MSC-CF-P-69-10

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AUG 1970
RECEIVED
NASA STI FACILITY
INPUT BRANCH

CSM RENDEZVOUS PROCEDURES

F MISSION

FINAL
REVISION A
APRIL 25, 1969

FACILITY FORM 602

N70-36050	
(ACCESSION NUMBER)	(THRU)
84	1
(PAGES)	(CODE)
TMX-65033	31
(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

PREPARED BY:

S. G. Paddock

For Mission F Procedures Development Group
Apollo Flight Crew Operations
McDonnell Douglas Astronautics Company

Duane K. Mosel

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

APPROVED BY:

John C. Callihan

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

Donald W. Lewis

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

Paul C. Kramer

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

J. W. Bilodeau

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

W. J. North

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

D. K. Slayton

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	9
	3.1 Undocking and Separation	9
	3.2 Descent Orbit Insertion	10
	3.3 Phasing	10
	3.4 Insertion	11
	3.5 Concentric Sequence Initiation	12
	3.6. Constant Delta Height and Plane Change	13
	3.7 Terminal Phase Initiation	14
	3.8 TPI To Station Keeping	15
4.0	NOMINAL ONBOARD RENDEZVOUS CHECKLIST	16
5.0	NOMINAL MAJOR PROCEDURES SUMMARY	27
	5.1 Summary Timeline	28
	5.2 Summary Rendezvous Checklist	36

PAGE

6.0 NOMINAL DETAILED PROCEDURES ---------- 37

6.1 Procedures Ground Rules ---------- 38

6.2 Detailed Procedures ---------- 42

6.3 Rendezvous Navigation Summary With Sun Angles ---------- 78

6.4 CSM Attitude Summary ---------- 79

7.0 DISCUSSION OF LM RESCUE CASES ---------- 80

7.1 LM PDI Abort ---------- 80

7.2 LM Partial Phasing Greater Than or Equal to 40 FPS ------ 80

7.3 LM Partial Phasing Less Than 40 FPS ---------- 81

7.4 LM Zero Insertion ---------- 82

7.5 LM Partial Insertion ---------- 83

8.0 LM RESCUE ONBOARD DATA ---------- 84

8.1 LM PDI Abort ---------- 85

8.1.1 Plot and Pads ---------- 86

8.1.2 Checklist ---------- 87

8.2 LM Partial Phasing Greater Than or Equal to 40 FPS ------ 88

8.2.1 Plot and Pads ---------- 89

8.2.2 Checklist ---------- 90

8.3 LM Partial Phasing Less Than 40 FPS ---------- 91

8.3.1 Plot and Pads ---------- 92

8.3.2 Checklist ---------- 93

8.4 LM Zero Insertion ---------- 94

8.4.1 Plot and Pads ---------- 95

8.4.2 Checklist ---------- 96

PAGE

8.5 LM Partial Insertion ---------- 97

8.5.1 Plot and Pads ---------- 98

8.5.2 Checklist ---------- 99

9.0 LM RESCUE PROCEDURES SUMMARY ---------- 100

9.1 Rescue Procedures Ground Rules ---------- 100

9.2 LM PDI Abort ---------- 101

9.2.1 Summary Timeline ---------- 102

9.2.2 Navigation Summary With Sun Angles ---------- 107

9.2.3 CSM Attitude Summary ---------- 108

9.3 LM Partial Phasing Greater Than or Equal to 40 FPS ---------- 109

9.3.1 Summary Timeline ---------- 110

9.3.2 Navigation Summary With Sun Angles ---------- 123

9.3.3 CSM Attitude Summary ---------- 124

9.4 LM Partial Phasing Less Than 40 FPS ---------- 125

9.4.1 Summary Timeline ---------- 126

9.4.2 Navigation Summary With Sun Angles ---------- 139

9.4.3 CSM Attitude Summary ---------- 140

9.5 LM Zero Insertion ---------- 141

9.5.1 Summary Timeline ---------- 142

9.5.2 Navigation Summary With Sun Angles ---------- 153

9.5.3 CSM Attitude Summary ---------- 154

9.6 LM Partial Insertion ---------- 155

9.6.1 Summary Timeline ---------- 156

9.6.2 Navigation Summary With Sun Angles ---------- 169

9.6.3 CSM Attitude Summary ---------- 170

PAGE

10.0 REFERENCES ---------- 171

FIGURES

MISSION F-RELATIVE MOTION FOR LM ACTIVE RENDEZVOUS

FIGURE (2-1) ---------- 4

MISSION F-LUNAR ORBIT RENDEZVOUS ATTITUDE TIME HISTORY

FIGURE (2-2) ---------- 5

FIGURE (2-3) ---------- 6

FIGURE (2-4) ---------- 7

FIGURE (2-5) ---------- 8

LIST OF ACRONYMS AND ABBREVIATIONS

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

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

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

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

Tracking Stations

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

1.0 PURPOSE

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

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

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

2.0 INTRODUCTION

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

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

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

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

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

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

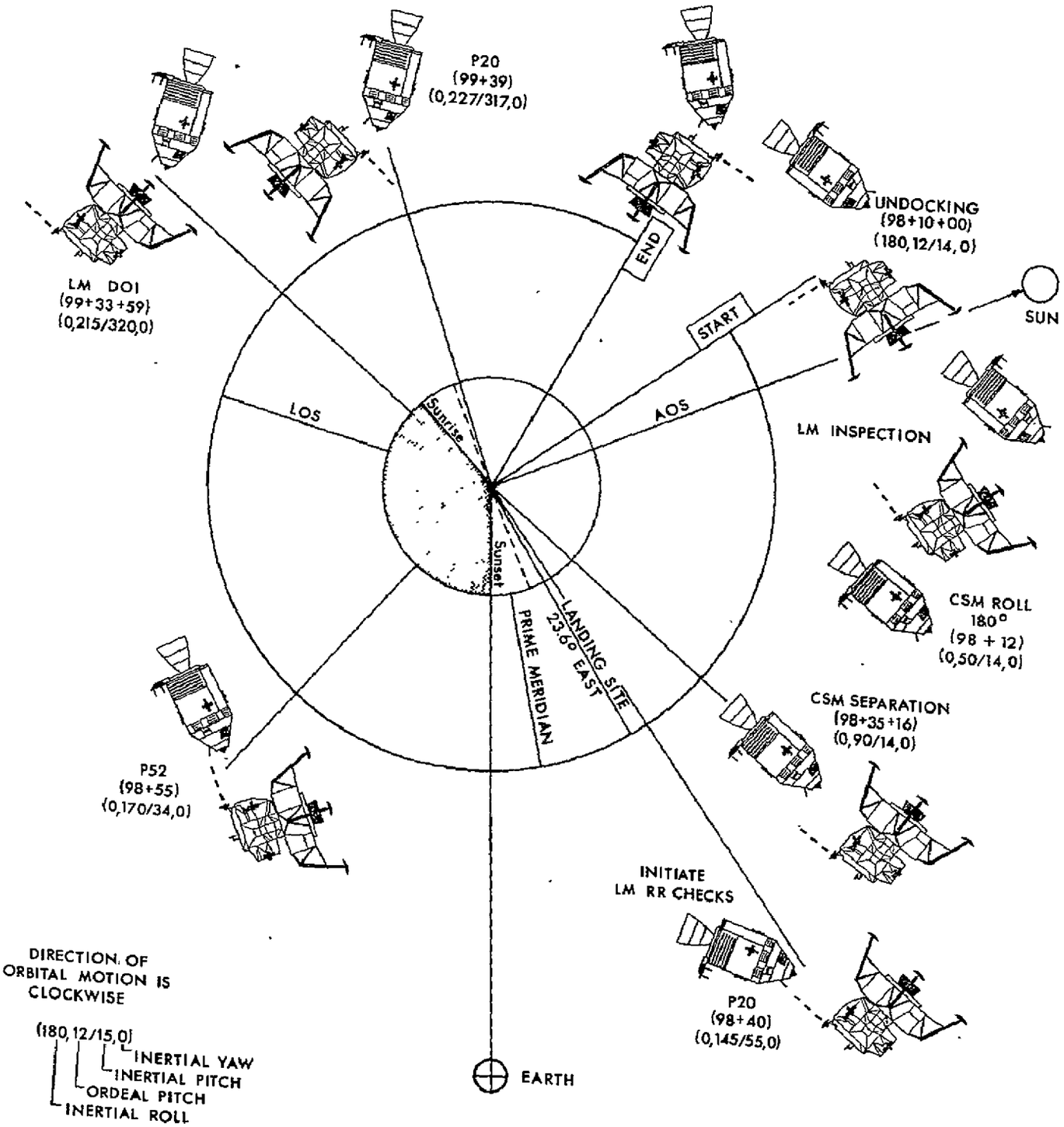
Section 8.0 contains the one-page onboard rescue checklist and a relative motion plot and pad page for each of the five LM rescue cases. A LM rescue procedures summary is contained in Section 9.0 including rescue procedures ground rules, summary timelines, and CSM attitude and navigation summaries for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

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

MISSION F

FIGURE 2-2

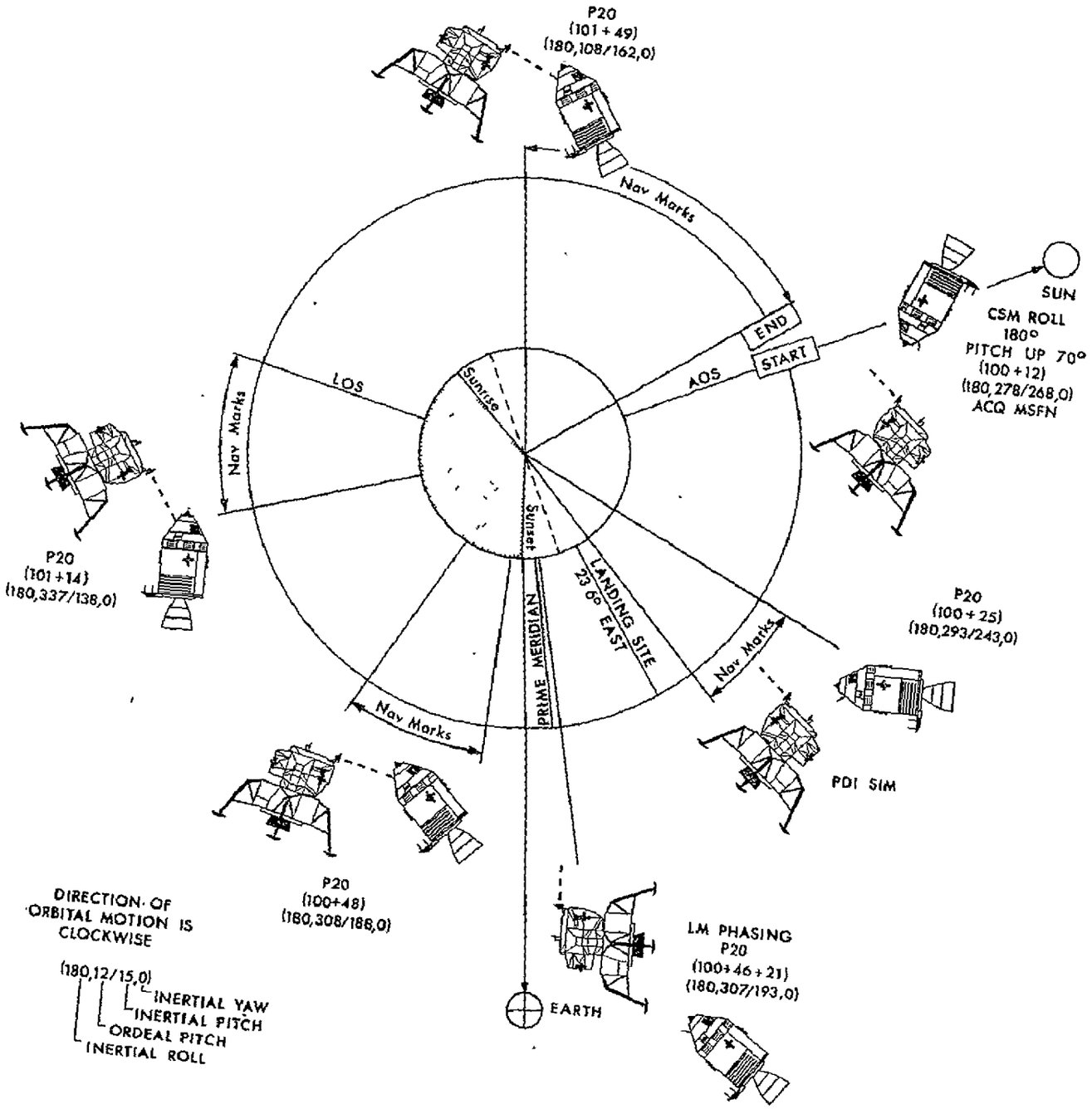
LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE CSM



MISSION F

FIGURE 2-3

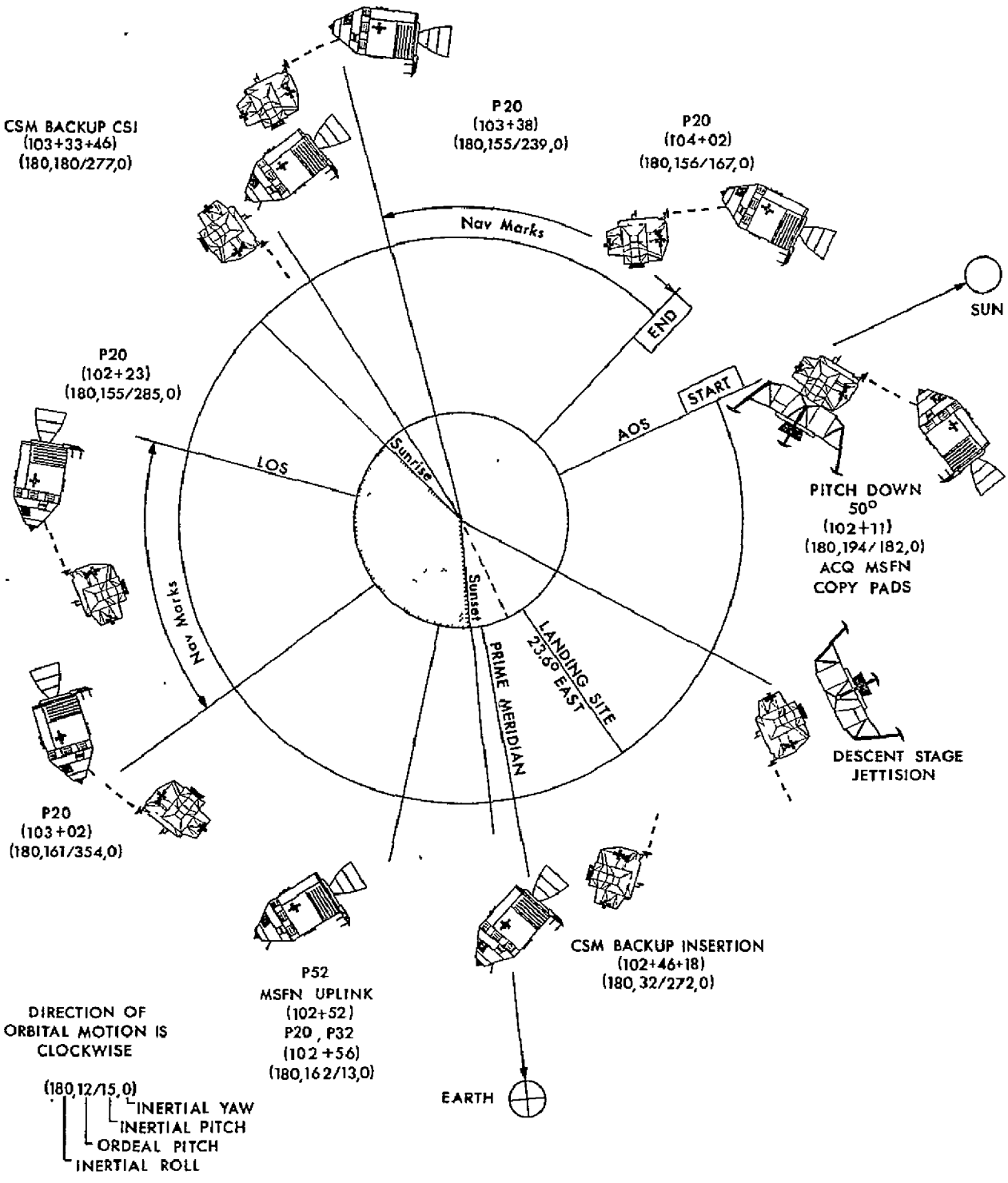
LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE CSM



MISSION F

FIGURE 2-4

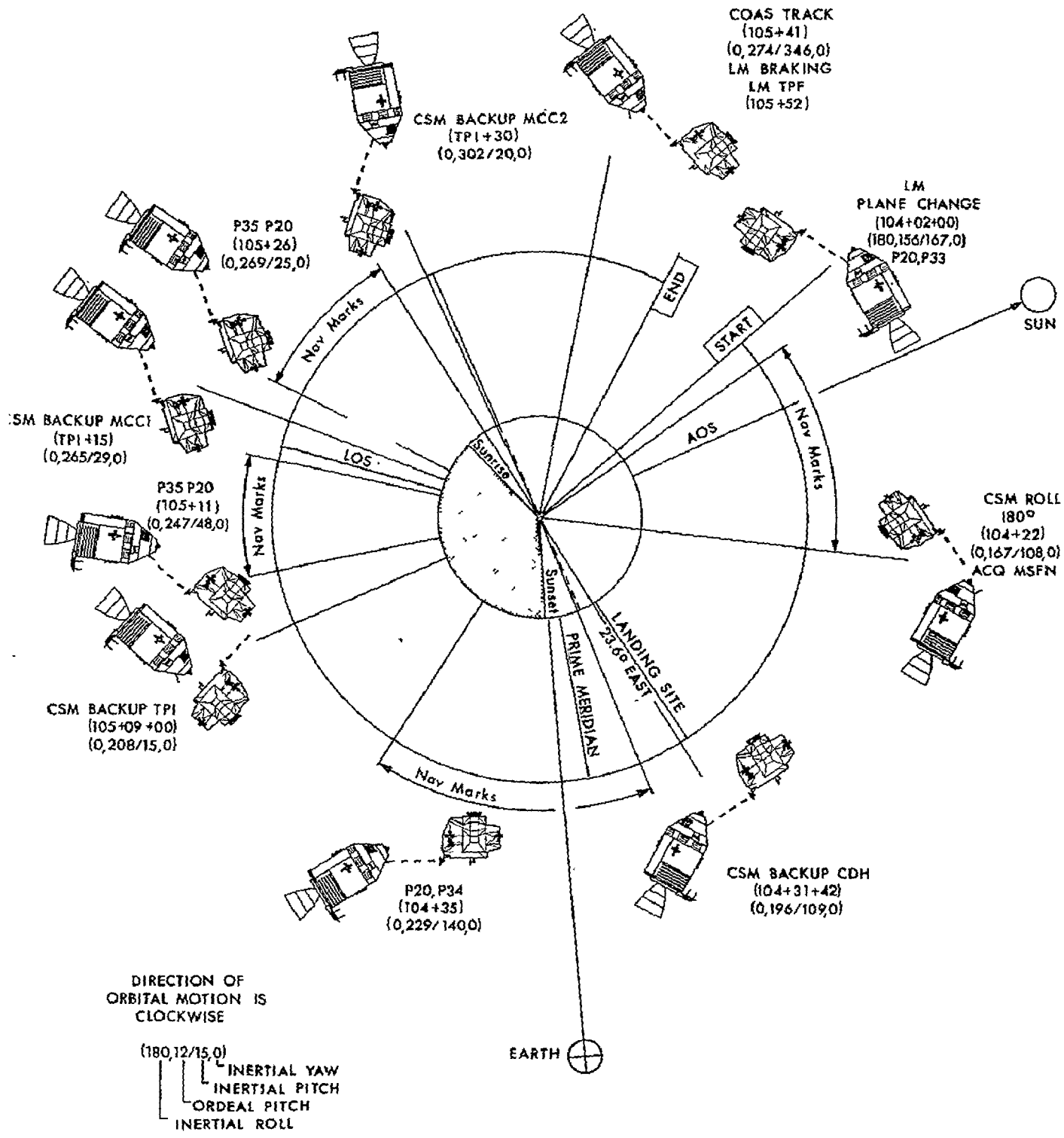
LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE CSM



MISSION F

FIGURE 2-5

LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE CSM



3.0 DISCUSSION OF NOMINAL MAJOR EVENTS

3.1 Undocking and Separation

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

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

3.2 Descent Orbit Insertion

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

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

3.3 Phasing

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

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

3.4 Insertion

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

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

3.5 Concentric Sequence Initiation

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

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

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

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

3.6 Constant Delta Height and Plane Change

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

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

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

3.7 Terminal Phase Initiation

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

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

3.8 TPI To Station Keeping

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

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

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

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

4.0 NOMINAL ONBOARD RENDEZVOUS CHECKLIST

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

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

EXTERNAL DV PADS

CSM SEP PAD

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

CSM BACKUP INSERTION PAD INITIAL

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

CSM BACKUP INSERTION PAD UPDATE

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

NOMINAL LM IGNITION TIMES

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

RESCUE TWO PAD

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

CANNED RESCUE TWO PADS FOR:

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

ARE INCLUDED ON RESCUE CHECKLISTS

CSM RENDEZVOUS RESCUE PADS

CSI ONE

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

CSI TWO

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

CDH

13	00 :	000 :	0 .
81	.	.	.

TPI

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

97:00

CONTINGENCY EVA PREP

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

97:10

MIN DB FOR LM RCS COLD FIRE CHECKS

M
S
F
N

MAX DB FOR LM RCS HOT FIRE CHECKS

97:20

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

L
O
S

97:30

97:30

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

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

GND 47	+	.	+	.
UPDATE 48		.		.

97:40

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

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

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

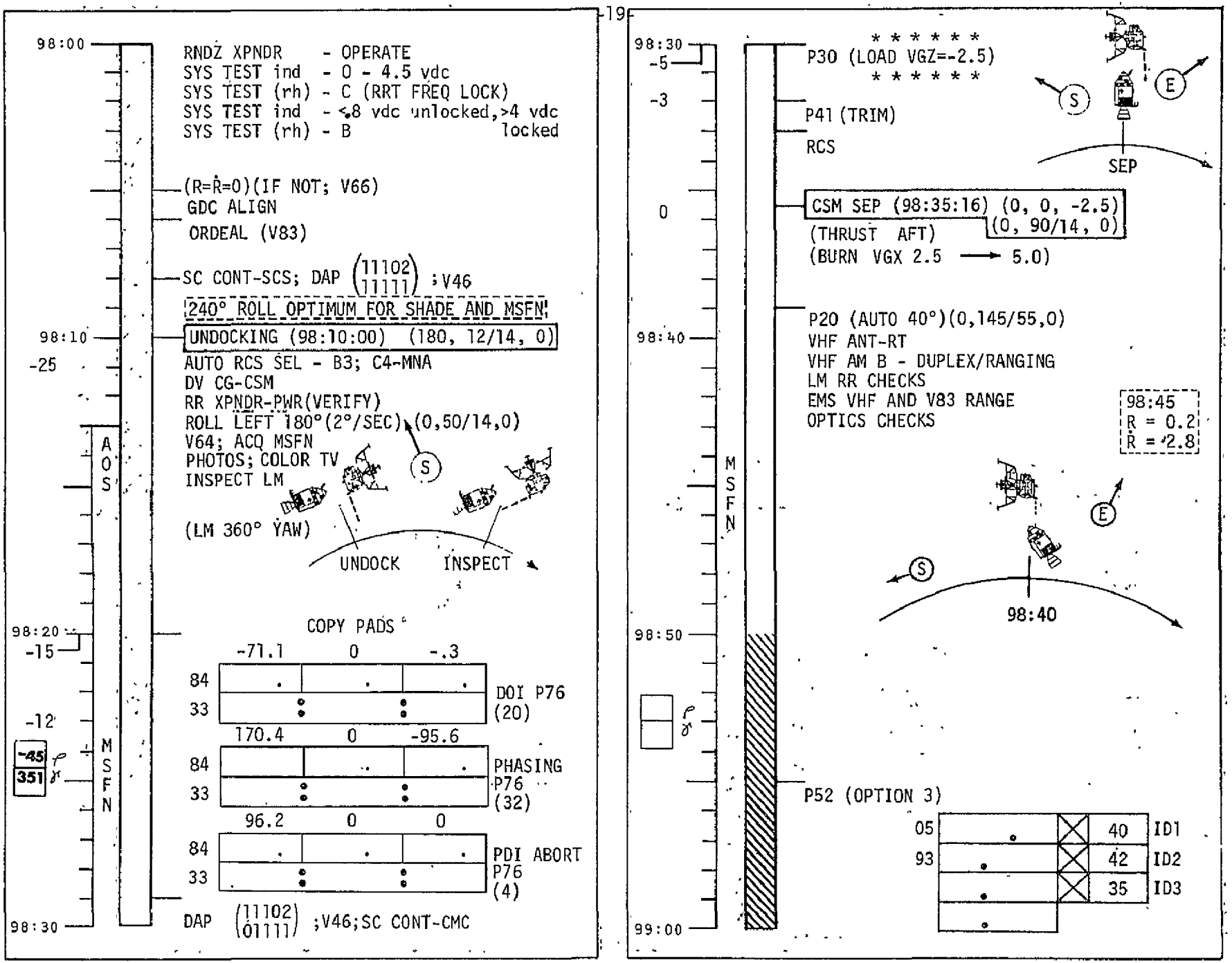
97:50

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

RR XPNDR CHECKS:

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

98:00



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

99:00
-29
99:10
99:20
-11
-6
99:30

MSFN
LOS

GDC ALIGN
ORDEAL (V83)

POO; MCC-H UPLINK CSM AND
LM VECTORS

99:05
R = 0.9
Ṙ = 4.2

VHF AM A-SIMPLEX/DATA

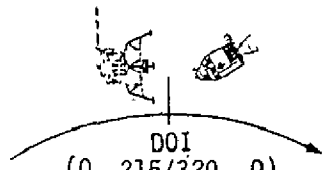
99:20
R = 1.5
Ṙ = 3.0

P20 (AUTO 55°)(0,206/332,0)

99:30
-2
0
99:40
-63
99:50
100:00

CONFIRM
VHF A/DATA
LBR,FWD

P76 LOAD

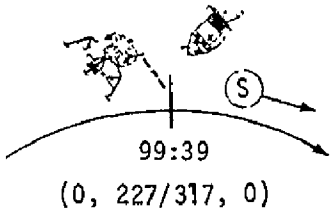


LM DOI (99:33:59)(-71.1,0,-.3)

VHF RCV ONLY-OFF
VHF AM B-DUPLEX/RANGING
COMPUTE RDOT FOR LM
CONFIRM LM DOI
P76(20); V82(LM)(10 x 60)

