260

NO

MSC-CF-P-69-11

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CSM RENDEZVOUS PROCEDURES

G MISSION

FINAL
REVISION A

23 JUNE 1969

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

FACILITY FORM 602

N70-34718 (ACCESSION NUMBER) (THRU)

167 (PAGES) 1 (CODE)

TMX 64412 (NASA CR OR TMX OR AD NUMBER) 31 (CATEGORY)

Reproduced by NATIONAL TECHNICAL INFORMATION SERVICE Springfield, Va 22151

PREPARED BY:

EOR Mission G Procedures Development Group
Apollo Flight Crew Operations
McDonnell Douglas Astronautics Company

D. K. Mosel
Technical Monitor (MDAC ED)
Orbital Procedures Section
Manned Spacecraft Center

APPROVED BY:

J. C. Callihan
Program Manager
Apollo Flight Crew Operations
McDonnell Douglas Astronautics Company

D. W. Lewis
Technical Manager (MDAC ED)
Flight Procedures Branch
Manned Spacecraft Center

P. C. Kramer
Chief Flight Procedures Branch
Manned Spacecraft Center

J. W. Bilodeau
Assistant Chief for Crew Integration
Flight Crew Support Division
Manned Spacecraft Center

W. J. North
Chief Flight Crew Support Division
Manned Spacecraft Center

D. K. Slayton
Chairman, Crew Procedures Control Board
Manned Spacecraft Center

TABLE OF CONTENTS

		PAGE
1.0	PURPOSE	1
2.0	INTRODUCTION	2
3.0	DISCUSSION OF MAJOR EVENTS	12
	3.1 Undocking and Separation	12
	3.2 Descent Orbit Insertion	13
	3.3 Powered Descent Initiation	13
	3.4 Orbital Navigation	14
	3.5 CSM Plane Change	14
	3.6 Concentric Sequence Initiation	15
	3.7 Constant Delta Height and Plane Change	16
	3.8 Terminal Phase Initiation	17
	3.9 TPI to Station Keeping	18
4.0	NOMINAL ONBOARD RENDEZVOUS CHECKLIST	20
5.0	NOMINAL MAJOR PROCEDURES SUMMARY	47
	5.1 Summary Timeline	48
	5.2 Summary Checklist	58

PAGE

6.0 NOMINAL DETAILED PROCEDURES ---------- 59

6.1 Procedures Ground Rules ---------- 59

6.2 Detailed Procedures ---------- 64

6.3 Rendezvous Navigation Summary with Sun Angles ---------- 105

6.4 CSM Attitude Summary ---------- 106

7.0 LM RESCUE CASES ---------- 108

7.1 Partial DOI (< 25 FPS) (CSM Active) ------- 109

7.1.1 Summary ---------- 109

7.1.2 Plot and Pads ---------- 110

7.1.3 Checklist ---------- 111

7.2 Partial DOI (≥ 25 FPS) (CSM Active) ------- 112

7.2.1 Summary ---------- 112

7.2.2 Plot and Pads ---------- 113

7.2.3 Checklist ---------- 114

7.3 No PDI_1 + 12 (LM Active) ---------- 115

7.3.1 Summary ---------- 115

7.3.2 Plot and Pads ---------- 116

7.3.3 Checklist ---------- 117

PAGE

7.4 No PDI_2 + 12 (LM Active) ---------- 118

7.4.1 Summary ---------- 118

7.4.2 Plot and Pads ---------- 119

7.4.3 Checklist ---------- 120

7.5 < 60 No PDI_1 + 12 (CSM Active) ---------- 121

7.5.1 Summary ---------- 121

7.5.2 Plot and Pads ---------- 122

7.5.3 Checklist ---------- 123

7.6 ≥ 60 No PDI_1 + 12 (CSM Active) ---------- 124

7.6.1 Summary ---------- 124

7.6.2 Plot and Pads ---------- 125

7.6.3 Checklist ---------- 126

7.7 < 40 No PDI_2 + 12 (CSM Active) ---------- 127

7.7.1 Summary ---------- 127

7.7.2 Plot and Pads ---------- 128

7.7.3 Checklist ---------- 129

7.8 40 - 90 No PDI_2 + 12 (CSM Active) --------- 130

7.8.1 Summary ---------- 130

7.8.2 Plot and Pads ---------- 131

7.8.3 Checklist ---------- 132

PAGE

7.9 ≥ 90 No PDI_2 + 12 (CSM Active) ---------- 133

7.9.1 Summary ---------- 133

7.9.2 Plot and Pads ---------- 134

7.9.3 Checklist ---------- 135

7.10 PDI_1 < 10 Variable Insertion (LM Active) --- 136

7.10.1 Summary ---------- 136

7.10.2 Plot and Pads ---------- 137

7.10.3 Checklist ---------- 138

7.11 PDI_1 + 12 (10-12.5 Minutes) (CSM Active) --- 139

7.11.1 Summary ---------- 139

7.11.2 Plot and Pads ---------- 140

7.11.3 Checklist ---------- 141

7.12 PDI_1 + 14:12 (12.5-15 Minutes) (CSM Active)- 142

7.12.1 Summary ---------- 142

7.12.2 Plot and Pads ---------- 143

7.12.3 Checklist ---------- 144

PAGE

7.13 PDI_1 + 21:24 Preferred Lift-off (T_2) (CSM Active) ---------- 145

7.13.1 Summary ---------- 145

7.13.2 Plot and Pads ---------- 146

7.13.3 Checklist ---------- 147

7.14 PDI_2 < 14.5 Variable Insertion (LM Active) - 148

7.14.1 Summary ---------- 148

7.14.2 Plot and Pads ---------- 149

7.14.3 Checklist ---------- 150

7.15 PDI_2 + 19:22 Preferred Lift-off (T_2) (CSM Active) ---------- 151

7.15.1 Summary ---------- 151

7.15.2 Plot and Pads ---------- 152

7.15.3 Checklist ---------- 153

8.0 REFERENCES ---------- 154

FIGURES

PAGE

Relative Motion Profile (2-1) ---------- 5

LUNAR ORBIT RENDEZVOUS ATTITUDE TIME HISTORY

Undocking - DOI (2-2) ---------- 6

PDI (2-3) ---------- 7

P22 Navigation (2-4) ---------- 8

CSM Plane Change (2-5) ---------- 9

Lift-off - CSI (2-6) ---------- 10

CDH - TPF (2-7) ---------- 11

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	Gyro 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
IVC	Inter-Vehicular Communication
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)	Roll, Pitch ORDEAL/Pitch INERTIAL, 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 GNCS crew procedures for the CSM-107 spacecraft which will be the target vehicle for the LM-5 active lunar orbit rendezvous. The procedures are given in the form of an onboard rendezvous checklist and as a set of detailed CSM procedures. Also included are onboard rendezvous checklists for fifteen LM rescue and abort cases. Detailed Test Objective H, Reference 8.1, subject "Landing LM Location" will be satisfied during this portion of the mission.

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 Mr. Richard J. Otto, Jr., Apollo Flight Crew Support Group, Houston Operations, McDonnell Douglas Astronautics Company, Extension 6101.

2.0 INTRODUCTION

The CSM-107/LM-5 lunar orbit rendezvous exercise will begin during the thirteenth revolution with undocking at 100:15:00 and end at approximately 127:40:38 with post rendezvous station keeping. The CSM procedures during this period are divided into nine segments of major activities which are discussed in detail in Section 3.0.

A nominal CSM-107/LM-5 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 were obtained from Reference 8.18. The rendezvous navigation update schedule assumed in the procedures was obtained from References 8.3 and 8.5. The schedule indicates tracking periods and assumes a one mark per minute frequency for both SXT and VHF marks taken during a track period. The minimum number of marks required during a tracking period are specified in the rendezvous checklist. However, it is recommended that more than the minimum number be planned since systems monitoring requirements or target visibility problems often pre-empt taking all the planned marks. In addition, the general rules for SXT/VHF marking as defined in Reference 8.4 should be followed.

A history of the CSM body attitudes during the rendezvous accompanies the major events discussed and is presented in Figures (2-2) through (2-7). 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 the 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 includes a description of the 15 abort and rescue cases as described in Reference 8.14. Also the one-page onboard rescue checklist and relative motion plot and pad page for each of the 15 abort and rescue cases are included. These cases are:

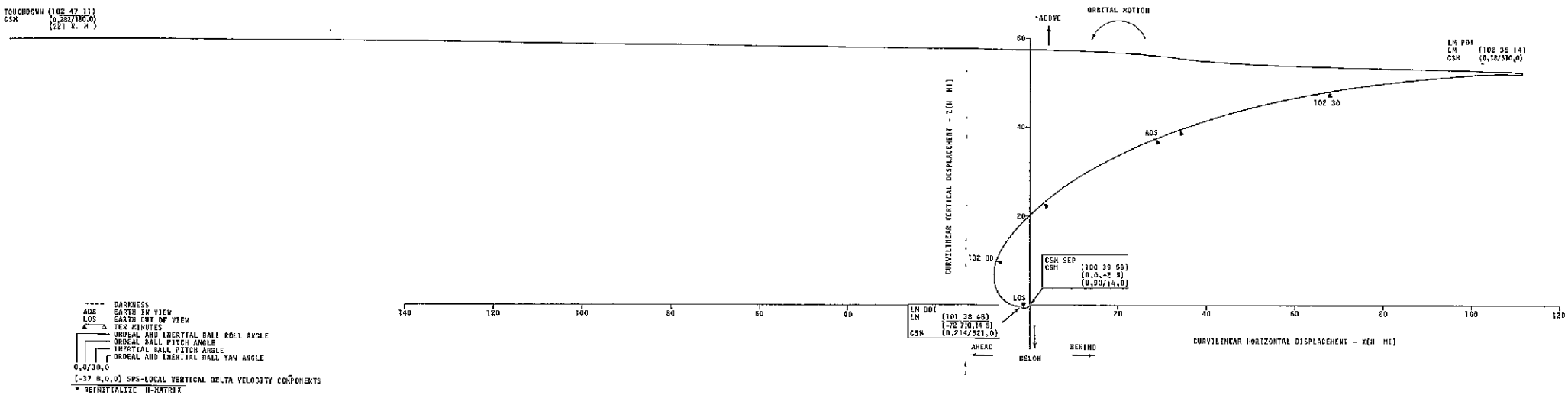
1) Partial DOI (< 25 FPS) (CSM Active)
2) Partial DOI (≥ 25 FPS) (CSM Active)
3) No PDI_1 + 12 (LM Active)
4) No PDI_2 + 12 (LM Active)
5) < 60 No PDI_1 + 12 (CSM Active)
6) ≥ 60 No PDI_1 + 12 (CSM Active)
7) < 40 No PDI_2 + 12 (CSM Active)
8) 40 - 90 No PDI_2 + 12 (CSM Active)

9) ≥ 90 No PDI_2 + 12 (CSM Active)
10) PDI_1 < 10 Variable Insertion (LM Active)
11) PDI_1 + 12 (10-12.5 Minutes) (CSM Active)
12) PDI_1 + 14:12 (12.5-15 Minutes) (CSM Active)
13) PDI_1 + 21:24 Preferred Lift-off (T_2) (CSM Active)
14) PDI_2 < 14.5 Variable Insertion (LM Active)
15) PDI_2 + 19:22 Preferred Lift-off (T_2) (CSM Active)

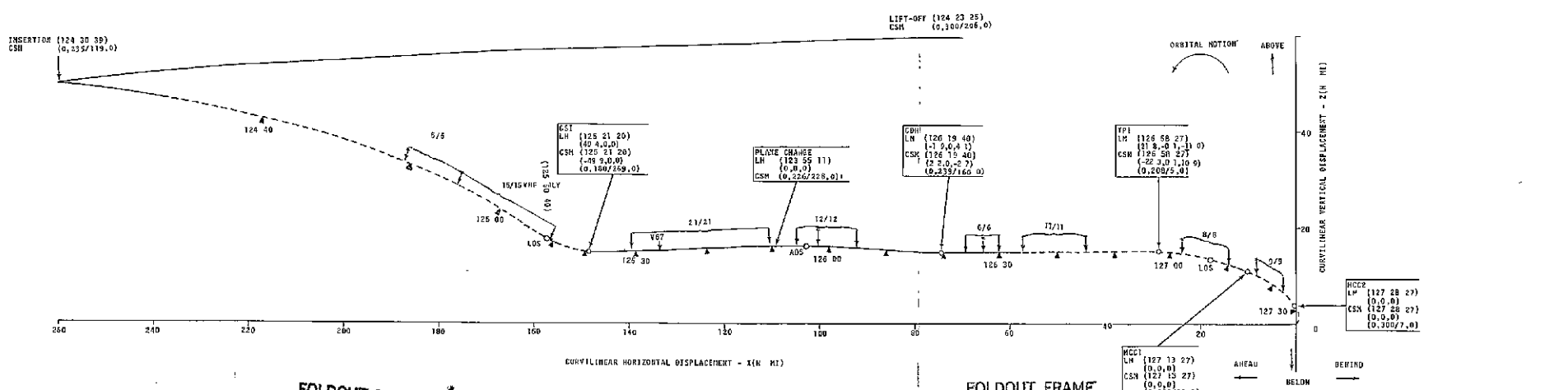
MISSION G - RELATIVE MOTION FOR LM ACTIVE RENDEZVOUS LM CENTERED

FIGURE 2-1

CSM SEP TO LM TOUCHDOWN



INSERTION TO TPF



FOLDOUT FRAME 1

FOLDOUT FRAME 2

FOLDOUT FRAME 3

FIGURE 2-2

MISSION G1 - LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY FOR THE CSM

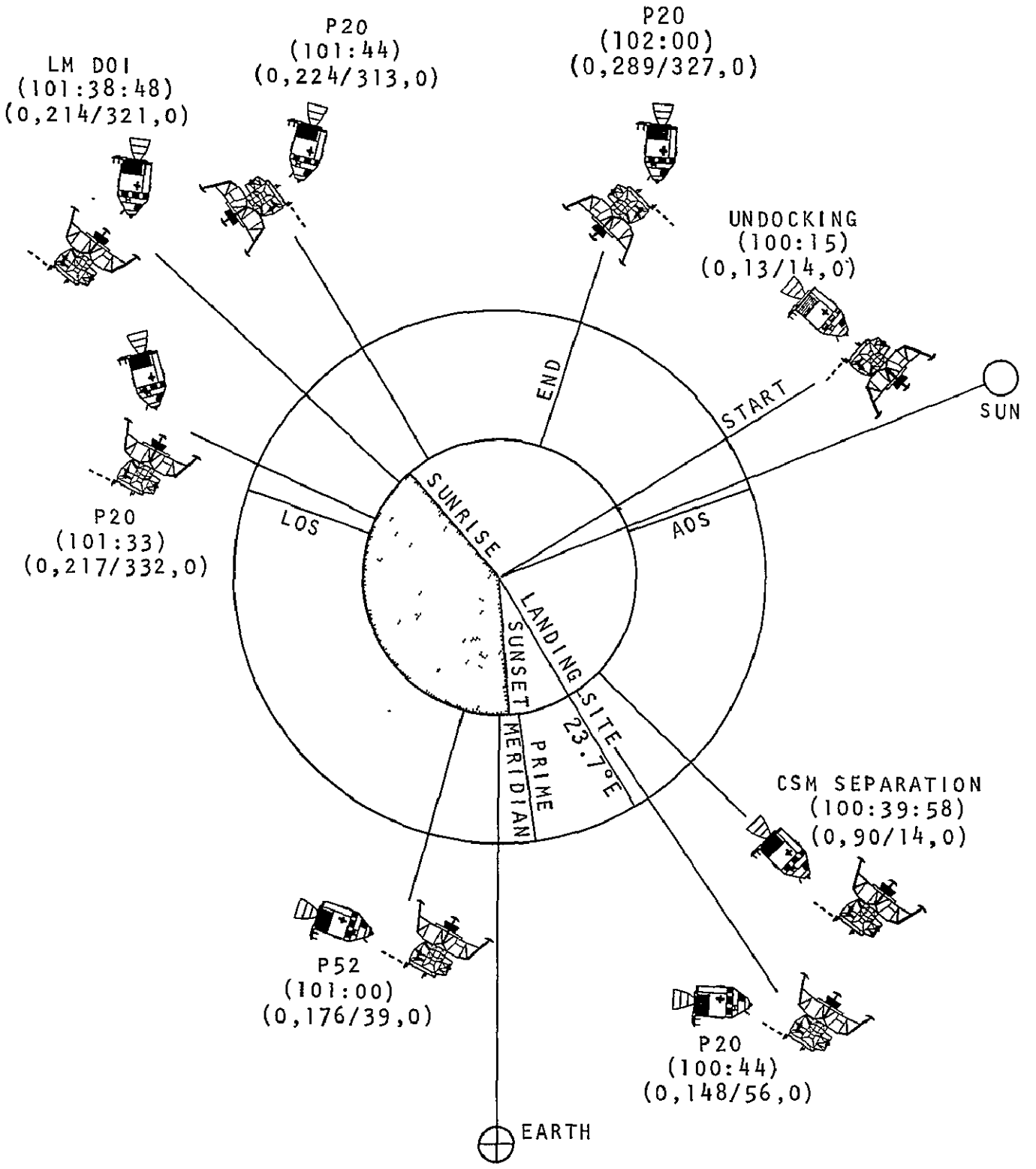


FIGURE 2-3

MISSION G1 - LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY FOR THE CSM

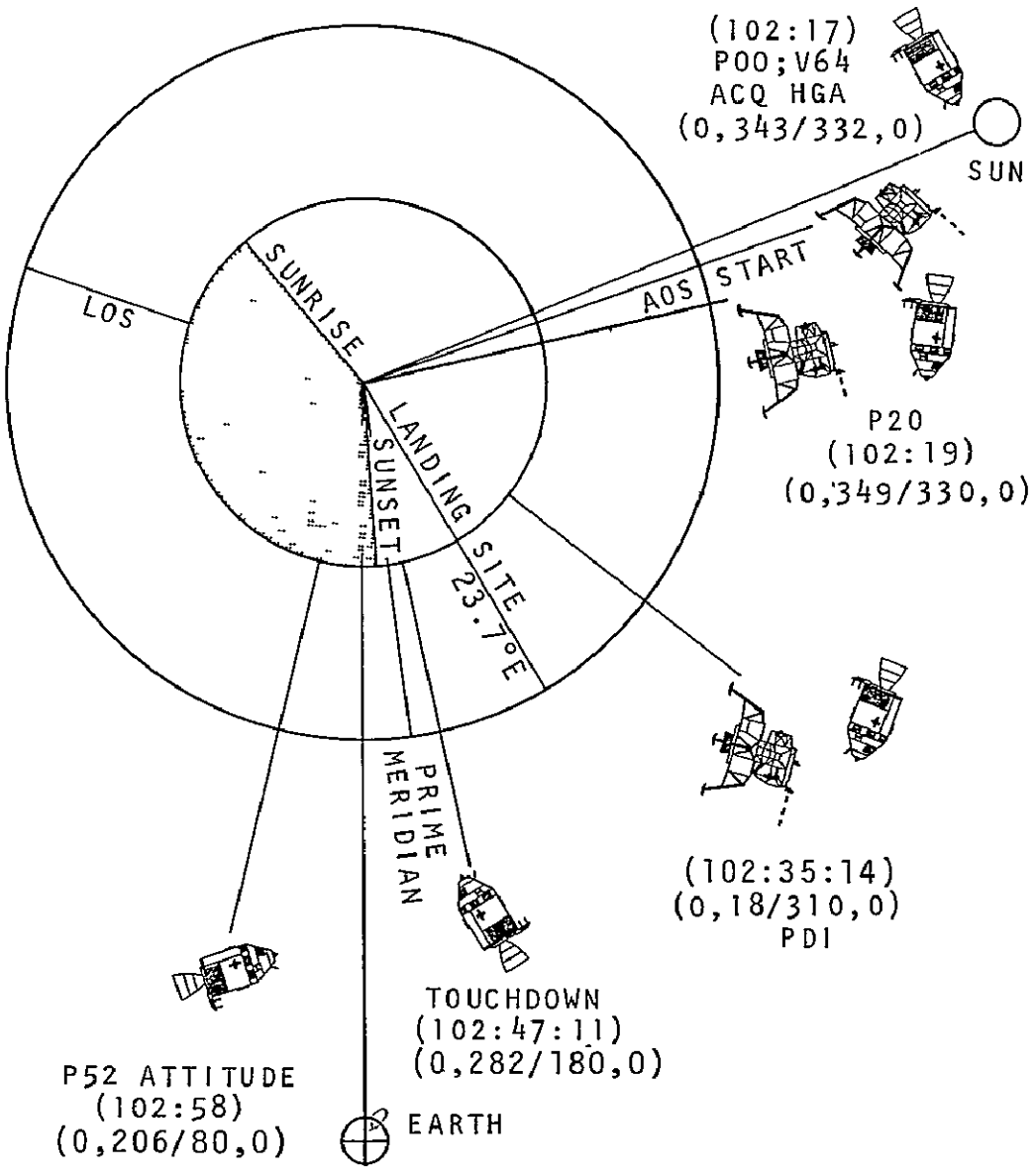


FIGURE 2-4

MISSION G1 - LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY FOR THE CSM

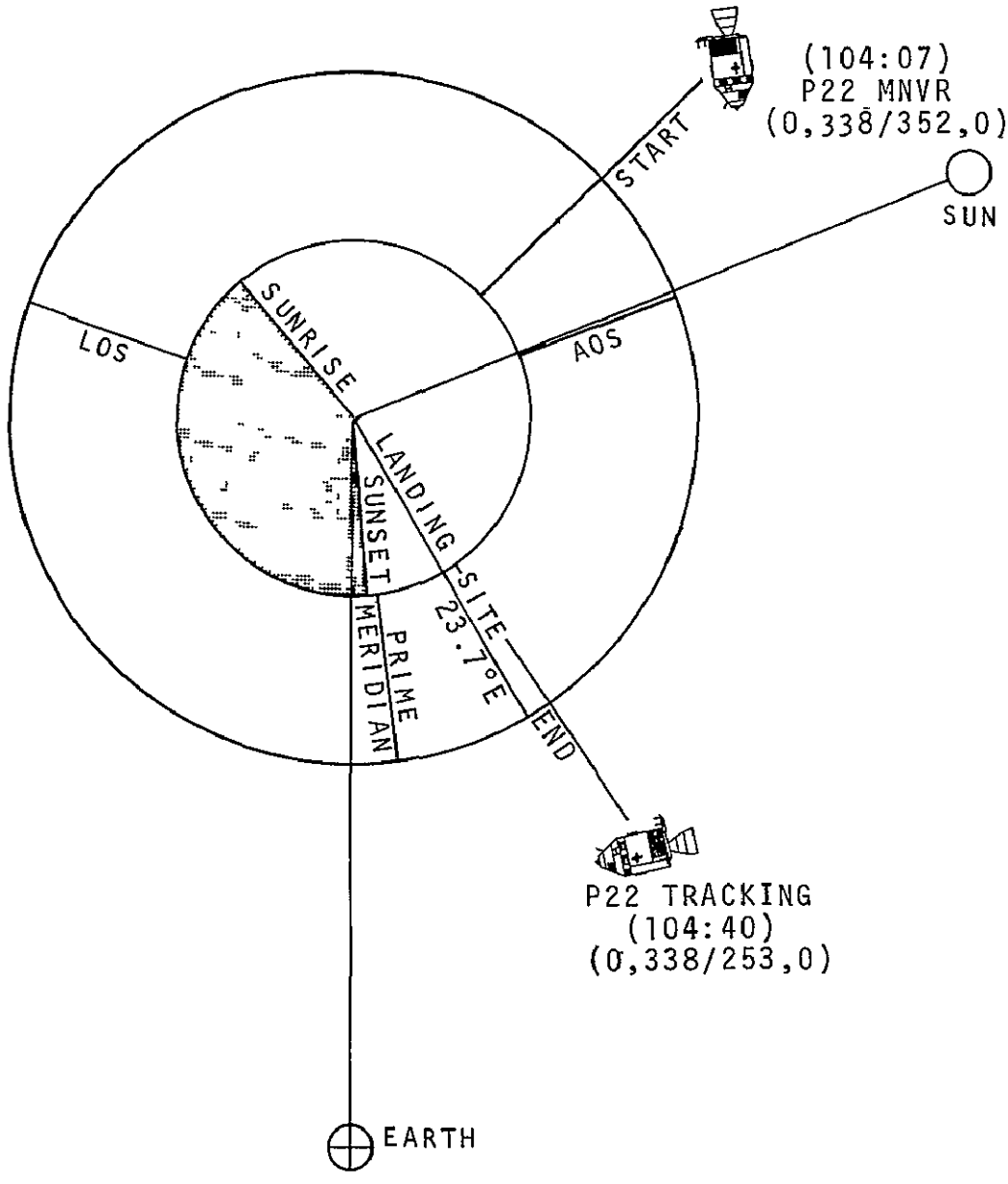


FIGURE 2-5

MISSION G1 - LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY FOR THE CSM

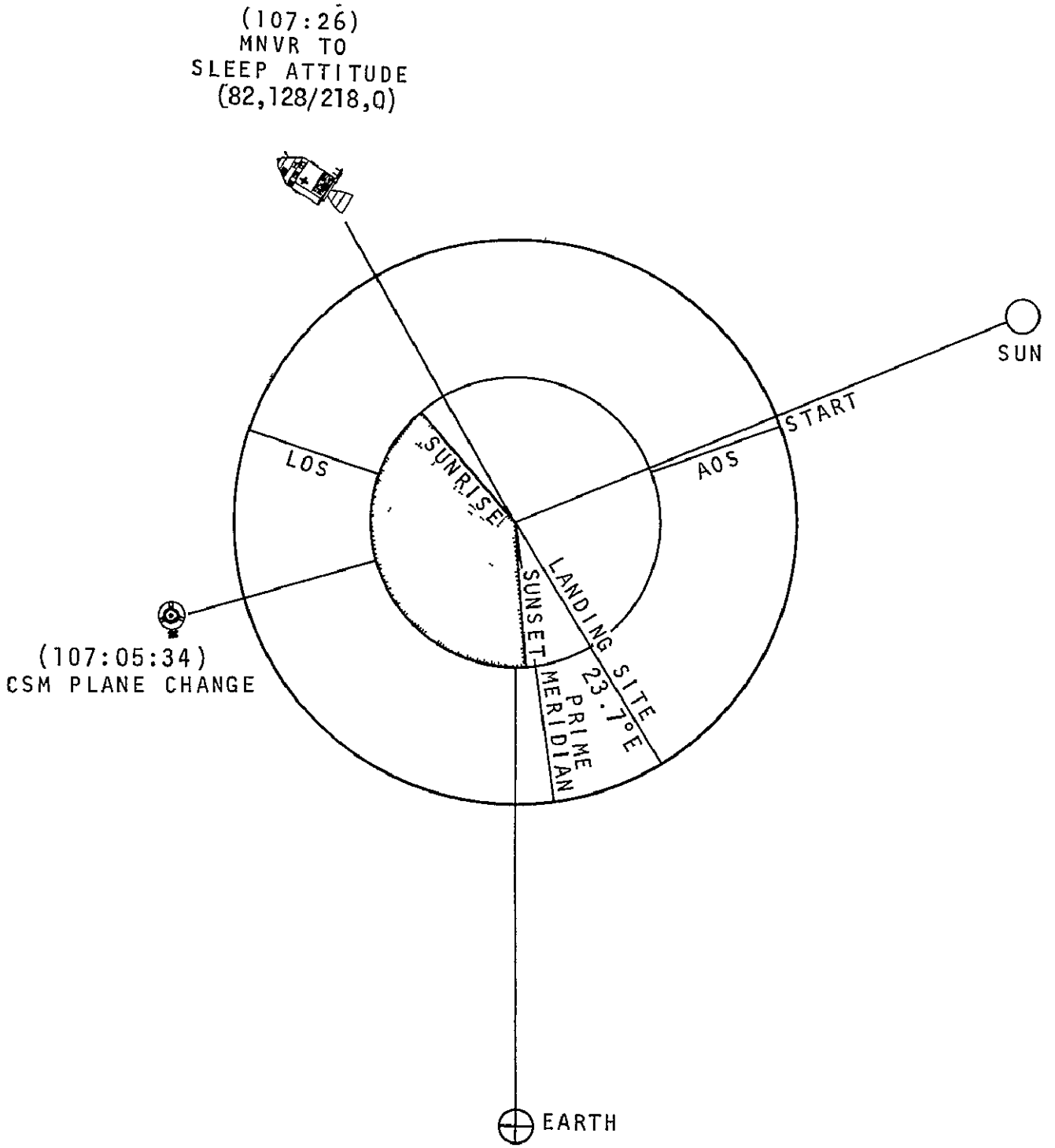


FIGURE 2-6

MISSION G1 - LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY FOR THE CSM

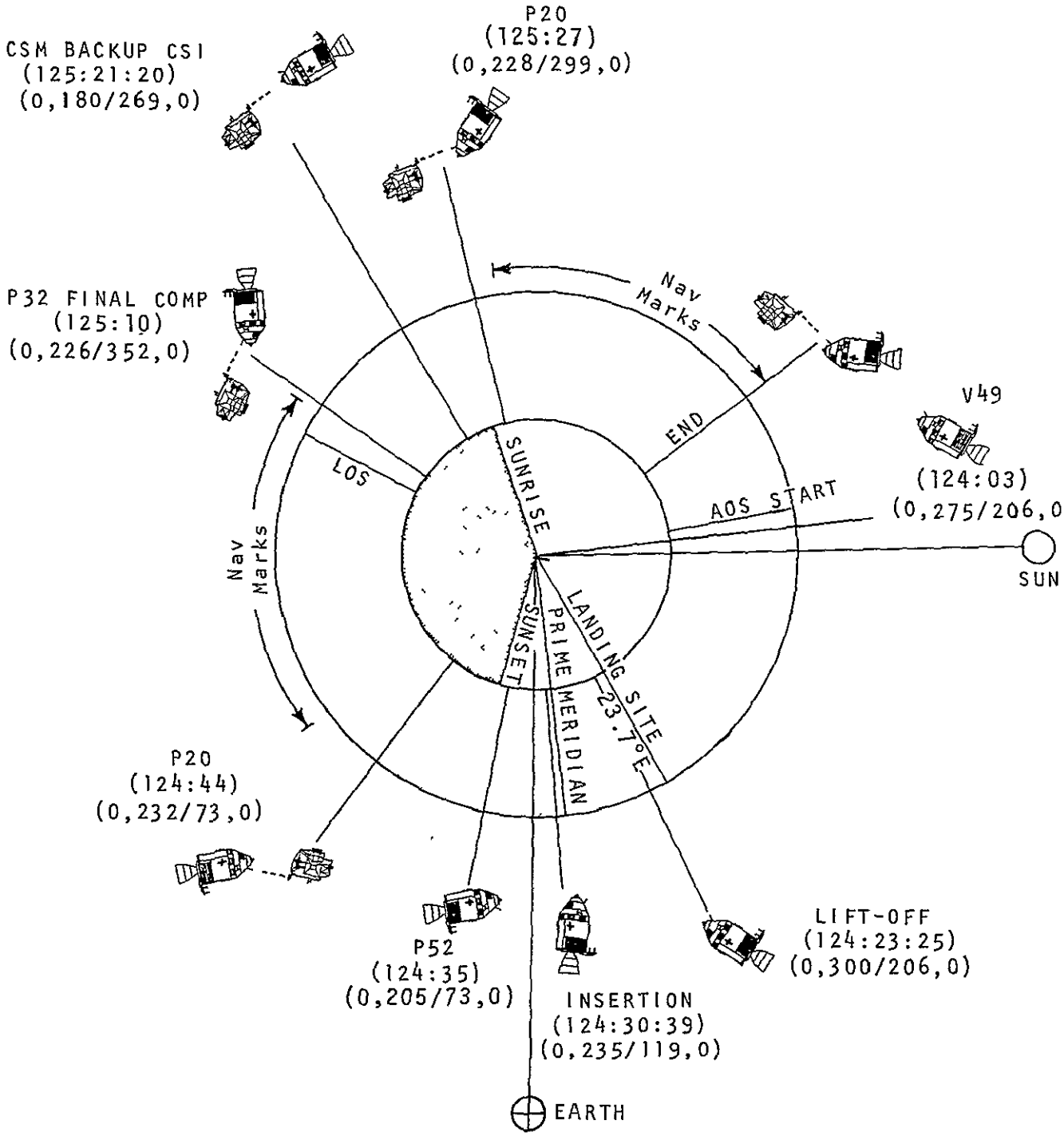
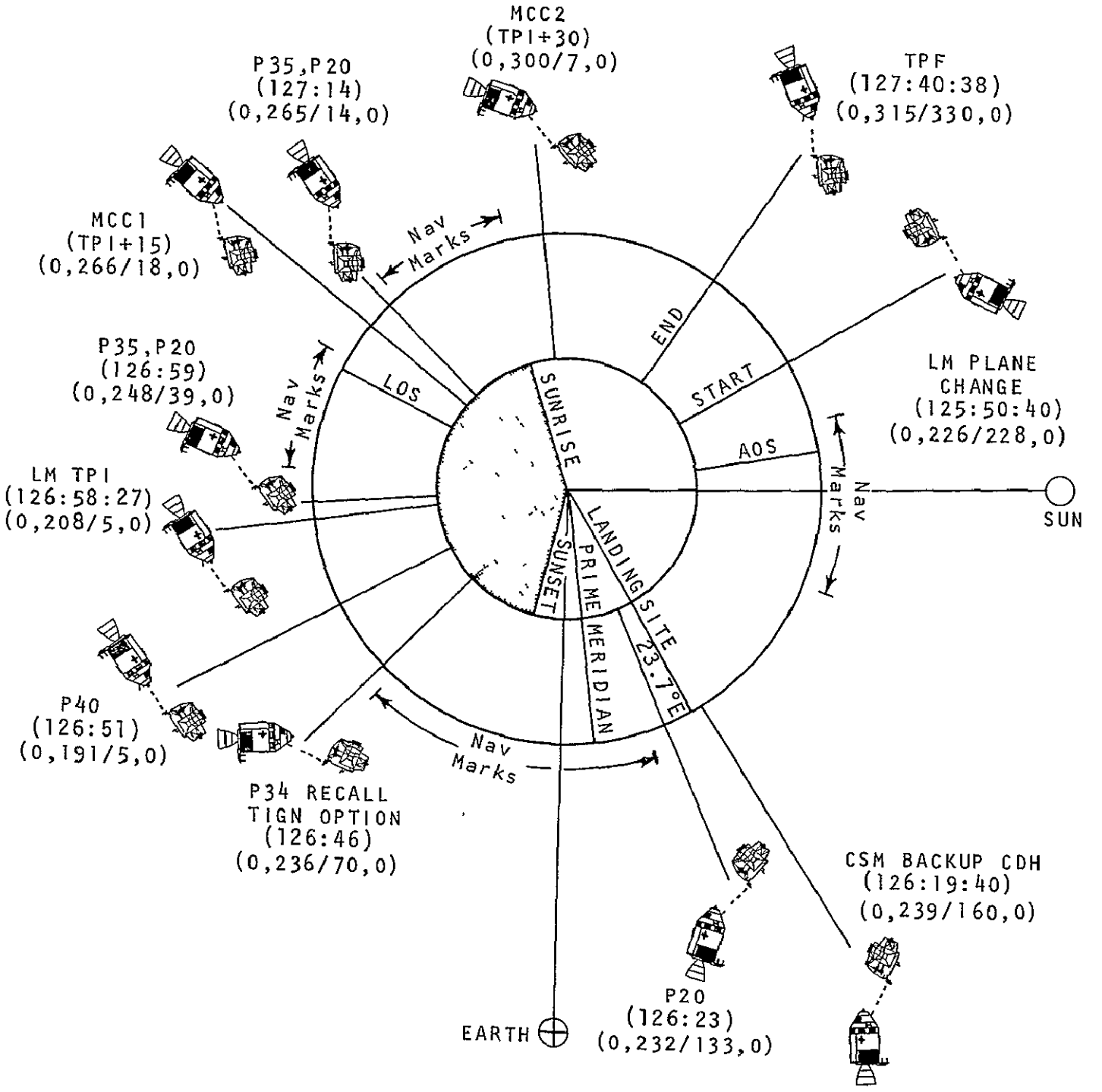


FIGURE 2-7

MISSION G1 - 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 99:10. Forty-three 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 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 100:15 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 CSM-active separation burn at 100:39:58, 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.) 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 42 degrees to the preferred track axis for LM radar, VHF range, and optics checks. At 100:52 the LM P76 DOI and PDI_1 + 12 abort pads, and the CSM rescue pad will be copied. An IMU realign to REFSMMAT will be performed after sunset at 101:00 using the IMU Realign Program, P52. At approximately 101:10 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 101:38:48.

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 Powered Descent Initiation

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. A period of SXT/VHF marking is scheduled at 101:52 At 102:17 the CMP will cease tracking and maneuver in order to acquire MSFN with the HGA . At 102:19 Program P20 will be called and the CSM will be

maneuvered to the preferred track axis. Four minutes prior to PDI the CMP will enter Program P00. The DAP will be loaded with a maneuver rate of .2 degree per second in order to maintain the LM in the SXT during powered descent. Extended verb 49 is used to initiate the pitch down rate at one minute after PDI initiation. At 102:35:14 the LM powered descent will be initiated with nominal touchdown occurring at 102:47:11 The CSM has HGA coverage from AOS until the P20 tracking is initiated. HGA coverage is again acquired during the LM powered descent.

3.4 Orbital Navigation

Following LM touchdown, a IMU realign to REFSMMAT will be performed at 103:01, using the IMU Realign Program, P52. The GDC will be aligned to the IMU and ORDEAL will be verified. At 103:17 the orbital navigation PAD will be copied. At 104:01 a manual maneuver to the tracking attitude will be performed. At 104:07 a pitch rate will be initiated to offset orbital motion during the P22 tracking sequence. The Orbital Navigation Program, P22, will be called at 104:07 and the PAD information will be loaded. The CMP will take five SXT marks on the landing site.

3.5 CSM Plane Change

Following the P22 tracking, the CSM is maneuvered at 104:43 to acquire MSFN. At about 104:59, MCC-H uplinks the plane change REFSMMAT. The IMU is aligned to the plane change REFSMMAT using the gyro torquing technique in the IMU

Realign Program, P52, at 105:04. The GDC is then aligned to the IMU. At 105:27 the Ground Track Determination Program, P21, may be called. At 106:15 the plane change PAD is recorded and the CSM state vector and target load are uplinked by MCC-H. At 106:37 the CSM is maneuvered to the plane change burn attitude. P30 is called at 106:52 and the plane change burn parameters are loaded. The SPS thrusting program, P40, is entered at 106:56. The CSM plane change burn occurs at 107:05:34. At 107:08 the CSM reacquires MSFN and the lift-off REFSMMAT is uplinked into the CMC. The platform is aligned to the lift-off REFSMMAT at 107:14 using the same procedure described above. The CSM is then maneuvered to the rest attitude.

3.6 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 trim maneuver will be made to the preferred track attitude. At 124:48 the CSI Targeting Program, P32, is called and the CSM backup CSI targeting parameters are loaded. The CSM CSI burn will be targeted for 125:21:20 which is identical to the LM TIGN. A period of SXT/VHF marking will then take place from 124:50 to 124:55 followed by a period of VHF only marks to 125:09. 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.

Program P40 will be called at 125:13 and an automatic pitch maneuver of 76 degrees will be made to the backup CSI burn attitude. At approximately 125:15 the LM will voice over its CSI solution for P76. The LM CSI burn occurs at 125:21:20. 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 (2-6) is compatible with HGA coverage from insertion through LOS at 125:08.

3.7 Constant Delta Height and Plane Change

At 125:27 approximately five minutes after the LM CSI burn, Program P20 will be called and an automatic maneuver of 30 degrees will be made to the preferred track axis. A period of SXT/VHF marks occurs from 125:29 to 125:50. At 125:32 after three SXT/VHF marks, the WR matrix (2000,2) will be loaded. Extended verb 90 will be called at 125:43 and the out-of-plane 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 125:50:40, the target DV parameters are incorporated into the LM state vector. Since the CSM normally does not backup the LM plane change burn, a trim maneuver to the preferred track axis should not be required when Program P20 is called at 125:53. SXT and VHF marks will be taken

from 125:53 to 126:05, at which time tracking is terminated and the CSM will voice to the LM an extended verb 90 out-of-plane solution. At 126:10 the CDH Targeting Program, P33, will be called and the CSM backup CDH burn will be targeted for 126:19:40 which is the LM TIGN. The RCS Thrust Program, P41, is called at 126:14 and the burn attitude maneuver is bypassed for the nominally small burn. Approximately four minutes before the LM CDH burn, the CMP copies the LM CDH pad for later loading of Program P76. Following the LM CDH burn at 126:19:40, Program P76 is called and the LM CDH burn incorporated into the CMC LM state vector.

The CSM attitude, as specified in Figure (2-7), is not compatible with HGA coverage from AOS until the end of the track period at about 126:05.

3.8 Terminal Phase Initiation

After completion of the LM CDH burn, Program P20 will be called which will request an automatic maneuver of 27 degrees to the preferred tracking attitude. SXT and VHF marks are scheduled for a period starting at 126:24. It is probable that sun interference in the SXT will limit the total number of SXT marks to 11 taken in darkness. At 126:30, Program P34 will be called and the CSM backup TPI burn data will be loaded with the elevation angle option.

After obtaining a CSM TPI TIGN, P34 will be terminated by recalling P20. SXT and VHF marks are scheduled from 126:34 until 126:45. 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 LM TIGN, compute the CSM TPI backup burn parameters. However, if the LM PGNCS has failed, the CMP will obtain a TPI solution based upon the elevation angle option. Program P40 will be called and an automatic

maneuver of 52 degrees will be made to the TPI burn attitude. The TPI burn will nominally be performed at 126:58:27 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 (2-7), the CSM has HGA coverage from prior to CDH through the TPI burn.

3.9 TPI to Station Keeping

After the TPI burn, Program P20 will be called and the CSM will be automatically maneuvered 34 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 127:02. 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 127:13:27 (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 nine minutes terminating at 127:25 The MCC2 solution will be compared with the LM MCC2 solution, after which Program P41 will be called. The CSM will remain at the preferred tracking attitude while the LM performs MCC2 at 127:28:27 (TPI plus 30 minutes). After MCC2 the CMP will incorporate the LM Target DV in Program P76.

The CSM will then be maneuvered automatically 37 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 127:40:38.

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 CSM GNCS activities required during the LM active rendezvous. Activities required for the operation and/or monitoring of systems other than the GNCS are included in the rendezvous checklist by the appropriate systems personnel.

CSM RENDEZVOUS RESCUE PADS

CSM SEP PAD

33	00		000		0	
81	+	0000.0	+	0000 0	−	0002 5
22	XXX		XXX		XXX	

DOI PAD

84			
33			

PDI_1 +12 ABORT PAD

84			
33			

"CSM RESCUE" PAD

PHAS	33	00	000	0
TPI(PDI < 10)	37	00	000	0
TPI(PDI > 10)	37	00	000	0

"CSM RESCUE UPDATE" PAD

PHAS	33	00	000	0
TPI(PDI < 145)	37	00	000	0
TPI(T_2)	37	00	000	

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				

CSI ONE

11		000	0
81			
N			

P22 PAD

T1		(HOR)
T2		(LMK)
	NM (N OR S)	
89		
	LAT / LONG/2 / ALT	

NOMINAL LM IGNITION TIMES

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

CSI TWO

11	00	000	0
81			
N			

CSI THREE

11	00	000	0
81			
N			

CSI FOUR

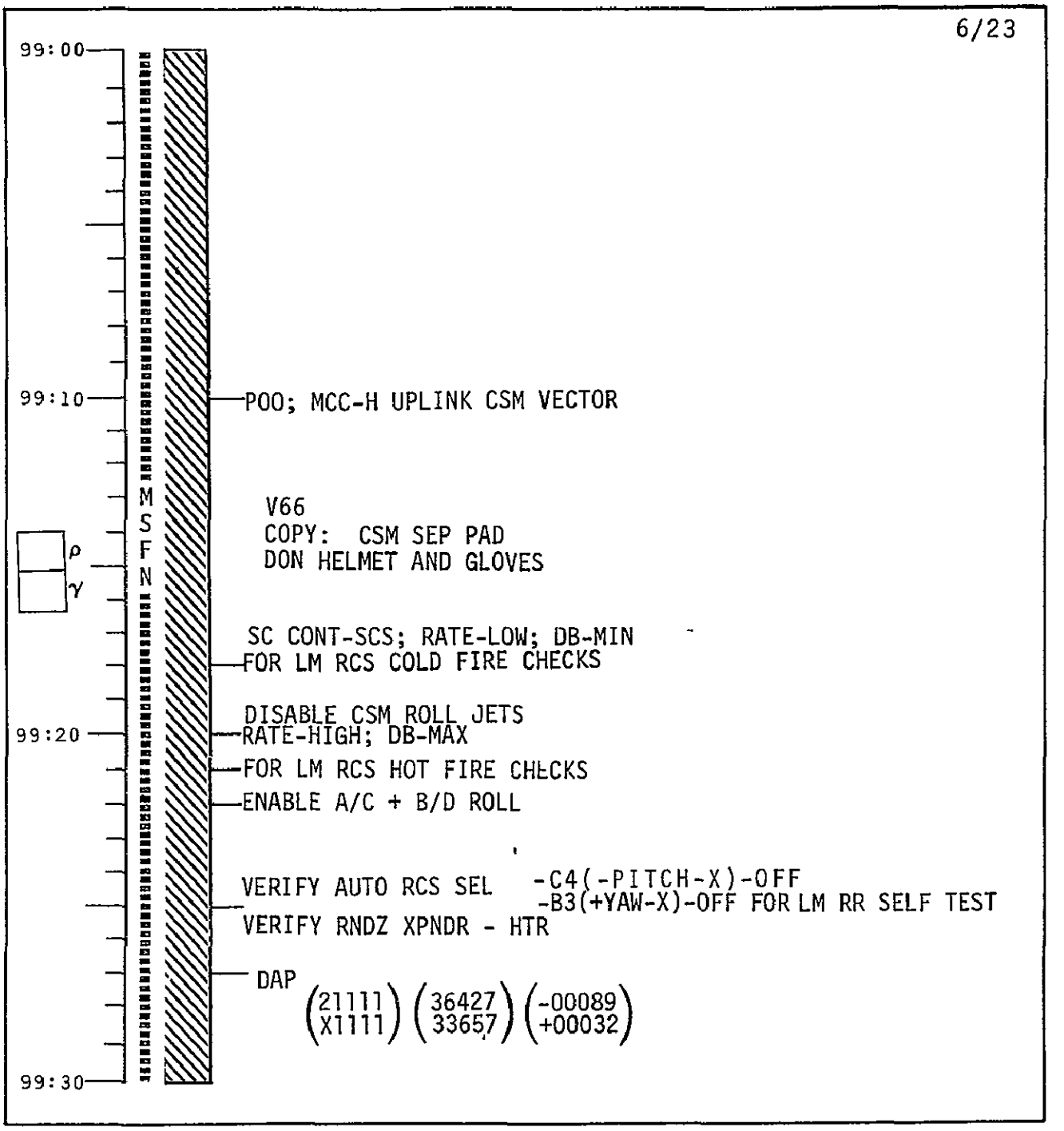
11	00	000	0
81			
N			

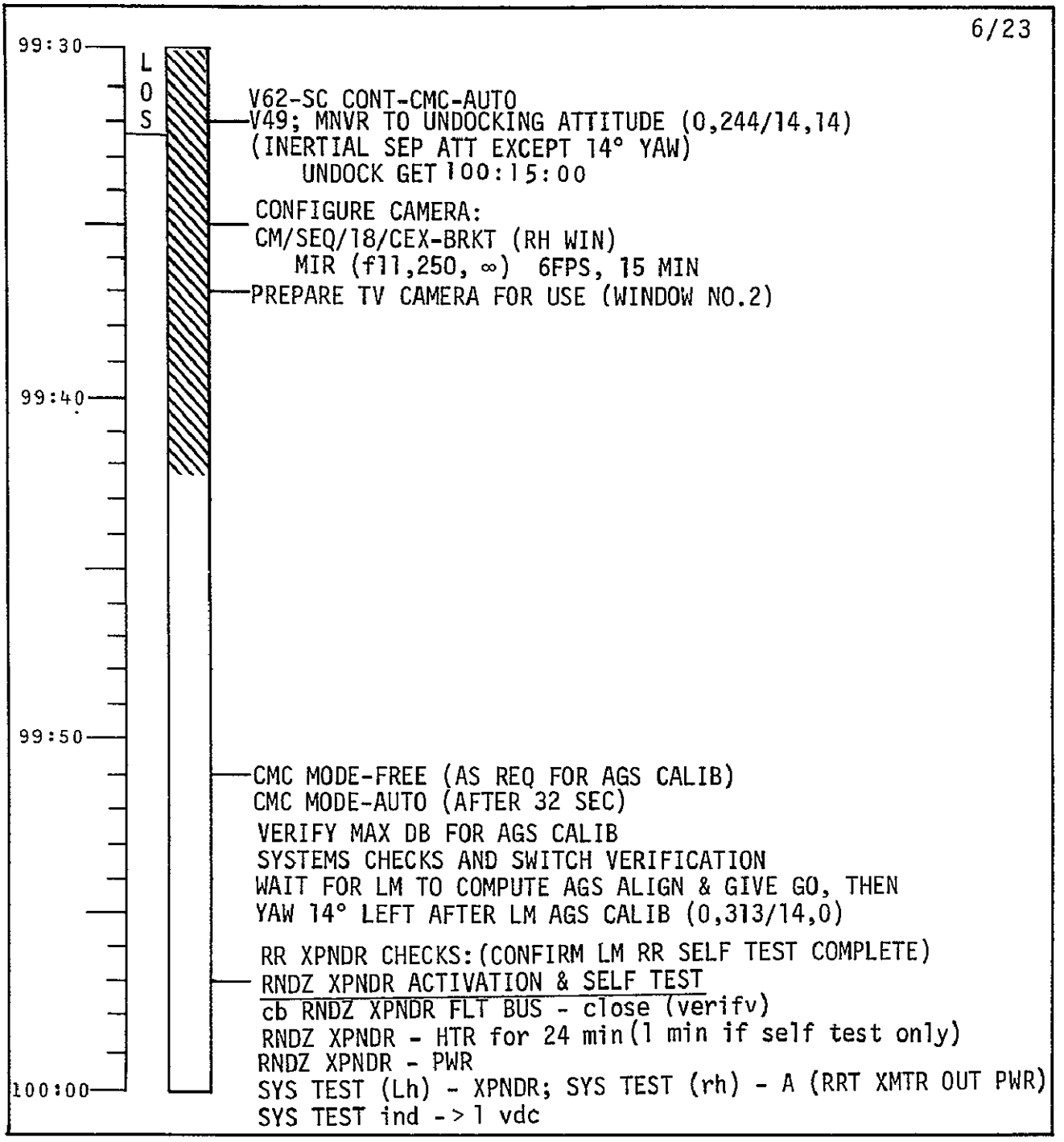
CDH

13	00	000	0
81			

TPI

37	00	000	0
81			
59			
LOS BT	XX	XX	XX


6/23
99:00
99:10
99:20
99:30
MSFN
ρ
γ
POO; MCC-H UPLINK CSM VECTOR
V66
COPY: CSM SEP PAD
DON HELMET AND GLOVES
SC CONT-SCS; RATE-LOW; DB-MIN
FOR LM RCS COLD FIRE CHECKS
DISABLE CSM ROLL JETS
RATE-HIGH; DB-MAX
FOR LM RCS HOT FIRE CHECKS
ENABLE A/C + B/D ROLL
VERIFY AUTO RCS SEL
-C4(-PITCH-X)-OFF
-B3(+YAW-X)-OFF FOR LM RR SELF TEST
VERIFY RNDZ XPNDR - HTR
DAP
21111
X1111
36427
33657
-00089
+00032


