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LIST OF ACRONYMS AND ABBREVIATIONS

ACQ	Acquisition
ADJ	Adjust
AOH	Apollo Operations Handbook
AOS	Acquisition of Signal
ATT	Attitude
AWY	Away
BEF	Blunt End Forward
B/U	Backup
CALIB	Calibration
CB	Circuit Breaker
CDH	Constant Delta Height
CDR	Commander
CM	Command Module
CMC	Command Module Computer
CMD	Command Module Commander's Position
CMP	Command Module Pilot
COAS	Crew Optical Alignment Sight
CSI	Concentric Sequence Initiation
CSM	Command and Service Module
CT	Cease Tracking
DAP	Digital Autopilot
DH	Delta Height
DOI	Descent Orbit Insertion
DPS	Descent Propulsion System
DSKY	Display and Keyboard
DV	Delta Velocity
DWN	Down
EMS	Entry Monitor System
ET	Event Timer
FDAI	Flight Director Attitude Indicator
FPS	Feet Per Second

FWD	Forward
GDC	Gryo Display Coupler
GET	Ground Elapsed Time
GETI	Ground Elapsed Time of Ignition
GMBL	Gimbal
GND	Ground (Mission Control)
GPI	Gimbal Position Indicator
HA	Apogee Altitude
HGA	High-Gain Antenna
HOR	Horizon
HORIZ	Horizontal
HP	Perigee Altitude
IMU	Inertial Measurement Unit
INS	Insertion
IT	Initiate Tracking
LEB	Lower Equipment Bay
LGC	LM Guidance Computer
LLMK	Lunar Landmark
LM	Lunar Module
LMK	Landmark
LMP	Lunar Module Pilot
LOI	Lunar Orbit Injection
LOS	Loss of Signal
LV	Launch Vehicle
MNVR	Maneuver
MCC	Midcourse Correction
MCC-H	Mission Control Center - Houston
MDC	Main Display Console
MGA	Middle Gimbal Angle
MSFN	Manned Space Flight Network
MTCS	Move to Command Seat
MTLEB	Move to Lower Equipment Bay
MTVC	Manual Thrust Vector Control
NAV	Navigation

OPT	Optics
ORDEAL	Orbital Rate Drive Earth and Lunar
OSS	Optical Subsystem
PAD	Data Voiced to Crew From Ground
PB	Pushbutton
PC	Plane Change
PDI	Powered Descent Initiation
PGNCS	Primary Guidance, Navigation, and Control System
PHS	Phasing
PIPA	Pulse Integrating Pendulous Accelerometers
PLM	LM Pitch Angle
PRO	Proceed
PROG	Program
PROP	Propellant
R	Range
RCS	Reaction Control System
RDOT	Range Rate
REFSMMAT	Reference Stable Member Matrix
RHC	Rotation Hand Controller
RR	Rendezvous Radar
S	Shaft
SC	Spacecraft
SCS	Stabilization and Control System
SCT	Scanning Telescope
SECS	Sequence Events Control System
SEF	Small End Forward
SEP	Separation
S-IVB	Saturn S-IVB Stage
SM	Service Module
SPS	Service Propulsion System
S/U	Setup
SXT	Sextant
SYNC	Synchronize
TEI	Transearth Injection
TEMCC	Transearth Midcourse Correction

TFI	Time From Ignition
THC	Translation Hand Controller
THETA	Angle Between SC +X Axis and Local Horizontal
TIGN	Time of Ignition
TLI	Translunar Injection
TLM	Telemetry
TLMCC	Translunar Midcourse Correction
TPF	Terminal Phase Finalization
TPI	Terminal Phase Initiation
TRUN	Trunnion
TVC	Thrust Vector Control
VG	Velocity to be Gained
VHF	Very High Frequency
(XX:XX)	Indicates GET From Liftoff in Hours:Minutes
(XXX:XX:XX)	Indicates GET From Liftoff in Hours:Minutes:Seconds
(XXX,XXX/XXX,XXX)	(Ordeal/Inertial) Angles (Roll, Pitch, Yaw)
(XX,XX,XX)	Local Vertical DV's

Tracking Stations

ANG	Antigua Near Space Support Station
BDA	Bermuda Near Space Support Station
CRO	Carnarvon Near Space Support Station
CYI	Canary Near Space Support Station
GYM	Guaymas Near Space Support Station
HSK	Honeysuckle Deep Space Support Station
HTV	Huntsville Near Space Support Station
MAD	Madrid Deep Space Support Station
MER	Mercury Near Space Support Ship
MIL	MILA Near Space Support Station
RED	Redstone Near Space Support Ship
TEX	Corpus Christi Near Space Support Station
VAN	Vanguard Near Space Support Ship

1.0 PURPOSE

This document contains the nominal PGNCS crew procedures for the CSM-106 spacecraft which will be the target vehicle for the LM-4 active lunar orbit rendezvous. The procedures were developed in accordance with the Detailed Test Objectives P20.78 and P20.77 defined in Reference 10.1.

The purpose of the CSM Rendezvous Procedures document is to provide a single source of procedures information for use in flight planning, in crew training, and in preparing onboard data.

This is a control document, subject to review by all elements of the Apollo Program and to approval by the Procedures Configuration Control Board. Comments should be directed to Mr. Duane K. Mosel, Flight Procedures Branch, Flight Crew Support Division, Extension 5340 or to Mr. Stephen G. Paddock, Jr., Apollo Flight Crew Operations Group, Houston Operations, McDonnell Douglas Astronautics Company, Extension 6101.

2.0 INTRODUCTION

The CSM-106/LM-4 lunar orbit rendezvous exercise will begin during the twelfth revolution with undocking at 98:10:00 and end at approximately 105:52 with post rendezvous station keeping. The CSM procedures during this period are divided into eight segments of major activities which are discussed in detail in Section 3.0.

The nominal CSM-106/LM-4 mission profile is contained in Figure (2-1). This figure shows the locations in time and relative positions in space of the most significant nominal mission events. Trajectory data used to generate the mission profile and timeline for procedures development was obtained from References 10.2, 10.15, and 10.18. The rendezvous navigation update schedule assumed in the procedures was obtained from References 10.16 and 10.20. The schedule indicates tracking periods and assumes a one per minute SXT and VHF mark frequency. The minimum number of marks required during a tracking period has been defined as five at the beginning and five at the end of the period. However, the minimum number of marks is not recommended since simulation experience has shown that the planned number of marks is not always achieved due to systems monitoring requirements or target visibility problems. In addition, the general rules for SXT/VHF marking as defined in Reference 10.3 should be followed.

A history of the CSM body attitudes during the rendezvous is presented in Figure (2-2) through (2-5). Each figure illustrates the body attitudes with respect to the Moon, Sun, and Earth

and indicates FDAI roll, pitch, and yaw gimbal angles and the ORDEAL pitch angle for significant events during each lunar orbit. The orbital position of the CSM at each event is assumed and no attempt is made to show the LM orbital position other than an indication of it being above (below) and behind (ahead) the CSM.

Sections 4.0, 5.0, and 6.0 contain the onboard nominal rendezvous checklist; a summary timeline and summary checklist for the nominal mission, and the procedures ground rules, detailed nominal mission procedures, and CSM attitude summary, respectively. Section 7.0 contains a description of the five abort and rescue cases for which onboard rescue checklists have been developed. These cases are:

1) PDI Abort - LM Active/CSM Backup
2) Partial LM Phasing (DV greater than or Equal to 40 FPS) - CSM Active
3) Partial LM Phasing (DV less than 40 FPS) - CSM Active
4) Zero LM Insertion - CSM Active
5) Partial LM Insertion - CSM Active

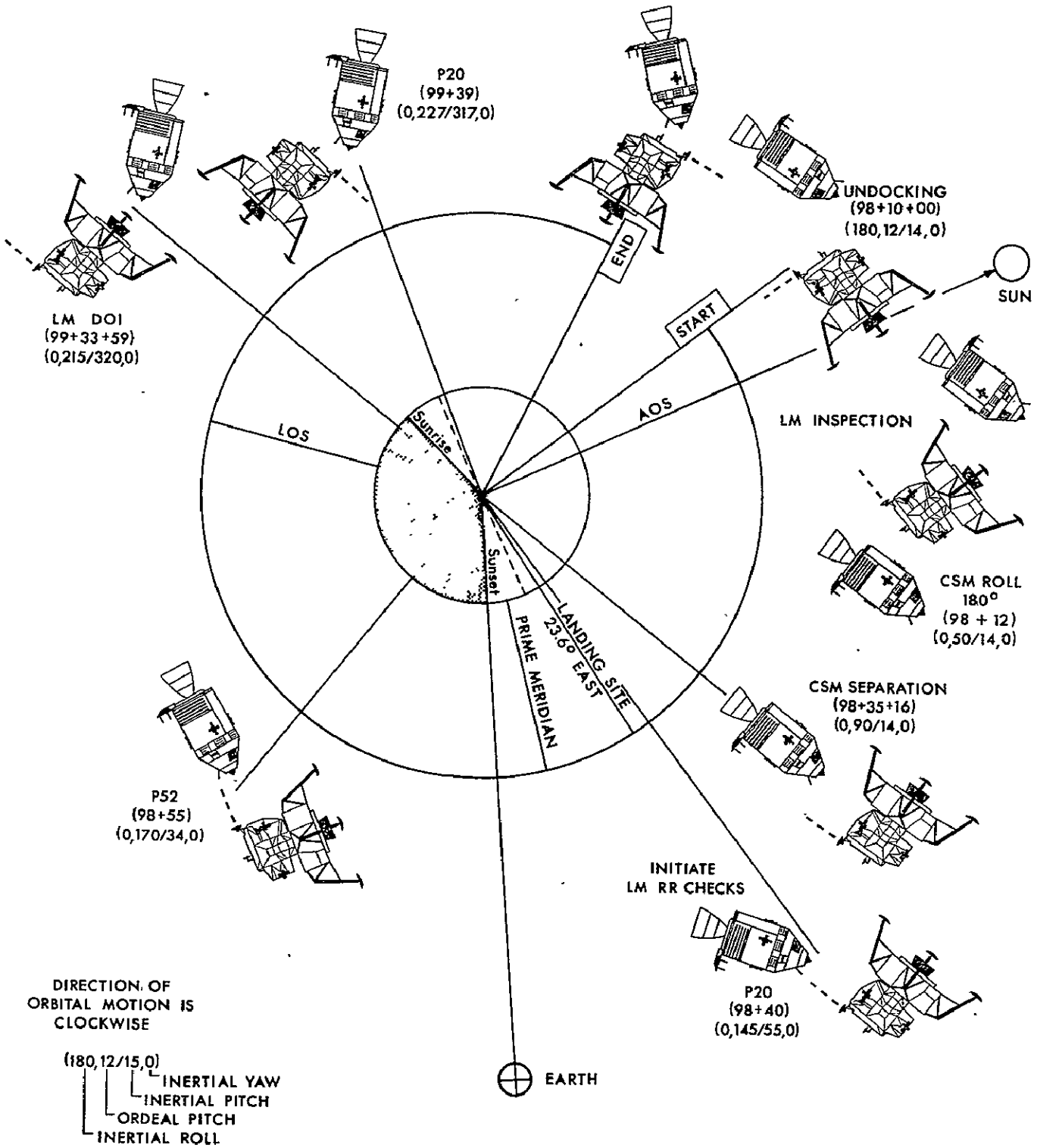
Section 8.0 contains the one-page onboard rescue checklist and a relative motion plot and pad page for each of the five LM rescue cases. A LM rescue procedures summary is contained in Section 9.0 including rescue procedures ground rules, summary timelines, and CSM attitude and navigation summaries for each rescue case.

All nominal and rescue procedures and onboard data were generated assuming a Mission F liftoff on 18 May 1969, at 16:49:00 GMI.

MISSION F

FIGURE 2-2

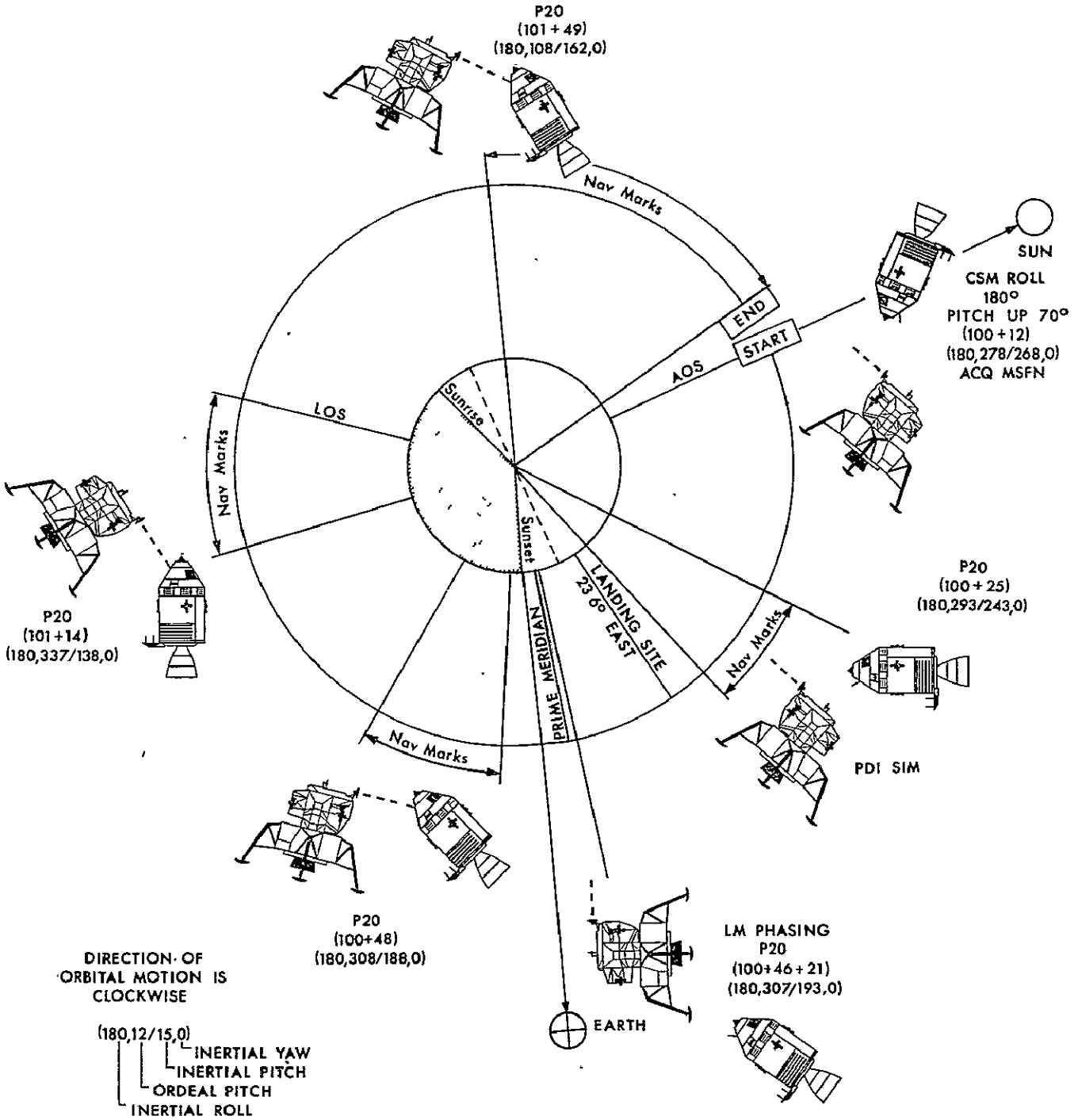
LUNAR ORBIT RENDEZVOUS ATTITUDE TIME HISTORY FOR THE CSM



MISSION F

FIGURE 2-3

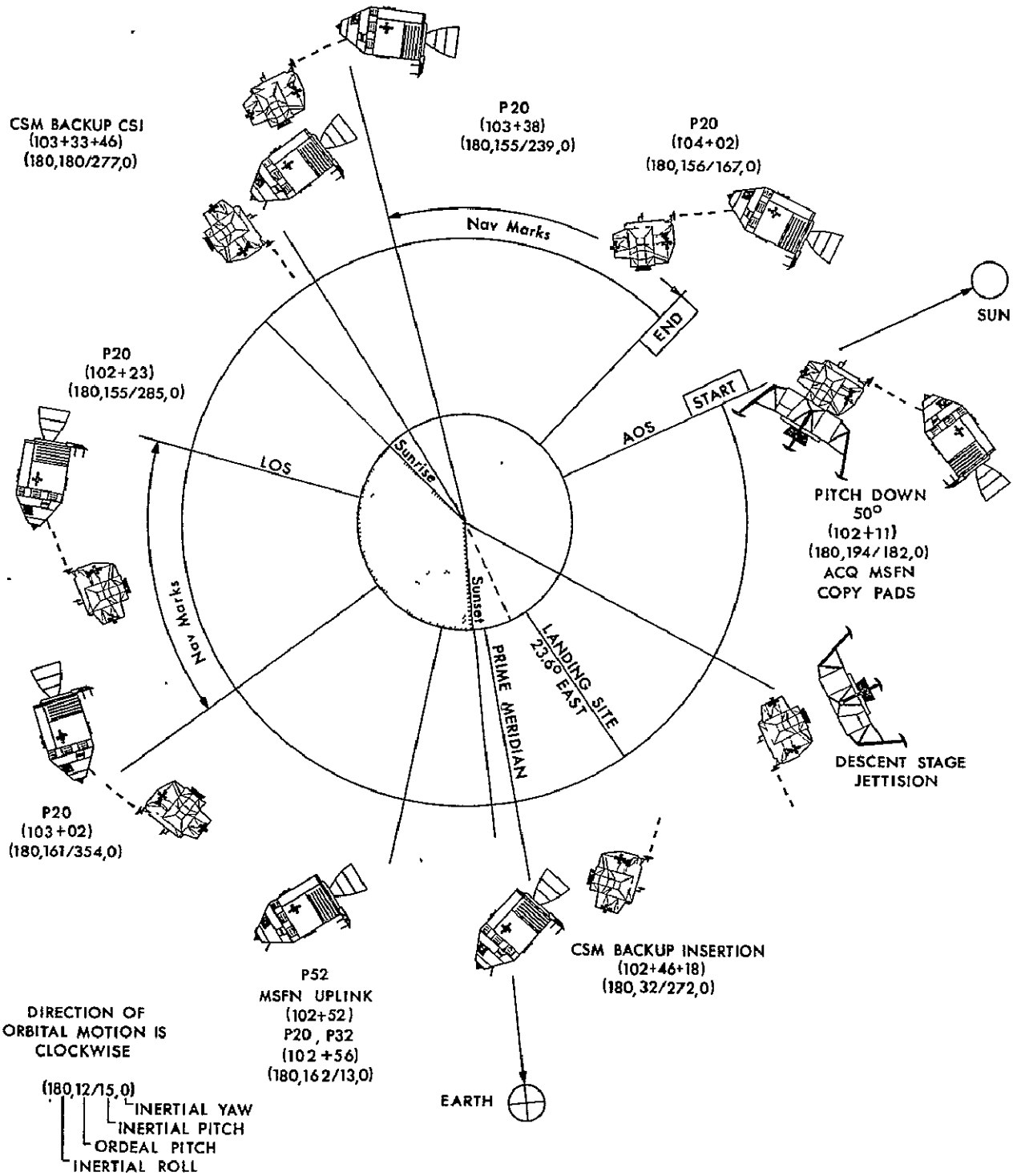
LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE CSM



MISSION F

FIGURE 2-4

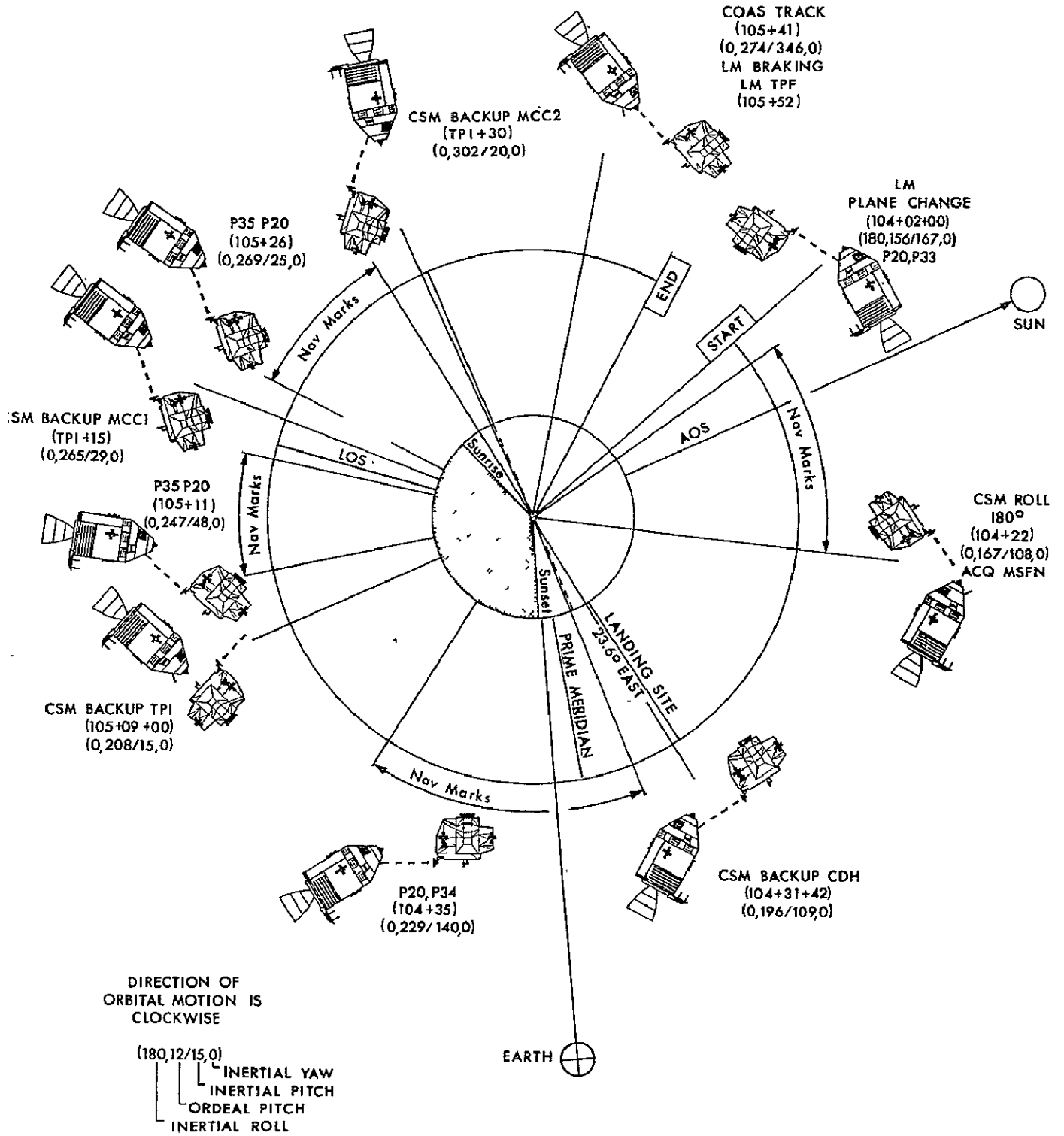
LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE CSM



MISSION F

FIGURE 2-5

LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE CSM



3.0 DISCUSSION OF NOMINAL MAJOR EVENTS

3.1 Undocking and Separation

The preparation for undocking includes obtaining a MCC-H uplink of the CSM vector and copying the Separation maneuver pad at 97:05. Thirty minutes prior to undocking an automatic maneuver to the undocking attitude is performed using extended verb 49. This attitude is identical inertially to the Separation burn attitude except for the roll angle which is 180 degrees and a 14-degree yaw which is required during a pre-undocking LM AGS calibration. Prior to undocking, the CSM is yawed to zero degrees, a RR transponder check is made, the GDC is aligned to the IMU, the FDAI ORDEAL is verified, and the DAP is reloaded to reflect a CSM only configuration. At 98:10 undocking is performed after which the CSM will station keep in SCS control at about 40 feet. The CMP will then inspect and photograph the LM landing gear and descent engine bell as the LM does a 360-degree yaw maneuver. Prior to the inspection the CSM will manually roll 180 degrees to allow acquisition of the MSFN with the HGA for color TV. At 98:20 LM maneuver P76 pads will be copied for the DOI, Phasing, and PDI abort burns. Prior to the CSM-active separation burn at 98:35:16, the CMP will load the External DV Program, P30, with a minus 2.5 FPS VG_Z (local vertical). The RCS Thrust Program, P41, will be called and an automatic maneuver will be made to the burn attitude which is shown in Figure (2-2). (This should be a very small maneuver since the undocking attitude was the inertial separation burn attitude, except for roll.) The burn will be accomplished

by thrusting aft in the CSM minus X direction (i.e. radially down) and increasing the DSKY VG_X (body) from a plus 2.5 FPS to 5 FPS. The HGA can be utilized for communication during the separation burn.

3.2 Descent Orbit Insertion

Following the CSM Separation burn, the Rendezvous Navigation Program, P20, will be called and the CSM maneuvered automatically 40 degrees to the preferred track axis for LM radar, VHF range, and optics checks. An IMU realign to REFSMMAT will be performed after sunset at 98:55 using the IMU Realign Program, P52. At approximately 99:05 CSM and LM state vectors will be uplinked by MCC-H. Since the CSM does not backup the DOI burn, its only function will be to monitor the LM burn and hold an attitude which provides radar transponder coverage. This will be done in Program P20 with SXT tracking along the preferred track axis. The Target DV Program, P76, will be loaded with the LM DOI burn parameters and these data incorporated when the burn is confirmed by the LM. LM DOI occurs at 99:33:59.

The attitude of the CSM from the CSM Separation burn through LOS prior to the LM DOI burn is favorable for HGA communications.

3.3 Phasing

Following the DOI burn, Program P20 will be called and the CSM attitude will be trimmed to the preferred track axis if required. The CMP will confirm that the rendezvous navigation program is tracking the LM correctly. At 100:07 the CSM will be manually rolled 180 degrees and pitched up 70 degrees to allow acquisition

with the HGA. At 100:25 Program P20 will be called and the CSM will be maneuvered 25 degrees to the preferred track axis. A period of SXT/VHF marking will occur from 100:27 to 100:37. The CSM will not back up the LM Phasing burn so it will be tracking with the preferred track axis during the burn. LM Phasing occurs at 100:46:21. After confirmation of the nominal LM Phasing burn, the CMP will incorporate the LM Phasing burn parameters into Program P76. In the event the LM cannot perform the Phasing burn or performs a partial burn, the CSM will do nothing immediately but will setup to do the prescribed rescue burn at approximately 101:33. The CSM has HGA coverage continuously from AOS through the Phasing burn.

3.4 Insertion

Following the LM Phasing burn, Program P20 will be called and tracking with the preferred track axis will again be established. A period of SXT/VHF marking occurs from 100:51 to 101:24. This period is interrupted for 13 minutes during which time the LM does a P52 (tracker light not visible). Only VHF marks are taken during this period. At approximately 101:10 maneuver pads for the LM Insertion burn and the CSM Backup Insertion burn are transmitted and copied. Another period of SXT/VHF navigation updates occurs from 101:49 to 102:09. These update periods include VHF marks only if the range is less than the 327 N.M. VHF range measurement limit. At 102:11 AOS occurs and the CSM will be pitched down 50 degrees and the MSFN acquired with the HGA. The MCC-H will uplink the CSM state vector and the CSM Backup Insertion burn pad will be updated at this time if required. The CSM Backup Insertion burn parameters, targeted three minutes after the LM ignition time, will be loaded into Program P30 at 102:30 and Program P40 will be called at 102:32. The maneuver to the burn

attitude will require a pitch down of 110 degrees. Following the attitude maneuver, the SPS will be configured for the backup burn and the GDC aligned to the IMU. The LM Insertion occurs at 102:43:18. After confirmation is received that the LM has completed the burn, Program P76 will be called and the LM burn data incorporated into the CMC LM state vector. The CSM attitudes as shown in Figure (2-3) and (2-4) are compatible with HGA usage during the phase.

3.5 Concentric Sequence Initiation

Immediately following the Insertion burn, a P52 IMU realign to REFSMMAT will be performed and the MCC-H will uplink the LM state vector to the CMC. The LM vector will be that computed by the LM after Insertion and relayed to the ground.

Program P20 will then be called and an automatic pitch maneuver of 101 degrees will be made to the preferred track attitude. At 102:59 the CSI Targeting Program, P32, is called and the CSM Backup CSI targeting parameters are loaded. The CSM CSI burn will be targeted for 103:33:46 which is identical to the LM TIGN. A period of SXT/VHF marking will then take place from 103:02 to 103:07 followed by a period of VHF only marks to 103:25. Concurrently with the VHF only tracking, the CMP will obtain the LM and CSM out-of-plane velocities from extended verb 90 for inclusion in the LM and CSM CSI targeting programs.

At approximately 103:28 the LM will voice over its CSI solution for P76. Program P40 will then be called and an automatic pitch maneuver of 11 degrees will be made to the Backup CSI burn attitude. The LM CSI burn occurs at 103:33:46. After verification of the nominal LM CSI burn, the CMP will incorporate the LM burn parameters in Program P76.

The CSM attitude, as specified in Figure (2-4) is compatible with HGA coverage from Insertion until the beginning of the track period at about 103:02 at which time the attitude may be unfavorable. The tracking attitude later in the period does afford HGA coverage until LOS at 103:23.

3.6 Constant Delta Height and Plane Change

At 103:38 approximately four minutes after the LM CSI burn, Program P20 will be called and an automatic maneuver of 38 degrees will be made to the preferred track axis. A period of SXT/VHF markings occurs from 103:41 to 104:02. At 103:44 after three SXT/VHF marks, the WR matrix (2000,2) will be loaded. Extended verb 90 will be called at 103:55 and the targeting parameters for the LM Plane Change maneuver will be computed and voiced to the LM. The CSM onboard state vectors are used instead of the LM state vectors, because the CSM knowledge of the out-of-plane positions with SXT tracking is more accurate than the LM knowledge of out-of-plane positions with radar tracking. Following the LM Plane Change burn at 104:02, the target DV parameters are incorporated into the LM state vector. At 104:05 the CDH targeting Program P33 will be called and the CSM Backup CDH burn will be targeted for 104:31:42 which is the LM TIGN. Since the CSM nominally does not backup the LM Plane Change burn, a trim maneuver to the preferred track axis should not be required when Program P33 is called. SXT and VHF marks will be taken from 104:08 to 104:20, at which time tracking is terminated and the CSM will voice to the LM an extended verb 90 out-of-plane solution. At 104:22 the CSM will be manually maneuvered 180 degrees in roll so that the MSFN can be acquired with the HGA. Approximately five minutes before the LM CDH burn the CMP copies the LM CDH pad for later loading of Program P76. The RCS Thrust Program, P41, is called at 104:29 and the burn

attitude maneuver is bypassed if the nominally zero burn is small. Following the LM CDH burn at 104:31:42, Program P76 is called and the LM CDH burn incorporated into the CMC LM state vector.

The CSM attitudes are favorable for HGA communications from approximately 104:22 through the CDH burn as shown in Figure (2-5).

3.7 Terminal Phase Initiation

After completion of the LM CDH burn, Program P20 will be called which will request an automatic maneuver of 49 degrees to the preferred tracking attitude. Program P34 will be called and the CSM Backup TPI burn Data will be loaded with the elevation angle option. SXT and VHF marks are scheduled for a period of 18 minutes starting at 104:38. It is probable that sun interference in the SXT will limit the total number of SXT marks to 11 taken in darkness.

After moving to the command seat, the CMP will verify the ORDEAL FDAI. He will then recall P34 and, using the "TIGN" option with the LM computed TPI TIGN, compute the CSM TPI Backup burn parameters. Program P40 will be called and an automatic maneuver of 53 degrees will be made to the TPI burn attitude. The TPI burn will nominally be performed at 105:09:00 with a CSM to LM elevation angle of 208.3 degrees. After the LM has completed the burn the CMP will incorporate the LM target DV in Program P76. As seen in Figure (2-5), the CSM has HGA coverage from acquisition right after AOS through the TPI burn.

3.8 TPI To Station Keeping

After the TPI burn, Program P20 will be called and the CSM will be automatically maneuvered 33 degrees to the preferred track attitude. The CMP will move to the LEB during the maneuver,

call the MCC Targeting Program, P35, and take SXT and VHF marks for eight minutes starting at 105:13. After obtaining the MCC1 solution in Program P35 he will compare it with the LM solution and call Program P41 in preparation for the backup burn. The CSM will not maneuver from the preferred tracking attitude. The MCC1 burn will nominally be performed by the LM at 105:24:00 (TPI plus 15 minutes). After MCC1 the CMP will incorporate the LM MCC1 Target DV in Program P76.

Following MCC1, Program P35 will be called and an automatic trim to the preferred tracking attitude will be made if required. SXT and VHF marks will be taken for a period of 9 minutes terminating at 105:35. The MCC2 solution will be compared with the LM TPI solution, after which Program P41 will be called. The CSM will remain at the preferred tracking attitude while the LM performs MCC2 at 105:39:00 (TPI plus 30 minutes). After MCC2 the CMP will incorporate the LM Target DV in Program P76.

The CSM will then be maneuvered automatically 34 degrees to the COAS tracking attitude using extended verb 89 while the CMP moves back to the command seat. The Thrust Monitor Program, P47, will be called at a range of 1.25 nautical miles and VHF ranging data and V83 will be used to monitor the LM line-of-sight control and braking. Should the LM experience difficulty, the CSM will perform the line-of-sight control and braking. The braking gates are specified in the checklist of Section 4.0. TPF nominally occurs at 105:52:00.

4.0 NOMINAL ONBOARD RENDEZVOUS CHECKLIST

The nominal CSM onboard rendezvous checklist is presented in this Section. The rendezvous checklist was formulated to be compatible with crew operations in simulators and in flight. Therefore, the checklist reflects procedures in an extremely abbreviated form. The narrative presented in Section 3.0 provides a word description of the checklist events. The rendezvous checklist procedures have in part been verified on a man-in-the-loop simulator. Additional simulations will occur before launch and the rendezvous checklist updated accordingly to produce a verified checklist.

The nominal onboard rendezvous checklist includes procedures for performing all CSM PGNCS activities required during the LM active rendezvous. All activities required for the operation and/or monitoring of systems other than the PGNCS will be included in the rendezvous checklist by the appropriate systems personnel.

EXTERNAL DV PADS

CSM SEP PAD

33	00 .	:	000	:	0 .	
81	+ 0000.0	+	0000.0	-	0002.5	
22	XXX		XXX		XXX	

CSM BACKUP INSERTION PAD INITIAL

47	+ .	+	00000.			
48	.		.			
33	00	:	000	:	0 .	
81	.		.		.	
22	XXX		XXX		XXX	
ΔV_C	X .					
11	00	:	000	:	0 .	
37	00	:	000	:	0 .	
N						

CSM BACKUP INSERTION PAD UPDATE

47	+ .	+	00000.			
48	.		.			
33	00	:	000	:	0 .	
81	.		.		.	
22	XXX		XXX		XXX	
ΔV_C	X .					
11	00	:	000	:	0 .	
37	00	:	000	:	0 .	
N						

NOMINAL LM IGNITION TIMES

CSI 11	00	:	000	:	0 .
PC 33	00	:	000	:	0 .
TPI 37	00	:	000	:	0 .

RESCUE TWO PAD

47	+ .	+	00000.			
48	.		.			
33	00	:	000	:	0 .	
81	.		.		.	
22	XXX		XXX		XXX	
ΔV_C	X .					
11	00	:	000	:	0 .	
37	00	:	000	:	0 .	
N						

CANNED RESCUE TWO PADS FOR:

1. LM PDI ABORT
2. PARTIAL PHASING (0 - 40)
3. PARTIAL PHASING (40 - NOM)
4. ZERO INSERTION
5. PARTIAL INSERTION

ARE INCLUDED ON RESCUE CHECKLISTS

CSM RENDEZVOUS RESCUE PADS

CSI ONE

11	00	:	000	:	0 .	
81	.		.		.	
N						

CSI TWO

11	00	:	000	:	0 .	
81	.		.		.	
N	.					

CDH

13	00	:	000	:	0 .	
81	.		.		.	

TPI

37	00	:	000	:	0 .	
81	.		.		.	
59	.		.		.	
LOS BT	XX :		XX :		XX :	

97:00 — CONTINGENCY EVA PREP

P00; MCC-H UPLINK RLS
AND CSM VECTOR
V66
COPY: CSM SEP PADS
DONN HELMET AND GLOVES
CSM/LM COMM CHECK
VHF AM A - SIMPLEX
VHF RCV ONLY - B DATA

97:10

MIN DB FOR LM RCS COLD FIRE CHECKS

MSFN

MAX DB FOR LM RCS HOT FIRE CHECKS

97:20

VERIFY AUTO RCS SEL-C4(-PITCH-X)-OFF
VERIFY AUTO RCS SEL-B3(+YAW-X)-OFF FOR LM
RR SELF TEST
VERIFY RNDZ XPNDR-OFF

LOS

97:30

97:30

CONFIGURE CAMERA:
CM/SEQ/18/CEX-BRKT (RH WIN)
MIR (f11,250,00) 6FPS,15 MIN

DAP (21112) (+37768) (-00052)
V46 (11111) (+30847) (+00059)

GND 47	+	.	+	.
UPDATE 48		.		.

97:40

V62
V49;AUTO TO UNDOCKING ATTITUDE (180, 282/14,14)
(INERTIAL SEP ATT EXCEPT ROLL AND 14° YAW)

UNDOCK GET	98:	10:	00
LOAD 22	180	14	14

SC CONT-CMC
CMC MODE-FREE (AS REQ FOR AGS CALIB)
CMC MODE-AUTO (AFTER 32 SEC)
VERIFY MAX DB FOR AGS CALIB
SYSTEMS CHECKS AND SWITCH VER

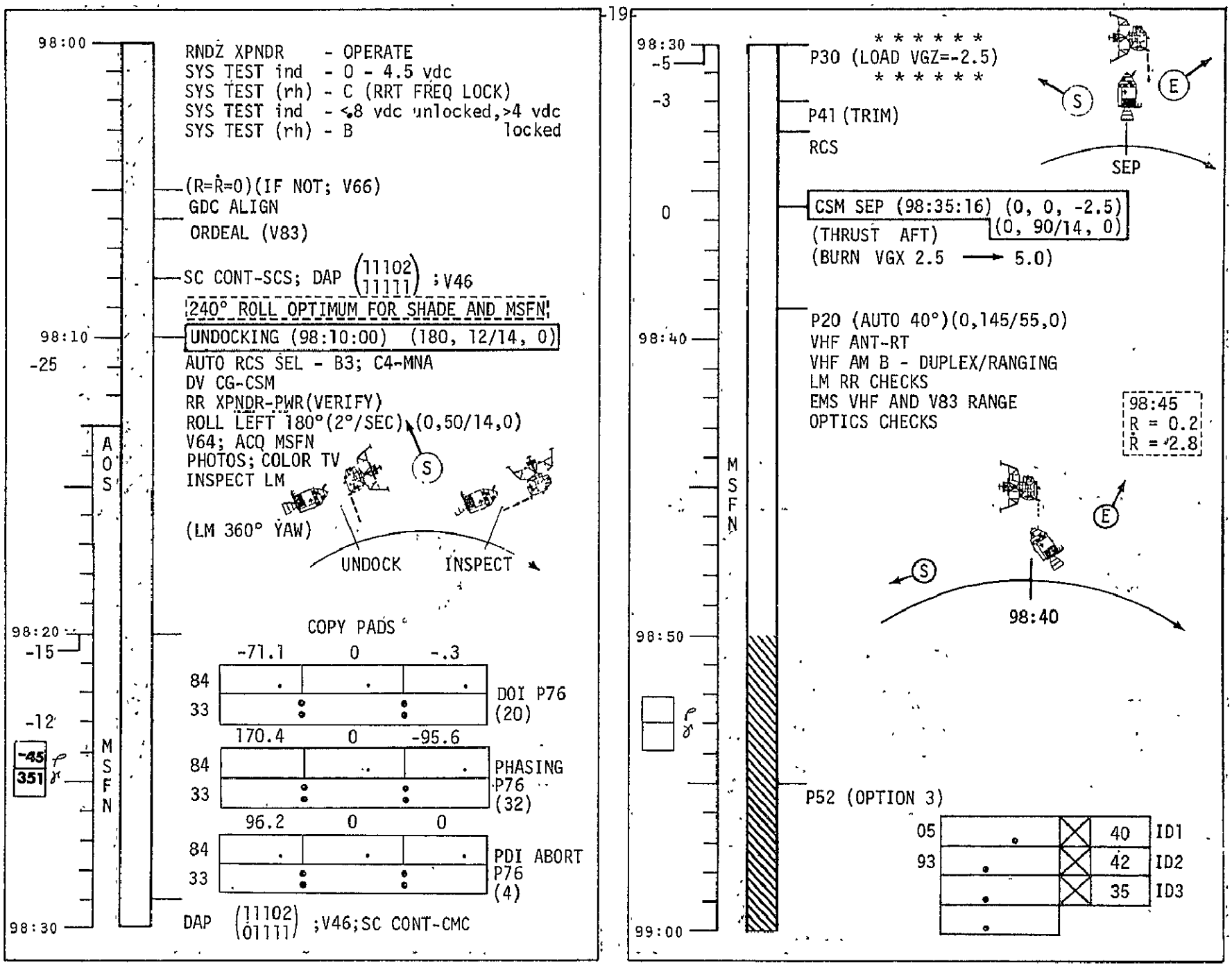
97:50

YAW 14° LEFT AFTER LM AGS
CALIB (180,312/14,0)

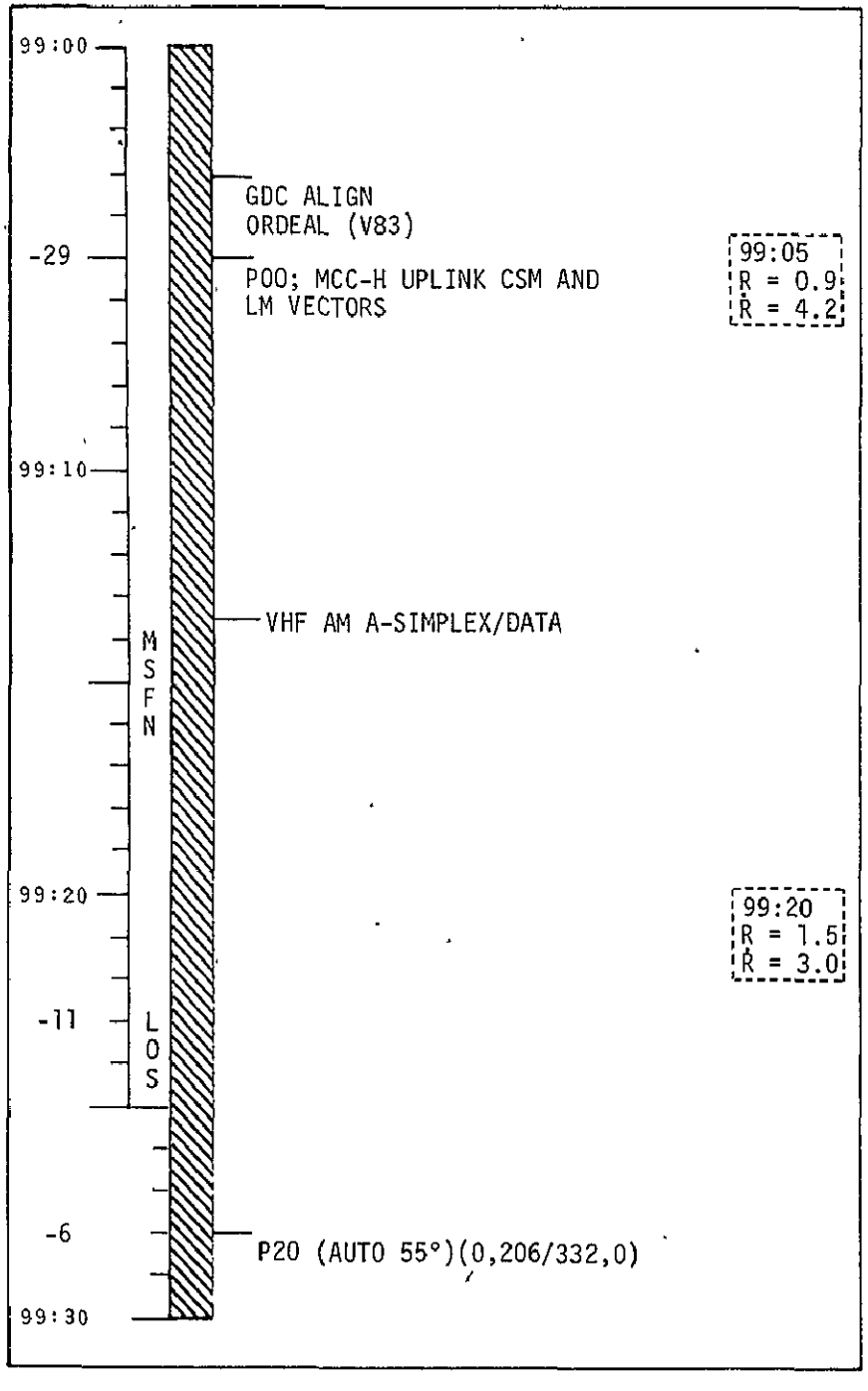
RR XPNDR CHECKS:

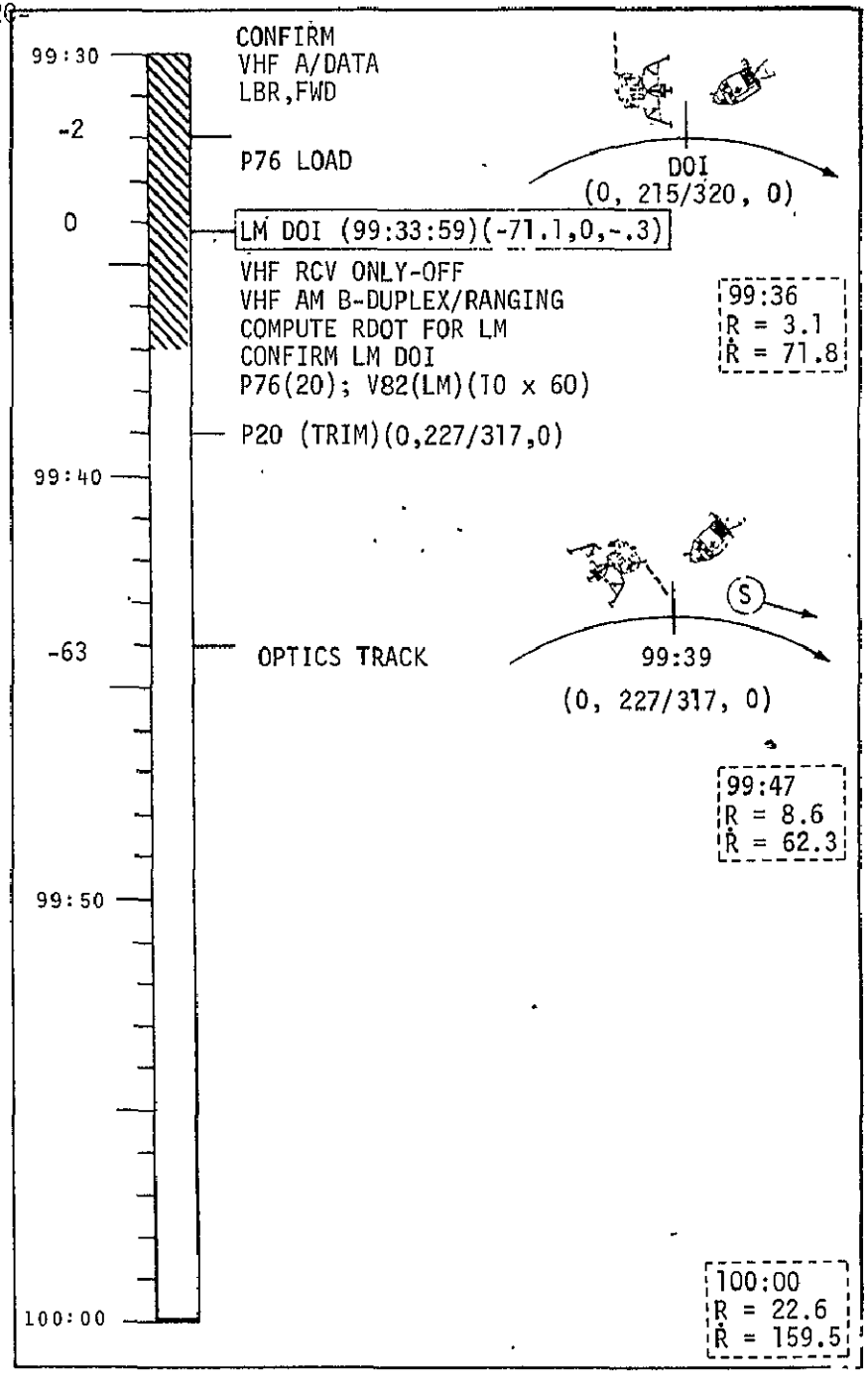
RNDZ XPNDR ACTIVATION & SELF TEST
cb RNDZ XPNDR FLT BUS - close (verify)
RNDZ XPNDR - HTR for 24 min
(1 min if self test only)
RNDZ XPNDR - PWR
SYS TEST (lh) - XPNDR
SYS TEST (rh) - A (RRT XMTR OUT PWR)
SYS TEST ind ->1 vdc
SYS TEST (rh) - B (RRT AGC SIG)
RNDZ XPNDR - TEST (hold)
SYS TEST ind ->1 vdc