99:36
R = 3.1
Ṙ = 71.8

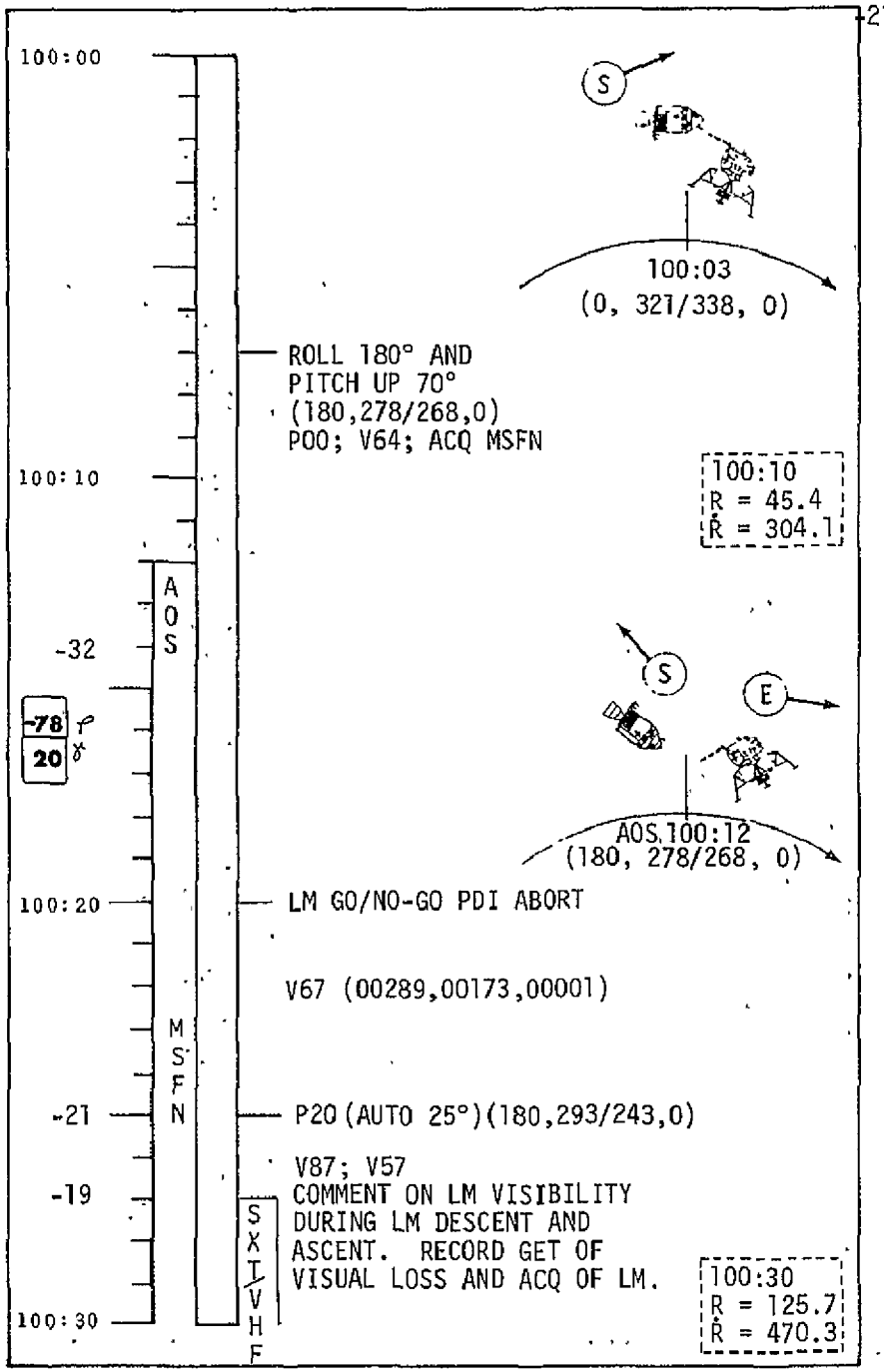
P20 (TRIM)(0,227/317,0)

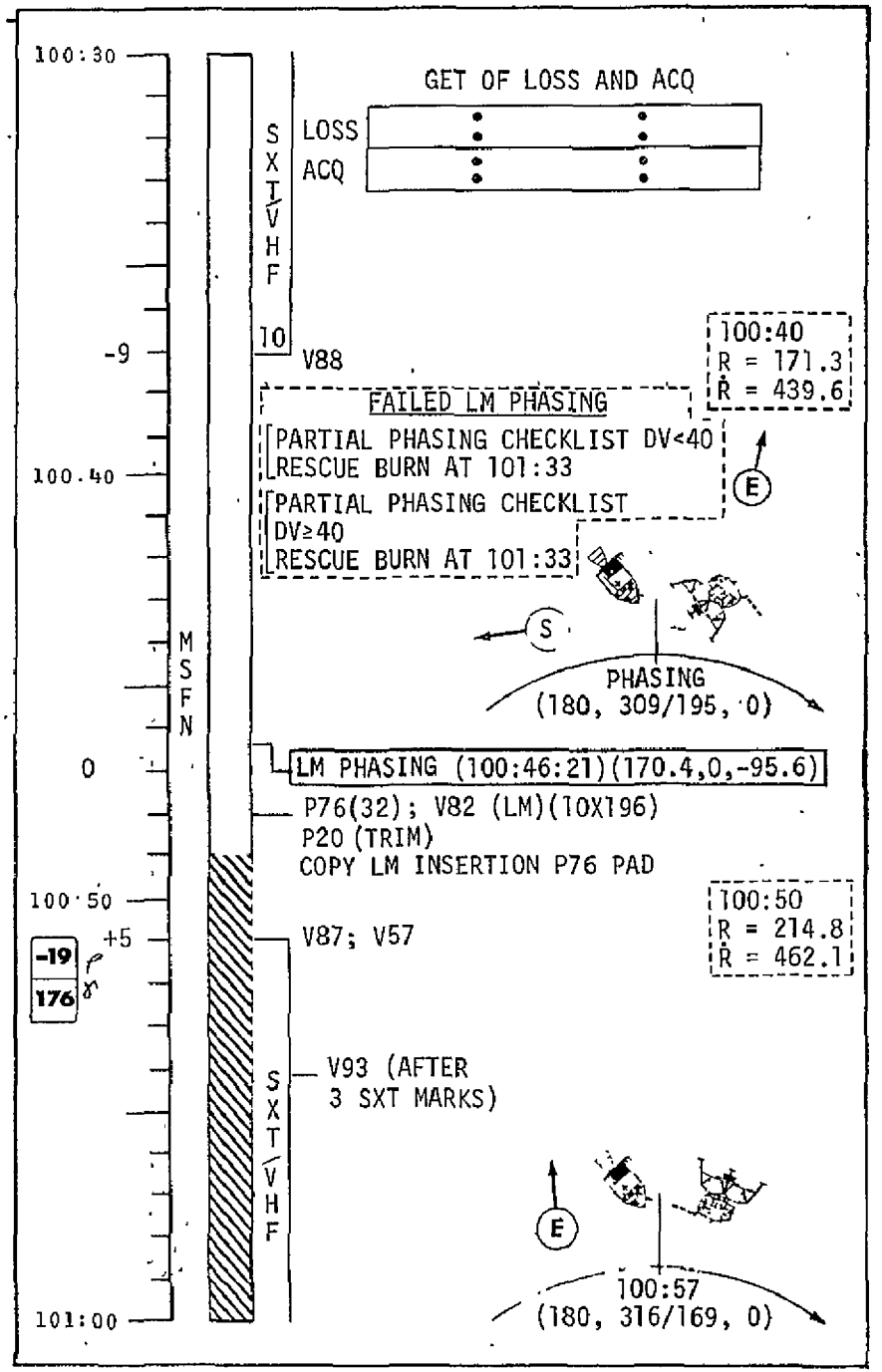


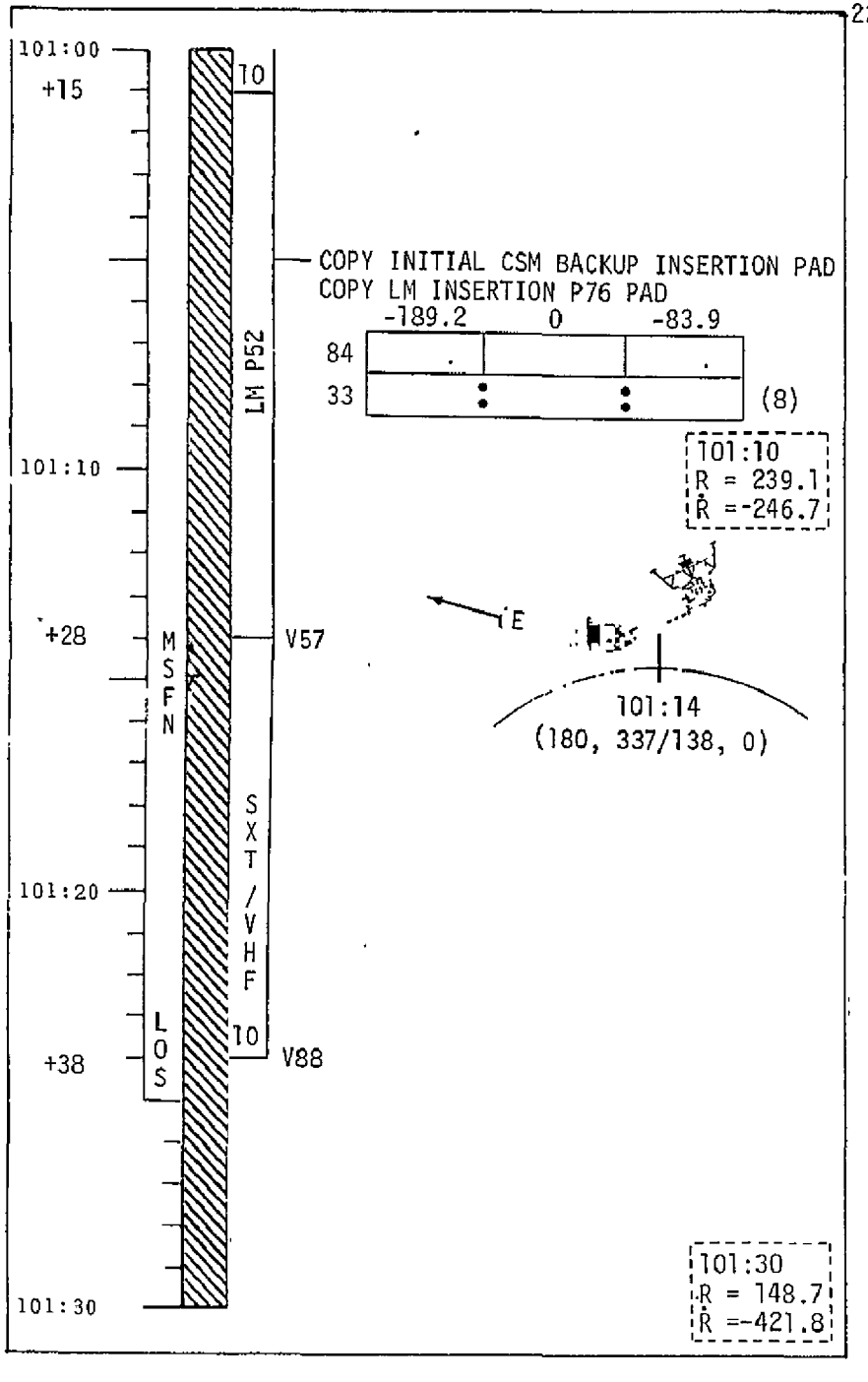
OPTICS TRACK

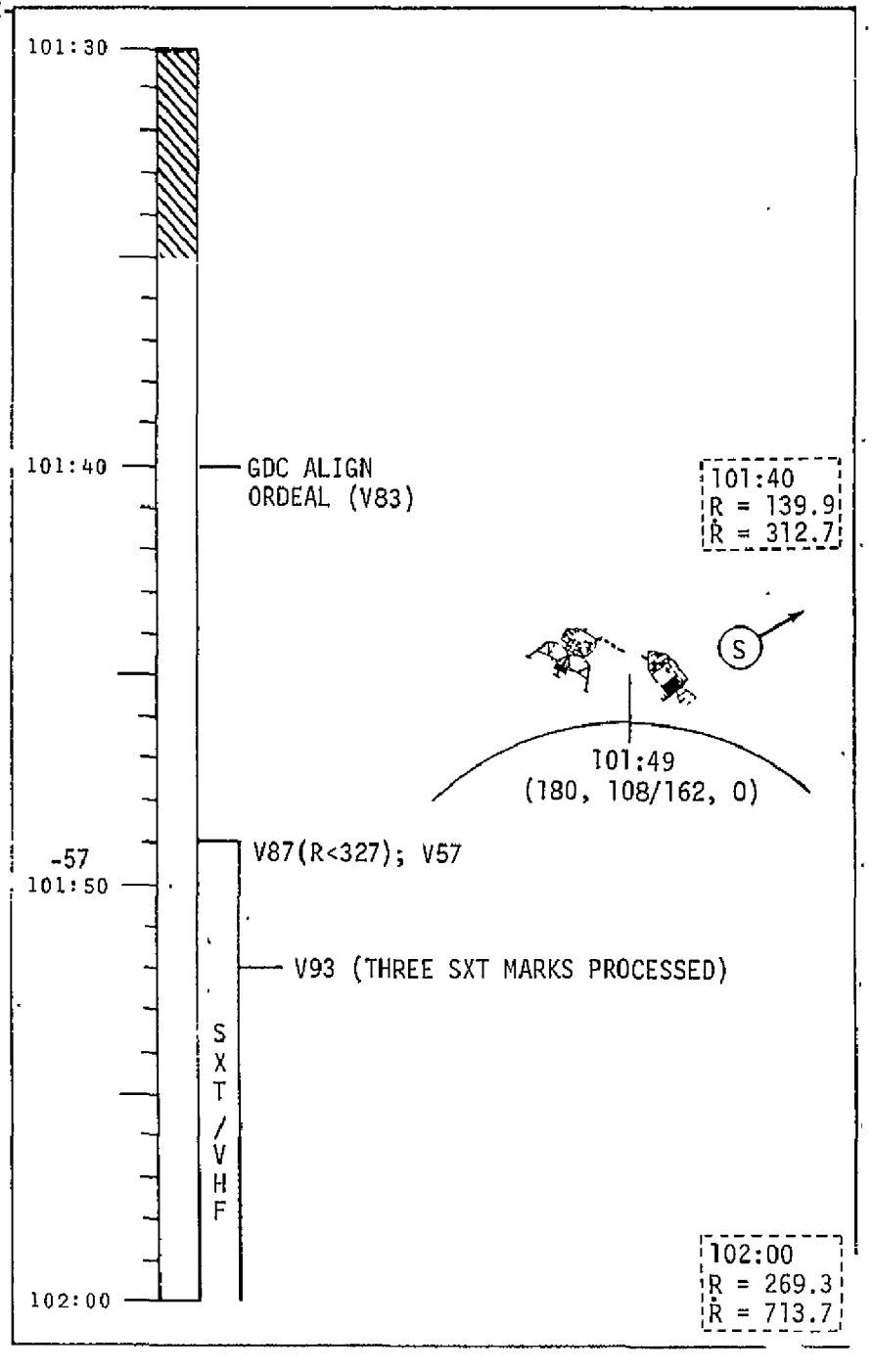
99:47
R = 8.6
Ṙ = 62.3

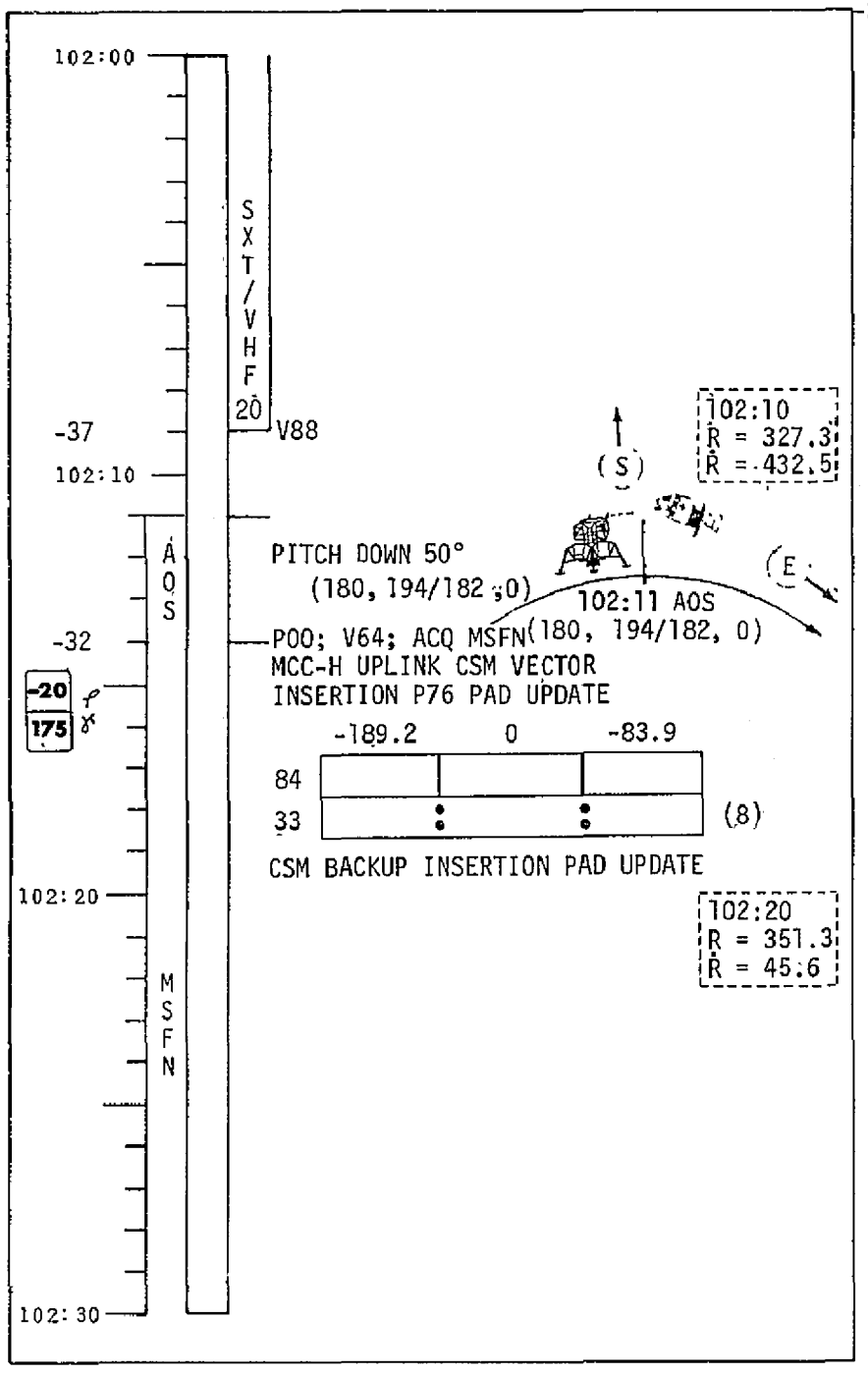
100:00
R = 22.6
Ṙ = 159.5

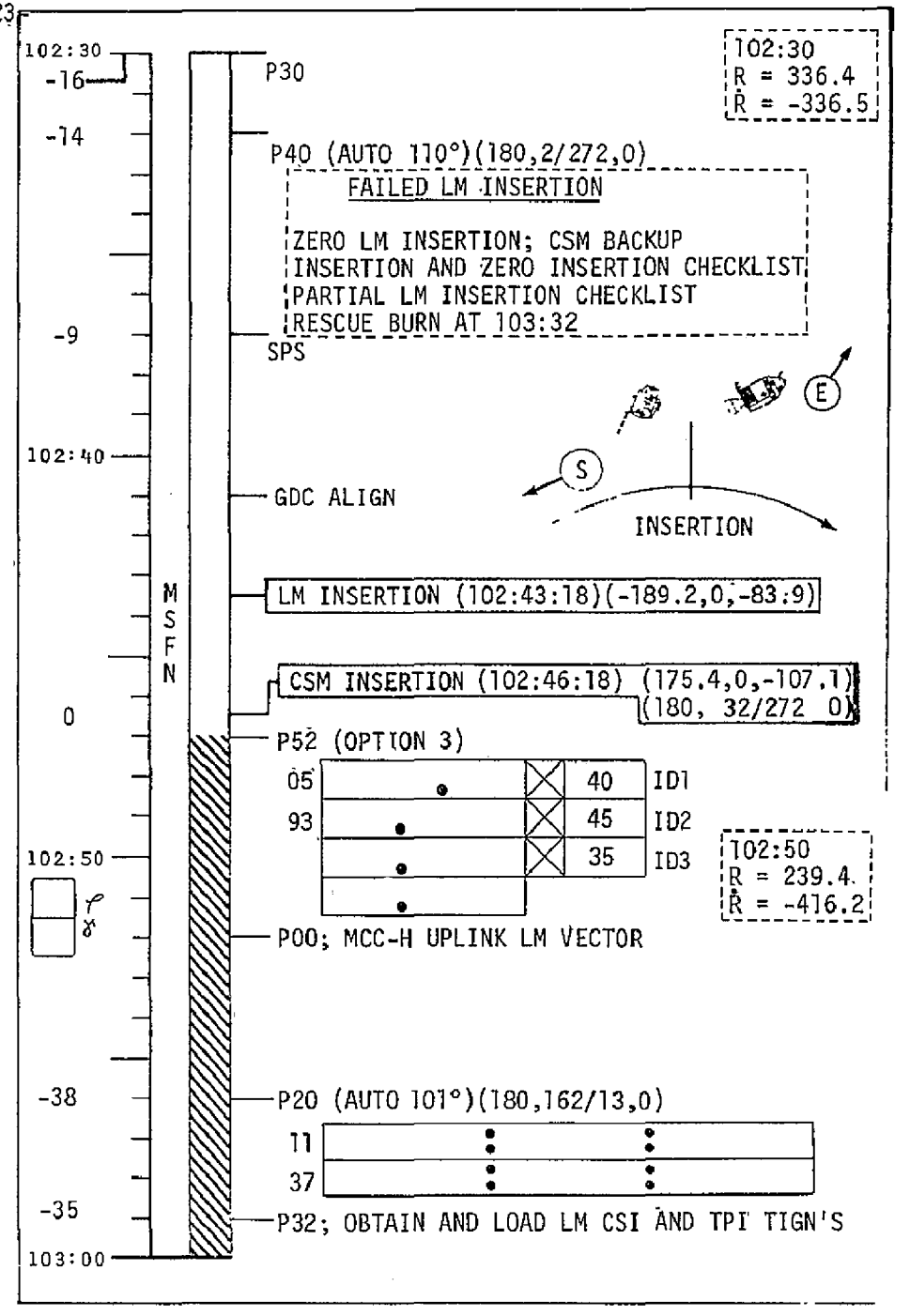

100:00
100:10
-32
-78
20
-21
-19
100:20
100:30
AOS
MSFN
SXT/VHF
S
100:03
(0, 321/338, 0)
ROLL 180° AND
PITCH UP 70°
(180,278/268,0)
POO; V64; ACQ MSFN
100:10
R = 45.4
Ṙ = 304.1
S
E
AOS 100:12
(180, 278/268, 0)
LM GO/NO-GO PDI ABORT
V67 (00289,00173,00001)
P20 (AUTO 25°)(180,293/243,0)
V87; V57
COMMENT ON LM VISIBILITY
DURING LM DESCENT AND
ASCENT. RECORD GET OF
VISUAL LOSS AND ACQ OF LM.
100:30
R = 125.7
Ṙ = 470.3

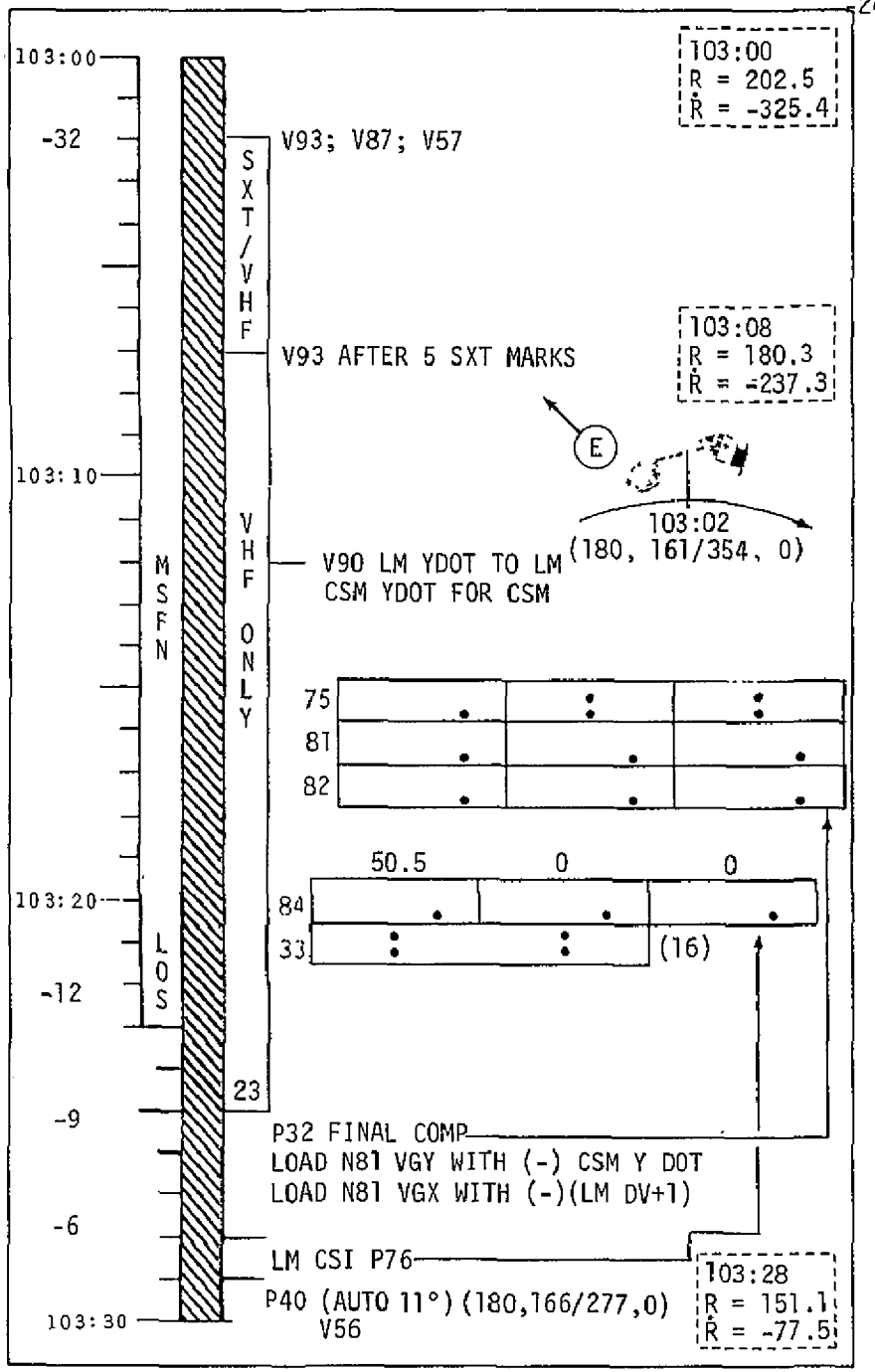

100:30
-9
100.40
0
100·50
+5
-19
176
101:00
MSFN
SXT/VHF
GET OF LOSS AND ACQ
LOSS
ACQ
10
V88
100:40
R = 171.3
Ṙ = 439.6
FAILED LM PHASING
PARTIAL PHASING CHECKLIST DV<40
RESCUE BURN AT 101:33
PARTIAL PHASING CHECKLIST
DV≥40
RESCUE BURN AT 101:33
E
S
PHASING
(180, 309/195, 0)
LM PHASING (100:46:21)(170.4,0,-95.6)
P76(32); V82 (LM)(10X196)
P20 (TRIM)
COPY LM INSERTION P76 PAD
100:50
R = 214.8
Ṙ = 462.1
V87; V57
V93 (AFTER
3 SXT MARKS)
E
100:57
(180, 316/169, 0)

