	1. CO2 CANISTER SEL vlv - PRIM	Ascent engine cover must be cleared of stowed equipment to gain access to ECS Li OH cartridge.
		2. CO2 comp caut lt - off	
		3. SEC CO2 CANISTER VENT pb - push	This step is required to vent ΔP pressure across canister.

4.12.13 PRIMARY Li OH CARTRIDGE REPLACEMENT/4.12.14 SECONDARY Li OH CARTRIDGE REPLACEMENT

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CREW-MAN	PNL	PROCEDURES	REMARKS
		- Rotate secondary CO2 canister cover to OPEN and remove - Rotate and remove used Li OH cartridge from canister - Obtain fresh secondary Li OH cartridge from interim stowage in LH midsection and replace with used cartridge - Align index marks on Li OH cartridge and canister then insert cartridge and rotate until properly seated - Install CO2 canister cover and rotate it to CLOSE - CO2 CANISTER SEL vlv - SEC - CO2 comp caut lt - on.	Returning CO2 CANISTER SEL vlv to SEC assumes primary Li OH cartridge has failed. Perform ARS/PGA Pressure Integrity check. Refer to paragraph 4.2.20.
		4.12.15 CABIN DEPRESSURIZATION	Assumptions: (1) ECS Basic (Unstaged) (2) both crewmen on S/C ECS.
	ECS	- Perform ARS/PGA Pressure Integrity check, ref para 4.2.20 - CABIN GAS RETURN vlv - EGRESS - PRESS REG A and B vlv - EGRESS - Cabin relief and dump vlv (fwd) - Cycle from AUTO to DUMP until cabin pressure is reduced to ~3.2 psia - Cabin relief and dump vlv (fwd) - AUTO - Verify suit pressure stabilizes between 3.6 and 4.3 psia - Cabin relief and dump vlv (fwd) - DUMP and reduce cabin pressure to zero psia.	Holding cabin pressure at ≈ 3.2 psia during this verification precludes catastrophic situation if suit integrity is lost. During cabin depressurization, SUIT CIRCUIT RELIEF vlv closes when cabin and ARS pressure drops to 4.3 psia. To verify proper operation (closure) of valve, cabin pressure must be below 4.3 psia.

4.12.14 SECONDARY Li OH CARTRIDGE REPLACEMENT/4.12.15 CABIN DEPRESSURIZATION

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR LMP	ECS	4.12.16 CABIN REPRESSURIZATION 1. Cabin relief and dump vlv (fwd) - AUTO 2. Cabin relief and dump vlv (ovhd) - AUTO 3. CABIN REPRESS vlv - AUTO	Both crewmen are on S/C ECS in a depressurized cabin.
CDR/ LMP CDR	1 & 2 1 ECS	4. PRESS REG A vlv - CABIN MASTER ALARM pb/lt - on CABIN warn lt - on CABIN REPRESS vlv opens 5. MASTER ALARM pb/lt - reset	
LMP	ECS	6. PRESS REG B vlv - CABIN 7. Verify CABIN REPRESS vlv closes CABIN warn lt - off 8. Verify cabin pressure stabilizes at 4.8 ± 0.2 psia 9. Set controls - ECS Basic (Unstaged)	CABIN REPRESS vlv closes and CABIN warn lt goes off when pressure reaches $4.45 \pm .15$ psia. Cabin pressure will stabilize approximately 2 minutes after CABIN REPRESS vlv closes.
	ECS	4.12.17. CABIN LEAK CHECK 1. PRESS REG A and B vlv - EGRESS 2. Monitor cabin pressure for TBD minutes and verify cabin pressure decay is <TBD psia 3. Set controls - ECS Basic (Unstaged)	Assume ECS Basic (Unstaged) This action closes SUIT GAS DIVERTER vlv and turns off cabin fans. Cabin leak check verifies gross leakage only. Exact leakage rates cannot be read on ECS: CABIN PRESS ind. Refer to paragraph 4.11.4.
		4.12.18 RELAY MODE: EVA	LMP is EVA.
CDR LMP	8 12	1. Perform Communications Basic, (ref para 4.12.5) except: AUDIO: VHF B sw - RCV S BAND T/R sw - OFF RELAY ON sw - RELAY ON	

