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LM RENDEZVOUS PROCEDURES

G MISSION

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RENDEZVOUS PROCEDURES

G MISSION

AS-506/CSM-107/LM-5

May 16, 1969

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LIST OF ACRONYMS AND ABBREVIATIONS

ACQ	Acquisition
ADJ	Adjust
AGS	Abort Guidance System
AOH	Apollo Operations Handbook
AOS	Acquisition of Signal
AOT	Alignment Optical Telescope
APS	Ascent Propulsion System
ATT	Attitude
BU	Backup
CALIB	Calibration
CB	Circuit Breaker
CDH	Constant Delta Height
CDR	Commander
CM	Command Module
CMC	Command Module Computer
CMD	Command Module Commander's Position
CMP	Command Module Pilot
COAS	Crew Optical Alignment Sight
CSI	Concentric Sequence Initiation
CSM	Command and Service Module
CT	Cease Tracking
DAP	Digital Autopilot
DH	Delta Height
DOI	Descent Orbit Insertion
DPS	Descent Propulsion System
DSKY	Display and Keyboard
DV	Delta Velocity
DWN	Down
EMS	Entry Monitor System
ET	Event Timer
FDAI	Flight Director Attitude Indicator
FPS	Feet Per Second
FWD	Forward
GDC	Gyro Display Coupler
GET	Ground Elapsed Time
GETI	Ground Elapsed Time of Ignition
GMBL	Gimbal
GND	Ground (Mission Control)
HA	Apogee Altitude
HGA	High-Gain Antenna
HOR	Horizon
HORIZ	Horizontal
HP	Perigee Altitude
IMU	Inertial Measurement Unit
INS	Insertion
IT	Initiate Tracking
LGC	LM Guidance Computer
LM	Lunar Module

LMP	Lunar Module Pilot
LOI	Lunar Orbit Injection
LOS	Line Of Sight
LV	Launch Vehicle
MNVR	Maneuver
MCC	Midcourse Correction
MCC1	First Midcourse Correction
MCC2	Second Midcourse Correction
MCC-H	Mission Control Center - Houston
MGA	Middle Gimbal Angle
MSFN	Manned Space Flight Network
NAV	Navigation
ORDEAL	Orbital Rate Drive Earth and Lunar
PAD	Data Voiced to Crew From Ground
PB	Pushbutton
PC	Plane Change
PDI	Powered Descent Initiation
PGNS	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
SHFT	Shaft
SC	Spacecraft
SEP	Separation
SM	Service Module
SXT	Sextant
SYNC	Synchronize
TFI	Time From Ignition
THC	Translation Hand Controller
THETA	Angle Between SC +X Axis and Local Horizontal
TIGN	Time of Ignition
TLM	Telemetry
TPF	Terminal Phase Finalization
TPI	Terminal Phase Initiation
TRUN	Trunnion
TTCA	Translation Thrust Control Assembly
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 primary procedures for the LM-5 active rendezvous with CSM-107 spacecraft, in accordance with Detailed Test Objective Section 4.0 defined in Reference 7.1.

The purpose of the LM 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 Stephen P. Grega, Flight Procedures Branch, Flight Crew Support Division, Extension 5348.

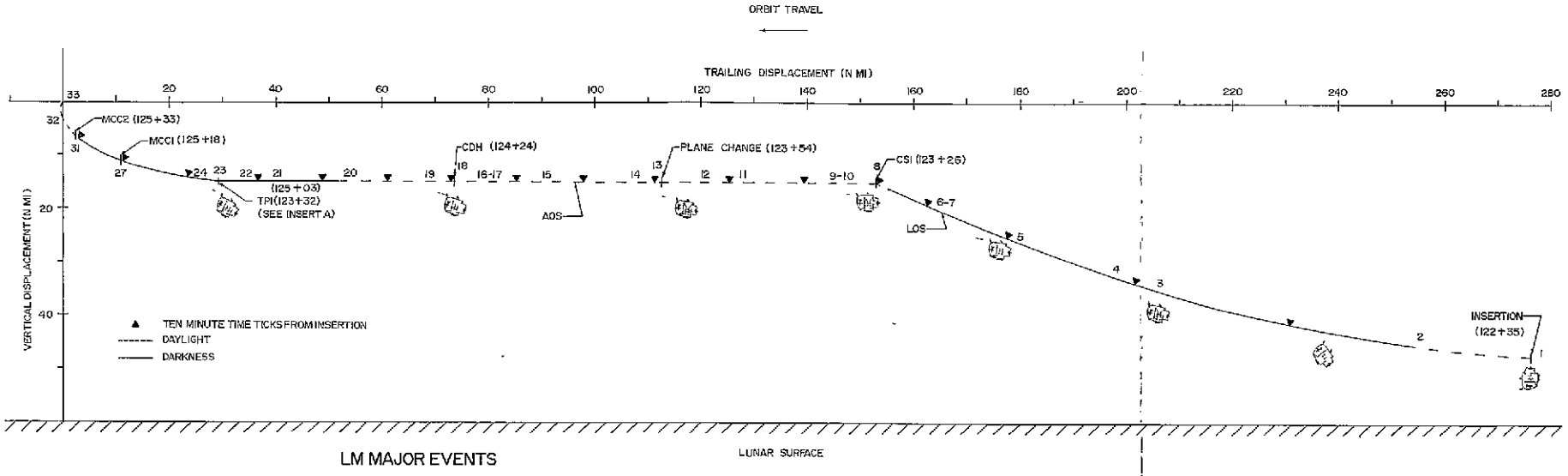
Beyond G mission planning, no additional techniques and trajectory information specific to Mission H have been made available as of this date. Therefore, since Missions G and H are expected to be similar in the area of rendezvous guidance and navigation procedures, the G mission final "LM Rendezvous Procedures Document" will serve as an H mission preliminary "LM Rendezvous and Procedures Document". After reviewal by all elements of the Apollo Program and approval by the Procedures Configuration Control Board, this document will then evolve into the control document for the Mission H crew procedures.

2.0 INTRODUCTION

The LM-5/CSM-107 lunar orbit rendezvous exercise will begin during the twenty-fourth CSM revolution with insertion at 122 35:25.5 and end at approximately 126:00:00 with post rendezvous station keeping. The LM procedures during this period are divided into segments of major activities which are discussed in detail in Section 3.0.

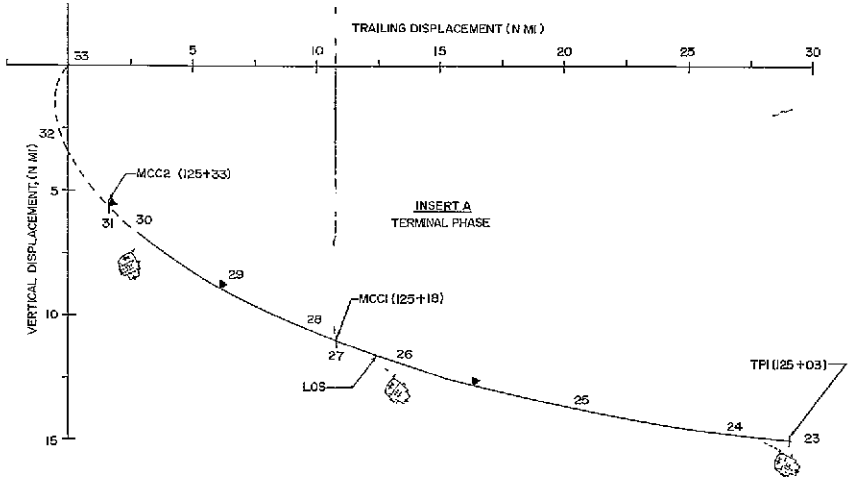
A nominal LM-5/CSM-107 mission profile is contained in Figure (2-1) This figure shows the locations in time and local horizontal position of the most significant nominal mission events. Trajectory data used to generate the mission profile and timeline for procedures development was obtained from Reference 7.2. The rendezvous navigation update schedule assumed in the procedures is defined in Reference 7.3.

A history of the LM body attitudes during the rendezvous accompanies the major events discussion and is also presented in Figures (2-2) and (2-3). 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.



LM MAJOR EVENTS

1	122+35	INSERTION
2	122+40	IMU REFSMMAT ALIGN (P52)
3	122+54	AGS UPDATE AND ALIGN (R47)
4	122+55	CSI TARGETING (P32 & AGS)
5	122+54—123+14	RR NAVIGATION (P20, 18 MARKS)
6	123+18	COMPUTE CSI BACKUP
7	123+19	AGS UPDATE AND ALIGN (R47)
8	123+26	CSI THRUSTING (P41)
9	123+30	SET W MATRIX (2000,2,5)
10	123+31	CDH TARGETING (P33 & AGS)
11	123+31—123+46	RR NAVIGATION (P20, 14 MARKS)
12	123+47	EXT ΔV FOR PLANE CHANGE (P30)
13	123+54	RCS PLANE CHANGE THRUSTING (P41)
14	123+56	CDH TARGETING (P33 & AGS)
15	123+56—124+12	RR NAVIGATION (P20, 13 MARKS)
16	124+15	COMPUTE CDH BACKUP
17	124+17	AGS UPDATE AND ALIGN (R47)
18	124+24	CDH THRUSTING (P41)
19	124+26	TPI TARGETING (P34 & AGS)
20	124+26—124+51	RR NAVIGATION (P20, 18 MARKS)
21	124+53	AGS UPDATE AND ALIGN (R47)
22	125+00	COMPUTE TPI BACKUP
23	125+03	TPI THRUSTING (P41)
24	125+05	MCC1 TARGETING (P35)
25	125+05—125+16	RR NAVIGATION (P20, 9 MARKS)
26	125+16	COMPUTE MCC1 THRUSTING (P41)
27	125+18	MCC 1 THRUSTING (P41)
28	125+20	MCC2 TARGETING (P35)
29	125+20—125+31	RR NAVIGATION (P20, 9 MARKS)
30	125+31	COMPUTE MCC 2 BACKUP
31	125+33	MCC2 THRUSTING (P41)
32	125+48	BRAKING (P47)
33	126+00	STATION KEEPING



FOLDOUT FRAME

FIGURE 2-1
G MISSION RENDEZVOUS
(CSM-CENTERED RELATIVE MOTION)

FOLDOUT FRAME

PREPARED BY STEPHEN P GREGA
ORBITAL PROCEDURES SECTION
MAY 16, 1969

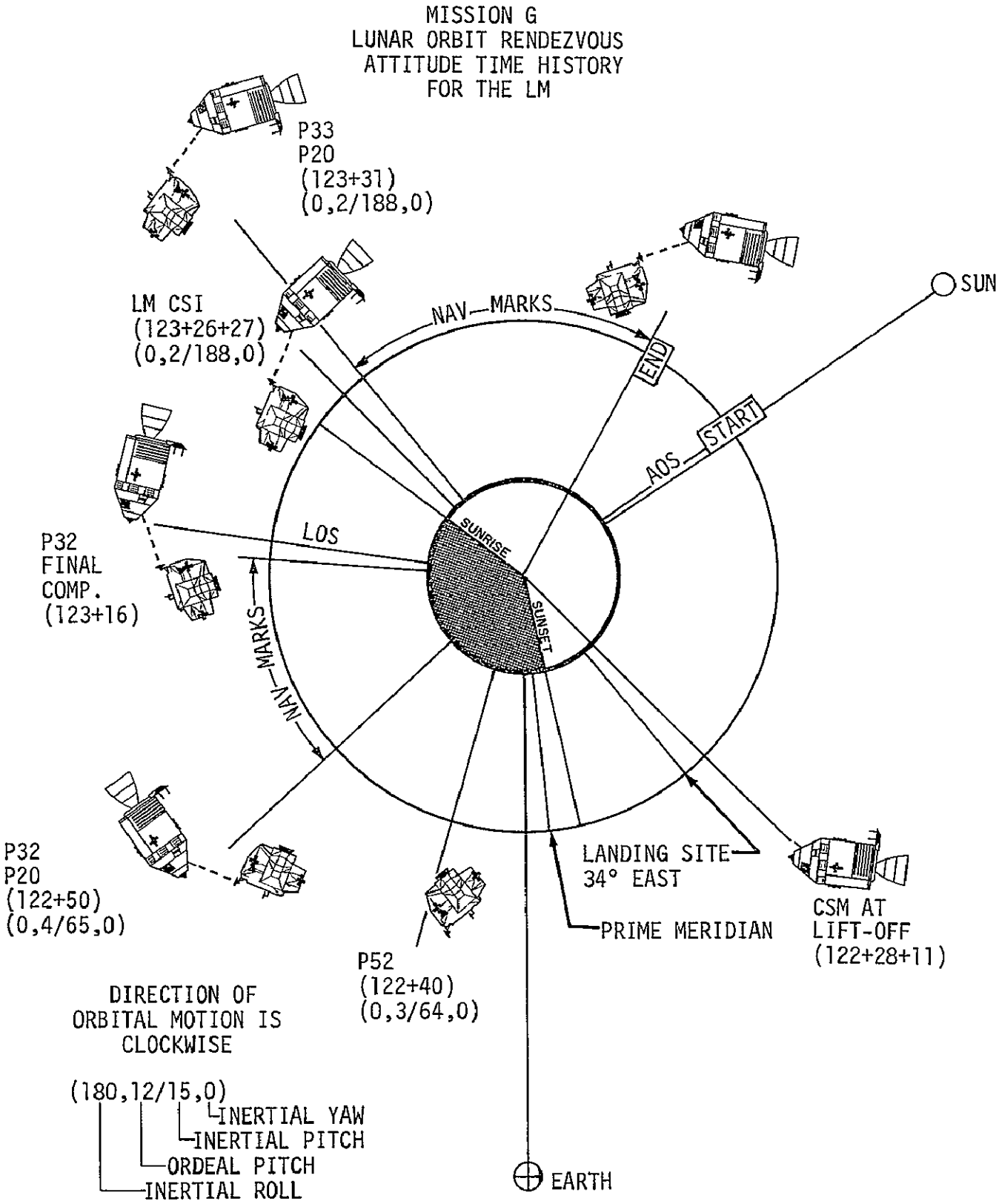

MISSION G
LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE LM
P33
P20
(123+31)
(0,2/188,0)
LM CSI
(123+26+27)
(0,2/188,0)
NAV—MARKS
END
START
AOS
SUN
LOS
SUNRISE
SUNSET
P32
FINAL
COMP.
(123+16)
NAV—MARKS
P32
P20
(122+50)
(0,4/65,0)
P52
(122+40)
(0,3/64,0)
LANDING SITE
34° EAST
PRIME MERIDIAN
CSM AT
LIFT-OFF
(122+28+11)
DIRECTION OF
ORBITAL MOTION IS
CLOCKWISE
(180,12/15,0)
INERTIAL YAW
INERTIAL PITCH
ORDEAL PITCH
INERTIAL ROLL
EARTH