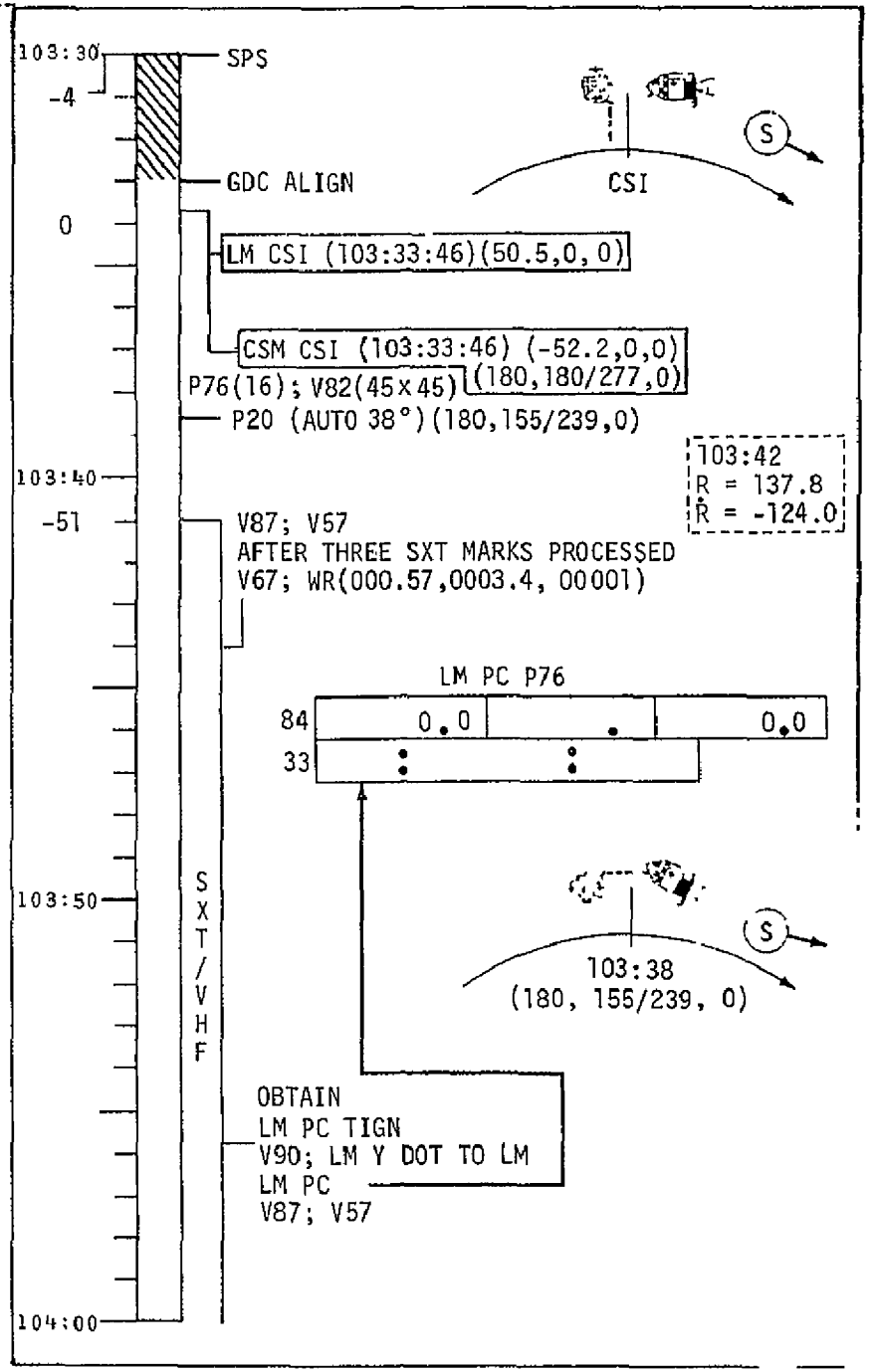

101:00
+15
101:10
+28
101:20
+38
101:30
10
LM P52
COPY INITIAL CSM BACKUP INSERTION PAD
COPY LM INSERTION P76 PAD
-189.2
0
-83.9
84
33
(8)
101:10
R = 239.1
Ṙ =-246.7
MSFN
V57
E
101:14
(180, 337/138, 0)
SXT/VHF
LOS
10
V88
101:30
R = 148.7
Ṙ =-421.8

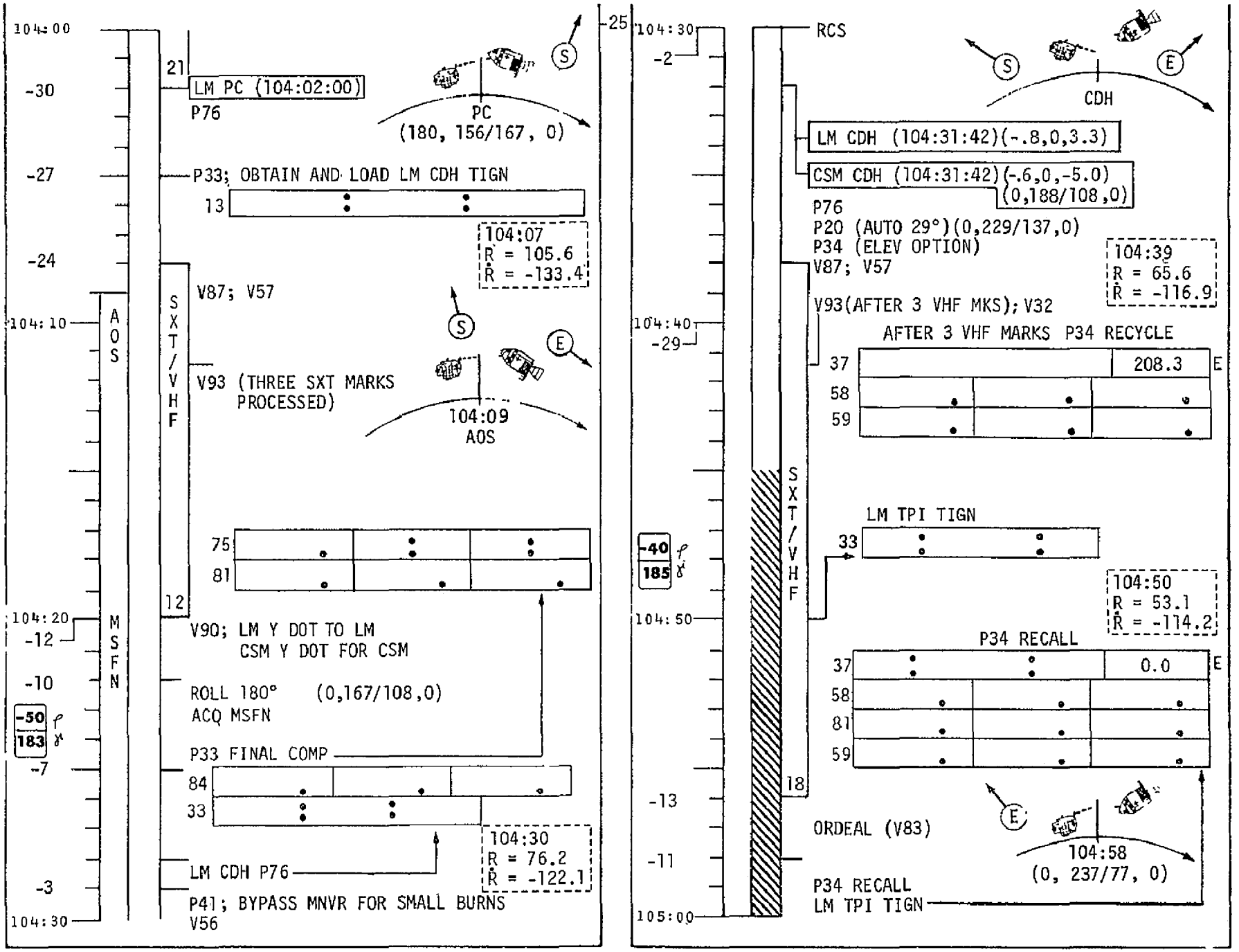

101:30
101:40
GDC ALIGN
ORDEAL (V83)
101:40
R = 139.9
Ṙ = 312.7
S
101:49
(180, 108/162, 0)
-57
101:50
V87(R<327); V57
V93 (THREE SXT MARKS PROCESSED)
SXT/VHF
102:00
102:00
R = 269.3
Ṙ = 713.7

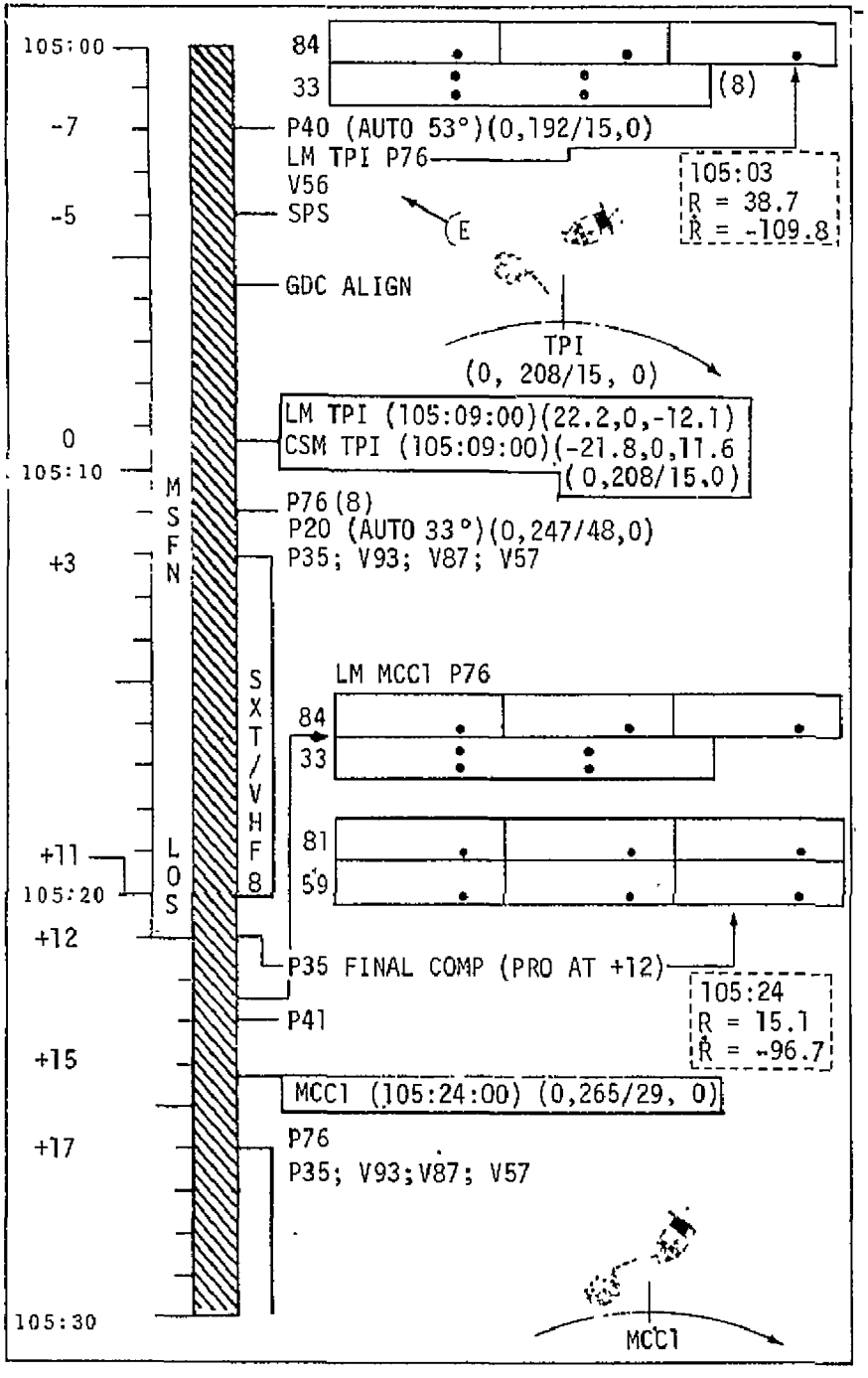

102:00
-37
102:10
-32
-20
175
102:20
102:30
S X T / V H F 20
V88
A O S
M S F N
102:10
R = 327.3
Ṙ = -432.5
(S)
(E)
PITCH DOWN 50°
(180, 194/182, 0)
102:11 AOS
(180, 194/182, 0)
P00; V64; ACQ MSFN
MCC-H UPLINK CSM VECTOR
INSERTION P76 PAD UPDATE
-189.2
0
-83.9
84
33
(8)
CSM BACKUP INSERTION PAD UPDATE
102:20
R = 351.3
Ṙ = 45.6

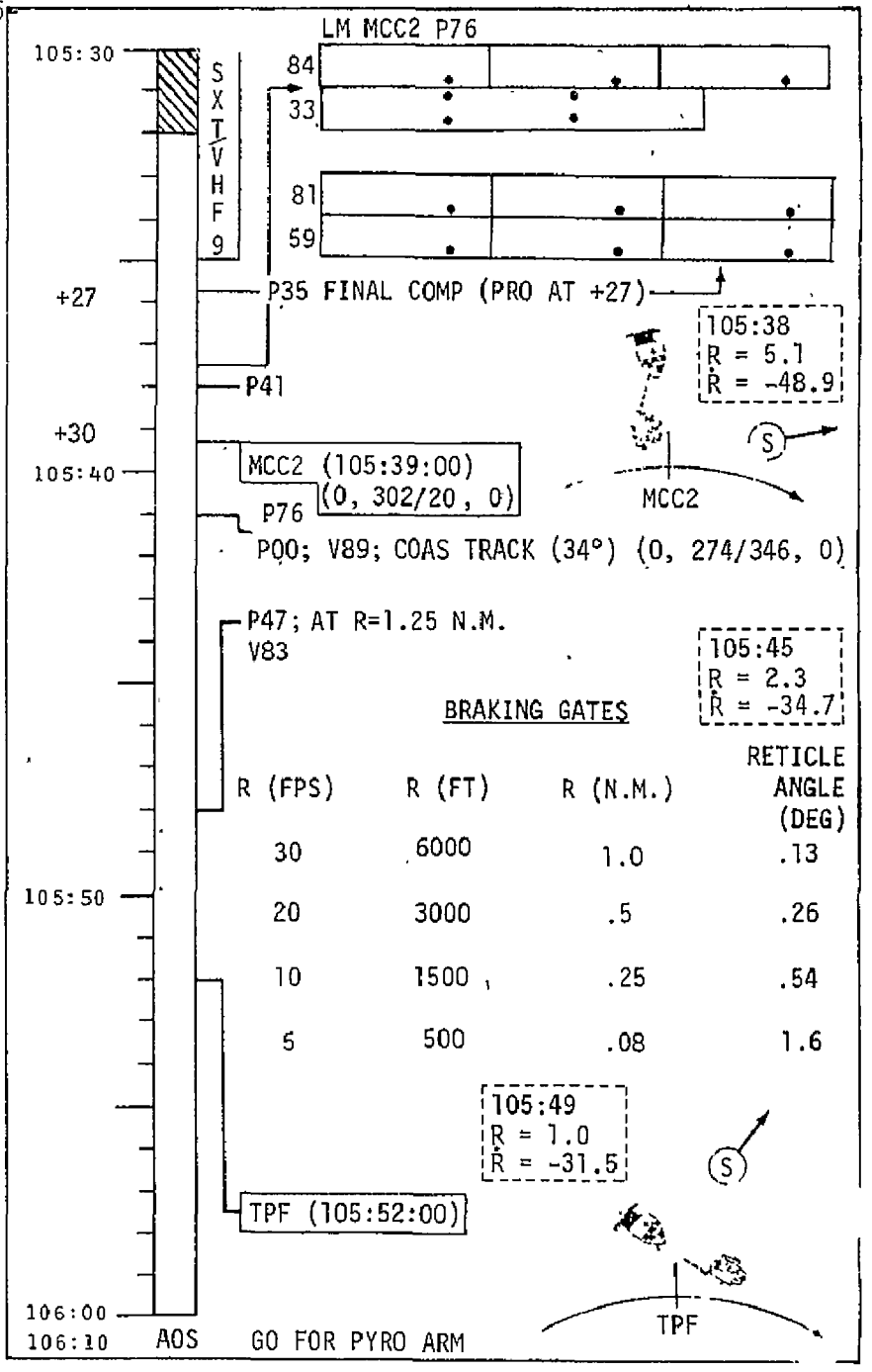

102:30
-16
-14
-9
102:40
0
102:50
-38
-35
103:00
M S F N
102:30
R = 336.4
Ṙ = -336.5
P30
P40 (AUTO 110°)(180,2/272,0)
FAILED LM INSERTION
ZERO LM INSERTION; CSM BACKUP
INSERTION AND ZERO INSERTION CHECKLIST
PARTIAL LM INSERTION CHECKLIST
RESCUE BURN AT 103:32
SPS
(E)
(S)
GDC ALIGN
INSERTION
LM INSERTION (102:43:18)(-189.2,0,-83.9)
CSM INSERTION (102:46:18) (175.4,0,-107.1)
(180, 32/272 0)
P52 (OPTION 3)
05
93
40
45
35
ID1
ID2
ID3
102:50
R = 239.4
Ṙ = -416.2
P00; MCC-H UPLINK LM VECTOR
P20 (AUTO 101°)(180,162/13,0)
11
37
P32; OBTAIN AND LOAD LM CSI AND TPI TIGN'S


103:00
-32
103:10
103:20
-12
-9
-6
103:30
MSFN
LOS
SXT/VHF
VHF ONLY
23
103:00
R = 202.5
Ṙ = -325.4
V93; V87; V57
103:08
R = 180.3
Ṙ = -237.3
V93 AFTER 5 SXT MARKS
E
103:02
(180, 161/354, 0)
V90 LM YDOT TO LM
CSM YDOT FOR CSM
75
81
82
50.5
0
0
84
33
(16)
P32 FINAL COMP
LOAD N81 VGY WITH (-) CSM Y DOT
LOAD N81 VGX WITH (-)(LM DV+1)
LM CSI P76
P40 (AUTO 11°) (180,166/277,0)
V56
103:28
R = 151.1
Ṙ = -77.5


103:30
-4
0
103:40
-51
103:50
104:00
SPS
GDC ALIGN
CSI
S
LM CSI (103:33:46)(50.5,0,0)
CSM CSI (103:33:46) (-52.2,0,0)
P76(16); V82(45x45) (180,180/277,0)
P20 (AUTO 38°)(180,155/239,0)
103:42
R = 137.8
Ṙ = -124.0
V87; V57
AFTER THREE SXT MARKS PROCESSED
V67; WR(000.57,0003.4, 00001)
LM PC P76
84
33
0.0
0.0
S
103:38
(180, 155/239, 0)
SXT/VHF
OBTAIN
LM PC TIGN
V90; LM Y DOT TO LM
LM PC
V87; V57


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


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


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

5.0 NOMINAL MAJOR PROCEDURES SUMMARY

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

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

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

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

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

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

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

GET	EVENT	PROG
+05	(100+51)	
	CALL MARKING ROUTINES(V87,V57) (PROCESS 3 MARKS,V93)	
	(101+01)	
	TERMINATE SXT MARKS	
	(101+05)	
	COPY INITIAL CSM BACKUP INSERTION PAD	
	(101+10)	
	COPY LM INSERTION P76 PAD	
+28	(101+14)	
	CALL MARKING ROUTINE(V57)	
+38	(101+24)	
	TERMINATE SXT/VHF MARKS,V88	
	LOS	
	(101+35)	
	SUNUP	
	MOVE TO COMMAND SEAT	
	(101+40)	
	GDC ALIGN TO IMU	
	VERIFY ORDEAL(V83)	
	MOVE TO LEB	
-57	(101+49)	
	CALL MARKING ROUTINES(V87,V57) (PROCESS 3 MARKS,V93)	
-37	(102+09)	
	TERMINATE SXT/VHF MARKS,V88	
	MOVE TO CMD SEAT	
	(102+11)	
	AOS	
	PITCH DOWN 50 DEG (180,174/162,0)	

GET	EVENT	PROG
-32	(102+14)	
	ACQUIRE MSFN (V64)	(P00)
	MCC-H UPLINK(CSM VECTOR)	
	COPY LM INSERTION P76 PAD UPDATE AS REQUIRED	
	COPY CSM BACKUP INSERTION PAD UPDATE AS REQUIRED	
	(102+29)	
	VERIFY ORDEAL(V83)	
-16	(102+30)	
	EXTERNAL DV TARGETING (INSERTION)	(P30)
-14	(102+32)	
	SPS THRUST PROGRAM (INSERTION)	(P40)
	AUTO MNVR TO BURN ATTITUDE (110 DEG) (180,3/272,0)	
-09	(102+37)	
	SPS THRUST SETUP (INSERTION)	(P40)
-05	(102+41)	
	GDC ALIGN	
-03	(102+43+18)	
	**********	
	LM INSERTION BURN (-189.2,0,-83.9)	
	**********	
0	(102+46+18)	
	**********	
	CSM BACKUP INSERTION BURN (175.4,0,-107.1) (180,32/272,0)	
	**********	

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

GET	EVENT	PROG
(103+25)		
	CSI TARGETING FINAL COMP	(P32)
	COPY CSM CSI SOLUTION	
	LOAD N91 VGY WITH(-) CSM YDOT	
(103+28)		
	COPY LM CSI PAD	
(103+29)		
	SPS THRUST PROGRAM,V56 AUTO MNVR TO BURN ATTITUDE (11 DEG) (180,166/277,0)	(P40)
(103+30)		
	SPS THRUST SETUP	(P40)
(103+31)		
	GDC ALIGN	
(103+33)		
	SUNUP	
(103+33+46)		
	**********	
	LM CSI BURN(50.5,0,0)	
	**********	
	**********	
	CSM BACKUP CSI BURN (52.2,0,0) (180,180/277,0)	
	**********	
	TARGET DV PROGRAM (CSI)	(P76)
	LM ORBIT PARAMETER DISPLAY(V82) (45X45)	

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

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

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

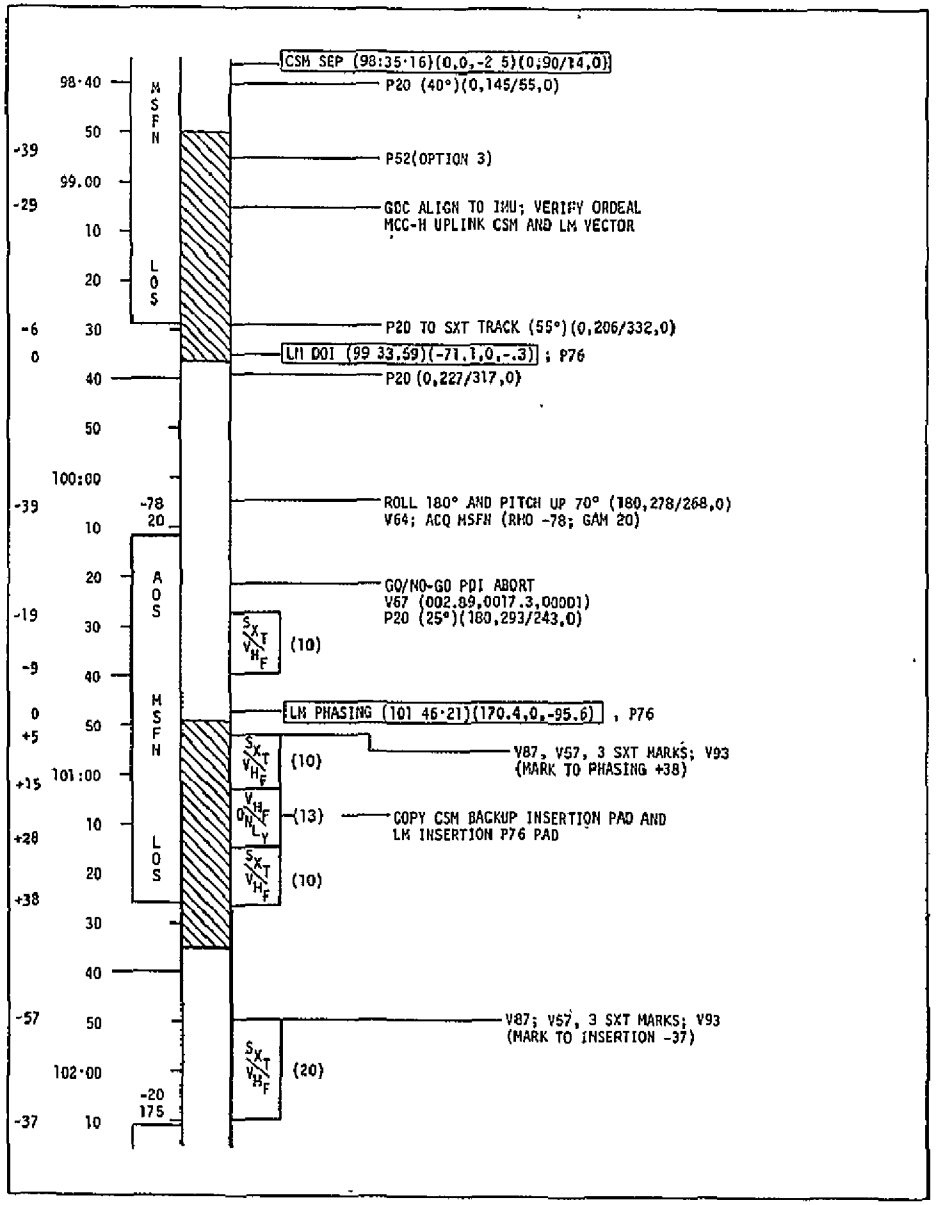
GET	EVENT	PROG
-05 (105+04)		
	SPS THRUST SETUP (TPI)	(P40)
-03 (105+06)		
	GDC ALIGN	
0 (105+09+00)		
	**********	
	LM TPI BURN(22.2,0,-12.1)	
	**********	
	**********	
	CSM TPI BACKUP BURN (-21.8,0,11.6) (0,208/15,0)	
	**********	
	TARGET DV PROGRAM (TPI)	(P76)
	RENDEZVOUS NAV PROGRAM AUTO MNVR TO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