4.12.16 CABIN REPRESSURIZATION/4.12.17 CABIN LEAK CHECK/4.12.18 RELAY MODE: EVA

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR LMP	8 12	COMM: VHF A RCVR sw - OFF VHF B RCVR sw - ON 2. After EVA mode is completed, return to Communications Basic. 4.12.19 RELAY MODE: CSM VOICE TO MSFN 1. Perform Communications Basic (ref para 4.12.5) except: AUDIO: VHF A sw - RCV S BAND T/R sw - RCV RELAY ON sw - RELAY ON 2. After relay is completed, return to Communications Basic.	
		4.12.20 S-BAND LBR DATA TRANSMISSION 1. Perform Communications Basic (ref para 4.12.5) except: COMM: TLM PCM sw - LO 2. After LBR data check completed, return to Communications Basic.	This task is performed for verification testing only.
LMP	12	4.12.21 VHF B DATA TRANSMISSION 1. Perform Communications Basic except: COMM: VHF B XMTR sw - DATA TLM PCM sw - LO 2. When ready to transmit S-Band data, return to Communications Basic.	This task is performed when not in LOS with MSFN.
LMP	12	4.12.22 TV OPERATION 1. Unstow TV camera and lens 2. Open cover on TV CAMERA CONNECT; connect and secure TV camera cable	

4.12.18 RELAY MODE: EVA/4.12.19 RELAY MODE: CSM VOICE TO MSFN/4.12.20 S-BAND LBR DATA TRANSMISSION/
 4.12.21 VHF B DATA TRANSMISSION

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	12	3. Connect cable to camera 4. Verify desired camera speed (1 or 10 fps) 5. COMM: S BAND MODULATE sw - FM 6. Remove and stow lens cover	Five-second warmup period is required after modulation change.
LMP	16	7. CB COMM: TV - close 8. Verify MSFN reception of TV signal	
LMP	16	9. When TV operation is completed: CB COMM: TV - open	Five-second warmup period is required after modulation time.
LMP	12	COMM: S BAND MODULATE sw - PM	
CDR	8	10. Disconnect TV camera cable from TV CAMERA CONNECT 11. Stow camera, lens, and cable.	Assumptions: (1) Ascent propulsion subsystem is pressurized and (2) + x - axis RCS thrusters are firing.
		4.12.23 APS/RCS PROPELLANT INTERCONNECT WARNING Ullage settling requirements for APS propellant must be met before opening interconnect, (thrusting maneuver or +g field). Interconnect must be closed before termination of thrusting maneuver to prevent helium injection into RCS causing RCS engine damage.	
CDR	TCA	1. Thrust for TBD seconds	Time for propellant to settle is dependent upon mission elapsed time.
LMP	2	2. RCS: SYS A ASC FEED 1, 2 sw - OPEN SYS A ASC FUEL, ASC OXID; tb - gray SYS A MAIN SOV sw - CLOSE; tb - bp TEMP/PRESS MON sel - FUEL MANF A PRESS ind - 178 to 188 psia TEMP/PRESS MON sel - OXID MANF A PRESS ind - 178 to 188 psia	

4.12.22 TV OPERATION/4.12.23 APS/RCS PROPELLANT INTERCONNECT

CREW-MAN	PNL	PROCEDURES	REMARKS
CDR	1	3. RCS: SYS B ASC FEED 1, 2 sw - OPEN SYS B ASC FUEL, ASC OXID; tb - gray SYS B MAIN SOV sw - CLOSE; tb - bp TEMP/PRESS MON sel - OXID MANF B PRESS ind - 178 to 188 psia TEMP/PRESS MON sel - FUEL MANF B PRESS ind - 178 to 188 psia 4. TBC seconds before termination of APS thrust: RCS: SYS A & SYS B MAIN SOV sw - OPEN; tb - gray SYS A & SYS B ASC FEED 1, 2 sw - CLOSE SYS A & SYS B ASC FUEL, ASC OXID; tb - bp TEMP/PRESS MON sel - FUEL MANF A & B PRESS ind - 178 to 188 psia TEMP PRESS MON sel - OXID MANF A & B PRESS ind - 178 to 188 psia 5. RCS: TEMP/PRESS MON - He. 4.12.24 DPS PERIODIC MONITORING 1. HELIUM MON sel - SUPCRIT PRESS MPS: HELIUM ind - TBD psia 2. PRPLNT TEMP/PRESS MON sw - DES 1 MPS: FUEL TEMP ind - 50° to 90° F OXID TEMP ind - 50° to 90° F FUEL PRESS ind - 229 to 253 psia OXID PRESS ind - 229 to 253 psia 3. PRPLNT TEMP/PRESS MON sw - DES 2 MPS: FUEL TEMP ind 50° to 90° F OXID TEMP ind - 50° to 90° F FUEL PRESS ind - 229 to 253 psia OXID PRESS ind - 229 to 253 psia	Procedure for closing APS/RCS interconnect Ascent feed valves can be opened after ascent engine has been shut down provided +X - axis RCS thrusters are firing before reopening valves. Range of pressure levels is 500 to 1380 psia for prepressurization; 300 to 1580 psia for postpressurization.

