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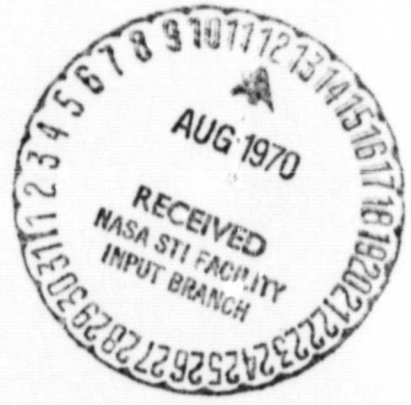
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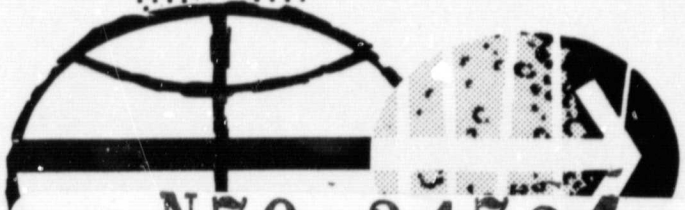
LM RENDEZVOUS PROCEDURES

F MISSION

FINAL

REVISION A

Flight Procedures Branch

FLIGHT CREW SUPPORT DIVISION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

APRIL 28, 1969

RENDEZVOUS PROCEDURES

F MISSION

AS-505/CSM-106/LM-4

April 28, 1969

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TABLE OF CONTENTS

1.0 <u>Purpose</u>

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 Major Events

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.
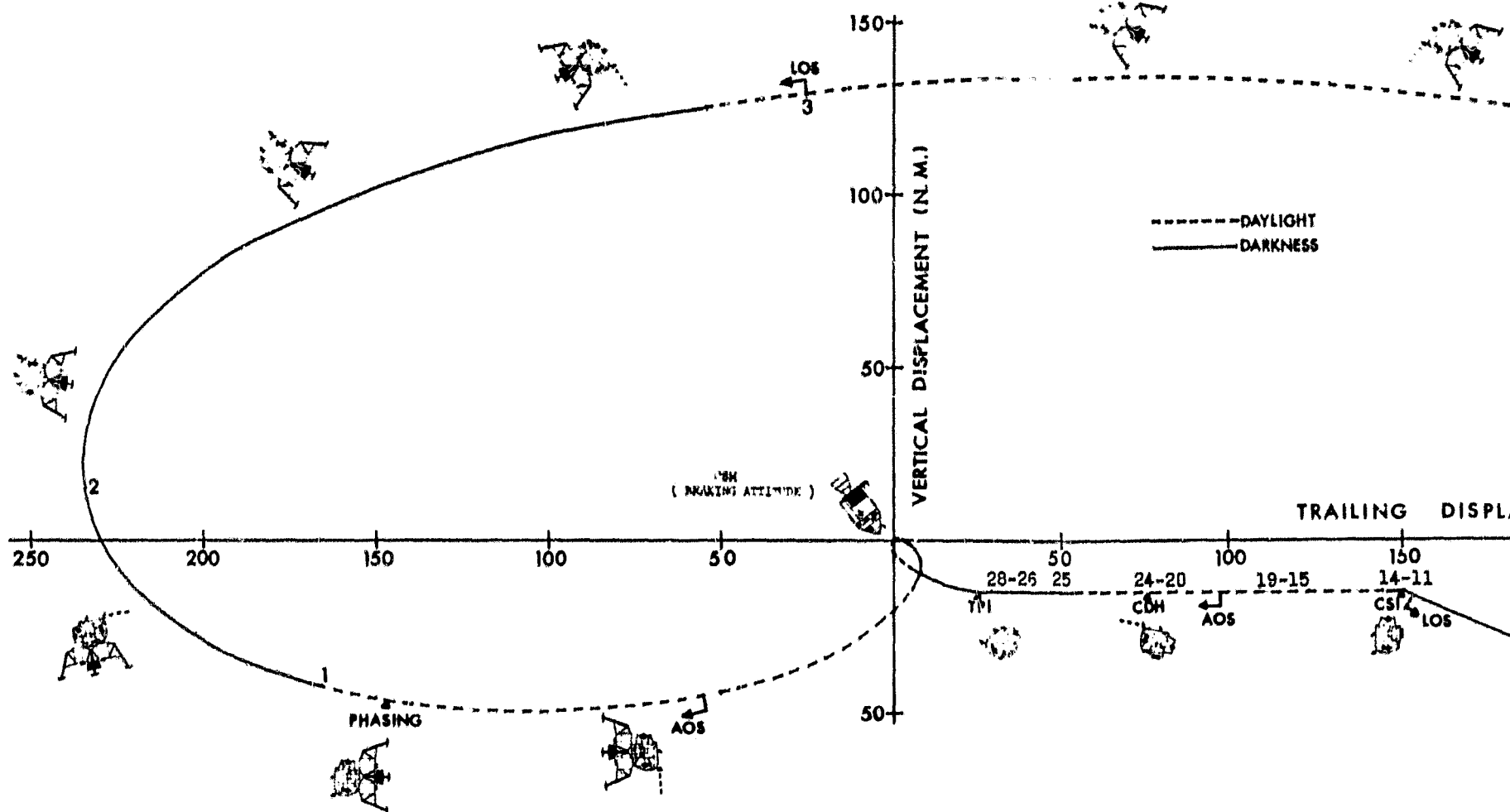
FIGURE 2-1
"F" MISSION RENDEZVOUS TRAJECTORY
(CSM CENTERED CURVILINEAR CO-ORD.)
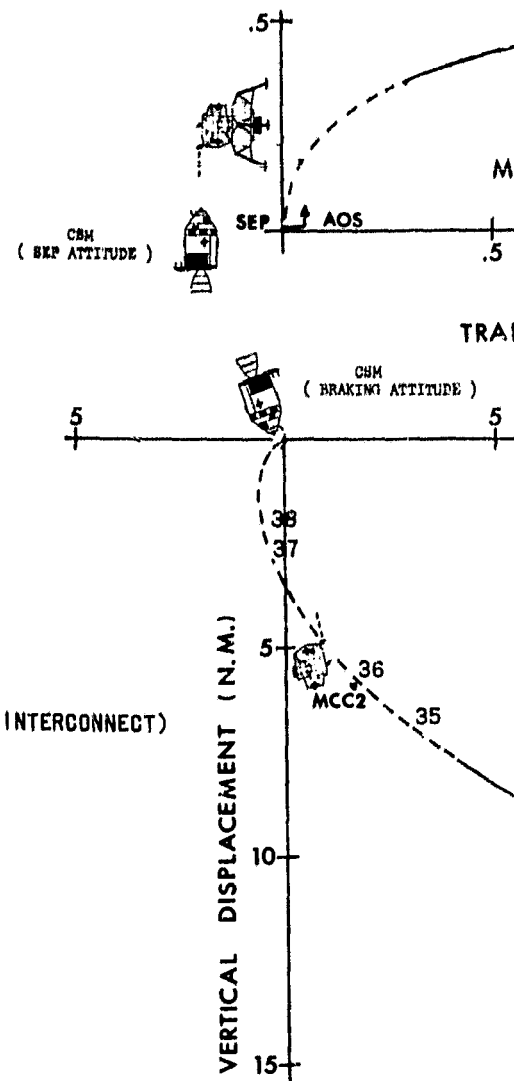
NO.	TIME	EVENT
1	100+52-100+57	RR NAVIGATION (P20, 5 MARKS)
2	100+58	IMU REFSMMAT ALIGN (P52)
3	101+16-101+31	RR NAVIGATION (P20, 15 MARKS)
4	102+08-102+21	RR NAVIGATION (P20, 13 MARKS)
5	102+22	CSM SV UPDATE (P27)
6	102+33	RCS STAGING (P47)
7	102+34	EXT ΔV FOR APS INSERTION (P30)
8	102+36	AGS UPDATE AND ALIGN (R47)
9	102+43	APS INSERTION (P42)
10	102+48	IMU REFSMMAT 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

LIGHT
KNESS

TRAILING   DISPLACEMENT (N.M.)

150   200   250   300   350   400

9-15   14-11
        CSI   LOS
                      10-9   AOS
                          8   7   6   5   4
                              TPI

MINI-FOOTBALL

.5

SEP   AOS   LOS
                .5   1.0   1.5   2.0   DOI

TRAILING   DISPLACEMENT (N.M.)

CSM
(BRAKING ATTITUDE)