FIGURE 2-2

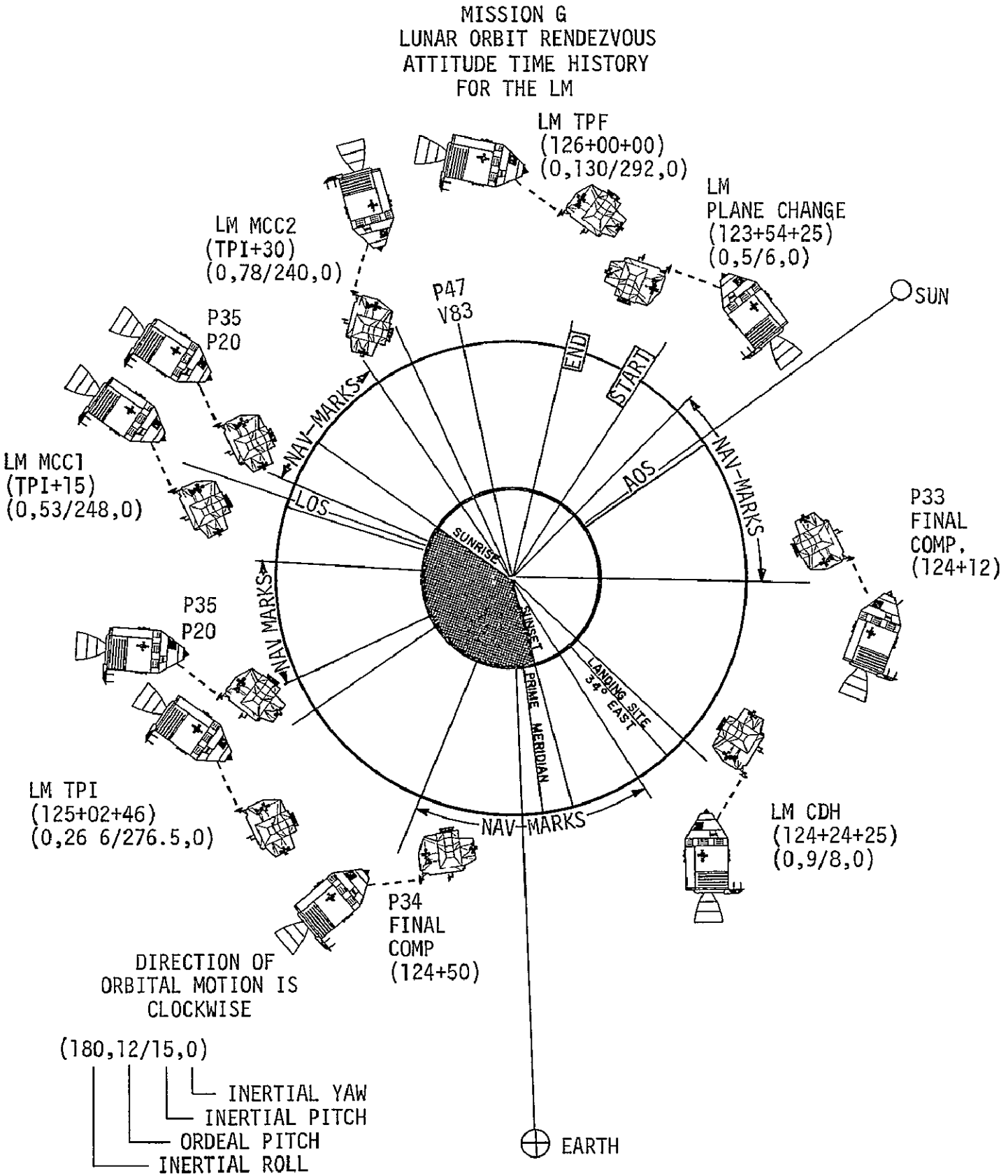

MISSION G
LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY
FOR THE LM
LM TPF
(126+00+00)
(0,130/292,0)
LM
PLANE CHANGE
(123+54+25)
(0,5/6,0)
SUN
LM MCC2
(TPI+30)
(0,78/240,0)
P47
V83
P35
P20
END
START
NAV-MARKS
AOS
LOS
LM MCC1
(TPI+15)
(0,53/248,0)
SUNRISE
SUNSET
PRIME MERIDIAN
LANDING SITE
34° EAST
P33
FINAL
COMP.
(124+12)
P35
P20
LM TPI
(125+02+46)
(0,26 6/276.5,0)
LM CDH
(124+24+25)
(0,9/8,0)
P34
FINAL
COMP
(124+50)
DIRECTION OF
ORBITAL MOTION IS
CLOCKWISE
(180,12/15,0)
INERTIAL YAW
INERTIAL PITCH
ORDEAL PITCH
INERTIAL ROLL
EARTH

FIGURE 2-3

3.0 DISCUSSION OF MAJOR EVENTS

3.1 Concentric Sequence Initiation

Immediately following Insertion the LM navigated vector will be downlinked to Mission Control Center-Houston, this state vector is then uplinked to the CSM. The LM commander will perform a Program 52 fine alignment to REFSMMAT at approximately 122.40.

The digital autopilot is configured to wide deadband, Program P20 is called, and an automatic pitch maneuver is initiated to the preferred track attitude At 122 55, CSI targeting parameters are loaded in the PGNS and AGS. A period of rendezvous radar marking will then take place from 122·57 to 123·15 Upon completion of tracking, the LM will obtain an out-of-plane velocity from the CSM to be vectored with the in-plane component of the CSI delta V. The CSM's estimate of out-of-plane velocity is alleged to be better than the LM's estimate. (Reference 7.4.)

At approximately 123 20 the LM will voice its CSI solution to the CSM; the AGS is updated, aligned, and targeted in external delta-V with the CDH solution to be excuted. Program P41 will then be called and the automatic pitch maneuver bypassed since the burn is to be executed with Z-Axis thrusting. The CSI burn occurs nominally at 123 26 27. After verification of the LM CSI burn, the CSM will incorporate the LM burn parameters in its CMC LM state vector

3.2 Constant Delta Height and Plane Change

At 123:30 approximately three minutes after the LM CSI burn, the W matrix will be set to (2000,2,5) and the LM targeting paramters are loaded in both the PGNS and AGS for the CDH maneuver. Out-of-plane velocity will then be computed and voiced to the LM from the CSM. Program P30 is loaded with the targeting parameters for the LM Plane Change maneuver which will be accomplished in Program P41 30 minutes prior to the CDH maneuver Following the burn, the target delta V parameters are voice to the CSM and incorporated into the CMC LM state vector. At 123:56 the CDH targeting parameters are loaded in both the PGNS and AGS for 124.24:25. A CDH chart solution is calculated 7 minutes prior to TIG. The AGS is updated, aligned, and targeted in external delta V with the CDH solution to be executed. The RCS Thrust Program, P41, is called at 124:18 and the burn attitude is bypassed since the LM executes CDH by thrusting out individual components of delta V while maintaining radar lock-on.

3 3 Terminal Phase Initiation

Radar tracking is initiated after the CDH maneuver and updating of the LGC continued. At 124:26, approximately two minutes after the LM CDH burn, targeting parameters are loaded in both the PGNS and AGS for the TPI maneuver which will be targeted for a node at intercept. Backup measurements are made at the appropriate times. The AGS is updated, aligned, and targeted in external delta V with the TPI solution to be executed. The RCS Thrust Program, P41, is called at 124:56 and the burn attitude is bypassed since the LM is burning along the plus Z-axis with the thrust direction established with the COAS.

3 4 Midcourse Corrections

Immediately after TPI the Midcourse Prethrust Program, P35, will be called and radar tracking reinitiated. Backup measurements are made and midcourse corrections chart solutions obtained. The MCC1 burn will nominally be performed at TPI plus 15 minutes (125:17:46). If MCC1 is to be excuted, Program P41 will be called and the burn attitude maneuver is bypassed since the plus Z-axis will remain boresighted at the CSM until docking.

Following MCC1, Program P35 will be called and targeted for MCC2 at TPI plus 30 minutes (125:32.46) and executed identically to MCC1.

3 5 Braking

In preparation for braking, the DAP is configured in narrow deadband Program P20 is terminated at 18,000 feet but the radar is kept in auto track to provide radar range and range rate displayed on the tapemeter. Average "G" is called by Program P47 prior to braking, and attitude hold is selected. The braking schedule is followed as contained in Section 4.

4.0 NOMINAL MISSION PROCEDURES

The procedures included in this section do not specify which crewmember, Commander or LM Pilot, performs each task. These need not be specified since the following basic rules define which crewmember performs each task.

4.1 Commander Tasks

1 All attitude changes, whether manual or automatic, will be accomplished by the CDR.
2 The operation of the DSKY during thrust programs (P40, P41, P42, P47) will be done by the CDR. Actual manipulation of the TTCA need not be always done by the CDR, but in most cases will be.
3. Operation of the rendezvous and landing radar will be done by the CDR.
4 The CDR will operate all other systems accessible to only his crew station.

4.2 LM Pilot Tasks

1 AGS operation.
2. DSKY operation will be done by the LMP except when keyboard entries affect the control of spacecraft attitude or thrusting.
3. Backup data logging and chart calculations.
4 All logging of maneuver solutions and systems performance.
5 The LMP will operate all other systems accessible to only his crew station.

These general rules are guidelines only, and may be deviated from by the LM crew if they develop more efficient Task assignments.

4.3 ABBREVIATIONS

The abbreviations used herein are consistant with those in the AOH. However, in order to condense and simplify the procedures so that they are representative of onboard data, a number of additional shorthand conventions have been used. To allow the unfamiliar reader to understand the procedures contained in this section, the following explanations are included

1. AGS - A single asterisk is employed to denote those procedures involving operations to be performed on the DEDA. The three number group following an asterisk specifies DEDA address An "R" following the address group indicates the address is to be read out. A five digit group behind the "R" indicates a nominal or expected display. If the three number address group is followed by a plus or minus sign, a data load is indicated. When a single digit follows the plus, addition of four zeros behind this digit is assumed. Once used, these conventions are easily handled and save considerable space.

2. PGNS - The verb-noun addresses in the PGNS are indicated to the left of the procedures column. An "F" is used to indicate a flashing display, or absence of an "F" a static display. To the right of the verb-noun, on the same line, are the contents of the three data registers. If numeric quantities appear, the DSKY should be correspondingly made to agree by executing a V21, V22, or V23 and performing a data load. The procedure of blanking and loading registers is not included since it is repeated often and is highly familiar to the crews.

EXAMPLE F 06 33 125·02 46 TIG OF TPI

Expanded, this means; Load flashing verb 06 noun 33 with the quantity 125 hours, 2 minutes and 46 seconds, the time of ignition of the RCS engine TPI maneuver. Procedurally, this is done by keying verb 25 enter, loading +000125 in register 1, +00002 in register 2, and +04600 in register 3.

If numberic quantities do not follow the verb-noun, it is indicated that a computed or information quantity is being displayed via the DSKY. If nominal values are listed for possible comparison, they appear in parentheses.

EXAMPLE· F 06 42 HA HP V

Expanded, this means Flashing verb 06 noun 42 has computed height of apogee in register 1, height of perigee in register 2, and velocity to be gained in register 3.

3. TIME - The numbers in the left hand column preceded by a plus or minus indicate "event timer" time referenced to an event. Minus indicates event timer counting down to a future event. Periodically, this same column contains the nominal mission ground elapsed times in parentheses. Asterisks following the event time indicate a time critical event which should be accomplished to the nearest second.