6/23
99:30
LOS
99:40
99:50
100:00
V62-SC CONT-CMC-AUTO
V49; MNVR TO UNDOCKING ATTITUDE (0,244/14,14)
(INERTIAL SEP ATT EXCEPT 14° YAW)
UNDOCK GET 100:15:00
CONFIGURE CAMERA:
CM/SEQ/18/CEX-BRKT (RH WIN)
MIR (f11,250, ∞) 6FPS, 15 MIN
PREPARE TV CAMERA FOR USE (WINDOW NO.2)
CMC MODE-FREE (AS REQ FOR AGS CALIB)
CMC MODE-AUTO (AFTER 32 SEC)
VERIFY MAX DB FOR AGS CALIB
SYSTEMS CHECKS AND SWITCH VERIFICATION
WAIT FOR LM TO COMPUTE AGS ALIGN & GIVE GO, THEN
YAW 14° LEFT AFTER LM AGS CALIB (0,313/14,0)
RR XPNDR CHECKS: (CONFIRM LM RR SELF TEST COMPLETE)
RNDZ XPNDR ACTIVATION & SELF TEST
cb RNDZ XPNDR FLT BUS - close (verifv)
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

6/23

100:00

SYS TEST (rh) - B (RRT AGC SIG); RNDZ XPNDR - TEST (hold)
SYS TEST ind - > 1 vdc
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

HAND CONTROLLER ADJ/ARMED; THC POWER - ON
SIMPLEX A RCV ONLY - B DATA
RECORD, FWD, LBR (AS REQUESTED BY LM)

100:10

GDC ALIGN TO IMU
ORDEAL (V83) ($R=\dot{R}=0$)
SC CONT - SCS; LOAD DAP $\begin{pmatrix} 11102 \\ X1111 \end{pmatrix}$; V46
DOCK PROBE CB(2)-IN
BMAGS-ATT 1/ RATE 2
START 16MM CAMERA
UNDOCKING (100:15:00)(0,13/14,0)

-25

AUTO RCS SEL - B3 - MNA
DV CG-CSM C4 - MNB
RR XPNDR-PWR(VERIFY)

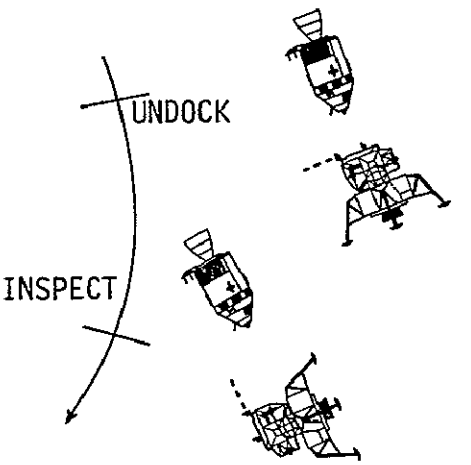
A
O
S

V64;ACQ HGA
PHOTOS: COLOR TV
INSPECT LM

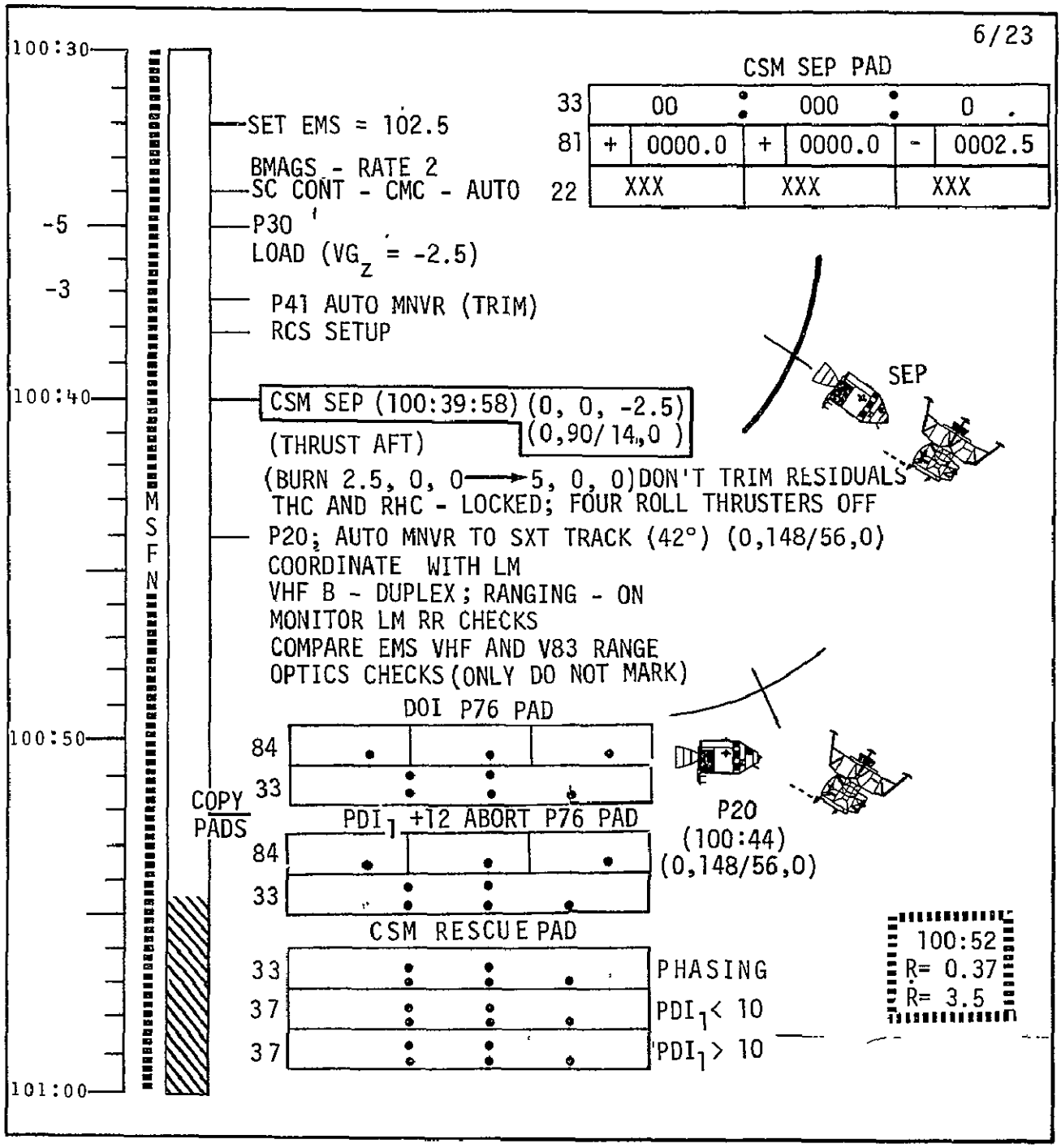
100:20

ρ
γ

(LM 360° YAW)



100:30


6/23
CSM SEP PAD
33 00 : 000 : 0 .
81 + 0000.0 + 0000.0 - 0002.5
22 XXX XXX XXX
100:30
-5
-3
100:40
100:50
101:00
MSFN
SET EMS = 102.5
BMAGS - RATE 2
SC CONT - CMC - AUTO
P30
LOAD (VG_Z = -2.5)
P41 AUTO MNVR (TRIM)
RCS SETUP
CSM SEP (100:39:58) (0, 0, -2.5)
(0,90/14,0)
(THRUST AFT)
SEP
(BURN 2.5, 0, 0 → 5, 0, 0) DON'T TRIM RESIDUALS
THC AND RHC - LOCKED; FOUR ROLL THRUSTERS OFF
P20; AUTO MNVR TO SXT TRACK (42°) (0,148/56,0)
COORDINATE WITH LM
VHF B - DUPLEX; RANGING - ON
MONITOR LM RR CHECKS
COMPARE EMS VHF AND V83 RANGE
OPTICS CHECKS (ONLY DO NOT MARK)
DOI P76 PAD
84
33
COPY PADS
PDI1 +12 ABORT P76 PAD
84
33
P20
(100:44)
(0,148/56,0)
CSM RESCUE PAD
33 PHASING
37 PDI1 < 10
37 PDI1 > 10
100:52
R= 0.37
Ṙ= 3.5

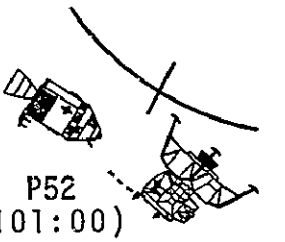
6/23

101:00

P52 (OPTION 3)

05 93 1D1 1D2 1D3

T TORQUE



P52
(101:00)
(0,176/39,0)

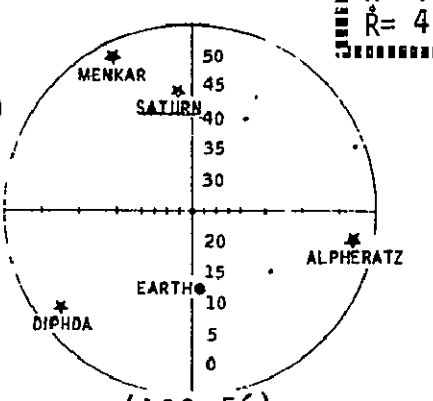
ρ γ

GDC ALIGN TO IMU
VERIFY ORDEAL (V83)

101:10

POO; MCC-H UPLINK
CSM AND LM VECTORS
CONFIRM PROPER SOLO CONFIG
ECS HOSES, COUCHES
CAMERA, STOWAGE
PANEL 10 SET FOR RELAY
MASTER ALARM AMPLIFIER - RIGGED

101:09
R= 1.10
Ṙ= 4.8



(100:56)
(0,38,0)

MSFN

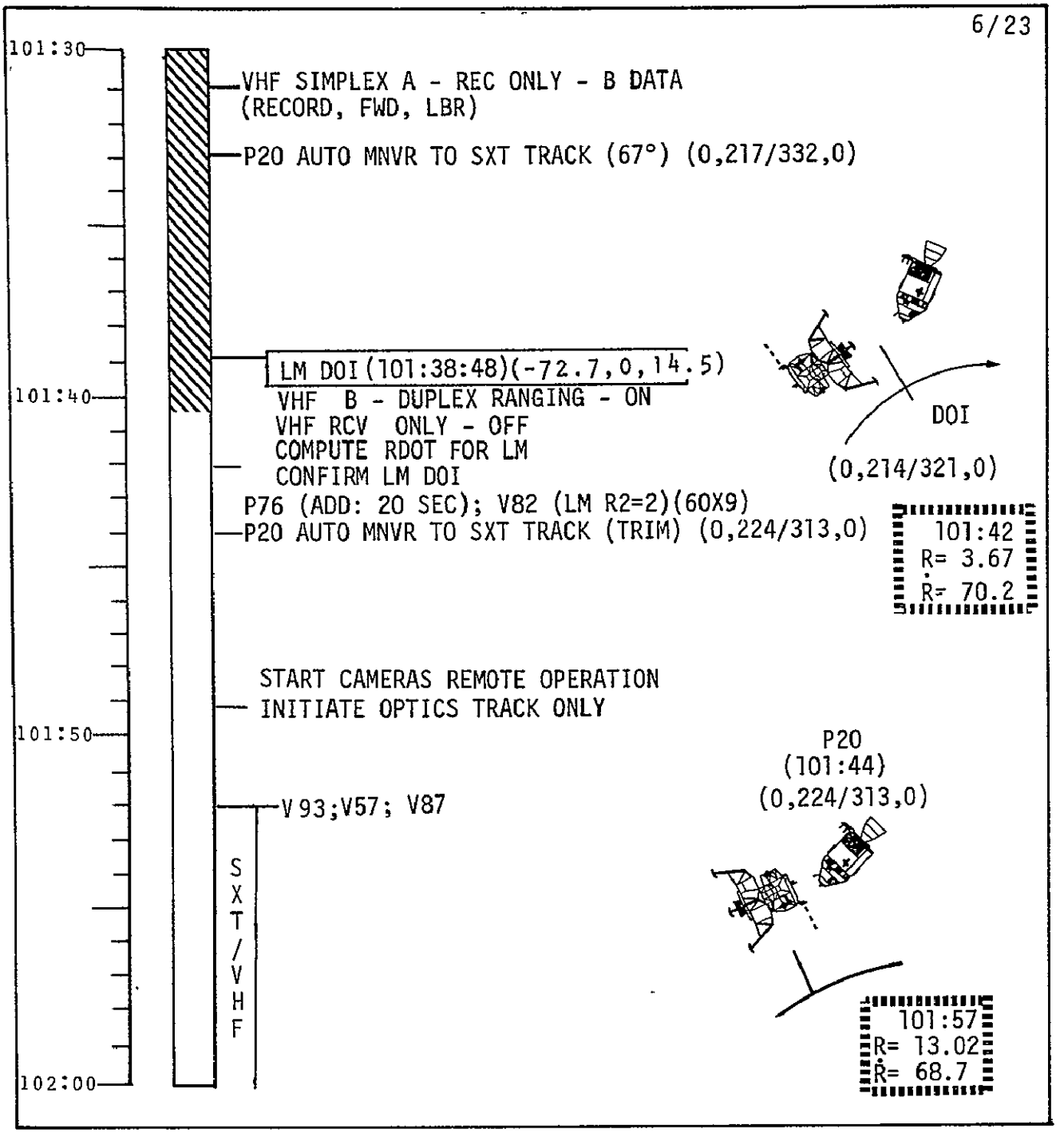
101:20

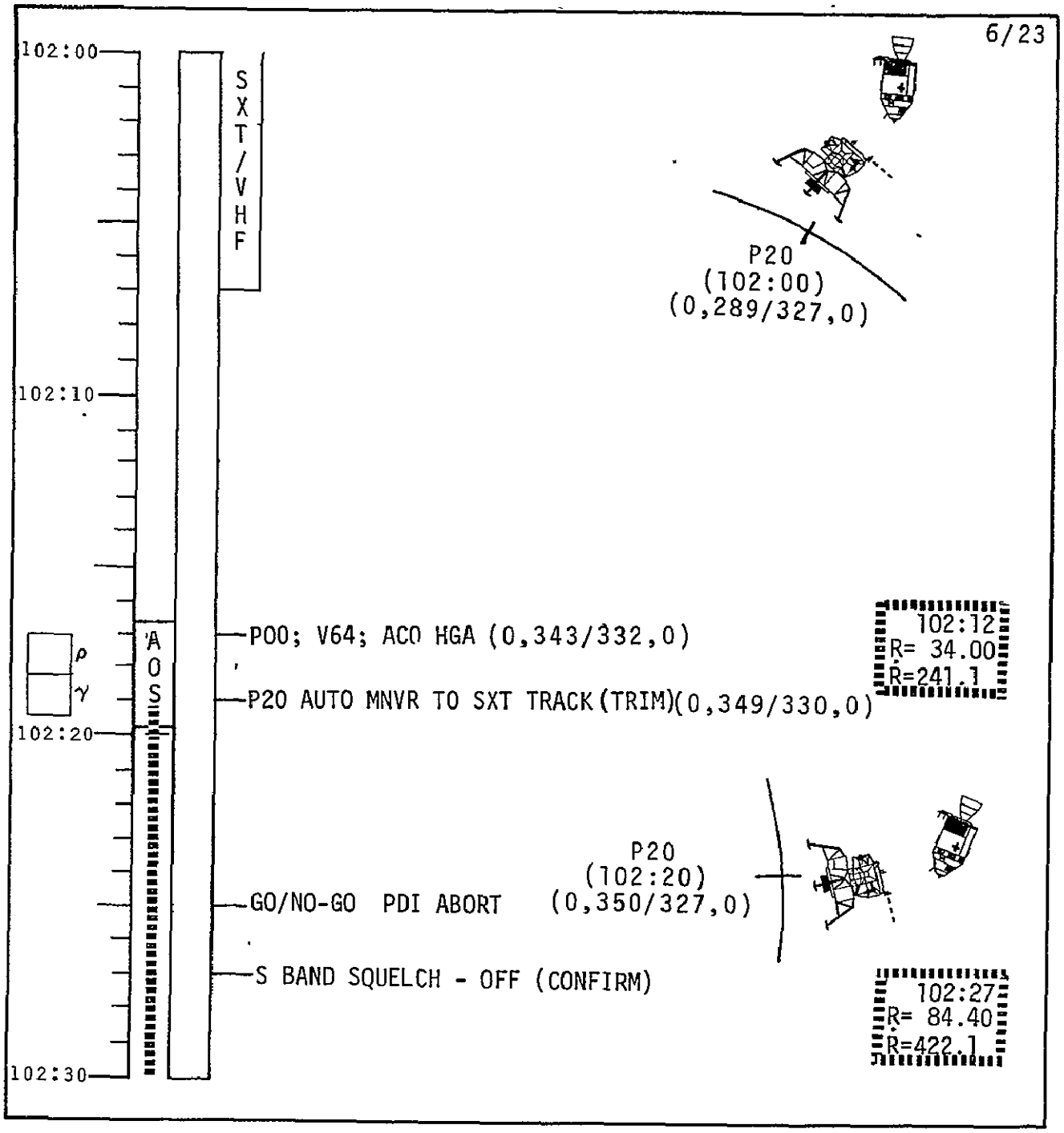
SYSTEM CHECKS PRIOR TO LOS

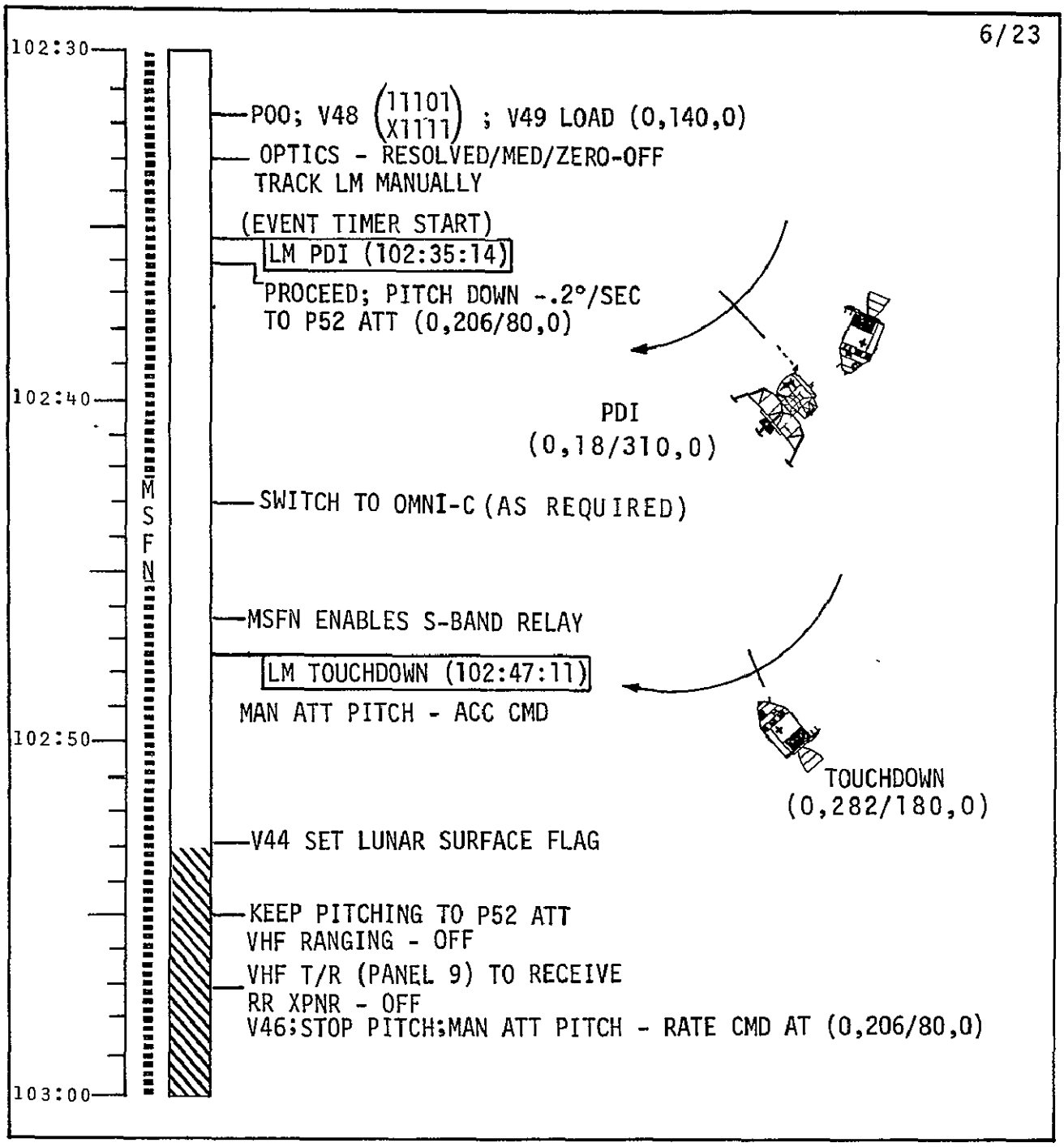
101:26
R= 1.84
Ṙ= 2.9

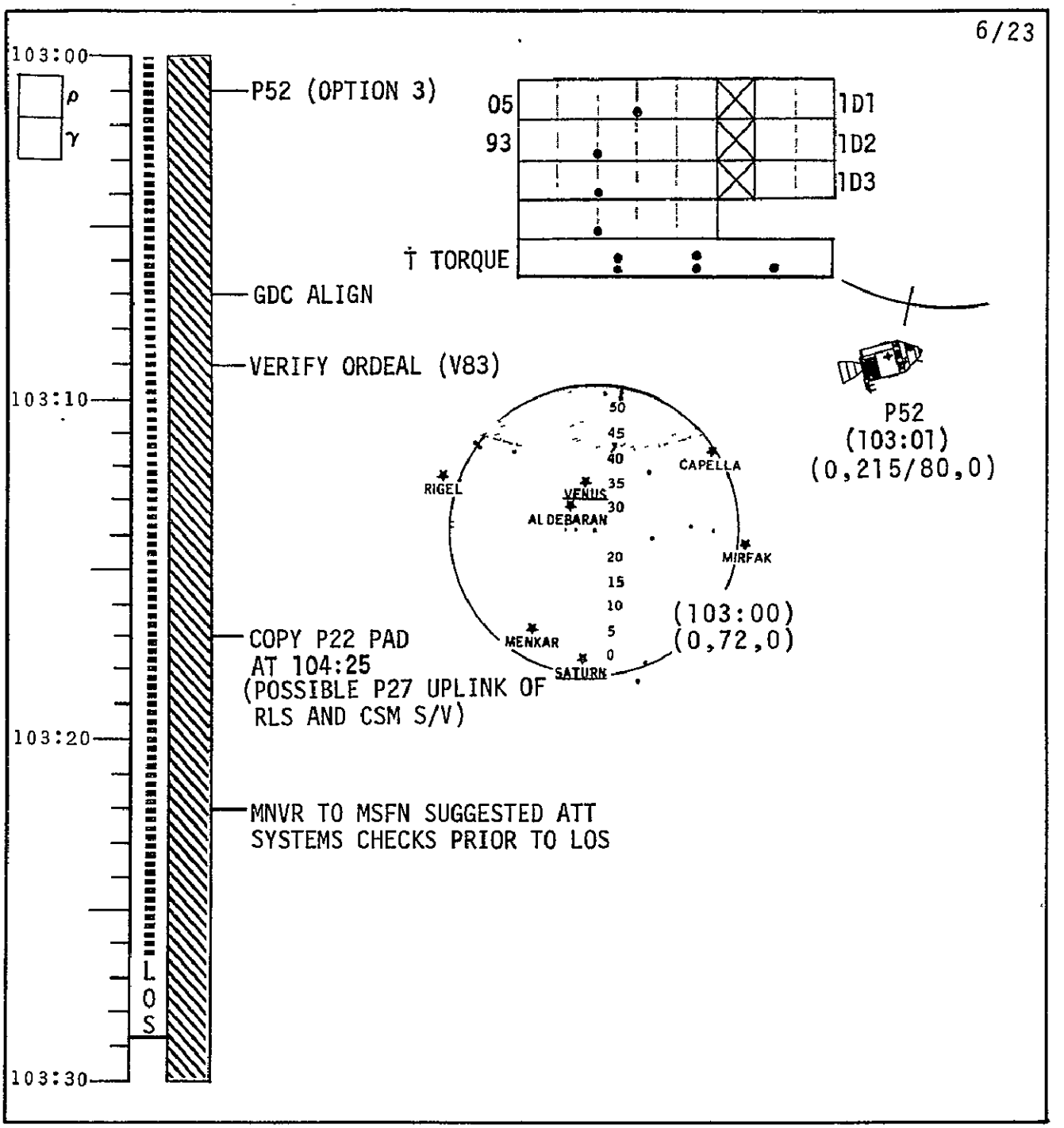
LOS

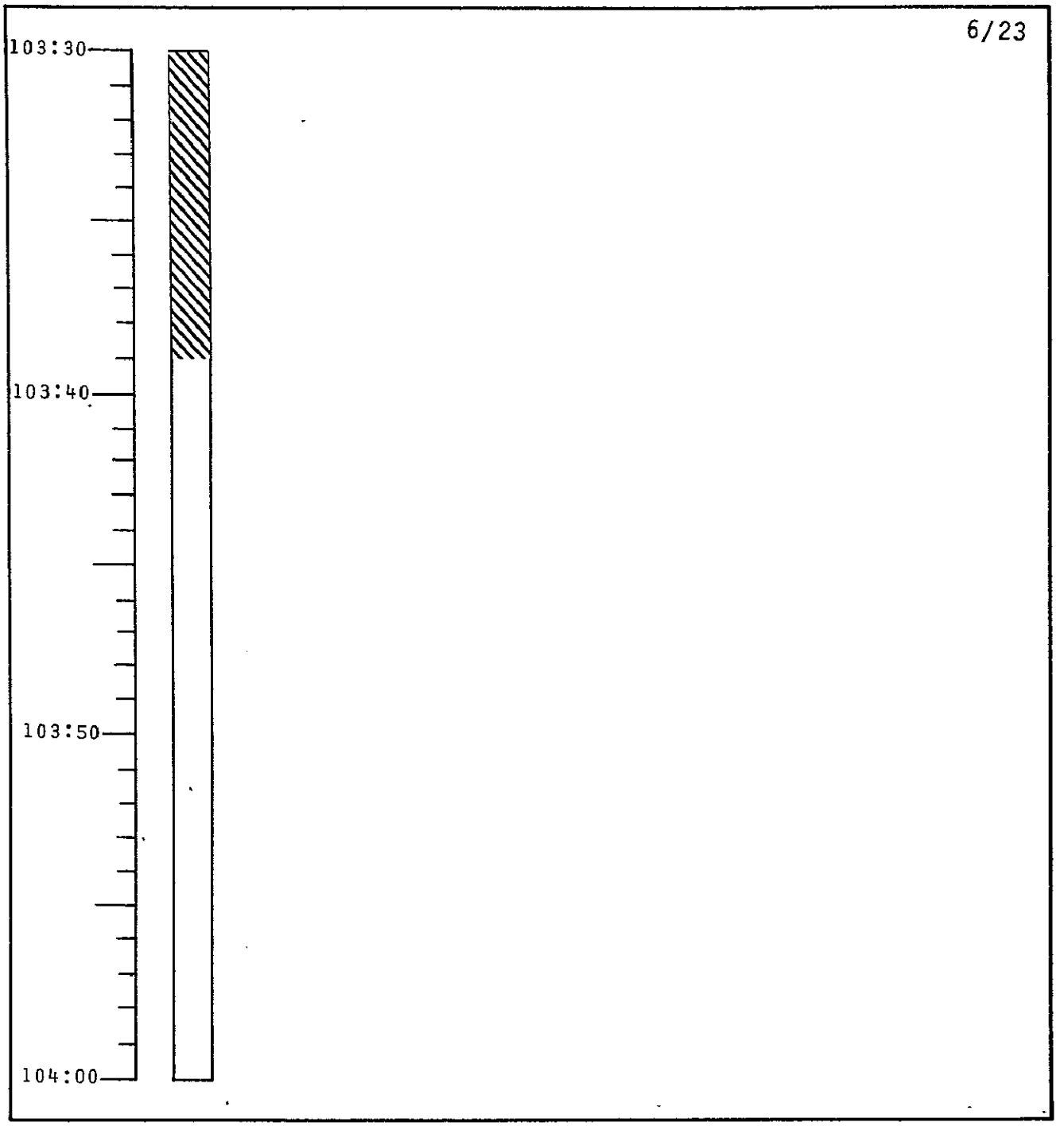
101:30

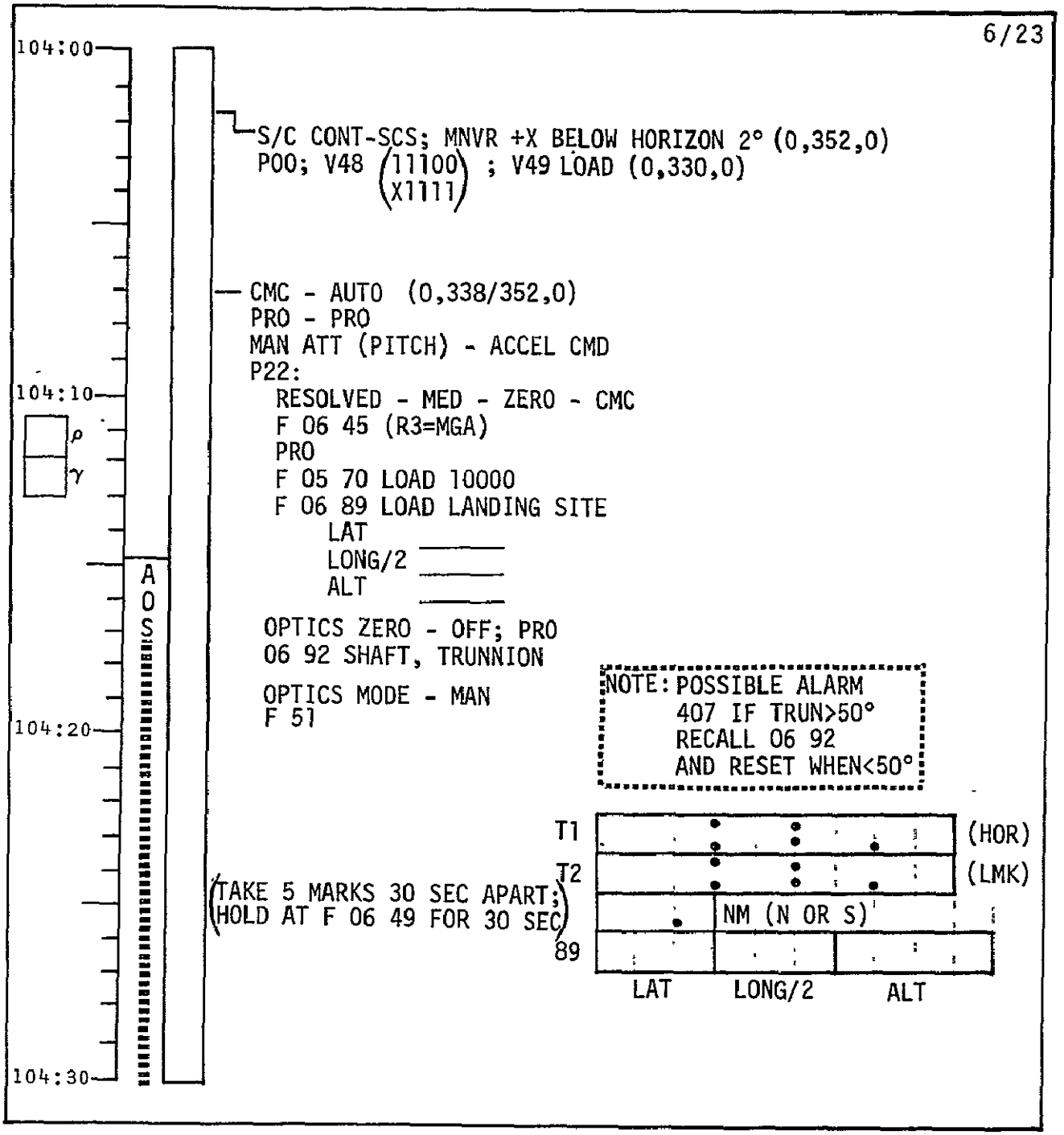

6/23
101:30
101:40
101:50
102:00
VHF SIMPLEX A - REC ONLY - B DATA
(RECORD, FWD, LBR)
P20 AUTO MNVR TO SXT TRACK (67°) (0,217/332,0)
LM DOI (101:38:48)(-72.7,0,14.5)
VHF B - DUPLEX RANGING - ON
VHF RCV ONLY - OFF
COMPUTE RDOT FOR LM
CONFIRM LM DOI
DOI
(0,214/321,0)
P76 (ADD: 20 SEC); V82 (LM R2=2)(60X9)
P20 AUTO MNVR TO SXT TRACK (TRIM) (0,224/313,0)
101:42
R= 3.67
Ṙ= 70.2
START CAMERAS REMOTE OPERATION
INITIATE OPTICS TRACK ONLY
P20
(101:44)
(0,224/313,0)
V93;V57; V87
SXT/VHF
101:57
R= 13.02
Ṙ= 68.7

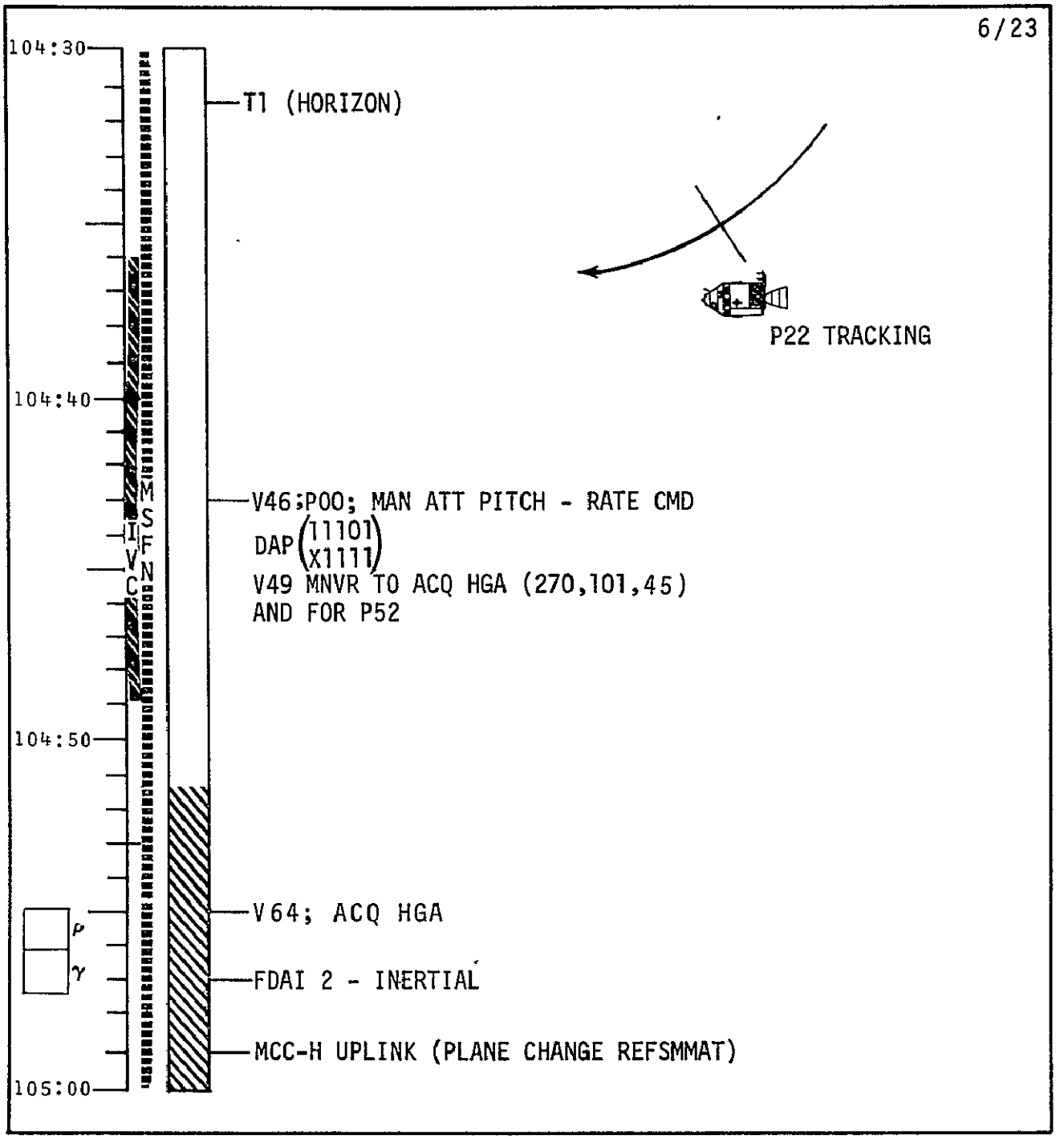

6/23
102:00
102:10
102:20
102:30
SXT/VHF
AOS
ρ
γ
P20
(102:00)
(0,289/327,0)
P00; V64; ACO HGA (0,343/332,0)
P20 AUTO MNVR TO SXT TRACK(TRIM)(0,349/330,0)
102:12
R= 34.00
R=241.1
P20
(102:20)
(0,350/327,0)
GO/NO-GO PDI ABORT
S BAND SQUELCH - OFF (CONFIRM)
102:27
R= 84.40
R=422.1

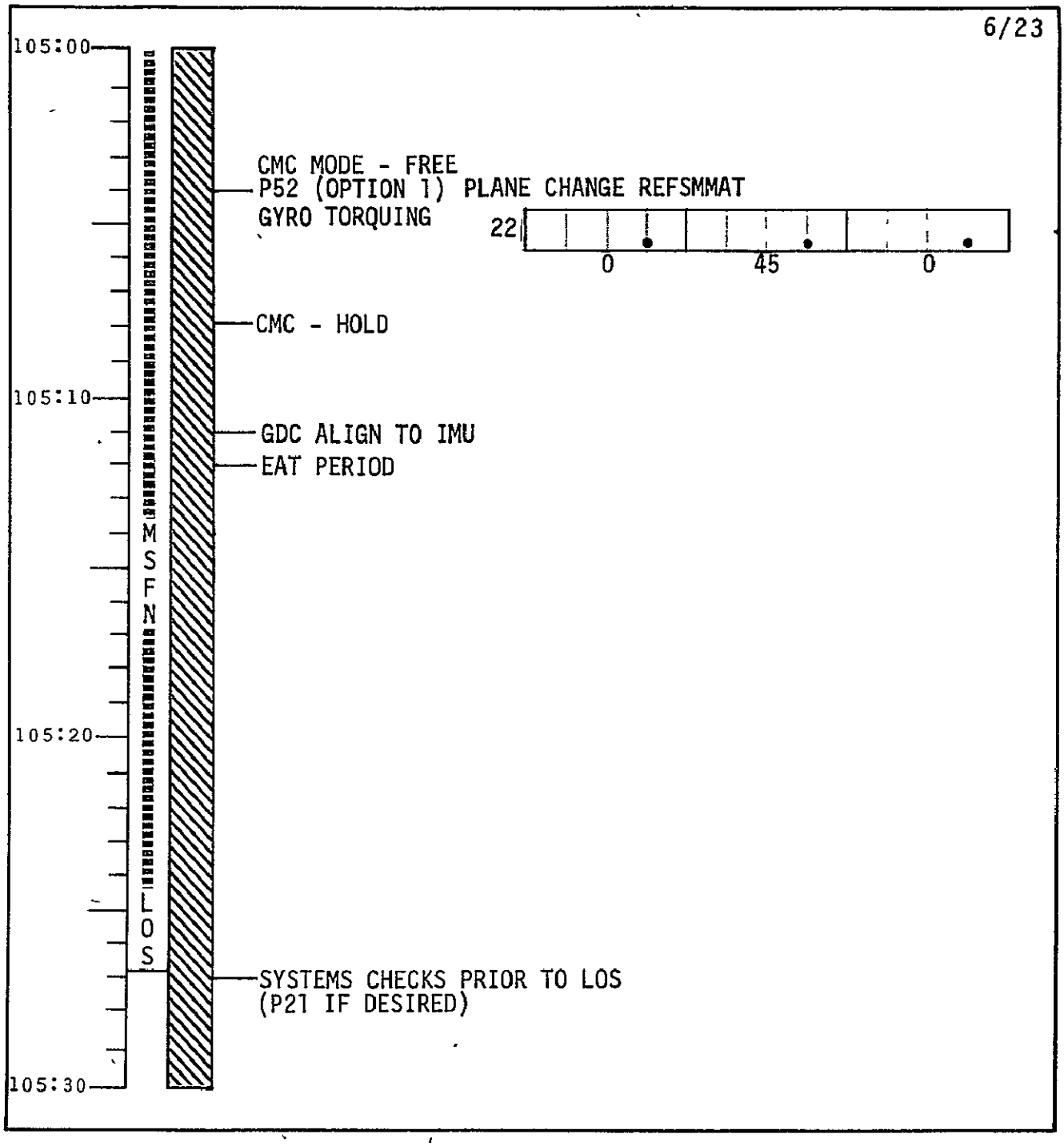

6/23
102:30
102:40
102:50
103:00
MSFN
P00; V48 (11101 / X1111) ; V49 LOAD (0,140,0)
OPTICS - RESOLVED/MED/ZERO-OFF
TRACK LM MANUALLY
(EVENT TIMER START)
LM PDI (102:35:14)
PROCEED; PITCH DOWN -.2°/SEC
TO P52 ATT (0,206/80,0)
PDI
(0,18/310,0)
SWITCH TO OMNI-C (AS REQUIRED)
MSFN ENABLES S-BAND RELAY
LM TOUCHDOWN (102:47:11)
MAN ATT PITCH - ACC CMD
TOUCHDOWN
(0,282/180,0)
V44 SET LUNAR SURFACE FLAG
KEEP PITCHING TO P52 ATT
VHF RANGING - OFF
VHF T/R (PANEL 9) TO RECEIVE
RR XPNR - OFF
V46;STOP PITCH;MAN ATT PITCH - RATE CMD AT (0,206/80,0)

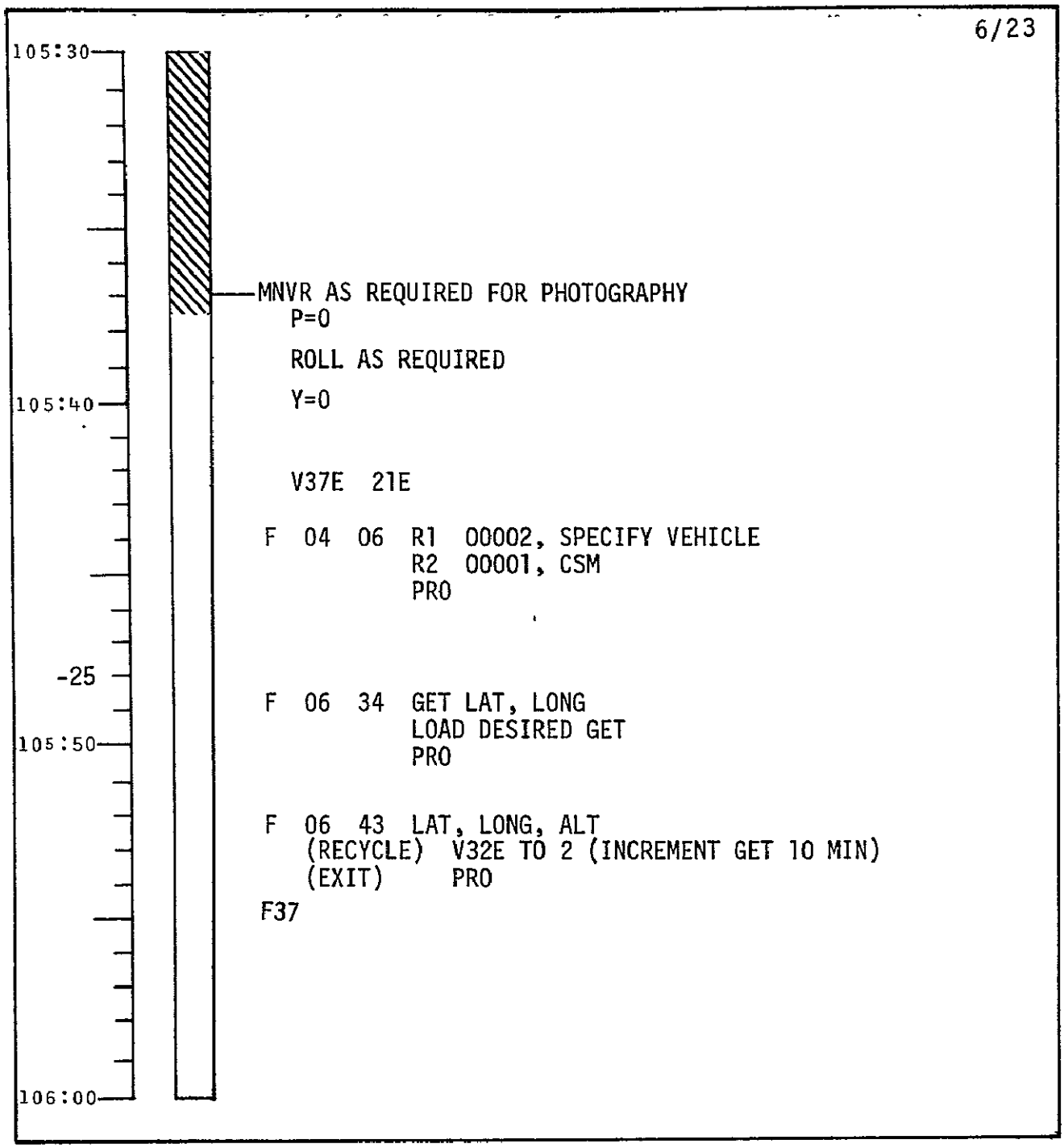

6/23
103:00
ρ
γ
P52 (OPTION 3)
05
93
1D1
1D2
1D3
Ṫ TORQUE
GDC ALIGN
VERIFY ORDEAL (V83)
103:10
P52
(103:01)
(0,215/80,0)
50
45
40
35
30
20
15
10
5
0
RIGEL
CAPELLA
VENUS
ALDEBARAN
MIRFAK
MENKAR
SATURN
(103:00)
(0,72,0)
COPY P22 PAD
AT 104:25
(POSSIBLE P27 UPLINK OF
RLS AND CSM S/V)
103:20
MNVR TO MSFN SUGGESTED ATT
SYSTEMS CHECKS PRIOR TO LOS
LOS
103:30

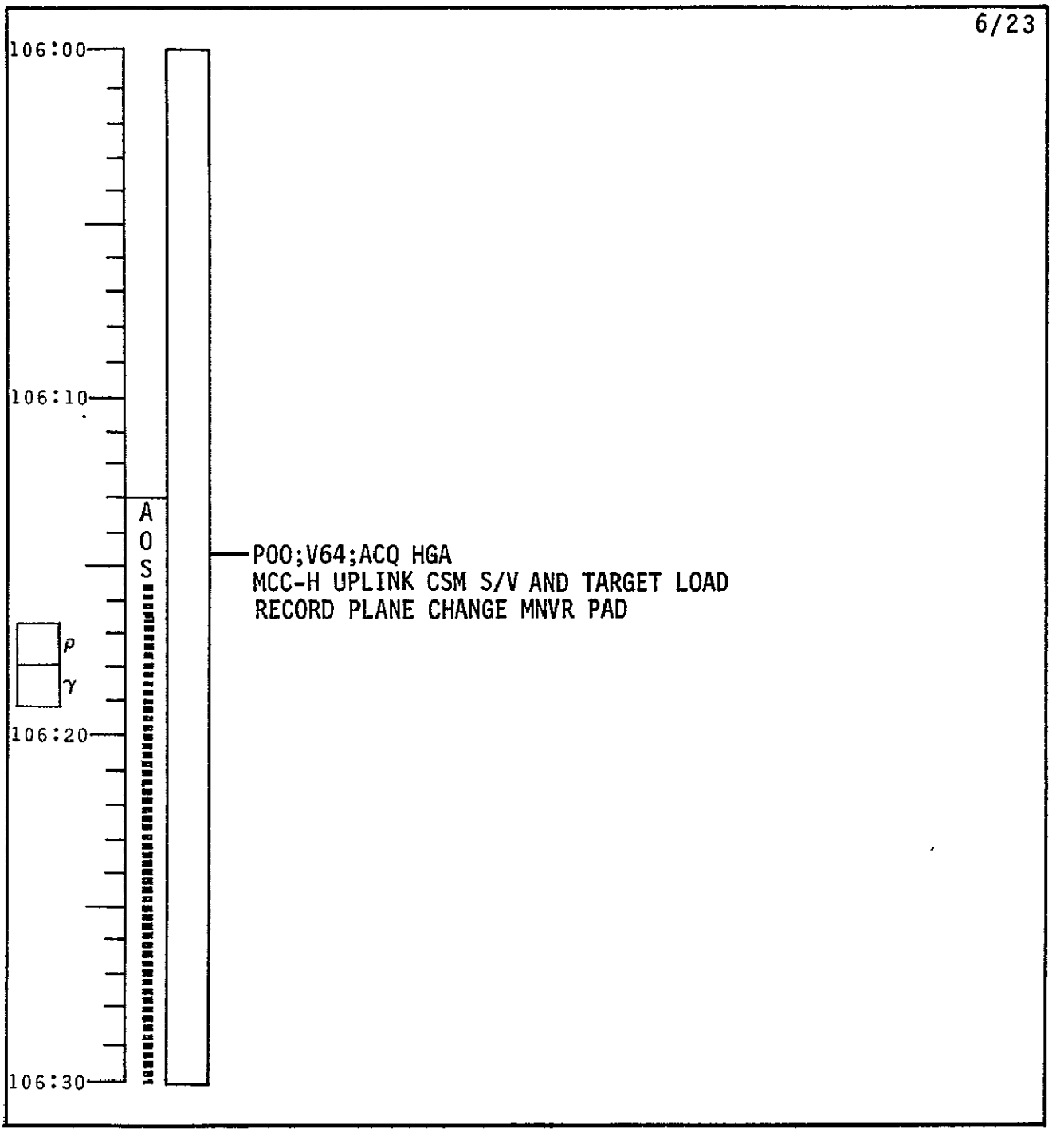

6/23
103:30
103:40
103:50
104:00

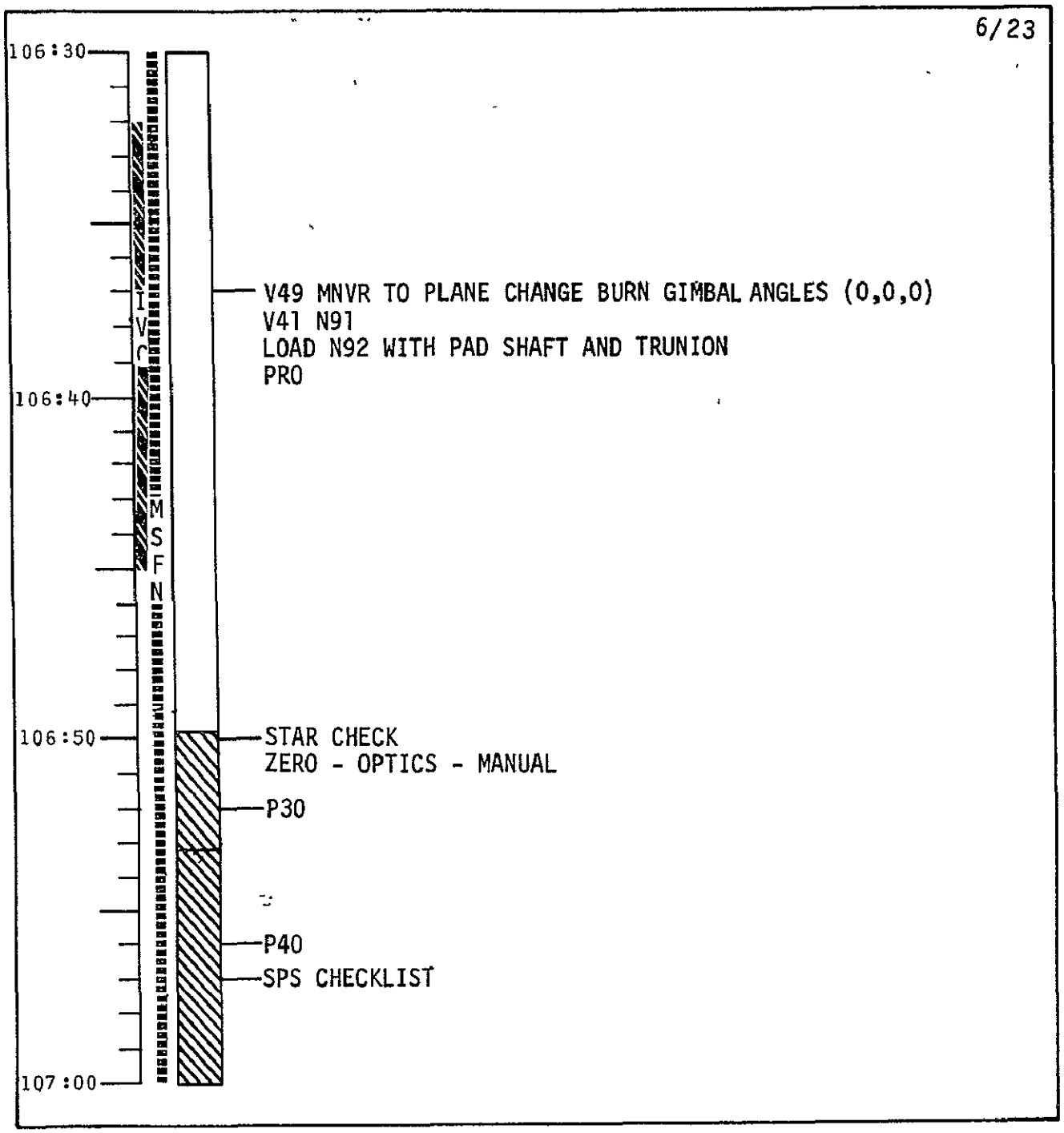

6/23
104:00
104:10
104:20
104:30
ρ
γ
AOS
S/C CONT-SCS; MNVR +X BELOW HORIZON 2° (0,352,0)
P00; V48 (11100 / X1111) ; V49 LOAD (0,330,0)
CMC - AUTO (0,338/352,0)
PRO - PRO
MAN ATT (PITCH) - ACCEL CMD
P22:
RESOLVED - MED - ZERO - CMC
F 06 45 (R3=MGA)
PRO
F 05 70 LOAD 10000
F 06 89 LOAD LANDING SITE
LAT
LONG/2
ALT
OPTICS ZERO - OFF; PRO
06 92 SHAFT, TRUNNION
OPTICS MODE - MAN
F 51
NOTE: POSSIBLE ALARM
407 IF TRUN>50°
RECALL 06 92
AND RESET WHEN<50°
(TAKE 5 MARKS 30 SEC APART;
HOLD AT F 06 49 FOR 30 SEC)
T1
T2
(HOR)
(LMK)
NM (N OR S)
89
LAT
LONG/2
ALT