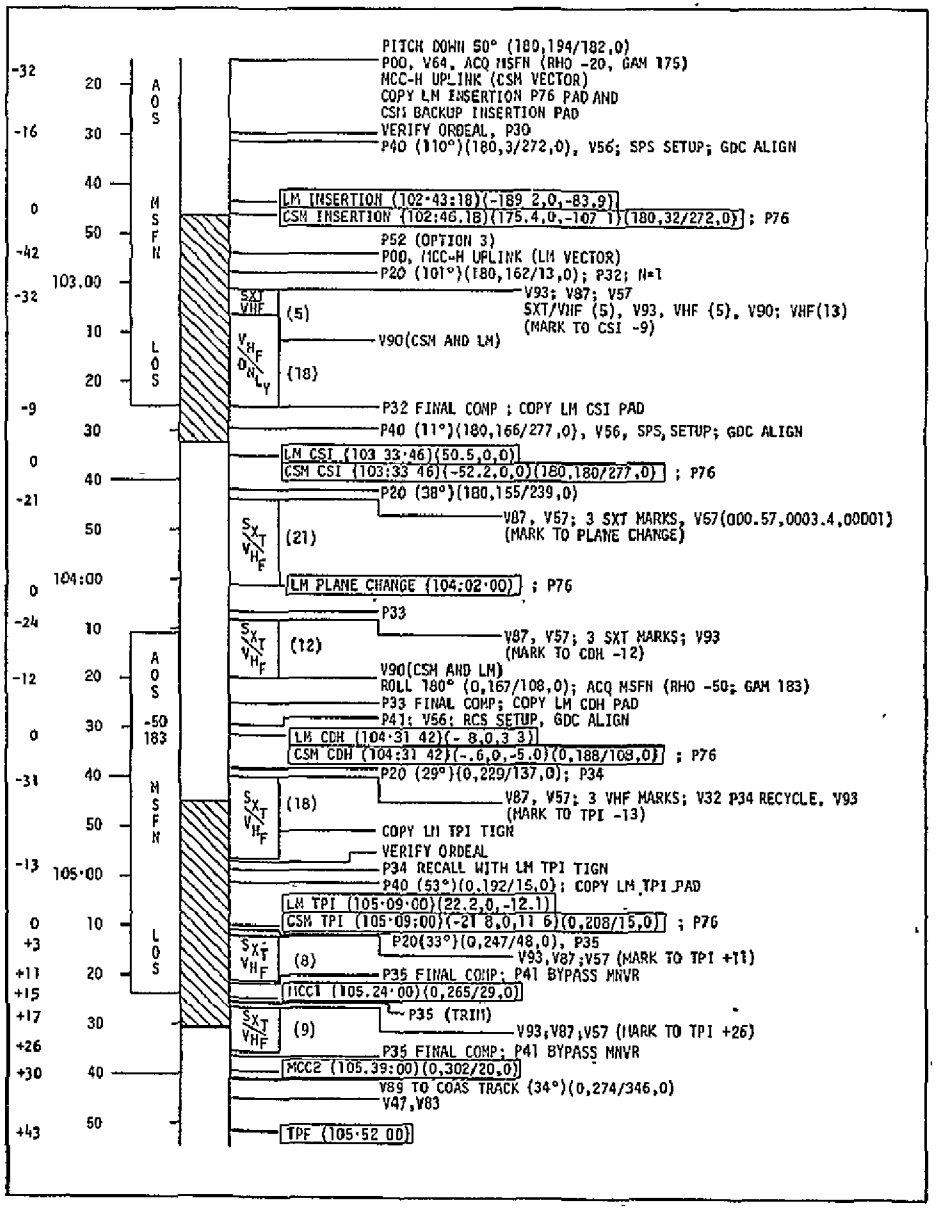
GET	EVENT	PROG
+13.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
+15	(105+24+00)	
	**********	
	LM MCC1 THRUST	
	**********	
	**********	
	CSM MCC1 BACKUP BURN	
	(0,265/29,0)	
	**********	
	TARGET DV PROGRAM	(P76)
	(MCC1)	
+16		
	MCC2 TARGETING PROGRAM	(P35)(P20)
	POSSIBLE AUTO MNVR TO SXT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

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

MISSION F NOMINAL TIMELINE APRIL 25, 1969

5.2 NOMINAL SUMMARY CHECKLIST





6.0 NOMINAL DETAILED PROCEDURES

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

6.1 Procedures Ground Rules

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6.2 DETAILED PROCEDURES

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

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

CDR SWITCH SETTINGS

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

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

LMP SWITCH SETTINGS

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

CMP SWITCH SETTINGS

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

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


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

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

      P00        KEY V37E00E

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

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

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

              SET MDC ET COUNTING DOWN TO
                 SEPARATION TIGN
                 (98+55+44)

(97+20)
              VERIFY AUTO RCS SEL
                 -C4(-PITCH-X)-OFF,AND
                 -B3(+YAW-X)-OFF(FOR LM
                 RDR SELF TEST)
              VERIFY RNDZ XPNDR-OFF
(97+27)
              LOSS OF SIGNAL
(97+30)
              CONFIGURE CAMERA!
                 CM/SEQ/18/CEX-BRKT(RH WIN)
                 MIR(F11,250,INFINITY)6FPS,
                 15 MIN
```

```
(97+35)
        **LOAD DAP**
              KEY V48E
     F 04 46 (DAP CONFIGURATION)
              LOAD
                   21112
                   11111
              PRO
     F 06 47 (CSM AND LM WT)
              LOAD
                   +37768
                   +30847
              PRO
     F 06 48 (SPS GMBL TRIM)
              LOAD
                   -00052
                   +00059
              PRO
              KEY V46E
              KEY V62E
(97+38)
              SUNUP
              VHF AM A-SIMPLEX
              VHF RCV ONLY-B DATA
(97+40)
        **MANEUVER TO UNDOCKING ATTITUDE**
              (INERTIAL SEP ATT EXCEPT ROLL
                 AND 14 DEG YAW)

              KEY V49E
     F 06 22 (COMMANDED R,P,Y)
              LOAD(180,14,14)
              PRO
     F 50 18 (COMMANDED R,P,Y)
              PRO
```

```
     06 18 (COMMANDED R,P,Y)
              MONITOR AUTO MANEUVER
     F 50 18 (COMMANDED R,P,Y)
                 (180,282/14,14)
              KEY ENTER
(97+46)
              CMC MODE-FREE(AS REQ FOR AGS
                 CALIB)
              CMC MODE-AUTO(AFTER 32 SEC)
          PERFORM SYSTEMS CHECK
         AND SWITCH VERIFICATION

(97+50)
              YAW 14 DEG LEFT AFTER
                 LM AGS CALIBRATION
               (180,312/14,0)
(97+52)
              MOVE TO LEB

         **RNDZ XPNDR ACTIVATION**
                AND SELF TEST

              CB RNDZ XPNDR FLT BUS-CLOSE
              RNDZ XPNDR PWR-HTR FOR 1 MIN
                 FOR SELF TEST
              RNDZ XPNDR PWR-PWR
              SYS TEST (LH)-XPONDER
              SYS TEST(RH)-A(RRT XMTR OUT
                 PWR)
              RNDZ XPNDR TEST-TEST(HOLD)
              SYS TEST IND-GRATER THAN 1 VDC
              SYS TEST(RH)-B(RRT AGC SIG)
              RNDZ XPNDR TEST-TEST(HOLD)
              SYS TEST IND-GREATER THAN 1
                 VDC
```

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

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

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

(98+06)
     **ORDEAL VERIFICATION**

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

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

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

     **PROCEDURES FOR UNDOCKING**

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

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

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


            **CSM STATION KEEPING**

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

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

            **ACQUIRE MSFN**

                 KEY V64E
        F 06 51  (RHO,GAMMA,BLANK)
                 SLEW HI GAIN ANT
    (98+13)
                 ACQUISITION OF SIGNAL
                 ACQUIRE MSFN
                 PRO

                 ACTIVATE COLOR TV
                 TAKE PHOTOS
                 INSPECT LM DURING LM 360 DEG
                  YAW
```

```
-15   (98+20)
                 **LM STATION KEEPING**

                      THC-LOCKED
                      RHC-LOCKED

-12   (98+23)
                      COPY DOI P76 PAD
                      COPY INITIAL PHASING P76 PAD
                      COPY INITIAL PDI ABORT P76 PAD
                      COPY NOMINAL BURN TIME PAD

      (98+29)
                 **RELOAD DAP**

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

-5    (98+30)
      P30             KEY V37E30E
          F 06 33     (GET OF SEP)
                      LOAD GET OF SEPARATION
                         (98+55+44)
                      PRO
```

```
        F 06 81 (VG-LV)                          -00+40
                LOAD (0,0,-2.5)                                  MONITOR COMP ACTV LT-OUT
                PRO                              -00+35
        F 06 42 (HA,HP,VG)                                       DSKY BLANKS
                VERIFY VG=2.5                    -00+30
                PRO                                           16 85 (VG-BODY) (AVG G ON)
        F 16 45 (MKS,TFI,MGA)                                    COMP ACTV LT-2 SEC FLASH
                SET MDC ET TO TFI,COUNTING                       EMS MODE-NORMAL
                   DOWN                          -00+25
                CONFIRM MGA LESS THAN 45 DEG                     CK VG FOR HI PIPA BIAS
                PRO                                                 (LESS THAN 2.0 FPS PER 5
        F 37 BB                                                     SEC)
                                                                 THC-ARMED
-3    (98+32)
            **RCS SEPARATION BURN SETUP**        0+00 (98+35+16)
                                                           F 16 85 (VG-BODY)
P41             KEY 41E                                          SET MDC ET COUNTING UP
        F 50 18 (COMMANDED R,P,Y)                                   FROM SEPARATION
                PRO                                              INCREASE VG-BODY FROM
          06 18 (COMMANDED R,P,Y)                                   (+2.5,0,0) TO (+5.0,0,0)
                MONITOR ATT TRIM                                    BY THRUSTING AFT
        F 50 18(COMMANDED R,P,Y)
                RHC-ARMED                                     ************************************
                ALIGN S/C IN ROLL                                CSM PERFORMS SEPARATION BURN
                PRO                                                 (0,0,-2.5)
          06 18 (COMMANDED R,P,Y)                                   (0,90/14,0)
                MONITOR ATT TRIM                                    WHEN BURN COMPLETE, VOICE
        F 50 18 (COMMANDED R,P,Y)                                   CONFIRMATION TO LM
                KEY ENTER                                     ************************************
          06 85 (VG-BODY)
                MONITOR COMP ACTV LT
                BMAG MODE(3)-ATT 1/RATE 2
                RATE-LOW
                EMS FUNCTION-DV SET
                SET DV IND TO +2.5
                EMS FUNCTION-DV
```

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

F 37 BB

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


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

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

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

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

             MOVE TO LEB

             PERFORM OPTICS CHECKS

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

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

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

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

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

```
F 06 93 (GYRO TORQ ANGLES)
        COPY DATA ON CHECKLIST
        PRO
F 50 25 (00014, PERFORM FINE ALIGN)
        PRO
F 50 25 (00015,PERFORM STAR ACQ)
        PRO
F 01 70 (STAR CODE)
        LOAD THIRD STAR CODE
           (RASALHAGUE=35)

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

P00     KEY V37E00E

        SET LEB ET COUNTING DOWN
           TO LM DOI TIGN

(99+03)
        MOVE TO CMD SEAT

     **ALIGN GDC TO IMU**

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

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

```
            MOVE TO CMD SEAT
(99+36)
            VHF AM A-OFF
            VHF AM B-DUPLEX
            VHF RCV ONLY-OFF
            VHF RANGING-RNG
            VHF RANGING-RESET(NO VOICE 12
               SEC)
            COMPUTE RDOT FROM VHF RANGE

            CONFIRM LM BURN COMPLETE

            PRO/INCORPORATE P76
     F 37 BB

            KEY V82E
     F 04 06 (VEHICLE OPTION CODES)
               LOAD R2=00002
               PRO
     F 16 44 (HA,HP,TFF)
            PRO
     F 37 BB
(99+37)
            SUNUP
(99+38)
        **MANEUVER TO TRACK ATTITUDE**

P20         KEY 20E

            MOVE TO LEB
(99+41)
            ZERO OPTICS-ZERO(15 SEC)
            ZERO OPTICS-OFF
```

```
-63   (99+44)
                INITIATE LM TRACK

                SET LEB ET COUNTING DOWN
                   TO LM PHASING TIGN

                ZERO OPTICS-ZERO
                CEASE TRACKING
                MOVE TO CMD SEAT
-39   (100+07)
                FDAI SCALE-5/5
                RHC-ARMED
                ROLL 180 DEG AND PITCH UP 70
                   DEG AT 1 DEG/SEC
                   (180,278/268,0)
                FDAI SCALE-5/1
                RHC-LOCKED

P00             KEY V37E00E
                KEY V64E
     F 06 51 (RHO,GAMMA,BLANK)
                SLEW HI GAIN ANT
                PRO
(100+12)
                ACQUISITION OF SIGNAL
                ACQUIRE MSFN
(100+20)
                OBTAIN GO/NO GO FOR PDI ABORT
                MOVE TO LEB

                KEY V67E
     F 06 99 (POS,VEL ERR,OPTION CODE)
```

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

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

```
0+00 (100+46+21)

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

                    CONFIRM LM BURN COMPLETE

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

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


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

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

(101+05)
               COPY INITIAL CSM BACKUP
                  INSERTION PAD
(101+10)
               COPY LM INSERTION P76 PAD
```

```
(101+14)
               KEY V57E
      F 51 BB  (PLEASE MARK)
               OPTICS MODE-MAN
               OHC-CENTER LM IN SXT
               MAKE 10 MARKS IN NEXT
                  10 MINUTES
(101+24)
               PRO/PROCESS LAST MARK
               KEY V88E/TERMINATE VHF RNG
               ZERO OPTICS-ZERO
               OPTICS MODE-CMC

               MOVE TO CMD SEAT

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

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

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

                  MOVE TO LEB

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

                  MOVE TO CMD SEAT
```

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

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

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

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

      (102+29)
            **ORDEAL VERIFICATION**

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

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

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

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

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

-9    (102+37)

            **SETUP SPS INSERTION BACKUP**

                   EMS MODE=STBY
                   EMS FUNCTION=DV SET
```

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

                   ALIGN S/C TO 180 DEG ROLL
                   PRO
             06 18 (COMMANDED R,P,Y)
                   MONITOR ATT TRIM
           F 50 18 (COMMANDED R,P,Y)
-5
            **GDC ALIGN**

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

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

```
-3     (102+43+18)
                    MONITOR LM ENGINE IGNITION
                ************************************
                    LM INSERTION BURN
                       (-189.2,0.1,-83.9)
                ************************************
*************************************************
*               ***************************      *
*               IF LM CANNOT PERFORM THE BURN    *
*               (USE ZERO INSERTION CHECKLIST)   *
*               (FOR PARTIAL LM INSERTION GO TO  *
*               PARTIAL INSERTION CHECKLIST FOR  *
*               RESCUE 2 BURN AT 103+32)         *
*               ***************************      *
*                    MN BUS TIE(BOTH)-ON         *
*                    NONESS BUS-MNA              *
*                    SPS HE VLV TB (BOTH)-BP     *
*                    SPS HE VLV (BOTH)-AUTO      *
*                    VERIFY SPS TH LT-OFF        *
*                    GMBL MTRS(4)-ON(SEQUENTIALLY)*
*                    TVC SERVO PWR 1-AC1/MNA     *
*                    TVC SERVO PWR 2-AC2/MNB     *
*                    KEY ENTER                   *
*              06 40 (TFI,VG,DV)                 *
*                    DV THRUST A-NORMAL          *
*                    THC-ARMED                   *
*-00+35                                          *
*                    DSKY BLANKS                 *
*-00+30                                          *
*              06 40 (TFI,VG,DV) (AVE G ON)      *
*                    EMS MODE-NORMAL             *
*-00+15                                          *
*                    THC-APPLY ULLAGE            *
```

```
*-00+05                                          *
*          F 99 40 (TFI,VG,DV)                   *
*                  PRO                           *
*                                                *
*00+00(102+46+18)                                *
*              ***************************       *
*              CSM BACKUP INSERTION BURN         *
*                     (175.4,0,-107.1)           *
*                     (180,32/272,0)             *
*              ***************************       *
*                                                *
*+00+01                                          *
*            06 40 (TFC,VG,DV)                   *
*                  THC-TERMINATE ULLAGE          *
*                  MONITOR SPS BURN              *
*          F 16 40 (TFC,VG,DV)                   *
*                  DV THRUST A-OFF               *
*                  GMBL MTRS(4)-OFF/SEQUENTIALLY*
*                  PRO                           *
*          F 16 85 (VG-BODY)                     *
*                  THC-NULL VGS                  *
*                  THC-LOCKED                    *
*                  EMS MODE-STBY                 *
*                  TVC SERVO PWR(BOTH)-OFF       *
*                  SPS HE VLV (BOTH)-OFF         *
*                  MN BUS TIE(BOTH)-OFF          *
*                  NONESS BUS-OFF                *
*                  PRO                           *
*          F 37 BB                               *
*                  (CONTINUE DETAILED PROCEDURES*
*                  BUT DELETE P76)               *
*************************************************
```

```
            CONFIRM LM BURN COMPLETE

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

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

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

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

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


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

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

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

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

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

(102+52)
P00          KEY V37E00E

        **LM STATE VECTOR UPLINK**

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

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

P20          KEY V37E20E
     F 50 18 (COMMANDED R,P,Y)
             PRO
       06 18 (COMMANDED R,P,Y)
             MONITOR AUTO MNVR
     F 50 18 (COMMANDED R,P,Y)
                (180,162/13,0)
```

```
                KEY ENTER
                ZERO OPTICS-OFF
     (102+59)
                COPY LM CSI AND TPI TIGNS

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

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

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

                 MOVE TO CMD SEAT

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

                 KEY V90E
        F 04 12  (VEHICLE OPTION)
                 LOAD R2=00001
                 PRO
        F 06 16  (TIME OF EVENT)
                 LOAD CSM CSI TIGN
                    (103+33+46)
                 PRO
        F 06 90  (Y,YDOT,PSI)
                 COPY (-)CSM YDOT
                    ON CHECKLIST
        F 16 45  (MKS,TFI-CSI,-00001)
```

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

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

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

```
*                                                  *
*+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
(103+37)
                LOAD(50,5,0,0)
                PRO
        F 06 33 (GETI OF CSI BURN)
                LOAD LM CSI TIGN
                   +16 SEC
                   (103+33+46)
                PRO
        F 37 BB

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

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


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

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

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

             ZERO OPTICS-OFF

(103+41)
             KEY V87E (VHF TRACKING)
             KEY V57E
     F 51 BB (PLEASE MARK)
             OPTICS MODE-MAN
             OHC-CENTER LM IN SXT
             MAKE 3 MARKS IN NEXT
                2 MINUTES
(103+43)
             PRO/PROCESS LAST MARK
```

```
             KEY V67E
     F 06 99 (POS ERR,VEL ERR,OPTION CODE)
             LOAD WR
                (000.57,0003.4,00001)
             PRO
(103+44)
             KEY V57E
     F 51 BB (PLEASE MARK)
             MAKE 11 MARKS IN NEXT
                11 MINUTES
(103+55)
             PRO/PROCESS LAST MARK
             OPTICS MODE-CMC

             OBTAIN LM PC TIGN

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


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

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

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

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

                CONFIRM LM PC BURN

                PRO/INCORPORATE P76
     F 37 BB
(104+05)
P33             KEY 33E
     F 06 13 (GETI-CDH)
                OBTAIN LM CDH TIGN
                LOAD LM CDH TIGN
                   (104+31+42)
                COPY DATA ON CHECKLIST
                PRO
     F 16 45 (MKS,TFI-CDH,-00001)
                KEY V32E
     F 06 75 (DH,DT-CDH/TPI,DT-TPI/TPI)
                PRO
```

```
     F 06 81 (CDH VG-LV)
                PRO
     F 16 45 (MKS,TFI-CDH,-00001)
                VERIFY ET-TFI

-24   (104+08)
                KEY V87E (VHF RANGING)
                KEY V57E
     F 51 BB (PLEASE MARK)
                OPTICS MODE-MAN
                OHC-CENTER LM IN SXT
                TAKE 4 MARKS IN NEXT
                   3 MINUTES
                KEY V93E (REINITIALIZE W MAT)
                TAKE 8 MARKS IN NEXT
                   9 MINUTES
                PRO / PROCESS LAST MARK
     F 16 45 (MKS,TFI,-00001)
                ZERO OPTICS-ZERO
                OPTICS MODE-CMC
   (104+09)
                ACQUISITION OF SIGNAL
-12   (104+20)
                KEY V90E
     F 04 12 (VEHICLE OPTION)
                LOAD R2-00002
                PRO
     F 06 16 (TIME OF EVENT)
                LOAD LM CDH TIGN
                   (104+31+42)
                PRO
     F 06 90 (Y,YDOT,PSI)
                VOICE LM YDOT TO LM
                PRO
     F 16 45 (MKS,TFI-CDH,-00001)
```

```
                MOVE TO CMD SEAT
(104+22)
                FDAI SCALE=5/5
                RHC=ARMED
                ROLL 180 DEG AT 2 DEG/SEC
                   (0,167/108,0)
                RHC=LOCKED
                FDAI SCALE=5/1
                ACQUIRE MSFN
                (RHO=-50,GAMMA=183)
-7  (104+25)
                PRO/MAKE FINAL PASS
        F 06 75 (DH+DT=CDH/TPI,DT=TPI/TPI)
                COPY DATA ON CHECKLIST
                PRO
        F 06 81 (CDH VG=LV)
                KEY V90E
        F 04 12 (VEHICLE OPTION)
                LOAD R2=00001
                PRO
        F 06 16 (TIME OF EVENT)
                LOAD LM CDH TIGN
                   (104+31+42)
                PRO
        F 06 90 (Y,YDOT,PSI)
                COPY (-) CSM YDOT ON CHECKLIST
                PRO
        F 06 81 (CDH VG=LV)
                OVER WRITE N81 WITH
                   (-) CSM YDOT
                COPY DATA ON CHECKLIST
                PRO
        F 16 45 (MKS,TFI=CDH,MGA)
                SET MDC ET=TFI
                PRO
        F 37 88
```

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

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

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

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

                  CONFIRM LM BURN COMPLETE

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

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

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

-35   (104+34)

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

     P34          KEY V37E34E
          F 06 37 (GETI-TPI)
                  LOAD TPI TIGN(105+09+00)
                  PRO
          F 06 55 (BLANK,ELANG,CENTANG)
                  LOAD R2 = +208.30(DEG)
                  LOAD R3 = +130.00 (DEG)
                  PRO
          F 16 45 (MKS,TFI,-00001)
                  SET LEB ET TO TFI
                     COUNTING DOWN
-31   (104+38)
                  ZERO OPTICS-OFF
                  KEY V87E (VHF RANGING)
                  KEY V57E
          F 51 BB (PLEASE MARK)
                  KEY V16N45E
          F 16 45 (MKS,TFI,-00001)
                  KEY RELEASE
          F 51 BB (PLEASE MARK)
                  OPTICS MODE-MAN
                  OHC-CENTER LM IN SXT
                  MAKE 4 MARKS IN NEXT
                     3 MINUTES (INCORPORATE 4)
                  OPTICS MODE-CMC
-28   (104+41)
                  KEY V32E
          F 06 37 (GETI-TPI)
                  COPY DATA ON CHECKLIST
                  PRO
          F 06 58 (HP,DVTPI,DVTPF)
                  COPY DATA ON CHECKLIST
                  PRO
          F 06 59 (VG-LOS)
                  COPY DATA ON CHECKLIST
                  PRO
          F 16 45 (MKS,TFI,-00001)

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

```
                MOVE TO CMD SEAT

            **VERIFY ORDEAL**

                KEY V83E
        F 16 54 (R,RDOT,THETA)
                SLEW/ADJUST FDAI TO THETA
                PRO
        F 16 45 (MKS,TFI,-00001)
-11   (104+58)
                KEY V37E34E
        F 06 37 (TPI TIGN)
                LOAD LM TPI TIGN
                   (105+09+00)
                PRO
        F 06 55 (BLNK,ELANG,CENTANG)
                LOAD R2 = +000,00
                PRO
        F 16 45 (MKS,TFI,-00001)
                PRO/MAKE FINAL PASS
        F 06 55 (BLNK,ELANG,CENTANG)
                COPY DATA ON CHECKLIST
                PRO
        F 06 58 (HP,DVTPI,DVTPF)
                COPY DATA ON CHECKLIST
                PRO
        F 06 81 (VG-LV)
                COPY DATA ON CHECKLIST
                PRO
        F 06 59 (VG-LOS)
                COPY DATA ON CHECKLIST
                PRO
        F 16 45 (MKS,TFI,MGA)
                RESET MDC ET WITH TFI
                PRO
        F 37 88
-7    (105+02)
            **MANEUVER TO TPI BACKUP ATTITUDE**

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

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

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

```
-3                                                  *
              **GDC ALIGN**                         *
                                                    *
                  ATT SET THUMBWHEELS TO N18        *
                  FDAI SELECT-1                     *
                  NULL ATT ERROR NEEDLES            *
                     ON FDAI 1 WITH ATT             *
                     SET THUMBWHEELS                *
                  FDAI SELECT-1/2                   *-00+15
                  ATT SET-GDC                       *
                  DEPRESS GDC ALIGN PB              *
                  ATT SET-IMU                       *
                                                    *
                  KEY ENTER                         *
          F 50 25 (00204, GMBL DRIVE TEST)          *  0+00
                  KEY ENTER                         *
            06 40 (TFI,VG,DV)                       *
                  DV THRUST A-NORMAL                *
                  THC-ARMED                         *
-00+35                                              *
                  DSKY BLANKS                       *
-00+30                                              *+00+01
            06 40 (TFI,VG,DV) (AVE G ON)            *
                  EMS MODE-NORMAL                   *
-00+05                                              *
          F 99 40 (TFI,VG,DV)                       *
                                                    *
      (105+09+00)                                   *
                                                    *
                  MONITOR LM ENGINE IGNITION        *
                                                    *
              ********************************      *
                  LM TPI BURN(22.0,0-12.1)          *
              ********************************      *
                                                    *
************************************************    *
```

```
                  ******************************    *
                  IF LM CANNOT PERFORM THE BURN     *
                  ******************************    *
                      MN BUS TIE (2)-ON(UP)         *
                      NONESS BUS-MNA                *
                      SPS HE VLV (BOTH)-AUTO        *
                      SPS HE VLV TB (BOTH)-BP       *
                      VERIFY SPS TH LT-OFF          *
                                                    *
                      THC-APPLY ULLAGE              *
                      GMBL MTRS(4)-ON(SEQUENTIALLY)*
                      TVC SERVO PWR 1-AC1/MNA       *
                      TVC SERVO PWR 2-AC2/MNB       *
                      PRO                           *
                                                    *
                  ******************************    *
                      CSM TPI BACKUP BURN           *
                         (-21.8,0,11.6)             *
                         (0,208/15,0)               *
                  ******************************    *
                                                    *
                                                    *
                                                    *
            06 40 (TFC,VG,DV)                       *
                      THC-TERMINATE ULLAGE          *
                      MONITOR SPS BURN              *
          F 16 40 (TFC,VG,DV)                       *
                      DV THRUST A-OFF               *
                      GMBL MTRS(4)-OFF/SEQUENTIALLY*
                      PRO                           *
          F 16 85 (VG-BODY)                         *
                      THC-NULL VGS                  *
                      THC-LOCKED                    *
                      EMS MODE-STBY                 *
                      TVC SERVO PWR(BOTH)-OFF       *
                      SPS HE VLV (BOTH)-OFF         *
                      MN BUS TIE (BOTH)-OFF         *
```

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

                     CONFIRM LM BURN COMPLETE

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

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

```
*************************************************
*                PROCEDURES FOR                 *
*                 TPI THRU TPF                  *
*************************************************
+2
            **MANEUVER TO SXT TRACK**

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

            **TARGET CSM MCC1 BACKUP**

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

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

                                                  MOVE TO COMMAND SEAT

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

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

                                                  COPY LM MCC1 PAD (P76)