4 4 Nominal PGNS Procedures

```
            ASSUMPTIONS

*****************************************
*            AFTER INSERTION            *
*****************************************

 1 INSERTION COMPLETE (RESIDUALS NULLED)
 2 VERIFY V82E (ORBIT)
 3 RNDZ RDR LOCKED ON IN MODE II
 4 LGC AT FLASHING VERB 37
 5 PROPER INITIAL W MATRIX LOADED IN LGC

   GUID CONT-PGNS
   ATTITUDE MON-PGNS(CDR)
   RATE ERR MON-CMPTR(LMP)
   ATTITUDE MON-AGS(LMP)
   SHFT/TRUN-+5 DEG
   X-POINTER-HI MULT
   RADAR TEST SW-OFF
   ENG ARM-OFF
   X-TRANSL-2JETS
   DEAD BAND-MIN
   PGNS MODE CONT-AUTO
   THROT/JET-JET
   CB/PGNS IMU OPR-CLOSE
   R/R MODE-LGC
   TTCA/TRANSL-ENABLE(CDR)

*****************************************
*  BAL CPL-ON                           *
*  MODE SEL-AGS                         *
*  RNG/ALT MON-RNG/RNGRT                *
*  RATE ERR MON-RNDZ RDR(CDR)           *
*  ATT CONT-PULSE(3)                    *
*  AGS MODE CONT-ATT HOLD               *
*  ACA/4JET-DISABLE(CDR)                *
*  TTCA/TRANSL-DISABLE(LMP)             *
*  ACA/4JET-DISABLE(LMP)                *
*****************************************

         KEY 00E (P00)
         (DOWNLINK LM STATE VECTOR)

         KEY V63E (RR SELF TEST)
```

```
     F 04 12 00004 00001
             PRO
     F 16 72 TRUN SHFT
             PRO
     F 16 78 R RDOT
             VERIFY TAPE METER WITH DSKY

    ****************************************
+2  *        VERIFY INSERTION VELOCITY     *
    *        WITH RNDZ RDR, WHERE          *
    *        RANGE = 264.2 N.M.            *
    *        RANGE RATE = -425.1 FPS       *
    ****************************************


             SUIT/CABIN PRESS - NOR
             GLYCOL TEMP/PRESS - NOR
             O2/H2O QUANTITY - NOMINAL

             KEY V34E (TERMINATE)
             KEY V48E (LOAD DAP)
     F 01 46 11002
             PRO
     F 06 47 LMWT CMWT
             PRO

             KEY V56E (KILL AUTO TRACK ENABLE)

+3           KEY V41N72E (COARSE ALIGN R/R)
     F 21 73 +000.00TRUN -077.00SHFT
     F 04 12 00006 00002 (CONTINUOUS DESIGNATE)
             PRO
       41    (COARSE ALIGN VERB)

             KEY V16N72E
       16 72 MONITOR TRUN/SHFT ANGLES


             CB PGNS RNDZ RDR-OPEN
             CB AC BUS A RNDZ RDR-OPEN
             KEY V44E (TERMINATE RR DESIGNATE)


             KEY V83E
     F 16 54 R RDOT THETA
             SET ORDEAL
             PRO


             CB HEATER AOT-CLOSE
             CB AOT LAMP-CLOSE

+5           KEY V37E52E (IMU REALIGN)
```

```
            *410+1 CSI ROUTINE
            *373+0206.5 CSI TIME
            *275+0302.8 TPI TIME
            *605+00777 COTANGENT OF LOS TO CSM
            *416+1 (ONE-HALF ORBITAL PERIOD)
            *411+0 RCS ENGINES
            *623+0 Z-AXIS PARALLEL TO CSM ORBIT
            *310R TIME TO CSI

            *267R _____ VELOCITY TO BE GAINED CSI

            *402R _____ DELTA H

            *371R _____ DELTA V CDH

            *372R _____ DELTA T CSI/CDH

      F 04 06 00001 00003 (REFSMMAT)
               PRO
      F 50 25 00015 SELECT 1ST STAR
               ENTR
      F 01 70 002DE LOAD 1ST STAR
               PRO

               PGNS MODE CONT-AUTO
      F 50 18 FDAI ANGLES (REQUEST MNVR)
               PRO (AUTO MNVR)
        06 18 FDAI ANGLES (AUTO MNVR)
      F 50 18 FDAI ANGLES (REQUEST MNVR)
               ENTR (BYPASS MNVR)

      F 01 71 002DE

               KEY V76E
               PGNS MODE CONT-ATT HOLD

               PRO
+10   F 54 71 MARK 1ST STAR
               PRO
      F 01 70 002DE LOAD 2ND STAR
               PRO

               PGNS MODE CONT-AUTO
      F 50 18 FDAI ANGLES (REQUEST MNVR)
               PRO (AUTO MNVR)
        06 18 FDAI ANGLES (AUTO MNVR)
      F 50 18 FDAI ANGLES (REQUEST MNVR)
               ENTR (BYPASS MNVR)

      F 01 71 002DE
               PGNS MODE CONT-ATT HOLD
               PRO
```

```
+14   F 54 71 MARK 2ND STAR
              PRO
      F 06 05 STAR ANGLE DIFFERENCE
              PRO
      F 06 93 GYRO TORQUE ANGLES
              PRO
      F 50 25 00014

              PRO (CHECK ALIGNMENT IF TIME WILL PERMIT)

      F 50 25 00015 SELECT 3RD STAR
              ENTR
      F 01 70 002DE LOAD 3RD STAR
              PRO

              PGNS MODE CONT-AUTO
      F 50 18 FDAI ANGLES (REQUEST MNVR)
              PRO (AUTO MNVR)
        06 18 FDAI ANGLES (AUTO MNVR)
      F 50 18 FDAI ANGLES (REQUEST MNVR)
              ENTR (BYPASS MNVR)

              VERIFY ALIGNMENT VIA AOT

              KEY V34E (TERMINATE)
      F 37 BB

              V48E (LOAD DAP)
      F 01 46 11012
              PRO
      F 06 47 LMWT CMWT
+17           PRO

              CB AOT LAMP-OPEN

-35           RESET ET (310R)


(122:53)      CB AC BUS A RNDZ RDR-CLOSE
              (WAIT 30 SEC)
              CB PGNS RNDZ RDR-CLOSE


              RR MODE-LGC
              KEY V37E20E (ACQUIRE RADAR)

              PGNS MODE CONT-AUTO
      F 50 18 FDAI ANGLES (REQUEST MNVR)
              PRO (AUTO MNVR)
        06 18 FDAI ANGLES (AUTO MNVR)
              AGS MODE CONT-AUTO
              RATE/ERR MON-CMPTR (LMP)
      F 50 18 FDAI ANGLES (REQUEST MNVR)
```

```
          ENTR (BYPASS MNVR)
          NO TRK LT-OFF
     F 50 72 RR TRUN/SHFT
          VERIFY R/R LOCK ON
          PRO
       DSKY BLANKS

          KEY V93E (BEFORE 1ST MARK REINIT W. MATRIX)
          KEY V80E (UPDATE LM SV)

          KEY V47E (INITIALIZE AGS)
     F 06 16 GET OF AGS 0 TIME (120:00:00)
          TELEMETRY PCM SW-HI
         *414+1 UPDATE AGS.
          PRO
         *414R (00000 COMPLETE)
     F 50 16 DOWNLINK COMPLETE
          PRO (UPDATE COMPLETE)

         *400+3 AGS ALIGN
         *400R (00000 COMPLETE)
         *507+0 Z-AXIS BORESIGHT
         *400+2 ACQUISITION STEERING


    ******************************************
    *                  CSI                   *
    ******************************************


(122:55)     KEY V37E32E (CSI)

     F 06 11 _____:___:___ LOAD TIG CSI FROM DATA PAD
          (NOM 123:26:27)
          PRO
     F 06 55 +00001N +026.60E +130.00 OMEGAT
          (CDH 180 DEG AFTER CSI)
          PRO

     F 06 37 _____:___:___ LOAD TIG TPI FROM DATA PAD
          (NOM 125:02:46)
          PRO
     F 16 45 MKS TFI -00001

-30*      COPY RDOT FOR 1ST CSI BU

         *310R TIME TO CSI

         *267R _________ VELOCITY TO BE GAINED CSI

         *402R _________ DELTA H

         *371R _________ DELTA V CDH
```

```
          *372R _________ DELTA T CSI/CDH

           KEY V32E (MARKS=5)

      F 06 75 DELTA H DELTA T CSI/CDH DELTA T CDH/TPI
              PRO
      F 06 81 DELTA V'S-LV (CSI)
              (NOM 50.1 DELTA VX)
                                  CSI(N81)

              DELTA VX(LV)        __________

              DELTA VY(LV)        __________

              DELTA VZ(LV)        __________

              PRO
      F 06 82 DELTA V'S-LV (CDH)
              (NOM 6.0 DELTA VX)
                                  CDH(82)

              DELTA VX(LV)        __________

              DELTA VY(LV)        __________

              DELTA VZ(LV)        __________

              PRO
      F 16 45 MKS TFI -00001

-22           KEY V32E (MARKS=10)

      F 06 75 DELTA H DELTA TCSI/CDH DELTA TCDH/TPI
              PRO
      F 06 81 DELTA V'S-LV (CSI)
                                  CSI(N81)

              DELTA VX(LV)        __________

              DELTA VY(LV)        __________

              DELTA VZ(LV)        __________

              PRO
      F 06 82 DELTA V'S-LV(CDH)
                                  CDH(82)

              DELTA VX(LV)        __________

              DELTA VY(LV)        __________

              DELTA VZ(LV)        __________
```

-20* COPY RDOT FOR 2ND CSI BU

PRO
F 16 45 MKS TFI -00001

TEMP/PRESS MON SEL - FUEL MAN
A + B PRESS 181 +-3 PSIG
TEMP/PRESS MON SEL - PRPLNT
A + B TEMP IND 40DEG TO 100DEG F
A + B PRESS IND 181 +-3 PSIA
TEMP/PRESS MON SEL - HEL

A + B PRESS IND _____ PSIA

A QUANTITY IND _____ PERCENT REMAINING

B QUANTITY IND _____ PERCENT REMAINING
TEMP MON SEL RCS QUAD 1, 4, 2, 3 (120 - 190 DEG F)

(LOS OF MSFN)
S-BAND - SLEW TO P = +90, Y = 0
S-BAND - FWD (OR AFT)
S-BAND - DN VOICE BU
BIOMED OFF

-12 PRO (FINAL COMP)

*267R _____ VELOCITY TO BE GAINED CSI

*402R _____ DELTA H

*372R _____ TIME CSI/CDH

*371R _____ PREDICTED VEL TO BE GAINED CDH

*263R _____ OUT-OF-PLANE

F 06 75 DELTA H DELTA TCSI/CDH DELTA TCDH/TPI
PRO
F 06 81 DELTA V'S-LV (CSI)

KEY V90E (OUT-OF-PLANE)

F 06 16 _____:_____:_____ LOAD TIG CSI FROM DATA PAD
(NOM 123:26:27)
PRO
F 06 90 Y YDOT PSI
N90 CSM

YDOT _____ _____

PRO

F 06 81 DELTA V*S-LV(CSI)

COPY YDOT FROM CSM AND LOAD NEGATIVE IN R2
CSI(N81)

DELTA VX(LV) _____

DELTA VY(LV) _____

DELTA VZ(LV) _____

PRO

F 06 82 DELTA V*S-LV (CDH)
CDH(82)

DELTA VX(LV) _____

DELTA VY(LV) _____

DELTA VZ(LV) _____

PRO

F 16 45 MKS TFI MGA

-10* COPY RANGE AND RDOT FOR 3RD CSI BU

COMPUTE CSI BU

-7 KEY V47E (INITIALIZE AGS)

F 06 16 GET OF AGS 0 TIME (120.00.00)
TELEMETRY PCM SW-HI
*414+1 UPDATE AGS
PRO
*414R (00000 COMPLETE)

F 50 16 DOWNLINK COMPLETE
PRO (UPDATE COMPLETE)

F 16 45 MKS TFI MGA

(TRANSMIT CSI DATA TO CSM)
VHF A XMTR - VOICE
VHF B XMTR - DATA
VHF B RCVR - OFF
TELEMETY PCM - LO

KEY V83E

F 16 54 R RDOT THETA
SET ORDEAL
PRO

*317R _____ RANGE

*440R _____ RANGE RATE

*400+3 AGS ALIGN
*400R (00000 COMPLETE)

*277R _____ THETA

PRO
F 37 BB

-6 KEY 41E (RCS THRUSTING)
F 50 18 FDAI ANGLES (REQUEST MNVR)
ENTR (BYPASS MNVR)

16 85 DELTA V*S-BODY

KEY V06N86E DELTA V*S-LV
F 06 86 DELTA V*S-LV

	AGS(N86)	CHART
DELTA VX(LV)	_____	_____
DELTA VY(LV)	_____	_____
DELTA VZ(LV)	_____	_____

KEY RELEASE

*507+1 Z-AXIS DELTA V
*400+2 Z-AXIS STEERING
*410+5 EXTERNAL DELTA V
*450 451 452 LOAD
*407+0 ROTATE EXTERNAL DELTA V RF

TRANSMIT TGT DELTA V*S TO CSM AND SYNC COUNTDOWN

16 85 DELTA V*S-BODY

*502R _____ DELTA VZ (NOM 50.1)

-.35 DSKY BLANKS

KEY V77E (ATT HOLD)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
*407+1 FREEZE EXTERNAL DELTA V

F 16 85 DELTA V*S-BODY

(123:26:27) BURN +Z

NULL DELTA V*S

```
          VERIFY AGS RESIDUALS
         *500R          501R          502R
          DELTA VX____ DELTA VY____ DELTA VZ____

          VERIFY PGNS RESIDUALS
                                N85

          DELTA VX(LM)      _________

          DELTA VY(LM)      _________

          DELTA VZ(LM)      _________

          PRO
 F 37 BB
```

