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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

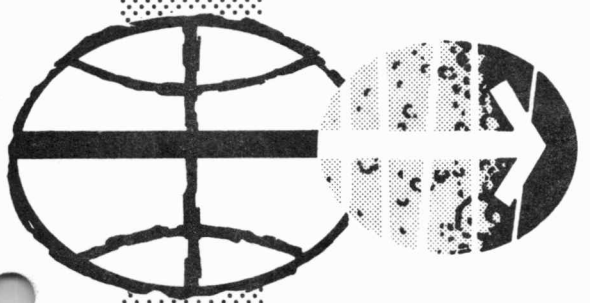
APOLLO 16
MISSION J-2

FINAL

CSM RENDEZVOUS PROCEDURES

PREPARED BY

CSM RENDEZVOUS PROCEDURES GROUP
MCDONNELL DOUGLAS ASTRONAUTICS COMPANY-EAST
HOUSTON OPERATIONS



MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

16 MARCH 1972

PROJECT APOLLO

CSM RENDEZVOUS PROCEDURES

MISSION J-2, APOLLO 16, CSM 113

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PREPARED FOR

CREW PROCEDURES DIVISION
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1.0 INTRODUCTION

The purpose of the CSM Rendezvous Procedures Document is to provide a single source of CSM Guidance and Navigation procedures information to be used in flight planning, crew training, and in preparing onboard data for the nominal and abort CSM/LM Apollo 16 rendezvous.

The procedures presented in this document are for the second J mission which will be flown with the CSM 113 spacecraft. Trajectory dependent information contained in this document is based on the prime launch date of 16 April 1972 and a LM lunar lift-off GET of 171:45:08.6.

Five appendices are contained in this document. They contain information which is of special interest for purposes of training, analysis or CSM interface discussion. Also included are the CSM onboard data as used during the nominal rendezvous and in case of LM abort.

This is a control document, subject to review by all elements of the Apollo Program and approval by the Crew Procedures Control Board. All comments, suggestions or questions concerning this document should be directed to Dennis C. Wammack, CSM Rendezvous Procedures Group, McDonnell Douglas Astronautics Company, phone 483-6101.

2.0 CMP NOMINAL RENDEZVOUS PROCEDURES

The G&N procedures employed by the Command Module Pilot during the Apollo 16 nominal rendezvous are presented in this section. These procedures are divided into groups of congruous operations called Steps.

The mission plan is discussed in subsection 2.1; the rendezvous Steps are listed and the purpose of each Step is discussed in subsection 2.2; and the detailed procedures for performing each Step are presented in subsection 2.3.

2.1 MISSION PLAN

The Command Module Pilot is scheduled to begin preparations for rendezvous approximately two hours prior to LM lift-off when he maneuvers the CSM to the COAS calibration attitude. The rendezvous is completed approximately two hours after lift-off when all docking activities are completed. The nominal GET for each major event during this period is listed below:

BEGIN RNDZ PREPARATION	169:53:XX
LM LIFT-OFF	171:45:08.6
LM INSERTION	171:52:22.9
LM TPI	172:39:22.9
LM TPF	173:22:16.5
DOCKING	173:50:00

The Apollo 16 nominal rendezvous will utilize the Direct Ascent rendezvous technique which was first employed by Apollo 14. This two-impulse technique requires 92 minutes from LM insertion to LM/CSM station-keeping. The LM is scheduled to apply the TPI burn 47 minutes after insertion and to apply the graduated braking burns approximately 130° of orbital travel after TPI. Two nominally zero DV midcourse corrections are scheduled at 15 minute intervals after TPI. These burns

adjust the relative trajectory between the two vehicles in case post-TPI trajectory dispersions exist. All post-insertion burns will be applied by the CSM if the LM is unable to apply them. The CSM will perform the rendezvous with a roll of 180 degrees.

Although Apollo 16 will utilize the same rendezvous technique as used for Apollo 15, several procedural changes have been made. The major changes affecting the CMP are listed below:

A. The CMP will attempt to take sextant marks prior to the darkness interval following LM insertion. However, the small sun angle and sun shafting may hamper the CMP in his effort to obtain these marks.

B. There will be no MSFN uplink after LM insertion if the CMC LM state vector is converging after five minutes of CSM navigation as determined by MCC-H.

C. A TPI recycle will not be performed.

D. A five-degree deadband will be used for tracking.

E. P79 will be terminated before the maneuver to the COAS track attitude. A V49 will be used to make the maneuver.

F. The S-band relay will be used for communication between the CSM and LM during the ascent phase. After LOS, VHF will be used for communication between the two vehicles.

Orbital motion and relative motion plots for the nominal Apollo 16 rendezvous are contained in Figures (1) and (2). The orbital motion plot presents the CSM and LM inertial positions at each burn during the rendezvous. The relative motion plot presents the CSM position at each burn and major CSM event in a curvilinear coordinate system referenced to the LM.

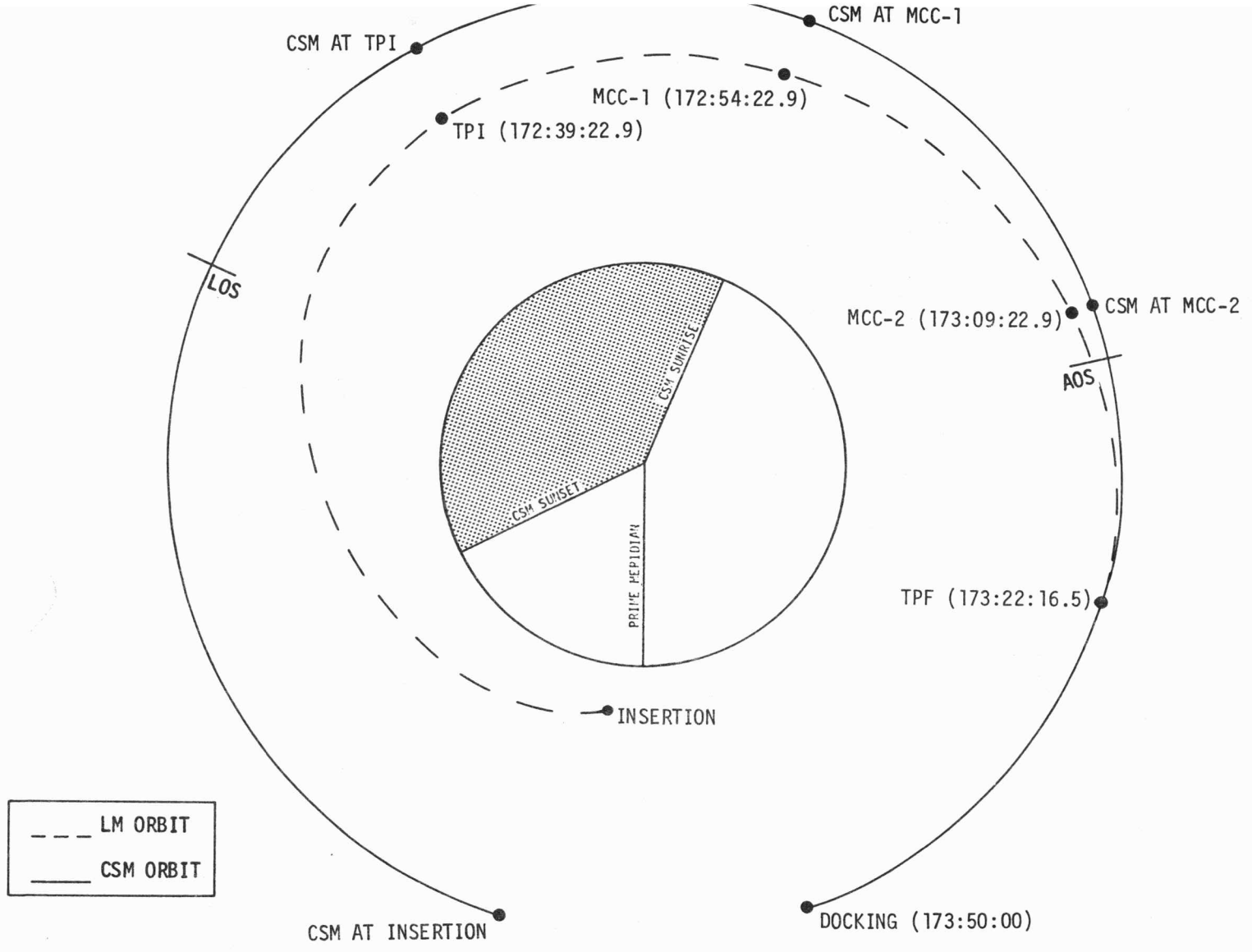

FIGURE 1. POST-INSERTION ORBITAL MOTION PLOT FOR THE DIRECT ASCENT RENDEZVOUS

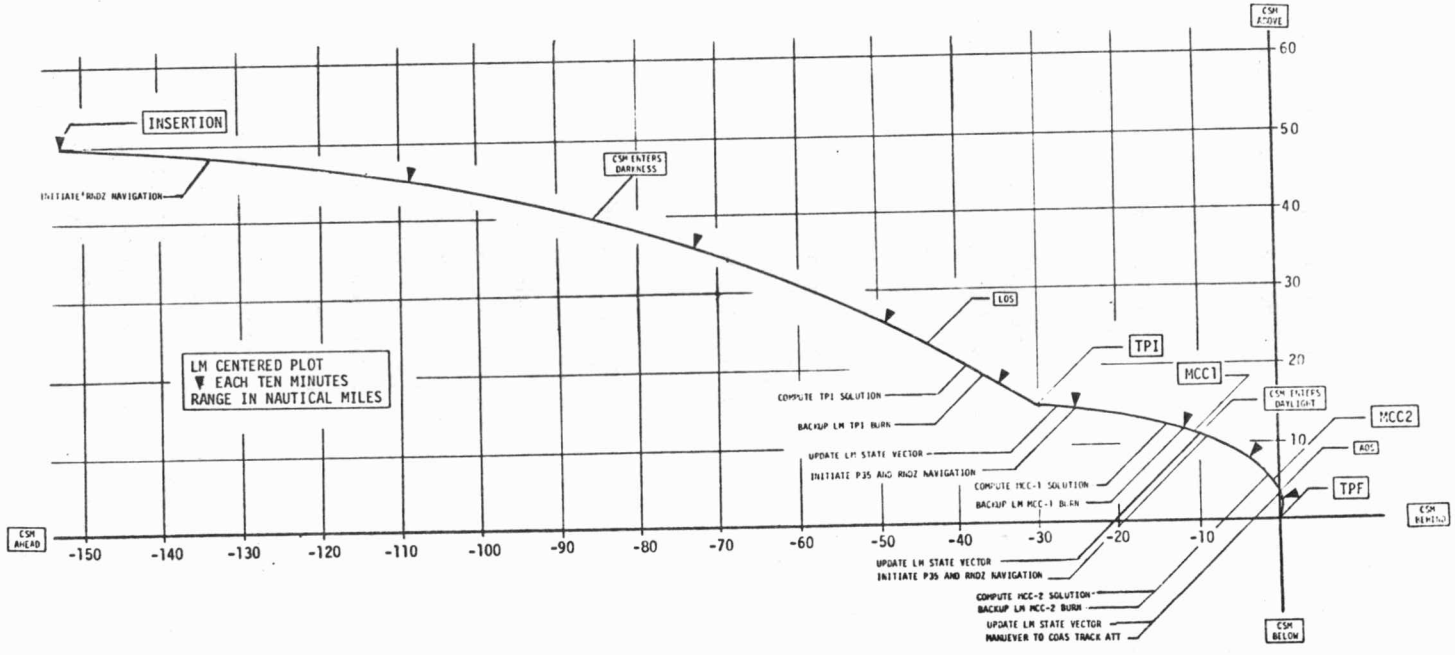

FIGURE 2. POST-INSERTION RELATIVE MOTION PLOT FOR THE DIRECT ASCENT RENDEZVOUS

2.2 NOMINAL PROCEDURES RATIONALE

This subsection presents the purpose and any constraints considered for each rendezvous Step. Only the CMP procedures for the nominal rendezvous are considered.

STEP 1 Reconfigure DAP. The DAP is reconfigured to provide a faster rate and a narrow deadband for DAP attitude maneuvers.

STEP 2 Maneuver to COAS Calibration Attitude. The maneuver to this attitude will center a star in the COAS to accomplish Step 6. This attitude will also allow HGA coverage and option 3 of P52.

STEP 3 Acquire MSFN with HGA. Ground communication is necessary in order to receive a data uplink and rendezvous information. The HGA is more efficient than the OMNI system, therefore its use is preferred.

STEP 4 Accept MSFN Uplink and Copy Update. A predicted CSM state vector at lift-off based on ground tracking is uplinked to improve the CMC knowledge of the CSM state vector. The predicted LM state vector at insertion +5 minutes is uplinked to furnish the CMC with a LM state vector valid after insertion. The Surface Flag Reset command is uplinked to allow CMC use of the LM state vector while the LM is still on the surface.

The pads for both the Direct Ascent and Coelliptic rendezvous are supplied by MCC-H so that the CMC pre-thrust program(s) may be initialized. The CSM weight is supplied so that the DAP's estimate of the weight may be updated to include expended RCS propellant.

The ground supplies the predicted CSM state vector at

lift-off and the LM state vector at insertion +5 minutes to the CMP in case the CMC's knowledge of the state vectors is degraded and there is no communication between the CSM and MCC-H.

The CSM consumables status is also relayed to the CMP. If required, the consumables pad will be updated.

STEP 5 Realign IMU. The IMU must be periodically fine-aligned in order to provide an accurate attitude reference for navigation computations and burn maneuvers.

STEP 6 Calibrate COAS. The COAS alignment must be calibrated in case COAS marking is required due to a sextant failure.

STEP 7 Align GDC. The GDC is aligned as a standard procedure after P52 completion to provide a backup attitude reference.

STEP 8 Verify DSE Tape Motion. Just prior to LOS the data storage equipment operation should be checked to assure the acquisition of systems data while the CSM is behind the moon.

STEP 9 Acquire MSFN with HGA. Ground communication is necessary to downlink the DSE record and to establish communication with the LM over the MSFN S-band relay.

STEP 10 Configure VHF and EMS for Ranging. The VHF and EMS should be configured for ranging during the rendezvous. They should be in this configuration prior to lift-off.

STEP 11 Configure Rendezvous Lights. The CSM exterior rendezvous lights should be activated so that the CDR may boresight the CSM in the AOT during darkness if the RR fails. The

CSM running lights should be activated prior to TPF so that the CDR may visually determine the CSM attitude during docking.

STEP 12 Load CSM and LM Weights. The DAP's knowledge of the CSM weight is updated to include expended RCS propellant. The DAP's knowledge of the LM weight is updated to the predicted LM weight at docking.

STEP 13 Maneuver to Post-Insertion Track Attitude. The CSM maneuvers to this attitude in order to be prepared for LM tracking after insertion. The attitude must allow HGA coverage since the possible post-insertion uplink cannot be performed using an OMNI.

STEP 14 Align GDC. The GDC is aligned to the IMU prior to lift-off to provide an accurate backup attitude reference during rendezvous.

STEP 15 Initiate P34. The TPI pre-thrust program is entered in order to accomplish the following:

A. Initiate P20
B. Initiate the automatic rendezvous program sequence (MINKEY)
C. Initialize the program for the final comp
D. Display the time until TPI
E. Display the number of sextant and VHF marks taken

P34 is entered at this time to allow the CMP to begin manual LM tracking immediately after insertion.

STEP 16 Initiate Rendezvous Navigation. Rendezvous navigation is started immediately after the LM tweak maneuver in order to

obtain sextant marks prior to darkness to insure an adequate TPI burn solution in the event of a tracker light failure.

If the initial navigation is inadequate, a MSFN uplink of the LM state vector is required. The adequacy of the CMC LM state vector is determined by MCC-H during the first five minutes of marking. A MSFN uplink of the LM state vector is also required if a sensor failure has been determined.

STEP 17 Initiate P20 Tracking. The CMP begins automatic P20 tracking after the UPLINK ACTIVITY light goes off (indicating that the line-of-sight to the LM is within 10 degrees of the preferred track axis).

STEP 18 Verify DSE Tape Motion. Just prior to LOS, the data storage equipment Operation should be checked to assure the acquisition of systems data while the CSM is behind the moon.

STEP 19 Compute TPI Solution and Terminate Navigation. The TPI burn components are computed and supplied to the CDR to be biased and compared with the LGC solution. The burn solution is also used by P40 for a possible CSM active TPI burn. The final comp terminates rendezvous navigation until after TPI.

STEP 20 Backup LM TPI Burn. In the event the LM cannot apply the TPI burn, it must be applied by the CSM in order to establish an intercept trajectory so that the rendezvous may be completed.

STEP 21 Update LM S.V. in the CMC. The CMC's knowledge of the LM state vector should be updated to include the LM TPI burn in order to minimize excessive updates during the next navigation period.

STEP 22 Initiate P35 and Rendezvous Navigation. The MCC pre-thrust program is entered at this time in order to:

A. Initiate LM tracking
B. Initiate VHF and sextant marking on the LM
C. Display the time since TPI
D. Display the number of sextant and VHF marks taken

STEP 23 Compute MCC-1 Solution and Terminate Navigation. The computed MCC solution is supplied to the CDR for a CMC and LGC solution comparison. The solution is also necessary in order for the CMP to backup the burn. MCC-1 is scheduled for TPI+15 minutes, so final comp initiation should be at TPI+12 minutes. The final comp terminates rendezvous navigation until after MCC-1.

STEP 24 Backup LM MCC-1 Burn. In the event the LM cannot apply the MCC-1 burn, it should be applied by the CSM to refine the intercept trajectory.

STEP 25 Update LM S.V. in the CMC. If the LM applies MCC-1, the CMC's knowledge of the LM state vector should be updated to include the burn in order to minimize excessive updates during the next navigation period.

STEP 26 Initiate P35 and Rendezvous Navigation. The MCC pre-thrust

program is entered at this time in order to:

A. Initiate LM tracking
B. Initiate VHF and sextant marking on the LM
C. Display the time since MCC-1
D. Display the number of sextant and VHF marks taken

STEP 27 Compute MCC-2 Solution and Terminate Navigation. The computed MCC solution is supplied to the CDR for a CMC and LGC solution comparison. The solution is also necessary in order for the CMP to backup the burn. MCC-2 is scheduled for MCC-1+15 minutes so final comp initiation should be at MCC-1+12 minutes. The final comp terminates rendezvous navigation.

STEP 28 Backup LM MCC-2 Burn. In the event the LM cannot apply the MCC-2 burn, it should be applied by the CSM to refine the intercept trajectory.

STEP 29 Update LM S.V. in the CMC. If the LM applies MCC-2, the CMC's knowledge of the LM state vector should be updated to include the burn to provide accurate CMC range and range rate information.

STEP 30 Maneuver to COAS Track Attitude. This maneuver is made by calling P00 to terminate P79 and then using V49 to maneuver to the COAS track attitude calculated by P79. This also results in returning to a narrow deadband which is necessary for proper line-of-sight monitoring during the braking phase.

STEP 31 Acquire MSFN with HGA. Ground communication is necessary to arm the pyros, for television transmission, and for the ground to monitor the docking.

STEP 32 Perform Docking Preparation Activities. These operations include configuring switches for docking and initiating LM photography.

STEP 33 Maneuver for CSM Inspection. A maneuver is scheduled so that the CDR may observe the condition of the CSM SIM Bay. The CMP then rolls the CSM 360° so that the area around the RCS jets may be inspected. CMP communication with MCC-H is temporarily suspended.

STEP 34 Mareuver to Docking Attitude. The CSM must maneuver to an attitude favorable for docking. HGA coverage is reacquired.

STEP 35 Arm Pyros. The pyros must be armed in order to retract the docking probe. The status of the SECS LOGIC and SECS PYRO ARM switches must be obtained from the ground since there is no onboard indication of their positions.

STEP 36 Perform Docking Activities. These operations are necessary in order to capture the LM latch and achieve hard docking. After docking is confirmed, the docking checklist is performed.

STEP 37 Reconfigure DAP. The DAP is reloaded to specify the docked CSM/LM configuration.

STEP 38 Configure Switches for Post-Docking. Spacecraft control is returned to the CMC after docking.

2.3 DETAILED PROCEDURES

The detailed procedures for the LM active nominal rendezvous are contained in this subsection. If the CSM is required to become active during the rendezvous, the supplementary detailed procedures presented in section 4.0 will be used.

These detailed procedures basically consider only the G&N requirements, although some non-G&N procedures are included for purposes of information and continuity.

Detailed procedures specify each change in the switch settings and the sequential changes in the DSKY displays.

The format of the detailed procedures is tabular. The GET column specifies the time associated with each Step and each time-critical event. Approximate times are indicated by an entry to the nearest minute (e.g., 169:53:XX), or by reference to the nearest minute to a time-critical event (e.g., TPI-10 MIN). Exact times are specified to the nearest second (e.g., 170:09:51). The LTNG column indicates the CSM in daylight (blank) or darkness (black), and the MSFN column indicates the CSM has MSFN coverage (dashed) or no MSFN coverage (blank).

The OPERATIONS column lists the Step and substep headings, which are underlined, and the set of operations necessary to complete each Step. The DSKY keystroke operations are left-justified and the switch-setting operations are indented. When a switch position is not specifically labeled on the panel, the position is specified as (CTR), (UP) or (DOWN). The panel on which each switch is located is shown in the STA/PANEL column.

The PROG, V-N DISPLAY and REGISTER DISPLAYS columns specify the status of the DSKY display. Entries into these columns are made for all changes of the Verbs, Nouns, or Programs and the associated values

in the three registers. Blanks in any individual digits are indicated by the letter "B". If a complete register is blank, it is omitted and only the remaining non-blank registers are shown. If the contents of any register display are known, the nominal design data are shown with the proper decimal place; if the contents are unknown, X's with the proper decimal place are shown.

The COMMENTS column contains supplemental information in order to clarify the procedures or indicate contingency options. All register display contents and information passed by the MSFN updates are defined. Additional MSFN or LM operations which involve the CMP and some internal computer routines (e.g., average-G) are noted. Information concerning marking schedules, AOS, LOS, and other events are provided for completeness.

The nominal detailed procedures begin 169 hours 53 minutes into the mission and continue through the post-docking switch configuration at 173 hours 54 minutes.

These procedures are presented in pages 15 through 45, with the first four and one-half pages containing assumed initial switch settings.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					ASSUMED SWITCH SETTINGS:				
					THC-LOCKED				
					RHC 1-LOCKED				
					RHC 2-LOCKED				
					EMS FUNCTION-OFF			1	
					MODE-STBY			1	
					CMC ATT-IMU			1	
					FDAI SCALE-5/1			1	
					SELECT-1/2			1	
					SOURCE-ATT SET			1	
					ATT SET-GDC			1	
					MANUAL ATTITUDE(3)-RATE CMD			1	
					LIMIT CYCLE-OFF			1	
					ATT DEADBAND-MAX			1	
					RATE-LOW			1	
					TRANS CONTR PWR-OFF			1	
					ROT CONTR PWR NORMAL 1-OFF			1	
					2-AC/DC			1	
					DIRECT(BOTH)-OFF			1	
					SC CONT-CMC			1	
					CMC MODE-AUTO			1	
					BMAG MODE(3)-RATE 2			1	
					SPS THRUST DIRECT-NORMAL			1	
					DV THRUST(2)-OFF			1	
					SCS TVC(2)-RATE CMD			1	
					SPS GIMBAL MOTORS(4)-OFF			1	
					DV CG-CSM			1	
					IMU CAGE-OFF			1	
					ENTRY EMS ROLL-OFF			1	
					ENTRY .05G-OFF			1	
					LV/SPS IND α-PC			1	
					LV/SPS IND SII/SIVB-GPI			1	
					TVC GMBL DRIVE(BOTH)-AUTO			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					DOCKING PROBE-OFF			2	
					DOCKING PROBE RETRACT(BOTH)-OFF(CTR)			2	
					EXTERIOR LIGHTS RUN/EVA-OFF			2	
					RNDZ-OFF(CTR)			2	
					CAUTION/WARNING NORMAL-NORMAL			2	
					CSM-CSM			2	
					POWER-POWER			2	
					UP TLM(2)-BLOCK			2	
					RCS TRNFR-SM			2	
					SM RCS SEC PRPLNT FUEL PRESS(4)-CLOSED			2	
					HIGH GAIN ANTENNA TRACK-REACQ			2	
					BEAM-NARROW			2	
					HIGH GAIN ANT POWER-POWER			2	
					SERVO ELEC-PRIM			2	
					VHF ANTENNA-RIGHT			3	
					SPS HE VLV(BOTH)-AUTO			3	
					SPS HE VLV TB(BOTH)-BP			3	
					S BAND NORMAL XPNDR-PRIM			3	
					PWR AMPL PRIM-PRIM			3	
					HIGH-HIGH			3	
					MODE VOICE-VOICE			3	
					PCM-PCM			3	
					RANGING-RANGING			3	
					S BAND AUX TAPE-DN VOICE BU			3	
					TV-OFF(CTR)			3	
					UP TLM DATA-DATA			3	
					CMD-RESET			3	
					S BAND ANTENNA OMNI-C			3	
					S BAND ANTENNA-OMNI D			3	
					VHF AM A-OFF			3	
					B-OFF			3	
					RCV ONLY-B DATA			3	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					VHF RANGING-OFF			3	
					S BAND SQUELCH-OFF			3	
					TAPE RECORDER-PCM/ANGL			3	
					-FWD			3	
					-RECORD			3	
					PCM BIT RATE-HIGH			3	
					G/N PWR-ACl			5	
					MAIN BUS TIE(2)-OFF			5	
					NONESS BUS-OFF			5	
					CB GUIDANCE/NAVIGATION(10)-CLOSED			5	
					TVC SERVO POWER(BOTH)-OFF			7	
					FDAI/GPI POWER-BOTH			7	
					LOGIC POWER 2/3-ON(UP)			7	
					SCS ELECTRONICS POWER-GDC/ECA			7	
					SIG CONDR/DRIVER BIAS PWR(BOTH)-ACl			7	
					BMAG POWER(BOTH)-ON			7	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					AUTO RCS SELECT(16)-MNA/MNB			8	
					EXCEPT: ROLL(4)-OFF			8	
					SEQ EVENTS CONT SYSTEM LOGIC(BOTH)-OFF			8	
					PYRO ARM(BOTH)-SAFE			8	
					ALL CB-CLOSED			8	
					EXCEPT:				
					DIRECT ULL(2)-OPEN			8	
					REACTION CONTROL SYSTEM RCS LOGIC(2)-OPEN			8	
					DOCK PROBE(2)-OPEN			8	
					SPS PITCH 1 AND YAW 1-OPEN			8	
					FLOAT BAG(3)-OPEN			8	
					SEQ EVENTS CONT SYS(4)-OPEN			8	
					ELS/CM-SM SEP(2)-OPEN			8	
					PL VENT FLT/PL-OPEN			8	
					VHF AM T/R-RCV			9	
					VHF RNG-NORM			9	
					FDAI 1-INRTL			13	
					FDAI 2-INRTL			13	
					EARTH/LUNAR-LUNAR			13	
					ALT SET-60 NM			13	
					MODE-OPR/SLOW			13	
					COAS POWER-ON(UP)			15	
					UTILITY POWER-ON(UP)			15	
					G/N POWER(2)-ON(UP)			100	
					RNDZ XPNDR-HTR			100	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					OPTICS ZERO-ZERO			122	
					TEL TRUN-SLAVE TO SXT			122	
					COUPLING-RSLV			122	
					MODE-CMC			122	
					SPEED-LO			122	
					CONDITION LAMPS-ON			122	
					UP TELEMETRY-ACCEPT			122	
					CB HI GAIN ANT(BOTH)-CLOSED			225	
					ALL CB-CLOSED			229	
					EXCEPT:				
					MAIN RELEASE(2)-OPEN			229	
169:53:XX			01	P00	RECONFIGURE DAP				
					CYCLE CMC MODE-FREE/AUTO			1	
					V48E				
						F 04 46	11111 X1111		R1-DAP CONFIGURATION R2-DAP CONFIGURATION
					V21E 11102E				
						F 04 46	11102 X1111		
					PRO				
						F 06 47	+XXXXX. +XXXXX.		R1-CSM WEIGHT (LBS) R2-LM WEIGHT (LBS)
					PRO				
						F 06 48	+XXX.XX +XXX.XX		R1-GIMBAL PITCH TRIM(DEG) R2-GIMBAL YAW TRIM(DEG)
					PRO				
						BB BB			

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
169:54:XX			02	P00	MANEUVER TO COAS CALIB ATTITUDE				
					V49E				
						F 06 22	+XXX.XX		R1-DESIRED ICDU ANG; ROLL(DEG)
							+XXX.XX		R2-DESIRED ICDU ANG; PITCH(DEG)
							+XXX.XX		R3-DESIRED ICDU ANG; YAW(DEG)
					V25E +18000E +25800E +35700E				
						F 06 22	+180.00		
							+258.00		
							+357.00		
					PRO				
						F 50 18	+180.00		R1-AUTO ATT MNVR; ROLL(DEG)
							+258.00		R2-AUTO ATT MNVR; PITCH(DEG)
							+357.00		R3-AUTO ATT MNVR; YAW(DEG)
					PRO				
						06 18	+180.00		
							+258.00		
							+357.00		
					MONITOR MANEUVER				
						F 50 18	+180.00		
							+258.00		
							+357.00		
					ENTER				
						BB BB			
169:59:XX			03	P00	ACQUIRE MSFN WITH HGA				
					V64E				
						F 06 51	-076.XX		R1-HGA ANG; RHO(DEG)
							+258.XX		R2-HGA ANG; GAMMA(DEG)
					HIGH GAIN ANTENNA TRACK-MAN			2	
					HGA PITCH POSITION-SET PITCH POSITION			2	RHO=-76
					HGA YAW POSITION-SET YAW POSITION			2	GAMMA=+258
					S BAND ANTENNA-HI GAIN			3	
					HIGH GAIN ANTENNA TRACK-AUTO			2	
					PRO				
						BB BB			

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
170:00:XX			04	P00	ACCEPT MSFN UPLINK AND COPY UPDATE				
					UP TLM CM-ACCEPT			2	
				P27	VERIFY UPLINK ACTIVITY LT-ON				UPLINK ACT LT-ON
					MONITOR UPLINK	XX XX	XXXXX		LM S.V.(INS+5)
							XXXXX		CSM S.V.(L/O)
							XXXXX		RESET SURFACE FLAG
					COPY UPDATE				CONSUMABLES(IF REQ'D)
									CSM S.V. (L/O)
									LM S.V. (INS+5)
									ASCENT PADS
									CSM WEIGHT
				P00	VERIFY UPLINK ACTIVITY LT-OFF	BB BB			UPLINK ACT LT-OFF
					UP TLM CM-BLOCK			2	
170:09:51									CSM ENTERS MOON SHADOW
170:10:XX			05	P00	REALIGN IMU				
					V37E 52E				
				P52		F 04 06	00001		R1-IMU ORIENTATION OPTION
							00003		R2-REFSMMAT
					PRO				
						F 50 25	00015		R1-CELESTIAL BODY ACQUISITION
					PRO				
						F 01 70	00037		R1-CELESTIAL BODY CODE (BEFORE MARK)
					OPTICS ZERO-OFF			122	
					CHECK FIRST STAR CODE				
					PRO				
						06 92	+345.XX		R1-NEW OCDU ANG; SHAFT (DEG)
							+26.XXX		R2-NEW OCDU ANG; TRUNNION (DEG)

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					OPTICS MODE-MAN			122	
						F 51 BB			PLEASE MARK
					OHC-CENTER STAR IN SXT			122	
					MARK BUTTON-DEPRESS			122	
						F 50 25	00016		R1-TERMINATE MARK SEQUENCE
					PRO				
						F 01 71	00037		R1-CELESTIAL BODY CODE (AFTER MARK)
					PRO				
						F 01 70	00045		R1-CELESTIAL BODY CODE (BEFORE MARK)
					CHECK SECOND STAR CODE				
					OPTICS MODE-CMC			122	
					PRO				
						06 92	+159.XX		R1-NEW OCDU ANG; SHAFT(DEG)
							+27.XXX		R2-NEW OCDU ANG; TRUNNION(DEG)
					OPTICS MODE-MAN			122	
						F 51 BB			PLEASE MARK
					OHC-CENTER STAR IN SXT			122	
					MARK BUTTON-DEPRESS			122	
						F 50 25	00016		R1-TERMINATE MARK SEQUENCE
					PRO				
						F 01 71	00045		R1-CELESTIAL BODY CODE(AFTER MARK)
					PRO				
						F 06 05	+000.XX		R1-ANG ERROR DIFFERENCE(DEG)
					RECORD DATA				
					PRO				
						F 06 93	+00.XXX		R1-DELTA GYRO ANG; X(DEG)
							±00.XXX		R2-DELTA GYRO ANG; Y(DEG)
							±00.XXX		R3-DELTA GYRO ANG; Z(DEG)
					RECORD DATA				
					CMC MODE-FREE			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO				
						F 50 25	00014		R1-FINE ALIGNMENT
					PRO				
						F 50 25	00015		R1-CELESTIAL BODY ACQUISITION
					ENTER				
						F 01 70	00045		R1-CELESTIAL BODY CODE (BEFORE MARK)
					V21E 41E				
						F 01 70	00041		
					OPTICS MODE-CMC			122	
					PRO				
						06 92	+286.XX +19.XXX		R1-NEW OCDU ANG; SHAFT(DEG) R2-NEW OCDU ANG; TRUNNION(DEG)
					VERIFY STAR CENTERED IN SXT				
					OPTICS MODE-MAN			122	
						F 51 BB			
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
170:15:XX			06	P52	CALIBRATE COAS				
					V37E 52E				
						F 04 06	00001		R1-IMU ORIENTATION OPTION
							00003		R2-REFSMMAT
					PRO				
						F 50 25	00015		R1-CELESTIAL BODY ACQUISITION
					ENTER				
						F 01 70	00041		R1-CELESTIAL BODY CODE (BEFORE MARK)
					V21E 33E				
						F 01 70	00033		
					PRO				
						06 92	+000.XX		R1-NEW OCDU ANG; SHAFT(DEG)
							+57.XXX		R2-NEW OCDU ANG; TRUNNION(DEG)
					RHC 2-ARMED				
					RHC 2-CENTER STAR IN COAS				
					KEY "VERB"				FREEZE DSKY DISPLAY
						BB 92	+000.XX		KEY RELEASE LIGHT-ON
							+57.XXX		
					RECORD SHAFT AND TRUNNION				
					RHC 2-LOCKED				
					CMC MODE-AUTO			1	
					37E 00E				
				P00		BB BB			KEY RELEASE LIGHT-OFF
170:21:XX			07	P00	ALIGN GDC				
					ATT SET TW-SET TO IMU ANGLES ON FDAI 1			1	
					FDAI SELECT-1			1	
					FDAI SOURCE-ATT SET(VERIFY)			1	
					ATT SET-IMU			1	
					ATT SET TW-NULL FDAI 1 ERROR NEEDLES			1	
					ATT SET-GDC			1	
					GDC ALIGN PB-PUSH UNTIL NEEDLES NULLED			1	
					FDAI SELECT-1/2			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
170:26:XX			08	P00	VERIFY DSE TAPE MOTION				MSFN ENABLES S-BAND RELAY
170:26:45									LOSS OF SIGNAL
170:56:16									CSM LEAVES MOON SHADOW
171:12:35			09	P00	ACQUIRE MSFN WITH HGA				ACQUISITION OF SIGNAL
171:16:XX			10	P00	CONFIGURE VHF AND EMS FOR RANGING				
					VHF AM T/R-OFF			9	
					VHF AM B-DUPLEX			3	
					A-OFF(VERIFY)			3	
					VHF RANGING-ON(UP)			3	
					EMS FUNCTION-DV SET/VHF RNG			1	
					EMS MODE-BACKUP/VHF RNG			1	
					RNDZ XPNDR-PWR			100	
171:20:XX			11	P00	CONFIGURE RNDZ LIGHTS				
					EXTERIOR LIGHTS(2)-ON(UP)			2	
171:21:XX			12	P00	LOAD CSM AND LM WT				
					V48E				
						F 04 46	11102		R1-DAP CONFIGURATION
							X1111		R2-DAP CONFIGURATION
					PRO				
						F 06 47	+XXXXX.		R1-CSM WEIGHT(LBS)
							+XXXXX.		R2-LM WEIGHT(LBS)

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					V24E +XXXXXE +5900E				
						F 06 47	+XXXXX. +05900.		
					PRO				
						F 06 48	+XXX.XX +XXX.XX		R1-GIMBAL PITCH TRIM(DEG) R2-GIMBAL YAW TRIM(DEG)
					PRO				
						BB BB			
171:23:XX			13	P00	MANEUVER TO-POST INSERTION TRACK ATTITUDE				
					V49E				
						F 06 22	+180.00 +258.00 +357.00		R1-DESIRED ICDU ANG; ROLL(DEG) R2-DESIRED ICDU ANG; PITCH(DEG) R3-DESIRED ICDU ANG: YAW(DEG)
					V25E +18000E +E +E				
						F 06 22	+180.00 +000.00 +000.00		
					PRO				
						F 50 18	+180.00 +000.00 +000.00		R1-AUTO ATT MNVR; ROLL(DEG) R2-AUTO ATT MNVR; PITCH(DEG) R3-AUTO ATT MNVR; YAW(DEG)
					PRO				
						06 18	+180.00 +000.00 +000.00		
					MONITOR MANEUVER				
						F 50 18	+180.00 +000.00 +000.00		
					ENTER				
						BB BB			
					HIGH GAIN ANTENNA TRACK-MAN			2	
					HGA PITCH POSITION-SET PITCH POSITION			2	RHO=+07
					HGA YAW POSITION-SET YAW POSITION			2	GAMMA=+346
					HIGH GAIN ANTENNA TRACK-AUTO			2	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
171:30:XX			14	P00	ALIGN GDC				
					ATT SET TW-SET TO IMU ANGLES ON FDAI 1			1	
					FDAI SELECT-1			1	
					FDAI SOURCE-ATT SET(VERIFY)			1	
					ATT SET-IMU			1	
					ATT SET TW-NULL FDAI 1 ERROR NEEDLES			1	
					ATT SET-GDC			1	
					GDC ALIGN PB-PUSH UNTIL NEEDLES NULLED			1	
					FDAI SELECT-1/2			1	
171:45:09									**LM LIFT-OFF**
171:45:XX			15	P00	INITIATE P34				
					V37E 34E				
				P20					
				P34		F 50 25	00017		R1-MINKEY SELECTION OPTION
					PRO				
						F 50 18	+180.00		R1-AUTO ATT MNVR; ROLL(DEG)
							+070.XX		R2-AUTO ATT MNVR; PITCH(DEG)
							+000.00		R3-AUTO ATT MNVR; YAW(DEG)
					ENTER				UPLINK ACT LT-ON
						F 06 37	+00XXX.		R1-GETI TPI(HRS)
							+000XX.		R2- (MIN)
							+0XX.XX		R3- (SEC)
					V88E				
					VHF RNG-RESET			9	
					CMC MODE-HOLD			1	
					V22 N79E +500E				LOAD 5 DEG DEADBAND

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					V25E +172E +39E +2290E	F 06 37	+00172. +00039. +022.90		
					PRO	F 06 55	+00000 +000.00 +130.00		R1-PRECISION OFFSETS R2-ELEVATION ANG(DEG) R3-TPI/TPF TRANSFER ANG(DEG)
					PRO	F 16 45	+XXB00 -50BXX -00001		R1-MARKS(VHF/OPTICS) R2-TFI(MIN/SEC) R3-NO FINAL COMP CODE
					SET MDC DET COUNTING UP TO TPI			1	
					SET LEB DET COUNTING UP TO TPI			306	
171:52:23									**LM INSERTION**
					START MANUAL LM TRACKING OPTICS ZERO-OFF OPTICS MODE-MAN OHC-ACQUIRE AND TRACK LM IN SXT			 122 122 122	
171:55:23					VERIFY LM TWEAK COMPLETE				**LM TWEAK**

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI-43MIN			16	P34	INITIATE RNDZ NAVIGATION				
					V87E				
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
					VHF VOICE CHECK				
					VHF AM T/R-T/R			9	
					VERIFY VHF VOICE				
					VHF AM T/R-OFF			9	
TPI-38MIN					VERIFY NO MSFN UPLINK				IF MSFN UPLINK, SEE SECTION 4.3
					VERIFY LM TRACKER LT-ON				VOICE CHECK
					CONTINUE SEXTANT MARKING				
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
172:08:38									CSM ENTERS MOON SHADOW
TPI-29MIN			17	P34	INITIATE P20 TRACKING				
					VERIFY UPLINK ACT LT-OFF				UPLINK ACT LT-OFF
					CMC MODE-AUTO			1	
172:23:XX			18	P34	VERIFY DSE TAPE MOTION				
					VHF AM T/R-T/R			9	GO VHF COMM
172:25:13									LOSS OF SIGNAL