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

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

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

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

                CONFIRM LM BURN COMPLETE

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

```
                    **TARGET CSM MCC2 BACKUP**
     P35            KEY 35E
          F 16 45 (MKS,TFI,-00001)
                  ZERO OPTICS-OFF
+17
                  KEY V93E (REINITIALIZE W MAT)
                  KEY V87E(VHF RANGING)
                  KEY V57E
          F 51 BB (PLEASE MARK)
                  KEY V16N45E
          F 16 45 (MKS,TFI,-00001)
                  OMC-CENTER LM IN SXT
                  OPTICS MODE-MAN
                  MAKE 9 MARKS IN NEXT
                     9 MINUTES
     (105+32)
                  SUNUP
+26
                  PRO/PROCESS LAST MARK
          F 16 45 (MARKS,TFI,-00001)
                  ZERO OPTICS-ZERO

                  MOVE TO COMMAND SEAT

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

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

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

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

                    CONFIRM LM BURN COMPLETE

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

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

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

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

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

6.3 P20 NAVIGATION SUMMARY WITH SUN ANGLES

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

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

6.4 CSM ATTITUDE SUMMARY

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

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

7.0 DISCUSSION OF LM ABORT AND RESCUE CASES

7.1 LM Active PDI Abort

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

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

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

7.2 Partial LM Phasing Greater Than or Equal to 40 FPS

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

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

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

7.3 Partial LM Phasing Less Than 40 FPS

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

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

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

7.4 Partial LM Insertion

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

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

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

7.5 Zero LM Insertion

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

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

8.0 LM RESCUE ONBOARD DATA

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

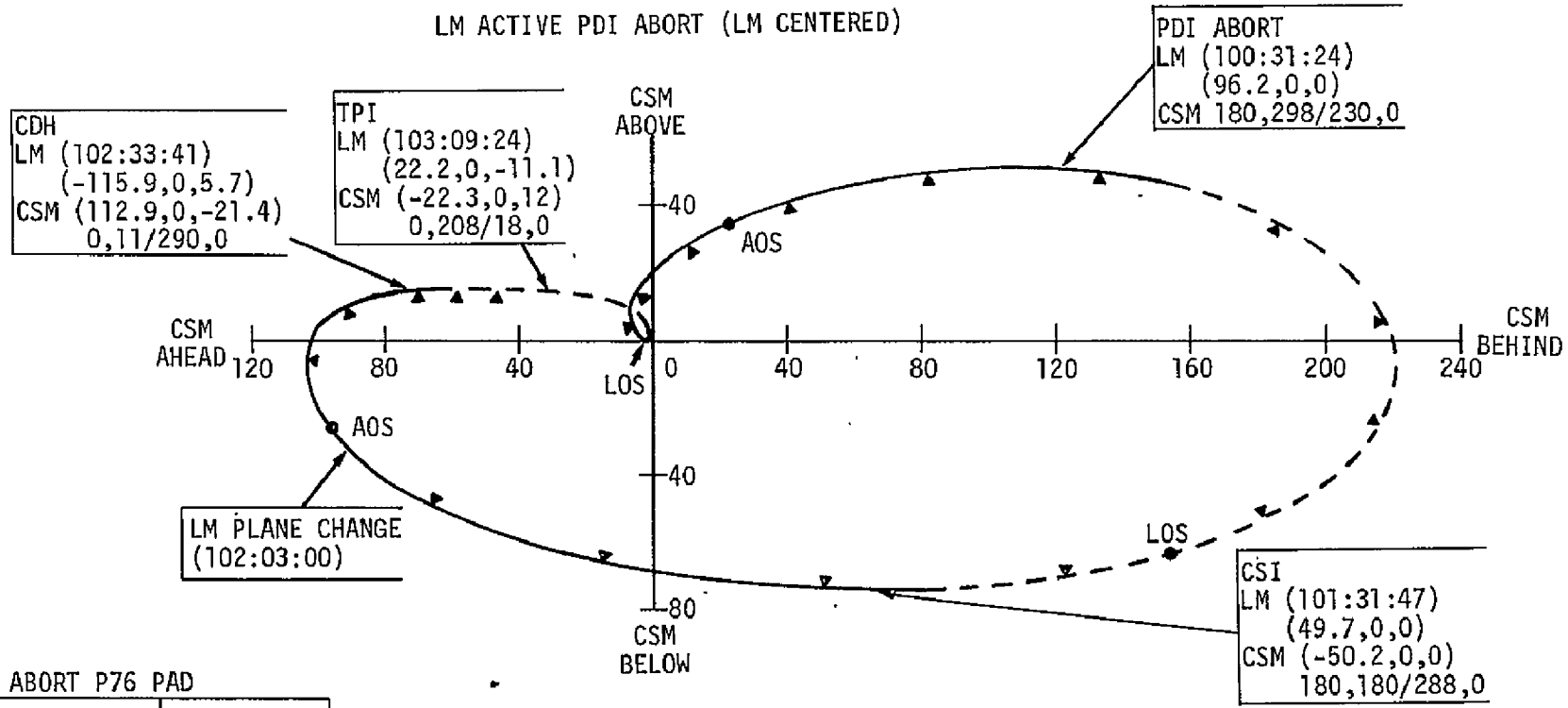
Accompanying each one page checklist will be a relative motion plot (LM centered) showing the orbital position of the CSM with respect to the LM. In addition to the plot, maneuver pads for copying onboard data will be provided for each burn during the five contingency rendezvous situations.

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

8.1 LM PDI Abort

8.1.1 Plot and Pads

LM ACTIVE PDI ABORT (LM CENTERED)



PDI ABORT P76 PAD

84	•	•	•
33	:	:	

CSM CSI COPY

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

LM CSI P76

84	•	•	•
33	:	:	

CSM PC COPY

33	:	:	
81	•	•	•

LM PC P76

84	•	•	•
33	:	:	

CSM CDH COPY

13	:	:	
75	•	:	:
81	•	•	•

LM CDH P76

84	•	•	•
33	:	:	

CSM TPI COPY

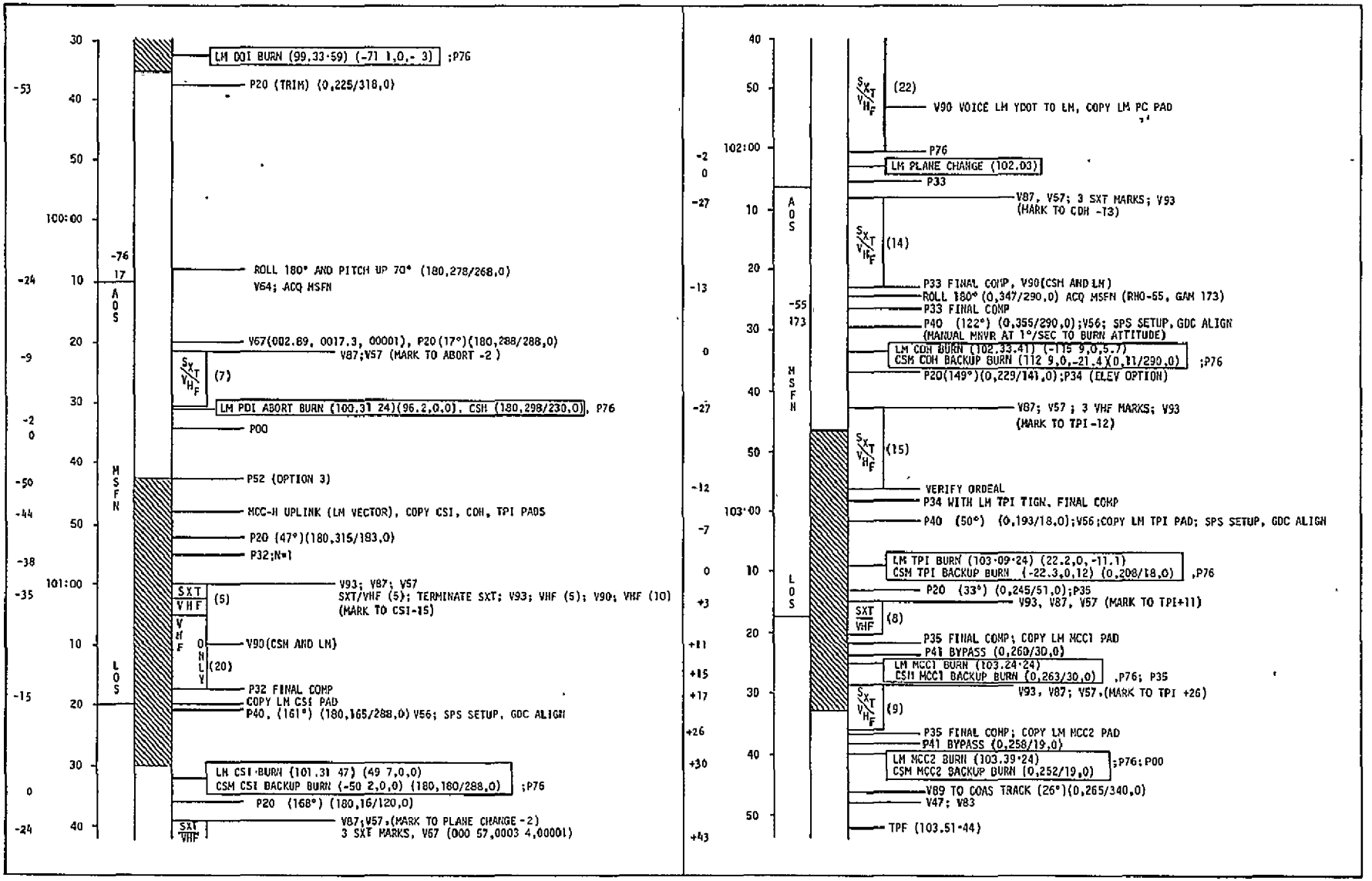
37	:	:	
58	•	•	•
81	•	•	•
59	•	•	•

LM TPI P76

84	•	•	•
33	:	:	

8.1.2 Checklist

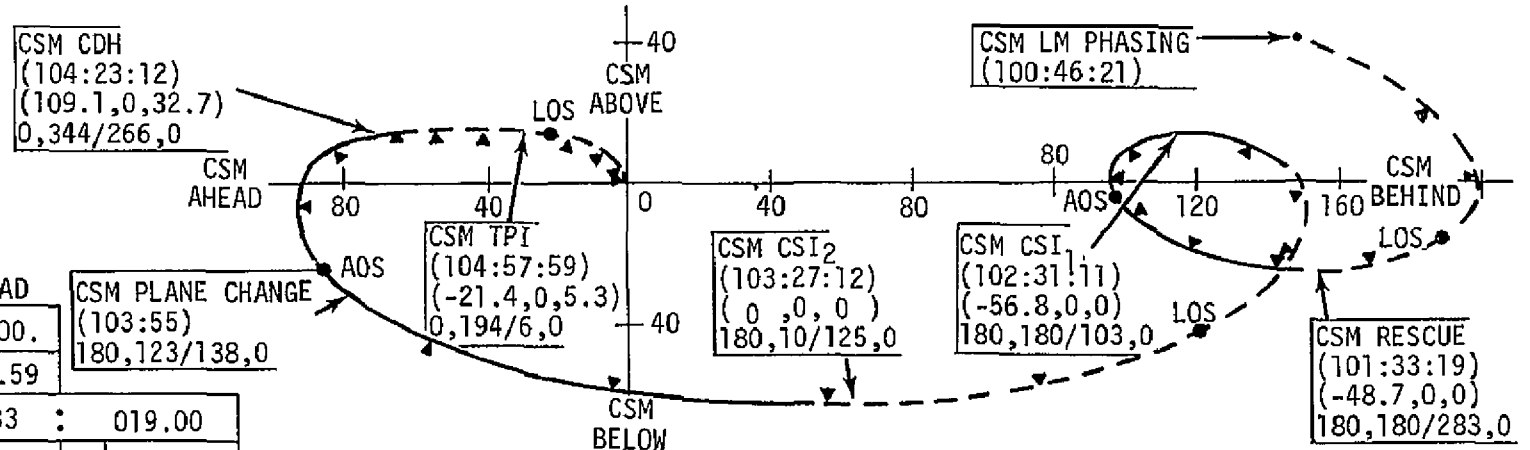
LM ACTIVE PDI ABORT



8.2 LM Partial Phasing Greater or Equal To 40 FPS

8.2.1 Plot and Pads

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



CANNED RESCUE TWO PAD

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

CSM CSI TWO COPY

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

CSM CDH COPY

13	:	:	
75	•	:	:
81	•	•	•

LM CDH P76

84	•	•	•
33	:	:	

CSM CSI ONE COPY

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

LM CSI TWO P76

84	•	•	•
33	:	:	

CSM TPI COPY

37	:	:	
58	•	•	•
81	•	•	•
59	•	•	•

CSM PC COPY

33	:	:	
81	•	•	•

LM CSI ONE P76

84	•	•	•
33	:	:	

LM PC P76

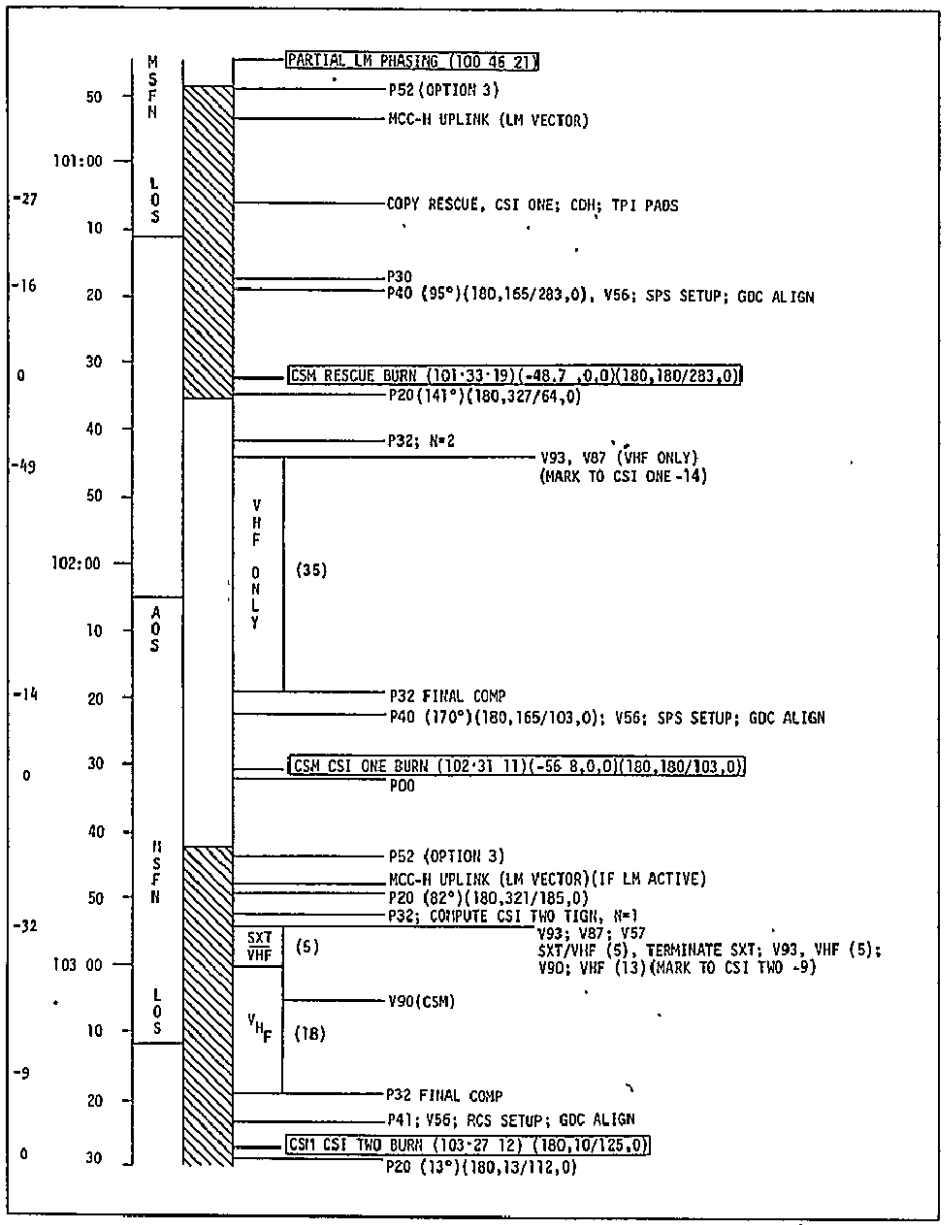
84	•	•	•
33	:	:	

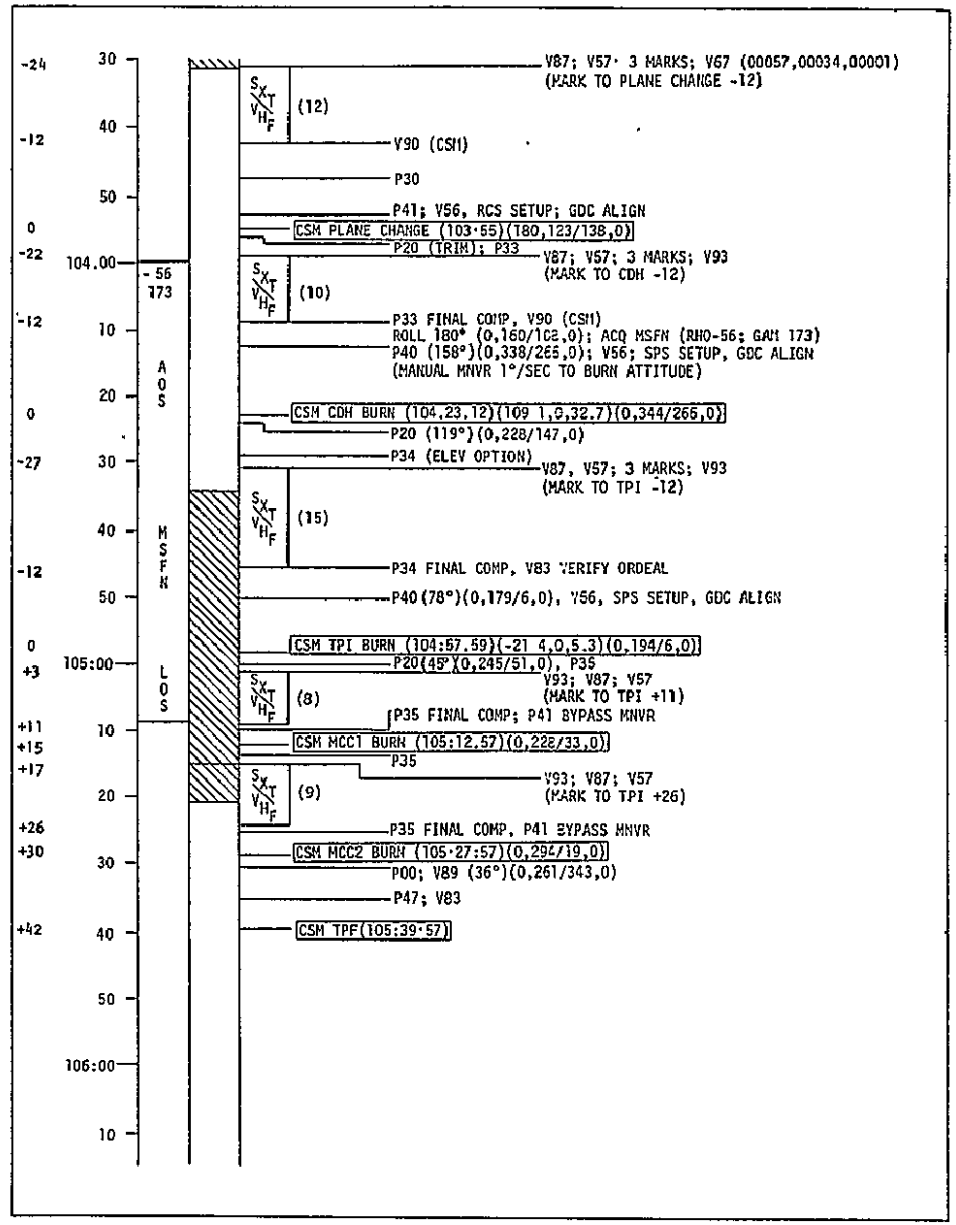
LM TPI P76

84	•	•	•
33	:	:	

8.2.2 Checklist

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



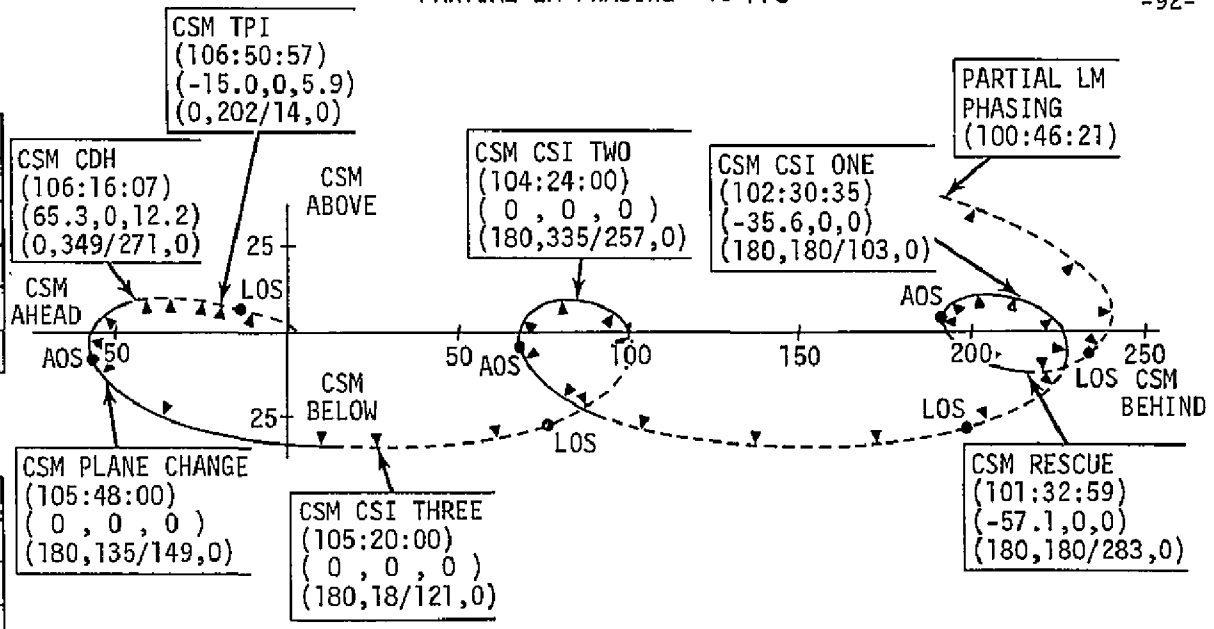


8.3 LM Partial Phasing Less Than 40 FPS

8.3.1 Plot and Pads
PARTIAL LM PHASING <40 FPS

CANNED RESCUE TWO PAD

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



CSM CSI ONE COPY

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

LM CSI ONE P76

84	•	•	•
33	•	•	

CSM CSI TWO COPY

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

LM CSI TWO P76

84	•	•	•
33	•	•	

CSM CSI THREE COPY

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

LM CSI THREE P76

84	•	•	•
33	•	•	

CSM PC COPY

33	•	•	
81	•	•	•

LM PC P76

84	•	•	•
33	•	•	

CSM CDH COPY

13	•	•	
75	•	•	•
81	•	•	•

LM CDH P76

84	•	•	•
33	•	•	

CSM TPI COPY

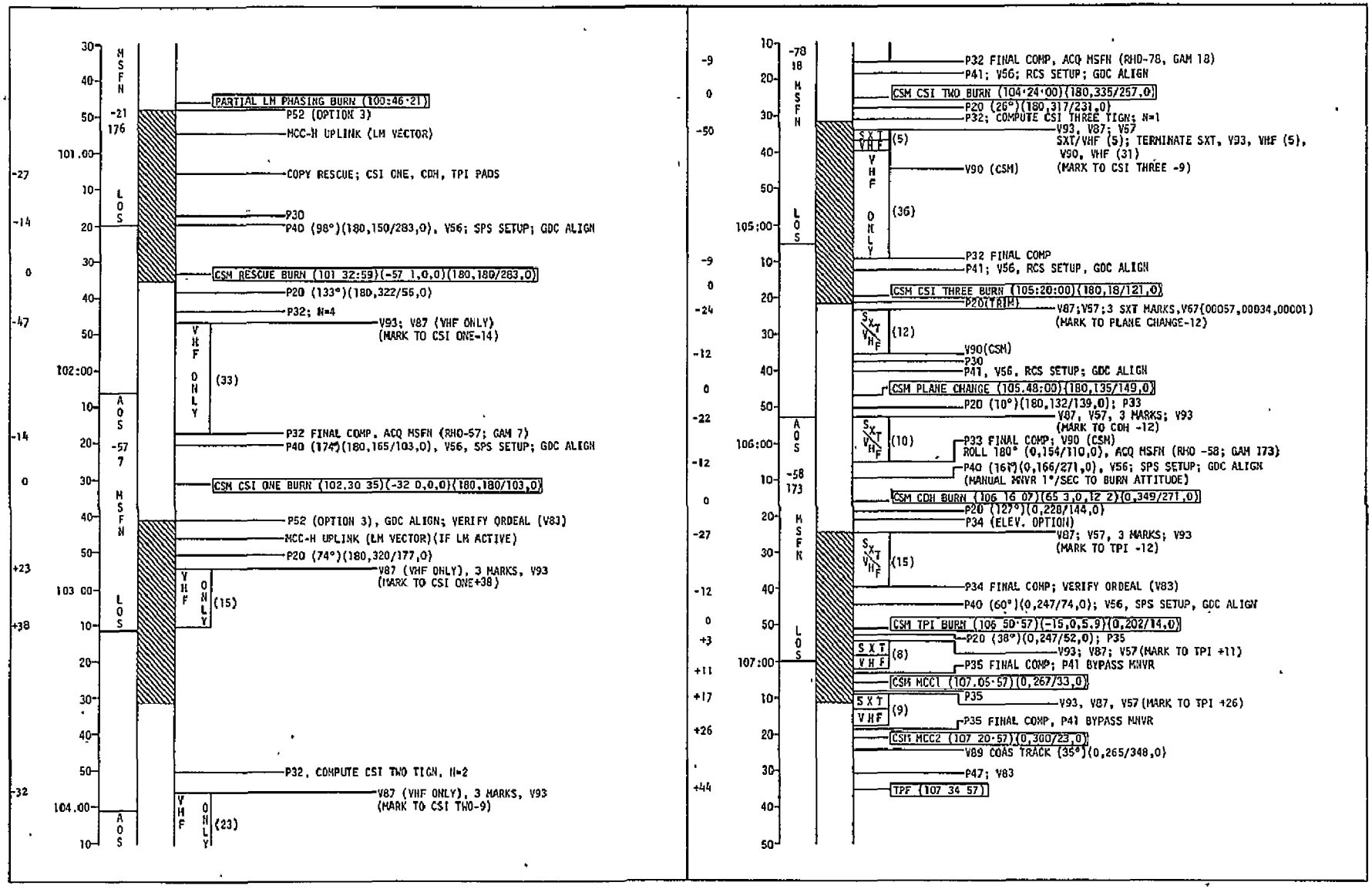
37	•	•	
58	•	•	•
81	•	•	•
59	•	•	•

LM TPI P76

84	•	•	•
33	•	•	

8.3 2 Checklist

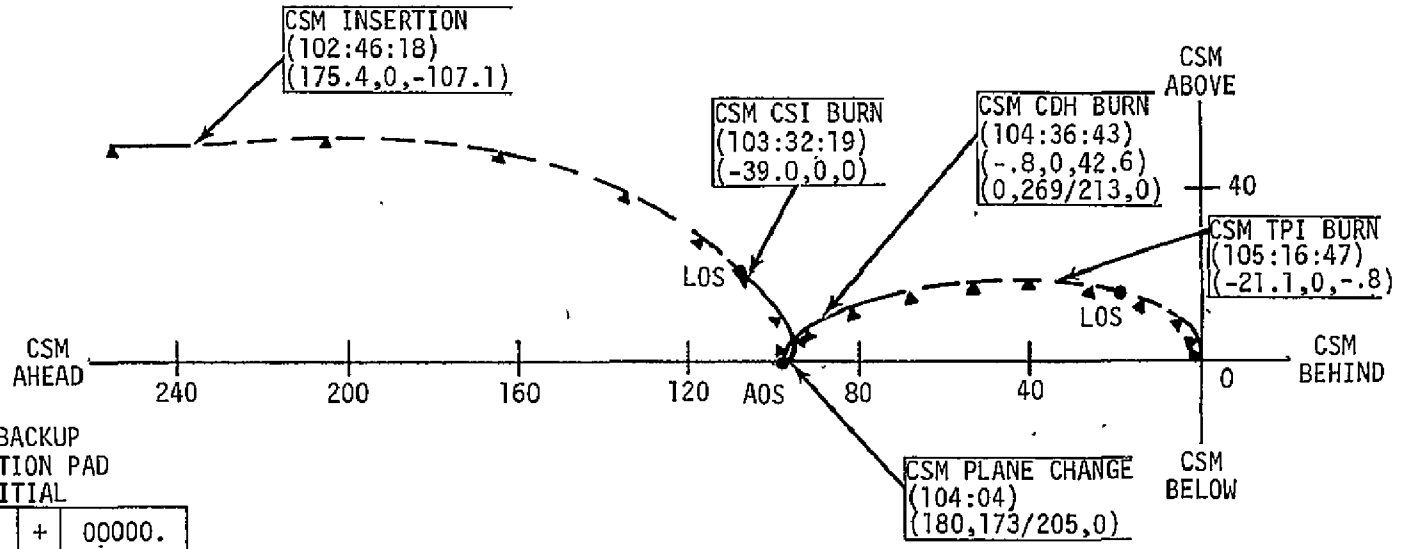
CSM ACTIVE LM RESCUE PHASING LESS THAN 40 FPS



8.4 LM Zero Insertion

8.4.1 Plot and Pads

CSM ACTIVE LM RESCUE-ZERO INSERTION (LM CENTERED)



CSM BACKUP INSERTION PAD INITIAL

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

CSM CSI COPY

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

LM CSI P76

84	.	.	.
33	:	:	

CSM PC COPY

33	:	:	
81	.	.	.

LM PC P76

84	.	.	.
33	:	:	

CSM CDH COPY

13	:	:	
75	.	:	:
81	.	.	.

LM CDH P76

84	.	.	.
33	:	:	

CSM TPI COPY

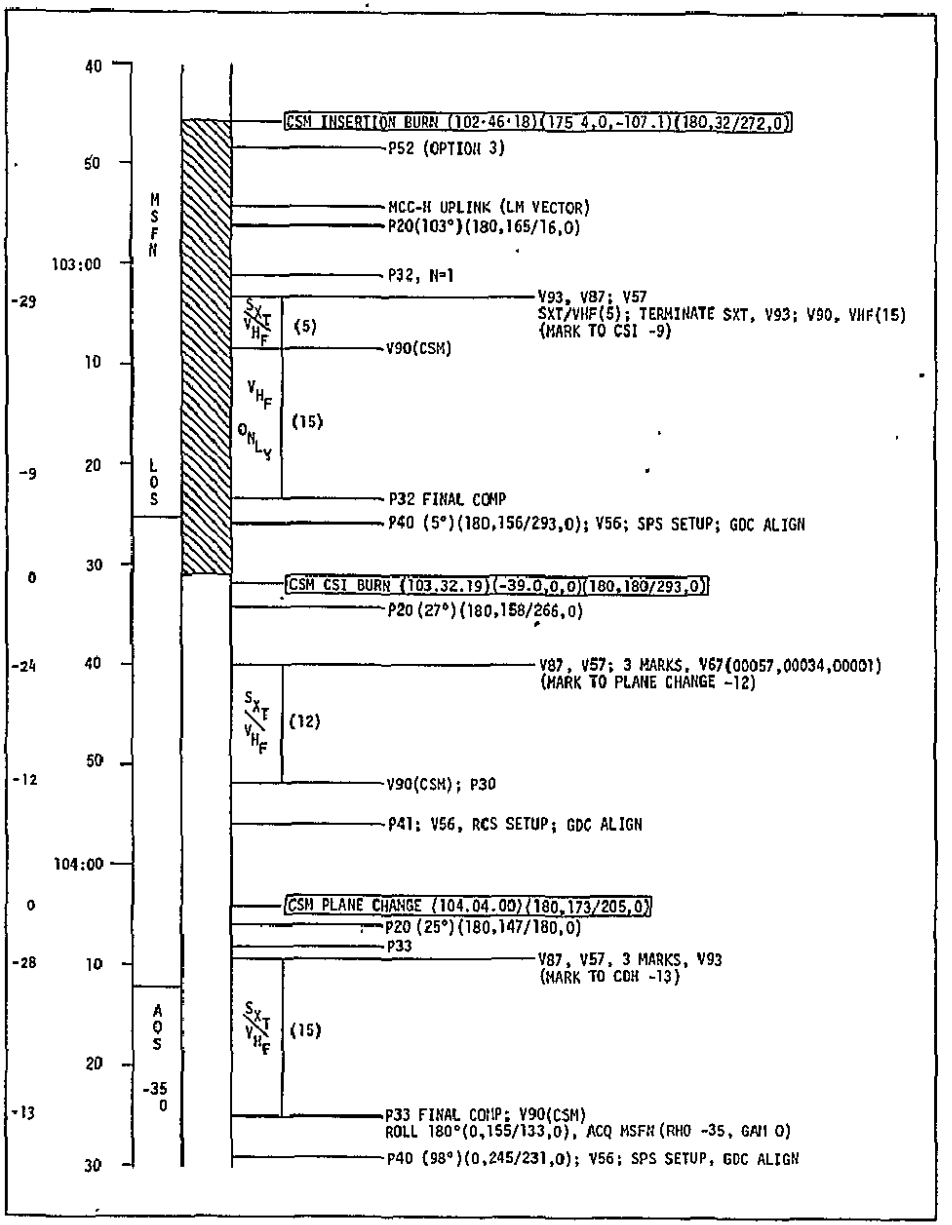
37	:	:	
58	.	.	.
81	.	.	.
59	.	.	.

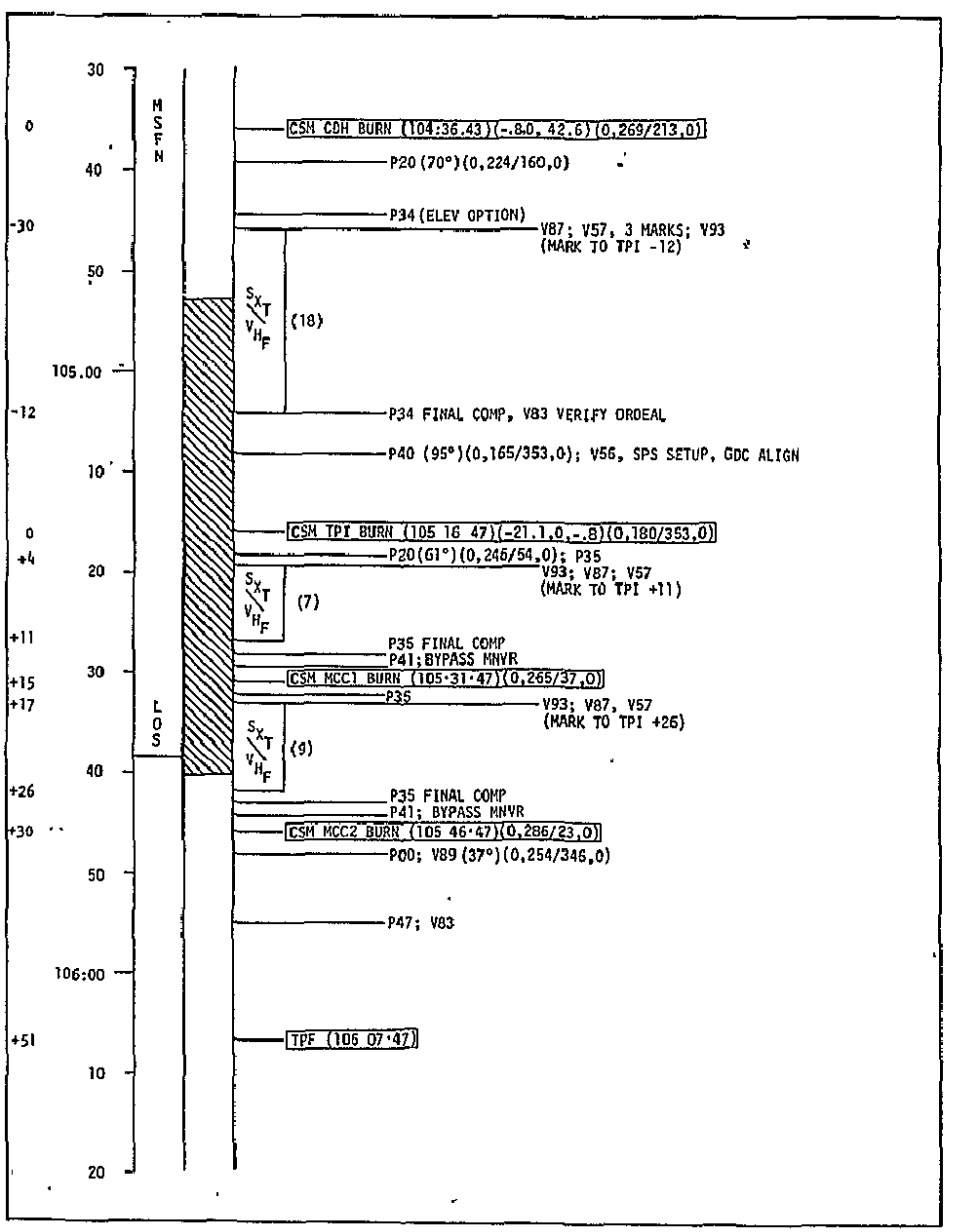
LM TPI P76

84	.	.	.
33	:	:	

8.4.2 Checklist