****
* CDH *
****

```
          KEY V76E (PGNS PULSE)
          PGNS MODE CONT-AUTO

          KEY V67E (RESET W MATRIX)
 F 06 99 +02000E +00020E +00005E
          PRO

         *507+0 Z-AXIS BORESIGHT

          (VHF RANGING WITH CSM)
          VHF A XMTR - VOICE/RNG
          VHF B XMTR - OFF
          VHF B RCVR - ON
          TELEMETRY PCM - HI

(123:31)  KEY V37E33E (CDH PRE-THRUST)

         *410+2 CDH ROUTINE

 F 06 13  ____:__:__ TIG CDH (NOM 124:24:25)
          -120 :00 :00 (AGS 0 TIME)

                       (CONVERT TO MINUTES)

         *411+0 THRUST ALONG Z-BODY AXIS
          ENTER IF YOU DON'T TARGET CSI

         *373R _________ (NOM 264.4)
         *310R TIME TO CDH
```

```
          *423R _________ DESIRED ALT RATE AT CDH

          *402R _________ DELTA H

          *450R _________ DELTA VX

          *452R _________ DELTA VZ

          *623+0 Z-AXIS PARALLEL TO CSM PLANE

           PRO
     F 16 45 MKS TFI -00001

-52        RESET ET

           KEY V93E (REINIT W MATRIX WHEN MARKS = 4)

           KEY V32E (MARKS = 3)

     F 06 75 DELTA HCDH DELTA TCDH/TPI DELTA TTPI
           PRO
     F 06 81 DELTA VCDH-LV
                              CDH(N81)

           DELTA VX(LV)       _________

           DELTA VY(LV)       _________

           DELTA VZ(LV)       _________

           PRO
     F 16 45 MKS TFI -00001

-47        KEY V90E (OUT-OF-PLANE)

           _____:__:____ TIG CDH (NOM 124:24:25)
                -30:00   TIME FROM CDH

     F 06 16 _____:__:____ LOAD TIG PLANE CHANGE
           (NOM 123:54:25)
           PRO
     F 06 90 Y YDOT PSI
                 N90          CSM

           YDOT _________     _________
           PRO

-42        KEY V32E (MARKS=10)

     F 06 75 DELTA HCDH DELTA TCDH/TPI DELTA TTPI/TPI
           PRO
     F 06 81 DELTA VCDH-LV
```

```
                DELTA VX(LV)      _________

                DELTA VY(LV)      _________

                DELTA VZ(LV)      _________

                PRO
      F 16 45   MKS TFI -00001
                KEY V34E (TERMINATE)
      F 37 BB


     ******************************************
     *              PLANE  CHANGE             *
     ******************************************


                KEY 30E (EXTERNAL DELTA V)

                _____:__:___ TIG CDH (NOM 124:24:25)
                    -30:00   TIME FROM CDH

      F 06 33   _____:__:___ LOAD TIG PLANE CHANGE
                (NOM 123:54:25)
                PRO
      F 06 81   DELTA V*S-LV (NOM 0.0)

-36*            COPY RDOT FOR 1ST CDH BU

                KEY V90E (OUT-OF-PLANE)

      F 06 16   _____:__:___ LOAD TIG PLANE CHANGE
                (NOM 123:54:25)
                PRO
      F 06 90   Y   YDOT   PSI
                        N90        CSM

                YDOT_________      _________
                PRO

      F 06 81   DELTA V*S-LV(NOM 0.0)

                COPY YDOT AND LOAD NEGATIVE IN R2
                PRO
      F 06 42   HA HP DELTA V
                PRO
      F 16 45   MKS TFI MGA

                PRO
      F 37 BB

                KEY 41E (RCS THRUSTING)
```

```
     F 50 18 FDAI ANGLES (REQUEST MNVR)
             ENTR (BYPASS MNVR)

            *410+5 EXTERNAL DELTA V
            *450+0  451-YDOT  452+0
             (LOAD CSM -YDOT)
            *407+0 ROTATE EXTERNAL DELTA V RF

       16 85 DELTA V*S-BODY

-30:35 DSKY BLANKS

             KEY V77E (ATT HOLD)
             PGNS MODE CONT-ATT HOLD
             AGS MODE CONT-ATT HOLD
            *407+1 FREEZE EXTERNAL DELTA V

     F 16 85 DELTA V*S-BODY


-30          NULL DELTA V*S

             PRO
     F 37 BB

             KEY V76E (PGNS PULSE)
             PGNS MODE CONT-AUTO
            *507+0 Z-AXIS BORESIGHT

(123:56)     KEY 33E (CDH PRE-THRUST)

            *410+2 CDH ROUTINE

     F 06 13 ____:__:__ TIG CDH (NOM 124:24:25)
             -120 :00 :00  (AGS 0 TIME)

                           (CONVERT TO MINUTES)

            *373R _______ (NOM 264.4)
            *310R TIME TO CDH

            *423R _______ DESIRED ALT RATE AT CDH


             (AOS OF MSFN)
             S-BAND - SLEW TO P = ____, Y = ____
             ACQUIRE HGA LOCK ON
             VOICE - BU/VOICE -- VOICE
             VERIFY VOICE, TLM
             BIOMED - LEFT (OR RIGHT)
            *402R _______ DELTA H
```

*450R _____ DELTA VX

*452R _____ DELTA VZ

PRO
F 16 45 MKS TFI -00001

-25 KEY V93E (REINIT W MATRIX WHEN MARKS = 4)

-23* COPY RDOT FOR 2ND CDH BU

KEY V32E (MARKS = 5)

TEMP/PRESS MON SEL - FUEL MAN
A + B PRESS 181 +-3 PSIG
TEMP/PRESS MON SEL - PRPLNT
A + B TEMP IND 40DEG TO 100DEG F
A + B PRESS IND 181 +-3 PSIA
TEMP/PRESS MON SEL - HEL

A + B PRESS IND_____PSIA

A QUANTITY IND _____ PERCENT REMAINING

B QUANTITY IND _____ PERCENT REMAINING
TEMP MON SEL RCS QUAD 1, 4, 2, 3 (120 - 190 DEG F)

SUIT/CABIN PRESS - NOR
GLYCOL TEMP/PRESS - NOR
O2/H2O QUANTITY - NOMINAL

F 06 75 DELTA HCDH DELTA TCDH/TPI DELTA TTPI/TPI
PRO
F 06 81 DELTA VCDH-LV
CDH(N81)

DELTA VX(LV) _____

DELTA VY(LV) _____

DELTA VZ(LV) _____

PRO
F 16 45 MKS TFI -00001

-12 PRO (FINAL COMP)

F 06 75 DELTA HCDH DELTA TCDH/TPI DELTA TTPI/TPI
PRO
F 06 81 DELTA VCDH-LV

KEY V90E (OUT-OF-PLANE)

```
     F 06 16  ____:____:____ LOAD TIG CDH FROM DATA PAD
              (NOM 124:24:25)
              PRO
     F 06 90  Y YDOT PSI
                       N90          CSM

              YDOT _________       _________
              PRO


              COPY YDOT FROM CSM AND LOAD NEGATIVE IN R2
                                   CDH(N81)

              DELTA VX(LV)         _____________

              DELTA  VY(LV)        _____________

              DELTA VZ(LV)         _____________

              PRO
     F 16 45  MKS TFI MGA

-10*          COPY RDOT FOR 3RD CDH BU

              COMPUTE CDH BU

              TRANSMIT TGT DELTA V'S TO CSM AND SYNC COUNTDOWN

-7            KEY V47E (INITIALIZE AGS)
     F 06 16  GET OF AGS 0 TIME (120:00:00)
              TELEMETRY PCM SW-HI
             *414+1 UPDATE AGS
              PRO
             *414R (00000 COMPLETE)
     F 50 16  DOWNLINK COMPLETE
              PRO (UPDATE COMPLETE)

     F 16 45  MKS TFI MGA

              KEY V83E
     F 16 54  R RDOT THETA
              SET ORDEAL
              PRO

             *317R _____._____ RANGE

             *440R ___________ RANGE RATE
             *400+3 AGS ALIGN
             *400R (00000 COMPLETE)

             *277R ___________ THETA
```

PRO
F 37 BB

-6 KEY 41E (RCS THRUSTING)
F 50 18 FDAI ANGLES (REQUEST MNVR)
ENTR (BYPASS MNVR)

16 85 DELTA V'S-BODY

KEY V06N86E
F 06 86 DELTA V'S-LV

	AGS(N86)	CHART
DELTA VX(LV)	_____	_____
DELTA VY(LV)	_____	_____
DELTA VZ(LV)	_____	_____

KEY RELEASE

*507+1 Z-AXIS DELTA V
*400+0 ATT HOLD
*410+5 EXTERNAL DELTA V
*450 451 452 LOAD
*407+0 ROTATE EXTERNAL DELTA V RF

16 85 DELTA V'S-BODY

*500R _____ DELTA VX (NOM -0.3)

*502R _____ DELTA VZ (NOM 6.0)

-:35 DSKY BLANKS

KEY V77E (ATT HOLD)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
*407+1 FREEZE EXTERNAL DELTA V

F 16 85 DELTA V'S BODY

(124:24:25) NULL DELTA V'S

VERIFY AGS RESIDUALS
*500R 501R 502R
DELTA VX ____ DELTA VY ____ DELTA VZ ____

VERIFY PGNS RESIDUALS
N85

DELTA VX(LM) _____

```
            DELTA VY(LM)      _____

            DELTA VZ(LM)      _____

            PRO
     F 37 BB


     ****************************************
     *                  TPI                 *
     ****************************************

            KEY V76E (PGNS PULSE)
            PGNS MODE CONT-AUTO
           *507+0 Z-AXIS BORESIGHT

(124:26)    KEY 34E (TPI)

-36         RESET ET

     F 06 37 ___:___:___ LOAD TIG TPI FROM DATA PAD
            (NOM 125:02:46)
            PRO
     F 06 55 +00000 +026.60E +130.00 OMEGAT
            PRO
     F 16 45 MARKS TFI -00001

-32         KEY V93E (REINIT W MATRIX WHEN MARKS = 4)

-29         KEY V32E (MARKS = 3)

     F 06 37 ___:___:___ TIG TPI
            PRO
     F 06 58 HP DELTA VTPI DELTA VTPF
            PRO
     F 06 59 DELTA V'S-LOS
                                N59

            DELTA V F/A       _____

            DELTA V R/L       _____

            DELTA V D/U       _____

            PRO
     F 16 45 MKS TFI -00001

            RESET ET

           *410+3 TPI SEARCH ROUTINE
           *307+043.00 DELTA T TRANSFER
```

-26 *310+026.00 TFI TPI

*303R _____ THETA AT TPI

*267R _____ DELTA VTPI

*371R _____ DELTA VTPI + DELTA VTPF

KEY V32E (MARKS = 10)

F 06 37 ____:__:__ TIG TPI
PRO
F 06 58 HP DELTA VTPI DELTA VTPF
PRO
F 06 59 DELTA V*S-LOS
N59

DELTA V F/A _____

DELTA V R/L _____

DELTA V D/U _____

PRO
F 16 45 MKS TFI -00001

TEMP/PRESS MON SEL - FUEL MAN
A + B PRESS 181 +-3 PSIG
TEMP/PRESS MON SEL - PRPLNT
A + B TEMP IND 40DEG TO 100DEG F
A + B PRESS IND 181 +-3 PSIA
TEMP/PRESS MON SEL - HEL

A + B PRESS IND _____ PSIA

A QUANTITY IND _____ PERCENT REMAINING

B QUANTITY IND _____ PERCENT REMAINING
TEMP MON SEL RCS QUAD 1, 4, 2, 3 (120 - 190 DEG F)

SUIT/CABIN PRESS - NOR
GLYCOL TEMP/PRESS - NOR
O2/H2O QUANTITY - NOMINAL

RESET ET

-13 *310+013.00 TFI TPI

*303R _____ THETA AT TPI

-12 PRO (FINAL COMP)
F 06 37 ____:__:__ TIG TPI

```
          TRANSMIT TIG OF TPI TO CSM

          PRO
F 06 58   HP DELTA VTPI DELTA VTPF
          PRO
F 06 81   DELTA V'S-LV

          KEY V90E (OUT-OF-PLANE)

F 06 16   ____:__:__ LOAD TIG TPI FROM DATA PAD
          (NOM 125:02:46)
          PRO
F 06 90   Y YDOT PSI
                   N90        CSM

          YDOT _________      _________

          PRO
F 06 81   DELTA V'S-LV

          COPY CSM YDOT AND LOAD NEGATIVE IN R2
                              N81

          DELTA VX(LV)      ___________

          DELTA VY(LV)      ___________

          DELTA VZ(LV)      ___________

          PRO
F 06 59   DELTA V'S LOS
                              N59

          DELTA V F/A       ___________

          DELTA V R/L       ___________

          DELTA V D/U       ___________

          PRO
F 16 45   MKS TFI MGA

          RESET ET

          PRO
F 37 BB

-10       KEY V47E (INITIALIZE AGS)
F 06 16   GET OF AGS 0 TIME (120:00:00)
          TELEMETRY PCM SW-HI
         *414+1 UPDATE AGS
          PRO
         *414R (00000 COMPLETE)
```

F 50 16 DOWNLINK COMPLETE
PRO (UPDATE COMPLETE)

*400+3 AGS ALIGN
*400R (00000 COMPLETE)

-9* *277R COPY TGT LOS ANGLE

*310+008.00

*303R _____ THETA AT TPI
*410+4 DIRECT TRANSFER AT ET=-8
*404+0 405+0 406+0
(MONITOR 470 471 472)

*373R _____ TIG TPI

*267R _____ DELTA V TPI

*371R _____ DELTA V TPI + DELTA V TPF

-6 KEY 41E (RCS THRUSTING)
F 50 18 FDAI ANGLES (REQUEST MNVR)
ENTR (BYPASS MNVR)

16 85 DELTA V'S-BODY

KEY V06N86E DELTA V'S-LV
F 06 86 DELTA V'S-LV

	AGS(N86)	CHART
DELTA VX(LV)	_____	_____
DELTA VY(LV)	_____	_____
DELTA VZ(LV)	_____	_____

KEY RELEASE

-5* *277R COPY TGT LOS ANGLE

COPY R, RDOT FROM TAPE METER FOR BU'S

*400+2 Z-AXIS STEERING
*410+5 EXTERNAL DELTA V
*450 451 452 LOAD
*407+0 ROTATE EXTERNAL DELTA V RF

COMPUTE TPI BU

COPY CSM TPI SOLUTION AND SYNC COUNTDOWN WITH CSM

16:85 DELTA V*S-BODY

*500R _____ DELTA VX(NOM -11.5)

*502R _____ DELTA VZ(NOM 22.9)