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI-10MIN			19	P34	COMPUTE TPI SOLUTION AND TERMINATE NAV				
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	
					PRO				
						F 06 55	+00000		R1-PRECISION OFFSETS
							+208.30		R2-ELEVATION ANG(DEG)
							+130.00		R3-TPI/TPF TRANSFER ANG(DEG)
					RECORD DATA				
					PRO				
						F 06 58	+0008.3		R1-PERILUNE ALT(POST-TPI)(NM)
							+0072.0		R2-DELTA V (TPI)(FPS)
							+0032.7		R3-DELTA V (TPF)(FPS)
					RECORD DATA				
					PRO				
						F 06 81	-0071.7		R1-DELTA VX (LV)(FPS)
							-0000.2		R2-DELTA VY (LV)(FPS)
							-0006.8		R3-DELTA VZ (LV)(FPS)
					RECORD DATA				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 16 45	+33B33 -08BXX +XXX.XX		R1-MARKS (VHF/OPTICS) R2-TFI (MIN/SEC) R3-MGA(DEG)
TPI-08MIN			20	P34	BACKUP LM TPI BURN				
					CYCLE CMC MODE-FREE/AUTO			1	
					PRO	F 50 18	+180.XX +284.XX +002.XX		R1-AUTO ATT MNVR; ROLL(DEG) R2-AUTO ATT MNVR; PITCH(DEG) R3-AUTO ATT MNVR; YAW(DEG)
				P40	PRO	06 18	+180.XX +284.XX +002.XX		ATTITUDE INCLUDES SPS GIMBAL OFFSET AND TRIM
					MONITOR MANEUVER	F 50 18	+180.XX +284.XX +002.XX		
					ALIGN GDC				
					ATT SET TW-SET TO IMU ANGLES ON FDAI 1			1	
					FDAI SELECT-1			1	
					FDAI SOURCE-ATT SET (VERIFY)			1	
					ATT SET-IMU			1	
					ATT SET TW-NULL FDAI 1 ERROR NEEDLES			1	
					ATT SET-GDC			1	
					GDC ALIGN PB-PUSH UNTIL NEEDLES NULLED			1	
					FDAI SELECT-1/2			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					RECORD P76 DATA				OBTAIN TPI P76 FROM CDR
					CONFIGURE EMS				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					EMS FUNCTION-DV SET/VHF RNG			1	
					LOAD 61.0 INTO EMS			1	TPI DV MINUS TAIL-OFF
					EMS FUNCTION-DV			1	
					CONFIGURE SCS				
					CB STAB CONT SYS(ALL)-CLOSE			8	
					CB SPS (12)-CLOSE			8	
					MANUAL ATTITUDE(3)-RATE CMD(VERIFY)			1	
					RATE-LOW(VERIFY)			1	
					DV CG-CSM(VERIFY)			1	
					SPS HE VLVS(BOTH)-AUTO(VERIFY)			3	
					CHECK N2 A AND N2 B			3	
					PRO				
						06 18	+180.XX		R1-AUTO ATT MNVR; ROLL(DEG)
							+284.XX		R2-AUTO ATT MNVR; PITCH(DEG)
							+002.XX		R3-AUTO ATT MNVR; YAW(DEG)
					MONITOR TRIM MANEUVER				
						F 50 18	+180.XX		
							+284.XX		
							+002.XX		
					ENTER				
						F 50 25	00204		R1-SPS GIMBAL TEST OPTION
					ENTER				
						06 40	-XXBXX		R1-TFI(MIN/SEC)
							+0072.0		R2-VG (FPS)
							+0000.0		R3-DELTA V ACCUMULATED(FPS)
					FDAI SCALE-5/1 (VERIFY)			1	
					VERIFY MDC DET SET			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI-35SEC					MONITOR DSKY BLANK	BB BB			
TPI-30SEC						06 40	-00B29 +0072.0 +0000.0		AVE G ON
					CHECK PIPA BIAS LESS THAN 2 FPS FOR 5 SEC				
TPI-05SEC						F 99 40	-00B05 +0072.0 +0000.0		ENGINE ON ENABLE REQUEST
172:39:23									**LM TPI**
					CONFIRM LM BURN COMPLETE				IF THE LM DID NOT APPLY THE TPI BURN, SEE SECTION 4.2.1
					ENTER	F 16 85	+XXXX.X ±XXXX.X ±XXXX.X		R1-BODY VGX(FPS) R2-BODY VGY(FPS) R3-BODY VGZ(FPS)
					EMS FUNCTION-OFF CB SPS PITCH 1 AND YAW 1-OPEN			1 8	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+01MIN			21	P40	UPDATE LM S.V. IN THE CMC				
					PRO				
				P76		F 06 33	+00172.		R1-GETI TPI(HRS)
							+00039.		R2- (MIN)
							+022.90		R3 (SEC)
					PRO				
						F 06 84	+0072.2		R1-LM DELTA VX(LV)(FPS)
							-0000.0		R2-LM DELTA VY(LV)(FPS)
							+0010.2		R3-LM DELTA VZ(LV)(FPS)
TPI+03MIN			22	P76	INITIATE P35 AND RNDZ NAVIGATION				
					CONFIGURE EMS FOR RANGING				
					EMS FUNCTION-DV SET/VHF RNG			1	
					EMS MODE-BACKUP/VHF RNG			1	
					VHF RNG-RESET			9	
					PRO				
				P35		F 16 45	+33B33		R1-MARKS(VHF/OPTICS)
							+03BXX		R2-TFI(MIN/SEC)
							-00001		R3-NO FINAL COMP CODE
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+12MIN			23	P35	COMPUTE MCC1 SOLUTION AND TERMINATE NAV				
					OPTICS MODE-CMC			122	
					PRO				
						F 06 81	±XXXX.X		R1-DELTA VX(LV)(FPS)
							±XXXX.X		R2-DELTA VY(LV)(FPS)
							±XXXX.X		R3-DELTA VZ(LV)(FPS)
					RECORD DATA				
					PRO				
						F 16 45	+09B09		R1-MARKS(VHF/OPTICS)
							-02BXX		R2-TFI(MIN/SEC)
							+XXX.XX		R3-MGA(DEG)
TPI+13MIN			24	P35	BACKUP LM MCC1 BURN				
					CYCLE CMC MODE-FREE/AUTO			1	
					PRO				
				P41		F 50 18	+XXX.XX		R1-AUTO ATT MNVR; ROLL(DEG)
							+XXX.XX		R2-AUTO ATT MNVR; PITCH(DEG)
							+XXX.XX		R3-AUTO ATT MNVR; YAW(DEG)
					ENTER				
						06 85	±XXXX.X		R1-BODY VGX(FPS)
							±XXXX.X		R2-BODY VGY(FPS)
							±XXXX.X		R3-BODY VGZ(FPS)
MCC-35SEC					MONITOR DSKY BLANK	BB BB			
MCC-30SEC									AVE G ON
						16 85	±XXXX.X		
							±XXXX.X		
							±XXXX.X		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
172:54:23						F 16 85	+XXXX.X +XXXX.X +XXXX.X		**LM MCC1**
					VERIFY LM BURN COMPLETE				IF THE LM CANNOT APPLY THE MCC1 BURN,SEE SECTION 4.2.2
TPI+16MIN			25	P41	UPDATE LM S.V. IN THE CMC				
					PRO				
				P76		F 06 33	+00172. +00054. +023.XX		R1-GETI MCC1(HRS) R2- (MIN) R3- (SEC)
					PRO				
						F 06 84	+XXXX.X +XXXX.X +XXXX.X		R1-LM DELTA VX(LV)(FPS) R2-LM DELTA VY(LV)(FPS) R3-LM DELTA VZ(LV)(FPS)
172:55:03									CSM LEAVES MOON SHADOW
TPI+18MIN			26	P76	INITIATE P35 AND RNDZ NAVIGATION				IF CSM ACTIVE AND TPF DELTA V > 55 FPS, SEE SECTION 4.2.3.
					PRO				
				P35		F 16 45	+09B09 +03BXX -00001		R1-MARKS(VHF/OPTICS) R2-TFI(MIN/SEC) R3-NO FINAL COMP CODE
					START SEXTANT MARKING				
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+27MIN			27	P35	COMPUTE MCC2 SOLUTION AND TERMINATE NAV				
					PRO	F 06 81	+XXXX.X ±XXXX.X ±XXXX.X		R1-DELTA VX(LV)(FPS) R2-DELTA VY(LV)(FPS) R3-DELTA VZ(LV)(FPS)
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	
					RECORD DATA				
					PRO	F 16 45	+09B09 -02BXX +XXX.XX		R1-MARKS (VHF/OPTICS) R2-TFI(MIN/SEC) R3-MGA(DEG)
TPI+28MIN			28	P35	BACKUP LM MCC2 BURN				
					CYCLE CMC MODE-FREE/AUTO			1	
					PRO				
				P41		F 50 18	+XXX.XX +XXX.XX +XXX.XX		R1-AUTO ATT MNVR; ROLL(DEG) R2-AUTO ATT MNVR; PITCH(DEG) R3-AUTO ATT MNVR; YAW(DEG)
					ENTER	06 85	+XXXX.X ±XXXX.X ±XXXX.X		R1-BODY VGX(FPS) R2-BODY VGY(FPS) R3-BODY VGZ(FPS)
MCC-35SEC					MONITOR DSKY BLANK	BB BB			
MCC-30SEC						16 85	+XXXX.X ±XXXX.X ±XXXX.X		AVE G ON

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
173:09:23						F 16 85	+XXXX.X +XXXX.X +XXXX.X		**LM MCC2**
					VERIFY LM BURN COMPLETE				IF THE LM CANNOT APPLY THE MCC2 BURN,SEE SECTION 4.2.2
TPI+31MIN			29	P41	UPDATE LM S.V. IN THE CMC				
					PRO				
				P76		F 06 33	+00173. +00009. +023.XX		R1-GETI MCC2(HRS) R2- (MIN) R3- (SEC)
					PRO				
						F 06 84	+XXXX.X +XXXX.X +XXXX.X		R1-LM DELTA VX(LV)(FPS) R2-LM DELTA VY(LV)(FPS) R3-LM DELTA VZ(LV)(FPS)
TPI+32MIN			30	P76	MANEUVER TO COAS TRACK ATTITUDE				
					PRO				
				P79		F 50 18	+180.XX +281.XX +000.XX		R1-AUTO ATT MNVR; ROLL(DEG) R2-AUTO ATT MNVR; PITCH(DEG) R3-AUTO ATT MNVR; YAW(DEG)
					V37E 00E				
				P00		BB BB			
					V49E				
						F 06 22	+180.XX +281.XX +000.XX		R1-DESIRED ICDU ANG; ROLL(DEG) R2-DESIRED ICDU ANG; PITCH(DEG) R3-DESIRED ICDU ANG; YAW(DEG)
					PRO				
						F 50 18	+180.XX +281.XX +000.XX		R1-AUTO ATT MNVR; ROLL(DEG) R2-AUTO ATT MNVR; PITCH(DEG) R3-AUTO ATT MNVR; YAW(DEG)

GET H:M:S	LTNG	MSFN	STEP	PROG.	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO				
						06 18	+180.XX		
							+281.XX		
							+000.XX		
					MONITOR MANEUVER				
						F 50 18	+180.XX		
							+281.XX		
							+000.XX		
					ENTER				
						BB BB			
					V83E				
						F 16 54	+XXX.XX		R1-RANGE(NM)
							-XXXX.X		R2-RANGE RATE(FPS)
							+XXX.XX		R3-THETA(DEG)
173:11:00									ACQUISITION OF SIGNAL
173:12:XX			31	P00	ACQUIRE MSFN WITH HGA				
					HIGH GAIN ANTENNA TRACK-MAN			2	
					HGA PITCH POSITION-SET PITCH POSITION			2	RHO=-64
					HGA YAW POSITION-SET YAW POSITION			2	GAMMA=+324
					S BAND ANTENNA-HI GAIN			3	
					HIGH GAIN ANTENNA TRACK-REACQ			2	
173:14:XX			32	P00	PERFORM DOCKING PREPARATION ACTIVITIES				
					PERFORM PRE-DOCK CHECKLIST				
					MANUAL ATTITUDE (3)-RATE CMD (VERIFY)			1	
					LIMIT CYCLE-OFF (VERIFY)			1	
					ATT DEADBAND-MIN			1	
					RATE-LOW(VERIFY)			1	
					TRANS CONTR PWR-ON			1	
					ROT CONTR PWR DIRECT (BOTH)-MNA/MNB			1	
					SC CONT-CMC (VERIFY)			1	
					AUTO RCS SELECT (16)-MNA/MNB			8	
					CB DOCK PROBE(2)-CLOSE			8	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					DOCKING PROBE RETRACT(BOTH)-OFF(CTR) (VERIFY)			2	
					DOCKING PROBE-RETRACT			2	
					DOCKING PROBE EXTD/REL TB(2)-GRAY (VERIFY)			2	
					CB SEQ EVENTS CONT SYS(4)-CLOSE			8	
					COAS POWER-ON(UP)(VERIFY)			15	
					EXTERIOR LIGHTS RUN/EVA-ON(UP)(VERIFY)			2	
									IF CSM ACTIVE BRAKING, SEE SECTION 4.2.4
173:20:XX					PHOTOGRAPH LM				
					UTILITY POWER-ON(UP)(VERIFY)			15	
					TV-ON				
					DAC-ON				
					BEGIN PHOTOS WITH DAC AND TV				
173:22:17									**TPF**
					CONFIGURE SWITCHES FOR POST-TPF				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					EXTERIOR LIGHTS RNDZ-OFF(CTR)			2	
173:26:XX					TERMINATE LM PHOTOS				
				PRO		BB BB			
					DAC-OFF				
					TV-OFF				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
173:28:XX			33	P00	MANEUVER FOR CSM INSPECTION				
					V49E	F 06 22	+180.XX +281.XX +000.XX		R1-DESIRED ICDU ANG; ROLL(DEG) R2-DESIRED ICDU ANG; PITCH(DEG) R3-DESIRED ICDU ANG; YAW(DEG)
					V25E +33200E +25200E +E	F 06 22	+332.00 +252.00 +000.00		
					PRO	F 50 18	+332.00 +252.00 +000.00		R1-AUTO ATT MNVR; ROLL(DEG) R2-AUTO ATT MNVR; PITCH(DEG) R3-AUTO ATT MNVR; YAW(DEG)
					PRO	06 18	+332.00 +252.00 +000.00		
					MONITOR MANEUVER	F 50 18	+332.00 +252.00 +000.00		
					ENTER	BB BB			
					MANUAL ATTITUDE ROLL-ACCEL CMD RHC-PERFORM 360 DEG ROLL AT 2 DEG/SEC MANUAL ATTITUDE ROLL-RATE CMD			1 1	
173:40:XX			34	P00	MANEUVER TO DOCKING ATTITUDE V49E	F 06 22	+332.00 +252.00 +000.00		R1-DESIRED ICDU ANG; ROLL(DEG) R2-DESIRED ICDU ANG; PITCH(DEG) R3-DESIRED ICDU ANG; YAW(DEG)
					V25E +18000E +28100E +E	F 06 22	+180.00 +281.00 +000.00		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 50 18	+180.00 +281.00 +000.00		R1-AUTO ATT MNVR; ROLL(DEG) R2-AUTO ATT MNVR; PITCH(DEG) R3-AUTO ATT MNVR; YAW(DEG)
					PRO	06 18	+180.00 +281.00 +000.00		
					MONITOR MANEUVER	F 50 18	+180.00 +281.00 +000.00		
					ENTER	BB BB			
					REACQUIRE MSFN HGA				
173:42:XX			35	P00	ARM PYROS				
					CUE MSFN FOR LOGIC ARM SEQ EVENTS CONT SYSTEM LOGIC(BOTH)- ON(UP)			8	
					SEQ EVENTS CONT SYSTEM PYRO ARM(BOTH)- ON(UP)			8	MSFN GO FOR PYRO ARM
173:45:XX			36	P00	PERFORM DOCKING ACTIVITIES V37E 47E				
				P47		F 16 83	+0000.0 +0000.0 +0000.0		R1-DELTA VX(FPS) R2-DELTA VY(FPS) R3-DELTA VZ(FPS)

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					INITIATE LM PHOTOGRAPHY				
					DAC-ON				
					TV-ON				
					PHOTOGRAPH LM MNVR				
					TRANSLATE TO CAPTURE LATCH				
					THC-ARMED				
					THC-MINIMUM THRUST FORWARD				
						F 16 83	+XXXX.X +XXXX.X ±XXXX.X		
					THC-LOCKED				
173:50:00					PERFORM AT CAPTURE				**DOCKING**
					DOCKING PROBE EXT/REL TB(2)-BP(VERIFY)			2	
					REPORT CAPTURE TO LM				
					SC CONT-CMC(VERIFY)			1	
					CMC MODE-FREE			1	
					ALLOW PROBE TO DAMP S/C MOTION (10 SEC)				
					DOCKING PROBE RETRACT SEC-1			2	WHEN WITHIN ±3 DEG OF
					PRIM-2 (IF REQ'D)			2	DOCKING ATTITUDE
					PERFORM AT DOCK LATCH				
					DOCKING PROBE EXTD/REL TB(2)-GRAY (VERIFY)			2	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PERFORM AT HARD DOCK				
					SEQ EVENTS CONT SYS PYRO ARM(BOTH)-SAFE			8	
					LOGIC(BOTH)-OFF			8	
					CB SEQ EVENTS CONT SYS(4)-OPEN			8	
					THC-LOCKED(VERIFY)				
					RHC 2-LOCKED(VERIFY)				
					BMAG MODE(3)-RATE 2(VERIFY)			1	
					DOCKING PROBE-OFF			2	
					DOCKING PROBE RETRACT(BOTH)-OFF(CTR)			2	
					EXTERIOR LIGHTS RUN/EVA-OFF			2	
					COAS POWER-OFF			15	
					AUTO RCS SELECT ROLL(4)-OFF			8	
					TRANS CONTR PWR-OFF			1	
					ROT CONTR PWR DIRECT (BOTH)-OFF			1	
					VHF RANGING-OFF			3	
173:51:XX					TERMINATE LM PHOTOGRAPHY AND P47				
					DAC-OFF				
					TV-OFF				
					PRO				
						F 37 BB			
					OOE				
				P00		BB BB			

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
173:52:XX			37	P00	RECONFIGURE DAP				
					V48E	F 04 46	11102 X1111		R1-DAP CONFIGURATION R2-DAP CONFIGURATION
					V21E 61111E	F 04 46	61111 X1111		
					PRO	F 06 47	+XXXXX. +05900.		R1-CSM WEIGHT(LBS) R2-LM WEIGHT(LBS)
					PRO	F 06 48	+XXX.XX +XXX.XX		R1-GIMBAL PITCH TRIM(DEG) R2-GIMBAL YAW TRIM(DEG)
					PRO	BB BB			
173:53:XX			38	P00	CONFIGURE SWITCHES FOR POST-DOCKING				
					CMC MODE-AUTO			1	
					RNDZ XPNDR-OFF			100	

3.0 CMP ABORT RENDEZVOUS PROCEDURES

During the period of CSM and LM separation, an abort may be initiated at a pre-determined time and the rendezvous completed by using one of several techniques. The LM active Direct Ascent, One Rev, or Two Rev technique will be used to complete the rendezvous if the LM obtains the desired insertion conditions or if the LM makes an accurate abort initiation maneuver.

The procedures for the Direct Ascent rendezvous are similar to those presented in the previous section. This section discusses the CMP procedures necessary to support the other two LM active rendezvous techniques.

3.1 ABORT PLAN

The abort plan defines pre-determined abort points and regions during CSM and LM separation and the rendezvous technique to be used after the abort. The two basic rendezvous techniques of the abort plan are discussed in subsection 3.1.1 and the abort points and regions are discussed in subsection 3.1.2. Detailed discussion of the abort plan may be found in Reference 9.

3.1.1 RENDEZVOUS TECHNIQUES

One Rev Rendezvous. The One Rev rendezvous consists of four LM burns with station-keeping occurring approximately 3.5 hours after the abort. The CMP will backup all maneuvers in case the LM is unable to apply them.

The first maneuver, CSI, is applied one-half rev after insertion at approximately LM apolune and establishes the desired catch-up or fall-back rate between the CSM and LM. Also, the out-of-plane velocity will be nulled at CSI establishing a node

approximately 30 minutes before CDH. The second maneuver, CDH, is applied one-half rev after the CSI burn and establishes a constant LM catch-up rate by establishing a constant 15 nm differential altitude between the orbits of the two vehicles. The third maneuver, TPI, is applied approximately 42 minutes after CDH at a LM elevation angle of 26.6° (the CSM elevation angle is 208.3°). This should occur anywhere from 22 to 16 minutes prior to sunrise. The TPI maneuver establishes a trajectory which intercepts the target 130° after the TPI burn. Nominally zero DV midcourse corrections are scheduled at 15 and 30 minutes after TPI to refine the intercept trajectory. The fourth maneuver, TPF, is actually divided into five braking gates which establish desired relative velocities at specified ranges. These braking gates are defined as follows:

at 1.50 nm 45 fps,
at 1.00 nm 30 fps (nominally the first braking gate),
at 0.50 nm 20 fps,
at 0.25 nm 10 fps,
at 0.08 nm 5 fps.

A plane change burn will be applied 30 minutes prior to CDH if the magnitude of the burn is greater than five feet per second. This burn, and the out-of-plane burn at CSI, remove most of the out-of-plane dispersions.

A generalized orbital motion plot is contained in Appendix E, page two. A family of relative motion curves is defined by the various abort insertion points. These curves are contained in Appendix E, page three.

Two Rev Rendezvous. The Two Rev rendezvous consists of six LM burns with station-keeping occurring approximately 5.5 hours after insertion. The CMP will backup all maneuvers except the LM boost burn.

The LM applies the boost burn one-half rev after insertion. It is

a 10.0 feet per second burn which raises the LM perilune altitude. One rev after insertion a HAM burn is applied by the LM so that the post-CDH DH will be 15 nm. The coelliptic sequence (CSI, CDH, TPI, TPF) is then initiated one and one-half revs after insertion.

A generalized orbital motion plot is contained in Appendix E, page six and the family of relative motion plots defined by the time of abort is contained in Appendix E, page seven. As shown in the third figure, a large range at insertion necessitates adding an additional rev between the boost burn and HAM for the T2-1 case.

3.1.2 ABORT POINTS

Separation to Circularization. In case of a "NO-GO" decision for the CSM circularization burn the LM will achieve station-keeping by applying a TPI maneuver 75 minutes after separation. There is no discrete abort point during this period.

Circularization to PDI. If a "NO-GO" decision is made for PDI, the LM applies an abort initiation maneuver 12 minutes after the scheduled PDI time. If the abort burn is applied after the first PDI opportunity, the One Rev technique is used for rendezvous. If the abort burn is made after the second PDI opportunity, the Two Rev technique is used.

PDI to T1 Time. The CDR may initiate an abort at any time between Powered Descent Initiation and T1 (T1 being the time when a LM abort would result in the minimum LM apolune of 30 nm). T1 time for the first PDI opportunity is approximately PDI_1+17 minutes and T1 for the second opportunitity is approximately PDI_2+15 minutes.

An abort during this region is classified as either a "PDI early abort" or an "PDI late abort". The crossover point between the early and

late aborts is determined by the phase angle between the LM and CSM. The approximate crossover times are PDI_1+10 minutes and PDI_2+6 minutes.

The One Rev rendezvous technique is used for a PDI_1 early abort and a PDI_2 late abort. The Two Rev technique is used for a PDI_1 late abort and a PDI_2 early abort.

T1 to T2. If a failure requiring an abort is found after T1, the abort will be initiated at a discrete time designated T2. (T2 being the first time after T1 when the LM apolune would be 30 nm). The approximate T2 times for the first two powered descent opportunities are PDI_1+24 minutes and PDI_2+22 minutes.

The Two Rev rendezvous technique will be used for an abort at the T2 time. In the event of a T2 abort from the first PDI opportunity, an additional rev is required between the boost and the HAM burns.

T2 to Nominal Lift-Off -10 Minutes. For each CSM rev that the LM is on the surface, MCC-H computes an abort lift-off time which will result in either a Direct Ascent rendezvous or a One Rev rendezvous. This time is designated as "T3".

If the CDR initiates an abort at a T3 time, the Direct Ascent rendezvous will be used whenever possible. If, however, trajectory or systems limitations prevent using the Direct Ascent technique, then the rendezvous will be performed using the One Rev technique with lift-off time delayed approximately two and one-half minutes.

Nominal Lift-Off Time -10 Minutes to Nominal Lift-Off Time. An APS leak during APS pressurization is cause for an immediate LM lift-off. This may occur as early as 10 minutes prior to nominal lift-off time and is designated as the "early coelliptic abort region". The Two Rev technique is used for rendezvous for aborts prior to eight minutes before

lift-off and the One Rev technique is used for aborts after eight minutes.

LM or CSM system failures may make the One Rev technique more desirable than the Direct Ascent technique for rendezvous. If these failures are determined before lift-off, then the lift-off is delayed approximately two and one-half minutes and the One Rev rendezvous is then performed. The abort is designated as a "coelliptic abort".

Nominal Lift-Off Time to Docking. If the LM inserts with an unacceptable trajectory dispersion which cannot be adjusted with a LM tweak maneuver, the rendezvous technique to be used is changed from the Direct Ascent to the One Rev technique. This is accomplished at five minutes after insertion when the LM applies a bailout burn which adjusts LM phasing to be compatible with the One Rev rendezvous requirements. The CMP backs up the bailout burn but would apply it at insertion +12 minutes.

Separation to Docking. A summary of the LM abort points and rendezvous techniques is contained in Figure 3.

PERIOD	ABORT NAME	RENDEZVOUS TECHNIQUE
FIRST POWERED DESCENT OPPORTUNITY	NO PDI+12 ABORT	ONE REV RENDEZVOUS
	PDI, EARLY ABORT	ONE REV RENDEZVOUS
	PDI, LATE ABORT	TWO REV RENDEZVOUS
	T2 ABORT	MODIFIED TWO REV RENDEZVOUS
SECOND POWERED DESCENT OPPORTUNITY	NO PDI+12 ABORT	TWO REV RENDEZVOUS
	PDI, EARLY ABORT	TWO REV RENDEZVOUS
	PDI, LATE ABORT	ONE REV RENDEZVOUS
	T2 ABORT	TWO REV RENDEZVOUS
POST-LANDING	T3 ABORT	DIRECT ASCENT RENDEZVOUS (ALTERNATE-ONE REV RENDEZVOUS)
	COELLIPTIC ABORT (8-10 MIN EARLY)	TWO REV RENDEZVOUS
	COELLIPTIC ABORT (2-8 MIN EARLY)	ONE REV RENDEZVOUS
	COELLIPTIC ABORT (NOM L/O +2.5 MIN)	ONE REV RENDEZVOUS
POST-LIFT-OFF	LM BAILOUT	ONE REV RENDEZVOUS

FIGURE 3. APOLLO 16 ABORT POINT AND RENDEZVOUS TECHNIQUE SUMMARY

3.2 ABORT PROCEDURES RATIONALE

Rationale for the Coelliptic rendezvous procedures after the TPI final comp is the same as for the Direct Ascent rendezvous. Rationale for additional procedures prior to the final comp necessary for performing a coelliptic rendezvous are contained in this section.

Reconfigure DAP. The DAP is reconfigured to change the vehicle's attitude maneuver rate and deadband.

A .5 degree/second attitude maneuver rate is used for rendezvous. This rate gives acceptable maneuver times without excessive fuel expenditures.

The R03 deadband is set to 0.5 degrees for rendezvous because:

A. P40/P41 will select the R03 deadband if P20 is running when P40/P41 is selected.

B. Line-of-sight monitoring after MCC-2 will be done with the R03 narrow deadband.

If a tracking deadband larger than .5 degrees is desired, it should be loaded via N79.

Manually narrowing the deadband in R03 does not change the attitude reference; therefore, when switching to the minimum deadband, the mode switch should be cycled to FREE and back to AUTO to re-establish the attitude hold reference.

Accept MSFN Uplink. The One Rev and Two Rev detailed procedures were developed assuming that the LM aborted after PDI. The MSFN uplink supplies the CMC with an initial LM state vector. If, however, the LM aborts without initiating PDI, P76 would be used to update the CMC LM state vector with the LM abort burn.

An additional MSFN uplink is scheduled prior to the HAM in the Two Rev rendezvous. This uplink will improve the CMC's knowledge of the CSM and LM state vectors and will give the CMC the capability to compute an accurate HAM if there has been no navigation prior to the HAM.

Update LM State Vector in the CMC. P76 is used to update the CMC's knowledge of the LM state vector to include any burn that the LM may apply to accomplish rendezvous.

Configure VHF and EMS for Ranging. The VHF and EMS are configured for ranging so that VHF marks may be taken.

Initiate Pre-Thrust Program and Rendezvous Navigation. The pre-thrust program is entered in order to:

A. Initiate P20 and LM tracking
B. Initiate VHF and sexant marking on the LM
C. Display the time to the burn
D. Display the number of sextant and VHF marks taken
E. Initialize the program for the upcoming recycle and final comp
F. To initiate the MINKEY sequence if this is the first pre-thrust program

Start Recycle Sequence. The burn components are computed for comparison with the LGC solution.

Compute Burn Solution and Terminate Navigation. The burn solution is used in the CMC for a possible CSM active burn. The final comp terminates rendezvous navigation until the next marking period.

Backup LM Burn. The CMP backs up the LM HAM, CSI, PC and CDH burns. If the LM fails to apply any of these burns, the CSM would become the active vehicle and perform the CMC computed burn.

A. Backup LM RCS Burn

The MINKEY logic specifies an RCS burn if the computed DV is less than seven feet per second. The CMP configures the CSM for an RCS burn but does not actually apply the burn. If the LM fails to apply the burn, the CMP would apply the burn by zeroing the burn components in the CMC P41 N85 display with the THC.

B. Backup LM SPS Burn

The MINKEY logic specifies an SPS burn if the computed DV is greater than or equal to seven feet per second. Except for arming the SPS engine and applying ullage, the CMP configures the CSM for an SPS burn. In the event the LM cannot apply the burn, the CMP would burn the CMC solution by:

(1) Arming the SPS engine
(2) Applying ullage for 11 seconds
(3) Proceeding on the flashing V99 N40 display

3.3 DETAILED PROCEDURES

The CSM detailed procedures for the LM active abort rendezvous are contained in subsection 3.3.1, 3.3.2, and 3.3.3. These detailed procedures consider primarily the G&N requirements, although some non-G&N procedures are included for purposes of information and continuity. The format for presenting the abort procedures is the same as the format used for presenting the nominal direct ascent rendezvous procedures (subsection 2.3). However, since the procedures cover generalized cases, no trajectory dependent data such as GET and DSKY register displays are shown.

3.3.1 TWO REV SEQUENCE

The Two Rev procedures begin five minutes before insertion and assume an abort after PDI. In the event of a no PDI abort, the procedures would contain a P76 velocity update rather than a MSFN state vector

uplink. The procedures continue through the CSI final comp which is the starting point for the common Coelliptic sequence (subsection 3.3.3).

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * * * * * *				
					TWO REV SEQUENCE				
					* * * * * * * * * *				
INS-05MIN			1		RECONFIGURE DAP				
					V37E 00E				
				P00		BB BB			
					CYCLE CMC MODE-FREE/AUTO			1	
					V48E				
						F 04 46	11111 01111		
					V21E 11102E				
						F 04 46	11102 01111		
					PRO				
						F 06 47	+XXXXX. +XXXXX.		
					PRO				
						F 06 48	+XXX.XX +XXX.XX		
					PRO				
						BB BB			
									INSERTION OR AIM
INS+05MIN			2	P00	ACCEPT MSFN UPLINK				
					UP TLM CM-ACCEPT			2	
				P27	VERIFY UPLINK ACTIVITY LT-ON				UPLINK ACT LT-ON
					MONITOR UPLINK:	XX XX	XXXXX XXXXX XXXXX		
				P00	VERIFY UPLINK ACTIVITY LT-OFF	BB BB			UPLINK ACT LT-OFF
					UP TLM CM-BLOCK			2	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
									OBTAIN LM BOOST TIG & DV FROM LM
HAM-60MIN									LM BOOST
HAM-59MIN			3	P00	UPDATE LM STATE VECTORS				
					V37E 76E				
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE				LOAD BOOST TIG
						F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO				
						F 06 84	+XXXX.X +XXXX.X +XXXX.X		
					V25E +100E +E +E				
						F 06 84	+0010.0 +0000.0 +0000.0		
					PRO				
						F 37 BB			
			4	P76	CONFIGURE VHF AND EMS FOR RANGING				
					VHF AM T/R-T/R			9	
					VHF ANTENNA-RIGHT			3	
					EMS FUNCTION - DV SET/VHF RNG			1	
					EMS MODE - BACKUP/VHF RNG			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
			5	P76	ACCEPT MSFN UPLINK				
					00E				
				P00		BB BB			
					UP TLM CM-ACCEPT			2	
				P27	VERIFY UPLINK ACTIVITY LT-ON				UPLINK ACT LT-ON
					MONITOR UPLINK	XX XX	XXXXX XXXXX XXXXX		
				P00	VERIFY UPLINK ACTIVITY LT-OFF	BB BB			UPLINK ACT LT-OFF
					UP TLM CM-BLOCK			2	
									OBTAIN CSI,TPI,AND HAM TIG'S FROM LM
HAM-40MIN			6	P00	INITIATE P31 AND RNDZ NAVIGATION				
					V37E 31E				
				P20					
				P31		F 50 25	00017		
					PRO				
						F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO				
						06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR AUTO MNVR				
					VHF RNG-RESET			9	
						F 06 11	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE				LOAD CSI TIG
						F 06 11	+00XXX. +000XX. +0XX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 06 55	+00001 +208.30 +130.00		
					PRO	F 06 37	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE				LOAD TPI TIG
						F 06 37	+00XXX. +000XX. +0XX.XX		
					PRO	F 06 33	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE				LOAD HAM TIG
						F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO	F 16 45	+0XB00 -XXBXX -00001		
HAM-20MIN			7	P31	START RECYCLE SEQUENCE V32E	F 06 90	+XXX.XX ±XXXX.X ±XXXX.X		
					RECORD DATA				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 06 81	+XXXX.X +XXXX.X +0000.0		
					RECORD DATA				
					PRO	F 16 45	+XXB00 -19BXX -00001		
HAM-12MIN			8	P31	COMPUTE HAM SOLUTION AND TERMINATE NAV				
					PRO	F 06 90	+XXX.XX +XXXX.X +XXXX.X		
					RECORD DATA				
					PRO	F 06 81	+XXXX.X +XXXX.X +0000.0		
					RECORD DATA				
					V22E +E				ZERO DVY
						F 06 81	+XXXX.X +0000.0 +0000.0		
					PRO	F 16 45	+XXB00 -11BXX +XXX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
HAM-11MIN			9	P31	BACKUP LM HAM BURN				
					PRO				
				P41		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ENTER				
						06 85	+XXXX.X +XXXX.X +XXXX.X		
HAM-35SEC					MONITOR DSKY BLANK	BB BB			
HAM-30SEC									AVE G ON
						16 85	+XXXX.X +XXXX.X +XXXX.X		
HAM TIG						F 16 85	+XXXX.X +XXXX.X +XXXX.X		LM HAM
					VERIFY LM HAM BURN COMPLETE				
HAM+01MIN			10	P41	UPDATE LM STATE VECTOR IN THE CMC				
					PRO				
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO				
						F 06 84	+XXXX.X +0000.0 +0000.0		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
HAM+02MIN			11	P76	INITIATE P32 AND RNDZ NAVIGATION				
					PRO				
				P32		F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					PRO				
						06 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR AUTO MNVR				
						F 06 11	+00XXX.		
							+000XX.		
							+0XX.XX		
					PRO				
						F 06 55	+00001		
							+208.30		
							+130.00		
					PRO				
						F 06 37	+00XXX.		
							+000XX.		
							+0XX.XX		
					PRO				
						F 16 45	+XXB00		
							-XXBXX		
							-00001		
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
CSI-20MIN			12	P32	START RECYCLE SEQUENCE				
					OPTICS MODE-CMC			122	
					V32E				
						F 06 90	+XXX.XX +XXXX.X +XXXX.X		
					RECORD DATA				
					PRO				
						F 06 81	+XXXX.X +XXXX.X +0000.0		
					RECORD DATA				
					PRO				
						F 16 45	+XXBXX -19BXX -00001		
					CONTINUE SEXTANT MARKING				
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
CSI-12MIN			13	P32	COMPUTE CSI SOLUTION AND TERMINATE NAV				
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 06 90	+XXX.XX +XXXX.X +XXXX.X		
					RECORD DATA PRO	F 06 81	+XXXX.X +XXXX.X +0000.0		
					RECORD DATA PRO	F 16 45	+XXBXX -10BXX +XXX.XX		
					* * * * * * * * * * * * * * * * * * * CONTINUE WITH STEP 1 OF THE COMMON COELLIPTIC SEQUENCE,SECTION 3.3.3 * * * * * * * * * * * * * * * * * * *				

3.3.2 ONE REV SEQUENCE

The One Rev procedures begin five minutes before insertion and assume an abort after PDI. In the event of a no-PDI abort, the procedures would contain a P76 velocity update rather than a MSFN state vector uplink. The procedures continue through CSI final comp where the common Coelliptic sequence (subsection 3.3.3) is initiated.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * * * * * ONE REV SEQUENCE * * * * * * * * *				
					RECONFIGURE DAP				
INS-01MIN			1	P00	V37E 00E	BB BB			
					V48E	F 04 46	11111 01111		
					V21E 11102E	F 04 46	11102 01111		
					PRO	F 06 47	+XXXXX. +XXXXX.		
					PRO	F 06 48	±XXX.XX ±XXX.XX		
			2	P00	CONFIGURE VHF ANF EMS FOR RANGING VHF AM T/R-T/R VHF ANTENNA-RIGHT EMS FUNCTION-DV SET/VHF RNG EMS MODE-BACKUP/VHF RNG			9 3 1 1	INSERTION OR AIM

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
INS+05MIN			3	P00	ACCEPT MSFN UPLINK				
					UP TLM CM-ACCEPT			2	
				P27	VERIFY UPLINK ACTIVITY LT-ON				UPLINK ACT LT-ON
					MONITOR UPLINK	XX XX	XXXXX XXXXX XXXXX		
				P00	VERIFY UPLINK ACTIVITY LT-OFF	BB BB			UPLINK ACT LT-OFF
					UP TLM CM-BLOCK			2	
									OBTAIN CSI&TPI TIG FROM LM
CSI-40MIN			4	P00	INITIATE P32 AND RNDZ NAVIGATION				
					V37E 32E				
				P20					
				P32		F 50 25	00017		
					PRO				
						F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO				
						06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR AUTO MNVR				
					VHF RNG-RESET			9	
						F 06 11	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE				LOAD CSI TIG
						F 06 11	+00XXX. +000XX. +0XX.XX		
					PRO				
						F 06 55	+00001 +208.30 +130.00		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 06 37	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE	F 06 37	+00XXX. +000XX. +0XX.XX		LOAD TPI TIG
					PRO	F 16 45	+XXB00 -XXBXX -00001		
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
CSI-20MIN			5	P32	START RECYCLE SEQUENCE				
					OPTICS MODE-CMC			122	
					V32E	F 06 90	+XXX.XX ±XXXX.X ±XXXX.X		
					RECORD DATA				
					PRO	F 06 81	+XXXX.X ±XXXX.X +0000.0		
					RECORD DATA				
					PRO	F 16 45	+XXBXX -19BXX -00001		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					CONTINUE SEXTANT MARKING				
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
CSI-12MIN			6	P32	COMPUTE CSI SOLUTION AND TERMINATE NAV				
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	
					PRO	F 06 90	+XXX.XX ±XXXX.X ±XXXX.X		
					RECORD DATA				
					PRO	F 06 81	+XXXX.X ±XXXX.X +0000.0		
					RECORD DATA				
					PRO	F 16 45	+XXBXX -10BXX +XXX.XX		
					* CONTINUE WITH STEP 1 OF THE COMMON COELLIPTIC SEQUENCE, SECTION 3.3.3 *				