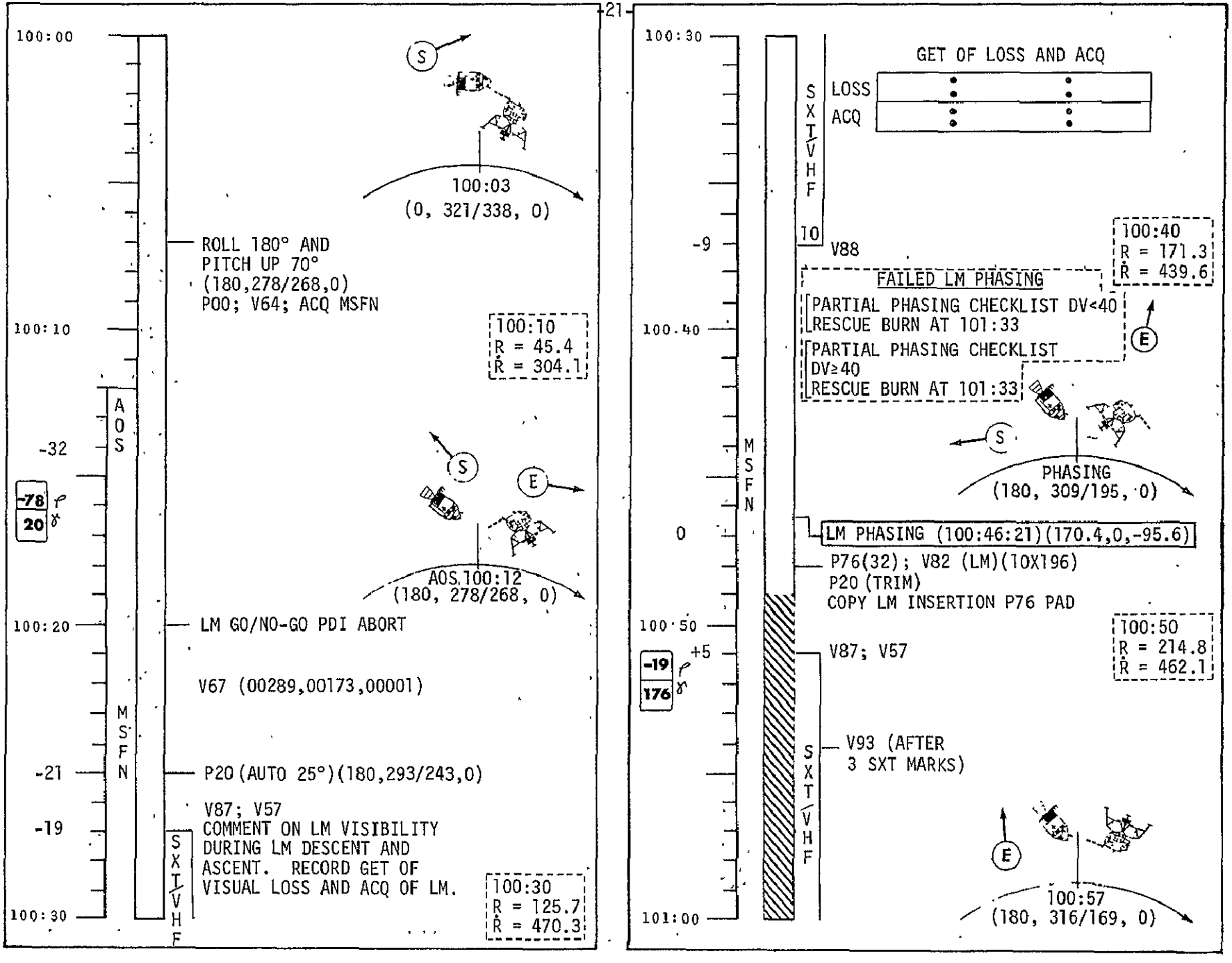
98:00

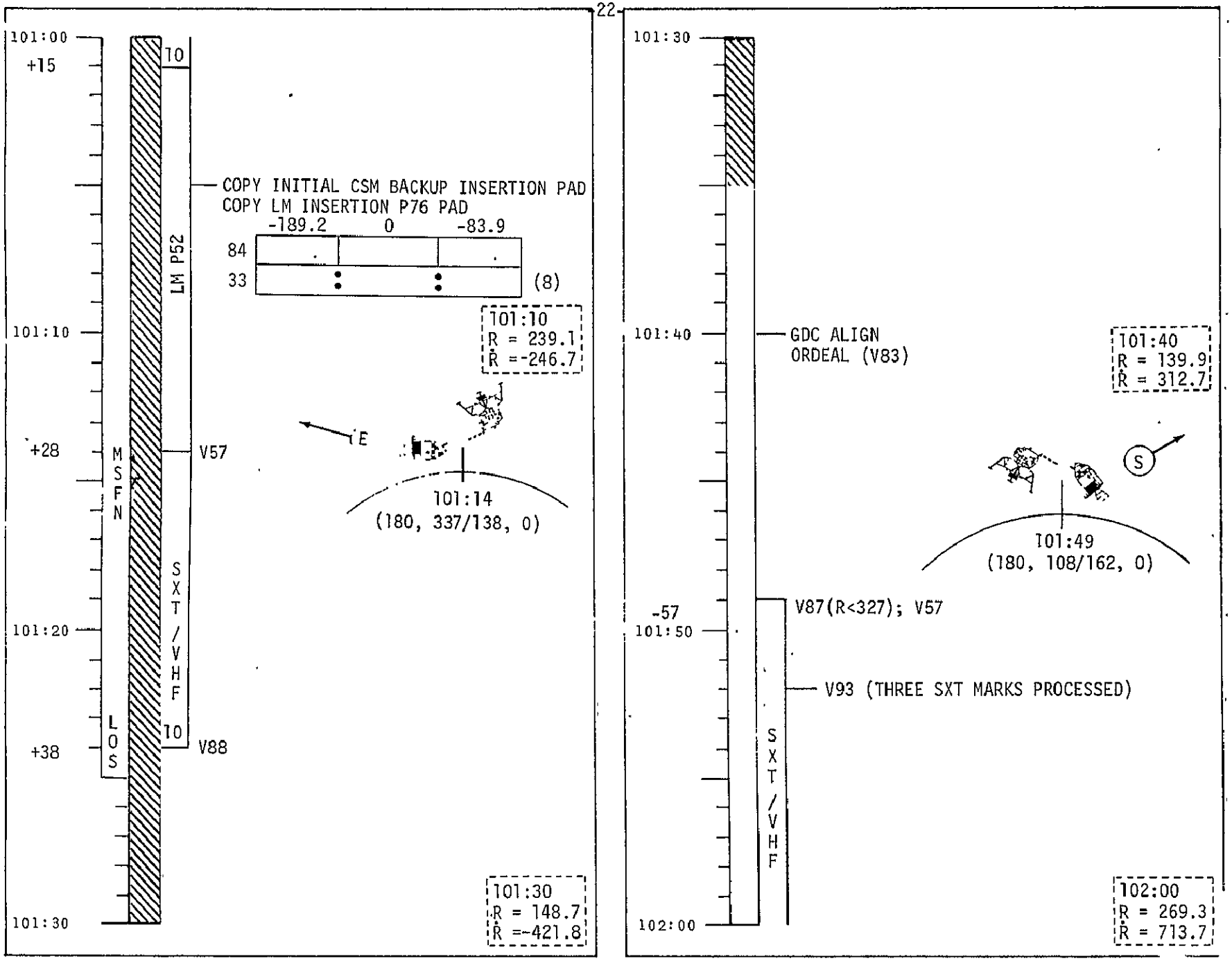


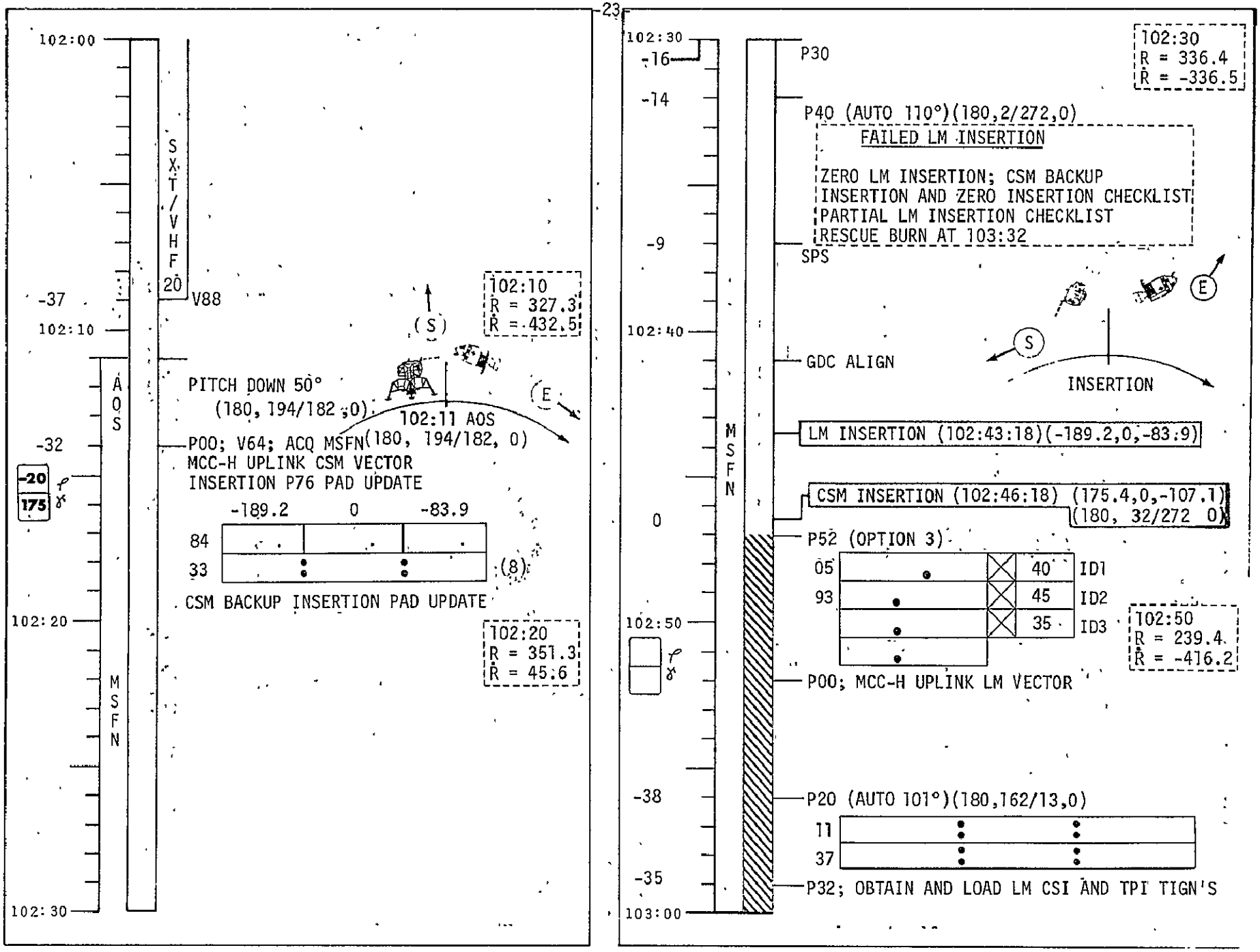
98:00
RNDZ XPNDR - OPERATE
SYS TEST ind - 0 - 4.5 vdc
SYS TEST (rh) - C (RRT FREQ LOCK)
SYS TEST ind - <.8 vdc unlocked,>4 vdc locked
SYS TEST (rh) - B
(R=Ṙ=0)(IF NOT; V66)
GDC ALIGN
ORDEAL (V83)
SC CONT-SCS; DAP (11102 / 11111) ;V46
240° ROLL OPTIMUM FOR SHADE AND MSFN
98:10
UNDOCKING (98:10:00) (180, 12/14, 0)
-25
AUTO RCS SEL - B3; C4-MNA
DV CG-CSM
RR XPNDR-PWR(VERIFY)
ROLL LEFT 180°(2°/SEC) (0,50/14,0)
V64; ACQ MSFN
PHOTOS; COLOR TV
INSPECT LM
(LM 360° YAW)
S
UNDOCK
INSPECT
AOS
98:20
-15
COPY PADS
-71.1 0 -.3
84
33
DOI P76 (20)
-12
-45
351
MSFN
170.4 0 -95.6
84
33
PHASING P76 (32)
96.2 0 0
84
33
PDI ABORT P76 (4)
98:30
DAP (11102 / 01111) ;V46;SC CONT-CMC
98:30
-5
-3
P30 (LOAD VGZ=-2.5)
P41 (TRIM)
RCS
S
E
SEP
0
CSM SEP (98:35:16) (0, 0, -2.5) (0, 90/14, 0)
(THRUST AFT)
(BURN VGX 2.5 → 5.0)
P20 (AUTO 40°)(0,145/55,0)
VHF ANT-RT
VHF AM B - DUPLEX/RANGING
LM RR CHECKS
EMS VHF AND V83 RANGE
OPTICS CHECKS
98:45
R = 0.2
Ṙ = 2.8
98:40
MSFN
98:50
P52 (OPTION 3)
05
93
40 ID1
42 ID2
35 ID3
99:00

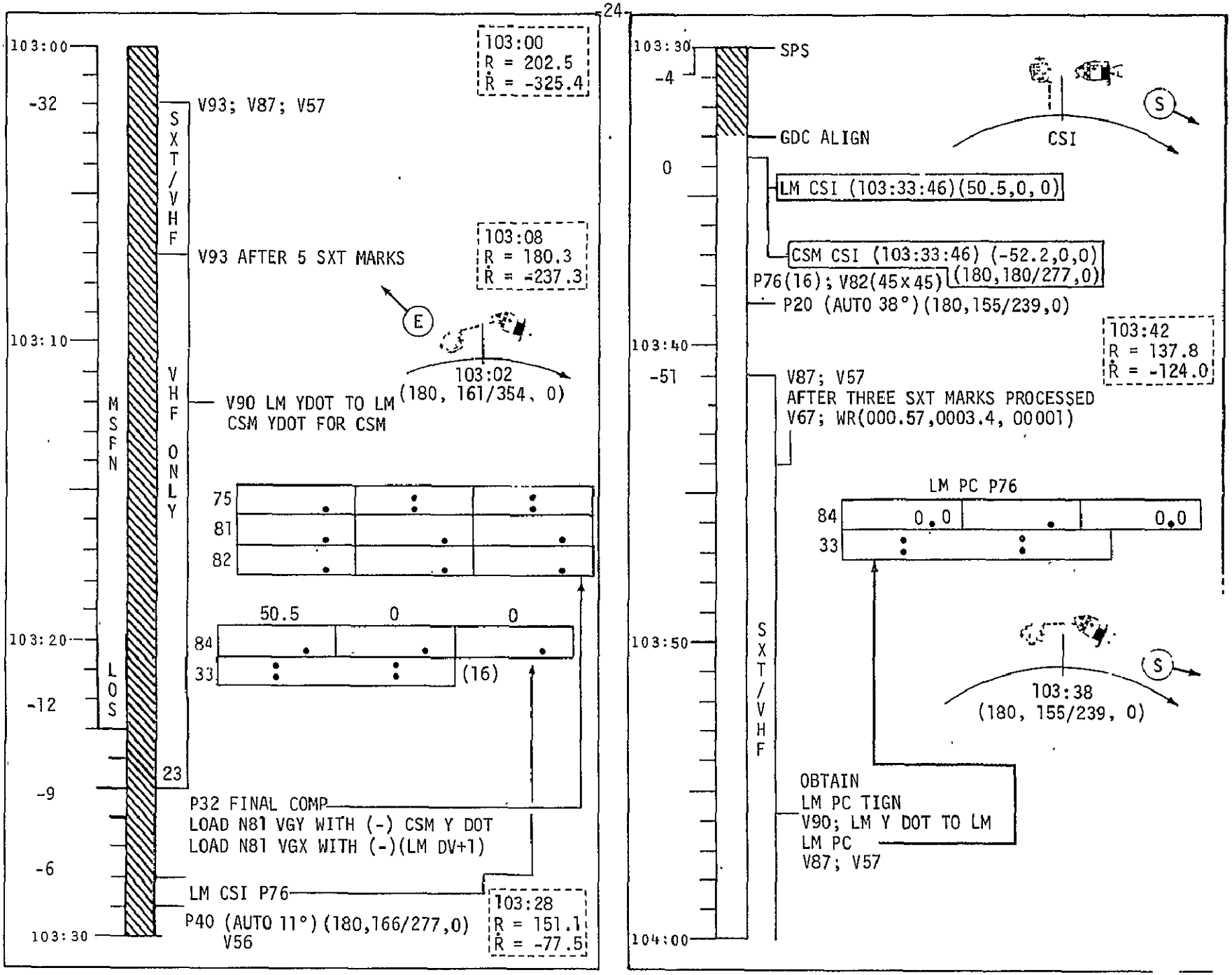

99:00
-29
99:10
-11
99:20
-6
99:30
MSFN
LOS
GDC ALIGN
ORDEAL (V83)
P00; MCC-H UPLINK CSM AND
LM VECTORS
99:05
R = 0.9
Ṙ = 4.2
VHF AM A-SIMPLEX/DATA
99:20
R = 1.5
Ṙ = 3.0
P20 (AUTO 55°)(0,206/332,0)

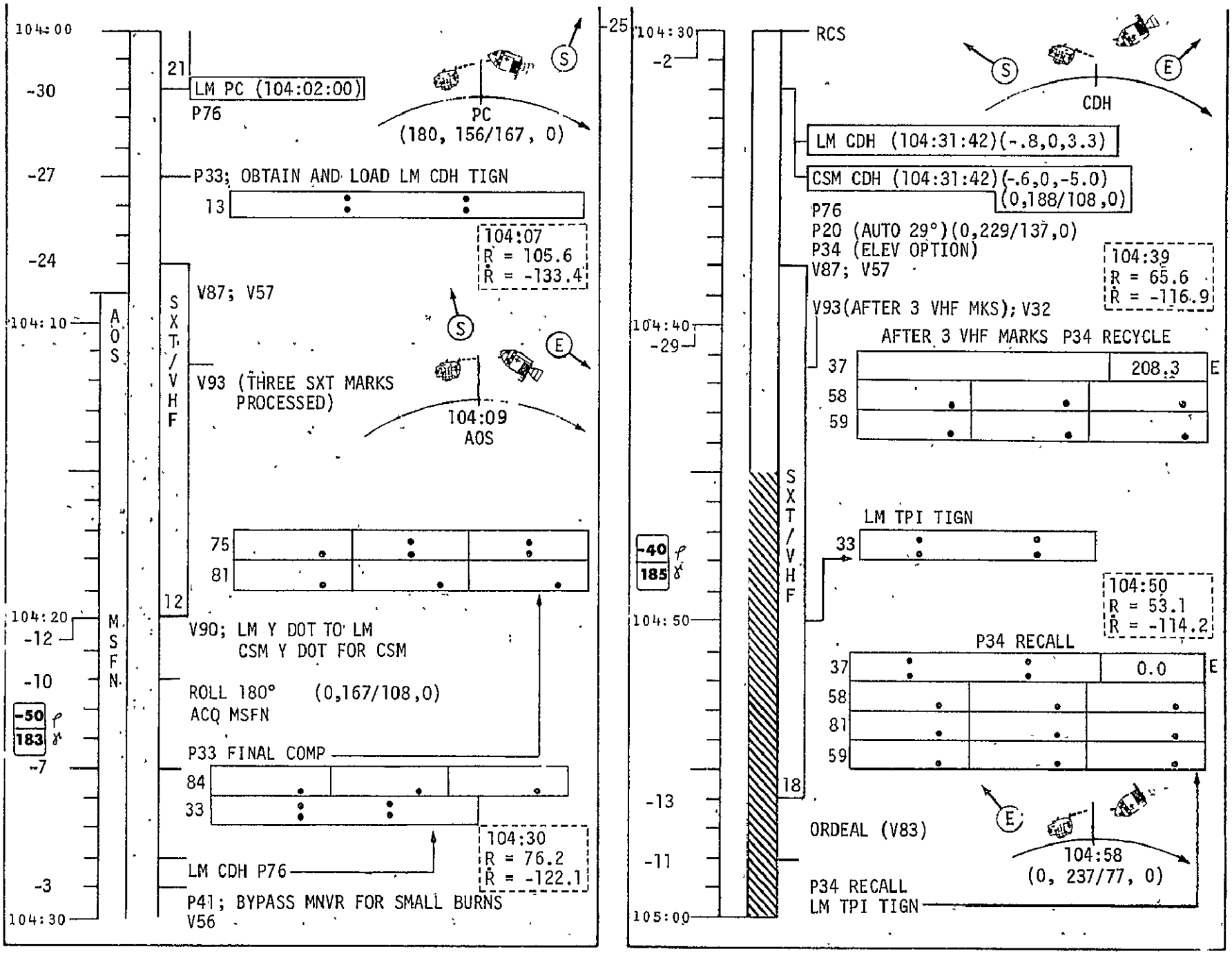

99:30
-2
0
99:40
-63
99:50
100:00
CONFIRM
VHF A/DATA
LBR,FWD
P76 LOAD
DOI
(0, 215/320, 0)
LM DOI (99:33:59)(-71.1,0,-.3)
VHF RCV ONLY-OFF
VHF AM B-DUPLEX/RANGING
COMPUTE RDOT FOR LM
CONFIRM LM DOI
P76(20); V82(LM)(10 x 60)
99:36
R = 3.1
Ṙ = 71.8
P20 (TRIM)(0,227/317,0)
OPTICS TRACK
S
99:39
(0, 227/317, 0)
99:47
R = 8.6
Ṙ = 62.3
100:00
R = 22.6
Ṙ = 159.5

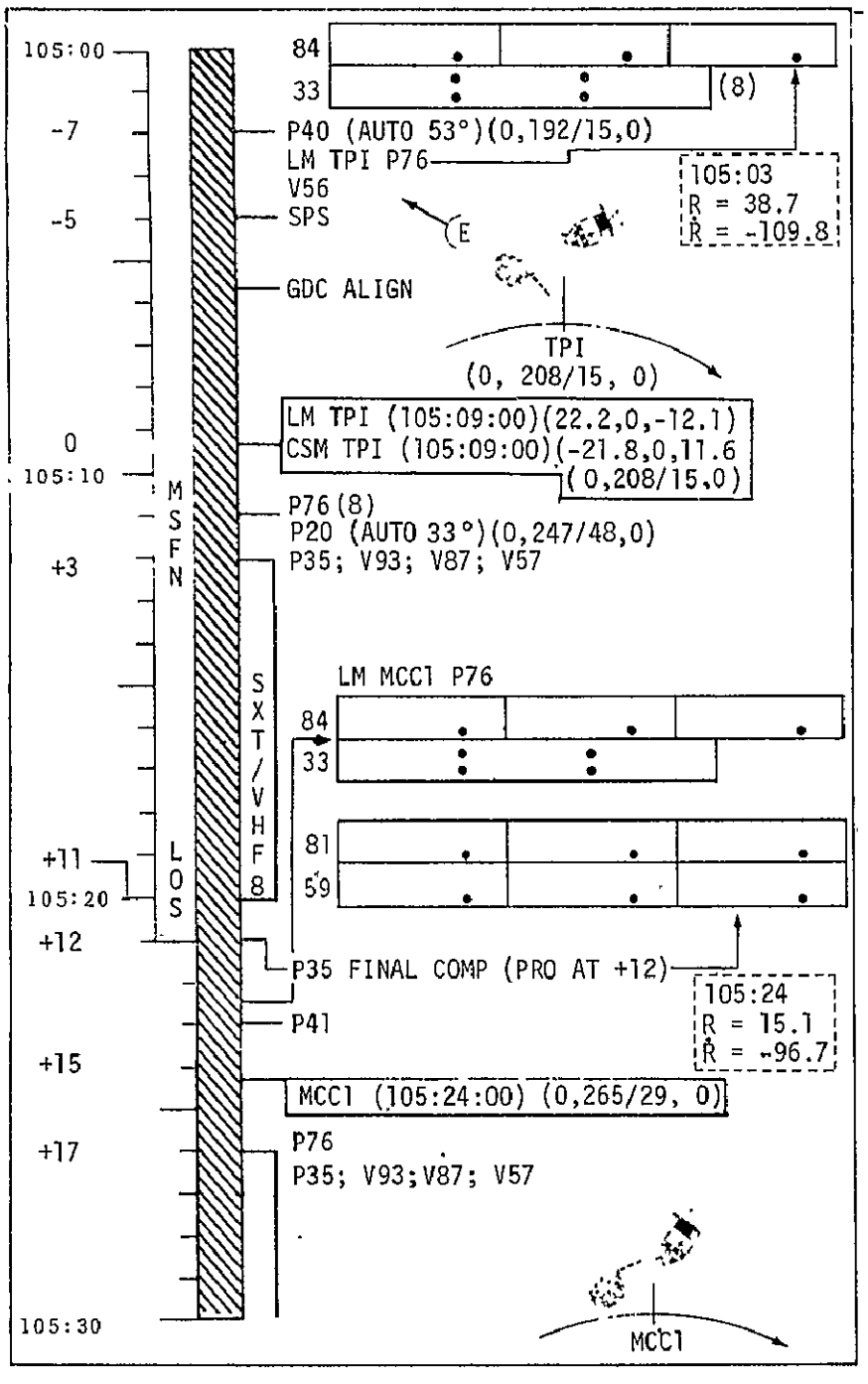

100:00
100:10
100:20
100:30
-32
-21
-19
-78
20
AOS
MSFN
SXT VHF
S
100:03
(0, 321/338, 0)
ROLL 180° AND
PITCH UP 70°
(180,278/268,0)
P00; V64; ACQ MSFN
100:10
R = 45.4
Ṙ = 304.1
E
AOS 100:12
(180, 278/268, 0)
LM GO/NO-GO PDI ABORT
V67 (00289,00173,00001)
P20 (AUTO 25°)(180,293/243,0)
V87; V57
COMMENT ON LM VISIBILITY
DURING LM DESCENT AND
ASCENT. RECORD GET OF
VISUAL LOSS AND ACQ OF LM.
100:30
R = 125.7
Ṙ = 470.3
21
100:30
100:40
100:50
101:00
-9
0
+5
-19
176
MSFN
SXT VHF
GET OF LOSS AND ACQ
LOSS
ACQ
10
V88
100:40
R = 171.3
Ṙ = 439.6
FAILED LM PHASING
PARTIAL PHASING CHECKLIST DV<40
RESCUE BURN AT 101:33
PARTIAL PHASING CHECKLIST
DV≥40
RESCUE BURN AT 101:33
E
S
PHASING
(180, 309/195, 0)
LM PHASING (100:46:21)(170.4,0,-95.6)
P76(32); V82 (LM)(10X196)
P20 (TRIM)
COPY LM INSERTION P76 PAD
100:50
R = 214.8
Ṙ = 462.1
V87; V57
V93 (AFTER
3 SXT MARKS)
E
100:57
(180, 316/169, 0)

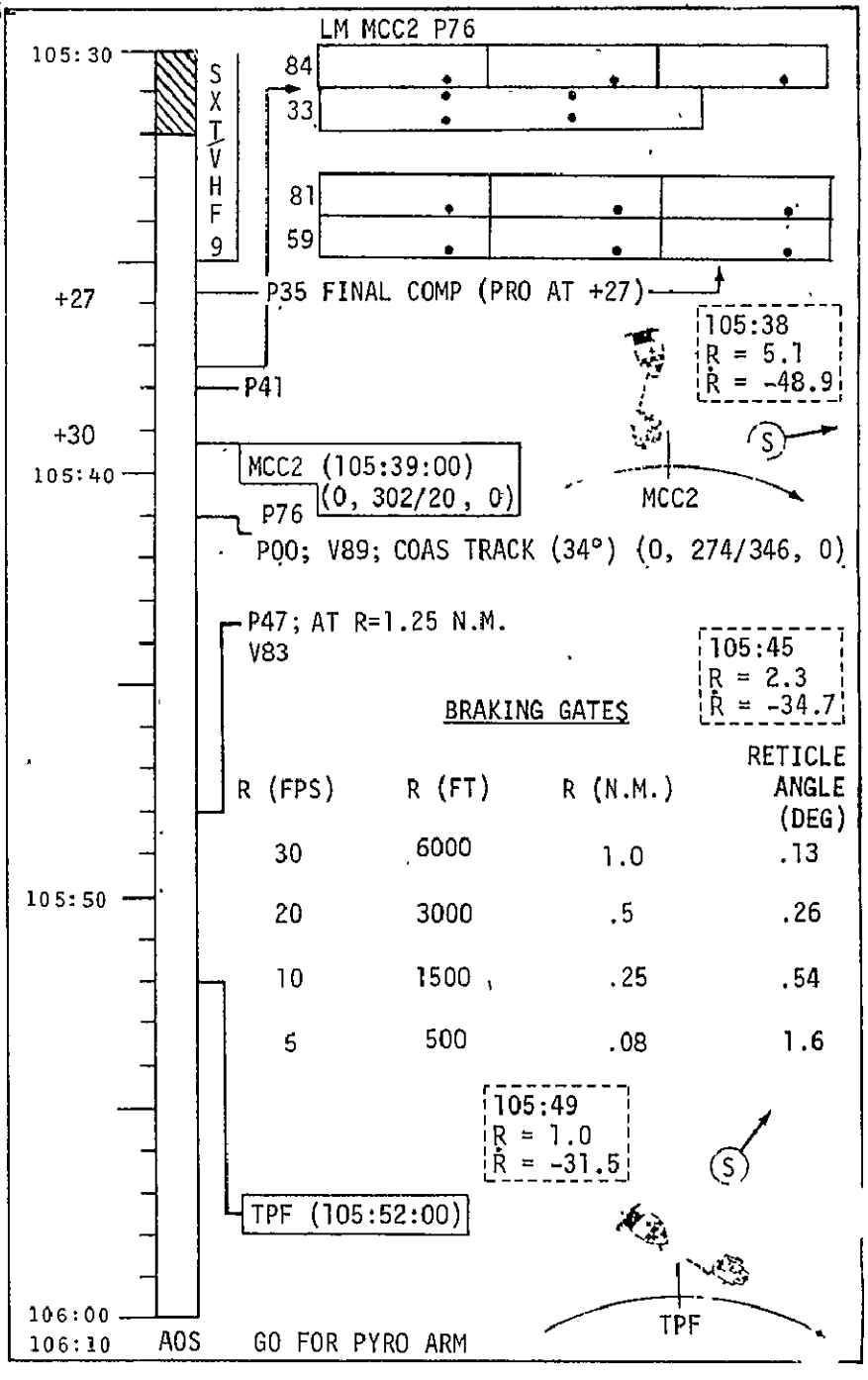

101:00
+15
101:10
+28
101:20
+38
101:30
10
LM P52
COPY INITIAL CSM BACKUP INSERTION PAD
COPY LM INSERTION P76 PAD
-189.2
0
-83.9
84
33
(8)
101:10
R = 239.1
Ṙ = -246.7
MSFN
V57
E
101:14
(180, 337/138, 0)
SXT/VHF
10
V88
LOS
101:30
R = 148.7
Ṙ = -421.8
101:30
101:40
GDC ALIGN
ORDEAL (V83)
101:40
R = 139.9
Ṙ = 312.7
S
101:49
(180, 108/162, 0)
-57
101:50
V87(R<327); V57
V93 (THREE SXT MARKS PROCESSED)
SXT/VHF
102:00
R = 269.3
Ṙ = 713.7
102:00


102:00
SXT/VHF 20
V88
-37
102:10
AOS
-32
-20
175
102:20
MSFN
102:30
102:10
R = 327.3
Ṙ = -432.5
(S)
PITCH DOWN 50°
(180, 194/182, 0)
102:11 AOS
(E)
P00; V64; ACQ MSFN (180, 194/182, 0)
MCC-H UPLINK CSM VECTOR
INSERTION P76 PAD UPDATE
-189.2
0
-83.9
84
33
(8)
CSM BACKUP INSERTION PAD UPDATE
102:20
R = 351.3
Ṙ = 45.6
102:30
-16
-14
-9
102:40
0
102:50
-38
-35
103:00
MSFN
P30
102:30
R = 336.4
Ṙ = -336.5
P40 (AUTO 110°)(180,2/272,0)
FAILED LM INSERTION
ZERO LM INSERTION; CSM BACKUP
INSERTION AND ZERO INSERTION CHECKLIST
PARTIAL LM INSERTION CHECKLIST
RESCUE BURN AT 103:32
SPS
GDC ALIGN
(S)
(E)
INSERTION
LM INSERTION (102:43:18)(-189.2,0,-83.9)
CSM INSERTION (102:46:18) (175.4,0,-107.1)
(180, 32/272, 0)
P52 (OPTION 3)
05
93
40
45
35
ID1
ID2
ID3
102:50
R = 239.4
Ṙ = -416.2
P00; MCC-H UPLINK LM VECTOR
P20 (AUTO 101°)(180,162/13,0)
11
37
P32; OBTAIN AND LOAD LM CSI AND TPI TIGN'S


103:00
-32
103:10
103:20
-12
-9
-6
103:30
MSFN
LOS
SXT/VHF
VHF ONLY
23
V93; V87; V57
103:00
R = 202.5
Ṙ = -325.4
V93 AFTER 5 SXT MARKS
103:08
R = 180.3
Ṙ = -237.3
E
103:02
(180, 161/354, 0)
V90 LM YDOT TO LM
CSM YDOT FOR CSM
75
81
82
50.5
0
0
84
33
(16)
P32 FINAL COMP
LOAD N81 VGY WITH (-) CSM Y DOT
LOAD N81 VGX WITH (-)(LM DV+1)
LM CSI P76
P40 (AUTO 11°) (180,166/277,0)
V56
103:28
R = 151.1
Ṙ = -77.5
103:30
-4
0
103:40
-51
103:50
104:00
SPS
GDC ALIGN
CSI
S
LM CSI (103:33:46)(50.5,0,0)
CSM CSI (103:33:46) (-52.2,0,0)
P76(16); V82(45x45) (180,180/277,0)
P20 (AUTO 38°)(180,155/239,0)
103:42
R = 137.8
Ṙ = -124.0
V87; V57
AFTER THREE SXT MARKS PROCESSED
V67; WR(000.57,0003.4, 00001)
LM PC P76
84
33
0.0
0.0
103:38
(180, 155/239, 0)
SXT/VHF
OBTAIN
LM PC TIGN
V90; LM Y DOT TO LM
LM PC
V87; V57


104:00
-30
-27
-24
104:10
104:20
-12
-10
-50
183
-7
104:30
-3
AOS
MSFN
SXT/VHF
21
LM PC (104:02:00)
P76
PC
(180, 156/167, 0)
P33; OBTAIN AND LOAD LM CDH TIGN
13
104:07
R = 105.6
Ṙ = -133.4
V87; V57
V93 (THREE SXT MARKS PROCESSED)
104:09
AOS
75
81
12
V90; LM Y DOT TO LM
CSM Y DOT FOR CSM
ROLL 180° (0,167/108,0)
ACQ MSFN
P33 FINAL COMP
84
33
104:30
R = 76.2
Ṙ = -122.1
LM CDH P76
P41; BYPASS MNVR FOR SMALL BURNS
V56
25
104:30
-2
104:40
-29
-40
185
104:50
-13
-11
105:00
RCS
CDH
LM CDH (104:31:42)(-.8,0,3.3)
CSM CDH (104:31:42)(-.6,0,-5.0)
(0,188/108,0)
P76
P20 (AUTO 29°)(0,229/137,0)
P34 (ELEV OPTION)
V87; V57
104:39
R = 65.6
Ṙ = -116.9
V93(AFTER 3 VHF MKS); V32
AFTER 3 VHF MARKS P34 RECYCLE
37
58
59
208.3
E
SXT/VHF
LM TPI TIGN
33
104:50
R = 53.1
Ṙ = -114.2
P34 RECALL
37
58
81
59
0.0
E
18
ORDEAL (V83)
104:58
(0, 237/77, 0)
P34 RECALL
LM TPI TIGN


105:00
-7
-5
0
105:10
+3
+11
105:20
+12
+15
+17
105:30
MSFN
LOS
SXT/VHF 8
84
33
(8)
P40 (AUTO 53°)(0,192/15,0)
LM TPI P76
V56
SPS
105:03
R = 38.7
Ṙ = -109.8
E
GDC ALIGN
TPI
(0, 208/15, 0)
LM TPI (105:09:00)(22.2,0,-12.1)
CSM TPI (105:09:00)(-21.8,0,11.6
(0,208/15,0)
P76 (8)
P20 (AUTO 33°)(0,247/48,0)
P35; V93; V87; V57
LM MCC1 P76
84
33
81
59
P35 FINAL COMP (PRO AT +12)
105:24
R = 15.1
Ṙ = -96.7
P41
MCC1 (105:24:00) (0,265/29, 0)
P76
P35; V93;V87; V57
MCC1


LM MCC2 P76
105:30
SXT/VHF 9
84
33
81
59
+27
P35 FINAL COMP (PRO AT +27)
105:38
R = 5.1
Ṙ = -48.9
P41
+30
105:40
MCC2 (105:39:00)
(0, 302/20, 0)
S
MCC2
P76
P00; V89; COAS TRACK (34°) (0, 274/346, 0)
P47; AT R=1.25 N.M.
V83
105:45
R = 2.3
Ṙ = -34.7
BRAKING GATES
R (FPS) R (FT) R (N.M.) RETICLE ANGLE (DEG)
30 6000 1.0 .13
20 3000 .5 .26
10 1500 .25 .54
5 500 .08 1.6
105:50
105:49
R = 1.0
Ṙ = -31.5
S
TPF (105:52:00)
TPF
106:00
106:10
AOS
GO FOR PYRO ARM

5.0 NOMINAL MAJOR PROCEDURES SUMMARY

The following sections present a summary timeline and checklist of major CSM activities during the nominal Mission F LM active rendezvous. The timeline in Section 5.1 will aid in interpreting the data included in the onboard rendezvous checklist and serves as a time correlated table of contents for the nominal detailed procedures which follow in Section 6.0. In addition, Section 5.2 includes a one-page summary checklist for the nominal mission in a format similar to that utilized for the LM rescue onboard data.

GET	EVENT	PROG
(97+03)		
	MOVE TO COMMAND SEAT	
(97+05)		
	MCC-H UPLINK(RLS AS REQUIRED(P00) AND CSM STATE VECTOR),V66	
	COPY CSM SEP PADS	
	DON HELMET AND GLOVES	
	CSM/LM COMM CHECK	
(97+14)		
	VERIFY DAP WIDE DB FOR LM RCS CHECKS	
(97+20)		
	VERIFY AUTO RCS SEL -C4(-PITCH-X)-OFF -B3(+YAW-X)-OFF FOR LM RDR SELF TEST	
	VERIFY RNDZ XPNDR-OFF	
(97+27)		
	LOS	
(97+30)		
	CONFIGURE CAMERA	
(97+35)		
	LOAD DAP (21112),(V46) (11111)	
(97+38)		
	SUNUP	-25
	VHF AM A-SIMPLEX	

GET	EVENT	PROG
(97+40)		
	V49,LOAD N22(180,14,14) MNVR TO UNDOCKING ATTITUDE (INERTIAL SEP ATT EXCEPT ROLL AND 14 DEG YAW) (180,282/14,14)	
(97+46)		
	CMC MODE-FREE(AS REQD FOR LM AGS CALIB)	
	CMC MODE-AUTO(AFTER 32 SEC)	
	PERFORM SYSTEMS CHECKS AND SWITCH VERIFICATION	
(97+50)		
	YAW 14 DEG LEFT AFTER LM AGS CALIB (180,312/14,0)	
	MOVE TO LEB	
(97+52)		
	RNDZ XPNDR CHECKS	
	MOVE TO COMMAND SEAT	
(98+05)		
	GDC ALIGN TO IMU	
(98+06)		
	VERIFY ORDEAL (V83)	
(98+07)		
	RELOAD DAP (11102),(V46) (11111)	
	SC CONT-SCS	
(98+10+00)		
	**********	
	UNDOCKING (180,12/14,0)	
	**********	
	STATION KEEP AT 40 FT	

GET	EVENT	PROG
	DV CG-CSM	
	RNDZ XPNDR PWR-PWR(VERIFY)	
	ROLL LEFT 180 DEG AT 2 DEG/SEC	
	(0,50/14,0)	
(98+13)		
	AOS	
	ACQUIRE MSFN (V64)	(P00)
	ACTIVATE COLOR TV	
	TAKE PHOTOS	
	INSPECT LM DURING LM 360 DEG YAW	
-15 (98+20)		
	LM STATION KEEP	
(98+23)		
	COPY PADS	
(98+29)		
	RELOAD DAP(11102),(V46)	
	(01111)	
	SC CONT-CMC	
-05 (98+30)		
	EXTERNAL DV TARGETING	(P30)
	(SEPARATION)	
-03 (98+32)		
	RCS THRUST PROGRAM	(P41)
	AUTO MNVR TO BURN ATTITUDE	
	(TRIM)	
	RCS THRUST SETUP	(P41)
0 (98+35+16)		
	**********	
	SEPARATION BURN(0,0,-2.5)	
	(0,90/14,0)	
	THRUST(-)X(2.5,0,0) TO (5.0,0,0)	
	**********	

GET	EVENT	PROG
(98+39)		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(40 DEG)	
	(0,142/54,0)	
	VHF ANT-RT	
	VHF AM B-DUPLEX/RANGING	
	MONITOR LM RR CHECKS	
	COMPARE EMS VHF AND V83 RANGE	
	MOVE TO LEB	
	PERFORM OPTICS CHECKS	
(98+50)		
	SUNDOWN	
(98+55)		
	IMU REALIGN TO REFSMMAT	(P52)
	(OPTION 3)	
	COPY GYRO TORQUE ANGLES	
(99+03)		
	MOVE TO CMD SEAT	
	GDC ALIGN TO IMU	
	VERIFY ORDEAL(V83)	
-29 (99+05)		
	MCC-H UPLINK(CSM AND	(P00)
	AND LM VECTORS)	
(99+14)		
	VHF AM A-SIMPLEX/DATA	
(99+25)		
	LOS	
(99+28)		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(55 DEG)	
	(0,206/332,0)	
	MOVE TO LEB	

	GET	EVENT	PROG
-02	(99+32)		
		LOAD TARGET DV PROGRAM (P76)	
		(DOI)	
	(99+33+59)		
		**********	
		LM DOI BURN(-71.1,0,-.3)	
		**********	
		MOVE TO CMD SEAT	-21
		VHF AM B-DUPLEX/RANGING	
		VHF RCV ONLY-OFF	
		COMPUTE RDOT FOR LM	
		LM ORBIT PARAMETER DISPLAY(V82)	
		(9X60)	-19
		CONFIRM LM DOI	
		INCORPORATE P76 DATA	-9
		(DOI)	
	(99+37)		0
		SUNUP	
	(99+38)		
		RENDEZVOUS NAV PROGRAM (P20)	
		POSSIBLE AUTO MNVR TO SXT TRACK	
		(TRIM)	
		(0,227/317,0)	
		MOVE TO LEB	
	(99+44)		
		INITIATE LM OPTICS TRACK	
-39	(100+07)		
		MOVE TO CMD SEAT	
		ROLL 180 DEG AND PITCH UP 70 DEG	
		AT 1 DEG/SEC	
		(180,278/268,0)	

	GET	EVENT	PROG
	(100+12)		
		AOS	
		ACQUIRE MSFN (V64)	(P00)
	(100+20)		
		OBTAIN GO/NO GO FOR PDI ABORT	
		MOVE TO LEB	
		V97 LOAD WI(002.89,0017.3,00001)	
	(100+25)		
		RENDEZVOUS NAV PROGRAM (P20)	
		AUTO MNVR TO SXT TRACK	
		(25 DEG)	
		(180,293/243,0)	
	(100+27)		
		CALL MARKING ROUTINES(V87,V57)	
	(100+37)		
		TERMINATE SXT/VHF MARKS(V88)	
	(100+46+21)		
		**********	
		LM PHASING BURN(170.4,0,-95.6)	
		(180,307/193,0)	
		**********	
	(100+47)		
		TARGET DV PROGRAM (P76)	
		(PHASING)	
		LM ORBIT PARAMETER DISPLAY(V82)	
		(10X196)	
	(100+48)		
		RENDEZVOUS NAV PROGRAM (P20)	
		POSSIBLE AUTO MNVR TO SXT TRACK	
		(TRIM)	
		(180,308/188,0)	
	(100+49)		
		SUNDOWN	

	GET	EVENT	PROG
+05	(100+51)	CALL MARKING ROUTINES(V87,V57) (PROCESS 3 MARKS,V93)	
	(101+01)	TERMINATE SXT MARKS	
	(101+05)	COPY INITIAL CSM BACKUP INSERTION PAD	
	(101+10)	COPY LM INSERTION P76 PAD	
+28	(101+14)	CALL MARKING ROUTINE(V57)	
+38	(101+24)	TERMINATE SXT/VHF MARKS,V88 LOS	
	(101+35)	SUNUP MOVE TO COMMAND SEAT	
	(101+40)	GDC ALIGN TO IMU VERIFY ORDEAL(V83) MOVE TO LEB	
-57	(101+49)	CALL MARKING ROUTINES(V87,V57) (PROCESS 3 MARKS,V93)	
-37	(102+09)	TERMINATE SXT/VHF MARKS,V88 MOVE TO CMD SEAT	
	(102+11)	AOS PITCH DOWN 50 DEG (180,174/162,0)	
-32	(102+14)	ACQUIRE MSFN (V64)	(P00)
		MCC-H UPLINK(CSM VECTOR) COPY LM INSERTION P76 PAD UPDATE AS REQUIRED COPY CSM BACKUP INSERTION PAD UPDATE AS REQUIRED	
	(102+29)	VERIFY ORDEAL(V83)	
-16	(102+30)	EXTERNAL DV TARGETING (INSERTION)	(P30)
-14	(102+32)	SPS THRUST PROGRAM (INSERTION) AUTO MNVR TO BURN ATTITUDE (110 DEG) (180,3/272,0)	(P40)
-09	(102+37)	SPS THRUST SETUP (INSERTION)	(P40)
-05	(102+41)	GDC ALIGN	
-03	(102+43+18)	**********	
		LM INSERTION BURN (-189.2,0,-83.9)	
		**********	
0	(102+46+18)	**********	
		CSM BACKUP INSERTION BURN (175.4,0,-107.1) (180,32/272,0)	
		**********	

	GET	EVENT	PROG
		TARGET DV PROGRAM (P76)	-09
		(INSERTION)	
		LM ORBIT PARAMETER DISPLAY(V82)	
		(10X45)	
	(102+47)		
		SUNDOWN	
		MOVE TO LEB	
		IMU REALIGN TO REFSMMAT (P52)	
		(OPTION 3)	
		COPY GYRO TORQUE ANGLES	
	(102+52)		
		MCC-H UPLINK(LM VECTOR) (P00)	-04
-41	(102+56)		
		RENDEZVOUS NAV PROGRAM (P20)	-03
		AUTO MNVR TO SXT TRACK(101 DEG)	
		(180,162/13,0)	
	(102+59)		
		CSI TARGETING PROGRAM (P32) (P20)	0
		OBTAIN LM CSI AND TPI TIGNS,	
		LOAD CSI TARGETING DATA	
-32	(103+02)		
		REINITIALZE W MATRIX (V93)	
		CALL MARKING ROUTINE(V87,V57)	
-27	(103+07)		
		TERMINATE SXT MARKS	
		REINITIALIZE W MATRIX (V93)	
		MOVE TO CMD SEAT	
-22	(103+12)		
		OUT OF PLANE DATA(V90)	
		(CSM AND LM)	
		VOICE LM Y DOT TO LM	
	(103+23)		
		LOS	