-:35 DSKY BLANKS

KEY V77E (ATT HOLD)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
*407+1 FREEZE EXTERNAL DELTA V

F 16 85 DELTA V*S-BODY

(125:02:46) BURN +Z

VERIFY AGS RESIDUALS
*500R 501R 502R
DELTA VX ____ DELTA VY ____ DELTA VZ ____

VERIFY PGNS RESIDUALS
N85

DELTA VX(LM) _____

DELTA VY(LM) _____

DELTA VZ(LM) _____

PRO

F 37 BB

****
* MCC1 *
****

KEY V76E (PGNS PULSE)
PGNS MODE CONT-AUTO

KEY V93E (BEFORE 1ST MARK REINIT W MATRIX)

+2 KEY 35E (TPM PRE-THRUST)

F 16 45 MKS TFI -00001

```
                (LOS OF MSFN)
                S-BAND - SLEW TO P = +90, Y = 0
                S-BAND - FWD (OR AFT)
                S-BAND - DN VOICE BU
                BIOMED OFF

               *404+0 405+0 406+0
                (MONITOR 470 471 472)

+9*            *277R COPY TGT LOS ANGLE

+12             PRO (COMPUTE MCC FOR TPI+15)
     F 06 81    DELTA V*S-LV
                PRO
     F 06 59    DELTA V*S-LOS
                PRO
     F 16 45    MKS TFI MGA

+13*           *277R COPY TGT LOS ANGLE

                COPY R, RDOT FROM TAPE METER FOR BU*S

                COMPUTE MCC1 BU

                PRO
     F 37 BB

+14             KEY 41E (RCS THRUSTING)
     F 50 18    FDAI ANGLES (REQUEST MNVR)
                ENTR (BYPASS MNVR)
       16 85    DELTA V*S-BODY

+14:25 DSKY BLANKS

                KEY V77E (ATT HOLD)
                PGNS MODE CONT-ATT HOLD
                AGS MODE CONT-ATT HOLD
               *407+1 FREEZE EXTERNAL DELTA V


+15  F 16 85    NULL DELTA V*S


                PRO
     F 37 BB

    ****************************************
    *                MCC2                  *
    ****************************************


               KEY V76E (PGNS PULSE)
```

```
                PGNS MODE CONT-AUTO

                KEY V93E (BEFORE 1ST MARK REINIT W MATRIX)

+16             KEY 35E (TPM PRE-THRUST)
     F 16 45 MKS TFI -00001

               *404+0 405+0 406+0
                (MONITOR 470 471 472)

+24*           *277R COPY TGT LOS ANGLE

+27             PRO (COMPUTE MCC FOR TPI+30)
     F 06 81 DELTA V*S-LV
                PRO
     F 06 59 DELTA V*S-LOS
                PRO
     F 16 45 MKS TFI MGA

+28*           *277R COPY TGT LOS ANGLE

                COPY R, RDOT FROM TAPE METER FOR BU*S

                COMPUTE MCC2 BU

                PRO
     F 37 BB


                KEY 41E (RCS THRUSTING)
     F 50 18 FDAI ANGLES (REQUEST MNVR)
                ENTR (BYPASS MNVR)
       16 85 DELTA V*S-BODY

+29:25 DSKY BLANKS

                KEY V77E (ATT HOLD)
                PGNS MODE CONT-ATT HOLD
                AGS MODE CONT-ATT HOLD
               *407+1 FREEZE EXTERNAL DELTA V


+30  F 16 85 NULL DELTA V*S


                PRO
     F 37 BB

                KEY 00E (P00)

                V63E (RR SELF TEST)
     F 04 12 00004 00001
                PRO
```

```
F 16 72 TRUN SHFT
        PRO
F 16 78 R RDOT
        KEY V34E (TERMINATE)

        KEY V37E47E (AVE G)
F 16 83 DELTA V'S

        V63E (RR SELF TEST)
F 04 12 00004 00001
        PRO

F 16 72 TRUN SHFT
        PRO
F 16 78 R RDOT
        VERIFY TAPE METER WITH DSKY
```

```
*****************************************
*         BRAKING GATE                  *
*            30 FPS - 6000 FT           *
*            20 FPS - 3000 FT           *
*            10 FPS - 1500 FT           *
*             5 FPS -  600 FT           *
*****************************************
```

RENDEZVOUS

STATION KEEPING

5.0 ABORT PROCEDURE

This is a specific AGS nominal abort procedure due to a PGNS failure between insertion and station keeping.

5.1 Nominal AGS Procedures

ASSUMPTIONS

```
*****************************************
*            AFTER INSERTION            *
*****************************************
```

1 INSERTION COMPLETE (RESIDUALS NULLED)
2 PGNS FAILURE BEFORE INSERTION
3 RADAR NOT LOCKED ON

GUID CONT-AGS
ATTITUDE MON-AGS(CDR)
RATE ERR MON-CMPTR(LMP)
ATTITUDE MON-AGS(LMP)
SHFT/TRUN-+5 DEG
X-POINTER-HI MULT
RADAR TEST SW-OFF
ENG GMBL-OFF
ENG ARM-OFF
X-TRANSL-2 JETS
DEAD BAND-MAX
PGNS MODE CONT-OFF
THROT/JET-JET
CB IMU OPR-ON
R/R MODE-AUTO TRACK
TTCA/TRANSL-ENABLE(CDR)

```
*****************************************
*  BAL CPL-ON                           *
*  MODE SEL-AGS                         *
*  RNG/ALT MON-RNG/RNGRT                *
*  RATE ERR MON-RNDZ RDR(CDR)           *
*  ATT CONT(3)-PULSE                    *
*  AGS MODE CONT-AUTO                   *
*  ACA/4JET-DISABLE(CDR)                *
*  TTCA/TRANSL-DISABLE(LMP)             *
*  ACA/4JET-DISABLE(LMP)                *
*****************************************
```

*507+0 Z-AXIS BORESIGHT
*400+2 Z-AXIS STEERING
PULSE TO NULL AGS ERRORS
POINT Z-AXIS IN DIRECTION OF CSM.
MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONTROL
R/R MODE - SLEW

```
          SLEW RATE - LO
          SLEW R/R ANT TO 0.0 ON FDAI
          VERIFY MAX SIGNAL STRENGTH
          R/R MODE-AUTO TRACK
          NO TRACK LIGHT OFF
          ATT CONT(3)-PULSE

*****************************************************
*         CHECK INSERTION VELOCITY WITH             *
*         TAPEMETER                                 *
*         COMPARE TAPEMETER WITH AGS STATE          *
*         VECTOR DATA                               *
*                                                   *
*        *317R__________RANGE(NOM 264.2)            *
*                                                   *
*        *440R__________RANGE RATE(NOM -425.1)      *
*****************************************************

          SUIT/CABIN PRESS - NOR
          GLYCOL TEMP/PRESS - NOR
          O2/H2O QUANTITY - NOMINAL

*****************************************
*                  CSI                  *
*****************************************

+3        *417+1 (RADAR FILTER INITIALIZED)
          *415+1 (NO BORESIGHT)
          *503-XXXX.X RANGE RATE

+5        *415+1 (NO BORESIGHT)
          *503-XXXX.X RANGE RATE
           BORESIGHT ON CSM
          *415+1
          *316+XXXX.X RANGE

          *410+1 CSI ROUTINE
          *373+0206.5 CSI TIME
          *275+0302.8 TPI TIME
          *605+00777 COTANGENT OF LOS TO CSM
          *416+1 (ONE-HALF ORBITAL PERIOD)
          *411+0 RCS ENGINES
          *623+0 Z-AXIS PARALLEL TO CSM ORBIT

          *310R TIME TO CSI

+43        RESET ET

          *267R__________VELOCITY TO BE GAINED CSI

          *402R__________DELTA H

          *371R__________DELTA V CDH
```

*372R_____DFLTA T CSI/CDH

-42 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-40 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-37 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-35 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-32 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

*31UR TIME TO CSI

RESET ET

*415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-30* COPY ROOT FOR 1ST CSI BU

BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-27 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

*267R_____VELOCITY TO BE GAINED CSI

*402R_____DELTA H

*371R_____DFLTA V CDH

*372R_____DELTA T CSI/CDH

-25 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-22 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

*415+1 (NO BORESIGHT)

*503-XXXX.X RANGE RATE

-20* COPY RDOT FOR 2ND CSI BU

BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

TEMP/PRESS MON SEL - FUEL MAN
A AND B PRESS 181 +-3 PSIG
TEMP/PRESS MON SEL - PRPLNT
A AND B TEMP IND 40DEG TO 100DEG F
A AND B PRESS IND 181 +-3 PSIA
TEMP/PRESS MON SEL - HEL

A AND B PRESS IND_____PSIA

A QUANTITY IND_____PERCENT REMAINING

B QUANTITY IND_____PERCENT REMAINING
TEMP MON SEL RCS QUAD 1, 4, 2, 3 (120 - 190 DEG F)

-17 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-15 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

(LOS OF MSFN)
S-BAND - SLEW TO P = +90, Y = 0
S-BAND - FWD (OR AFT)
S-BAND - DN VOICE BU
BIOMED OFF

-12 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

*267R_____VELOCITY TO BE GAINED CSI

*402R_____DELTA H

*372R_____TIME CSI/CDH

*371R_____PREDICTED VEL TO BE GAINED CDH

*263R_____OUT-OF-PLANE

*415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-10* COPY RANGE AND RDOT FOR 3RD CSI BU

BORESIGHT ON CSM
*415+1

*316+XXXX.X RANGE

COMPUTE CSI BU

-7 *415+1 NO BORESIGHT
*503-XXXX.X RANGE RATE

(TRANSMIT CSI DATA TO CSM)
VHF A XMTR - VOICE
VHF B XMTR - DATA
VHF B RCVR - OFF
TELEMETY PCM - LO

-5 *415+1 NO BORESIGHT
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

*277R_____THETA
SET ORDEAL

*317R_____RANGE

*440R_____RANGE RATE

*507+1 Z-AXIS DELTA V
*400+0 ATT HOLD
*410+5 EXTERNAL DELTA V
(LOAD SOLUTION TO BE EXECUTED)
*450 451 452
*407+0 ROTATE EXTERNAL DELTA V RF

NULL ERROR SIGNALS WITH AGS PULSE

TRANSMIT TGT DELTA V'S TO CSM AND SYNC COUNTDOWN

*502R_____DELTA VZ (NOM 50.1)

-:20 DEADBAND-MIN
(DEFLECT RHC OUT OF DETENT)
AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT
*407+1 FREEZE EXTERNAL DELTA V

SET ET COUNTING UP AT ZERO

(123:26:27) BURN +Z

NULL DELTA V'S

VERIFY AGS RESIDUALS
*500R 501R 502R
DELTA VX_____DELTA VY_____DELTA VZ_____

```
**********************************************
*                    CDH                     *
**********************************************

          ATT CONT(3)-PULSE
          AGS MODE CONT-AUTO
         *507+0 Z-AXIS BORESIGHT
         *400+2 Z-AXIS STEERING

+5       *410+2 CDH ROUTINE

          (VHF RANGING WITH CSM)
          VHF A XMTR - VOICE/RNG
          VHF B XMTR - OFF
          VHF B RCVR - ON
          TELEMETRY PCM - HI

         *411+0 THRUST ALONG Z-BODY AXIS

         *373R__________(NOM 264.4)
         *310R TIME TO CDH

-52       RESET ET

         *423R__________DESIRED ALT RATE AT CDH

         *402R__________DELTA H

         *450R__________DELTA VX

         *452R__________DELTA VZ
         *623+0 Z-AXIS PARALLEL TO CSM PLANE

         *417+1 (RADAR FILTER INITIALIZED)
-50      *415+1 (NO BORESIGHT)
         *503-XXXX.X RANGE RATE
          BORESIGHT ON CSM
         *415+1
         *316+XXXX.X RANGE

-47      *415+1 (NO BORESIGHT)
         *503-XXXX.X RANGE RATE

-45      *415+1 (NO BORESIGHT)
         *503-XXXX.X RANGE RATE
          BORESIGHT ON CSM
         *415+1
         *316+XXXX.X RANGE

-42      *415+1 (NO BORESIGHT)
         *503-XXXX.X RANGE RATE

-40      *415+1 (NO BORESIGHT)
         *503-XXXX.X RANGE RATE
```

```
            BORESIGHT ON CSM
           *415+1
           *316+XXXX.X RANGE


     **********************************
     *          PLANE  CHANGE         *
     **********************************


           *415+1 (NO BORESIGHT)
           *503-XXXX.X RANGE RATE

-36*        COPY RDOT FOR 1ST CDH BU

-35         BORESIGHT ON CSM
           *415+1
           *316+XXXX.X RANGE

           *507+1 Z-AXIS DELTA V
           *400+0 ATT HOLD
           *410+5 EXTERNAL DELTA V
            (COPY YDOT FROM CSM AND LOAD NEGATIVE IN 451)
           *450+0  451  452+0
           *407+0 ROTATE EXTERNAL DELTA V RF

            NULL ERROR SIGNALS WITH AGS PULSE

-:2U        DEADBAND-MIN
            (DEFLECT RHC OUT OF DETENT)
            AGS MODE CONT-ATT HOLD
            ATT CONT(3)-MODE CONT
           *407+1 FREEZE EXTERNAL DELTA V


-30         NULL DELTA V'S


            ATT CONT(3)-PULSE
            AGS MODE CONT-AUTO
           *507+0 Z-AXIS BORESIGHT
           *400+2 Z-AXIS STEERING

           *410+2 CDH ROUTINE

           *373R_____(NOM 264.4)
           *31UR TIME TO CDH

           *423R_____DESIRED ALT RATE AT CDH

           *402R_____DELTA H

           *450R_____DELTA VX

           *452R_____DELTA VZ
```