CSM ACTIVE LM RESCUE - LM INSERTION = 0

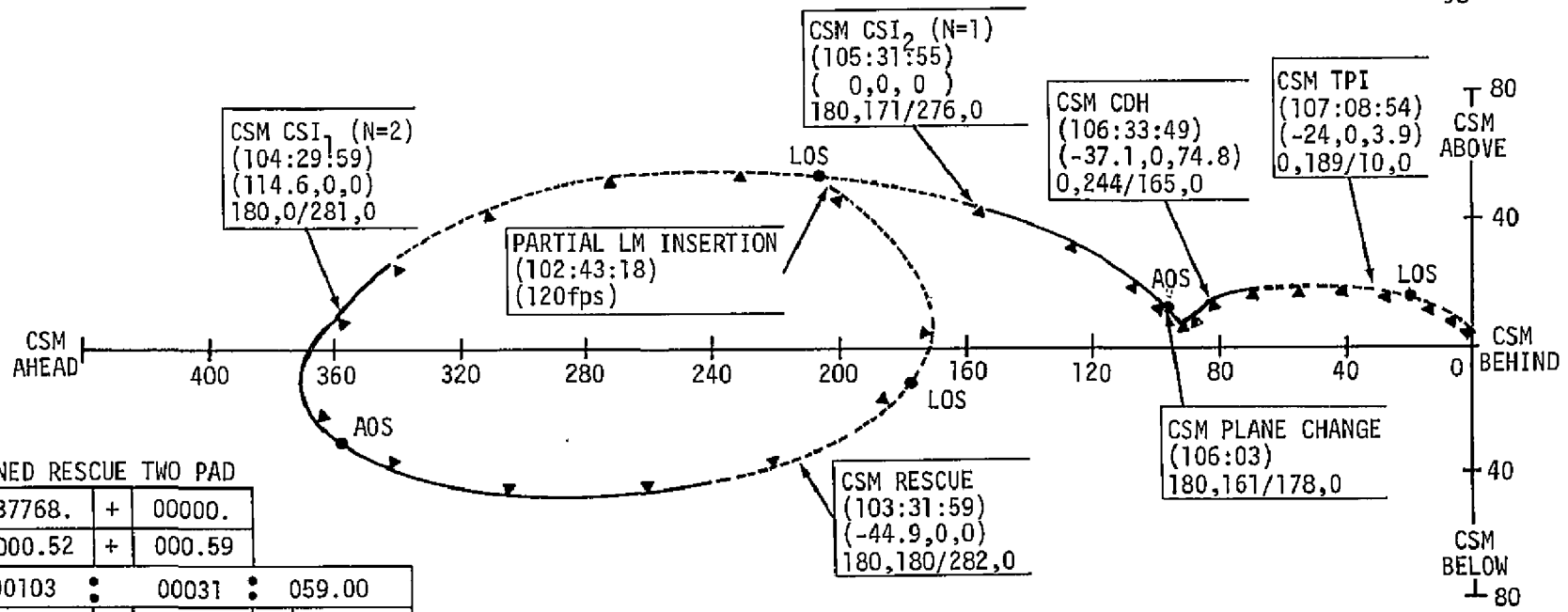




8.5 LM Partial Insertion

8.5.1 Plot and Pads

CSM ACTIVE LM - PARTIAL LM INSERTION (LM CENTERED)



CANNED RESCUE TWO PAD

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

CSM CSI TWO COPY

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

CSM CDH COPY

13	:		:
75	•	:	:
81	•	•	•

LM CDH P76

84	•	•	•
33	:		:

CSM CSI ONE COPY

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

LM CSI TWO P76

84	•	•	•
33	:		:

CSM TPI COPY

37	:		:
58	•	•	•
81	•	•	•
59	•	•	•

CSM PC COPY

33	:		:
81	•	•	•

LM CSI ONE P76

84	•	•	•
33	:		:

LM PC P76

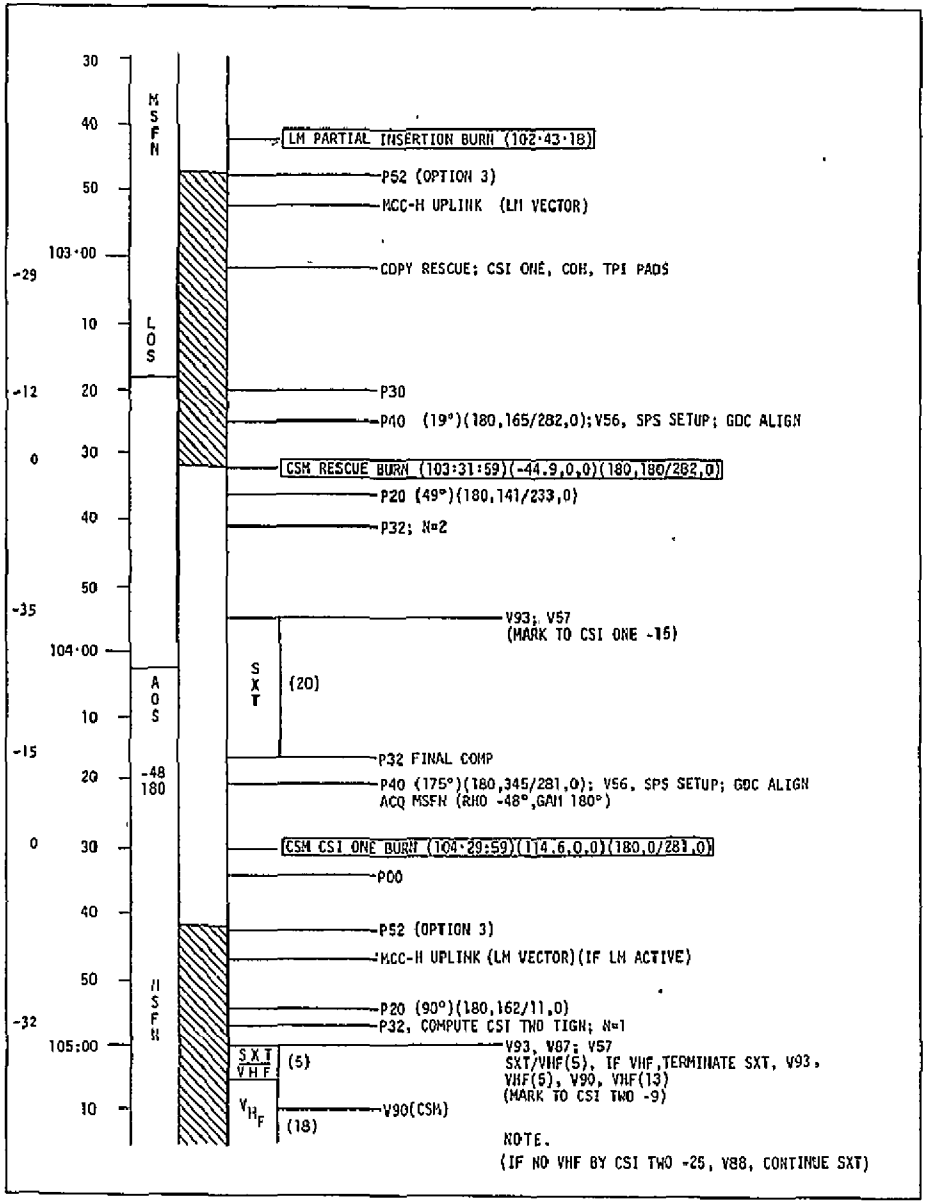
84	•	•	
33	:		:

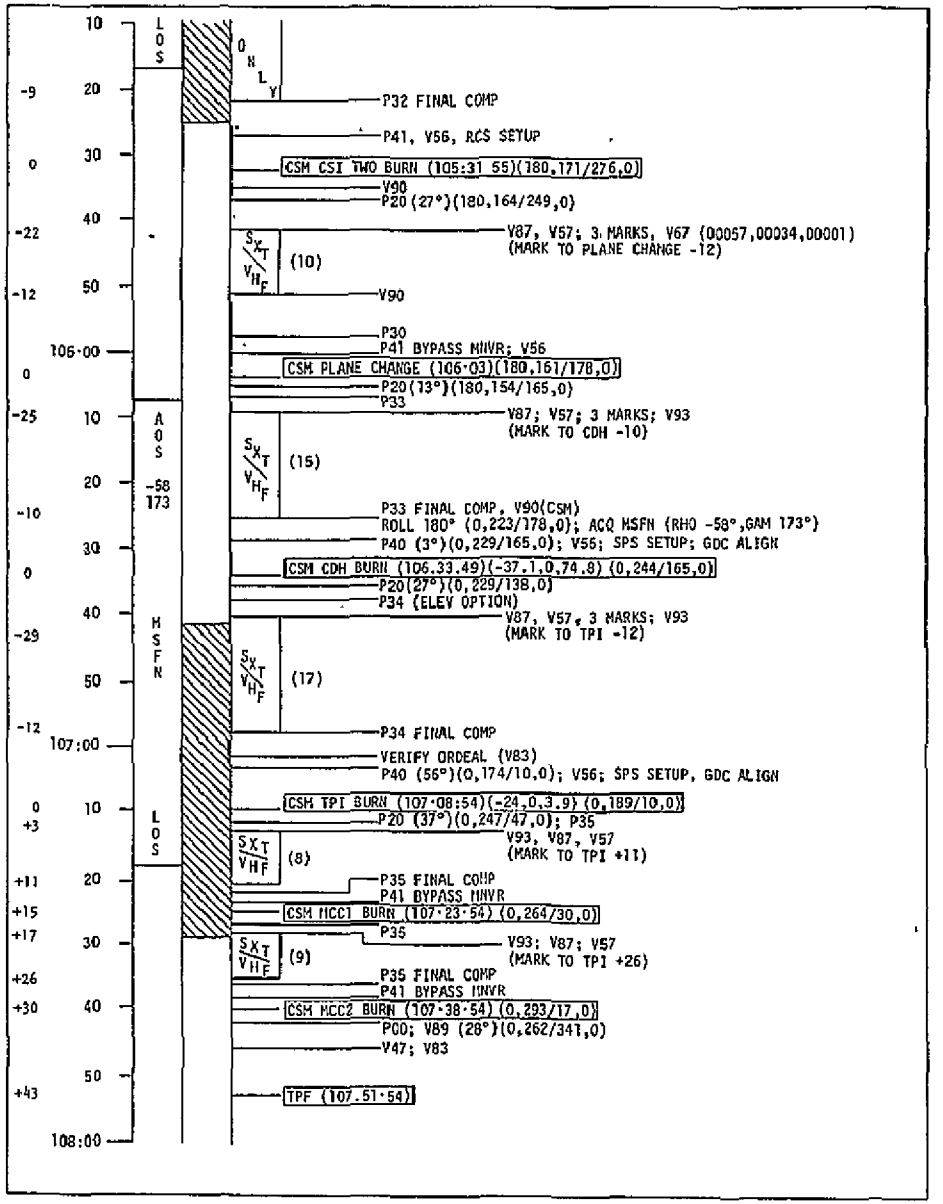
LM TPI P76

84	•	•	•
33	:		:

8.5.2 Checklist

CSM ACTIVE LM RESCUE - PARTIAL LM INSERTION (ΔV APPLIED = 120 FPS)





9.0 LM RESCUE PROCEDURES SUMMARY

9.1 Rescue Procedures Ground Rules

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

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

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

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

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

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

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

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

9.2 LM PDI ABORT

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

GET	EVENT	PROG
(100+20)		
	V67 LOAD WI(002.89,0017.3,00001)	
	MOVE TO LEB	
(100+21)		
	RENDEZVOUS NAV PROGRAM (P20)	
	AUTO MNVR TO SXT TRACK	
	(17 DEG)	
	(180,288/251,0)	
(100+22)		
	CALL MARKING ROUTINES(V87,V57)	
(100+29)		
	TERMINATE MARKS (7)	
(100+31+24)		
	**********	
	LM PDI ABORT BURN (96+2,0,0)	
	(180,298/230,0)	
	**********	
	TARGET DV PROGRAM (P76)	
(100+34)		
	CMC IDLING PROGRAM (P00)	
100+42)		
	SUNDOWN	
	IMU REALIGN TO REFSMMAT (P52)	
	(OPTION 3)	
	COPY GYRO TORQUE ANGLES	
(100+48)		
	MCC-H UPLINK(LM VECTOR) (P00)	
	COPY CSI,CDH,TPI PADS	

GET		EVENT	PROG
-40	(100+52)		
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK	
		(47 DEG)	
		(180,315/183,0)	
-38	(100+54)		
		CSI TARGETING PROGRAM	(P32)(P20)
		OBTAIN LM CSI AND TPI TIGNS,	
		LOAD N55 WITH	
		R1=00001	
		R2=20830	
		R3=13000	
		MOVE TO LEB	
-35	(100+57)		
		CALL MARKING ROUTINE(V93,V87,V57)	
		(AFTER 5 MARKS V93)	
-30	(101+02)		
		TERMINATE SXT MARKS,V93	
		CONTINUE VHF	
-25	(101+07)		
		OUT OF PLANE DATA(V90)	
		VOICE LM Y DOT TO LM	
		CONTINUE VHF	
-15	(101+17)		
		TERMINATE MARKS(20)	
		MOVE TO CMD SEAT	
		CSI TARGETING FINAL COMP	(P32)
		COPY CSM CSI SOLUTION	
		OVERWRITE N81 WITH(-)CSM	
		YDOT(V90)	
-12	(101+20)		
		COPY LM CSI PAD	
		LOS	

GET		EVENT	PROG
-11	(101+21)		
		SPS THRUST PROGRAM,V56	(P40)
		AUTO MNVR TO BURN ATTITUDE	
		(161 DEG)	
		(180,165/288,0)	
-5	(101+27)		
		SPS THRUST SETUP	(P40)
		GDC ALIGN	
-2	(101+30)		
		SUNUP	
0	(101+31+47)		
		**********	
		LM CSI BURN (49.7,0,0)	
		**********	
		**********	
		CSM CSI BACKUP BURN(-50.2,0,0)	
		(180.180/288,0)	
		**********	
		TARGET DV PROGRAM	(P76)
		(CSI)	
-30	(101+33)		
		RENDEZVOUS NAV PROGRAM	(P20)
		AUTO MNVR TO SXT TRACK	
		(168 DEG)	
		(180,16/120,0)	
-24	(101+39)		
		CALL MARKING ROUTINES(V87,V57)	
		AFTER 3 SXT MARKS PROCESSED	
		V67 LOAD WR(000.57,+003,4,00001)	

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

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

GET	EVENT	PROG
-33	(102+36)	
	TARGET DV PROGRAM (CDH)	(P76)
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(149 DEG)	
	(0,229/141,0)	
	MOVE TO LEB	
	TPI TARGETING PROGRAM	(P34)(P20)
	LOAD N55 WITH	
	R2=20830	
	R3=13000	
-27	(102+42)	
	CALL MARKING ROUTINE(V87,V57) (PROCESS THREE MARKS,V93)	
-22	(102+47)	
	SUNDOWN	
-17	(102+52)	
	COPY LM TPI TIGN	
-12	(102+57)	
	TERMINATE MARKS (15)	
	MOVE TO CMD SEAT	
	VERIFY ORDEAL(V83)	
-10	(102+59)	
	TPI TARGETING PROGRAM	(P34)
	FINAL COMP (TIGN OPTION WITH LM TIGN)	
-7	(103+02)	
	SPS THRUST PROGRAM,V56	(P40)
	AUTO MNVR TO BURN ATTITUDE	
	(50 DEG)	
	(0,193/18,0)	
	COPY LM TPI P76 PAD	

GET	EVENT	PROG
-5	(103+04)	
	SPS THRUST SETUP (TPI)	(P40)
	GDC ALIGN	
0	(103+09+24)	
	**********	
	LM TPI BURN (22.2,0,-11.1)	
	**********	
	**********	
	CSM TPI BACKUP BURN (-22.3,0,12) (0,208/18,0)	
	**********	
	TARGET DV PROGRAM (TPI)	(P76)
+02		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(33 DEG)	
	(0,245/51,0)	
	MCC TARGETING PROGRAM	(P35)
	MOVE TO LEB	
+03		
	CALL MARKING ROUTINE(V93,V87,V57)	
	(103+18)	
	LOS	
+11		
	TERMINATE MARKS(8)	
+12		
	MCC1 TARGETING FINAL COMP	(P35)
	COPY CSM MCC1 SOLUTION	
	COPY LM MCC1 PAD	

GET	EVENT	PROG
13.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	(0,260/30,0)	
15 (103+24+24)		
	**********	
	LM MCC1 THRUST	
	**********	
	**********	
	CSM MCC1 BACKUP BURN	
	(0,263/30,0)	
	**********	
	TARGET DV PROGRAM	(P76)
	(MCC1)	
16		
	MCC2 TARGETING PROGRAM	(P35)(P20)
	POSSIBLE AUTO MNVR TO SXT TRACK	
	(TRIM)	
	(0,264/27,0)	
17		
	CALL MARKING ROUTINE(V93,V87,V57)	
103+33)		
	SUNUP	
26		
	TERMINATE MARKS(9)	
	MOVE TO CMD SEAT	
27		
	MCC2 TARGETING FINAL COMP	(P35)
	COPY CSM MCC2 SOLUTION	
	COPY LM MCC2 PAD	
28.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	(0,258/19,0)	

GET	EVENT	PROG
+30 (103+39+24)		
	**********	
	LM MCC2 BURN	
	**********	
	**********	
	CSM MCC2 BACKUP BURN	
	(0,252/19,0)	
	**********	
	TARGET DV PROGRAM	(P76)
	(MCC2)	
	AUTO MNVR TO COAS TRACK(V89)	(P00)
	(26 DEG)	
	(0,265/340,0)	
+39 (103+48)		
	THRUST MONITORING PROGRAM	(P47)
	**********	
	* BRAKING GATES	RETICLE ANGLE *
	* 30 FPS AT 6000 FT	.13 DEG. *
	* 20 FPS AT 3000 FT	.26 DEG. *
	* 10 FPS AT 2500 FT	.54 DEG. *
	* 5 FPS AT 500 FT	1.60 DEG. *
	**********	
+43 (103+52)		
	**********	
	TPF	
	**********	

9.2.2 RENDEZVOUS NAVIGATION SUMMARY WITH SUN ANGLES
LM ACTIVE - PDI ABORT
(MISSION F)
IT - INITIATE TRACK
CT - CEASE TRACK
(OUT-OF-PLANE SUN ANGLE IS 4 DEG)

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

9.2.3 CSM ATTITUDE SUMMARY

** ——**

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

——

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

9.3 LM PARTIAL PHASING GREATER THAN OR EQUAL TO 40 FPS

LM PHASING GREATER THAN 40 FPS RESCUE TIMELINE