GET	EVENT	PROG
(103+25)		
	CSI TARGETING FINAL COMP (P32)	
	COPY CSM CSI SOLUTION	
	LOAD N81 VGY WITH(-) CSM YDOT	
(103+28)		
	COPY LM CSI PAD	
(103+29)		
	SPS THRUST PROGRAM,V56 (P40)	
	AUTO MNVR TO BURN ATTITUDE	
	(11 DEG)	
	(180,166/277,0)	
(103+30)		
	SPS THRUST SETUP (P40)	
(103+31)		
	GDC ALIGN	
(103+33)		
	SUNUP	
(103+33+46)		
	**********	
	LM CSI BURN(50,5,0,0)	
	**********	
	**********	
	CSM BACKUP CSI BURN	
	(52,2,0,0)	
	(180,180/277,0)	
	**********	
	TARGET DV PROGRAM (P76)	
	(CSI)	
	LM ORBIT PARAMETER DISPLAY(V82)	
	(45X45)	

	GET	EVENT	PROG
	(103+38)		
		RENDEZVOUS NAV PROGRAM (P20)	
		AUTO MNVR TO SXT TRACK	
		(39 DEG)	
		(180,155/239,0)	
-54	(103+41)		-12
		CALL MARKING ROUTINES(V87,V57)	
		(PROCESS 3 MARKS)	
		V67 LOAD WR(000.57,0003.4,00001)	
	(103+44)		
		CALL MARKING ROUTINE (V57)	
	(103+55)		
		TERMINATE SXT MARKS	
		COPY LM PC TIGN	
		OUT OF PLANE DATA(V90)	-07
		VOICE LM YDOT TO LM	
		COPY LM PC PAD	
	(103+57)		
		CALL MARKING ROUTINE(V57)	
30	(104+02+00)		-03
		TERMINATE MARKS	
		**********	
		LM PLANE CHANGE(0,0,0)	
		**********	-02
		LOAD TARGET DV PROGRAM (P76)	
		INCORPORATE P76 DATA	
		(PLANE CHANGE)	0
	(104+05)		
		CDH TARGETING PROGRAM (P33)	
		POSSIBLE AUTO MNVR TO SXT TRACK	
		(TRIM)	
		(180,157/158,0)	
		OBTAIN LM CDH TIGN	
		LOAD CDH TARGETING DATA	

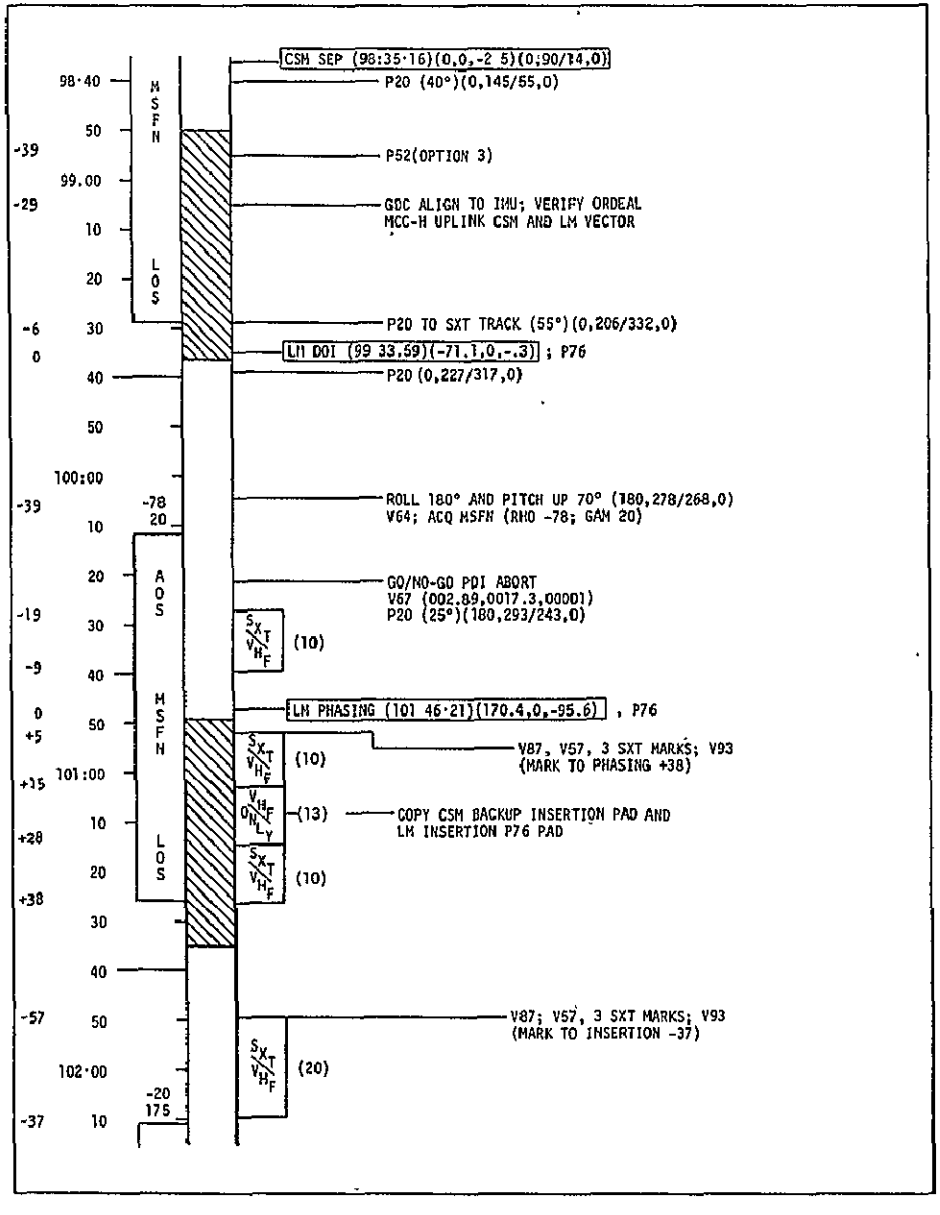
GET	EVENT	PROG
(104+08)		
	CALL MARKING ROUTINE(V87,V57)	
(104+09)		
	AOS	
	(PROCESS THREE MARKS,V93)	
(104+20)		
	TERMINATE SXT MARKS	
	OUT OF PLANE DATA(V90)	
	VOICE LM YDOT TO LM	
	MOVE TO CMD SEAT	
(104+22)		
	ROLL 180 DEG AT 2 DEG/SEC	
	ACQUIRE MSFN	
	(0,167/108,0)	
(104+25)		
	CDH TARGETING FINAL COMP (P33)	
	COPY CSM CDH SOLUTION	
(104+28)		
	COPY LM CDH PAD	
(104+29)		
	RCS THRUST PROGRAM (P41)	
	BYPASS BURN ATTITUDE MNVR	
	FOR SMALL BURNS	
(104+30)		
	RCS THRUST SETUP (P41)	
	GDC ALIGN	
(104+31+42)		
	**********	
	LM CDH BURN(-.8,0,3.3)	
	**********	
	**********	
	CSM CDH BURN (-.6,0,-5.0)	
	(0,188/108,0)	
	**********	

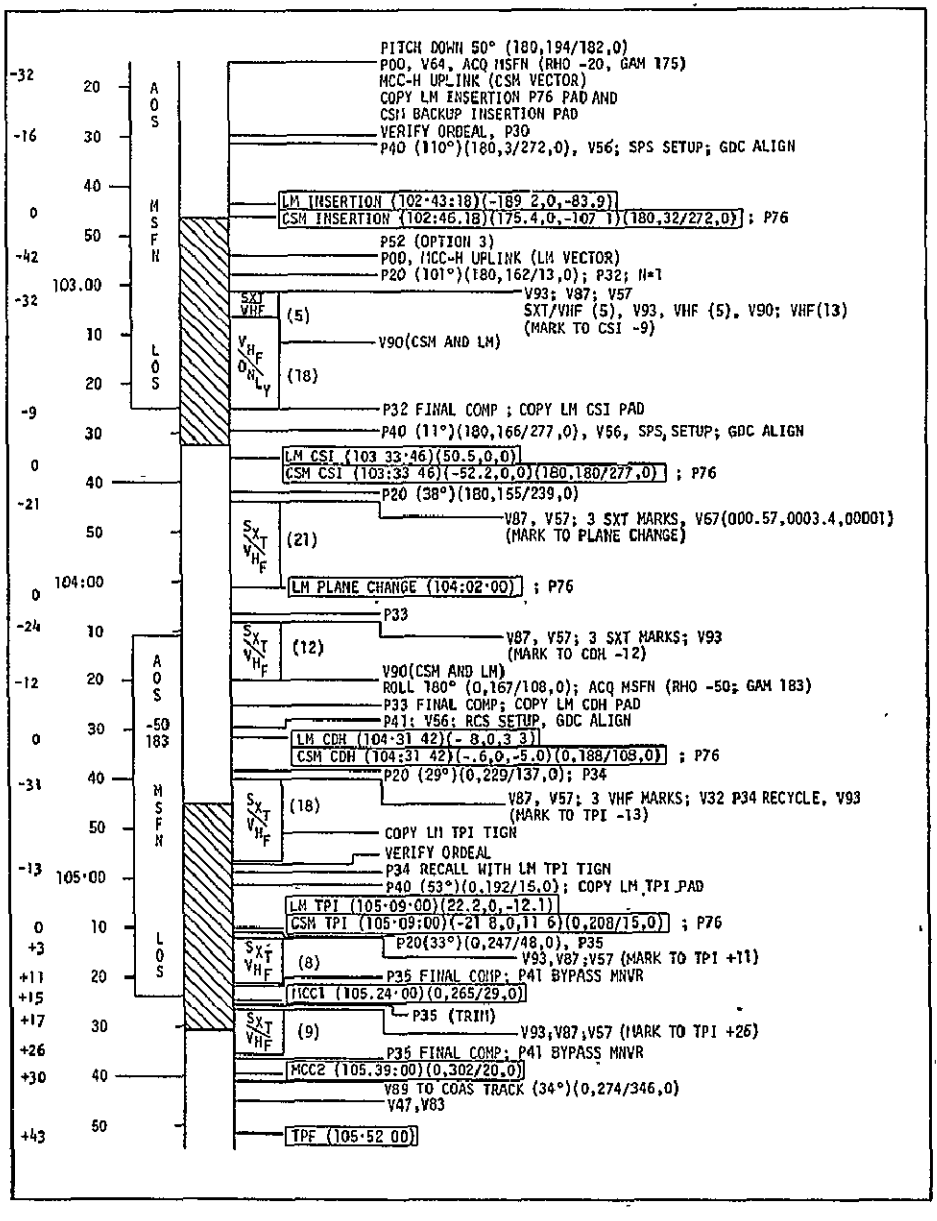
	GET	EVENT	PROG
	(104+34)		
		TARGET DV PROGRAM	(P76)
		(CDH)	
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK	
		(29 DEG)	
		(0,229/137,0)	
		MOVE TO LEB	
		TPI TARGETING PROGRAM	(P34)(P20)
		LOAD TPI TARGETING DATA WITH ELEV OPTION	
-31	(104+38)		
		CALL MARKING ROUTINE(V87,V57)	
		AFTER 3 MARKS PROCESSED	
		RECYCLE TPI TARGETING PROGRAM	(P34)
		CALL MARKING ROUTINE(V57)	
	(104+45)		
		SUNDOWN	
	(104+50)		
		COPY LM TPI TIGN	
-13	(104+56)		
		TERMINATE SXT MARKS	
		MOVE TO CMD SEAT	
		VERIFY ORDEAL(V83)	
-11	(104+58)		
		TPI TARGETING PROGRAM	(P34)
		(TIGN OPTION WITH LM TIGN)	
-07	(105+02)		
		SPS THRUST PROGRAM,V56	(P40)
		AUTO MNVR TO BURN ATTITUDE	
		(53 DEG)	
		(0,192/15,0)	
		COPY LM TPI P76 PAD	

	GET	EVENT	PROG
-05	(105+04)		
		SPS THRUST SETUP	(P40)
		(TPI)	
-03	(105+06)		
		GDC ALIGN	
0	(105+09+00)		
		**********	
		LM TPI BURN(22.2,0,-12.1)	
		**********	
		**********	
		CSM TPI BACKUP BURN	
		(-21.8,0,11.6)	
		(0,208/15,0)	
		**********	
		TARGET DV PROGRAM	(P76)
		(TPI)	
+02			
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK	
		(33 DEG)	
		(0,247/48,0)	
		MOVE TO LEB	
		MCC TARGETING PROGRAM	(P35)
+03			
		CALL MARKING ROUTINE(V93,V87,V57)	
+11			
		TERMINATE SXT MARKS	
		MOVE TO COMMAND SEAT	
+12	(105+21)		
		LOS	
		MCC1 TARGETING FINAL COMP	(P35)
		COPY CSM MCC1 SOLUTION	
		COPY LM MCC1 PAD	

GET	EVENT	PROG
+13.5	RCS THRUST PROGRAM BYPASS BURN ATTITUDE MNVR	(P41)
+15 (105+24+00)	********** LM MCC1 THRUST ********** ********** CSM MCC1 BACKUP BURN (0,265/29,0) ********** TARGET DV PROGRAM (MCC1)	(P76)
+16	MCC2 TARGETING PROGRAM (P35) POSSIBLE AUTO MNVR TO SXT TRACK (TRIM)	(P20)
+17	CALL MARKING ROUTINE(V93,V87,V57)	
(105+32)	SUNUP	
+26	TERMINATE SXT MARKS MOVE TO CMD SEAT	
+27	MCC2 TARGETING FINAL COMP COPY CSM MCC2 SOLUTION COPY LM MCC2 PAD	(P35)
+28.5	RCS THRUST PROGRAM BYPASS BURN ATTITUDE MNVR	(P41)

GET	EVENT	PROG
+30 (105+39+00)	********** LM MCC2 BURN ********** ********** CSM MCC2 BACKUP BURN (0,302/20,0) ********** TARGET DV PROGRAM (MCC2) AUTO MNVR TO COAS TRACK(V89) (34 DEG) (0,274/346,0)	(P76) (P00)
+39 (105+48)	THRUST MONITORING PROGRAM (KEY V83 AND MONITOR LM BRAKING) ********** * BRAKING GATES RETICLE ANGLE * * 30 FPS AT 6000 FT .13 DEG. * * 20 FPS AT 3000 FT .26 DEG. * * 10 FPS AT 2500 FT .54 DEG. * * 5 FPS AT 500 FT 1.60 DEG. * **********	(P47)
+43 (105+52)	********** TPF(0,310/353,0) **********	


CSM SEP (98:35:16)(0,0,-2.5)(0;90/14,0)
P20 (40°)(0,145/55,0)
P52(OPTION 3)
GDC ALIGN TO IMU; VERIFY ORDEAL
MCC-H UPLINK CSM AND LM VECTOR
P20 TO SXT TRACK (55°)(0,206/332,0)
LM DOI (99 33.59)(-71.1,0,-.3) ; P76
P20 (0,227/317,0)
ROLL 180° AND PITCH UP 70° (180,278/268,0)
V64; ACQ MSFN (RHO -78; GAM 20)
GO/NO-GO PDI ABORT
V67 (002.89,0017.3,00001)
P20 (25°)(180,293/243,0)
LM PHASING (101 46·21)(170.4,0,-95.6) , P76
V87, V57, 3 SXT MARKS; V93
(MARK TO PHASING +38)
COPY CSM BACKUP INSERTION PAD AND
LM INSERTION P76 PAD
V87; V57, 3 SXT MARKS; V93
(MARK TO INSERTION -37)
MSFN
LOS
AOS
98·40
99.00
100:00
101:00
102·00
(10)
(13)
(20)


PITCH DOWN 50° (180,194/182,0)
P00, V64, ACQ MSFN (RHO -20, GAM 175)
MCC-H UPLINK (CSM VECTOR)
COPY LM INSERTION P76 PAD AND
CSM BACKUP INSERTION PAD
VERIFY ORDEAL, P30
P40 (110°)(180,3/272,0), V56; SPS SETUP; GDC ALIGN
LM INSERTION (102·43:18)(-189.2,0,-83.9)
CSM INSERTION (102:46.18)(175.4,0,-107.1)(180,32/272,0) ; P76
P52 (OPTION 3)
P00, MCC-H UPLINK (LM VECTOR)
P20 (101°)(180,162/13,0); P32; N=1
V93; V87; V57
SXT/VHF (5), V93, VHF (5), V90; VHF(13)
(MARK TO CSI -9)
V90(CSM AND LM)
P32 FINAL COMP ; COPY LM CSI PAD
P40 (11°)(180,166/277,0), V56, SPS, SETUP; GDC ALIGN
LM CSI (103 33·46)(50.5,0,0)
CSM CSI (103:33 46)(-52.2,0,0)(180,180/277,0) ; P76
P20 (38°)(180,155/239,0)
V87, V57; 3 SXT MARKS, V67(000.57,0003.4,00001)
(MARK TO PLANE CHANGE)
LM PLANE CHANGE (104:02·00) ; P76
P33
V87, V57; 3 SXT MARKS; V93
(MARK TO CDH -12)
V90(CSM AND LM)
ROLL 180° (0,167/108,0); ACQ MSFN (RHO -50; GAM 183)
P33 FINAL COMP; COPY LM CDH PAD
P41: V56: RCS SETUP, GDC ALIGN
LM CDH (104·31 42)(-8.0,3.3)
CSM CDH (104:31 42)(-.6,0,-5.0)(0,188/108,0) ; P76
P20 (29°)(0,229/137,0); P34
V87, V57; 3 VHF MARKS; V32 P34 RECYCLE, V93
(MARK TO TPI -13)
COPY LM TPI TIGN
VERIFY ORDEAL
P34 RECALL WITH LM TPI TIGN
P40 (53°)(0,192/15.0); COPY LM TPI PAD
LM TPI (105·09·00)(22.2,0,-12.1)
CSM TPI (105·09:00)(-21.8,0,11.6)(0,208/15,0) ; P76
P20(33°)(0,247/48,0), P35
V93,V87;V57 (MARK TO TPI +11)
P35 FINAL COMP; P41 BYPASS MNVR
MCC1 (105.24·00)(0,265/29,0)
P35 (TRIM)
V93,V87;V57 (MARK TO TPI +26)
P35 FINAL COMP; P41 BYPASS MNVR
MCC2 (105.39:00)(0,302/20,0)
V89 TO COAS TRACK (34°)(0,274/346,0)
V47,V83
TPF (105·52 00)
AOS
MSFN
LOS
(5)
(18)
(21)
(12)
(18)
(8)
(9)

6.0 NOMINAL DETAILED PROCEDURES

The following four sections contain 1) The procedural ground rules assumed when generating procedures, 2) The detailed nominal procedures, 3) A summary of the rendezvous navigation schedule including the angle between the LOS to the Sun and LOS to the LM, and 4) A Summary of the inertial roll gimbal angle and the ORDEAL pitch and inertial pitch gimbal angles during the nominal F Mission.

6.1 Procedures Ground Rules

6.1.1 The CSM will be targeted for a TIGN three minutes after the LM TIGN for the insertion burn. No bias will be used for the CSI, CDH, or TPI burns.

6.1.2 The CSM will obtain from the LM the CSI, CDH, and TPI times utilized in the LGC targeting programs. These TIGN's loaded into the CMC targeting programs.

6.1.3 LM burn data will be incorporated into the CMC LM state vector using Program P76 following each LM burn. No attempt will be made to account for LM burn residuals. The LM burn TIGN loaded in Program P76 will be biased by a fixed number simulating an impulsive LM burn. The non-zero LM burns considered and the corresponding bias times are DOI (20 Sec), Phasing (32 Sec), Insertion (8 Sec), CSI (16 Sec), and TPI (8 Sec).

6.1.4 The CSM will compute using V90, the out-of-plane velocity of the LM prior to the CSI, Plane Change, and CDH burns for use in the LM targeting programs.

6.1.5 The ordeal setup on FDAI 2 will be verified approximately once per orbit.

6.1.6 The GDC will be aligned to the IMU prior to each backup CSM burn.

6.1.7 No burn attitude verification using stars or the horizon will be made in the CSM.

6.1.8 The PIPA bias determination, EMS DV test, and EMS accelerometer check, identified in the AOH as required

before each SPS burn, need be scheduled only prior to the entire rendezvous sequence.

6.1.9 The SM RCS propulsion check identified in the AOH as required before each SPS burn, should not include recording the values monitored.

6.1.10 It is assumed that the CMP is able to move to the LEB or command seat during automatic attitude maneuvers and the time required to move is less than one minute.

6.1.11 The procedures contained herein reflect the COMANCHE 44, 45 programs and routines.

6.1.12 The minimum times to be allowed for the CMC programs are:

A.	P52	5 Min.
B.	P76	1 Min.
C.	P30	2 Min.
D.	P32 Final Comp	3 Min.
E.	P33 Final Comp	3 Min.
F.	P34 Final Comp	3 Min.
G.	P35 Final Comp	1.5 Min.
H.	P41 (Excluding ATT Mnvr and Including RCS Setup)	1.5 Min.
I.	P40 (Excluding ATT Mnvr and Including SPS Setup)	5 Min

6.1.13 All automatic maneuvers (DAP) are made at a rate of .5 Deg/Sec.

6.1.14 The state vector of the active vehicle (LM) will be updated in the rendezvous navigation Program, P20.

6.1.15 The SXT navigation mark frequency during a tracking period is one per minute.

6.1.16 Recycles for CMC targeting Programs P32, P33, and P34 during mark periods have not been scheduled. They will be included, as desired for solution comparison purposes, when they do not preclude taking the minimum number of SXT and VHF marks prior to a burn.

6.1.17 The delta time between the PRO for Final Comp in Program P35 and the MCC is three minutes.

6.1.18 Program P20 will be terminated (V56) in the thrust program prior to each backup CSM burn. This will necessitate calling Program P20 after the burn in addition to a pre-thrust program. Exceptions: Insertion (P00 does it) and the MCC burns.

6.1.19 The automatic star selection routine in Program P52 will be used during each IMU realignment.

6.1.20 The CSM attitude has been specified to be compatible with HGA communications when no other attitude constraint prohibits HGA coverage.

6.1.21 The procedures have been developed to be compatible with Mission G1 procedural requirements.

6.1.22 The SPS gimbal motors will not be activated for a CSM backup of a LM burn until the CSM knows it must become active.

6.1.23 Backup charts for the CSI, CDH, TPI, and MCC burns will not be used in the CSM.

6.1.24 VHF navigation marks cannot be taken at ranges greater than 327 nautical miles.

6.2 DETAILED PROCEDURES

****
* *
* MISSION F RENDEZVOUS PROCEDURES *
* *
****

****
* ASSUMED INITIAL SWITCH SETTINGS *
****

CDR SWITCH SETTINGS

CMC ATT-IMU
FDAI SCALE-5/1
FDAI SELECT-1/2
FDAI SOURCE-ATT SET
ATT SET-IMU
MAN ATT(3)-RATE CMD
LIMIT CYCLE-OFF
ATT DB-MAX
RATE-LOW
THC-LOCKED
RHC-LOCKED
TRANS CONT PWR-ON(UP)
ROT CONTR PWR NORMAL(BOTH)-
AC/DC
ROT CONTR PWR DIRECT(BOTH)-
OFF
SC CONT-CMC
CMC MODE-AUTO
BMAG MODE(3)-RATE2
SPS THRUST DIRECT-NORMAL
DV THRUST(A,B)-OFF
SCS TVC (BOTH)-RATE CMD
SPS GMBL MTR(4)-OFF
DV CG-LM/CSM
IMU CAGE-OFF
EMS ROLL-OFF
.05 G-OFF
LV/SPS IND (BOTH)-PC,GPI
TVC GMBL DRIVE (BOTH)-1
FCSM(A,B)-RESET/OVERRIDE
EMS FUNCTION-OFF
EMS MODE-STBY
UP TLM(CM,IU)-BLOCK
RCS TRNFR-SM
PANEL 8 CB CLOSED EXCEPT
RCS LOGIC(2)
DOCK PROBE(2)
ELS BAT A,BAT B
PL VENT FLT/PL
FLOAT BAG(3)
SECS ARM BAT A,BAT B
AUTO RCS SEL(16)-MNA
EXCEPT
-C4(+PITCH-X)-OFF
-B3(+YAW-X)-OFF
TVC SERVO PWR (BOTH)-OFF
FDAI/GPI PWR-BOTH
LOGIC PWR 2/3-ON(UP)
SCS ELECT PWR-GDC/ECA
SIG COND/DRVR BIAS PWR(2)-AC1
BMAG PWR(BOTH)-ON
COAS PWR (L WIND)-ON

FDAI SW1=INERTIAL
FDAI SW2=ORB RATE
EARTH/LUNAR=LUNAR
ALT SET KNOB TO AVE ALT
MODE=OPR/SLOW

LMP SWITCH SETTINGS

G/N PWR=AC1
MN BUS TIE(2)=OFF
NONESS BUS=OFF
PANEL 5 G/N CB(10)=CLOSED
PANEL 229 CB CLOSED EXCEPT
MN REL PYRO(2)

CMP SWITCH SETTINGS

G/N PWR OPTICS=ON
G/N PWR, IMU=ON
RNDZ XPONDER=OFF
OPTICS MODE=CMC
ZERO OPTICS=ZERO
CONT SPEED=LO
CONT COUPLING=RESOLVED
SCT TRUN=SLAVE TO SXT
CONDITION LAMPS=ON
UP TLM(LEB)=ACCEPT
C/W=NORMAL
C/W=CSM
C/W=POWER

```
**************************************************
*                                                *
*      TIMELINED RENDEZVOUS PROCEDURES           *
*                                                *
**************************************************


**************************************************
*           PROCEDURES THRU UNDOCKING            *
**************************************************

      (97+03)
                MOVE TO CMD SEAT
      (97+05)
           **MCC-H UPLINK RLS(AS REQUIRED)**
              AND CSM STATE VECTOR

      P00       KEY V37E00E

                UP TLM(CM)(MDC)=ACCEPT
                MONITOR UPLINK ACT LT=ON
                MONITOR GND UPLINK
                MONITOR UPLINK ACT LT=OFF
                UP TLM(CM)(MDC)=BLOCK
                CONFIRM COMP LT=OFF
                KEY V66E

                COPY SEPARATION PAD
                DON HELMET AND GLOVES
                CSM/LM COMM CHECK

      (97+14)
                **VERIFY DAP WIDE DB FOR**
                   LM RCS CHECKS
                KEY V48E
           F 04 46 (DAP CONFIGURATION)
                VERIFY R1 = XXX1X
                PRO
           F 06 47 (CSM AND LM WT)
                PRO
           F 06 48 (SPS GMBL TRIM)
                PRO

                SET MDC ET COUNTING DOWN TO
                   SEPARATION TIGN
                   (98+55+44)
      (97+20)
                VERIFY AUTO RCS SEL
                   =C4(=PITCH=X)=OFF,AND
                   =B3(+YAW=X)=OFF(FOR LM
                   RDR SELF TEST)
                VERIFY RNDZ XPNDR=OFF
      (97+27)
                LOSS OF SIGNAL
      (97+30)
                CONFIGURE CAMERA:
                   CM/SEQ/18/CEX=BRKT(RH WIN)
                   MIR(F11,250,INFINITY)6FPS,
                   15 MIN
```

(97+35)

LOAD DAP

KEY V48E

F 04 46 (DAP CONFIGURATION)

LOAD

21112

11111

PRO

F 06 47 (CSM AND LM WT)

LOAD

+37768

+30847

PRO

F 06 48 (SPS GMBL TRIM)

LOAD

-00052

+00059

PRO

KEY V46E

KEY V62E

(97+38)

SUNUP

VHF AM A-SIMPLEX

VHF RCV ONLY-B DATA

(97+40)

MANEUVER TO UNDOCKING ATTITUDE

(INERTIAL SEP ATT EXCEPT ROLL AND 14 DEG YAW)

KEY V49E

F 06 22 (COMMANDED R,P,Y)

LOAD(180,14,14)

PRO

F 50 18 (COMMANDED R,P,Y)

PRO

06 18 (COMMANDED R,P,Y)

MONITOR AUTO MANEUVER

F 50 18 (COMMANDED R,P,Y)

(180,282/14,14)

KEY ENTER

(97+46)

CMC MODE-FREE(AS REQ FOR AGS CALIB)

CMC MODE-AUTO(AFTER 32 SEC)

PERFORM SYSTEMS CHECK AND SWITCH VERIFICATION

(97+50)

YAW 14 DEG LEFT AFTER LM AGS CALIBRATION

(180,312/14,0)

(97+52)

MOVE TO LEB

RNDZ XPNDR ACTIVATION AND SELF TEST

CB RNDZ XPNDR FLT BUS-CLOSE

RNDZ XPNDR PWR-HTR FOR 1 MIN FOR SELF TEST

RNDZ XPNDR PWR-PWR

SYS TEST (LH)-XPONDER

SYS TEST(RH)-A(RRT XMTR OUT PWR)

RNDZ XPNDR TEST-TEST(HOLD)

SYS TEST IND-GRATER THAN 1 VDC

SYS TEST(RH)-B(RRT AGC SIG)

RNDZ XPNDR TEST-TEST(HOLD)

SYS TEST IND-GREATER THAN 1 VDC

```
          RNDZ XPNDR TEST-OPERATE
          SYS TEST IND-0-4.5 VDC
          SYS TEST(RH)-C(RRT FREQ LOCK)
          SYS TEST IND
             -LESS THAN .8 VDC UNLOCKED
             -MORE THAN 4 VDC LOCKED
          SYS TEST(RH)-B(RRT AGC SIG
             OPERATE)

          MOVE TO CMD SEAT
(98+05)
        **GDC ALIGN TO IMU**

          KEY V16N20E
     16 20 (R,P,Y)
          ATT SET THUMBWHEELS TO N20
          FDAI SELECT-1
          NULL ATT ERROR NEEDLES
             ON FDAI 1 WITH ATT
             SET THUMBWHEELS
          FDAI SELECT-1/2
          ATT SET-GDC
          DEPRESS GDC ALIGN PB
          ATT SET-IMU
          KEY RELEASE

(98+06)
     **ORDEAL VERIFICATION**

          KEY V82E
   F 04 06 (VEHICLE OPTION CODES)
          PRO
   F 16 44 (HA,HP,TFF)
          CALC AVE ALT
          PRO
          ALT SET KNOB TO AVE ALT
```

```
          KEY V83E
   F 16 54 (R,RDOT,THETA)
          VERIFY R=RDOT=0
          IF NOT,KEY V66E
          SLEW/ADJUST FDAI TO THETA
          PRO
(98+07)
          S/C CONT-SCS
     **LOAD DAP**

          KEY V48E
   F 04 46 (DAP CONFIGURATION)
          LOAD
               11102
               11111
                 B
          PRO
   F 06 47 (CSM AND LM WT)
          PRO
   F 06 48 (SPS GMBL TRIM)
          PRO
          KEY V46E

     **PROCEDURES FOR UNDOCKING**

          INSTALL DOCKING TARGET
          RATE-HI
          ROT CONT PWR DIR(BOTH)-MNA/MNB
          RHC-ARMED
          THC-ARMED
          CB DOCK PROBE(2)-CLOSED
          EVNT TMR RESET-DOWN
          EVNT TMR START (ON CDR SIGNAL)
-25  (98+10+00)
```

PROBE EXTD/REL-EXTD/REL (HOLD
UNTIL LM SEP PLUS 5 SEC)
PROBE EXTD/REL TB(2)-GRAY TO
BP TO GRAY
MONITOR LM UNDOCKING/MAINTAIN
UNDOCKING ATTITUDE
(180,12/14,0)
PROBE EXTD/REL-RETR
DV CG-CSM
AUTO RCS SELECT
-B3(+YAW-X)-MNA
-C4(-PITCH-X)-MNA
ROT CONT PWR DIR(BOTH)-OFF
BMAG MODE(3)-ATT 1/RATE 2
CB DOCK PROBE(2)-OPEN

```
**************************************************
*                PROCEDURES FOR                  *
*          UNDOCKING THRU SEPARATION             *
**************************************************
```

CSM STATION KEEPING

ATT DB=MIN
RNDZ XPNDR PWR=PWR(VERIFY)
PERFORM STATION KEEPING
MANEUVERS/MAINTAIN 40 FT
SEPARATION

FDAI SCALE=5/5
ROLL 180 DEG LEFT AT
2 DEG/SEC
(0,50/14,0)
FDAI SCALE=5/1

ACQUIRE MSFN

KEY V64E
F 06 51 (RHO,GAMMA,BLANK)
SLEW HI GAIN ANT

(98+13)
ACQUISITION OF SIGNAL
ACQUIRE MSFN
PRO

-5 (98+30)
ACTIVATE COLOR TV
TAKE PHOTOS
INSPECT LM DURING LM 360 DEG
YAW

-15 (98+20)

LM STATION KEEPING

THC=LOCKED
RHC=LOCKED

-12 (98+23)

COPY DOI P76 PAD
COPY INITIAL PHASING P76 PAD
COPY INITIAL PDI ABORT P76 PAD
COPY NOMINAL BURN TIME PAD

(98+29)

RELOAD DAP

KEY V48E
F 04 46 (DAP CONFIGURATION)
LOAD
11112
01111
8
PRO
F 06 47 (CSM AND LM WT)
PRO
F 06 48 (SPS GMBL TRIM)
PRO
BMAG MODE(3)=RATE 2
KEY V46E
S/C CONT=CMC

P30 (98+30)
KEY V37E30E
F 06 33 (GET OF SEP)
LOAD GET OF SEPARATION
(98+55+44)
PRO

```
      F 06 81 (VG=LV)                                    -00+40
              LOAD (0,0,=2.5)
              PRO                                        -00+35
      F 06 42 (HA,HP,VG)
              VERIFY VG=2.5                              -00+30
              PRO
      F 16 45 (MKS,TFI,MGA)
              SET MDC ET TO TFI,COUNTING
                 DOWN                                    -00+25
              CONFIRM MGA LESS THAN 45 DEG
              PRO
      F 37 88

=3    (98+32)
           **RCS SEPARATION BURN SETUP**          0+00 (98+35+16)
    P41       KEY 41E                                F 16 85 (VG=BODY)
      F 50 18 (COMMANDED R,P,Y)                            SET MDC ET COUNTING UP
              PRO                                             FROM SEPARATION
        06 18 (COMMANDED R,P,Y)                            INCREASE VG=BODY FROM
              MONITOR ATT TRIM                                 (+2.5,0,0) TO (+5.0,0,0)
      F 50 18(COMMANDED R,P,Y)                                 BY THRUSTING AFT
              RHC=ARMED
              ALIGN S/C IN ROLL                    **************************************
              PRO                                        CSM PERFORMS SEPARATION BURN
        06 18 (COMMANDED R,P,Y)                             (0,0,=2.5)
              MONITOR ATT TRIM                              (0,90/14,0)
      F 50 18 (COMMANDED R,P,Y)                             WHEN BURN COMPLETE, VOICE
              KEY ENTER                                     CONFIRMATION TO LM
        06 85 (VG=BODY)                            **************************************
              MONITOR COMP ACTV LT
              BMAG MODE(3)=ATT 1/RATE 2
              RATE=LOW
              EMS FUNCTION=DV SET
              SET DV IND TO +2.5
              EMS FUNCTION=DV
                                                       MONITOR COMP ACTV LT=OUT
                                                       DSKY BLANKS
                                                 16 85 (VG=BODY) (AVG G ON)
                                                       COMP ACTV LT=2 SEC FLASH
                                                       EMS MODE=NORMAL
                                                       CK VG FOR HI PIPA BIAS
                                                          (LESS THAN 2.0 FPS PER 5
                                                          SEC)
                                                       THC=ARMED
```