*417+1 (RADAR FILTER INITIALIZED)

-27 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-25 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

(AOS OF MSFN)
S-BAND - SLEW TO P =____, Y =____
ACQUIRE HGA LOCK ON
VOICE - BU/VOICE -- VOICE
VERIFY VOICE, TLM
BIOMED - LEFT (OR RIGHT)

*415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-23* COPY RDOT FOR 2ND CDH BU

TEMP/PRESS MON SEL - FUEL MAN
A AND B PRESS 181 +-3 PSIG
TEMP/PRESS MON SEL - PRPLNT
A AND B TEMP IND 40DEG TO 100DEG F
A AND B PRESS IND 181 +-3 PSIA
TEMP/PRESS MON SEL - HEL

A AND B PRESS IND_____PSIA

A QUANTITY IND_____PERCENT REMAINING

B QUANTITY IND_____PERCENT REMAINING
TEMP MON SEL RCS QUAD 1, 4, 2, 3 (120 - 190 DEG F)

SUIT/CABIN PRESS - NOR
GLYCOL TEMP/PRESS - NOR
O2/H2O QUANTITY - NOMINAL

-20 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-17 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-15 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-12 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

*415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-10* COPY RDOT FOR 3RD CDH BU

BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

COMPUTE CDH BU

-7 *415+1 NO BORESIGHT
*503-XXXX.X RANGE RATE

-5 *415+1 NO BORESIGHT
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

*277R_____THETA
SET ORDEAL

*317R_____RANGE

*440R_____RANGE RATE

*507+1 Z-AXIS DELTA V
*400+0 ATT HOLD
*410+5 EXTERNAL DELTA V
(LOAD SOLUTION TO BE EXECUTED)
*450 451 452
*407+0 ROTATE EXTERNAL DELTA V RF

NULL ERROR SIGNALS WITH AGS PULSE

TRANSMIT TGT DELTA V'S TO CSM AND SYNC COUNTDOWN

*500R_____DELTA VX (NOM -0.3)

*502R_____DELTA VZ (NOM 6.0)

-:20 DEADBAND-MIN
(DEFLECT RHC OUT OF DETENT)
AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT
*407+1 FREEZE EXTERNAL DELTA V

SET ET COUNTING UP AT ZERO

(124:24:25) NULL DELTA V'S

VERIFY AGS RESIDUALS
*500R 501R 502R

DELTA VX_____DELTA VY_____DELTA VZ_____

****
* TPI *
****

ATT CONT(3)-PULSE
AGS MODE CONT-AUTO
*507+0 Z-AXIS BORESIGHT
*400+2 Z-AXIS STEERING

*417+1 (RADAR FILTER INITIALIZED)
*415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

+3 *410+3 TPI SEARCH ROUTINE
*307+043.00 DELTA T TRANSFER
*310+034.00 TFI TPI

*303R_____THETA AT TPI
*410+4 (WHEN 303 = 26.60 DEG)

*310R_____TFI TPI

RESET ET

*267R_____DELTA V TPI

*371R_____DELTA V TPI + DELTA V TPF

-32 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-30 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-27 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

-25 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-22 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

*410+3 TPI SEARCH ROUTINE
*307+043.00 DELTA T TRANSFER
-21 *310+021.00 TFI TPI

*303R_____THETA AT TPI
*410+4 (WHEN 303 = 26.60 DEG)

*310R_____TFI TPI

RESET ET

*267R_____DELTA V TPI

*371R_____DELTA V TPI + DELTA V TPF

-20 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-17 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

TEMP/PRESS MON SEL - FUEL MAN
A AND B PRESS 181 +-3 PSIG
TEMP/PRESS MON SEL - PRPLNT
A AND B TEMP IND 40DEG TO 100DEG F
A AND B PRESS IND 181 +-3 PSIA
TEMP/PRESS MON SEL - HEL

A AND B PRESS IND_____PSIA

A QUANTITY IND_____PERCENT REMAINING

B QUANTITY IND_____PERCENT REMAINING
TEMP MON SEL RCS QUAD 1, 4, 2, 3 (120 - 190 DEG F)

SUIT/CABIN PRESS - NOR
GLYCOL TEMP/PRESS - NOR
O2/H2O QUANTITY - NOMINAL

-15 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

-12 *415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE

*410+3 TPI SEARCH ROUTINE
*307+043.00 DELTA T TRANSFER
-11 *310+011.00 TFI TPI

*303R_____THETA AT TPI
*410+4 (WHEN 303 = 26.60 DEG)

*277R_____THETA
SET ORDEAL

*310R_____TFI TPI

RESET ET

*267R_____DELTA V TPI

*371R_____DELTA V TPI + DELTA V TPF

TRANSMIT TIG OF TPI TO CSM

-9* *277R COPY TGT LOS ANGLE

-7 *415+1 NO BORESIGHT
*503-XXXX.X RANGE RATE

*404+0 405+0 406+0
(MONITOR 470 471 472)

*415+1 NO BORESIGHT
*503-XXXX.X RANGE RATE

-5* *277R COPY TGT LOS ANGLE

COPY R, RDOT FROM TAPE METER FOR BU'S

BORESIGHT ON CSM
*415+1
*316+XXXX.X RANGE

*373R_____TIG TPI

*267R_____DELTA V TPI

COMPUTE TPI BU

*371R_____DELTA V TPI + DELTA V TPF

*507+1 Z-AXIS DELTA V
*400+0 ATT HOLD
*410+5 EXTERNAL DELTA V
(LOAD SOLUTION TO BE EXECUTED
*450 451 452
*407+0 ROTATE EXTERNAL DELTA V RF

NULL ERROR SIGNALS WITH AGS PULSE

COPY CSM TPI SOLUTION AND SYNC COUNTDOWN WITH CSM

*500R_____DELTA VX (NOM -11.5)

*502R_____DELTA VZ (NOM 22.9)

-:20 DEADBAND-MIN
(DEFLECT RHC OUT OF DETENT)
AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT

*407+1 FREEZE EXTERNAL DELTA V

SET ET COUNTING UP AT ZERO

(125:02:46) BURN +Z

VERIFY AGS RESIDUALS
*500R 501R 502R
DELTA VX_____DELTA VY_____DELTA VZ_____

****
* MCC1 *
****

ATT CONT(3)-PULSE
AGS MODE CONT-AUTO
*507+0 Z-AXIS BORESIGHT
*400+2 Z-AXIS STEERING

(LOS OF MSFN)
S-BAND - SLEW TO P = +90, Y = 0
S-BAND - FWD (OR AFT)
S-BAND - DN VOICE BU
BIOMED OFF

*404+0 405+0 406+0

+9* *277R COPY TGT LOS ANGLE

+13* *277R COPY TGT LOS ANGLE

COPY R, RDOT FROM TAPE METER FOR BU'S

COMPUTE MCC1 BU

+14.40 DEADBAND-MIN
(DEFLECT RHC OUT OF DETENT)
AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT
*400+0 ATT HOLD
*470R 471R 472R

+15 NULL DELTA V S

****
* MCC2 *
****

ATT CONT(3)-PULSE
AGS MODE CONT-AUTO
*404+0 405+0 406+0

+24* *277R COPY TGT LOS ANGLE

+28* *277R COPY TGT LOS ANGLE

COPY R, RDOT FROM TAPE METER FOR BU'S

COMPUTE MCC2 BU

+29,40 DEADBAND-MIN
(DEFLECT RHC OUT OF DETENT)
AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT
*470R 471R 472R

+30 NULL DELTA V S

ATT CONT(3)-PULSE
VERIFY TAPE METER WITH AGS

LOS CONTROL

****
* BRAKING GATE *
* 30 FPS - 6000 FT *
* 20 FPS - 3000 FT *
* 10 FPS - 1500 FT *
* 5 FPS - 600 FT *
****

RENDEZVOUS

STATION KEEPING

6.0 ONBOARD RENDEZVOUS CHARTS

Charts 6.1 thru 6.6 are the nominal onboard rendezvous charts for Mission G

R1	F1	$\dot{R}2$	F2	$\dot{R}3$	F3	R3	F4
-240 0	247.3	-140.0	254.7	-70.0	72.4	120 0	15.2
-241.0	248.4	-141.0	256.6	-71.0	73 4	121.0	15.5
-242.0	249.4	-142.0	258.4	-72.0	74 4	122.0	15.7
-243.0	250.5	-143 0	260.2	-73.0	75 5	123.0	15.9
-244.0	251.5	-144.0	262.1	-74.0	76.5	124.0	16.1
-245.0	252.5	-145.0	263.9	-75.0	77.5	125.0	16.3
-246.0	253.6	-146.0	265 7	-76.0	78.6	126.0	16.5
-247.0	254.6	-147.0	267.6	-77.0	79 6	127.0	16.7
-248.0	255.7	-148.0	269 4	-78.0	80.6	128.0	16.9
-249.0	256.7	-149 0	271 3	-79.0	81.7	129.0	17 1
-250.0	257.8	-150.0	273.1	-80 0	82.7	130 0	17.3
-251.0	258.8	-151.0	274.9	-81.0	83.7	131 0	17.5
-252.0	259.9	-152.0	276 8	-82 0	84.8	132.0	17.7
-253.0	260.9	-153.0	278.6	-83.0	85.8	133.0	17.9
-254.0	262.0	-154.0	280.4	-84.0	86.9	134 0	18.1
-255.0	263.0	-155.0	282.3	-85.0	87.9	135 0	18.4
-256 0	264.1	-156.0	284.1	-86.0	88.9	136.0	18.6
-257 0	265.1	-157 0	286.0	-87.0	90.0	137 0	18.8
-258 0	266.2	-158 0	287.8	-88.0	91.0	138.0	19.0
-259 0	267.2	-159.0	289.7	-89 0	92.0	139.0	19.2
-260.0	268.3	-160 0	291.5	-90.0	93.1	140.0	19 4
-261.0	269.3	-161.0	293.4	-91 0	94.1	141 0	19.6
-262.0	270.4	-162.0	295 2	-92.0	95 2	142.0	19.8
-263.0	271.4	-163.0	297.0	-93.0	96.2	143.0	20.0
-264 0	272 5	-164.0	298.9	-94.0	97.2	144.0	20.2
-265.0	273 5	-165.0	300 7	-95 0	98.3	145 0	20.5
-266.0	274.6	-166.0	302.6	-96.0	99.3	146.0	20.7
-267.0	275.7	-167.0	304.4	-97.0	100.4	147 0	20.9
-268.0	276.7	-168.0	306.3	-98.0	101.4	148.0	21.1
-269.0	277.8	-169 0	308.1	-99.0	102.4	149.0	21 3
-270.0	278.8	-170 0	310 0	-100.0	103.5	150.0	21.5
-271.0	279.9	-171.0	311 9	-101.0	104 5	151 0	21.7
-272.0	281.0	-172 0	313.7	-102.0	105.6	152.0	21.9
-273.0	282.0	-173.0	315 6	-103.0	106 6	153.0	22.1
-274.0	283.1	-174 0	317.4	-104.0	107.7	154.0	22 4
-275.0	284.2	-175.0	319.3	-105.0	108.7	155 0	22.6
-276.0	285.2	-176.0	321 1	-106.0	109.7	156.0	22.8
-277.0	286.3	-177.0	323 0	-107.0	110 8	157.0	23.0
-278.0	287.4	-178.0	324.9	-108.0	111.8	158 0	23.2
-279.0	288.4	-179.0	326.7	-109.0	112.9	159.0	23 4
-280.0	289.5	-180.0	328 6	-110.0	113.9	160 0	23.6
-281.0	290 6	-181.0	330 4	-111.0	115 0	161.0	23.8

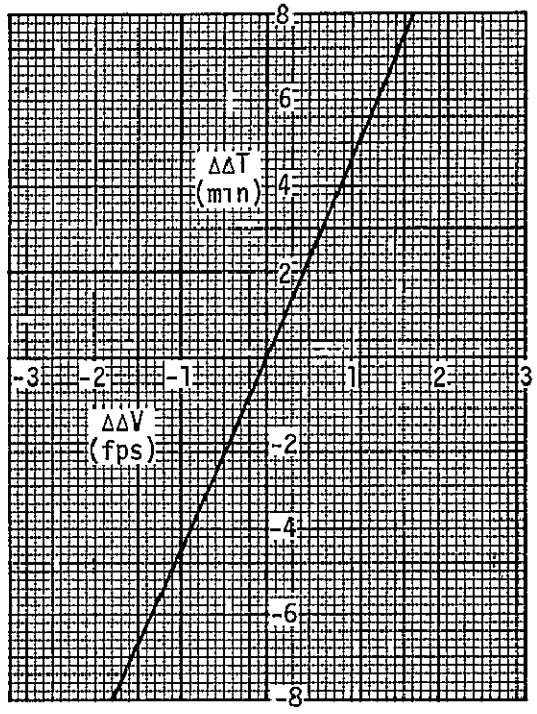
CSI BACKUP TABLE
MISSION G

TIME (Min)		NOMINAL
-30 $\dot{R}1$	_____	(-283.3)
-20 $\dot{R}2$	_____	(-173.9)
-10 $\dot{R}3$	_____	(- 94.0)
-10 R3	_____	(154.1)
F1	_____	(293.0)
+F3	_____	(97.2)
	_____	(390.2)
-F2	_____	(-317.3)
	_____	(72.9)
-F4	_____	(- 22.4)
	_____	(50.5)
+ VCSI	_____	(0.0)
VCSI	[ ]	(50.5)