3.3.3 COMMON COELLIPTIC SEQUENCE

The common Coelliptic sequence begins immediately after the CSI final comp and continues through the post-docking switch configuration. This sequence is common to both the One Rev and Two Rev rendezvous techniques.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * * * * * * * * * * *				
					COMMON COELLIPTIC SEQUENCE				
					* * * * * * * * * * * * * * *				
						F 16 45	+XXBXX		
							-10BXX		
							+XXX.XX		
CSI-10MIN			1	P32	BACKUP LM CSI BURN				
					PRO				
				P40		F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					PRO				
						06 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR AUTO MNVR				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					ALIGN GDC TO IMU				
					ATT SET TW-SET TO IMU ANGLES ON FDAI 1			1	
					FDAI SELECT-1			1	
					FDAI SOURCE-ATT SET (VERIFY)			1	
					ATT SET-IMU			1	
					ATT SET TW-NULL FDAI 1 ERROR NEEDLES			1	
					ATT SET-GDC			1	
					GDC ALIGN PB-PUSH UNTIL NEEDLES NULLED			1	
					FDAI SELECT-1/2			1	
					RECORD P76 DATA				OBTAIN CSI P76 FROM CDR

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					CONFIGURE EMS FOR BURN				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					-DV SET/VHF RNG			1	
					LOAD DV MINUS 11 FPS IN EMS			1	
					EMS FUNCTION-DV			1	
					CONFIGURE SCS				
					CB STAB CONT SYS(ALL)-CLOSE			8	
					CB SPS(12)-CLOSE			8	
					MANUAL ATTITUDE(3)-RATE CMD(VERIFY)			1	
					RATE-LOW(VERIFY)			1	
					DV CG-CSM(VERIFY)			1	
					SPS HE VLVS(BOTH)-AUTO(VERIFY)			3	
					CHECK N2 A AND N2 B			3	
					TVC PREPARATION				
					SCS TVC(BOTH)-RATE CMD(VERIFY)			1	
					TVC GIMBAL DRIVE(BOTH)-AUTO(VERIFY)			1	
					MAIN BUS TIE(2)-ON			5	
					TVC SERVO POWER 1-AC1/MNA			7	
					TVC SERVO POWER 2-AC2/MNB			7	
					ROT CONTR PWR NORMAL 2-AC			1	
					ROT CONTR PWR DIRECT 2-OFF(VERIFY)			1	
					ATT DEADBAND-MIN			1	
					BMAG MODE(3)-ATT 1/RATE 2			1	
					SC CONT-SCS			1	
					RHC 2-ARMED				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRIMARY TVC CHECK				
					SPS GIMBAL MOTORS PITCH 1-START/ON			1	
					YAW 1-START/ON			1	
					VERIFY TRIM CONTROL AND SET			1	
					VERIFY MTVC				
					SC CONT-CMC			1	
					THC-CLOCKWISE				
					VERIFY NO MTVC				
					SECONDARY TVC CHECK:				
					SPS GIMBAL MOTORS PITCH 2-START/ON			1	
					YAW 2-START/ON			1	
					SET GPI TRIM			1	
					VERIFY MTVC				
					THC-NEUTRAL				
					VERIFY NO MTVC				
					VERIFY GPI RETURNS TO 0,0				
					ROT CONTR PWR NORMAL(BOTH)-AC/DC			1	
					DIRECT(BOTH)-MNA/MNB			1	
					BMAG MODE(3)-RATE 2			1	
				PRO					
						06 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR TRIM MANEUVER				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					BMAG MODE(3)-ATT 1/RATE 2			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					ENTER				
						F 50 25	00204		
					PRO				
					MONITOR GPI RESPONSE:	BB BB			
						06 40	-XXBXX		
							+XXXX.X		
							+0000.0		
					FDAI SCALE-5/1(VERIFY)			1	
					VERIFY DET SET			1	
					RATE-HIGH			1	
CSI-01MIN					EMS MODE-NORMAL			1	
					TRANS CONTR PWR-ON			1	
CSI-35SEC					MONITOR DSKY BLANK	BB BB			
CSI-30SEC									AVE G ON
						06 40	-00B29		
							+XXXX.X		
							+0000.0		
					CHECK PIPA BIAS LESS THAN 2 FPS FOR 5 SEC				
CSI-05SEC						F 99 40	-00B05		ENGINE ON ENABLE REQUEST
							+XXXX.X		
							+0000.0		
CSI TIG									LM CSI
					VERIFY LM BURN COMPLETE				
					ENTER				
						F 16 85	+XXXX.X		
							+XXXX.X		
							+XXXX.X		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					SPS GIMBAL MOTORS(4)-OFF SEQUENTIALLY			1	
					TVC SERVO POWER(BOTH)-OFF			7	
					RHC 2-LOCKED				
					TRANS CONTR PWR-OFF			1	
					ROT CONTR PWR DIRECT(BOTH)-OFF			1	
					CB DIRECT ULLAGE(BOTH)-OPEN			8	
					CB SPS PITCH 1 AND YAW 1-OPEN			8	
					RECORD DV COUNTER AND RESIDUALS				
					EMS FUNCTION-OFF			1	
					EMS MODE-STBY			1	
CSI+02MIN				P40	UPDATE LM S.V. IN THE CMC				
					PRO				
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					ATT DEADBAND-MAX			1	
					RATE-LOW			1	
					BMAG MODE(3)-RATE 2			1	
					MAIN BUS TIE(2)-OFF			5	
					PRO				
						F 06 84	+XXXX.X +XXXX.X +XXXX.X		
									COPY LM PC TIG

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
CSI+03MIN			2	P76	INITIATE P36 AND RNDZ NAVIGATION				
					PRO				
				P36		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR AUTO MNVR				
					RECONFIGURE EMS FOR RANGING				
					EMS FUNCTION-DV SET/VHF RNG			1	
					EMS MODE-BACKUP/VHF RNG			1	
					VHF RNG-RESET			9	
						F 06 33	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE				OVERWRITE WITH LM PC TIG
						F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO	F 16 45	+XXBXX -XXBXX -00001		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
PC-09MIN			3	P36	COMPUTE PC SOLUTION AND TERMINATE NAV				
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	
					PRO	F 06 90	±XXX.XX ±XXXX.X ±XXXX.X		
					RECORD DATA				
					PRO	F 06 81	+0000.0 ±XXXX.X ±0000.0		
					RECORD DATA				IF DVY GREATER THAN 5 FPS, BUT LESS THAN 7 FPS, SEE SECTION 4.1.1. IF DVY GREATER THAN OR EQUAL TO 7 FPS, SEE SECTION 4.1.2.
			4	P36	BYPASS PC MANEUVER				
					V22E +E	F 06 81	+0000.0 +0000.0 +0000.0		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 16 45	+XXBXX -08BXX +XXX.XX		
				P76	PRO	F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO	F 06 84	+0000.0 +0000.0 +0000.0		
			5	P33	PRO INITIATE P33 AND RNDZ NAVIGATION	F 06 13	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE	F 06 13	+00XXX. +000XX. +0XX.XX		OVERWRITE WITH LM CDH TIG
					PRO	F 16 45	+XXBXX -XXBXX -00001		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
CDH-20MIN			6	P33	START RECYCLE SEQUENCE				
					OPTICS MODE-CMC			122	
					V32E				
						F 06 90	±XXX.XX +XXXX.X ±XXXX.X		
					RECORD DATA				
					PRO				
						F 06 81	±XXXX.X ±XXXX.X ±XXXX.X		
					RECORD DATA				
					PRO				
						F 16 45	+XXBXX -19BXX -00001		
					CONTINUE SEXTANT MARKING				
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
CDH-12MIN			7	P33	COMPUTE CDH SOLUTION AND TERMINATE NAV				
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	
					PRO				
						F 06 90	+XXX.XX ±XXXX.X ±XXXX.X		
					RECORD DATA				
					PRO				
						F 06 81	+XXXX.X ±XXXX.X ±XXXX.X		
					RECORD DATA				
					PRO				
						F 16 45	+XXBXX -10BXX +XXX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
CDH-10MIN			8	P33	BACKUP LM CDH BURN				
					PRO				
				P40		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO				
						06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR AUTO MNVR				
						F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ALIGN GDC TO IMU				
					ATT SET TW-SET TO IMU ANGLES ON FDAI 1			1	
					FDAI SELECT-1			1	
					FDAI SOURCE-ATT SET			1	
					ATT SET-IMU			1	
					ATT SET TW-NULL FDAI 1 ERROR NEEDLES			1	
					ATT SET-GDC			1	
					GDC ALIGN PB-PUSH UNTIL NEEDLES NULLED			1	
					FDAI SELECT-1/2			1	
					RECORD P76 DATA				OBTAIN CDH P76 FROM CDR
					CONFIGURE EMS FOR BURN				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					EMS FUNCTION-DV SET/VHF RNG			1	
					LOAD DV MINUS 11 FPS IN EMS			1	
					EMS FUNCTION-DV			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					CONFIGURE SCS				
					CB STAB CONT SYS(ALL)-CLOSE			8	
					CB SPS(12)-CLOSE			8	
					MANUAL ATTITUDE(3)-RATE CMD(VERIFY)			1	
					RATE-LOW(VERIFY)			1	
					DV CG-CSM(VERIFY)			1	
					SPS HE VLVS(BOTH)-AUTO(VERIFY)			3	
					CHECK N2 A AND N2 B			3	
					TVC PREPARATION				
					SCS TVC(BOTH)-RATE CMD(VERIFY)			1	
					TVC GIMBAL DRIVE(BOTH)-AUTO(VERIFY)			1	
					MAIN BUS TIE(2)-ON			5	
					TVC SERVO POWER 1-AC1/MNA			7	
					TVC SERVO POWER 2-AC2/MNB			7	
					ROT CONTR PWR NORMAL 2-AC			1	
					ROT CONTR PWR DIRECT 2-OFF(VERIFY)			1	
					ATT DEADBAND-MIN			1	
					BMAG MODE(3)-ATT 1/RATE 2			1	
					SC CONT-SCS			1	
					RHC 2-ARMED				
					PRIMARY TVC CHECK				
					SPS GIMBAL MOTORS PITCH 1-START/ON			1	
					YAW 1-START/ON			1	
					VERIFY TRIM CONTROL AND SET			1	
					VERIFY MTVC				
					SC CONT-CMC			1	
					THC-CLOCKWISE				
					VERIFY NO MTVC				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					SECONDARY TVC CHECK:				
					SPS GIMBAL MOTORS PITCH 2-START/ON			1	
					YAW 2-START/ON			1	
					SET GPI TRIM			1	
					VERIFY MTVC				
					THC-NEUTRAL				
					VERIFY NO MTVC				
					VERIFY GPI RETURNS TO 0,0				
					ROT CONTR PWR NORMAL(BOTH)-AC/DC			1	
					ROT CONTR PWR DIRECT(BOTH)-MNA/MNB			1	
					BMAG MODE(3)-RATE 2			1	
					PRO				
						06 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR TRIM MANEUVER				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					BMAG MODE(3)-ATT 1/RATE 2			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					ENTER				
						F 50 25	00204		
					PRO				
					MONITOR GPI RESPONSE:	BB BB			
						06 40	-XXBXX		
							+XXXX.X		
							+0000.0		
					FDAI SCALE-5/1 (VERIFY)			1	
					VERIFY DET SET			1	
					RATE-HIGH			1	
CDH-01MIN					EMS MODE-NORMAL			1	
					TRANS CONTR PWR-ON			1	
CDH-35SEC					MONITOR DSKY BLANK	BB BB			
CDH-30SEC									AVE G ON
						06 40	-00B29		
							+XXXX.X		
							+0000.0		
					CHECK PIPA BIAS LESS THAN 2 FPS FOR 5 SEC				
CDH-05SEC						F 99 40	-00B05		ENGINE ON ENABLE REQUEST
							+XXXX.X		
							+0000.0		
CDH TIG									LM CDH
					VERIFY LM BURN COMPLETE				
					ENTER				
						F 16 85	+XXXX.X		
							+XXXX.X		
							+XXXX.X		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					SPS GIMBAL MOTORS(4)-OFF SEQUENTIALLY			1	
					TVC SERVO POWER(BOTH)-OFF			7	
					RHC 2-LOCKED				
					TRANS CONTR PWR-OFF			1	
					ROT CONTR PWR DIRECT(BOTH)-OFF			1	
					CB DIRECT ULLAGE(BOTH)-OPEN			8	
					CB SPS PITCH 1 AND YAW 1-OPEN			8	
					RECORD DV COUNTER AND RESIDUALS				
					EMS FUNCTION-OFF			1	
					EMS MODE-STBY			1	
CDH+01MIN			9	P40	UPDATE LM S.V. IN THE CMC				
					PRO				
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					ATT DEADBAND-MAX			1	
					RATE-LOW			1	
					BMAG MODE(3)-RATE 2			1	
					MAIN BUS TIE(2)-OFF			5	
					PRO				
						F 06 84	+XXXX.X +XXXX.X +XXXX.X		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
CDH+03MIN			10	P76	INITIATE P34 AND RNDZ NAVIGATION				
					PRO				
				P34		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR AUTO MNVR				
					RECONFIGURE EMS FOR RANGING				
					EMS FUNCTION-DV SET/VHF RNG			1	
					EMS MODE-BACKUP/VHF RNG			1	
					VHF RNG-RESET			9	
						F 06 37	+00XXX. +000XX. +0XX.XX		
					PRO	F 06 55	+00000 +000.00 +130.00		
					V22E +20830E	F 06 55	+00000 +208.30 +130.00		SPECIFY ELEV ANG OPTION
					PRO	F 16 45	+XXBXX -XXBXX -00001		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
TPI-20MIN			11	P34	START RECYCLE SEQUENCE				
					OPTICS MODE-CMC			122	
					V32E				
						F 06 37	+00XXX. +000XX. +0XX.XX		
					RECORD DATA				
					PRO				
						F 06 58	+XXXX.X +XXXX.X +XXXX.X		
					RECORD DATA				
					PRO				
						F 06 81	+XXXX.X +XXXX.X +XXXX.X		
					RECORD DATA				
					PRO				
						F 16 45	+XXBXX -18BXX -00001		
					CONTINUE SEXTANT MARKING				
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI-12MIN			12	P34	COMPUTE TPI SOLUTION AND TERMINATE NAV				
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	
									OBTAIN TPI TIG FROM LM
					PRO	F 06 37	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE				OVERWRITE WITH LM TPI TIG
						F 06 37	+00XXX. +000XX. +0XX.XX		
					PRO	F 06 55	+00000 +XXX.XX +130.00		
					RECORD DATA				
					PRO	F 06 58	+XXXX.X +XXXX.X +XXXX.X		
					RECORD DATA				
					PRO	F 06 81	+XXXX.X +XXXX.X +XXXX.X		
					RECORD DATA				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 16 45	+XXBXX -10BXX +XXX.XX		
TPI-10MIN			13	P34	BACKUP LM TPI BURN				
					PRO				
				P40		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR TRIM MANEUVER	F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ALIGN GDC				
					ATT SET TW-SET TO IMU ANGLES ON FDAI 1			1	
					FDAI SELECT-1			1	
					FDAI SOURCE-ATT SET(VERIFY)			1	
					ATT SET-IMU			1	
					ATT SET TW-NULL FDAI 1 ERROR NEEDLES			1	
					ATT SET-GDC			1	
					GDC ALIGN PB-PUSH UNTIL NEEDLES NULLED			1	
					FDAI SELECT-1/2			1	
					RECORD P76 DATA				OBTAIN TPI P76 FROM CDR

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					CONFIGURE EMS				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					-DV SET/VHF RNG			1	
					LOAD DV MINUS 11 FPS IN EMS			1	
					EMS FUNCTION-DV			1	
					CONFIGURE SCS				
					CB STAB CONT SYS(ALL)-CLOSE			8	
					CB SPS(12)-CLOSE			8	
					MANUAL ATTITUDE(3)-RATE CMD(VERIFY)			1	
					RATE-LOW(VERIFY)			1	
					DV CG-CSM(VERIFY)			1	
					SPS HE VLVS(BOTH)-AUTO(VERIFY)			3	
					CHECK N2 A AND N2 B			3	
					PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR TRIM MANEUVER	F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ENTER	F 50 25	00204		
					ENTER	06 40	-XXBXX +XXXX.X +0000.0		
					FDAI SCALE-5/1(VERIFY)			1	
					VERIFY DET SET			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI-35SEC					MONITOR DSKY BLANK	BB BB			
TPI-30SEC									AVE G ON
						06 40	-00B29 +XXXX.X +0000.0		
					CHECK PIPA BIAS LESS THAN 2 FPS FOR 5 SEC				
TPI-05SEC						F 99 40	-00B05 +XXXX.X +0000.0		ENGINE ON ENABLE REQUEST
TPI TIG									LM TPI
					CONFIRM LM BURN COMPLETE				IF THE LM CANNOT APPLY THE TPI BURN, SEE SECTION 4.2.1.
					ENTER				
						F 16 85	+XXXX.X +XXXX.X +XXXX.X		
					EMS FUNCTION-OFF			1	
					CB SPS PITCH 1 AND YAW 1-OPEN			8	
TPI+01MIN			14	P40	UPDATE LM S.V. IN THE CMC				
					PRO				
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO				
						F 06 84	+XXXX.X +XXXX.X +XXXX.X		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+03MIN			15	P76	INITIATE P35 AND RNDZ NAVIGATION				
					CONFIGURE EMS FOR RANGING				
					EMS FUNCTION-DV SET/VHF RNG			1	
					EMS MODE-BACKUP/VHF RNG			1	
					VHF RNG-RESET			9	
					PRO				
				P35		F 16 45	+XXBXX +03BXX -00001		
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
TPI+12MIN			16	P35	COMPUTE MCC1 SOLUTION AND TERMINATE NAV				
					OPTICS MODE-CMC			122	
					PRO				
						F 06 81	+XXXX.X +XXXX.X +XXXX.X		
					RECORD DATA				
					PRO				
						F 16 45	+09B09 -02BXX +XXX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+13MIN			17	P35	BACKUP LM MCC1 BURN				
				PRO					
				P41		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ENTER				
						06 85	+XXXX.X +XXXX.X +XXXX.X		
MCC-35SEC					MONITOR DSKY BLANK	BB BB			
MCC-30SEC									AVE G ON
						16 85	+XXXX.X +XXXX.X +XXXX.X		
TPI+15MIN						F 16 85	+XXXX.X +XXXX.X +XXXX.X		LM MCC1
					VERIFY LM BURN COMPLETE				IF THE LM CANNOT APPLY THE MCC1 BURN, SEE SECTION 4.2.2
TPI+16MIN			18	P41	UPDATE LM S.V. IN THE CMC				
				PRO					
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO				
						F 06 84	+XXXX.X +XXXX.X +XXXX.X		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+18MIN			19	P76	INITIATE P35 AND RNDZ NAVIGATION				IF THE CSM IS ACTIVE AND TPF DELTA V > 55 FPS, SEE SECTION 4.2.3
					PRO				
				P35		F 16 45	+09B09 +03BXX -00001		
					START SEXTANT MARKING				
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
TPI+27MIN			20	P35	COMPUTE MCC2 SOLUTION AND TERMINATE NAV				
					PRO				
						F 06 81	+XXXX.X ±XXXX.X ±XXXX.X		
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	
					RECORD DATA				
					PRO				
						F 16 45	+09B09 -02BXX +XXX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+28MIN			21	P35	BACKUP LM MCC2 BURN				
				PRO					
				P41		F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					ENTER				
						06 85	+XXXX.X		
							+XXXX.X		
							+XXXX.X		
MCC-35SEC					MONITOR DSKY BLANK	BB BB			
MCC-30SEC									AVE G ON
						16 85	+XXXX.X		
							+XXXX.X		
							+XXXX.X		
TPI+30MIN						F 16 85	+XXXX.X		LM MCC2
							+XXXX.X		
							+XXXX.X		IF THE LM CANNOT APPLY THE
					VERIFY LM BURN COMPLETE				MCC2 BURN, SEESECTION 4.2.2.
TPI+31MIN			22	P41	UPDATE LM S.V. IN THE CMC				
				PRO					
				P76		F 06 33	+00XXX.		
							+000XX.		
							+0XX.XX		
					PRO				
						F 06 84	+XXXX.X		
							+XXXX.X		
							+XXXX.X		
TPI+32MIN			23	P76	MANEUVER TO COAS TRACK ATTITUDE				
				PRO					
				P79		F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					V37E 00E				
				P00		BB BB			
					V49E				
						F 06 22	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					PRO				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					PRO				
						06 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR MANEUVER				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					ENTER				
						BB BB			
					V83E				
						F 16 54	+XXX.XX		
							-XXXX.X		
							+XXX.XX		
TPI+34MIN			24	P00	ACQUIRE MSFN WITH HGA				
					HIGH GAIN ANTENNA TRACK-MAN			2	
					HGA PITCH POSITION-SET PITCH POSITION			2	
					HGA YAW POSITION-SET YAW POSITION			2	
					S BAND ANTENNA-HI GAIN			3	
					HIGH GAIN ANTENNA TRACK-AUTO			2	
TPI+35MIN			25	P00	PERFORM DOCKING PREPARATION ACTIVITIES				
					PERFORM PRE-DOCK CHECKLIST				
					MANUAL ATTITUDE(3)-RATE CMD(VERIFY)			1	
					LIMIT CYCLE-OFF(VERIFY)			1	
					ATT DEADBAND-MIN			1	
					RATE-LOW(VERIFY)			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					TRANS CONTR PWR-ON			1	
					ROT CONTR PWR DIRECT(BOTH)-MNA/MNB			1	
					SC CONT-CMC(VERIFY)			1	
					AUTO RCS SELECT(16)-MNA/MNB			8	
					CB DOCK PROBE(2)-CLOSE			8	
					DOCKING PROBE RETRACT(BOTH)-OFF(CTR) (VERIFY)			2	
					DOCKING PROBE-RETRACT			2	
					DOCKING PROBE EXTD/REL TB (2) - GRAY (VERIFY)			2	
					CB SEQ EVENTS CONT SYS(4)-CLOSE			8	
					COAS POWER-ON(UP)(VERIFY)			15	
					EXTERIOR LIGHTS RUN/EVA-ON(UP)(VERIFY)			2	
									IF CSM ACTIVE BRAKING, SEE SECTION 4.2.4.
TPI+40MIN					PHOTOGRAPH LM				
					UTILITY POWER-ON(UP)(VERIFY)			15	
					TV-ON				
					DAC-ON				
					BEGIN PHOTOS WITH DAC AND TV				
									TPF
TPI+42MIN					CONFIGURE SWITCHES FOR POST TPF				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					EXTERIOR LIGHTS RNDZ-OFF(CTR)			2	
					TERMINATE LM PHOTOS				
					PRO	BB BB			
					DAC-OFF				
					TV-OFF				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+49MIN			26	P00	MANEUVER FOR CSM INSPECTION				
					V49E	F 06 22	+XXX.XX +XXX.XX +XXX.XX		
					V25E +XXXXXE +XXXXXE +XXXXXE	F 06 22	+XXX.XX +XXX.XX +XXX.XX		LOAD DESIRED ATTITUDE
					PRO	F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR MANEUVER	F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ENTER	BB BB			
					MANUAL ATTITUDE ROLL-ACCEL CMD RHC-PERFORM 360 DEG ROLL AT 2 DEG/SEC MANUAL ATTITUDE ROLL-RATE CMD			1 1	
TPI+60MIN			27	P00	MANEUVER TO DOCKING ATTITUDE				
					V49E	F 06 22	+XXX.XX +XXX.XX +XXX.XX		
					V25E +XXXXXE +XXXXXE +XXXXXE	F 06 22	+XXX.XX +XXX.XX +XXX.XX		LOAD DOCKING ATTITUDE

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR MANEUVER	F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ENTER	BB BB			
					REACQUIRE MSFN HGA				
			28	P00	ARM PYROS				
					CUE MSFN FOR LOGIC ARM				
					SEQ EVENTS CONT SYSTEM LOGIC(BOTH)-ON(UP)			8	MSFN GO FOR PYRO ARM
					SEQ EVENTS CONT SYSTEM PYRO ARM(BOTH)-ON(UP)			8	
TPI+64MIN			29	P00	PERFORM DOCKING ACTIVITIES				
					V37E 47E				
				P47		F 16 83	+0000.0 +0000.0 +0000.0		
					INITIATE LM PHOTOGRAPHY				
					DAC-ON				
					TV-ON				
					PHOTOGRAPH LM MNVR				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					TRANSLATE TO CAPTURE LATCH				
					THC-ARMED				
					THC-MINIMUM THRUST FORWARD				
						F 16 83	±XXXX.X		
							±XXXX.X		
							±XXXX.X		
					THC-LOCKED				
TPI+68MIN					PERFORM AT CAPTURE				DOCKING
					DOCKING PROBE EXT/REL TB(2)-BP(VERIFY)			2	
					REPORT CAPTURE TO LM				
					SC CONT-CMC(VERIFY)			1	
					CMC MODE-FREE			1	
					ALLOW PROBE TO DAMP S/C MOTION(10 SEC)				
					DOCKING PROBE RETRACT SEC-1			2	WHEN WITHIN ±3 DEG OF
					PRIM-2(IF REQ'D)			2	DOCKING ATTITUDE
					PERFORM AT DOCK LATCH				
					DOCKING PROBE EXTD/REL TB(2)-GRAY (VERIFY)			2	
					PERFORM AT HARD DOCK				
					SEQ EVENTS CONT SYS PYRO ARM(BOTH)-SAFE			8	
					LOGIC(BOTH)-OFF			8	
					CB SEQ EVENTS CONT SYS(4)-OPEN			8	
					THC-LOCKED				
					RHC 2-LOCKED(VERIFY)				
					BMAG MODE(3)-RATE 2(VERIFY)				
					DOCKING PROBE-OFF			2	
					DOCKING PROBE RETRACT(BOTH)-OFF(CTR)			2	
					EXTERIOR LIGHTS RUN/EVA-OFF			2	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					COAS POWER-OFF			15	
					AUTO RCS SELECT ROLL(4)-OFF			8	
					TRANS CONTR PWR-OFF			1	
					ROT CONTR PWR DIRECT(BOTH)-OFF			1	
					VHF RANGING-OFF			3	
					TERMINATE LM PHOTOGRAPHY AND P47				
					DAC-OFF				
					TV-OFF				
					PRO				
						F 37 BB			
					00E				
				P00		BB BB			
DOCK+2MIN			30	P00	RECONFIGURE DAP				
					V48E				
						F 04 46	11102 X1111		
					V21E 61111E				
						F 04 46	61111 X1111		
					PRO				
						F 06 47	+XXXXX. +XXXXX.		
					PRO				
						F 06 48	+XXX.XX +XXX.XX		
					PRO				
						BB BB			
DOCK+3MIN			31	P00	CONFIGURE SWITCHES FOR POST-DOCKING				
					CMC MODE-AUTO			1	
					RNDZ XPNDR-OFF			100	

4.0 CMP SUPPLEMENTARY PROCEDURES

The supplemental CMP procedures are non-nominal procedures for backing up a LM active plane change burn, performing a CSM active burn, or obtaining a LM insertion state vector uplink. The format used for the procedures is identical to the format used for the abort detailed procedures (Section 3.3).

4.1 PLANE CHANGE BURNS

During a coelliptic rendezvous, the LM is scheduled to apply a plane change burn 30 minutes prior to the CDH maneuver if the required PC DV is greater than five feet per second. The CMC MINKEY logic schedules either an RCS or an SPS burn to enable the CMP to backup the maneuver. The PC is not applied if it is less than five feet per second. In this event the CMP bypasses the MINKEY PC burn sequence by loading N81 with zeros.

4.1.1 RCS PLANE CHANGE

If the CMC computed CSM PC DV is less than seven feet per second, the MINKEY logic will specify that the CMP backup the LM PC with P41. To apply the burn the CMP would use the following procedures to burn the P41 N85 values to zero.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * * * * * *				
					RCS PLANE CHANGE				
					* * * * * * * * * *				
				P36		F 06 81	+0000.0 +000X.X +0000.0		
					PRO	F 16 45	+XXBXX -XXBXX +XXX.XX		
					PRO				
				P52		F 06 22	+XXX.XX +XXX.XX +XXX.XX		
					PRO				
						F 50 25	00020		
					ENTER				BYPASS IMU TORQUE
				P41		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ENTER				BYPASS MNVR
						06 85	+XXXX.X +XXXX.X +XXXX.X		
PC-35SEC					MONITOR DSKY BLANK	BB BB			
PC-30SEC									AVE G ON
						16 85	+XXXX.X +XXXX.X +XXXX.X		
PC TIG									LM PC
						F 16 85	+XXXX.X +XXXX.X +XXXX.X		
					VERIFY LM BURN COMPLETE				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
				P36	UPDATE LM S.V. IN CMC				
					PRO				
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO	F 06 84	+0000.0 ±000X.X +0000.0		
					PRO * * * * * * * * * * * * * * * * * * * CONTINUE WITH STEP 5 OF THE COMMON COELLIPTIC SEQUENCE, SECTION 3.3.3 * * * * * * * * * * * * * * * * * * *				

4.1.2 SPS PLANE CHANGE

If the CMC computed CSM PC DV is equal to or greater than seven feet per second, the MINKEY logic will provide the option to torque the platform so that the PC burn can be made with the SPS engine. The following procedures for the PC include torquing the platform, backing up the burn, and torquing the platform back to its original orientation.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * * * * *				
					SPS PLANE CHANGE				
					* * * * * * * * *				
				P36		F 06 81	+0000.0 +XXXX.X +0000.0		
					PRO				
						F 16 45	+XXBXX -XXBXX +XXX.XX		
					PRO				
				P52		F 06 22	+XXX.XX +XXX.XX +XXX.XX		
					ALIGN GDC				
					ATT SET TW-SET TO ROLL-90 OR 270 DEG			1	
					PITCH- 0 OR 180 DEG			1	
					YAW- 0 DEG			1	
					FDAI SELECT-1			1	
					FDAI SOURCE-ATT SET(VERIFY)			1	
					ATT SET-GDC(VERIFY)			1	
					GDC ALIGN PB-PUSH UNTIL NEEDLES NULLED			1	
					FDAI SELECT-1/2			1	
					CMC MODE-FREE			1	
					PRO				
						F 50 25	00020		
					PRO				TORQUE PLATFORM
						F 16 20	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR PLATFORM TORQUING				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
				P40		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					CMC MODE-AUTO			1	
					PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR MANEUVER	F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					RECORD P76 DATA				OBTAIN TPI P76 FROM CDR
					CONFIGURE EMS				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					EMS FUNCTION-DV SET/VHF RNG			1	
					LOAD DV MINUS 11 FPS INTO EMS			1	
					EMS FUNCTION-DV			1	
					CONFIGURE SCS				
					CB STAB CONT SYS(ALL)-CLOSE			8	
					CB SPS(12)-CLOSE			8	
					MANUAL ATTITUDE(3)-RATE CMD(VERIFY)			1	
					RATE-LOW(VERIFY)			1	
					DV CG-CSM(VERIFY)			1	
					SPS HE VLVS(BOTH)-AUTO(VERIFY)			3	
					CHECK N2 A AND N2 B			3	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					TVC PREPARATION				
					SCS TVC(BOTH)-RATE CMD(VERIFY)			1	
					TVC GIMBAL DRIVE(BOTH)-AUTO(VERIFY)			1	
					MAIN BUS TIE(2)-ON			5	
					TVC SERVO POWER 1-AC1/MNA			7	
					TVC SERVO POWER 2-AC2/MNB			7	
					ROT CONTR PWR NORMAL 2-AC			1	
					ROT CONTR PWR DIRECT 2-OFF(VERIFY)			1	
					ATT DEADBAND-MIN			1	
					BMAG MODE(3)-ATT 1/RATE 2			1	
					SC CONT-SCS			1	
					RHC 2-ARMED				
					PRIMARY TVC CHECK				
					SPS GIMBAL MOTORS PITCH 1-START/ON			1	
					YAW 1-START/ON			1	
					VERIFY TRIM CONTROL AND SET			1	
					VERIFY MTVC				
					SC CONT-CMC			1	
					THC-CLOCKWISE				
					VERIFY NO MTVC				
					SECONDARY TVC CHECK:				
					SPS GIMBAL MOTORS PITCH 2-START/ON			1	
					YAW 2-START/ON			1	
					SET GPI TRIM			1	
					VERIFY MTVC				
					THC-NEUTRAL				
					VERIFY NO MTVC				
					VERIFY GPI RETURNS TO 0,0				
					ROT CONTR PWR NORMAL(BOTH)-AC/DC			1	
					ROT CONTR PWR DIRECT(BOTH)-MNA/MNB			1	
					BMAG MODE(3)-RATE 2			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO				
						06 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR TRIM MANEUVER				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					BMAG MODE(3)-ATT 1/RATE 2			1	
					ENTER				
						F 50 25	00204		
					PRO				
					MONITOR GPI RESPONSE:	BB BB			
						06 40	-XXBXX		
							+XXXX.X		
							+0000.0		
					FDAI SCALE-5/1(VERIFY)			1	
					VERIFY DET SET			1	
					RATE-HIGH			1	
PC-01MIN					EMS MODE-NORMAL			1	
					TRANS CONTR PWR-ON			1	
					THC-ARMED				
PC-35SEC					MONITOR DSKY BLANK	BB BB			
PC-30SEC									AVE G ON
						06 40	-00B29		
							+XXXX.X		
							+XXXX.X		
					CHECK PIPA BIAS LESS				
					THAN 2 FPS FOR 5 SEC				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
PC-05SEC						F 99 40	-00B05 +XXXX.X +0000.0		ENGINE ON ENABLE REQUEST
PC TIG									LM PC
					CONFIRM LM BURN COMPLETE				
					ENTER				
						F 16 85	+XXXX.X +XXXX.X +XXXX.X		
					SPS GIMBAL MOTORS(4)-OFF SEQUENTIALLY			1	
					TVC SERVO POWER(BOTH)-OFF			7	
					RHC 2-LOCKED				
					THC-LOCKED				
					TRANS CONTR PWR-OFF			1	
					ROT CONTR PWR DIRECT(BOTH)-OFF			1	
					CB DIRECT ULLAGE(BOTH)-OPEN			8	
					CB SPS PITCH 1 AND YAW 1-OPEN			8	
					RECORD DV COUNTER AND RESIDUALS				
					EMS FUNCTION-OFF			1	
					EMS MODE-STBY			1	
				P40	UPDATE LM S.V. IN THE CMC				
					PRO				
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					ATT DEADBAND-MAX			1	
					RATE-LOW			1	
					BMAG MODE(3)-RATE 2			1	
					MAIN BUS TIE(2)-OFF			5	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO				
						F 06 84	+XXX.XX ±XXX.XX ±XXX.XX		
					RHC-MANUALLY MANEUVER BACK TO ORIGINAL GDC ATTITUDE(IF REQUIRED)				
					PRO				
				P20		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					PRO				
						06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR MANEUVER				
				P52		F 06 22	+XXX.XX +XXX.XX +XXX.XX		
					PRO				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
						F 50 25	00020		
					CMC MODE-FREE			1	
					PRO				TORQUE PLATFORM
						F 16 20	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR PLATFORM TORQUING				
					CMC MODE-AUTO			1	
					RECONFIGURE EMS FOR RANGING				
					EMS FUNCTION-DV SET/VHF RNG			1	
					EMS MODE-BACKUP/VHF RNG			1	
					VHF RNG-RESET			9	
					* * * * * * * * * * * * * * * * * * *				
					CONTINUE WITH STEP 5 OF THE COMMON COELLIPTIC SEQUENCE, SECTION 3.3.3				
					* * * * * * * * * * * * * * * * * * *				

4.2 CSM ACTIVE BURNS

The CSM active burn procedures used by the CMP to perform TPI, MCC, and braking are presented. In all cases it is assumed that the LM has lost all translation capability and did not perform any part of the burn.

