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LM RENDEZVOUS PROCEDURES

F MISSION

FINAL
REVISION A

Flight Procedures Branch

FLIGHT CREW SUPPORT DIVISION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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RENDEZVOUS PROCEDURES

F MISSION

AS-505/CSM-106/LM-4

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TABLE OF CONTENTS

1.0   Purpose

This document contains the primary procedures for the post-phasing-maneuver portion of the LM-4 active rendezvous with the CSM-106 spacecraft and is based on data obtained from the Mission Planning and Analysis Division on April 4, 1969, concerning a May 18, 1969, launch trajectory.

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

2.0   <u>Major Events</u>

The post-phasing maneuver portion of the LM-4/CSM-106

rendezvous occurs between the times of 100 hours and

107 hours G.E.T.   The procedures for this period are

presented in Section 3.0 and cover all major activities

immediately following the phasing maneuver.

Figure 2-1 shows the LM attitude time history and the

locations in time and position of the 40 major events of

the nominal mission.

3.0   Nominal Mission Procedures

The procedures included in this section do not

specify which crewmember, Commander or LM Pilot,

performs each listed task. These need not be

specified since the following basic rules define

which crewmember performs each task. These rules

are:

COMMANDER (CDR):

1. All attitude changes, whether manual or auto-

    matic, will be accomplished by the CDR.

2. The operation of the DSKY during thrust pro-

    grams (P40, P41, P42, P47) will be done by

    the CDR. Actual manipulation of the Translation

    Thrust Control Assembly (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.

LM PILOT (LMP) 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 cnly, and may be
deviated from by the LM crew if they develop more
efficient Task assignments.

The abbreviations used herein are consistent 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 + or - sign, a data load is indicated. When a single digit follows the +, addition of 4 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, re 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 33 102:43:18 TIG INSERTION

Expanded, this means; Load flashing verb 06 noun 33

with the quantity 102 hours, 43 minutes and 18

seconds; the time of ignition of the insertion

maneuver. Procedurally, this is done by keying

verb 25 enter, loading +00102 in register 1, +00043

in register 2, and +01800 in register 3.

In order to maintain integrated correction flexibility

and ease of reproduction, the procedures have been

incorporated into a computer card deck and are pre-

sented as a computer printout beginning on Page 3-6.
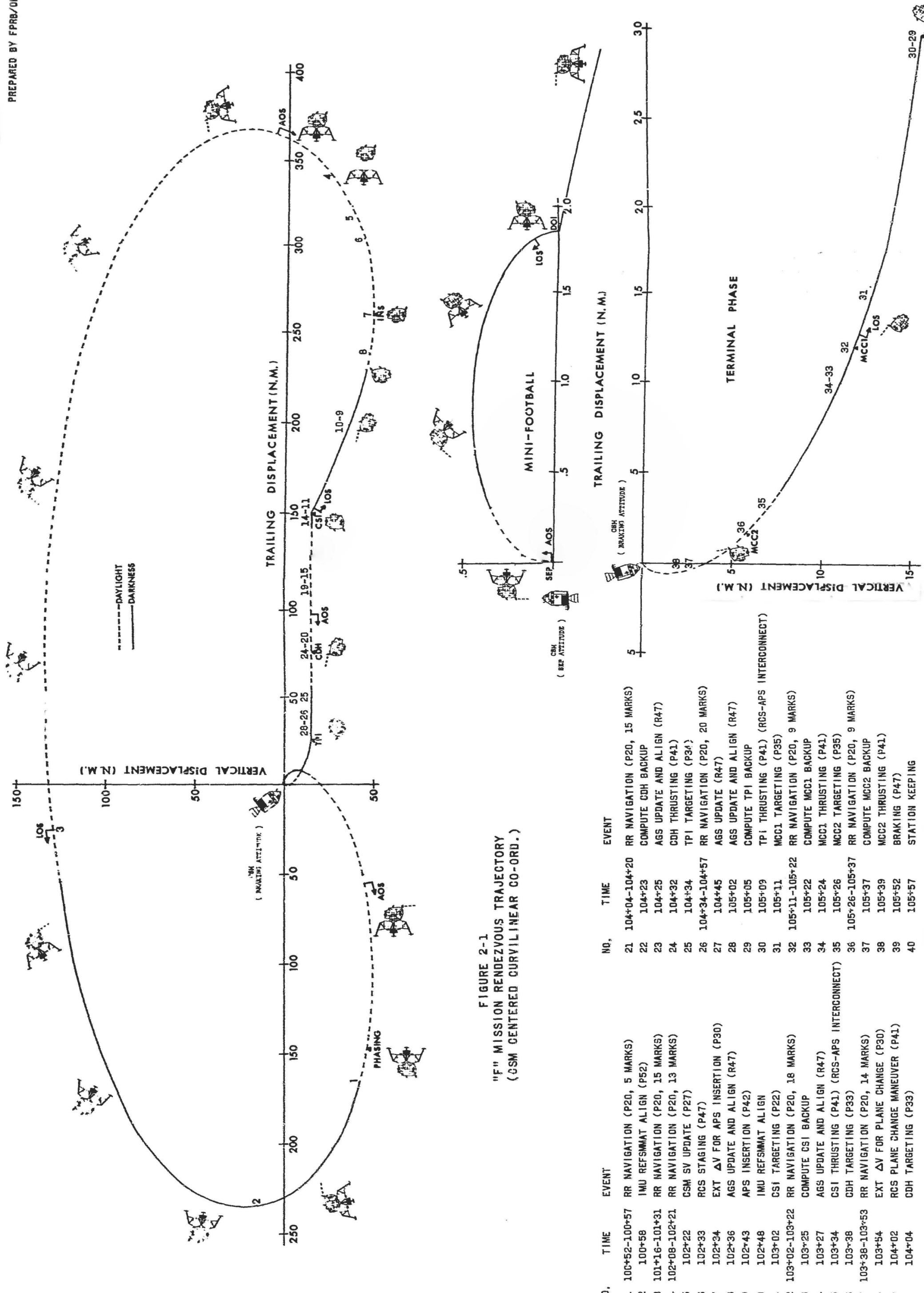
FIGURE 2-1
"F" MISSION RENDEZVOUS TRAJECTORY
(CSM CENTERED CURVILINEAR CO-ORD.)