PREPARED by FPrB/OPS

MISSION APOLLO 11, MAY 16, 1969

R1	F1	R2	F2	R3	F3	R3	F4
-282.0	291.6	-182.0	332 3	-112.0	116 0	162.0	24.0
-283.0	292.7	-183.0	334.2	-113.0	117.0	163.0	24.2
-284.0	293.8	-184 0	336 0	-114.0	118.1	164.0	24.5
-285.0	294.8	-185.0	337.9	-115.0	119.1	165 0	24 7
-286.0	295.9	-186.0	339.8	-116 0	120 2	166 0	24.9
-287 0	297.0	-187.0	341.6	-117.0	121.2	167 0	25.1
-288.0	298.1	-188.0	343.5	-118.0	122.3	168 0	25.3
-289.0	299.2	-189 0	345.4	-119.0	123 3	169.0	25 5
-290.0	300.2	-190 0	347 2	-120 0	124.4	170.0	25.7
-291.0	301.3	-191.0	349.1	-121.0	125 4	171.0	25.9
-292 0	302.4	-192.0	351 0	-122.0	126.5	172.0	26.1
-293.0	303.5	-193.0	352 9	-123.0	127.5	173.0	26.3
-294.0	304.6	-194.0	354 7	-124.0	128 6	174.0	26.5
-295.0	305.6	-195 0	356 6	-125 0	129 6	175.0	26.7
-296.0	306.7	-196.0	358.5	-126 0	130 7	176.0	26.9
-297.0	307 8	-197.0	360.4	-127 0	131 7	177.0	27 1
-298.0	308 9	-198.0	362.2	-128 0	132 8	178 0	27 3
-299.0	310 0	-199.0	364.1	-129 0	133.8	179 0	27 5
-300.0	311.1	-200 0	366.0	-130 0	134 9	180.0	27.7
-301.0	312.2	-201 0	367 9	-131 0	135.9	181 0	27.9
-302.0	313.2	-202.0	369.8	-132.0	137.0	182 0	28.1
-303.0	314 3	-203.0	371.6	-133.0	138.0	183 0	28.3
-304.0	315 4	-204.0	373.5	-134.0	139.1	184.0	28.5
-305.0	316.5	-205.0	375.4	-135 0	140 1	185 0	28 7
-306.0	317.6	-206.0	377.3	-136.0	141.2	186.0	28 9
-307.0	318.7	-207.0	379.2	-137 0	142.2	187.0	29.1
-308.0	319.8	-208.0	381.1	-138.0	143.3	188.0	29.3
-309.0	320.9	-209.0	383.0	-139.0	144.3	189.0	29.5
-310.0	322.0	-210.0	384.9	-140.0	145 4	190.0	29 7
-311.0	323.1	-211.0	386.8	-141.0	146.4	191.0	29.9
-312.0	324 2	-212 0	388.7	-142 0	147.5	192.0	30.1
-313.0	325 3	-213.0	390 5	-143.0	148.5	193.0	30.3
-314.0	326.4	-214.0	392 4	-144 0	149 6	194.0	30.5
-315.0	327.5	-215.0	394.3	-145 0	150.7	195.0	30.7
-316.0	328.6	-216.0	396.2	-146 0	151.7	196.0	30.9
-317.0	329.7	-217 0	398.1	-147.0	152.8	197.0	31.0
-318.0	330.8	-218.0	400.0	-148.0	153.8	198.0	31.2
-319.0	331 9	-219.0	401.9	-149.0	154.9	199 0	31.4
-320.0	333.0	-220.0	403.8	-150.0	155.9	200 0	31.6
-321.0	334 1	-221.0	405 7	-151 0	157.0	201.0	31.8
-322.0	335 3	-222.0	407.7	-152.0	158.1	202.0	32 0
-323.0	336.4	-223.0	409 6	-153.0	159 1	203.0	32.2



TIG TPI ___ ___ . ___

- TIG TPI ___ . ___ ___

ΔT ___ . ___ ___

- NOM ΔT - 1 35:21

ΔΔT ___ ___

ΔVCSI

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MISSION APOLLO 11, MAY 16, 1969

RDOT	X1	Z1	X2	Z2	X3	Z3
-75.	29.7	52.6	30.6	132 0	.9	79 2
-76.	30.1	53.4	31.0	133.9	9	80.3
-77.	30.5	54.3	31.3	135.9	.9	81.5
-78.	30.8	55.1	31.7	137.9	.9	82.6
-79.	31.2	55.9	32.1	139.9	.9	83.8
-80.	31.6	56.8	32.5	141.8	.9	84.9
-81.	32.0	57.6	32.8	143.8	.9	86.1
-82.	32.4	58.4	33.2	145.8	.9	87.2
-83.	32.7	59.3	33.6	147.8	.8	88.4
-84.	33.1	60.1	33.9	149.8	.8	89.6
-85.	33.5	61.0	34.3	151.8	.8	90.7
-86.	33.9	61.8	34.7	153.8	.8	91.9
-87.	34.2	62.7	35 0	155.9	.8	93.1
-88.	34.6	63 5	35 4	157.9	.8	94.2
-89.	35.0	64.4	35.8	159.9	8	95.4
-90.	35.4	65.3	36.1	161.9	.8	96.6
-91.	35.7	66.1	36.5	164.0	.8	97.8
-92.	36.1	67.0	36.9	166.0	.8	98.9
-93.	36.5	67.9	37.2	168.1	.7	100.1
-94.	36.9	68.8	37.6	170.o	.7	101.3
-95.	37.2	69.6	38.0	172.2	.7	102.5
-96.	37.6	70.5	38.3	174.2	.7	103.7
-97	38 0	71.4	38.7	176.3	.7	104.9
-98.	38.3	72 3	39.0	178.4	.7	106.1
-99.	38.7	73.2	39.4	180.5	.6	107.3
-100.	39.1	74.1	39 8	182.6	.6	108.5
-101	39.5	75.0	40.1	184.7	.6	109.7
-102.	39.8	75.9	40.5	186 7	.6	110.9
-103.	40.2	76.8	40.8	188.9	.6	112.1
-104.	40.6	77.7	41.2	191.0	.6	113.3
-105.	40.9	78.6	41.5	193.1	.5	114.5
-106.	41.3	79.5	41.9	195.2	.5	115.7
-107.	41.7	80.4	42.2	197.3	.5	116.9
-108.	42.0	81.4	42.6	199.4	.5	118.2
-109.	42.4	82.3	42.9	201.6	.5	119.4
-110.	42.8	83.2	43.3	203.7	.4	120.6
-111.	43.1	84.2	43.6	205.9	.4	121.8
-112.	43.5	85.1	44.0	208 0	.4	123.0
-113.	43.9	86.0	44.3	210.2	.4	124.3
-114.	44 2	87.0	44.7	212.3	.4	125.5
-115.	44.6	87.9	45.0	214.5	.3	126.7
-116.	45.0	88.9	45.4	216 7	.3	128.0
-117.	45.3	89.8	45.7	218.8	.3	129.2

CDH BACKUP TABLE
MISSION G

TIME (MIN)		NOMINAL	
-36 R1		(-122.21)	
-23 R2		(-122 68)	
-10 R3		(-122.87)	
VX-	X1	(47.2)	
	+X3	(0.1)	
		(47.3)	
	-X2	(-47.7)	
	VX	(- 0 4)	FPS
VZ.	Z2	(231.3)	
	-Z1	(-94.8)	
		(136.5)	
	-Z3	(-136.5)	
	VZ	(0.0)	FPS

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MISSION APOLLO 11, MAY 16, 1969

RDOT	X1	Z1	X2	Z2	X3	Z3
-118	45.7	90.8	46 1	221 0	.3	130.5
-119.	46 1	91.7	46 4	223.2	.2	131.7
-120.	46.4	92.7	46.7	225.4	.2	132.9
-121.	46 8	93.6	47.1	227.6	.2	134 2
-122.	47.1	94.6	47.4	229.8	2	135 4
-123.	47.5	95.6	47.8	232.0	.1	136.7
-124.	47.9	96.5	48.1	234.2	.1	137.9
-125.	48.2	97.5	48 4	236.4	.1	139.2
-126.	48.6	98.5	48 8	238.6	.0	140.5
-127.	48.9	99 5	49 1	240.9	0	141 7
-128.	49 3	100.5	49.5	243.1	-.0	143.0
-129.	49.7	101.5	49.8	245.3	- 0	144 3
-130.	50.0	102.4	50.1	247.6	- 1	145.5
-131.	50.4	103.4	50.5	249.8	-.1	146 8
-132.	50.7	104.4	50.8	252.1	-.1	148.1
-133.	51.1	105.4	51.1	254 4	-.2	149.3
-134	51.5	106.4	51.4	256 6	-.2	150.6
-135.	51.8	107.4	51.8	258.9	-.2	151 9
-136.	52.2	108.5	52.1	261.2	- 3	153 2
-137.	52.5	109.5	52.4	263.4	-.3	154 5
-138.	52.9	110.5	52 8	265.7	-.3	155.8
-139.	53.2	111.5	53 1	268.0	-.4	157 0
-140.	53.6	112.5	53.4	270.3	-.4	158 3
-141.	53 9	113.6	53 7	272.6	-.4	159.6
-142.	54.3	114.6	54.1	274.9	- 5	160.9
-143.	54.6	115.6	54.4	277.2	-.5	162.2
-144.	55.0	116 6	54.7	279.6	-.5	163.5
-145.	55.3	117 7	55.0	281.9	-.6	164.8
-146	55.7	118.7	55.3	284.2	-.6	166.1
-147.	56.1	119.8	55.7	286.5	-.7	167.4
-148	56 4	120.8	56.0	288.9	-.7	168.8
-149.	56.8	121.9	56.3	291.2	- 7	170.1
-150	57.1	122.9	56.6	293.6	- 8	171.4
-151.	57.5	124 0	56.9	295.9	-.8	172.7
-152	57.8	125 0	57 3	298.3	-.9	174.0
-153.	58.2	126.1	57.6	300 7	-.9	175.3
-154	58.5	127.2	57.9	303.0	- 9	176.7
-155.	58.8	128.2	58.2	305.4	-1.0	178.0
-156.	59.2	129.3	58.5	307.8	-1.0	179 3
-157.	59.5	130.4	58 8	310.2	-1.1	180.7
-158.	59.9	131 5	59 1	312.6	-1.1	182 0
-159.	60.2	132.6	59.4	315.0	-1 2	183.3

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MISSION APOLLO 11, MAY 16, 1969