4.2.1 TPI BURN

The following procedures for performing the TPI burn involve recalling P40, applying the CMC computed TPI burn and re-entering the MINKEY sequencer by calling P35.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * TPI BURN * * * * *				
				P40	RECALL SPS THRUSTING PROGRAM V37E 40E				
				P40		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					TVC PREPARATION				
					SCS TVC(BOTH)-RATE CMD(VERIFY)			1	
					TVC GIMBAL DRIVE(BOTH)-AUTO(VERIFY)			1	
					MAIN BUS TIE(2)-ON			5	
					TVC SERVO POWER 1-AC1/MNA			7	
					TVC SERVO POWER 2-AC2/MNB			7	
					ROT CONTR PWR NORMAL 2-AC			1	
					ROT CONTR PWR DIRECT 2-OFF(VERIFY)			1	
					ATT DEADBAND-MIN			1	
					BMAG MODE(3)-ATT 1/RATE 2			1	
					SC CONT-SCS			1	
					RHC 2-ARMED				
					PRIMARY TVC CHECK				
					SPS GIMBAL MOTORS PITCH 1-START/ON			1	
					YAW 1-START/ON			1	
					VERIFY TRIM CONTROL AND SET			1	
					VERIFY MTVC				
					SC CONT-CMC			1	
					THC-CLOCKWISE				
					VERIFY NO MTVC				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					SECONDARY TVC CHECK				
					SPS GIMBAL MOTORS PITCH 2-START/ON			1	
					YAW 2-START/ON			1	
					SET GPI TRIM			1	
					VERIFY MTVC				
					THC-NEUTRAL				
					VERIFY NO MTVC				
					VERIFY GPI RETURNS TO 0,0				
					ROT CONTR PWR NORMAL(BOTH)-AC/DC			1	
					ROT CONTR PWR DIRECT(BOTH)-MNA/MNB			1	
					BMAG MODE(3)-RATE 2			1	
					PRO				
						06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR TRIM MANEUVER				
						F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					BMAG MODE(3)-ATT 1/RATE 2			1	
					FDAI SCALE-5/1(VERIFY)			1	
					VERIFY DET SET			1	
					RATE-HIGH			1	
					EMS MODE-NORMAL			1	
					TRANS CONTR PWR-ON			1	
					DV THRUST A(B)-NORMAL			1	
					THC-ARMED				
					ENTER				
						F 50 25	00204		
					PRO				
					MONITOR GPI RESPONSE	BB BB			
									PROG LT-ON(SLIPPED TIG)
						06 40	+XXBXX +XXXX.X +0000.0		
					RESET				PROG LT-OFF

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI-35SEC					MONITOR DSKY BLANK	BB BB			
TPI-30SEC						06 40	-00B29 +XXXX.X +0000.0		AVE G ON
					CHECK PIPA BIAS LESS THAN 2 FPS FOR 5 SEC				
TPI-11SEC					THC-APPLY ULLAGE				
TPI-05SEC						F 99 40	-00B05 +XXXX.X +XXXX.X		ENGINE ON ENABLE REQUEST
					PRO	06 40	-00BXX +XXXX.X +XXXX.X		
					THC-TERMINATE ULLAGE AT TIG+1 SEC				
TPI TIG					MONITOR CSM TPI BURN	F 16 40	+00BXX +XXXX.X +XXXX.X		
					DV THRUST A(B)-OFF			1	
					PRO	F 16 85	+XXXX.X +XXXX.X +XXXX.X		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					SPS GIMBAL MOTORS(4)-OFF SEQUENTIALLY			1	
					TVC SERVO POWER(BOTH)-OFF			7	
					THC-NULL RESIDUALS				
						F 16 85	± XXXX.X ± XXXX.X ± XXXX.X		
					THC-LOCKED				
					RHC 2-LOCKED				
					TRANS CONTR PWR-OFF			1	
					ROT CONTR PWR DIRECT(BOTH)-OFF			1	
					CB DIRECT ULLAGE(BOTH)-OPEN			8	
					CB SPS PITCH 1 AND YAW 1-OPEN			8	
					RECORD DV COUNTER AND RESIDUALS				
					EMS FUNCTION-OFF			1	
					EMS MODE-STBY			1	
					PRO				
						F 37 BB			
TPI+03MIN				P40	INITIATE P35 AND RNDZ NAVIGATION				
					35E				
				P20					
				P35		F 50 25	00017		
					ATT DEADBAND-MAX			1	
					RATE-LOW			1	
					BMAG MODE(3)-RATE 2			1	
					MAIN BUS TIE(2)-OFF			5	
					PRO				
						F 16 45	+XXBXX +03BXX -00001		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					CONFIGURE EMS FOR RANGING				
					EMS FUNCTION-DV SET/VHF RNG			1	
					EMS MODE-BACKUP/VHF RNG			1	
					VHF RNG-RESET			9	
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
					* * * * * * * * * * * * * * * * * * * *				
					FOR DIRECT ASCENT RENDEZVOUS, CONTINUE WITH STEP 23 OF SECTION 2.3. FOR AN ABORT, CONTINUE WITH STEP 16 OF SECTION 3.3.3.				
					* * * * * * * * * * * * * * * * * * * *				

4.2.2 MCC BURN

If the LM attempts to apply the MCC burn but fails, the CMP would use the following procedures to burn the P41 N85 values to zero.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * MCC BURN * * * * *				
				P41	VERIFY NO LM BURN THC-ARMED RHC 2-ARMED TRANS CONTR PWR-ON			1	
MCC TIG						F 16 85	+XXXX.X +XXXX.X +XXXX.X		
					THC-NULL VG'S	F 16 85	+0000.0 +0000.0 +0000.0		
					THC-LOCKED RHC 2-LOCKED TRANS CONTR PWR-OFF			1	
MCC+02MIN				P41	UPDATE LM S.V. IN THE CMC PRO				
				P76		F 06 33	+00XXX. +000XX. +0XX.XX		
					PRO	F 06 84	+0000.0 +0000.0 +0000.0		
					* * * * * * * * * * * * * * * * FOR A DIRECT ASCENT RENDEZVOUS CONTINUE WITH STEP 26(30) OF SECTION 2.3. FOR AN ABORT, CONTINUE WITH STEP 19(23) OF SECTION 3.3.3. * * * * * * * * * * * * * * * *				

4.2.3 PRE-BRAKING SPS BURN

If the CSM is the active vehicle and an excessive TPF DV exists (Register 3 of N58 greater than 55 feet per second), the CMP should use the following procedures to perform a pre-braking burn. The burn procedures are initiated by recalling P34 after MCC-1. The burn is scheduled for TPI+37 minutes and a transfer angle equal to one-half the TPF DV in N58 is loaded into N55. The burn re-establishes the nominal closing rate at the desired range.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * * * * * * *				
					PRE-BRAKING SPS BURN				
					* * * * * * * * * * *				
					COMPUTE TPI(2)TIG=TPI TIG+37 MIN				
					COMPUTE TRANSFER ANG=(TPF DELTA V)/2				
TPI+18MIN				P76	INITIATE P34 AND RNDZ NAVIGATION				
					V93E				
					V37E 34E				
				P20					
				P34		F 50 25	00017		
					PRO	F 06 37	+00XXX. +000XX. +0XX.XX		
					V25E +XXXE +XXE +XXXXE				LOAD COMPUTED TPI(2)TIG
						F 06 37	+00XXX. +000XX. +0XX.XX		
					PRO				
						F 06 55	+00000 +000.00 +130.00		
					V23E +XXXXXE				LOAD COMPUTED TRANSFER ANGLE
						F 06 55	+00000 +000.00 +XXX.XX		
					PRO				
						F 16 45	+XXBXX -17BXX -00001		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
				P34	START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
TIG-10MIN				P34	COMPUTE P34 SOLUTION AND TERMINATE NAV				
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LOW			122	
					OPTICS MODE-CMC			122	
					PRO	F 06 55	+00000 +XXX.XX +XXX.XX		
					RECORD DATA				
					PRO	F 06 58	+XXXX.X +XXXX.X +XXXX.X		
					RECORD DATA				
					PRO	F 06 81	+XXXX.X +XXXX.X +XXXX.X		
					RECORD DATA				
					PRO	F 16 45	+XXBXX -08BXX +XXX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TIG-08MIN				P34	RECONFIGURE DAP				
					V48E	F 04 46	11102 X1111		
					V21E 11103E	F 04 46	11103 X1111		
					PRO	F 06 47	+XXXXX. +05900.		
					PRO	F 06 48	+XXX.XX +XXX.XX		
					PRO	F 16 45	+XXBXX -07BXX +XXX.XX		
TIG-07MIN				P34	INITIATE P40 THRUSTING PROGRAM				
					PRO	F 50 18	+XXX.XX +XXX.XX +XXX.XX		
				P40	PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR MANEUVER	F 50 18	+XXX.XX +XXX.XX +XXX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TIG-05MIN					CONFIGURE EMS				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					EMS FUNCTION-DV SET/VHF RNG			1	
					LOAD DV MINUS 11 FPS INTO EMS			1	
					EMS FUNCTION-DV			1	
					CONFIGURE SCS				
					CB STAB CONT SYS(ALL)-CLOSE			8	
					CB SPS(12)-CLOSE			8	
					MANUAL ATTITUDE(3)-RATE CMD(VERIFY)			1	
					RATE-LOW(VERIFY)			1	
					DV CG-CSM(VERIFY)			1	
					SPS HE VLVS(BOTH)-AUTO(VERIFY)			3	
					CHECK N2 A AND N2 B			3	
					TVC PREPARATION				
					SCS TVC(BOTH)-RATE CMD(VERIFY)			1	
					TVC GIMBAL DRIVE(BOTH)-AUTO(VERIFY)			1	
					MAIN BUS TIE(2)-ON			5	
					TVC SERVO POWER 1-AC1/MNA			7	
					TVC SERVO POWER 2-AC2/MNB			7	
					ROT CONTR PWR NORMAL 2-AC			1	
					ROT CONTR PWR DIRECT 2-OFF(VERIFY)			1	
					ATT DEADBAND-MIN			1	
					BMAG MODE(3)-ATT 1/RATE 2			1	
					SC CONT-SCS			1	
					RHC 2-ARMED				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRIMARY TVC CHECK:				
					SPS GIMBAL MOTORS PITCH 1-START/ON			1	
					YAW 1-START/ON			1	
					VERIFY TRIM CONTROL AND SET				
					VERIFY MTVC				
					SC CONT-CMC			1	
					THC-CLOCKWISE				
					VERIFY NO MTVC				
					SECONDARY TVC CHECK:				
					SPS GIMBAL MOTORS PITCH 2-START/ON			1	
					YAW 2-START/ON			1	
					SET GPI TRIM			1	
					VERIFY MTVC				
					THC-NEUTRAL				
					VERIFY NO MTVC				
					VERIFY GPI RETURN TO 0,0				
					ROT CONTR PWR NORMAL(BOTH)-AC/DC			1	
					DIRECT(BOTH)-MNA/MNB			1	
					BMAG MODE(3)-RATE 2			1	
				PRO					
						06 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR TRIM MANEUVER				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					BMAG MODE(3)-ATT 1/RATE 2			1	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					ENTER				
						F 50 25	00204		
					PRO				
					MONITOR GPI RESPONSE:	BB BB			
						06 40	-XXBXX		
							+XXXX.X		
							+0000.0		
					FDAI SCALE-5/1(VERIFY)			1	
					VERIFY DET SET			1	
					RATE-HIGH			1	
TIG-01MIN					EMS MODE-NORMAL			1	
					TRANS CONTR PWR-ON			1	
					DV THRUST A(B)-NORMAL			1	
					THC-ARMED				
TIG-35SEC					MONITOR DSKY BLANK	BB BB			
TIG-30SEC									AVE G ON
						06 40	-00B29		
							+XXXX.X		
							+0000.0		
					CHECK PIPA BIAS LESS THAN 2 FPS FOR 5 SEC				
TIG-11SEC					THC-APPLY ULLAGE				
TIG-05SEC						F 99 40	-00B05		ENGINE ON ENABLE REQUEST
							+XXXX.X		
							+XXXX.X		
					PRO				
						06 40	-00BXX		
							+XXXX.X		
							+XXXX.X		
TPI(2)TIG					THC-TERMINATE ULLAGE AT TIG +1 SEC				
					MONITOR CSM TPI(2) BURN				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
						F 16 40	+00BXX +XXXX.X +XXXX.X		
					DV THRUST A(B)-OFF			1	
					PRO				
						F 16 85	+XXXX.X +XXXX.X +XXXX.X		
					SPS GIMBAL MOTORS(4)-OFF SEQUENTIALLY			1	
					TVC SERVO POWER(BOTH)-OFF			7	
					THC-NULL RESIDUALS				
						F 16 85	+XXXX.X +XXXX.X +XXXX.X		
					RHC 2-LOCKED				
					THC-LOCKED				
					TRANS CONTR PWR-OFF			1	
					ROT CONTR PWR DIRECT(BOTH)-OFF			1	
					CB DIRECT ULLAGE(BOTH)-OPEN			8	
					CB SPS PITCH 1 AND YAW 1-OPEN			8	
					RECORD DV COUNTER AND RESIDUALS				
					EMS FUNCTION-OFF			1	
					EMS MODE-STBY			1	
TIG+02MIN				P40	MANEUVER TO COAS TRACK ATTITUDE				
					V37E 79E				
				P79		F 50 18	+XXX.XX +XXX.XX +XXX.XX		
					ATT DEADBAND-MAX			1	
					RATE-LOW			1	
					BMAG MODE(3)-RATE 2			1	
					MAIN BUS TIE(2)-OFF			5	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					V37E 00E				
				P00		BB BB			
					V49E				
						F 06 22	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					PRO				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					PRO				
						06 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					MONITOR MANEUVER				
						F 50 18	+XXX.XX		
							+XXX.XX		
							+XXX.XX		
					ENTER				
						BB BB			
					V83E				
						F 16 54	+XXX.XX		
							-XXXX.X		
							+XXX.XX		
					CONFIGURE EMS FOR RANGING				
					EMS FUNCTION-DV SET/VHF RNG			1	
					EMS MODE-BACKUP/VHF RNG			1	
					VHF RNG-RESET			9	
TPI+39MIN				P00	ACQUIRE MSFN WITH HGA				
					HIGH GAIN ANTENNA TRACK-MAN			2	
					HGA PITCH POSITION-SET PITCH POSITION			2	
					HGA YAW POSITION-SET YAW POSITION			2	
					S BAND ANTENNA-HI GAIN			3	
					HIGH GAIN ANTENNA TRACK-AUTO			2	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
TPI+40MIN				P00	RECONFIGURE DAP				
					PRO	BB BB			
					V48E	F 04 46	11103 X1111		
					V21E 11102E	F 04 46	11102 X1111		
					PRO	F 06 47	+XXXXX. +05900.		
					PRO	F 06 48	+XXX.XX +XXX.XX		
					PRO	BB BB			
				P00	PERFORM DOCKING PREPARATION ACTIVITIES				
					PERFORM PRE-DOCK CHECKLIST				
					MANUAL ATTITUDE(3)-RATE CMD(VERIFY)			1	
					LIMIT CYCLE-OFF(VERIFY)			1	
					ATT DEADBAND-MIN			1	
					RATE-LOW(VERIFY)			1	
					TRANS CONTR PWR-ON			1	
					ROT CONTR PWR DIRECT(BOTH)-MNA/MNB			1	
					SC CONT-CMC(VERIFY)			1	
					CMC MODE-AUTO(VERIFY)			1	
					AUTO RCS SELECT(16)-MNA/MNB(VERIFY)			8	
					CB DOCK PROBE(2)-CLOSE			8	

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					DOCKING PROBE RETRACT(BOTH)-OFF(CTR) (VERIFY)			2	
					DOCKING PROBE-RETRACT			2	
					DOCKING PROBE EXTD/REL TB(2)-GRAY (VERIFY)			2	
					CB SEQ EVENTS CONT SYS(4)-CLOSE(VERIFY)			8	
					COAS POWER-ON(UP)(VERIFY)			15	
					EXTERIOR LIGHTS RUN/EVA-ON(UP)(VERIFY)			2	
									IF CSM ACTIVE BRAKING, SEE SECTION 4.2.4.
					PHOTOGRAPH LM				
					UTILITY POWER-ON(UP)(VERIFY)			15	
					TV-ON				
					DAC-ON				
					BEGIN PHOTOS WITH DAC AND TV				
									TPF
					CONFIGURE SWITCHES FOR POST-TPF				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					EXTERIOR LIGHTS RNDZ-OFF(CTR)			2	
					TERMINATE LM PHOTOS				
					DAC-OFF				
					TV-OFF				
					* * * * * * * * * * * * * * * * * * * *				
					FOR DIRECT ASCENT RENDEZVOUS, CONTINUE WITH STEP 33 OF SECTION 2.3. FOR AN ABORT, CONTINUE WITH STEP 26 OF SECTION 3.3.3.				
					* * * * * * * * * * * * * * * * * * * *				

4.2.4 BRAKING

If the CSM is the active vehicle, the following braking procedures are used by the CMP after MCC-2 to achieve station-keeping.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * BRAKING * * * *				
				P00	INITIATE THRUST MONITOR PROGRAM				
					MONITOR EMS RANGE UNTIL 1.25 NM				
					V37E 47E				PERFORM WHEN RANGE = 1.25 NM
				P47		F 16 83	+0000.0 +0000.0 +0000.0		
					SM RCS SEC PRPLNT FUEL PRESS(4)-OPEN			2	
					V83E	F 16 54	+001.XX -XXXX.X +XXX.XX		
					THC-ARMED RHC 2-ARMED				
					MONITOR EMS RANGE UNTIL 1.11 NM (APPROX)				
					N83E				KEY RELEASE LT-ON
						F 16 83	+0000.0 +0000.0 +0000.0		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					MONITOR F 16 83, R1 THC-THRUST AFT TO REDUCE RDOT TO -30.0 FPS AT 1.00 NM				
					KEY "KEY RELEASE"	F 16 54	+001.00 -0030.0 +XXX.XX		KEY RELEASE LT-OFF
					THC-NULL LINE-OF-SIGHT RATES MONITOR EMS RANGE UNTIL 0.65 NM (APPROX)				
					N83E	F 16 83	+XXXX.X +XXXX.X +XXXX.X		KEY RELEASE LT-ON
					MONITOR F 16 83, R1 THC-THRUST AFT TO REDUCE RDOT TO -20.0 FPS AT 0.50 NM				
					KEY "KEY RELEASE"	F 16 54	+000.50 -0020.0 +XXX.XX		KEY RELEASE LT-OFF
					THC-NULL LINE-OF-SIGHT RATES MONITOR EMS RANGE UNTIL 0.35 NM (APPROX)				
					N83E	F 16 83	+XXXX.X +XXXX.X +XXXX.X		KEY RELEASE LT-ON
					MONITOR F 16 83, R1 THC-THRUST AFT TO REDUCE RDOT TO -10.0 FPS AT 0.25 NM				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					KEY "KEY RELEASE"	F 16 54	+000.25 -0010.0 +XXX.XX		KEY RELEASE LT-OFF
					THC-NULL LINE-OF-SIGHT RATES MONITOR EMS RANGE UNTIL .09 NM (APPROX)				
					N83E	F 16 83	+XXXX.X +XXXX.X +XXXX.X		KEY RELEASE LT-ON
					MONITOR F 16 83, R1 THC-THRUST AFT TO REDUCE RDOT TO -5.0 FPS AT .08 NM				
					KEY "KEY RELEASE"	F 16 54	+000.08 -0005.0 +XXX.XX		KEY RELEASE LT-OFF
					MONITOR LM THRU COAS RHC-CENTER LM IN COAS THC-NULL LINE-OF-SIGHT RATES MONITOR LM GROWTH IN COAS FOR RANGE AND RDOT THC-THRUST AFT TO REDUCE RDOT TO ZERO AT 100 FT(LM DIAMETER APPROX 8.5 DEG)				
					PRO	F 16 83	+XXXX.X +XXXX.X +XXXX.X		
					RECORD N83 VALUES				

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
				P47	MAINTAIN STATION KEEPING				
				P47	PHOTOGRAPH LM				
					UTILITY POWER-ON(UP)(VERIFY)			15	
					TV-ON				
					DAC-ON				
					BEGIN PHOTOS WITH DAC AND TV				
				P47	CONFIGURE SWITCHES FOR POST-TPF				
					EMS MODE-STBY			1	
					EMS FUNCTION-OFF			1	
					EXTERIOR LIGHTS RNDZ-OFF(CTR)			2	
				P47	TERMINATE LM PHOTOS AND P47				
					PRO				
						F 37 BB			
					00E				
				P00		BB BB			
					DAC-OFF				
					TV-OFF				
					* * * * * * * * * * * * * * * * * * * *				
					FOR DIRECT ASCENT RENDEZVOUS, CONTINUE WITH STEP 33 OF SECTION 2.3. FOR AN ABORT, CONTINUE WITH STEP 26 OF SECTION 3.3.3.				
					* * * * * * * * * * * * * * * * * * * *				

4.3 POST-INSERTION UPLINK

If necessary the following procedures are used by the CMP to obtain a CMC LM state vector uplink after insertion during the Direct Ascent rendezvous.

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					* * * * * * * * * * *				
					POST-INSERTION UPLINK				
					* * * * * * * * * * *				
TPI-36MIN				P34	ACCEPT MSFN UPLINK				
					OPTICS SPEED-HI			122	
					OHC-DRIVE TRUNNION TO LESS THAN 10 DEG			122	
					OPTICS ZERO-ZERO			122	
					OPTICS SPEED-LO			122	
					OPTICS MODE-CMC			122	
					V37E 00E	BB BB			
				P00					
					CMC MODE-AUTO			1	
					UP TLM CM-ACCEPT			2	
				P27	VERIFY UPLINK ACTIVITY LT-ON				UPLINK ACT LT-ON
					MONITOR UPLINK	XX XX	XXXXX XXXXX XXXXX		
				P00	VERIFY UPLINK ACTIVITY LT-OFF	BB BB			UPLINK ACT LT-OFF
					UP TLM CM-BLOCK			2	
					V37E 34E				
				P20					
				P34		F 50 25	00017		
					PRO				
						F 50 18	+XXX.XX +XXX.XX +XXX.XX		

GET H:M:S	LTNG	MSFN	STEP	PROG	OPERATIONS	V-N DISPLAY	REGISTER DISPLAYS	STA PANEL	COMMENTS
					PRO	06 18	+XXX.XX +XXX.XX +XXX.XX		
					MONITOR MANEUVER	F 06 37	+XXXXX. +XXXXX. +XXX.XX		
					PRO	F 06 55	+00000. +000.00 +130.00		
					PRO	F 16 45	+XXBXX -XXBXX -00001		
					V22 N79E +500E				LOAD WIDE DEADBAND VOICE CHECK
					VERIFY LM TRACKER LT-ON				
					START SEXTANT MARKING				
					OPTICS ZERO-OFF			122	
					OPTICS MODE-MAN			122	
					OHC-CENTER LM IN SXT			122	
					TAKE ONE SXT MARK PER MIN				
					* * * * * * * * * * *				
					CONTINUE WITH STEP 1.7				
					OF SECTION 2.3.				
					* * * * * * * * * * *				

5.0 ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ACCEL	Acceleration
AGS	Abort Guidance System
AIM	Abort Initiation Maneuver
ALT	Altitude
AM	Amplitude Modulation
AMPL	Amplifier
ANG	Angle
ANGL	Angle
ANT	Antenna
AOS	Acquisition of Signal
AOT	Alignment Optical Telescope
APPROX	Approximate
APS	Ascent Propulsion System
ATT	Attitude
AUTO	Automatic
AUX	Auxiliary
AVE	Average
B	Blank
BMAG	Body-Mounted Attitude Gyro
BP	Barber Pole
BU	Backup
CALIB	Calibration
CB	Circuit Breaker
CCW	Counterclockwise
CDH	Constant Delta Altitude
CDR	Commander
CG	Center of Gravity
CM	Command Module
CMC	Command Module Computer
CMD	Command
CMP	Command Module Pilot
COAS	Crew Optical Alignment Sight

COMM	Communication
COMP	Computation
CONDR	Conditioner
CONT	Control, Controller
CONTR	Control, Controller
CSI	Concentric Sequence Initiation
CSM	Command and Service Module
CTR	Center
CW	Clockwise
DAC	Data Acquisition Camera
DAP	Digital Autopilot
DC	Direct Current
DEG	Degree
DET	Digital Event Timer
DH	Delta Height
DN	Down
DPS	Descent Propulsion System
DSE	Data Storage Equipment
DSKY	Display and Keyboard
DV	Delta Velocity
E	Enter
ELEC	Electronics
ELEV	Elevation Angle
ELS	Earth Landing Subsystem
EMS	Entry Monitor System
EVA	Extravehicular Activity
EXTD	Extended
F	Flashing Verb-Noun Display
FDAI	Flight Director Attitude Indicator
FPS	Feet Per Second
FWD	Forward
G	Gravitational Acceleration
GDC	Gyro Display Coupler

GET	Ground Elapsed Time
GETI	Ground Elapsed Time of Ignition
GMBL	Gimbal
GND	Ground (Mission Control)
G&N	Guidance and Navigation
GPI	Gimbal Position Indicator
HA	Height of Apolune
HAM	Height Adjust Maneuver
HE	Helium
HGA	High Gain Antenna
HI	High
HORIZ	Horizontal
HP	Height of Perilune
HR	Hours
ICDU	Inertial Coupling Data Unit
IMU	Inertial Measurement Unit
IND	Indicator
INRTL	Inertial
INS	Insertion
LBS	Pounds
LEB	Lower Equipment Bay
LGC	Lunar Module Guidance Computer
LM	Lunar Module
LMP	Lunar Module Pilot
L/O	Lift-off
LO	Low
LOS	Loss of Signal, Line-of-Sight
LT	Light
LTNG	Lighting
LV	Local Vertical, Launch Vehicle
m	Minkey
MAN	Manual
MAX	Maximum

MCC	Midcourse Correction
MCC-H	Mission Control Center-Houston
MDC	Main Display Console
MGA	Middle Gimbal Angle
MIN	Minute, Minimum
MIN IMP	Minimum Impulse
MINKEY	Minimum Keystroke
MNA	Main Bus A
MNB	Main Bus B
MNVR	Maneuver
MSFN	Manned Space Flight Network
MTVC	Manual Thrust Vector Control
N	Noun
NASA	National Aeronautics and Space Administration
NAV	Navigation
NM	Nautical Miles
NO.	Number
NONESS	Nonessential
NORM	Normal
OCDU	Optical Coupling Data Unit
OHC	Optics Hand Controller
OMNI	Omnidirectional Antenna
OPR	Operate
OPT	Optics
ORB	Orbital
ORDEAL	Orbital Rate Drive Earth and Lunar
OSS	Optical Subsystem
P	Program, Pitch
PB	Pushbutton
PC	Plane Change, Chamber Pressure
PCM	Pulse Code Modulation
PDI	Powered Descent Initiation
PGNCS	Primary Guidance, Navigation and Control System

PHOTO	Photography, Photograph
PIPA	Pulse Integrating Pendulous Accelerometer
PL	Postlanding
PRIM	Primary
PRO	Proceed
PROG	Program
PROP, PRPLNT	Propellant
PWR	Power
PYRO	Pyrotechnic
R	Range, Register
RCS	Reaction Control System
RCV	Receive, Receiver
RDOT	Range Rate
REACQ	Reacquire
REFSMMAT	Reference Stable Member Matrix
REL	Release
REQ'D	Required
REV	Revolution
RNDZ	Rendezvous
RHC	Rotational Hand Controller
RNG	Ranging, Range
ROT	Rotation
RR	Rendezvous Radar
RSLV	Resolver
RSS	Root Sum Square
S	Shaft, Seconds
S/C, SC	Spacecraft
SCS	Stabilization and Control System
SEC	Seconds, Secondary
SECS	Sequential Events Control System
SEP	Separation
SEQ	Sequential
SIG	Signal
SIM	Scientific Instrument Module
SM	Service Module
SPS	Service Propulsion System

STA/PANEL	Station/Panel
STBY	Standby
S.V.	State Vector
SXT	Sextant
SYS	System
TB	Talkback
TEL	Telescope
TFI	Time from Ignition
TIG	Time of Ignition
THC	Translational Hand Controller
TLM	Telemetry
TPF	Terminal Phase Finalization
TPI	Terminal Phase Initiation
TRNFR	Transfer
TRUN	Trunnion
TV	Television
TVC	Thrust Vector Control
TW	Thumbwheel
V	Verb, Velocity
VG	Velocity to be Gained
VGX	Velocity to be Gained, X-Component
VGY	Velocity to be Gained, Y-Component
VGZ	Velocity to be Gained, Z-Component
VHF	Very High Frequency
VLV	Valve
VX	Velocity; X-Component
VY	Velocity; Y-Component
VZ	Velocity; Z-Component
WRI	W-Matrix Reinitialization
WT	Weight
XPNDR	Transponder
Y	Yaw

6.0 REFERENCES

1. Apollo 16 Flight Plan for 16 April 1972 Launch (Final); dated March 1972.

2. Apollo 16 CSM Rescue Book (Change A); dated 10 March 1972.

3. Apollo 16 G&C Checklist (Basic); dated 8 December 1971.

4. Apollo 15 CSM Rendezvous Procedures, MSC-04496; dated 30 June 1971.

5. Apollo Operations Handbook - Command and Service Module - Volume 2, MSC-04904 (Volume 2), dated 1 October 1971.

6. CSM/LM Spacecraft Operational Data Book, Volume III, SNA-8-D-027, REV 2, Amendment 94; dated 10 December 1970.

7. Guidance System Operations Plan for Manned CM Earth Orbital and Lunar Missions Using Program COLOSSUS 3, Section 4, Revision 17; dated November 1972.

8. LM Rendezvous Procedures, J2 and J3 Missions (Final); MSC-05183; dated 29 December 1971.

9. Operational LM Abort and Rescue Plan for Apollo 13, Volume II; MSC Internal Note No. 70-FM-9; dated 30 January 1970.

10. Apollo 16 Rendezvous Data for Flight Planning Based on a 16 April Launch Date; MSC Memorandum No. FM22(72-24); dated 1 February 1972.

11. Apollo Illumination Environment Simulation and Study; MSC-00130; dated June 1969.

APPENDIX A

CMP RENDEZVOUS NAVIGATION SCHEDULES

- NOMINAL RENDEZVOUS NAVIGATION SCHEDULES FOR THE DIRECT ASCENT RENDEZVOUS
- CONTINGENCY RENDEZVOUS NAVIGATION SCHEDULES FOR THE DIRECT ASCENT RENDEZVOUS
- NOMINAL RENDEZVOUS NAVIGATION SCHEDULES FOR COELLIPTIC RENDEZVOUS

NOMINAL RENDEZVOUS NAVIGATION SCHEDULES FOR THE DIRECT ASCENT RENDEZVOUS

A MSFN uplink is scheduled approximately two hours prior to lift-off and contains the predicted CSM state vector at lift-off and the predicted LM state vector at insertion +5 minutes. Another LM state vector uplink may be performed at insertion +9 minutes if required by CSM navigation sensor failure or inadequate post-tweak navigation.

The W-matrix reinitializations are controlled by the MINKEY logic. The logic reinitializes the W-matrix to 10,000 feet and 10 feet per second prior to the processing of the first mark of the pre-TPI marking period. After TPI the logic will reinitialize the W-matrix to 2,000 feet and two feet per second prior to the processing of the first mark after TPI and MCC-1. Figure A-1 contains the nominal rendezvous navigation schedule with and without the second MSFN uplink.

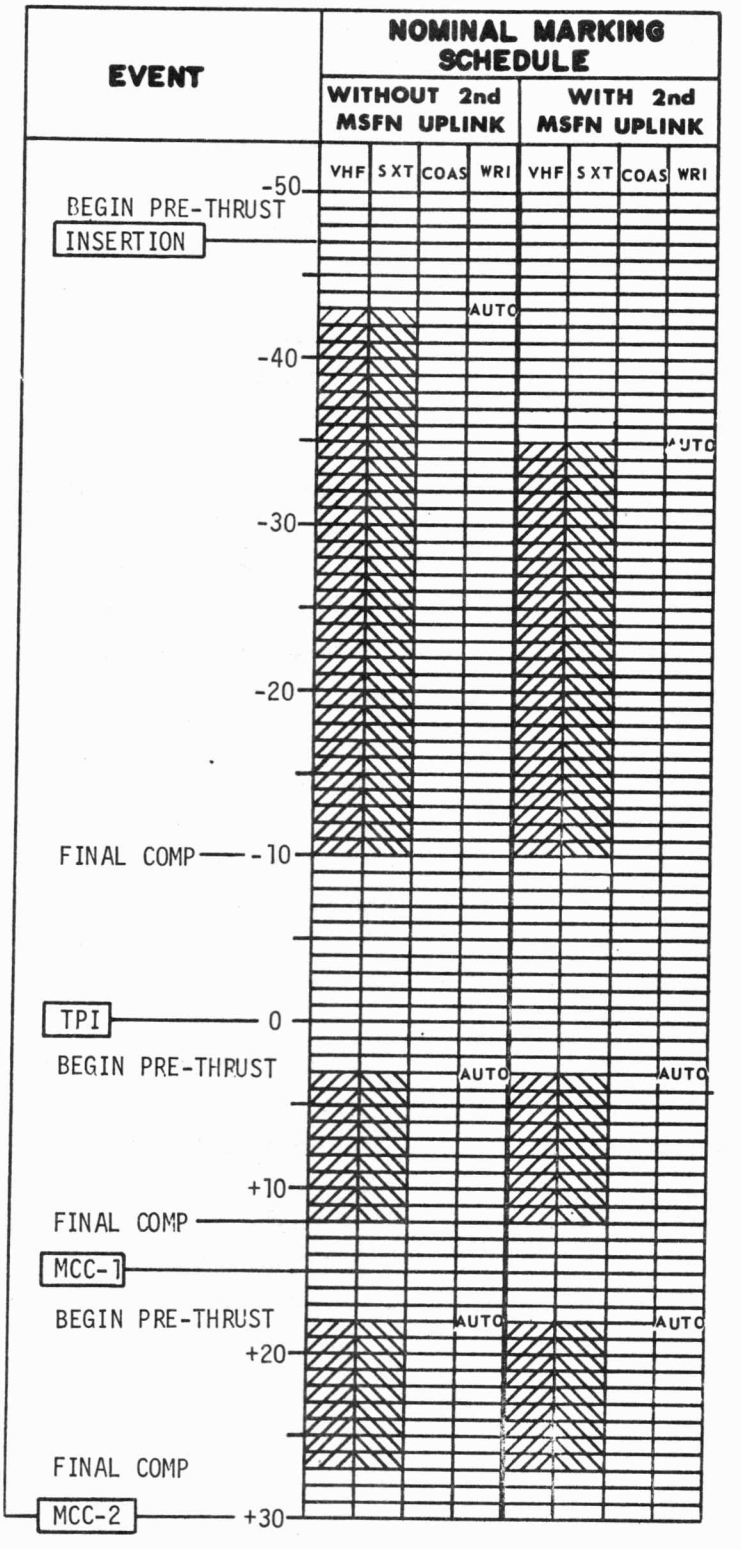

FIGURE A-1. NOMINAL RENDEZVOUS NAVIGATION SCHEDULES FOR THE DIRECT ASCENT RENDEZVOUS

CONTINGENCY RENDEZVOUS NAVIGATION SCHEDULES FOR THE DIRECT ASCENT RENDEZVOUS

Contingency navigation procedures are required for sextant, LM tracker light, and VHF failures. A schedule for each failure is contained in Figure A-2.

SEXTANT FAILURE (USABLE). In the event of a frozen but optically usable sextant, the COAS variance is manually loaded into the CMC prior to each marking period. The CMP must maneuver the CSM to center the LM in the frozen sextant. Upon centering the LM the CMP presses the mark button to record the mark. This failure alone does not require a LM state vector uplink after insertion.

LM TRACKER LIGHT FAILURE. In the event of a tracker light failure, optical marks cannot be taken during periods of darkness. The 12 sextant marks obtained prior to darkness should yield an acceptable TPI solution. Optics marks are again possible after the LM enters daylight immediately after MCC-1. This failure alone does not require a LM state vector uplink after insertion.

SEXTANT FAILURE (UNUSABLE). COAS marking is required in the event of an unusable sextant. The procedure for taking COAS marks requires manual X-axis tracking and use of Routine 23 (V54). This routine will:

A. Load the COAS variance into the CMC
B. Allow the CMP to load the shaft and trunnion angles that would result if the optics could be pointed along the X-axis
C. Provide a COAS marking display

To take a COAS mark the CMP maneuvers the CSM with the RHC to center the LM in the COAS. Once the LM has been centered, a mark is taken by pressing the ENTER key. This failure requires the LM state vector to be uplinked to the CMC after insertion.

VHF FAILURE[1]: In the event of a VHF failure, the nominal sextant marking schedule is followed; however, the FULTKFLG flag is set (V57, R2=1) before TPI to inhibit the second W-matrix reinitialization until after MCC-1. This failure requires the LM state vector to be uplinked to the CMC after insertion.

---

[1] This schedule does not account for the possibility of using the erasable memory program MARGIN to input ranging marks through the DSKY on voice command from the LM. Should this program be used, the nominal marking schedule would be applicable.

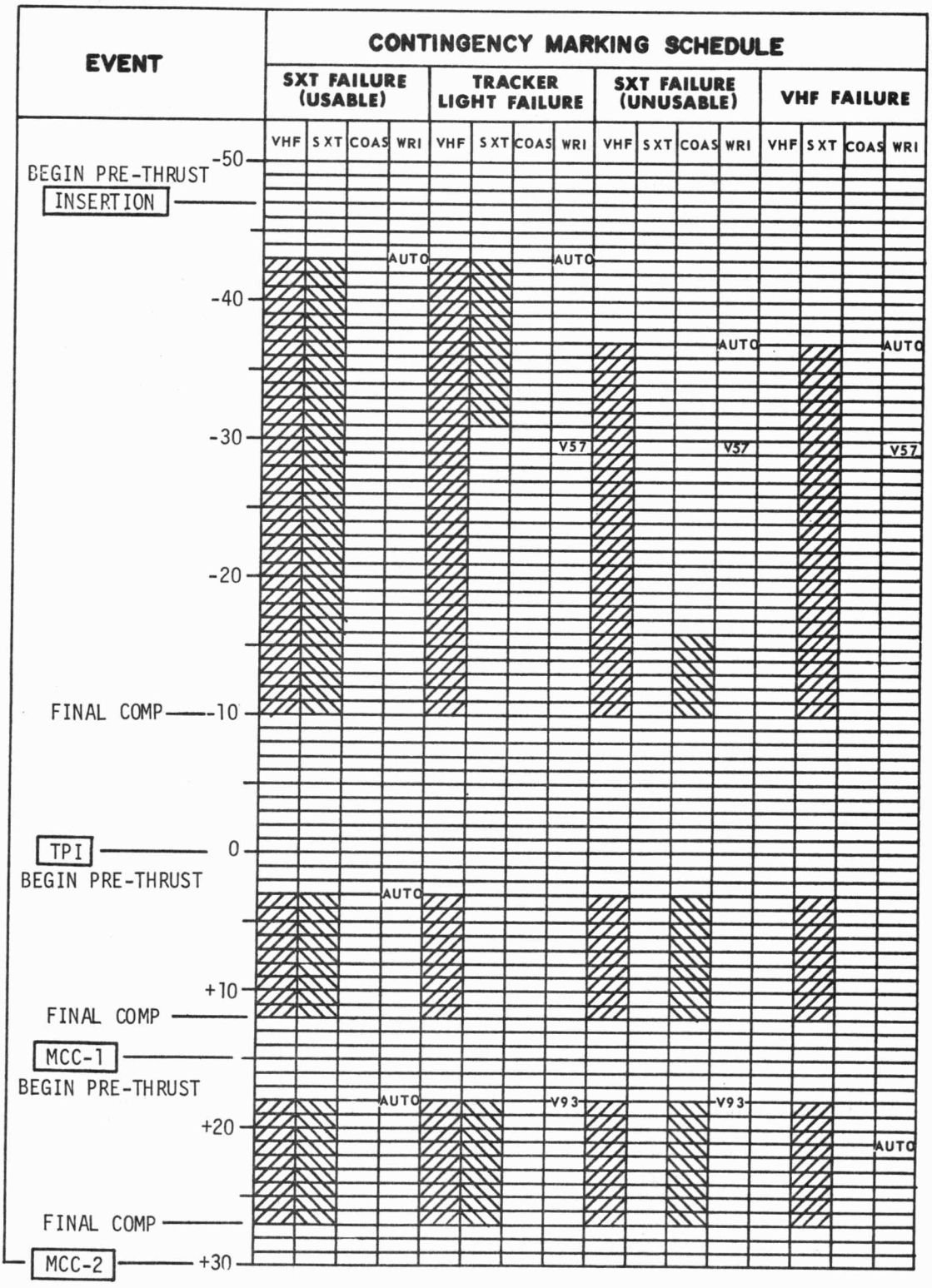

FIGURE A-2. CONTINGENCY NAVIGATION SCHEDULES FOR THE DIRECT ASCENT RENDEZVOUS

NOMINAL RENDEZVOUS NAVIGATION SCHEDULES FOR COELLIPTIC RENDEZVOUS

A MSFN uplink of the LM state vector will be required for LM aborts after PDI. The uplink is scheduled immediately after LM insertion. In the event of a no-PDI abort, P76 (rather than the MSFN uplink) is used to update the state vector. A second uplink prior to the HAM is scheduled for the Two Rev rendezvous because ranges greater than 327 nm will result in loss of CSM navigation. Ranges greater than 327 nm are probable during this period.

The W-matrix is nominally reinitialized by the MINKEY logic. This logic will reinitialize the W-matrix diagonals to 10,000 feet and 10 feet per second until a final comp has been performed; thereafter it will reinitialize to 2,000 feet and two feet per second. The diagonal values should be re-defined to 10,000 feet, 10 feet per second after HAM via V67 so that the first hybrid navigation will occur using the larger diagonals. The navigation schedule for the One Rev rendezvous through TPI is shown in Figure A-3. Figure A-4 contains the Two Rev navigation scheduled through TPI. This schedule assumes the full VHF navigation period prior to HAM.

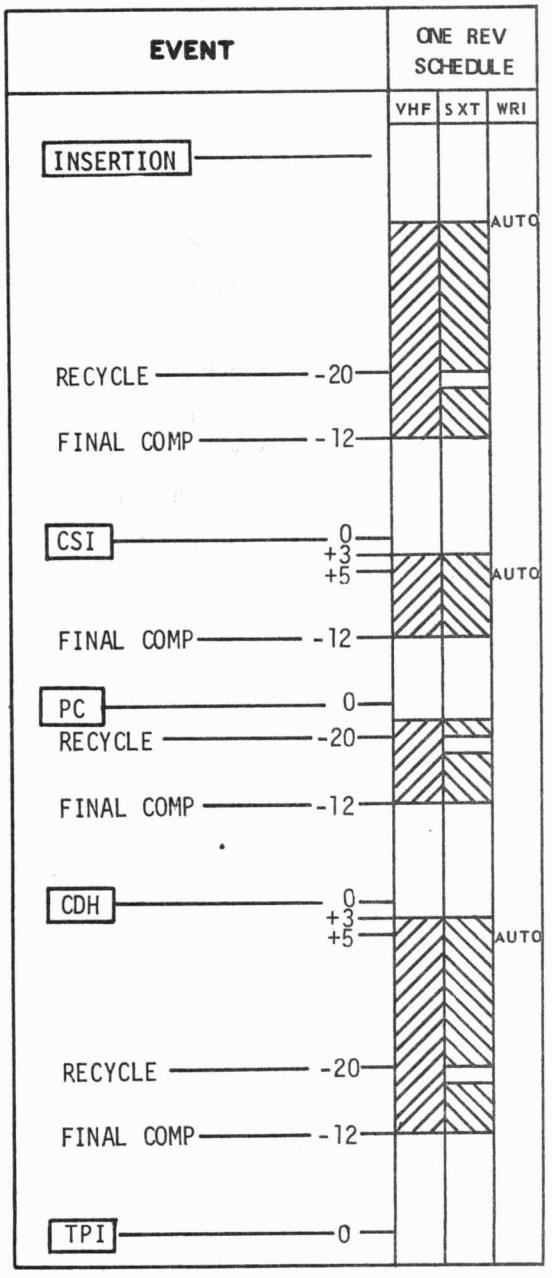

FIGURE A-3. NOMINAL NAVIGATION SCHEDULE FOR THE ONE REV RENDEZVOUS

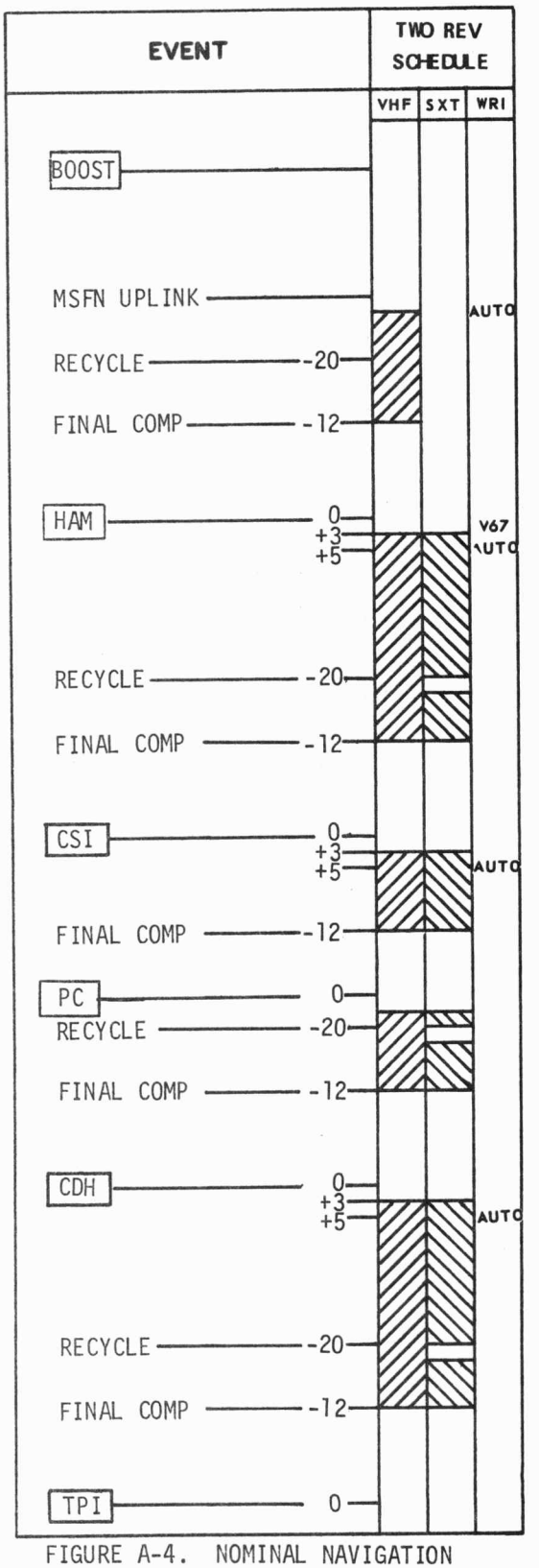

FIGURE A-4. NOMINAL NAVIGATION SCHEDULE FOR THE TWO REV RENDEZVOUS

APPENDIX B

CSM ATTITUDE REQUIREMENTS FOR THE NOMINAL APOLLO 16 RENDEZVOUS

The Apollo 16 CSM G&N rendezvous attitude requirements begin approximately two hours prior to LM lift-off and continue until docking.