NO.	TIME	EVENT
1	100+52-100+57	RR NAVIGATION (P20, 5 MARKS)
2	100+58	IMU REFSMMAT ALIGN (P52)
3	101+16-101+31	RR NAVIGATION (P20, 15 MARKS)
4	102+08-102+21	RR NAVIGATION (P20, 13 MARKS)
5	102+22	CSM SV UPDATE (P27)
6	102+33	RCS STAGING (P47)
7	102+34	EXT ΔV FOR APS INSERTION (P30)
8	102+36	AGS UPDATE AND ALIGN (R47)
9	102+43	APS INSERTION (P42)
10	102+48	IMU REFSMAT ALIGN
11	103+02	CSI TARGETING (P22)
12	103+02-103+22	RR NAVIGATION (P20, 18 MARKS)
13	103+25	COMPUTE CSI BACKUP
14	103+27	AGS UPDATE AND ALIGN (R47)
15	103+34	CSI THRUSTING (P41) (RCS-APS INTERCONNECT)
16	103+38	CDH TARGETING (P33)
17	103+38-103+53	RR NAVIGATION (P20, 14 MARKS)
18	103+54	EXT ΔV FOR PLANE CHANGE (P30)
19	104+02	RCS PLANE CHANGE MANEUVER (P41)
20	104+04	CDH TARGETING (P33)
21	104+04-104+20	RR NAVIGATION (P20, 15 MARKS)
22	104+23	COMPUTE CDH BACKUP
23	104+25	AGS UPDATE AND ALIGN (R47)
24	104+32	CDH THRUSTING (P41)
25	104+34	TPI TARGETING (P34)
26	104+34-104+57	RR NAVIGATION (P20, 20 MARKS)
27	104+45	AGS UPDATE (R47)
28	105+02	AGS UPDATE AND ALIGN (R47)
29	105+05	COMPUTE TPI BACKUP
30	105+09	TPI THRUSTING (P41) (RCS-APS INTERCONNECT)
31	105+11	MCC1 TARGETING (P35)
32	105+11-105+22	RR NAVIGATION (P20, 9 MARKS)
33	105+22	COMPUTE MCC1 BACKUP
34	105+24	MCC1 THRUSTING (P41)
35	105+26	MCC2 TARGETING (P35)
36	105+26-105+37	RR NAVIGATION (P20, 9 MARKS)
37	105+37	COMPUTE MCC2 BACKUP
38	105+39	MCC2 THRUSTING (P41)
39	105+52	BRAKING (P47)
40	105+57	STATION KEEPING

ASSUMPTIONS

1. TRANSFER COMPLETE
2. SYSTEMS CHECKS COMPLETE
3. PGNS ACTIVATED
4. AGS ON AND SELF TESTED
5. RCS PRESSURIZATION AND TEST FIRING COMPLETE
6. RNDZ RDR SELF TEST COMPLETE
7. PHASING MANEUVER COMPLETE