4.12.23 APS/RCS PROPELLANT INTERCONNECT/4.12.24 DPS PERIODIC MONITORING

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	2	4. PRPLNT TEMP/PRESS MON sw - DES 1 5. PRPLNT QTY MON sw - DES 1 MPS: OXID QUANTITY ind - 0% to 95% FUEL QUANTITY ind - 0% to 95% 6. PRPLNT QTY MON sw - DES 2 MPS: OXID QUANTITY ind - 0% to 95% FUEL QUANTITY ind - 0% to 95% 7. PRPLNT QTY MON sw - OFF 8. MPS: PRESS ind pwr fail lt - off.	PQGS is operated during thrusting maneuvers. This provides ullage necessary to detect an accurate quantity level. Light goes on when power to this indicator is interrupted. Decreases in temperature and pressure are expected during system use. Temperature range during engine burn is -120° to 148° F; after burn range is -140° to +70° F.
		4.12.25 APS PERIODIC MONITORING	
CDR	1	1. HELIUM MON sel - TEMP 1 MPS: HELIUM ind - 30° to 140° F 2. HELIUM MON sel - TEMP 2 MPS: HELIUM ind - 30° to 140° F 3. HELIUM MON sel - PRESS 1 MPS: HELIUM ind - 2800 to 3400 psia 4. HELIUM MON sel - PRESS 2 MPS: HELIUM ind - 2800 to 3400 psia. 5. PRPLNT TEMP/PRESS MON sw - ASC	Ascent helium tank pressure varies as function of time and is dependent on same as initial tank loading conditions. Refer to Table 4-3, for expected helium tank pressure. ASC PRESS warn lt goes on for helium tank pressure of 2773 psia. Propellant pressure during engine burn is 190 ±10 psia; after burn 178 to 203 psia. Fuel and oxidizer pressure should not differ by more than 1 psia. Maximum ΔT between fuel and oxidizer is 10° F for efficient combustion.

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CREW- MAN	PNL	PROCEDURES	REMARKS
LMP	2	MPS: FUEL TEMP ind - 50° to 90° F OXID TEMP ind - 50° to 90° F FUEL PRESS ind - 180 to 200 psia OXID PRESS ind - 180 to 200 psia 6. If unstaged: PRPLNT TEMP/PRESS MON sw - DES 1 HELIUM MON sel - SUPCRIT PRESS MPS: PRESS ind pwr fail lt - off. 4.12.26 RCS PERIODIC MONITORING 1. RCS: PRESS ind pwr fail lt - off QUANTITY ind pwr fail lt - off 2. RCS: A and B QUANTITY ind - Record percentage of usable propellant remaining 3. RCS: TEMP PRESS MON sel - He A and B PRESS ind - Record pressure 4. RCS: TEMP/PRESS MON sel - PRPLNT A and B TEMP ind - 40° to 100° F A and B PRESS ind - 178 to 188 psia 5. RCS: TEMP/PRESS MON sel - FUEL MANF A and B PRESS ind - 178 to 188 psia 6. RCS: TEMP/PRESS MON sel - OXID MANF A and B PRESS ind - 178 to 188 psia 7. RCS: SYS A ASC FUEL tb - bp SYS A ASC OXID tb - bp	Light goes on when power to this indicator is interrupted. This procedure checks status of propellants, helium, and valve positions before each burn and at intervals during coast periods. During vehicle power down when CB RCS SYS B: TEMP/PRESS DISP FLAGS and CB RCS SYS B: PQGS DISP are open, RCS: PRESS ind pwr fail lt and RCS: QUANTITY ind pwr fail lt are on.