The attitude maneuver and the events which impact or are impacted by CSM attitude are presented in Table B-1.

Figures B-1, B-2, and B-3 present the CSM attitude history for REVS 49, 50 and 51, respectively.

GET (HRS:MIN:SEC)	EVENT	INERTIAL ATTITUDE		MANEUVER TIME (MIN:SEC)
		START (ROLL,PITCH,YAW)	STOP (ROLL,PITCH,YAW)	
169:54:XX	MNVR TO COAS CALIB ATT		(180,258,357)	
170:00:XX	MSFN UPLINK	(180,258,357)		
170:10:XX	P52 (OPTION 3)	(180,258,357)		
170:15:XX	COAS CALIB	(180,258,357)		
171:23:XX	MNVR TO TRACK ATT	(180,258,357)	(180,000,000)	03:30
171:52:XX	MANUALLY TRACK LM WITH OHC	(180,000,000)		
172:01:XX	MSFN UPLINK (IF REQ'D)	(180,000,000)		
172:10:XX	BEGIN P20 TRACKING	(180,000,000)		
172:10:XX	TRACK LM	(180,000,000)	(180,306,000)	20:00
172:31:XX	MNVR TO TPI BURN ATT	(180,306,000)	(180,284,000)	00:40
172:39:22.9	TPI BURN	(180,284,000)		
172:41:XX	MNVR TO P20 TRACK ATT	(180,284,000)	(180,278,000)	00:10
172:42:XX	TRACK LM	(180,278,000)	(180,259,000)	11:20
172:54:22.9	MCC-1 BURN	(180,259,000)		
172:56:XX	MNVR TO P20 TRACK ATT	(180,259,000)	(180,254,000)	00:10
172:57:XX	TRACK LM	(180,254,000)	(180,248,000)	11:20
173:09:22.9	MCC-2 BURN	(180,248,000)		
173:11:XX	MNVR TO COAS TRACK ATT	(180,248,000)	(180,281,000)	01:10
173:22:16.5	TPF	(180,281,000)		
173:28:XX	MNVR TO SIM BAY INSPECTION ATT	(180,281,000)	(332,252,000)	04:40
173:37:XX	PERFORM MANUAL 360 DEG ROLL MNVR	(332,252,000)	(332,252,000)	03:00
173:40:XX	MNVR TO DOCKING ATT	(332,252,000)	(180,281,000)	04:40
173:50:00	DOCKING	(180,281,000)	(180,281,000)	

TABLE B-1. APOLLO 16 CSM MANEUVER REQUIREMENTS FOR DIRECT ASCENT RENDEZVOUS

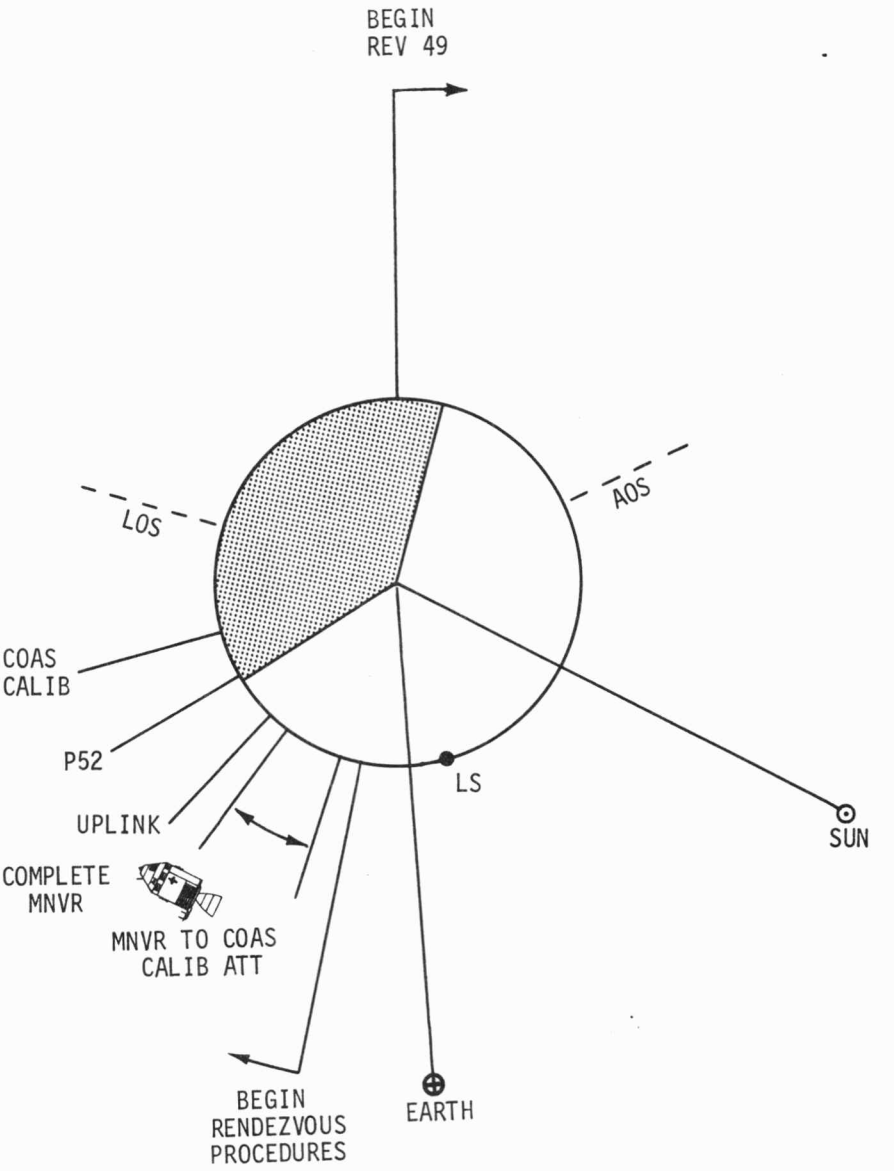

FIGURE B-1. CSM ATTITUDE HISTORY FOR REV 49

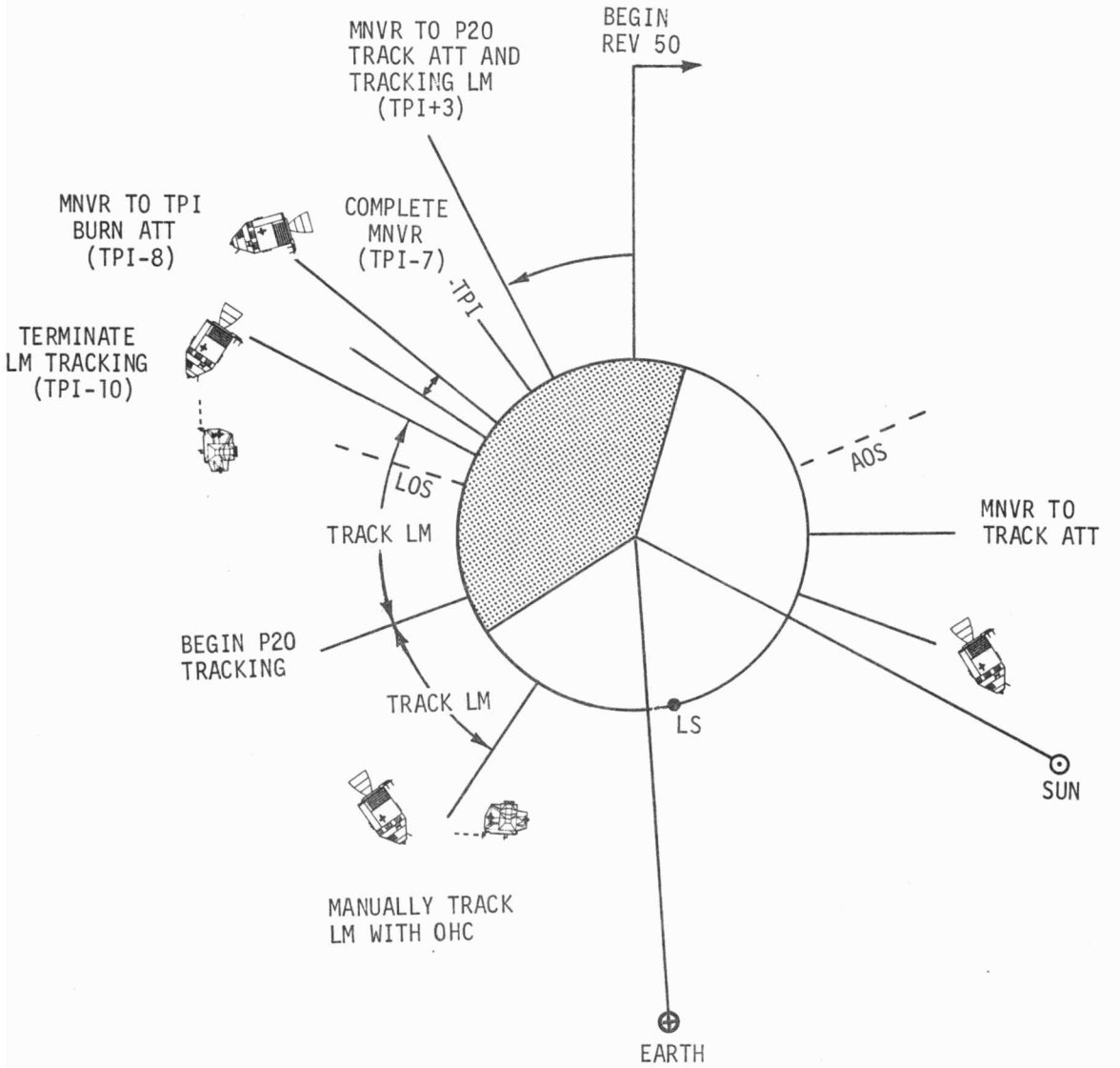

FIGURE B-2. CSM ATTITUDE HISTORY FOR REV 50

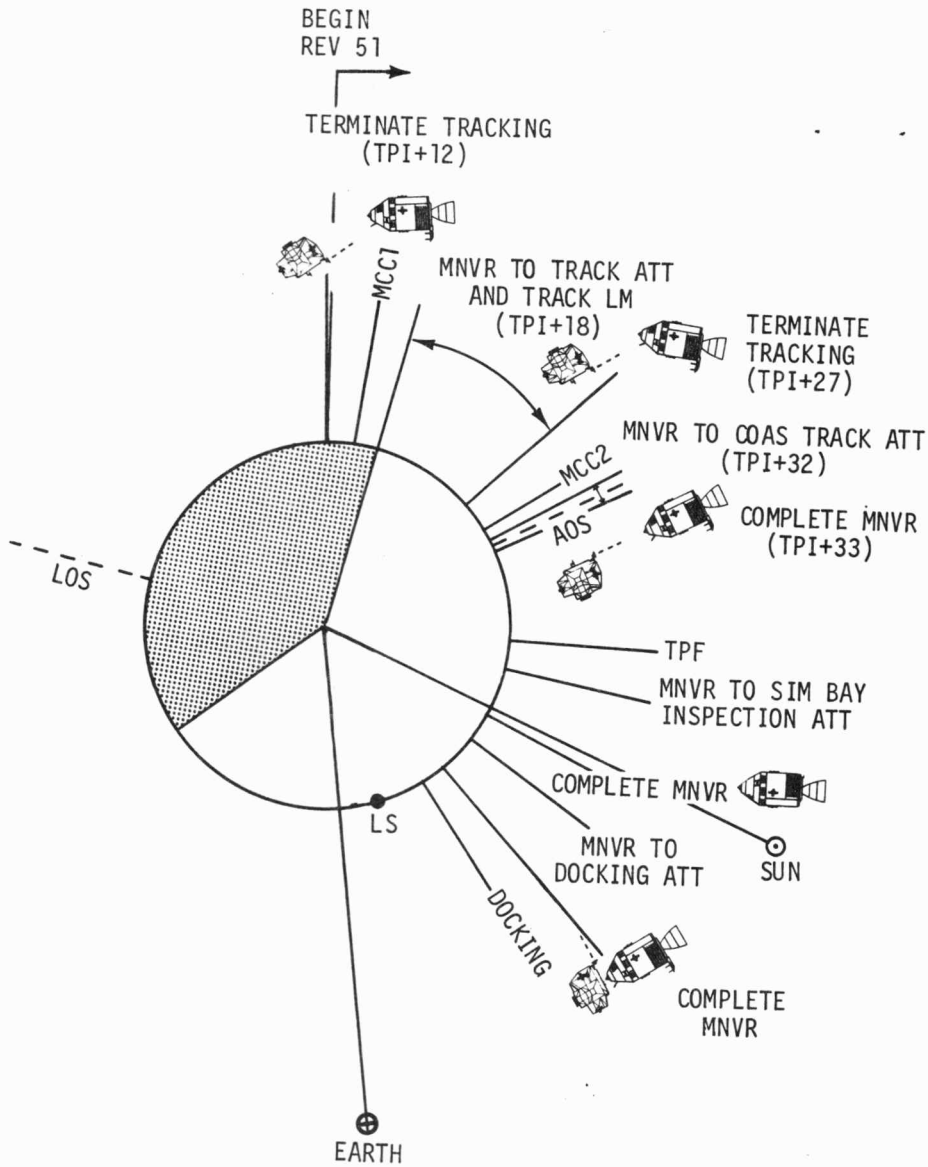

FIGURE B-3. CSM ATTITUDE HISTORY FOR REV 51

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APPENDIX C

CMP INTERFACE REQUIREMENTS FOR THE NOMINAL APOLLO 16 RENDEZVOUS

During a rendezvous, data must constantly be transferred between MSFN, CSM and LM. This appendix documents the data concerning the CMP to be exchanged during the rendezvous.

TIME	MSFN	CMP	CDR/LMP
169:00	VERIFY	ACQUIRE MSFN WITH HGA	
	UPLINK TO CMC: LM S.V. FOR INS+5 CSM S.V. FOR L/O RESET SURFACE FLAG	ACCEPT	
	UPDATE TO CSM: CONSUMABLES STATUS CSM S.V. FOR L/O LM S.V. FOR INS+5	COPY	
	UPDATE TO LM: ASCENT PADS CSI PAD LM DAP WEIGHTS	COPY AS REQUIRED	COPY
170:06	DSE DUMP		
170:12	COPY	REPORT P52 GYRO TORQUING ANGLES	
170:26	START DSE	VERIFY	
	ENABLE MSFN S-BAND	VERIFY	VERIFY
171:13	DSE DUMP	ACQ MSFN WITH HGA	
171:36	GO/NO-GO FOR L/O	ACKNOWLEDGE	ACKNOWLEDGE

TIME	MSFN	CMP	CDR/LMP
171:56		CHECK VHF COMM WITH LM	ACKNOWLEDGE
TPI-38 MIN	UPLINK TO CMC (IF REQ'D) LM S.V.	ACCEPT	
TPI-34 MIN		REQUEST LM TRACKER LT STATUS	VERIFY LM TRACKER LT ON
TPI-15 MIN	START DSE	VERIFY	
	DISABLE MSFN S-BAND RELAY	GO VHF COMM	GO VHF COMM
TPI-6 MIN		SUPPLY TPI SOLUTION AT CDR REQUEST	COMPARE TPI SOLUTIONS
		REQUEST TPI P76 PAD FROM CDR	SUPPLY P76 PAD TO CMP
TPI		ACKNOWLEDGE	VERIFY GOOD TPI BURN TO CMP
TPI+13 MIN		SUPPLY MCC-1 SOLUTION AT CDR REQUEST	REQUEST MCC-1 SOLUTION
		REQUEST MCC-1 P76 PAD FROM CDR	
MCC-1		ACKNOWLEDGE	VERIFY GOOD MCC-1 BURN TO CMP

TIME	MSFN	CMP	CDR/LMP
TPI+28 MIN		SUPPLY MCC-2 SOLUTION AT CDR REQUEST	REQUEST MCC-2 SOLUTION
		REQUEST MCC-2 P76 PAD FROM CDR	SUPPLY P76 PAD TO CMP
MCC-2		ACKNOWLEDGE	VERIFY GOOD MCC-2 BURN TO CMP
173:12	DSE DUMP	ACQUIRE MSFN WITH HGA	
173:42	VERIFY SWITCH POSITION	POSITION SWITCH: SECS LOGIC(BOTH)-ON	
	GO/NO-GO FOR PYRO ARM	ACKNOWLEDGE	
	VERIFY SWITCH POSITION	POSITION SWITCH: SECS PYRO ARM(2)-ON	

APPENDIX D

FLIGHT DATA FILE
NOMINAL RENDEZVOUS PROCEDURES

The Apollo 16 nominal CSM rendezvous procedures are contained in the FLIGHT PLAN for inclusion in the Flight Data File to be carried onboard the spacecraft. This appendix presents the CMP rendezvous procedures as contained in the Apollo 16 FLIGHT PLAN.

169:30
(P20)
(0.5°DB)

(11111)
(X1111)

SIM EXP STATUS
(*0000)
(01214)

P24 (L/S LDMK 16-3).
OPT ZERO - OFF
OPT MODE - CMC

169:40

M
S
F
N

0:00 T1(HORIZON)DET - RESET/START

VHF COMM CHECK WITH LM

3:50 - DAC - ON

4:50 - T2(LDMK ACQ) OPT MODE - MAN, TAKE MARKS 10 SEC APART

6:30 - TCA
7:18 - T3(LDMK LOSS) DAC - OFF

(11111)
(X1111)

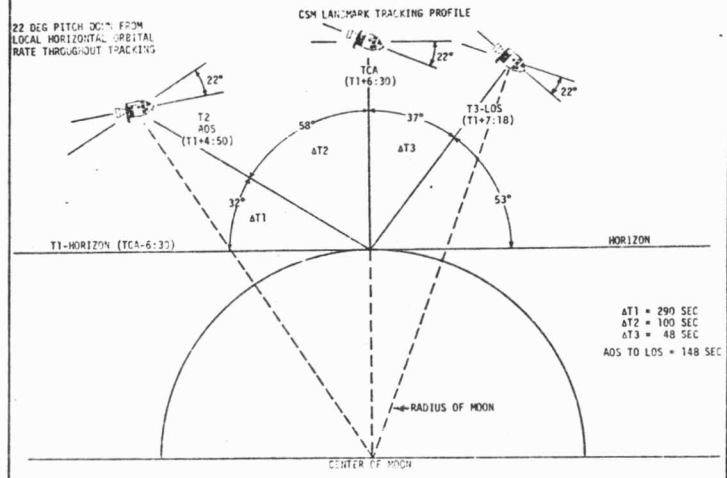
P00

169:50

VHF AM A - OFF (CTR)
MODE - INTERCOM/PTT
RNDZ XPNDR - HTR

CYCLE CMC MODE - FREE/AUTO
(11102)
(X1111)
V48 (11102)
(X1111)
V49 MNVR TO P52/COAS CAL ATT (170:00)
(180,258,357) HGA P -76, Y 258

170:00



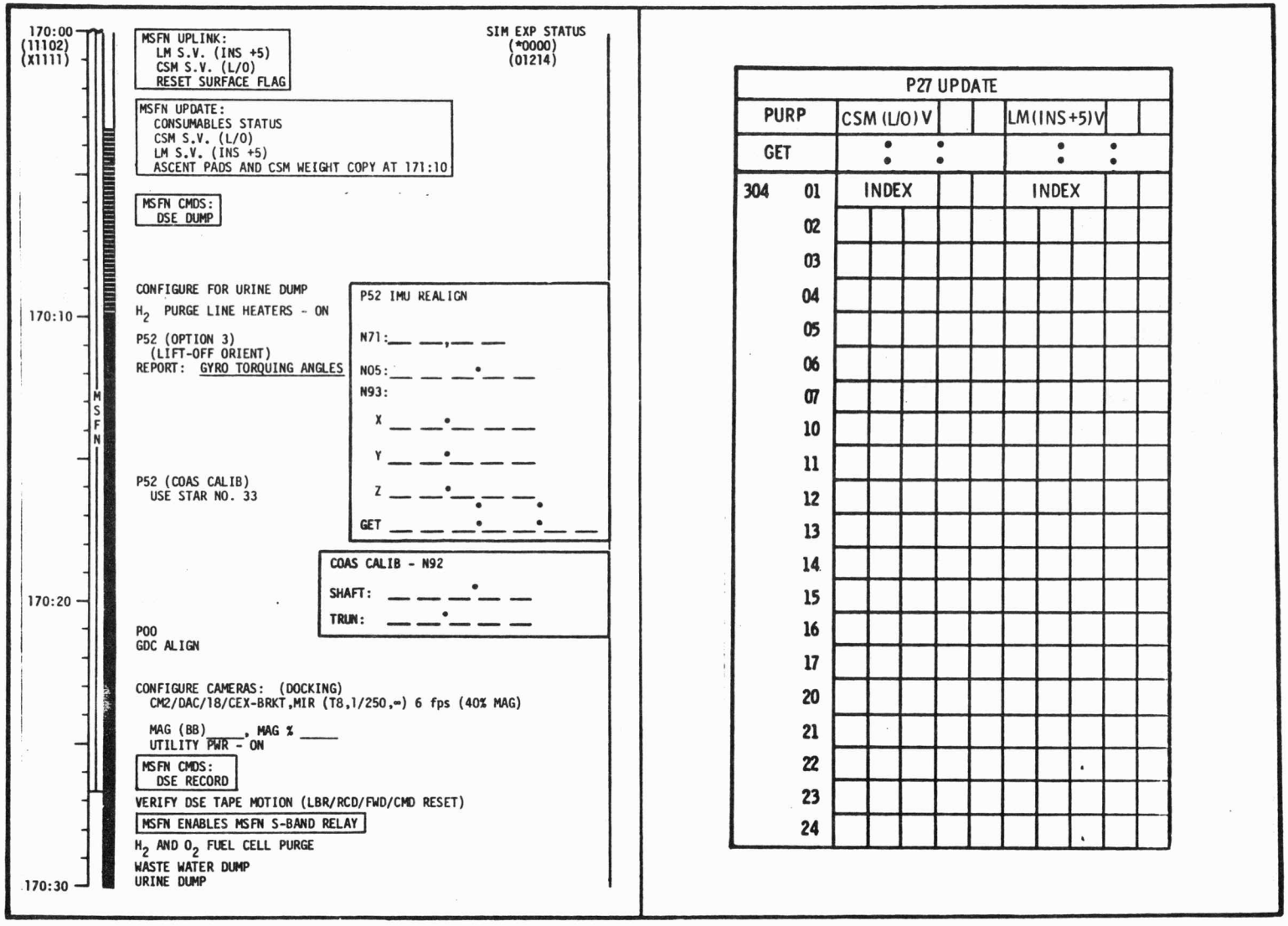
P24 LDMK TRACKING
TGT: 16-3 ( )

T_1 — — — • — • — —
T_2 — — — • — • — —
TCA — — — • — • — —
T_3 — — — • — • — —

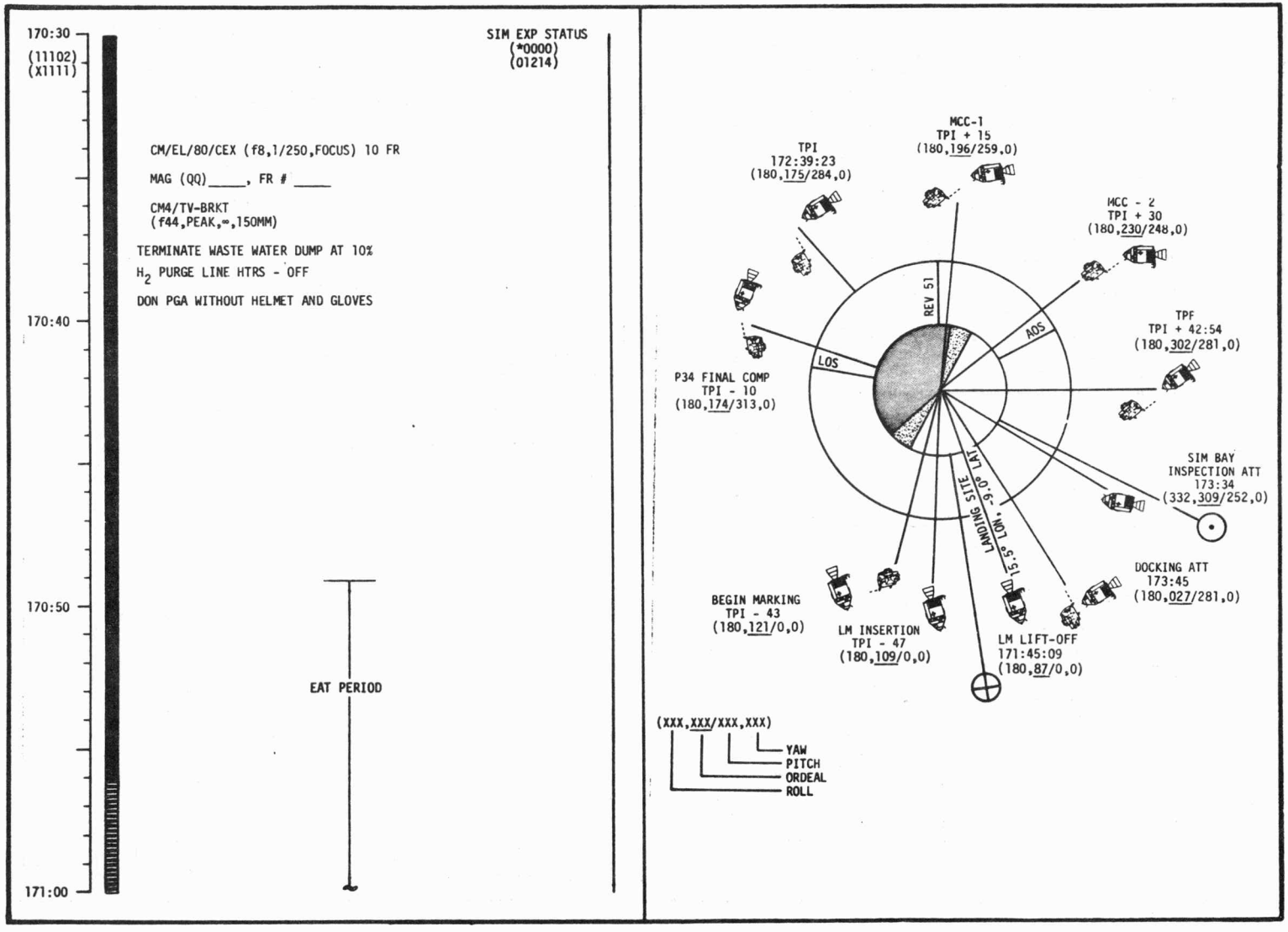
R ___ °P ___ °Y ___ ° (T2 ACQ)

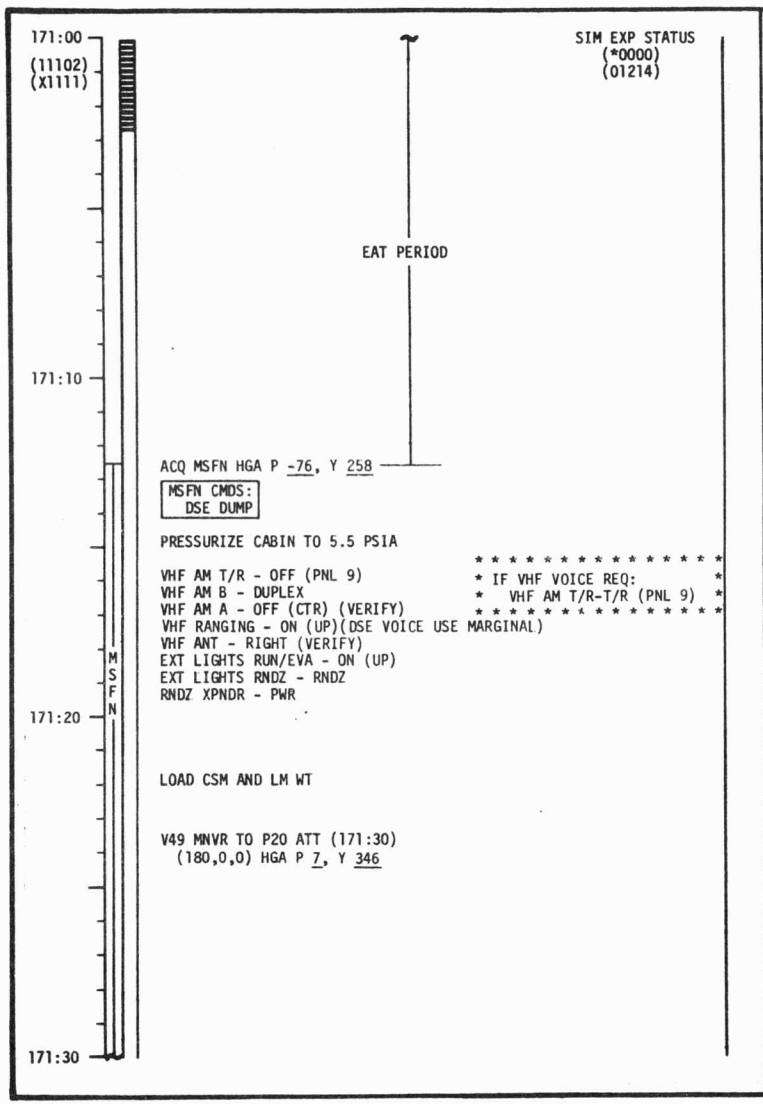
N or S NM ___ / SA ___ TA ___ (T2 ACQ)

N89
LAT -09.000
LONG/2 +07.745
ALT -000.14



P27 UPDATE										
PURP		CSM (L/O) V				LM (INS+5) V				
GET		: :				: :				
304	01	INDEX				INDEX				
	02									
	03									
	04									
	05									
	06									
	07									
	10									
	11									
	12									
	13									
	14									
	15									
	16									
	17									
	20									
	21									
	22								.	
	23									
	24								.	

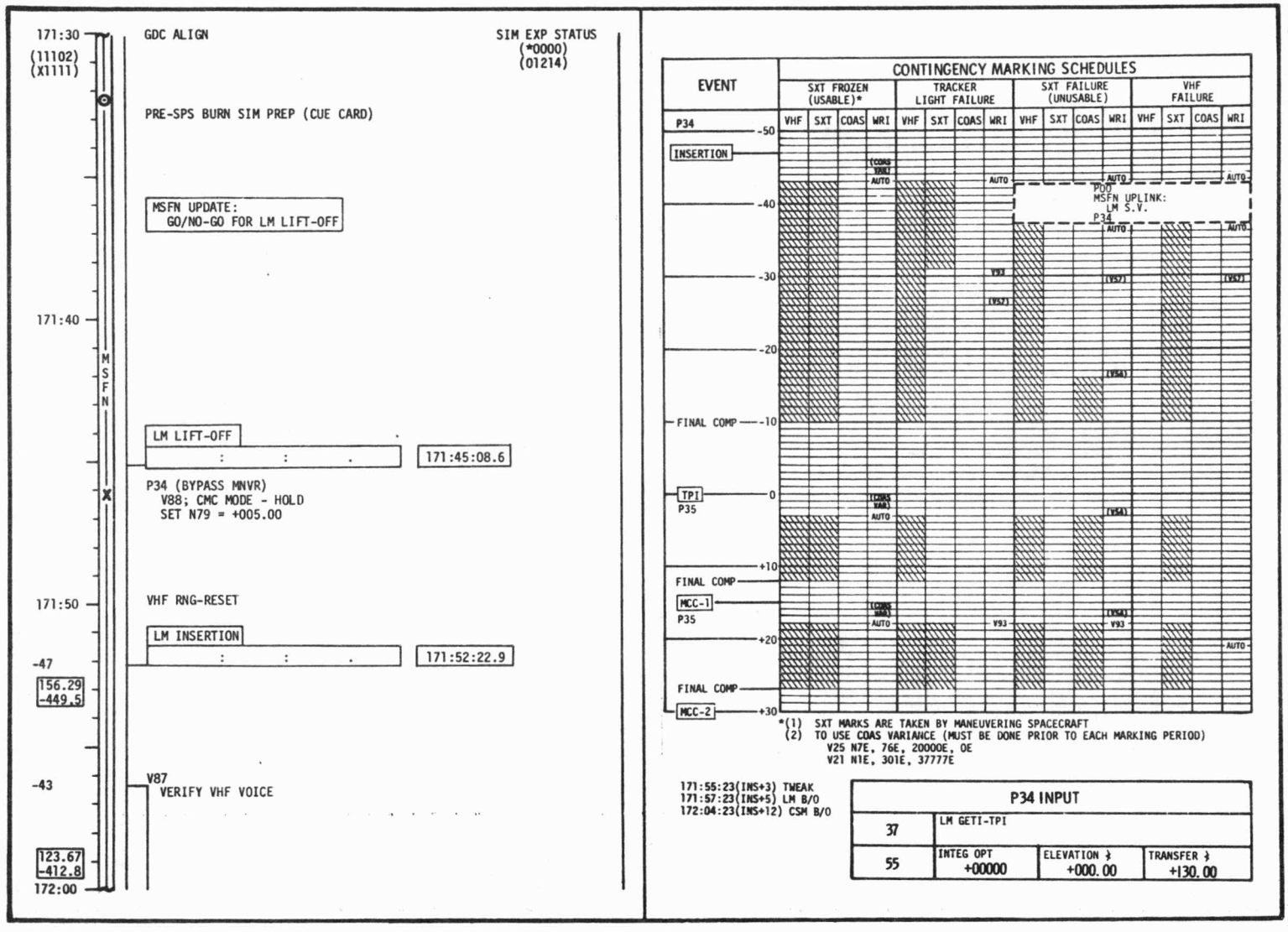

170:30
(11102)
(X1111)
170:40
170:50
171:00
SIM EXP STATUS
(*0000)
(01214)
CM/EL/80/CEX (f8,1/250,FOCUS) 10 FR
MAG (QQ)_____, FR # _____
CM4/TV-BRKT
(f44,PEAK,∞,150MM)
TERMINATE WASTE WATER DUMP AT 10%
H_2 PURGE LINE HTRS - OFF
DON PGA WITHOUT HELMET AND GLOVES
EAT PERIOD
MCC-1
TPI + 15
(180,196/259,0)
TPI
172:39:23
(180,175/284,0)
MCC - 2
TPI + 30
(180,230/248,0)
REV 51
AOS
LOS
TPF
TPI + 42:54
(180,302/281,0)
P34 FINAL COMP
TPI - 10
(180,174/313,0)
SIM BAY
INSPECTION ATT
173:34
(332,309/252,0)
LANDING SITE
-9.0° LAT
15.5° LON
DOCKING ATT
173:45
(180,027/281,0)
BEGIN MARKING
TPI - 43
(180,121/0,0)
LM INSERTION
TPI - 47
(180,109/0,0)
LM LIFT-OFF
171:45:09
(180,87/0,0)
(XXX,XXX/XXX,XXX)
YAW
PITCH
ORDEAL
ROLL

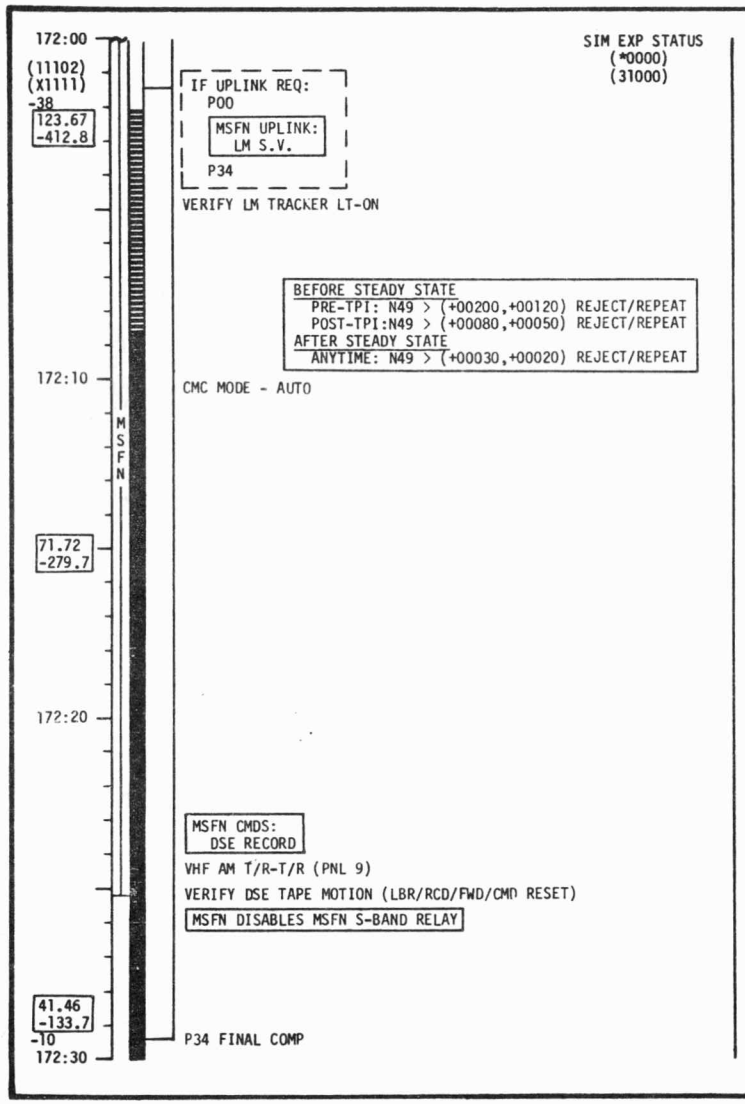


DIRECT ASCENT RNDZ PAD								UPDATE (IF REQ)						
GETI LIFT-OFF	HRS	+	0	0				+	0	0				
	MIN	+	0	0	0			+	0	0	0			
	SEC	+	0					+	0					
GETI	HRS	+	0	0				+	0	0				
TPI	MIN	+	0	0	0			+	0	0	0			
N37	SEC	+	0					+	0					

CSM WT	+						
LM WT	+	0	5	9	0	0	

COELLIPTIC RNDZ PAD								UPDATE (IF REQ)						
GETI LIFT-OFF	HRS	+	0	0				+	0	0				
	MIN	+	0	0	0			+	0	0	0			
	SEC	+	0					+	0					
GETI	HRS	+	0	0				+	0	0				
CSI	MIN	+	0	0	0			+	0	0	0			
N11	SEC	+	0					+	0					
GETI	HRS	+	0	0				+	0	0				
TPI	MIN	+	0	0	0			+	0	0	0			
N37	SEC	+	0					+	0					