GUID CONT-PGNS
MODE SEL-LDG RADAR
RNG/ALT MON-RNG/RNGRT
RATE ERR MON-RNDZ RDR(CDR)
ATTITUDE MON-PGNS(CDR)
RATE ERR MON-CMPTR(LMP)
ATTITUDE MON-AGS(LMP)
SHFT/TRUN-+50
X-POINTER-HI MULT
RADAR TEST SW-OFF
ENG GMBL-ENABLE
ENG ARM-OFF
X-TRANSL-2JETS
BAL CPL-ON
DEADBAND-MIN
ATT CONT-Pulse(3)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
THROT/JET-JET
IMU-ON
R/R MODE-LGC
TTCA/TRANSL(CDR)-ENABLE
ACA/4JET(CDR)-ENABLE
TTCA/TRANSL(LMP)-ENABLE
ACA/4JET(LMP)-ENABLE

```
                   KEY V82E (RNDZ PAR)
      F 04 12 00002 00001
                   PRO
      F 16 44 HA  HP  TFF
                   (VERIFY PERIGEE ALT)
                   PRO

                   KEY V79E (TERMINATE LR SPUR
                     TEST)

                   YAW RIGHT 180DEG
                   PITCH DOWN 90DEG

(100:49)           CB AC BUS A RNDZ RDR-CLOSE
                   (WAIT 30 SEC)
                   CB PGNS RNDZ RDR-CLOSE

                   KEY V37E20E (ACQUIRE RADAR)
      F 50 18 FDAI ANGLES
                   KEY V81E (UPDATE CSM SV)
                   PGNS MODE CONT-AUTO
                   PRO (AUTO MANEUVER)
          06 18

             *507+0
             *400+2 ACQ STEERING
              AGS MODE CONT-AUTO
              RATE/ERR MON-CMPTR (LMP)

      F 50 18 FDAI ANGLES
                   ENTR (BYPASS MANEUVER)
      F 50 25 00201 SEL AUTO MODE
                   RR MODE-LGC
                   PRO

                   NO TRK LT-OFF

          DSKY BLANKS

                   VERIFY MAIN LOBE LOCK-ON

+7                 KEY V16N45E
      F 16 45 MKS TFI -00001
+11(APPROX)   KEY V56E-5MKS

                   KEY V37E00E (P00)

(100:58)           KEY V41N72E (RR DESIGNATE)
      F 21 73 +000.00TRUN  +283.00SHFT
      F 04 12 00006 00002 CONTINUOUS
                   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
                    CONTINUOUS DESIGNATE)

+15                 KEY V37E52E (ALIGN)

                    CB AOT LAMP-CLOSE

         F 04 06 00001 00003 (REFSMMAT)
                  PRO
         F 50 25 00015 SELECT 1ST STAR
                  ENTR
         F 01 70 002DE LOAD STAR 1
                  PRO
         F 50 18 FDAI ANGLES
                  PGNS MODE CONT-AUTO
                  PRO (AUTO MANEUVER)
           06 18
         F 50 18 FDAI ANGLES
                  ENTR (BYPASS MANEUVER)
         F 01 71 002DE
                  PRO
+19      F 54 71 MARK 1ST STAR
                  PRO
         F 01 70 002DE LOAD 2ND STAR
                  PRO
         F 50 18 FDAI ANGLES
                  PGNS MODE CONT-AUTO
                  PRO (AUTO MANEUVER
           06 18
         F 50 18 FDAI ANGLES
                  ENTR (BYPASS MANEUVER)
         F 01 71 002DE
                  PRO
+23      F 54 71 MARK 2ND STAR
                  PRO
         F 06 05 ANGLE DIFFERENCE
                  PRO
         F 06 93 GYRO TORQUE ANGLES
                  PRO
         F 50 25 00014
                  PRO (COAS CALIBRATION)
         F 50 25 00015 SELECT 3RD STAR
                  ENTR
         F 01 70 005DE LOAD 3RD STAR
                  PRO
         F 06 87 AZ-EL CALIB ANGLES
                  (LOAD 0 CALIB ANGLES)
                  PRO
         F 50 18 FDAI ANGLES
                  PGNS MODE CONT-AUTO
                  PRO (AUTO MANEUVER)
           06 18
         F 50 18 FDAI ANGLES
```

```
                        ENTR (BYPASS MANEUVER)
+2/   F 01 71 00508
                        OBSERVE STAR IN COAS, WHEN
                          ATTITUDE ERRS ARE ZERO
                          MARK AZ-EL ANGLE ON COAS
                          DIAGRAM.
                        PRO
      F 06 87 AZ-EL CALIB ANGLES
                        PRO
                        KEY V34E TERMINATE
      F 37 00

                        CB AOT LAMP-OPEN

                        *400+3

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

(101:16)                KEY 20E (ACQUIRE RADAR)
      F 50 18 FDAI ANGLES
                        KEY V81E (UPDATE CSM SV)
                        PGNS MODE CONT-AUTO
                        PRO (AUTO MANEUVER)
      06 18

                       · *507+0
                        *400+2 ACQ STEERING
                        AGS MODE CONT-AUTO
                        RATE/ERR MON-CMPTR (LMP)

      F 50 18 FDAI ANGLES
                        ENTR (BYPASS MANEUVER)
      F 50 25 00201 SEL AUTO MODE

                        RR MODE-LGC

                        PRO

                        NO TRK LT-OFF

      DSKY BLANKS

                        VERIFY MAIN LOBE LOCK-ON

(101:18)                KEY V37E30E (EXT ΔV)

      F 06 33 _____:_____ TIG INSERTION
                        (NOM 102:43:18)
                        PRO
      F 06 81 ΔV'S-LV
                        PRO
      F 06 42 HA HP ΔV
                        PRO
      F 16 45 MKS TFI MGA
```

+34(APPROX)   V93E (REINIT W MATRIX-4MKS)

+45(APPROX)   V34E TERMINATE (11MKS)
      F 37 BB
              KEY 00E (P00)

              CB PGNS RNDZ RDR-OPEN
              CB AC BUS A RNDZ RDR-OPEN

              PERFORM PRESTAGE CHECKS

(102:07)   CB AC BUS A RNDZ RDR-CLOSE
              (WAIT 30 SEC)
              CB PGNS RNDZ RDR-CLOSE

              V37E20E (ACQUIRE RADAR)
      F 50 18 FUAI ANGLES
              KEY V81E (UPDATE CSM SV)
              PGNS MODE CONT-AUTO
              PRO (AUTO MANEUVER)
         06 18

                  *400+2 ACQ STEERING
                   AGS MODE CONT-AUTO
                   RATE/ERR MON-CMPTR (LMP)

      F 50 18 ENTR (BYPASS MANEUVER)
      F 50 25 00201 SEL AUTO MODE
              RR MODE-LGC
              PRO

              NO TRK LT-OFF

         DSKY BLANKS
              VERIFY MAIN LOBE LOCK-ON

(102:10)   KEY V37E30E (EXT ΔV)
      F 06 33 ____:____:____ TIG INSERTION
              (NOM 102:43:18)
              PRO
      F 06 81 ΔV'S-LV
              PRO
      F 06 42 HA HP ΔV
              PRO
      F 16 45 MKS TFI MGA