4.12.25 APS PERIODIC MONITORING/4.12.26 RCS PERIODIC MONITORING

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CREW-MAN	PNL	PROCEDURES	REMARKS
LMP	3	SYS B ASC FUEL tb - bp SYS B ASC OXID tb - bp SYS A QUAD 1 tb - gray SYS A QUAD 4 tb - gray SYS B QUAD 1 tb - gray SYS B QUAD 4 tb - gray SYS A QUAD 2 tb - gray SYS A QUAD 3 tb - gray SYS B QUAD 2 tb - gray SYS B QUAD 3 tb - gray CRSFD tb - bp SYS A MAIN SOV tb - gray SYS B MAIN SOV tb - gray TEMP/PRESS MON sel - He 8. Verify RCS quad temperature readings: HTR CONT: TEMP MON sel - QUAD 1, 2, 3, 4 TEMP ind - 120° to 190° F (each quad) RCS SYS A/B 2 QUAD 1, 2, 3, 4 sw - AUTO. 4.12.27 HEATERS STATUS CHECK	
LMP	3	1. HTR CONT: TEMP MON sel - RNDZ RADAR TEMP ind - -40° to +145° F TEMP MON sel - LDG RADAR TEMP ind - +50° to +150° F TEMP MON sel - RCS QUAD 1, 2, 3, 4 TEMP ind - 120° to 190° F (each quad) TEMP MON sel - S BAND TEMP ind - +65° to 160° F 2. HTR CONT: TEMP MON sel - RNDZ RADAR	This procedure is performed before LM/CSM separation and during LM manned coasting periods, to verify that all heater temperatures are within tolerance. Assumption: All heater circuit breakers are closed.

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SECTION 5
CONTINGENCY PROCEDURES

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CREW- MAN	PNL	PROCEDURES	REMARKS
		5.1 <u>ABORT PROCEDURES</u> (To be supplied)	

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CREW- MAN	PNL	PROCEDURES	REMARKS
		5.2 <u>MALFUNCTION PROCEDURES</u> (To be supplied)	

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CREW-MAN	PNL	PROCEDURES	REMARKS
		5.3 <u>EMERGENCY PROCEDURES</u> Emergency procedures provide the crew with necessary steps to perform corrective action in the event of hazardous situations. These procedures require instant response on the part of the crew to prevent the situation from becoming worse. The procedures consist of the following: - Excessive cabin leak - Fire in cabin - Suit leak in depressurized cabin.	
		5.3.1 EXCESSIVE CABIN LEAK 1. When cabin pressure drops to 4.15 ± 0.15 psia, following occurs automatically: MASTER ALARM pb/lt - on CABIN warn lt - on CABIN REPRESS vlv - opens SUIT GAS DIVERter vlv - PULL EGRESS	Assumption: ECS is in Basic (unstaged) configuration when cabin leak occurs. In ECS Basic (staged), only steps 1, 2, and 5 are required.
CDR/LMP	1&2 1 ECS		
	ECS 1 ECS	2. PRESS REG A and B vlv - EGRESS CABIN warn lt - off CABIN REPRESS vlv closes Cabin fans go off.	
		3. CABIN REPRESS vlv - CLOSE	
LMP	ECS	4. CB ECS: CABIN REPRESS - open	
CDR/LMP	1&2	5. MASTER ALARM pb/lt - reset.	
		5.3.2 FIRE IN CABIN 1. PRESS REG A and B vlv - EGRESS	Method of extinguishing fire will be real-time decision. If water is used, cloud of droplets may form under zero g conditions. If water is used and cabin is subsequently depressurized, water will flash to ice.