EMS MODE=STBY
RECORD DV IND
EMS FUNCTION=OFF
RHC=LOCKED
THC=LOCKED
BMAG MODE(3)=RATE 2
AUTO RCS SEL A/C ROLL(4)=OFF
PRO

F 37 88

```
**************************************************
*                PROCEDURES FOR                  *
*           SEPARATION THRU PHASING              *
**************************************************


(98+39)
        **MANEUVER TO SXT TRACK ATTITUDE**

P20             KEY 20E
     F 50 18    (COMMANDED R,P,Y)
                PRO
       06 18    (COMMANDED R,P,Y)
                MONITOR AUTO MNVR
     F 50 18    (COMMANDED R,P,Y)
                   (0,142/54,0)
                KEY ENTER

                VHF ANT=RT
                EMS FUNCTION=VHF RNG
                EMS MODE=VHF RNG
                VHF AM A=OFF
                VHF AM B=DUPLEX
                VHF RCV ONLY=OFF
                VHF RANGING=RNG
                VHF RNG=RESET
                MONITOR EMS FOR RANGE

                KEY V83E
     F 16 54    (R,RDOT,THETA)
                COMPARE EMS AND V83 RANGE
                COMPARE LM RR RANGE AND
                   RANGE RATE WITH EMS
                   AND V83 RANGE AND RANGE
                   RATE
                PRO

                MOVE TO LEB

                PERFORM OPTICS CHECKS

                ZERO OPTICS=OFF
                ZERO OPTICS=ZERO(15 SEC)
                ZERO OPTICS=OFF
                MONITOR LM IN SCT AND SXT
                OPTICS MODE=MAN
(98+50)
                SUNDOWN

(98+55)
        **REALIGN IMU TO REFSMMAT**

                ADJUST RETICLE BRTNESS
P52             KEY V37E52E
     F 04 06    (ALIGN OPTION CODE)
                LOAD 00003 IN R2 FOR
                   REALIGN TO REFSMMAT
                PRO
     F 50 25    (00015, PERFORM STAR ACQ)
                OHC=MANEUVER SCT TO ACQ
                   TWO SUITABLE STARS
                   (ALTAIR=40,PEACOCK=42)
                PRO
     F 01 70    (STAR CODE)
                CHECK FIRST STAR CODE
                ZERO OPTICS=ZERO(15 SEC)
                ZERO OPTICS=OFF
```

```
        OPTICS MODE=CMC
        PRO
  06 92 (SHAFT,TRUN,BLANK)
        MONITOR OPT DRIVE TO STAR ONE
        IDENTIFY STAR ONE
        OPTICS MODE=MAN
F 51 BB (PLEASE MARK)
        CENTER FIRST STAR IN SXT
        MARK ON STAR ONE
F 50 25 (00016, TERMINATE MARK SEQ)
        PRO
F 01 71 (MARKED STAR CODE)
        PRO

F 01 70 (STAR CODE)
        CHECK SECOND STAR CODE
        ZERO OPTICS=ZERO (15SEC)
        ZERO OPTICS=OFF
        OPTICS MODE=CMC
        PRO
  06 92 (SHAFT,TRUN,BLANK)
        MONITOR OPT DRIVE TO STAR TWO
        IDENTIFY STAR TWO
        OPTICS MODE=MAN
F 51 BB (PLEASE MARK)
        CENTER SECOND STAR IN SXT
        MARK ON STAR TWO
F 50 25 (00016, TERMINATE MARK SEQ)
        PRO
F 01 71 (MARKED STAR CODE)
        PRO
F 06 05 (ANGLE DIFF)
        COPY DATA ON CHECKLIST
        PRO
F 06 93 (GYRO TORQ ANGLES)
        COPY DATA ON CHECKLIST
        PRO
F 50 25 (00014, PERFORM FINE ALIGN)
        PRO
F 50 25 (00015,PERFORM STAR ACQ)
        PRO
F 01 70 (STAR CODE)
        LOAD THIRD STAR CODE
           (RASALHAGUE=35)


        ZERO OPTICS=ZERO (15SEC)
        ZERO OPTICS=OFF
        OPTICS MODE=CMC
        PRO
  06 92 (SHAFT,TRUN,BLANK)
        MONITOR OPTICS DRIVE TO STAR
           THREE
        ZERO OPTICS=ZERO
P00     KEY V37E00E

        SET LEB ET COUNTING DOWN
           TO LM DOI TIGN

(99=03)
        MOVE TO CMD SEAT

     **ALIGN GDC TO IMU**

        KEY V16N20E
  16 20 (R,P,Y)
        ATT SET THUMBWHEELS TO N20
        FDAI SELECT=1
```

```
                NULL ATT ERROR NEEDLES          -9     (99+25)
                   ON FDAI 1 WITH ATT                                LOSS OF SIGNAL
                   SET THUMBWHEELS              -6     (99+28)
                FDAI SELECT-1/2                                 **MANEUVER TO SXT TRACK ATTITUDE**
                ATT SET-GDC
                DEPRESS GDC ALIGN PB.                  P20          KEY V37E20E
                ATT SET-IMU                                  F 50 18 (COMMANDED R,P,Y)
                KEY RELEASE                                          PRO
                                                               06 18 (COMMANDED R,P,Y)
          **ORDEAL VERIFICATION**                                    MOVE TO LEB DURING AUTO MNVR
                                                             F 50 18 (COMMANDED R,P,Y)
                KEY V83E                                                (0,206/332,0)
        F 16 54 (R,RDOT,THETA)                                       KEY ENTER
                SLEW/ADJUST FDAI TO THETA
                PRO                                                  ZERO OPTICS-OFF
                                                                     OPTICS MODE-CMC
-29   (99+05)
          **MCC-H UPLINK(CSM AND LM VECTOR)** -4     (99+30)
                                                                     VERIFY VHF AM A-SIMPLEX
                UP TLM(CM)(MDC)-ACCEPT                               VERIFY PCM BIT RATE-LOW
                MONITOR UPLINK ACT LT-ON                             VERIFY TAPE RCDR FWD-FWD
                MONITOR GND UPLINK              -2     (99+32)
                MONITOR UPLINK ACT LT-OFF              P76          KEY V37E76E
                UP TLM(CM)(MDC)-BLOCK                        F 06 84 (DV,S OF LM DOI BURN)
                CONFIRM COMP ACT LT-OFF                              LOAD (-71.1,0,-.3)
                                                                     PRO
                SET MDC ET COUNTING DOWN                     F 06 33 (GETI OF DOI)
                   TO LM DOI TIGN                                    LOAD LM DOI TIGN +20 SEC
                                                                        (99+34+19)
      (99+14)
                VHF AM A-SIMPLEX                0+00 (99+33+59)
                VHF AM B-OFF                                     ********************************
                VHF RCV ONLY-B DATA                                  LM DOI BURN
                VHF RANGING-OFF                                         (-71.1,0.0,-0.3)
                                                                 ********************************
```

```
            MOVE TO CMD SEAT
(99+36)
            VHF AM A-OFF
            VHF AM B-DUPLEX
            VHF RCV ONLY-OFF
            VHF RANGING-RNG
            VHF RANGING-RESET(NO VOICE 12
               SEC)
            COMPUTE RDOT FROM VHF RANGE
            CONFIRM LM BURN COMPLETE
            PRO/INCORPORATE P76
     F 37 BB
            KEY V82E
     F 04 06 (VEHICLE OPTION CODES)
               LOAD R2=00002
               PRO
     F 16 44 (HA,HP,TFF)
            PRO
     F 37 BB
(99+37)
            SUNUP
(99+38)
        **MANEUVER TO TRACK ATTITUDE**
P20         KEY 20E
            MOVE TO LEB
(99+41)
            ZERO OPTICS-ZERO(15 SEC)
            ZERO OPTICS-OFF
```

```
-63   (99+44)
                INITIATE LM TRACK
                SET LEB ET COUNTING DOWN
                   TO LM PHASING TIGN
                ZERO OPTICS-ZERO
                CEASE TRACKING
                MOVE TO CMD SEAT
-39   (100+07)
                FDAI SCALE-5/5
                RHC-ARMED
                ROLL 180 DEG AND PITCH UP 70
                   DEG AT 1 DEG/SEC
                   (180,278/268,0)
                FDAI SCALE-5/1
                RHC-LOCKED
P00             KEY V37E00E
                KEY V64E
     F 06 51 (RHO,GAMMA,BLANK)
                SLEW HI GAIN ANT
                PRO
(100+12)
                ACQUISITION OF SIGNAL
                ACQUIRE MSFN
(100+20)
                OBTAIN GO/NO GO FOR PDI ABORT
                MOVE TO LEB
                KEY V67E
     F 06 99 (POS,VEL ERR,OPTION CODE)
```

```
                LOAD WI
                    +002.89
                    +0017.3
                    +00001
                PRO
(100+25)
        **MANEUVER TO TRACK ATTITUDE**

P20             KEY V37E20E
     F 50 18 (COMMANDED R,P,Y)
                PRO
       06 18 (COMMANDED R,P,Y)
                MONITOR AUTO MANUEVER
     F 50 18 (COMMANDED R,P,Y)
                   (180,293/243,0)
                KEY ENTER
                ZERO OPTICS=OFF
                KEY V87E
                KEY V57E
     F 51 BB (PLEASE MARK)
                OPTICS MODE=MAN
                OHC=CENTER LM IN SXT
                MAKE 10 MARKS IN NEXT
                   10 MINUTES
                COMMENT ON LM VISIBILITY
                   DURING LM DESCENT AND
                   ASCENT. RECORD GET OF
                   VISUAL LOSS AND ACQ OF LM
-9   (100+37)
                PRO/PROCESS LAST MARK
                OPTICS MODE=CMC
                KEY V88E/TERMINATE VHF RNG

0+00 (100+46+21)

                ********************************
                    LM PHASING BURN
                       (170.4,0,-95.6)
                       (180,307/193,0)
                ********************************
(100+47)

                CONFIRM LM BURN COMPLETE

P76             KEY V37E76E
     F 06 84 (DV,S OF LM PHASING BURN)
                LOAD(170.4,0,-95.6)
                PRO
     F 06 33 (GETI OF PHASING BURN)
                LOAD LM PHASING TIGN
                   +32 SEC
                   (100+46+53)
                PRO
     F 37 BB
                KEY V82E
     F 04 06 (VEHICLE OPTION CODES)
                   LOAD R2=00002
                   PRO
     F 16 44 (HA,HP,TFF)
                PRO
     F 37 BB
```

```
**************************************************
*                PROCEDURES FOR                  *
*          PHASING THRU INSERTION                *
**************************************************



      (100+48)
            **MANEUVER TO TRACK ATTITUDE**

      P20             KEY 20E
      (100+49)
                      SUNDOWN
      (100+51)
                      KEY V87E
                      KEY V57E
           F 51 BB    (PLEASE MARK)
                      OPTICS MODE=MAN
                      OHC=CENTER LM IN SXT
                      MAKE 4 MARKS IN NEXT
                         3 MINUTES
      (100+54)
                      KEY V93E(REINITIALIZE W MAT)
                      MAKE 6 MARKS IN NEXT
                      7 MINUTES
      (101+01)
                      PRO/PROCESS LAST MARK
                      OPTICS MODE=CMC

      (101+05)
                      COPY INITIAL CSM BACKUP
                         INSERTION PAD
      (101+10)
                      COPY LM INSERTION P76 PAD
      (101+14)
                      KEY V57E
           F 51 BB    (PLEASE MARK)
                      OPTICS MODE=MAN
                      OHC=CENTER LM IN SXT
                      MAKE 10 MARKS IN NEXT
                         10 MINUTES
      (101+24)
                      PRO/PROCESS LAST MARK
                      KEY V88E/TERMINATE VHF RNG
                      ZERO OPTICS=ZERO
                      OPTICS MODE=CMC

                      MOVE TO CMD SEAT

                      LOSS OF SIGNAL
      (101+35)
                      SUNUP
      (101+40)
            **ALIGN GDC TO IMU**

                      KEY V16N20E
             16 20    (R,P,Y)
                      ATT SET THUMBWHEELS TO N20
                      FDAI SELECT=1
                      NULL ATT ERROR NEEDLES
                         ON FDAI 1 WITH ATT
                         SET THUMBWHEELS
                      FDAI SELECT=1/2
                      ATT SET=GDC
                      DEPRESS GDC ALIGN PB
                      ATT SET=IMU
```

```
          **ORDEAL VERIFICATION**
                KEY V83E
          F 16 54 (R,RDOT,THETA)
                SLEW/ADJUST FDAI TO THETA
                PRO

                MOVE TO LEB

-58   (101+48)
                SET LEB ET COUNTING DOWN
                   TO INSERTION USING LM
                   INSERTION TIGN +3 MIN AND
                   MISSION TIMER
-57   (101+49)
                ZERO OPTICS=OFF
                KEY V87E
                KEY V57E
          F 51 88 (PLEASE MARK)
                OPTICS MODE=MAN
                OHC=CENTER LM IN SXT
                MAKE 4 MARKS IN NEXT
                   3 MINUTES
-54   (101+52)
                KEY V93E(REINITIALIZE W MAT)
                TAKE 16 MARKS IN NEXT
                   17 MINUTES
-37   (102+09)
                PRO/PROCESS LAST MARK
                KEY V88E/TERMINATE VHF RNG
                ZERO OPTICS=ZERO
                OPTICS MODE=CMC

                MOVE TO CMD SEAT

      (102+11)
                ACQUISITION OF SIGNAL
                PITCH DOWN 50 DEG
                   (180,194/182,0)
-32   (102+14)
P00             KEY V37E00E
                KEY V64E
          F 06 51 (RHO GAMMA,BLANK)
                SLEW HI GAIN ANT
                ACQUIRE MSFN
                PRO

             **MCC-H UPLINK CSM VECTOR**
                UP TLM(CM)(MDC)=ACCEPT
                MONITOR UPLINK ACT LT=ON
                MONITOR GND UPLINK
                MONITOR UPLINK ACT LT=OFF
                UP TLM(CM)(MDC)=BLOCK

                COPY LM INSERTION P76 PAD
                   UPDATE AS REQUIRED
                COPY CSM BACKUP INSERTION PAD
                   UPDATE AS REQUIRED

                SET MDC ET COUNTING DOWN TO
                   INSERTION USING LM
                   INSERTION TIGN +3 MIN AND
                   MISSION TIMER

      (102+29)
             **ORDEAL VERIFICATION**

                KEY V83E
          F 16 54 (R,RDOT,THETA)
                SLEW/ADJUST FDAI TO THETA
                PRO
```

```
-16   (102+30)
          **TARGET CSM INSERTION BACKUP**

      P30          KEY V37E30E
           F 06 33 (GETI OF CSM INS BACKUP)
                   LOAD (102+46+18)
                   PRO
           F 06 81 (VG - LV)
                .  LOAD(175.4,0,-107.1)
                   PRO
           F 06 42 (HA,HP,VG)
                   PRO
           F 16 45 (MKS,TFI,MGA)
                   VERIFY ET=TFI
                   CONFIRM MGA LESS THAN 45 DEG
                   PRO                              -5
           F 37 BB

-14   (102+32)
          **MANEUVER TO INSERTION ATTITUDE**

      P40          KEY 40E
           F 50 18 (COMMANDED R,P,Y)
                   PRO
             06 18 (COMMANDED R,P,Y)
                   MONITOR ATT MNVR
           F 50 18 (COMMANDED R,P,Y)
                      (180,3/272,0)

-9    (102+37)

          **SETUP SPS INSERTION BACKUP**

               EMS MODE=STBY
               EMS FUNCTION=DV SET
               LOAD INSERTION BURN VC
               EMS FUNCTION=DV
               FDAI SCALE=5/5
               RATE=HIGH
               RHC PWR DIRECT(BOTH)=MNA/MNB
               BMAG MODE(3)=ATT1/RATE2
               SCS TVC(BOTH)=RATE CMD
               TVC GMBL DRIVE(BOTH)=AUTO
               AUTO RCS SEL A/C ROLL(4)=MNA
               RHC=ARMED

               ALIGN S/C TO 180 DEG ROLL
               PRO
             06 18 (COMMANDED R,P,Y)
               MONITOR ATT TRIM
           F 50 18 (COMMANDED R,P,Y)

          **GDC ALIGN**

               ATT SET THUMBWHEELS TO N18
               FDAI SELECT=1
               NULL ATT ERROR NEEDLES
                  ON FDAI 1 WITH ATT
                  SET THUMBWHEELS
               FDAI SELECT=1/2
               ATT SET=GDC
               GDC ALIGN PB=PUSH
               ATT SET=IMU

               KEY ENTER
           F 50 25 (00204, GMBL DRIVE TEST)
```

```
-3    (102+43+18)
                MONITOR LM ENGINE IGNITION

            ************************************
                LM INSERTION BURN
                   (-189.2,0.1,-83.9)
            ************************************************************
                                                                        *
*************************************************************           *
*           ****************************                    *           *
*           IF LM CANNOT PERFORM THE BURN                   *           *
*           (USE ZERO INSERTION CHECKLIST)                  *           *
*           (FOR PARTIAL LM INSERTION GO TO                 *           *
*           PARTIAL INSERTION CHECKLIST FOR                 *           *
*           RESCUE 2 BURN AT 103+32)                        *           *
*           ****************************                    *           *
*                MN BUS TIE(BOTH)-ON                        *           *
*                NONESS BUS-MNA                             *           *
*                SPS HE VLV TB (BOTH)-BP                    *           *
*                SPS HE VLV (BOTH)-AUTO                     *           *
*                VERIFY SPS TH LT-OFF                       *           *
*                GMBL MTRS(4)-ON(SEQUENTIALLY)              *           *
*                TVC SERVO PWR 1-AC1/MNA                    *           *
*                TVC SERVO PWR 2-AC2/MNB                    *           *
*                KEY ENTER                                  *           *
*           06 40 (TFI,VG,DV)                               *           *
*                DV THRUST A-NORMAL                         *           *
*                THC-ARMED                                  *           *
*-00+35                                                      *           *
*                DSKY BLANKS                                *           *
*-00+30                                                      *           *
*           06 40 (TFI,VG,DV) (AVE G ON)                    *           *
*                EMS MODE-NORMAL                            *           *
*-00+15                                                      *           *
*                THC-APPLY ULLAGE                           *           *
*-00+05                                                      *           *
*                F 99 40 (TFI,VG,DV)                        *           *
*                        PRO                                *           *
*                                                           *           *
*00+00(102+46+18)                                           *           *
*                ****************************               *           *
*                CSM BACKUP INSERTION BURN                  *           *
*                        (175.4,0,-107.1)                   *           *
*                        (180,32/272,0)                     *           *
*                ****************************               *           *
*                                                           *           *
*+00+01                                                     *           *
*                  06 40 (TFC,VG,DV)                        *           *
*                        THC-TERMINATE ULLAGE               *           *
*                        MONITOR SPS BURN                   *           *
*                F 16 40 (TFC,VG,DV)                        *           *
*                        DV THRUST A-OFF                    *           *
*                        GMBL MTRS(4)-OFF/SEQUENTIALLY      *           *
*                        PRO                                *           *
*                F 16 85 (VG-BODY)                          *           *
*                        THC-NULL VGS                       *           *
*                        THC-LOCKED                         *           *
*                        EMS MODE-STBY                      *           *
*                        TVC SERVO PWR(BOTH)-OFF            *           *
*                        SPS HE VLV (BOTH)-OFF              *           *
*                        MN BUS TIE(BOTH)-OFF               *           *
*                        NONESS BUS-OFF                     *           *
*                        PRO                                *           *
*                F 37 BB                                    *           *
*                        (CONTINUE DETAILED PROCEDURES      *           *
*                        BUT DELETE P76)                    *           *
*************************************************************           *
                                                                        *
```

```
          CONFIRM LM BURN COMPLETE

P76       KEY V37E76E
     F 06 84 (DV,S OF LM INSERTION BURN)

          RHC=LOCKED
          THC=LOCKED
          AUTO RCS SEL, A/C ROLL (4)=OFF
          EMS FUNCTION=VHF RNG
          EMS MODE=VHF RNG
          VHF RNG=RESET
          FDAI SCALE=5/1
          RATE=LOW
          ROT CONT PWR DIRECT (BOTH)=OFF
          BMAG MODE(3)=RATE2
          TVC GIMBAL DRIVE(BOTH)=1

          LOAD (=189.2,0,=83.9)
          PRO
     F 06 33 (GETI OF INSERTION BURN)
          LOAD LM INSERTION TIGN
             +8 SEC
           (102+43+18)
          PRO
     F 37 BB

          KEY V82E
     F 04 06 (VEHICLE OPTION CODES)
             LOAD R2=00002
             PRO
     F 16 44 (HA,HP,TFF)
          PRO
     F 37 BB
```

```
**************************************************
*                PROCEDURES FOR                  *
*              INSERTION THRU CSI                *
**************************************************


(102*47)
                SUNDOWN
                MOVE TO LEB
                SET LEB ET COUNTING DOWN TO
                   CSI USING LM CSI TIGN
                   AND MISSION TIMER

          **REALIGN IMU TO REFSMMAT**
P52             KEY 52E
                ADJUST RETICLE BRTNESS
      F 04 06   (ALIGN OPTION CODE)
                LOAD 00003 IN R2 FOR
                   REALIGN TO REFSMMAT
                PRO
      F 50 25   (00015, PERFORM STAR ACQ)
                OMC=MANEUVER SCT TO ACQ
                   TWO SUITABLE STARS
                   (ALTAIR=40,FOMALHAUT=45)
                PRO
      F 01 70   (STAR CODE)
                CHECK FIRST STAR CODE
                ZERO OPTICS=OFF
                PRO
        06 92   (SHAFT,TRUN,BLANK)
                MONITOR OPT DRIVE TO STAR ONE
                IDENTIFY STAR ONE
                OPTICS MODE=MAN
      F 51 BB   (PLEASE MARK)
                CENTER FIRST STAR IN SXT
                MARK ON STAR ONE
      F 50 25   (00016, TERMINATE MARK SEQ)
                PRO
      F 01 71   (MARKED STAR CODE)
                PRO

      F 01 70   (STAR CODE)
                CHECK SECOND STAR CODE
                ZERO OPTICS=ZERO (15SEC)
                ZERO OPTICS=OFF
                OPTICS MODE=CMC
                PRO
        06 92   (SHAFT,TRUN,BLANK)
                MONITOR OPT DRIVE TO STAR TWO
                IDENTIFY STAR TWO
                OPTICS MODE=MAN
      F 51 BB   (PLEASE MARK)
                CENTER SECOND STAR IN SXT
                MARK ON STAR TWO
      F 50 25   (00016, TERMINATE MARK SEQ)
                PRO
      F 01 71   (MARKED STAR CODE)
                PRO
      F 06 05   (ANGLE DIFF)
                COPY DATA ON CHECKLIST
                PRO
      F 06 93   (GYRO TORQ ANGLES)
                COPY DATA ON CHECKLIST
                PRO
      F 50 25   (00014, PERFORM FINE ALIGN)
                PRO
      F 50 25   (00015,PERFORM STAR ACQ)
                PRO
```

```
     F 01 70 (STAR CODE)
             LOAD THIRD STAR CODE
                (RASALHAGUE=35)


             ZERO OPTICS=ZERO (15SEC)
             ZERO OPTICS=OFF
             OPTICS MODE=CMC
             PRO
       06 92 (SHAFT,TRUN,BLANK)
             MONITOR OPTICS DRIVE TO STAR
                THREE
             ZERO OPTICS=ZERO

(102*52)
P00          KEY V37E00E

         **LM STATE VECTOR UPLINK**

             UP TLM(CM)(MDC)=ACCEPT
             MONITOR UPLINK ACT LT=ON
             MONITOR GND UPLINK
             MONITOR UPLINK ACT LT=OFF
             UP TLM(CM)(MDC)=BLOCK

(102*56)
         **MANEUVER TO TRACK ATTITUDE**

P20          KEY V37E20E
     F 50 18 (COMMANDED R,P,Y)
             PRO
       06 18 (COMMANDED R,P,Y)
             MONITOR AUTO MNVR
     F 50 18 (COMMANDED R,P,Y)
                (180,162/13,0)
             KEY ENTER
             ZERO OPTICS=OFF
(102*59)
             COPY LM CSI AND TPI TIGNS

P32          KEY V37E32E
     F 06 11 (GETI=CSI)
             LOAD LM CSI TIGN
                (103*33*46)
             PRO
     F 06 55 (N,E,CENTANG)
             LOAD R2=*208.30
             LOAD R3=130.00
             PRO
     F 06 37 (GETI=TPI)
             LOAD LM TPI TIGN
                (105*09*00)
             PRO
     F 16 45 (MKS,TFI=CSI,=00001)
             SET LEB ET=TFI
             KEY V32E
     F 06 75 (DH,DT=CSI/CDH,DT=CDH/TPI)
             PRO
     F 06 81 (CSI VG=LV)
             PRO
     F 06 82 (CDH VG=LV)
             PRO
     F 16 45 (MKS,TFI=CSI,=00001)

=32  (103*02)
             KEY V93/REINITIALIZE W MATRIX
             KEY V87E (VHF RANGING)
             KEY V57E
     F 51 88 (PLEASE MARK)
             OPTICS MODE=MAN
             OHC=CENTER LM IN SXT
```

```
                    MAKE 6 MARKS IN NEXT
                       5 MINUTES
-27   (103+07)
                    PRO/PROCESS LAST MARK
          F 16 45   (MKS,TFI=CSI,=00001)
                    ZERO OPTICS=ZERO
                    OPTICS MODE=CMC

                    MOVE TO CMD SEAT

-22   (103+12)
                    KEY V90E
          F 04 12   (VEHICLE OPTION)
                    LOAD R2=00002
                    PRO
          F 06 16   (TIME OF EVENT)
                    LOAD LM CSI TIGN
                       (103+33+46)
                    PRO
          F 06 90   (Y,YDOT,PSI)
                    VOICE LM YDOT TO LM
                    PRO
          F 16 45   (MKS,TFI=CSI,=00001)

                    KEY V90E
          F 04 12   (VEHICLE OPTION)
                    LOAD R2=00001
                    PRO
          F 06 16   (TIME OF EVENT)
                    LOAD CSM CSI TIGN
                       (103+33+46)
                    PRO
          F 06 90   (Y,YDOT,PSI)
                    COPY (=)CSM YDOT
                       ON CHECKLIST
          F 16 45   (MKS,TFI=CSI,=00001)
   (103+23)
                    LOSS OF SIGNAL
-9    (103+25)
                    PRO/MAKE FINAL PASS
          F 06 75   (DH,DT=CSI/CDH,DT=CDH/TPI)
                    COPY DATA ON CHECKLIST
                    PRO
          F 06 81   (CSI VG=LV)
                    OVERWRITE N81 VGY WITH
                       (=) CSM YDOT
                    COPY DATA ON CHECKLIST
                    PRO
          F 06 82   (CDH VG=LV)
                    COPY DATA ON CHECKLIST
                    PRO
          F 16 45   (MKS,TFI=CSI,MGA)
                    SET MDC ET=TFI
                    PRO
          F 37 88
   (103+28)
                    COPY LM CSI PAD (P76)
   (103+29)
   P40              KEY 40E
          F 50 18   (COMMANDED R,P,Y)
                    KEY V56E
                    PRO
            06 18   (COMMANDED R,P,Y)
                    MONITOR MANEUVER
          F 50 18   (COMMANDED R,P,Y)
                       (180,166/277,0)
-4    (103+30)
                 **SETUP SPS CSI BACKUP**

                    EMS MODE=STBY
                    EMS FUNCTION=DV SET
                    LOAD CSI BURN VC
```

```
                EMS FUNCTION-DV                  -00+35
                FDAI SCALE-5/5                                  DSKY BLANKS
                RATE-HIGH                        -00+30
                RHC PWR DIRECT(BOTH)-MNA/MNB                 06 40 (TFI,VG,DV) (AVE G ON)
                BMAG MODE(3)-ATT 1/RATE 2                       EMS MODE-NORMAL
                TVC GMBL DRIVE(BOTH)-AUTO        -00+05
                AUTO RCS SEL A/C ROLL (4)-MNA              F 99 40 (TFI,VG,DV)
                RHC-ARMED                        00+00 (103+33+46)
                                                                MONITOR LM ENGINE IGNITION
                ALIGN S/C TO 180 DEG ROLL
                PRO                                          ********************************
          06 18 (COMMANDED R,P,Y)                                LM CSI BURN
                MONITOR ATT TRIM                                    (50.5,0,0)
        F 50 18 (COMMANDED R,P,Y)                            ********************************
-3
             **GDC ALIGN**                       ***********************************************
                                                 *            ***************************      *
                ATT SET THUMBWHEELS TO N18       *            IF LM CANNOT PERFORM THE BURN    *
                FDAI SELECT-1                    *            ***************************      *
                NULL ATT ERROR NEEDLES           *                MN BUS TIE (2)-ON(UP)        *
                   ON FDAI 1 WITH ATT            *                NONESS BUS-MNA               *
                   SET THUMBWHEELS               *                SPS HE VLV TB (BOTH)-BP      *
                FDAI SELECT-1/2                  *                SPS HE VLV (BOTH)-AUTO       *
                ATT SET-GDC                      *                VERIFY SPS TH LT-OFF         *
                GDC ALIGN PB-PUSH                *-00+15                                       *
                ATT SET-IMU                      *                THC-APPLY ULLAGE             *
                                                 *                GMBL MTRS(4)-ON(SEQUENTIALLY)*
                KEY ENTER                        *                TVC SERVO PWR 1-AC1/MNA      *
        F 50 25 (00204, GMBL DRIVE TEST)         *                TVC SERVO PWR 2-AC2/MNB      *
   (103+33)                                      *                PRO                          *
                SUNUP                            *                                             *
-2                                               *            ***************************      *
                KEY ENTER                        *                CSM BACKUP CSI BURN          *
          06 40 (TFI,VG,DV)                      *                   (52.2,0,0)                *
                DV THRUST A-NORMAL               *                   (180,180/277,0)           *
                THC-ARMED                        *            ***************************      *
```

```
*                                                  *                    ROT CONT PWR DIRECT (BOTH)-OFF
*+00+01                                            *                    BMAG MODE(3)-RATE 2
*            06 40 (TFC,VG,DV)                     *                    TVC GIMBAL DRIVE(BOTH)-1
*                  THC-TERMINATE ULLAGE            *       (103+37)
*                  MONITOR SPS BURN                *                    LOAD(50.5,0,0)
*          F 16 40 (TFC,VG,DV)                     *                    PRO
*                  DV THRUST A-OFF                 *            F 06 33 (GETI OF CSI BURN)
*                  GMBL MTRS(4)-OFF/SEQUENTIALLY*                       LOAD LM CSI TIGN
*                  PRO                             *                       +16 SEC
*          F 16 85 (VG-BODY)                       *                       (103+33+46)
*                  THC-NULL VGS                    *                    PRO
*                  THC-LOCKED                      *            F 37 BB
*                  TVC SERVO PWR(BOTH)-OFF         *
*                  EMS MODE-STBY                   *                    KEY V82E
*                  SPS HE VLV (BOTH)-OFF           *            F 04 06 (VEHICLE OPTION CODES)
*                  MN BUS TIE (BOTH)-OFF           *                       LOAD R2=00002
*                  NONESS BUS-OFF                  *                       PRO
*                  PRO                             *            F 16 44 (HA,HP,TFF)
*          F 37 BB                                 *                    PRO
*                  (CONTINUE DETAILED PROCEDURES*            F 37 BB
*                  BUT DELETE P76)                 *
*****************************************************

                   CONFIRM LM BURN COMPLETE

      P76          KEY V37E76E
           F 06 84 (DV,S OF CSI BURN)

                   RHC-LOCKED
                   THC-LOCKED
                   AUTO RCS SEL, A/C ROLL (4)-OFF
                   EMS FUNCTION-VHF RNG
                   EMS MODE-VHF RNG
                   VHF RNG-RESET
                   FDAI SCALE-5/1
                   RATE-LOW
```

```
**************************************************
*                PROCEDURES FOR                  *
*                 CSI THRU CDH                   *
**************************************************


(103+38)
        **MANEUVER TO TRACK ATTITUDE**

P20             KEY 20E
     F 50 18 (COMMANDED R,P,Y)
             PRO
       06 18 (COMMANDED R,P,Y)
             MOVE TO LER DURING
             AUTO MANEUVER
     F 50 18 (COMMANDED R,P,Y)
                (180,155/239,0)
             KEY ENTER

             SET LEB ET COUNTING DOWN TO
                CDH USING  LM CDH TIGN
                AND MISSION TIMER

             ZERO OPTICS=OFF

(103+41)
             KEY V87E (VHF TRACKING)
             KEY V57E
     F 51 88 (PLEASE MARK)
             OPTICS MODE=MAN
             OHC=CENTER LM IN SXT
             MAKE 3 MARKS IN NEXT
                2 MINUTES
(103+43)
             PRO/PROCESS LAST MARK
             KEY V67E
     F 06 99 (POS ERR,VEL ERR,OPTION CODE)
             LOAD WR
                (000.57,0003.4,00001)
             PRO
(103+44)
             KEY V57E
     F 51 88 (PLEASE MARK)
             MAKE 11 MARKS IN NEXT
                11 MINUTES
(103+55)
             PRO/PROCESS LAST MARK
             OPTICS MODE=CMC

             OBTAIN LM PC TIGN

             KEY V90E
     F 04 12 (VEHICLE OPTION)
             LOAD R2=00002
             PRO
     F 06 16 (TIME OF EVENT)
             LOAD LM PC TIGN
                (104+02+00)
             PRO
     F 06 90 (Y, YDOT, PSI)
             VOICE LM YDOT TO LM
             PRO


             COPY LM PC PAD
(103+57)
             KEY V57E
     F 51 88 (PLEASE MARK)
             OPTICS MODE=MAN
```

```
                OHC=CENTER LM IN SXT
                MAKE 5 MARKS IN NEXT
                   5 MINUTES
-30   (104+02+00)
                PRO/PROCESS LAST MARK
                OPTICS MODE=CMC

             ************************************
             LM PLANE CHANGE(0,0,0)
             ************************************

P76             KEY V37E76E
     F 06 84 (DV,S OF LM PC BURN)
                LOAD LM PLANE CHANGE DV,S
                PRO
     F 06 33 (GETI OF PC BURN)
                LOAD GETI=PC BURN
                   (104+02+00)

                CONFIRM LM PC BURN

                PRO/INCORPORATE P76
     F 37 BB
(104+05)
P33             KEY 33E
     F 06 13 (GETI=CDH)
                OBTAIN LM CDH TIGN
                LOAD LM CDH TIGN
                   (104+31+42)
                COPY DATA ON CHECKLIST
                PRO
     F 16 45 (MKS,TFI=CDH,=00001)
                KEY V32E
     F 06 75 (DH,DT_CDH/TPI,DT=TPI/TPI)
                PRO
     F 06 81 (CDH VG=LV)
                PRO
     F 16 45 (MKS,TFI=CDH,=00001)
                VERIFY ET=TFI
-24   (104+08)
                KEY V87E (VHF RANGING)
                KEY V57E
     F 51 BB (PLEASE MARK)
                OPTICS MODE=MAN
                OHC=CENTER LM IN SXT
                TAKE 4 MARKS IN NEXT
                   3 MINUTES
                KEY V93E (REINITIALIZE W MAT)
                TAKE 8 MARKS IN NEXT
                   9 MINUTES
                PRO / PROCESS LAST MARK
     F 16 45 (MKS,TFI,=00001)
                ZERO OPTICS=ZERO
                OPTICS MODE=CMC
   (104+09)
                ACQUISITION OF SIGNAL
-12   (104+20)
                KEY V90E
     F 04 12 (VEHICLE OPTION)
                LOAD R2=00002
                PRO
     F 06 16 (TIME OF EVENT)
                LOAD LM CDH TIGN
                   (104+31+42)
                PRO
     F 06 90 (Y,YDOT,PSI)
                VOICE LM YDOT TO LM
                PRO
     F 16 45 (MKS,TFI=CDH,=00001)
```

```
                MOVE TO CMD SEAT
      (104+22)
                FDAI SCALE=5/5
                RHC=ARMED
                ROLL 180 DEG AT 2 DEG/SEC
                   (0,167/1.08,0)
                RHC=LOCKED
                FDAI SCALE=5/1
                ACQUIRE MSFN
                (RHO=-50,GAMMA=183)
-7    (104+25)
                PRO/MAKE FINAL PASS
          F 06 75 (DH,DT=CDH/TPI,DT=TPI/TPI)
                COPY DATA ON CHECKLIST
                PRO
          F 06 81 (CDH VG=LV)
                KEY V90E
          F 04 12 (VEHICLE OPTION)
                LOAD R2=00001
                PRO
          F 06 16 (TIME OF EVENT)
                LOAD LM CDH TIGN
                   (104+31+42)
                PRO
          F 06 90 (Y,YDOT,PSI)
                COPY (-) CSM YDOT ON CHECKLIST
                PRO
          F 06 81 (CDH VG=LV).
                OVER WRITE N81 WITH
                   (-) CSM YDOT
                COPY DATA ON CHECKLIST
                PRO
          F 16 45 (MKS,TFI=CDH,MGA)
                SET MDC ET=TFI
                PRO
          F 37 88
```

```
      (104+28)
                COPY LM CDH P76 PAD
-3    (104+29)
      P41       KEY 41E
          F 50 18 (COMMANDED R,P,Y)
                KEY V56E
                KEY ENTER(BYPASS MNVR)
            06 85 (VG=BODY)
-2    (104+30)
                **SETUP RCS CDH BACKUP**
                   BMAG MODE(3)=ATT1/RATE2
                   AUTO RCS SEL A/C ROLL(4)=MNA
      (104+31)
                **ALIGN GDC TO IMU**
                KEY V16N20E
            16 20 (R,P,Y)
                ATT SET THUMBWHEELS TO N20
                FDAI SELECT=1
                NULL ATT ERROR NEEDLES
                   ON FDAI 1 WITH ATT
                   SET THUMBWHEELS
                FDAI SELECT=1/2
                ATT SET=GDC
                DEPRESS GDC ALIGN PB
                ATT SET=IMU
                KEY RELEASE
-00+35
                DSKY BLANKS
-00+30
            16 85 (VG=BODY) (AVE G ON)
                THC=ARMED
                RHC=ARMED
                EMS MODE=NORMAL
```

```
0+00  (104+31+42)
          F 16 85 (VG-BODY)
                  MONITOR LM IGNITION

              ************************************
                  LM CDH BURN(-0.8,0,3.3)
              ************************************

*************************************************
*             ****************************      *
*             IF LM CANNOT PERFORM THE BURN     *
*             ****************************      *
*             ****************************      *
*             CSM BACKUP CDH BURN               *
*                (-.6,0,-5.0)                   *
*                (0,188/108,0)                  *
*             ****************************      *
*                  THC-NULL VGS                 *
*                  THC-LOCKED                   *
*                  PRO                          *
*          F 37 BB                              *
*                  (CONTINUE DETAILED PROCEDURES*
*                  BUT DELETE P76               *
*************************************************

                  CONFIRM LM BURN COMPLETE

                  PRO(TO BYPASS CSM-CDH BURN)
          F 37 BB
                  RHC-LOCKED
                  AUTO RCS SEL A/C ROLL(4)-OFF
                  BMAG MODE (3)-RATE 2
```

```
P76               KEY 76E
      F 06 84 (DV,S OF LM CDH BURN)
              LOAD LM CDH DV,S
              LOAD (-0.5,0,+5.8)
              PRO
      F 06 33 (GETI OF CDH BURN)
              LOAD LM CDH GETI
                 (104+31+42)
              PRO
      F 37 BB
```

```
**************************************************
*                PROCEDURES FOR                  *
*                 CDH THRU TPI                   *
**************************************************

-35   (104+34)

          **TARGET CSM TPI BACKUP**
     P20          KEY 20E
          F 50 18 (COMMANDED R,P,Y)
                  PRO
            06 18 (COMMANDED R,P,Y)
                  MOVE TO LEB DURING
                     AUTO MANEUVER
          F 50 18 (COMMANDED R,P,Y)
                     (0,229/137,0)
                  KEY ENTER

     P34          KEY V37E34E
          F 06 37 (GETI=TPI)
                  LOAD TPI TIGN(105+09+00)
                  PRO
          F 06 55 (BLANK,ELANG,CENTANG)
                  LOAD R2 = +208,30(DEG)
                  LOAD R3 = +130,00 (DEG)
                  PRO
          F 16 45 (MKS,TFI,=00001)
                  SET LEB ET TO TFI
                    COUNTING DOWN
-31   (104+38)
                  ZERO OPTICS=OFF
                  KEY V87E (VHF RANGING)
                  KEY V57E
          F 51 BB (PLEASE MARK)
                  KEY V16N45E
          F 16 45 (MKS,TFI,=00001)
                  KEY RELEASE
          F 51 BB (PLEASE MARK)
                  OPTICS MODE=MAN
                  OHC=CENTER LM IN SXT
                  MAKE 4 MARKS IN NEXT
                     3 MINUTES (INCORPORATE 4)
                  OPTICS MODE=CMC
-28   (104+41)
                  KEY V32E
          F 06 37 (GETI=TPI)
                  COPY DATA ON CHECKLIST
                  PRO
          F 06 58 (HP,DVTPI,DVTPF)
                  COPY DATA ON CHECKLIST
                  PRO
          F 06 59 (VG=LOS)
                  COPY DATA ON CHECKLIST
                  PRO
          F 16 45 (MKS,TFI,=00001)

                  KEY V93E(REINITIALIZE W MAT)
                  KEY V57E
          F 51 BB (PLEASE MARK)
                  OPTICS MODE=MANUAL
                  OHC=CENTER LM IN SXT
                  TAKE 14 MARKS IN NEXT
                     14 MINUTES
     (104+45)
                  SUNDOWN
-19   (104+50)
                  COPY LM TPI TIGN ON CHECKLIST
-13   (104+56)
                  PRO/PROCESS LAST MARK
          F 16 45 (MKS,TFI,=00001)
                  ZERO OPTICS=ZERO
                  OPTICS MODE=CMC
```

```
                MOVE TO CMD SEAT

            **VERIFY ORDEAL**

                KEY V83E
          F 16 54 (R,RDOT,THETA)
                SLEW/ADJUST FDAI TO THETA
                PRO
          F 16 45 (MKS,TFI,-00001)
-11  (104+58)
                KEY V37E34E
          F 06 37 (TPI TIGN)
                LOAD LM TPI TIGN
                   (105+09+00)
                PRO
          F 06 55 (BLNK,ELANG,CENTANG)
                LOAD R2 = +000.00
                PRO
          F 16 45 (MKS,TFI,-00001)
                PRO/MAKE FINAL PASS
          F 06 55 (BLNK,ELANG,CENTANG)
                COPY DATA ON CHECKLIST
                PRO
          F 06 58 (HP,DVTPI,DVTPF)
                COPY DATA ON CHECKLIST
                PRO
          F 06 81 (VG-LV)
                COPY DATA ON CHECKLIST
                PRO
          F 06 59 (VG-LOS)
                COPY DATA ON CHECKLIST
                PRO
          F 16 45 (MKS,TFI,MGA)
                RESET MDC ET WITH TFI
                PRO
          F 37 88
-7   (105+02)
            **MANEUVER TO TPI BACKUP ATTITUDE**

     P40        KEY 40E
          F 50 18 (COMMANDED R,P,Y)
                KEY V56E
                PRO
            06 18 (COMMANDED R,P,Y)
                MONITOR ATT MNVR
          F 50 18 (COMMANDED R,P,Y)
                   (0,192/15,0)

                COPY LM TPI PAD(P76)
-5   (105+04)
            **SETUP SPS TPI BACKUP**

                EMS MODE-STBY
                EMS FUNCTION-DV SET
                LOAD INSERTION BURN VC
                EMS FUNCTION-DV
                FDAI SCALE-5/5
                RATE-HIGH
                RHC PWR DIRECT(BOTH)-MNA/MNB
                BMAG MODE (3)-ATT1/RATE2
                TVC GMBL DRIVE(BOTH)-AUTO
                AUTO RCS SEL A/C ROLL (4)-MNA
                RHC-ARMED
                ALIGN S/C TO ZERO ROLL
                PRO
            06 18 (COMMANDED R,P,Y)
                MONITOR ATT TRIM
          F 50 18 (COMMANDED R,P,Y)
```

```
-3
                **GDC ALIGN**

                    ATT SET THUMBWHEELS TO N18
                    FDAI SELECT=1
                    NULL ATT ERROR NEEDLES
                       ON FDAI 1 WITH ATT
                       SET THUMBWHEELS
                    FDAI SELECT=1/2
                    ATT SET=GDC
                    DEPRESS GDC ALIGN PB
                    ATT SET=IMU

                    KEY ENTER
              F 50 25 (00204, GMBL DRIVE TEST)
                    KEY ENTER
                06 40 (TFI,VG,DV)
                    DV THRUST A=NORMAL
                    THC=ARMED
-00+35
                    DSKY BLANKS
-00+30
                06 40 (TFI,VG,DV) (AVE G ON)
                    EMS MODE=NORMAL
-00+05
              F 99 40 (TFI,VG,DV)

        (105+09+00)

                    MONITOR LM ENGINE IGNITION

                 ************************************
                    LM TPI BURN(22.0,0-12.1)
                 ************************************
```

```
                 ****************************
                 IF LM CANNOT PERFORM THE BURN
                 ****************************
                    MN BUS TIE (2)=O(UP)
                    NONESS BUS=MNA
                    SPS HE VLV (BOTH)=AUTO
                    SPS HE VLV TB (BOTH)=BP
                    VERIFY SPS TH LT=OFF
-00+15
                    THC=APPLY ULLAGE
                    GMBL MTRS(4)=ON(SEQUENTIALLY)
                    TVC SERVO PWR 1=AC1/MNA
                    TVC SERVO PWR 2=AC2/MNB
                    PRO
  0+00
                 ****************************
                    CSM TPI BACKUP BURN
                       (=21,B,0,11.6)
                       (0,208/15,0)
                 ****************************

-00+01
                06 40 (TFC,VG,DV)
                    THC=TERMINATE ULLAGE
                    MONITOR SPS BURN
              F 16 40 (TFC,VG,DV)
                    DV THRUST A=OFF
                    GMBL MTRS(4)=OFF/SEQUENTIALLY
                    PRO
              F 16 85 (VG=BODY)
                    THC=NULL VGS
                    THC=LOCKED
                    EMS MODE=STBY
                    TVC SERVO PWR(BOTH)=OFF
                    SPS HE VLV (BOTH)=OFF
                    MN BUS TIE (BOTH)=OFF
```

```
*                   NONESS BUS-OFF                  *
*                   PRO                             *
*          F 37 BB                                  *
*                   (CONTINUE DETAIL PROCEDURES     *
*                   BUT DELETE P76)                 *
*****************************************************

                    CONFIRM LM BURN COMPLETE

      P76           KEY V37E76E
          F 06 84   (DV,S OF LM TPI BURN)
                    RHC-LOCKED
                    THC-LOCKED
                    FDAI SCALE-5/1
                    RATE-LOW
                    ROT CONT PWR DIRECT (BOTH)-OFF
                    BMAG MODE (3)-RATE 2
                    TVC GIMBAL DRIVE(BOTH)-OFF
                    AUTO RCS SEL A/C ROLL(4)-OFF
                    EMS FUNCTION-VHF RNG
                    EMS MODE-VHF RNG
                    VHF RNG-RESET

                    LOAD (22.2,0-12.1)
                    PRO
          F 06 33   (GETI OF TPI BURN)
                    LOAD LM GET-TPI
                       +8 SEC
                       (105+09+08)
                    PRO
          F 37 BB
```

```
**********************************************
*                PROCEDURES FOR              *
*                 TPI THRU TPF               *
**********************************************

*2
          **MANEUVER TO SXT TRACK**

     P20          KEY 20E
          F 50 18 (COMMANDED R,P,Y)
                  PRO
            06 18 (COMMANDED R,P,Y)
                  MOVE TO LEB DURING AUTO
                     MANEUVER
          F 50 18 (COMMANDED R,P,Y)
                     (0,247/48,0)
                  KEY ENTER

          **TARGET CSM MCC1 BACKUP**

     P35          KEY V37E35E
          F 16 45 (MKS,TFI,-00001)
                     (TIME FROM TPI)
                  SET LEB ET TO TFI,
                     COUNTING UP
                  ZERO OPTICS-OFF
*3
                  KEY V93E (REINITIALIZE W MAT)
                  KEY V87E (VHF RANGING)
                  KEY V57E
          F 51 BB (PLEASE MARK)
                  KEY V16N45E
          F 16 45 (MKS,TFI,-00001)
                  OPTICS MODE-MAN

                                                  OHC-CENTER LM IN SXT
                                                  MAKE 8 MARKS IN NEXT
                                                     8 MINUTES
+11    (105+20)
                                                  PRO/PROCESS LAST MARK
                                        F 16 45 (MKS,TFI,-00001)
                                                  ZERO OPTICS-ZERO
                                                  OPTICS MODE-CMC

                                                  MOVE TO COMMAND SEAT

+12+00(TIGN-3.0 MIN)
                                                  LOSS OF SIGNAL

                                                  PRO/MAKE FINAL PASS
                                        F 06 81 (VG-LV)
                                                  COPY DATA ON CHECKLIST
                                                  PRO
                                        F 06 59 (VG-LOS)
                                                  COPY DATA ON CHECKLIST
                                                  PRO
                                        F 16 45 (MKS,TFI,MGA)
                                                  PRO
                                        F 37 BB

                                                  COPY LM MCC1 PAD (P76)

+13+30
                                           P41    KEY 41E
                                        F 50 18 (COMMANDED R,P,Y)
                                                  KEY ENTER(BYPASS MNVR)
                                          06 85 (VG-BODY)

                                              **SET UP MCC1 BACKUP**
+14+25
                                                  DSKY BLANKS
```

```
+14+30
          16 85 (VG=BODY)(AVE G ON)
                THC=ARMED
                RHC=ARMED
+15   (105+24+00)
          F 16 85 (VG=BODY)
                ************************************
                     LM PERFORMS MCC1 BURN
                ************************************

                ************************************
                     CSM MCC1 BACKUP BURN
                        (0,265/29,0)
                ************************************

                     CONFIRM LM BURN COMPLETE

                     PRO (TO BYPASS CSM=MCC1 BURN)
          F 37 BB
                     THC=LOCKED
                     RHC=LOCKED
     P76             KEY 76E
          F 06 84 (DV,S OF LM MCC1 BURN)
                     LOAD LM MCC1 DV,S
                     PRO
          F 06 33 (GETI OF MCC1 BURN)
                     LOAD LM GET=MCC1
                        (105+24+00)
                     PRO
          F 37 BB
                     MOVE TO LEB

                     **TARGET CSM MCC2 BACKUP**

     P35             KEY 35E
          F 16 45 (MKS,TFI,=00001)
                     ZERO OPTICS=OFF
+17
                     KEY V93E (REINITIALIZE W MAT)
                     KEY V87E(VHF RANGING)
                     KEY V57E
          F 51 BB (PLEASE MARK)
                     KEY V16N45E
          F 16 45 (MKS,TFI,=00001)
                     OMC=CENTER LM IN SXT
                     OPTICS MODE=MAN
                     MAKE 9 MARKS IN NEXT
                        9 MINUTES
     (105+32)
                     SUNUP
+26
                     PRO/PROCESS LAST MARK
          F 16 45 (MARKS,TFI,=00001)
                     ZERO OPTICS=ZERO

                     MOVE TO COMMAND SEAT

+27  (TIGN=3.0 MIN)
                     PRO/MAKE FINAL PASS
          F 06 81 (VG=LV)
                     COPY DATA ON CHECKLIST
                     PRO
          F 06 59 (VG=LOS)
                     COPY DATA ON CHECKLIST
                     PRO
          F 16 45 (MARKS,TFI,MGA)
                     PRO
          F 37 BB
```

```
                    COPY LM MCC2 PAD
                    COMPARE CSM SOLN WITH LM
                       SOLUTION
+28+30
      P41           KEY 41E
            F 50 18 (COMMANDED R,P,Y)
                    KEY V56E
                    KEY ENTER(BYPASS MNV...
              06 85 (VG-BODY)

                  **SET UP MCC2 BURN**
+29+25
                    DSKY BLANKS
+29+30
              16 85 (VG-BODY)(AVE G ON)
                    THC-ARMED
                    RHC-ARMED
+30+00(105+39+00)
            F 16 85 (VG-BODY)
                  ************************************
                       LM PERFORMS MCC2 BURN
                  ************************************

                  ************************************
                       CSM MCC2 BACKUP BURN
                          (0,302/20,0)
                  ************************************

                       CONFIRM LM BURN COMPLETE

                       PRO (TO BYPASS CSM-MCC2 BURN)
                       THC-LOCKED
                       RHC-LOCKED
            F 37 BB
```

```
      P76           KEY 76E
            F 06 84 (DV,S OF LM MCC2 BURN)
                       LOAD LM MCC2 DV,S
                    PRO
            F 06 33 (GETI OF MCC2 BURN)
                    LOAD LM GET-MCC2
                       (105+39+00)
                    PRO
            F 37 BB
+31

                  **MANEUVER TO COAS TRACK ATTITUDE**

      P00           KEY 00E
                    KEY V89E
            F 04 06 (00003,00001,BLNK)
                    LOAD R2 = 00002
                    PRO
            F 06 18 (COMMANDED R,P,Y)
                    PRO
            F 50 18 (COMMANDED R,P,Y)
                    PRO
              06 18 (COMMANDED R,P,Y)
                    MONTIOR ATT NMVR
            F 50 18 (COMMANDED R,P,Y)
                    ALIGN S/C TO ZERO DEG ROLL
                    PRO
              06 18 (COMMANDED R,P,Y)
            F 50 18 (COMMANDED R,P,Y)
                       (0,274/346,0)
                    KEY ENTER
```

```
*************************************************
*        PROCEDURES FOR BRAKING                 *
*************************************************
+34
                  RHC=ARMED
                  CENTER LM IN RETICLE
                  BMAG MODE(3)=ATT1/RATE 2
                  MONITOR EMS FOR RANGE
+39
      P47         KEY V37E47E
          F 16 83 (DV=BODY)
                  KEY V83E
          F 16 54 (R,RDOT,THETA)
                  THC=ARMED
                  MONITOR LOS CONTROL
                  MONITOR  R AND R DOT
               ***************************
               *   BRAKING GATES AND RET ANGS  *
               *                           *
               *    30 FPS AT 6000 FT=±13 DEG  *
               *    20 FPS AT 3000 FT=±26 DEG  *
               *    10 FPS AT 1500 FT=±54 DEG  *
               *     5 FPS AT  500 FT=1.6 DEG  *
               ***************************

                  USE RANGE ON DSKY TO CHECK EMS
                     RANGE INDICATOR. USE
                     RETICLE ANGLE AS THIRD
                     VOTE.
+43   (105+52)
             ************************************
                  TPF(0,310/353,0)
             ************************************
```

6.3 P20 NAVIGATION SUMMARY WITH SUN ANGLES

IT - INITIATE TRACK
CT - CEASE TRACK
(OUT-OF-PLANE SUN ANGLE IS 4 DEG)

GET	EVENT	SUN ANGLE (L.O.S. TO SUN) DEG
98:35	CSM SEP	
98:50	SUNSET	
99:34	LM DOI	
99:37	SUNRISE	
100:27	IT (SXT/VHF) (10/10)	207
100:32		186
100:37	CT (SXT/VHF)	174
100:46	LM PHASING	
100:49	SUNSET	
100:51	IT (SXT/VHF) (4/3,V93,6/7)	
101:01	CT (SXT)	
101:14	IT (SXT/VHF) (10/10)	
101:24	CT (SXT/VHF)	
101:35	SUNSET	
101:49	(T (SXT/VHF) (4/3,V93,16/17)	131
101:54		117
101:59		111
102:04		102
102:09	CT (SXT/VHF)	93
102:43	LM INSERTION	
102:47	SUNSET	
103:02	IT (SXT/VHF) (V93,6/5,V93,17/18)	
103:07	CT (SXT)	
103:25	CT (VHF)	
103:33	SUNRISE	
103:34	LM CSI	
103:41	IT (SXT/VHF) (3/3;V67,00057,00034,00001; 16/16)	186
103:46		171
103:51		156
103:55		144
103:57		138
104:02	CT	123
104:02	LM PLANE CHANGE	
104:08	IT (SXT/VHF) (4/3,V93,8/9)	105
104:14		87
104:20	CT (SXT/VHF)	70
104:32	LM CDH	
104:38	IT (SXT/VHF) (4/3,V93,14/15)	17
104:43		4
104:45	SUNSET	5
104:56	CT (SXT/VHF)	
105:09	LM TPI	
105:12	IT (SXT/VHF) (V93,8/8)	
105:20	CT (SXT/VHF)	
105:24	LM MCC1	
105:26	IT (SXT/VHF) (V93,9/9)	
105:32	SUNRISE	91
105:35	CT (SXT/VHF)	92
105:39	MCC2	
105:52	TPF	

6.4 CSM ATTITUDE SUMMARY

INERTIAL AND ORDEAL FDAI GIMBAL ANGLE
PROFILE FOR THE NOMINAL F MISSION
(YAW = 0.0)

TIME GET	ROLL	PITCH ORDEAL	PITCH INERTIAL	PITCH MNVR
97:40	180	282	14 (Yaw = 14.0)	
97:50	180	312	14	
98:10	180	12	14	
98:12	0	21	14	
98:35	0	90	14	
98:39	0	142	54	40
98:55	0	170	34	
99:28	0	206	332	55
99:39	0	227	317	
100:07	180	278	268	70
100:25	180	293	243	25
100:48	180	308	188	
101:14	180	337	138	
101:49	180	108	162	
102:11	180	174	162	50
102:36	180	3	272	110
102:46	180	32	272	
102:56	180	162	13	101
103:05	180	161	346	
103:29	180	166	277	11
103:34	180	180	277	
103:38	180	155	239	39
104:02	180	156	167	
104:05	180	157	158	
104:25	0	167	108	
104:32	0	188	108	
104:36	0	229	137	29
104:58	0	235	75	
105:02	0	192	15	53
105:09	0	208	15	
105:11	0	247	48	33
105:24	0	265	29	
105:39	0	302	20	
105:42	0	274	346	34
105:52	0	310	353	

7.0 DISCUSSION OF LM ABORT AND RESCUE CASES

7.1 LM Active PDI Abort

A LM active PDI abort rendezvous is planned if a failure occurs after DOI which precludes continuation of the nominal rendezvous mission. The LM PDI abort burn is targeted to occur at LM perilune one-half revolution after LM DOI. This burn provides phasing such that the LM TPI burn occurs one revolution earlier than the nominal TPI time. The LM CSI burn occurs one-half revolution after the PDI abort burn and the LM CDH burn occurs one-half revolution after the CSI burn. The CDH burn is targeted to produce a 15 nautical mile delta height. The LM TPI burn will be cued at an elevation angle of 26.6 degrees and will occur near the midpoint of darkness.

Since the LM is active for this rendezvous, the function of the CSM will be to target the CSI, CDH, and TPI burns and backup the LM burns.

The onboard data for this case is valid if the CSM becomes active following the LM PDI abort burn.

7.2 Partial LM Phasing Greater Than or Equal to 40 FPS

This abort and rescue case was developed to provide a rendezvous capability assuming the LM could not complete the Phasing burn but could apply at least 40 FPS. This is the most likely partial Phasing situation since the LM RCS could be used to apply 40 FPS even if a failure of both the LM DPS and APS engines precluded application of the burn. The rendezvous sequence assuming a partial Phasing burn greater than or equal to 40 FPS requires the CSM to perform a rescue burn approximately one revolution after the LM DOI burn. This rescue burn is sized, based upon the magnitude of the partial Phasing burn, so that the terminal rendezvous approach is similar to that in the nominal case. A canned rescue burn (48.7 FPS retrograde)

will be provided onboard which is valid for the partial phasing equal to 40 FPS, the most likely failure situation. This burn will nominally be updated by the ground 20 minutes after the failed LM burn based upon the LM DV applied at phasing. Updating the Rescue burn preserves the nominal terminal rendezvous approach.

The CSM Rescue burn at 101:33 lowers the CSM perilune to about 20 nautical miles and provides phasing which results in TPI occurring near the nominal TPI time (105:09). The CSM CSI One burn is targeted so that the CDH burn occurs one revolution after the CSI One burn. A CSI Two burn (nominally zero) is scheduled half way between the CSI One and CDH burns. The CSM TPI burn at a delta height of 15 nautical miles will be cued on an elevation angle of 208.3 degrees which results in TPI at the midpoint of darkness. There exists the possibility that the LM could become active following the CSM Rescue burn. This would require slightly different targeting for the terminal rendezvous phase; however, the CSM onboard data would not be affected significantly.