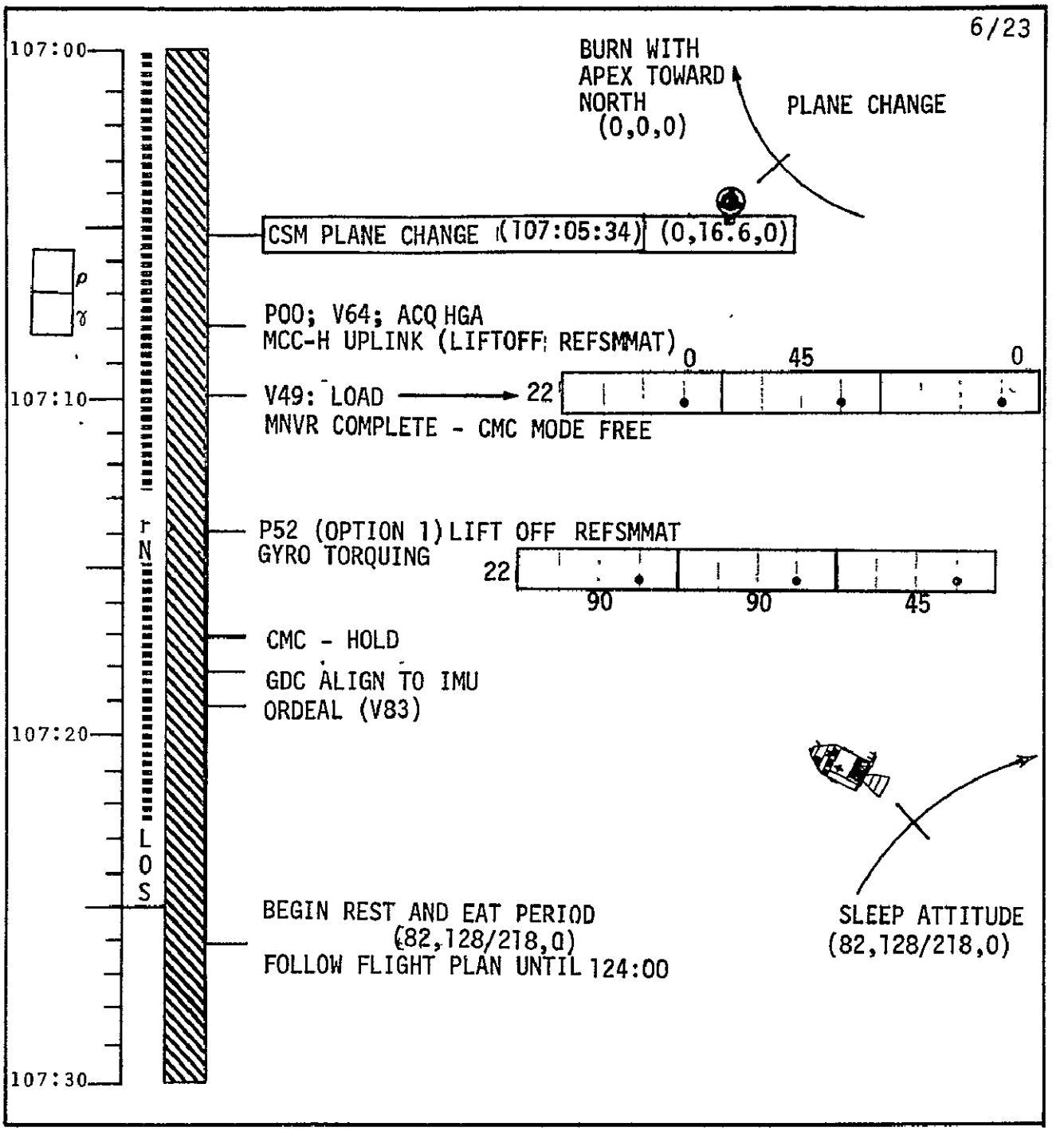

6/23
104:30
104:40
104:50
105:00
T1 (HORIZON)
P22 TRACKING
V46;P00; MAN ATT PITCH - RATE CMD
DAP (11101 / X1111)
V49 MNVR TO ACQ HGA (270,101,45)
AND FOR P52
V64; ACQ HGA
FDAI 2 - INERTIAL
MCC-H UPLINK (PLANE CHANGE REFSMMAT)
IVC
MSFN
P
γ

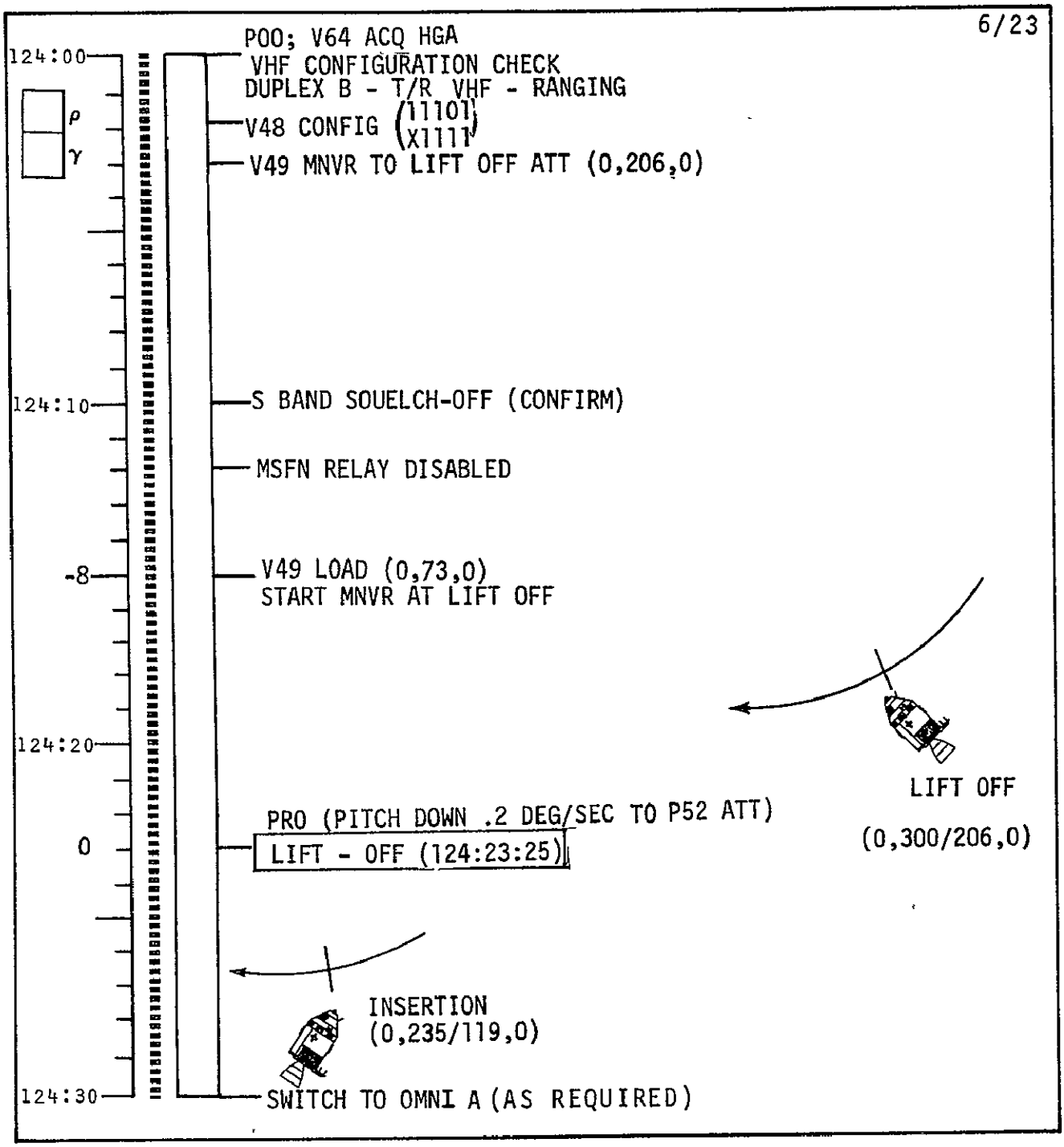

6/23
105:00
105:10
105:20
105:30
MSFN
LOS
CMC MODE - FREE
P52 (OPTION 1) PLANE CHANGE REFSMMAT
GYRO TORQUING
22
0
45
0
CMC - HOLD
GDC ALIGN TO IMU
EAT PERIOD
SYSTEMS CHECKS PRIOR TO LOS
(P21 IF DESIRED)

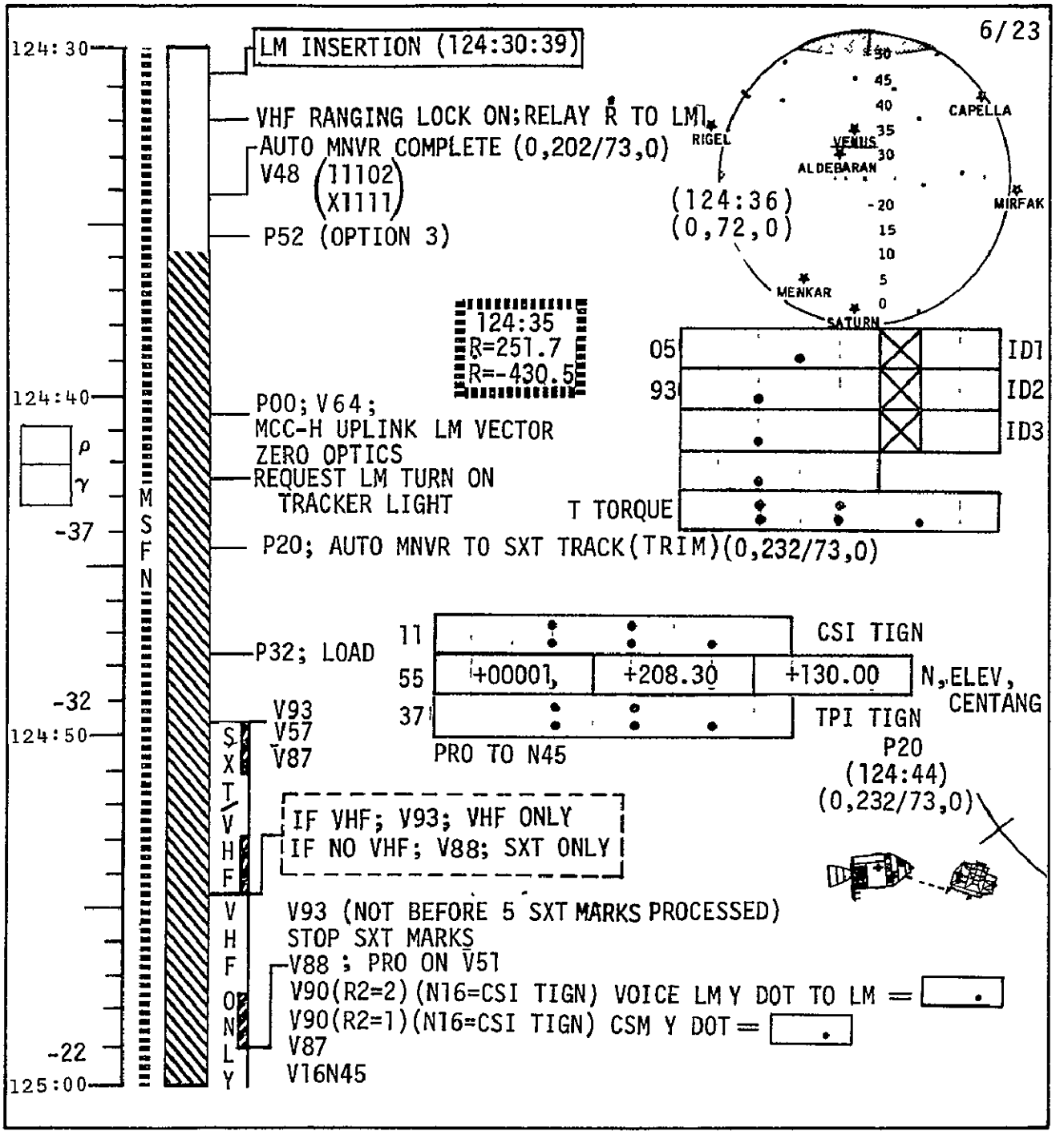

6/23
105:30
105:40
-25
105:50
106:00
MNVR AS REQUIRED FOR PHOTOGRAPHY
P=0
ROLL AS REQUIRED
Y=0
V37E 21E
F 04 06 R1 00002, SPECIFY VEHICLE
R2 00001, CSM
PRO
F 06 34 GET LAT, LONG
LOAD DESIRED GET
PRO
F 06 43 LAT, LONG, ALT
(RECYCLE) V32E TO 2 (INCREMENT GET 10 MIN)
(EXIT) PRO
F37

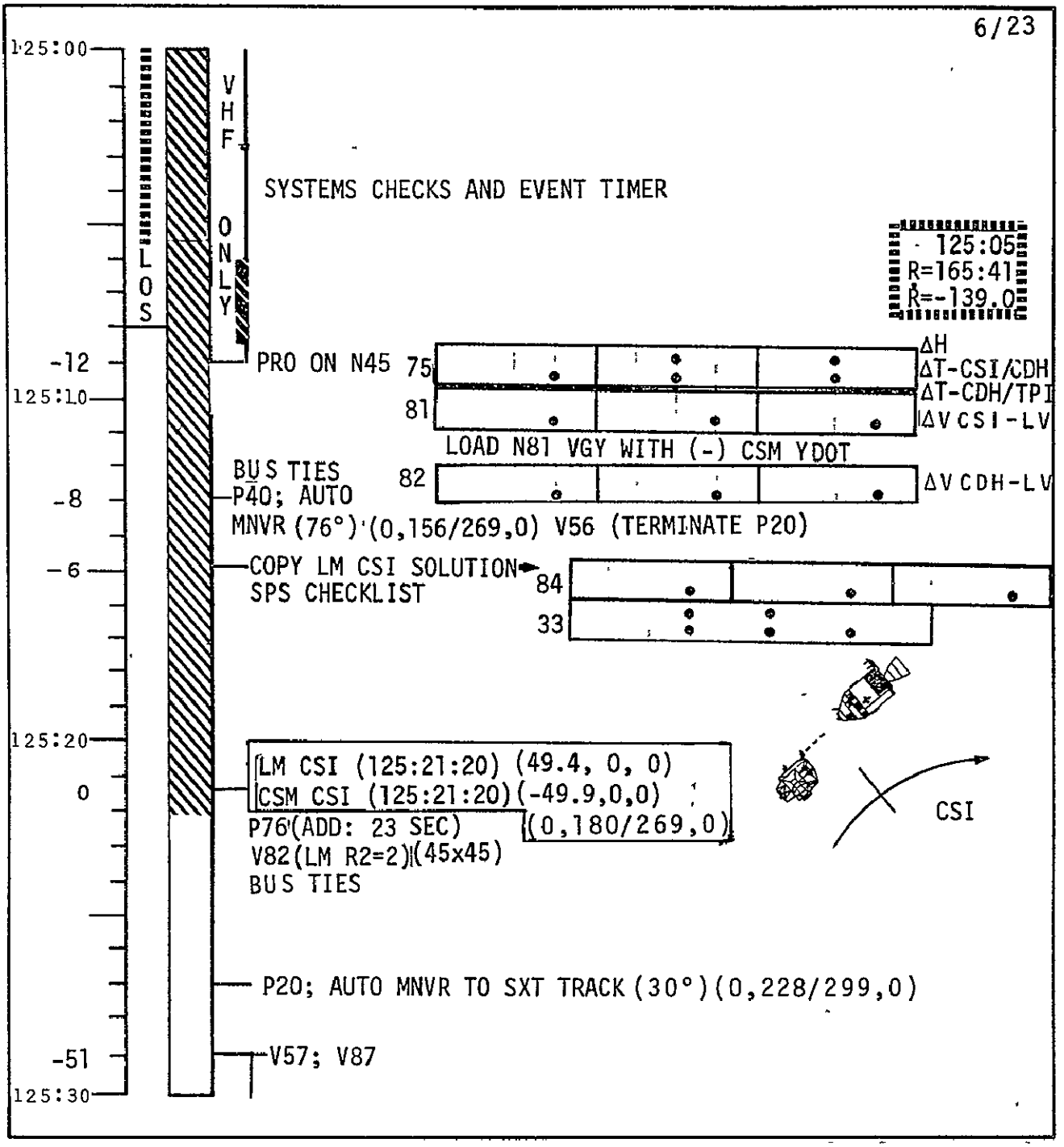

6/23
106:00
106:10
106:20
106:30
AOS
P
Y
P00;V64;ACQ HGA
MCC-H UPLINK CSM S/V AND TARGET LOAD
RECORD PLANE CHANGE MNVR PAD

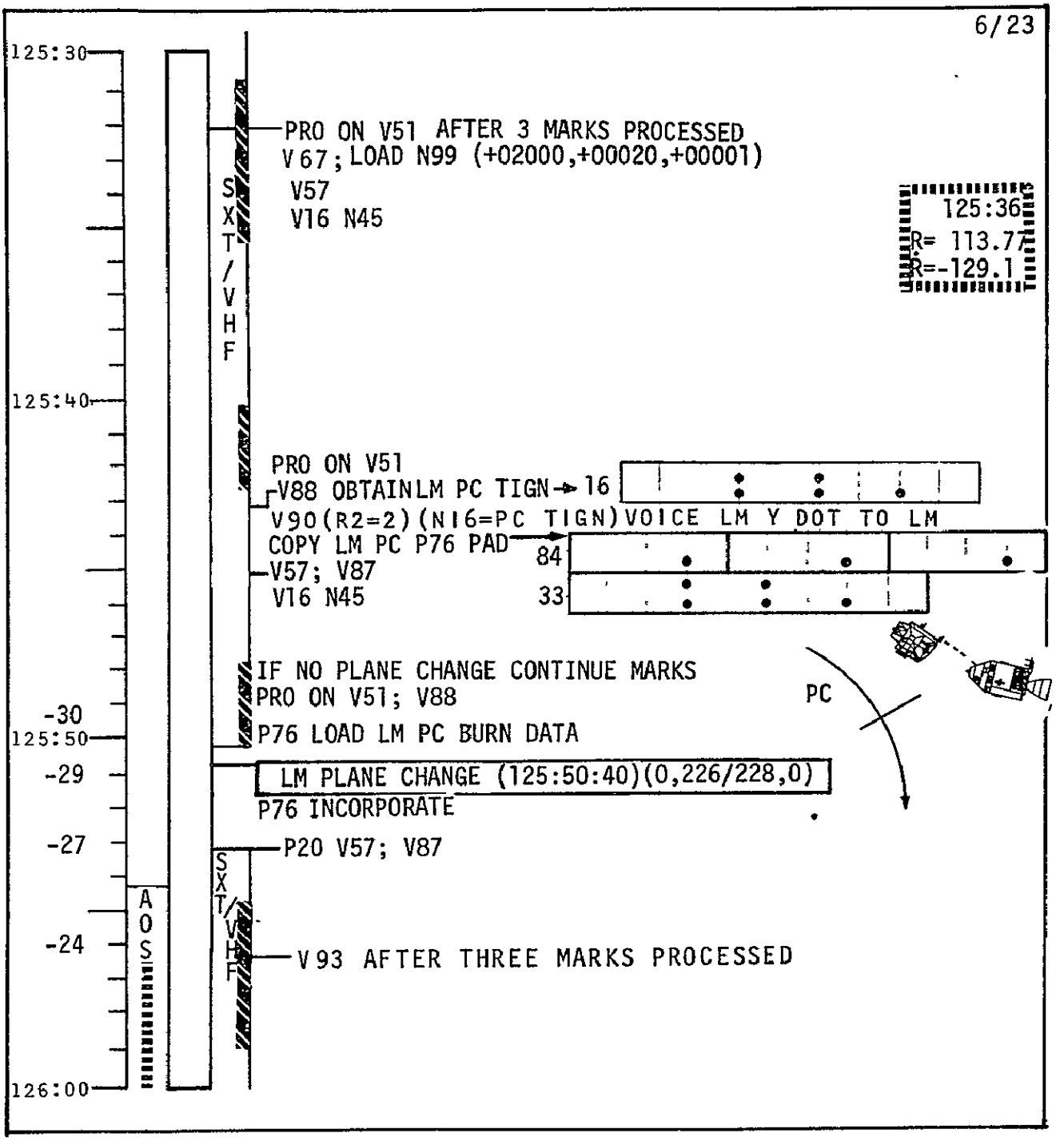

6/23
106:30
106:40
106:50
107:00
I
V
C
M
S
F
N
V49 MNVR TO PLANE CHANGE BURN GIMBAL ANGLES (0,0,0)
V41 N91
LOAD N92 WITH PAD SHAFT AND TRUNION
PRO
STAR CHECK
ZERO - OPTICS - MANUAL
P30
P40
SPS CHECKLIST

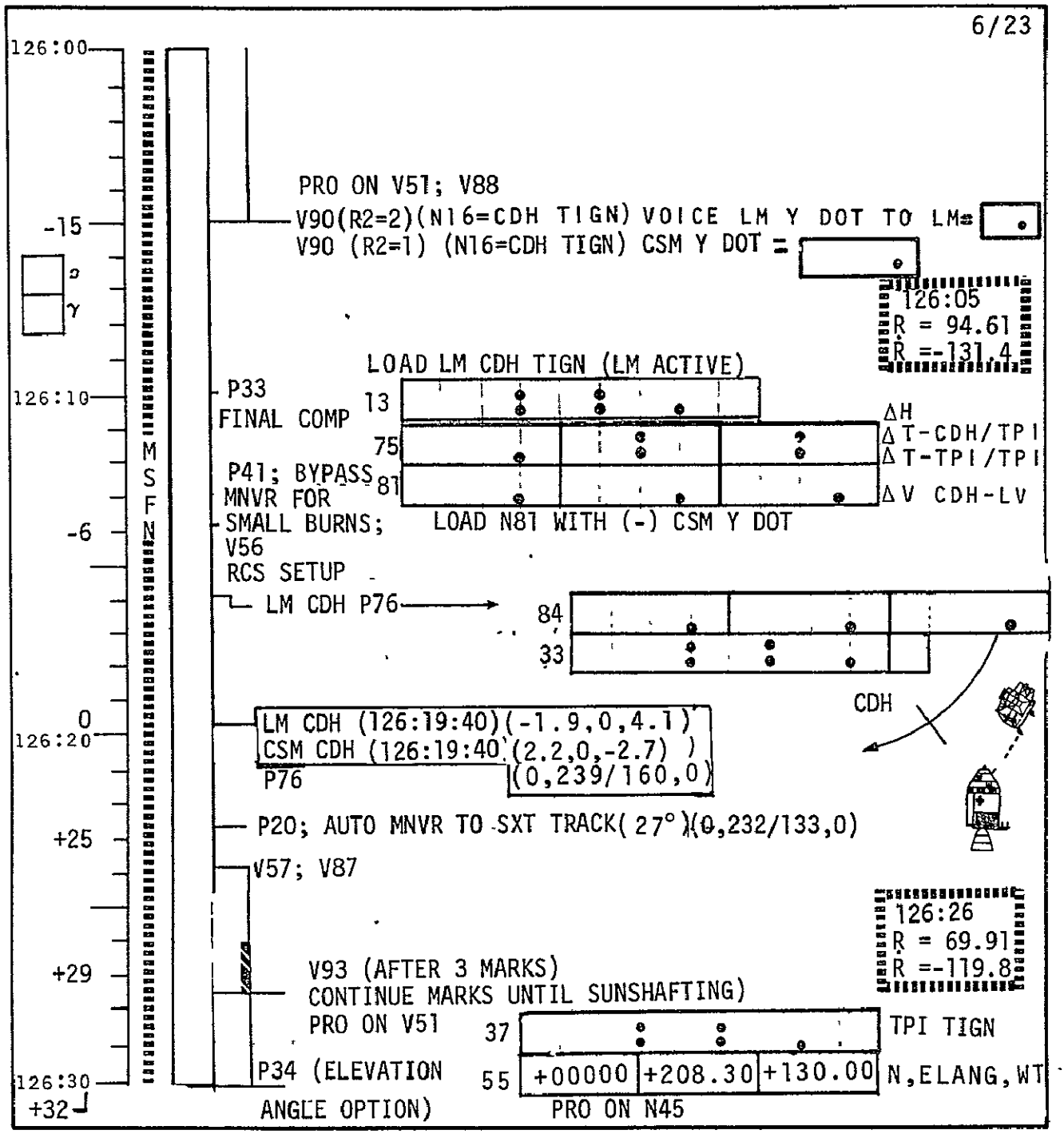

6/23
107:00
107:10
107:20
107:30
BURN WITH
APEX TOWARD
NORTH
(0,0,0)
PLANE CHANGE
CSM PLANE CHANGE (107:05:34) (0,16.6,0)
ρ
γ
POO; V64; ACQ HGA
MCC-H UPLINK (LIFTOFF REFSMMAT)
0
45
0
V49: LOAD → 22
MNVR COMPLETE - CMC MODE FREE
r
N
P52 (OPTION 1) LIFT OFF REFSMMAT
GYRO TORQUING
22
90
90
45
CMC - HOLD
GDC ALIGN TO IMU
ORDEAL (V83)
L
O
S
BEGIN REST AND EAT PERIOD
(82,128/218,0)
FOLLOW FLIGHT PLAN UNTIL 124:00
SLEEP ATTITUDE
(82,128/218,0)

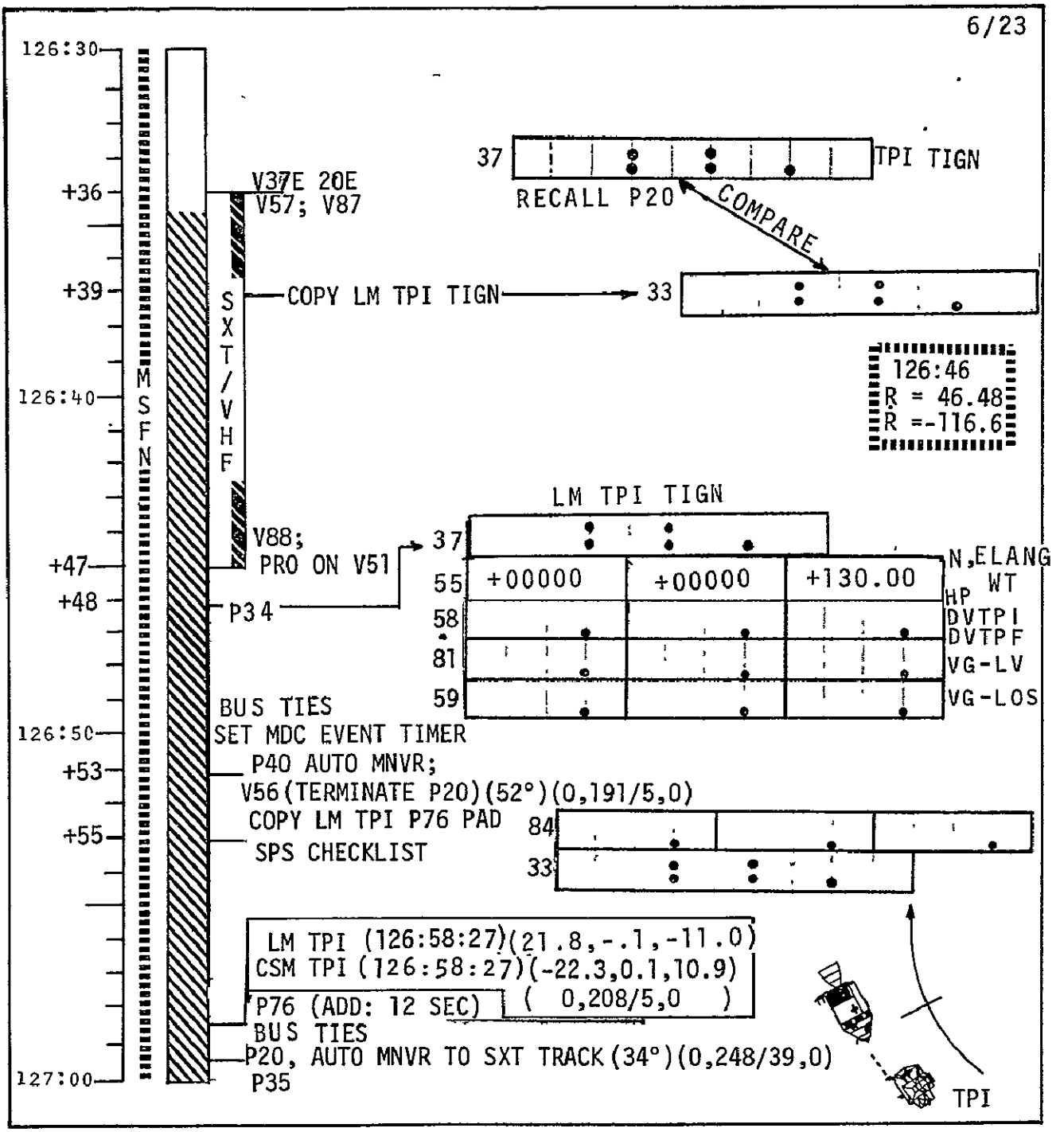

6/23
124:00
ρ
γ
P00; V64 ACQ HGA
VHF CONFIGURATION CHECK
DUPLEX B - T/R VHF - RANGING
V48 CONFIG (11101 / X1111)
V49 MNVR TO LIFT OFF ATT (0,206,0)
124:10
S BAND SOUELCH-OFF (CONFIRM)
MSFN RELAY DISABLED
-8
V49 LOAD (0,73,0)
START MNVR AT LIFT OFF
124:20
LIFT OFF
(0,300/206,0)
PRO (PITCH DOWN .2 DEG/SEC TO P52 ATT)
0
LIFT - OFF (124:23:25)
INSERTION
(0,235/119,0)
124:30
SWITCH TO OMNI A (AS REQUIRED)

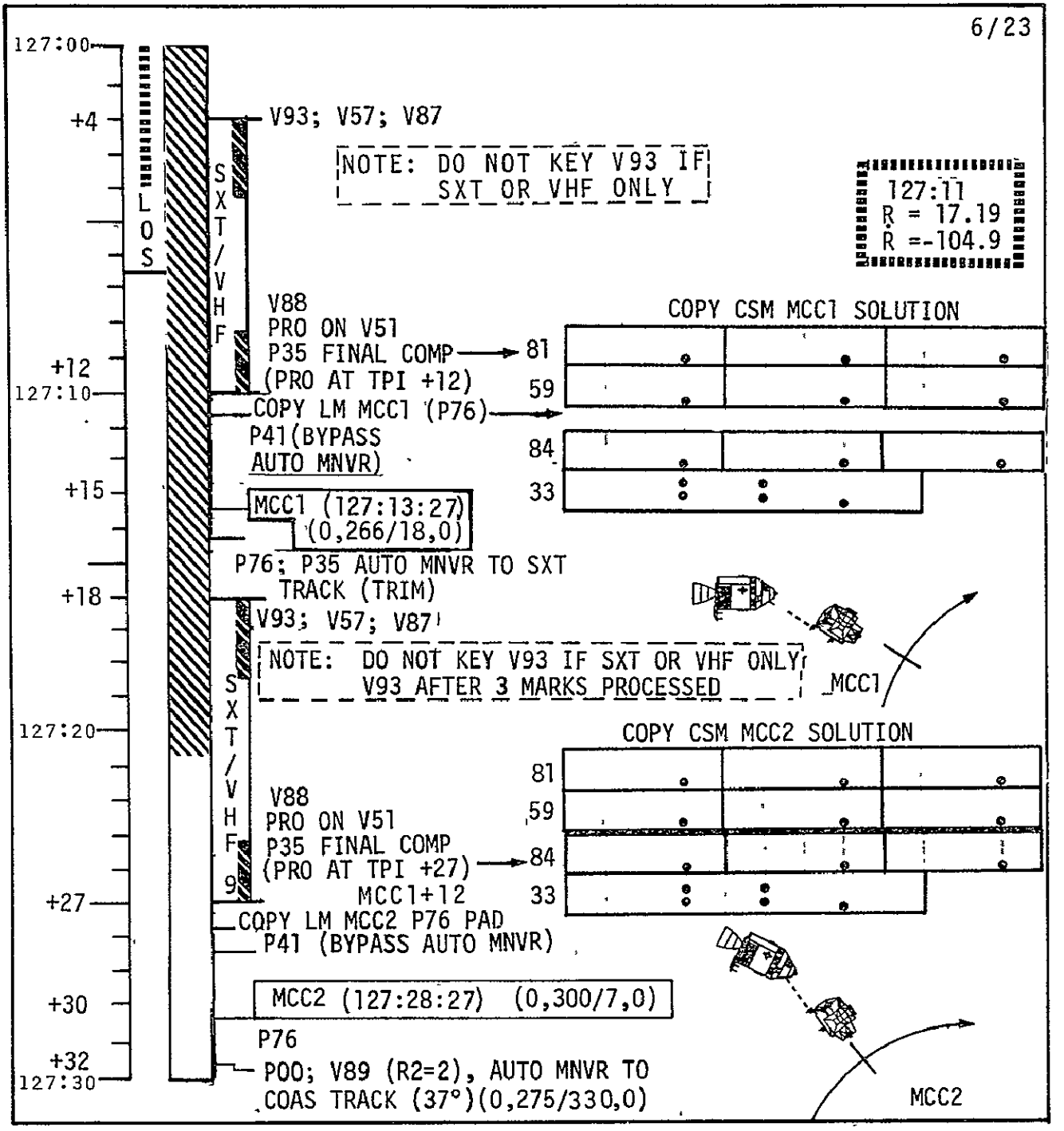

6/23
124:30
LM INSERTION (124:30:39)
VHF RANGING LOCK ON;RELAY R TO LM
AUTO MNVR COMPLETE (0,202/73,0)
V48 (11102 X1111)
P52 (OPTION 3)
RIGEL
CAPELLA
VENUS
ALDEBARAN
MIRFAK
MENKAR
SATURN
(124:36)
(0,72,0)
124:35
R=251.7
R=-430.5
05
93
ID1
ID2
ID3
T TORQUE
124:40
ρ
γ
P00; V64;
MCC-H UPLINK LM VECTOR
ZERO OPTICS
REQUEST LM TURN ON
TRACKER LIGHT
-37
P20; AUTO MNVR TO SXT TRACK(TRIM)(0,232/73,0)
MSFN
P32; LOAD
11
CSI TIGN
55
+00001
+208.30
+130.00
N,ELEV,
CENTANG
37
TPI TIGN
PRO TO N45
-32
124:50
V93
V57
V87
SXT/VHF
P20
(124:44)
(0,232/73,0)
IF VHF; V93; VHF ONLY
IF NO VHF; V88; SXT ONLY
V93 (NOT BEFORE 5 SXT MARKS PROCESSED)
STOP SXT MARKS
V88 ; PRO ON V51
VHF ONLY
V90(R2=2)(N16=CSI TIGN) VOICE LM Y DOT TO LM =
V90(R2=1)(N16=CSI TIGN) CSM Y DOT =
V87
V16N45
-22
125:00


6/23
125:00
LOS
VHF ONLY
SYSTEMS CHECKS AND EVENT TIMER
125:05
R=165:41
Ṙ=-139.0
-12
125:10
PRO ON N45
75
81
ΔH
ΔT-CSI/CDH
ΔT-CDH/TPI
ΔV CSI-LV
LOAD N81 VGY WITH (-) CSM YDOT
BUS TIES
P40; AUTO
82
ΔV CDH-LV
-8
MNVR (76°) (0,156/269,0) V56 (TERMINATE P20)
-6
COPY LM CSI SOLUTION
SPS CHECKLIST
84
33
125:20
0
LM CSI (125:21:20) (49.4, 0, 0)
CSM CSI (125:21:20) (-49.9,0,0)
P76 (ADD: 23 SEC) (0,180/269,0)
V82 (LM R2=2) (45x45)
BUS TIES
CSI
P20; AUTO MNVR TO SXT TRACK (30°) (0,228/299,0)
-51
125:30
V57; V87


6/23
125:30
125:40
-30
125:50
-29
-27
-24
126:00
AOS
SXT/VHF
SXT/VHF
PRO ON V51 AFTER 3 MARKS PROCESSED
V67; LOAD N99 (+02000,+00020,+00001)
V57
V16 N45
125:36
R= 113.77
R=-129.1
PRO ON V51
V88 OBTAINLM PC TIGN→16
V90(R2=2)(N16=PC TIGN)VOICE LM Y DOT TO LM
COPY LM PC P76 PAD→
84
33
V57; V87
V16 N45
IF NO PLANE CHANGE CONTINUE MARKS
PRO ON V51; V88
P76 LOAD LM PC BURN DATA
PC
LM PLANE CHANGE (125:50:40)(0,226/228,0)
P76 INCORPORATE
P20 V57; V87
V93 AFTER THREE MARKS PROCESSED


6/23
126:00
-15
126:10
-6
0
126:20
+25
+29
126:30
+32
MSFN
PRO ON V51; V88
V90(R2=2)(N16=CDH TIGN) VOICE LM Y DOT TO LM=
V90 (R2=1) (N16=CDH TIGN) CSM Y DOT =
126:05
R = 94.61
R =-131.4
LOAD LM CDH TIGN (LM ACTIVE)
P33
FINAL COMP
13
75
81
ΔH
ΔT-CDH/TPI
ΔT-TPI/TPI
ΔV CDH-LV
P41; BYPASS
MNVR FOR
SMALL BURNS;
V56
RCS SETUP
LOAD N81 WITH (-) CSM Y DOT
LM CDH P76
84
33
CDH
LM CDH (126:19:40)(-1.9,0,4.1)
CSM CDH (126:19:40)(2.2,0,-2.7)
P76
(0,239/160,0)
P20; AUTO MNVR TO SXT TRACK(27°)(0,232/133,0)
V57; V87
126:26
R = 69.91
R =-119.8
V93 (AFTER 3 MARKS)
CONTINUE MARKS UNTIL SUNSHAFTING)
PRO ON V51
37
TPI TIGN
P34 (ELEVATION
ANGLE OPTION)
55
+00000
+208.30
+130.00
N,ELANG,WT
PRO ON N45


6/23
126:30
+36
+39
126:40
+47
+48
126:50
+53
+55
127:00
MSFN
SXT/VHF
V37E 20E
V57; V87
COPY LM TPI TIGN
37
TPI TIGN
RECALL P20
COMPARE
33
126:46
R = 46.48
R =-116.6
LM TPI TIGN
V88;
PRO ON V51
37
55
+00000
+00000
+130.00
N,ELANG
WT
HP
58
DVTPI
DVTPF
81
VG-LV
59
VG-LOS
P34
BUS TIES
SET MDC EVENT TIMER
P40 AUTO MNVR;
V56(TERMINATE P20)(52°)(0,191/5,0)
COPY LM TPI P76 PAD
SPS CHECKLIST
84
33
LM TPI (126:58:27)(21.8,-.1,-11.0)
CSM TPI (126:58:27)(-22.3,0.1,10.9)
P76 (ADD: 12 SEC)
(0,208/5,0)
BUS TIES
P20, AUTO MNVR TO SXT TRACK(34°)(0,248/39,0)
P35
TPI


6/23
127:00
+4
+12
127:10
+15
+18
127:20
+27
+30
+32
127:30
LOS
SXT/VHF
V93; V57; V87
NOTE: DO NOT KEY V93 IF SXT OR VHF ONLY
127:11
R = 17.19
R =-104.9
V88
PRO ON V51
P35 FINAL COMP
(PRO AT TPI +12)
COPY CSM MCC1 SOLUTION
81
59
84
33
COPY LM MCC1 (P76)
P41(BYPASS AUTO MNVR)
MCC1 (127:13:27) (0,266/18,0)
P76; P35 AUTO MNVR TO SXT TRACK (TRIM)
V93; V57; V87
NOTE: DO NOT KEY V93 IF SXT OR VHF ONLY
V93 AFTER 3 MARKS PROCESSED
MCC1
SXT/VHF
COPY CSM MCC2 SOLUTION
81
59
84
33
V88
PRO ON V51
P35 FINAL COMP
(PRO AT TPI +27)
MCC1+12
COPY LM MCC2 P76 PAD
P41 (BYPASS AUTO MNVR)
MCC2 (127:28:27) (0,300/7,0)
P76
P00; V89 (R2=2), AUTO MNVR TO COAS TRACK (37°)(0,275/330,0)
MCC2

6/23

127:30

16 RCS JETS - ON

P47; V83 AT R = 1.25 N.M.

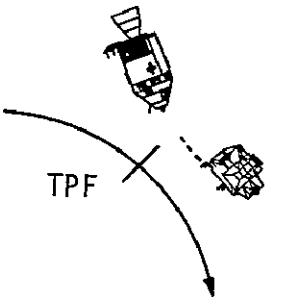
127:26
R = 5.60
Ṙ =-52.2

BRAKING GATES

	Ṙ(FPS)	R(FT)	R(N.M.)	RETICLE ANGLE (DEG)
+38	30	6000	1.0	.13
	20	3000	.5	.26
127:40	10	1500	.25	.54
	5	500	.08	1.6
		300	.05	2.7
		200	.03	4.0
		100	.02	8.5

127:41
R = 0.06
Ṙ =-12.3

TPF (127:40:38)



127:50

DOCK CHECKLIST;
CB DOCK PROBE (2) - IN
CB SECS ARM (2) - IN
PROBE RETRACT -VERIFY
SECS PYRO ARM A AND B - ON
4 QUADS - ON (8 T/B - GRAY)
CMC - AUTO
AT CONTACT;
CMC MODE FREE
NULL RATES
BOTTLES PRIM (2), SEC (2)
DAP (61112) (11111)

AOS

128:00

2

5.0 NOMINAL MAJOR PROCEDURES SUMMARY

The following sections present a summary timeline and checklist of major CSM activities during the nominal Mission G LM active rendezvous. The timeline in Section 5.0 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.