-31   RESET ET

-22   PRO (13 MKS)
      F 37 BB
              KEY 00E (P00)

              CB AC BUS A RNDZ RDR-OPEN
              CB PGNS RNDZ RDR-OPEN

UPLINK ACT'Y LT-ON

(P27 UPDATE)

UPLINK ACT'Y LT-OFF
F 37 BH (P00)

    YAW 180 DEG
    PITCH UP 90 DEG

-12   KEY V48E (LOAD DAP)
F 01 46 12002
    PRO
F 06 47 LMWT CMWT
    PRO

-11   KEY V57E47E (ΔV MONITOR)
F 16 85 ΔV'S-BODY

    ED:MASTER ARM-ON

    THRUST -X 2 FPS
-10   STAGE SW-FIRE
    THRUST +X 2 FPS

    FU:MASTER ARM-OFF

    PRO
F 37 BH
    KEY OUE (P00)

-9   KEY V57E30E (EXT ΔV)
F 06 33 TIG INSERTION
    PRO
F 06 81 ΔV'S-LV
            N81

    ΔVX(LV) _____ (-189.2)

    ΔVY(LV) _____ (0.0)

    ΔVZ(LV) _____ (-83.8)

    PRO
F 06 42 HA HP ΔV
    PRO
F 16 45 MKS TFI MGA
    PRO
F 37 BH
-7   KEY V47E (AGS UPDATE)
F 06 16 GET OF AGS U TIME (90:00:00)
    *414+1 UPDATE AGS
    PRO
    06 16
F 50 16 UPDATE COMPLETE
    *414R (00000 COMPLETE)

```
                          PRO
              F 37 BB

                        *400+3  AGS  ALIGN
                        *410+5  EXT  ΔV
                        *411+1  APS  ENGINE

                        *514+0
                        *515+4
                        *516+0
                        *623+1

                        *************
                        *  INSERTION  *
                        *************

-6                      KEY  42E  (APS  THRUST)
              F 50 18 FDAI ANGLES
                        KEY  V06N86E
                                    AGS(N86)

                        ΔVX(LV)

                        ΔVY(LV)

                        ΔVZ(LV)
                        KEY  RELEASE

              F 50 18 FDAI ANGLES
                        MODE  CONT-AUTO
                        PRO  (AUTO MANEUVER)
                  06 18

                        *450    451    452   LOAD
                        *407+0  (AFTER MNVR)
                        *400+1  GUID  STEERING

              F 50 18 FDAI ANGLES
                        ENTR  (BYPASS MANEUVER)
                  06 40 TFI VG DVM

                        *500RΔVX  (NOM 206.9)
                        DB-MIN
                        AGS MODE  CONT-ATT HOLD
                        ENG ARM-ON
-:35    DSKY BLANKS

-:05 F 99 40 REQUEST ENG ON

-:03.5          MONITOR ULLAGE
(102:43:18)  PRO FOR IGNITION

                  06 40 TFC VG DVM

              F 16 40 TFC VG DVM
                        ENG ARM-OFF
```

```
                      PRO
          F 16 85  ΔV'S-BODY
                                N85

                      ΔVX(LM) _____

                      ΔVY(LM) _____

                      ΔVZ(LM) _____

                      NULL ΔV'S

                      VERIFY AGS RESIDUALS
                      *500R          501R          502R
                       ΔVX _____ ΔVY _____ ΔVZ _____

                      *623+0

                      PRO
          F 37 88
                      KEY 00E (P00)

                      KEY V82E (RNDZ PAR)
          F 04 12  00002 00001
                      PRO
          F 16 44  HA    HP    TFF
                      SET ORDEAL
                      PRO

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

    +3                KEY V41N72E (RR DESIGNATE)
          F 21 73  +000.00TRUN   +283.00SHFT
          F 04 12  00006 00002 CONTINUOUS
                      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
                       CONTINUOUS DESIGNATE)

    +5                KEY V37E52E (ALIGN)

                      CB AOT LAMP-CLOSE

          F 04 06  00001 00003 (REFSMMAT)
                      PRO
          F 50 25  00015 SELECT 1ST STAR
                      ENTR
```

```
        F 01 70 002DE LOAD STAR 1
                PRO
        F 50 18 FDAI ANGLES
                PGNS MODE CONT-AUTO
                PRO (AUTO MANEUVER)
           06 18
        F 50 18 FDAI ANGLES
                ENTR (BYPASS MANEUVER)
        F 01 71 002DE
                PRO
+10     F 54 71 MARK 1ST STAR
                PRO
        F 01 70 002DE LOAD 2ND STAR
                PRO
        F 50 18 FDAI ANGLES
                PGNS MODE CONT-AUTO
                PRO (AUTO MANEUVER
           06 18
        F 50 18 FDAI ANGLES
                ENTR (BYPASS MANEUVER)
        F 01 71 002DE
                PRO
+14     F 54 71 MARK 2ND STAR
                PRO
        F 06 05 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
        F 50 18 FDAI ANGLES
                PGNS MODE CONT-AUTO
                PRO (AUTO MANEUVER)
           06 18
        F 50 18 FDAI ANGLES
                ENTR (BYPASS MANEUVER)

+17             VERIFY ALIGNMENT VIA AOT

                KEY V34E TERMINATE
        F 37 88

                CB AOT LAMP-OPEN

              *400+3

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

                KEY V37E20E (ACQUIRE RADAR)
```

F 50 18 FUAL ANGLES
KEY V8UE (UPDATE LM SV)