.5   1.0   1.5   2.0   2.5   3.0

38
37

TERMINAL   PHASE

5
        36
MCC2   35

10   34-33
                                32
                            MCC1   LOS   31

15   30-29
                                                        TPI
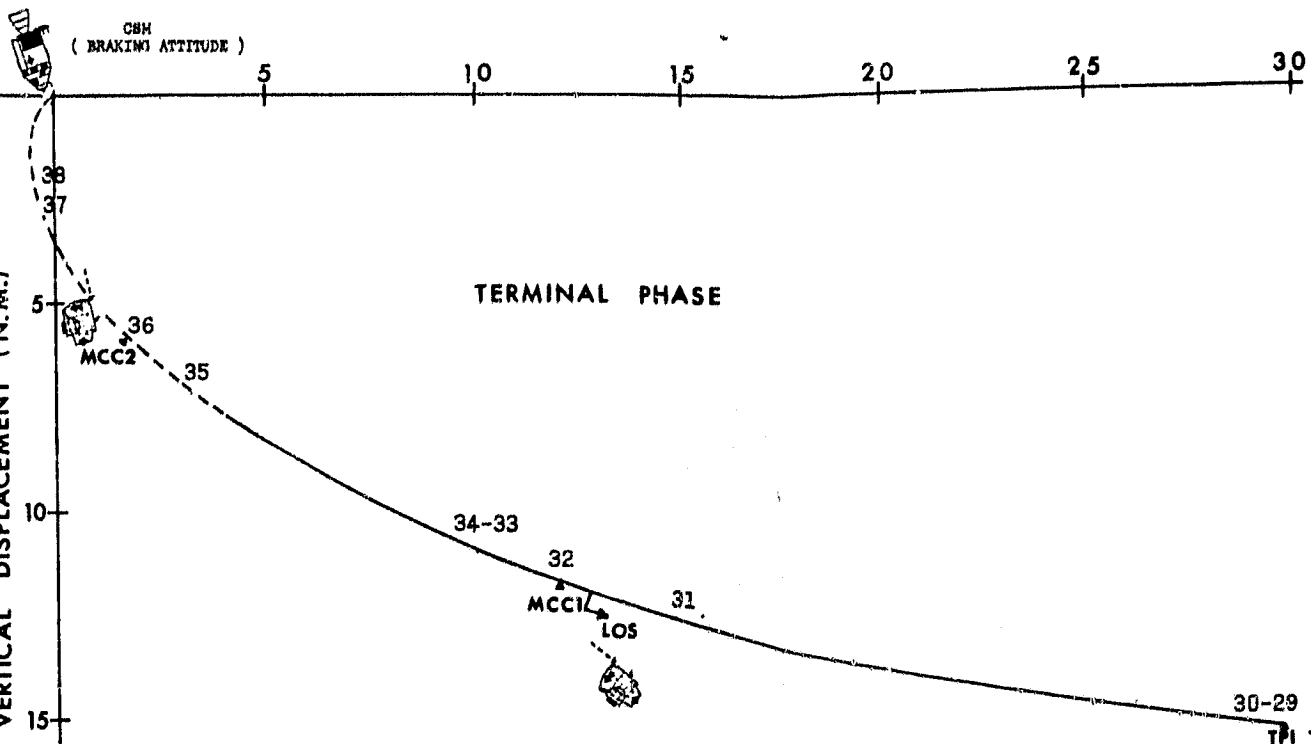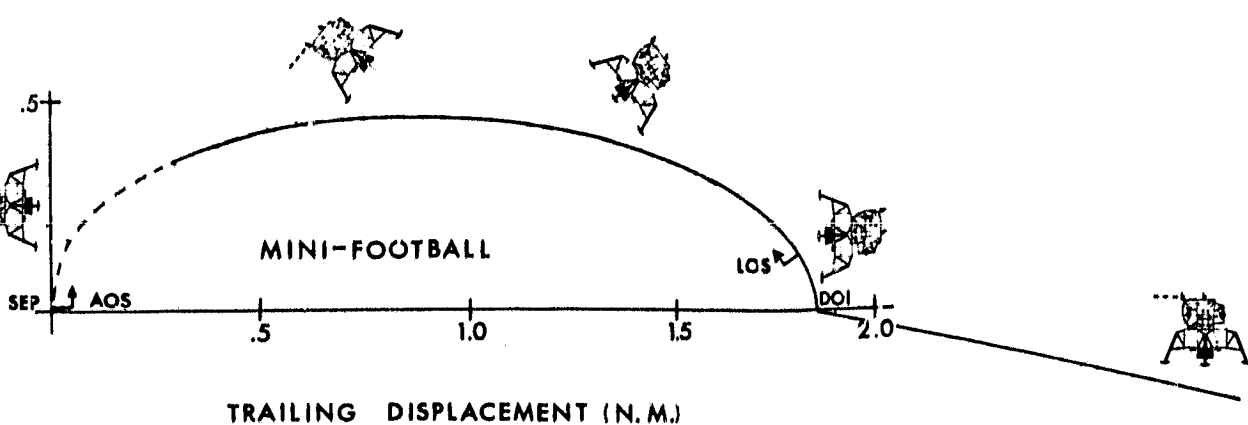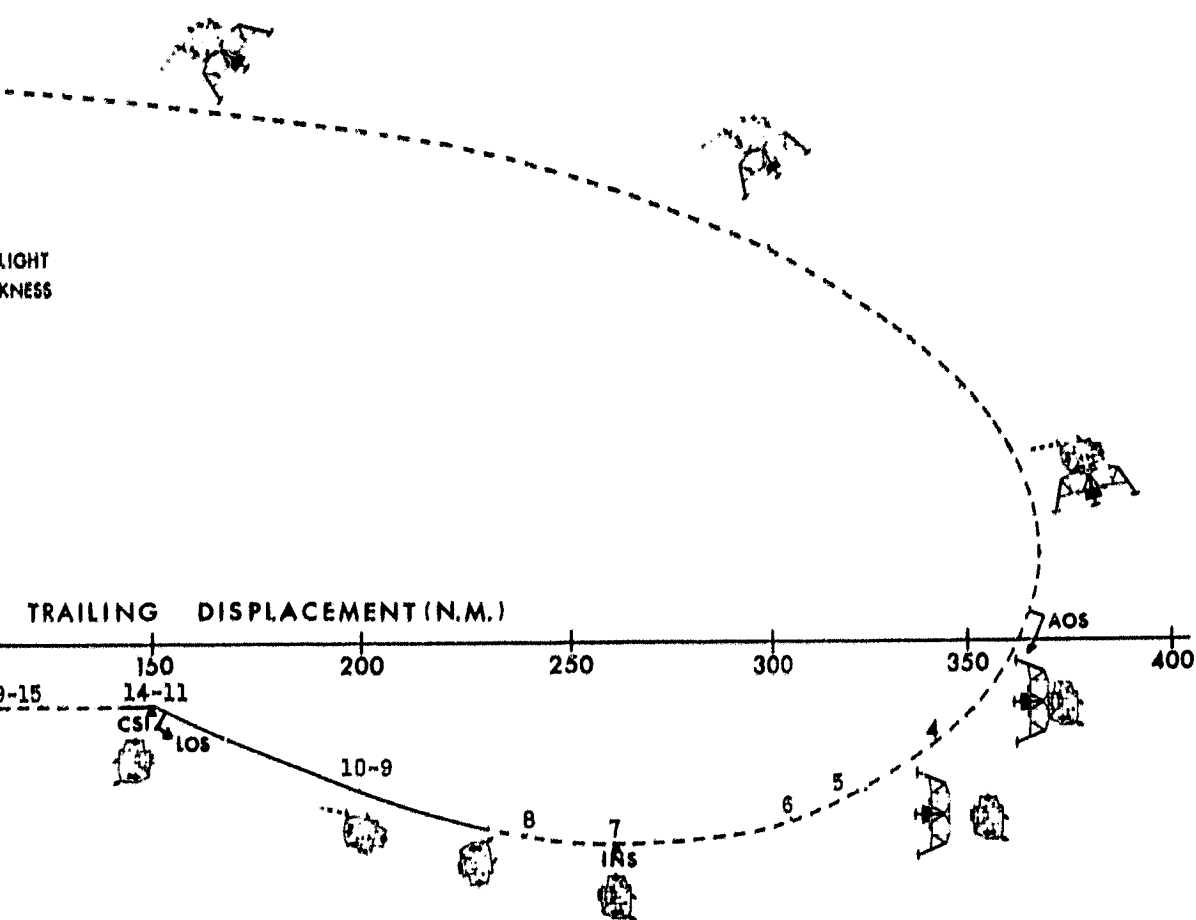
MSC-6503-69