5.1 SUMMARY TIMELINE

GET	EVENT	PROG
(99+10)		
	MCC-H UPLINK CSM STATE VECTOR	(P00)
	TRANSFER THIS VEHICLE STATE VECTOR TO OTHER VEHICLE STATE VECTOR	(V66)
	COPY CSM SEP PAD	
	DON HELMET AND GLOVES	
(99+18)		
	SC CONT = SCS	
	RATE = LOW	
	ATT DB = MIN	
	LM RCS COLD FIRE CHECKS	
(99+20)		
	DISABLE CSM ROLL JETS	
	RATE = HIGH	
	ATT DB = MAX	
(99+21)		
	LM RCS HOT FIRE CHECKS	
(99+22)		
	ENABLE A/C AND B/D ROLL	
(99+25)		
	VERIFY AUTO RCS SEL	
	-C4(-PITCH-X)-OFF	
	-B3(+YAW-X)-OFF	
	FOR LM RR SELF TEST	
	VERIFY RNDZ XPNDR-PTR	
(99+27)		
	LOAD DAP WITH GROUND UPDATE	
	(21111) (36427) (-00089)	
	(X1111) (33657) (+00032)	

GET	EVENT	PROG
(99+32)		
	LOS	
	DISPLAY TOTAL ATTITUDE ERROR	(V62)
	SC CONT = CMC	
	CMC MODE = AUTO	
	AUTO MNVR TO (0, 14, 14)	(V49)
	(INERTIAL SEP ATT EXCEPT YAW)	
(99+35)		
	CONFIGURE CAMERA	
(99+42)		
	SUNUP	
(99+51)		
	CMC MODE=FREE(AS REQD FOR LM AGS CALIB)	
	CMC MODE=AUTO(AFTER 32 SEC)	
	VERIFY MAX DB FOR AGS CALIB	
	PERFORM SYSTEMS CHECKS AND SWITCH VERIFICATION	
	WAIT FOR LM TO COMPUTE AGS ALIGN AND GIVE GO, THEN	
	YAW 14 DEG LEFT AFTER LM AGS CALIB (0, 313/14, 0)	
(99+57)		
	RNDZ XPNDR CHECKS	
(100+07)		
	HAND CONTROLLERS ADJ/ARMED	
	THC POWER-ON	
	VHF A-SIMPLEX	
	VHF RCV ONLY-B DATA	
	TAPE RECORDER-FWD	
	PCM BIT RATE-LOW	

	GET	EVENT	PROG
	(100+10)		
		GDC ALIGN TO IMU	
	(100+11)		
		VERIFY ORDEAL (V83)	
	(100+13)		
		SC CONT-SCS	
		RELOAD DAP (11102),(V46)	
		(X1111)	
		BMAG MODE - ATT 1/RATE 2	
-25	(100+15+00)		
		**********	
		UNDOCKING (0, 13/14, 0)	
		**********	
		AUTO RCS SEL-B3-MNA	
		C4-MNB	
		DV CG-CSM	
		RNDZ XPNDR PWR-PWR(VERIFY)	
	(100+19)		
		AOS	
		ACQUIRE HGA (V64)	(P00)
		ACTIVATE COLOR TV	
		TAKE PHOTOS	
		INSPECT LM DURING LM 360 DEG YAW	
	(100+32)		
		SET EMS= 102.5	
	(100+34)		
		BMAG MODE - RATE 2	
		SC CONT-CMC	
		CMC MODE - AUTO	
-5	(100+35)		
		EXTERNAL DV TARGETING	(P30)
		LOAD VGZ = -2.5	

	GET	EVENT	PROG
-3	(100+37)		
		RCS THRUST PROGRAM	(P41)
		AUTO MNVR TO BURN ATTITUDE	
		(TRIM)	
	(100+38)		
		RCS THRUST SETUP	(P41)
	(100+39+58)		
		**********	
		CSM SEPARATION (0, 0, -2.5)	
		(0, 90/14, 0)	
		**********	
	(100+44)		
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK (42 DEG)	
		(0,148/56,0)	
		VHF B-DUPLEX	
		VHF RANGING-RANGING	
		MONITOR LM RR CHECKS	
		COMPARE EMS VHF AND V83 RANGE	
		PERFORM OPTICS CHECKS	
	(100+52)		
		COPY DOI P76 PAD	
		COPY PDI1 + 12 P76 PAD	
		COPY CSM RESCUE PAD	
	(100+54)		
		SUNDOWN	
	(101+00)		
		IMU REALIGN TO REFSMMAT	(P52)
		(OPTION 3)	
		COPY GYRO TORQUE ANGLES	
	(101+08)		
		GDC ALIGN TO IMU	
		VERIFY ORDEAL(V83)	

GET	EVENT	PROG
(101+10)	MCC-H UPLINK CSM AND LM STATE VECTORS	(P00)
(101+26)	SYSTEMS CHECK PRIOR TO LOS	
(101+28)	LOS	
(101+31)	VHF A-SIMPLEX VHF RCV ONLY-B DATA TAPE RECORDER-FWD PCM BIT RATE-LOW	
(101+33)	RENDEZVOUS NAV PROGRAM AUTO MNVR TO SXT TRACK (67 DEG) (0,217/332,0)	(P20)
(101+38+48)	********** LM DOI(-72.7,0,14.5) **********	
	VHF B-DUPLEX VHF RANGING-RANGING VHF RCV ONLY-OFF COMPUTE RDOT FOR LM	
(101+40)	SUNUP	
(101+42)	CONFIRM LM DOI TARGET DV PROGRAM (ADD 20 SECONDS) LM ORBIT PARAMETER DISPLAY(V82) (60X9)	(P76)
(101+44)	RENDEZVOUS NAV PROGRAM POSSIBLE AUTO MNVR TO SXT TRACK (TRIM) (0,224/313,0)	(P20)
(101+49)	START CAMERAS REMOTE OPERATION INITIATE OPTICS TRACK ONLY	
(101+52)	REINITIALIZE W MATRIX(V93) CALL MARKING ROUTINE (V57) SET VHF RANGE FLAG (V87)	
(102+07)	TERMINATE MARKS	
(102+17)	AOS ACQUIRE HGA (V64)	(P00)
(102+19)	RENDEZVOUS NAV PROGRAM AUTO MNVR TO SXT TRACK(TRIM) (0, 352/330, 0)	(P20)
(102+25)	OBTAIN GO/NO GO FOR PDI ABORT	
(102+27)	CONFIRM S-BAND SQUELCH-OFF	
(102+32)	RELOAD DAP(11101) (X1111) AUTO MNVR TO (0, 140, 0) (V49)	
(102+35+14)	MAINTAIN LM IN SXT FIELD OF VIEW ********** LM PDI **********	

GET	EVENT	PROG
(102+36)		
	PRO (PITCH DOWN AT .2 DEG/SEC TO P52 ATTITUDE)	
(102+43)		
	SWITCH TO OMNI-C(AS REQUIRED)	
(102+46)		
	MSFN ENABLES S-BAND RELAY	
(102+47+11)		
	**********	
	LM TOUCHDOWN	
	**********	
	MAN ATT (PITCH) - ACCEL CMD	
(102+53)		
	SUNDOWN	
	SET LUNAR SURFACE FLAG (V44)	
(102+55)		
	VHF RANGING - OFF	
	VHF T/R - RECEIVE	
(102+57)		
	RR XPNDR-OFF	
	STOP PITCH RATE	
	MANUAL ATT(PITCH) - RATE CMD AT PITCH ANGLE OF 80 DEG (0, 206/80, 0)	
(103+01)		
	IMU REALIGN TO REFSMMAT (OPTION 3)	(P52)
	COPY GYRO TORQUING ANGLES	
(103+07)		
	GDC ALIGN	
(103+09)		
	VERIFY ORDEAL(V83)	
(103+17)		
	COPY P22 PAD INTO CHECKLIST AT GET TIME OF 104+25 (POSSIBLE P27 UPLINK OF RLS AND CSM STATE VECTORS)	
(103+22)		
	MNVR TO MSFN SUGGESTED ATTITUDE	
	SYSTEMS CHECKS PRIOR TO LOS	
(103+29)		
	LOS	
(103+39)		
	SUNUP	
(104+01)		
	SC CONT - SCS	
	MNVR +X AXIS TO 2 DEG BELOW HORIZON (0, 352, 0)	
	CMC IDLING PROGRAM	(P00)
	RELOAD DAP(11100) (X1111)	
	AUTO MNVR TO(0,330,0)(V49)	
(104+07)		
	CMC MODE - AUTO	
	PRO(START MNVR)	
	MAN ATT (PITCH) - ACCEL CMD	
	ORBIT NAV PROGRAM (TAKE 5 MARKS 30 SEC APART)	(P22)
(104+15)		
	AOS	
(104+43)		
	CMC IDLING PROGRAM	(P00)
	MAN ATT(PITCH) - RATE CMD	
	RELOAD DAP (11101) (X1111)	
	AUTO MNVR TO(270,101,45) (V49)	

GET	EVENT	PROG
(104+51)		
	SUNDOWN	
(104+55)		
	ACQUIRE HGA (V64)	
(104+57)		
	FDAI SW 2 - INERTIAL	
(104+59)		
	MCC-H UPLINK	(P27)
	(PLANE CHANGE REFSMMAT)	
(105+04)		
	CMC MODE - FREE	
	IMU REALIGN TO REFSMMAT	(P52)
	PLANE CHANGE REFSMMAT	
	(OPTION 1)	
	GYRO TORQUING	
(105+08)		
	CMC MODE - HOLD	
(105+11)		
	GDC ALIGN	
(105+12)		
	INITIATE EAT PERIOD	
(105+27)		
	SYSTEMS CHECKS PRIOR TO LOS	
	(P21 IF DESIRED)	
(105+27)		
	LOS	
(105+37)		
	SUNUP	
	MNVR AS REQUIRED FOR PHOTOGRAPHY	
(106+13)		
	AOS	
(106+15)		
	ACQUIRE HGA (V64)	(P00)
	MCC-H UPLINK CSM STATE VECTOR AND	
	TARGET LOAD	
	RECORD PLANE CHANGE MNVR PAD	
(106+37)		
	AUTO MNVR TO (0, 0, 0) (V49)	
	COARSE ALIGN CDU (V41)	
	LOAD N92 WITH PAD SHAFT AND	
	TRUNNION	
	PRO	
(106+50)		
	SUNDOWN	
	STAR CHECK	
(106+52)		
	EXTERNAL DV TARGETING	(P30)
(106+56)		
	BURN ATTITUDE MNVR	(P40)
(106+57)		
	SPS THRUST SETUP	(P40)
(107+05+34)		
	**********	
	CSM PLANE CHANGE (0, 16.6,0)	
	(0, 0, 0)	
	**********	
(107+08)		
	ACQUIRE HGA (V64)	(P00)
	MCC-H UPLINK	(P27)
	(LIFT-OFF REFSMMAT)	
(107+10)		
	AUTO MNVR TO (0, 45, 0) (V49)	
	AFTER MNVR COMPLETE	
	CMC MODE - FREE	

GET	EVENT	PROG
(107+14)	IMU REALIGN TO LANDING SITE REFSMMAT (OPTION 1) GYRO TORQUING	(P52)
(107+17)	CMC MODE - HOLD	
(107+18)	GDC ALIGN TO IMU	
(107+19)	ORDEAL (V83)	
(107+25)	LOS	
(107+26)	BEGIN REST AND EAT PERIOD AUTO MNVR TO REST ATTITUDE	

GET	EVENT	PROG
(124+00)	ACQUIRE HGA(V64)	(P00)
	VHF CONFIGURATION CHECK VHF B - DUPLEX VHF T/R - RECEIVE VHF RANGING - RANGING	
(124+02)	RELOAD DAP (11101) (X1111)	
(124+03)	AUTO MNVR TO (0, 206, 0) (V49)	
(124+10)	CONFIRM S-BAND SQUELCH=OFF	
(124+12)	MSFN RELAY DISABLED	
(124+15)	AUTO MNVR TO (0, 73, 0) (V49) START MNVR AT LIFT-OFF	
(124+23+25)	PRO(PITCH DOWN AT 2 DEG/SEC TO P52 ATTITUDE) ********** LIFT-OFF **********	
(124+30)	SWITCH TO OMNI A(AS REQUIRED)	
(124+30+39)	********** LM INSERTION **********	
(124+32)	VHF RANGING LOCK ON RELAY RDOT TO LM	

GET	EVENT	PROG
(124+34)		
	AUTO MNVR COMPLETE (0, 202/73, 0)	
	RELOAD DAP (11102)	
	(X1111)	
(124+35)		
	IMU REALIGN TO REFSMMAT	(P52)
	(OPTION 3)	
	COPY GYRO TORQUE ANGLES	
(124+36)		-12
	SUNDOWN	
(124+40)		
	MCC-H UPLINK LM STATE VECTOR	(P00)
(124+42)		
	REQUEST LM TURN ON TRACKER LIGHT	-8
.37 (124+44)		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK (TRIM)	
	(0,232/73,0)	
(124+47)		-6
	CSI TARGETING PROGRAM	(P32) (P20)
	LOAD CSI TARGETING DATA	
.32 (124+49)		0
	REINITIALIZE w MATRIX (V93)	
	SET VHF RANGE FLAG (V87)	
	CALL MARKING ROUTINE (V57)	
(124+54)		
	AFTER FIVE SXT MARKS PROCESSED	
	REINITIALZE w MATRIX (V93)	
	TERMINATE SXT MARKS	

GET	EVENT	PROG
(124+59)		
	TERMINATE VHF MARKS (V88)	
	OUT OF PLANE DATA (V90)	
	(CSM AND LM)	
	VOICE LM Y DOT TO LM	
	SET VHF RANGE FLAG (V87)	
(125+08)		
	LOS	
(125+09)		
	TERMINATE VHF MARKS	
	CSI TARGETING FINAL COMP	(P32)
	COPY CSM CSI SOLUTION	
	LOAD N81 VGY WITH(-) CSM YCOT	
(125+13)		
	SPS THRUST PROGRAM	(P40)
	TERMINATE P20 (V56)	
	AUTO MNVR TO BURN ATTITUDE	
	(76 DEG) (0, 156/269, 0)	
(125+15)		
	COPY LM CSI PAD	
	SPS THRUST SETUP	(P40)
(125+21+20)		
	**********	
	LM CSI (49.4,0,0)	
	**********	
	**********	
	CSM CSI (-49.9,0,0)	
	(0, 180/269, 0)	
	**********	
	TARGET DV PROGRAM	(P76)
	(ADD 23 SECONDS)	
	LM ORBIT PARAMETER DISPLAY (V82)	
	(45X45)	

GET	EVENT	PROG
(125+22)		
	SUNUP	
(125+27)		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK (30 DEG)	
	(0,228/299,0)	
-51 (125+29)		
	CALL MARKING ROUTINE(V57)	
	SET VHF RANGE FLAG(V87)	
(125+32)		
	AFTER THREE MARKS PROCESSED, V67	
	LOAD N99(+02000,+00020,+00001)	
	CALL MARKING ROUTINE (V57)	
(125+43)		
	TERMINATE VHF MARKING(V88)	
	COPY LM PC TIGN	
	OUT OF PLANE DATA(V90)	
	VOICE LM YDOT TO LM	
	COPY LM PC PAD	
(125+45)		
	CALL MARKING ROUTINE(V57)	
-30 (125+50)		
	TERMINATE MARKS	
	LOAD TARGET DV PROGRAM	(P76)
-29 (125+50+40)		
	**********	
	LM PLANE CHANGE	0
	**********	
	INCORPORATE P76 DATA	

GET	EVENT	PROG
-27 (125+53)		
	RENDEZVOUS NAV PROGRAM	(P20)
	POSSIBLE AUTO MNVR TO SXT TRACK (TRIM)	
	CALL MARKING ROUTINE(V57)	
	SET VHF RANGE FLAG (V87)	
(125+54)		
	AOS	
-24 (125+56)		
	AFTER THREE MARKS PROCESSED, REINITIALIZE W MATRIX (V93)	
-15 (126+05)		
	TERMINATE MARKS	
	OUT OF PLANE DATA(V90)	
	VOICE LM YDOT TO LM	
-10 (126+10)		
	CDH TARGETING FINAL COMP	(P33)
	COPY CSM CDH SOLUTION	
-6 (126+14)		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR FOR SMALL BURNS	
	TERMINATE P20 (V56)	
	RCS THRUST SETUP	(P41)
(126+16)		
	COPY LM CDH PAD	
0 (126+19+40)		
	**********	
	LM CDH(-1.9,0,4.1)	
	**********	
	**********	
	CSM CDH (2.2,0,-2.7)	
	(0, 239/160, 0)	
	**********	

MISSION G SUMMARY TIMELINE

	GET	EVENT	PROG
		TARGET DV PROGRAM	(P76)
+25	(126+23)		
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK (27 DEG)	
		(0,232/133,0)	
	(126+24)		
		CALL MARKING ROUTINE(V57)	
		SET VHF RANGE FLAG(V87)	
+29	(126+27)		
		AFTER THREE MARKS PROCESSED	
		REINITIALIZE W MATRIX (V93)	
+32	(126+30)		
		TPI TARGETING PROGRAM	(P34)
		(ELEVATION ANGLE OPTION)	
+36	(126+34)		
		CALL MARKING ROUTINE(V57)	
+39	(126+37)		
		COPY LM TPI TIGN	
+47	(126+45)		
		TERMINATE MARKS	
+48	(126+46)		
		TPI TARGETING PROGRAM	(P34)
		(TIGN OPTION WITH LM TIGN)	
		SET MDC EVENT TIMER	
+53	(126+51)		
		SPS THRUST PROGRAM	(P40)
		TERMINATE P20 (V56)	
		AUTO MNVR TO BURN ATTITUDE	(52 DEG)
		(0,191/5,0)	
		COPY LM TPI P76 PAD	
+55	(126+53)		
		SPS THRUST SETUP	(P40)

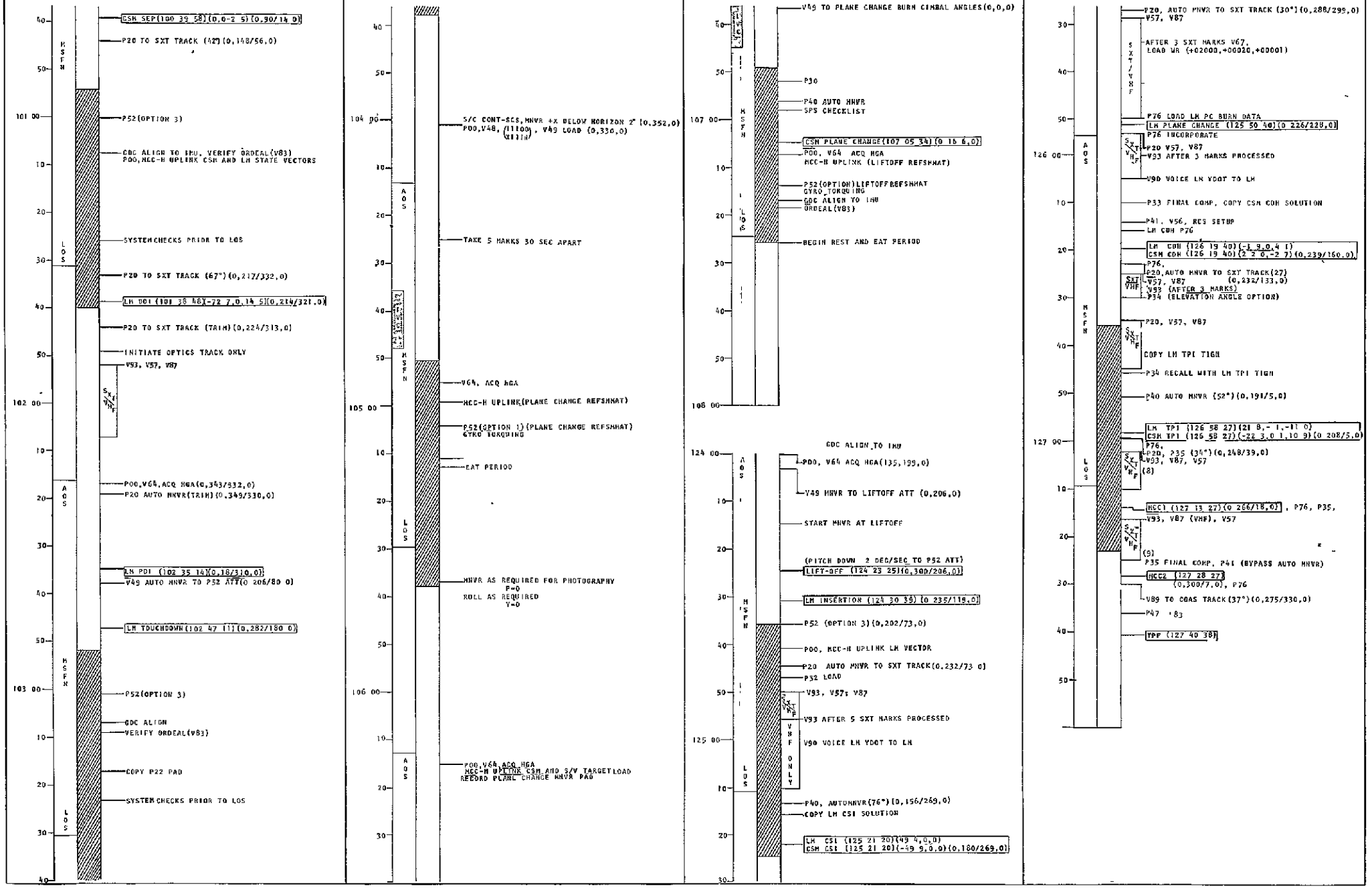
	GET	EVENT	PROG
		TARGET DV PROGRAM	(P76)
0	(126+58+27)		
		**********	
		LM TPI(21.8,-.1,-11.0)	
		**********	
		**********	
		CSM TPI (-22.3,0.1,10.9)	
		(0, 208/5, 0)	
		**********	
		TARGET DV PROGRAM	(P76)
		(ADD 12 SECONDS)	
	(126+59)		
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK (34 DEG)	
		(0, 248/39, 0)	
		MCC TARGETING PROGRAM	(P35)
+4	(127+02)		
		REINITIALIZE W MATRIX (V93)	
		CALL MARKING ROUTINE(V57)	
		SET VHF RANGE FLAG(V87)	
	(127+06)		
		LOS	
+12	(127+10)		
		TERMINATE MARKS	
		MCC1 TARGETING FINAL COMP	(P35)
		COPY CSM MCC1 SOLUTION	
		COPY LM MCC1 PAD	
	(127+11)		
		RCS THRUST PROGRAM	(P41)
		BYPASS BURN ATTITUDE MNVR	

GET	EVENT	PROG
+15	(127+13+27)	
	**********	
	LM MCC1	
	**********	
	**********	
	CSM MCC1 (0, 266/18, 0)	
	**********	
	(127+14)	
	TARGET DV PROGRAM	(P76)
	MCC2 TARGETING PROGRAM	(P35)(P20)
	POSSIBLE AUTO MNVR TO SXT TRACK (TRIM)	
+18	(127+16)	
	REINITIALIZE W MATRIX(V93)	
	CALL MARKING ROUTINE(V57)	
	SET VHF RANGE FLAG(V87)	
	(127+21)	
	SUNUP	
+27	(127+25)	
	TERMINATE MARKS	
	MCC2 TARGETING FINAL COMP	(P35)
	COPY CSM MCC2 SOLUTION	
	COPY LM MCC2 PAD	
+28	(127+26)	
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
+30	(127+28+27)	
	**********	
	LM MCC2	
	**********	
	**********	
	CSM MCC2 (0, 300/7, 0)	
	**********	
	TARGET DV PROGRAM	(P76)
+32	(127+30)	
	AUTO MNVR TO COAS TRACK(V89)	(P00)
	(37 DEG) (0,275/330,0)	
+38	(127+36)	
	THRUST MONITORING PROGRAM	(P47)
	(KEY V83 AND MONITOR LM BRAKING)	

```
**************************************
*                                    *
*    BRAKING GATES AND RET ANG,S     *
*                                    *
* 30FPS AT 6000FT.(1.00NM)-.13 DEG   *
* 20FPS AT 3000FT.( .50NM)-.26 DEG   *
* 10FPS AT 1500FT.( .25NM)-.54 DEG   *
*  5FPS AT  500FT.( .08NM)-1.6 DEG   *
*           300FT.( .05NM)-2.7 DEG   *
*           200FT.( .03NM)-4.0 DEG   *
*           100FT.( .02NM)-8.5 DEG   *
*                                    *
**************************************
```

(127+40+38)		
	**********	
	TPF	
	**********	

MISSION G SUMMARY TIMELINE



FOLDOUT FRAME 1

FOLDOUT FRAME 2

FOLDOUT FRAME

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 G Mission.

6.1 Procedures Ground Rules

6.1.1 The CSM will be targeted for the same TIGN as the LM for the CSI, CDH, and 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 are 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), CSI (23 Sec), and TPI (12 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 after LM Insertion.

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 and P33, 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 G1 onboard checklist should closely resemble the F onboard checklist.

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 G 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-1 OFF,2 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 MDC(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-ACT
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
CONT SPEED-LO
OPTICS MODE-CMC
ZERO OPTICS-ZERO
RNDZ XPONDER-OFF
CONT COUPLING-RESOLVED
SCT TRUN-SLAVE TO SXT
CONDITION LAMPS-ON
UP TLM(LEB)-ACCEPT
C/W-NORMAL
C/W-CSM
C/W-POWER
HIGH GAIN ANT TRACK-AUTO
HIGH GAIN ANT BEAM-WIDE
HIGH GAIN ANT PWR-ON(UP)
HIGH GAIN ANT SERVO-PRIM

MISSION G DETAILED PROCEDURES

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


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

      (99+10)
              **MCC-H UPLINK 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

      (99+18)
                      BMAG MODE(3)-ATT1/RATE2
                      RATE - LOW
                      ATT DB - MIN
                      SC CONT - SCS
                      LM RCS COLD FIRE CHECKS
      (99+20)
                      AUTO RCS SEL-A/C,
                         B/D ROLL-OFF
                      RATE - HIGH
                      ATT DB - MAX
                      LM RCS HOT FIRE CHECKS
                      AUTO RCS SEL-A/C,
                         B/D ROLL-MNA
      (99+25)
                      VERIFY AUTO RCS SEL
                         B3(+YAW-X)-OFF
                         C4(-PITCH-X)-OFF
                         FOR LM RR SELF TEST
                      VERIFY RNDZ XPNDR-HTR
      (99+27)
              **LOAD DAP**
                      KEY V48E
           F 04 46 (DAP CONFIGURATION)
                      LOAD
                           21111
                           X1111
                      PRO
           F 06 47 (CSM AND LM WT)
                      LOAD
                           +36427
                           +13657
                      PRO
           F 06 48 (SPS GMBL TRIM)
                      LOAD
                           -00089
                           +00032
                      PRO
                      KEY V46E
                      KEY V62E
                      BMAG MODE(3)-RATE 2
                      SC CONT - CMC
                      CMC MODE - AUTO

                      SET MDC ET COUNTING DOWN TO
```

SEPARATION TIGN
(100+39+58)

(99+32)

LOSS OF SIGNAL
MANEUVER TO UNDOCKING ATTITUDE

(INERTIAL SEP ATT EXCEPT 14
DEG YAW)

KEY V49E
F 06 22 (COMMANDED R,P,Y)
LOAD (0, 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)
(0, 244/14, 14)
KEY ENTER

(99+35)

CONFIGURE CAMERA
CM/SEG/18/CEX-BRKT(RH WIN)
MIR(F11,250,INFINITY)6FPS,
15 MIN

(99+42)

SUNUP

(99+51)

CMC MODE-FREE(AS REQ FOR AGS
CALIB)
CMC MODE-AUTO(AFTER 32 SEC)

VERIFY MAX DB FOR AGS CALIB
PERFORM SYSTEMS CHECK AND
SWITCH VERIFICATION

WAIT FOR LM TO COMPUTE AGS
ALIGN AND GIVE GO AHEAD, THEN
YAW 14 DEG LEFT AFTER
LM AGS CALIBRATION
(0,313/14,0)

(99+57)

MOVE TO LEB

RNDZ XPNDR ACTIVATION
AND SELF TEST

CB RNDZ XPNDR FLT BUS-CLOSE
RNDZ XPNDR-HTR FOR (1 MIN
SELF TEST)
RNDZ XPONDER PWR-ON
SYS TEST (LH)-XPONDER
SYS TEST(RH)-A(RRT XMTR OUT
PWR)
RNDZ XPNDR TEST-TEST (HOLD)
SYS TEST IND-GREATER THAN 1 VD
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

(100+10)

GDC ALIGN TO IMU

KEY V16N20E
16 20 (R,P,Y)
FDAI SW2-INERTIAL
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
FDAI SW2-ORB RATE

(100+11)

ORDEAL VERIFICATION

KEY V82E
F 04 12 (VEHICLE OPTION)
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

(100+13)

S/C CONT-SCS
BMAG MODE(3)-ATT1/RATE2

LOAD DAP

KEY V48E
F 04 46 (DAP CONFIGURATION)
LOAD
11102
XIIII
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-HIGH
ROT CONTR PWR DIRECT(BCTH)-
MNA,MNB
RHC-ARMED
THC-ARMED
CB DOCK PROBE(2)-CLOSED
EVENT TMR RESET-DOWN
EVENT TMR START(ON CDR SIGNAL)

-25 (100+15)

PROBE EXTD/REL-EXTD/REL (HOLD
UNTIL SEP PLUS 5 SECONDS
PROBE EXTD/REL TB(2) GRAY TO
8P TO GRAY
MONITOR LM UNDOCKING/MAINTAIN
UNDOCKING ATTITUDE
(0,13/14,0)
PROBE EXTD/REL-RETR
DV CG-CSM
AUTO RCS SELECT
-B3(+YAW-X)-MNA
-C4(-PITCH-X)-MNA
ROT CONT PWR DIR(BOTH)-OFF
CB DOCK PROBE(2)-OPEN

```
**************************************************
*                PROCEDURES FOR                  *
*          UNDOCKING THRU SEPARATION             * -5
**************************************************


          **CSM STATION KEEPING**

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


(100+19)
          **ACQUIRE HGA**
               KEY V64E
     F 06 51   (RHO,GAMMA,BLANK)
               SLEW HI GAIN ANT
               PRO                                -3
               ACQUISITION OF SIGNAL
               ACQUIRE HGA

               ACTIVATE COLOR TV
               TAKE PHOTOS
               INSPECT LM DURING LM 360 DEG
                YAW
(100+32)
               EMS FUNCTION-DV SET
               SET DV IND TO +102.5
(100+34)
               BMAG MODE(3)-RATE 2
               S/C CONT-CMC
               CMC MODE-AUTO
```

```
               THC-LOCKED
               RHC-LOCKED
(100+35)
P30            KEY V37E30E
     F 06 33   (GET OF SEP)
               LOAD GET OF SEPARATION
                  (100+39+58)
               PRO
     F 06 81   (VG-LV)
               LOAD (0,0,-2.5)
               PRO
     F 06 42   (HA,HP,VG)
               VERIFY VG=2.5
               PRO
     F 16 45   (MKS,TFI,MGA)
               SET MDC ET TO TFI,COUNTING
                  DOWN
               CONFIRM MGA LESS THAN 45 DEG
               PRO
     F 37 88

(100+37)
          **RCS SEPARATION BURN SETUP**

P41            KEY 41E
     F 50 18   (COMMANDED R,P,Y)
               PRO
       06 18   (COMMANDED R,P,Y)
               MONITOR ATT TRIM
     F 50 18(COMMANDED R,P,Y)
               RHC-ARMED
               ALIGN S/C IN ROLL
               PRO
       06 18   (COMMANDED R,P,Y)
               MONITOR ATT TRIM
     F 50 18   (COMMANDED R,P,Y)
```

KEY ENTER

06 85 (VG=BODY)
MONITOR COMP ACTV LT
BMAG MODE(3)=ATT 1/RATE 2
RATE=LOW
EMS FUNCTION=DV

-00+40

MONITOR COMP ACTV LT=OUT

+00+35

DSKY BLANKS

+00+30

16 85 (VG=BODY) (AVG G ON)
COMP ACTV LT=2 SEC FLASH
EMS MODE=NORMAL

+00+25

CK VG FOR HI PIPA BIAS
(LESS THAN 2.0 FPS PER 5
SEC)
THC=ARMED

)+00 (100+39+58)

F 16 85 (VG=BODY)
SET MDC ET COUNTING UP
FROM SEPARATION
INCREASE VG=BODY FROM
(+2.5,0,0) TO (+5.0,0,0)
BY THRUSTING AFT

****

CSM PERFORMS SEPARATION BURN
(0,0,-2.5)
(0,90/14,0)

****

WHEN BURN COMPLETE, VOICE
CONFIRMATION TO LM

EMS MODE=STBY
RECORD DV IND
EMS FUNCTION=OFF
RHC=LOCKED
THC=LOCKED
BMAG MODE(3)=RATE2
AUTO RCS SEL A/C ROLL(4)=OFF
PRO

F 37 BB

MISSION G DETAILED PROCEDURES

```
*************************************************
*                PROCEDURES FOR                 *
*           SEPARATION THRU TOUCHDOWN           *
*************************************************

(100+44)
        **MANEUVER TO SXT TRACK ATTITUDE**

P20             KEY 20E
     F 50 18    (COMMANDED R,P,Y)
                PRO
       06 18    (COMMANDED R,P,Y)
                MONITOR AUTO MANEUVER
     F 50 18    (COMMANDED R,P,Y)
                   (0, 148/56, 0)
                KEY ENTER

                PERFORM REND? XPONDER CHECKS

                VHF ANT-RT
                EMS FUNCTION-VHF RNG
                EMS MODE-VHF RNG
                VHF A - OFF
                VHF B - DUPLEX
                VHF RCV ONLY-OFF
                VHF RANGING-RNG
                VHF RNG-RESET
                MONITOR EMS FOR RANGE
                KEY V83E
     F 16 54    (R,R DOT,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
(100+52)
                COPY DOI P76 PAD
                COPY NO PDI 1+12 P76 PAD
                COPY CSM RESCUE PAD
(100+54)
                SUNDOWN

(101+00)
        **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)
                OPTICS MODE-MANUAL
                OMC-MANEUVER SCT TO AOQ
                   TWO SUITABLE STARS
                PRO
     F 01 70    (STAR CODE)
                CHECK FIRST STAR CODE
                ZERO OPTICS-ZERO(15SEC)
                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 88   (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 88   (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 TORG ANGLES)
          COPY DATA ON CHECKLIST
          MOVE TO CMD SEAT

          CMC MODE-FREE
```

```
          PRO
F 50 25   (00014, PERFORM FINE ALIGN)
          PRO
F 50 25   (00015,PERFORM STAR AOG)
          PRO
F 01 70   (STAR CODE)
          LOAD THIRD STAR CODE
          CMC MODE-AUTO

          MOVE TO LEB

          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
             (101+38+48)

(101+08)

          MOVE TO CMD SEAT

       **ALIGN GDC TO IMU**

          KEY V16N20E
 16 20    (R,P,Y)
          FDAI SW2-INERTIAL
          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-GUC
                DEPRESS GUC ALIGN PB
                ATT SET-IMU
                FDAI SW2-ORB RATE

          **ORDEAL VERIFICATION**

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

(101+10)
          **MCC-H UPLINK(CSM AND LM VECTOR)**

                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 ACT LT-OFF

                SET MDC ET COUNTING DOWN
                   TO LM DOI TIGN

(101+30)
                LOSS OF SIGNAL
(101+31)
                VHF AM A-SIMPLEX
                VHF AM B-OFF
                VHF RCV ONLY-B DATA
                TAPE RCDR FWD-FWD
```

```
                PCM BIT RATE-LOW
(101+33)
          **MANEUVER TO SXT TRACK ATTITUDE**

P20             KEY V37E20E
          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, 217/332, 0)
                KEY ENTER


                ZERO OPTICS-OFF
                OPTICS MODE-CMC

0+00  (101+38+48)
          ************************************
                LM DOI BURN
                   (-72.7,0,14.5)
          ************************************

                MOVE TO CMD SEAT
                CONFIRM LM DOI BURN COMPLETE

(101+40)
                SUNUP

(101+42)
                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

P76             KEY V37E76E
     F 06 84    (DV,S OF LM DOI BURN)
                   LOAD (-72.7,0,14.5)
                PRO
     F 06 33    (GETI OF DOI)
                LOAD LM DOI TIGN + 20 SEC
                   (101+39+08)
                PRO
     F 37 BB

                KEY V82E
     F 04 06    (VEHICLE OPTION CODES)
                   LOAD R2=00002
                   PRO
     F 16 44    (HA,HP,TFF)
                VERIFY (60X9)
                PRO
     F 37 BB

(101+44)
        **MANEUVER TO TRACK ATTITUDE**

P20             KEY 20E
                MOVE TO LEB


(101+49)
                ZERO OPTICS-ZERO(15 SEC)
                ZERO OPTICS-OFF

                START CAMERAS REMOTE OPERATION
                INITIATE LM OPTICS TRACK
```

```
                SET LEB ET COUNTING DOWN
                   TO LM PDI TIGN
(101+52)
                KEY V93E
                KEY V57E
     F 51 BB    (PLEASE MARK)
                KEY V87E
                OPTICS MODE MANUAL
                OMC-CENTER LM IN SXT
                TAKE 15 MARKS IN NEXT
                   FIFTEEN MINUTES
                PRO/PROCESS LAST MARK
(102+07)
                CEASE TRACKING
                ZERO OPTICS-ZERO
                OPTICS MODE-CMC
                MOVE TO CMD SEAT

(102+17)
                ACQUISITION OF SIGNAL
P00             KEY V37E00E
                KEY V64E
     F 06 51    (RHO,GAMMA,BLANK)
                SLEW HI GAIN ANT
                PRO


(102+19)
        **MANEUVER TO TRACK ATTITUDE**

P20             KEY V37E20E
     F 50 18    (COMMANDED R,P,Y)
                PRO
       06 18    (COMMANDED R,P,Y)
                MOVE TO LEB DURING AUTO
```

```
                TRIM
    F 50 18 (COMMANDED R,P,Y)
                (0,352/330,0)
            KEY ENTER
            ZERO OPTICS-OFF
            INITIATE TRACK ONLY
(102+25)
            OBTAIN GO/NO GO FOR PDI ABORT
(102+32)
P00         KEY V37E00E
            KEY V48E
    F 04 46 (DAP CONFIGURATION)
            LOAD
                11101
                X1111
            PRO
    F 06 47 (CSM AND LM WT)
            PRO
    F 06 48 (SPS GMBL TRIM)
            PRO
            KEY V49E
    F 06 22 (COMMANDED R,P,Y)
            LOAD (0,140,0)
            PRO
    F 50 18 (COMMANDED R,P,Y)
            OPTICS MODE-MANUAL
            OHC-CENTER LM IN SXT

(102+35+14)
        ************************************
         LM PDI
        ************************************

(102+36)
            PRO
       06 18 (COMMANDED R,P,Y)
```

MISSION G DETAILED PROCEDURES

```
                (PITCH DOWN .2 DEG/SEC TO
                P52 ATT)
(102+46)
            MSFN ENABLES S-BAND RELAY

(102+47+11)
        ************************************
         LM TOUCHDOWN
        ************************************

            MAN ATT(PITCH)-ACCEL CMD
            ZERO OPTICS-ZERO
(102+53)
            SUNDOWN
            KEY V46E(SET LUNAR SURFACE
              FLAG)
(102+55)
            VHF RANGING - OFF
            VHF T/R - RECEIVE

(102+57)    RR XPNDR-OFF
            KEY V46E
            MANUAL ATT(PITCH) - RATE CMD
              (0, 206/80, 0)
```

```
*****************************************************
*                                                   *
*              PROCEDURES FOR TOUCHDOWN             *
*                TO CSM PLANE CHANGE                *
*                                                   *
*****************************************************
(103+01)
        **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)
              ZERO OPTICS-OFF
              OPTICS MODE-MAN
              OMC-MANEUVER SCT TO ACQ
                 TWO SUITABLE STARS
              PRO
     F 01 70  (STAR CODE)
              CHECK FIRST STAR CODE
              OPTICS MODE-CMC
              PRO
       06 92  (SHAFT,TRUN,BLANK)
              MONITOR OPT DRIVE TO STAR ONE
              IDENTIFY STAR ONE
              OPTICS MODE-MAN
     F 51 88  (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 88  (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

              MOVE TO CMD SEAT
              CMC MODE-FREE
              PRO
     F 50 25  (00014, PERFORM FINE ALIGN)
              PRO
     F 50 25  (00015,PERFORM STAR AQQ)
              PRO
     F 01 70  (STAR CODE)
              LOAD THIRD STAR CODE
              CMC MODE-AUTO

              MOVE TO LEB
```

```
            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 V37E 00E

(103+07)
            MOVE TO CMD SEAT

        **ALIGN GDC TO IMU**

            KEY V16N20E
      16 20 (R,P,Y)
            FDAI SW2-INERTIAL
            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
            FDAI SW2-ORB RATE
(103+09)
        **ORDEAL VERIFICATION**

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

```
            PRO

(103+17)
            COPY P22 PAD AT GET 104+25
(103+29)
            LOSS OF SIGNAL
(103+39)
            SUNUP
(104+01)
            SC CONT - SCS
            MNVR +X TO 2 DEG BELOW HORIZON
            KEY V48E
      F 04 06 (DAP CONFIGURATION)
            LOAD
                 11100
                 01111
            PRO
      F 06 47 (CSM AND LM WT)
            PRO
      F 06 48 (SPS GMBL TRIM)
            PRO
            KEY V49E
      F 06 22 (COMMANDED R,P,Y)
            LOAD (0,330,0)
            PRO
      F 50 18 (COMMANDED R,P,Y)
            BMAG MODE (3)-RATE 2
            SC CONTROL-CMC
(104+07)
            PRO
        06 18 (COMMANDED R,P,Y)
            AFTER MANEUVER STARTED
            MAN ATT (PITCH)-ACCEL CMD


            MOVE TO LEB
```

**ORBIT NAVIGATION PROGRAM **

P22
KEY V37E22E
F 06 45 (BLANK, BLANK, MGA)
PRO
F 05 70 (BLANK, LMK CODE, BLANK)
KEY V22E10000E
F 06 89 (LAT, LONG/2, ALT)
LOAD (MK COORDS)
OPTICS ZERO-OFF
PRO
06 92 (SHAFT,TRUN)
OPTICS MODE-MANUAL
F 51 88 PLEASE MARK
TAKE 5 MARKS 30 SEC APART
PRO
F 05 71 (BLANK,LMK CODE,BLANK)
PRO
F 06 89 (LAT,LONG/2,ALT)
PRO
F 06 49 (DELTA R,DELTA V, BLANK)
HOLD FOR 30 SEC
PRO
F 06 89 (LAT,LONG/2,ALT)
KEY V34E
F 37 88
P00
KEY 00E
(104+15)
AOS
(104+43)
KEY V46E
MANUAL ATT PITCH-RATE CMD
KEY V48E
F 04 06 (DAP CONFIGURATION)
LOAD
11101
01111

MISSION G DETAILED PROCEDURES

PRO
F 06 47 (CSM AND LM WT)
PRO
F 06 48 (SPS GMBL TRIM)
PRO
KEY V49E
F 06 22 (COMMANDED R,P,Y)
LOAD (270,101,45)
F 50 18 (COMMANDED R,P,Y)
BMAG MODE (3)-RATE 2
SC CONTROL-CMC
PRO
06 18 (COMMANDED R,P,Y)
MONITOR AUTO MANEUVER
F 50 18 (COMMANDED R,P,Y)
(270,101,45)
KEY ENTER
(104+51)
SUNDOWN
(104+55)
KEY V64E
F 06 51 (RHO,GAMMA,BLANK)
SLEW HIGH GAIN ANT.
PRO
ACQUIRE HGA
(104+57)
FDAI 2-INERTIAL
(104+59)

MCC-H UPLINK(PLANE CHANGE
REFSMMAT)

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

```
                UP TLM(CM)(MDC)-BLOCK
(105+04)

                CMC MODE -FREE
             **REALIGN IMU TO PLANE CHANGE
               REFSMMAT,GYRO TORQUING**
P52             KEY V37E52E
     F 04 06 (00001,00002,BLANK)
                PRO
     F 06 22 (R,P,Y)
                LOAD N22
                PRO
     F 50 25 (00013 GYRO TORQUE)
                KEY ENTER
       16 20 (R,P,Y)
                WHEN TORQUE COMPLETE
     F 50 25 (00014 ALIGNMENT CHECK)
                KEY ENTER
     F 37 BB
(105+08)
P00             KEY 00E
                CMC MODE-HOLD
(105+11)
           **ALIGN GDC TO IMU**

                KEY V16N20E
         16 20 (R,P,Y)
                FDAI SW2-INERTIAL
                ATT SET THUMBWHEELS TO N20
                FDAI SELECT-1
                NULL ATT ERROR NEEDLES
                   ON FDAI 1 WITH ATT
                   SET THUMBWHFELS
                FDAI SELECT-1/2
                ATT SET-GDC
                DEPRESS GDC ALIGN PB
```

```
                ATT SET-IMU
(105+12)
                INITIATE EAT PERIOD
(105+27)
                LOSS OF SIGNAL
(105+37)
                SUNUP
(106+13)
                ACQUISITION OF SIGNAL
(106+15)
                KEY V64E
     F 06 51 (RHO,GAMMA,BLANK)
                SET ANTENNA TO THESE ANGLES
                PRO
                ACQUIRE HGA

          **MCC-H UPLINK CSM STATE VECTOR**
            AND PLANE CHANGE TARGET LOAD

                UP TLM(CM)(MDC)-ACCEPT
                MONITOR UPLINK ACT LT-ON
                MONITOR GND UPLINK
                MONITOR UPLINK ACT LT-OFF
                UP TLM(CM)(MDC)-BLOCK
                RECORD MNVR PAD
(106+37)
                KEY V49E
     F 06 22 (COMMANDED R,P,Y)
                LOAD (0,0,0)
                PRO
     F 50 18 (COMMANDED R,P,Y)
                BMAG MODE (3)-RATE 2
                SC CONTROL-CMC
                 CMC MODE-AUTO
                PRO
```

```
      06 18 (COMMANDED R,P,Y)
            MONITOR AUTO MANEUVER
   F 50 18 (COMMANDED R,P,Y)
               (0,0,0)
            KEY ENTER

            OPTICS MODE -CMC
            ZERO OPTICS - OFF
            KEY V41E N91E
   F 21 92 SHAFT,TRUN
            LOAD N92 WITH PAD SHAFT AND
               TRUNION
      41    OPTICS DRIVE
(106+50)
            SUNDOWN
            OPTICS MODE=MANUAL
               VERIFY STAR IN SXT FIELD
               OF VIEW
            ZERO OPTICS - ZERO
            OPTICS MODE-CMC
(106+52)

P30         KEY V37E30E
   F 06 33 (GETI OF CSM PLANE CHANGE)
            LOAD GET OF PLANE CHANGE
               (107+05+34)
            PRO
   F 06 81 (VG - LV)
            LOAD PAD PLANE CHANGE DV
            PRO
   F 06 42 (HA,HP,VG)
            VERIFY VG= PAD DVR
            PRO
   F 16 45 (MKS,TFI,MGA)
            SET MDC ET TO TFI,COUNTING
               DOWN
            CONFIRM MGA LESS THAN 45 DEG
            PRO
   F 37 BB
(106+56)
P40         KEY 40E
   F 50 18 (COMMANDED R,P,Y)
            PRO
      06 18 (COMMANDED R,P,Y)
            MONITOR ATTITUDE TRIM
   F 50 18 (COMMANDED R,P,Y)

(106+57)

      **SETUP SPS PLANE CHANGE**

            MN BUS TIE (2)-ON(UP)
            SPS HE VLV TB (BOTH)-BP
            SPS HE VLV (BOTH)-AUTO
            NONESS BUS-MNA
            RHC-ARMED
            BMAG MODE(3)-ATT1/RATE2
            PERFORM MTVC CHECK
            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-VERIFY NO MTVC
            GMBL MTRS PITCH 2 STRT-ON
            GMBL MTRS YAW   2 STRT-ON
            SET SPS GIMBALS TW(2)-TRIM
            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)
-2+00
                FDAI SCALE-5/5
                VERIFY SPS TH LT-OFF
                EMS MODE-STBY
                EMS FUNCTION-DV SET
                LOAD PLANE CHANGE DV
                EMS FUNCTION-DV
                THC-ARMED
                RHC-ARMED
                DV THRUST(BOTH)-NORMAL
-00+35
                DSKY BLANKS
-00+30
          06 40 (TFI,VG,DVM)
                EMS MODE-NORMAL
-00+25
                CK DVM FOR HI PIPA BIAS
                   (LESS THAN 2 FPS/5 SEC)
-00+15
                PERFORM ULLAGE
-00+05
        F 99 40 (REQUEST FOR ENGINE ENABLE)
```

```
                PRO
          06 40 (TFI,VG,DVM)


(107+05,+34)
                ********************************
                   CSM PERFORMS PLANE CHANGE
                      BURN
                ********************************
                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
```

```
                AUTO RCS SEL, A/C ROLL(4)-OFF
                THC-LOCKED
                RHC-LOCKED
                BMAG MODE(3)-RATE2
                PRO
      F 37 BB
P00             KEY 00E
 (107+08)
                KEY V64E
      F 06 51   (RHO GAMMA,BLANK)
                SET ANTENNA TO THESE ANGLES
                PRO
                ACQUIRE HGA

          **MCC-H UPLINK LIFTOFF REFSMMAT**

                UP TLM(CM)(MDC)-ACCEPT
                MONITOR UPLINK ACT LT-ON
                MONITOR GND UPLINK
                MONITOR UPLINK ACT LT-OFF
                UP TLM(CM)(MDC)-BLOCK
 (107+10)
                KEY V49E
      F 06 22   (COMMANDED R,P,Y)
                LOAD (0,45,0)
                PRO
      F 50 18   (COMMANDED R,P,Y)
                BMAG MODE(3)-RATE 2
                PRO
        06 18   (COMMANDED R,P,Y)
                AFTER MNVR COMPLETE
                CMC MODE - FREE
 (107+14)
           **REALIGN IMU TO LANDING SITE
                REFSMMAT,GYRO TORQUING**
P52             KEY V37E52E
```

```
      F 04 06   (00001,00001,BLANK)
                PRO
      F 06 22   (R,P,Y)
                LOAD N22
                PRO
      F 50 25   (00013 GYRO TORQUE)
                KEY ENTER
        16 20   (R,P,Y)
                WHEN TORQUE COMPLETE
      F 50 25   (00014 ALIGNMENT CHECK)
                KEY ENTER
      F 37 BB
 (107+17)
P00             KEY 00E
                CMC MODE - HOLD
 (107+18)
          **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
                FDAI SW2-ORB RATE
 (107+19)
         **ORDEAL VERIFICATION**

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

```
                PRO
(107+25)
                LOSS OF SIGNAL
(107+26)
                MNVR TO ATTITUDE FOR REST
                   PERIOD
                KEY V49E
      F 06 22   (COMMANDED R,P,Y)
                LOAD (135,97/199,0)
                PRO
      F 50 18   (COMMANDED R,P,Y)
                BMAG MODE (3)=RATE 2
                SC CONTROL=CMC
                CMC MODE=AUTO
                PRO
        06 18   (COMMANDED R,P,Y)
                MONITOR AUTO MANEUVER
      F 50 18   (COMMANDED R,P,Y)
                (82,128/218,0)
                KEY ENTER
(107+35)
                BEGIN REST AND EAT PERIOD
```

```
**************************************************
*                                                *
*                PROCEDURES THRU                 *
*                  INSERTION                     *
*                                                *
**************************************************

(124+00)
P00             KEY V37E00E
                KEY V64E
     F 06 51    (RHO GAMMA,BLANK)
                SLEW HI GAIN ANT
                PRO
(124+02)
                KEY V48E
     F 04 46    (DAP CONFIGURATION)
                LOAD
                     11101
                     01111
                PRO
     F 06 47    (CSM AND LM WT)
                PRO
     F 06 48    (SPS GMBL TRIM)
                PRO

(124+03)
                KEY V49E
     F 06 22    (COMMANDED R,P,Y)
                LOAD (0,206,0)
                PRO
     F 50 18    (COMMANDED R,P,Y)
                BMAG MODE (3)-RATE 2
                SC CONTROL-CMC
                CMC MODE-AUTO
                PRO
       06 18    (COMMANDED R,P,Y)
                MONITOR AUTO MANEUVER
     F 50 18    (COMMANDED R,P,Y)
                   (0,206,0)
                KEY ENTER
(124+15)
                KEY V49E
     F 06 22    (COMMANDED R,P,Y)
                LOAD (0,73,0)
                PRO
     F 50 18    (COMMANDED R,P,Y)

                MOVE TO LEB
                ZERO OPTICS-ZERO(15 SEC)
                ZERO OPTICS-OFF
                OPTICS MODE-MANUAL
                OMC-CENTER LM IN SXT
(124+23+25)
                PRO
       06 18    (COMMANDED R,P,Y)
                   (PITCH DOWN AT 2 DEG/SEC
                   TO P52 ATT)
(124+23+25)
          ************************************
           LM LIFT-OFF
          ************************************
(124+30+39)

          ************************************
               LM COMPLETES INSERTION BURN
          ************************************

               CONFIRM LM BURN COMPLETE

(124+34)
     F 50 18    (COMMANDED R,P,Y)
                   (0,202/73,0)
```

```
          KEY ENTER
          ZERO OPTICS=ZERO
          OPTICS MODE=CMC
          KEY V48E
F 04 46   (DAP CONFIGURATION)
          LOAD
               11102
               X1111
          PRO
F 06 47   (CSM AND LM WT)
          PRO
F 06 48   (SPS GMBL TRIM)
          PRO
```

```
**************************************************
*                PROCEDURES FOR                  *
*             INSERTION THRU CST                 *
**************************************************

(124+35)
              SUNDOWN
              SET LEB ET COUNTING DOWN TO
                 CSI USING LM CSI TIGN
                 AND MISSION TIMER

        **REALIGN IMU TO REFSMMAT**
P52           KEY V37E52E

              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)
              OPTICS MODE-MANUAL
              OMC-MANEUVER SCT TO ACQ
                 TWO SUITABLE STARS
              PRO
      F 01 70 (STAR CODE)
              CHECK FIRST STAR CODE
              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

              MOVE TO CMD SEAT

              CMC MODE-FREE
              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
             CMC MODE-AUTO

             MOVE TO LEB

             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
(124+40)
P00          KEY V37E00E
             KEY V64E
     F 06 51 (RHO GAMMA,BLANK)
             SLEW HI GAIN ANT
             PRO

        **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
(124+44)
        **MANEUVER TO TRACK ATTITUDE**

P20          KEY V37E20E
     F 50 18 (COMMANDED R,P,Y)
             PRO
       06 18 (COMMANDED R,P,Y)
             MONITOR AUTO TRIM
     F 50 18 (COMMANDED R,P,Y)
                (0, 232/73, 0)
             KEY ENTER
             EMS FUNCTION-VHF RNG
             EMS MODE-VHF RNG
             VHF RNG-RESET

 (124+47)
P32          KEY V37E32E
     F 06 11 (GETI-CSI)
             LOAD LM CSI TIGN
                (125+21+20)
             PRO
     F 06 55 (N,E,CENTANG)
             VERIFY R1=+00001
             LOAD R2=+208.30
             LOAD R3=+130.00
             PRO
     F 06 37 (GETI-TPI)
             LOAD LM TPI TIGN
                (129+58+27)
             PRO
     F 16 45 (MKS,TFI-CSI,-00001)
             SET LEB ET=TFI
             KEY V32E
 (124+49)
             KEY V93E/REINITIALIZE W MATRIX
             KEY V57E
     F 51 BB (PLEASE MARK)
             KEY V87E (VHF RANGING)
             ZERO OPTICS-OFF
             OPTICS MODE-MAN
             OMC-CENTER LM IN SXT
             TAKE 5 MARKS IN NEXT 5
                MINUTES
             PRO/PROCESS LAST MARK
```

```
      F 16 45 (MKS,TFI-CSI,-00001)
              ZERO OPTICS-ZERO
              OPTICS MODE-CMC
              KEY V93E
              TAKE 5 MARKS IN 5 MINUTES

              MOVE TO COMMAND SEAT

(124+59)
              KEY V88E
              KEY V90E
      F 04 12 (VEHICLE OPTION)
              LOAD R2=00002
              PRO
      F 06 16 (TIME OF EVENT)
              LOAD LM CSI TIGN
                 (125+21+20)
              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
                 (125+21+20)
              PRO
      F 06 90 (Y,YDOT,PSI)
              COPY (-)CSM YDOT
                 ON CHECKLIST
              PRO
      F 16 45 (MKS,TFI-CSI,-00001)
              KEY V87E
              TAKE 8 MARKS IN 8 MINUTES

(125+08)
              LOSS OF SIGNAL
-12   (125+09)
              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)
              OVER WRITE N81 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 MDR ET=TFI
              PRO
      F 37 BB
-8    (125+13)
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)
                 (0, 156/269, 0)
-6    (125+15)
              COPY LM CSI PAD (P76)
```