V93E (BEFORE 1ST MK)

PGNS MODE CONT-AUTO
PRO (AUTO MANEUVER)
06 18

*400+2 ACQ STEERING
AGS MODE CONT-AUTO
RATE/ERR MON-CMPTR (LMP)

F 50 18 FUAL ANGLES
ENTR (BYPASS MANEUVER)
F 50 25 00201 SEL AUTO MODE
RR MODE-LGC
PRO

NO TRK LT-OFF

DSKY BLANKS

VERIFY MAIN LOBE LOCK-ON

(103:02)   KEY V37E32E (CSI)

F 06 11 _____:_____:_____TIG CSI
        (NOM 103:33:47)
        PRO
F 06 55 +00001N +026.60E +130.00WT
        (CDH 180° AFTER CSI)
        PRO

F 06 37 _____:_____:_____TIG TPI
        (NOM 105:09:00)
        PRO
F 16 45 MKS TFI -00001

-31   RESET ET

-30*   READ RDOT FOR CSI BU

-29(APPROX) V32E RECYCLE-5MKS

F 06 75 ΔH ΔTCSI/CDH ΔTCDH/TPI
        PRO
F 06 81 ΔV'S-LV (CSI)
        (NOM 50.5ΔVX)
                CSI(N81)   CDH(N82)

        ΔVX(LV) _____ _____

        ΔVY(LV) _____ _____

        ΔVZ(LV) _____ _____

```
                        PRO
            F 06 82 ΔV'S-LV (CDH)
                    (NOM 0.0)
                        PRO
            F 16 45 MKS TFI -00001

-24(APPROX)   V32E RECYCLE-10MKS

            F 06 75 ΔH ΔTCSI/CDH ΔTCDH/TPI
                    PRO
            F 06 81 ΔV'S-LV (CSI)
                            CSI(N81)   CDH(N82)

                    ΔVX(LV)  _____  _____

                    ΔVY(LV)  _____  _____

                    ΔVZ(LV)  _____  _____

-20*            COPY RDOT FOR CSI BU

                    PRO
            F 06 82 ΔV'S-LV (CDH)
                    PRO
            F 16 45 MKS TFI -00001

                    KEY V90E

            F 06 16  _____:_____:_____ TIG CSI
                    (NOM 103:33:47)
                    PRO
            F 06 90 Y YDOT PS1
                            N90        CSM

                    YDOT  _____  _____

                    PRO
            F 16 45 MKS TFI -00001

-12             PRO (FINAL COMP)
            F 06 75 ΔH ΔTCSI/CDH ΔTCDH/TPI
                    PRO
            F 06 81 ΔV'S-LV (CSI)
                            CSI(N81)   CDH(N82)

                    ΔVX(LV)  _____  _____

                    ΔVY(LV)  _____  _____

                    ΔVZ(LV)  _____  _____

                    COPY YDOT FROM CSM
                    LOAD NEGATIVE IN R2

                    PRO
            F 06 82 ΔV'S-LV (CDH)
                    PRO
```

```
          F 16 45 MKS TFI MGA

-10*              COPY ROOT FOR CSI BU
                  COMPUTE CSI BU

-7                KEY V47E (AGS UPDATE)
          F 06 16 GET OF AGS 0 (90:00:00)
                  *414+1 UPDATE AGS
                  PRO
            06 16
          F 50 16 UPDATE COMPLETE
                  *414R (00000)
                  PRO

          F 16 45 MKS TFI MGA

                  *400+3 AGS ALIGN
                  *410+5 EXTERNAL ΔV
                  *411+0 RCS ENGINE

                  PRO
          F 37 00
                  KEY 00E (POO)

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

-6                KEY V37E41E (RCS THRUST)
          F 50 18 FDAI ANGLES

                  KEY V06N86E ΔV'S-LV
          F 06 86 ΔV'S-LV
                          AGS(N86)      CHART

                  ΔVX(LV) _____  _____

                  ΔVY(LV) _____

                  ΔVZ(LV) _____

                  KEY RELEASE

          F 50 18 FDAI ANGLES
                  PGNS MODE CONT-AUTO
                  PRO (AUTO MANEUVER)
            06 18 FDAI ANGLES

                  *450, 451, 452 LOAD
                  *407+0 (AFTER MNVR)
                  *400+1 GUID STEERING

                  TRANSMIT TGT ΔV'S TO CSM
                  AND SYNC COUNTDOWN

          F 50 18 FDAI ANGLES
                  ENTR (BYPASS MANEUVER)
```

```
            16 85 ΔV'S-BODY

                  *500R ΔVX ( 50.5 NOM)
                  DB-MIN
                  AGS MODE CONT-ATT HOLD

-:35     DSKY BLANKS

         F 16 85 ΔV'S-BODY

(103:33:47)  BURN +X

+:45                USE RCS/ASC FEED

                    VERIFY AGS RESIDUALS
                    *500R      501R       502R
                    ΔVX _____ ΔVY _____ ΔVZ _____

                    PRO
         F 37 88
                    KEY 00E (P00)

                    KEY V82E (RNDZ PAR)
         F 04 12 00002 00001
                    PRO
         F 16 44 APO   PER   TFF
                    RESET ORDEAL
                  · PRO

(103:35)            KEY V21N01E
                    KEY 2000E
                    KEY 1142E (2000 FT)
                    KEY N15E
                    KEY 144E (2 FPS)
                    KEY ENTR
                    KEY 5075E (5 MR)
                    KEY ENTR
                    KEY 5075E (5 MR)

                    KEY V37E20E (ACQUIRE RADAR)
         F 50 18 FDAI ANGLES
                    PGNS MODE CONT-AUTO
                    PRO (AUTO MANEUVER)
            06 18 FDAI ANGLES

                    *507+0
                    *400+2 ACQ STEERING
                    AGS MODE CONT-AUTO
                    RATE/ERR MON-CMPTR (LMP)

         F 50 18 FDAI ANGLES
                    ENTR (BYPASS MANEUVER)
         F 50 25 00201 SEL AUTO MODE
                    RR MODE-LGC
                    PRO

                    NO TRK LT-OFF
```