7.3 Partial LM Phasing Less Than 40 FPS

In the event the LM cannot apply 40 FPS of the Phasing burn (the DPS, APS, and RCS have failed), a rendezvous plan similar to that in Section 7.2 will be utilized. A CSM rescue burn is applied at 101:33, one revolution after the DOI burn, and the magnitude of the rescue burn is a function of the LM DV applied (zero to 40 FPS). A canned rescue burn (57.1 FPS retrograde) is also provided onboard for this case. This canned burn is valid for a LM DV of 20 FPS and will be updated after the failed LM burn. A partial LM burn of 20 FPS was chosen simply because it is midway in the zero to 40 FPS partial burn range.

This rendezvous plan differs from the LM partial Phasing greater than 40 FPS plan in that there are two revolutions between the CSM

CSI One and CSM CDH burns. A CSI Two burn is scheduled half way between the CSI One and CDH burns and a CSI Three burn is scheduled half way between the CSI Two and CDH burns. Both the CSI Two and CSI Three burns are nominally zero. The CDH burn for this rescue is targeted so that the delta height between CDH and TPI is 10 nautical miles instead of the nominal 15 nautical miles. The TPI burn is cued as in the nominal case at an elevation angle of 208.3 degrees. The LM could be active after the CSM rescue burn.

7.4 Partial LM Insertion

Should the LM APS fail during the Insertion burn DV be outside the LM-RCS capability either to complete the Insertion burn or to null out the applied DV (i.e., DV > 40 or V_G > .80) a CSM active rescue will be initiated. For LM applied DV of less than 45 FPS the LM will use the RCS to burn the DV back to zero. If the velocity-to-go is less than 80, the LM will use the RCS to complete the burn. For other LM-applied DV's, the LM will use the RCS to apply an additional 80 FPS along the burn vector to prevent the subsequent maximum ranges from becoming greater than 400 nautical miles. Based upon the LM DV applied, the MCC-H will target the CSM Rescue burn magnitude to preserve the nominal Terminal Phase characteristics, but will result in a TPI one revolution later than nominal. A pad containing this Rescue burn, as well as CSI, CDH, and TPI burn data will be voiced to the CSM approximately 20 minutes after the failed LM Insertion burn. Should the CSM fail to receive these pads, the CSM will apply a canned Rescue burn of 44.9 FPS (regrograde) at DOI + 238 min. (2 revs after DOI). This Rescue burn is valid for a LM applied DV of 120 FPS at the

partial Insertion burn, which is approximately in the middle of the range of LM-applied DV's for which this rescue would be initiated.

After the CSM Rescue burn, the usual concentric rendezvous sequencing of CSI, CDH, and TPI is initiated, with CSI scheduled to occur at one-half revolution after the Rescue burn, and CDH one revolution after the CSI burn. Half-way between CSI and CDH a second, nominally zero, CSI is scheduled, followed by a Plane Change burn half-way between the second CSI and CDH. TPI occurs 35 minutes after CDH at an elevation angle of 208.3, approximately 23 minutes before sunrise. TPF occurs approximately two and one-half revolutions after the failed Insertion burn. The LM could become active after the CSM Rescue burn.

7.5 Zero LM Insertion

Should the LM APS fail at the Insertion burn with less than 45 FPS being applied, the LM will use the RCS to reduce the total DV to zero. The CSM will initiate a ground supplied backup Insertion burn at 102:46:18, three minutes after the LM Insertion TIGN.

This burn preserves the relative trajectory, producing a CSI, CDH, TPI sequence similar to the nominal case; however, due to the increased orbital period of the CSM, the delta times between burns will be somewhat larger than nominal. The resulting TPI time is seven minutes later than nominal and 23 minutes before sunrise. TPI occurs at an elevation angle of 208.3, and at a delta height of 15 nautical miles. The LM could become active after the CSM Backup Insertion burn.

8.0 LM RESCUE ONBOARD DATA

The onboard procedures data required to perform CSM active LM rescues will take the form of a one-page summary checklist which covers the complete timeline for each rescue case. Each summary checklist will show all activities from the failed LM burn to TPF required to complete the LM rescue including program requirements, navigation schedules, and burn schedules. In addition, sunrise/sunset, LOS/AOS, and tracking and burn attitudes will be indicated. In order to condense activities into one page, considerable abbreviation from the nominal checklist format is required. This may necessitate the crew referring to the nominal checklist if additional detail on a particular activity is desired.

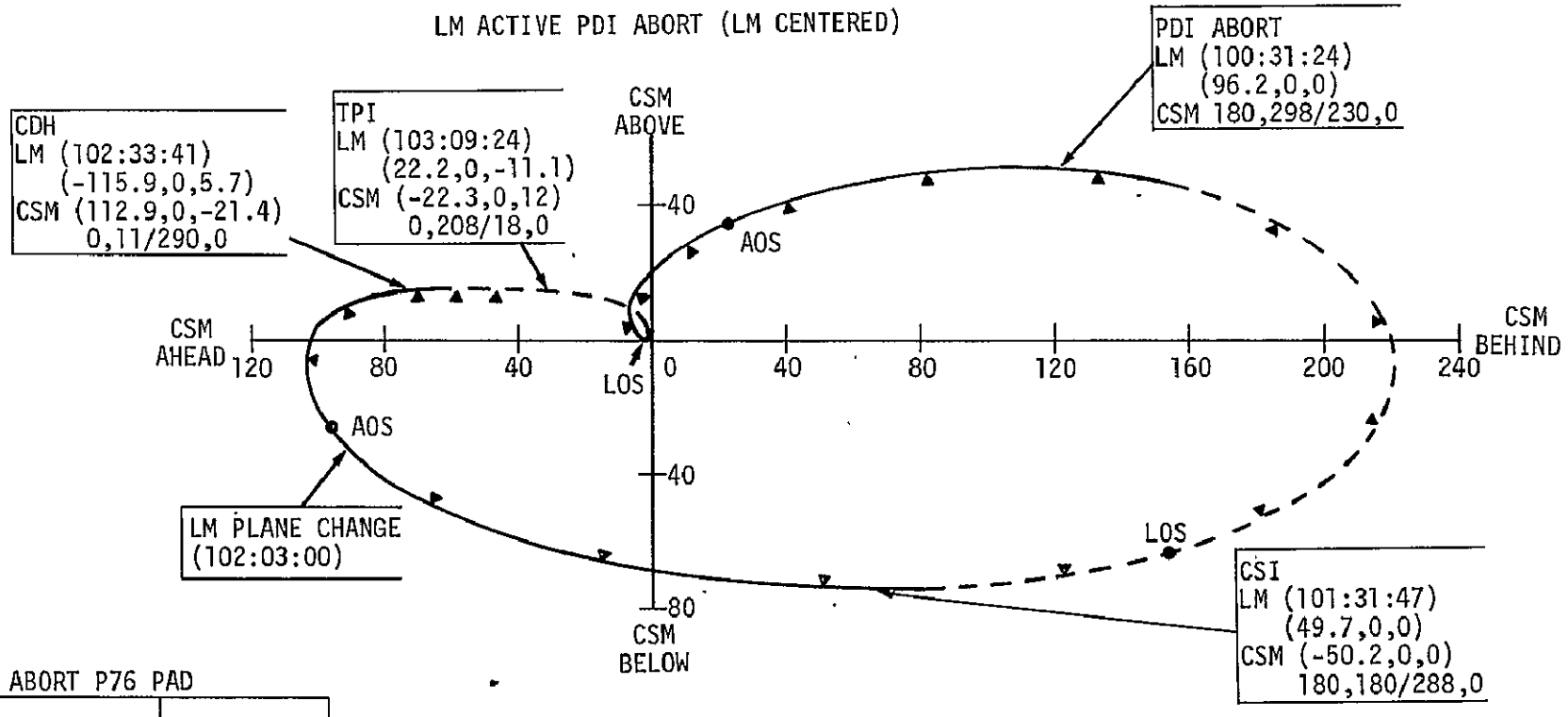
Accompanying each one page checklist will be a relative motion plot (LM centered) showing the orbital position of the CSM with respect to the LM. In addition to the plot, maneuver pads for copying onboard data will be provided for each burn during the five contingency rendezvous situations.

The rescue checklist timelines, relative motion plots, and burn data for the two partial LM Phasing cases and one partial LM Insertion case were formulated assuming the CSM applied the canned rescue burn. The onboard data for the zero LM Insertion rescue case assumes a nominal trajectory to Insertion and a ground targeted CSM Backup Insertion burn. The PDI abort case assumes the LM DOI burn was nominal and the LM is active for the rendezvous. The CSM in this case provides a backup to the LM maneuvers after the PDI abort burn.

8.1 LM PDI Abort

8.1.1 Plot and Pads

LM ACTIVE PDI ABORT (LM CENTERED)



PDI ABORT P76 PAD

84
33

CSM CSI COPY

11
37
75
81
82

LM CSI P76

84
33

CSM PC COPY

33
81

LM PC P76

84
33

CSM CDH COPY

13
75
81

LM CDH P76

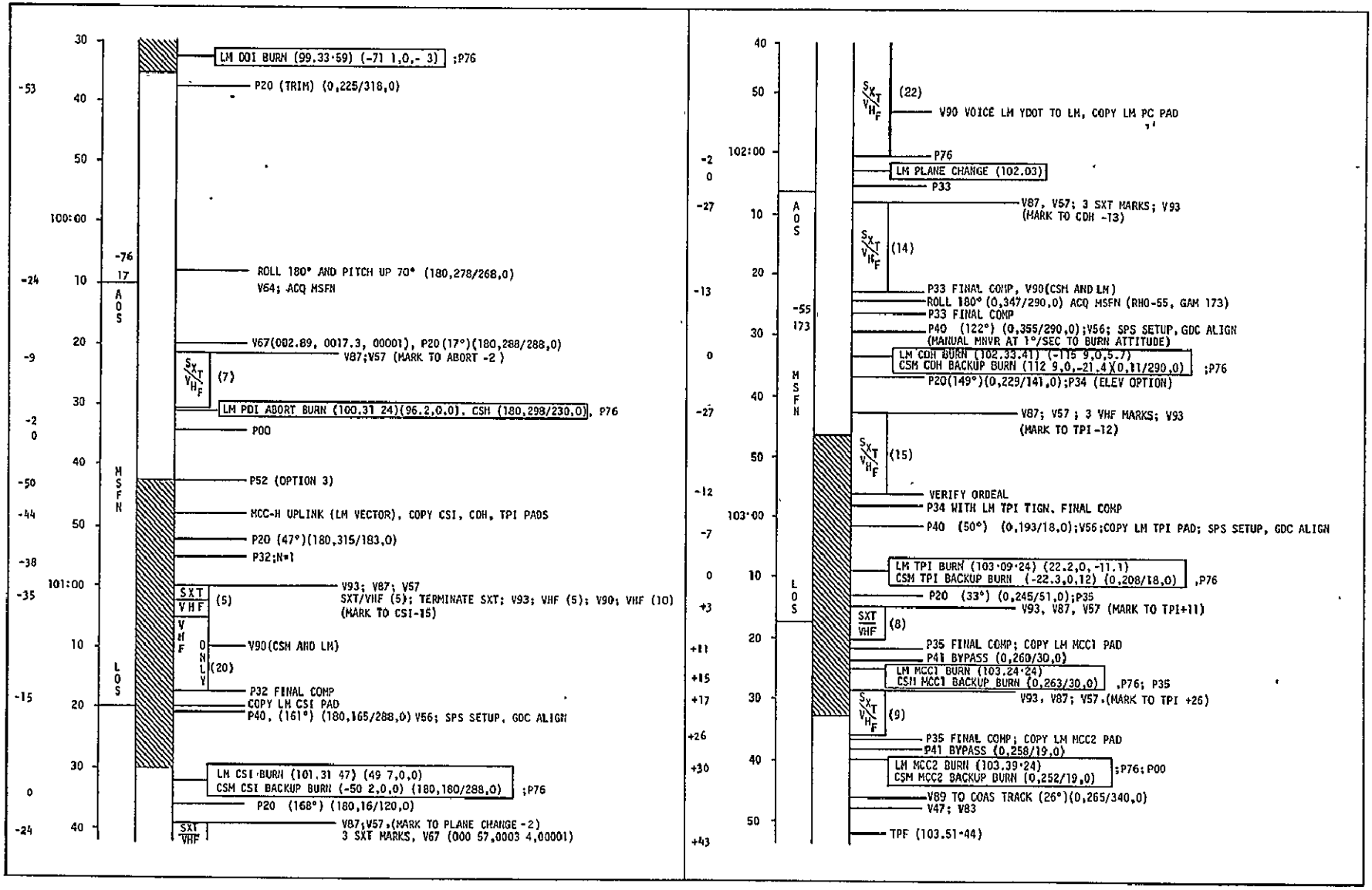
84
33

CSM TPI COPY

37
58
81
59

LM TPI P76

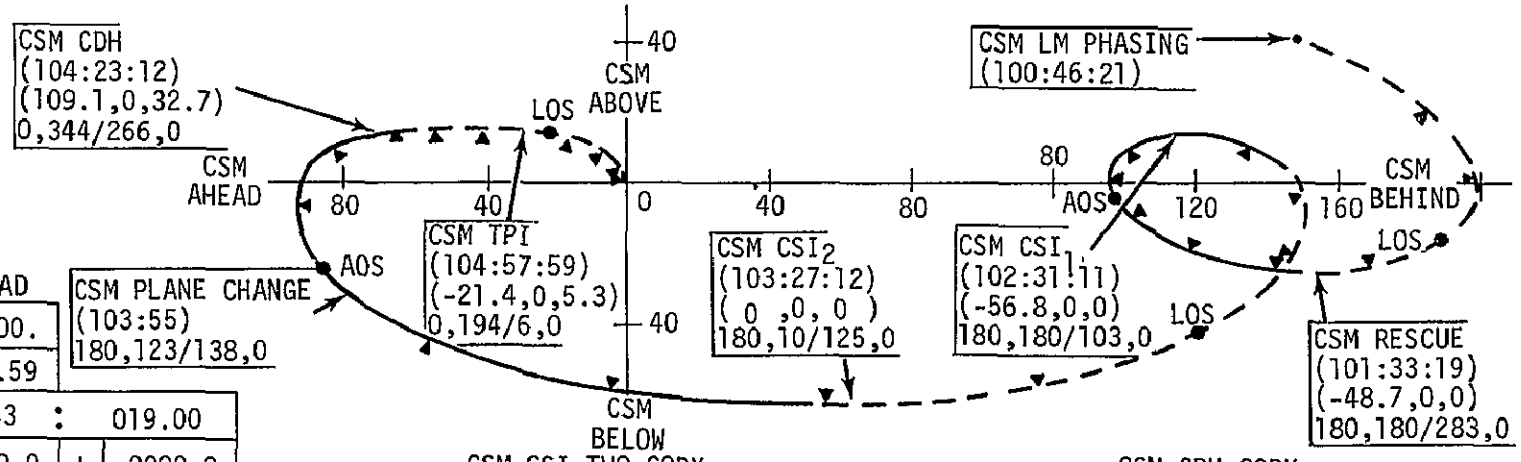
84
33


LM DOI BURN (99.33.59) (-71 1.0,- 3) ;P76
P20 (TRIM) (0,225/318,0)
ROLL 180° AND PITCH UP 70° (180,278/268,0)
V64; ACQ MSFN
V67(082.89, 0017.3, 00001), P20(17°)(180,288/288,0)
V87;V57 (MARK TO ABORT -2)
(7)
LM PDI ABORT BURN (100,31 24)(96.2,0,0), CSH (180,298/230,0), P76
P00
P52 (OPTION 3)
MCC-H UPLINK (LM VECTOR), COPY CSI, CDH, TPI PADS
P20 (47°)(180,315/183,0)
P32;N=1
V93; V87; V57
SXT/VHF (5); TERMINATE SXT; V93; VHF (5); V90; VHF (10)
(MARK TO CSI-15)
(5)
(20)
V90(CSM AND LM)
P32 FINAL COMP
COPY LM CSI PAD
P40, (161°) (180,165/288,0) V56; SPS SETUP, GDC ALIGN
LM CSI BURN (101.31 47) (49 7,0,0)
CSM CSI BACKUP BURN (-50 2,0,0) (180,180/288,0) ;P76
P20 (168°) (180,16/120,0)
V87;V57,(MARK TO PLANE CHANGE -2)
3 SXT MARKS, V67 (000 57,0003 4,00001)
AOS
MSFN
LOS
-76
17
-53
-24
-9
-2
0
-50
-44
-38
-35
-15
100:00
101:00
(22)
V90 VOICE LM YDOT TO LM, COPY LM PC PAD
P76
LM PLANE CHANGE (102.03)
P33
V87, V57; 3 SXT MARKS; V93
(MARK TO CDH -13)
(14)
P33 FINAL COMP, V90(CSM AND LM)
ROLL 180° (0,347/290,0) ACQ MSFN (RHO-55, GAM 173)
P33 FINAL COMP
P40 (122°) (0,355/290,0);V56; SPS SETUP, GDC ALIGN
(MANUAL MNVR AT 1°/SEC TO BURN ATTITUDE)
LM CDH BURN (102.33.41) (-115 9,0,5.7)
CSM CDH BACKUP BURN (112 9,0,-21.4)(0,11/290,0) ;P76
P20(149°)(0,229/141,0);P34 (ELEV OPTION)
V87; V57 ; 3 VHF MARKS; V93
(MARK TO TPI-12)
(15)
VERIFY ORDEAL
P34 WITH LM TPI TIGN, FINAL COMP
P40 (50°) (0,193/18,0);V56;COPY LM TPI PAD; SPS SETUP, GDC ALIGN
LM TPI BURN (103·09·24) (22.2,0,-11.1)
CSM TPI BACKUP BURN (-22.3,0,12) (0,208/18,0) ,P76
P20 (33°) (0,245/51,0);P35
V93, V87, V57 (MARK TO TPI+11)
(8)
P35 FINAL COMP; COPY LM MCC1 PAD
P41 BYPASS (0,260/30,0)
LM MCC1 BURN (103.24·24)
CSM MCC1 BACKUP BURN (0,263/30,0) ,P76; P35
V93, V87; V57,(MARK TO TPI +26)
(9)
P35 FINAL COMP; COPY LM MCC2 PAD
P41 BYPASS (0,258/19,0)
LM MCC2 BURN (103.39·24)
CSM MCC2 BACKUP BURN (0,252/19,0) ;P76; P00
V89 TO COAS TRACK (26°)(0,265/340,0)
V47; V83
TPF (103.51·44)
AOS
MSFN
LOS
102:00
103·00
-2
0
-27
-13
-55
173
-12
-7
+3
+11
+15
+17
+26
+30
+43

8.2 LM Partial Phasing Greater or Equal To 40 FPS

8.2.1 Plot and Pads

CSM ACTIVE LM RESCUE PARTIAL PHASING ≥40fps (LM CENTERED)



CANNED RESCUE TWO PAD

47	+	37768.	+	00000.	
48	-	000.52	+	000.59	
33	00101	:	00033	:	019.00
81	- 0048.7	+	0000.0	+	0000.0
22	XXX180		XXX283		XXX000
ΔV_C	X0038.8				
11	00102	:	00031	:	011.00
37	00104	:	00057	:	059.00
N	2				

CSM CSI TWO COPY

11			
37			
75			
81			
82			

CSM CDH COPY

13			
75			
81			

LM CDH P76

84			
33			

CSM CSI ONE COPY

11			
37			
75			
81			
82			

LM CSI TWO P76

84			
33			

CSM TPI COPY

37			
58			
81			
59			

CSM PC COPY

33			
81			

LM CSI ONE P76

84			
33			

LM PC P76

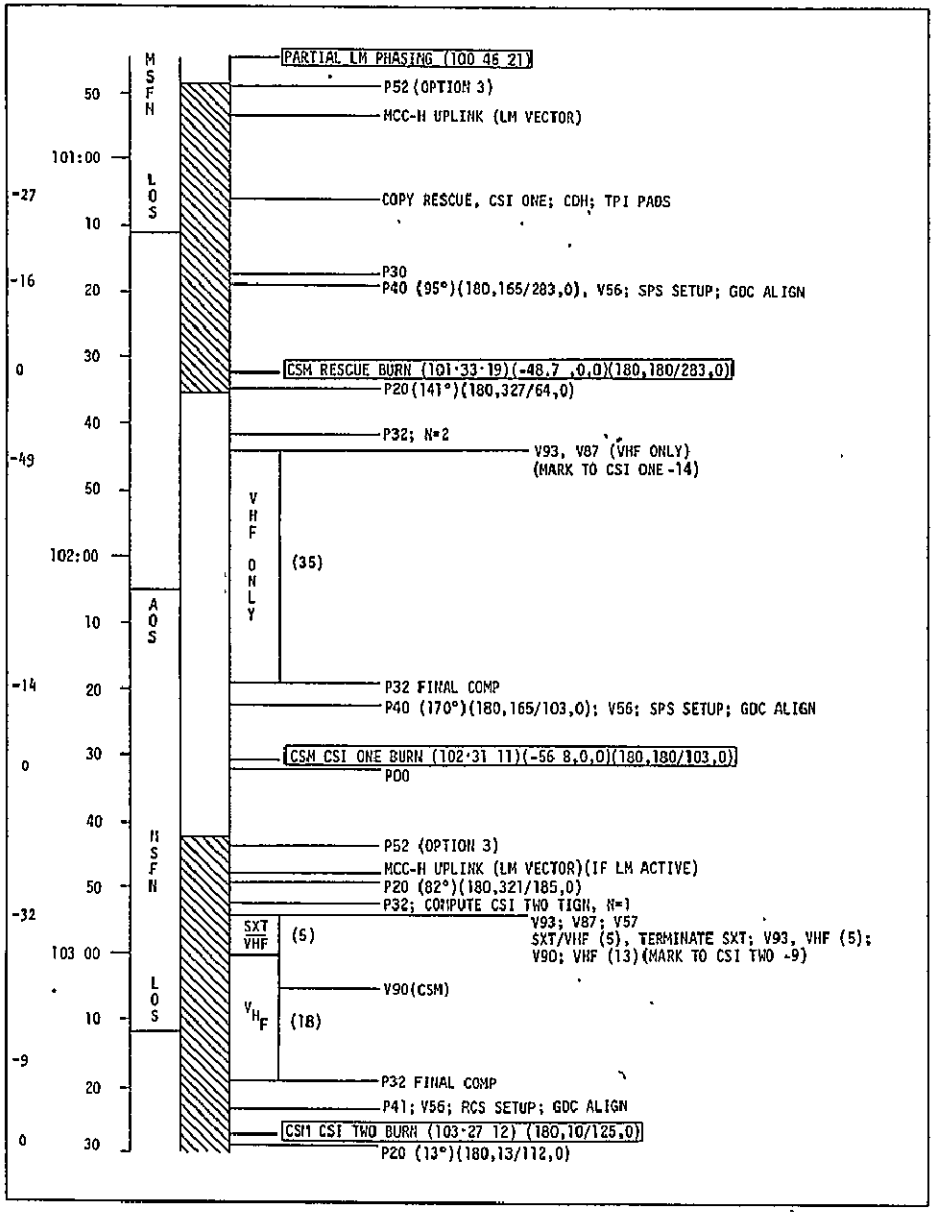
84			
33			

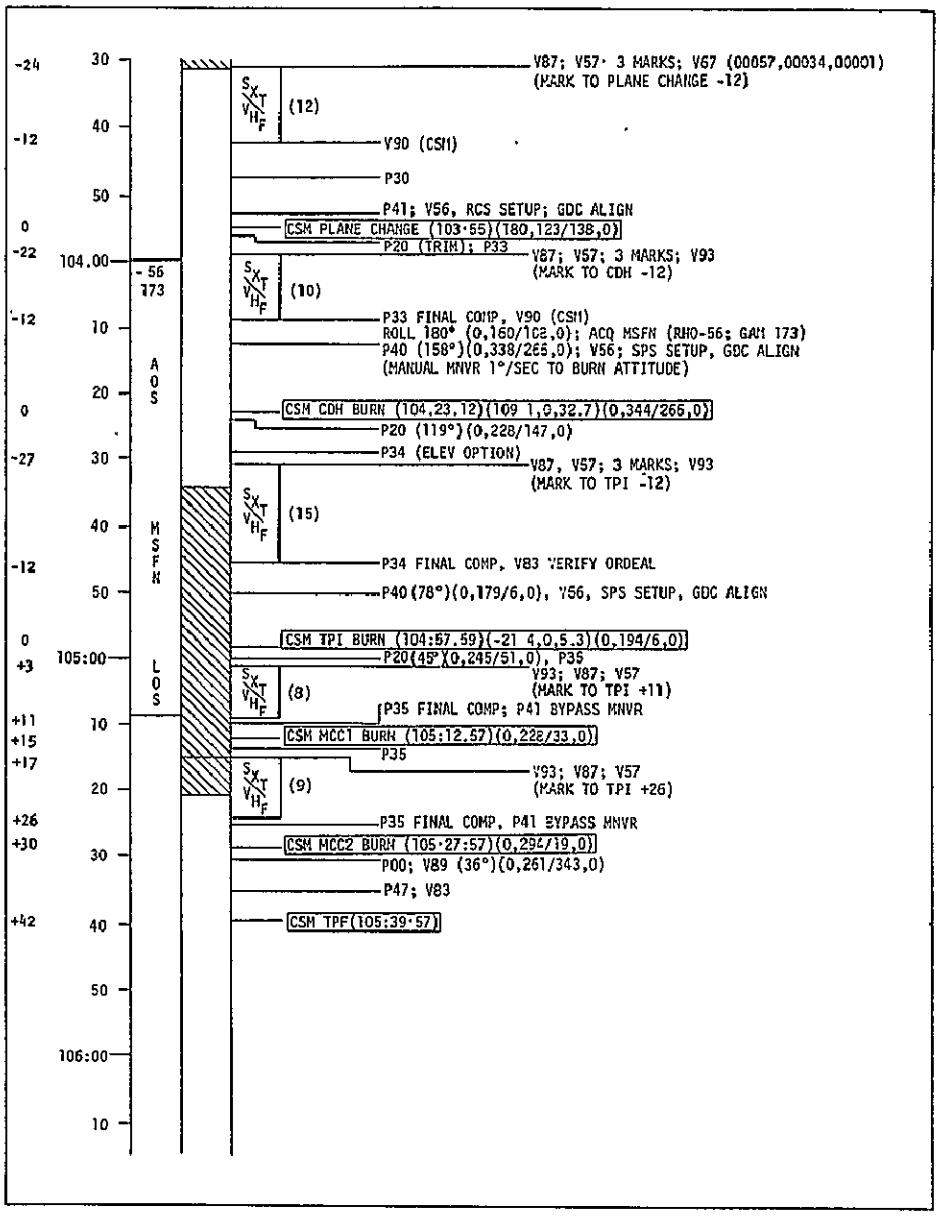
LM TPI P76

84			
33			

8.2.2 Checklist

CSM ACTIVE LM RESCUE - LM PHASING ≥ 40 FPS (ΔV APPLIED = 40 FPS)

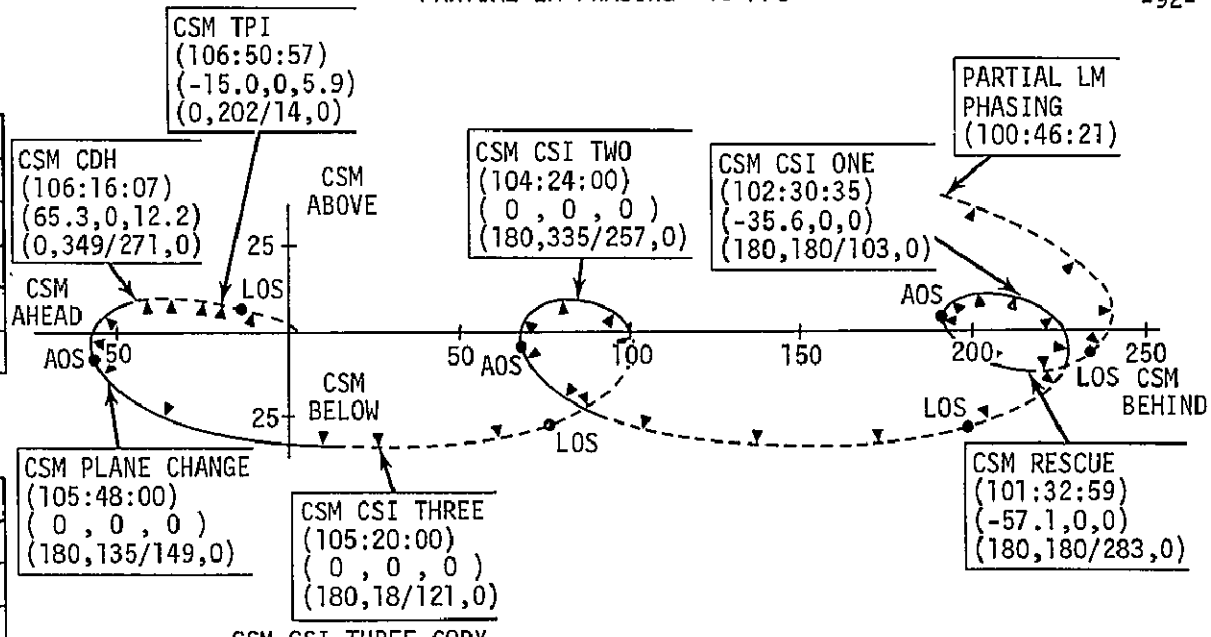




8.3 LM Partial Phasing Less Than 40 FPS

CANNED RESCUE TWO PAD

47	+	37768.	+	00000.		
48	-	000.52	+	000.59		
33	00101		00032		059.00	
81	-	0057.1	+	0000.0	+	0000.0
22	XXX180		XXX283		XXX000	
ΔV_C	X0047.1					
11	00102		00030		035.00	
37	00106		00050		057.00	
N	4					



CSM CSI ONE COPY

11	
37	
75	
81	
82	

LM CSI ONE P76

84	
33	

CSM CSI TWO COPY

11	
37	
75	
81	
82	

LM CSI TWO P76

84	
33	

CSM CSI THREE COPY

11	
37	
75	
81	
82	

LM CSI THREE P76

84	
33	

CSM PC COPY

33	
81	

LM PC P76

84	
33	

CSM CDH COPY

13	
75	
81	

LM CDH P76

84	
33	

CSM TPI COPY

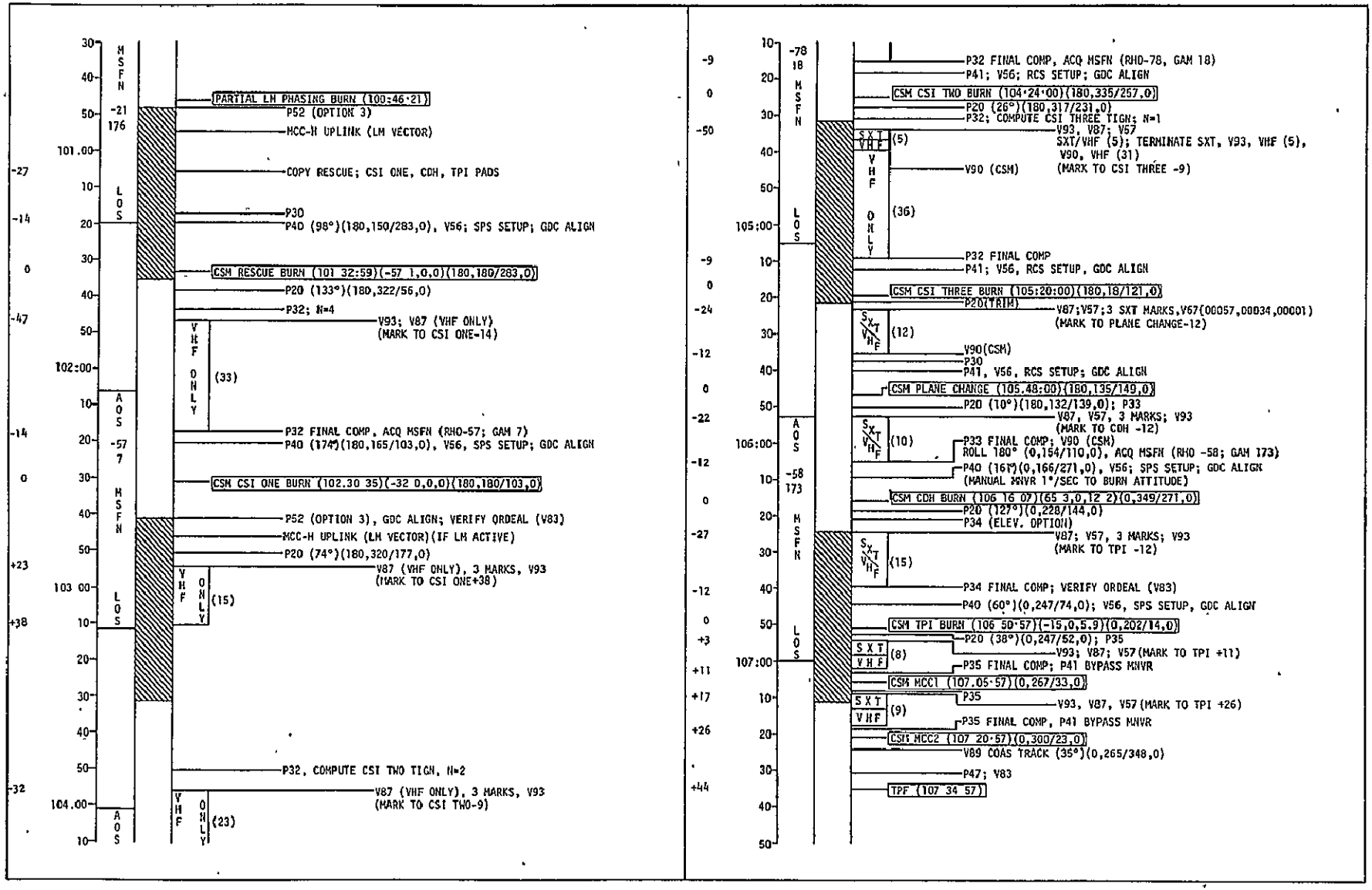
37	
58	
81	
59	

LM TPI P76

84	
33	

8.3 2 Checklist

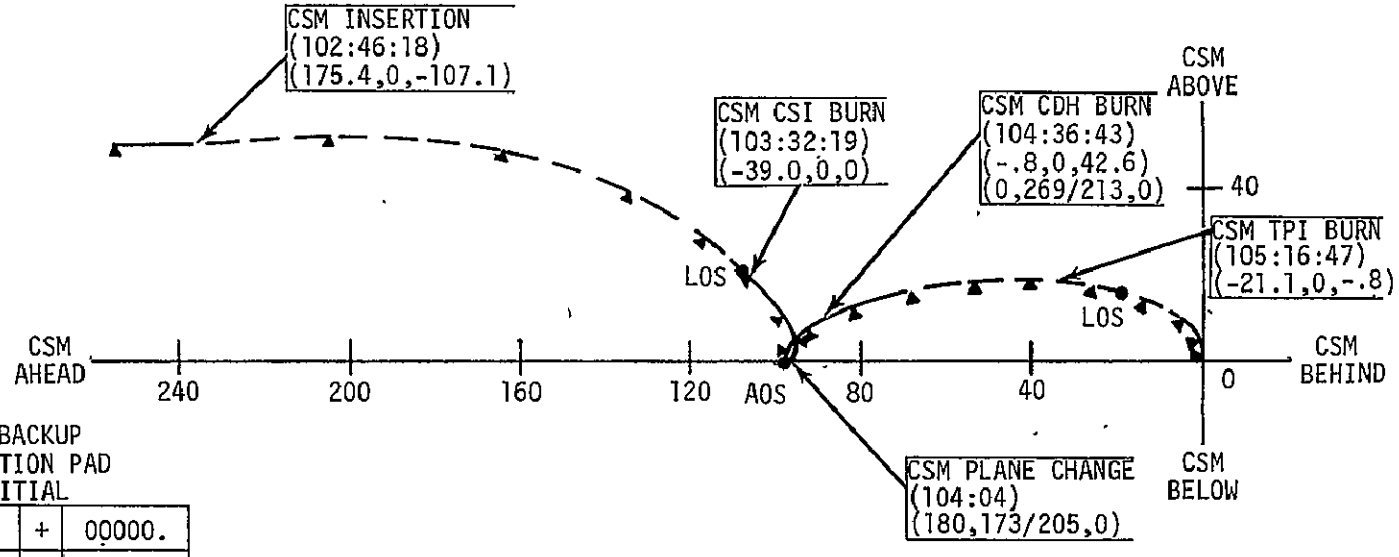
CSM ACTIVE LM RESCUE PHASING LESS THAN 40 FPS



8.4 LM Zero Insertion

8.4.1 Plot and Pads

CSM ACTIVE LM RESCUE-ZERO INSERTION (LM CENTERED)



CSM BACKUP INSERTION PAD INITIAL

47	+	37768.	+	00000.		
48	-	000.52	+	000.59		
33	00102	:	00046	:	018.00	
81	+	175.4	+	0000.0	-	107.1
22	XXX180		XXX272		XXX00	
ΔV_C	X192.7					
11	00103	:	00032	:	019.	
37	00105	:	00016	:	047.	
N	1					

CSM CSI COPY

11	:	:	
37	:	:	
75	:	:	:
81			
82			

LM CSI P76

84	
33	: : :

CSM PC COPY

33	:	:	
81			

LM PC P76

84	
33	: : :

CSM CDH COPY

13		:	:
75		:	:
81			

LM CDH P76

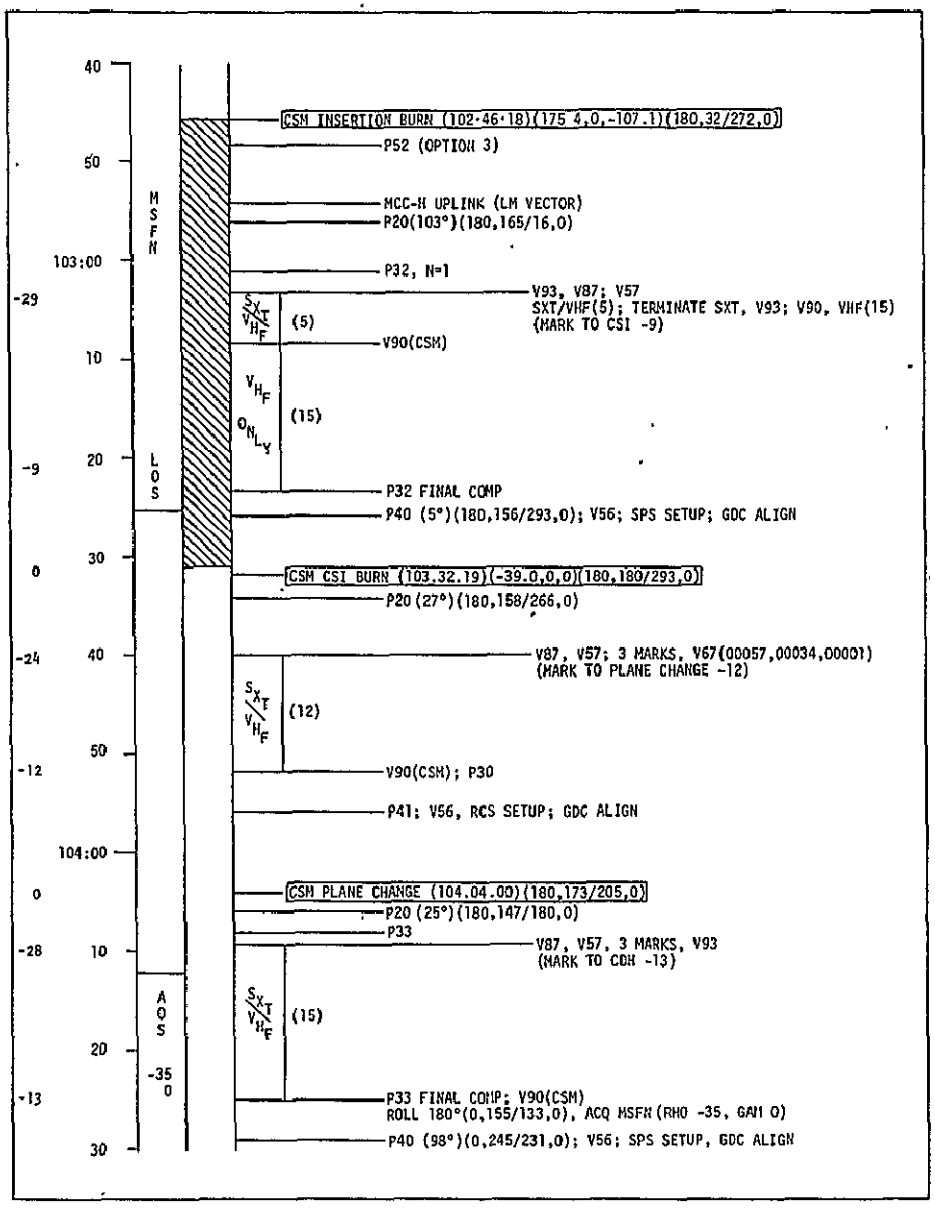
84	
33	: :

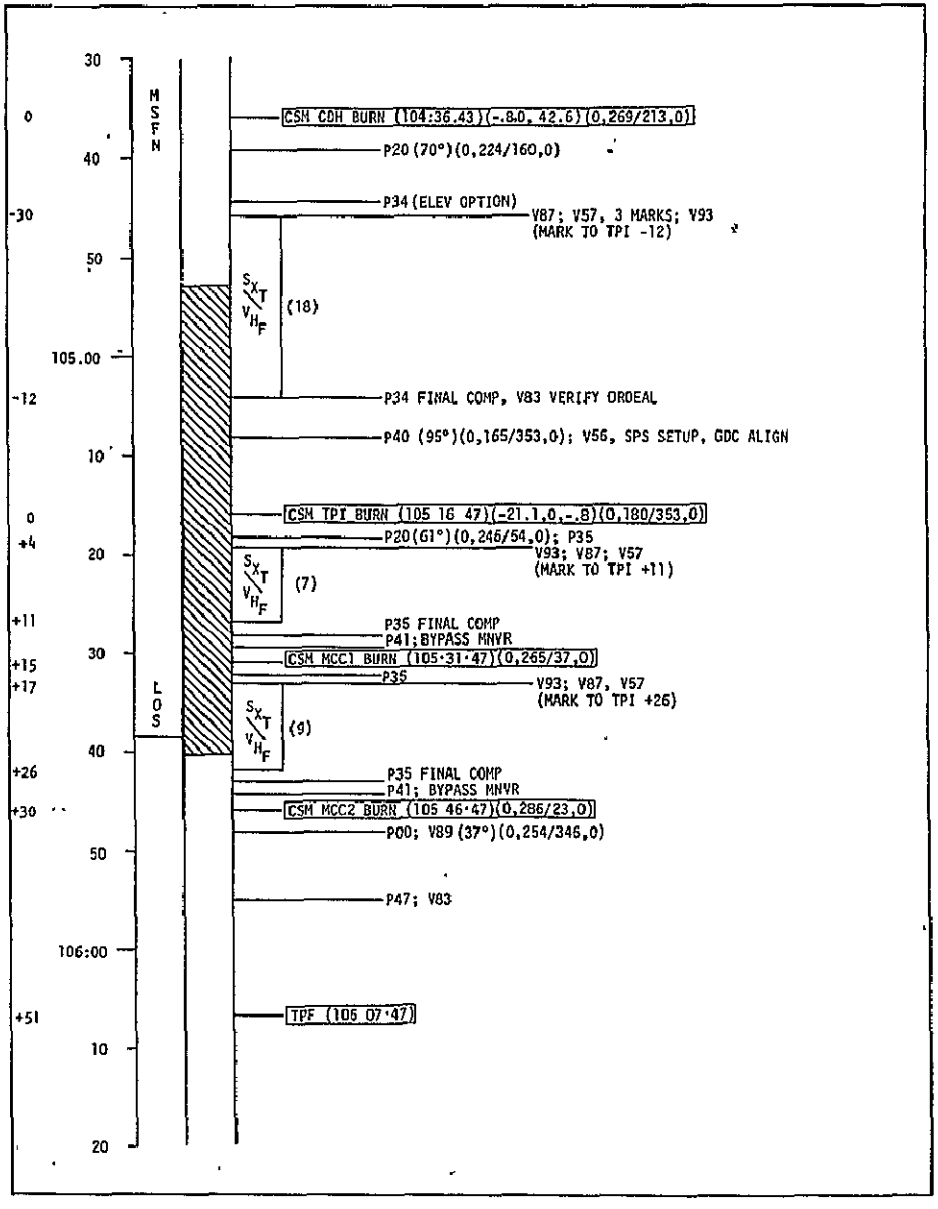
CSM TPI COPY

37	:	:	
58			
81			
59			

LM TPI P76

84	
33	: :

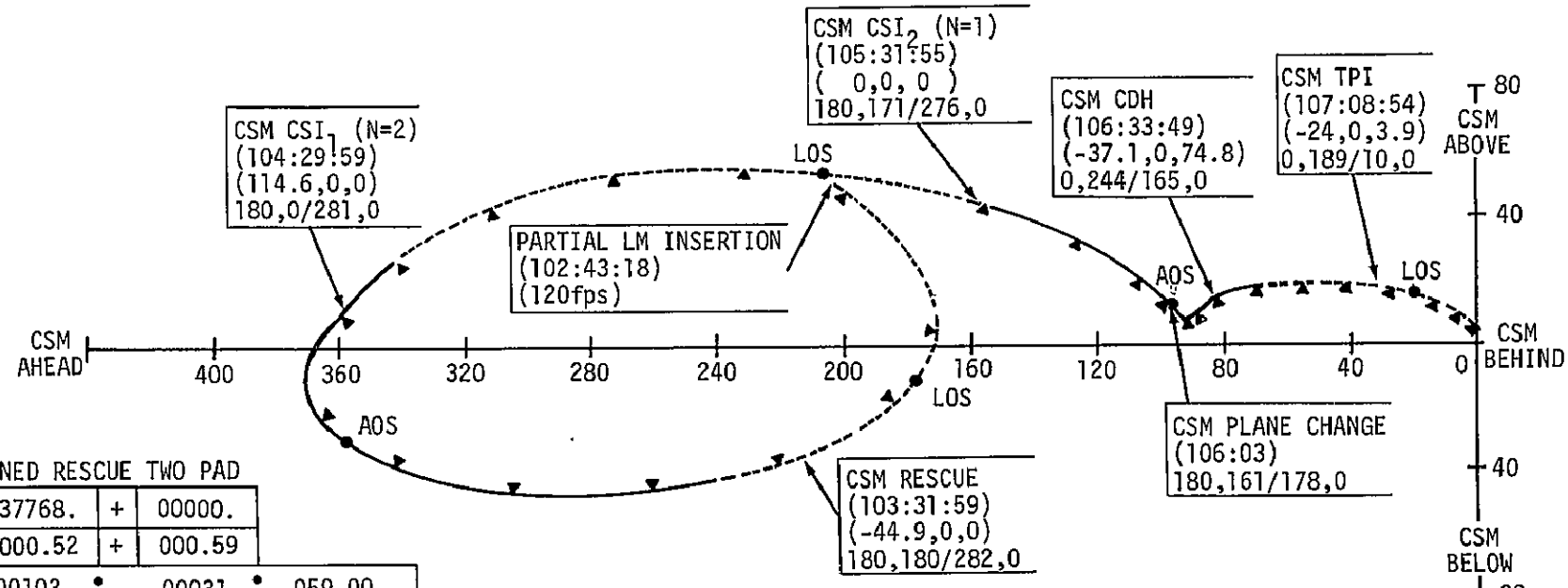

40
50
103:00
-29
10
-9
20
0
30
-24
40
-12
50
104:00
0
-28
10
-13
20
30
MSFN
LOS
AOS
-35
0
CSM INSERTION BURN (102:46:18)(175.4,0,-107.1)(180,32/272,0)
P52 (OPTION 3)
MCC-H UPLINK (LM VECTOR)
P20(103°)(180,165/16,0)
P32, N=1
V93, V87; V57
SXT/VHF(5); TERMINATE SXT, V93; V90, VHF(15)
(MARK TO CSI -9)
(5)
V90(CSM)
(15)
P32 FINAL COMP
P40 (5°)(180,156/293,0); V56; SPS SETUP; GDC ALIGN
CSM CSI BURN (103.32.19)(-39.0,0,0)(180,180/293,0)
P20 (27°)(180,158/266,0)
V87, V57; 3 MARKS, V67(00057,00034,00001)
(MARK TO PLANE CHANGE -12)
(12)
V90(CSM); P30
P41; V56, RCS SETUP; GDC ALIGN
CSM PLANE CHANGE (104.04.00)(180,173/205,0)
P20 (25°)(180,147/180,0)
P33
V87, V57, 3 MARKS, V93
(MARK TO CDH -13)
(15)
P33 FINAL COMP; V90(CSM)
ROLL 180°(0,155/133,0), ACQ MSFN(RHO -35, GAM 0)
P40 (98°)(0,245/231,0); V56; SPS SETUP, GDC ALIGN