```
**SETUP SPS CSI BACKUP**                  -2
                                                                KEY ENTER
      EMS MODE-STBY                                      06 40 (TFI,VG,DV)
      EMS FUNCTION-DV SET                                      DV THRUST A-NORMAL
      LOAD CSI BURN VC                                         THC-ARMED
      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                           0+00  (125+21+20)

      ALIGN S/C TO 0 DEG ROLL                          ***********************************
      PRO                                                      LM CSI BURN
  06 18 (COMMANDED R,P,Y)                                         (49.4,0,0)
      MONITOR ATT TRIM                                 ***********************************
F 50 18 (COMMANDED R,P,Y)
                                          ***********************************************
     **GDC ALIGN**                        *             ***********************         *
                                          *             IF LM CANNOT PERFORM THE BURN   *
      ATT SET THUMBWHEELS TO N18          *             ***********************         *
      FDAI SELECT-1                       *                  MN BUS TIE (2)-ON(UP)      *
      NULL ATT ERROR NEEDLES              *                  NONESS BUS-MNA             *
         ON FDAI 1 WITH ATT               *                  SPS HE VLV TB (BOTH)-BP    *
         SET THUMBWHEELS                  *                  SPS HE VLV (BOTH)-AUTO     *
      FDAI SELECT-1/2                                        VERIFY SPS TH LT-OFF
      ATT SET-GDC                         *                                             *
      GDC ALIGN PB-PUSH                   *-00+15            THC-APPLY ULLAGE           *
      ATT SET-IMU                         *                  GMBL MTRS(4)-ON(SEQUENTIALLY)*
                                          *                  TVC SERVO PWR 1-AC1/MNA    *
      KEY ENTER                           *                  TVC SERVO PWR 2-AC2/MNB    *
                                          *                  PRO                        *
F 50 25 (00204, GMBL DRIVE TEST)          *                                             *
                                          *             ***********************         *
```

```
*                    CSM BACKUP CSI BURN                  *
                        (-49.9,0,0)
                        (0,180/269,0)
*              ******************************             *
*                                                         *
*+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                           *
*                    TVC SERVO PWR(BOTH)-OFF              *
*                    EMS MODE-STBY                        *
*                    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 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
                     ROT CONT PWR DIRECT (BOTH)-OFF
                     BMAG MODE(3)-RATE 2
                     TVC GIMBAL DRIVE(BOTH)-1
      P76            KEY V37E76E
            F 06 84 (DV,S OF LM CSI BURN)
                     LOAD (50.1,0,0.1)
                     PRO
            F 06 33 (GETI OF CSI)
                     LOAD LM CSI TIGN + 23 SEC
                        (125+21+43)
                     PRO
            F 37 BB
                     KEY V82E
            F 04 06 (VEHICLE OPTION CODES)
                        LOAD R2=00002
                        PRO
            F 16 44 (HA,HP,TFF)
                     VERIFY (45X45)
                     PRO
            F 37 BB
      (125+22)
                     SUNUP
```

MISSION G DETAILED PROCEDURES

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

      (125+27)
              **MANEUVER TO TRACK ATTITUDE**

      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)
                         (0,228/299,0)
                      KEY ENTER

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

                      ZERO OPTICS-OFF

-51   (125+29)
                      KEY V57E
           F 51 BB    (PLEASE MARK)
                      KEY V87E
                      OPTICS MODE-MAN
                      OMC-CENTER LM IN SXT
                      MAKE 3 MARKS IN NEXT
                         3 MINUTES
      (125+32)
                      PRO/PROCESS LAST MARK
                      KEY V67E
```

```
           F 06 99    (POS ERR,VEL ERR,OPTION CODE)
                      LOAD W=
                         (+02000,+00020,00001)
                      PRO
                      KEY V57E
           F.51 BB    (PLEASE MARK)
                      MAKE 11 MARKS IN NEXT
                         11 MINUTES
      (125+43)
                      PRO/PROCESS LAST MARK
                      OPTICS MODE-CMC

                      COPY LM PC TIGN
                      KEY V88E

                      KEY V90E
           F 04 12    (VEHICLE OPTION)
                      LOAD R2=00002
                      PRO
           F 06 16    (TIME OF EVENT)
                      LOAD LM PC TIGN
                         (125+50+40)
                      PRO
           F 06 90    (Y, YDOT, PSI)
                      VOICE LM YDOT TO LM
                      PRO


                      COPY LM PC PAD
      (125+45)
                      KEY V57E
           F 51 BB    (PLEASE MARK)
                      KEY V87E
                      OPTICS MODE-MAN
                      OMC-CENTER LM IN SXT
```

```
                MAKE 5 MARKS IN NEXT
                   5 MINUTES
                PRO/PROCESS LAST MARK
                OPTICS MODE-CMC
     (125+50)

     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
                   (125+50+40)
-29  (125+50+40)
          ************************************
                LM PLANE CHANGE
          ************************************

                CONFIRM LM PC BURN

                PRO/INCORPORATE P76
          F 37 BB
-27  (125+53)
     P20        KEY20E
                KEY V57E
          F 51 BB (PLEASE MARK)
                KEY V87E (VHF RANGING)
                OPTICS MODE-MAN
                OHC-CENTER LM IN SXT
                TAKE 4 MARKS IN NEXT
                   3 MINUTES
     (125+54)
                ACQUISITION OF SIGNAL
-24  (125+56)
                KEY V93E (REINITIALIZE W MAT)
                TAKE 8 MARKS IN NEXT
                   9 MINUTES
                PRO / PROCESS LAST MARK
                ZERO OPTICS=ZERO
                OPTICS MODE=CMC
-15  (126+05)
                KEY V88E
                KEY V90E
          F 04 12 (VEHICLE OPTION)
                LOAD R2=00002
                PRO
          F 06 16 (TIME OF EVENT)
                OBTAIN LM CDH TIGN
                LOAD LM CDH TIGN
                   (126+19+40)
                PRO
          F 06 90 (Y,YDOT,PSI)
                VOICE LM YDOT TO LM
                PRO

                MOVE TO CMD SEAT
                KEY V90E
          F 04 12 (VEHICLE OPTION)
                LOAD R2=00001
                PRO
          F 06 16 (TIME OF EVENT)
                LOAD CSM CDH TIGN
                   (126+19+40)
                PRO
          F 06 90 (Y,YDOT,PSI)
                COPY (-) CSM YDOT
                   ON CHECKLIST
                PRO

-10  (126+10)
     P33        KEYV37E33E
          F 06 13 (GETI=CDH)
```

```
          LOAD LM CDH TIGN                                          ON FDAI 1 WITH ATT
             (126+19+40)                                            SET THUMBWHEELS
          PRO                                                     FDAI SELECT-1/2
    F 16 45 (MKS,TFI-CDH,-00001)                                  ATT SET-GDC
          PRO/MAKE FINAL PASS                                     DEPRESS GDC ALIGN PB
    F 06 75 (DH,DT-CDH/TPI,DT-TPI/TPI)                            ATT SET-IMU
          COPY DATA ON CHECKLIST                                  KEY RELEASE
          PRO                                       (126+16)
    F 06 81 (CDH VG-LV)                                           COPY LM CDH P76 PAD
          OVER WRITE N81 WITH                -00+35
             (-) CSM YDOT                                         DSKY BLANKS
          COPY DATA ON CHECKLIST             -00+30
          PRO                                             16 85 (VG-BODY) (AVE G ON)
    F 16 45 (MKS,TFI-CDH,MGA)                                     THC-ARMED
          SET MDC ET=TFI                                          RHC-ARMED
          PRO                                           F 16 85 (VG-BODY)
    F 37 BB                                                       MONITOR LM IGNITION
-6  (126+14)
P41       KEY 41E                                   (126+19+40)
    F 50 18 (COMMANDED R,P,Y)                                 ************************************
                                                                  LM CDH BURN
          KEY V56E                                                   (-1.9,0,4.1)
          KEY ENTER(BYPASS MNVR)
      06 85 (VG-BODY)                                         ************************************

        **SETUP RCS CDH BACKUP**                ***********************************************
                                                *                 ***************************     *
          BMAG MODE(3)-ATT1/RATE2               *                 IF LM CANNOT PERFORM THE BURN   *
          AUTO RCS SEL A/C ROLL(4)-MNA          *                 ***************************     *
      **ALIGN GDC TO IMU**                      *                 ***************************     *
                                                *                 CSM BACKUP CDH BURN             *
          KEY V16N20E                                                (2.2,0,-2.7)
      16 20 (R,P,Y)                                                 (0,239/151,0)
          ATT SET THUMBWHEELS TO N20            *                 ***************************     *
          FDAI SELECT-1                         *                     THC-NULL VGS                *
          NULL ATT ERROR NEEDLES                *                     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 (-1.9,0,4.1)
                PRO
          F 06 33 (GETI OF CDH BURN)
                LOAD LM CDH GETI
                   (126+19+40)
                PRO
          F 37 BB
```

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

+25   (126+23)

          **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)
                     (0,232/133,0)
                  KEY ENTER

     (126+24)
                  KEY V57E
          F 51 BB (PLEASE MARK)
                  KEY V87E (VHF RANGING)
                  ZERO OPTICS-OFF
                  OPTICS MODE-MAN
                  OHC-CENTER LM IN SXT
                  MAKE 4 MARKS IN NEXT
                     3 MINUTES (INCORPORATE 3)
                  OPTICS MODE-CMC
+29   (126+27)
                  KEY V93E(REINITIALIZE W MAT)
+32   (126+30)
                  PRO/PROCESS LAST MARK
     P34          KEY V37E34E
          F 06 37 (GETI-TPI)
                  LOAD TPI TIG
                     (126+56+27)
                  PRO
          F 06 55 (+00000,ELANG,CENTANG)
                  LOAD R2 = +208.30(DEG)
                  LOAD R3 = +130.00 (DEG)
                  PRO
          F 16 45 (MKS,TFI,-00001)
                  PRO
          F 06 37 (GETI-TPI)
                  COPY DATA ON CHECKLIST
+36   (126+34)
                  SUNDOWN
     P20          KEYV37E20E
                  KEY V57E
          F 51 BB (PLEASE MARK)
                  KEY V87E
                  OPTICS MODE-MANUAL
                  OHC-CENTER LM IN SXT
                  TAKE 11 MARKS IN NEXT
                     11 MINUTES
+39   (126+37)
                  COPY LM TPI TIGN ON CHECKLIST
+47   (126+45)
                  PRO/PROCESS LAST MARK
                  ZERO OPTICS-ZERO
                  OPTICS MODE CMC

                  MOVE TO CMD SEAT


              **VERIFY ORDEAL**

                  KEY V83E
          F 16 54 (R,RDOT,THETA)
                  ADJUST FDAI TO THETA
                  PRO
          F 16 45 (MKS,TFI,-00001)
```

```
+48   (126+46)
      P34          KEY V37E34E
           F 06 37 (TPI TIGN)
                   LOAD LM TPI TIGN
                      (126+58+27)
                   PRO
           F 06 55 (+00000,ELANG,CENTANG)
                   LOAD R2 = +000.00
                   PRO
           F 16 45 (MKS,TFI,-00001)
                   PRO/MAKE FINAL PASS
           F 06 55 (+00000, 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
                   COUNTING UP
                   PRO
           F 37 88


+53   (126+51)
            **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 MANEUVER
           F 50 18 (COMMANDED R,P,Y)
                      (0,191/5,0)

                   COPY LM TPI PAD(P76)

+55   (126+53)
            **SETUP SPS TPI BACKUP**

                   EMS MODE-STBY
                   EMS FUNCTION-DV SET
                   LOAD TPI 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)

              **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)
                KEY ENTER
            06 40 (TFI,VG,DV)
                DV THRUST A-NORMAL
                THC-ARMED
+59+25
                DSKY BLANKS
+59+30
            06 40 (TFI,VG,DV) (AVE G ON)
                EMS MODE-NORMAL
+59+55
          F 99 40 (TFI,VG,DV)
 0     (126+58+27)
                MONITOR LM ENGINE IGNITION

              ************************************
                LM TPI BURN
                   (21.8,-0.1,-11.0)
              ************************************

*************************************************
*             ****************************      *
*             IF LM CANNOT PERFORM THE BURN     *
*             ****************************      *
*                MN BUS TIE (2)-ON(UP)          *
*                NONESS BUS-MNA                 *
*                SPS HE VLV (BOTH)-AUTO         *
*                SPS HE VLV TB (BOTH)-RP        *
*                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          *
                   (-22.3,0.1,10.9)
                   (0,208/5,0)               *
            ******************************   *
+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      *
                MN BUS TIE (BOTH)-OFF        *
                SPS HE VLV (BOTH)-OFF        *
                NONESS BUS-OFF               *
                PRO
          F 37 88                            *
                (CONTINUE DETAILED PROCEDURES*
                   BUT DELETE P76)           *
*************************************************

                CONFIRM LM BURN COMPLETE
```

```
P76          KEY V37E76E
     F 06 84 (DV+S OF LM TPT 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
             EMS FUNCTION-VHF RNG
             EMS MODE-VHF RNG
             VHF RNG-RESET

             LOAD (21.8,-0.1,-11.0)
             PRO
     F 06 33 (GETI OF TPI BURN)
             LOAD LM GET-TPI
                +12 SECS
                (126+58+39)
             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)
                       (0,248/39,0)
                    KEY ENTER

            **TARGET CSM MCC1 BACKUP**

      P35           KEY V37E35E
           F 16 45  (MKS,TFI,-0000))
                       (TIME FROM TPI)
                    SET LEB ET TO TFI,
                       COUNTING UP
                    ZERO OPTICS-OFF
+4    (127+02)
                    KEY V93E (REINITIALIZE W MAT)
                    KEY V57E
           F 51 BB  (PLEASE MARK)
                    KEY V87E (VHF RANGING)
                    OPTICS MODE-MAN
                    CMC-CENTER LM IN SXT
                    MAKE 8 MARKS IN NEXT
                       8 MINUTES
      (127+06)
                       LOSS OF SIGNAL
+12   (127+10)
                       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)
                       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)
      (127+11)
      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   (127+13+27)
      F 16 85 (VG-BODY)
         ************************************
              LM PERFORMS MCC1 BURN
         ************************************

         ************************************
              CSM MCC1 BACKUP BURN
                 (0,266/18,0)
         ************************************

              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
                 (127+13+27)
              PRO
      F 37 BB
              MOVE TO LEH

         **TARGET CSM MCC2 BACKUP**

   P35        KEY 35E
      F 16 45 (MKS,TFI,-00001)
              ZERO OPTICS-OFF
              OPTICS MODE-CMC

+18   (127+16)
```

```
              KEY V93E (REINITIALIZE W MAT)
              KEY V57E
      F 51 BB (PLEASE MARK)
              KEY V87E(VHF RANGING)
              OMC-CENTER LM IN SXT
              OPTICS MODE-MAN
              MAKE 9 MARKS IN NEXT
                 9 MINUTES
      (127+21)
              SUNUP
+27   (127+25)
              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

+28   (127+27)
              COPY LM MCC2 PAD

+28+30
   P41        KEY 41E
      F 50 18 (COMMANDED R,P,Y)
              KEY V56E
```

```
          KEY ENTER(BYPASS MNVR)
       06 85 (VG-BODY)                          +32

          **SET UP MCC2 BURN**
+29+25
          DSKY BLANKS
+29+30
       16 85 (VG-BODY)(AVE G ON)
          THC-ARMED
          RHC-ARMED
+30  (127+28+27)
     F 16 85 (VG-BODY)
          ************************************
          LM PERFORMS MCC2 BURN
          ************************************

          ************************************
          CSM MCC2 BACKUP BURN
             (0,300/7,0)
          ************************************ +34

          CONFIRM LM BURN COMPLETE

          PRO (TO BYPASS CSM-MCC2 BURN)
          THC-LOCKED
          RHC-LOCKED
     F 37 88
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
             (127+28+27)
          PRO
     F 37 88
```

```
          **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)
          MOVE TO CMD SEAT
             DURING AUTO MANUVER
     F 50 18 (COMMANDED R,P,Y)
             (0,275/330,0)
          KEY ENTER
```