5.3.1 EXCESSIVE CABIN LEAK/5.3.2 FIRE IN CABIN

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CREW-MAN	PNL	PROCEDURES	REMARKS
CDR/ LMP CDR	1&2 1 ECS	2. Cabin relief and dump vlv (fwd and ovhd) - DUMP OR 3. Operate water hose to extinguish fire 4. Perform Emergency Power Down - TBD. 5.3.3 SUIT LEAK IN DEPRESSURIZED CABIN 1. MASTER ALARM pb/lt - on CABIN warn lt - on SUIT/FAN warn lt - on CABIN REPRESS vlv opens SUIT ISOL vlv (CDR) - SUIT DISCONN SUIT ISOL vlv (LMP) - SUIT DISCONN 2. Forward hatch - close 3. Forward hatch handle - LOCK 4. Cabin relief and dump vlv (fwd) - AUTO 5. Verify CABIN REPRESS vlv has opened 6. PRESS REG A vlv - CABIN 7. PRESS REG B vlv - CABIN 8. SUIT ISOL vlv (CDR) - SUIT FLOW 9. SUIT ISOL vlv (LMP) - SUIT FLOW	These events occur simultaneously and automatically when SUIT PRESS ind falls below 3.1 psia. Crewman with intact suit will perform steps 2 and subsequent. Omit steps 2 to 4 if forward hatch is closed and forward cabin relief and dump valve is not set to DUMP. If valve has not opened: CABIN REPRESS vlv - MANUAL When CABIN PRESS ind reads 4.45 ±0.15 psia: CABIN REPRESS vlv - AUTO SUIT/FAN warn lt - off when suit pressure exceeds 3.1 psia. CABIN warn lt - off when cabin pressure greater than 4.45 ±1.5 psia. Steps 8 and 9 are performed when cabin pressure exceeds 3.1 psia.
	CDR/ LMP 1&2	10. MASTER ALARM pb/lt - reset.	

5.3.2 FIRE IN CABIN/5.3.3 SUIT LEAK IN DEPRESSURIZED CABIN

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Appendix D

G&C TERMS AND EXPRESSIONS

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Appendix D

DEFINITION OF G&C TERMS AND EXPRESSIONS.

Table D-1 lists the terms and expressions used in the G&C normal/backup procedures.

Table D-1. Definition of Terms and Expressions

Term/Expression	Definition
CDH	Constant Δ altitude
CDH Apsis	Future apsidal crossing (apogee at perigee) of the active vehicle at which TIG (CDH) should occur.
Co	CSI iteration error (AGS)
CSI	Co-elliptic sequence initiation
DAP	Digital autopilot
E	Elevation angle (angle between the LM/CSM LOS and the LM local horizontal plane at TIG measured from the direction of flight)
FITH	Fire in the hole
FOV	Field of view
GET	Ground elapsed time
GETI	Ground elapsed time of ignition
H	Altitude of active vehicle above launch pad radius at TIG.
h	LM altitude (AGS)
Ha	Apogee
Hp	Perigee
IG	Inner gimbal (pitch)
IGA	Inner gimbal angle
K	Ground elapsed time of AEA clock zero
KALCMANU	Maneuver calculation
LOS	Line of sight
LV	Local vertical (axes)
MG	Middle gimbal (roll)
MGA	Middle gimbal angle
MID	Midcourse
N	Number of marks

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Table 4-11. (cont)

Term/Expression	Definition
OG	Outer gimbal (yaw)
OGA	Outer gimbal angle
q	Perigee (AGS)
q1	Perigee altitude of predicted LM trajectory (AGS)
R	Geocentric radius vector
R	LM to CSM range (AGS)
rcx	X component of CSM position (AGS)
rcy	Y component of CSM position (AGS)
rcz	Z component of CSM position (AGS)
REFSMMAT	Reference stable member matrix
rf	Predicted orbit insertion burnout radius (AGS)
rx	X component of LM position (AGS)
ry	Y component of LM position (AGS)
rz	Z component of LM position (AGS)
State vectors	Position, velocity, and time
t	AGS computer time (AGS)
T (Align)	State vector time (GET) selected to define IMU and LM orientation
TAo	Time from CSI to CDH (AGS)
TC	Time from CDH to TPI (AGS)
Tco	Predicted time from CDH to TPI
TFF	Time of free fall to 300,000 ft
TFI	Time from TIG
TF INT	Time from intercept
TG	Time to go to engine cutoff
Ti	Time to CSI (AGS)
TIG	Time of ignition
TigA	AGS computer time of CSI maneuver (AGS)
TigC	AGS computer time of TPI or midcourse maneuver (AGS)
T Perigee	Time to perigee
TPF	Transfer phase final (or breaking)
TPI	Transfer phase initiation