30
0
40
-30
50
105.00
-12
10
0
+4
20
+11
+15
+17
30
+26
+30
40
50
106:00
+51
10
20
MSFN
LOS
CSM CDH BURN (104:36.43)(-.8.0, 42.6)(0,269/213,0)
P20 (70°)(0,224/160,0)
P34 (ELEV OPTION)
V87; V57, 3 MARKS; V93
(MARK TO TPI -12)
(18)
P34 FINAL COMP, V83 VERIFY ORDEAL
P40 (95°)(0,165/353,0); V56, SPS SETUP, GDC ALIGN
CSM TPI BURN (105 16 47)(-21.1,0,-.8)(0,180/353,0)
P20(61°)(0,246/54,0); P35
V93; V87; V57
(MARK TO TPI +11)
(7)
P35 FINAL COMP
P41; BYPASS MNVR
CSM MCC1 BURN (105:31:47)(0,265/37,0)
P35
V93; V87, V57
(MARK TO TPI +26)
(9)
P35 FINAL COMP
P41; BYPASS MNVR
CSM MCC2 BURN (105 46:47)(0,286/23,0)
P00; V89 (37°)(0,254/346,0)
P47; V83
TPF (106 07:47)

8.5 LM Partial Insertion

8.5.1 Plot and Pads

CSM ACTIVE LM - PARTIAL LM INSERTION (LM CENTERED)



CANNED RESCUE TWO PAD

47	+	37768.	+	00000.	
48	-	000.52	+	000.59	
33	00103		00031		059.00
81	-	0044.9	+	0000.0	+ 0000.0
22	XXX180		XXX282		XXX000
V_C	X0035.0				
11	00104		00029		059.00
37	00107		00008		054.00
N	2				

CSM CSI TWO COPY

11	•	•	
37	•	•	
75	•	•	•
81	•	•	•
82	•	•	•

CSM CDH COPY

13	•	•	
75	•	•	•
81	•	•	•

LM CDH P76

84	•	•	•
33	•	•	

CSM CSI ONE COPY

11	•	•	
37	•	•	
75	•	•	•
81	•	•	•
82	•	•	•

LM CSI TWO P76

84	•	•	•
33	•	•	

CSM TPI COPY

37	•	•	
58	•	•	•
81	•	•	•
59	•	•	•

CSM PC COPY

33	•	•	
81	•	•	•

LM CSI ONE P76

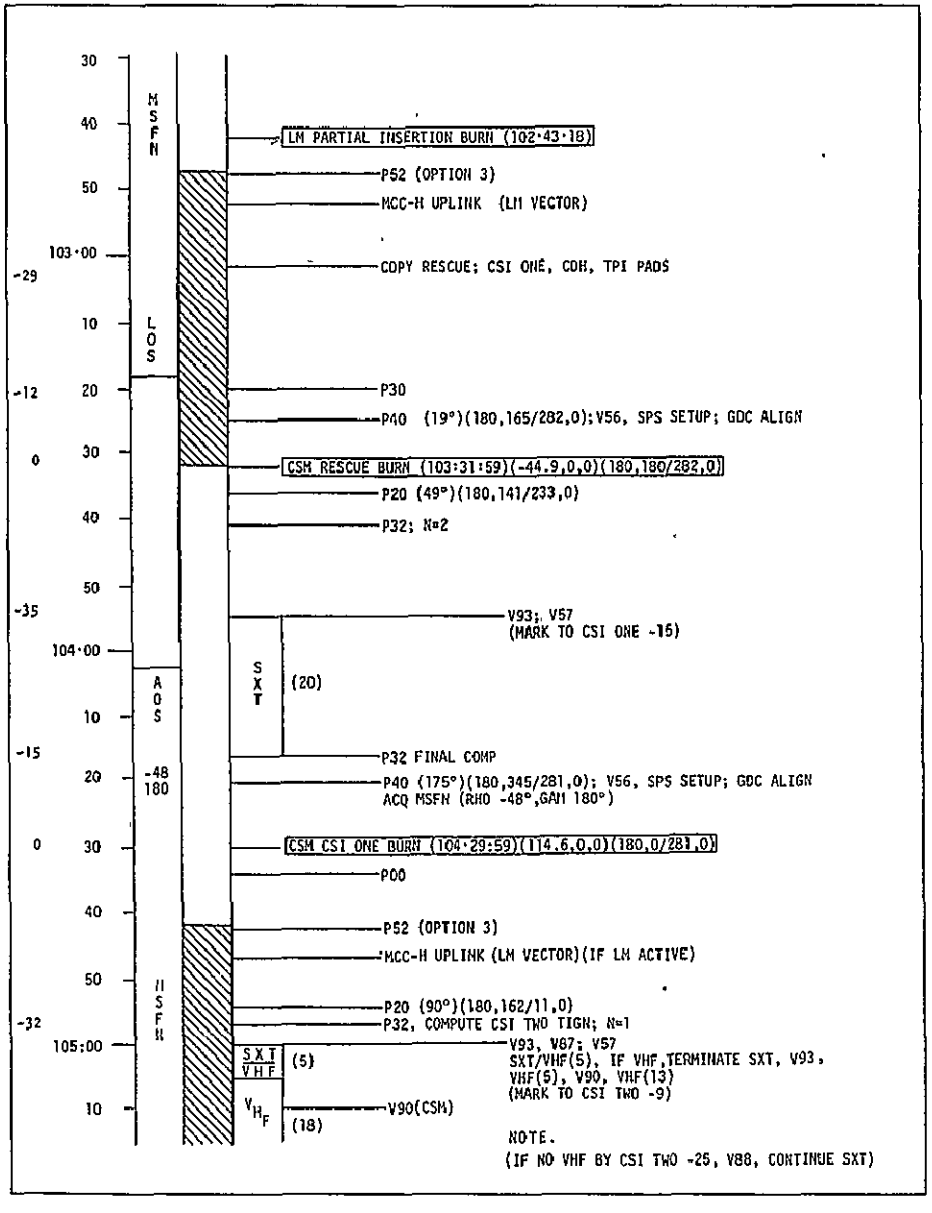
84	•	•	•
33	•	•	

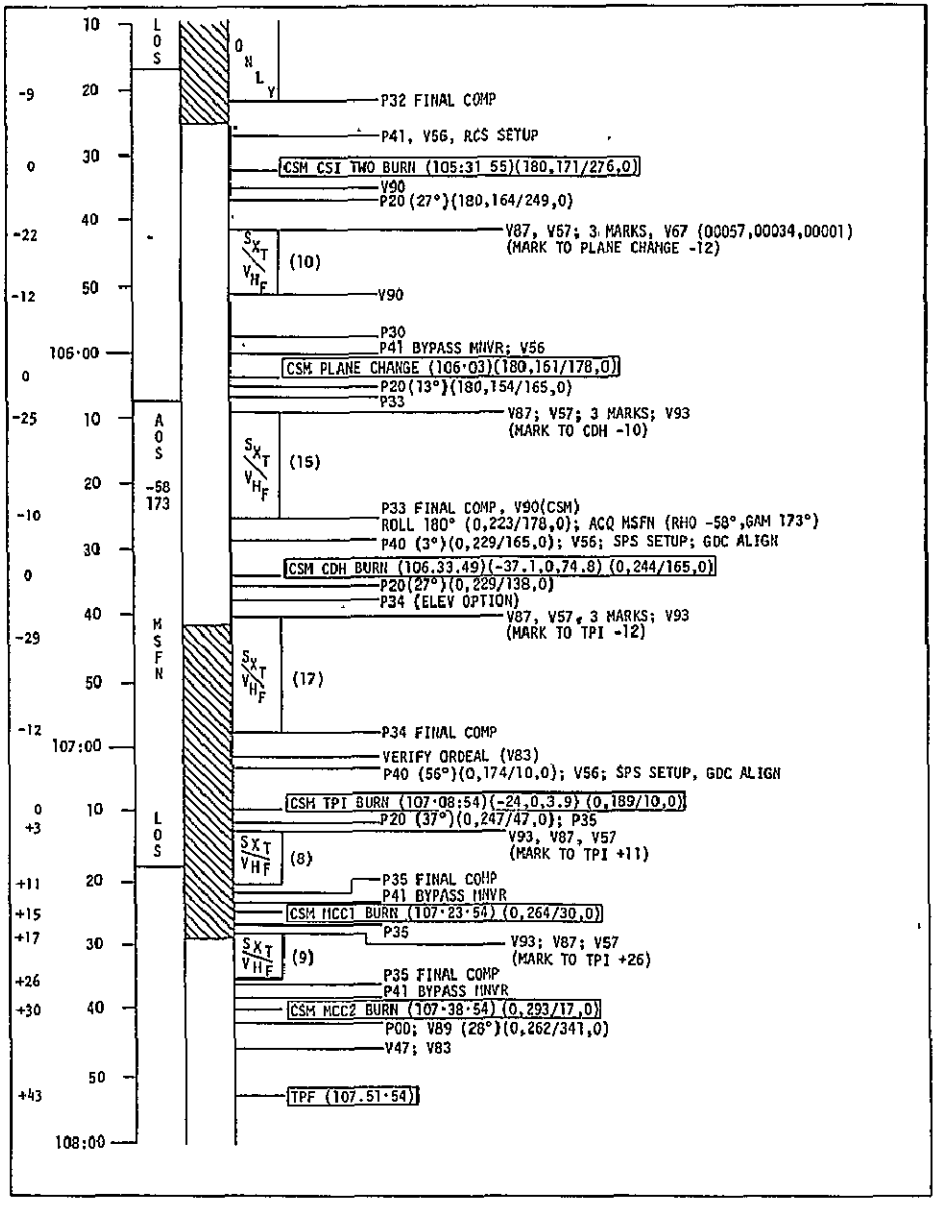
LM PC P76

84	•	•	•
33	•	•	

LM TPI P76

84	•	•	•
33	•	•	


MSFN
LOS
AOS
-48
180
MSFN
LOS
103:00
104:00
105:00
LM PARTIAL INSERTION BURN (102:43:18)
P52 (OPTION 3)
MCC-H UPLINK (LM VECTOR)
COPY RESCUE; CSI ONE, CDH, TPI PADS
P30
P40 (19°)(180,165/282,0);V56, SPS SETUP; GDC ALIGN
CSM RESCUE BURN (103:31:59)(-44.9,0,0)(180,180/282,0)
P20 (49°)(180,141/233,0)
P32; N=2
V93; V57
(MARK TO CSI ONE -15)
SXT
(20)
P32 FINAL COMP
P40 (175°)(180,345/281,0); V56, SPS SETUP; GDC ALIGN
ACQ MSFN (RHO -48°,GAM 180°)
CSM CSI ONE BURN (104:29:59)(114.6,0,0)(180,0/281,0)
P00
P52 (OPTION 3)
MCC-H UPLINK (LM VECTOR)(IF LM ACTIVE)
P20 (90°)(180,162/11,0)
P32, COMPUTE CSI TWO TIGN; N=1
V93, V87; V57
SXT/VHF (5)
SXT/VHF(5), IF VHF,TERMINATE SXT, V93,
VHF(5), V90, VHF(13)
(MARK TO CSI TWO -9)
VHF (18)
V90(CSM)
NOTE.
(IF NO VHF BY CSI TWO -25, V88, CONTINUE SXT)


LOS
ONLY
AOS
-58
173
MSFN
LOS
P32 FINAL COMP
P41, V56, RCS SETUP
CSM CSI TWO BURN (105:31:55)(180,171/276,0)
V90
P20 (27°)(180,164/249,0)
V87, V57; 3 MARKS, V67 (00057,00034,00001)
(MARK TO PLANE CHANGE -12)
SXT/VHF (10)
V90
P30
P41 BYPASS MNVR; V56
CSM PLANE CHANGE (106:03)(180,161/178,0)
P20(13°)(180,154/165,0)
P33
V87; V57; 3 MARKS; V93
(MARK TO CDH -10)
SXT/VHF (15)
P33 FINAL COMP, V90(CSM)
ROLL 180° (0,223/178,0); ACQ MSFN (RHO -58°,GAM 173°)
P40 (3°)(0,229/165,0); V56; SPS SETUP; GDC ALIGN
CSM CDH BURN (106:33:49)(-37.1,0,74.8) (0,244/165,0)
P20(27°)(0,229/138,0)
P34 (ELEV OPTION)
V87, V57, 3 MARKS; V93
(MARK TO TPI -12)
SXT/VHF (17)
P34 FINAL COMP
VERIFY ORDEAL (V83)
P40 (56°)(0,174/10,0); V56; SPS SETUP, GDC ALIGN
CSM TPI BURN (107:08:54)(-24.0,3.9) (0,189/10,0)
P20 (37°)(0,247/47,0); P35
V93, V87, V57
(MARK TO TPI +11)
SXT/VHF (8)
P35 FINAL COMP
P41 BYPASS MNVR
CSM MCC1 BURN (107:23:54) (0,264/30,0)
P35
V93; V87; V57
(MARK TO TPI +26)
SXT/VHF (9)
P35 FINAL COMP
P41 BYPASS MNVR
CSM MCC2 BURN (107:38:54) (0,293/17,0)
P00; V89 (26°)(0,262/341,0)
V47; V83
TPF (107:51:54)
108:00

9.0 LM RESCUE PROCEDURES SUMMARY

9.1 Rescue Procedures Ground Rules

9.1.1 The GDC will be aligned to the IMU before all SPS burns.

9.1.2 P20 will be terminated with a verb 56 before all SPS burns and the Plane Change burn.

9.1.3 A rescue pad will be received by the CSM 20 minutes after LM failure in all cases where a Rescue rather than Backup burn is used. The pad will include CSI, CDH, and TPI burn data.

9.1.4 The detailed procedures for SPS burns are listed on the timelines because gimbal motor checks are included which are not employed in the nominal backups.

9.1.5 Moves to the LEB or CMD seat are not made during auto maneuvers unless time is limited.

9.1.6 The 180-degree option should be taken in P32 by loading in a non-zero central angle of 130 degrees.

9.1.7 TIGN for CSI Two (and Three) burns will be computed onboard to be half way between the previous CSI TIGN and P32 CDH TIGN.

9.1.8 The LM state vector will always be updated unless notified otherwise by the ground.

9.2 LM PDI ABORT

GET	EVENT	PROG
		-11
	PDI ABORT	
(99+33+59)		-10
	**********	
	LM DOI BURN(-71.1,0,-.3)	
	**********	
	CONFIRM LM DOI	
	INCORPORATE P76 DATA	-9
	(DOI)	
(99+37)		-2
	SUNUP	
-53 (99+38)		0
	RENDEZVOUS NAV PROGRAM (P20)	
	POSSIBLE AUTO MNVR TO SXT TRACK	
	(TRIM)	
	(0,225/318,0)	
	MOVE TO LEB	
-47 (99+44)		
	INITIATE LM OPTICS TRACK	
-24 (100+07)		-50
	MOVE TO CMD SEAT	
	ROLL 180 DEG AND PITCH UP 70 DEG	
	AT 1 DEG/SEC	
	ACQUIRE MSFN (V64) (P00)	
	(180,278/268,0)	-44
(100+09)		
	AOS	
	RHO=-76 , GAMMA=17	

GET	EVENT	PROG
(100+20)		
	V67 LOAD WI(002.89,0017.3,00001)	
	MOVE TO LEB	
(100+21)		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(17 DEG)	
	(180,288/251,0)	
(100+22)		
	CALL MARKING ROUTINES(V87,V57)	
(100+29)		
	TERMINATE MARKS (7)	
(100+31+24)		
	**********	
	LM PDI ABORT BURN (96.2,0,0)	
	(180,298/230,0)	
	**********	
	TARGET DV PROGRAM (P76)	
(100+34)		
	CMC IDLING PROGRAM (P00)	
100+42)		
	SUNDOWN	
	IMU REALIGN TO REFSMMAT (P52)	
	(OPTION 3)	
	COPY GYRO TORQUE ANGLES	
(100+48)		
	MCC-H UPLINK(LM VECTOR) (P00)	
	COPY CSI,CDH,TPI PADS	

	GET	EVENT	PROG
-40	(100+52)		
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK	
		(47 DEG)	
		(180,315/183,0)	
-38	(100+54)		
		CSI TARGETING PROGRAM	(P32)(P20)
		OBTAIN LM CSI AND TPI TIGNS,	
		LOAD N55 WITH	
		R1=00001	
		R2=20830	
		R3=13000	
		MOVE TO LEB	
-35	(100+57)		
		CALL MARKING ROUTINE(V93,V87,V57)	
		(AFTER 5 MARKS V93)	
-30	(101+02)		
		TERMINATE SXT MARKS,V93	
		CONTINUE VHF	
-25	(101+07)		
		OUT OF PLANE DATA(V90)	
		VOICE LM Y DOT TO LM	
		CONTINUE VHF	
-19	(101+17)		
		TERMINATE MARKS(20)	
		MOVE TO CMD SEAT	
		CSI TARGETING FINAL COMP	(P32)
		COPY CSM CSI SOLUTION	
		OVERWRITE N81 WITH(-)CSM	
		YDOT(V90)	
-12	(101+20)		
		COPY LM CSI PAD	
		LOS	

	GET	EVENT	PROG
-11	(101+21)		
		SPS THRUST PROGRAM,V56	(P40)
		AUTO MNVR TO BURN ATTITUDE	
		(161 DEG)	
		(180,165/288,0)	
-5	(101+27)		
		SPS THRUST SETUP	(P40)
		GDC ALIGN	
-2	(101+30)		
		SUNUP	
0	(101+31+47)		
		**********	
		LM CSI BURN (49.7,0,0)	
		**********	
		**********	
		CSM CSI BACKUP BURN(-50.2,0,0)	
		(180.180/288,0)	
		**********	
		TARGET DV PROGRAM	(P76)
		(CSI)	
-30	(101+33)		
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK	
		(168 DEG)	
		(180,16/120,0)	
-24	(101+39)		
		CALL MARKING ROUTINES(V87,V57)	
		AFTER 3 SXT MARKS PROCESSED	
		V67 LOAD WR(000.57,1003,4,00001)	

GET	EVENT	PROG
-10	(101+53)	
	COPY LM PC TIGN	
	OUT OF PLANE DATA(V90)	
	VOICE LM YDOT TO LM	
	COPY LM PC PAD	
-2	(102+01)	
	TERMINATE MARKS (22)	
	LOAD TARGET DV PROGRAM	(P76)
0	(102+03+00)	
	**********	
	LM PLANE CHANGE(0,0,0)	
	**********	
	INCORPORATE P76 DATA	
	(PLANE CHANGE)	
-29	(102+05)	
	CDH TARGETING PROGRAM	(P33)
	POSSIBLE AUTO MNVR TO SXT TRACK	
	(TRIM)	
	OBTAIN LM CDH TIGN	
	LOAD CDH TARGETING DATA	
-27	(102+07)	
	CALL MARKING ROUTINE(V87,V57)	
	(PROCESS THREE MARKS,V93)	
	AOS	

GET	EVENT	PROG
-13	(102+21)	
	TERMINATE MARKS (14)	
	OUT OF PLANE DATA(V90)	
	VOICE LM YDOT TO LM	
	MOVE TO CM SEAT	
	ROLL 180 DEG AT 2 DEG/SEC	(P00)
	ACQ MSFN	
	RHO=-55 , GAMMA=173	
	(0,347/290,0)	
	CDH TARGETING FINAL COMP	(P33)
	COPY CSM CDH SOLUTION	
	COPY LM CDH PAD	
-9	(102+25)	
	SPS THRUST PROGRAM, V56	(P40)
	MANUAL MNVR AT 1 DEG/SEC TO BURN	
	ATTITUDE	
	(122 DEG)	
	(0,356/290,0)	
-5	(102+29)	
	(SPS THRUST SETUP	(P40)
	GDC ALIGN	
0	(102+33+41)	
	**********	
	LM CDH BURN (-115.9,0,5.7),	
	**********	
	**********	
	CSM CDH BACKUP BURN (112.9,0,-21.4	
	(0,11/290,0)	
	**********	

GET	EVENT	PROG
-33 (102+36)		
	TARGET DV PROGRAM (76DH)	(P76)
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(149 DEG)	
	(0,22^9/141,0)	
	MOVE TO LEB	
	TPI TARGETING PROGRAM	(P34) (P20)
	LOAD N55 WITH	
	R2=20830	
	R3=13000	
-27 (102+42)		
	CALL MARKING ROUTINE(V87,V57)	
	(PROCESS THREE MARKS,V93)	
-22 (102+47)		+02
	SUNDOWN	
-17 (102+52)		
	COPY LM TPI TIGN	
-12 (102+57)		
	TERMINATE MARKS (15)	
	MOVE TO CMD SEAT	
	VERIFY ORDEAL(V83)	+03
-10 (102+59)		
	TPI TARGETING PROGRAM	(P34)
	FINAL COMP	
	(TIGN OPTION WITH LM TIGN)	+11
-7 (103+02)		
	SPS THRUST PROGRAM,V56	(P40) +12
	AUTO MNVR TO BURN ATTITUDE	
	(50 DEG)	
	(0,193/18,0)	
	COPY LM TPI P76 PAD	

GET	EVENT	PROG
-5 (103+04)		
	SPS THRUST SETUP	(P40)
	(TPI)	
	GDC ALIGN	
0 (103+09+24)		
	**********	
	LM TPI BURN (22.2,0,-11,1)	
	**********	
	**********	
	CSM TPI BACKUP BURN (-22.3,0,12)	
	(0,208/18,0)	
	**********	
	TARGET DV PROGRAM	(P76)
	(TPI)	
+02		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(33 DEG)	
	(0,245/51,0)	
	MCC TARGETING PROGRAM	(P35)
	MOVE TO LEB	
+03		
	CALL MARKING ROUTINE(V93,V87,V57)	
(103+18)		
	LOS	
+11		
	TERMINATE MARKS(8)	
+12		
	MCC1 TARGETING FINAL COMP	(P35)
	COPY CSM MCC1 SOLUTION	
	COPY LM MCC1 PAD	

GET	EVENT	PROG
13.5		
	RCS THRUST PROGRAM (P41)	
	BYPASS BURN ATTITUDE MNVR	
	(0,260/30,0)	
15 (103+24+24)		
	**********	
	LM MCC1 THRUST	
	**********	
	**********	
	CSM MCC1 BACKUP BURN	
	(0,263/30,0)	
	**********	
	TARGET DV PROGRAM (P76)	
	(MCC1)	
16		
	MCC2 TARGETING PROGRAM (P35) (P20)	
	POSSIBLE AUTO MNVR TO SXT TRACK	
	(TRIM)	
	(0,264/27,0)	
17		
	CALL MARKING ROUTINE (V93,V87,V57)	
103+33)		
	SUNUP	
26		
	TERMINATE MARKS(9)	
	MOVE TO CMD SEAT	
27		
	MCC2 TARGETING FINAL COMP (P35)	
	COPY CSM MCC2 SOLUTION	
	COPY LM MCC2 PAD	
28.5		
	RCS THRUST PROGRAM (P41)	
	BYPASS BURN ATTITUDE MNVR	
	(0,258/19,0)	
+30	(103+39+24)	
	**********	
	LM MCC2 BURN	
	**********	
	**********	
	CSM MCC2 BACKUP BURN	
	(0,252/19,0)	
	**********	
	TARGET DV PROGRAM (P76)	
	(MCC2)	
	AUTO MNVR TO COAS TRACK (V89) (P00)	
	(26 DEG)	
	(0,265/340,0)	
+39	(103+48)	
	THRUST MONITORING PROGRAM (P47)	
	**********	
	* BRAKING GATES RETICLE ANGLE *	
	* 30 FPS AT 6000 FT .13 DEG. *	
	* 20 FPS AT 3000 FT .26 DEG. *	
	* 10 FPS AT 2500 FT .54 DEG. *	
	* 5 FPS AT 500 FT 1.60 DEG. *	
	**********	
+43	(103+52)	
	**********	
	TPF	
	**********	

9.2.2 RENDEZVOUS NAVIGATION SUMMARY WITH SUN ANGLES

LM ACTIVE - PDI ABORT
(MISSION F)
IT - INITIATE TRACK
CT - CEASE TRACK
(OUT-OF-PLANE SUN ANGLE IS 4 DEG)

GET	EVENT	SUN ANGLE (LOS TO SUN) DEG
99:34	LM DOI	
99:37	SUNRISE	
100:22	IT (SXT/VHF) (7/7)	156
100:29	CT (SXT/VHF)	171
100:31	LM PDI ABORT	
100:42	SUNSET	
100:57	IT (SXT/VHF) (V93,6/5,V93,14/15)	
101:02	CT (SXT)	
101:17	CT (VHF)	
101:30	SUNRISE	
101:32	LM CSI	
101:39	IT (SXT/VHF) (4/3,V67,00057,00034,00001;18/19)	80
101:44		91
101:49		101
101:54		103
101:59		101
102:01	CT (SXT/VHF)	99
102:03	LM PLANE CHANGE	
102:07	IT (SXT/VHF) (4/3,V93,10/11)	90
102:12		83
102:17		71
102:21	CT (SXT/VHF)	63
102:34	LM CDH	
102:42	IT (SXT/VHF) (4/3,V93/11/12)	8
102:47	SUNSET	6
102:57	CT (SXT/VHF)	
103:09	LM TPI	
103:12	IT (SXT/VHF) (V93,8/8)	
103:20	CT (SXT/VHF)	
103:24	LM MCC1	
103:26	IT (SXT/VHF) (V93,9/9)	
103:33	SUNRISE	96
103:35	CT (SXT/VHF)	97
103:39	LM MCC2	
103:52	TPF	

9.2.3 CSM ATTITUDE SUMMARY

INERTIAL AND ORDEAL FDAI BALL GIMBAL ANGLE PROFILE FOR THE LM ACTIVE PDI ABORT RESCUE CASE (MISSION F) (YAW = 0.0)

TIME GET	ROLL	PITCH ORDEAL	PITCH INERTIAL	PITCH MNVR
99:34	0	215	320	
99:38	0	225	318	
100:07	180	278	268	70
100:21	180	288	251	17
100:31	180	298	230	
100:52	180	315	183	47
101:21	180	165	288	161
101:32	180	180	288	
101:33	180	16	120	168
102:03	180	130	143	
102:21	0	347	290	
102:25	0	356	290	122
102:34	0	11	290	
102:36	0	229	141	149
103:02	0	193	18	50
103:09	0	208	18	
103:11	0	245	51	33
103:23	0	260	30	
103:24	0	263	30	
103:25	0	264	27	
103:37	0	258	19	
103:39	0	252	19	
103:40	0	265	340	26
103:52	0	277	340	

9.3 LM PARTIAL PHASING GREATER THAN OR EQUAL TO 40 FPS

LM PHASING GREATER THAN 40 FPS RESCUE TIMELINE

GET	EVENT	PROG
(100+46+21)	**********	*
	LM PHASING BURN(34.9,0.-19.55)	*
	**********	*
(100+48)		*
	SUNSET	*
	MOVE TO LEB	*
(100+49)		*
	IMU REALIGN TO REFSMMAT	(P52) *
	(OPTION 3)	*
(100+54)		*
	MCC-H UPLINK(LM VECTOR)	(P00) *
	MOVE TO CMD SEAT	*
(101+06)		*
	COPY RESCUE,CSI ONF,CDH,TPI PADS	*
-16 (101+17)		*
	EXTERNAL DV PROGRAM	(P30)(P20) *
14 (101+19)		*
	SPS THRUST PROGRAM,V56	(P40) *
	AUTO MNVR TO BURN ATTITUDE	*
	(95 DEG)	*
	(180,165/283,0)	*
(101+20)		*
	LOS	*
**********		*
-14 (101+19)		* *
	KEY 40E	* *
	F 50 18 (COMMANDED R,P,Y)	* *
	KEY V56E	* *
	RHC-ARMED	* *
	ALIGN ROLL TO -180 DEG.	* *

GET	EVENT	PROG
	RHC-LOCKED	*
	PRO	*
06 18	(COMMANDED R,P,Y)	*
	MONITOR MNVR	*
F 50 18	(COMMANDED R,P,Ỹ)	*
	MN BUS TIE(2)-ON(UP)	*
	SPS HE VLV TB(BOTH)-BP	*
	SPS HE VLV(BOTH)-AUTO	*
	ASNESS BUS-MNA	*
	PRO	*
06 18	(COMMANDED R,P,Ỹ)	*
	MONITOR ATT TRIM	*
F 50 18	(COMMANDED R,P,Ỹ)	*
**********		*
-8 (101+25)		
	SPS THRUST SETUP	(P40)
**********		*
-8 (101+25)		*
		*
	GDC ALIGN	*
		*
		*
	ALT SET KNOB TO 60 NM	*
	FDAI SELECT-1	*
	ATT SET THUMBWHEELS TO N18	*
	NULL ATT ERROR NEEDLES	*
	ON FDAI 1 WITH ATT	*
	SET THUMBWHEELS	*
	ATT SET-GDC	*
	DEPRESS GDC ALIGN PB	*
	FDAI SELECT-1/2	*

GET	EVENT	PROG
	ATT SET-TMU	
	MTVC CHECKS	
	BMAG MODE(3)-ATT1/RATE?	
	TVC SERVO PWR 1-AC1/MNA	
	TVC SERVO PWR 2-AC2/MNB	
	TRANS CONTR PWR-ON	
	RHC PWR NORM 2-AC	
	GMBL MTRS PITCH 1 STRT-ON	
	GMBL MTRS YAW 1 STRT-ON	
	THC-CLOCKWISE	
	RHC-ARMED	
	RHC-VERIFY NO MTVC	
	GMBL MTRS PITCH 2-STRT-ON	
	GMBL MTRS YAW 2-STRT-ON	
	SET SPS GIMBALS TW(2)-	
	PITCH = -.52	
	YAW = +.59	
	RHC-VERIFY MTVC	
	THC-NEUTRAL	
	RHC PWR NORM 2-AC/DC	
	RHC-LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
	KEY ENTER	
F 50 25	(00204,GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)-MNA/MNB	
	RATE-HIGH	
	AUTO RCS SEL A/C ROLL(4)-MNA	
	PRO	

GET	EVENT	PROG
	MONITOR GMBL DRIVE SEQ AND TRIM	
06 40	(TFI,VG,DVM)	
	FDAI SCALE-5/5	
	VERIFY SPS TH LT-OFF	
	EMS MODE STBY	
	EMS FUNCTION-DV SET	
	LOAD RESCUE VC	
	EMS FUNCTION-DV	
	THC-ARMED	
	RHC-ARMED	
	DV THRUST(A)-NORMAL	
	DSKY BLANKS	
06 40	(TFI,VG,DVM)	
	EMS MODE-NORMAL	
	PERFORM ULLAGE	
F 99 40	(REQUEST FOR ENGINE ENABLE)	
	PRO	
06 40	(TFI,VG,DVM)	
	**********	
0	(101,33,19)	
	**********	
	CSM RESCUE BURN(-48.75,0,0) (180,180/283,0)	
	**********	

GET	EVENT	PROG
	**********	*
	SET MUC EI-RESET,START	*
	MONITOR	*
	SPS THRUST LT-ON	*
	DV INDICATOR-DECREASING	*
+00+01		*
	ULLAGE-OFF	*
06 40	(TFC,VG,DVM)	*
	MONITOR SPS OPERATION	*
	PC INDICATOR-95-105 PSI	*
	MONITOR SPS ENGINE CUTOFF	*
	SPS THRUST LT-OFF	*
F 16 40	(TFC,VG,DVM)	*
	DV THRUST(BOTH)-OFF	*
	MONITOR	*
	PC INDICATOR = 0	*
	SPS INJ VLV IND(4)-CLOSE	*
	SPS HE VLV TB(BOTH)-BP	*
	SPS GIMBLS RETURN TO SERVO NULL	*
	GIMBL MTRS-OFF(SEQUENTIALLY)	*
	TVC SERVO PWR(BOTH)-OFF	*
	FDAI SCALE-5/1	*
	RATE-LOW	*
	ROT CONT PWR DIRECT(BOTH)-OFF	*
	PRO	*
F 16 85	(VG=BODY)	*
	THC-NULL VG COMPONENTS	*
	THC-LOCKED	*
	PHC-LOCKED	*
	EMS FUNCTION-VHF RNG	*

GET	EVENT	PROG
	EMS MODE-VHF RNG	*
	VHF RNG-RESET	*
	VN BUS TIE(2)-OFF	*
	PRO	*
F 37 BR		*
	**********	*
	MOVE TO LEB	
(101+34)		
	SUNRISE	
(101+35)		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(141 DEG)	
	(180,327/64,0)	
(101+40)		
	CSI TARGETING PROGRAM (P35)(P20)	
	LOAD N55 R1=+00002	
	R2=+20830	
	R3=+13000	
-49 (101+42)		
	CALL MARKING ROUTINE(V93,V87)	
(102+07)		
	AOS	
-14 (102+17)		
	TERMINATE MARKS(35)	
	CSI TARGETING FINAL (P32)(P20)	
	COMP	
	MOVE TO CMD SEAT	
-11 (102+20)		
	SPS THRUST PROGRAM,V56 (P40)	
	AUTO MNVR TO BURN ATTITUDE	
	(170 DEG)	
	(180,165/103,0)	

GET	EVENT	PROG
-11	(102+20)	
	KEY 40E	
F 50 18	(COMMANDED R,P,Y)	
	KEY V56E	
	RHC=ARMED	
	ALIGN ROLL TO 180 DEG.	
	RHC=LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR MNVR	
F 50 18	(COMMANDED R,P,Y)	
	MN BUS TIE(2)=ON(UP)	
	SPS HE VLV TB(BOTH)=BP	
	SPS HE VLV(BOTH)=AUTO	
	NONESS BUS=MNA	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
-5	(102+26)	
	SPS THRUST SETUP	(P40)
-5	(102+26)	
	GDC ALIGN	
	ALT SET KNOB TO 60 NM	
	FDAI SELECT=1	
	ATT SET THUMBWHEELS TO N18	

GET	EVENT	PROG
	NULL ATT ERROR NEEDLES	
	ON FDAI 1 WITH ATT	
	SET THUMBWHEELS	
	ATT SET=GDC	
	DEPRESS GDC ALIGN PB	
	FDAI SELECT=1/2	
	ATT SET=TMU	
	MTVC CHECKS	
	BMAG MODE(3)=ATT1/RATE2	
	TVC SERVO PWR 1=AC1/MNA	
	TVC SERVO PWR 2=AC2/MNB	
	TRANS CONTR PWR=ON	
	RHC PWR NORM 2=AC	
	GMBL MTRS PITCH 1 STRT=ON	
	GMBL MTRS YAW 1 STRT=ON	
	THC=CLOCKWISE	
	RHC=ARMED	
	RHC=VERIFY NO MTVC	
	GMBL MTRS PITCH 2=STRT=ON	
	GMBL MTRS YAW 2=STRT=ON	
	SET SPS GIMBALS TW(2)=	
	PITCH = -.52	
	YAW = +.59	
	RHC=VERIFY MTVC	
	THC=NEUTRAL	
	RHC PWR NORM 2=AC/DC	
	RHC=LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
	KEY ENTER	

GET	EVENT	PROG
*	F 50 25 (00204,GMBL DRIVE TEST)	*
*	RHC PWR DIRECT(BOTH)-MNA/MNB	*
*	RATE-HIGH	*
*	AUTO RCS SEL A/C ROLL(4)-MNA	*
*	PRO	*
*	MONITOR GMBL DRIVE	*
*	SEQ AND TRIM	*
*	06 40 (TFI,VG,DVM)	*
*-02+00		*
*	FDAI SCALE-5/5	*
*	VERIFY SPS THRUST-OFF	*
*	EMS MODE STBY	*
*	EMS FUNCTION-DV SET	*
*	LOAD CSI VC	*
*	EMS FUNCTION-DV	*
*	THC-ARMED	*
*	RHC-ARMED	*
*	DV THRUST(A)-NORMAL	*
*-00+35		*
*	DSKY BLANKS	*
*-00+30		*
*	06 40 (TFI,VG,DVM)	*
*	EMS MODE-NORMAL	*
*-00+15		*
*	PERFORM ULLAGE	*
*-00+05		*
*	F 99 40 (REQUEST FOR ENGINE ENABLE)	*
*	PRO	*
*	06 40 (TFI,VG,DVM)	*
**********	**********	*

GET	EVENT	PROG
*	0 (102+31+11)	*
*	**********	*
*	CSM CSI ONE BURN(-56.8,0,0)	*
*	(180,180/103,0)	*
*	**********	*
**********	**********	*
* *	SET MDC ET-RESET,START	*
* *	MONITOR	*
* *	SPS THRUST LT-ON	*
* *	DV INDICATOR-DECREASING	*
*+00+01		*
* *	ULLAGE-OFF	*
* *	06 40 (TFC,VG,DVM)	*
* *	MONITOR SPS OPERATION	*
* *	PC INDICATOR-95-105 PSI	*
* *	MONITOR SPS ENGINE CUTOFF	*
* *	SPS THRUST LT-OFF	*
* *	F 16 40 (TFC,VG,DVM)	*
* *	DV THRUST(BOTH)-OFF	*
* *	MONITOR	*
* *	PC INDICATOR = 0	*
* *	SPS INJ VLV IND(4)-CLOSE	*
* *	SPS HE VLV TB(BOTH)-BP	*
* *	SPS GMBLS RETURN TO SERVO	*
* *	NULL	*
* *	GMBL MTRS-OFF(SEQUENTIALLY)	*
* *	TVC SERVO PWR(BOTH)-OFF	*
* *	FDAI SCALE-5/1	*
* *	RATE-LOW	*
* *	ROT CONT PWR DIRECT(BOTH)-OFF	*
* *	PRO	*
* *	F 16 85 (VG=BODY)	*
* *	THC-NULL VG COMPONENTS	*
* *	THC-LOCKED	*

GET	EVENT	PROG	GET	EVENT	PROG
	RHC-LOCKED	*	(103+00)		
	EMS FUNCTION-VHF RNG	*		TERMINATE SXT,CONT, VHF	
	EMS MODE-VHF RNG	*	(103+05)		
	VHF RNG-RESET	*		OUT OF PLANE DATA(V60)	
	MN BUS TIE(2)-OFF	*		COPY CSM YDOT	
	PRO	*	(103+12)		
F 37 RR		*		LOS	
		-9	(103+18)	TERMINATE MARKS(23)	
(102+32)				CSI TARGETING FINAL (P32)(P20)	
	CMC IDLING PROGRAM (P00)			COMP	
	MOVE TO LEB			OVERWRITE NAV WITH(-)CSM YDOT	
(102+42)					
	SUNSET	-6	(103+21)	RCS THRUST PROGRAM,V56 (P41)	
	IMU REALIGN TO REFSMMAT (P52)			AUTO MNVR TO BURN ATTITUDE	
	(OPTION 3)				
(102+47)			(103+25)		
	MOVE TO CMD SEAT			RCS THRUST SETUP (P41)	
	MCC-H UPLINK(LM VECTOR)			GDC ALIGN	
	(IF LM ACTIVE)	0	(103+27)		
(102+49)				**********	
	RENDEZVOUS NAV PROGRAM (P20)			CSM CSI TWO BURN(, ,)	
	AUTO MNVR TO SXT TRACK			(180,10/125,0)	
	(82 DEG)			**********	
	(180,321/185,0)		(103+28)		
(102+52)				RENDEZVOUS NAV PROGRAM (P20)	
	CSI TARGETING PROGRAM (P32)(P20)			AUTO MNVR TO SXT TRACK	
	LOAD N55 R1=+00001			(13 DEG)	
	R2=+20830			(180,13/112,0)	
	R3=+13000	-24	(103+31)		
	MOVE TO LEB			SUNRISE	
-32 (102+55)				CALL MARKING ROUTINE(V87,V57)	
	CALL MARKING ROUTINE(V93,V87,V57)			AFTER 3 MARKS PROCESSED	
	(V93 AFTER 5 MKS PROCESSED)			V67,LOAD WR(00057,00034,00001)	

	GET	EVENT	PROG
-12	(103+43)	TERMINATE MARKS(12)	
		OUT OF PLANE DATA(V90)	
	(103+47)	EXTERNAL DV TARGETING (P30)(P20)	
-8	(103+53)	RCS THRUST PROGRAM,V56 (P41)	
		BY PASS BURN ATTITUDE MNVR	
		RCS THRUST SETUP (P41)	
		GDC ALIGN	
0	(103+55)	**********	
		CSM PLANE CHANGE(180,123/138,0)	
		**********	
	(103+56)	RENDEZVOUS NAV PROGRAM (P20)	
		POSSIBLE AUTO MNVR TO SXT TRACK	
		(TRIM)	
	(103+57)	COM TARGETING PROGRAM (P33)(P20)	
	(104+00)	AOS	
-22	(104+01)	CALL MARKING ROUTINE(V87,V57)	
		(V93 AFTER MKS PROCESSED)	
-12	(104+11)	TERMINATE MARKS(10)	
		MOVE TO CMD SEAT	
		ROLL 180 DEG,ACQ MSFN	
		(0,160/108,0)	
		(RHO -56, GAM 173)	
		COM TARGETING FINAL (P33)(P20)	
		COMP	

GET	EVENT	PROG
	OUT OF PLANE DATA(V90)	
	OVERWRITE NAV WITH(-) CSM YDOT)	
(104+13)		
	SPS THRUST PROGRAM,V56 (P40)	
	MANUAL MNVR (1 DEG/SEC)	
	TO BURN ATT	
	(158 DEG)	
	(0,338/266,0)	
	**********	
-8 (104+13)		*
	KEY 40E	*
	F 50 18 (COMMANDED R,P,V)	*
	KEY V56F	*
	RHC-ARMED	*
	ALIGN ROLL TO 0 DEG.	*
	RHC-LOCKED	*
	PRO	*
	06 18 (COMMANDED R,P,V)	*
	MONITOR MNVR	*
	F 50 18 (COMMANDED R,P,V)	*
	MN BUS TIE(2)-ON(UP)	*
	SPS HE VLV TB(BOTH)-BP	*
	SPS HE VLV(BOTH)-AUTO	*
	NONESS BUS-MNA	*
	PRO	*
	06 18 (COMMANDED R,P,V)	*
	MONITOR ATT TRIM	*
	F 50 18 (COMMANDED R,P,V)	*
	**********	
-5 (104+18)		
	SPS THRUST SETUP (P40)	

GET	EVENT	PROG
-5 (104+18)		
	GDC ALIGN	
	ALT SET KNOB TO 60 NM	
	FDAI SELECT-1	
	ATT SET THUMBWHEELS TO N18	
	NULL ATT ERROR NEEDLES ON FDAI 1 WITH ATT SET THUMBWHEELS	
	ATT SET-GDC	
	DEPRESS GDC ALIGN PB	
	FDAI SELECT-1/2	
	ATT SET-TMU	
	MTVC CHECKS	+02+00
	BMAG MODE(3)-ATT1/RATE2	
	TVC SERVO PWR 1-AC1/MNA	
	TVC SERVO PWR 2-AC2/MNB	
	TRANS CONTR PWR-ON	
	RHC PWR NORM 2-AC	
	GMBL MTRS PITCH 1 STRT-ON	
	GMBL MTRS YAW 1 STRT-ON	
	THC-CLOCKWISE	
	RHC-ARMED	+00+35
	RHC-VERIFY NO MTVC	
	GMBL MTRS PITCH 2-STRT-ON	+00+30
	GMBL MTRS YAW 2-STRT-ON	
	SET SPS GIMBALS TW(2)- PITCH = -.52 YAW = +.59	+00+15
	RHC-VERIFY MTVC	
	THC-NEUTRAL	
	RHC PWR NORM 2-AC/DC	
	RHC-LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
	KEY ENTER	
F 50 25	(00204 GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)-MNA/MNB	
	RATE-HIGH	
	AUTO RCS SEL A/C ROLL(4)-MNA	
	PRO	
	MONITOR GMBL DRIVE SEQ AND TRIM	
06 40	(TFI,VG,DVM)	
	FDAI SCALE-5/5	
	VERIFY SPS TH LT-OFF	
	EMS MODE STBY	
	EMS FUNCTION-DV SET	
	LOAD CDH VC	
	EMS FUNCTION-DV	
	THC-ARMED	
	RHC-ARMED	
	DV THRUST(A)-NORMAL	
	DSKY BLANKS	
06 40	(TFI,VG,DVM)	
	EMS MODE-NORMAL	
	PERFORM ULLAGE	

```
      GET        EVENT                                  PROG

*-00+05                                                 * *
*          F 99 40 (REQUEST FOR ENGINE ENABLE)          * *
*                  PRO                                  * *
*             06 40 (TFI,VG,DVM)                        * *
*************************************************       *
  0    (104+23+12)                                      *
                ********************************       *
                CSM CDH BURN(109.1,0,32.7)              *
                          (0,344/266,0)                 *
                ********************************       *
*************************************************       *
*                  SET MDC ET-RESET,START               * *
*                  MONITOR                              * *
*                     SPS THRUST LT-ON                  *
*                     DV INDICATOR-DECREASING           *
*+00+01                                                 *
*                  ULLAGE-OFF                           *
*             06 40 (TFC,VG,DVM)                        *
*                  MONITOR SPS OPERATION                *
*                     PC INDICATOR-95-105 PSI           *
*                  MONITOR SPS ENGINE CUTOFF            *
*                     SPS THRUST LT-OFF                 *
*          F 16 40 (TFC,VG,DVM)                         *
*                  DV THRUST(BOTH)-OFF                  * -27
*                  MONITOR                              *
*                     PC INDICATOR = 0                  *
*                     SPS INJ VLV IND(4)-CLOSE          *
*                     SPS HE VLV TB(BOTH)-BP            *
*                     SPS GMBLS RETURN TO SERVO         * -12
*                       NULL                            *
*                  GMBL MTRS-OFF(SEQUENTIALLY)          *
*                  TVC SERVO PWR(BOTH)-OFF              *
*                  FDAI SCALE-5/1                       *
*                  RATE-LOW                             *
```

```
      GET        EVENT                                  PROG

*                  ROT CONT PWR DIRECT(BOTH)-OFF*
*                  PRO                                  *
*          F 16 85 (VG-BODY)                            *
*                  THC-NULL VG COMPONENTS               *
*                  THC-LOCKED                           *
*                  RHC-LOCKED                           *
*                  EMS FUNCTION-VHF RNG                 *
*                  EMS MODE-VHF RNG                     *
*                  VHF RNG-RESET                        *
*                  MN BUS TIE(2)-OFF                    *
*                  PRO                                  *
*          F 37 BB                                      *
*************************************************
      (104+24)
                RENDEZVOUS NAV PROGRAM        (P20)
                 AUTO MNVR TO SXT TRACK
                (119 DEG)
                (0,228/147,0)
      (104+28)
                TPI TARGETING PROGRAM   (P34)(P20)
                 LOAD R2=+20830
                      R3=+13000
                MOVE TO LEB
-27   (104+31)
                CALL MARKING ROUTINE(V87,V57)
                 (V93 AFTER 3 MKS PROCESSED)
      (104+34)
                SUNSET
-12   (104+46)
                TERMINATE MARKS(15)
                MOVE TO CMD SEAT
                VERIFY ORDEAL(V83)
                TPI TARGETING FINAL     (P34)(P20)
                 COMP
```

GET	EVENT	PROG
-7	(104+51)	
	SPS THRUST PROGRAM,V56 (P40)	
	AUTO MNVR TO BURN ATTITUDE	
	(78 DEG)	
	(0,179/6,0)	
-7	(104+51)	
	KEY 40E	
F 50 18	(COMMANDED R,P,Y)	
	KEY V56E	
	RHC-ARMED	
	ALIGN ROLL TO 0 DEG.	
	RHC-LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR MNVR	
F 50 18	(COMMANDED R,P,Y)	
	MN BUS TIE(2)-ON(UP)	
	SPS HE VLV TB(BOTH)-BP	
	SPS HE VLV(BOTH)-AUTO	
	NONESS BUS-MNA	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
-5	(104+53)	
	SPS THRUST SETUP	
-5	(104+53)	
	GDC ALIGN	
	ALT SET KNOB TO 60 NM	