```
*************************************************
*          PROCEDURES FOR BRAKING               *
*************************************************
                  RHC-ARMED
                  CENTER LM IN RETICLE
                  BMAG MODE(3)-ATT1/RATE 2
                  MONITOR EMS FOR RANGE
+38   (127+36)
      P47         KEY V37E47E
            F 16 83 (DV-BODY)
                  KEY VB3E
            F 16 54 (R,RDOT,THETA)
                  THC-ARMED
                  MONITOR LOS CONTROL
                  MONITOR  R AND R DOT
               ***************************************
               *                                     *
               *    BRAKING GATES AND RET ANG,S      *
               *                                     *
               * 30FPS AT 6000FT.(1.00NM)-.13 DEG    *
               * 20FPS AT 3000FT.( .50NM)-.26 DEG    *
               * 10FPS AT 1500FT.( .25NM)-.54 DEG    *
               *  5FPS AT  500FT.( .08NM)-1.6 DEG    *
               *           300FT.( .05NM)-2.7 DEG    *
               *           200FT.( .03NM)-4.0 DEG    *
               *           100FT.( .02NM)-8.5 DEG    *
               *                                     *
               ***************************************
                     USE RANGE ON DSKY TO CHECK EMS
                        RANGE INDICATOR. USE
                        RETICLE ANGLE AS THIRD
                        VOTE.
      (127+40+38)
               ***************************************
                     TPF
               ***************************************
```

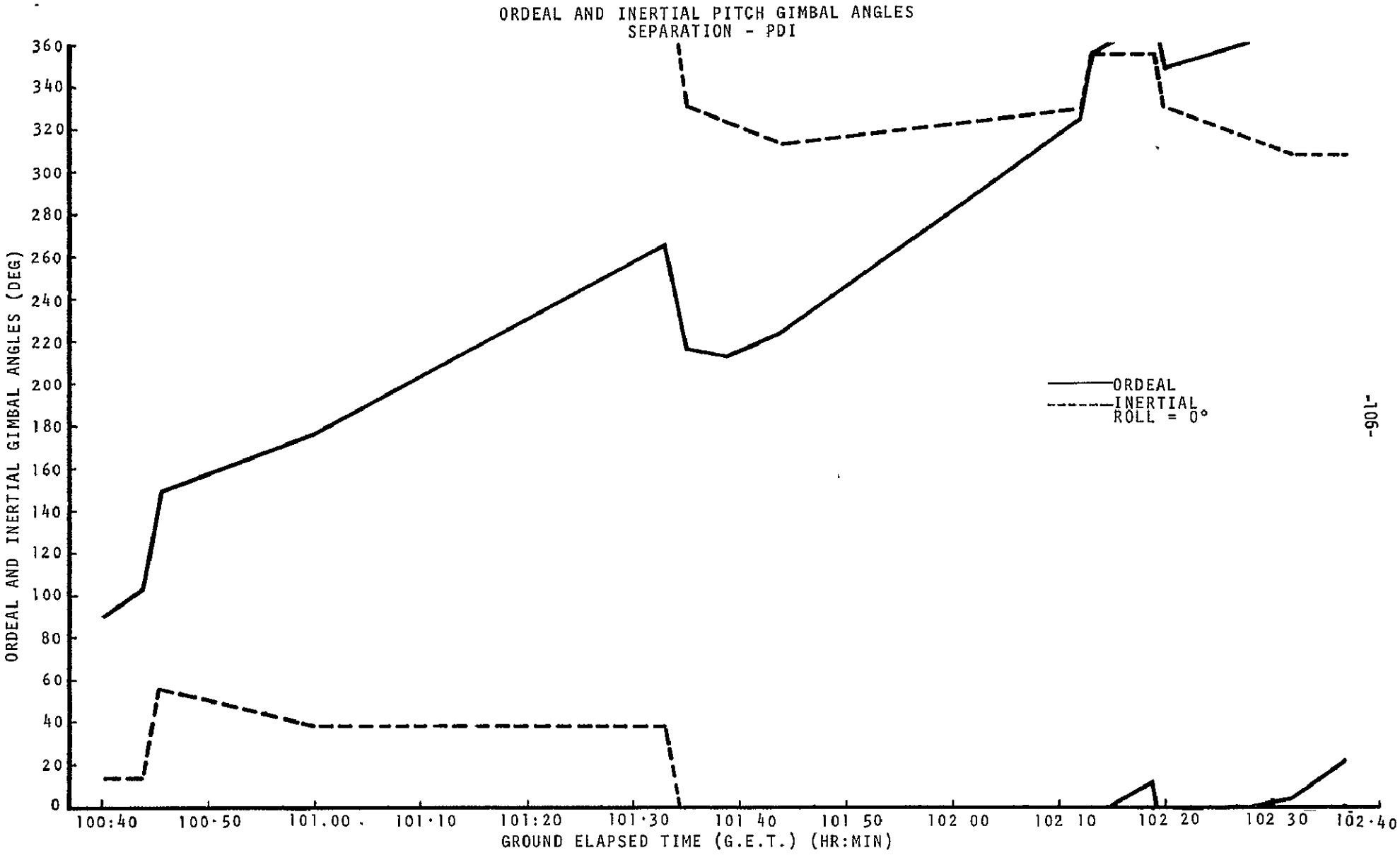
MISSION G DETAILED PROCEDURES

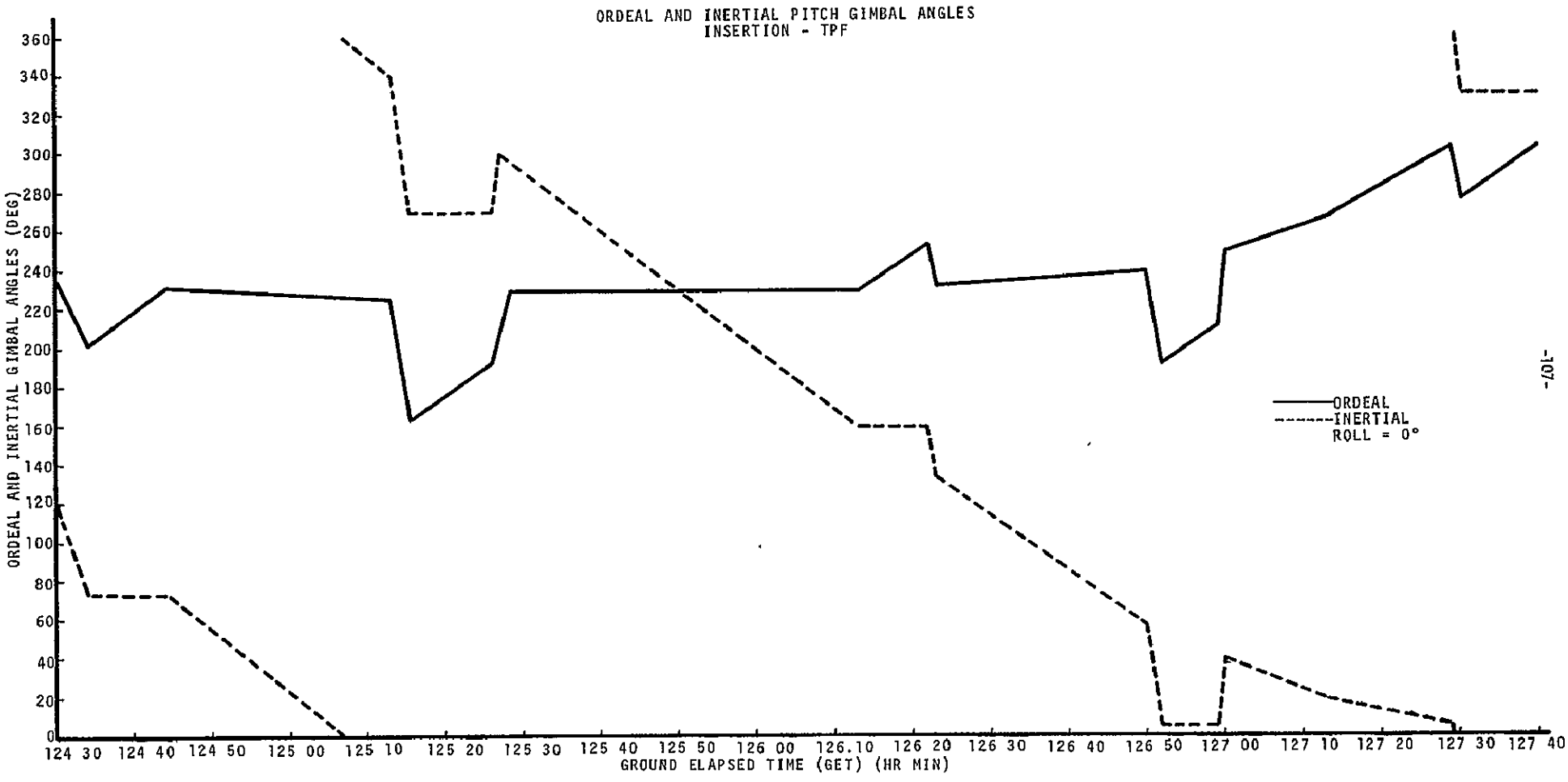
 PRECEDING PAGE BLANK NOT FILMED

6.3 P20 NAVIGATION SUMMARY WITH SUN ANGLES

IT - INITIATE TRACK
CT - CEASE TRACK
X/Y; X = NUMBER OF MARKS
Y = MINUTES IN MARKING PERIOD

GET	EVENT	SUN ANGLE (LOS TO SUN) DEGREES
124:30:39	LM INSERTION	
124:36	SUNSET	
124:49	IT (SXT/VHF) (V93,5/5,V93, 15 VHF/15)	
124:54	CT (SXT)	
125:09	CT (VHF)	
125:21:20	LM CSI	
125:22	SUNRISE	
125:29	IT (SXT/VHF) (3/3;V67,02000,00020 00001;18/18)	173
125:34		172
125:39		158
125:45		141
125:50	CT	126
125:50:40	LM PLANE CHANGE	
125:53	IT (SXT/VHF) (3/3,V93,9/9)	117
125:59		99
126:05	CT (SXT/VHF)	81
126:19:40	LM CDH	
126:24	IT (SXT/VHF) (3/3,V93,2/2)	26
126:30	CT (SXT/VHF)	9
126:34	SUNSET	
126:34	IT (SXT/VHF) (11/11)	
126:45	CT (SXT/VHF)	
126:58:27	LM TPI	
127:02	IT (SXT/VHF) (V93,8/8)	
127:10	CT (SXT/VHF)	
127:13:27	LM MCC1	
127:16	IT (SXT/VHF) (V93,9/9)	
127:21	SUNRISE	97
127:25	CT (SXT/VHF)	97
127:28:27	MCC2	
127:40:38	TPF	


ORDEAL AND INERTIAL PITCH GIMBAL ANGLES
SEPARATION - PDI
ORDEAL AND INERTIAL GIMBAL ANGLES (DEG)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
ORDEAL
INERTIAL
ROLL = 0°
100:40
100·50
101.00
101·10
101:20
101·30
101 40
101 50
102 00
102 10
102 20
102 30
102·40
GROUND ELAPSED TIME (G.E.T.) (HR:MIN)


ORDEAL AND INERTIAL PITCH GIMBAL ANGLES
INSERTION - TPF
ORDEAL AND INERTIAL GIMBAL ANGLES (DEG)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
124 30
124 40
124 50
125 00
125 10
125 20
125 30
125 40
125 50
126 00
126.10
126 20
126 30
126 40
126 50
127 00
127 10
127 20
127 30
127 40
GROUND ELAPSED TIME (GET) (HR MIN)
ORDEAL
INERTIAL
ROLL = 0°

7.0 LM RESCUE CASES

Numerous rescue cases occur for Mission G caused by a decision to abort the mission. These cases are either CSM passive where it is only necessary to monitor and back-up the LM activity or CSM active where it is necessary to rescue the LM. Investigation of the possible situations which might occur and the need for procedural support of these cases has led to the need for defining fifteen possible rescue cases. These cases are discussed in the following sections.

It should be noted that the particular rescue cases discussed in the following sections were based on the operational trajectory presented in Reference 8.2. The times have been adjusted to reflect the new operational trajectory given in Reference 8.18; however, the burns were assumed to be unchanged.

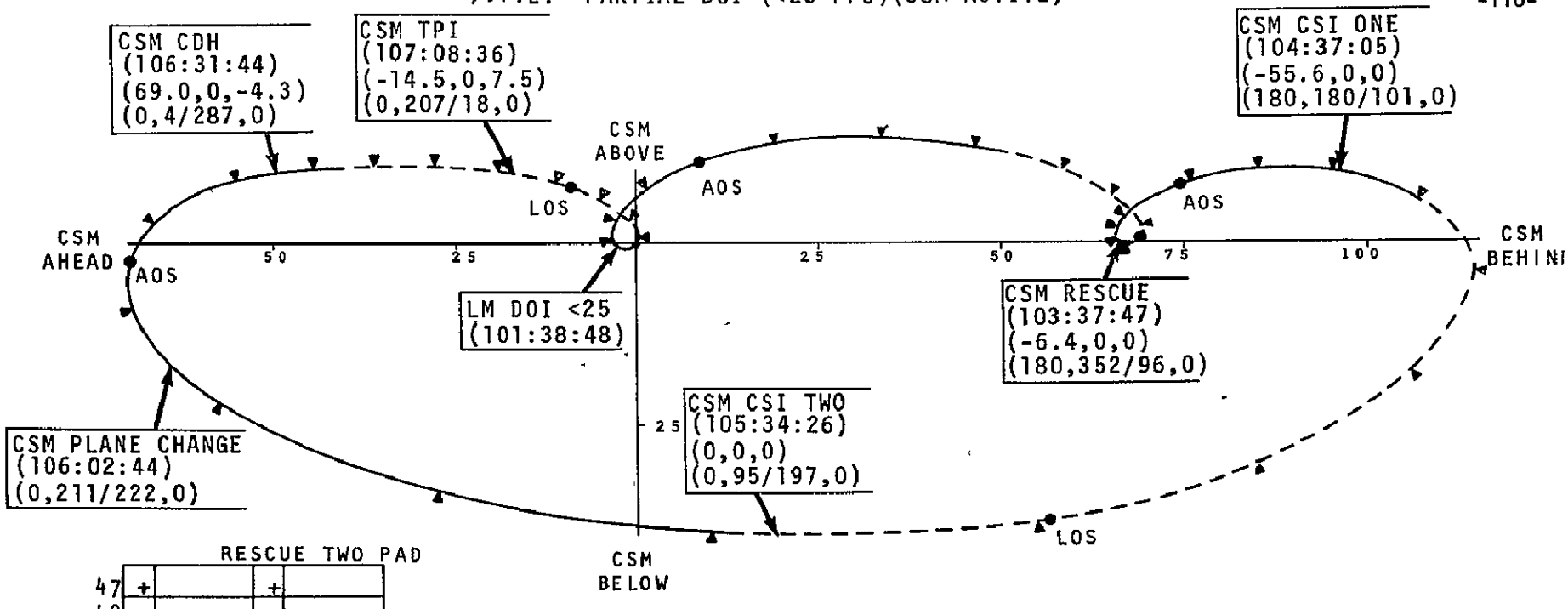
7.1 Partial DOI (< 25 FPS) (CSM Active)

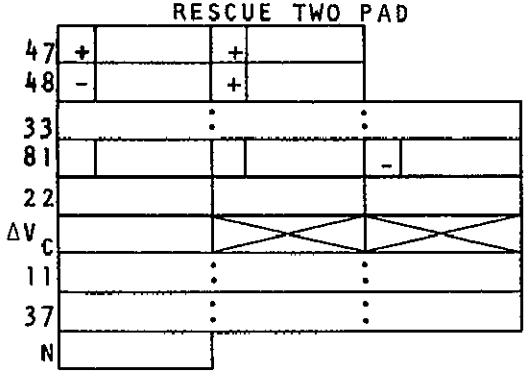
7.1.1 Summary

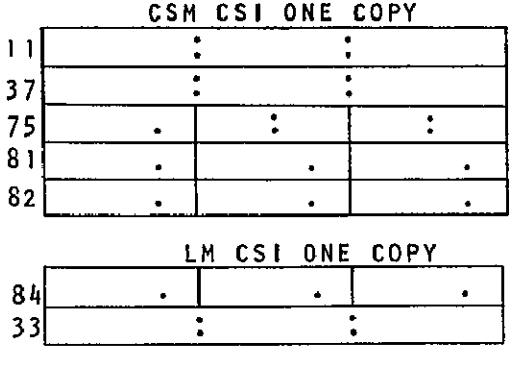
This rescue case provides for the situation where the LM applies less than 25 feet per second of the DOI burn and cannot perform a direct return. The CSM performs a height maneuver one rev after DOI. This height maneuver is a Rescue II burn and is targeted for a delta height of 10 nautical miles one half rev later. CSI_1 occurs one half rev after the height maneuver and is a retrograde burn. The CSI burn lowers the CSM apogee allowing the CSM to catch up to the LM. A CSI_2 burn (nominally zero) is scheduled halfway between CSI_1 and CDH. CDH occurs one rev after CSI_1 and results in a delta height of 10 nautical miles. TPI occurs on a CSM elevation angle of 208.3 degrees.

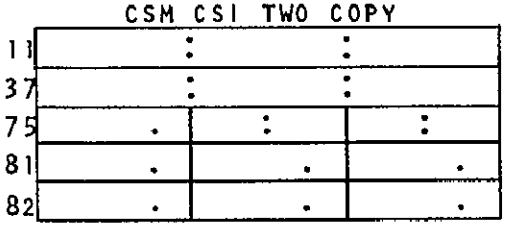
The relative profile and the burns shown in the following pages represent the particular situation where the LM applies 20 feet per second of the DOI burn. This data for other partial DOI burns will vary although the same basic checklist may be followed.

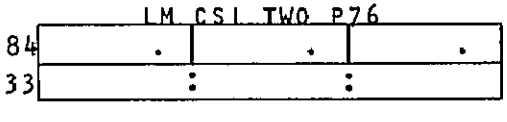
7.1.2. PARTIAL DOI (<25 FPS)(CSM ACTIVE)

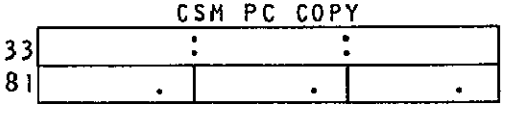


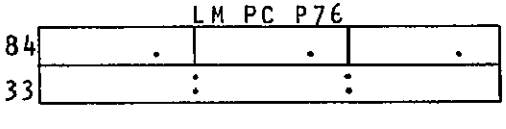


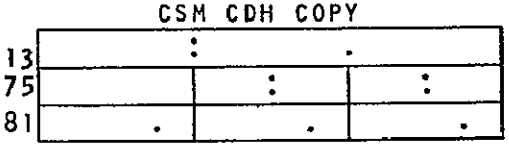


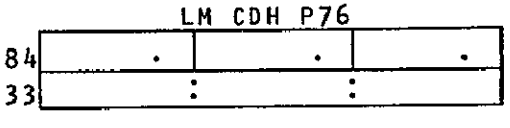


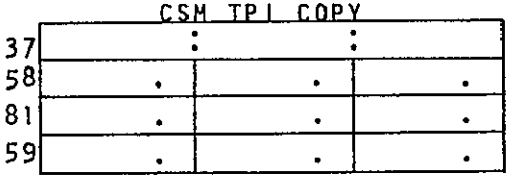




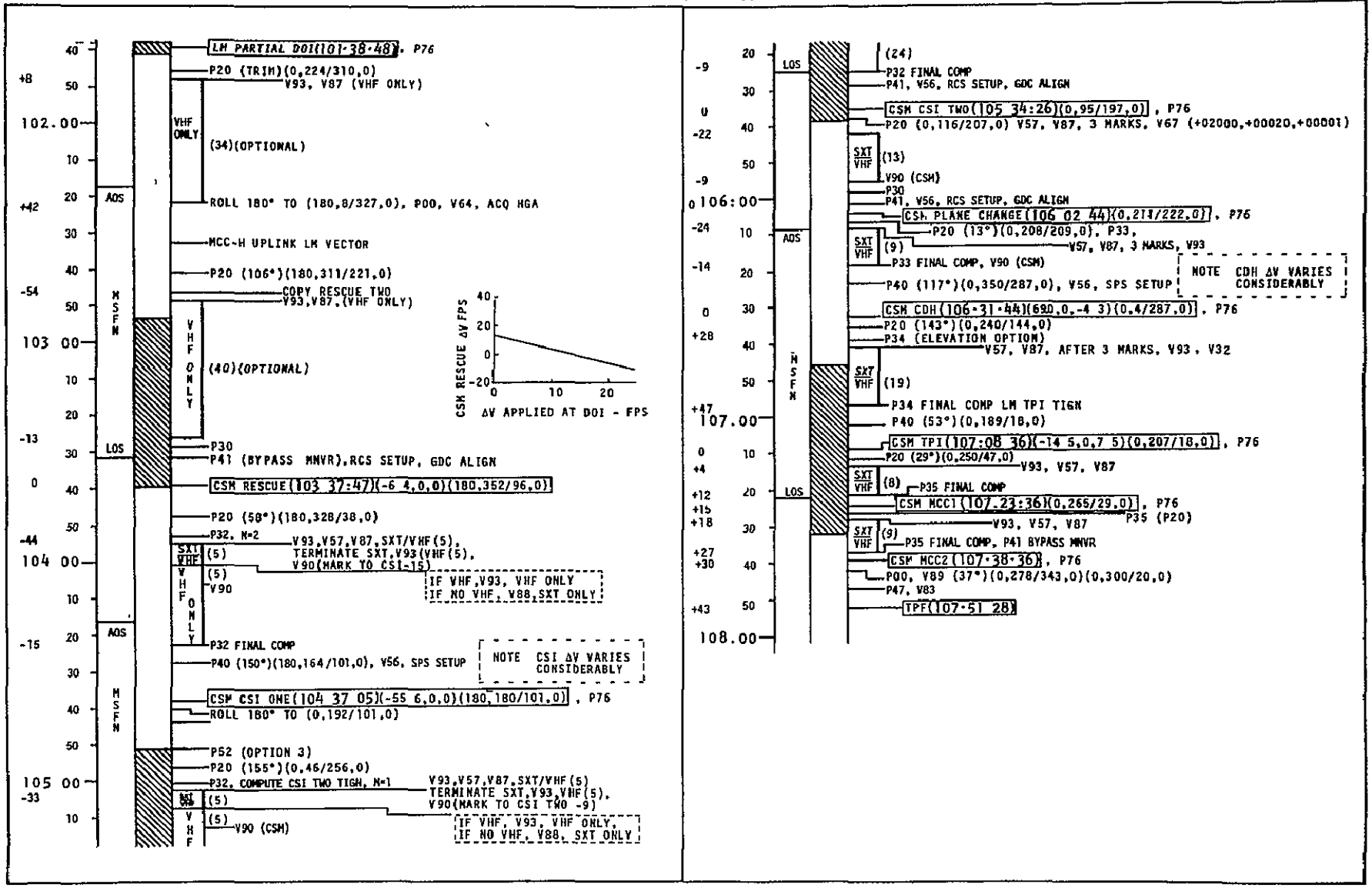








7 1 3 PARTIAL DOI (<25 FPS)(CSM ACTIVE)



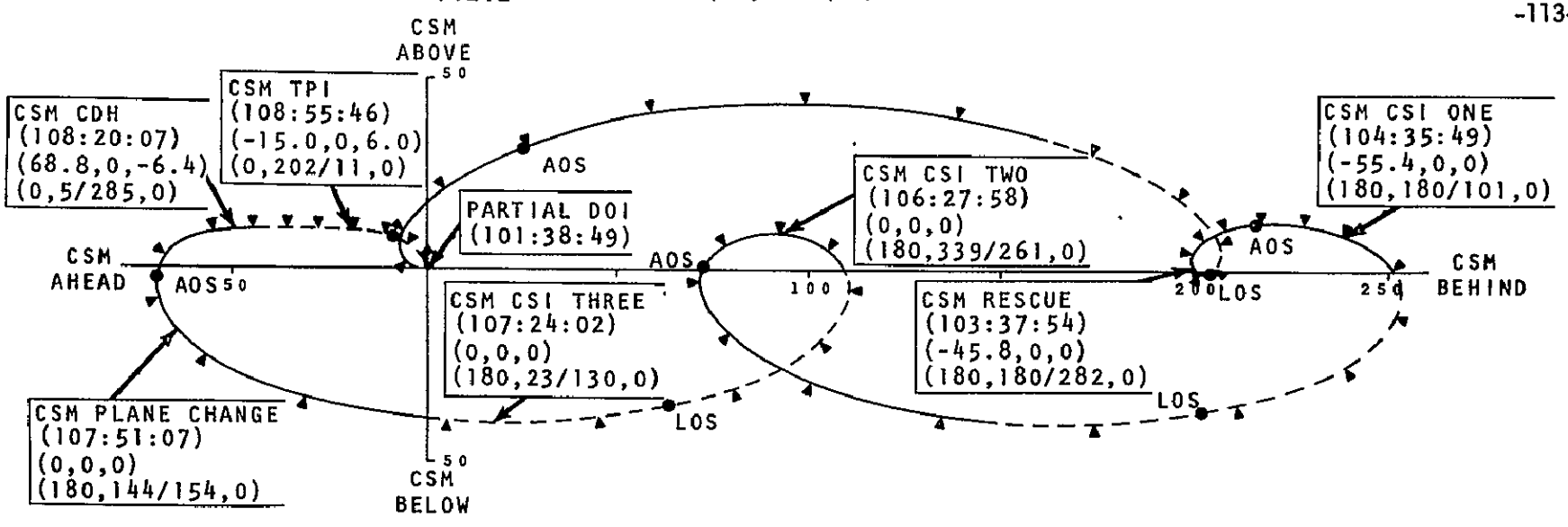
7.2 Partial DOI (≥ 25 FPS) (CSM Active)

7.2.1 Summary

This rescue case provides for the situation where the LM applies more than 25 feet per second of the DOI burn and cannot perform a direct return. This case is identical to the Partial DOI <25 Rescue except that there is one more rev between CSI_1 and CDH and consequently an additional CSI burn. CSI_2 (nominally zero) occurs one rev after CSI_1 and CSI_3 (nominally zero) is scheduled halfway between CSI_2 and CDH.

The relative profile and the burns shown in the following pages represent the particular situation where the LM applies 60 feet per second of the DOI burn. This data for other partial DOI burns greater than 25 feet per second will vary although the same basic checklist may be followed.

7.2.2 PARTIAL DOI (≥25 FPS) (CSM ACTIVE)



RESCUE TWO PAD

47
48
33
81
22
V_C
11
37
N

CSM CSI TWO COPY

11
37
75
81
82

LM CSI TWO P76

84
33

CSM CSI ONE COPY

11
37
75
81
82

CSM CSI THREE COPY

11
81

LM CSI THREE P76

84
33

LM CSI ONE P76

84
33

CSM PC COPY

33
81

LM PC P76

84
33

CSM CDH COPY

13
75
81

LM CDH P76

84
33

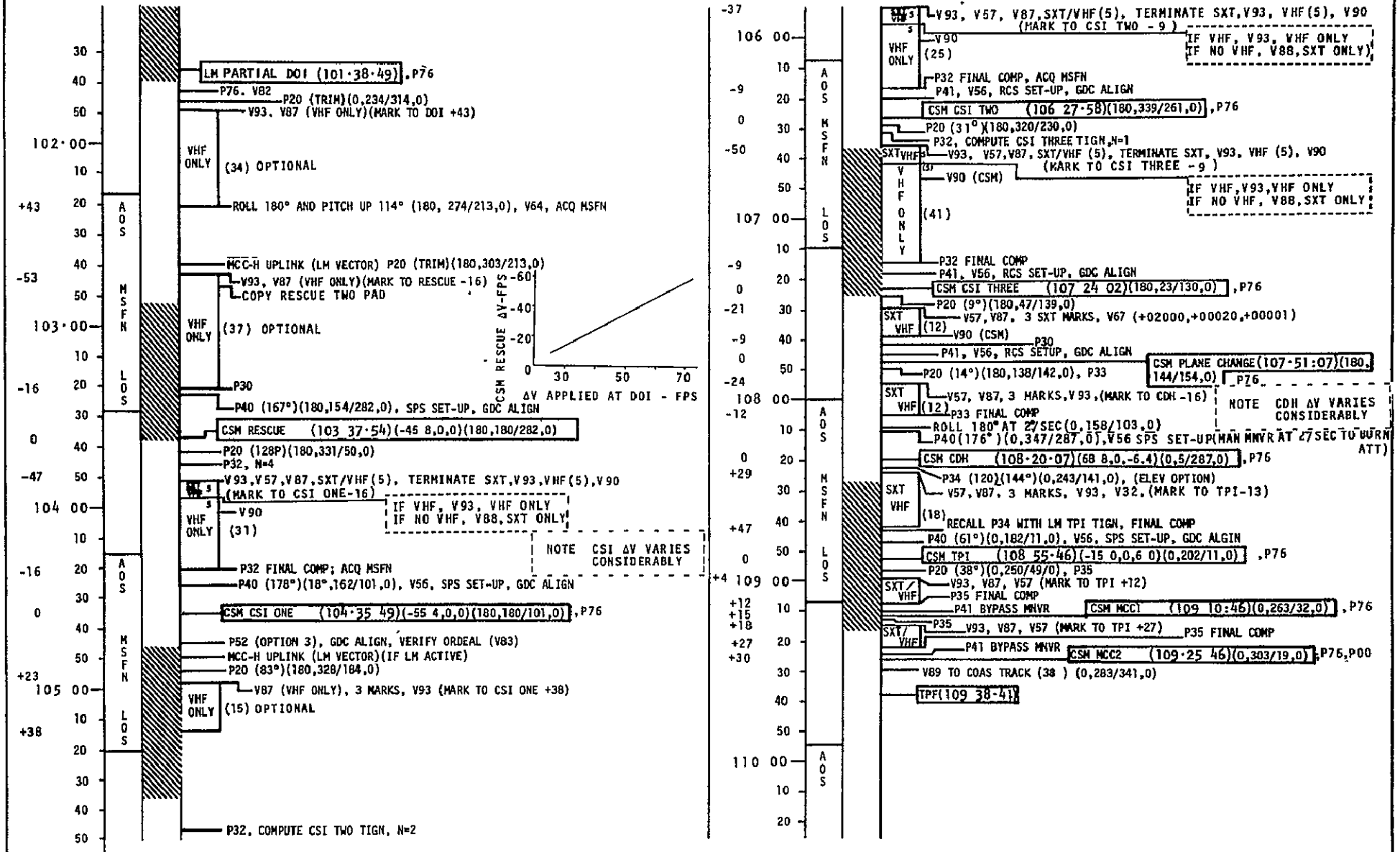
CSM TPI COPY

37
58
81
59

LM TPI P76

84
33

7 2 3 PARTIAL DOI (≥25FPS) (CSM ACTIVE)

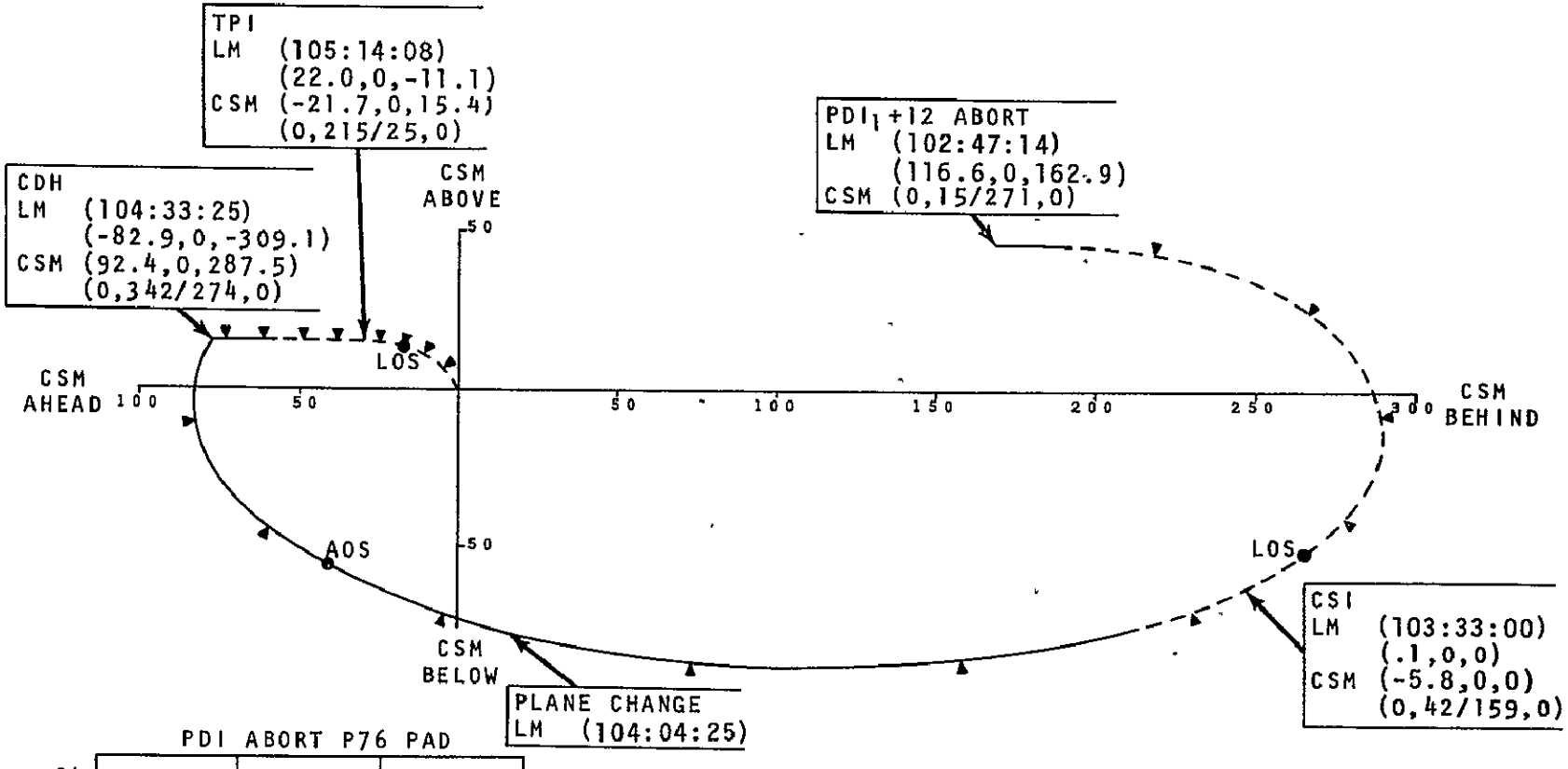


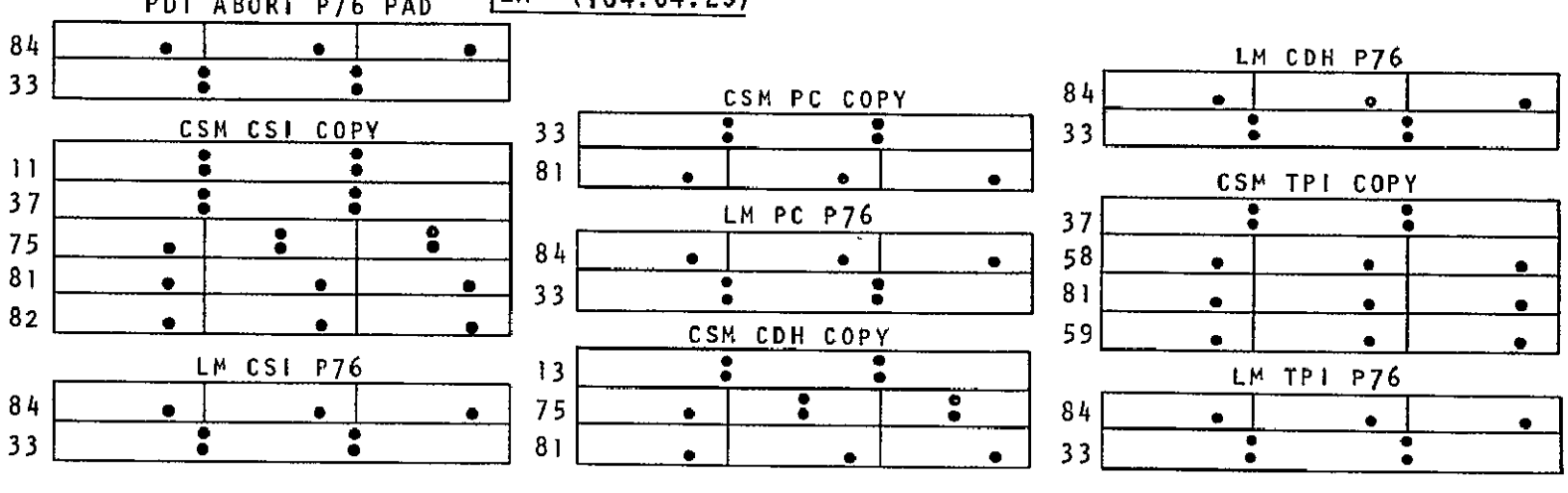
7.3 No PDI_1 + 12 (LM Active)

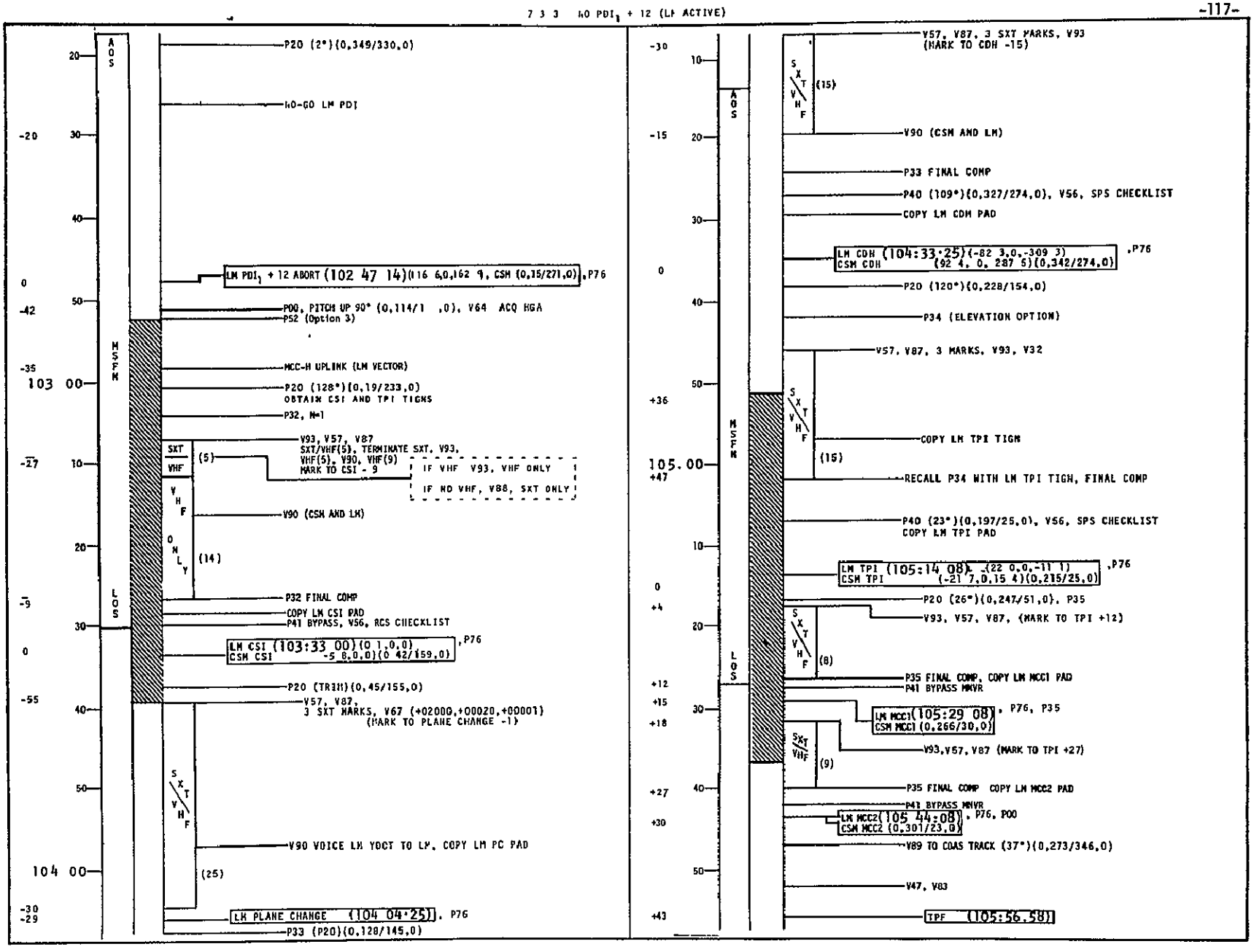
7.3.1 Summary

This situation arises when a failure prevents continuation of the planned mission after DOI and the LM initiates rendezvous with the CSM. The LM phasing burn is applied 12 minutes after nominal PDI_1 time and is targeted by the ground or obtained from onboard charts. The CSI maneuver is applied one-half revolution (LM) after phasing and the CDH maneuver is one-half rev later. TPI occurs approximately 40 minutes after CDH at a delta altitude of approximately 15 nautical miles and is targeted for a LM elevation angle of 26.6 degrees. The LM CSI burn is nominally zero; however, if it is necessary for the CSM to apply this burn, it is not nominally zero even though it is targeted for the LM CSI time.

7.3.2. NO PDI_1 + 12 (LM ACTIVE)





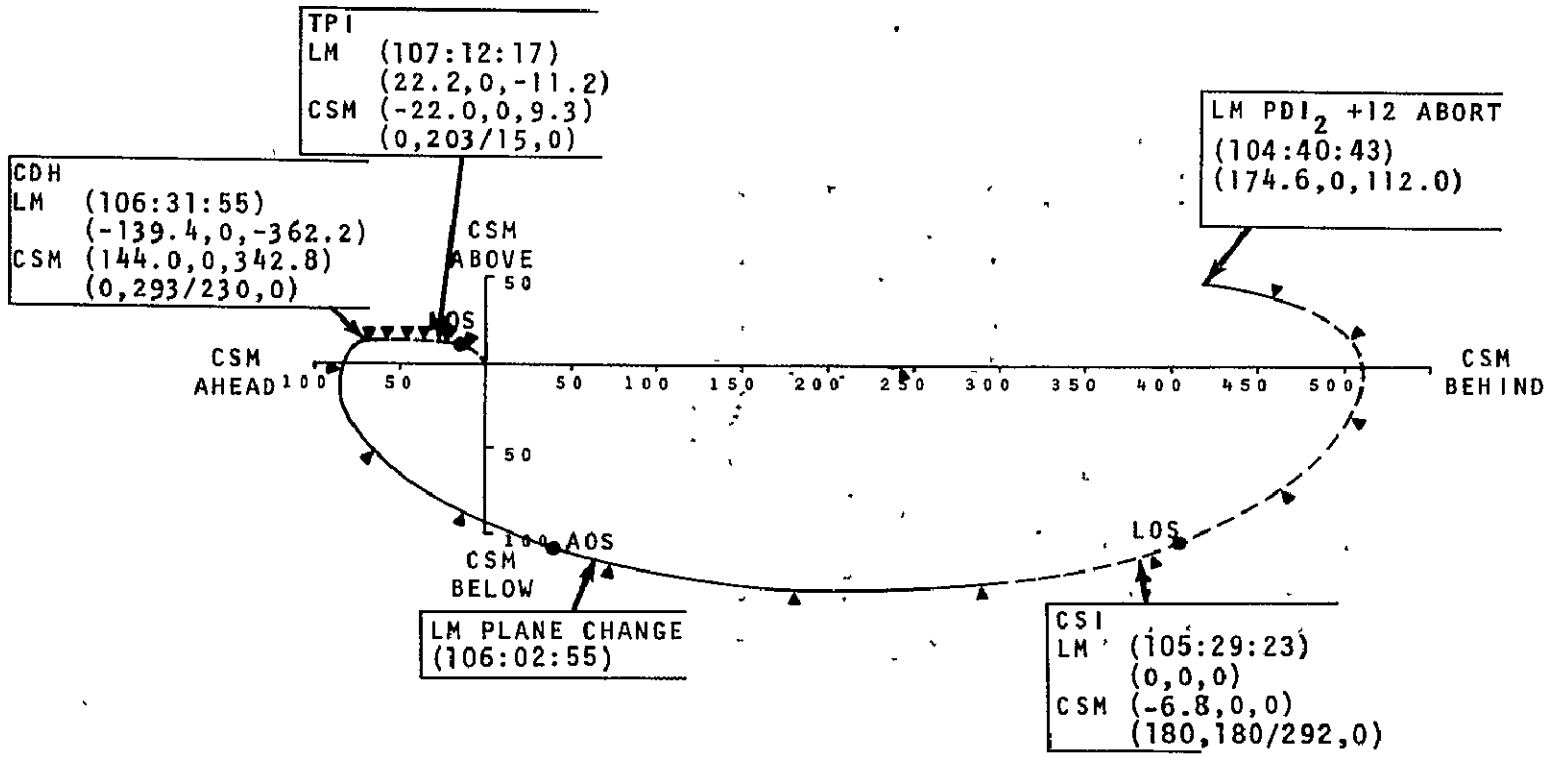

7 3 3 HO PDI1 + 12 (LM ACTIVE)
AOS
LOS
MSFN
P20 (2°)(0,349/330,0)
HO-GO LM PDI
LM PDI1 + 12 ABORT (102 47 14)(116 6,0,162 9, CSM (0,15/271,0), P76
P00, PITCH UP 90° (0,114/1 ,0), V64 ACQ HGA
P52 (Option 3)
MCC-H UPLINK (LM VECTOR)
P20 (128°)(0,19/233,0)
OBTAIN CSI AND TPI TIGNS
P32, N=1
SXT/VHF
(5)
V93, V57, V87
SXT/VHF(5), TERMINATE SXT, V93,
VHF(5), V90, VHF(9)
MARK TO CSI - 9
IF VHF V93, VHF ONLY
IF NO VHF, V88, SXT ONLY
VHF ONLY
(14)
V90 (CSM AND LM)
P32 FINAL COMP
COPY LM CSI PAD
P41 BYPASS, V56, RCS CHECKLIST
LM CSI (103:33 00)(0 1,0,0)
CSM CSI -5 8,0,0)(0 42/159,0)
,P76
P20 (TRIM)(0,45/155,0)
V57, V87,
3 SXT MARKS, V67 (+02000,+00020,+00001)
(MARK TO PLANE CHANGE -1)
SXT/VHF
V90 VOICE LM YOCT TO LM, COPY LM PC PAD
(25)
LM PLANE CHANGE (104 04:25), P76
P33 (P20)(0,128/145,0)
103 00
104 00
105.00
V57, V87, 3 SXT MARKS, V93
(MARK TO CDH -15)
(15)
V90 (CSM AND LM)
P33 FINAL COMP
P40 (109°)(0,327/274,0), V56, SPS CHECKLIST
COPY LM CDH PAD
LM CDH (104:33:25)(-82 3,0,-309 3)
CSM CDH (92 4, 0, 287 5)(0,342/274,0)
,P76
P20 (120°)(0,228/154,0)
P34 (ELEVATION OPTION)
V57, V87, 3 MARKS, V93, V32
COPY LM TPI TIGN
RECALL P34 WITH LM TPI TIGN, FINAL COMP
P40 (23°)(0,197/25,0), V56, SPS CHECKLIST
COPY LM TPI PAD
LM TPI (105:14 08), (22 0,0,-11 1)
CSM TPI (-21 7,0,15 4)(0,215/25,0)
,P76
P20 (26°)(0,247/51,0), P35
V93, V57, V87, (MARK TO TPI +12)
(8)
P35 FINAL COMP, COPY LM MCC1 PAD
P41 BYPASS MNVR
LM MCC1(105:29 08), P76, P35
CSM MCC1 (0,266/30,0)
V93,V57, V87 (MARK TO TPI +27)
(9)
P35 FINAL COMP COPY LM MCC2 PAD
P41 BYPASS MNVR
LM MCC2(105 44:08), P76, P00
CSM MCC2 (0,301/23,0)
V89 TO COAS TRACK (37°)(0,273/346,0)
V47, V83
TPF (105:56.58)

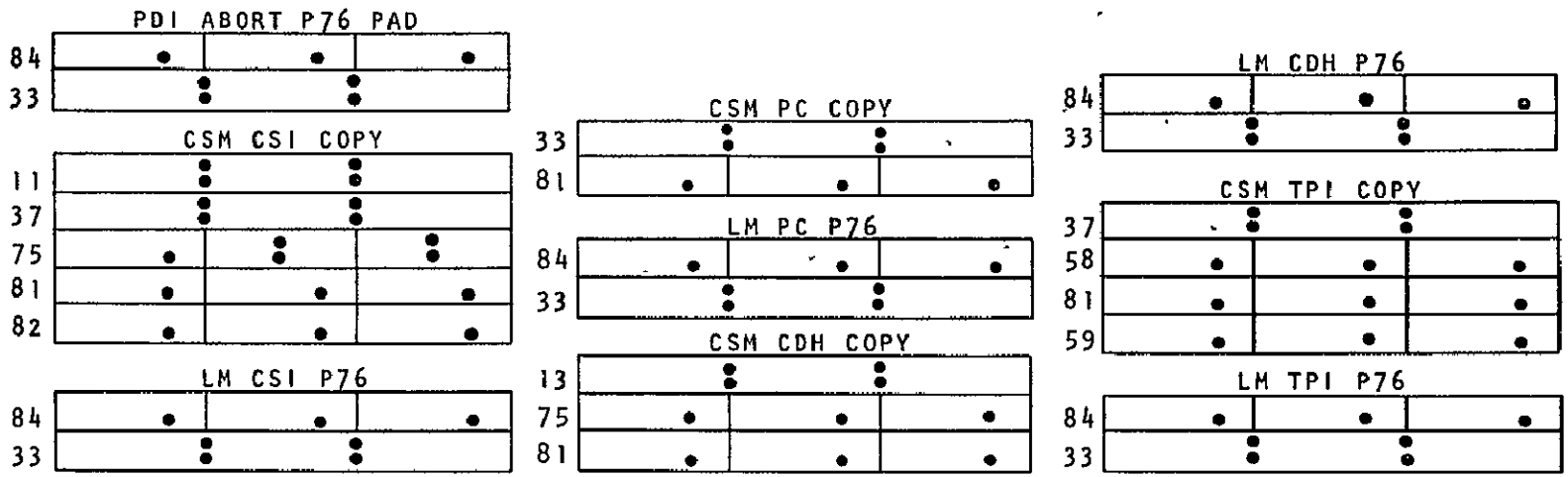
7.4 No PDI_2 + 12 (LM Active)

7.4.1 Summary

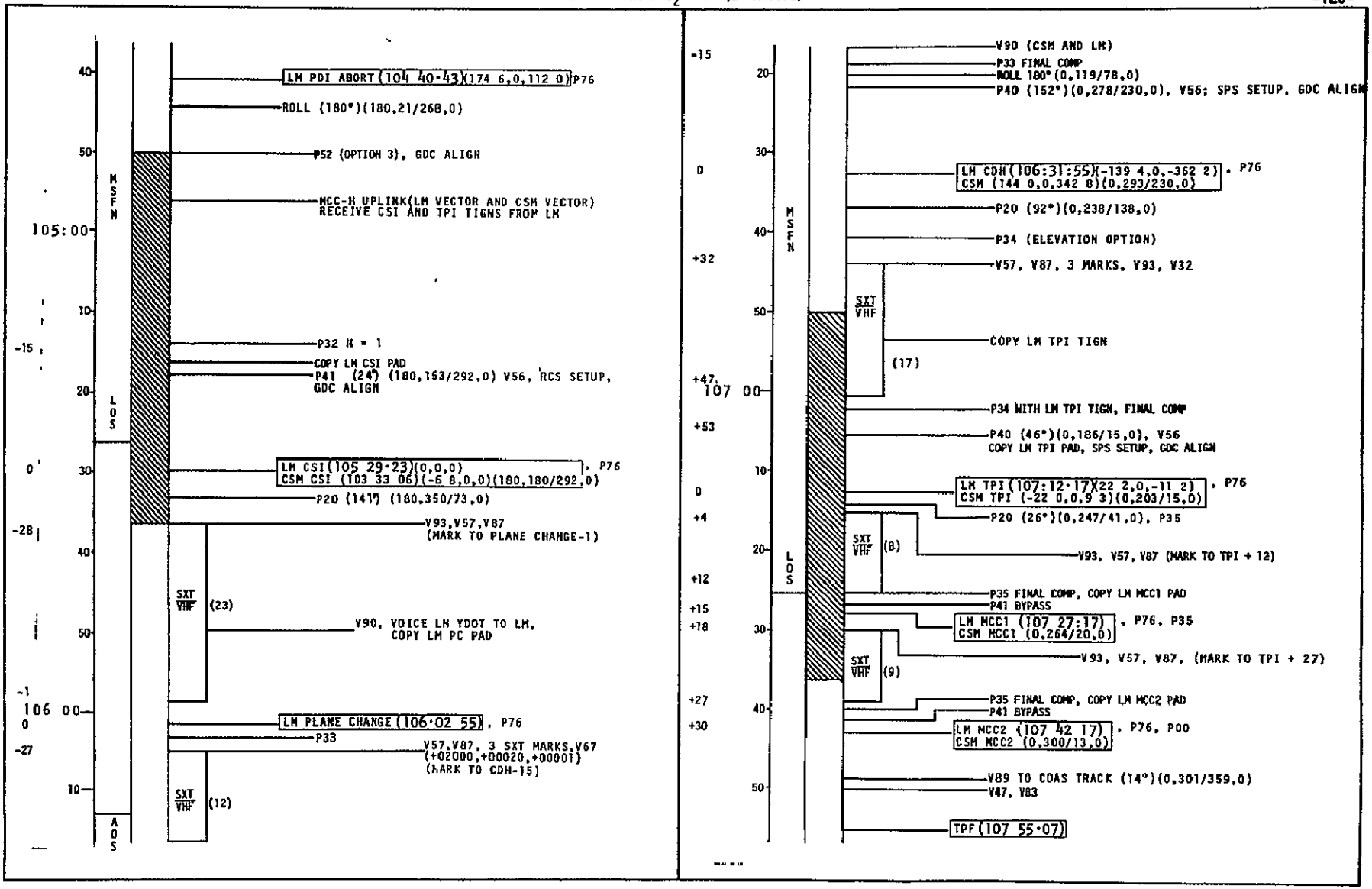
This condition arises when the first PDI opportunity is passed due to some difficulty, but the difficulty is of such a nature that it is desired to try to initiate PDI at the second opportunity. If it is obvious at this time that the problem still exists, the LM initiates an abort. At 12 minutes after PDI_2 time, the phasing burn is applied. This burn is ground targeted or based on onboard charts. The CSI maneuver is applied one-half rev (LM) after phasing and the CDH maneuver is one-half rev later. TPI occurs at a delta altitude of 15 nautical miles and is targeted with a LM elevation angle of 26.6 degrees. The LM CSI burn is nominally zero; however, if it is necessary for the CSM to apply this burn, it is not nominally zero even though it is targeted for the LM CSI time.

7.4.2. NO PDI_2 + 12 (LM ACTIVE)





7 4 3 NO PDI$_2$ + 12 (LM ACTIVE)

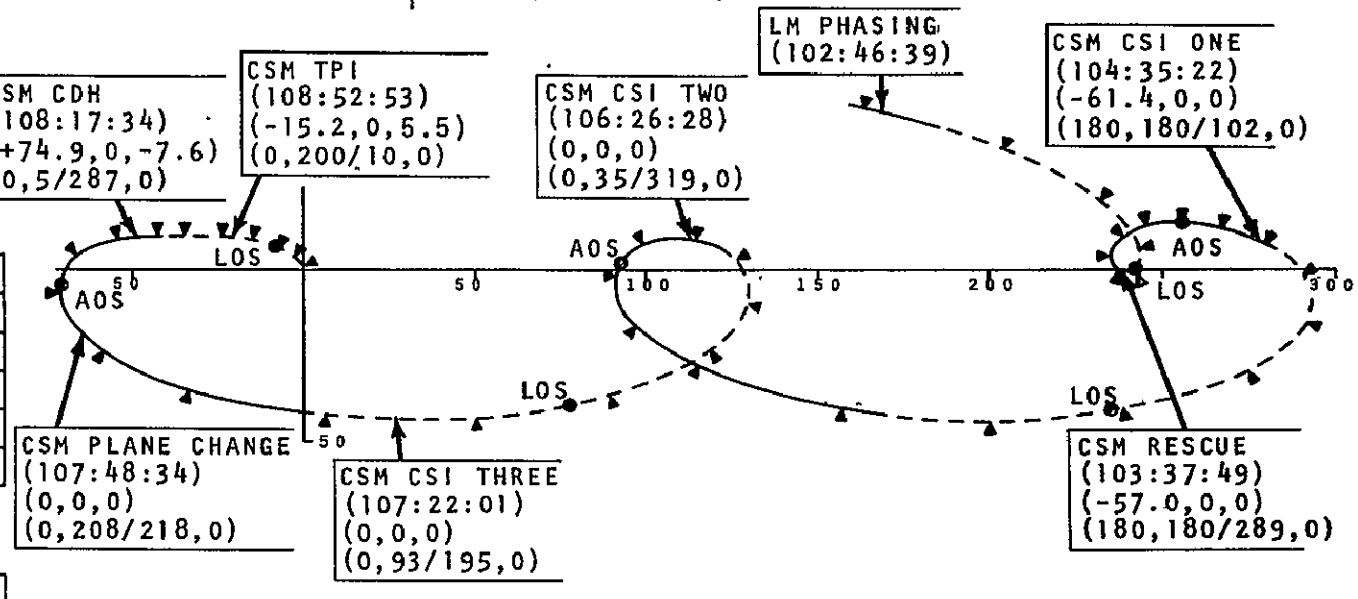


7.5 < 60 No PDI_1 + 12 (CSM Active)

7.5.1 Summary

This situation occurs when the LM is completely inactive following the DOI burn or applies less than 60 feet per second of the phasing burn, i.e., the LM cannot apply the PDI burn nor can it complete the rendezvous. Under this condition, the CSM may accomplish the entire rendezvous. The first of the series of rescue burns is either ground targeted or taken from an onboard chart. This burn occurs at one rev after the DOI maneuver. A CSI_1 burn is applied one-half rev later and is targeted with a CDH to occur two revs later. A CSI_2 burn (nominally zero) is scheduled half way between CSI_1 and CDH. A third CSI (CSI_3) again nominally zero is scheduled half way between CSI_2 and CDH. The CDH burn is targeted for a differential height of 10 nautical miles and the TPI burn is cued on a CSM elevation angle of 208.3 degrees.

The relative profile and the burns shown in the following pages represent the particular situation where the LM was not able to apply any of the phasing burn. This data for all cases where a partial burn less than 60 feet per second is applied will vary although the same basic checklist may be followed.



RESCUE TWO PAD

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

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

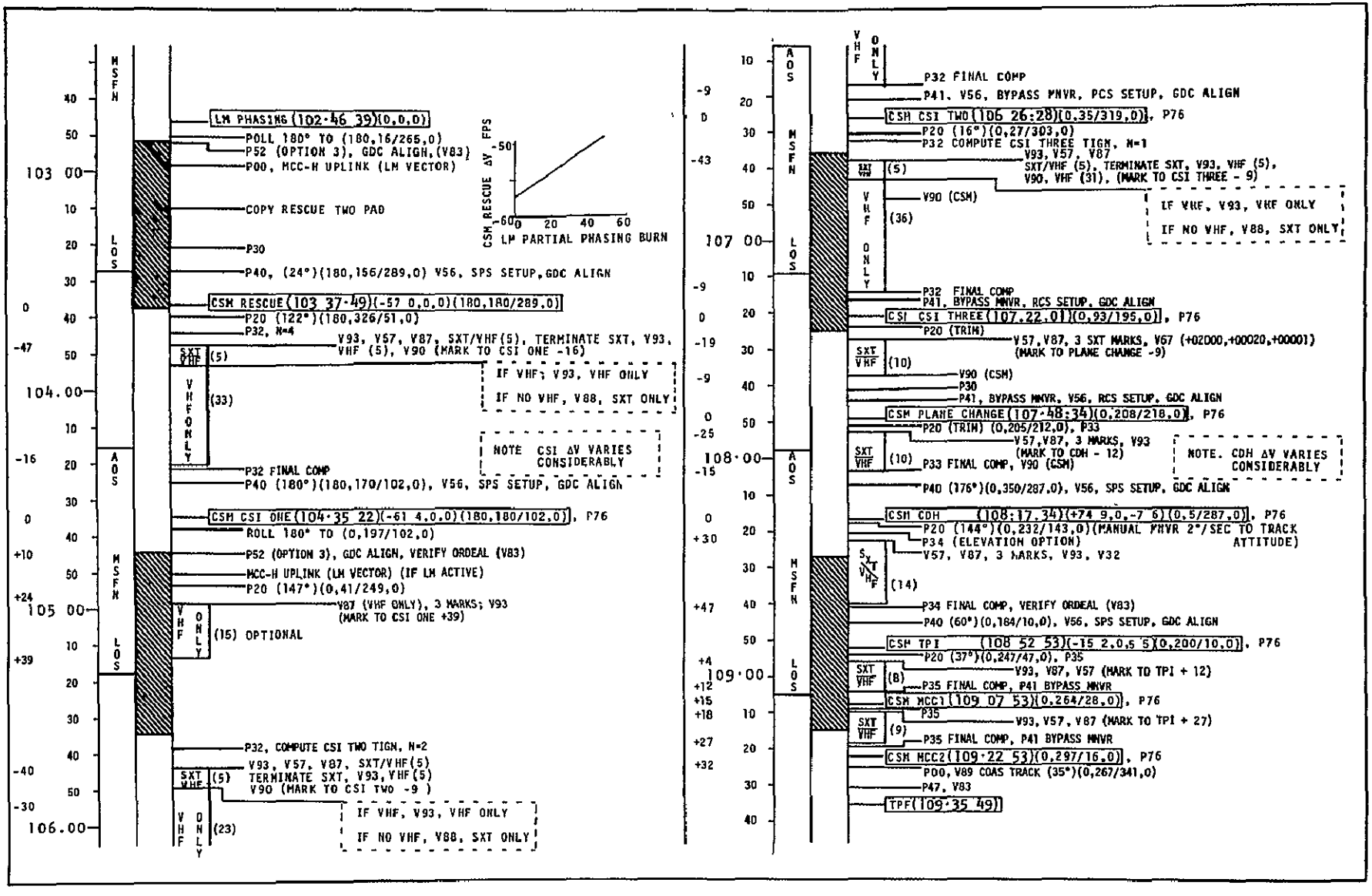
84	.	.	.
33	:	:	

CSM TPI COPY

37	:	:	
58	.	.	.
81	.	.	.
59	.	.	.

LM TPI P76

84	.	.	.
33	:	:	


MSFN
LOS
AOS
103 00
104.00
105 00
106.00
107 00
108·00
109·00
LM PHASING (102·46 39)(0,0,0)
POLL 180° TO (180,16/265,0)
P52 (OPTION 3), GDC ALIGN,(V83)
P00, MCC-H UPLINK (LM VECTOR)
COPY RESCUE TWO PAD
P30
P40, (24°)(180,156/289,0) V56, SPS SETUP,GDC ALIGN
CSM RESCUE (103 37 49)(-57 0,0,0)(180,180/289,0)
P20 (122°)(180,326/51,0)
P32, N=4
V93, V57, V87, SXT/VHF(5), TERMINATE SXT, V93, VHF (5), V90 (MARK TO CSI ONE -16)
SXT VHF (5)
VHF ONLY (33)
IF VHF; V93, VHF ONLY
IF NO VHF, V88, SXT ONLY
NOTE CSI ΔV VARIES CONSIDERABLY
P32 FINAL COMP
P40 (180°)(180,170/102,0), V56, SPS SETUP, GDC ALIGN
CSM CSI ONE (104·35 22)(-61 4,0,0)(180,180/102,0), P76
ROLL 180° TO (0,197/102,0)
P52 (OPTION 3), GDC ALIGN, VERIFY ORDEAL (V83)
MCC-H UPLINK (LM VECTOR) (IF LM ACTIVE)
P20 (147°)(0,41/249,0)
V87 (VHF ONLY), 3 MARKS; V93 (MARK TO CSI ONE +39)
VHF ONLY (15) OPTIONAL
P32, COMPUTE CSI TWO TIGN, N=2
V93, V57, V87, SXT/VHF(5)
SXT VHF (5) TERMINATE SXT, V93,VHF(5)
V90 (MARK TO CSI TWO -9)
VHF ONLY (23)
IF VHF, V93, VHF ONLY
IF NO VHF, V88, SXT ONLY
ΔV FPS
CSM RESCUE
-50
-60
0 20 40 60
LM PARTIAL PHASING BURN
VHF ONLY
P32 FINAL COMP
P41, V56, BYPASS MNVR, PCS SETUP, GDC ALIGN
CSM CSI TWO (106 26:28)(0,35/319,0), P76
P20 (16°)(0,27/303,0)
P32 COMPUTE CSI THREE TIGN, N=1
V93, V57, V87
SXT/VHF (5), TERMINATE SXT, V93, VHF (5), V90, VHF (31), (MARK TO CSI THREE - 9)
SXT VHF (5)
VHF ONLY (36)
V90 (CSM)
IF VHF, V93, VHF ONLY
IF NO VHF, V88, SXT ONLY
P32 FINAL COMP
P41, BYPASS MNVR, RCS SETUP, GDC ALIGN
CSI CSI THREE (107,22,0)(0,93/195,0), P76
P20 (TRIM)
V57,V87, 3 SXT MARKS, V67 (+02000,+00020,+00001) (MARK TO PLANE CHANGE -9)
SXT VHF (10)
V90 (CSM)
P30
P41, BYPASS MNVR, V56, RCS SETUP, GDC ALIGN
CSM PLANE CHANGE (107·48:34)(0,208/218,0), P76
P20 (TRIM) (0,205/212,0), P33
V57,V87, 3 MARKS, V93 (MARK TO CDH - 12)
SXT VHF (10) P33 FINAL COMP, V90 (CSM)
NOTE. CDH ΔV VARIES CONSIDERABLY
P40 (176°)(0,350/287,0), V56, SPS SETUP, GDC ALIGN
CSM CDH (108:17 34)(+74 9,0,-7 6)(0,5/287,0), P76
P20 (144°)(0,232/143,0)(MANUAL MNVR 2°/SEC TO TRACK ATTITUDE)
P34 (ELEVATION OPTION)
V57, V87, 3 MARKS, V93, V32
SXT VHF (14)
P34 FINAL COMP, VERIFY ORDEAL (V83)
P40 (60°)(0,164/10,0), V56, SPS SETUP, GDC ALIGN
CSM TPI (108 52 53)(-15 2,0,5 5)(0,200/10,0), P76
P20 (37°)(0,247/47,0), P35
V93, V87, V57 (MARK TO TPI + 12)
SXT VHF (8)
P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC1 (109 07 53)(0,264/28,0), P76
P35
V93, V57, V87 (MARK TO TPI + 27)
SXT VHF (9)
P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC2 (109·22 53)(0,297/16,0), P76
P00, V89 COAS TRACK (35°)(0,267/341,0)
P47, V83
TPF (109·35 49)

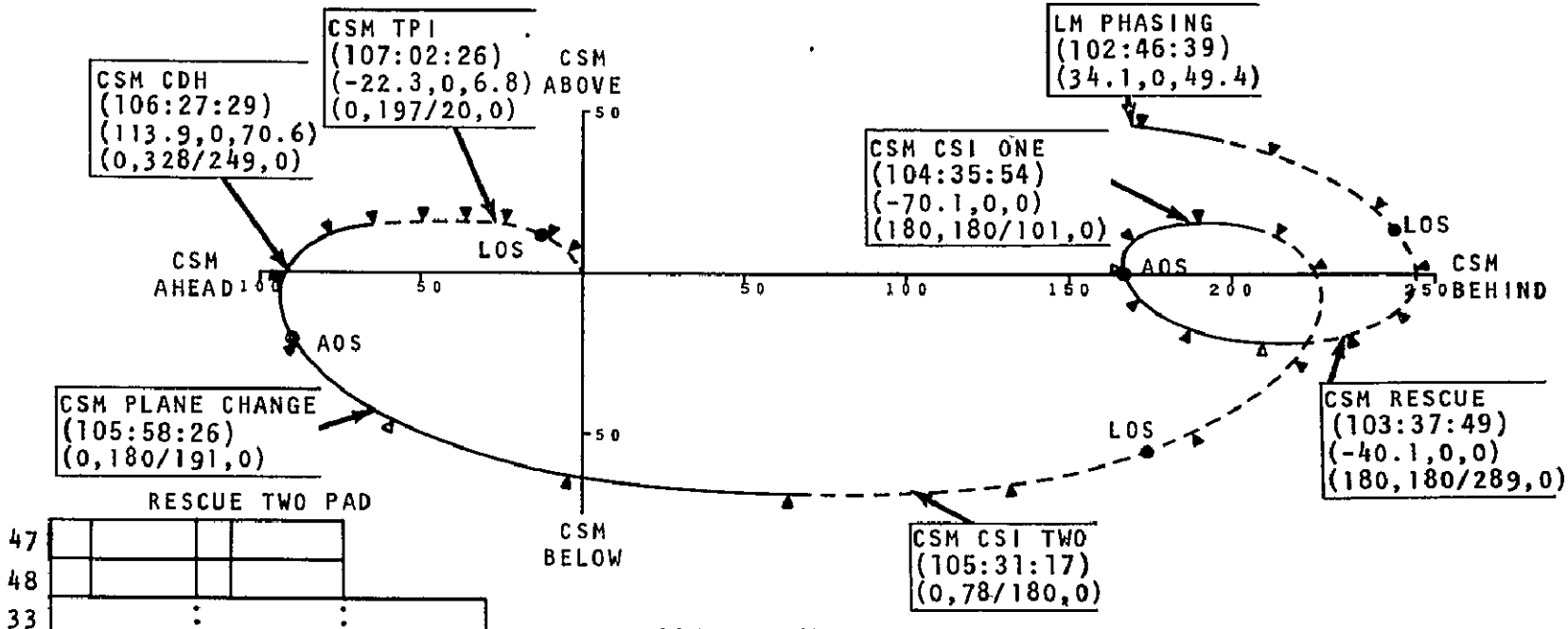