171:30
(11102)
(X1111)
GDC ALIGN
SIM EXP STATUS
(*0000)
(01214)
PRE-SPS BURN SIM PREP (CUE CARD)
MSFN UPDATE:
GO/NO-GO FOR LM LIFT-OFF
171:40
M
S
F
N
LM LIFT-OFF
: : .
171:45:08.6
P34 (BYPASS MNVR)
V88; CMC MODE - HOLD
SET N79 = +005.00
171:50
VHF RNG-RESET
LM INSERTION
: : .
171:52:22.9
-47
156.29
-449.5
-43
V87
VERIFY VHF VOICE
123.67
-412.8
172:00
CONTINGENCY MARKING SCHEDULES
EVENT
SXT FROZEN (USABLE)*
TRACKER LIGHT FAILURE
SXT FAILURE (UNUSABLE)
VHF FAILURE
VHF
SXT
COAS
WRI
P34
-50
INSERTION
-40
-30
-20
FINAL COMP
-10
TPI
P35
0
+10
FINAL COMP
MCC-1
P35
+20
FINAL COMP
MCC-2
+30
AUTO
V93
(V57)
(V54)
PDD
MSFN UPLINK:
LM S.V.
P34
*(1) SXT MARKS ARE TAKEN BY MANEUVERING SPACECRAFT
(2) TO USE COAS VARIANCE (MUST BE DONE PRIOR TO EACH MARKING PERIOD)
V25 N7E, 76E, 20000E, 0E
V21 N1E, 301E, 37777E
171:55:23(INS+3) TWEAK
171:57:23(INS+5) LM B/O
172:04:23(INS+12) CSM B/O
P34 INPUT
37
LM GETI-TPI
55
INTEG OPT
+00000
ELEVATION ϑ
+000.00
TRANSFER ϑ
+130.00



P30 MANEUVER

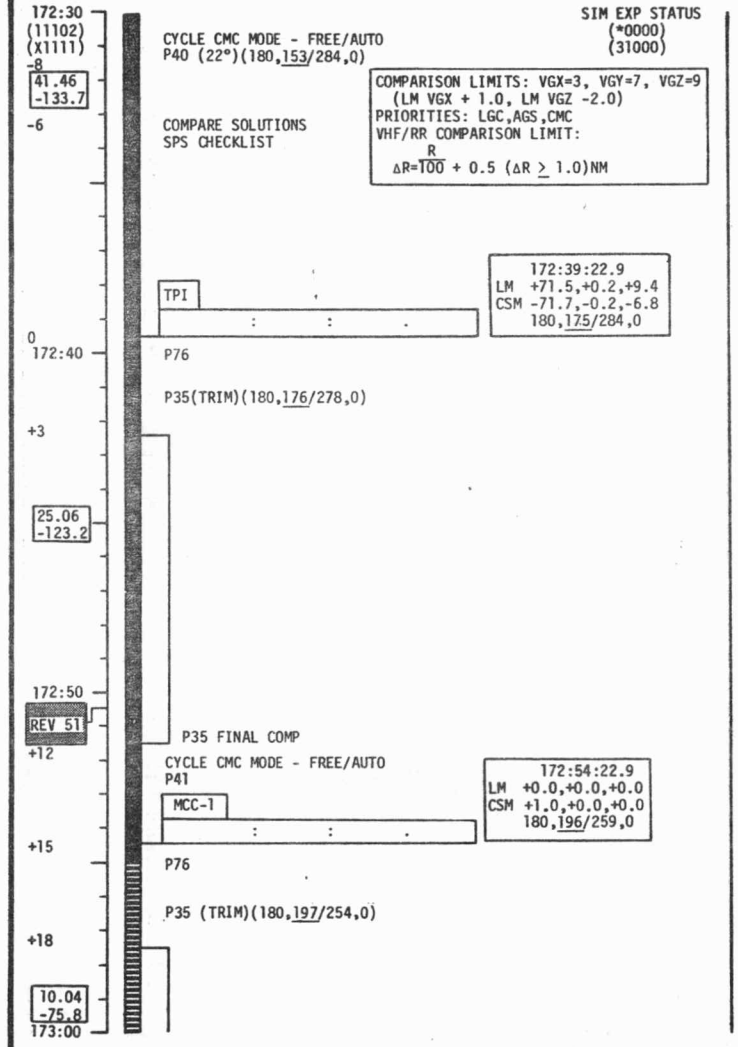
N/A / SET STARS	C/S	S/P	M/S	B/G	/&	O/N	PURPOSE / PROP/GUID	
	+			N	/	A	WT	N47
R ALIGN N / A		0	0	N	/	A	P_{TRIM}	N48
P ALIGN N / A		0	0	N	/	A	Y_{TRIM}	
Y ALIGN N / A	+	0	0				HRS	GETI
	+	0	0	0			MIN	N33
	+	0					SEC	
ULLAGE							ΔV_X	N81
4 JET, 11 SEC							ΔV_Y	
							ΔV_Z	
	X	X	X				R	
	X	X	X				P	
	X	X	X				Y	
ΔVC	+			N	/	A	H_A	N44
				N	/	A	H_P	

*IF LM BAILOUT REQ:
* COPY P76 DATA FROM LM
*33 : :
*84 . . .
*GO TO RESCUE BOOK PG 4

*IF CSM BAILOUT REQ:
*MSFN UPDATE:
* CSM BAILOUT P30 PAD
*P30
*P40; SET UP EMS
*SPS BURN CUE CARD
*CSM BAILOUT BURN
*GO TO RESCUE BOOK PG 4

P34 RECYCLE

55	INTEG OPT +00000	ELEVATION ↑	TRANSFER ↑ +130.00
58	PERILUNE ALT	TPI ΔV	TPF ΔV
81	TPI ΔV-LV		
84	LM TPI ΔV-LV		



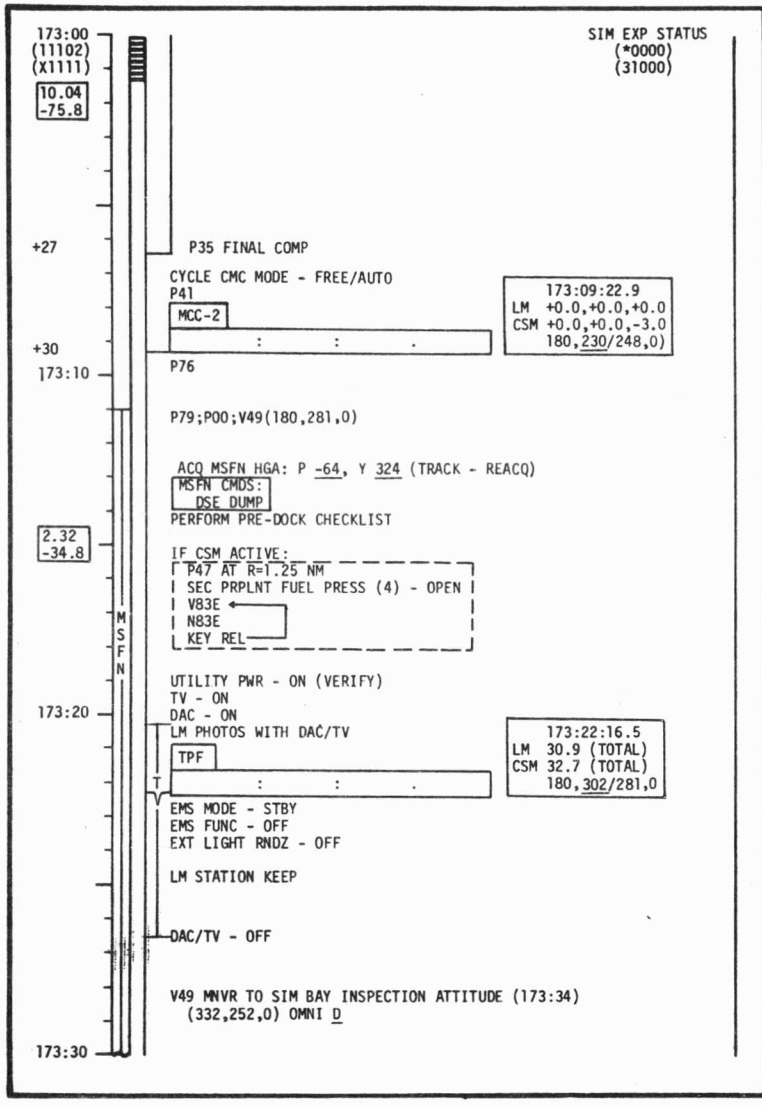
GROUND TPI FOR LM

						ΔV_X
						ΔV_Y
						ΔV_Z

P34 FINAL COMP			
55	INTEG OPT +00000	ELEVATION ↕	TRANSFER ↕ +130.00
58	PERILUNE ALT	TPI ΔV	TPF ΔV
81	TPI ΔV-LV		
84	LM TPI ΔV-LV		
P76 84	LM TPI ΔV-LV		

P35 FINAL COMP			
81	MCC1 ΔV-LV		
84	LM MCC1 ΔV-LV		
P76 84	LM MCC1 ΔV-LV		

* *
* IF CSM ACTIVE & N58 TPF ΔV >55 FPS *
* GO TO PRE-BRAKING SPS BURN PROCEDURES *
* (SEE RESCUE BOOK PG 38) *
* *



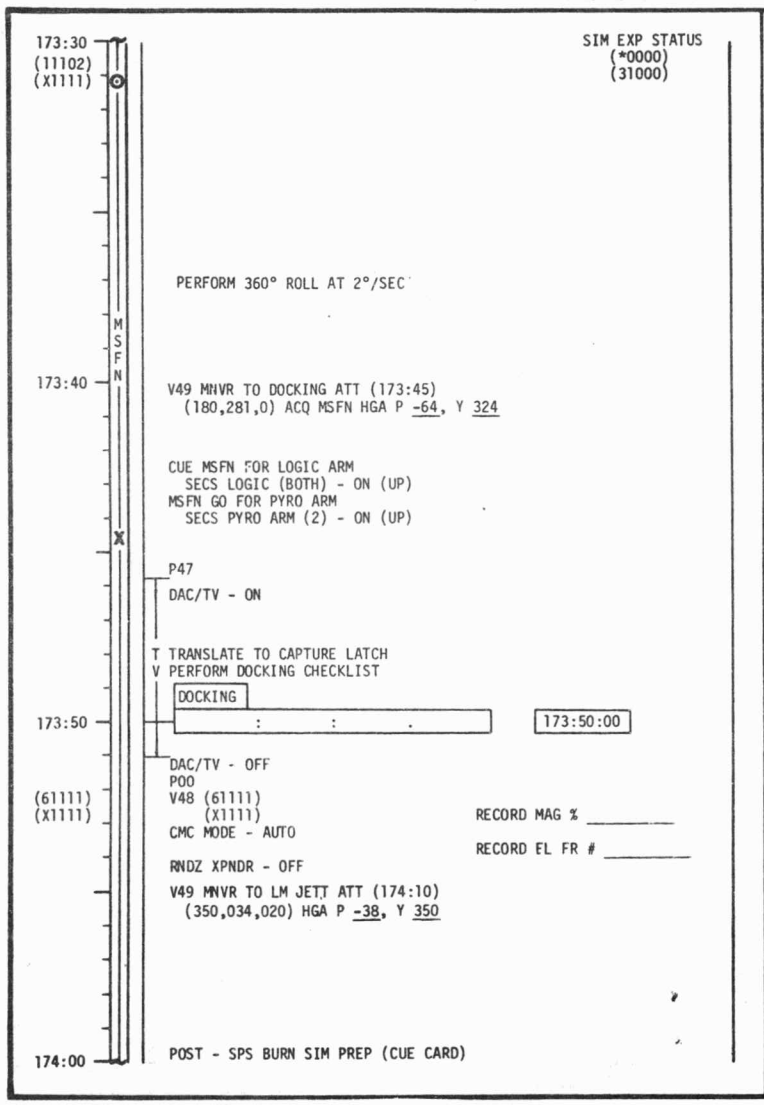
P35 FINAL COMP			
81	MCC2 ΔV-LV		
84	LM MCC2 ΔV-LV		
P76 84	LM MCC2 ΔV-LV		

PRE-DOCK CHECKLIST

MAN ATT (3) RATE CMD (VERIFY)	CB DOCK PROBE (2) - CLOSED
LIMIT CYCLE - OFF (VERIFY)	PROBE RETRACT (2) - OFF (VERIFY)
ATT DB - MIN	PROBE EXTD/REL - RETRACT
RATE - LOW (VERIFY)	PROBE EXTD/REL TB (2) - GRAY (VERIFY)
TRANS CONTR PWR - ON (UP)	(IF TB NOT GRAY, GO TO PG S/2-13,E)
ROT CONTR PWR DIRECT (BOTH) - MNA/MNB	CB SECS LOGIC (2) - CLOSED (VERIFY)
SC CONT - CMC (VERIFY)	CB SECS ARM (2) - CLOSED
AUTO RCS SEL (16) - MNA/MNB	EXT LIGHTS RUN/EVA - ON (UP) (VERIFY)
	COAS PWR - ON (UP) (VERIFY)

BRAKING GATES

R,NM	R,FPS	RETICLE ANG,DEG	R,FT
1.50	45	.08	9000
1.00	30	.13	6000
.50	20	.26	3000
.25	10	.54	1500
.08	5	1.60	500
.05		2.70	300
.03		4.00	200
.02		8.50	100



DOCKING CHECKLIST

AT CAPTURE

PROBE EXTD/REL TB (2) - BP (VERIFY)
(IF TB NOT BP, GO TO PG S/2-11, A)
REPORT CAPTURE TO LM
SC CONT - CMC (VERIFY)
CMC MODE - FREE
ALLOW PROBE TO DAMP SC MOTION (10 SEC)
WHEN WITHIN +3° OF DOCKING ATTITUDE
PROBE RETRACT SEC - 1 (PRIM - 2 IF REQD)

AT DOCK LATCH

PROBE EXTD/REL TB (2) - GRAY

AT HARD DOCK

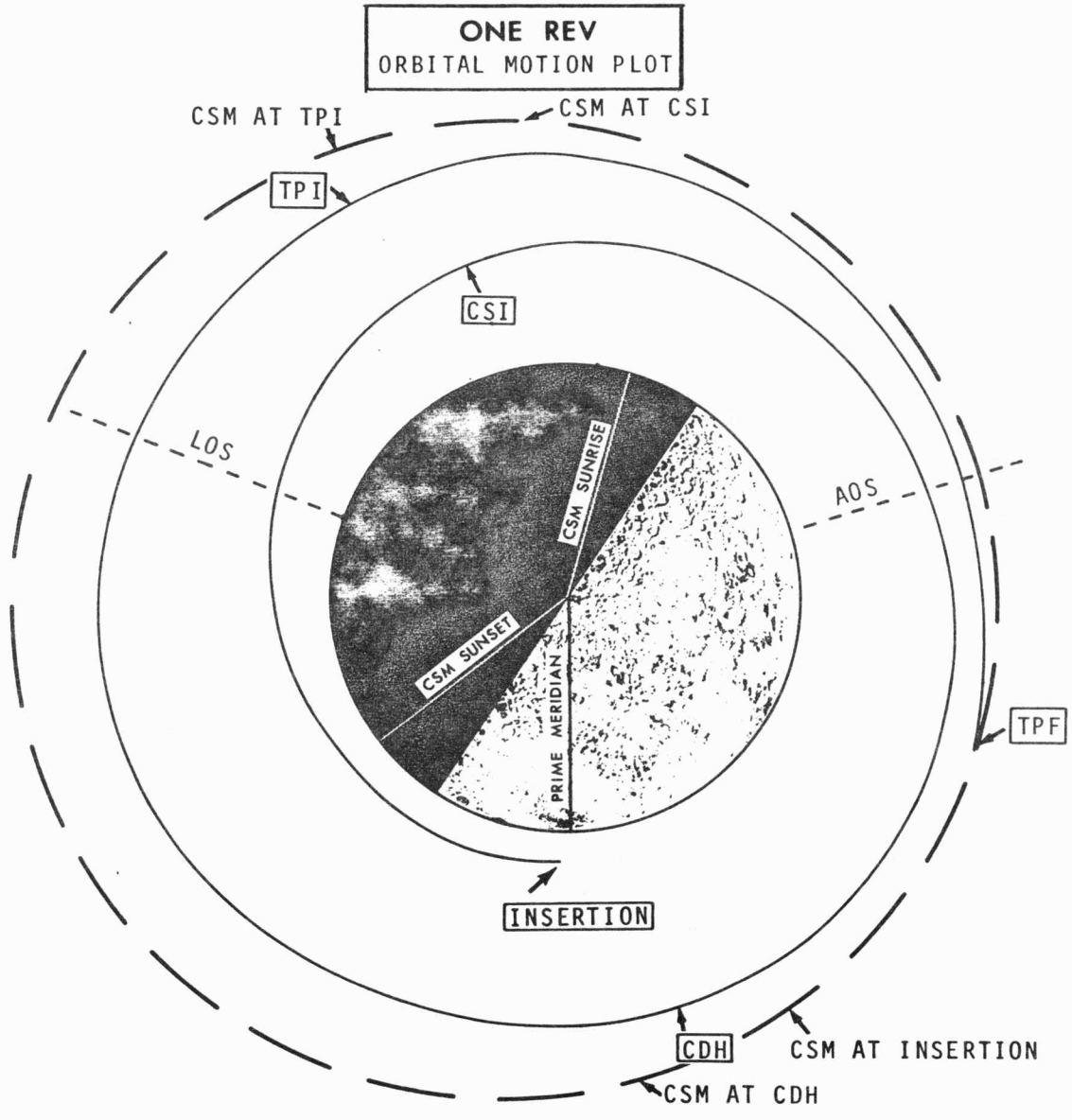
SECS PYRO ARM (2) - SAFE
SECS LOGIC (BOTH) - OFF
CB SECS ARM (2) - OPEN
CB DOCK PROBE (2) - OPEN
THC - LOCKED
RHC - LOCKED
BMAG MODE (3) - RATE 2 (VERIFY)
PROBE EXTD/REL - OFF
PROBE RETRACT (2) - OFF
EXT LIGHTS (2) - OFF
COAS PWR - OFF
AUTO RCS SEL: ROLL (4) - OFF
TRANS CONTR PWR - OFF
ROT CONTR PWR DIRECT (BOTH) - OFF
VHF RANGING - OFF

APPENDIX E

FLIGHT DATA FILE
ABORT AND RESCUE RENDEZVOUS PROCEDURES

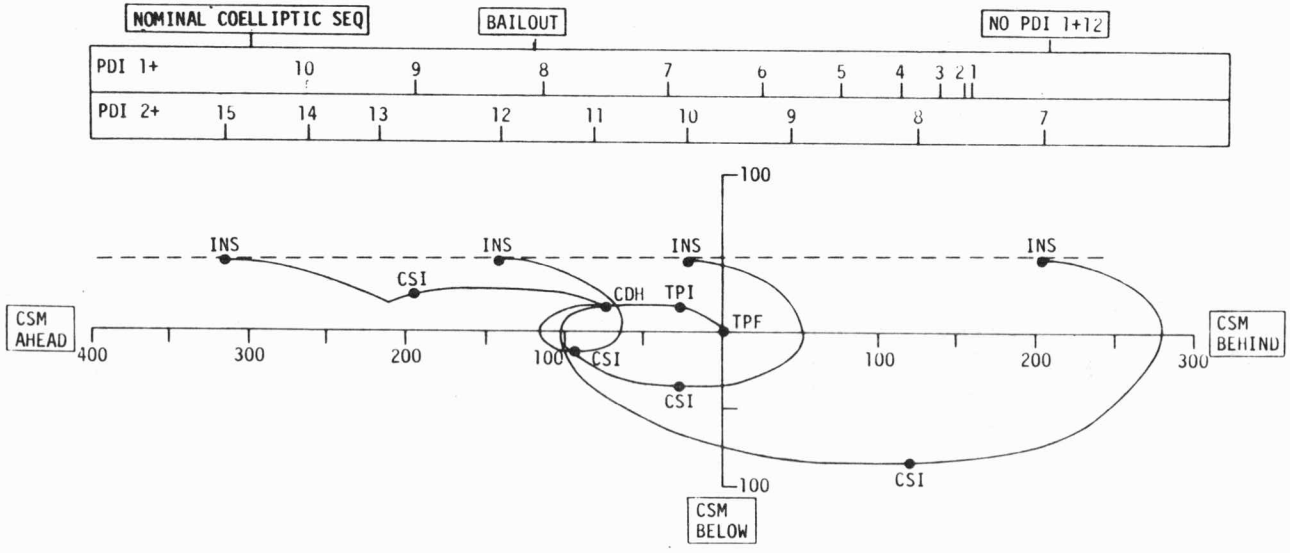
Two LM active rendezvous techniques are available in case of an abort. These are commonly referred to as the One Rev and Two Rev rendezvous. Three other techniques are available but require one or more CSM SPS burns and will not be used except under extreme conditions. These are the Rescue Two, Dwell, and Manual Insertion rendezvous.

CMP procedures of these five techniques are contained in the CSM RESCUE BOOK for inclusion in the Apollo 16 CSM RESCUE BOOK.


ONE REV
ORBITAL MOTION PLOT
CSM AT TPI
CSM AT CSI
TPI
CSI
LOS
AOS
CSM SUNRISE
CSM SUNSET
PRIME MERIDIAN
TPF
INSERTION
CDH
CSM AT INSERTION
CSM AT CDH

ONE REV
RELATIVE MOTION PLOT

LM CENTERED



ONE REV
BURN TIMES

NO PDI 1+12 ABORT
CSI AT PDI TIME+60 MIN

PDI 1, EARLY ABORT
CSI AT INS +55 MIN

PDI 2, LATE ABORT
CSI AT INS +55 MIN

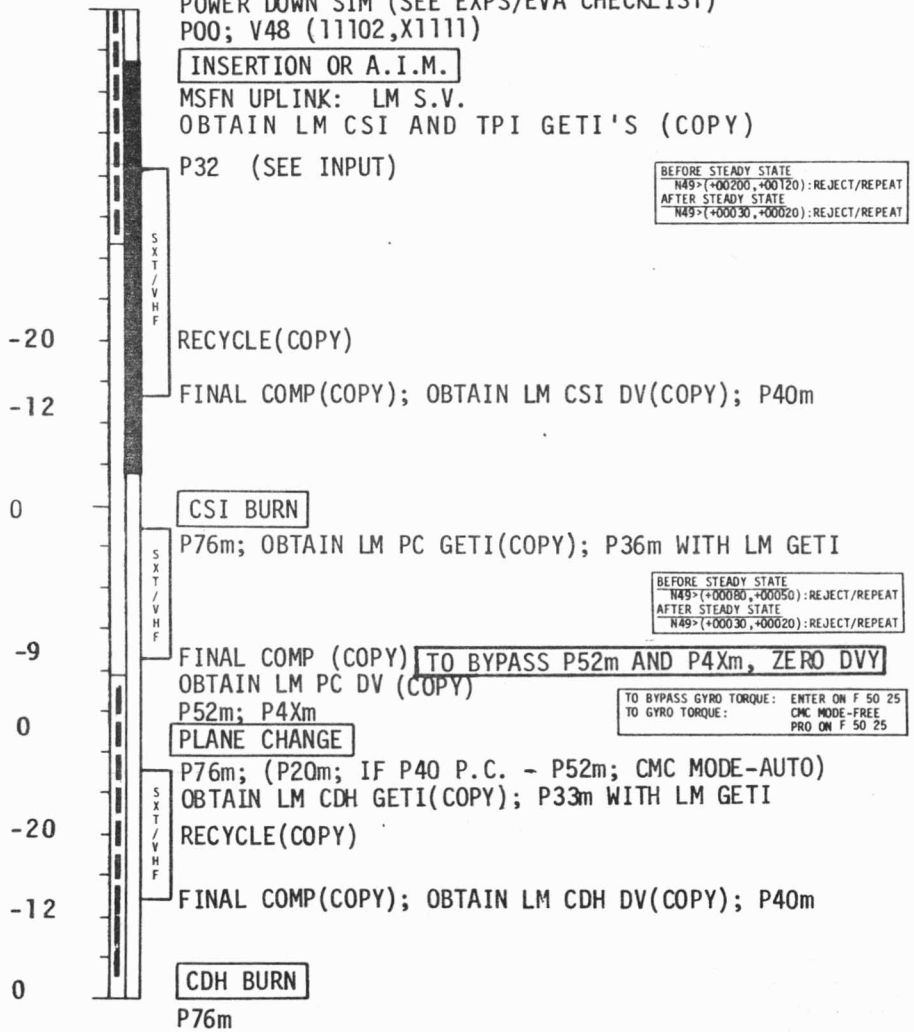
NOMINAL COELLIPTIC SEQUENCE
CSI AT INS +50 MIN

EARLY COELLIPTIC SEQ. FOR APS LEAK
CSI AT INS +60 MIN

LM BAILOUT
CSI AT INS +55 MIN

CSM BAILOUT
CSI AT INS +55 MIN

ONE REV TIMELINE

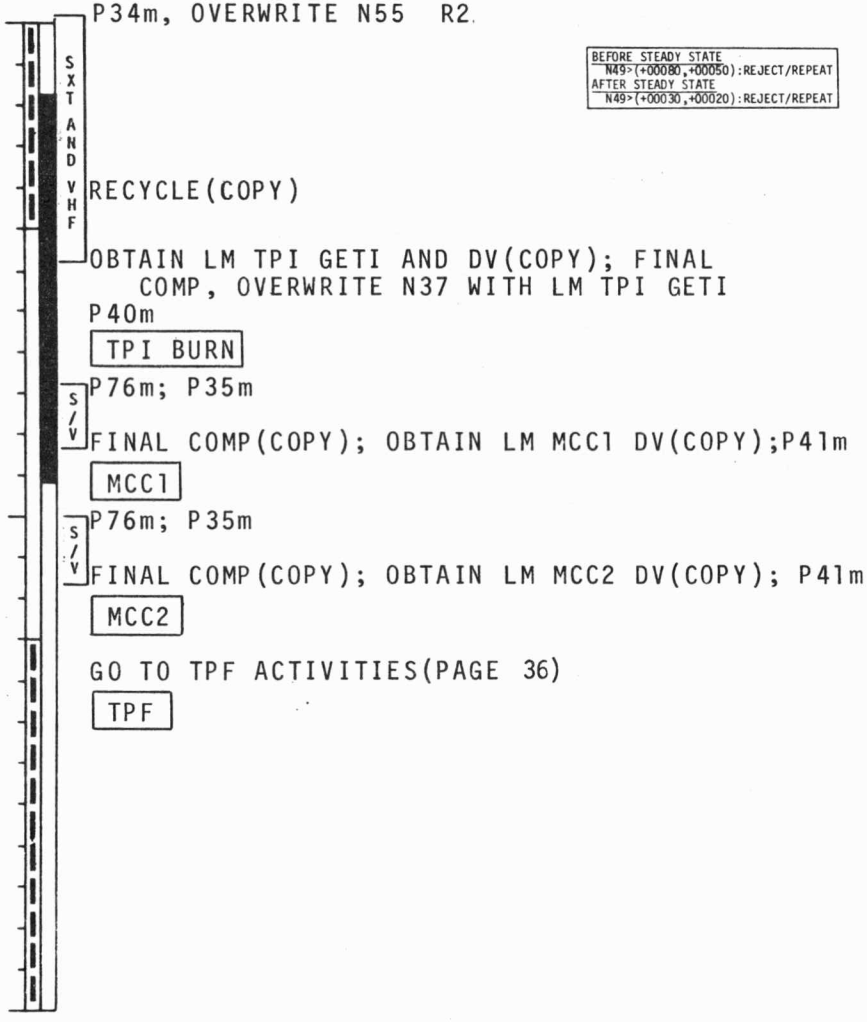


INSERTION		LM INSERTION TIME : : .
A.I.M. P76	33	LM A.I.M.GETI : : .
	84	LM A.I.M.ΔV-LV . . .

CSI COMPUTATION				
INPUT	11	LM CSI GETI : : .		
	55	N +00001	ELEVATION ϕ +208.30	180° OPT +130.00
	37	LM TPI GETI : : .		
RECYCLE	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	.	+0000.0
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	.	+0000.0
P76	84	LM CSI ΔV-LV .	.	.

PLANE CHANGE COMPUTATION				
INPUT	33	LM PC GETI : : .		
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	PC ΔV-LV +0000.0	.	+0000.0
P76	84	LM PC ΔV-LV +0000.0	.	+0000.0

CDH COMPUTATION				
INPUT	13	LM CDH GETI : : .		
RECYCLE	90	Y .	Y DOT .	LM Y DOT .
	81	CDH ΔV-LV .	.	.
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CDH ΔV-LV .	.	.
P76	84	LM CDH ΔV-LV .	.	.



TPI-ELEVATION OPTION				
INPUT	37	TPI GETI : PROCEED ON DISPLAYED GETI :		
	55	INTEG OPT +00000	ELEVATION +208.30	TRANSFER +130.00
RECYCLE	37	TPI GETI : PROCEED ON DISPLAYED GETI :		
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.
FINAL COMP	37	LM TPI GETI : : :		
	55	INTEG OPT +00000	ELEVATION .	TRANSFER +130.00
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.
P76	33	LM TPI GETI : : .		
	84	LM TPI ΔV-LV .	.	.

MCC COMPUTATION				
FIN COMP	81	MCC1 ΔV-LV .	.	.
P76	84	LM MCC1 ΔV-LV .	.	.

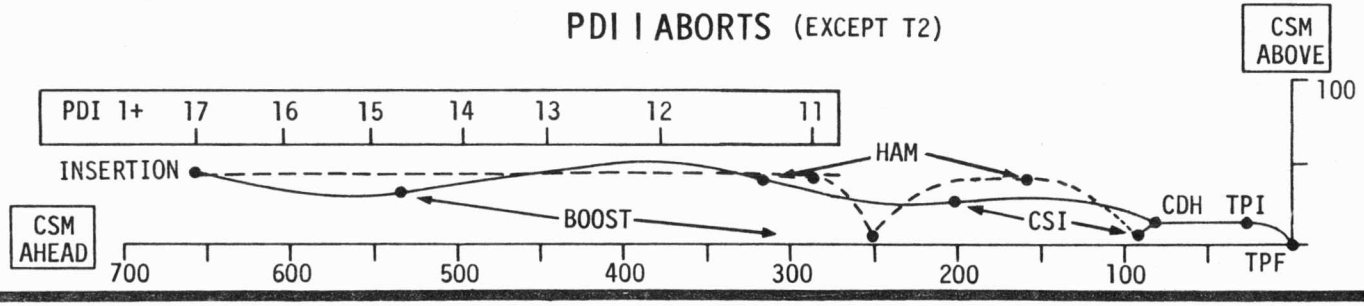
MCC COMPUTATION				
FIN COMP	81	MCC2 ΔV-LV .	.	.
P76	84	LM MCC2 ΔV-LV .	.	.

CSI
BOOST
TWO REV
ORBITAL MOTION PLOT
CSM AT CSI
CSM AT TPI
TPI
LOS
AOS
CSM SUNRISE
CSM SUNSET
PRIME MERIDIAN
TPF
INSERTION
HAM
CDH
CSM AT INSERTION
CSM AT CDH
CSM AT HAM

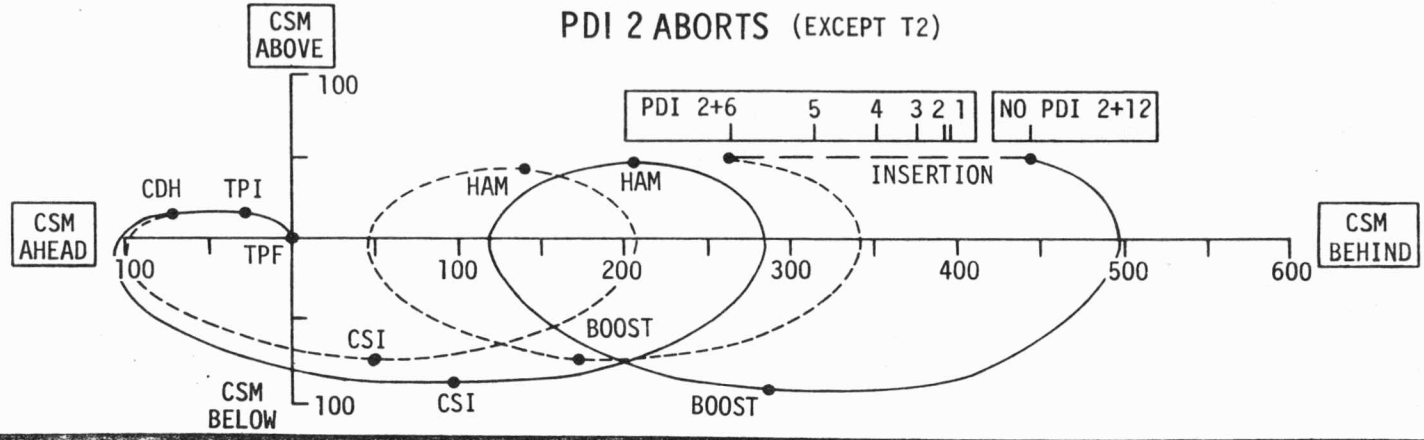
TWO REV
RELATIVE MOTION PLOT

LM CENTERED

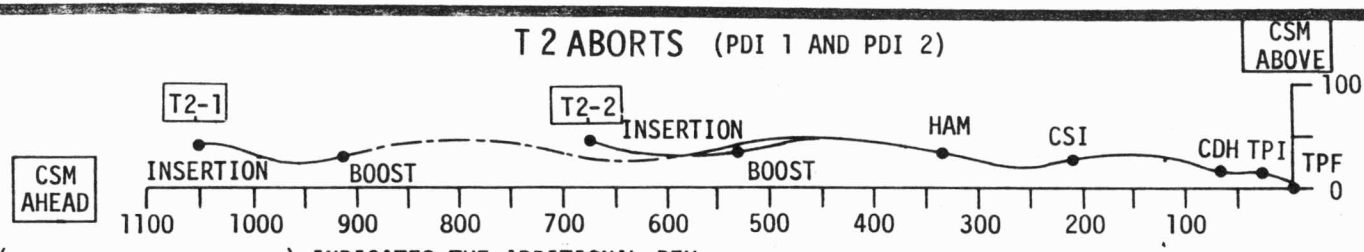
PDI 1 ABORTS (EXCEPT T2)



PDI 2 ABORTS (EXCEPT T2)



T 2 ABORTS (PDI 1 AND PDI 2)



NOTE: (— · — · — · — · —) INDICATES THE ADDITIONAL REV NECESSARY TO MODIFY THE TWO REV TECHNIQUE FOR A T2-1 ABORT.

TWO REV BURN TIMES

PDI 1, LATE ABORT
BOOST AT INS + 50 MIN
HAM AT BOOST + 60 MIN
CSI AT HAM + 50 MIN

T2 ABORT, 1ST OPP
BOOST AT INS +50 MIN
HAM AT BOOST +180 MIN
CSI AT HAM + 50 MIN

NO PDI 2+12 ABORT
BOOST AT PDI TIME +67 MIN
HAM AT BOOST +60 MIN
CSI AT HAM +60 MIN

PDI 2, EARLY ABORT
BOOST AT INS +60 MIN
HAM AT BOOST +60 MIN
CSI AT HAM +60 MIN

T2 ABORT, 2ND OPP
BOOST AT INS +50 MIN
HAM AT BOOST +60 MIN
CSI AT HAM +50 MIN

TWO REV TIMELINE

POWER DOWN SIM (SEE EXPS/EVA CHECKLIST)
P00; V48(11102,X1111)

INSERTION OR A. I. M.

MSFN UPLINK: LM S.V.

INSERTION		LM INSERTION TIME .	: .	.
A.I.M. P76	33	LM AIM GETI :	:	.
	84	LM AIM ΔV-LV .	.	.

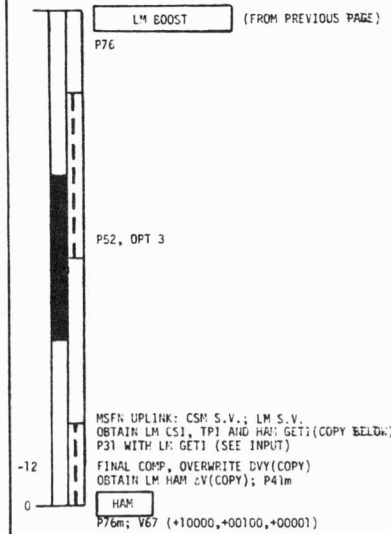
LM BOOST P76	33	LM BOOST GETI :	:	.
	84	LM BOOST ΔV-LV	+0000.0	+0000.0

OBTAIN LM BOOST GETI AND DV(COPY)

LM BOOST

P76

MODIFIED TWO REV RNDZ (FOR T2-1 ABORT ONLY)



LM BOOST (FROM PREVIOUS PAGE)

P76

P52, OPT 3

MSFN UPLINK: CSM S.V.; LM S.V.
OBTAIN LM CSI, TPI AND HAM GETI(COPY BELOW)
P31 WITH LM GETI (SEE INPUT)

-12 FINAL COMP, OVERWRITE DVY(COPY)
OBTAIN LM HAM ΔV(COPY); P41m

0 HAM

P76m; V67 (+10000,+00100,+00001)

GO TO PAGE 10

MSFN UPLINK: CSM S.V.; LM S.V.
OBTAIN LM CSI, TPI AND HAM GETI(COPY)
P31 WITH LM GETI

IF 15 VHF MARKS CAN NOT BE TAKEN PRIOR TO FINAL COMP:
V88

BEFORE STEADY STATE
N49>(+00200,+00120):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

-20 RECYCLE(COPY)

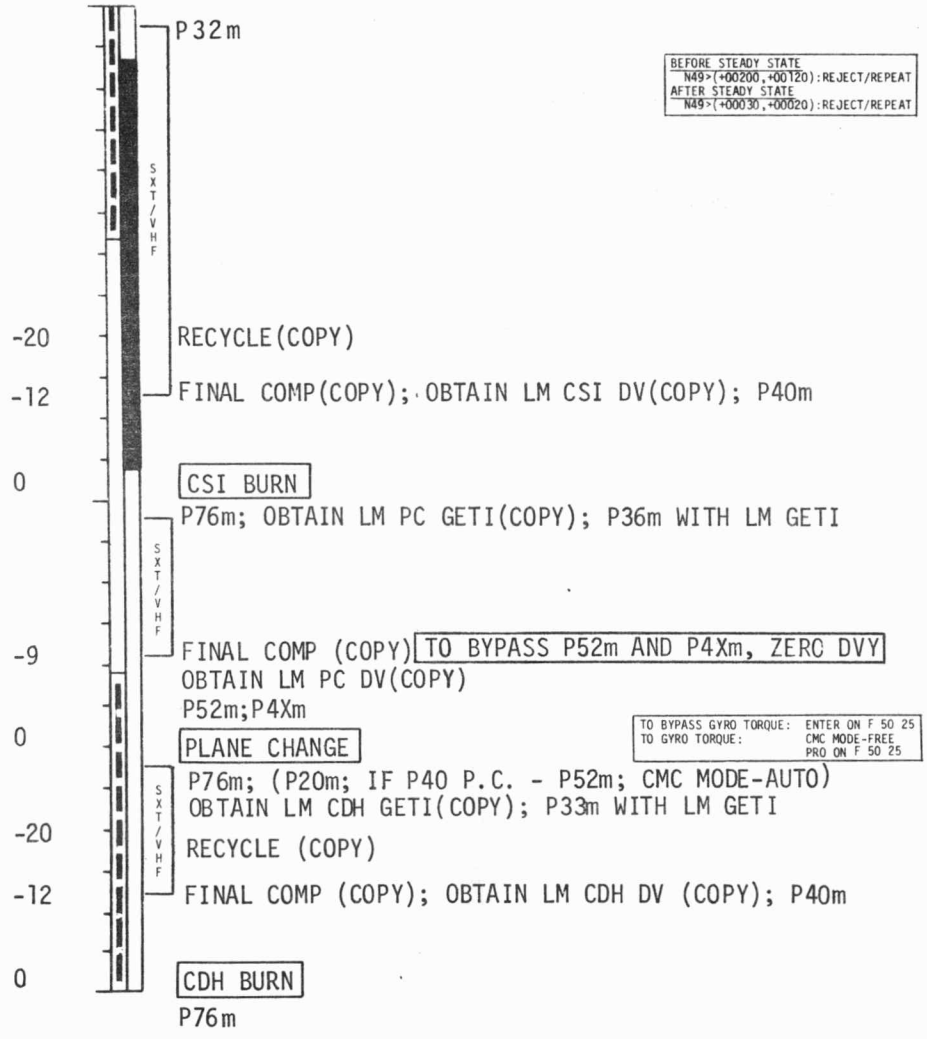
-12 FINAL COMP, OVERWRITE DVY (COPY);
OBTAIN LM HAM ΔV(COPY)
P41m

0 HAM

P76m; V67(+10000,+00100,+00001)

IF NO MARKS HAVE BEEN TAKEN:
V87

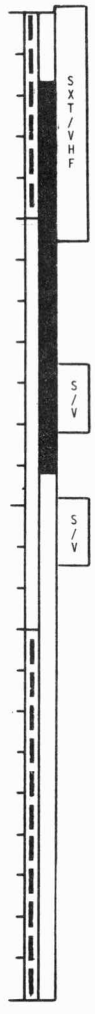
HAM COMPUTATION				
INPUT	11	LM CSI GETI : : .		
	55	N +00001	ELEVATION ϕ +208.30	180° OPT +130.00
	37	LM TPI GETI : : .		
	33	LM HAM GETI : : .		
RECYCLE	90	Y .	Y DOT .	LM Y DOT .
	81	HAM ΔV-LV .	.	+0000.0
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	HAM ΔV-LV .	+0000.0	+0000.0
P76	84	LM HAM ΔV-LV .	.	+0000.0



CSI COMPUTATION				
INPUT	11	LM CSI GETI : : PROCEED ON DISPLAYED GETI •		
	55	N +00001	ELEVATION ° +208.30	180° OPT +130.00
	37	LM TPI GETI : : PROCEED ON DISPLAYED GETI •		
RECYCLE	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	.	+0000.0
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	.	+0000.0
P76	84	LM CSI ΔV-LV .	.	.