DSKY BLANKS

VERIFY MAIN LOBE LOCK-ON

(103:39)   KEY V37E33E (CDH)
     F 06 13 _____:_____:_____TIG CDH
             (NOM 104:31:44)
             PRO
     F 16 45 MKS TFI -00001

             V93E (REINIT W MATRIX-4MKS)
+7(APPROX)   KEY V32E RECYCLE

     F 06 75 ΔHCDH ΔTCDH/TPI ΔTTPI/TPI
             PRO
     F 06 81 ΔVCDH-LV
                     CDH(N81)

             ΔVX(LV) _____

             ΔVY(LV) _____

             ΔVZ(LV) _____

             PRO
     F 16 45 MKS TFI -00001

-48   RESET ET

-46(APPROX) KEY V32E RECYCLE-5MKS
     F 06 75 ΔHCDH ΔTCDH/TPI ΔTTPI/TPI
             PRO
     F 06 81 ΔVCDH-LV
                     CDH(N81)

             ΔVX(LV) _____

             ΔVY(LV) _____

             ΔVZ(LV) _____

             PRO
     F 16 45 MKS TFI -00001

-39(APPROX) KEY V34E (TERMINATE)
     F 37 BB

             KEY 30E (EXT ΔV)

     F 06 33 _____:_____:_____TIG PLANE CHG
             (NOM 104:02:00)
             PRO
     F 06 81 ΔV'S-LV (NOM 0.0)

             KEY V90E

     F 06 16 _____:_____:_____TIG PLANE CHG

```
                    (NOM 104:02:00)
                    PRO
      F 06 90 Y  YDOT  PSI
                              N90           CSM

              YDOT _____ _____

              PRO

      F 06 81 ΔV'S-LV
              (LOAD CSM -YDOT)

                *410+5 EXTERNAL ΔV
                *450+0  451-YDOT  452+0
                (LOAD CSM SOLUTION)
                *407+0
                *400+1 GUID STEERING

                PRO
      F 06 42 HA HP ΔV
                PRO
      F 16 45 MKS TFI MGA

   -36*         COPY RDOT FOR CDH BU

   -7           RESET ET

                PRO
      F 37 BB
                KEY 00E (P00)

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

                KEY V37E41E (RCS THRUST)
      F 50 18 FDAI ANGLES
                ENTR (BYPASS MANEUVER)
        16 85 ΔV'S BODY

                DB-MIN
                AGS MODE CONT-ATT HOLD

   -:35    DSKY BLANKS

      F 16 85 ΔV'S BODY

                *407+1
104:02:00       NULL ΔV'S

                PRO
      F 37 BB
                KEY 20E (ACQUIRE RADAR)
      F 50 18 FDAI ANGLES
                PGNS MODE CONT-AUTO
                PRO (AUTO MANEUVER)
        06 18 FDAI ANGLES
```

```
                         *507+0
                         *400+2 ACQ STEERING
                          AGS MODE CONT-AUTO
                          RATE/ERR MON-CMPTR (LMP)

        F  50  18  FDAI ANGLES
                   ENTR (BYPASS MANEUVER)
        F  50  25  00201 SEL AUTO MODE
                   RR MODE-LGC
                   PRO

                   NO TRK LT-OFF

            DSKY BLANKS

                   VERIFY MAIN LOBE LOCK-ON

                   KEY V37E33E (CDH)

        F  06  13  ____:____:____ TIG CDH
                   (NOM 104:31:44)
                   PRO
        F  16  45  MKS TFI -00001

-25                RESET EI

-23*               COPY RDOT FOR CDH BU
-23(APPROX)        V93E (REINIT W MATRIX-4MKS)

-18(APPROX)        V32E RECYCLE-5MKS
        F  06  75  ΔHCDH ΔTCDH/TPI ΔTTPI/TPI
                   PRO
        F  06  81  ΔVCDH-LV
                           CDH(N81)

                   ΔVX(LV) _____

                   ΔVY(LV) _____

                   ΔVZ(LV) _____

                   PRO
        F  16  45  MKS TFI -00001

                   KEY V90E

        F  06  16  ____:____:____ TIG CDH
                   (NOM 104:31:44)
                   PRO
        F  06  90  Y YDOT PSI
                           N90          CSM

                   YDOT _____ _____

                   PRO
```

```
              F 16 45 MKS TFI -00001

-12                   PRO (FINAL COMP)
              F 06 75 ΔHCDH ΔTCDH/TPI ΔTTPI/TPI
                      PRO
              F 06 81 ΔVCDH-LV

                              CDH(N81)

                      ΔVX(LV) _____

                      ΔVY(LV) _____

                      ΔVZ(LV) _____

                      COPY YDOT FROM CSM
                      LOAD NEGATIVE IN R2

                      PRO
              F 16 45 MKS TFI MGA

-10*        .         COPY RDOT FOR CDH BU

                      TRANSMIT TGT ΔV'S TO CSM
                       AND SYNC COUNTDOWN.

-7                    KEY V47E (AGS UPDATE)
              F 06 16 GET OF AGS 0 (90:00:00)
                    . *414+1 UPDATE AGS
                .     PRO
                06 16
              F 50 16 UPDATE COMPLETE
                      *414R (00000 COMPLETE)
                      PRO

              F 16 45 MKS TFI MGA

                      *400+3 AGS ALIGN
                      *410+5 EXTERNAL ΔV
                      *407+0

                      PRO
              F 37 00
                      KEY 00E (P00)

                      *******
                      * CDH *
                      *******

-6                    KEY V37E41E (RCS THRUST)
              F 50 18 FDAI ANGLES

                      KEY V06N86E
            . F 06 86 ΔV'S-LV
                              AGS(N86)       CHART

                      ΔVX(LV) _____  _____
```