GET	EVENT	PROG
	FDAI SELECT-1	
	ATT SET THUMBWHEELS TO N18	
	NULL ATT ERROR NEEDLES	
	ON FDAI 1 WITH ATT	
	SET THUMBWHEELS	
	ATT SET-GDC	
	DEPRESS GDC ALIGN PB	
	FDAI SELECT-1/2	
	ATT SET-TMU	
	MTVC CHECKS	
	BMAG MODE(3)-ATT1/RATE2	
	TVC SERVO PWR 1-AC1/MNA	
	TVC SERVO PWR 2-AC2/MNB	
	TRANS CONTR PWR-ON	
	RHC PWR NORM 2-AC	
	GMBL MTRS PITCH 1 STRT-ON	
	GMBL MTRS YAW 1 STRT-ON	
	THC-CLOCKWISE	
	RHC-ARMED	
	RHC-VERIFY NO MTVC	
	GMBL MTRS PITCH 2-STRT-ON	
	GMBL MTRS YAW 2-STRT-ON	
	SET SPS GIMBALS TW(2)-	
	PITCH = -.52	
	YAW = +.59	
	RHC-VERIFY MTVC	
	THC-NEUTRAL	
	RHC PWR NORM 2-AC/DC	
	RHC-LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	

GET	EVENT	PROG
	F 50 19 (COMMANDER) R,P,Y	
	KEY ENTER	
	F 50 25 (00204,GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)-MNA/MNB	
	RATE-HIGH	
	AUTO RCS SEL A/C ROLL(4)-MNA	
	PRO	
	MONITOR GMBL DRIVE	
	SEQ AND TRIM	
06 40	(TFI,VG,DVM)	
-02+00		
	FDAI SCALE-5/5	
	VERIFY SPS TH LT-OFF	
	EMS MODE STBY	
	EMS FUNCTION-DV SET	
	LOAD TPI VC	
	EMS FUNCTION-DV	
	THC-ARMED	
	RHC-ARMED	
	DV THRUST(A)-NORMAL	
-00+35		
	DSKY BLANKS	
-00+30		
06 40	(TFI,VG,DVM)	
	EMS MODE-NORMAL	
-00+15		
	PERFORM ULLAGE	
-00+05		
F 99 41	(REQUEST FOR ENGINE ENABLE)	
	PRO	
06 40	(TFI,VG,DVM)	

GET	EVENT	PROG
0	(104+57+59)	
	**********	
	CSM TPI BURN(-21.4,0,5.3)	
	(0,194/6,0)	
	**********	
	SET MDC ET-RESET,START	
	MONITOR	
	SPS THRUST LT-ON	
	DV INDICATOR-DECREASING	
+00+01		
	ULLAGE-OFF	
06 40	(TFC,VG,DVM)	
	MONITOR SPS OPERATION	
	PC INDICATOR-95-105 PSI	
	MONITOR SPS ENGINE CUTOFF	
	SPS THRUST LT-OFF	
F 16 40	(TFC,VG,DVM)	
	DV THRUST(BOTH)-OFF	
	MONITOR	
	PC INDICATOR = 0	
	SPS INJ VLV IND(4)-CLOSE	
	SPS HE VLV TB(BOTH)-BP	
	SPS GMBLS RETURN TO SERVO NULL	
	GMBL MTRS-OFF(SEQUENTIALLY)	
	TVC SERVO PWR(BOTH)-OFF	
	FDAI SCALE-5/1	
	RATE-LOW	
	ROT CONT PWR DIRECT(BOTH)-OFF	
	PRO	
F 16 85	(VG-BODY)	
	THC-NULL VG COMPONENTS	
	THC-LOCKED	

GET	EVENT	PROG
	RHC-LOCKED	+16
	EMS FUNCTION-VHF RNG	
	EMS MODE-VHF RNG	
	VHF RNG-RESET	+17
	MN BUS TIE(2)-OFF	
	PRO	+23
F 37 RR		
		+26
+2		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK'	+27
	(45 DEG)	
	(0,245/51,0)	
	MOVE TO LEB DURING AUTO MNVR . .	+28.5
	MCC TARGETING PROGRAM (P35)(P20)	
+3		
	CALL MARKING ROUTINE(V93,V87,V57)	
(105+08)		+30
	LOS	
+11		
	TERMINATE MARKS(8)	
+12		+31
	MCC TARGETING FINAL (P35)(P20)	
	COMP	
+13.5		
	RCS THRUST PROGRAM (P41)	
	BYPASS BURN ATTITUDE MNVR	
	RCS THRUST SETUP (P41)	
+15 (105+12+57)		
	**********	
	MCC1 BURN(0,228/33,0)	
	**********	

GET	EVENT	PROG
	MCC TARGETING PROGRAM (P35)(P20)	
	POSSIBLE MNVR TO SXT TRACK	
	CALL MARKING ROUTINE(V93,V87,V57)	
	SUNRISE	
	TERMINATE MARKS(9)	
	MOVE TO CMD SEAT	
	MCC TARGETING FINAL (P35)(P20)	
	COMP	
	RCS THRUST PROGRAM (P41)	
	BYPASS BURN ATTITUDE MNVR	
	RCS THRUST SETUP (P41)	
(105+27+57)		
	**********	
	MCC2 BURN(0,294/19,0)	
	**********	
	AUTO MNVR TO COAS TRACK(V89)(P00)	
	(36 DEG)	
	(0,261/343,0)	
	CALL P47 WHEN R=1.25 N.M.	
	THRUST MONITOR PROGRAM (P47)	
	V83,PERFORM BRAKING AND	
	LOS CONTROL	

```
GET        EVENT                                    PROG

                                  ***************
           *BRAKING GATES          RETICLE ANGLE*
           * 30 FPS AT 6000 FT        .13 DEG. *
           * 20 FPS AT 3000 FT        .26 DEG. *
           * 10 FPS AT 2500 FT        .54 DEG. *
           *  5 FPS AT  500 FT       1.60 DEG. *
           ***********************************
+42   (105+39+57)
           ***********************************
           TPF
           ***********************************
```

9.3.2 NAVIGATION SUMMARY
LM PARTIAL PHASING ≥ 40 FPS
P20 NAVIGATION SUMMARY WITH SUN ANGLES
IT-INITIATE TRACK
CT-CEASE TRACK
(OUT-OF-PLANE SUN ANGLE IS 4 DEG)

GET	EVENT	SUN ANGLE (LOS TO SUN) DEG
100:46	LM PHASING	
100:48	SUNSET	
101:33	CSM RESCUE BURN	
101:34	SUNRISE	
101:42	IT (VHF) (V93,35/35)	108
102:17	CT (VHF)	144
102:31	CSM CSI ONE BURN	
102:42	SUNSET	
102:55	IT (SXT/VHF) (V93,6/5,V93,14/15)	
103:00	CT (SXT)	
103:15	CT (VHF)	
103:27	CSM CSI TWO BURN	
103:31	SUNRISE	
	IT (SXT/VHF) (4/3;V67,00057,00034,00001;8/9)	66
103:43	CT (SXT/VHF)	83
103:55	CSM PLANE CHANGE	
104:01	IT (SXT/VHF) (4/3,V93,6/7)	82
104:06		72
104:11	CT (SXT/VHF)	61
104:23	CSM CDH BURN	
104:31	IT (SXT/VHF) (4/3,V93,11/12)	1
104:34	SUNSET	14
104:46	CT (SXT/VHF)	
104:58	CSM TPI BURN	
105:01	IT (SXT/VHF) (V93,8/8)	
105:09	CT (SXT/VHF)	
105:13	CSM MCC1 BURN	
105:15	IT (SXT/VHF) (V93,9/9)	
105:21	SUNRISE	97
105:24	CT (SXT/VHF)	100
105:28	CSM MCC2 BURN	
105:40	TPF	

9.3.3 CSM ATTITUDE SUMMARY. INERTIAL AND ORDEAL FDAI BALL GIMBAL ANGLE PROFILE FOR LM PHASING ≥ 40 FPS (MISSION F) (YAW = 0.0)

TIME GET	ROLL	PITCH ORDEAL	PITCH INERTIAL	PITCH MNVR
100:46	180	307	193	
101:19	180	165	283	95
101:33	180	180	283	
101:35	180	327	64	141
102:20	180	165	103	170
102:31	180	180	103	
102:49	180	321	185	82
103:27	180	10	125	
103:28	180	13	112	13
103:55	180	123	138	
104:11	0	160	108	
104:13	0	338	266	158
104:23	0	344	266	
104:24	0	228	147	119
104:51	0	179	6	78
104:58	0	194	6	
105:00	0	245	51	45
105:13	0	228	33	
105:28	0	294	19	
105:29	0	261	343	36

9.4 LM PARTIAL PHASING LESS THAN 40 FPS

```
      GET      EVENT                                  PROG
PHASING LESS THAN 40 FPS                                 *
                                                         *
                                                         *
     (100+46+21)                                         *
              ********************************************* *
              PARTIAL LM PHASING BURN                     *
              ********************************************* *
-45  (100+48)                                            *
              SUNSET                                      *
              IMU REALIGN TO REFSMAT          (P52)       *
              (OPTION 3)                                  *
-39  (100+54)                                            *
              MCC-H UPLINK(LM VECTOR)         (P00)       *
              RHO=-21,GAMMA=176                           *
-27  (101+06)                                            *
              COPY RESCUE,CSI ONE,CDH,TPI PADS            *
-16  (101+17)                                            *
              EXTERNAL DV TARGETING           (P30)       *
-14  (101+19)                                            *
              SPS THRUST PROGRAM,V56          (P40)       *
               AUTO MNVR TO BURN ATTITUDE                 *
              (98 DEG)                                    *
              (180,150/283,0)                             *
              LOS                                         *
*************************************************************
*-14  (101+19)                                          * *
*                KEY 40F                                 * *
*          F 50 18 (COMMANDED R,P,Y)                     * *
*                KEY V56E                                * *
*                RHC-ARMED                               * *
*                ALIGN ROLL TO                           * *
```

```
      GET      EVENT                                  PROG
                RHC-LOCKED                                *
                PRO                                       *
          06 18 (COMMANDED R,P,Y)                         *
                MONITOR MNVR                              *
        F 50 18 (COMMANDED R,P,Y)                         *
                MN BUS TIE(2)-ON(UP)                      *
                SPS HE VLV TB(BOTH)-BP                    *
                SPS HE VLV(BOTH)-AUTO                     *
                MONESS BUS-MNA                            *
                PRO                                       *
          06 18 (COMMANDED R,P,Y)                         *
                MONITOR ATT TRIM                          *
        F 50 18 (COMMANDED R,P,Y)                         *
*************************************************************
-10  (101+23)
              SPS THRUST SETUP                  (P40)
*************************************************************
*-10  (101+23)                                            *
*                                                         *
*              **GDC ALIGN**                              *
*                                                         *
*                                                         *
*                ALT SET KNOB TO 60 NM                    *
*                FDAI SELECT-1                            *
*                ATT SET THUMBWHEELS TO N18               *
*                NULL ATT ERROR NEEDLES                   *
*                   ON FDAI 1 WITH ATT                    *
*                   SET THUMBWHEELS                       *
*                ATT SET-GDC                              *
*                DEPRESS GDC ALIGN PB                     *
*                FDAI SELECT-1/2                          *
```

GET	EVENT	PROG
	ATT SET-TMU	
	MTVC CHECKS	
	RMAG MODE(3)-ATT1/RATE2	
	TVC SERVO PWR 1-AC1/MNA	
	TVC SERVO PWR 2-AC2/MNB	
	TRANS CONTR PWR-ON	
	RHC PWR NORM 2-AC	
	GMBL MTRS PITCH 1 STRT-ON	
	GMBL MTRS YAW 1 STRT-ON	
	THC-CLOCKWISE	
	RHC-ARMED	
	RHC-VERIFY NO MTVC	
	GMBL MTRS PITCH 2-STRT-ON	
	GMBL MTRS YAW 2-STRT-ON	
	SET SPS GIMBALS TW(2)-	
	PITCH = -.52	
	YAW = +.59	
	RHC-VERIFY MTVC	
	THC-NEUTRAL	
	RHC PWR NORM 2-AC/DC	
	RHC-LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
	KEY ENTER	
F 50 25	(00204,GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)-MNA/MNB	
	RATE-HIGH	
	AUTO RCS SEL A/C ROLL(4)-MNA	
	PRO	

GET	EVENT	PROG
	MONITOR GMBL DRIVE	
	SEQ AND TRIM	
06 40	(TFI,VG,DVM)	
	-02+00	
	FDAI SCALE-5/5	
	VERIFY SPS TH LT-OFF	
	EMS MODE STBY	
	EMS FUNCTION-DV SET	
	LOAD RESCUE VC	
	EMS FUNCTION-DV	
	THC-ARMED	
	RHC-ARMED	
	DV THRUST(A)-NORMAL	
	-00+35	
	DSKY BLANKS	
	-00+30	
06 40	(TFI,VG,DVM)	
	EMS MODE-NORMAL	
	-00+15	
	PERFORM ULLAGE	
	-00+05	
F 99 40	(REQUEST FOR ENGINE ENABLE)	
	PRO	
06 40	(TFI,VG,DVM)	
	(101+32+59)	
	CSM RESCUE BURN(-57.1,0,0) (180.180/283,0)	
	SET MDC ET-RESET,START	

GET	EVENT	PROG
	MONITOR:	
	SPS THRUST LT-ON	
	DV INDICATOR-DECREASING	
+00+01		
	ULLAGE-OFF	
06 40	(TFC,VG,DVM)	
	MONITOR SPS OPERATION:	
	PC INDICATOR-95-105 PSI	
	MONITOR SPS ENGINE CUTOFF:	
	SPS THRUST LT-OFF	
F 16 40	(TFC,VG,DVM)	
	DV THRUST(BOTH)-OFF	
	MONITOR:	
	PC INDICATOR = 0	
	SPS INJ. VLV IND(4)-CLOSE	
	SPS HE VLV TB(BOTH)-BP	
	SPS GMBLS RETURN TO SERVO NULL	
	GMBL MTRS-OFF(SEQUENTIALLY)	
	TVC SERVO PWR(BOTH)-OFF	
	FDAI SCALE-5/1	
	RATE-LOW	
	ROT CONT PWR DIRECT(BOTH)-OFF	
	PRO	
F 16 85	(VG=BODY)	
	THC-NULL VG COMPONENTS	
	THC-LOCKED	
	RHC-LOCKED	
	EMS FUNCTION-VHF RNG	
	EMS MODE-VHF RNG	
	VHF RNG-RESET	
	MN BUS TIE(2)-OFF	
	PRO	
F 37 88		

GET	EVENT	PROG
	(101+35)	
	SUNRISE	
	MOVE TO LEB	
-55	(101+36)	
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(133 DEG)	
	(180,322/56,0)	
-50	(101+41)	
	CSI TARGETING PROGRAM	(P32)
	LOAD N55 WITH	
	R1=+00004	
	R2=+20830	
	R3=+13000	
-47	(101+44)	
	CALL MARKING ROUTINE(V93,V87)	
	(102+06)	
	AOS	
-14	(102+17)	
	TERMINATE MARKS(33)	
	MOVE TO CMD SEAT	
	CSI TARGETING FINAL COMP	(P32)
	ACQ, MSFN,RHO=-57,GAMMA=7	
	OUT OF PLANE DATA(V60)	
	OVERWRITE N81 WITH (-) CSM YDOT	
-11	(102+19)	
	SPS THRUST PROGRAM,V56	(P40)
	AUTO MNVR TO BURN ATTITUDE	
	(174 DEG)	
	(180,165/103,0)	
*-11	(102+19)	
*	KEY 40E	

GET	EVENT	PROG
	F 50 18 (COMMANDED R,P,Y)	
	KEY V56E	
	RHC-ARMED	
	ALIGN ROLL TO	
	RHC-LOCKED	
	PRO	
	06 18 (COMMANDED R,P,Y)	
	MONITOR MNVR	
	F 50 18 (COMMANDED R,P,Y)	
	MN BUS TIE(2)-ON(UP)	
	SPS HE VLV TB(BOTH)-BP	
	SPS HE VLV(BOTH)-AUTO	
	NONESS BUS-MNA	
	PRO	
	06 18 (COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
	F 50 18 (COMMANDED R,P,Y)	
-5	(102+26)	
	SPS THRUST SETUP (P40)	
-5	(102+26)	
	GDC ALIGN	
	ALT SET KNOB TO 60 NM	
	FDAI SELECT-1	
	ATT SET THUMBWHEELS TO N18	
	NULL ATT ERROR NEEDLES ON FDAI 1 WITH ATT SET THUMBWHEELS	
	ATT SET-GDC	
	DEPRESS GDC ALIGN PB	

GET	EVENT	PROG
	FDAI SELECT-1/2	
	ATT SET-TMU	
	MTVC CHECKS	
	RMAG MODE(3)-ATT1/RATE2	
	TVC SERVO PWR 1-AC1/MNA	
	TVC SERVO PWR 2-AC2/MNB	
	TRANS CONTR PWR-ON	
	RHC PWR NORM 2-AC	
	GMBL MTRS PITCH 1 STRT-ON	
	GMBL MTRS YAW 1 STRT-ON	
	THC-CLOCKWISE	
	RHC-ARMED	
	RHC-VERIFY NO MTVC	
	GMBL MTRS PITCH 2-STRT-ON	
	GMBL MTRS YAW 2-STRT-ON	
	SET SPS GIMBALS TW(2)- PITCH = -.52 YAW = +.59	
	RHC-VERIFY MTVC	
	THC-NEUTRAL	
	RHC PWR NORM 2-AC/DC	
	RHC-LOCKED	
	PRO	
06	18 (COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50	18 (COMMANDED R,P,Y)	
	KEY ENTER	
F 50	25 (00204,GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)-MNA/MNB	
	RATE-HIGH	
	AUTO RCS SEL A/C ROLL(4)-MNA	
	PRO	

GET	EVENT	PROG
*	MONITOR GMBL DRIVE	*
*	SEQ AND TRIM	*
*	06 40 (TFI,VG,DVM)	*
*-02+00		
*	FDAI SCALE=5/5	*
*	VERIFY SPS THR LT=OFF	*
*	EMS MODE STBY	*
*	EMS FUNCTION=DV SET	*
*	LOAD CSI TO VC	*
*	EMS FUNCTION=DV [illegible]	*
*	THC-ARMED	*
*	RHC-ARMED	*
*	DV THRUST(A)-NORMAL	*
*-00+35		
*	OSKY BLANKS	*
*-00+30		
*	06 40 (TFI,VG,DVM)	*
*	EMS MODE-NORMAL	*
*-00+15		
*	PERFORM ULLAGE	*
*-00+05		
*	F 99 40 (REQUEST FOR ENGINE ENABLE)	*
*	PRO	*
*	06 40 (TFI,VG,DVM)	*
**********		**********
(102+30+35)		*
	**********	*
	CSM CSI ONE BURN (-35.6,0,0)	*
	(180,180/103,0)	*
	**********	*

GET	EVENT	PROG
**********		**********
*	SET MDC FT-RESET,START	*
*	MONITOR	*
*	SPS THRUST LT-ON	*
*	DV INDICATOR_DECREASING	*
*+00+01		
*	ULLAGE-OFF	*
*	06 40 (TFC,VG,DVM)	*
*	MONITOR SPS OPERATION	*
*	PC INDICATOR_95-105 PSI	*
*	MONITOR SPS ENGINE CUTOFF	*
*	SPS THRUST LT-OFF	*
*	F 16 40 (TFC,VG,DVM)	*
*	DV THRUST(BOTH)-OFF	*
*	MONITOR	*
*	PC INDICATOR = 0	*
*	SPS INJ VLV IND(4)-CLOSE	*
*	SPS HE VLV TB(BOTH)-BP	*
*	SPS GMBLS RETURN TO SERVO NULL	*
*	GMBL MTRS-OFF(SEQUENTIALLY)	*
*	TVC SERVO PWR(BOTH)-OFF	*
*	FDAI SCALE-5/1	*
*	RATE-LOW	*
*	ROT CONT PWR DIRECT(BOTH)-OFF	*
*	PRO	*
*	F 16 85 (VG-BODY)	*
*	THC-NULL VG COMPONENTS	*
*	THC-LOCKED	*
*	RHC-LOCKED	*
*	EMS FUNCTION-VHF RNG	*
*	EMS MODE-VHF RNG	*
*	VHF RNG-RESET	*
*	MN BUS TIE(2)-OFF	*

GET	EVENT	PROG
*	PRO	*
*	F 37 BR	*
**********		
(102+32)		
	CMC IDLING PROGRAM	(P00)
(102+40)		
	SUNSET	
	IMU REALIGN TO REFSMMAT (OPTION 3)	(P52)
	GDC ALIGN	
	VERIFY ORDEAL (V83)	
(102+46)		
	MCC-H UPLINK(LM VECTOR,IF LM ACTIVE)	(P00)
(102+51)		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(74 DEG)	
	(180,320/177,0)	
+23 (102+54)		
	CALL MARKING ROUTINE(V87) THREE MARKS,V93	
+38 (103+09)		
	TERMINATE MARKS(15)	
(103+11)		
	LOS	
(103+29)		
	SUNRISE	
-38 (103+46)		
	CSI TARGETING PROGRAM	(P32)
	LOAD N55 WITH	
	R1=+00002	
	R2=+20830	
	R3=+13000	

GET	EVENT	PROG
-32 (103+52)		
	MOVE TO LEB	
	CALL MARKING ROUTINE(V87)	
	(V93 AFTER 3 MARKS PROCESSED)	
(104+00)		
	AOS	
-9 (104+15)		
	TERMINATE MARKS(23)	
	MOVE TO CMD SEAT	
	CSI TARGETING FINAL COMP	(P32)
	ACQ. MSFN,RHO=-77.5,GAMMA=18.1	
-6 (104+18)		
	RCS THRUST PROGRAM,V56	(P41)
	AUTO MNVR TO BURN ATTITUDE	
-2 (104+22)		
	RCS THRUST SETUP,GDC ALIGN	(P41)
(104+24+00)		
	**********	
	CSM CSI TWO BURN(180,335/257,0)	
	**********	
-54 (104+26)		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(26 DEG)	
	(180,317/231,0)	
-53 (104+27)		
	CSI TARGETING PROGRAM	(P32)
	LOAD N55 WITH	
	R1 = +00001	
	R2 = +20830	
	R3 = +13000	
	MOVE TO LEB	

GET	EVENT	PROG
-50	(104+30)	
	CALL MARKING ROUTINE(V93,V87,V57)	
	(V93 AFTER 5 MARKS PROCESSED)	
	(104+33)	
	SUNSET	
-45	(104+35)	
	TERMINATE SXT MARKS,V93	
	CONTINUE VHF	
-40	(104+40)	
	OUT OF PLANE DATA(V90)	
	VOICE LM YDOT TO LM	
	CONTINUE VHF	
	(105+04)	
	LOS	
-9	(105+11)	
	TERMINATE MARKS(41)	
	MOVE TO CMD SEAT	
	CSI TARGETING FINAL COMP (P32)	
-5	(105+15)	
	RCS THRUST PROGRAM,V56 (P41)	
	AUTO MNVR TO BURN ATTITUDE	
-2	(105+18)	
	RCS THRUST SETUP,GDC ALIGN (P41)	
0	(105+20+00)	
	**********	
	CSM CSI THREE BURN	
	(180,18/121,0)	
	**********	
	(105+21)	
	SUNRISE	

GET	EVENT	PROG
-25	(105+22)	
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(TRIM)	
	(180,18/120,0)	
-24	(105+24)	
	MOVE TO LEB	
	CALL MARKING ROUTINE(V87,V57)	
	AFTER 3 SXT MARKS PROCESSED	
	V67,LOAD WB(00057,06034.00001)	
-12	(105+36)	
	TERMINATE MARKS(12)	
	MOVE TO CMD SEAT	
	OUT OF PLANE DATA(V90)	
-9	(105+39)	
	EXTERNAL DV TARGETING (P30)	
-6	(105+42)	
	RCS THRUST PROGRAM,V56 (P41)	
	AUTO MNVR TO BURN ATTITUDE	
-2	(105+46)	
	RCS THRUST SETUP,GDC ALIGN (P41)	
0	(105+48+00)	
	**********	
	CSM PLANE CHANGE	
	(180,135/149,0)	
	**********	
-26	(105+50)	
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(10 DEG)	
	(180,132/139,0)	
-25	(105+51)	
	CDH TARGETING PROGRAM (P33)	
	MOVE TO LEB	

GET	EVENT	PROG
(105+52)		
	AOS	
-22 (105+54)		
	CALL MARKING ROUTINE(V87,V57)	
	(V93 AFTER 3 MARKS PROCESSED)	
-12 (106+04)		
	TERMINATE MARKS(10)	
	MOVE TO CMD SEAT	
	CDH TARGETING FINAL COMP (P33)	
	OUT OF PLANE DATA(V90)	
	OVERWRITE NB1 WITH (-) CSM YDOT	
	ROLL 180 DEG,ACQ MSFN	
	RHO=-58°GAMMA=173	
	(0,154/110,0)	
-8 (106+08)		
	SPS THRUST PROGRAM,V56 (P40)	
	MANUAL MNVR TO 1 DEG/SET TO BURN ATTITUDE	
	(161 DEG)	
	(0,166/271,0)	
**********	**********	**********
*-8 (106+08)		*
*	KEY 40E	*
* F 50 18	(COMMANDED R,P,Y)	*
*	KEY V56E	*
*	RHC=ARMED	*
*	ALIGN ROLL TO	*
*	RHC=LOCKED	*
*	PRO	*
* 06 18	(COMMANDED R,P,Y)	*
*	MONITOR MNVR	*
* F 50 18	(COMMANDED R,P,Y)	*
*	MN BUS TIE(2)=ON(UP)	*
*	SPS HE VLV TB(BOTH)=BP	*

GET	EVENT	PROG
*	SPS HE VLV(BOTH)=AUTO	*
*	NONESS BUS=MNA	*
*	PRO	*
* 06 18	(COMMANDED R,P,Y)	*
*	MONITOR ATT TRIM	*
* F 50 18	(COMMANDED R,P,Y)	*
**********	**********	**********
-5 (106+11)		
	SPS THRUST SETUP (P40)	
**********	**********	**********
*-5 (106+11)		*
*		*
*	**GDC ALIGN**	*
*		*
*		*
*	ALT SET KNOB TO 60 NM	*
*	FDAI SELECT=1	*
*	ATT SET THUMBWHEELS TO N18	*
*	NULL ATT ERROR NEEDLES	*
*	ON FDAI 1 WITH ATT	*
*	SET THUMBWHEELS	*
*	ATT SET=GDC	*
*	DEPRESS GDC ALIGN PB	*
*	FDAI SELECT=1/2	*
*	ATT SET=TMU	*
*		*
*	**MTVC CHECKS**	*
*		*
*	BMAG MODE(3)=ATT1/RATE2	*
*	TVC SERVO PWR 1 AC1/MNA	*
*	TVC SERVO PWR 2 AC2/MNB	*
*	TRANS CONTR PWR=ON	*
*	RHC PWR NORM 2=AC	*
*	GMBL MTRS PITCH 1 STRT=ON	*

GET	EVENT	PROG
	GMBL MTRS YAW 1 STRT-ON	
	THC-CLOCKWISE	
	RHC-ARMED	
	RHC-VERIFY NO RTVC	
	GMBL MTRS PITCH 2-STRT-ON	
	GMBL MTRS YAW 2-STRT-ON	
	SET SPS GIMBALS TW(2)-	
	PITCH = -.52	
	YAW = +.59	
	RHC-VERIFY MTVC	
	THC-NEUTRAL	
	RHC PWR NORM 2-AC/DC	
	RHC-LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
	KEY ENTER	
F 50 25	(00204,GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)-MNA/MNB	
	RATE-HIGH	
	AUTO RCS SEL A/C ROLL(4)-MNA	
	PRO	
	MONITOR GMBL DRIVE	
	SEQ AND TRIM	
06 40	(TFI,VG,DVM)	
+02+00		
	EDAI SCALE-5/5	
	VERIFY SPS TH LT-OFF	
	EMS MODE STBY	
	EMS FUNCTION-DV SET	
	LOAD CDH VC	
	EMS FUNCTION-DV	
	THC-ARMED	

GET	EVENT	PROG
	RHC-ARMED	
	DV THRUST(A)-NORMAL	
+00+35		
	DSKY BLANKS	
+00+30		
06 40	(TFI,VG,DVM)	
	EMS MODE-NORMAL	
+00+15		
	PERFORM ULLAGE	
+00+05		
F 99 40	(REQUEST FOR ENGINE ENABLE)	
	PRO	
06 40	(TFI,VG,DVM)	
0	(106+16+07)	
	CSM CDH BURN(65.3,0,12.2)	
	(0,349/271,0)	
	SET MDC ET-RESET,START	
	MONITOR	
	SPS THRUST LT-ON	
	DV INDICATOR-DECREASING	
+00+01		
	ULLAGE-OFF	
06 40	(TFC,VG,DVM)	
	MONITOR SPS OPERATION	
	PC INDICATOR-95-105 PSI	
	MONITOR SPS ENGINE CUTOFF	
	SPS THRUST LT-OFF	
F 16 40	(TFC,VG,DVM)	
	DV THRUST(BOTH)-OFF	
	MONITOR	

GET	EVENT	PROG
	PC INDICATOR = 0	
	SPS INJ VLV IND(4)=CLOSE	
	SPS HE VLV TB(BOTH)=BP	
	SPS GMBLS RETURN TO SERVO NULL	
	GMBL MTRS=OFF(SEQUENTIALLY)	
	TVC SERVO PWR(BOTH)=OFF	
	FDAI SCALE=5/1	
	RATE=LOW	
	ROT CONT PWR DIRECT(BOTH)=OFF	
	PRO	
F 16 85	(VG=BODY)	
	THC=NULL VG COMPONENTS	
	THC=LOCKED	
	RHC=LOCKED	
	EMS FUNCTION=VHF RNG	
	EMS MODE=VHF RNG	
	VHF RNG=RESET	
	MN BUS TIE(2)=OFF	
	PRO	
F 37 88		
-33 (106+18)		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(127 DEG)	
	(0,228/144,0)	
	MOVE TO LEB	
-29 (106+22)		
	TPI TARGETING PROGRAM (P34)	
	LOAD N55	
	R2=+20830	
	R3=+13000	
-27 (106+24)		
	CALL MARKING ROUTINE(V87,V57)	
	(V93 AFTER 3 MARKS PROCESSED)	
(106+26)		
	SUNSET	
-12 (106+39)		
	TERMINATE MARKS(15)	
	MOVE TO CMD SEAT	
	TPI TARGETING FINAL COMP (P34)	
	VERIFY ORDEAL(V83)	
-7 (106+44)		
	SPS THRUST PROGRAM,V56 (P40)	
	AUTO MNVR TO BURN ATTITUDE	
	(60 DEG)	
	(0,247/74,0)	
-7 (106+44)		
	KEY 40E	
F 50 18	(COMMANDED R,P,Y)	
	KEY V56E	
	RHC=ARMED	
	ALIGN BOLL TO	
	RHC=LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR MNVR	
F 50 18	(COMMANDED R,P,Y)	
	MN BUS TIE(2)=ON(UP)	
	SPS HE VLV TB(BOTH)=BP	
	SPS HE VLV(BOTH)=AUTO	
	NONESS BUS=MNA	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	

```
      GET      EVENT                                  PROG
*          F 50 19 (COMMANDED R,P,Y)                  * *
*************************************************** *
-5    (106+46)                                        *
                SPS THRUST SETUP                (P40)  *
*************************************************** *
*-5   (106+46)                                       * *
*                                                    * *
*              **GDC ALIGN**                         * *
*                                                    * *
*                                                    * *
*                  ALT SET KNOB TO 60 NM             * *
*                  FDAI SELECT-1                     * *
*                  ATT SET THUMBWHEELS TO 118        * *
*                  NULL ATT ERROR NEEDLES            * *
*                     ON FDAI 1 WITH ATT             * *
*                     SET THUMBWHEELS                * *
*                  ATT SET-GDC                       * *
*                  DEPRESS GDC ALIGN PB              * *
*                  FDAI SELECT-1/2                   * *
*                  ATT SET-TMU                       * *
*                                                    * *
*              **TVC CHECKS**                        * *-02+00
*                                                    * *
*                  BMAG MODE(3)-ATT1/RATE2           * *
*                  TVC SERVO PWR 1-AC1/MNA           * *
*                  TVC SERVO PWR 2-AC2/MNB           * *
*                  TRANS CONTR PWR-ON                * *
*                  RHC PWR NORM 2-AC                 * *
*                  GMBL MTRS PITCH 1 STRT-ON         * *
*                  GMBL MTRS YAW 1 STRT-ON           * *
*                  THC-CLOCKWISE                     * *
*                  RHC-ARMED                         * *-00+35
*                  RHC-VERIFY NO MTVC                * *
*                  GMBL MTRS PITCH 2-STRT-ON         *
```

```
      GET      EVENT                                  PROG
                GMBL MTRS  YAW  2-STRT-ON            *
                SET SPS GIMBALS TW(2)-               *
                   PITCH = -.52                      *
                   YAW   = +.59                      *
                RHC-VERIFY MTVC                      *
                THC-NEUTRAL                          *
                RHC PWR NORM 2-AC/DC                 *
                RHC-LOCKED                           *
                PRO                                  *
          06 18 (COMMANDED R,P,Y)                    *
                MONITOR ATT TRIM                     *
        F 50 18 (COMMANDED R,P,Y)                    *
                KEY ENTER                            *
        F 50 25 (00204 GMBL DRIVE TEST)              *
                RHC PWR DIRECT(BOTH)-MNA/MNB         *
                RATE-HIGH                            *
                AUTO RCS SEL A/C ROLL(4)-MNA         *
                PRO                                  *
                MONITOR GMBL DRIVE                   *
                   SEQ AND TRIM                      *
          06 40 (TFI,VG,DVM)                         *
                                                     *
                FDAI SCALE-5/5                       *
                VERIFY SPS TH LT-OFF                 *
                EMS MODE STBY                        *
                EMS FUNCTION-DV SET                  *
                LOAD TRT VC                          *
                EMS FUNCTION-DV                      *
                THC-ARMED                            *
                RHC-ARMED                            *
                DV THRUST(A)-NORMAL                  *
                                                     *
                DSKY BLANKS                          *
```

GET	EVENT	PROG
*-00+30		* *
	06 40 (TFI,VG,DVM)	* *
	EMS MODE-NORMAL	* *
*-00+15		* *
	PERFORM ULLAGE	* *
*-00+05		* *
	F 99 40 (REQUEST FOR ENGINE ENABLE)	* *
	PRO	* *
	06 40 (TFI,VG,DVM)	* *
**********		* *
0 (106+50+57)		*
	**********	* *
	CSM TPI BURN(-15,0,5.9)	*
	(0,202/14,0)	*
	**********	* *
**********		* *
	SET MDC ET-RESET,START	* *
	MONITOR:	* *
	SPS THRUST LT-ON	* *
	DV INDICATOR-DECREASING	* *
*+00+01		*
	ULLAGE-OFF	*
	06 40 (TFC,VG,DVM)	*
	MONITOR SPS OPERATION:	*
	PC INDICATOR-95-105 PSI	*
	MONITOR SPS ENGINE CUTOFF:	*
	SPS THRUST LT-OFF	* +3
	F 16 40 (TFC,VG,DVM)	*
	DV THRUST(BOTH)-OFF	*
	MONITOR:	*
	PC INDICATOR = 0	* +11
	SPS INJ VLV IND(4)-CLOSE	*
	SRS HE VLV TR(BOTH)-BP	* +12

GET	EVENT	PROG
	SPS GMBLS RETURN TO SERVO NULL	*
	GMBL MTRS-OFF(SEQUENTIALLY)	*
	TVC SERVO PWR(BOTH)-OFF	*
	FDAI SCALE-5/1	*
	RATE-LOW	*
	ROT CONT PWR DIRECT(BOTH)-OFF	*
	PRO	*
	F 16 85 (VG-BODY)	*
	THC-NULL VG COMPONENTS	*
	THC-LOCKED	*
	RHC-LOCKED	*
	EMS FUNCTION-VHF RNG	*
	EMS MODE-VHF RNG	*
	VHF RNG-RESET	*
	MN BUS TIE(2)-OFF	*
	PRO	*
	F 37 BB	*
**********		* *
+2		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(38 DEG)	
	(0,247/52,0)	
	MCC1 TARGETING PROGRAM (P35)(P20)	
	MOVE TO LEB	
+3		
	CALL MARKING ROUTINE(V93,V87,V57)	
(107+00)		
	LOS	
	TERMINATE MARKS(8)	
	MCC1 TARGETING FINAL COMP (P35)	

MISSION F RESCUE TIMELINE APRIL 25,1969

GET	EVENT	PROG
+13.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	RCS THRUST SETUP	(P41)
+15 (107+05+57)		
	**********	
	CSM MCC1(0,267/33.0)	
	**********	
+16		
	MCC2 TARGETING PROGRAM	(P35)(P20)
+17		
	CALL MARKING ROUTINE(V93,V87,V57)	
(107+14)		
	SUNRISE	
+26		
	TERMINATE MARKS(9)	
	MOVE TO CMD SEAT	
+27		
	MCC2 TARGETING FINAL COMP	(P35)
+28.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	RCS THRUST SETUP	(P41)
+30 (107+20+57)		
	**********	
	CSM MCC2(0,300/23.0)	
	**********	
+32		
	MNVR TO COAS TRACK(V89)	(P00)
	(35 DEG)	
	(0,265/348.0)	

GET	EVENT	PROG
+33 (107+24)		
	THRUST MONITORING PROGRAM	(P47)
	V83,PERFORM BRAKING AND LOS	
	CONTROL	
	**********	
	* BRAKING GATES RETICLE ANGLE *	
	* 30 FPS AT 6000 FT .13 DEG. *	
	* 20 FPS AT 3000 FT .26 DEG. *	
	* 10 FPS AT 2500 FT .54 DEG. *	
	* 5 FPS AT 500 FT 1.60 DEG. *	
	**********	
+44 (107+34+57)		
	**********	
	TPF	
	**********	

9.4.2 RENDEZVOUS NAVIGATION SUMMARY WITH SUN ANGLES
CSM ACTIVE LM RESCUE - PARTIAL PHASING < 40 FPS
(MISSION F)
IT - INITIATE TRACK
CT - CEASE TRACK
(OUT-OF-PLANE SUN ANGLE IS 4 DEG)

GET	EVENT	SUN ANGLE (LOS TO SUN) DEG
100:46	PARTIAL LM PHASING	
100:48	SUNSET	
101:33	CSM RESCUE	
101:35	SUNRISE	
101:44	IT (VHF) (V93,33/33)	15
101:49		30
101:54		46
101:59		63
102:04		80
102:09		97
102:14		113
102:17	CT (VHF)	123
102:31	CSM CSI ONE	
102:40	SUNSET	
102:54	IT (VHF) (4/3,V93,11/12)	
103:09	CT (VHF)	
103:29	SUNRISE	
103:52	IT (VHF) (4/3,V93,19/20)	48
103:57		68
104:02		98
104:07		105
104:12		129
104:15	CT (VHF)	141
104:24	CSM CSI TWO	
104:30	IT (SXT/VHF) (V93,6/5,V93,35/36)	171
104:33	SUNSET	163
104:35	CT (SXT)	
105:11	CT (VHF)	
105:20	CSM CSI THREE	
105:21	SUNRISE	
105:24	IT (SXT/VHF) (4/3,V67,00057,00034,00001;8/9)	77
105:29		87
105:33		98
105:36	CT (SXT/VHF)	101
105:48	CSM PLANE CHANGE	
105:54	IT (SXT/VHF) (4/3,V93,6/7)	84
105:59		73
106:04	CT (SXT/VHF)	62
106:16	CSM CDH	
106:24	IT (SXT/VHF) (4/3,V93,11/12)	4
106:26	SUNSET	9
106:39	CT (SXT/VHF)	
106:51	CSM TPI	
106:54	IT (SXT/VHF) (V93,8/8)	
107:02	CT (SXT/VHF)	
107:06	CSM MCC1	
107:08	IT (SXT/VHF) (V93,9/9)	
107:14	SUNRISE	96
107:17	CT (SXT/VHF)	96
107:21	CSM MCC2	
107:35	TPF	

9.4.3 CSM ATTITUDE SUMMARY

INERTIAL AND ORDEAL FDAI BALL GIMBAL ANGLE PROFILE
FOR THE LM PARTIAL PHASING < 40 FPS RESCUE CASE
(MISSION F) (YAW = 0.0)

TIME GET	ROLL	PITCH ORDEAL	PITCH INERTIAL	PITCH MNVR
100:46	180	307	193	
101:19	180	150	283	98
101:33	180	180	283	
101:36	180	322	56	133
102:19	180	165	103	174
102:31	180	180	103	
102:51	180	320	177	74
104:24	180	335	257	
104:26	180	317	231	26
105:20	180	18	121	
105:22	180	18	120	
105:48	180	135	149	
105:50	180	132	139	10
106:04	0	154	110	
106:08	0	166	271	161
106:16	0	349	271	
106:18	0	228	144	127
106:44	0	247	74	60
106:51	0	202	14	
106:53	0	247	52	38
107:06	0	267	33	
107:21	0	300	23	
107:23	0	265	348	35
107:35	0	298	348	

9.5 LM ZERO INSERTION

LM INSERTION EQUALS 0 FPS RESCUE TIMELINE

	GET	EVENT	PROG
	(102+46+18)	**********	
		CSM INSERTION BURN(175.4,0,-107.1)	
		(180,32/272,0)	
		**********	
		SUNSET	
	(102+48)		
		IMU REALIGN TO REFSMMAT	(P52)
		(OPTION 3)	
	(102+53)		
		MCC-H UPLINK(LM VECTOR)	(P00)
		MOVE TO LEB	
	(102+56)		
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK	
		(103 DEG)	
		(180,165/16,0)	
	(103+01)		
		CSI TARGETING PROGRAM	(P32)(P20)
		LOAD N55 R1=+00001	
		R2=+20830	
		R3=+13000	
-29	(103+03)		
		CALL MARKING ROUTINE(V93,V87,V57)	
		(V93 AFTER 5 MKS PROCESSED)	
	(103+08)		
		TERMINATE SXT,CONT,VHF	
		V90(CSM)	
		COPY CSM YDOT	
-9	(103+23)		
		TERMINATE MARKS(20)	
		MOVE TO CMD SEAT	
		CSI TARGETING FINAL	(P32)(P20)
		COMP	
		OVERWRITE N81 WITH(=)CSM YDOT	
-6	(103+26)		
		SPS THRUST PROGRAM,V56	(P40)
		AUTO MNVR TO BURN ATTITUDE	
		(5 DEG)	
		(180,156/293,0)	
		**********	
		*-6 (103+26) *	
		* KEY 40E *	
		* F 50 18 (COMMANDED R,P,Y) *	
		* KEY V56E *	
		* RHC-ARMED *	
		* ALIGN ROLL TO 180 DEG *	
		* RHC-LOCKED *	
		* PRO *	
		* 06 18 (COMMANDED R,P,Y) *	
		* MONITOR MNVR *	
		* F 50 18 (COMMANDED R,P,Y) *	
		* MN BUS TIE(2)-ON(UP) *	
		* SPS HE VLV TB(BOTH)-BP *	
		* SPS HE VLV(BOTH)-AUTO *	
		* NONESS BUS-MNA *	
		* PRO *	
		* 06 18 (COMMANDED R,P,Y) *	
		* MONITOR ATT TRIM *	
		* F 50 18 (COMMANDED R,P,Y) *	
		**********	

GET	EVENT	PROG
(103+25)		*
	LOS	*
-5 (103+27)		*
	SPS THRUST SETUP	*
**********	**********	*
*-5 (103+27)		* *
*	**GDC ALIGN**	* *
*		* *
*		* *
*	ALT SET KNOB TO 60 NM	* *
*	FDAI SELECT-1	* *
*	ATT SET THUMBWHEELS TO N18	* *
*	NULL ATT ERROR NEEDLES	* *
*	ON FDAI 1 WITH ATT	* *
*	SET THUMBWHEELS	* *
*	ATT SET-GDC	* *
*	DEPRESS GDC ALIGN PB	* *
*	FDAI SELECT-1/2	* *
*	ATT SET-TMU	* *
*		* *
*	**MTVC CHECKS**	* *-02+00
*		* *
*	BMAG MODE(3)-ATT1/RATE2	* *
*	TVC SERVO PWR 1-AC1/MNA	* *
*	TVC SERVO PWR 2-AC2/MNB	* *
*	TRANS CONTR PWR-ON	* *
*	RHC PWR NORM 2-AC	* *
*	GMBL MTRS PITCH 1 STRT-ON	* *
*	GMBL MTRS YAW 1 STRT-ON	* *
*	THC-CLOCKWISE	* *
*	RHC-ARMED	* *-00+35
*	RHC-VERIFY NO MTVC	* *
*	GMBL MTRS PITCH 2-STRT-ON	* *-00+30
*	GMBL MTRS YAW 2-STRT-ON	* *

GET	EVENT	PROG
	SET SPS GIMBALS TW(2)-	*
	PITCH = -.52	*
	YAW = +.59	*
	RHC-VERIFY MTVC	*
	THC-NEUTRAL	*
	RHC PWR NORM 2-AC/DC	*
	RHC-LOCKED	*
	PRO	*
06 18	(COMMANDED R,P,Y)	*
	MONITOR ATT TRIM	*
F 50 18	(COMMANDED R,P,Y)	*
	KEY ENTER	*
F 50 25	(00204,GMBL DRIVE TEST)	*
	RHC PWR DIRECT(BOTH)-MNA/MNB	*
	RATE-HIGH	*
	AUTO RCS SEL A/C ROLL(4)-MNA	*
	PRO	*
	MONITOR GMBL DRIVE	*
	SEQ AND TRIM	*
06 40	(TFI,VG,DVM)	*
		*
	FDAI SCALE-5/5	*
	VERIFY SPS TH LT-OFF	*
	EMS MODE STBY	*
	EMS FUNCTION-DV SET	*
	LOAD CSI VC	*
	EMS FUNCTION-DV	*
	THC-ARMED	*
	RHC-ARMED	*
	DV THRUST(A)-NORMAL	*
		*
	DSKY BLANKS	*
		*
06 40	(TFI,VG,DVM)	*

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```
      GET      EVENT                                PROG
*                  EMS MODE-NORMAL                  * *
*-00+15                                             * *
*                  PERFORM ULLAGE                   * *
*-00+05                                             * *
*          F 99 40 (REQUEST FOR ENGINE ENABLE)      * *
*                  PRO                              * *
*            06 40 (TFI,VG,DVM)                     * *
*************************************************** *
 0    (103+32+19)                                   *
              ********************************** *
              CSM CSI BURN(-39.0,0,0)               *
                         (180,180/293,0)            *
              ********************************** *
              SUNRISE                               *
*************************************************** *
*                  SET MDC ET-RESET,START           * *
*                  MONITOR                          * *
*                     SPS THRUST LT-ON              *
*                     DV INDICATOR-DECREASING       *
*+00+01                                             *
*                  ULLAGE-OFF                       *
*            06 40 (TFC,VG,DVM)                     *
*                  MONITOR SPS OPERATION            *
*                     PC INDICATOR-95-105 PSI       * -24
*                  MONITOR SPS ENGINE CUTOFF        *
*                     SPS THRUST LT-OFF             *
*          F 16 40 (TFC,VG,DVM)                     *
*                  DV THRUST(BOTH)-OFF              * -12
*                  MONITOR                          *
*                     PC INDICATOR = 0              *
*                     SPS INJ VLV IND(4)-CLOSE      *
*                     SPS HE VLV TB(BOTH)-BP        *
*                     SPS GMBLS RETURN TO SERVO     *
*                       NULL                        *
```