PLANE CHANGE COMPUTATION				
INPUT	33	LM PC GETI : : .		
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	PC ΔV-LV +0000.0	.	+0000.0
P76	84	LM PC ΔV-LV +0000.0	.	+0000.0

CDH COMPUTATION				
INPUT	13	LM CDH GETI : : .		
RECYCLE	90	Y .	Y DOT .	LM Y DOT .
	81	CDH ΔV-LV .	.	.
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CDH ΔV-LV .	.	.
P76	84	LM CDH ΔV-LV .	.	.



P34m, OVERWRITE N55 R2

BEFORE STEADY STATE
N49>(+00080,+00050):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

-20 RECYCLE(COPY)

-12 OBTAIN LM TPI GETI AND DV(COPY); FINAL COMP, OVERWRITE N37 WITH LM TPI GETI
P40m

0 [TPI BURN]
P76m; P35m

+12 FINAL COMP(COPY);OBTAIN LM MCC1 DV(COPY); P41m

+15 [MCC1]
P76m; P35m

+27 FINAL COMP(COPY); OBTAIN LM MCC2 DV(COPY); P41m

+30 [MCC2]

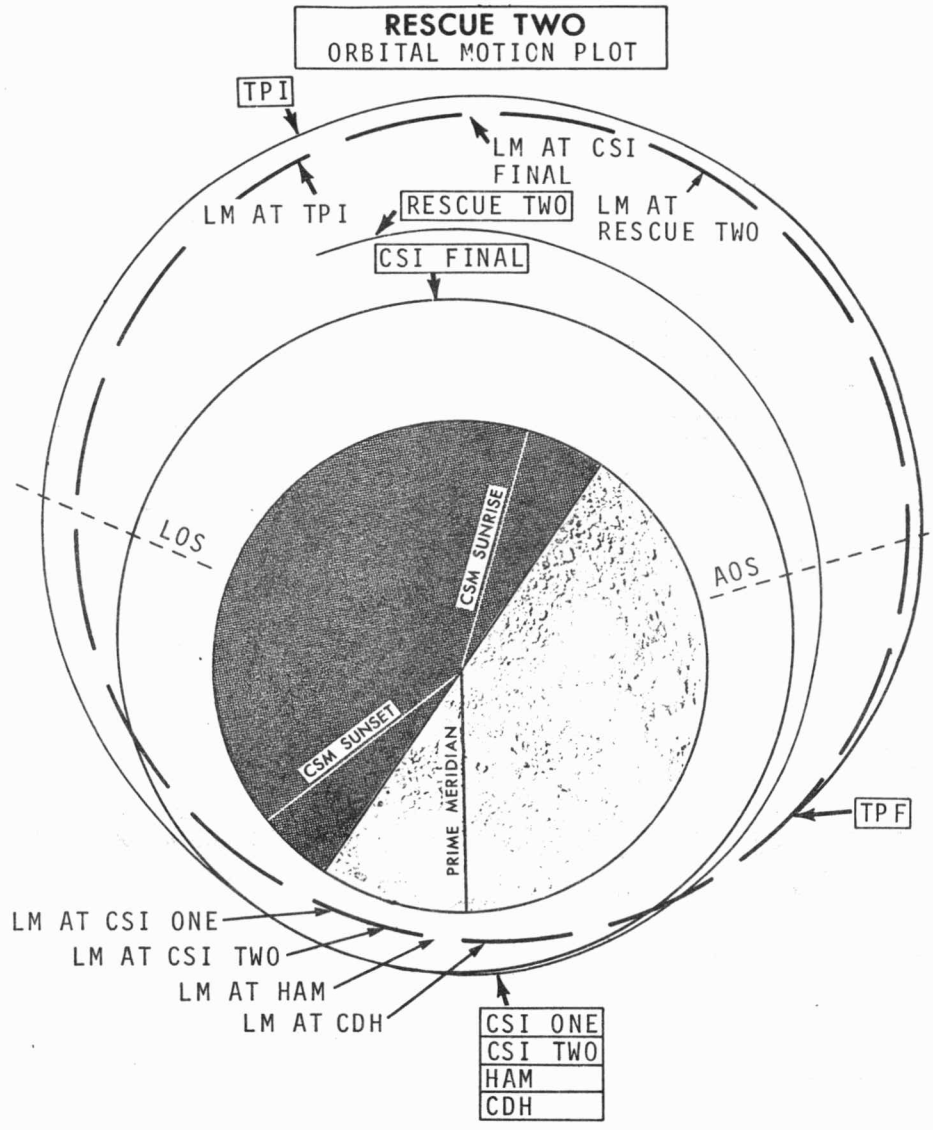
GO TO TPF ACTIVITIES(PAGE 36)

+42 [TPF]

TPI-ELEVATION OPTION				
INPUT	37	TPI GETI . . . PROCEED ON DISPLAYED GETI .		
	55	INTEG OPT +00000	ELEVATION ◂ +208.30	TRANSFER ◂ +130.00
RECYCLE	37	TPI GETI . . . PROCEED ON DISPLAYED GETI .		
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.
FINAL COMP	37	LM TPI GETI . . .		
	55	INTEG OPT +00000	ELEVATION ◂ .	TRANSFER ◂ +130.00
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.
P76	33	LM TPI GETI . . .		
	84	LM TPI ΔV-LV .	.	.

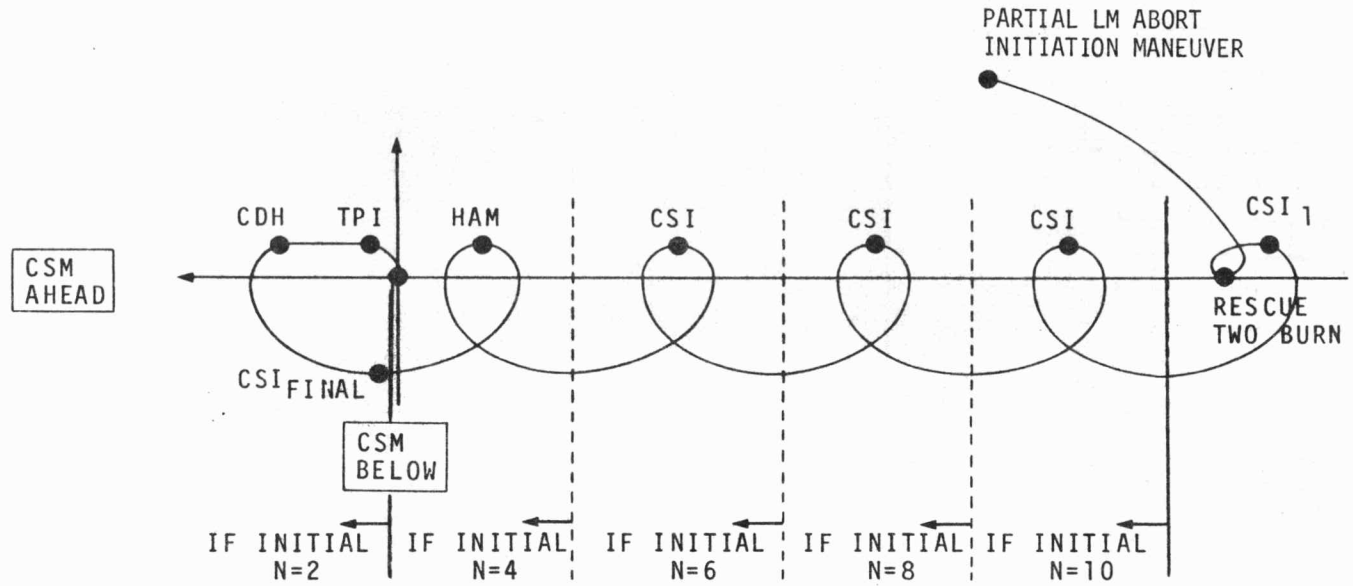
MCC COMPUTATION				
FIN COMP	81	MCC1 ΔV-LV .	.	.
P76	84	LM MCC1 ΔV-LV .	.	.

MCC COMPUTATION				
FIN COMP	81	MCC2 ΔV-LV .	.	.
P76	84	LM MCC2 ΔV-LV .	.	.


RESCUE TWO
ORBITAL MOTION PLOT
TPI
LM AT CSI FINAL
LM AT TPI
RESCUE TWO
LM AT RESCUE TWO
CSI FINAL
LOS
AOS
CSM SUNRISE
CSM SUNSET
PRIME MERIDIAN
TPF
LM AT CSI ONE
LM AT CSI TWO
LM AT HAM
LM AT CDH
CSI ONE
CSI TWO
HAM
CDH

RESCUE TWO
RELATIVE MOTION PLOT

LM CENTERED



RESCUE TWO
TIMELINE

POWER DOWN SIM (SEE EXPS/EVA CHECKLIST)
P00; V48 (11102,X1111)

INSERTION OR A.I.M.

MSFN UPLINK: LM S.V.
MSFN UPDATE: RESCUE TWO P30 PAD
P32 INITIALIZATION PAD

-12 P30; P40

0 RESCUE TWO BURN

P00

RESCUE TWO P30 PAD

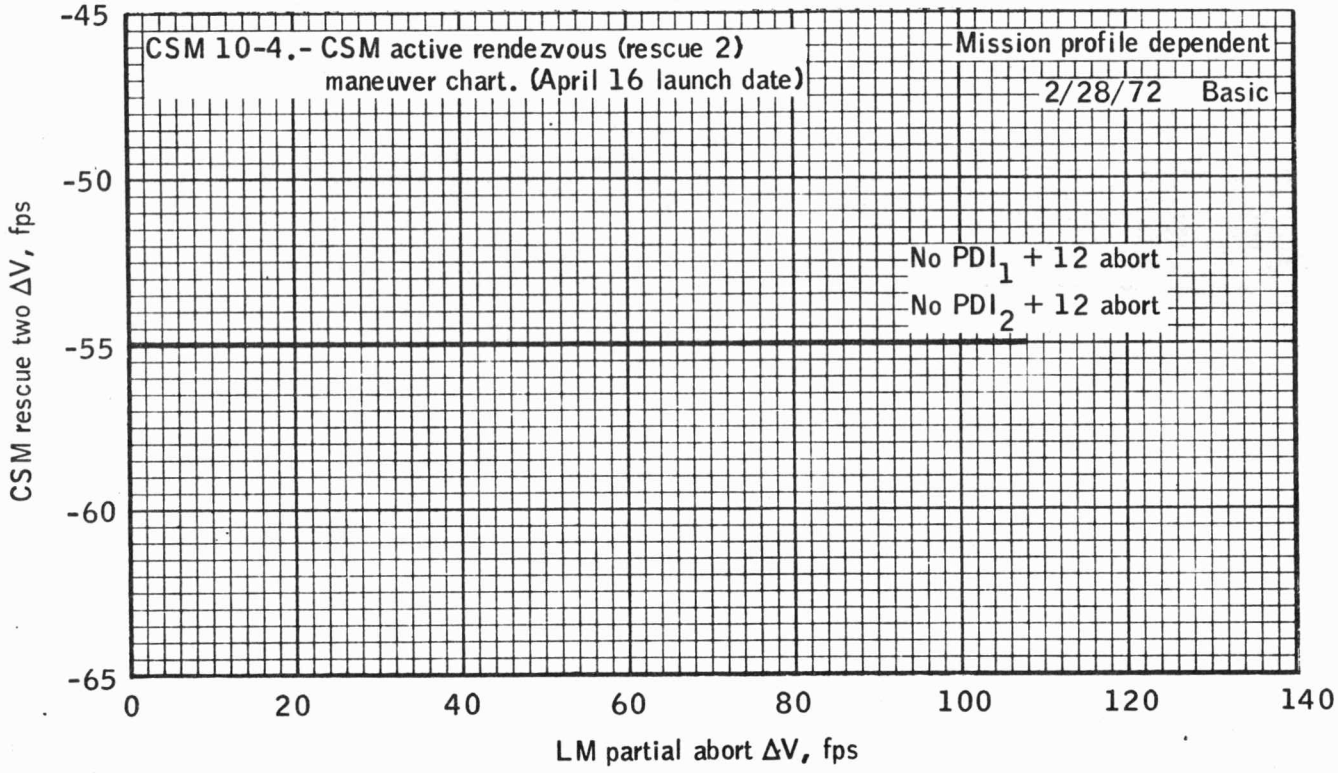
SET STARS	R / S	2/N P	= S/G	&	N	PURPOSE / PROP/GUID
	+					WT N47
R_{ALIGN} ___ ___ ___		0 0	.			P_{TRIM} N48
P_{ALIGN} ___ ___ ___		0 0	.			Y_{TRIM}
Y_{ALIGN} ___ ___ ___	+	0 0				HRS GETI
	+	0 0 0				MIN N33
	+	0	.			SEC
ULLAGE ___				.		ΔV_X N81
	+	0 0 0	0	.	0	ΔV_Y
	+	0 0 0	0	.	0	ΔV_Z
	X	X X				R
	X	X X				P
	X	X X				Y
OTHER ___	+			.		H_A N44
				.		H_P
	+			.		ΔVT
	X	X X	.			BT
	X			.		ΔVC

P32 INITIALIZATION PAD

N11	CSI GETI	+			:	:	.	
N55	N	+	0	0	0			
	ELEV ∢	+	2	0	8	3	0	
	180° OPT	+	1	3	0	0	0	
N37	TPI GETI	+			:	:	.	

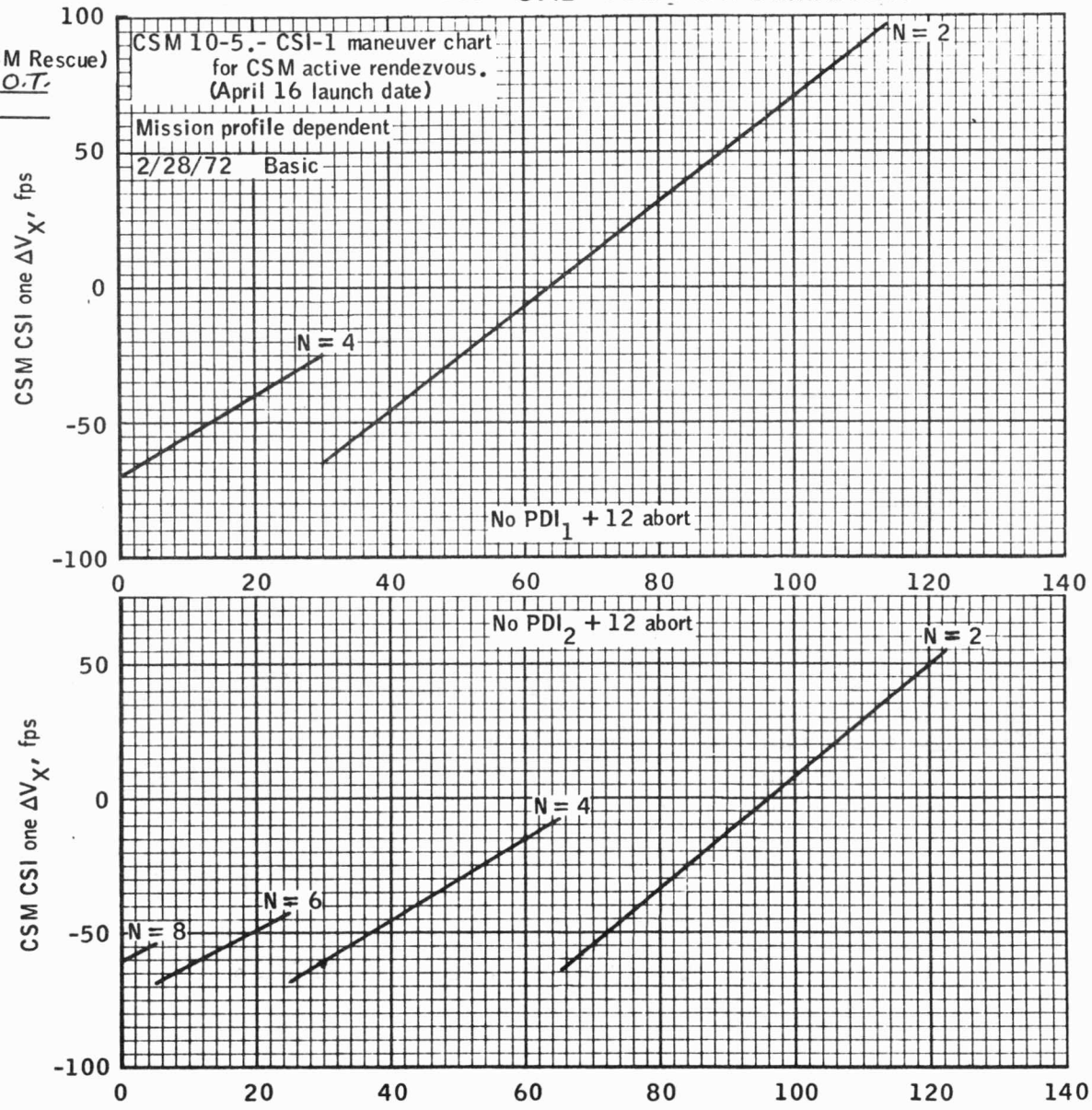
RESCUE TWO BURN INFORMATION

DuPont/MAB/MPAD (for CSM Rescue)
Data source Spacecraft O.T.
Data confirmed GSS

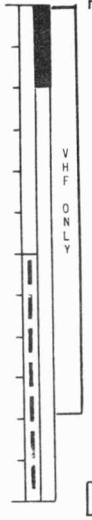


DuPont/MAB/MPAD (for CSM Rescue)
Data source Spacecraft O.T.
Data confirmed 9/10

CSI ONE BURN INFORMATION



P32 (LOAD P32 INITIALIZATION PAD ON PAGE 14)



BEFORE STEADY STATE
N49>(+00200,+00120):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

P32 FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	+0000.0	+0000.0

-12 FINAL COMP, OVERWRITE DVY(COPY); P40m

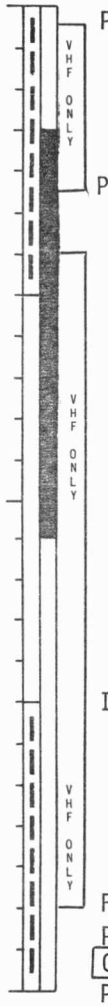
0 CSI ONE BURN

P76m; V67(+10000,+00100,+00001)

IF INITIAL N>4, CONTINUE ON PAGE 18
IF INITIAL N=4, CONTINUE ON PAGE 19
IF INITIAL N=2, CONTINUE ON PAGE 20

GROUND ΔVX [.]

COMPARISON LIMIT=±3 FPS



Ⓐ P32m, REDUCE PREVIOUS N BY 2 ,OVERWRITE N55 R1(COPY)

P52,OPT 3; P32

BEFORE STEADY STATE
N49>(+00200,+00120):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

IF NECESSARY: MSFN UPLINK-LM S.V.
CSM S.V.

-9 FINAL COMP, OVERWRITE DVY(COPY);

P41m

CSI BURN

0 P76m; V67(+10000,+00100,+00001)

RECYCLE TO Ⓐ UNTIL
N=4 WAS INPUT FOR THE
PREVIOUS CSI BURN,
THEN CONTINUE TO PAGE 19.

FOR N=8

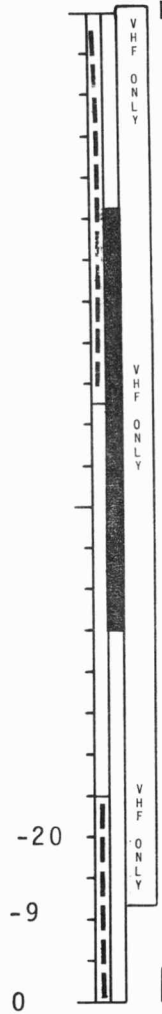
CSI ☐ COMPUTATION				
INPUT	11	CSI GETI . . PROCEED ON DISPLAYED GETI .		
	55	N +00008	ELEVATION ♑ +208.30	180° OPT +130.00
	37	TPI GETI . . PROCEED ON DISPLAYED GETI .		
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	+0000.0	+0000.0

FOR N=6

CSI ☐ COMPUTATION				
INPUT	11	CSI GETI . . PROCEED ON DISPLAYED GETI .		
	55	N +00006	ELEVATION ♑ +208.30	180° OPT +130.00
	37	TPI GETI . . PROCEED ON DISPLAYED GETI .		
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	+0000.0	+0000.0

FOR N=4

CSI ☐ COMPUTATION				
INPUT	11	CSI GETI . . PROCEED ON DISPLAYED GETI .		
	55	N +00004	ELEVATION ♑ +208.30	180° OPT +130.00
	37	TPI GETI . . PROCEED ON DISPLAYED GETI .		
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	+0000.0	+0000.0



P31m (COPY), LOAD ΔH = 10.0

V24	N1E
	2367E
	0E
	22062E

BEFORE STEADY STATE
N49>(+00200,+00120):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

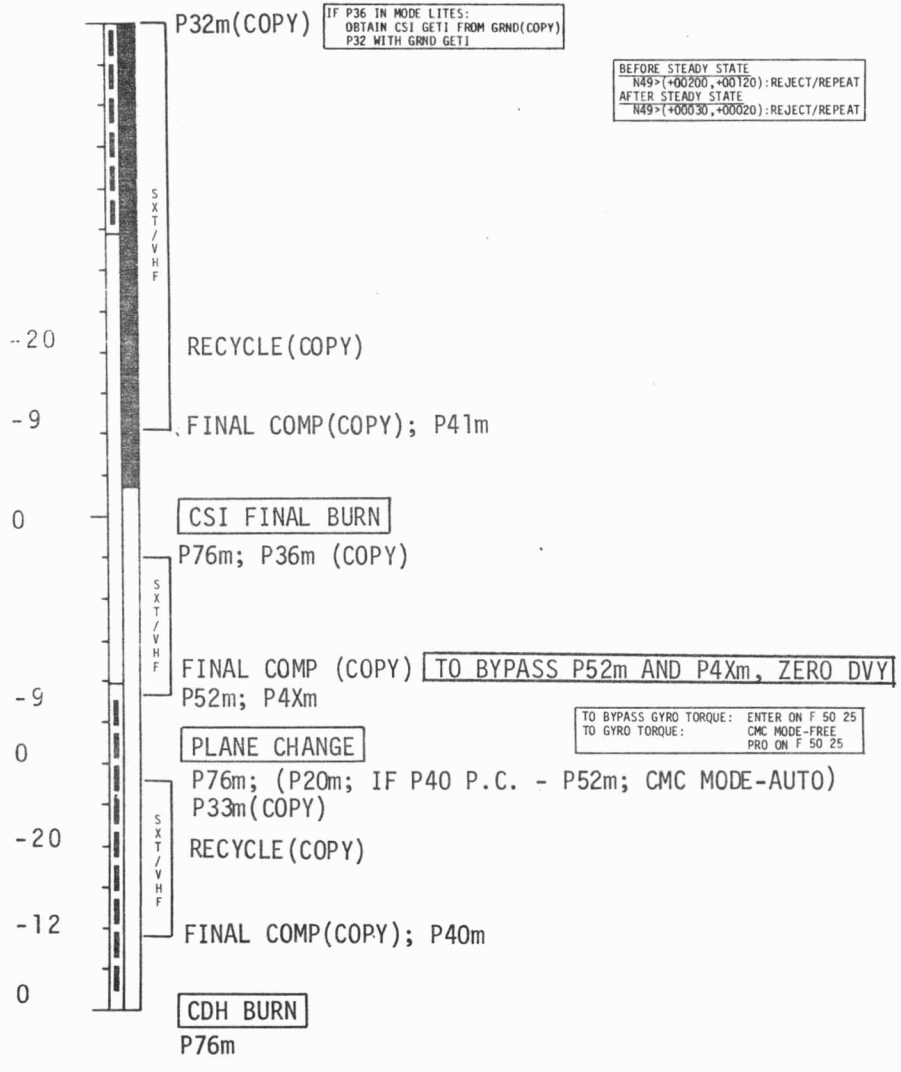
RECYCLE (COPY)

FINAL COMP, OVERWRITE DVY(COPY); P41m

HAM

P76m; V67(+10000,+00100,+00001)

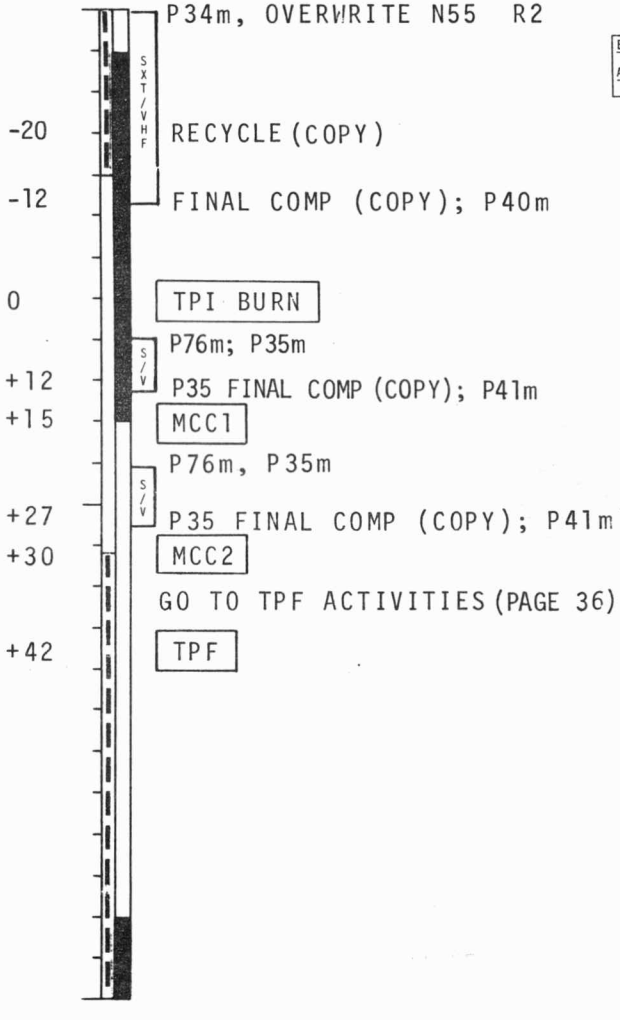
HAM COMPUTATION				
INPUT	11	CSI GETI	PROCEED ON DISPLAYED GETI	
	55	N +00001	ELEVATION Θ +208.30	TEC OPT +130.00
	37	TPI GETI	PROCEED ON DISPLAYED GETI	
	33	HAM GETI	PROCEED ON DISPLAYED GETI	
RECYCLE	90	Y	Y DOT	LM Y DOT
	81	HAM ΔV-LV		+0000.0
FINAL COMP	90	Y	Y DOT	LM Y DOT
	81	HAM ΔV-LV	+0000.0	+0000.0



CSI COMPUTATION				
INPUT	11	CSI GETI	PROCEED ON DISPLAYED GETI	
	55	N +00001	ELEVATION +208.30	180° OPT +130.00
	37	TPI GETI	PROCEED ON DISPLAYED GETI	
RECYCLE	90	Y	Y DOT	LM Y DOT
	81	CSI ΔV-LV		+0000.0
FINAL COMP	90	Y	Y DOT	LM Y DOT
	81	CSI ΔV-LV		+0000.0

PLANE CHANGE COMPUTATION				
INPUT	33	PC GETI	PROCEED ON DISPLAYED GETI	
FINAL COMP	90	Y	Y DOT	LM Y DOT
	81	PC ΔV-LV +0000.0		+0000.0

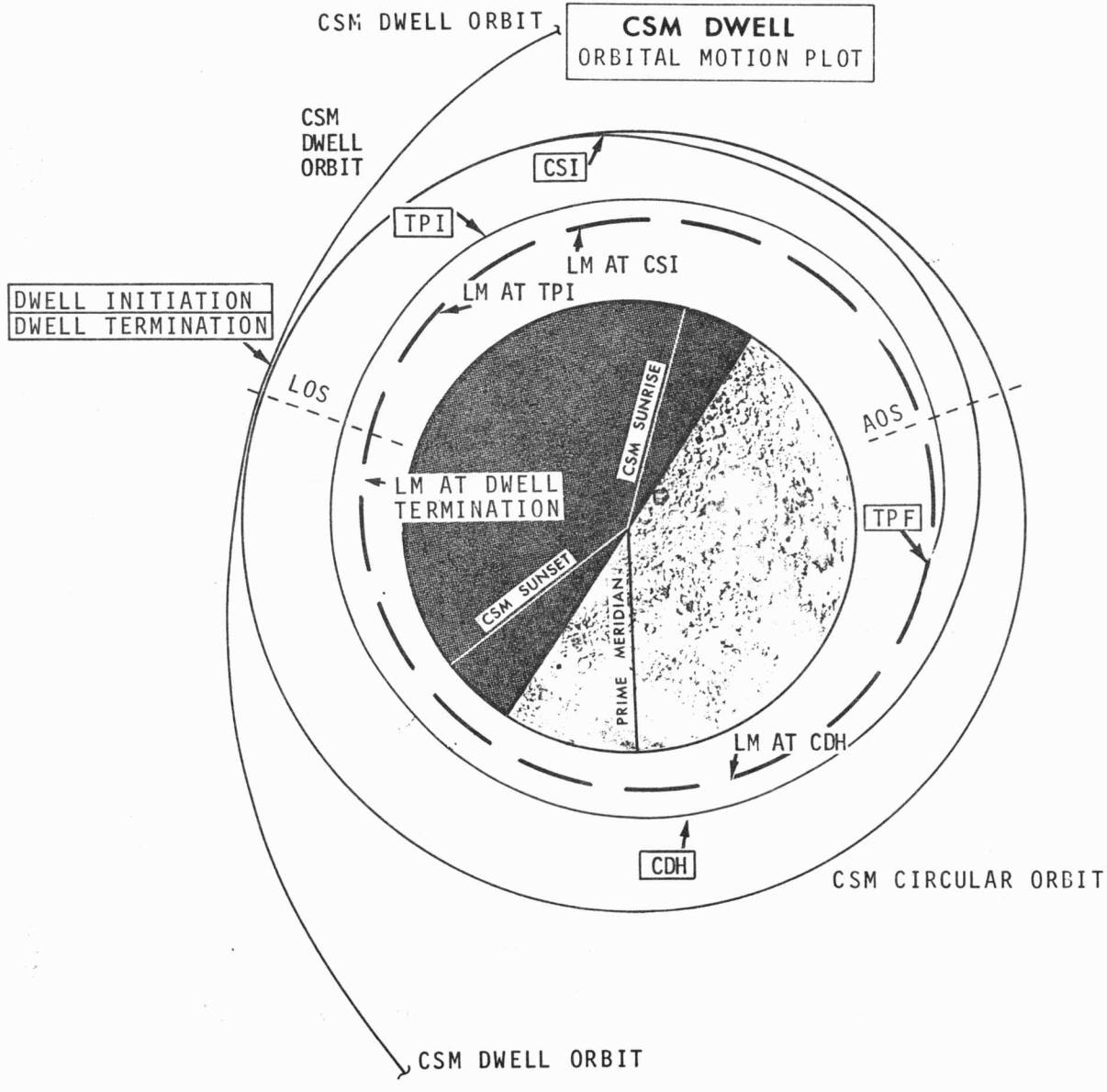
CDH COMPUTATION				
INPUT	13	LM CDH GETI	PROCEED ON DISPLAYED GETI	
RECYCLE	90	Y	Y DOT	LM Y DOT
	81	CDH ΔV-LV		
FINAL COMP	90	Y	Y DOT	LM Y DOT
	81	CDH ΔV-LV		



TPI-ELEVATION OPTION				
INPUT	37	TPI GETI : :		
		PROCEED ON DISPLAYED GETI		
	55	INTEG OPT +00000	ELEVATION ◂ +208.30	TRANSFER ◂ +130.00
RECYCLE	37	TPI GETI : :		
		PROCEED ON DISPLAYED GETI		
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.
FINAL COMP	37	TPI GETI : :		
		PROCEED ON DISPLAYED GETI		
	55	INTEG OPT +00000	ELEVATION ◂ .	TRANSFER ◂ +130.00
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.

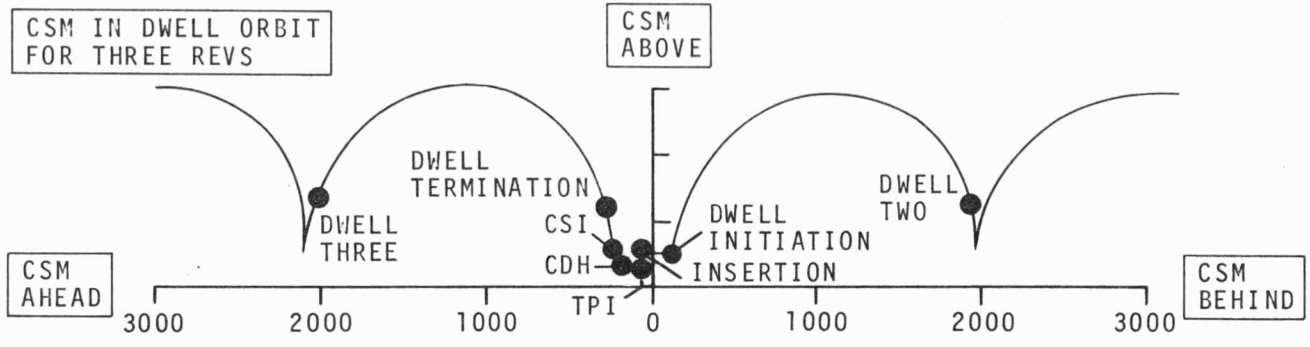
MCC COMPUTATION				
FIN COMP	81	MCC1 ΔV-LV .	.	.

MCC COMPUTATION				
FIN COMP	81	MCC2 ΔV-LV .	.	.


CSM DWELL ORBIT
CSM DWELL ORBIT
ORBITAL MOTION PLOT
CSM DWELL ORBIT
CSI
TPI
LM AT CSI
LM AT TPI
DWELL INITIATION
DWELL TERMINATION
LOS
AOS
CSM SUNRISE
LM AT DWELL TERMINATION
TPF
CSM SUNSET
PRIME MERIDIAN
LM AT CDH
CDH
CSM CIRCULAR ORBIT
CSM DWELL ORBIT

CSM DWELL
RELATIVE MOTION PLOT

LM CENTERED



CSM DWELL
RENDEZVOUS

CSM DWELL
TIMELINE

-15

0

POWER DOWN SIM (SEE EXPS/EVA CHECKLIST)

INSERTION

MSFN UPLINK: LM S.V.
MSFN UPDATE: DWELL INITIATION P30 PAD (COPY)
P32 INITIALIZATION PAD (COPY)

P30; P40

DWELL INITIATION BURN

P00

DWELL INITIATION P30 PAD

SET STARS	D S	W P	E S/G	L &	L N	I	PURPOSE / PROP/GUID	
	+						WT	N47
R_{ALIGN} ___ ___ ___		0	0				P_{TRIM}	N48
P_{ALIGN} ___ ___ ___		0	0				Y_{TRIM}	
Y_{ALIGN} ___ ___ ___	+	0	0				HRS	GETI
	+	0	0	0			MIN	N33
	+	0					SEC	
ULLAGE ___							ΔV_X	N81
___							ΔV_Y	
___							ΔV_Z	
___	X	X	X				R	
___	X	X	X				P	
	X	X	X				Y	
OTHER ___								
REMAIN IN	+						H_A	N44
THE DWELL							H_P	
ORBIT FOR	+						ΔVT	
☐ REVS	X	X	X				BT	
	X						ΔVC	

P32 INITIALIZATION PAD

N11	CSI GETI	+			:		:	.	
N55	N	+	0	0	0	0	1		
	ELEV ◁	+	2	0	8	.	3	0	
	180° OPT	+	1	3	0	.	0	0	
N37	TPI GETI	+			:		:	.	

MSFN UPDATE: DWELL TWO P30 PAD(COPY)
P32 INITIALIZATION PAD(COPY)

P52, OPT 3
P00

-9 P30; P41

0 DWELL TWO BURN
P00

DWELL TWO P30 PAD

SET STARS	D	W	E	L / G	L &	2 N	PURPOSE / PROP/GUID	
	+						WT	N47
R_{ALIGN} ___ ___ ___		0	0				P_{TRIM}	N48
P_{ALIGN} ___ ___ ___		0	0				Y_{TRIM}	
Y_{ALIGN} ___ ___ ___	+	0	0				HRS	GETI
	+	0	0	0			MIN	N33
	+	0					SEC	
ULLAGE _____							ΔV_X	N81
_____							ΔV_Y	
_____							ΔV_Z	
_____	X	X	X				R	
	X	X	X				P	
	X	X	X				Y	
	+						H_A	N44
							H_P	
	+						ΔVT	
	X	X	X				BT	
	X						ΔVC	

P32 INITIALIZATION PAD

N11	CSI GETI	+						
N55	N	+	0	0	0	0	1	
	ELEV ◁	+	2	0	8	3	0	
	180° OPT	+	1	3	0	0	0	
N37	TPI GETI	+						

THIS PAGE IS FOR A THREE REV DWELL ONLY.

IF DWELL TERMINATION IS THE NEXT BURN, GO TO PAGE 27.

MSFN UPDATE: DWELL THREE P30 PAD(COPY)
P32 INITIALIZATION PAD(COPY)

P52, OPT 3
P00

-9 P30; P41

0 DWELL THREE BURN
P00

DWELL THREE P30 PAD

SET STARS	D	W	E	L	L	3	PURPOSE	
				/G	&	N	PROP/GUID	
	+						WT	N47
R_{ALIGN} ___ ___ ___		0	0				P_{TRIM}	N48
P_{ALIGN} ___ ___ ___		0	0				Y_{TRIM}	
Y_{ALIGN} ___ ___ ___	+	0	0				HRS	GETI
	+	0	0	0			MIN	N33
	+	0					SEC	
							ΔV_X	N81
ULLAGE _____							ΔV_Y	
_____							ΔV_Z	
_____	X	X	X				R	
_____	X	X	X				P	
	X	X	X				Y	
	+						H_A	N44
							H_P	
	+						ΔVT	
	X	X	X				BT	
	X						ΔVC	

P32 INITIALIZATION PAD

N11	CSI GETI	+			:		:	.	
N55	N	+	0	0	0	0	1		
	ELEV ◁	+	2	0	8	.	3	0	
	180° OPT	+	1	3	0	.	0	0	
N37	TPI GETI	+			:		:	.	

MSFN UPDATE: DWELL TERMINATION
P30 PAD INCLUDING
OUT OF PLANE COMPONENT(COPY)
P32 INITIALIZATION PAD(COPY)

P52, OPT 3
P00
V48(11102,X1111)
-15 P30; P40

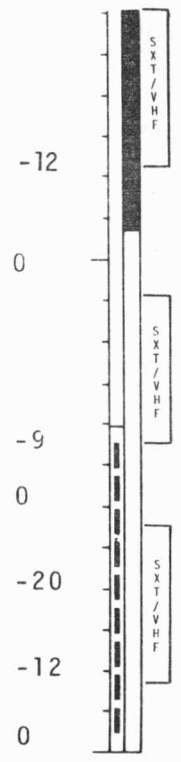
0 DWELL TERMINATION BURN

DWELL TERMINATION PAD

SET STARS	D S	W P	E S/G	L &	T N	PURPOSE / PROP/GUID	
	+					WT	N47
R_{ALIGN} ___ ___ ___		0	0			P_{TRIM}	N48
P_{ALIGN} ___ ___ ___		0	0			Y_{TRIM}	
Y_{ALIGN} ___ ___ ___	+	0	0			HRS	GETI
	+	0	0	0		MIN	N33
	+	0				SEC	
						ΔV_X	N81
ULLAGE ___						ΔV_Y	
___						ΔV_Z	
___							
___	X	X	X			R	
	X	X	X			P	
	X	X	X			Y	
OTHER ___							
BURN INCLUDES	+					H_A	N44
PLANE CHANGE						H_P	
COMPONENT	+					ΔVT	
	X	X	X			BT	
	X					ΔVC	

P32 INITIALIZATION PAD

N11	CSI GETI	+				:		:	.
N55	N	+	0	0	0	0	1		
	ELEV ∢	+	2	0	8	.	3	0	
	180° OPT	+	1	3	0	.	0	0	
N37	TPI GETI	+				:		:	.