ΔVY(LV) _____

ΔVZ(LV) _____ _____

KEY RELEASE

F 50 18 FDAI ANGLES
ENTR (BYPASS MANEUVER)

*450   451   452 LOAD
*400+1 GUIDANCE STEERING
GUID CONT-AGS

16 85 ΔV'S-BODY

DB-MIN
*500R ΔVX (0.0 NUM)
-1   AGS MODE CONT-ATT HOLD

-:35   DSKY BLANKS

F 16 85 ΔV'S-BODY

*407+1

*500R   501R   502R
(104:31:44) NULL ΔV'S

VERIFY PGNS RESIDUALS
N85

ΔVX(LM) _____

ΔVY(LM) _____

ΔVZ(LM) _____

PRO
F 37 00
KEY OUE (POU)

+1   KEY V37E20E (ACQUIRE RADAR)
F 50 18 FDAI ANGLES
GUID CONT-PGNS
PGNS MODE CONT-AUTO
PRO (AUTO MANEUVER)
06 18 FDAI ANGLES

*507+0
*400+2 ACG STEERING
AGS MODE CONT-AUTO
RATE/ERR MON-CMPTR (LMP)

F 50 18 FDAI ANGLES
ENTR (BYPASS MANEUVER)
F 50 25 00201 SEL AUTO MODE
RR MODE-LGC

PRO

NO TRK LT-OFF

DSKY BLANKS

VERIFY MAIN LOBE LOCK-ON

PGNS MODE CONT-ATT HOLD
KEY V76E (PGNS PULSE)

+3   KEY V37E34E (TPI)

F 06 57 _____:_____:_____TIG TPI
(NOM 105:09:00)
PRO
F 06 55 B +026.60E +130.00WT
PRO
F 16 45 MARKS TFI -00001

-32   RESET ET

-30(APPROX) V93E (REINIT W MATRIX-4MKS)

-24   KEY V47E (AGS UPDATE)
F 06 16 GET OF AGS 0 TIME(90:00:00)
*414+1 UPDATE AGS
PRO

06 16
F 50 16 UPDATE COMPLETE
*414R (00000)
PRO

*410+3 TPI SEARCH ROUTINE
*307+043.00 ΔT XFER
*310+021.00 TFI TPI
*303R THETA AT TPI

-21   *410+4 (WHEN ET=-21 OR
WHEN 303=+026.60)

*370R_____ ΔVTPI

*371R_____ ΔVTPI+ΔVTPF

-19(APPROX) V32E RECYCLE-11MKS

F 06 57 _____:_____:_____TIG TPI
PRO
F 06 58 HP ΔVTPI ΔVTPF
PRO
F 06 59 ΔV'S-LOS
N59

ΔV F/A _____

ΔV R/L _____

ΔV D/O _____

PRO

F 16 45 MKS TFI -00001

RESET ET

TRANSMIT TIG OF TPI TO CSM

-15   KEY V47E (AGS UPDATE)

F 06 16 GET OF AGS 0 TIMF(90:00:00)

    *414+1 UPDATE AGS

    PRO

  06 16

F 50 16 UPDATE COMPLETE

    *414R (00000)

    PRO

F 16 45 MKS TFI -00001

    *400+3 AGS ALIGN

    *410+5 EXTERNAL ΔV

-12   PRO (FINAL COMP)

F 06 37 _____ : _____ : _____ TIG TPI

    PRO

F 06 58 HP ΔVTPI ΔVTPF

    PRO

F 06 81 ΔV'S-LV

          N81

ΔVX(LV)

ΔVY(LV)

ΔVZ(LV)

KEY V90E

F 06 16 _____ : _____ : _____ TIG TPI

    (NOM 105:09:00)

    PRO

F 06 90 Y YDOT PSI

          N90   CSM

YDOT _____ _____

PRO

F 06 81 ΔV'S-LV

COPY CSM YDOT

LOAD NEGATIVE IN R2

PRO

F 06 59 ΔV'S-LOS

N59

ΔV F/A _____

ΔV R/L _____

ΔV D/U _____

PRO

F 16 45 MKS TFI MGA

    BORESIGHT ON CSM
     VIA PULSES
-9*   *304R COPY TGT LOS ANGLE

    RESET ET

    PRO

F 37 00

    KEY 00E (P00)

    ****
    * TPI *
    ****

6   KEY V37E41E (RCS THRUST)

F 50 18 FDAI ANGLES

    KEY V06N86E (ΔV'S-LV)
         AGS(N86)