7.6 ≥ 60 No PDI_1 + 12 (CSM Active)

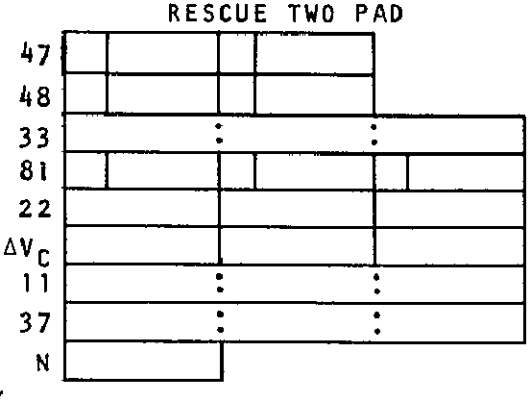
7.6.1 Summary

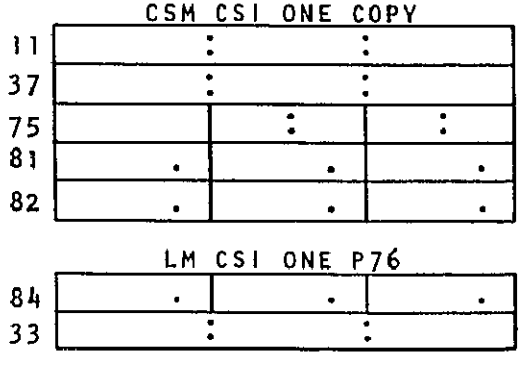
This rescue case provides for the situation where the LM applies at least 60 feet per second of the phasing burn but cannot complete the burn and it is necessary for the CSM to initiate a rescue. This case is similar to the previous case except that one less rev is required for rendezvous since at least a partial phasing burn was achieved. The initial rescue burn occurs one rev after DOI and is again ground targeted or taken from an on-board chart. The CSI_1 burn occurs one-half rev after the initial rescue burn and is targeted for a CDH one rev later. A CSI_2 burn, nominally zero, is scheduled one-half way between CSI_1 and CDH. The CDH burn results in a differential height of approximately 15 nautical miles and the TPI burn is cued on a CSM elevation angle of 208.3 degrees.

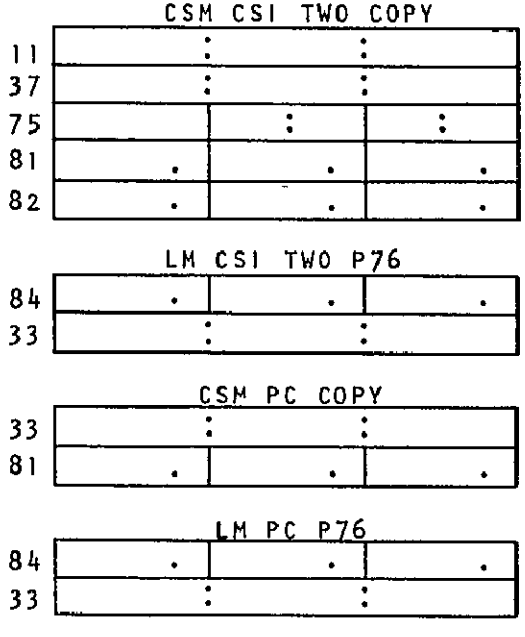
The relative profile and the burns shown in the following pages represent the particular situation where the LM applies a partial burn of 60 feet per second. This data for all cases where a partial burn greater than 60 feet per second is applied will vary although the same basic checklist may be followed.

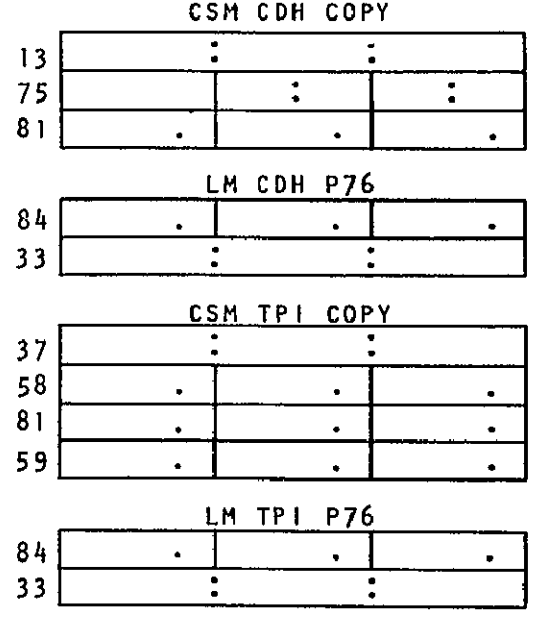
7.6.2. >60 NO PDI$_1$ + 12 (CSM ACTIVE)

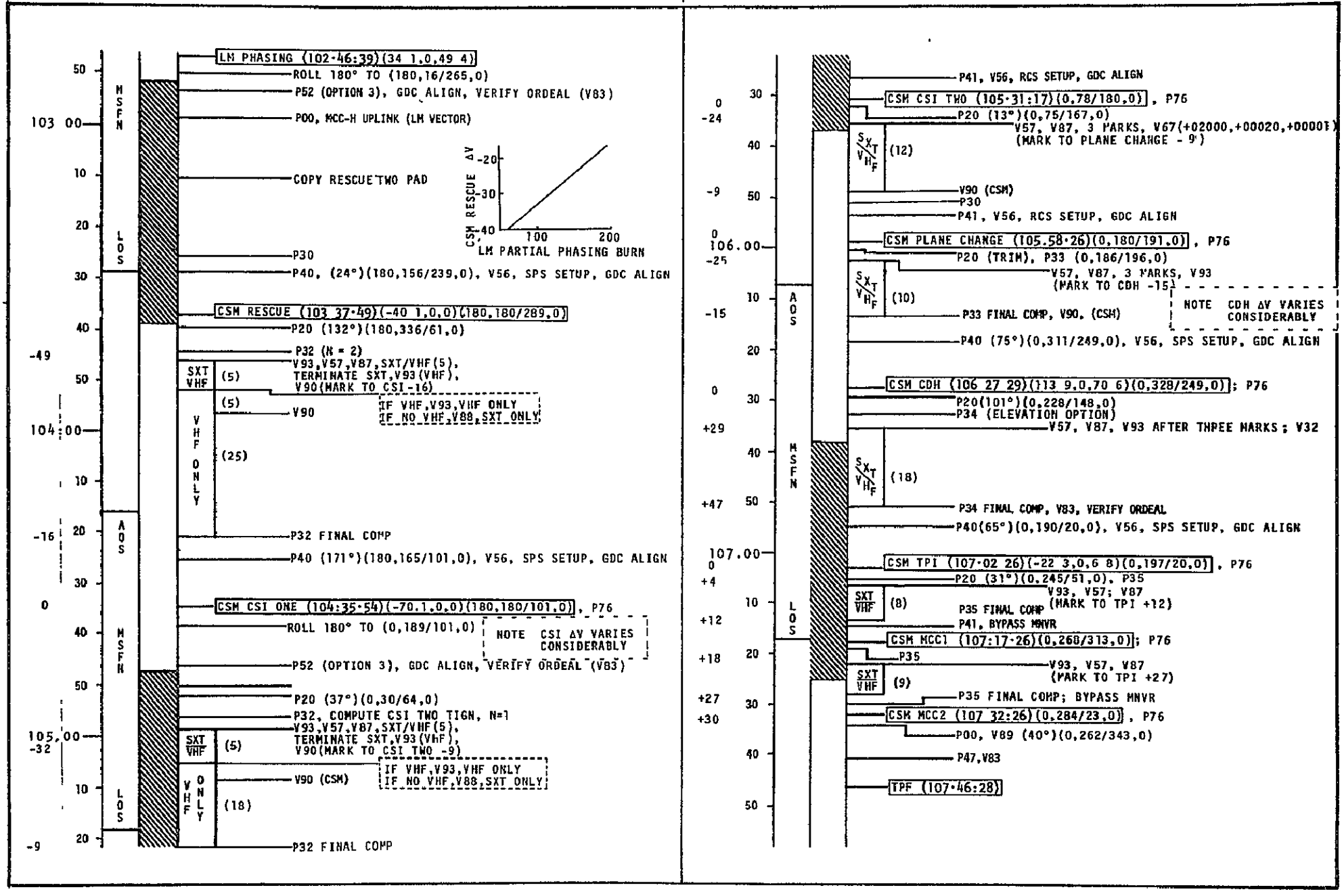










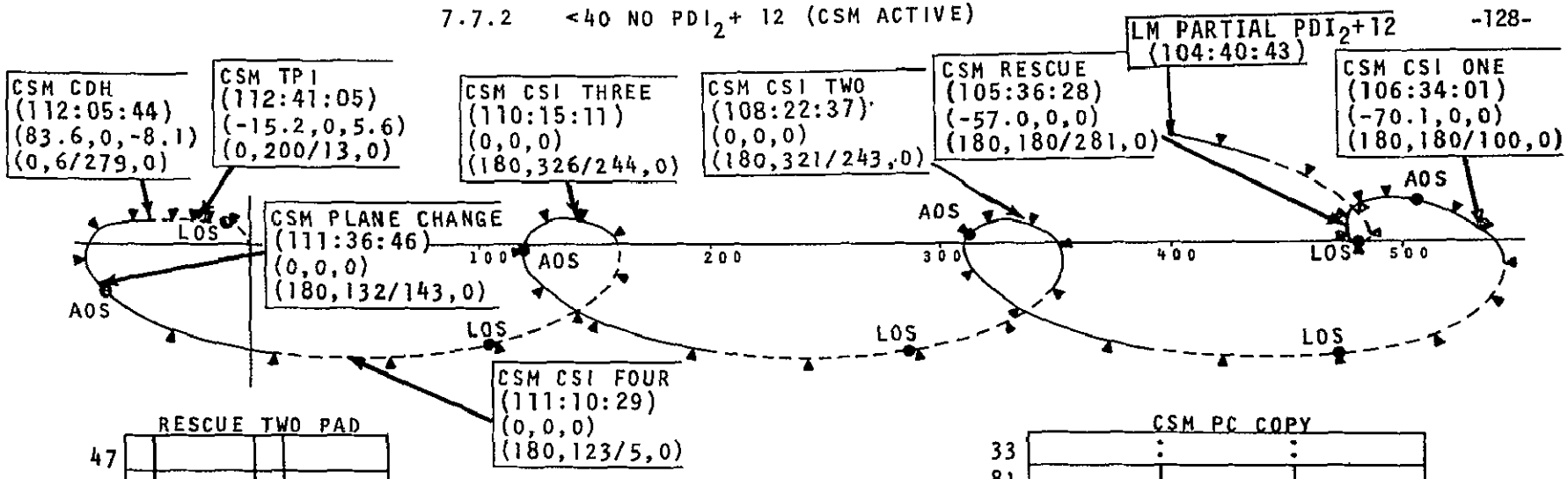

LM PHASING (102-46:39)(34 1,0,49 4)
ROLL 180° TO (180,16/265,0)
P52 (OPTION 3), GDC ALIGN, VERIFY ORDEAL (V83)
P00, MCC-H UPLINK (LM VECTOR)
COPY RESCUE TWO PAD
CSM RESCUE ΔV
-20
-30
-40
100
200
LM PARTIAL PHASING BURN
P30
P40, (24°)(180,156/239,0), V56, SPS SETUP, GDC ALIGN
CSM RESCUE (103 37·49)(-40 1,0,0)(180,180/289,0)
P20 (132°)(180,336/61,0)
P32 (N = 2)
V93,V57,V87,SXT/VHF(5),
TERMINATE SXT,V93(VHF),
V90(MARK TO CSI-16)
SXT VHF (5)
(5)
V90
IF VHF,V93,VHF ONLY
IF NO VHF,V88,SXT ONLY
VHF ONLY
(25)
P32 FINAL COMP
P40 (171°)(180,165/101,0), V56, SPS SETUP, GDC ALIGN
CSM CSI ONE (104:35·54)(-70.1,0,0)(180,180/101,0), P76
ROLL 180° TO (0,189/101,0)
NOTE CSI ΔV VARIES CONSIDERABLY
P52 (OPTION 3), GDC ALIGN, VERIFY ORDEAL (V83)
P20 (37°)(0,30/64,0)
P32, COMPUTE CSI TWO TIGN, N=1
V93,V57,V87,SXT/VHF(5),
TERMINATE SXT,V93(VHF),
V90(MARK TO CSI TWO -9)
SXT VHF (5)
V90 (CSM)
IF VHF,V93,VHF ONLY
IF NO VHF,V88,SXT ONLY
VHF ONLY
(18)
P32 FINAL COMP
MSFN
LOS
AOS
MSFN
LOS
103 00
10
20
30
40
-49
50
104 00
10
20
-16
30
0
40
50
105 00
-32
10
20
-9
P41, V56, RCS SETUP, GDC ALIGN
CSM CSI TWO (105·31:17)(0,78/180,0), P76
P20 (13°)(0,75/167,0)
V57, V87, 3 MARKS, V67(+02000,+00020,+00001)
(MARK TO PLANE CHANGE - 9')
SXT VHF (12)
V90 (CSM)
P30
P41, V56, RCS SETUP, GDC ALIGN
CSM PLANE CHANGE (105.58·26)(0,180/191,0), P76
P20 (TRIM), P33 (0,186/196,0)
V57, V87, 3 MARKS, V93
(MARK TO CDH -15)
SXT VHF (10)
P33 FINAL COMP, V90, (CSM)
NOTE CDH ΔV VARIES CONSIDERABLY
P40 (75°)(0,311/249,0), V56, SPS SETUP, GDC ALIGN
CSM CDH (106 27 29)(113 9,0,70 6)(0,328/249,0); P76
P20(101°)(0,228/148,0)
P34 (ELEVATION OPTION)
V57, V87, V93 AFTER THREE MARKS; V32
SXT VHF (18)
P34 FINAL COMP, V83, VERIFY ORDEAL
P40(65°)(0,190/20,0), V56, SPS SETUP, GDC ALIGN
CSM TPI (107·02 26)(-22 3,0,6 8)(0,197/20,0), P76
P20 (31°)(0,245/51,0), P35
V93, V57; V87
SXT VHF (8)
P35 FINAL COMP (MARK TO TPI +12)
P41, BYPASS MNVR
CSM MCC1 (107:17·26)(0,268/313,0); P76
P35
V93, V57, V87
(MARK TO TPI +27)
SXT VHF (9)
P35 FINAL COMP; BYPASS MNVR
CSM MCC2 (107 32:26)(0,284/23,0), P76
P00, V89 (40°)(0,262/343,0)
P47,V83
TPF (107·46:28)
AOS
MSFN
LOS
106.00
-25
10
-15
20
0
30
+29
40
+47
50
107.00
0
+4
10
+12
+18
20
+27
+30
30
40
50

7.7 < 40 No PDI_2 + 12 (CSM Active)

7.7.1 Summary

This situation occurs when the LM is inactive and unable to apply the PDI_2 maneuver and is able to achieve less than 40 feet per second of the phasing maneuver. Under these conditions, the CSM initiates a rescue with the first burn occurring two revs after DOI. CSI_1 occurs 180 degrees later with a CSI_2 and CSI_3 (both nominally zero) occurring one and two revs later, respectively. CSI_4 occurs 180 degrees after CSI_3 and CDH occurs three revs after CSI_1 at a delta altitude of 10 nautical miles. With this rendezvous situation, rendezvous would be completed approximately 12 hours after DOI.

The relative profile and the burns shown in the following pages represent the particular situation where the LM is unable to apply any of the phasing burn. This data for all cases where the LM applies a partial burn less than 40 feet per second will vary although the same basic checklist may be followed.



RESCUE TWO PAD

47	
48	
33	:
81	
22	
ΔV_C	
11	:
37	:
N	

CSM CSI ONE COPY

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

LM CSI ONE P76

84	. . .
33	: :

CSM CSI TWO COPY

11	: :
81	. . .

LM CSI TWO P76

84	. . .
33	: :

CSM CSI THREE COPY

11	: :
81	. . .

LM CSI THREE P76

84	. . .
33	: :

CSM CSI FOUR COPY

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

LM CSI FOUR P76

84	. . .
33	: :

CSM PC COPY

33	: :
81	. . .

LM PC P76

84	. . .
33	: :

CSM CDH COPY

13	: :
75	. : :
81	. . .

LM CDH P76

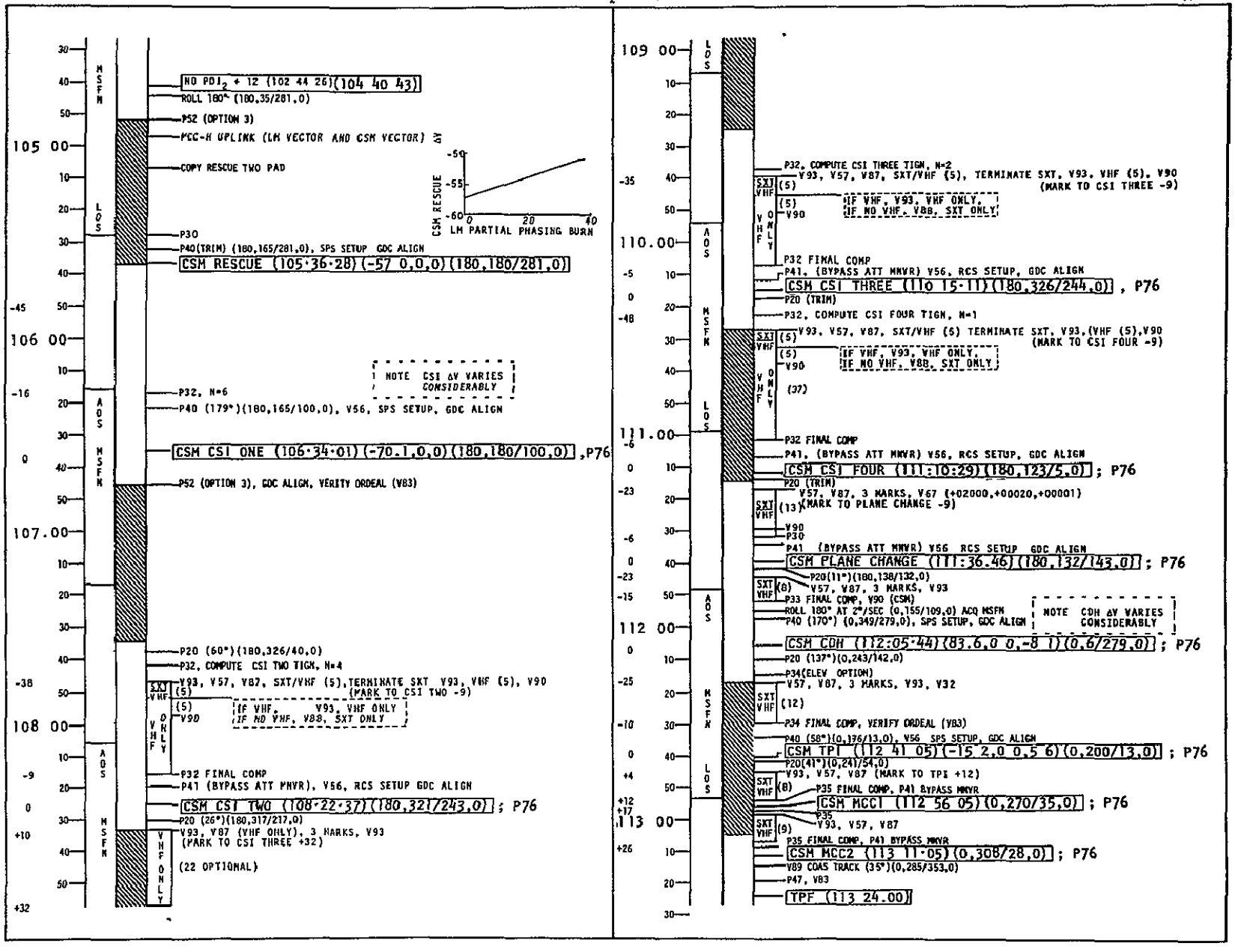
84	. . .
33	: :

CSM TPI COPY

37	: :
58	. . .
81	. . .
59	. . .

LM TPI P76

84	. . .
33	: :

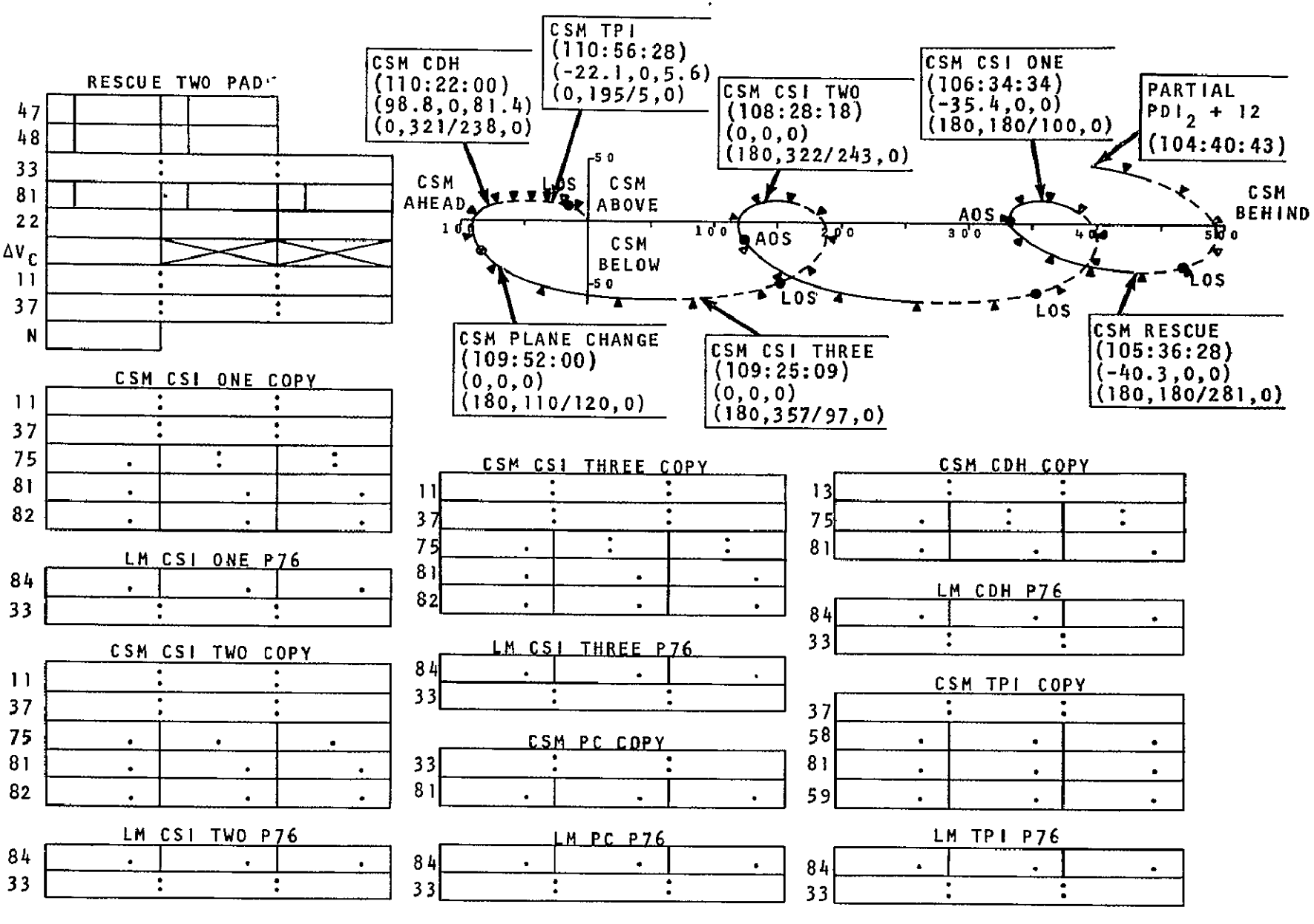

NO PDI2 + 12 (102 44 26)(104 40 43)
ROLL 180^ (180,35/281,0)
P52 (OPTION 3)
PCC-H UPLINK (LM VECTOR AND CSM VECTOR)
COPY RESCUE TWO PAD
CSM RESCUE ΔV
-50
-55
-60
0
20
40
LM PARTIAL PHASING BURN
P30
P40(TRIM) (180,165/281,0), SPS SETUP GDC ALIGN
CSM RESCUE (105·36·28)(-57 0,0,0)(180,180/281,0)
NOTE CSE ΔV VARIES CONSIDERABLY
P32, N=6
P40 (179°)(180,165/100,0), V56, SPS SETUP, GDC ALIGN
CSM CSI ONE (106·34·01)(-70.1,0,0)(180,180/100,0) ,P76
P52 (OPTION 3), GDC ALIGN, VERIFY ORDEAL (V83)
P20 (60°)(180,326/40,0)
P32, COMPUTE CSI TWO TIGN, N=4
SXT VHF
V93, V57, V87, SXT/VHF (5),TERMINATE SXT V93, VHF (5), V90
(5) (MARK TO CSI TWO -9)
(5) IF VHF, V93, VHF ONLY
V90 IF NO VHF, V88, SXT ONLY
VHF ONLY
P32 FINAL COMP
P41 (BYPASS ATT MNVR), V56, RCS SETUP GDC ALIGN
CSM CSI TWO (108·22·37)(180,321/243,0) ; P76
P20 (26°)(180,317/217,0)
V93, V87 (VHF ONLY), 3 MARKS, V93
(MARK TO CSI THREE +32)
(22 OPTIONAL)
P32, COMPUTE CSI THREE TIGN, N=2
V93, V57, V87, SXT/VHF (5), TERMINATE SXT, V93, VHF (5), V90
(5) (MARK TO CSI THREE -9)
(5) IF VHF, V93, VHF ONLY,
V90 IF NO VHF, V88, SXT ONLY
P32 FINAL COMP
P41, (BYPASS ATT MNVR) V56, RCS SETUP, GDC ALIGN
CSM CSI THREE (110 15·11)(180,326/244,0) , P76
P20 (TRIM)
P32, COMPUTE CSI FOUR TIGN, N=1
V93, V57, V87, SXT/VHF (5) TERMINATE SXT, V93,(VHF (5),V90
(5) (MARK TO CSI FOUR -9)
(5) IF VHF, V93, VHF ONLY,
V90 IF NO VHF, V88, SXT ONLY
(37)
P32 FINAL COMP
P41, (BYPASS ATT MNVR) V56, RCS SETUP, GDC ALIGN
CSM CSI FOUR (111:10:29)(180,123/5,0) ; P76
P20 (TRIM)
V57, V87, 3 MARKS, V67 (+02000,+00020,+00001)
(13) (MARK TO PLANE CHANGE -9)
V90
P30
P41 (BYPASS ATT MNVR) V56 RCS SETUP GDC ALIGN
CSM PLANE CHANGE (111:36.46)(180,132/143,0) ; P76
P20(11°)(180,138/132,0)
(8) V57, V87, 3 MARKS, V93
P33 FINAL COMP, V90 (CSM)
ROLL 180° AT 2°/SEC (0,155/109,0) ACQ MSFN
P40 (170°) (0,349/279,0), SPS SETUP, GDC ALIGN
NOTE CDH ΔV VARIES CONSIDERABLY
CSM CDH (112:05:44)(83.6,0 0,-8 1)(0,6/279,0) ; P76
P20 (137°)(0,243/142,0)
P34(ELEV OPTION)
V57, V87, 3 MARKS, V93, V32
(12)
P34 FINAL COMP, VERIFY ORDEAL (V83)
P40 (58°)(0,176/13,0), V56 SPS SETUP, GDC ALIGN
CSM TPI (112 41 05)(-15 2,0 0,5 6)(0,200/13,0) ; P76
P20(41°)(0,241/54,0)
V93, V57, V87 (MARK TO TPI +12)
(8) P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC1 (112 56 05)(0,270/35,0) ; P76
V35
(9) V93, V57, V87
P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC2 (113 11·05)(0,308/28,0) ; P76
V89 COAS TRACK (35°)(0,285/353,0)
P47, V83
TPF (113 24.00)
LOS
AOS
MSFN
105 00
106 00
107.00
108 00
109 00
110.00
111.00
112 00
113 00

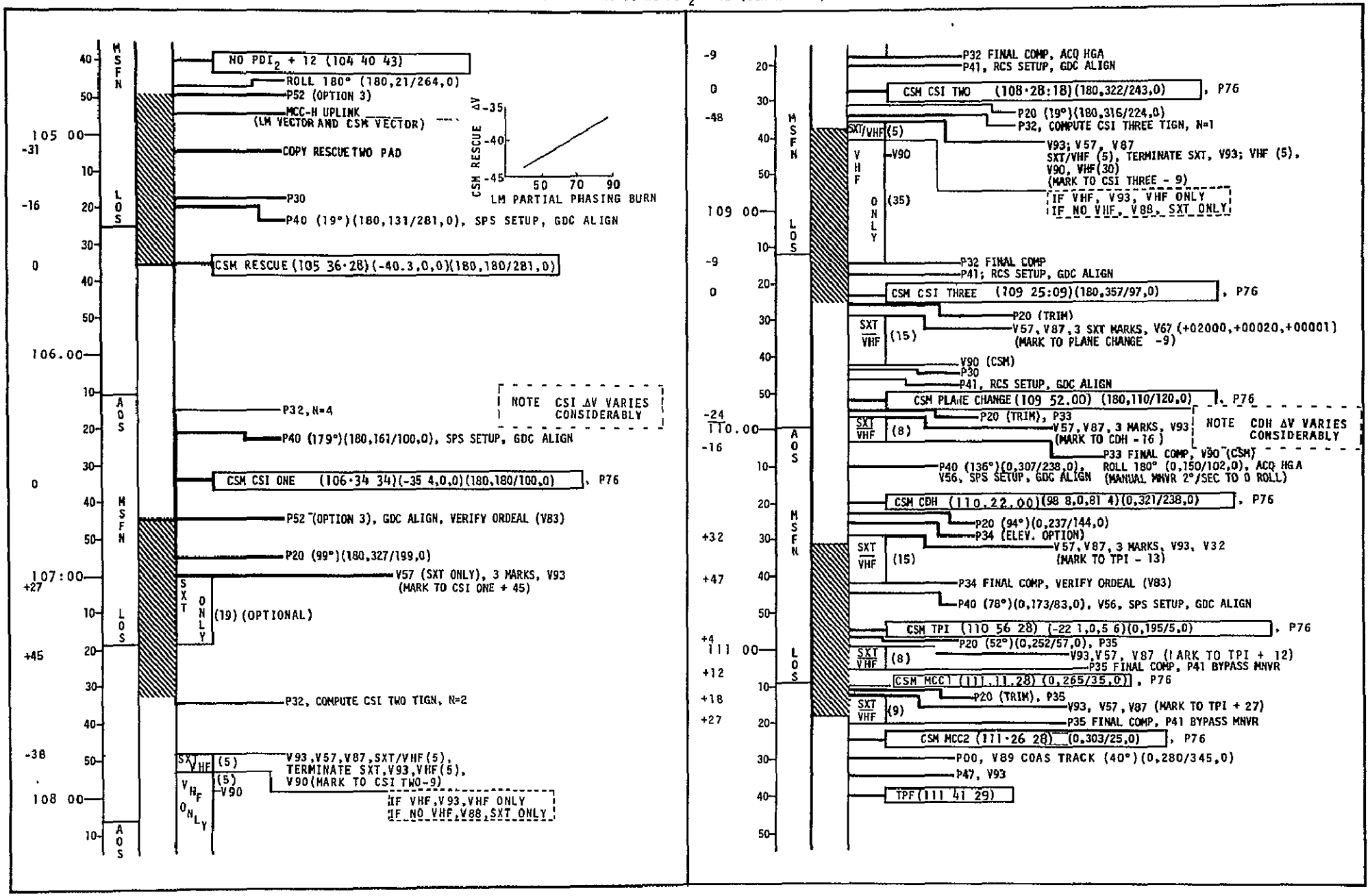
7.8 40-90 No PDI_2 + 12 (CSM Active)

7.8.1 Summary

This rescue case provides for the situation where the LM could not complete the phasing burn after initiating an abort at PDI_2. The first rescue burn occurs two revs after DOI and is followed by CSI_1 one-half rev later. The CSI_1 burn is targeted for a CDH to occur two revs later at a delta altitude of 15 nautical miles with the CSI_2 burn (nominally zero) scheduled half way between CSI and CDH. The rendezvous would be completed approximately 10 hours after DOI.

The relative profile and the burns shown in the following pages represent the particular situation where the LM applies a partial burn of 65 feet per second. This data for other dases where a partial burn between 40 add 90 feet per second is applied will vary although the same basic checklist may be followed.


RESCUE TWO PAD
47
48
33
81
22
ΔVC
11
37
N
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 CDH (110:22:00) (98.8,0,81.4) (0,321/238,0)
CSM TPI (110:56:28) (-22.1,0,5.6) (0,195/5,0)
CSM CSI TWO (108:28:18) (0,0,0) (180,322/243,0)
CSM CSI ONE (106:34:34) (-35.4,0,0) (180,180/100,0)
PARTIAL PDI2 + 12 (104:40:43)
CSM AHEAD
LOS
CSM ABOVE
CSM BELOW
AOS
AOS
LOS
LOS
LOS
CSM BEHIND
CSM PLANE CHANGE (109:52:00) (0,0,0) (180,110/120,0)
CSM CSI THREE (109:25:09) (0,0,0) (180,357/97,0)
CSM RESCUE (105:36:28) (-40.3,0,0) (180,180/281,0)
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


MSFN
LOS
AOS
NO PDI2 + 12 (104 40 43)
ROLL 180° (180,21/264,0)
P52 (OPTION 3)
MCC-H UPLINK
(LM VECTOR AND CSM VECTOR)
COPY RESCUE TWO PAD
CSM RESCUE ΔV
LM PARTIAL PHASING BURN
P30
P40 (19°)(180,131/281,0), SPS SETUP, GDC ALIGN
CSM RESCUE (105 36·28)(-40.3,0,0)(180,180/281,0)
NOTE CSI ΔV VARIES CONSIDERABLY
P32, N=4
P40 (179°)(180,161/100,0), SPS SETUP, GDC ALIGN
CSM CSI ONE (106·34 34)(-35 4,0,0)(180,180/100,0), P76
P52 (OPTION 3), GDC ALIGN, VERIFY ORDEAL (V83)
P20 (99°)(180,327/199,0)
V57 (SXT ONLY), 3 MARKS, V93
(MARK TO CSI ONE + 45)
SXT ONLY (19) (OPTIONAL)
P32, COMPUTE CSI TWO TIGN, N=2
SXT/VHF (5)
VHF ONLY (5) V90
V93,V57,V87,SXT/VHF(5),
TERMINATE SXT,V93,VHF(5),
V90(MARK TO CSI TWO-9)
IF VHF,V93,VHF ONLY
IF NO VHF,V88,SXT ONLY
P32 FINAL COMP, ACQ HGA
P41, RCS SETUP, GDC ALIGN
CSM CSI TWO (108·28:18)(180,322/243,0), P76
P20 (19°)(180,316/224,0)
P32, COMPUTE CSI THREE TIGN, N=1
V93; V57, V87
SXT/VHF (5), TERMINATE SXT, V93; VHF (5),
V90, VHF(30)
(MARK TO CSI THREE - 9)
IF VHF, V93, VHF ONLY
IF NO VHF, V88, SXT ONLY
P32 FINAL COMP
P41; RCS SETUP, GDC ALIGN
CSM CSI THREE (109 25:09)(180,357/97,0), P76
P20 (TRIM)
V57, V87, 3 SXT MARKS, V67 (+02000,+00020,+00001)
(MARK TO PLANE CHANGE -9)
V90 (CSM)
P30
P41, RCS SETUP, GDC ALIGN
CSM PLANE CHANGE (109 52.00) (180,110/120,0), P76
P20 (TRIM), P33
V57, V87, 3 MARKS, V93
(MARK TO CDH - 16)
NOTE CDH ΔV VARIES CONSIDERABLY
P33 FINAL COMP, V90 (CSM)
P40 (136°)(0,307/238,0), V56, SPS SETUP, GDC ALIGN
ROLL 180° (0,150/102,0), ACQ HGA
(MANUAL MNVR 2°/SEC TO 0 ROLL)
CSM CDH (110.22.00)(98 8,0,81 4)(0,321/238,0), P76
P20 (94°)(0,237/144,0)
P34 (ELEV. OPTION)
V57, V87, 3 MARKS, V93, V32
(MARK TO TPI - 13)
P34 FINAL COMP, VERIFY ORDEAL (V83)
P40 (78°)(0,173/83,0), V56, SPS SETUP, GDC ALIGN
CSM TPI (110 56 28) (-22 1,0,5 6)(0,195/5,0), P76
P20 (52°)(0,252/57,0), P35
V93,V57, V87 (MARK TO TPI + 12)
P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC (111.11.28) (0,265/35,0), P76
P20 (TRIM), P35
V93, V57, V87 (MARK TO TPI + 27)
P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC2 (111·26 28) (0,303/25,0), P76
P00, V89 COAS TRACK (40°)(0,280/345,0)
P47, V93
TPF (111 41 29)

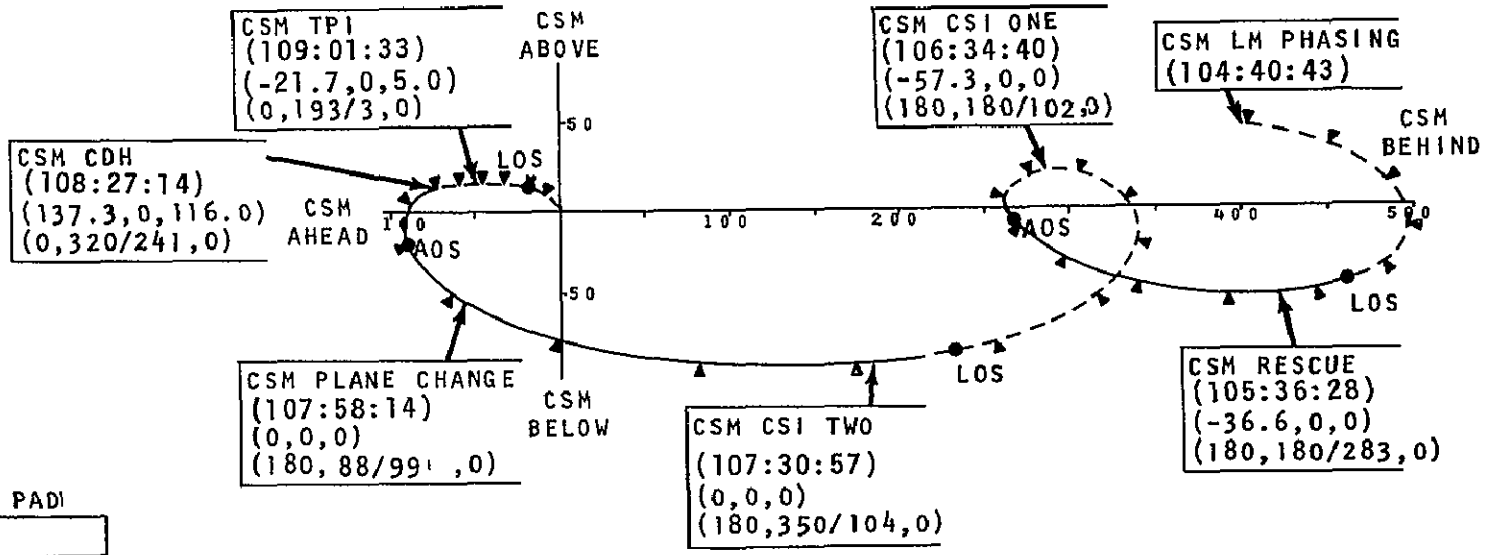
7.9 ≥ 90 No PDI_2 + (CSM Active)

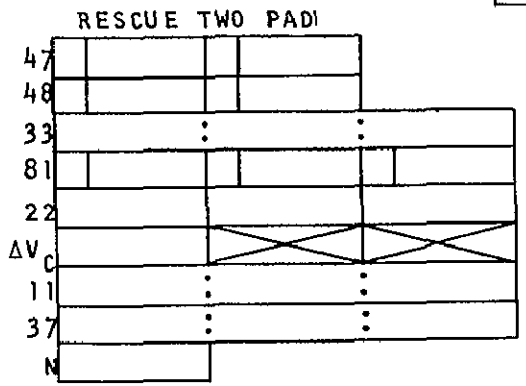
7.9.1 Summary

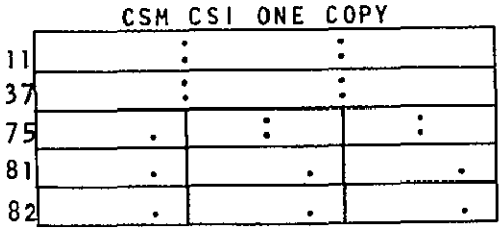
This rescue provides for the situation where the LM completes a partial phasing burn greater than 90 feet per second. This case is similar to the previous 40-90 No PDI_2 + 12 Rescue except that one less rev is required between CSI_1 and CDH. This rendezvous would be completed approximately 8 hours after DOI.

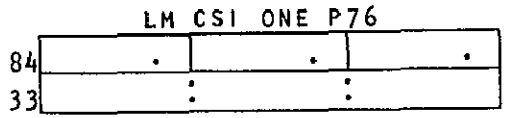
The relative profile and the burns shown in the following pages represent the particular situation where the LM applies a partial burn of 90 feet per second. This data for all cases where a partial burn greater than 90 feet per second is applied will vary although the same basic checklist may be followed.

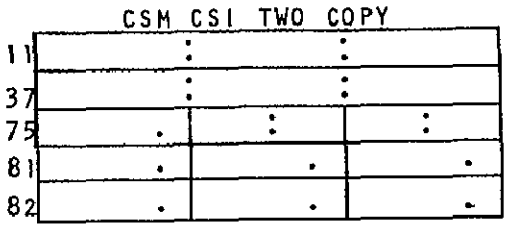
7.9.2 ≥90 NO PDI$_2$ + 12 (CSM ACTIVE)

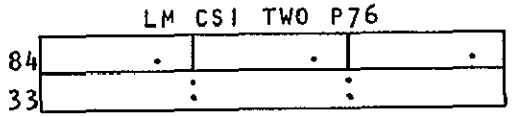


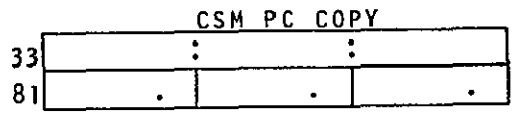


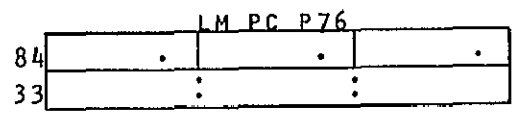


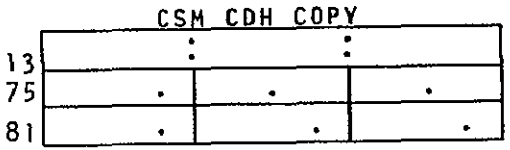


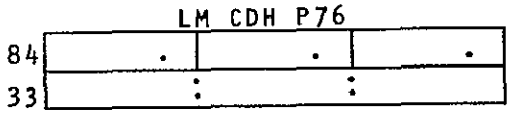


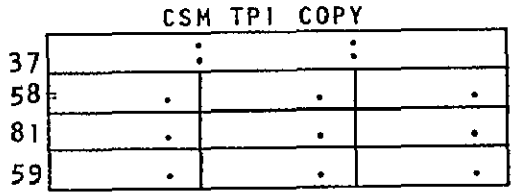


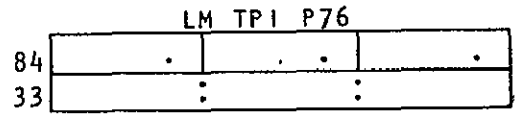


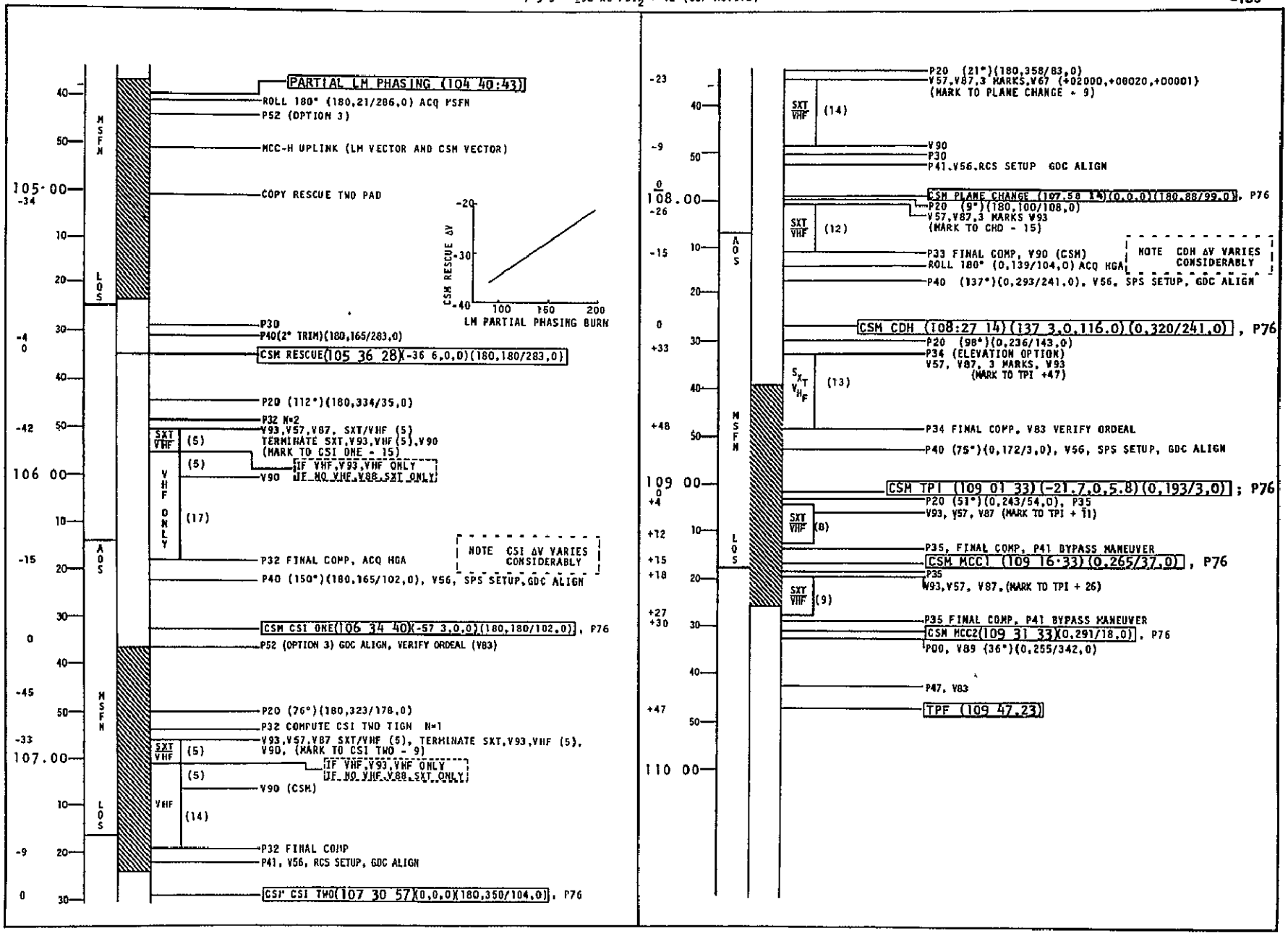











PARTIAL LM PHASING (104 40:43)
ROLL 180° (180,21/286,0) ACQ PSFN
P52 (OPTION 3)
MCC-H UPLINK (LM VECTOR AND CSM VECTOR)
COPY RESCUE TWO PAD
CSM RESCUE ΔV
LM PARTIAL PHASING BURN
P30
P40(2° TRIM)(180,165/283,0)
CSM RESCUE(105 36 28)(-36 6,0,0)(180,180/283,0)
P20 (112°)(180,334/35,0)
P32 N=2
V93,V57,V87, SXT/VHF (5)
TERMINATE SXT,V93,VHF(5),V90
(MARK TO CSI ONE - 15)
IF VHF,V93,VHF ONLY
IF NO VHF,V88,SXT ONLY
V90
P32 FINAL COMP, ACQ HGA
NOTE CSI ΔV VARIES CONSIDERABLY
P40 (150°)(180,165/102,0), V56, SPS SETUP,GDC ALIGN
CSM CSI ONE(106 34 40)(-57 3,0,0)(180,180/102,0), P76
P52 (OPTION 3) GDC ALIGN, VERIFY ORDEAL (V83)
P20 (76°)(180,323/178,0)
P32 COMPUTE CSI TWO TIGN N=1
V93,V57,V87 SXT/VHF (5), TERMINATE SXT,V93,VHF (5),
V90, (MARK TO CSI TWO - 9)
IF VHF,V93,VHF ONLY
IF NO VHF,V88,SXT ONLY
V90 (CSM)
P32 FINAL COMP
P41, V56, RCS SETUP, GDC ALIGN
CSI* CSI TWO(107 30 57)(0,0,0)(180,350/104,0), P76
P20 (21°)(180,358/83,0)
V57,V87,3 MARKS,V67 (+02000,+00020,+00001)
(MARK TO PLANE CHANGE - 9)
V90
P30
P41,V56,RCS SETUP GDC ALIGN
CSM PLANE CHANGE (107.58 14)(0,0,0)(180,88/99,0), P76
P20 (9°)(180,100/108,0)
V57,V87,3 MARKS V93
(MARK TO CHD - 15)
P33 FINAL COMP, V90 (CSM)
ROLL 180° (0,139/104,0) ACQ HGA
NOTE CDH ΔV VARIES CONSIDERABLY
P40 (137°)(0,293/241,0), V56, SPS SETUP, GDC ALIGN
CSM CDH (108:27 14)(137 3,0,116.0)(0,320/241,0), P76
P20 (98°)(0,236/143,0)
P34 (ELEVATION OPTION)
V57, V87, 3 MARKS, V93
(MARK TO TPI +47)
P34 FINAL COMP, V83 VERIFY ORDEAL
P40 (75°)(0,172/3,0), V56, SPS SETUP, GDC ALIGN
CSM TPI (109 01 33)(-21.7,0,5.8)(0,193/3,0); P76
P20 (51°)(0,243/54,0), P35
V93, V57, V87 (MARK TO TPI + 11)
P35, FINAL COMP, P41 BYPASS MANEUVER
CSM MCC1 (109 16 33)(0,265/37,0), P76
P35
V93,V57, V87,(MARK TO TPI + 26)
P35 FINAL COMP, P41 BYPASS MANEUVER
CSM MCC2(109 31 33)(0,291/18,0), P76
P00, V89 (36°)(0,255/342,0)
P47, V83
TPF (109 47.23)