G MISSION TERMINAL PHASE INITIATION

PREPARED BY FPRB/OPS

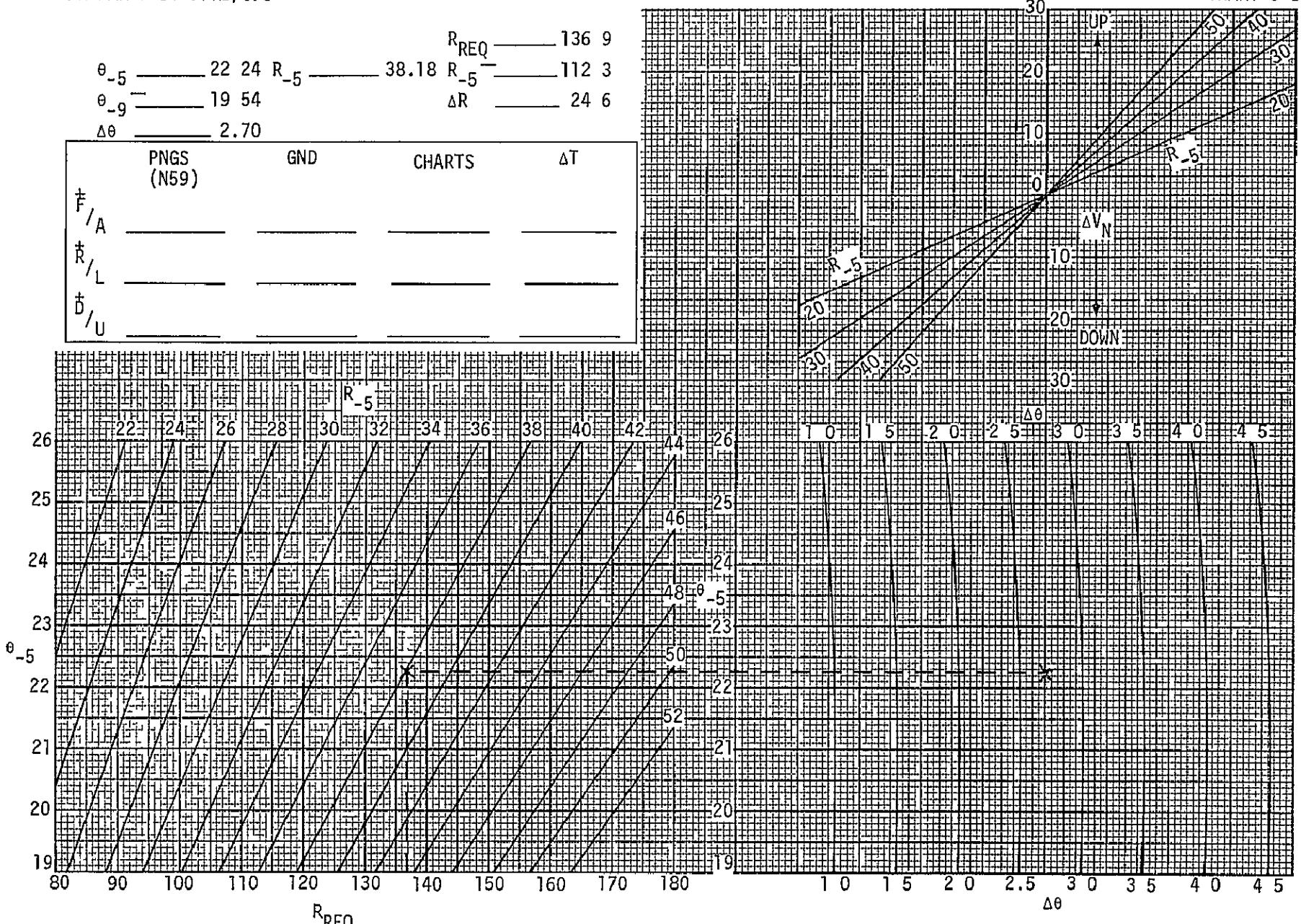
CHART 6 3

θ_{-5} _____ 22 24 R_{-5} _____ 38.18 R_{REQ} _____ 136 9

θ_{-9} _____ 19 54 R_{-5} _____ 112 3

$\Delta\theta$ _____ 2.70 ΔR _____ 24 6

	PNGS (N59)	GND	CHARTS	ΔT
$\dot{F}/A$				
$\dot{R}/L$				
$\dot{D}/U$				



MISSION APOLLO 11, MAY 16, 1969

G MISSION FIRST MIDCOURSE CORRECTION

CHART 6 4

PREPARED BY FPRB/OPS

θ_{13} 43.28 R_{13} 17.23

θ_9 37 24

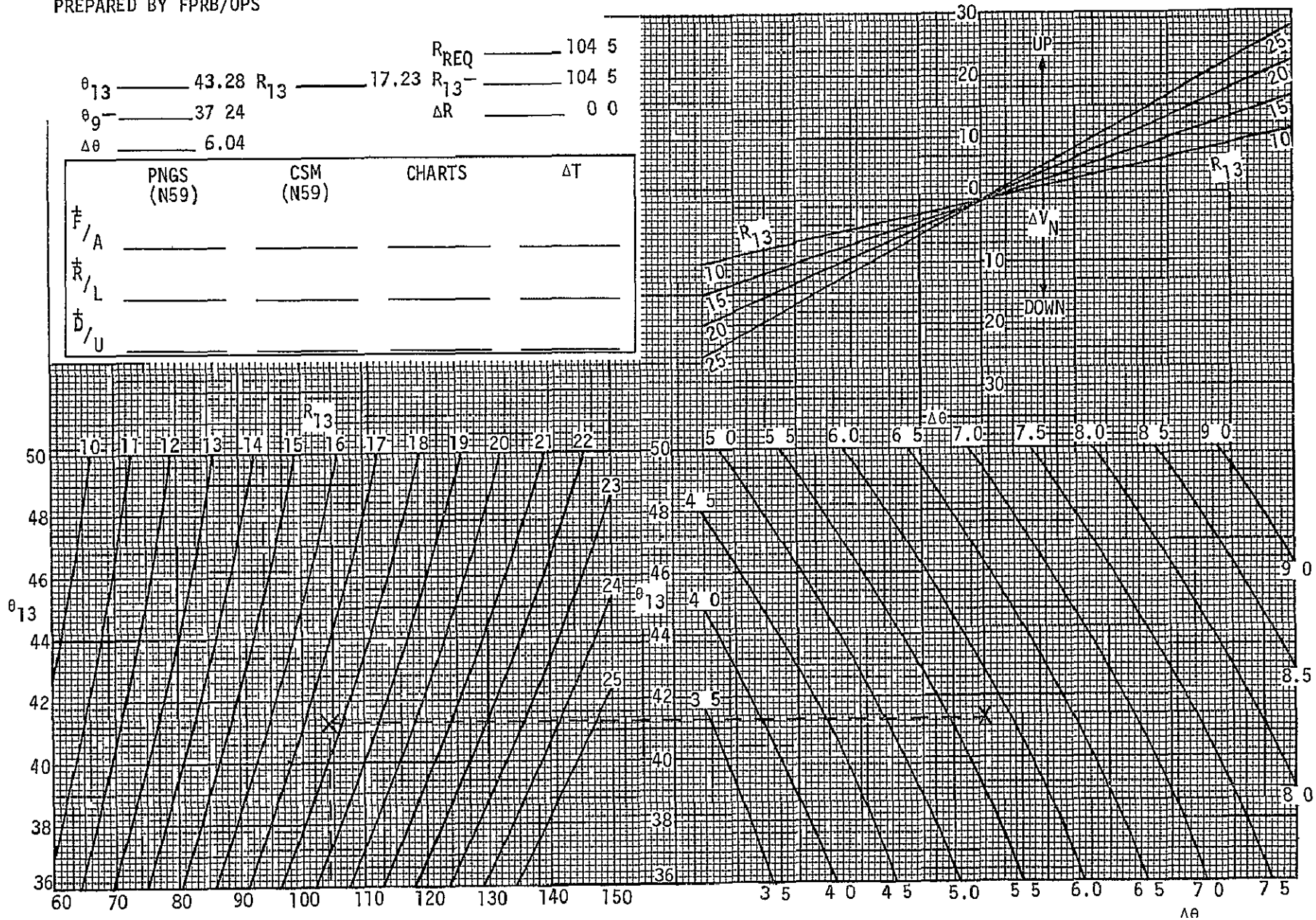
$\Delta\theta$ 6.04

R_{REQ} 104 5

R_{13} 104 5

ΔR 0 0

	PNGS (N59)	CSM (N59)	CHARTS	ΔT
$\dot{F}/A$				
$\dot{R}/L$				
$\dot{D}/U$				



G MISSION SECOND MIDCOURSE CORRECTION

CHART 6.5

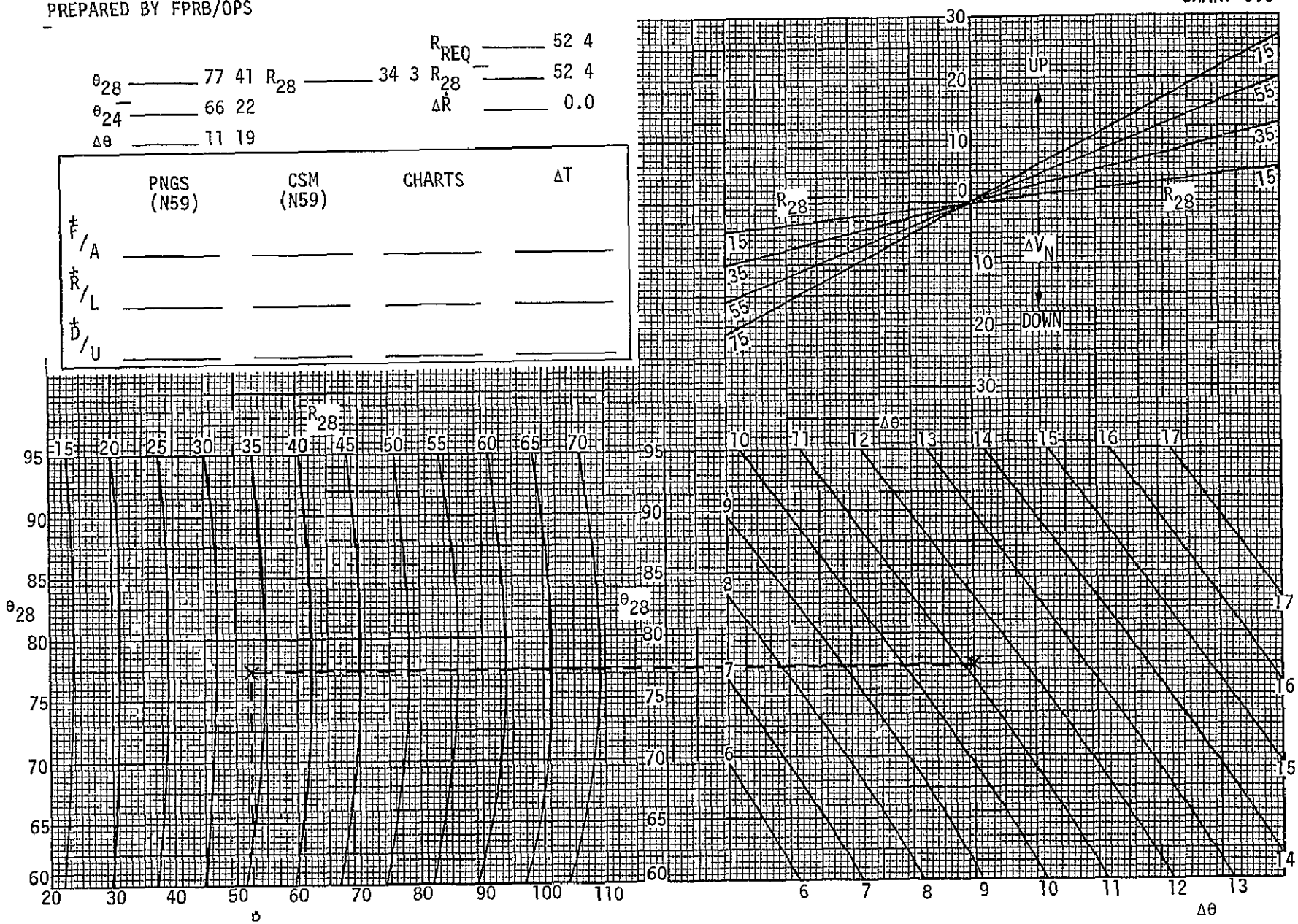
PREPARED BY FPRB/OPS

θ_{28} _____ 77 41 R_{28} _____ 34 3 R_{REQ} _____ 52 4

θ_{24} _____ 66 22 R_{28} _____ 52 4

$\Delta\theta$ _____ 11 19 $\Delta\dot{R}$ _____ 0.0

	PNGS (N59)	CSM (N59)	CHARTS	ΔT
$\overset{+}{F}/_A$				
$\overset{+}{R}/_L$				
$\overset{+}{D}/_U$				



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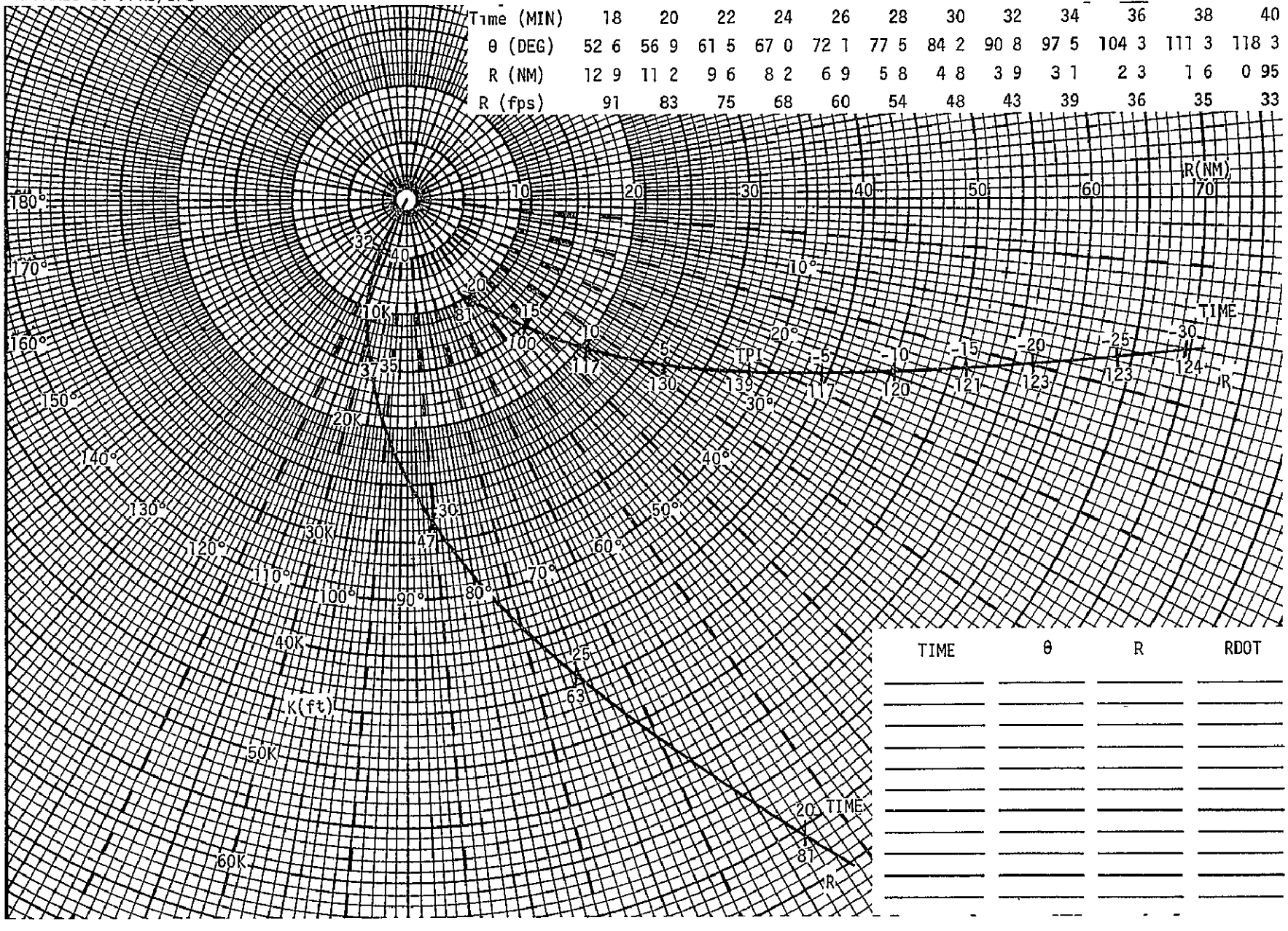
G MISSION RELATIVE REFERENCE TRAJECTORY

CHART 6 6

Time (MIN)	18	20	22	24	26	28	30	32	34	36	38	40
θ (DEG)	52 6	56 9	61 5	67 0	72 1	77 5	84 2	90 8	97 5	104 3	111 3	118 3
R (NM)	12 9	11 2	9 6	8 2	6 9	5 8	4 8	3 9	3 1	2 3	1 6	0 95
R (fps)	91	83	75	68	60	54	48	43	39	36	35	33



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