    $\Delta VX(LV)$ _____

    $\Delta VY(LV)$ _____

    $\Delta VZ(LV)$ _____

    KEY RELEASE

F 50 18 FDAI ANGLES

    BORESIGHT ON CSM
     VIA PULSES
-5*   *304R COPY TGT LOS ANGLE
     COPY R, RDOT FROM TM
      FOR BU'S

    PGNS MODE CONT-AUTO
    PRO (AUTO MANEUVER)

06 18

    *450, 451, 452 LOAD
    *407+0 (AFTER MNVR)
    *400+1 GUIDANCE STEERING

    CALCULATE BU SOLUTION

COPY CSM TPI SOLUTION
SYNC COUNTDOWN WITH CSM

F 50 18 FDAI ANGLES
      ENTR (BYPASS MANEUVER)
16 85 ΔV'S-BODY

    *407+0 VERIFY
    *500RΔVX (25.0 NOM)
    DB-MIN
    AGS MODE CONT-ATT HOLD

-:35   DSKY BLANKS

    [*410+5 IF AGS TPI]

F 16 85 ΔV'S-BODY

(105:09:00) BURN +X

+:06   USE RCS/ASC FEED

    VERIFY AGS RESIDUALS
    *500R   501R   502R
    ΔVX_____ΔVY_____ΔVZ_____

    PRO
F 37 00
    KEY OUT (P00)

    KEY V37E20E (ACQUIRE RADAR)
F 50 18 FDAI ANGLES

    V95E (BEFORE 1ST MK)

    PGNS MODE CONT-AUTO
    PRO (AUTO MANEUVER)
06 18 FDAI ANGLES

    *507+0
    *400+2 ACQ STEERING
    AGS MODE CONT-AUTO
    RATE/ERR MON-CMPTR (LMP)

F 50 18 FDAI ANGLES
    ENTR (BYPASS MANEUVER)
F 50 25 00201 SEL AUTO MODE
    RR MODE-LGC
    PRO

    NO TRK LT-OFF

  DSKY BLANKS

    VERIFY MAIN LOBE LOCK-ON

    PGNS MODE CONT-ATT HOLD

```
                    KEY V76E (PGNS PULSE)

+3                  KEY V37E35E (MCC1)
        F 16 45 MKS TFI -00001

                    V48E (LOAD DAP)
        F 01 46 11002
                PRO
        F 01 47 LMWT CMWT
                PRO
        F 16 45 MKS TFI -00001

                    AGS EXT ΔV:
                    *407+0
                    *450+0   451+0   452+0
                    *407+1
                    [MONITOR 500,  501,  502]

                    BORESIGHT ON CSM
                     VIA PULSES
+9*                 *304R IGT LOS ANGLE

+12*                PRO (COMPUTE MC FOR TPI+15)
        F 06 81 ΔV'S-LV
                PRO
        F 06 59 ΔV'S-LOS
                PRO
        F 16 45 MKS TFI MGA

                    BORESIGHT ON CSM
                     VIA PULSES
+13*                *304R COPY THETA, R, RDOT
                    COMPUTE BU MCC

                    PRO
        F 37 BB
                    KEY 00E (P00)

                    ********
                    * MCC1 *
                    ********

+14                 KEY V37E41E (RCS THRUST)
        F 50 18 FDAI ANGLES
                    ENTR (BYPASS MANEUVER)
          16 85 ΔV'S-BODY

                    KEY V77E (PGNS ATT HOLD)

+14:25 DSKY BLANKS

+15  F 16 85 NULL ΔV'S

                    PRO
        F 37 BB
                    KEY 00E (P00)
```

```
+10         KEY V37E20E (ACQUIRE RADAR)
     F 50 18 FDAI ANGLES

            V93E (BEFORE 1ST MK)

            ENTR (BYPASS MANEUVER)
     F 50 25 00201 SEL AUTO MODE
            RR MODE-LGC
            PRO

            NO TRK LT-OFF

      DSKY BLANKS

            VERIFY MAIN LOBE LOCK-ON

+18         KEY V37E35E (MCC2)
     F 16 45 MKS TFI -00001
            KEY V76E (PGNS PULSE)

            AGS EXT ΔV:
            *407+0
            *407+1
            [MONITOR 500,  501,  502]

            BORESIGHT ON CSM
             VIA PULSES
+24*        · *304R THETA FOR BU

+27*        PRO (COMP MC FOR TP1+30)
     F 06 81 ΔV'S-LV
            PRO
     F 06 59 ΔV'S-LOS

            BORESIGHT ON CSM
             VIA PULSES
+28*        *304R THETA, R, RDOT
            COMPUTE BU MCC

            PRO
     F 16 45 MKS TFI MGA
            PRO
     F 37 88
            KEY ∅∅E (P00)

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

            KEY V37E41E (RCS THRUST)
     F 50 18 FDAI ANGLES
            ENTR (BYPASS MANEUVER)
         16 85 ΔV'S-BODY
            KEY V77E (PGNS ATT HOLD)

+29:25 DSKY BLANKS
```

```
+30   F 16 85  NULL ΔV'S

               PRO
      F 37 88
               KEY 00E (P00)


               V63E (RR SELF TEST)
      F 04 12  00004 00001
               PRO
      F 16 72  TRUN SHFT
               PRO
      F 16 78  R RDOT
               V34E TERMINATE


               KEY V37E47E (AVE G)
      F 16 85  ΔV'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:                  |
|    30 FPS - 6000 FT       |
|    20 FPS - 3000 FT       |
|    10 FPS - 1500 FT       |
|     5 FPS -  500 FT       |
+---------------------------+
```