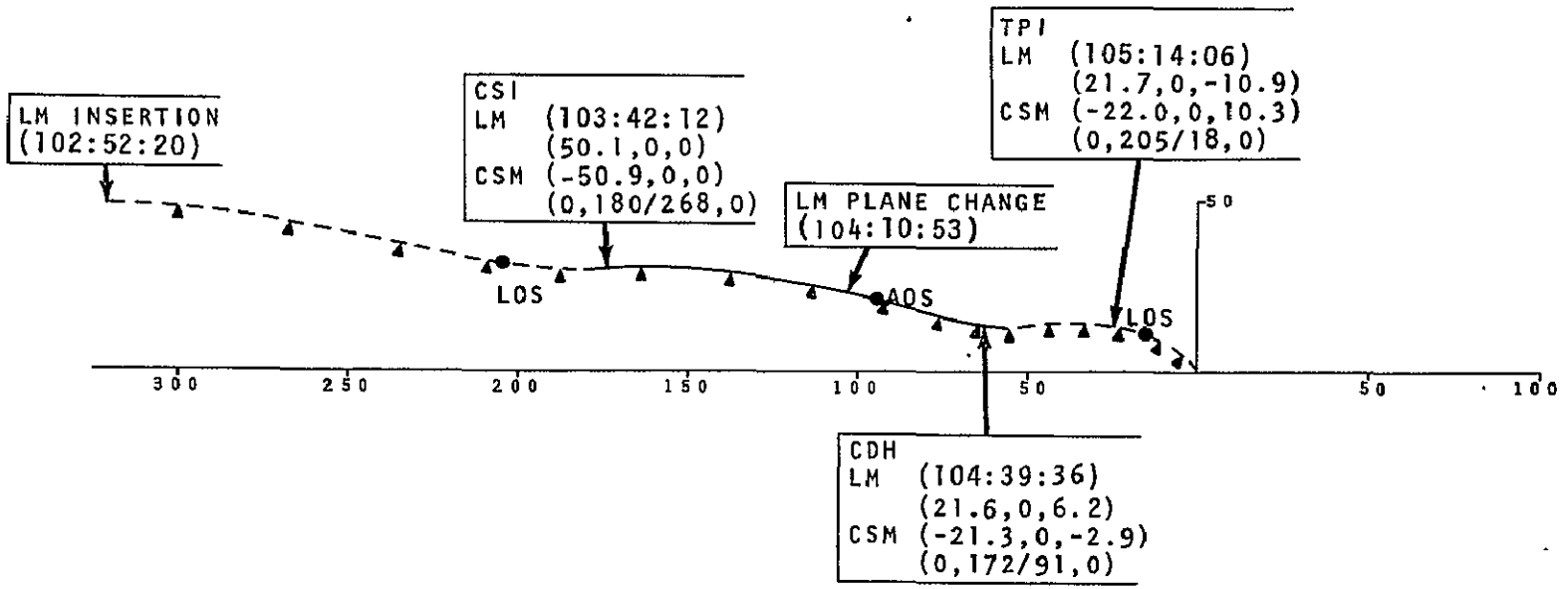
7.10 PDI_1 < 10 Variable Insertion (LM Active)

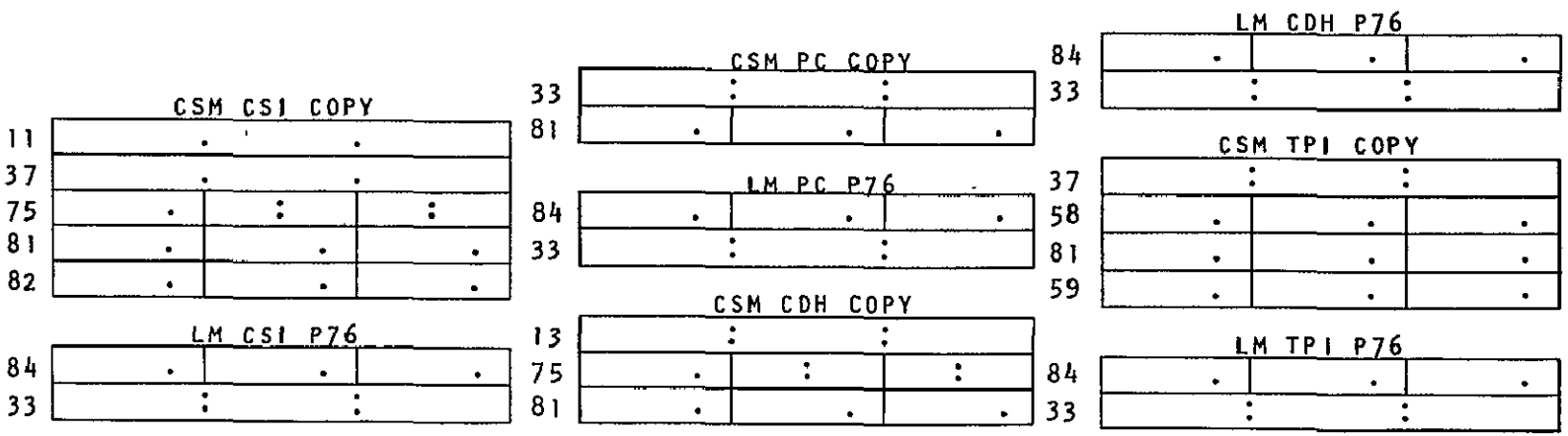
7.10.1 Summary

This rescue results from an abort less than 10 minutes into the powered descent. Under these conditions, the LM inserts into a variable insertion orbit. No rescue burn is required for this rendezvous. The first burn, CSI is scheduled at 50 minutes after LM insertion with CDH one-half rev later.

The relative profile and the burns shown in the following pages represent the particular situation where the abort occurs at PDI_1 + 10 minutes. This data for other cases where the abort is initiated less than 10 minutes into the descent will vary particularly for the CDH burn. However, the same basic checklist is applicable.

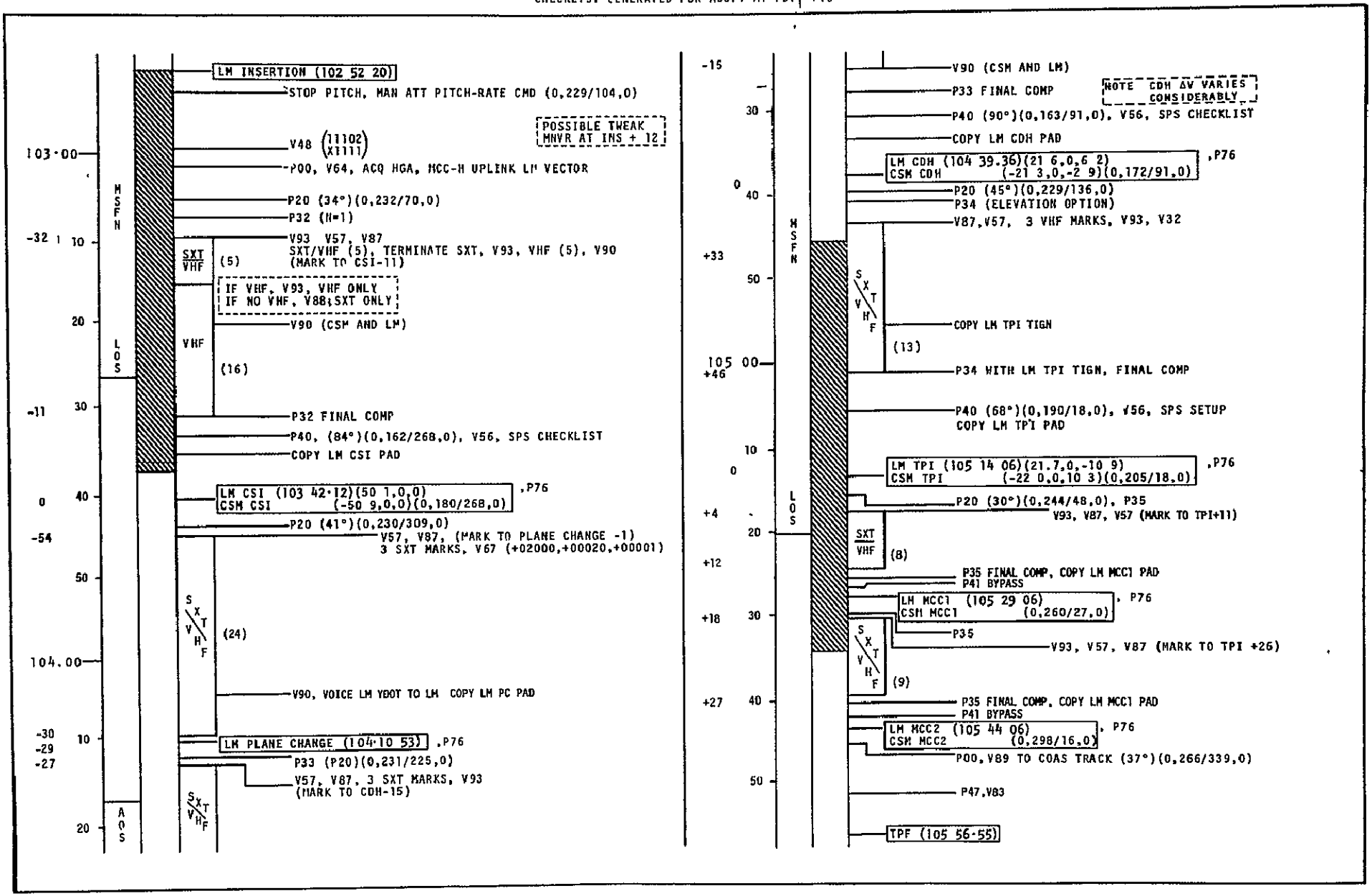
7.10.2. PDI_1 <10 VARIABLE INSERTION (LM ACTIVE)





7 10 3 PDI_1 <10 VARIABLE INSERTION (LM ACTIVE)

CHECKLIST GENERATED FOR ABORT AT PDI_1 +10

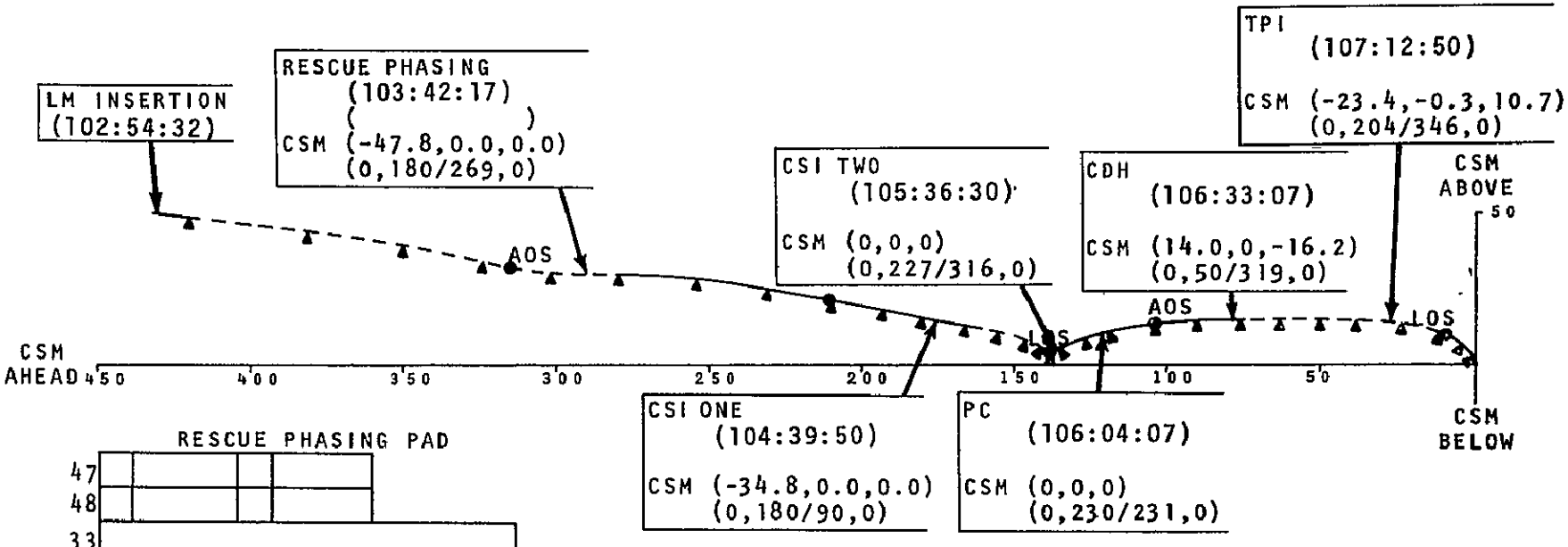


7.11 PDI_1 + 12 (10-12.5 Minutes) (CSM Active)

7.11.1 Summary

This rescue results from an abort during the powered descent. It is assumed that following the decision to abort, the LM will be able to insert into a fixed 10 X 30 orbit and that the CSM will then complete the rendezvous. The initial rescue phasing burn will be performed at a fixed GET defined as 50 minutes from that insertion cut off time associated with an abort at PDI_1 + 10 minutes. This rescue phasing burn will be a constant 47.8 feet per second retrograde burn for cases where an abort is initiated between PDI_1 + 10 and PDI_1 + 12.5 minutes. The CSI_1 burn is targeted for the LM CSI time and occurs approximately one-half rev after the rescue phasing burn. The CDH burn is scheduled for one rev after CSI_1 with a nominally zero CSI_2 burn half way between CSI_1 and CDH. For this rescue situation, rendezvous is completed approximately six hours after DOI.

The relative profile and burns shown in the following pages represent the particular situation where the abort occurs at PDI_1 + 12 minutes. This data for other cases where the abort is initiated between 10 and 12.5 minutes after PDI will vary; however, the same basic checklist is applicable.



RESCUE PHASING PAD

47	
48	
33	
81	
22	
ΔV_C	
11	
37	
N	

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

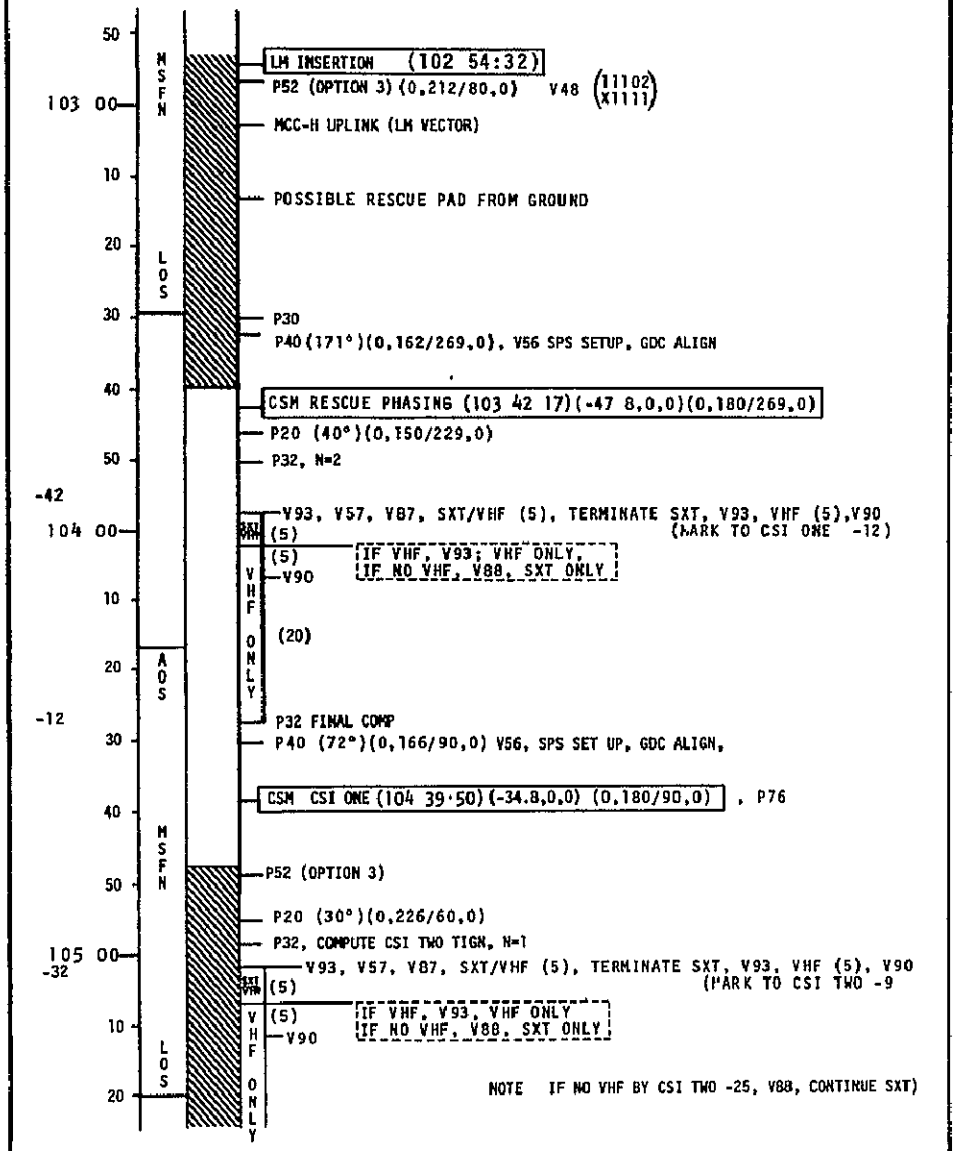
84	.	.	.
33	:	:	

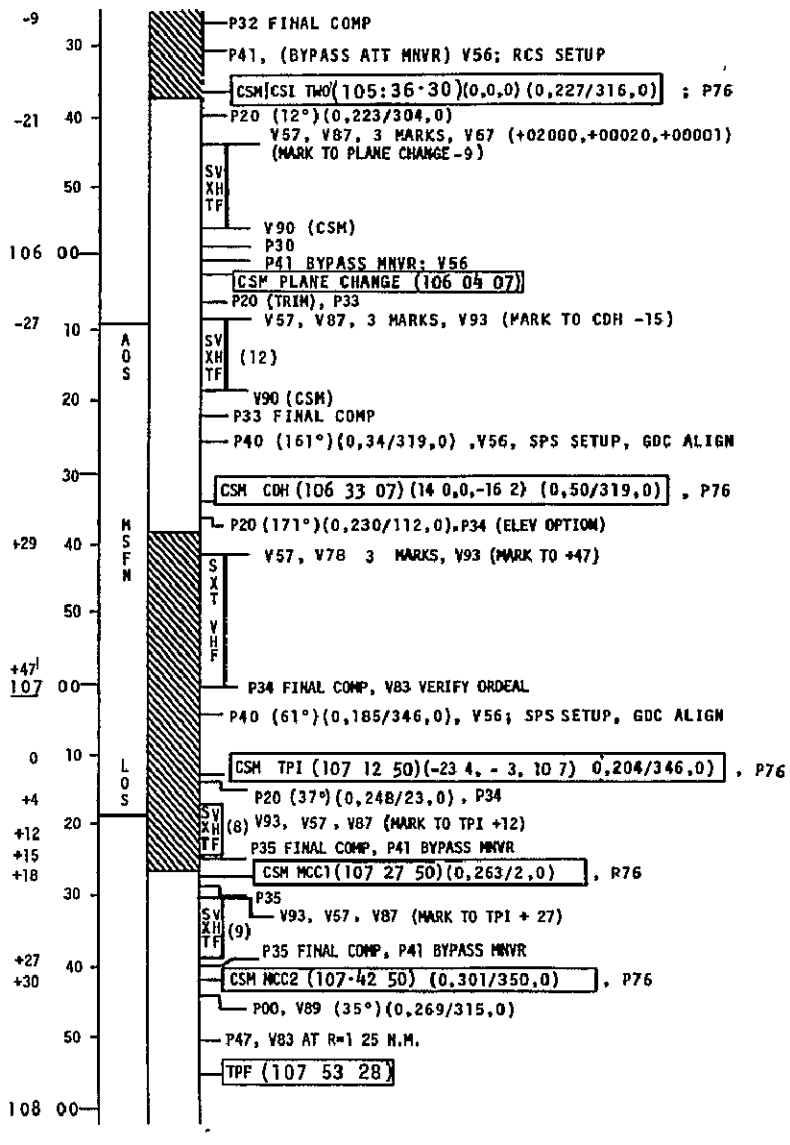
LM PC P76

84	.	.	.
33	:	:	

LM TPI P76

84	.	.	.
33	:	:	


LM INSERTION (102 54:32)
P52 (OPTION 3) (0,212/80,0) V48 (11102 X1111)
MCC-H UPLINK (LM VECTOR)
POSSIBLE RESCUE PAD FROM GROUND
P30
P40 (171°)(0,162/269,0), V56 SPS SETUP, GDC ALIGN
CSM RESCUE PHASING (103 42 17)(-47 8,0,0)(0,180/269,0)
P20 (40°)(0,150/229,0)
P32, N=2
V93, V57, V87, SXT/VHF (5), TERMINATE SXT, V93, VHF (5),V90
(MARK TO CSI ONE -12)
(5)
(5) IF VHF, V93; VHF ONLY, IF NO VHF, V88, SXT ONLY
V90
(20)
P32 FINAL COMP
P40 (72°)(0,166/90,0) V56, SPS SET UP, GDC ALIGN,
CSM CSI ONE (104 39 50)(-34.8,0,0) (0,180/90,0) , P76
P52 (OPTION 3)
P20 (30°)(0,226/60,0)
P32, COMPUTE CSI TWO TIGN, N=1
V93, V57, V87, SXT/VHF (5), TERMINATE SXT, V93, VHF (5), V90
(MARK TO CSI TWO -9
(5)
(5) IF VHF, V93, VHF ONLY IF NO VHF, V88, SXT ONLY
V90
NOTE IF NO VHF BY CSI TWO -25, V88, CONTINUE SXT)
MSFN
LOS
AOS
MSFN
LOS
VHF ONLY
VHF ONLY
103 00
-42
104 00
-12
105 00
-32


P32 FINAL COMP
P41, (BYPASS ATT MNVR) V56; RCS SETUP
CSM CSI TWO (105:36:30)(0,0,0) (0,227/316,0) ; P76
P20 (12°)(0,223/304,0)
V57, V87, 3 MARKS, V67 (+02000,+00020,+00001)
(MARK TO PLANE CHANGE -9)
V90 (CSM)
P30
P41 BYPASS MNVR; V56
CSM PLANE CHANGE (106 04 07)
P20 (TRIM), P33
V57, V87, 3 MARKS, V93 (MARK TO CDH -15)
(12)
V90 (CSM)
P33 FINAL COMP
P40 (161°)(0,34/319,0) ,V56, SPS SETUP, GDC ALIGN
CSM CDH (106 33 07) (14 0,0,-16 2) (0,50/319,0) , P76
P20 (171°)(0,230/112,0),P34 (ELEV OPTION)
V57, V78 3 MARKS, V93 (MARK TO +47)
P34 FINAL COMP, V83 VERIFY ORDEAL
P40 (61°)(0,185/346,0), V56; SPS SETUP, GDC ALIGN
CSM TPI (107 12 50)(-23 4, - 3, 10 7) 0,204/346,0) , P76
P20 (37°)(0,248/23,0) , P34
(8) V93, V57 , V87 (MARK TO TPI +12)
P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC1 (107 27 50)(0,263/2,0) , R76
P35
V93, V57, V87 (MARK TO TPI + 27)
(9)
P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC2 (107 42 50) (0,301/350,0) , P76
P00, V89 (35°)(0,269/315,0)
P47, V83 AT R=1 25 N.M.
TPF (107 53 28)
AOS
MSFN
LOS
SV XH TF
SV XH TF
SV XH TF
SV XH TF
SXT VHF
-9
-21
106 00
-27
+29
+47
107 00
0
+4
+12
+15
+18
+27
+30
108 00

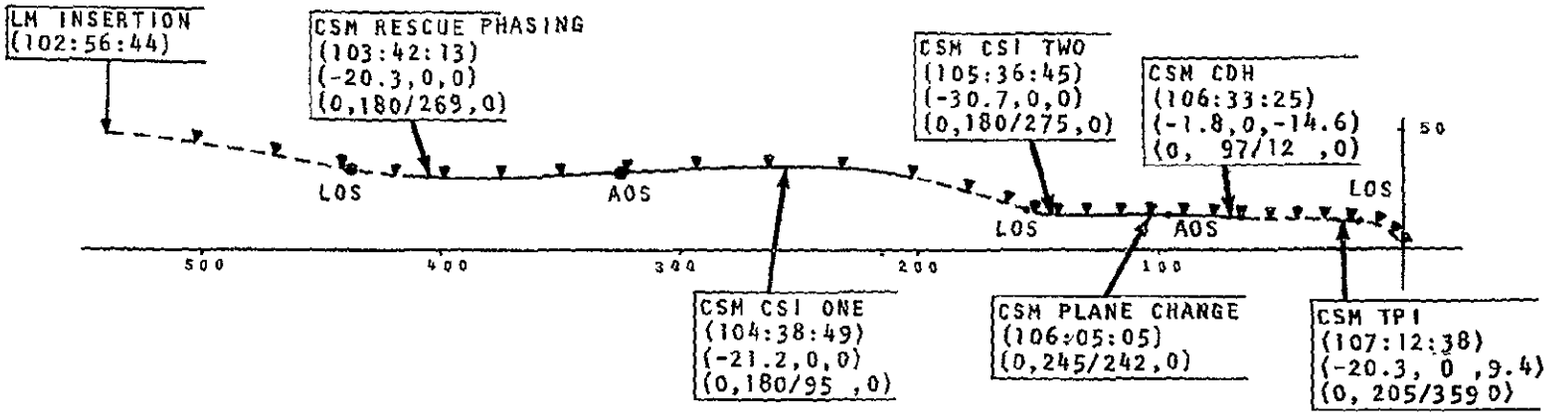
7.12 PDI_1 + 14:12 (12.5-15 Minutes) (CSM Active)

7.12.1 Summary

This rescue also results from an abort during the powered descent. This rescue is similar to the PDI_1 + 12 Rescue except that for those cases from PDI_1 + 12.5 to PDI_1 + 15 minutes, the CSM rescue phasing burn is a mirror image of the desired LM phasing burn. Also the CSI_1 burn is targeted for a CDH one-half rev later. However, this CDH burn is not applied but replaced by a CSI_2 which make the two orbits co-elliptic. For this rescue situation, rendezvous is completed approximately six hours after DOI.

The relative profile and the burns shown in the following pages represent the particular situation where the abort occurs at PDI_1 + 14:12. This data for other cases where the abort is initiated between 12.5 and 15 minutes after PDI will vary; however, the same basic checklist is applicable.

7.12.2 PDI_1+ 14:12 (12.5-15 MINUTES) (CSM ACTIVE)



RESCUE PHASING PAD

47	
48	
33	
81	
22	
ΔV_C	
11	
37	
N	

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 PC COPY

33	
81	

LM PC P76

84	
33	

CSM CDH COPY

13	
75	
81	

LM CDH P76

84	
33	

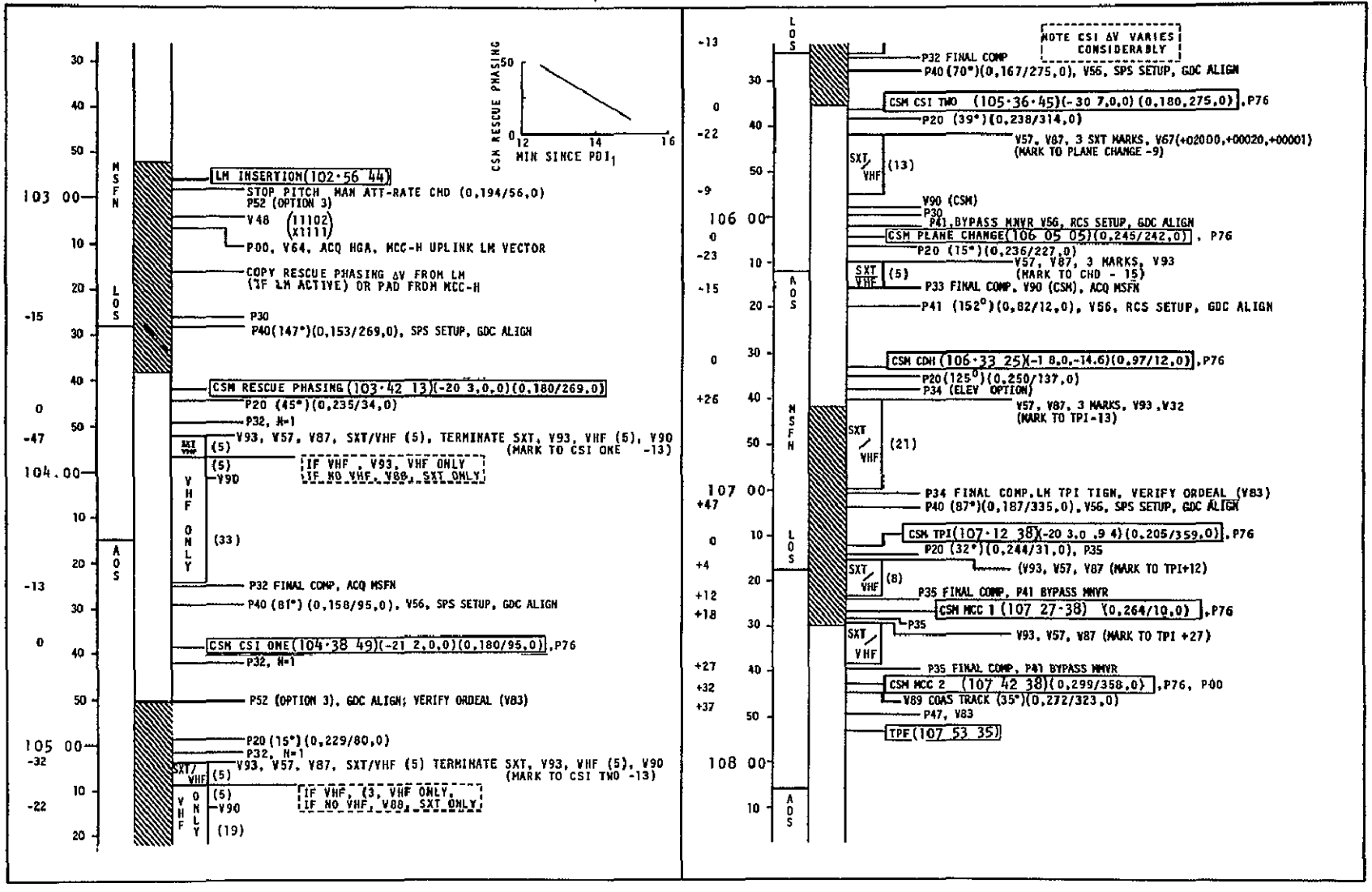
CSM TPI COPY

37	
58	
81	
59	

LM TPI P76

84	
33	

7 12 3 PDI_1+14 12 (12 5-15 MINUTES)(CSM ACTIVE)

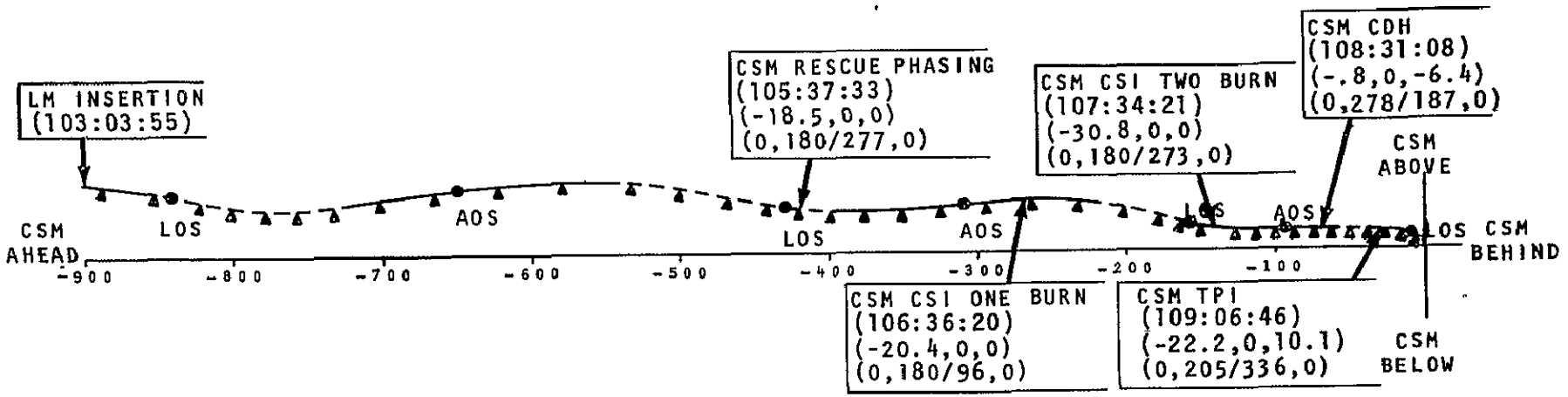


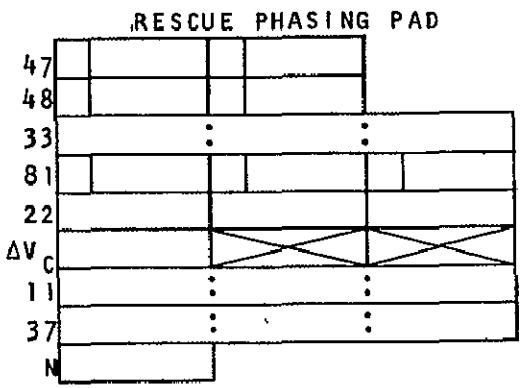
7.13 PDI_1 + 21:24 Preferred lift-off (T_2) (CSM Active)

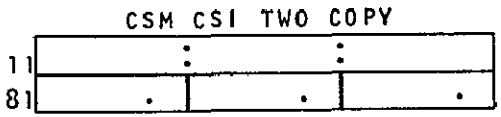
7.13.1 Summary

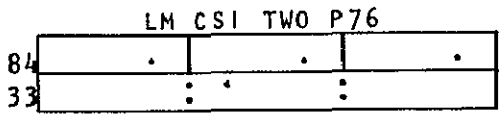
This rescue results from an abort 21 minutes and 24 seconds after initiation of the powered descent. This coincides with the first preferred lift-off time (T_2) after PDI. The initial rescue phasing burn will be performed at a fixed GET which is approximately 153 minutes after LM insertion cut off (when the CSM reaches the longitude where the LM would have done phasing). This delay is due to the fact that the CSM cannot back-up the phasing burn at the LM phasing time because of the lack of spacecraft communications at that time. CSI_1 occurs one-half rev after the rescue phasing burn with CSI_2 occurring half-way between CSI_1 and CDH. For this rescue situation, rendezvous is completed approximately eight hours after DOI.

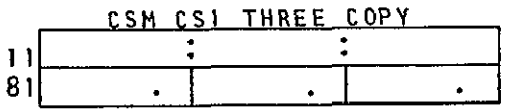
7.13.2. PDI_1 + 21:24 PREFERRED LIFT-OFF (T_2) (CSM ACTIVE)

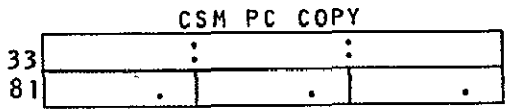


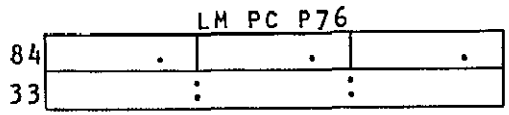


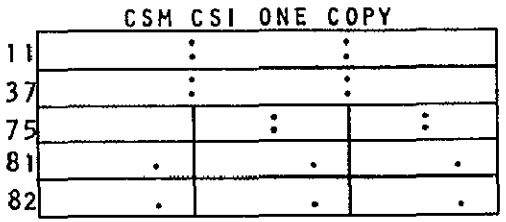


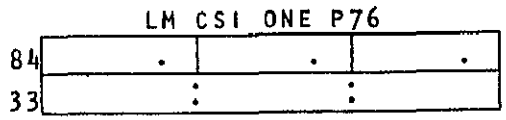


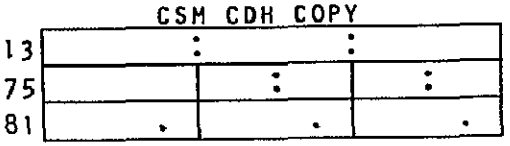


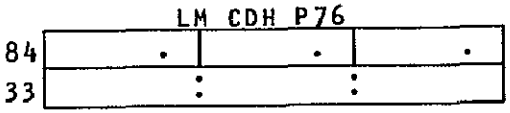


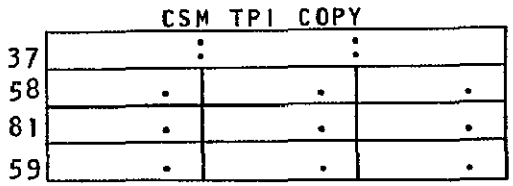


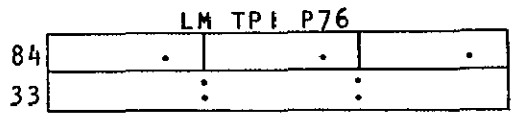




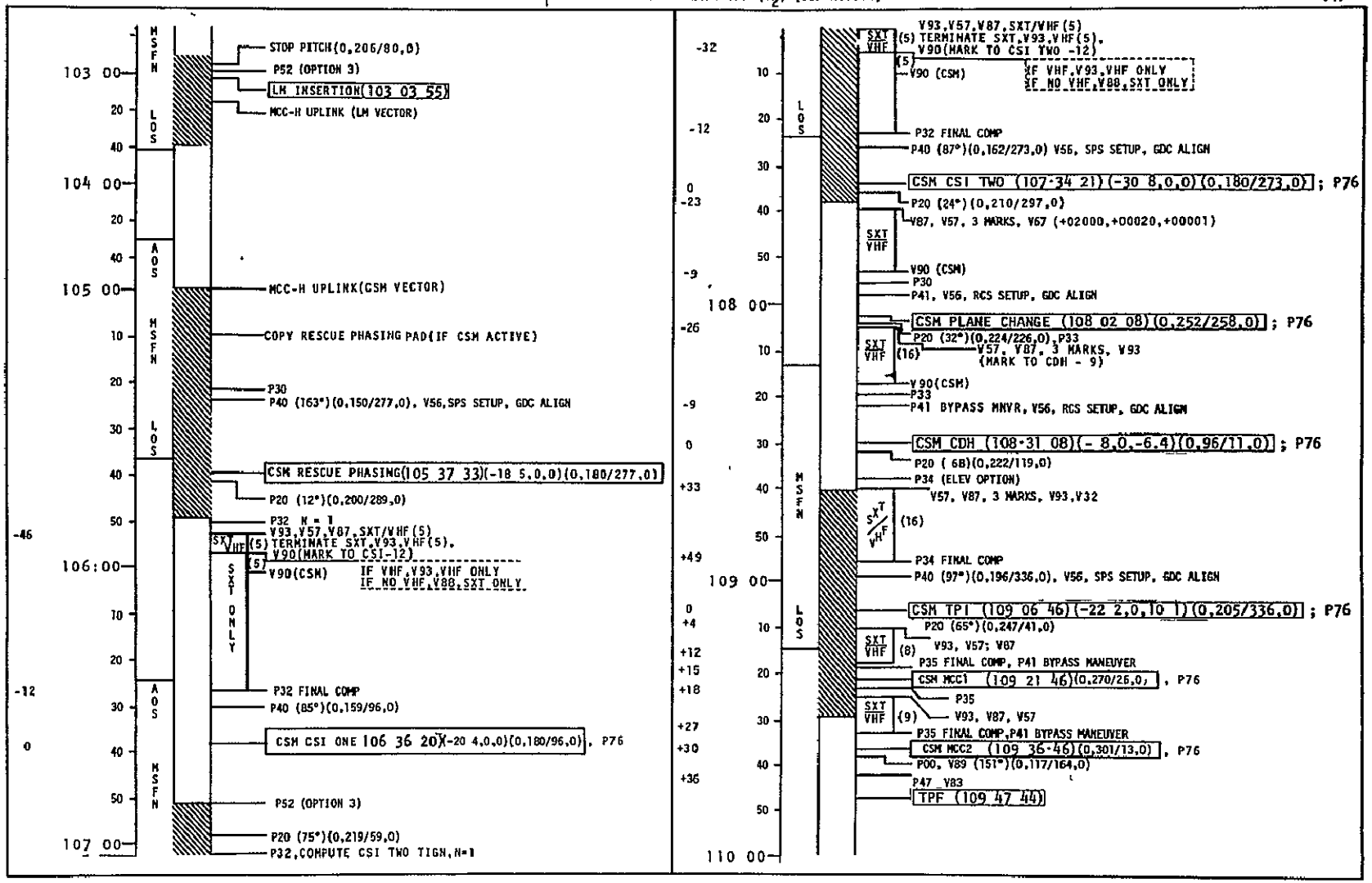








7 13 3 PDI$_1$ + 21 24 PREFERRED LIFT-OFF (T_2) (CSM ACTIVE)

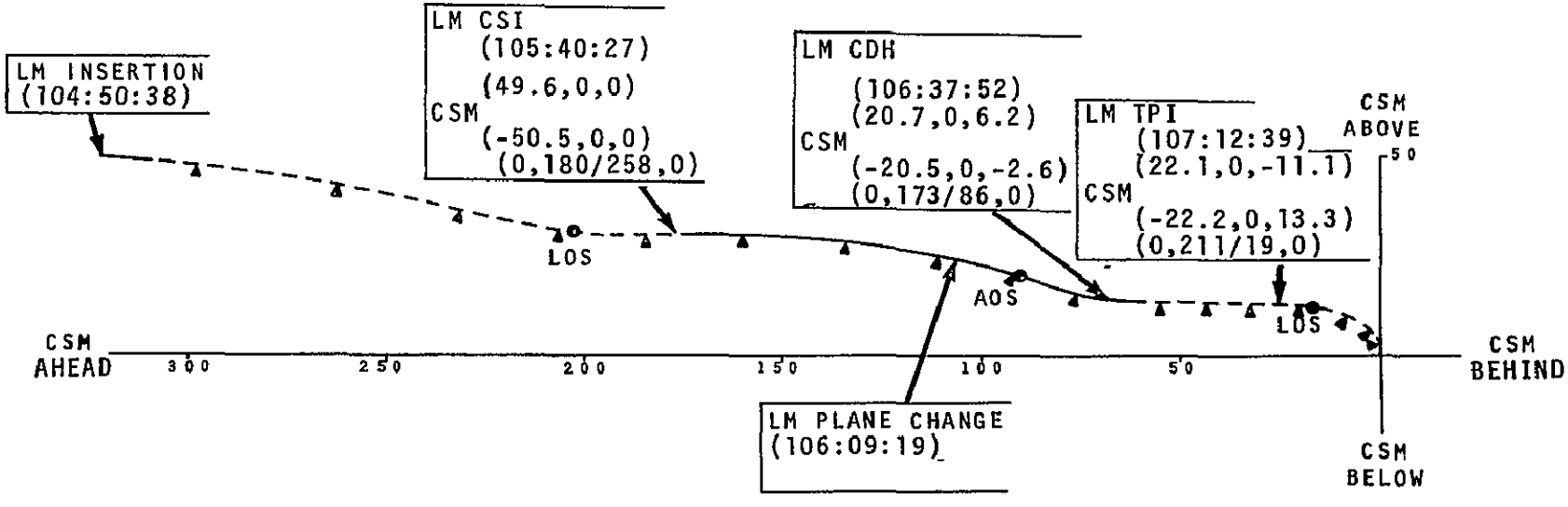


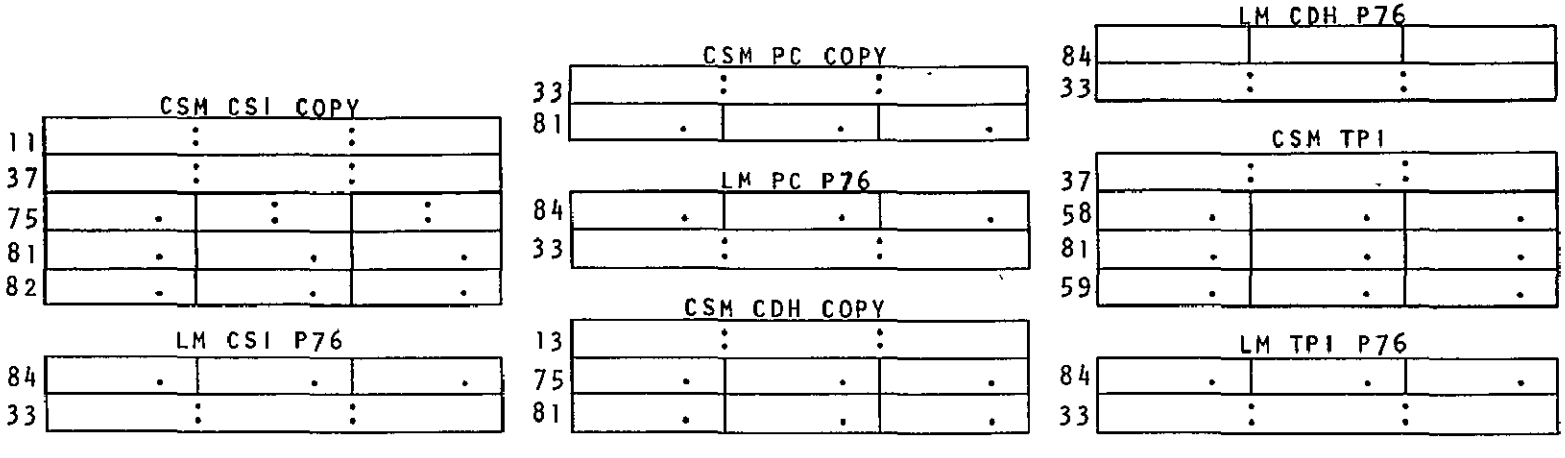
7.14 $PDI_2 \leq 14.5$ Variable Insertion (LM Active)

7.14.1 Summary

This rescue results from an abort during the powered descent where the descent was initiated at the second opportunity. It is assumed that following the decision to abort, the LM will be able to insert into orbit and that the CSM will then complete the rendezvous. This case is similar to the PDI_1 case described in Section 7.10. The LM is assumed to achieve a variable insertion orbit followed by a CSI burn (LM active) 50 minutes after insertion. The CDH burn is scheduled one-half rev after CSI_1.

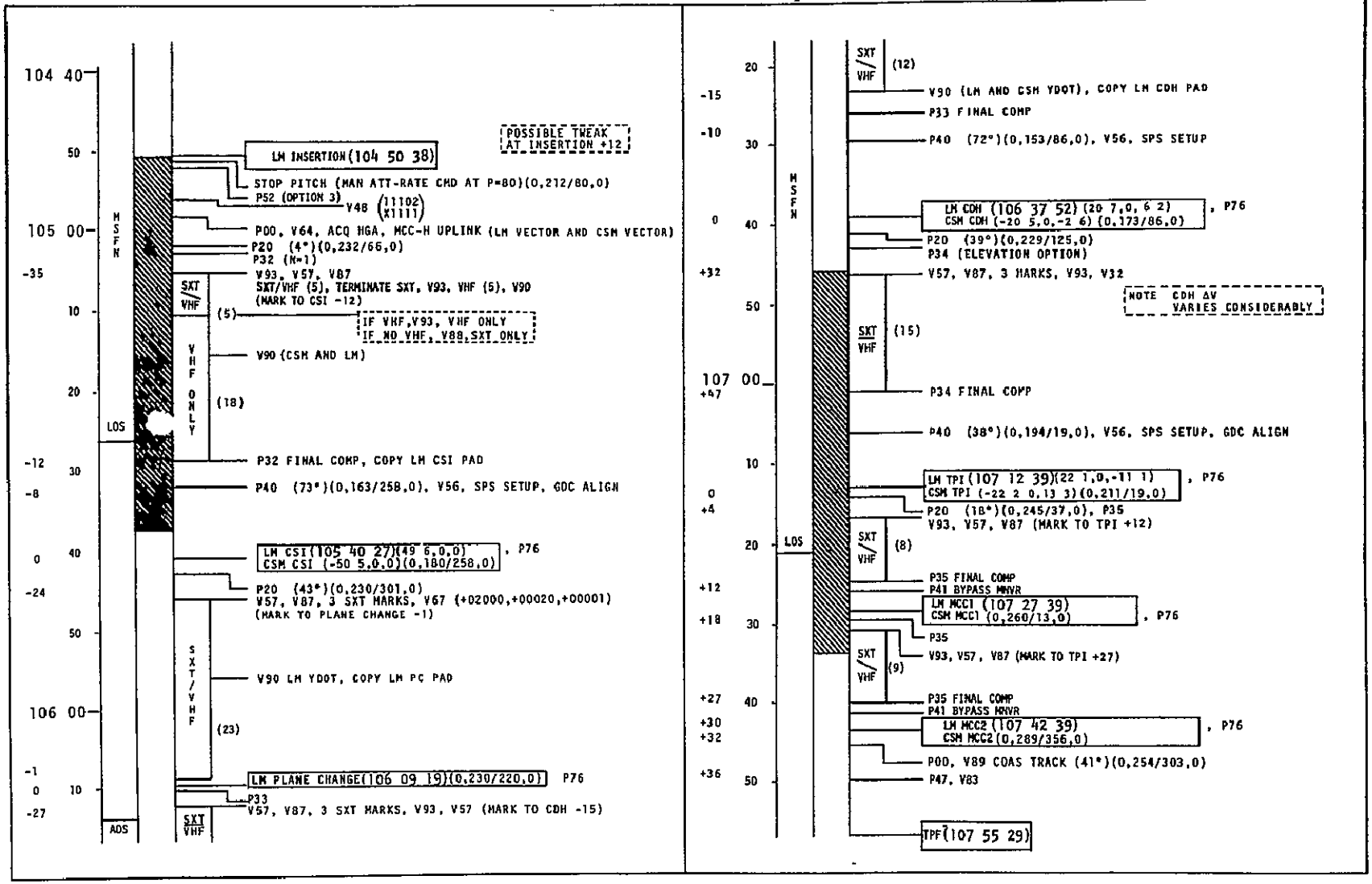
The relative profile and the burns shown in the following pages represent the particular situation where the abort occurs at PDI_2 + 14:24. This data for other cases where the abort is initiated less than 14 1/2 minutes into the descent will vary particularly for the CDH burn. However, the same basic checklist is applicable.


LM INSERTION
(104:50:38)
LM CSI
(105:40:27)
(49.6,0,0)
CSM
(-50.5,0,0)
(0,180/258,0)
LM CDH
(106:37:52)
(20.7,0,6.2)
CSM
(-20.5,0,-2.6)
(0,173/86,0)
LM TPI
(107:12:39)
(22.1,0,-11.1)
CSM
(-22.2,0,13.3)
(0,211/19,0)
CSM ABOVE
50
LOS
AOS
LOS
CSM AHEAD
300
250
200
150
100
50
CSM BEHIND
LM PLANE CHANGE
(106:09:19)
CSM BELOW


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
37
58
81
59
LM TPI P76
84
33

7 14 3 PDI$_2$ <14 30 VARIABLE INSERTION (LM ACTIVE)

CHECKLIST GENERATED FOR ABORT AT PDI$_2$ +14 24

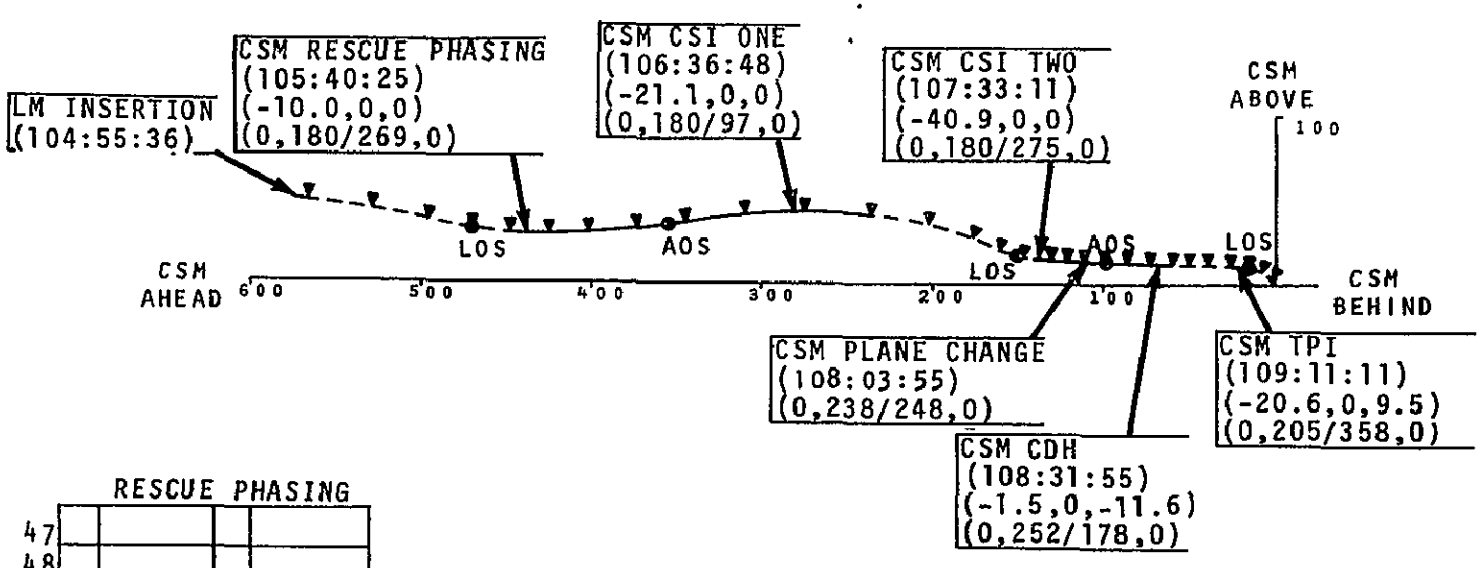


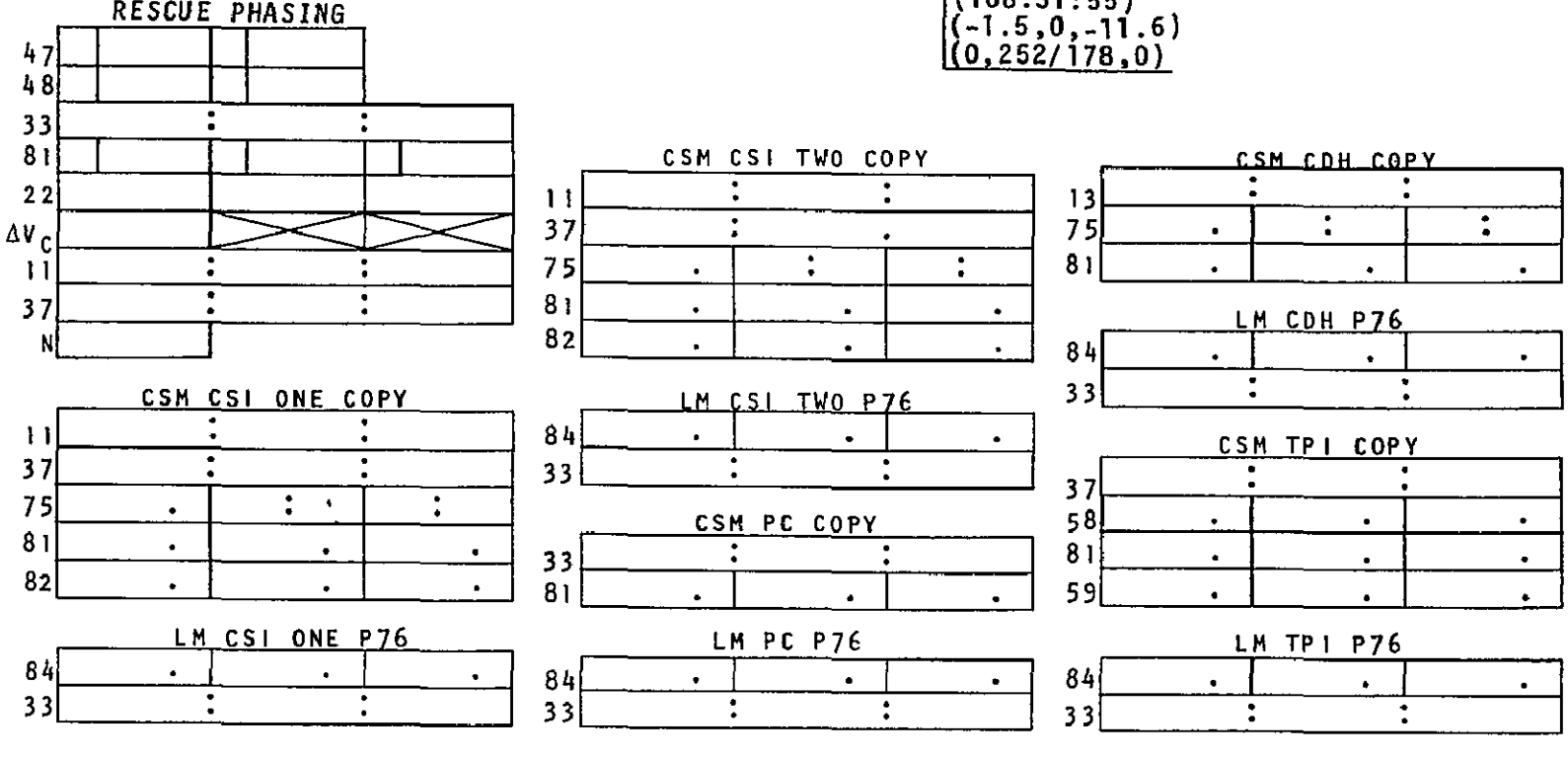
7.15 PDI_2 + 19:22 Preferred Lift-off (T_2) (CSM Active)

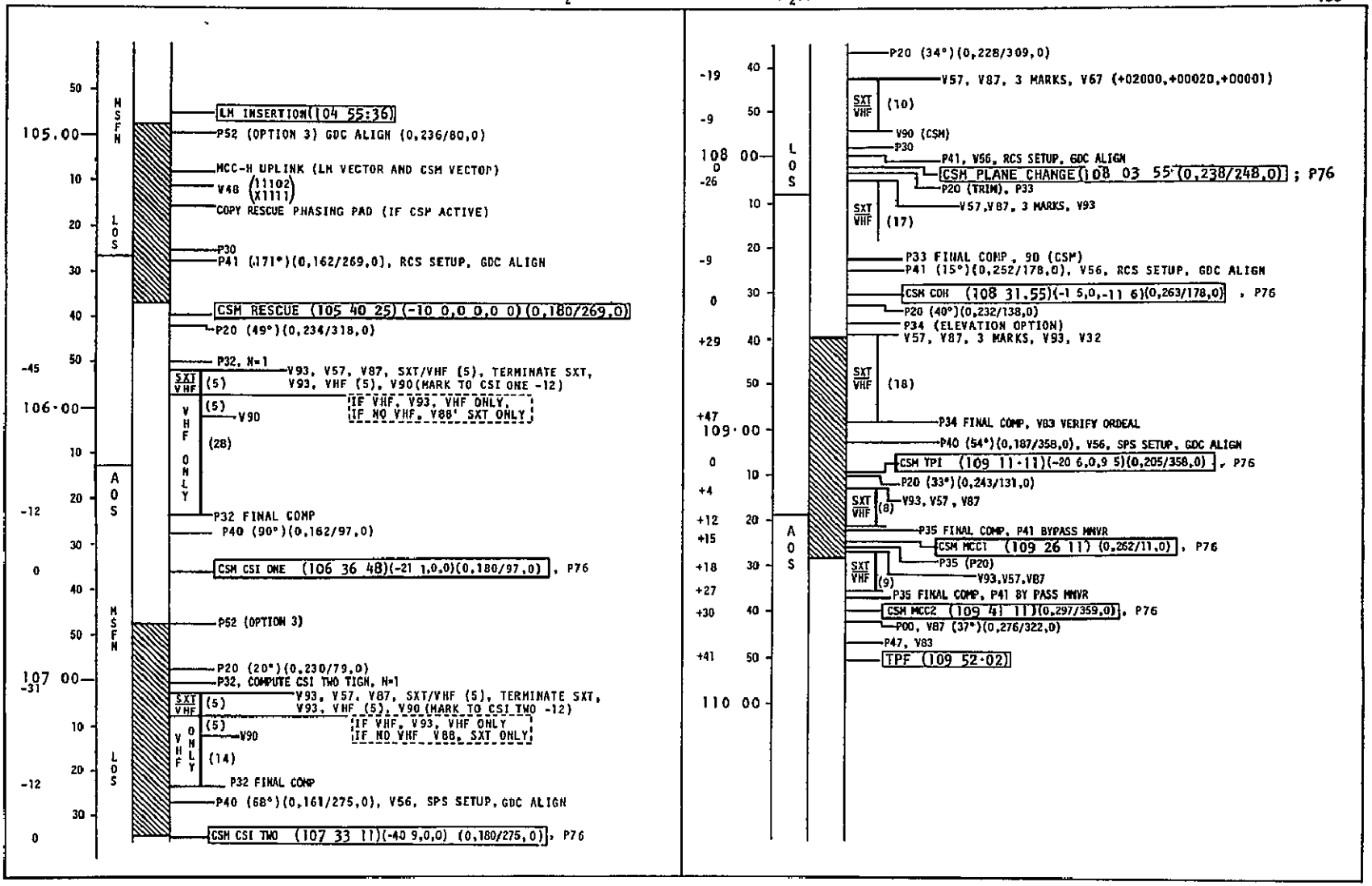
7.15.1 Summary

This rescue results from an abort approximately 19 minutes and 22 seconds into powered descent where the descent was initiated at the second opportunity. This coincides with the first preferred lift-off (T_2) after PDI_2. The LM is assumed to have reached a fixed 10 X 30 orbit. The rescue phasing burn occurs at a fixed GET defined as 50 minutes from that insertion cut-off time associated with an abort at PDI_2 + 14.5 minutes. CSI_1 occurs one-half rev after the rescue phasing burn, with CSI_2 occurring one-half rev later. CDH occurs one-half rev after CSI_2.

7.15.2 PDI_2+ 19:22 PREFERRED LIFT-OFF (T_2) (CSM ACTIVE)






LM INSERTION(104 55:36)
P52 (OPTION 3) GDC ALIGN (0,236/80,0)
MCC-H UPLINK (LM VECTOR AND CSM VECTOR)
V48 (11102) (X1111)
COPY RESCUE PHASING PAD (IF CSM ACTIVE)
P30
P41 (171°)(0,162/269,0), RCS SETUP, GDC ALIGN
CSM RESCUE (105 40 25)(-10 0,0 0,0 0)(0,180/269,0)
P20 (49°)(0,234/318,0)
P32, N=1
SXT/VHF (5) V93, V57, V87, SXT/VHF (5), TERMINATE SXT,
(5) V93, VHF (5), V90(MARK TO CSI ONE -12)
V90
IF VHF, V93, VHF ONLY,
IF NO VHF, V88' SXT ONLY
VHF ONLY (28)
P32 FINAL COMP
P40 (90°)(0,162/97,0)
CSM CSI ONE (106 36 48)(-21 1,0,0)(0,180/97,0), P76
P52 (OPTION 3)
P20 (20°)(0,230/79,0)
P32, COMPUTE CSI TWO TIGN, N=1
SXT/VHF (5) V93, V57, V87, SXT/VHF (5), TERMINATE SXT,
(5) V93, VHF (5), V90 (MARK TO CSI TWO -12)
V90
IF VHF, V93, VHF ONLY
IF NO VHF, V88, SXT ONLY
VHF ONLY (14)
P32 FINAL COMP
P40 (68°)(0,161/275,0), V56, SPS SETUP, GDC ALIGN
CSM CSI TWO (107 33 11)(-40 9,0,0) (0,180/275,0), P76
MSFN
LOS
AOS
MSFN
LOS
105.00
106·00
107 00
-45
-12
0
-31
-12
0
P20 (34°)(0,228/309,0)
V57, V87, 3 MARKS, V67 (+02000,+00020,+00001)
SXT/VHF (10)
V90 (CSM)
P30
P41, V56, RCS SETUP, GDC ALIGN
CSM PLANE CHANGE(108 03 55(0,238/248,0) ; P76
P20 (TRIM), P33
V57,V87, 3 MARKS, V93
SXT/VHF (17)
P33 FINAL COMP, 90 (CSM)
P41 (15°)(0,252/178,0), V56, RCS SETUP, GDC ALIGN
CSM COH (108 31.55)(-1 5,0,-11 6)(0,263/178,0) , P76
P20 (40°)(0,232/138,0)
P34 (ELEVATION OPTION)
V57, V87, 3 MARKS, V93, V32
SXT/VHF (18)
P34 FINAL COMP, V83 VERIFY ORDEAL
P40 (54°)(0,187/358,0), V56, SPS SETUP, GDC ALIGN
CSM YPI (109 11·11)(-20 6,0,9 5)(0,205/358,0) , P76
P20 (33°)(0,243/131,0)
SXT/VHF (8) V93, V57, V87
P35 FINAL COMP, P41 BYPASS MNVR
CSM MCC1 (109 26 11) (0,262/11,0), P76
P35 (P20)
SXT/VHF (9) V93,V57,V87
P35 FINAL COMP, P41 BY PASS MNVR
CSM MCC2 (109 41 11)(0,297/359,0), P76
P00, V87 (37°)(0,276/322,0)
P47, V83
TPF (109 52·02)
LOS
AOS
108 00
110 00
-19
-9
-9
0
+29
+47
0
+4
+12
+15
+18
+27
+30
+41

8.0 REFERENCES

8.1 Mission Requirements SA-506/CSM-107/LM-5, "G" Type Mission, Lunar Landing; dated 5 March 1969.

8.2 Spacecraft Operational Trajectory, Volume 1; Operational Mission Profile Launched 16 July 1969; MSC Internal Note No. 69-FM-98; dated 16 May 1969.

8.3 Shreffler, J. H.; Onboard Tracking Schedules for Mission F and G; Memo No. 69-FM46-29, dated 7 February 1969.

8.4 Shreffler, J. H.; On the Efficacious Utilization of VHF Range Data when Sextant Marking is Interrupted; Memo No. 68-FM46-482; dated 19 December 1968.

8.5 Pixley, P. T.; F Rendezvous Navigation Mission Techniques Panel Meeting; MSC Memorandum 69-FM46-107; dated 10 April 1969.

8.6 Guidance System Operations Plan for Manned CM Earth Orbital and Lunar Missions Using Program COLOSSUS 2 (COMANCHE REV. 44,45)Section 4 Operational Modes, Revision 7; dated March 1969.

8.7 Guidance Navigation and Control Command Module Functional Description and Operations Using Flight Program COLOSSUS 2A(COMANCHE 55) Volume II, Normal Procedures; dated June 1969.

8.8 Apollo Operations Handbook Command and Service Modules - Volume II, Operational Procedures; dated 17 April 1969.

8.9 Diekelman, D.P.; MDAC Apollo Design Note No. 114, "Evaluation of the Current Navigation Schedule for Mission G Lunar Rendezvous;" dated 4 June 1969.

8.10 Worley, N.; MDAC Apollo Design Note No. 111, "Mission G Nominal Reference Trajectory;" dated 7 May 1969.

8.11 Preliminary Apollo 11 Flight Plan; AS-506/CSM-107/LM-5; dated 15 April 1969.

8.12 Puschinsky, R. W.; McRae, M.; Otto, R.; CSM Rendezvous Procedures D Mission, Final Revision A; dated 1 February 1969.

8.13 Tindall, H. W.; Apollo Mission Techniques Mission F and G Lunar Orbit Activities - Volume I, Techniques Descriptions, MSC Internal Note No. S-PA-9T-044, dated 28 February 1969.

8.14 Lunar Contingency Rendezvous Group; "Preliminary Operational LM Abort and Rescue Plan for Apollo 11 (Lunar Landing Mission);" dated 6 June 1969.

8.15 Arceneaux, W.K.; MDAC Apollo Design Note No. 117, "Evaluation of the Nominal Mission G Lunar Rendezvous Navigation Mark Types and the A Priori Measurement Range Variance (VARMIN);" dated 12 June 1969.

8.16 Fudurich, R.; MDAC Apollo Design Note No. 107, "Effects of a LM Tracker Light Failure Upon a CSM Active Rendezvous During Mission F;" dated 21 April 1969.

8.17 Carrico, L. D.; Paddock, S. G.; MDAC Apollo Design Note No. 113, "The Effects of VHF Only Navigation on the Terminal Rendezvous Phase of Mission F;" dated 16 May 1969.

8.18 Revision 1 to Spacecraft Operational Trajectory for Mission G, Volume 1; Operational Mission Profile Launched 16 July 1969.

8.19 Diekelman, D., MDAC Apollo Design Note No. 114, "Evaluation of the Nominal Mission G Lunar Rendezvous Navigation W-Matrix Diagonal Elements and Initialization Schedule."

8.20 Mangiaracina, C., Diekelman, D., MDAC Apollo Design Note No. 118, "Evaluation of the Current Mission G CSM Nominal Lunar Rendezvous Navigation W-Matrix Diagonal Elements and Initialization Schedule."