```
GET        EVENT                                  PROG

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

```
GET        EVENT                                  PROG

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

```
GET      EVENT                                PROG
            ATT SET-TMU                       * *
                                              * *
         **MTVC CHECKS**                      * *
                                              * *-02+00
            BMAG MODE(3)-ATT1/RATE2           * *
            TVC SERVO PWR 1-AC1/MNA           * *
            TVC SERVO PWR 2-AC2/MNB           * *
            TRANS CONTR PWR-ON                * *
            RHC PWR NORM 2-AC                 * *
            GMBL MTRS PITCH 1 STRT-ON         * *
            GMBL MTRS YAW 1 STRT-ON           * *
            THC-CLOCKWISE                     * *
            RHC-ARMED                         * *
            RHC-VERIFY NO MTVC                * *-00+35
            GMBL MTRS PITCH 2-STRT-ON         * *
            GMBL MTRS  YAW  2-STRT-ON         * *-00+30
            SET SPS GIMBALS TW(2)-            * *
               PITCH = -.52                   * *
               YAW   = +.59                   * *-00+15
            RHC-VERIFY MTVC                   * *
            THC-NEUTRAL                       * *-00+05
            RHC PWR NORM 2-AC/DC              * *
            RHC-LOCKED                        * *
            PRO                               * *
      06 18 (COMMANDED R,P,Y)                 * ***********************************
            MONITOR ATT TRIM                  *   0    (101+33+19)
   F 50 18  (COMMANDED R,P,Y)                 *                 ******************
            KEY ENTER                         *                 CSM RESCUE BURN(-48.75,0,0)
   F 50 25  (00204,GMBL DRIVE TEST)           *                                (180.180/283.0)
            RHC PWR DIRECT(BOTH)-MNA/MNB      *                 ******************
            RATE-HIGH                         *
            AUTO RCS SEL A/C ROLL(4)-MNA      *
            PRO                               *
```

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

MISSION F RESCUE TIMELINE APRIL 25, 1969

```
GET        EVENT                                   PROG

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

```
GET        EVENT                                   PROG

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

```
      GET      EVENT                                   PROG

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

```
      GET      EVENT                                   PROG

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

```
GET      EVENT                                   PROG

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

```
GET      EVENT                                   PROG

*    0    (102+31+11)                             *
*                 ***********************************
*                 CSM CSI ONE BURN(-54.8,0,0)       *
*                                (180,180/103,0)    *
*                 ***********************************
*****************************************************
*                    SET MDC ET-RESET,START         *
*                    MONITOR                        *
*                       SPS THRUST LT-ON            *
*                       DV INDICATOR-DECREASING     *
*+00+01                                             *
*                    ULLAGE-OFF                     *
*            06 40 (TFC,VG,DVM)                     *
*                    MONITOR SPS OPERATION          *
*                       PC INDICATOR-95-105 PSI     *
*                    MONITOR SPS ENGINE CUTOFF      *
*                       SPS THRUST LT-OFF           *
*          F 16 40 (TFC,VG,DVM)                     *
*                    DV THRUST(BOTH)-OFF            *
*                    MONITOR                        *
*                       PC INDICATOR = 0            *
*                       SPS INJ VLV IND(4)-CLOSE    *
*                       SPS HE VLV TB(BOTH)-BP      *
*                       SPS GMBLS RETURN TO SERVO   *
*                         NULL                      *
*                    GMBL MTRS-OFF(SEQUENTIALLY)    *
*                    TVC SERVO PWR(BOTH)-OFF        *
*                    FDAI SCALE-5/1                 *
*                    RATE-LOW                       *
*                    ROT CONT PWR DIRECT(BOTH)-OFF  *
*                    PRO                            *
*          F 16 85 (VG-BODY)                        *
*                    THC-NULL VG COMPONENTS         *
*                    THC-LOCKED                     *
```

```
      GET        EVENT                                PROG
*                RHC-LOCKED                            *
*                EMS FUNCTION-VHF RNG                  *
*                EMS MODE-VHF RNG                      *
*                VHF RNG-RESET                         *
*                MN BUS TIE(2)-OFF                     *
*                PRO                                   *
*          F 37 RR                                     *
*****************************************************
      (102+32)
               CMC IDLING PROGRAM            (P00)
               MOVE TO LEB
      (102+42)
               SUNSET
               IMU REALIGN TO REFSMMAT       (P52)
                (OPTION 3)
      (102+47)
               MOVE TO CMD SEAT
               MCC-H UPLINK(LM VECTOR)
                (IF LM ACTIVE)
      (102+49)
               RENDEZVOUS NAV PROGRAM        (P20)
                AUTO MNVR TO SXT TRACK
               (82 DEG)
               (180,321/185,0)
      (102+52)
               CSI TARGETING PROGRAM  (P32)(P20)
               LOAD N55 R1=+00001
                        R2=+20830
                        R3=+13000
               MOVE TO LEB
-32   (102+55)
               CALL MARKING ROUTINE(V93,V87,V57)
               (V93 AFTER 5 MKS PROCESSED)
```

```
      GET        EVENT                                PROG
                                                      (103+00)
                                                      TERMINATE SXT,CONT, VHF
                                                      (103+05)
                                                      OUT OF PLANE DATA(V80)
                                                       COPY CSM YDOT
                                                      (103+12)
                                                      LOS
                                                      (103+18)
                                                      TERMINATE MARKS(23)
                                                      CSI TARGETING FINAL     (P32)(P20)
                                                       COMP
                                                       OVERWRITE N81 WITH(-)CSM YDOT
                                                      (103+21)
                                                      RCS THRUST PROGRAM,V56       (P41)
                                                       AUTO MNVR TO BURN ATTITUDE
                                                      (103+25)
                                                      RCS THRUST SETUP             (P41)
                                                      GDC ALIGN
                                                      (103+27)
                                                      ***********************************
                                                      CSM CSI TWO BURN(    ,    ,    )
                                                                      (180,10/125,0)
                                                      ***********************************
                                                      (103+28)
                                                      RENDEZVOUS NAV PROGRAM       (P20)
                                                       AUTO MNVR TO SXT TRACK
                                                      (13 DEG)
                                                      (180,13/112,0)
                                                      (103+31)
                                                      SUNRISE
                                                      CALL MARKING ROUTINE(V87,V57)
                                                      AFTER 3 MARKS PROCESSED
                                                      V67,LOAD WR(00057,00034,00001)
```

```
      GET.     EVENT                                  PROG
-12   (103+43)
               TERMINATE MARKS(12)
               OUT OF PLANE DATA(V90)
      (103+47)
               EXTERNAL DV TARGETING   (P30)(P20)
-8    (103+53)
               RCS THRUST PROGRAM,V56        (P41)
               BY PASS BURN ATTITUDE MNVR
               RCS THRUST SETUP              (P41)
               GDC ALIGN
0     (103+55)
               ********************************
               CSM PLANE CHANGE(180,123/138,0)
               ********************************
      (103+56)
               RENDEZVOUS NAV PROGRAM        (P20)
                POSSIBLE AUTO MNVR TO SXT TRACK
               (TRIM)
      (103+57)
               CDH TARGETING PROGRAM   (P33)(P20)
      (104+00)
               AOS
-22   (104+01)
               CALL MARKING ROUTINE(V87,V57)
                (V93 AFTER 3MKS PROCESSED)
-12   (104+11)
               TERMINATE MARKS(10)
               MOVE TO CMD SEAT
               ROLL 180 DEG,ACQ MSFN
               (0,160/108,0)
               (RHO -56, GAM 173)
               CDH TARGETING FINAL     (P33)(P20)
                COMP
```

```
      GET      EVENT                                  PROG
               OUT OF PLANE DATA(V90)
                OVERWRITE N81 WITH(-) CSM YDOT)
      (104+13)
               SPS THRUST PROGRAM,V56        (P40)
               MANUAL MNVR (1 DEG/SEC)
                TO BURN ATT
               (158 DEG)
               (0,338/266,0)
*****************************************************
*-8   (104+13)                                      *
*                KEY 40E                            *
*          F 50 18 (COMMANDED R,P,Y)                *
*                KEY V56F                           *
*                RHC-ARMED                          *
*                ALIGN ROLL TO 0 DEG.               *
*                RHC-LOCKED                         *
*                PRO                                *
*            06 18 (COMMANDED R,P,Y)                *
*                MONITOR MNVR                       *
*          F 50 18 (COMMANDED R,P,Y)                *
*                MN BUS TIE(2)-ON(UP)               *
*                SPS HE VLV TB(BOTH)-BP             *
*                SPS HE VLV(BOTH)-AUTO              *
*                NONESS BUS-MNA                     *
*                PRO                                *
*            06 18 (COMMANDED R,P,Y)                *
*                MONITOR ATT TRIM                   *
*          F 50 18 (COMMANDED R,P,Y)                *
*****************************************************
-5    (104+18)
               SPS THRUST SETUP              (P40)
```

```
      GET      EVENT                                  PROG
*************************************************** *
*-5   (104+18)                                      * *
*                **GDC ALIGN**                       * *
*                                                    * *
*                                                    * *
*                    ALT SET KNOB TO 60 NM           * *
*                    FDAI SELECT-1                   * *
*                    ATT SET THUMBWHEELS TO N18      * *
*                    NULL ATT ERROR NEEDLES          * *
*                       ON FDAI 1 WITH ATT           * *
*                       SET THUMBWHEELS              * *
*                    ATT SET-GDC                     * *
*                    DEPRESS GDC ALIGN PB            * *
*                    FDAI SELECT-1/2                 * *
*                    ATT SET-TMU                     * *
*                                                    * *
*                **MTVC CHECKS**                     * *-02+00
*                                                    * *
*                    BMAG MODE(3)-ATT1/RATE2         * *
*                    TVC SERVO PWR 1-AC1/MNA         * *
*                    TVC SERVO PWR 2-AC2/MNB         * *
*                    TRANS CONTR PWR-ON              * *
*                    RHC PWR NORM 2-AC               * *
*                    GMBL MTRS PITCH 1 STRT-ON       * *
*                    GMBL MTRS YAW 1 STRT-ON         * *
*                    THC-CLOCKWISE                   * *
*                    RHC-ARMED                       * *-00+35
*                    RHC-VERIFY NO MTVC              * *
*                    GMBL MTRS PITCH 2-STRT-ON       * *-00+30
*                    GMBL MTRS  YAW  2-STRT-ON       * *
*                    SET SPS GIMBALS TW(2)-          * *
*                       PITCH = -.52                 * *-00+15
*                       YAW   = +.59                 * *
*                    RHC-VERIFY MTVC                 *
```

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

```
      GET      EVENT                                  PROG
*-00+05                                                 * *                  ROT CONT PWR DIRECT(BOTH)-OFF*
*          F 99 40 (REQUEST FOR ENGINE ENABLE)          * *                  PRO                          *
*                  PRO                                  * *          F 16 85 (VG-BODY)                     *
*            06 40 (TFI,VG,DVM)                         * *                  THC-NULL VG COMPONENTS       *
*************************************************** *                  THC-LOCKED                   *
  0   (104+23+12)                                       *                  RHC-LOCKED                   *
              ********************************** *                  EMS FUNCTION-VHF RNG         *
              CSM CDH BURN(109.1,0,32.7)                *                  EMS MODE-VHF RNG             *
                          (0,344/266,0)                 *                  VHF RNG-RESET                *
              ********************************** *                  MN BUS TIE(2)-OFF            *
*************************************************** *                  PRO                          *
*                  SET MDC ET-RESET,START               * *          F 37 BB                              *
*                  MONITOR                              * ***********************************************
*                     SPS THRUST LT-ON                  *       (104+24)
*                     DV INDICATOR-DECREASING           *                RENDEZVOUS NAV PROGRAM      (P20)
*+00+01                                                 *                 AUTO MNVR TO SXT TRACK
*                  ULLAGE-OFF                           *                (119 DEG)
*            06 40 (TFC,VG,DVM)                         *                (0,228/147,0)
*                  MONITOR SPS OPERATION                *       (104+28)
*                     PC INDICATOR-95-105 PSI           *                TPI TARGETING PROGRAM  (P34)(P20)
*                  MONITOR SPS ENGINE CUTOFF            *                 LOAD R2=+20830
*                     SPS THRUST LT-OFF                 *                      R3=+13000
*          F 16 40 (TFC,VG,DVM)                         *                MOVE TO LER
*                  DV THRUST(BOTH)-OFF                  * -27   (104+31)
*                  MONITOR                              *                CALL MARKING ROUTINE(V87,V57)
*                     PC INDICATOR = 0                  *                 (V93 AFTER 3 MKS PROCESSED)
*                     SPS INJ VLV IND(4)-CLOSE          *       (104+34)
*                     SPS HE VLV TB(BOTH)-BP            *                SUNSET
*                     SPS GMBLS RETURN TO SERVO         * -12   (104+46)
*                       NULL                            *                TERMINATE MARKS(15)
*                  GMBL MTRS-OFF(SEQUENTIALLY)          *                MOVE TO CMD SEAT
*                  TVC SERVO PWR(BOTH)-OFF              *                VERIFY ORDEAL(V83)
*                  FDAI SCALE-5/1.                      *                TPI TARGETING FINAL    (P34)(P20)
*                  RATE-LOW                             *                 COMP
```

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

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

```
      GET.      EVENT                                  PROG
*           F 50 19 (COMMANDED R,P,Y)                  * 0      (104+57+59)
*                   KEY ENTER                          *                  ********************************
*           F 50 25 (00204,GMBL DRIVE TEST)            *                  CSM TPI BURN(-21.4,0,5.3)
*                   RHC PWR DIRECT(BOTH)-MNA/MNB       *                              (0,194/6,0)
*                   RATE-HIGH                          *                  ********************************
*                   AUTO RCS SEL A/C ROLL(4)-MNA       * ***********************************************
*                   PRO                                * *                  SET MDC ET-RESET,START        *
*                   MONITOR GMBL DRIVE                 * *                  MONITOR                       *
*                      SEQ AND TRIM                    * *                     SPS THRUST LT-ON           *
*             06 40 (TFI,VG,DVM)                       * *                     DV INDICATOR-DECREASING    *
*-02+00                                               * *+00+01                                          *
*                   FDAI SCALE-5/5                     * *                  ULLAGE-OFF                    *
*                   VERIFY SPS TH LT-OFF               * *             06 40 (TFC,VG,DVM)                 *
*                   EMS MODE STBY                      * *                  MONITOR SPS OPERATION         *
*                   EMS FUNCTION-DV SET                * *                     PC INDICATOR-95-105 PSI    *
*                   LOAD TPI VC                        * *                  MONITOR SPS ENGINE CUTOFF     *
*                   EMS FUNCTION-DV                    * *                     SPS THRUST LT-OFF          *
*                   THC-ARMED                          * *           F 16 40 (TFC,VG,DVM)                 *
*                   RHC-ARMED                          * *                  DV THRUST(BOTH)-OFF           *
*                   DV THRUST(A)-NORMAL                * *                  MONITOR                       *
*-00+35                                               * *                     PC INDICATOR = 0           *
*                   DSKY BLANKS                        * *                     SPS INJ VLV IND(4)-CLOSE   *
*-00+30                                               * *                     SPS HF VLV TB(BOTH)-BP     *
*             06 40 (TFI,VG,DVM)                       * *                     SPS GMBLS RETURN TO SERVO  *
*                   EMS MODE-NORMAL                    * *                       NULL                     *
*-00+15                                               * *                  GMBL MTRS-OFF(SEQUENTIALLY)   *
*                   PERFORM ULLAGE                     * *                  TVC SERVO PWR(BOTH)-OFF       *
*-00+05                                               * *                  FDAI SCALE-5/1                *
*           F 99 40 (REQUEST FOR ENGINE ENABLE)        * *                  RATE-LOW                      *
*                   PRO                                * *                  ROT CONT PWR DIRECT(BOTH)-OFF*
*             06 40 (TFI,VG,DVM)                       * *                  PRO                           *
*************************************************** *           F 16 85 (VG-BODY)                     *
                                                       *                  THC-NULL VG COMPONENTS        *
                                                       *                  THC-LOCKED                    *
```

MISSION F RESCUE TIMELINE APRIL 25, 1969

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

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

MISSION F RESCUE TIMELINE APRIL 25, 1969

```
GET        EVENT                                    PROG

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

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

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

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

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

9.4 LM PARTIAL PHASING LESS THAN 40 FPS

9.4.1 SUMMARY TIMELINE


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

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

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

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

MISSION F RESCUE TIMELINE APRIL 25,1969

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

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

```
GET      EVENT                                  PROG

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

```
GET      EVENT                                  PROG

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

```
      GET        EVENT                                  PROG
*                    MONITOR GMBL DRIVE                 *
*                       SEQ AND TRIM                    *
*              06 40 (TFI,VG,DVM)                       *
*-02+00                                                 *
*                    FDAI SCALE-5/5                     *
*                    VERIFY SPS TH LT-OFF               *
*                    EMS MODE STBY                      *
*                    EMS FUNCTION-DV SET                *
*                    LOAD CSI ( VC                      *
*                    EMS FUNCTION-DV                    *
*                    THC-ARMED                          *
*                    RHC-ARMED                          *
*                    DV THRUST(A)-NORMAL                *
*-00+35                                                 *
*                    DSKY BLANKS                        *
*-00+30                                                 *
*              06 40 (TFI,VG,DVM)                       *
*                    EMS MODE-NORMAL                    *
*-00+15                                                 *
*                    PERFORM ULLAGE                     *
*-00+05                                                 *
*            F 99 40 (REQUEST FOR ENGINE ENABLE)        *
*                    PRO                                *
*              06 40 (TFI,VG,DVM)                       *
*************************************************************
      (102+30+35)                                        *
                 ********************************************
                 CSM CSI ONE BURN (-35,6,0,0)            *
                                  (180,180/103,0)        *
                 ********************************************
                                                         *
                                                         *
                                                         *
                                                         *
```

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

MISSION F RESCUE TIMELINE APRIL 25,1969

```
        GET       EVENT                                   PROG

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

```
        GET       EVENT                                   PROG

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

GET	EVENT	PROG
-50	(104+30)	
	CALL MARKING ROUTINE(V93,V87,V57)	
	(V93 AFTER 5 MARKS PROCESSED)	
	(104+33)	
	SUNSET	
-45	(104+35)	
	TERMINATE SXT MARKS,V93	
	CONTINUE VHF	
-40	(104+40)	
	OUT OF PLANE DATA(V80)	
	VOICE LM YDOT TO LM	
	CONTINUE VHF	
	(105+04)	
	LOS	
-9	(105+11)	
	TERMINATE MARKS(41)	
	MOVE TO CMD SEAT	
	CSI TARGETING FINAL COMP	(P32)
-5	(105+15)	
	RCS THRUST PROGRAM,V56	(P41)
	AUTO MNVR TO BURN ATTITUDE	
-2	(105+18)	
	RCS THRUST SETUP,GDC ALIGN	(P41)
0	(105+20+00)	
	**********	
	CSM CSI THREE BURN	
	(180,18/121,0)	
	**********	
	(105+21)	
	SUNRISE	

GET	EVENT	PROG
-25	(105+22)	
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(TRIM)	
	(180,18/120,0)	
-24	(105+24)	
	MOVE TO LEB	
	CALL MARKING ROUTINE(V87,V57)	
	AFTER 3 SXT MARKS PROCESSED	
	V67,LOAD WB(00057,00034,00001)	
-12	(105+36)	
	TERMINATE MARKS(12)	
	MOVE TO CMD SEAT	
	OUT OF PLANE DATA(V80)	
-9	(105+39)	
	EXTERNAL DV TARGETING	(P30)
-6	(105+42)	
	RCS THRUST PROGRAM,V56	(P41)
	AUTO MNVR TO BURN ATTITUDE	
-2	(105+46)	
	RCS THRUST SETUP,GDC ALIGN	(P41)
0	(105+48+00)	
	**********	
	CSM PLANE CHANGE	
	(180,135/149,0)	
	**********	
-26	(105+50)	
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(10 DEG)	
	(180,132/139,0)	
-25	(105+51)	
	CDH TARGETING PROGRAM	(P33)
	MOVE TO LEB	

```
      GET      EVENT                                  PROG
     (105+52)                                          *
              AOS                                      *
-22  (105+54)                                          *
              CALL MARKING ROUTINE(V87,V57)            *
               (V93 AFTER 3 MARKS PROCESSED)           *
-12  (106+04)                                          *
              TERMINATE MARKS(10)                      *
              MOVE TO CMD SEAT                         *
              CDH TARGETING FINAL COMP     (P33)       *
              OUT OF PLANE DATA(V90)                   *
              OVERWRITE N81 WITH (-) CSM YDOT          *
              ROLL 180 DEG,ACQ MSFN                    *
              RHO=-58,GAMMA=173                        *
              (0.154/110,0)                            *
-8   (106+08)                                          *
              SPS THRUST PROGRAM,V56       (P40)       *
               MANUAL MNVR TO 1 DEG/SET TO BURN        *
              ATTITUDE                                 *
              (161 DEG)                                *
              (0,166/271,0)                            *
*****************************************************  *
*-8  (106+08)                                        * *
*                 KEY 40E                           * *
*          F 50 18 (COMMANDED R,P,Y)                * *
*                 KEY V56E                          * *
*                 RHC-ARMED                         * *
*                 ALIGN ROLL TO                     * *
*                 RHC-LOCKED                        * *
*                 PRO                               * *
*            06 18 (COMMANDED R,P,Y)                * *
*                 MONITOR MNVR                      * *
*          F 50 18 (COMMANDED R,P,Y)                * *
*                 MN BUS TIE(2)-ON(UP)              * *
*                 SPS HE VLV TB(BOTH)-BP            * *
```

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

MISSION F RESCUE TIMELINE APRIL 25,1969

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

```
GET      EVENT                                  PROG
*                RHC-ARMED                        *
*                DV THRUST(A)-NORMAL              *
*-00+35                                           *
*                OSKY BLANKS                      *
*-00+30                                           *
*          06 40 (TFI,VG,DVM)                     *
*                EMS MODE-NORMAL                  *
*-00+15                                           *
*                PERFORM ULLAGE                   *
*-00+05                                           *
*        F 99 40 (REQUEST FOR ENGINE ENABLE)      *
*                PRO                              *
*          06 40 (TFI,VG,DVM)                     *
*************************************************
 0     (106+16+07)
                ***********************************
                CSM CDH BURN(65.3,0.12.2)
                          (0,349/271,0)
                ***********************************
*************************************************
*                SET MDC ET-RESET,START           *
*                MONITOR                          *
*                   SPS THRUST LT-ON              *
*                   DV INDICATOR-DECREASING       *
*+00+01                                           *
*                ULLAGE-OFF                       *
*          06 40 (TFC,VG,DVM)                     *
*                MONITOR SPS OPERATION            *
*                   PC INDICATOR-95-105 PSI       *
*                MONITOR SPS ENGINE CUTOFF        *
*                   SPS THRUST LT-OFF             *
*        F 16 40 (TFC,VG,DVM)                     *
*                DV THRUST(BOTH)-OFF              *
*                MONITOR                          *
```

```
GET      EVENT                                  PROG
*                  PC INDICATOR = 0              *
*                  SPS INJ VLV IND(4)-CLOSE      *
*                  SPS HE VLV TB(BOTH)-BP        *
*                  SPS GMBLS RETURN TO SERVO     *
*                    NULL                        *
*              GMBL MTRS-OFF(SEQUENTIALLY)       *
*              TVC SERVO PWR(BOTH)-OFF           *
*              FDAI SCALE-5/1                    *
*              RATE-LOW                          *
*              ROT CONT PWR DIRECT(BOTH)-OFF     *
*              PRO                               *
*       F 16 85 (VG-BODY)                        *
*              THC-NULL VG COMPONENTS            *
*              THC-LOCKED                        *
*              RHC-LOCKED                        *
*              EMS FUNCTION-VHF RNG              *
*              EMS MODE-VHF RNG                  *
*              VHF RNG-RESET                     *
*              MN BUS TIE(2)-OFF                 *
*              PRO                               *
*       F 37 88                                  *
*****************************************************
-33   (106+18)
            RENDEZVOUS NAV PROGRAM        (P20)
             AUTO MNVR TO SXT TRACK
            (127 DEG)
            (0,228/144,0)
            MOVE TO LEB
-29   (106+22)
            TPI TARGETING PROGRAM         (P34)
            LOAD N55
            R2=+20830
            R3=+13000
```

```
GET      EVENT                                  PROG
-27   (106+24)
            CALL MARKING ROUTINE(V87,V57)
            (V93 AFTER 3 MARKS PROCESSED)
      (106+26)
            SUNSET
-12   (106+39)
            TERMINATE MARKS(15)
            MOVE TO CMD SEAT
            TPI TARGETING FINAL COMP      (P34)
            VERIFY ORDEAL(V83)
-7    (106+44)
            SPS THRUST PROGRAM,V56        (P40)
             AUTO MNVR TO BURN ATTITUDE
            (60 DEG)
            (0,247/74,0)
*****************************************************
*-7   (106+44)                                     *
*                KEY 40E                            *
*          F 50 18 (COMMANDED R,P,Y)                *
*                KEY V56E                           *
*                RHC-ARMED                          *
*                ALIGN ROLL TO                      *
*                RHC-LOCKED                         *
*                PRO                                *
*            06 18 (COMMANDED R,P,Y)                *
*                MONITOR MNVR                       *
*          F 50 18 (COMMANDED R,P,Y)                *
*                MN BUS TIE(2)-ON(UP)               *
*                SPS HE VLV TB(BOTH)-BP             *
*                SPS HE VLV(BOTH)-AUTO              *
*                NONESS BUS-MNA                     *
*                PRO                                *
*            06 18 (COMMANDED R,P,Y)                *
*                MONITOR ATT TRIM                   *
```

```
      GET      EVENT                                  PROG

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

```
      GET      EVENT                                  PROG

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

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

```
      GET        EVENT                                  PROG
                       SPS GMBLS RETURN TO SERVO        *
                          NULL                          *
                    GMBL MTRS-OFF(SEQUENTIALLY)         *
                    TVC SERVO PWR(BOTH)-OFF             *
                    FDAI SCALE-5/1                      *
                    RATE-LOW                            *
                    ROT CONT PWR DIRECT(BOTH)-OFF       *
                    PRO                                 *
            F 16 85 (VG-BODY)                           *
                    THC-NULL VG COMPONENTS              *
                    THC-LOCKED                          *
                    RHC-LOCKED                          *
                    EMS FUNCTION-VHF RNG                *
                    EMS MODE-VHF RNG                    *
                    VHF RNG-RESET                       *
                    MN BUS TIE(2)-OFF                   *
                    PRO                                 *
            F 37 BB                                     *
*************************************************************
 +2
                RENDEZVOUS NAV PROGRAM        (P20)
                 AUTO MNVR TO SXT TRACK
                (38 DEG)
                (0,247/52,0)
                MCC1 TARGETING PROGRAM (P35)(P20)
                MOVE TO LEB
 +3
                CALL MARKING ROUTINE(V93,V87,V57)
        (107+00)
                LOS
 +11
                TERMINATE MARKS(8)
 +12
                MCC1 TARGETING FINAL COMP    (P35)
```

MISSION F RESCUE TIMELINE APRIL 25,1969

GET	EVENT	PROG
+13.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	RCS THRUST SETUP	(P41)
+15 (107+05+57)		
	**********	
	CSM MCC1(0,267/33,0)	
	**********	
+16		
	MCC2 TARGETING PROGRAM	(P35)(P20)
+17		
	CALL MARKING ROUTINE(V93,V87,V57)	
(107+14)		
	SUNRISE	
+26		
	TERMINATE MARKS(9)	
	MOVE TO CMD SEAT	
+27		
	MCC2 TARGETING FINAL COMP	(P35)
+28.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN ATTITUDE MNVR	
	RCS THRUST SETUP	(P41)
+30 (107+20+57)		
	**********	
	CSM MCC2(0,300/23,0)	
	**********	
+32		
	MNVR TO COAS TRACK(V89)	(P00)
	(35 DEG)	
	(0,265/348.0)	

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

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

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

9.4.3 CSM ATTITUDE SUMMARY

**

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

**

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

9.5 LM ZERO INSERTION

9.5.1 Summary Timeline

LM INSERTION EQUALS 0 FPS RESCUE TIMELINE