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Table 4-11. (cont)

Term/Expression	Definition
TPM	Transfer phase midcourse
Tr	Time to rendezvous (AGS)
TVC	Thrust vector control
T Δ	Time to CDH, CSI, or TPI
T Δ V	Target Δ V (AGS)
V	Interial velocity vector at TIG
V	LM velocity (AGS)
V _{cx}	X component of CSM velocity (AGS)
V _{cy}	Y component of CSM velocity (AGS)
V _{cz}	Z component of CSM velocity (AGS)
V _{dx}	Minus descent stage capability + Δ V expended (AGS)
VG	Magnitude of velocity to be gained
VGX (LM)	Component of the VG vector resolved along the present X axis
VGX (LV)	Component of the VG vector at TIG along (RXV) XR
VGY (LM)	Component of the VG vector resolved along the present Y axis
VGY (LV)	Component of the VG vector at TIG along VXR
VGZ (LM)	Component of the VG vector resolved along the present Z axis
VGZ (LV)	Component of the VG vector at TIG along - R
V _o	Δ V for CSI maneuver (AGS)
V _{po}	CDH maneuver Δ V (AGS)
V _{py}	Velocity perpendicular to CSM orbit (AGS)
VT	Velocity to rendezvous
VX	Velocity along the X axis
V _x	X component of LM velocity (AGS)
VY	Velocity along the Y axis
V _y	Y component of LM velocity (AGS)
V _{yo}	LM velocity normal to CSM orbit plane (AGS)
VZ	Velocity along the Z axis
V _z	Z component of LM velocity (AGS)

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Table 4-11. (cont)

Term/Expression	Definition
Wbx	X unit vector for commanding attitude (AGS)
Wby	Y unit vector for commanding attitude (AGS)
Wbz	Z unit vector for commanding attitude (AGS)
Wcx	X unit vector normal to CSM orbit (AGS)
Wcy	Y unit vector normal to CSM orbit (AGS)
Wcz	Z unit vector normal to CSM orbit (AGS)
X	LM vertical axis
Y	LM lateral axis
Ycx	X component of CSM position (AGS)
Ycy	Y component of CSM position (AGS)
Ycz	Z component of CSM position (AGS)
yf	Predicted value of out-of-CSM-orbit place position (AGS)
Yx	X component of LM position (AGS)
Yy	Y component of LM position (AGS)
Yz	Z component of LM position (AGS)
Z	LM fore-aft axis
ΔH	Altitude between the active and passive vehicle at TIG
Δh	AGS computer time (AGS)
ΔR	Magnitude of difference between the position state vector before and after incorporation of mark data
Δro	Differential altitude in co-elliptic orbit (AGS)
ΔT TRANS	Time required for transfer from TIG (TPI) to time of intercept
ΔV	Magnitude of difference between the velocity state vector before and after incorporation of mark data.
ΔV (CDH)	Required impulsive ΔV to accomplish CDH maneuver at TIG (CDH)
ΔV (CSI)	Required impulsive ΔV to accomplish CSI maneuver at TIG (CSI)
ΔV_{gx}	ΔV in X direction (AGS)
ΔV_{gy}	ΔV in Y direction (AGS)
ΔV_{gz}	ΔV in Z direction (AGS)
ΔV_m	Measured ΔV magnitude
ΔV (MID)	Required impulsive ΔV to accomplish next midcourse maneuver at TIG (MID)