```
      GET      EVENT                                PROG
*                  GMBL MTRS-OFF(SEQUENTIALLY)      *
*                  TVC SERVO PWR(BOTH)-OFF          *
*                  FDAI SCALE-5/1                   *
*                  RATE-LOW                         *
*                  ROT CONT PWR DIRECT(BOTH)-OFF*
*                  PRO                              *
*          F 16 85 (VG-BODY)                        *
*                  THC-NULL VG COMPONENTS           *
*                  THC-LOCKED                       *
*                  RHC-LOCKED                       *
*                  EMS FUNCTION-VHF RNG             *
*                  EMS MODE-VHF RNG                 *
*                  VHF RNG-RESET                    *
*                  MN BUS TIE(2)-OFF                *
*                  PRO                              *
*          F 37 BB                                  *
*************************************************** *
      (103+34)
                RENDEZVOUS NAV PROGRAM      (P20)
                 AUTO MNVR TO SXT TRACK
                (27 DEG)
                (180,158/266,0)
                MOVE TO LEB
-24   (103+40)
                CALL MARKING ROUTINE(V87,V57)
                AFTER 3 MARKS PROCESSED
                V67,LOAD WR(+00057,+00034,+00001)
-12   (103+52)
                TERMINATE MARKS(12)
                OUT OF PLANE DATA(V90)
                EXTERNAL DV PROGRAM    (P30)(P20)
                 LOAD OUT OF PLANE DATA
```

MISSION F RESCUE TIMELINE APRIL 25, 1969

	GET	EVENT	PROG
-8	(103+56)		
		RCS THRUST PROGRAM,V56 (P41)	
		BYPASS BURN ATTITUDE MNVR	
		RCS THRUST SETUP	
	(104+04+00)		
		**********	
		CSM PLANE CHANGE(180,173/205,0)	
		**********	
	(104+05)		
		RENDEZVOUS NAV PROGRAM (P20)	
		AUTO MNVR TO SXT TRACK	
		(25 DEG)	
		(180,147/180,0)	
-30	(104+07)		
		CDH TARGETING PROGRAM (P33)(P20)	
-28	(104+09)		
		CALL MARKING ROUTINE(V87,V57)	
		(V93 AFTER 3 SXT MARKS PROCESSED)	
	(104+12)		
		AOS	
-13	(104+24)		
		TERMINATE MARKS(15)	
		MOVE TO CMD SEAT	
		ROLL 180 DEG,ACQ MSFN	
		(0,155/133,0)	
		(RHO -35, GAM 0)	
		CDH TARGETING FINAL (P33)(P20)	
		COMP	
		OUT OF PLANE DATA(V90)	
		OVERWRITE N81 WITH(-)CSM YDOT	

	GET	EVENT	PROG
-9	(104+28)		
		SPS THRUST PROGRAM,V56 (P40)	
		AUTO MNVR TO BURN ATTITUDE	
		(98 DEG)	
		(0,245/231,0)	
		**********	
	(104+28)	*	
		KEY 40E *	
	F 50 18	(COMMANDED R,P,Y) *	
		KEY V56E *	
		RHC=ARMED *	
		ALIGN ROLL TO 0 DEG, *	
		RHC=LOCKED *	
		PRO *	
	06 18	(COMMANDED R,P,Y) *	
		MONITOR MNVR *	
	F 50 18	(COMMANDED R,P,Y) *	
		MN BUS TIE(2)=ON(UP) *	
		SPS HE VLV TB(BOTH)=BP *	
		SPS HE VLV(BOTH)=AUTO *	
		NONESS BUS=MNA *	
		PRO *	
	06 18	(COMMANDED R,P,Y) *	
		MONITOR ATT TRIM *	
	F 50 18	(COMMANDED R,P,Y) *	
		**********	
-5	(104+32)		
		SPS THRUST SETUP (P40)	
		**********	
	(104+32)	*	
		GDC ALIGN *	
		*	
		*	
		ALT SET KNOB TO 60 NM *	

GET	EVENT	PROG
	FDAI SELECT=1	
	ATT SET THUMBWHEELS TO N18	
	NULL ATT ERROR NEEDLES	
	ON FDAI 1 WITH ATT	
	SET THUMBWHEELS	
	ATT SET=GDC	
	DEPRESS GDC ALIGN PB	
	FDAI SELECT=1/2	
	ATT SET=TMU	
	MTVC CHECKS	
	BMAG MODE(3)=ATT1/RATE2	
	TVC SERVO PWR 1=AC1/MNA	
	TVC SERVO PWR 2=AC2/MNB	
	TRANS CONTR PWR=ON	
	RHC PWR NORM 2=AC	
	GMBL MTRS PITCH 1 STRT=ON	
	GMBL MTRS YAW 1 STRT=ON	
	THC=CLOCKWISE	
	RHC=ARMED	
	RHC=VERIFY NO MTVC	
	GMBL MTRS PITCH 2=STRT=ON	
	GMBL MTRS YAW 2=STRT=ON	
	SET SPS GIMBALS TW(2)=	
	PITCH = -.52	
	YAW = +.59	
	RHC=VERIFY MTVC	
	THC=NEUTRAL	
	RHC PWR NORM 2=AC/DC	
	RHC=LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
		-02+00
	FDAI SCALE=5/5	
	VERIFY SPS TH LT=OFF	
	EMS MODE STBY	
	EMS FUNCTION=DV SET	
	LOAD CDH VC	
	EMS FUNCTION=DV	
	THC=ARMED	
	RHC=ARMED	
	DV THRUST(A)=NORMAL	
		-00+35
	DSKY BLANKS	
		-00+30
06 40	(TFI,VG,DVM)	
	EMS MODE=NORMAL	
		-00+15
	PERFORM ULLAGE	
		-00+05
F 99 40	(REQUEST FOR ENGINE ENABLE)	
	PRO	
06 40	(TFI,VG,DVM)	
F 50 18	(COMMANDED R,P,Y)	
	KEY ENTER	
F 50 25	(00204,GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)=MNA/MNB	
	RATE=HIGH	
	AUTO RCS SEL A/C ROLL(4)=MNA	
	PRO	
	MONITOR GMBL DRIVE	
	SEQ AND TRIM	
06 40	(TFI,VG,DVM)	

```
      GET      EVENT                                  PROG
 0    (104+36+43)                                      *
              ********************************** *
              CSM CDH BURN(-.8,0,42.6)                 *
                          (0,269/213,0)                *
              ********************************** *
************************************************ *
*                  SET MDC ET-RESET,START          * *
*                  MONITOR                         * *
*                     SPS THRUST LT-ON             * -37
*                     DV INDICATOR-DECREASING      *
*+00+01                                            *
*                  ULLAGE-OFF                      *
*            06 40 (TFC,VG,DVM)                    *
*                  MONITOR SPS OPERATION           * -32
*                     PC INDICATOR-95-105 PSI      *
*                  MONITOR SPS ENGINE CUTOFF       *
*                     SPS THRUST LT-OFF            *
*          F 16 40 (TFC,VG,DVM)                    * -30
*                  DV THRUST(BOTH)-OFF             *
*                  MONITOR                         *
*                     PC INDICATOR = 0             *
*                     SPS INJ VLV IND(4)-CLOSE     *
*                     SPS HE VLV TB(BOTH)-BP       * -12
*                     SPS GMBLS RETURN TO SERVO    *
*                       NULL                       *
*                  GMBL MTRS-OFF(SEQUENTIALLY)     *
*                  TVC SERVO PWR(BOTH)-OFF         *
*                  FDAI SCALE-5/1                  *
*                  RATE-LOW                        * -8
*                  ROT CONT PWR DIRECT(BOTH)-OFF*
*                  PRO                             *
*          F 16 85 (VG-BODY)                       *
*                  THC-NULL VG COMPONENTS          *
*                  THC-LOCKED                      *
```

```
      GET      EVENT                                  PROG
                  RHC-LOCKED                          *
                  EMS FUNCTION-VHF RNG                *
                  EMS MODE-VHF RNG                    *
                  VHF RNG-RESET                       *
                  MN BUS TIE(2)-OFF                   *
                  PRO                                 *
          F 37 BB                                     *
************************************************ *
                  RENDEZVOUS NAV PROGRAM        (P20)
                   AUTO MNVR TO SXT TRACK
                  (70 DEG)
                  (0,224/160,0)
                  TPI TARGETING PROGRAM   (P34)(P20)
                   LOAD N55 R2=+20830
                            R3=+13000
                  CALL MARKING ROUTINE(V87,V57)
                   (V93 AFTER 3 SXT MARKS PROCESSED)
      (104+53)
                  SUNSET
                  TERMINATE MARKS(18)
                  MOVE TO CMD SEAT
                  TPI TARGETING FINAL     (P34)(P20)
                   COMP
                  VERIFY ORDEAL(V83)
                  SPS THRUST PROGRAM,V56        (P40)
                   AUTO MNVR TO BURN ATTITUDE
                  (95 DEG)
                  (0,165/353,0)
```

MISSION F RESCUE TIMELINE APRIL 25, 1969

GET	EVENT	PROG
-8		
	KEY 40E	
F 50 18	(COMMANDED R,P,Y)	
	KEY V56E	
	RHC=ARMED	
	ALIGN ROLL TO 0 DEG	
	RHC=LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR MNVR	
F 50 18	(COMMANDED R,P,Y)	
	MN BUS TIE(2)=ON(UP)	
	SPS HE VLV TB(BOTH)=BP	
	SPS HE VLV(BOTH)=AUTO	
	NONESS BUS=MNA	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
-5		
	SPS THRUST SETUP	
-5		
	GDC ALIGN	
	ALT SET KNOB TO 60 NM	
	FDAI SELECT=1	
	ATT SET THUMBWHEELS TO N18	
	NULL ATT ERROR NEEDLES	
	ON FDAI 1 WITH ATT	
	SET THUMBWHEELS	
	ATT SET=GDC	
	DEPRESS GDC ALIGN PB	
	FDAI SELECT=1/2	
	ATT SET=TMU	
	MTVC CHECKS	
	BMAG MODE(3)=ATT1/RATE2	
	TVC SERVO PWR 1=AC1/MNA	
	TVC SERVO PWR 2=AC2/MNB	
	TRANS CONTR PWR=ON	
	RHC PWR NORM 2=AC	
	GMBL MTRS PITCH 1 STRT=ON	
	GMBL MTRS YAW 1 STRT=ON	
	THC=CLOCKWISE	
	RHC=ARMED	
	RHC=VERIFY NO MTVC	
	GMBL MTRS PITCH 2=STRT=ON	
	GMBL MTRS YAW 2=STRT=ON	
	SET SPS GIMBALS TW(2)=	
	PITCH = -.52	
	YAW = +.59	
	RHC=VERIFY MTVC	
	THC=NEUTRAL	
	RHC PWR NORM 2=AC/DC	
	RHC=LOCKED	
	PRO	
06 18	(COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
F 50 18	(COMMANDED R,P,Y)	
	KEY ENTER	
F 50 25	(00204,GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)=MNA/MNB	
	RATE=HIGH	

GET	EVENT	PROG
*	AUTO RCS SEL A/C ROLL(4)=MNA	*
*	PRO	*
*	MONITOR GMBL DRIVE	*
*	SEQ AND TRIM	*
*	06 40 (TFI,VG,DVM)	*
*-02+00		*
*	FDAI SCALE=5/5	*
*	VERIFY SPS TH LT=OFF	*
*	EMS MODE STBY	*
*	EMS FUNCTION=DV SET	*
*	LOAD TPI VC	*
*	EMS FUNCTION=DV	*
*	THC=ARMED	*
*	RHC=ARMED	*
*	DV THRUST(A)=NORMAL	*
*-00+35		*
*	DSKY BLANKS	*
*-00+30		*
*	06 40 (TFI,VG,DVM)	*
*	EMS MODE=NORMAL	*
*-00+15		*
*	PERFORM ULLAGE	*
*-00+05		*
*	F 99 40 (REQUEST FOR ENGINE ENABLE)	*
*	PRO	*
*	06 40 (TFI,VG,DVM)	*
**********	**********	*
(105+16+47)		*
	**********	*
	CSM TPI BURN(-21.1,0,-.8)	*
	(0,180/353,0)	*
	**********	

GET	EVENT	PROG
**********	**********	*
	SET MDC ET=RESET,START	*
	MONITOR	*
	SPS THRUST LT=ON	*
	DV INDICATOR=DECREASING	*
*+00+01		*
	ULLAGE=OFF	*
06 40	(TFC,VG,DVM)	*
	MONITOR SPS OPERATION	*
	PC INDICATOR=95=105 PSI	*
	MONITOR SPS ENGINE CUTOFF	*
	SPS THRUST LT=OFF	*
F 16 40	(TFC,VG,DVM)	*
	DV THRUST(BOTH)=OFF	*
	MONITOR	*
	PC INDICATOR = 0	*
	SPS INJ VLV IND(4)=CLOSE	*
	SPS HE VLV TB(BOTH)=BP	*
	SPS GMBLS RETURN TO SERVO	*
	NULL	*
	GMBL MTRS=OFF(SEQUENTIALLY)	*
	TVC SERVO PWR(BOTH)=OFF	*
	FDAI SCALE=5/1	*
	RATE=LOW	*
	ROT CONT PWR DIRECT(BOTH)=OFF	*
	PRO	*
F 16 85	(VG=BODY)	*
	THC=NULL VG COMPONENTS	*
	THC=LOCKED	*
	RHC=LOCKED	*
	EMS FUNCTION=VHF RNG	*

GET	EVENT	PROG
*	EMS MODE-VHF RNG	*
*	VHF RNG-RESET	*
*	MN BUS TIE(2)-OFF	*
*	PRO	*
*	F 37 BB	*
**********	**********	**********
+2		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(61 DEG)	
	(0,246/54,0)	
	MCC TARGETING PROGRAM	(P35)(P20)
	MOVE TO LEB DURING AUTO MNVR	
+4		
	CALL MARKING ROUTINE(V93,V87,V57)	
+11		
	TERMINATE MARKS(7)	
+12		
	MCC TARGETING FINAL	(P35)(P20)
	COMP	
+13.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	RCS THRUST SETUP	(P41)
+15 (105+31+47)		
	**********	
	MCC1 BURN(0,265/37,0)	
	**********	
	LOS	
+16		
	MCC TARGETING PROGRAM	(P35)(P20)
	POSSIBLE MNVR TO SXT TRACK	
+17		
	CALL MARKING ROUTINE(V93,V87,V57)	

GET	EVENT	PROG
	(105+40)	
	SUNRISE	
+26		
	TERMINATE MARKS(9)	
+27		
	MCC TARGETING FINAL	(P35)(P20)
	COMP	
+28.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	RCS THRUST SETUP	(P41)
+30	(105+46+47)	
	**********	
	MCC2 BURN(0,286/23,0)	
	**********	
+32		
	AUTO MNVR TO COAS TRACK(V89)	(P00)
	MOVE TO CMD SEAT	
	(37 DEG)	
	(0,254/346,0)	
	CALL P47 AT R=1.25N.M.	
	THRUST MONITOR PROGRAM	(P47)
	V83,PERFORM BRAKING AND	
	LOS CONTROL	

BRAKING GATES	RETICLE ANGLE
30 FPS AT 6000 FT	.13 DEG.
20 FPS AT 3000 FT	.26 DEG.
10 FPS AT 2500 FT	.54 DEG.
5 FPS AT 500 FT	1.60 DEG.

GET	EVENT	PROG
+51	(106+07+47)	
	**********	
	TPF	
	**********	

MISSION F RESCUE TIMELINE APRIL 25, 1969

9.5.2 NAVIGATION SUMMARY
LM INSERTION = 0 FPS

P20 NAVIGATION SUMMARY WITH SUN ANGLES
IT - INITIATE TRACK
CT - CEASE TRACK
(OUT-OF-PLANE SUN ANGLE IS 4 DEG)

GET	EVENT	SUN ANGLE (LOS TO SUN) DEG
102:46	CSM INSERTION BURN SUNSET	
103:03	IT (SXT/VHF) (V93;6/5;V93;14/15)	
103:08	CT (SXT)	
103:23	CT (VHF)	
103:32	CSM CSI BURN SUNRISE	
103:40	IT (SXT/VHF) (4/3;V67,00057,00034,00001;8/9)	158
103:45		172
103:50		174
103:52	CT (SXT/VHF)	168
104:04	CSM PLANE CHANGE	
104:09	IT (SXT/VHF) (4/3,V93,11/12)	123
104:14		109
104:19		97
104:24	CT (SXT/VHF)	83
104:37	CSM CDH BURN	
104:47	IT (SXT/VHF) (4/3,V93,14/15)	19
104:52		1
104:53	SUNSET	1
105:05	CT (SXT/VHF)	
105:17	CSM TPI BURN	
105:21	IT (SXT/VHF) (V93,7/7)	
105:28	CT (SXT/VHF)	
105:32	CSM MCC1 BURN	
105:33	IT (SXT/VHF) (V93,9/9)	
105:40	SUNRISE	93
105:42	CT (SXT/VHF)	94
106:02	CSM MCC2 BURN	
106:08	TPF	

9.5.3 CSM ATTITUDE SUMMARY
INERTIAL AND ORDEAL FDAI BALL GIMBAL ANGLE
PROFILE FOR LM INSERTION = 0 RESCUE CASE
(MISSION F) (YAW = 0.0)

TIME GET	ROLL	PITCH ORDEAL	PITCH INERTIAL	PITCH MNVR
102:46	180	32	272	
102:56	180	165	16	103
103:26	180	156	293	5
103:32	180	180	293	
103:34	180	158	266	27
104:04	180	173	205	
104:05	180	147	180	25
104:26	0	155	133	
104:28	0	245	231	98
104:37	0	269	231	
104:40	0	244	160	70
105:09	0	165	353	95
105:16	0	180	353	
105:19	0	246	54	61
105:32	0	265	37	
106:02	0	286	23	
106:04	0	254	346	37

9.6 LM PARTIAL INSERTION

GET	EVENT	PROG
	(LM INSERTION=120 FPS)	
(102+43+18)		
	**********	
	LM INSERTION BURN (-106.8,0.-54.5)	
	**********	
(102+47)		
	SUNSET	
	MOVE TO LER	
	IMU REALIGN TO REFSMMAT	
	(OPTION 3)	(P52)
(102+52)		
	MCC-H UPLINK (LM STATE	
	VECTOR)	(P00)
-29 (103+03)		
	COPY RESCUE,CSI ONE,CDH,TPI PADS	
(103+17)		
	LOS	
	MOVE TO CMD SEAT	
-12 (103+20)		
	EXTERNAL DV PROGRAM	(P30)
-7 (103+25)		
	SPS THRUST PROGRAM,V56	(P40)
	AUTO MNVR TO BURN ATTITUDE	
	(19 DEG)	
	(180,165/282,0)	

GET	EVENT	PROG
-7 (103+25)		
	KEY 40E	
	F 50 18 (COMMANDED R,P,Y)	
	KEY V56E	
	RHC-ARMED	
	ALIGN ROLL TO	
	RHC-LOCKED	
	PRO	
	06 18 (COMMANDED R,P,Y)	
	MONITOR MNVR	
	F 50 18 (COMMANDED R,P,Y)	
	MN BUS TIE(2)-ON(UP)	
	SPS HE VLV TB(BOTH)-BP	
	SPS HE VLV(BOTH)-AUTO	
	NONESS BUS-MNA	
	PRO	
	06 18 (COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
	F 50 18 (COMMANDED R,P,Y)	
-5 (103+27)		
	SPS THRUST SETUP	(P40)
-5 (103+27)		
	GDC ALIGN	
	ALT SET KNOB TO 60 NM	
	FDAI SELECT-1	

GET	EVENT	PROG
	ATT SET THUMBWHEELS TO N18	*
	NULL ATT ERROR NEEDLES	*
	ON FDAI 1 WITH ATT	*
	SET THUMBWHEELS	*
	ATT SET-GDC	*
	DEPRESS GDC ALIGN PB	*
	FDAI SELECT-1/2	*
	ATT SET-TMU	*
		*
	MTVC CHECKS	*
		*
	BMAG MODE(3)-ATT1/RATE?	*
	TVC SERVO PWR 1-AC1/MNA	*
	TVC SERVO PWR 2-AC2/MNB	*
	TRANS CONTR PWR-ON	*
	RHC PWR NORM 2-AC	*
	GMBL MTRS PITCH 1 STRT-ON	*
	GMBL MTRS YAW 1 STRT-ON	*
	THC-CLOCKWISE	*
	RHC-ARMED	*
	RHC-VERIFY NO MTVC	*
	GMBL MTRS PITCH 2-STRT-ON	*
	GMBL MTRS YAW 2-STRT-ON	*
	SET SPS GIMBALS TW(2)-	*
	PITCH = -.52	*
	YAW = +.59	*
	RHC-VERIFY MTVC	*
	THC-NEUTRAL	*
	RHC PWR NORM 2-AC/DC	*
	RHC-LOCKED	*
	PRO	*
06 18	(COMMANDED R,P,Y)	*
	MONITOR ATT TRIM	*
F 50 18	(COMMANDED R,P,Y)	*
		*
	*-02+00	*
		*
	FDAI SCALE-5/5	*
	VERIFY SPS TH LT-OFF	*
	EMS MODE STBY	*
	EMS FUNCTION-DV SET	*
	LOAD RESCUE VC	*
	EMS FUNCTION-DV	*
	THC-ARMED	*
	RHC-ARMED	*
	DV THRUST(A)-NORMAL	*
		*
	*-00+35	*
		*
	DSKY BLANKS	*
		*
	*-00+30	*
06 40	(TFI,VG,DVM)	*
	EMS MODE-NORMAL	*
		*
	*-00+15	*
		*
	PERFORM ULLAGE	*
		*
	*-00+05	*
F 99 40	(REQUEST FOR ENGINE ENABLE)	*
	PRO	*
06 40	(TFI,VG,DVM)	*
	**********	**********

GET	EVENT	PROG
	KEY ENTER	*
F 50 25	(00204,GMBL DRIVE TEST)	*
	RHC PWR DIRECT(BOTH)-MNA/MNB	*
	RATE-HIGH	*
	AUTO RCS SEL A/C ROLL(4)-MNA	*
	PRO	*
	MONITOR GMBL DRIVE	*
	SEQ AND TRIM	*
06 40	(TFI,VG,DVM)	*
		*
	FDAI SCALE-5/5	*
	VERIFY SPS TH LT-OFF	*
	EMS MODE STBY	*
	EMS FUNCTION-DV SET	*
	LOAD RESCUE VC	*
	EMS FUNCTION-DV	*
	THC-ARMED	*
	RHC-ARMED	*
	DV THRUST(A)-NORMAL	*
		*
	DSKY BLANKS	*
		*
06 40	(TFI,VG,DVM)	*
	EMS MODE-NORMAL	*
		*
	PERFORM ULLAGE	*
		*
F 99 40	(REQUEST FOR ENGINE ENABLE)	*
	PRO	*
06 40	(TFI,VG,DVM)	*
	**********	**********

```
      GET       EVENT                                        PROG

 0    (103+31+59)                                                  *
             ************************************                  *
             CSM RESCUE BURN (-44.9,0.0),                          *
                          (180,180/282.0)                          *
             ************************************                  *
*************************************************                *
*                 SET MUC ET-RESET,START          *             *
*                 MONITOR:                        *             *
*                   SPS THRUST LT-ON              *             *
*                   DV INDICATOR-DECREASING       *             *
*+00+01                                            *             *
*                 ULLAGE-OFF                      *             *
*           06 40 (TFC,VG,DVM)                    *             *
*                 MONITOR SPS OPERATION:          *             *
*                   PC INDICATOR-95-105 PSI       *             *
*                 MONITOR SPS ENGINE CUTOFF:      *             *
*                   SPS THRUST LT-OFF             *             *
*         F 16 40 (TFC,VG,DVM)                    *             *
*                 DV THRUST(BOTH)-OFF             *             *
*                 MONITOR:                        *             *
*                   PC INDICATOR = 0              *             *
*                   SPS INJ VLV IND(4)-CLOSE      *             *
*                   SPS HE VLV TB(BOTH)-BP        *             *
*                   SPS GMBLS RETURN TO SERVO     *             *
*                     NULL                        *             *
*                 GMBL MTRS-OFF(SEQUENTIALLY)     * -35 (103+55)*
*                 TVC SERVO PWR(BOTH)-OFF         *             *
*                 FDAI SCALE-5/1                  *             *
*                 RATE-LOW                        *             *
*                 ROT CONT PWR DIRECT(BOTH)-OFF   *             *
*                 PRO                             *             *
*                                                 *             *
*                                                 *       (104+05)*
*                                                 *             *
*                                                 *             *
*                                                 *             *
```

GET	EVENT	PROG
-15	(104+15)	
	TERMINATE MARKS(20)	
	MOVE TO CMD SEAT	
	CST TARGETING PROGRAM	(P32)
	FINAL COMP	
	OUT OF PLANE DATA(V90)	
	OVERWRITE N81 WITH (-) CSM YDOT	
-11	(104+19)	
	SPS THRUST PROGRAM,V56	(P40)
	AUTO MNVR TO BURN ATTITUDE	
	(175 DEG)	
	(180,345/281,0)	
	ACQ MSFN,R40=-48,GAMMA=180	
*-11	(104+19)	
*	KEY 40E	
*	F 50 18 (COMMANDED R,P,Y)	
*	KEY V56E	
*	RHC-ARMED	
*	ALIGN ROLL TO	
*	RHC-LOCKED	
*	PRO	
*	06 18 (COMMANDED R,P,Y)	
*	MONITOR MNVR	
*	F 50 18 (COMMANDED R,P,Y)	
*	MN BUS TIE(2)-ON(UP)	
*	SPS HE VLV TB(BOTH)-RP	
*	SPS HE VLV(BOTH)-AUTO	
*	NONESS BUS-MNA	
*	PRO	
*	06 18 (COMMANDED R,P,Y)	
*	MONITOR ATT TRIM	
*	F 50 18 (COMMANDED R,P,Y)	

GET	EVENT	PROG
-5	(104+25)	
	SPS THRUST SETUP	(P40)
*-5	(104+25)	
*	**GDC ALIGN**	
*	ALT SET KNOB TO 60 NM	
*	FDAI SELECT-1	
*	ATT SET THUMBWHEELS TO N18	
*	NULL ATT ERROR NEEDLES	
*	ON FDAI 1 WITH ATT	
*	SET THUMBWHEELS	
*	ATT SET-GDC	
*	DEPRESS GDC ALIGN PB	
*	FDAI SELECT-1/2	
*	ATT SET-TMU	
*	**MTVC CHECKS**	
*	BMAG MODE(3)-ATT1/RATE2	
*	TVC SERVO PWR 1-AC1/MNA	
*	TVC SERVO PWR 2-AC2/MNB	
*	TRANS CONTR PWR-ON	
*	RHC PWR NORM 2-AC	
*	GMBL MTRS PITCH 1 STRT-ON	
*	GMBL MTRS YAW 1 STRT-ON	
*	THC-CLOCKWISE	
*	RHC-ARMED	
*	RHC-VERIFY NO MTVC	
*	GMBL MTRS PITCH 2-STRT-ON	
*	GMBL MTRS YAW 2-STRT-ON	

GET	EVENT	PROG
	SET SPS GIMBALS TW(2)-	
	PITCH = -.52	
	YAW = +.59	
	RHC-VERIFY MTVC	
	THC-NEUTRAL	
	RHC PWR NORM 2-AC/DC	
	RHC-LOCKED	
	PRO	
06 1R	(COMMANDED R,P,Y)	
	MONITOR ATT TRTM	
F 50 1R	(COMMANDED R,P,Y)	
	KEY ENTER	
F 50 25	(00204,GMBL DRIVE TEST)	
	RHC PWR DIRECT(BOTH)-MNA/MNB	
	RATE-HIGH	
	AUTO RCS SEL A/C ROLL(4)-MNA	
	PRO	
	MONITOR GMBL DRIVE	
	SEQ AND TRIM	
06 40	(TFI,VG,DVM)	
-02+00		
	FDAI SCALE-5/5	
	VERIFY SPS TH LT-OFF	
	EMS MODE STBY	
	EMS FUNCTION-DV SET	
	LOAD CSI VC	
	EMS FUNCTION-DV	
	THC-ARMED	
	RHC-ARMED	
	DV THRUST(A)-NORMAL	
-00+35		
	DSKY BLANKS	

GET	EVENT	PROG
-00+30		
06 40	(TFI,VG,DVM)	
	EMS MODE-NORMAL	
-00+15		
	PERFORM ULLAGE	
-00+05		
F 99 40	(REQUEST FOR ENGINE ENABLE)	
	PRO	
06 40	(TFI,VG,DVM)	
	**********	
(104+29+59)		
	**********	
	CSM CSI ONE BURN(114.6,0,0)	
	(180,0,281,0)	
	**********	
	**********	
	SET MDC ET-RESET,START	
	MONITOR	
	SPS THRUST LT-ON	
	DV INDICATOR-DECREASING	
+00+01		
	ULLAGE-OFF	
06 40	(TFC,VG,DVM)	
	MONITOR SPS OPERATION	
	PC INDICATOR-95-105 PSI	
	MONITOR SPS ENGINE CUTOFF	
	SPS THRUST LT-OFF	
F 16 40	(TFC,VG,DVM)	
	DV THRUST(BOTH)-OFF	
	MONITOR	
	PC INDICATOR = 0	
	SPS INJ VLV IND(4)-CLOSE	
	SPS HE VLV TB(BOTH)-BP	

GET	EVENT	PROG
	SPS GMBLS RETURN TO SERVO	-35
	NULL	
	GMBL MTRS-OFF(SEQUENTIALLY)	
	TVC SERVO PWR(BOTH)-OFF	
	FDAI SCALE-5/1	
	RATE-LOW	
	ROT CONT PWR DIRECT(BOTH)-OFF	-32
	PRO	
F 16 RS	(VG-BODY)	
	THC-NULL VG COMPONENTS	
	THC-LOCKED	
	RHC-LOCKED	
	EMS FUNCTION-VHF RNG	
	EMS MODE-VHF RNG	
	VHF RNG-RESET	
	MN BUS TIE(2)-OFF	
	PRO	
F 37 BR		
		-9
(104+34)		
	CMC IDLING PROGRAM (P00)	
-50 (104+42)		
	SUNSET	-5
	MOVE TO LER	
	IMU REALIGN TO REFSMMAT (P52)	
	(OPTION 3)	
-45 (104+47)		
	MCC-H UPLINK(LM VECTOR)(IF LM ACTIVE) (P00)	-2
-40 (104+52)		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(90 DEG)	
	(180,162/11,0)	

GET	EVENT	PROG
(104+57)		
	CSI TARGETING PROGRAM (P32)	
	LOAD N55 WITH	
	R1=+00001	
	R2=+20830	
	R3=+13000	
(105+00)		
	CALL MARKING ROUTINE(V93,V87,V57)	
	(V93 AFTER 5 MARKS PROCESSED)	
(105+05)		
	TERMINATE SXT MARKS,V93	
	CONTINUE VHF	
(105+10)		
	OUT OF PLANE DATA(V90)	
	OVERWRITE N81 WITH (-) CSM YDOT	
	CONTINUE VHF	
(105+18)		
	LOS	
(105+23)		
	TERMINATE MARKS(23)	
	MOVE TO CMD SEAT	
	CSI TARGETING FINAL COMP (P32)	
(105+27)		
	RCS THRUST PROGRAM,V56 (P41)	
	AUTO MNVR TO BURN ATTITUDE	
	(180,165/276,0)	
(105+29)		
	SUNRISE	
(105+30)		
	RCS THRUST SETUP (P41)	

GET	EVENT	PROG
(105+31+55)		0
	**********	
	CSM CST TWO BURN(,0,)	
	(180,171/276,0)	
	**********	
-28 (105+35)		-30
	OUT OF PLANE DATA(V90)	
	MOVE TO LEB	
-26 (105+37)		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(27 DEG)	
	(180,164/249,0)	-27
-22 (105+41)		
	CALL MARKING ROUTINE(V87,V57)	
	AFTER 3 SXT MARKS PROCESSED	-25
	V67,LOAD WR(00057,00034,00001)	
-12 (105+51)		
	TERMINATE MARKS(10)	-10
	MOVE TO CMD SEAT	
	OUT OF PLANE DATA V90	
-5 (105+58)		
	EXTERNAL DV TARGETING (P30)	
	OVERWRITE N81 WITH (-) CSM YDOT	
-3 (106+00)		
	RCS THRUST PROGRAM,V56 (P41)	
	BYPASS BURN ATTITUDE MNVR	
	(180,155/178,0)	-6
-2 (106+01)		
	RCS THRUST SETUP (P41)	

GET	EVENT	PROG
(106+03+00)		
	**********	
	CSM PLANE CHANGE(0, ,0)	
	(180,161/178,0)	
	**********	
(106+04)		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(13 DEG)	
	(180,154/165,0)	
(106+06)		
	AOS	
(106+07)		
	CDH TARGETING PROGRAM (P33)	
	MOVE TO LEB	
(106+09)		
	CALL MARKING ROUTINE(V87,V57)	
	(V93 AFTER 3 MARKS PROCESSED)	
(106+24)		
	TERMINATE MARKS(15)	
	MOVE TO CMD SEAT	
	CDH TARGETING FINAL COMP (P33)	
	ROLL 180 DEG,ACQ MSFN	
	(0,223/178,0)	
	(RHO=-58,GAMMA=173)	
	OUT OF PLANE DATA (V90)	
	OVERWRITE N81 WITH (-) CSM YDOT	
(106+27)		
	SPS THRUST PROGRAM,V56 (P40)	
	AUTO MNVR TO BURN ATTITUDE	
	(3 DEG)	
	(0,229/165,0)	

GET	EVENT	PROG
-6	(106+27)	
	KEY 40E	
	F 50 18 (COMMANDED R,P,Y)	
	KEY V56E	
	RHC-ARMED	
	ALIGN ROLL TO	
	RHC-LOCKED	
	PRO	
	06 18 (COMMANDED R,P,Y)	
	MONITOR MNVR	
	F 50 18 (COMMANDED R,P,Y)	
	MN BUS TIE(2)-ON(UP)	
	SPS HE VLV TB(BOTH)-RP	
	SPS HE VLV(BOTH)-AUTO	
	NONESS BUS-MNA	
	PRO	
	06 18 (COMMANDED R,P,Y)	
	MONITOR ATT TRIM	
	F 50 18 (COMMANDED R,P,Y)	
-5	(106+29)	
	SPS THRUST SETUP (P40)	
-5	(106+29)	
	GDC ALIGN	
	ALT SET KNOB TO 60 NM	
	FDAI SELECT-1	
	ATT SET THUMBWHEELS TO N18	

GET	EVENT	PROG
	NULL ATT ERROR NEEDLES	
	ON FDAI 1 WITH ATT	
	SET THUMBWHEELS	
	ATT SET-GDC	
	DEPRESS GDC ALIGN PB	
	FDAI SELECT-1/2	
	ATT SET-TMU	
	MTVC CHECKS	
	BMAG MODE(3)-ATT1/RATE2	
	TVC SERVO PWR 1-AC1/MNA	
	TVC SERVO PWR 2-AC2/MNB	
	TRANS CONTR PWR-ON	
	RHC PWR NORM 2-DC	
	GMBL MTRS PITCH 1 STRT-ON	
	GMBL MTRS YAW 1 STRT-ON	
	THC-CLOCKWISE	
	RHC-ARMED	
	RHC-VERIFY NO MTVC	
	GMBL MTRS PITCH 2-STRT-ON	
	GMBL MTRS YAW 2-STRT-ON	
	SET SPS GIMBALS TW(2)-	
	PITCH = -.52	
	YAW = +.59	
	RHC-VERIFY MTVC	
	THC-NEUTRAL	
	RHC PWR NORM 2-AC/DC	
	RHC-LOCKED	
	PRO	
06	18 (COMMANDED R,P,Y)	
	MONITOR ATT TRIM	

```
      GET       EVENT                                PROG
*          F 50 18 (COMMANDED R,P,Y)                  *
*                  KEY ENTER                          *
*          F 50 25 (00204,GMBL DRIVE TEST)            *
*                  RHC PWR DIRECT(BOTH)-MNA/MNB       *
*                  RATE-HIGH                          *
*                  AUTO RCS SEL A/C ROLL(4)-MNA       *
*                  PRO                                *
*                  MONITOR GMBL DRIVE                 *
*                    SEQ AND TRIM                     *
*            06 40 (TFI,VG,DVM)                       *
*-02+00                                               *
*                  FDAI SCALE-5/5                     *
*                  VERIFY SPS TH LT-OFF               *
*                  EMS MODE STBY                      *
*                  EMS FUNCTION-DV SET                *
*                  LOAD CDH VC                        *
*                  EMS FUNCTION-DV                    *
*                  THC-ARMED                          *
*                  RHC-ARMED                          *
*                  DV THRUST(A)-NORMAL                *
*-00+35                                               *
*                  DSKY BLANKS                        *
*-00+30                                               *
*            06 40 (TFI,VG,DVM)                       *
*                  EMS MODE-NORMAL                    *
*-00+15                                               *
*                  PERFORM ULLAGE                     *
*-00+05                                               *
*          F 99 40 (REQUEST FOR ENGINE ENABLE)        *
*                  PRO                                *
*            06 40 (TFI,VG,DVM)                       *
*************************************************** *
```

```
      GET       EVENT                                PROG
 0     (106+33+49)
                 ***********************************
                 CSM CDH BURN (-37.1,0,74.8),
                              (0,244/165,0)
                 ***********************************
*************************************************
*                  SET MDC ET-RESET,START           *
*                  MONITOR                          *
*                     SPS THRUST LT-ON              *
*                     DV INDICATOR-DECREASING       *
*+00+01                                             *
*                  ULLAGE-OFF                       *
*            06 40 (TFC,VG,DVM)                     *
*                  MONITOR SPS OPERATION            *
*                     PC INDICATOR-95-105 PSI       *
*                  MONITOR SPS ENGINE CUTOFF        *
*                     SPS THRUST LT-OFF             *
*          F 16 40 (TFC,VG,DVM)                     *
*                  DV THRUST(BOTH)-OFF              *
*                  MONITOR                          *
*                     PC INDICATOR = 0              *
*                     SPS INU VLV IND(4)-CLOSE      *
*                     SPS HE VLV TB(BOTH)-BP        *
*                     SPS GMBLS RETURN TO SERVO     *
*                       NULL                        *
*                  GMBL MTRS-OFF(SEQUENTIALLY)      *
*                  TVC SERVO PWR(BOTH)-OFF          *
*                  FDAI SCALE-5/1                   *
*                  RATE-LOW                         *
*                  ROT CONT PWR DIRECT(BOTH)-OFF    *
*                  PRO                              *
```

GET	EVENT	PROG
	F 16 85 (VG=BODY)	
	THC=NULL VG COMPONENTS	
	THC=LOCKED	
	RHC=LOCKED	
	EMS FUNCTION=VHF RNG	
	EMS MODE=VHF RNG	
	VHF RNG=RESET	
	MN BUS TIE(2)=OFF	
	PRO	
	F 37 88	
-33 (106+36)		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(27 DEG)	
	(0,229/138,0)	
	MOVE TO LEB	
-31 (106+38)		
	TPI TARGETING PROGRAM	(P34)
	LOAD N55 WITH	
	R2=+20830	
	R3=+13000	
-29 (106+40)		
	CALL MARKING ROUTINE(V87,V57)	
	(V93 AFTER 3 MARKS PROCESSED)	
(106+44)		
	SUNSET	
-12 (106+57)		
	TERMINATE MARKS(17)	
	MOVE TO CMD SEAT	
	TPI TARGETING FINAL COMP	(P34)
-8 (107+01)		
	VERIFY ORDEAL(V83)	

GET	EVENT	PROG
-7 (107+02)		
	SPS THRUST PROGRAM,V56	(P40)
	AUTO MNVR TO BURN ATTITUDE	
	(56 DEG)	
	(0,174/10,0)	
-7 (107+02)		
	KEY 40E	
	F 50 18 (COMMANDED R,P,V)	
	KEY V56E	
	RHC=ARMED	
	ALIGN ROLL TO	
	RHC=LOCKED	
	PRO	
	06 18 (COMMANDED R,P,V)	
	MONITOR MNVR	
	F 50 18 (COMMANDED R,P,V)	
	MN BUS TIE(2)=ON(UP)	
	SPS HE VLV TB(BOTH)=BP	
	SPS HE VLV(BOTH)=AUTO	
	NONESS BUS=MNA	
	PRO	
	06 18 (COMMANDED R,P,V)	
	MONITOR ATT TRIM	
	F 50 18 (COMMANDED R,P,V)	
-4 (107+05)		
	SPS THRUST SETUP	(P40)
-4 (107+05)		
	GDC ALIGN	

GET	EVENT	PROG
		* *
	ALT SET KNOB TO 60 NM	* *
	FDAI SELECT-1	* *
	ATT SET THUMBWHEELS TO N18	* *
	NULL ATT ERROR NEEDLES	* *
	ON FDAI 1 WITH ATT	* *
	SET THUMBWHEELS	* *
	ATT SET-GDC	* *
	DEPRESS GDC ALIGN PB	* *
	FDAI SELECT-1/2	* *
	ATT SET-TMU	* *
		* *
	MTVC CHECKS	* *-02+00
		* *
	BMAG MODE(3)-ATT1/RATE2	* *
	TVC SERVO PWR 1-AC1/MNA	* *
	TVC SERVO PWR 2-AC2/MNB	* *
	TRANS CONTR PWR-ON	* *
	RHC PWR NORM 2-AC	* *
	GMBL MTRS PITCH 1 STRT-ON	* *
	GMBL MTRS YAW 1 STRT-ON	* *
	THC-CLOCKWISE	* *
	RHC-ARMED	* *-00+35
	RHC-VERIFY NO MTVC	* *
	GMBL MTRS PITCH 2-STRT-ON	* *-00+30
	GMBL MTRS YAW 2-STRT-ON	* *
	SET SPS GIMBALS TW(2)-	* *
	PITCH = -.52	* *-00+15
	YAW = +.59	* *
	RHC-VERIFY MTVC	* *-00+05
	THC-NEUTRAL	* *
	RHC PWR NORM 2-AC/DC	* *
	RHC-LOCKED	* *
	PRO	* **********

GET	EVENT	PROG
06 18	(COMMANDED R,P,Y)	*
	MONITOR ATT TRIM	*
F 50 18	(COMMANDED R,P,Y)	*
	KEY ENTER	*
F 50 25	(00204,GMBL DRIVE TEST)	*
	RHC PWR DIRECT(BOTH)-MNA/MNB	*
	RATE-HIGH	*
	AUTO RCS SEL A/C ROLL(4)-MNA	*
	PRO	*
	MONITOR GMBL DRIVE	*
	SEQ AND TRIM	*
06 40	(TFI,VG,DVM)	*
		*
	FDAI SCALE-5/5	*
	VERIFY SPS TH LT-OFF	*
	EMS MODE STBY	*
	EMS FUNCTION-DV SET	*
	LOAD TBI VC	*
	EMS FUNCTION-DV	*
	THC-ARMED	*
	RHC-ARMED	*
	DV THRUST(A)-NORMAL	*
		*
	DSKY BLANKS	*
		*
06 40	(TFI,VG,DVM)	*
	EMS MODE-NORMAL	*
		*
	PERFORM ULLAGE	*
		*
F 99 40	(REQUEST FOR ENGINE ENABLE)	*
	PRO	*
06 40	(TFI,VG,DVM)	* **********

GET	EVENT	PROG
(107+08+54)		
	**********	
	CSM TPI BURN(-24.0,3.9)	
	(0,189/10.0)	
	**********	
**********		
	SET MDC ET-RESET,START	
	MONITOR	
	SPS THRUST LT-ON	
	DV-INDICATOR-DECREASING	
+00+01		
	ULLAGE-OFF	
06 40	(TFC,VG,DVM)	
	MONITOR SPS OPERATION	
	PC INDICATOR-95-105 PSI	
	MONITOR SPS ENGINE CUTOFF	
	SPS THRUST LT-OFF	
F 16 40	(TFC,VG,DVM)	
	DV THRUST(BOTH)-OFF	
	MONITOR	
	PC INDICATOR = 0	
	SPS INJ VLV IND(4)-CLOSE	
	SPS HE VLV TB(BOTH)-RP	+11
	SPS GMBLS RETURN TO SERVO NULL	
		+12
	GMBL MTRS-OFF(SEQUENTIALLY)	
	TVC SERVO PWR(BOTH)-OFF	+13.5
	FDAI SCALE-5/1	
	RATE-LOW	
	ROT CONT PWR DIRECT(BOTH)-OFF	
	PRO	

GET	EVENT	PROG
F 16 85	(VG-BODY)	
	THC-NULL VG COMPONENTS	
	THC-LOCKED	
	RHC-LOCKED	
	EMS FUNCTION-VHF RNG	
	EMS MODE-VHF RNG	
	VHF RNG-RESET	
	MN BUS TIE(2)-OFF	
	PRO	
F 37 88		
**********		
+2		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(37 DEG)	
	(0,247/47,0)	
	MOVE TO LEB	
	MCC TARGETING PROGRAM	(P35)
+3		
	CALL MARKING ROUTINE(V93,V87,V57)	
(107+18)		
	LOS	
	TERMINATE MARKS(8)	
	MCC TARGETING FINAL COMP	(P35)
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	(0,268/30,0)	
	RCS THRUST SETUP	(P41)

GET	EVENT	PROG
+15	(107+23+54)	
	**********	
	CSM MCC1 BURN	
	(0,264/30,0)	
	**********	
16		
	MCC TARGETING PROGRAM	(P35)
17		
	CALL MARKING ROUTINE(V93,V87,V57)	
(107+31)	SUNRISE	
+26		
	TERMINATE MARKS(9)	
27		
	MCC TARGETING FINAL COMP	(P35)
28.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN AUTO MNVR	
	(0,287/17,0)	
	RCS THRUST SET UP	(P41)
30	(107+38+54)	
	**********	
	CSM MCC2 BURN	
	((0,293/17,0)	
	**********	
31		
	AUTO MNVR TO COAS TRACK(V89)	(P00)
	(28 DEG)	
	(0,262/341,0)	
	MOVE TO CMD SEAT	
37	(107+46)	
	THRUST MONITORING PROGRAM	(P47)
	V89,PERFORM BRAKING AND LOS	
	CONTROL	

GET	EVENT	PROG
	**********	
	* BRAKING GATES RETICLE ANGLE *	
	* 30 FPS AT 6000 FT .13 DEG. *	
	* 20 FPS AT 3000 FT .26 DEG. *	
	* 10 FPS AT 2500 FT .54 DEG. *	
	* 5 FPS AT 500 FT 1.60 DEG. *	
	**********	
+43	(107+51+54)	
	**********	
	TPF	
	**********	

9.6.2 RENDEZVOUS NAVIGATION SUMMARY WITH SUN ANGLES

CSM ACTIVE LM RESCUE-PARTIAL INSERTION=120 FPS
(MISSION F)
IT - INITIATE TRACK
CT - CEASE TRACK
(OUT-OF-PLANE SUN ANGLE IS 4 DEG)

GET	EVENT	SUN ANGLE (LOS TO SUN) DEG
102:43	LM PARTIAL INSERTION	
102:47	SUNSET	
103:32	CSM RESCUE	
103:33	SUNRISE	
103:55	IT (SXT) (V93,20/20)	129
104:00		116
104:05		102
104:10		87
104:15	CT (SXT)	74
104:30	CSM CSI ONE	
104:42	SUNSET	
105:00	IT (SXT/VHF) (V93,6/5,V93,17/18)	
105:05	CT (SXT)	
105:23	CT (VHF)	
105:29	SUNRISE	
105:32	CSM CSI TWO	
105:41	IT (SXT/VHF) (4/3,V67,00057,00034,00001;6/7)	171
105:46		174
105:51	CT (SXT/VHF)	159
106:03	CSM PLANE CHANGE	
106:09	IT (SXT/VHF)(4/3,V93,11/12)	99
106:14		84
106:19		68
106:24	CT (SXT/VHF)	59
106:34	CSM CDH	
106:40	IT (SXT/VHF) (4/3,V93,13/14)	9
106:44	SUNSET	4
106:57	CT (SXT/VHF)	
107:09	CSM TPI	
107:12	IT (SXT/VHF) (V93,8/8)	
107:20	CT (SXT/VHF)	
107:24	CSM MCC1	
107:26	IT (SXT/VHF) (V93,9/9)	
107:31	SUNRISE	63
107:35	(CT (SXT/VHF)	77
107:39	CSM MCC2	
107:52	TPF	

9.6.3 CSM ATTITUDE HISTORY

INERTIAL AND ORDEAL FDAI BALL GIMBAL ANGLE PROFILE FOR THE LM
PARTIAL INSERTION = 120 FPS RESCUE CASE (MISSION F) (YAW = 0.0)

TIME GET	ROLL	PITCH ORDEAL	PITCH INERTIAL	PITCH MNVR
102:46	180	32	272	
103:25	180	165	282	19
103:32	180	180	282	
103:35	180	141	233	49
104:19	180	345	281	175
104:30	180	0	281	
104:52	180	162	11	90
105:27	180	165	276	
105:32	180	171	276	
105:37	180	164	249	27
106:00	180	155	178	
106:03	180	161	178	
106:04	180	154	165	13
106:22	0	223	178	
106:27	0	229	165	
106:34	0	244	165	
106:36	0	229	138	27
107:02	0	174	10	56
107:09	0	189	10	
107:11	0	247	47	37
107:22	0	258	30	
107:24	0	264	30	
107:37	0	287	17	
107:39	0	293	17	
107:40	0	262	341	28
107:52	0	298	341	

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