```
GET      EVENT                                PROG          GET      EVENT                                PROG

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

MISSION F RESCUE TIMELINE APRIL 25, 1969

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

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


Page 143 Missing in Original Document

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

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

MISSION F RESCUE TIMELINE APRIL 25, 1969

```
      GET      EVENT                                PROG          GET      EVENT                                PROG

-8    (103+56)                                        -9    (104+28)
               RCS THRUST PROGRAM,V56       (P41)                  SPS THRUST PROGRAM,V56       (P40)
                BYPASS BURN ATTITUDE MNVR                          AUTO MNVR TO BURN ATTITUDE
               RCS THRUST SETUP                                    (98 DEG)
      (104+04+00)                                                  (0,245/231,0)
               ********************************** ***************************************************
               CSM PLANE CHANGE(180,173/205,0)    *-9    (104+28)                                    *
               ********************************** *                  KEY 40E                          *
      (104+05)                                    *          F 50 18 (COMMANDED R,P,Y)                *
               RENDEZVOUS NAV PROGRAM       (P20)  *                  KEY V56E                         *
                AUTO MNVR TO SXT TRACK            *                  RHC-ARMED                        *
               (25 DEG)                           *                  ALIGN ROLL TO 0 DEG.             *
               (180,147/180,0)                    *                  RHC-LOCKED                       *
-30   (104+07)                                    *                  PRO                              *
               CDH TARGETING PROGRAM  (P33)(P20)  *            06 18 (COMMANDED R,P,Y)                *
-28   (104+09)                                    *                  MONITOR MNVR                     *
               CALL MARKING ROUTINE(V87,V57)      *          F 50 18 (COMMANDED R,P,Y)                *
                (V93 AFTER 3 SXT MARKS PROCESSED) *                  MN BUS TIE(2)-ON(UP)             *
      (104+12)                                    *                  SPS HE VLV TB(BOTH)-BP           *
               AOS                                *                  SPS HE VLV(BOTH)-AUTO            *
-13   (104+24)                                    *                  NONESS BUS-MNA                   *
               TERMINATE MARKS(15)                *                  PRO                              *
               MOVE TO CMD SEAT                   *            06 18 (COMMANDED R,P,Y)                *
               ROLL 180 DEG,ACQ MSFN              *                  MONITOR ATT TRIM                 *
               (0,155/133,0)                      *          F 50 18 (COMMANDED R,P,Y)                *
               (RHO -35, GAM 0)                   ***************************************************
               CDH TARGETING FINAL    (P33)(P20)  -5    (104+32)
                COMP                                               SPS THRUST SETUP             (P40)
               OUT OF PLANE DATA(V90)             ***************************************************
                OVERWRITE N81 WITH(-)CSM YDOT     *-5    (104+32)                                    *
                                                  *                **GDC ALIGN**                       *
                                                  *                                                    *
                                                  *                                                    *
                                                  *                  ALT SET KNOB TO 60 NM             *
```

MISSION F RESCUE TIMELINE APRIL 25, 1969

```
GET      EVENT                                PROG
*                FDAI SELECT-1                  * *
*                ATT SET THUMBWHEELS TO N18     * *
*                NULL ATT ERROR NEEDLES         * *
*                   ON FDAI 1 WITH ATT          * *
*                   SET THUMBWHEELS             * *
*                ATT SET-GDC                    * *
*                DEPRESS GDC ALIGN PB           * *
*                FDAI SELECT-1/2                * *
*                ATT SET-TMU                    * *
*                                               * *
*            **MTVC CHECKS**                    * *-02+00
*                                               * *
*                BMAG MODE(3)-ATT1/RATE2        * *
*                TVC SERVO PWR 1-AC1/MNA        * *
*                TVC SERVO PWR 2-AC2/MNB        * *
*                TRANS CONTR PWR-ON             * *
*                RHC PWR NORM 2-AC              * *
*                GMBL MTRS PITCH 1 STRT-ON      * *
*                GMBL MTRS YAW 1 STRT-ON        * *
*                THC-CLOCKWISE                  * *
*                RHC-ARMED                      * *-00+35
*                RHC-VERIFY NO MTVC             * *
*                GMBL MTRS PITCH 2-STRT-ON      * *-00+30
*                GMBL MTRS  YAW  2-STRT-ON      * *
*                SET SPS GIMBALS TW(2)-         * *
*                   PITCH = -.52                * *-00+15
*                   YAW   = +.59                * *
*                RHC-VERIFY MTVC                * *-00+05
*                THC-NEUTRAL                    * *
*                RHC PWR NORM 2-AC/DC           * *
*                RHC-LOCKED                     * *
*                PRO                            * ***************************************
*          06 18 (COMMANDED R,P,Y)              *
*                MONITOR ATT TRIM               *
```

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

MISSION F RESCUE TIMELINE APRIL 25, 1969

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

```
      GET      EVENT                                  PROG
                  RHC-LOCKED                          *
                  EMS FUNCTION-VHF RNG                *
                  EMS MODE-VHF RNG                    *
                  VHF RNG-RESET                       *
                  MN BUS TIE(2)-OFF                   *
                  PRO                                 *
            F 37 BB                                   *
*****************************************************
-37
                RENDEZVOUS NAV PROGRAM        (P20)
                 AUTO MNVR TO SXT TRACK
                (70 DEG)
                (0,224/160,0)
-32
                TPI TARGETING PROGRAM   (P34)(P20)
                 LOAD N55 R2=+20830
                          R3=+13000
-30
                CALL MARKING ROUTINE(V87,V57)
                 (V93 AFTER 3 SXT MARKS PROCESSED)
        (104+53)
                SUNSET
-12
                TERMINATE MARKS(18)
                MOVE TO CMD SEAT
                TPI TARGETING FINAL     (P34)(P20)
                 COMP
                VERIFY ORDEAL(V83)
-8
                SPS THRUST PROGRAM,V56        (P40)
                 AUTO MNVR TO BURN ATTITUDE
                (95 DEG)
                (0,165/353,0)
```

MISSION F RESCUE TIMELINE APRIL 25, 1969

```
GET      EVENT                                   PROG
*************************************************  *
*-8                                                *
*                KEY 40E                            *
*          F 50 18 (COMMANDED R,P,Y)                *
*                KEY V56E                           *
*                RHC-ARMED                          *
*                ALIGN ROLL TO 0 DEG                *
*                RHC-LOCKED                         *
*                PRO                                *
*            06 18 (COMMANDED R,P,Y)                *
*                MONITOR MNVR                       *
*          F 50 18 (COMMANDED R,P,Y)                *
*                MN BUS TIE(2)-ON(UP)               *
*                SPS HE VLV TB(BOTH)-BP             *
*                SPS HE VLV(BOTH)-AUTO              *
*                NONESS BUS-MNA                     *
*                PRO                                *
*            06 18 (COMMANDED R,P,Y)                *
*                MONITOR ATT TRIM                   *
*          F 50 18 (COMMANDED R,P,Y)                *
*************************************************  *
-5                                                  *
              SPS THRUST SETUP                      *
*************************************************  *
*-5                                                *
*             **GDC ALIGN**                         *
*                                                   *
*                                                   *
*                ALT SET KNOB TO 60 NM              *
*                FDAI SELECT-1                      *
*                ATT SET THUMBWHEELS TO N18         *
*                NULL ATT ERROR NEEDLES             *
*                   ON FDAI 1 WITH ATT              *
*                   SET THUMBWHEELS                 *
```

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

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

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

MISSION F RESCUE TIMELINE APRIL 25, 1969

```
      GET      EVENT                                PROG          GET      EVENT                                PROG

*                  EMS MODE-VHF RNG                 *        (105+40)
*                  VHF RNG-RESET                    *                 SUNRISE
*                  MN BUS TIE(2)-OFF                * +26
*                  PRO                              *                 TERMINATE MARKS(9)
*          F 37 BB                                  * +27
*************************************************                      MCC TARGETING FINAL     (P35)(P20)
+2                                                                      COMP
              RENDEZVOUS NAV PROGRAM       (P20)   +28.5
               AUTO MNVR TO SXT TRACK                                  RCS THRUST PROGRAM           (P41)
              (61 DEG)                                                  BYPASS BURN ATTITUDE MNVR
              (0,246/54,0)                                            RCS THRUST SETUP             (P41)
              MCC TARGETING PROGRAM  (P35)(P20)   +30    (105+46+47)
              MOVE TO LEB DURING AUTO MNVR                            ***********************************
+4                                                                    MCC2 BURN(0,286/23,0)
              CALL MARKING ROUTINE(V93,V87,V57)                       ***********************************
+11                                                   +32
              TERMINATE MARKS(7)                                      AUTO MNVR TO COAS TRACK(V89)(P00)
+12                                                                   MOVE TO CMD SEAT
              MCC TARGETING FINAL     (P35)(P20)                      (37 DEG)
               COMP                                                   (0,254/346,0)
+13.5
              RCS THRUST PROGRAM           (P41)                      CALL P47 AT R=1.25N.M.
               BYPASS BURN ATTITUDE MNVR                              THRUST MONITOR PROGRAM       (P47)
              RCS THRUST SETUP             (P41)                      V83,PERFORM BRAKING AND
+15   (105+31+47)                                                      LOS CONTROL
              ***********************************                   ***********************************
              MCC1 BURN(0,265/37,0)                                 * BRAKING GATES       RETICLE ANGLE *
              ***********************************                   *  30 FPS AT 6000 FT      .13 DEG.  *
              LOS                                                   *  20 FPS AT 3000 FT      .26 DEG.  *
+16                                                                 *  10 FPS AT 2500 FT      .54 DEG.  *
              MCC TARGETING PROGRAM  (P35)(P20)                     *   5 FPS AT  500 FT     1.60 DEG.  *
               POSSIBLE MNVR TO SXT TRACK                           ***********************************
+17
              CALL MARKING ROUTINE(V93,V87,V57)
```

MISSION F RESCUE TIMELINE APRIL 25, 1969

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

MISSION F RESCUE TIMELINE APRIL 25, 1969

9.5.2 NAVIGATION SUMMARY
LM INSERTION = 0 FPS

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

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

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

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

9.6 LM PARTIAL INSERTION

9.6.1 SUMMARY TIMELINE

```
      GET        EVENT                                  PROG          GET        EVENT                                  PROG

                 (LM INSERTION=120 FPS)                  ***********************************************
                                                         *-7    (103+25)                                        *
      (102+43+18)                                        *                  KEY 40E                             *
                 ********************************        *          F 50 18 (COMMANDED R,P,Y)                   *
                 LM INSERTION BURN (-106.8,0,-54.5)      *                  KEY V56E                            *
                 ********************************        *                  RHC-ARMED                           *
      (102+47)                                           *                  ALIGN ROLL TO                       *
                 SUNSET                                  *                  RHC-LOCKED                          *
                 MOVE TO LEB                             *                  PRO                                 *
                 IMU REALIGN TO REFSMMAT                 *            06 18 (COMMANDED R,P,Y)                   *
                  (OPTION 3)                    (P52)    *                  MONITOR MNVR                        *
      (102+52)                                           *          F 50 18 (COMMANDED R,P,Y)                   *
                 MCC-H UPLINK (LM STATE                  *                  MN BUS TIE(2)-ON(UP)                *
                  VECTOR)                       (P00)    *                  SPS HE VLV TB(BOTH)-BP              *
-29   (103+03)                                           *                  SPS HE VLV(BOTH)-AUTO               *
                 COPY RESCUE,CSI ONE,CDH,TPI PADS        *                  NONESS BUS-MNA                      *
      (103+17)                                           *                  PRO                                 *
                 LOS                                     *            06 18 (COMMANDED R,P,Y)                   *
                 MOVE TO CMD SEAT                        *                  MONITOR ATT TRIM                    *
-12   (103+20)                                           *          F 50 18 (COMMANDED R,P,Y)                   *
                 EXTERNAL DV PROGRAM            (P30)    ***********************************************
-7    (103+25)                                           -5     (103+27)
                 SPS THRUST PROGRAM,V56         (P40)                SPS THRUST SETUP                  (P40)
                  AUTO MNVR TO BURN ATTITUDE             ***********************************************
                 (19 DEG)                                *-5    (103+27)                                        *
                 (180,165/282,0)                         *                                                      *
                                                         *                **GDC ALIGN**                           *
                                                         *                                                      *
                                                         *                                                      *
                                                         *                  ALT SET KNOB TO 60 NM               *
                                                         *                  FDAI SELECT-1                       *
```

MISSION F RESCUE TIMELINE APRIL 25,1969

```
GET      EVENT                                PROG
*                ATT SET THUMBWHEELS TO N18    * *
*                NULL ATT ERROR NEEDLES        * *
*                   ON FDAI 1 WITH ATT         * *
*                   SET THUMBWHEELS            * *
*                ATT SET-GDC                   * *
*                DEPRESS GDC ALIGN PB          * *
*                FDAI SELECT-1/2               * *
*                ATT SET-TMU                   * *
*                                              * *
*            **MTVC CHECKS**                   * *-02+00
*                                              * *
*                BMAG MODE(3)-ATT1/RATE2       * *
*                TVC SERVO PWR 1-AC1/MNA       * *
*                TVC SERVO PWR 2-AC2/MNB       * *
*                TRANS CONTR PWR-ON            * *
*                RHC PWR NORM 2-AC             * *
*                GMBL MTRS PITCH 1 STRT-ON     * *
*                GMBL MTRS YAW 1 STRT-ON       * *
*                THC-CLOCKWISE                 * *
*                RHC-ARMED                     * *-00+35
*                RHC-VERIFY NO MTVC            * *
*                GMBL MTRS PITCH 2-STRT-ON     * *-00+30
*                GMBL MTRS  YAW  2-STRT-ON     * *
*                SET SPS GIMBALS TW(2)-        * *
*                   PITCH = -.52               * *-00+15
*                   YAW   = +.59               * *
*                RHC-VERIFY MTVC               * *-00+05
*                THC-NEUTRAL                   * *
*                RHC PWR NORM 2-AC/DC          * *
*                RHC-LOCKED                    * *
*                PRO                           * ***********************************************
*          06 18 (COMMANDED R,P,Y)             *
*                MONITOR ATT TRIM              *
*        F 50 18 (COMMANDED R,P,Y)             *
```

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

MISSION F RESCUE TIMELINE APRIL 25,1969

```
GET      EVENT                                   PROG

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

```
GET      EVENT                                   PROG

        F 16 85 (VG-BODY)                        *
                THC-NULL VG COMPONENTS           *
                THC-LOCKED                       *
                RHC-LOCKED                       *
                EMS FUNCTION-VHF RNG             *
                EMS MODE-VHF RNG                 *
                VHF RNG-RESET                    *
                MN BUS TIF(2)-OFF                *
                PRO                              *
        F 37 BB                                  *
*****************************************
      (103+33)
                SUNRISE
-55   (103+35)
                RENDEZVOUS NAV PROGRAM      (P20)
                 AUTO MNVR TO SXT TRACK
                (49 DEG)
                (180,141/233.0)
                MOVE TO LEB
-52   (103+38)
                CSI TARGETING PROGRAM       (P32)
                LOAD N55 WITH
                R1=+00002
                R2=+20830
                R3=+13000
-35   (103+55)
                CALL MARKING ROUTINE(V93,V57 SXT
                 ONLY)
      (104+05)
                AOS
```

MISSION F RESCUE TIMELINE APRIL 25,1969

```
      GET      EVENT                                  PROG

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

```
      GET      EVENT                                  PROG

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

MISSION F RESCUE TIMELINE APRIL 25,1969

```
      GET        EVENT                                  PROG          GET        EVENT                                  PROG
*                   SET SPS GIMBALS TW(2)-              * *-00+30                                                      *
*                      PITCH = -.52                     * *              06 40 (TFI,VG,DVM)                            *
*                      YAW   = +.59                     * *                    EMS MODE-NORMAL                         *
*                   RHC-VERIFY MTVC                     * *-00+15                                                      *
*                   THC-NEUTRAL                         * *                    PERFORM ULLAGE                          *
*                   RHC PWR NORM 2-AC/DC                * *-00+05                                                      *
*                   RHC-LOCKED                          * *            F 99 40 (REQUEST FOR ENGINE ENABLE)             *
*                   PRO                                 * *                    PRO                                     *
*              06 18 (COMMANDED R,P,Y)                  * *              06 40 (TFI,VG,DVM)                            *
*                   MONITOR ATT TRIM                    * ***********************************************************
*            F 50 18 (COMMANDED R,P,Y)                  *        (104+29+59)
*                   KEY ENTER                           *                 ***********************************
*            F 50 25 (00204,GMBL DRIVE TEST)            *                 CSM CSI ONE BURN(114,6,0,0)
*                   RHC PWR DIRECT(BOTH)-MNA/MNB        *                                (180,0,281,0)
*                   RATE-HIGH                           *                 ***********************************
*                   AUTO RCS SEL A/C ROLL(4)-MNA        * ***********************************************************
*                   PRO                                 * *                    SET MDC ET-RESET,START                  *
*                   MONITOR GMBL DRIVE                  * *                    MONITOR                                 *
*                      SEQ AND TRIM                     * *                       SPS THRUST LT-ON                     *
*              06 40 (TFI,VG,DVM)                       * *                       DV INDICATOR_DECREASING              *
*-02+00                                                 * *+00+01                                                      *
*                   FDAI SCALE-5/5                      * *                    ULLAGE-OFF                              *
*                   VERIFY SPS TH LT-OFF                * *              06 40 (TFC,VG,DVM)                            *
*                   EMS MODE STBY                       * *                    MONITOR SPS OPERATION                   *
*                   EMS FUNCTION-DV SET                 * *                       PC INDICATOR_95-105 PSI              *
*                   LOAD CSI VC                         * *                    MONITOR SPS ENGINE CUTOFF               *
*                   EMS FUNCTION-DV                     * *                       SPS THRUST LT-OFF                    *
*                   THC-ARMED                           * *            F 16 40 (TFC,VG,DVM)                            *
*                   RHC-ARMED                           * *                    DV THRUST(BOTH)-OFF                     *
*                   DV THRUST(A)-NORMAL                 * *                    MONITOR                                 *
*-00+35                                                 * *                       PC INDICATOR = 0                     *
*                   DSKY BLANKS                         * *                       SPS INJ VLV IND(4)-CLOSE             *
                                                         *                       SPS HE VLV TB(BOTH)-BP               *
```

MISSION F RESCUE TIMELINE APRIL 25,1969

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

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

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

GET	EVENT	PROG
(106+03+00)		
	**********	
	CSM PLANE CHANGE(0, ,0)	
	(180,161/178,0)	
	**********	
-30 (106+04)		
	RENDEZVOUS NAV PROGRAM	(P20)
	AUTO MNVR TO SXT TRACK	
	(13 DEG)	
	(180,154/165,0)	
(106+06)		
	AOS	
-27 (106+07)		
	CDH TARGETING PROGRAM	(P33)
	MOVE TO LEB	
-25 (106+09)		
	CALL MARKING ROUTINE(V87,V57)	
	(V93 AFTER 3 MARKS PROCESSED)	
-10 (106+24)		
	TERMINATE MARKS(15)	
	MOVE TO CMD SEAT	
	CDH TARGETING FINAL COMP	(P33)
	ROLL 180 DEG,ACQ MSFN	
	(0,223/178,0)	
	(RHO=-58,GAMMA=173)	
	OUT OF PLANE DATA (V90)	
	OVERWRITE N81 WITH (-) CSM YDOT	
-6 (106+27)		
	SPS THRUST PROGRAM,V56	(P40)
	AUTO MNVR TO BURN ATTITUDE	
	(3 DEG)	
	(0,229/165,0)	

```
      GET       EVENT                                   PROG

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

```
      GET       EVENT                                   PROG

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

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

```
      GET        EVENT                                PROG
0     (106+33+49)
                 ***********************************
                 CSM CDH BURN (-37.1,0,74.8),
                                (0,244/165,0)
                 ***********************************

*************************************************
*                  SET MDC ET-RESET,START          *
*                  MONITOR                         *
*                     SPS THRUST LT-ON             *
*                     DV INDICATOR-DECREASING      *
*+00+01                                            *
*                  ULLAGE-OFF                      *
*            06 40 (TFC,VG,DVM)                    *
*                  MONITOR SPS OPERATION           *
*                     PC INDICATOR-95-105 PSI      *
*                  MONITOR SPS ENGINE CUTOFF       *
*                     SPS THRUST LT-OFF            *
*          F 16 40 (TFC,VG,DVM)                    *
*                  DV THRUST(BOTH)-OFF             *
*                  MONITOR                         *
*                     PC INDICATOR = 0             *
*                     SPS 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                             *
```

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

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

MISSION F RESCUE TIMELINE APRIL 25,1969

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

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

```
GET      EVENT                                  PROG

(107+08+54)                                      *
          ********************************       *
          CSM TPI BURN(-24,0,3,9)                *
                          (0,189/10,0)           *
          ********************************       *
*********************************************     *
                SET MDC ET-RESET,START           *
                MONITOR                          *
                   SPS THRUST LT-ON              *
                   DV INDICATOR-DECREASING       *
+00+01                                           *
                ULLAGE-OFF                       *
         06 40  (TFC,VG,DVM)                     *
                MONITOR SPS OPERATION            *
                   PC INDICATOR-95-105 PSI       *
                MONITOR SPS ENGINE CUTOFF        *
                   SPS THRUST LT-OFF             *
        F 16 40 (TFC,VG,DVM)                     *
                DV THRUST(BOTH)-OFF              *
                MONITOR                          *
                   PC INDICATOR = 0              *
                   SPS INJ VLV IND(4)-CLOSE      *
                   SPS HE VLV TB(BOTH)-BP        *
                   SPS GMBLS RETURN TO SERVO     *
                     NULL                        *
                GMBL MTRS-OFF(SEQUENTIALLY)      *
                TVC SERVO PWR(BOTH)-OFF          *
                FDAI SCALE-5/1                   *
                RATE-LOW                         *
                ROT CONT PWR DIRECT(BOTH)-OFF    *
                PRO                              *
```

```
GET      EVENT                                  PROG

        F 16 85 (VG-BODY)                        *
                THC-NULL VG COMPONENTS           *
                THC-LOCKED                       *
                RHC-LOCKED                       *
                EMS FUNCTION-VHF RNG             *
                EMS MODE-VHF RNG                 *
                VHF RNG-RESET                    *
                MN BUS TIE(2)-OFF                *
                PRO                              *
        F 37 BB                                  *
*********************************************
 +2
                RENDEZVOUS NAV PROGRAM          (P20)
                 AUTO MNVR TO SXT TRACK
                (37 DEG)
                (0,247/47,0)
                MOVE TO LEB
                MCC TARGETING PROGRAM           (P35)
 +3
                CALL MARKING ROUTINE(V93,V87,V57)
      (107+18)
                LOS
 +11
                TERMINATE MARKS(8)
 +12
                MCC TARGETING FINAL COMP        (P35)
 +13.5
                RCS THRUST PROGRAM              (P41)
                 BYPASS BURN ATTITUDE MNVR
                (0,268/30,0)
                RCS THRUST SETUP                (P41)
```

MISSION F RESCUE TIMELINE APRIL 25,1969

GET	EVENT	PROG
+15	(107+23+54)	
	**********	
	CSM MCC1 BURN	
	(0.264/30.0)	
	**********	
+16		
	MCC TARGETING PROGRAM	(P35)
17		
	CALL MARKING ROUTINE(V93,V87,V57)	
(107+31)		
	SUNRISE	
+26		
	TERMINATE MARKS(9)	
27		
	MCC TARGETING FINAL COMP	(P35)
28.5		
	RCS THRUST PROGRAM	(P41)
	BYPASS BURN AUTO MNVR	
	(0.287/17.0)	
	RCS THRUST SET UP	(P41)
30	(107+38+54)	
	**********	
	CSM MCC2 BURN	
	((0.293/17.0)	
	**********	
31		
	AUTO MNVR TO COAS TRACK(V89)	(P00)
	(28 DEG)	
	(0.262/341.0)	
	MOVE TO CMD SEAT	
37	(107+46)	
	THRUST MONITORING PROGRAM	(P47)
	V83,PERFORM BRAKING AND LOS	
	CONTROL	

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

9.6.2 RENDEZVOUS NAVIGATION SUMMARY WITH SUN ANGLES

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

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

9.6.3 CSM ATTITUDE HISTORY

**

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

**

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

10.0 REFERENCES

10.1 Mission Requirements, SA-505/CSM-106/LM-4, "F" Type Mission, Lunar Orbit; dated 11 February 1969.

10.2 Alexander, J.D.; Moore, R.H.; Currently Proposed LM-Active Phase of Mission F; Memo No. 68-FM64-333; dated 15 November 1968. (Updated as per conversations with R. H. Moore and review of an unofficial trajectory print-out on 17 January 1969.)

10.3 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.

10.4 Puschinsky, R.W. and Lewis, D.W.; CSM Rendezvous "D" Mission, Final, dated 16 December 1968.

10.5 Guidance System Operations Plan for Manned CM Earth Orbital and Lunar Missions Using Program COLOSSUS II Section Four, GNCS Operational Modes, Revision 7, dated March 1969.

10.6 Pippert, E.B., Apollo AS-505/106/LM-4 Reference Flight Plan, dated 22 November 1968.

10.7 Apollo Operations Handbook Command and Service Modules - Volume II, Operational Procedures, dated 2 December 1968.

10.8 Paddock, S.G. and Mosel, D.K.; CSM Rendezvous Procedures F Mission, Preliminary Copy; dated 23 January 1969.

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

10.10 Paddock, S.G.; MDAC Apollo Design Note No. 85, "Procedures for CSM Backup of a LM Active Catch-up Maneuver During Mission D Rendezvous"; dated 17 May 1968.

10.11 Paddock, S.G.; MDAC Apollo Design Note No. 86, "TPI Iteration Logic for Design and Off Design Approach Orbits"; dated 20 May 1968.

10.12 Dugge, P.M.; MDAC Apollo Design Note No. 101, "W-Matrix Initialization Schedules for Mission D, Assuming 1000;1 W-Matrix"; dated 16 August 1968.

10.13 Alexander, J.D. and DuPont, A.L.; Preliminary LM Abort and Rescue Procedures for Apollo Mission F - Volume I, Nontime-Critical Procedures; MSC Internal Note No. 69-FM-34, dated 11 February 1969.

10.14 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.

10.15 Collins, M.A.; Preliminary Apollo 10 (F) Mission Operational Trajectory Simulator Data Package; Memo No. 69-FM13-45; dated 30 January 1969.

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

10.17 Hutchins, J.E. and Axford, J.C.; AS-504/CSM-105/LM-4, LM Rendezvous Procedures F Mission; dated 28 January 1969.

10.18 Collins, M.A.; Update to Preliminary Apollo 10 (F) Mission Operational Trajectory Simulator Data Package; Memo No. 69-FM13-73; dated 11 February 1969.

10.19 Guidance Navigation and Control Command Module Functional Description and Operations Using Flight Program COLOSSUS IA-Volume II, Normal Procedures; dated January 1969.

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

10.21 Final Flight Mission Rules, Apollo 10 (AS-505/CSM-106/LM-4); dated 15 April 1969.

10.22 Fudurich, R.; MDAC Apollo Design Note No. 108, "Mission F Nominal Reference Trajectory;" dated 23 April 1969.