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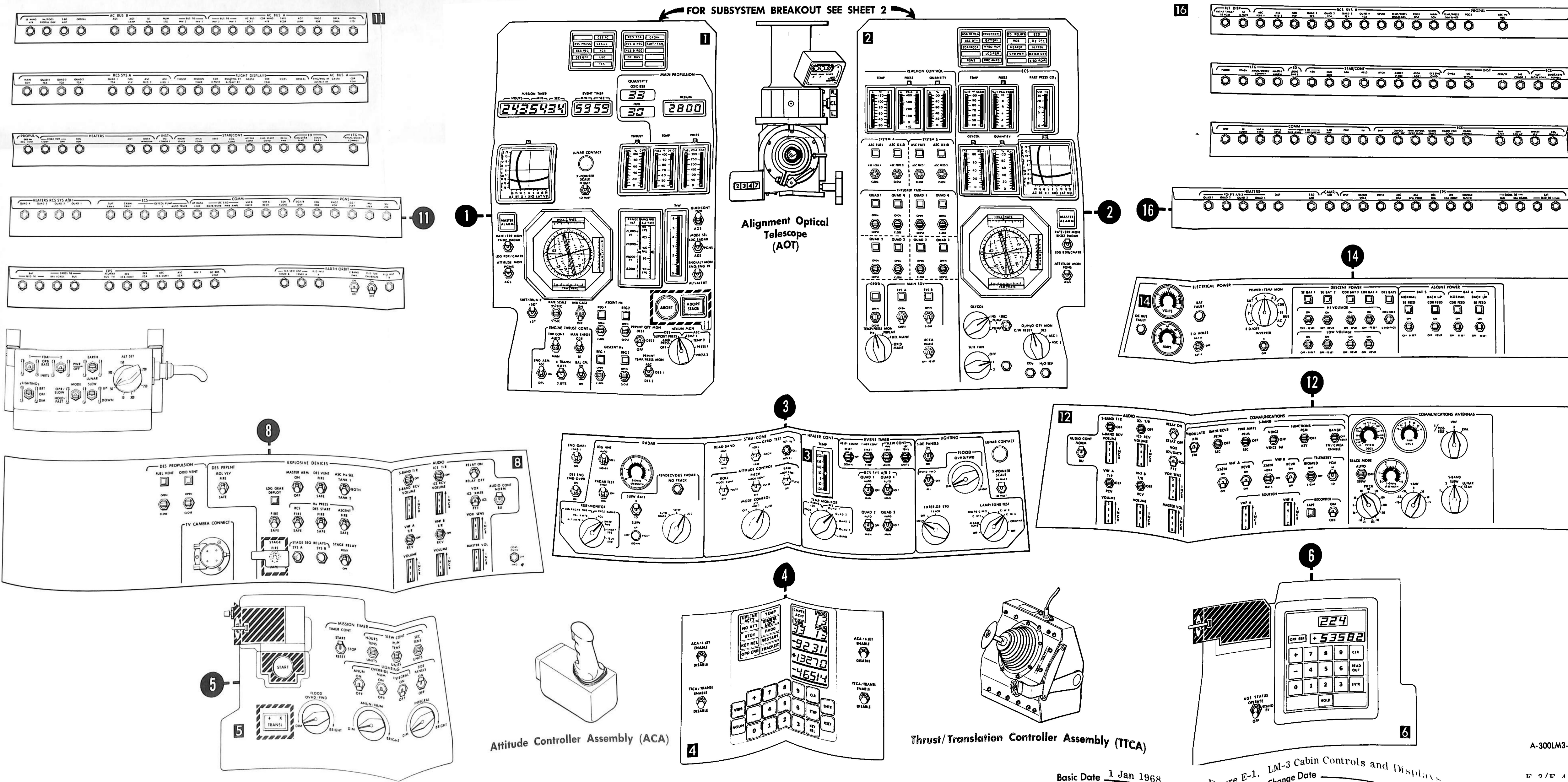
Table 4-11. (cont)

Term/Expression	Definition
ΔV (TPF)	Required impulsive ΔV to accomplish intercept (TPF) maneuver at calculated time of intercept.
ΔV (TPI)	Required impulsive ΔV to accomplish TPI maneuver at TIG (TPI)
ΔV_y	External ΔV component in horizontal direction perpendicular to CSM orbit plane (AGS)
ΔV_X (LM)	Component of integrated acceleration along the LM + X axis
ΔV_X (LV)	Component of ΔV applied at TIG along (RXV) XR
ΔV_Y (LM)	Component of integrated acceleration along the LM + Y axis
ΔV_Y (LV)	Component of ΔV applied at TIG along VXR
ΔV_Z (LM)	Component of integrated acceleration along the LM + Z axis
ΔV_Z (LV)	Component of ΔV applied at TIG along - R
$\Delta \theta$	Angular difference between the RR indicated LOS and the state vector LOS
ζ	Angle between the LM + Z axis and the local horizontal plane (AGS)
θ	Angle between the LM + Z axis and the local horizontal plane (Pitch)
θ LOS	Predicted LOS angle at TPI time (AGS)
ϕ	Yaw
ψ	Roll
Ω	Angle between the RR LOS and the LM + Z axis