P32 (LOAD P32 INITIALIZATION PAD)

BEFORE STEADY STATE
N49>(+00200,+00120):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

FINAL COMP(COPY); P40m

CSI BURN
P76m; P36m(COPY)

BEFORE STEADY STATE
N49>(+00080,+00050):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

FINAL COMP(COPY), TO BYPASS P52m AND P4Xm, ZERO DVY
P52m; P4Xm

TO BYPASS GYRO TORQUE: ENTER ON F 50 25
TO GYRO TORQUE: CMC MODE-FREE
PRO ON F 50 25

PLANE CHANGE
P76m; (P20m; IF P40 P.C. - P52m; CMC MODE-AUTO)
P33m(COPY)

RECYCLE(COPY)

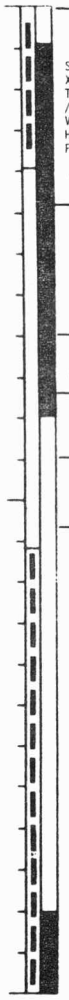
FINAL COMP(COPY); P40m

CDH BURN
P76m

CSI COMPUTATION				
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	.	+0000.0

PLANE CHANGE COMPUTATION				
INPUT	33	PC GETI .	. PROCEED ON DISPLAYED GETI	
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	PC ΔV-LV +0000.0	.	+0000.0

CDH COMPUTATION				
INPUT	13	CDH GETI .	. PROCEED ON DISPLAYED GETI	
RECYCLE	90	Y .	Y DOT .	LM Y DOT .
	81	CDH ΔV-LV .	.	.
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CDH ΔV-LV .	.	.



P34m, OVERWRITE N55 R2

-20 RECYCLE(COPY)

-12 FINAL COMP(COPY); P40m

0 TPI BURN

P76m; P35m

+12 FINAL COMP (COPY); P41m

+15 MCC1

P76m, P35m

+27 FINAL COMP(COPY); P41m

+30 MCC2

GO TO TPF ACTIVITIES (PAGE 36)

+42 TPF

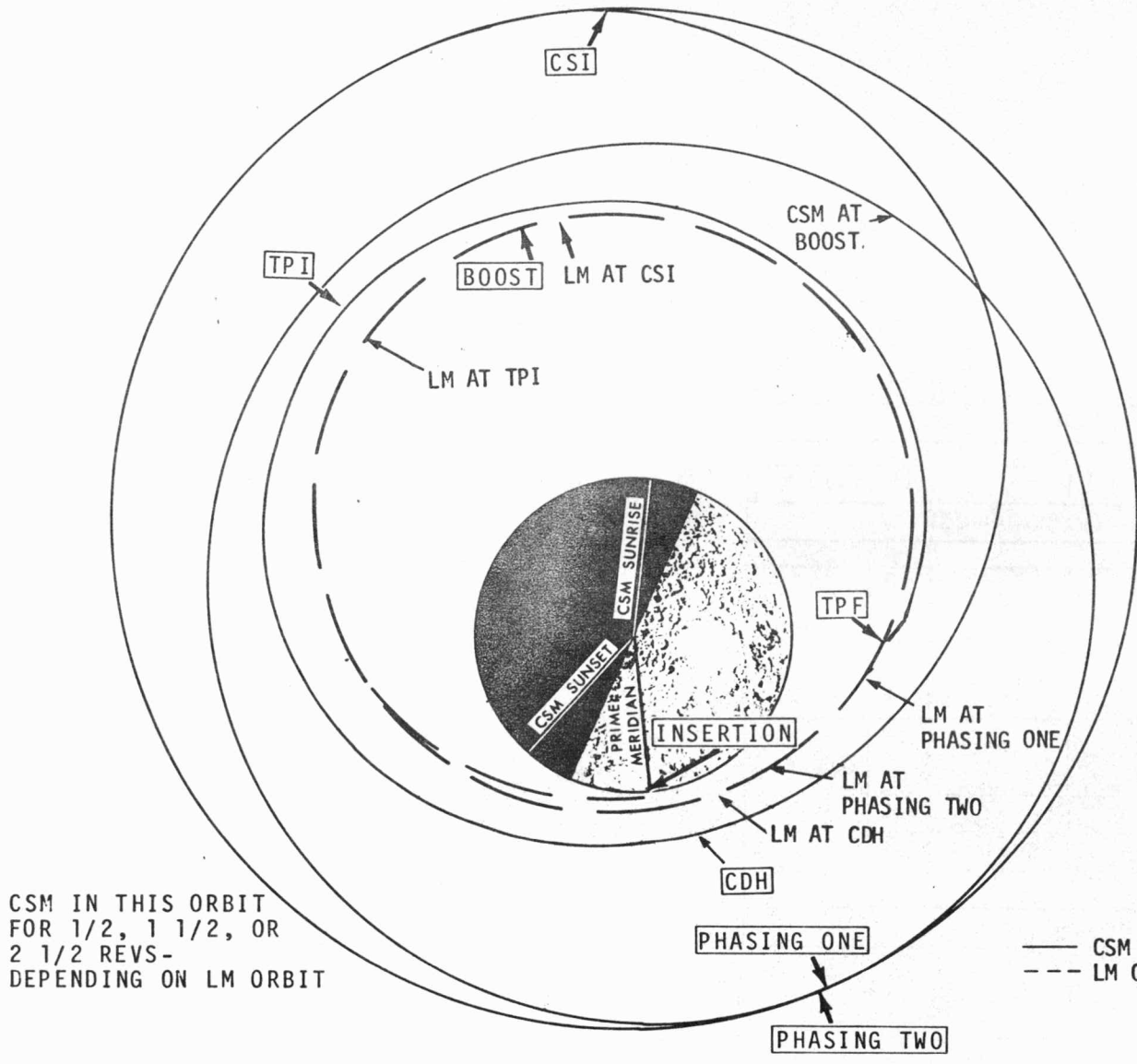
BEFORE STEADY STATE
N49>(+00080,+00050):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

TPI ELEVATION OPTION				
INPUT	37	TPI GETI . . . PROCEED ON DISPLAYED GETI		
	55	INTEG OPT +00000	ELEVATION ◁ +208.30	TRANSFER ◁ +130.00
RECYCLE	37	TPI GETI . . . PROCEED ON DISPLAYED GETI		
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.
FINAL COMP	37	TPI GETI . . . PROCEED ON DISPLAYED GETI		
	55	INTEG OPT +00000	ELEVATION ◁ .	TRANSFER ◁ +130.00
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.

MCC COMPUTATION				
FIN COMP	81	MCC1 ΔV-LV .	.	.

MCC COMPUTATION				
FIN COMP	81	MCC2 ΔV-LV .	.	.

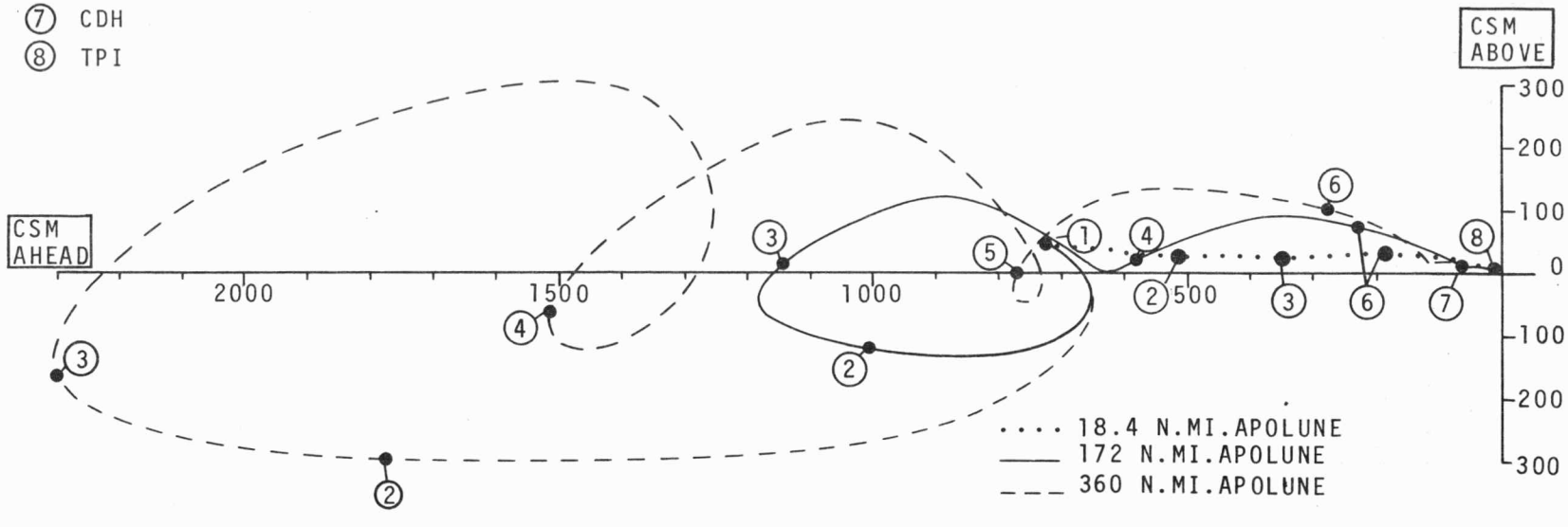
MANUAL INSERTION
ORBITAL MOTION PLOT



MANUAL INSERTION
RELATIVE MOTION PLOTS

LM CENTERED

① INSERTION
② LM BOOST
③ PHASING ONE
④ PHASING TWO (NOMINALLY ZERO)
⑤ PHASING THREE (NOMINALLY ZERO)
⑥ CSI
⑦ CDH
⑧ TPI



MANUAL INS
RENDEZVOUS

MANUAL INSERTION
TIMELINE

-110

POWER DOWN SIM (SEE EXPS/EVA CHECKLIST)

INSERTION

MSFN UPLINK: LM S.V.

P52, OPT 3
P00

LM BOOST P76	33	LM GETI-BOOST : : .		
	84	LM BOOST ΔV-LV +0010.0	+0000.0	+0000.0

LM BOOST

VERIFY LM BOOST BURN
P76

MSFN UPDATE: PHASING P30 PAD (COPY)
P32 INITIALIZATION PAD (COPY)

-15

P30; P40

0

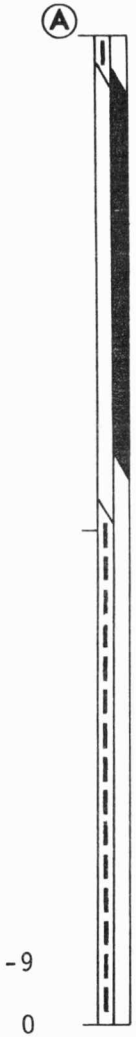
PHASING ONE

PHASING P30 PAD

SET STARS	PHASE SP	PHASE PROP	ASE GUID	SEN &	SEN N	PURPOSE / PROP/GUID	
	+					WT	N47
R_{ALIGN} ___ ___ ___		0	0			P_{TRIM}	N48
P_{ALIGN} ___ ___ ___		0	0			Y_{TRIM}	
Y_{ALIGN} ___ ___ ___	+	0	0			HRS	GETI
	+	0	0	0		MIN	N33
	+	0				SEC	
ULLAGE ___						ΔV_X	N81
___						ΔV_Y	
___						ΔV_Z	
___	X	X	X			R	
	X	X	X			P	
OTHER ___	X	X	X			Y	
___	+					H_A	N44
___						H_P	
___	+					ΔVT	
	X	X	X			BT	
	X					ΔVC	

P32 INITIALIZATION PAD

N11	CSI GETI	+				:	:	.
N55	N	+	0	0	0	0	1	
	ELEV ✧	+	2	0	8	3	0	
	180° OPT	+	1	3	0	0	0	
N37	TPI GETI	+				:	:	.



PHASING TWO P30 PAD

SET STARS	P	H	A	S/G	E &	2 N	PURPOSE / PROP/GUID
	+						WT N47
R_{ALIGN} ___ ___ ___		0	0				P_{TRIM} N48
P_{ALIGN} ___ ___ ___		0	0				Y_{TRIM}
Y_{ALIGN} ___ ___ ___	+	0	0				HRS GETI
	+	0	0	0			MIN N33
	+	0					SEC
ULLAGE _____							ΔV_X N81
_____							ΔV_Y
_____							ΔV_Z
_____	X	X	X				R
	X	X	X				P
	X	X	X				Y
	+						H_A N44
							H_P
	+						ΔVT
	X	X	X				BT
	X						ΔVC

P32 INITIALIZATION PAD

N11	CSI GETI	+			:	:	.	
N55	N	+	0	0	0	0	1	
	ELEV ◁	+	2	0	8	3	0	
	180° OPT	+	1	3	0	0	0	
N37	TPI GETI	+			:	:	.	

PHASING THREE P30 PAD

SET STARS	P	H	A	S/G	E &	3 N	PURPOSE / PROP/GUID
	+						WT N47
R_{ALIGN} ___ ___ ___		0	0				P_{TRIM} N48
P_{ALIGN} ___ ___ ___		0	0				Y_{TRIM}
Y_{ALIGN} ___ ___ ___	+	0	0				HRS GETI
	+	0	0	0			MIN N33
	+	0					SEC
ULLAGE _____							ΔV_X N81
_____							ΔV_Y
_____							ΔV_Z
_____	X	X	X				R
	X	X	X				P
	X	X	X				Y
	+						H_A N44
							H_P
	+						ΔVT
	X	X	X				BT
	X						ΔVC

P32 INITIALIZATION PAD

N11	CSI GETI	+			:	:	.	
N55	N	+	0	0	0	0	1	
	ELEV ◁	+	2	0	8	3	0	
	180° OPT	+	1	3	0	0	0	
N37	TPI GETI	+			:	:	.	

V48(11102,X1111)
P32(LOAD P32 INITIALIZATION PAD)

BEFORE STEADY STATE
N49>(+00200,+00120):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

SXT/VHF

-20 RECYCLE(COPY)

-12 FINAL COMP(COPY); P40m

0 CSI BURN
P76m; P36m(COPY)

SXT/VHF

BEFORE STEADY STATE
N49>(+00080,+00050):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

-9 FINAL COMP(COPY), TO BYPASS P52m AND P4Xm, ZERO DVY
P52m; P4Xm

TO BYPASS GYRO TORQUE: ENTER ON F 50 25
TO GYRO TORQUE: CMC MODE-FREE
PRO ON F 50 25

0 PLANE CHANGE
P76m; (P20m; IF P40 P.C. - P52m; CMC MODE-AUTO)
P33m(COPY)

SXT/VHF

-20 RECYCLE(COPY)

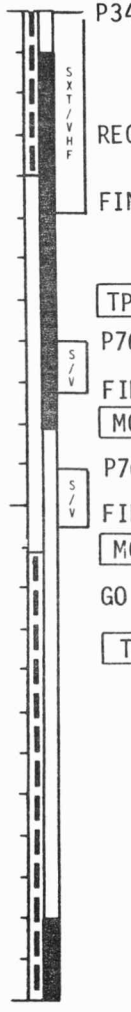
-12 FINAL COMP(COPY); P40m

0 CDH BURN
P76m

CSI COMPUTATION				
RECYCLE	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	.	+0000.0
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CSI ΔV-LV .	.	+0000.0

PLANE CHANGE COMPUTATION				
INPUT	33	PC GETI . .	• PROCEED ON DISPLAYED GETI •	
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	PC ΔV-LV +0000.0	.	+0000.0

CDH COMPUTATION				
INPUT	13	CDH GETI . .	• PROCEED ON DISPLAYED GETI •	
RECYCLE	90	Y .	Y DOT .	LM Y DOT .
	81	CDH ΔV-LV .	.	.
FINAL COMP	90	Y .	Y DOT .	LM Y DOT .
	81	CDH ΔV-LV .	.	.



P34m, OVERWRITE N55 R2

BEFORE STEADY STATE
N49>(+00080,+00050):REJECT/REPEAT
AFTER STEADY STATE
N49>(+00030,+00020):REJECT/REPEAT

-20 RECYCLE (COPY)

-12 FINAL COMP (COPY); P40m

0 TPI BURN

P76m; P35m

+12 FINAL COMP(COPY); P41m

+15 MCC1

P76m; P35m

+27 FINAL COMP(COPY); P41m

+30 MCC2

GO TO TPF ACTIVITIES (PAGE 36)

+42 TPF

TPI-ELEVATION OPTION				
INPUT	37	TPI GETI : : PROCEED ON DISPLAYED GETI		
	55	INTEG OPT +00000	ELEVATION ◂ +208.30	TRANSFER ◂ +130.00
RECYCLE	37	TPI GETI : : PROCEED ON DISPLAYED GETI		
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.
FINAL COMP	37	TPI GETI : : PROCEED ON DISPLAYED GETI		
	55	INTEG OPT +00000	ELEVATION ◂ .	TRANSFER ◂ +130.00
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.

MCC COMPUTATION				
FIN COMP	81	MCC1 ΔV-LV .	.	.

MCC COMPUTATION				
FIN COMP	81	MCC2 ΔV-LV .	.	.

TPF ACTIVITIES

+30

(11102)
(X1111)

MCC2

P76m; P79m; POO
V49 MNVR TO X-AXIS TRACK ATTITUDE

ACQ MSFN

PERFORM PRE-DOCK CHECKLIST

IF CSM ACTIVE

P47 AT 1.25 N.M.
SEC PRPLNT FUEL PRESS(4)-OPEN
V83E
N83E
KEY REL

UTILITY PWR-ON (VERIFY)
TV-ON
DAC-ON
LM PHOTOS WITH DAC/TV

+42

TPF

EMS MODE-STBY
EMS FUNC-OFF

EXT RNDZ LT-OFF
LM STATION KEEP

DAC/TV-OFF

PRE-DOCK CHECKLIST
MAN ATT(3)-RATE CMD(VERIFY)
LIMIT CYCLE-OFF(VERIFY)
ATT DB-MIN
RATE-LOW(VERIFY)
TRANS CONTR PWR-ON(UP)
ROT CONTR PWR DIRECT(BOTH)-MNA/MNB
SC CONT-CMC(VERIFY)
AUTO RCS SEL(16)-MNA/MNB
CB DOCK PROBE(2)-CLOSED
PROBE RETR(2)-OFF(VERIFY)
PROBE EXTD/REL-RETR
PROBE EXTD/REL TB(2)-GRAY(VERIFY)
(IF TB NOT GRAY, GO TO PG S/2-13,E)
CB SECS LOGIC(2)-CLOSED(VERIFY)
CB SECS ARM(2)-CLOSED
EXT LIGHTS RUN/EVA-ON(UP)(VERIFY)
COAS PWR-ON(UP)(VERIFY)

BRAKING GATES			
R,NM	Ṙ,FPS	RETICLE ANG,DEG	R,FT
1.50	45	.08	9000
1.00	30	.13	6000
.50	20	.26	3000
.25	10	.54	1500
.08	5	1.60	500
.05		2.70	300
.03		4.00	200
.02		8.50	100

V49 MNVR TO SIM BAY INSPECTION ATTITUDE (330 ,246,0)

V49 MNVR TO DOCKING ATTITUDE (180 ,285,0)

DOCKING ATTITUDE
VERIFY HGA

CUE MSFN FOR LOGIC ARM
SECS LOGIC (BOTH)-ON(UP)
MSFN GO FOR PYRO ARM
SECS PYRO ARM (2)-ON(UP)

P47
DAC/TV-ON
LM MNVR TO DOCKING ATTITUDE
TRANSLATE TO CAPTURE LATCH
PERFORM DOCKING CHECKLIST

DOCKING

DAC/TV-OFF
P00
V48 (61111 X1111)

(61111 X1111)

CMC MODE-AUTO
RNDZ XPONDER-OFF
GO TO VOLUME II OF THE FLIGHT PLAN

DOCKING CHECKLIST

AT CAPTURE

PROBE EXTD/REL TB(2)-BP(VERIFY)
(IF TB NOT BP, GO TO PG S/2-11, A)
REPORT CAPTURE TO LM
SC CONT-CMC(VERIFY)
CMC MODE-FREE
ALLOW PROBE TO DAMP S/C MOTION(10 SEC)
WHEN WITHIN ±3° OF DOCKING ATTITUDE
PROBE RETRACT SEC-1 (PRIM-2 IF REQ)

AT DOCK LATCH

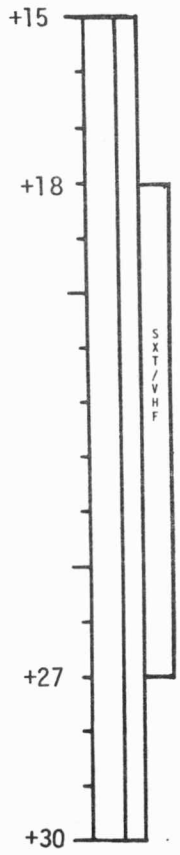
PROBE EXTD/REL TB(2)-GRAY

AT HARD DOCK

SECS PYRO ARM (2) - SAFE
SECS LOGIC (BOTH) - OFF
CB SECS ARM (2) - OPEN
CB DOCK PROBE (2) - OPEN
THC - LOCKED
RHC - LOCKED
BMAG MODE (3) - RATE 2(VERIFY)
PROBE EXTD/REL - OFF
PROBE RETRACT (2) - OFF
EXT RUN/EVA LIGHT - OFF
EXT RNDZ LIGHT - OFF
COAS PWR - OFF
AUTO RCS SEL ROLL (4)-OFF
TRANS CONTR PWR-OFF
ROT CONTR PWR DIRECT (BOTH)-OFF
VHF RANGING OFF

TPF ACTIVITIES

PRE-BRAKING SPS BURN PROCEDURES



MCC-1

COMPUTE PRE-BRAKING BURN GETI AND TRANSFER ANGLE(COPY)

V93
P34(SEE INPUT)

FINAL COMP (COPY)

V48(11103,X1111)
P40

GETI-TPI		
ΔT: TPI-PRE-BRAKING	+37	00.00
GETI- PRE-BRAKING		

TRANSFER ϑ COMPUTATION
OBTAIN TPF ΔV FROM N58 OF TPI SOLUTION

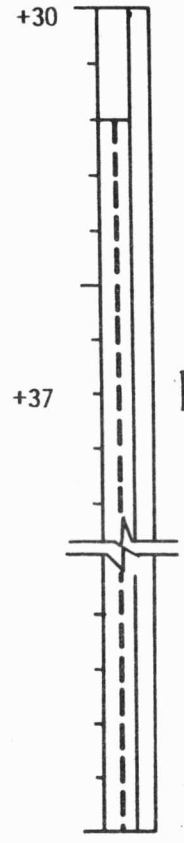
TRANSFER ϑ = TPF ΔV / 2

= • / 2

TRANSFER ϑ = •

LOAD INTO N55 (R3)

PRE-BRAKING BURN COMPUTATION				
INPUT	37	COMPUTED P34 GETI		
	55	INTEG OPT +00000	ELEVATION ◂ +0000.0	COMPUTED TRANSFER
FINAL COMP	55	INTEG OPT +00000	ELEVATION ◂	TRANSFER ◂
	58	PERILUNE ALT	P34 ΔV	TPF ΔV
	81	P34 ΔV-LV		



+30 P40

SPS CHECKLIST

+37 PRE-BRAKING BURN

P79; P00; V49 MNVR TO X-AXIS TRACK ATTITUDE
ACQ MSFN HGA
V48(11102,X1111)
PERFORM PRE-DOCK CHECKLIST

P47 AT R=1.25 NM
SEC PRPLNT FUEL PRESS(4)-OPEN
V83E, N83E KEY REL

UTIL PWR-ON (VERIFY)
DAC/TV-ON
LM PHOTOS WITH DAC/T V

TPF

EMS MODE-STBY
EMS FUNC-OFF
EXT RNDZ LT-OFF
LM STATION KEEP
GO TO VOL II OF FLIGHT PLAN

PRE-DOCK CHECKLIST
MAN ATT(3)-RATE CMD(VERIFY)
LIMIT CYCLE-OFF(VERIFY)
ATT DB-MIN
RATE-LOW(VERIFY)
TRANS CONTR PWR-ON(UP)
ROT CONTR PWR DIRECT(BOTH)-MNA/MNB
SC CONT-CMC(VERIFY)
AUTO RCS SEL(16)-MNA/MNB
CB DOCK PROBE(2)-CLOSED
PROBE RETR(2)-OFF(VERIFY)
PROBE EXTD/REL-RETR
PROBE EXTD/REL TB(2)-GRAY(VERIFY)
(IF TB NOT GRAY, GO TO PG S/2-13,E)
CB SECS LOGIC(2)-CLOSED(VERIFY)
CB SECS ARM(2)-CLOSED
EXT LIGHTS RUN/EVA-ON(UP)(VERIFY)
COAS PWR-ON(UP)(VERIFY)

BRAKING GATES			
R,NM	$\dot{R}$,FPS	RETICLE ANG,DEG	R,FT
1.50	45	.08	9000
1.00	30	.13	6000
.50	20	.26	3000
.25	10	.54	1500
.08	5	1.60	500
.05		2.70	300
.03		4.00	200
.02		8.50	100

IMU FAILURE RENDEZVOUS

WHEN IMU FAILURE KNOWN:
PERFORM IMU FAILURE SWITCH CHECKLIST
PERFORM GDC REFSMMAT DETERMINATION PROCEDURE(G/7-13)
(IF REQD: PERFORM GDC REFSMMAT REALIGN(P52-OPT 4)(G/7-15)

MNVR TO TRACK/STAR FIELD ATT(180,280,0), ACQ HGA
LOAD N20 AND ATT SET TW'S TO(180,280,0)
MNVR BY NULLING ERROR NEEDLES

SET REFSMMAT FLAG(VERIFY)
V25 N7E,77E,10000E,1E

PRE-SPS BURN SIM PREP (CUE CARD)

IMU FAILURE SWITCH CHECKLIST

IMU POWER-OFF
FDAI SELECT-1
FDAI SOURCE-ATT SET
ATT SET-GDC
ATT DB-MIN
RATE-LOW
SC CONT-SCS
BMAG MODE(3)-ATT 1/RATE 2

DIRECT ASCENT RNDZ PAD								UPDATE (IF REQ'D)						
GETI LIFT-OFF	HRS	+	0	0				+	0	0				
	MIN	+	0	0	0			+	0	0	0			
	SEC	+	0			.		+	0			.		
GETI TPI N37	HRS	+	0	0				+	0	0				
	MIN	+	0	0	0			+	0	0	0			
	SEC	+	0			.		+	0			.		

COELLIPTIC RNDZ PAD								UPDATE (IF REQ'D)						
GETI LIFT-OFF	HRS	+	0	0				+	0	0				
	MIN	+	0	0	0			+	0	0	0			
	SEC	+	0			.		+	0			.		
GETI CSI N11	HRS	+	0	0				+	0	0				
	MIN	+	0	0	0			+	0	0	0			
	SEC	+	0			.		+	0			.		
GETI TPI N37	HRS	+	0	0				+	0	0				
	MIN	+	0	0	0			+	0	0	0			
	SEC	+	0			.		+	0			.		

MSFN UPDATE:
GO/NO GO FOR LIFT-OFF

0 LM LIFT-OFF __ : __ : __ . __

VHF RNG-RESET

-47 LM INSERTION __ : __ : __ . __

P52(OPTION 3)

RECORD STAR NO.	SHAFT	TRUNNION

P00

MSFN UPLINK:
LM S.V.

-39 P34(ACCEPT MNKY)(BYPASS MNVR)
V57-LOAD R2=1

VHF ONLY

BEFORE STEADY STATE
PRE-TPI: N49 > (+00200,+00120) REJECT/REPEAT
POST-TPI: N49 > (+00080,+00050) REJECT/REPEAT
AFTER STEADY STATE
ANYTIME: N49 > (+00030,+00020) REJECT/REPEAT

VERIFY LM TRACKER LT-ON
ALIGN GDC TO N20

-31 PERFORM GDC REFSMMAT DETERMINATION PROCEDURE
V37E00E; V96E; V21 N1E,1214E,63E;
V25 N26E,13001E,3425E,30005E; V30E

SCS BURN MANEUVER

N/A / SET STARS	C	S	M	B	/	O	PURPOSE
	S	P	S/	G	&	N	PROP/GUID
	+			N	/	A	WT N47
^{R}ALIGN N / A		0	0	N	/	A	P_{TRIM} N48
^{P}ALIGN N / A		0	0	N	/	A	Y_{TRIM}
^{Y}ALIGN N / A	+	0	0				HRS GETI
	+	0	0	0			MIN N33
	+	0					SEC
ULLAGE							ΔV_X N81
4 JET, 11 SEC							ΔV_Y
							ΔV_Z
	X	X	X				R
	X	X	X				P
	X	X	X				Y
ΔVC	+			N	/	A	H_A N44
				N	/	A	H_P

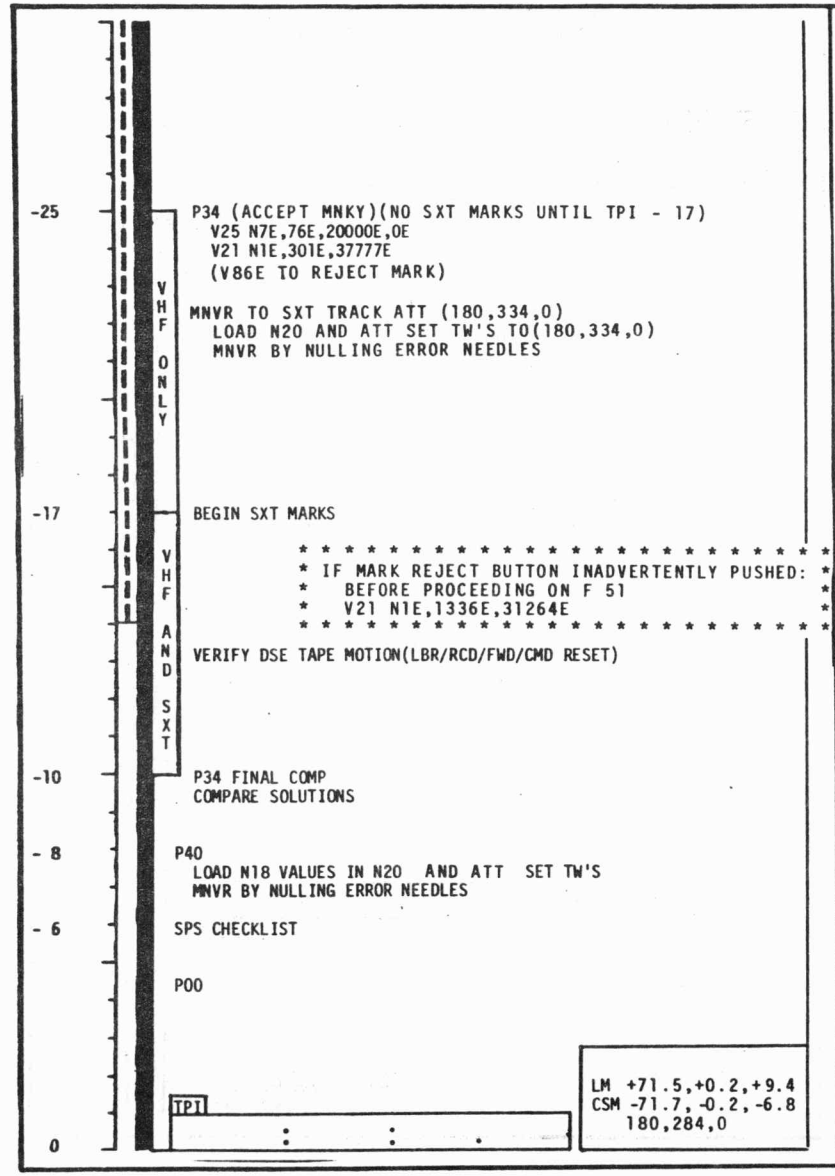
*IF LM BAILOUT REQ'D:
COPY P76 DATA FROM LM
*33 __ : __ : __ . __
*84 __ . __ . __ . __
*GO TO RESCUE BOOK PG 4

*IF CSM BAILOUT REQ'D:
*MSFN UPDATE:
CSM BAILOUT P30 PAD
*P30
*P40; SET UP EMS
*SPS BURN CUE CARD
*CSM BAILOUT BURN
*GO TO RESCUE BOOK PG 4

APPENDIX E

P34 INPUT			
37	LM GETI-TPI : : .		
55	INTEG OPT +00000	ELEVATION ∮° +000.00	TRANSFER ∮ +130.00

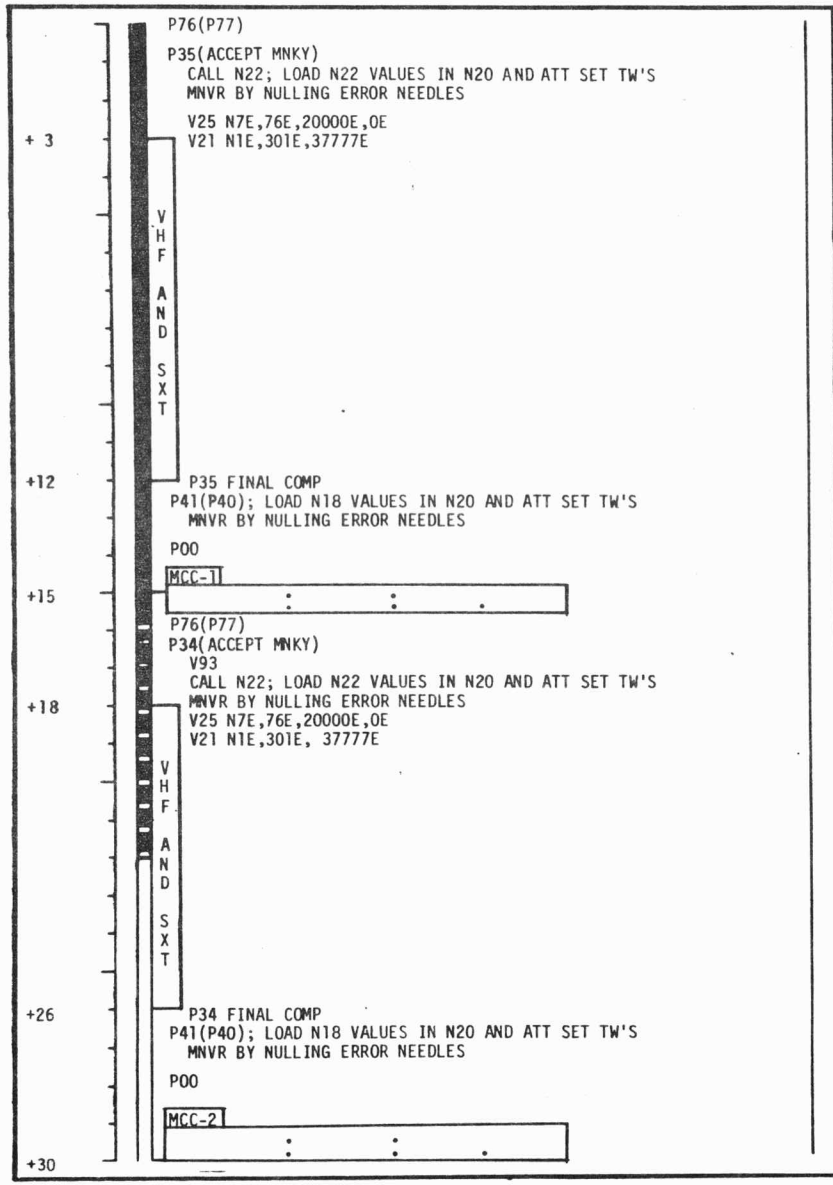
IMU FAILURE
RENDEZVOUS



GROUND TPI FOR LM

						ΔV_X
						ΔV_Y
						ΔV_Z

	P34 FINAL COMP			
	55	INTEG OPT +00000	ELEVATION ⟩ .	TRANSFER ⟩ +130.00
	58	PERILUNE ALT .	TPI ΔV .	TPF ΔV .
	81	TPI ΔV-LV .	.	.
	84	LM TPI ΔV-LV .	.	.
P76	84	LM TPI ΔV-LV .	.	.



P35 FINAL COMP				
	81	MCC1 ΔV-LV		
	84	LM MCC1 ΔV-LV		
P76	84	LM MCC1 ΔV-LV		

P34 INPUT				
	37	GETI-MCC2		
	55	INTEG OPT +00000	ELEVATION } +000.00	TRANSFER } +040.00

P34 FINAL COMP				
	55	INTEG OPT +00000	ELEVATION }	TRANSFER } +040.00
	58	PERILUNE ALT	MCC2 ΔV	TPF ΔV
	81	MCC2 ΔV-LV		
	84	LM MCC2 ΔV-LV		
P76	84	LM MCC2 ΔV-LV		

P76(P77)

P79
LOAD N22 VALUES IN ATT SET TW'S
MNVR BY NULLING ERROR NEEDLES

ACQ MSFN HGA

PERFORM PRE-DOCK CHECKLIST

CENTER LM IN COAS
CYCLE BMAG MODE SWITCHES-RATE 2/ATT 1 RATE 2
FDAI SOURCE-GDC(VERIFY)

IF CSM ACTIVE:
AT R=1.25 NM; LOAD EMS WITH -(100+TPFΔV)
FOR DSKY DISPLAY OF VHF RANGE:
V25 N7E,75E,100E,1E; V87E; V16 N2E,3703E
SEC PRPLNT FUEL PRESS(4)-OPEN
EMS FUNC-ΔV
EMS MODE-NORMAL

+42

TPF

LM 30.9 (TOTAL)
CSM 32.7 (TOTAL)
180,285,0

EMS MODE-STBY
EMS FUNC-OFF
EXT RNDZ LT-OFF

LM STATION KEEP

P00

CUE MSFN FOR LOGIC ARM
SECS LOGIC(BOTH)-ON(UP)
MSFN GO FOR PYRO ARM
SECS PYRO ARM(2)-ON(UP)

LM MNVR TO DOCKING ATTITUDE

TRANSLATE TO CAPTURE LATCH
PERFORM DOCKING CHECKLIST

DOCKING

PRE-DOCK CHECKLIST

FDAI SOURCE-GDC
LIMIT CYCLE-OFF(VERIFY)
TRANS CONTR PWR-ON(UP)
ROT CONTR PWR DIRECT(BOTH)-MNA/MNB
AUTO RCS SEL(16)-MNA/MNB
CB DOCK PROBE(2)-CLOSED
PROBE RETRACT(2)-OFF(VERIFY)
PROBE EXTD/REL - RETR
PROBE EXTD/REL TB (2) - GRAY (VERIFY)
(IF TB NOT GRAY, GO TO PG S/2-13,E)
CB SECS LOGIC (2) - CLOSED (VERIFY)
CB SECS ARM (2) - CLOSED
EXT LIGHTS RUN/EVA - ON (UP) (VERIFY)
COAS PWR - ON (UP) (VERIFY)

BRAKING GATES

R,NM	R,FPS	RETICLE ANG,DEG	R,FT
1.50	45	.08	9000
1.00	30	.13	6000
.50	20	.26	3000
.25	10	.54	1500
.08	5	1.60	500
.05		2.70	300
.03		4.00	200
.02		8.50	100

DOCKING CHECKLIST

AT CAPTURE

PROBE EXTD/REL TB (2) - BP (VERIFY)
(IF TB NOT BP, GO TO PG S/2-11, A)
REPORT CAPTURE TO LM
BMAG MODE (3) - RATE 2
ALLOW PROBE TO DAMP SC MOTION (10 SEC)
WHEN WITHIN ± 3° OF DOCKING ATTITUDE
PROBE RETRACT SEC - 1 (PRIM - 2 IF REQ'D)

AT DOCK LATCH

PROBE EXTD/REL TB (2) - GRAY

AT HARD DOCK

SECS PYRO ARM (2) - SAFE
SECS LOGIC (BOTH) - OFF
CB SECS ARM (2) - OPEN
CB DOCK PROBE (2) - OPEN
THC - LOCKED
RHC - LOCKED
PROBE EXTD/REL - OFF
PROBE RETRACT (2) - OFF
VHF RANGING-OFF
EXT RUN/EVA LIGHT - OFF
EXT RNDZ LIGHT - OFF
COAS PWR - OFF
LIMIT CYCLE - ON
ATT DB - MAX
BMAG MODE (3) - ATT 1/RATE 2
AUTO RCS SEL ROLL(4)-OFF
THC PWR - OFF
RHC PWR DIR (2) - OFF

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