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Appendix E

CONTROLS AND DISPLAYS



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Figure E-1. LM-3 Cabin Controls and Displays

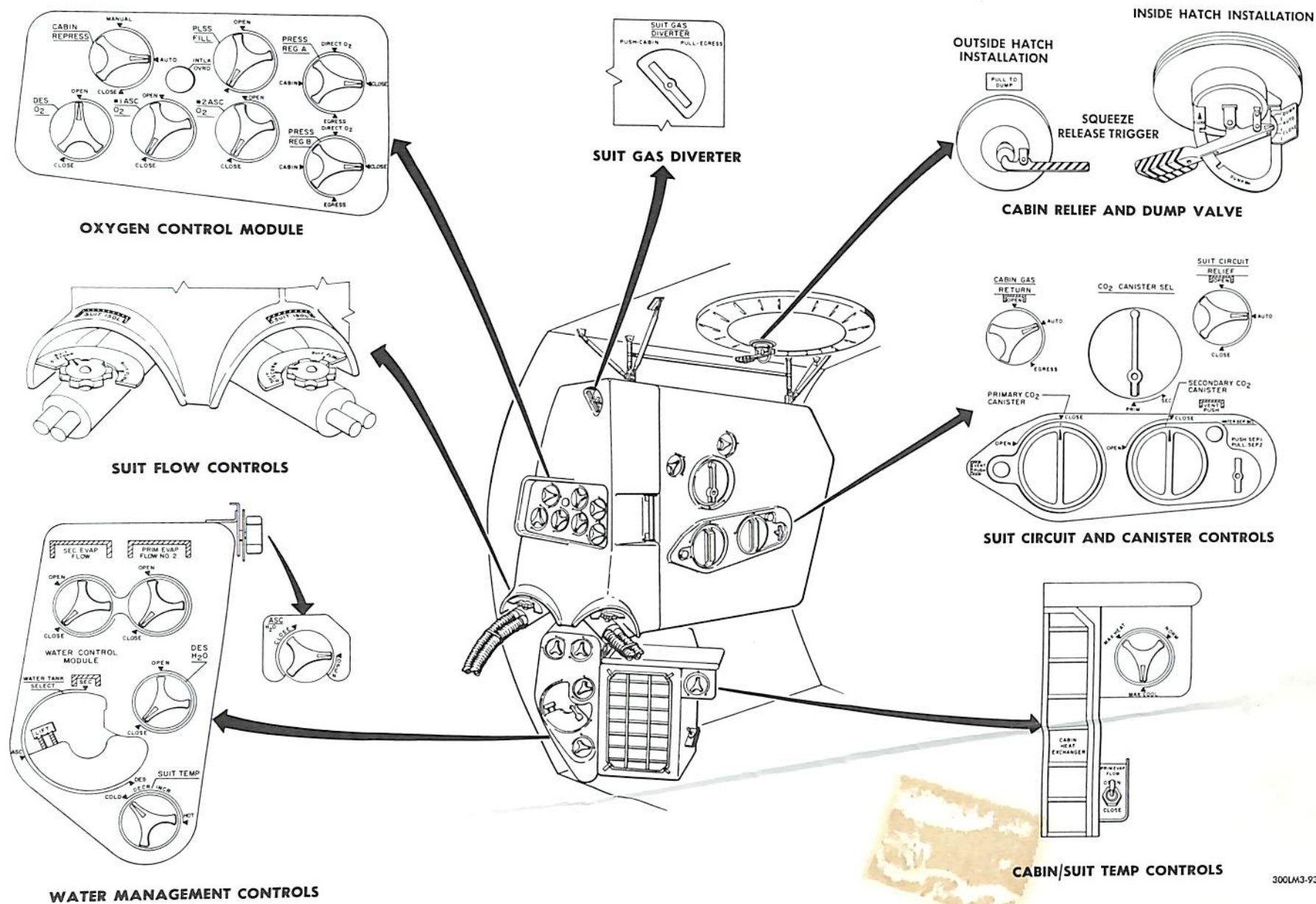


Figure E-2. ECS Aft Bulkhead Controls