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 (POO)

(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)
+27  F 01 71 00500
                         OBSERVE STAR IN COAS, WHEN
                          ATTITUDE ERRS ARE ZERO
                          MARK AZ-EL ANGLE ON COAS
                          DIAGRAM.
                         PRO
     F 06 07 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 FDAI 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 DV)
         F 06 33  ___:___:___  TIG INSERTION
                   (NOM 102:43:18)
                   PRO
         F 06 81 DV'S-LV
                   PRO
         F 06 42 HA HP DV
                   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 00 (POO)

                       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 V37E47E (ΔV MONITOR)
             F 16 85 ΔV'S-BODY

                       EO:MASTER ARM-ON

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

                       EO:MASTER ARM-OFF

                       PRO
             F 37 00
                       KEY 00E (POO)

-9                     KEY V37E30E (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 00
-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 VU6N86E
                               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 _____

              *625+0

              PRO
F 37 00
              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 00

             CB AOT LAMP-OPEN

             *400+3

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

             KEY V37E20 (ACQUIRE RADAR)
```

```
F 50 18 FDAI ANGLES
         KEY V80E (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 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

(103:02)   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 U (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 0H
            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)    CHAR1

            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

+:05              USE RCS/ASC FEED

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

                  PRO
      F  37  BB
                  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 NOM)
-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 0H
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 AGS 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 37 _____:_____:_____ 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 37 _____:_____:_____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 TIME(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 88
      KEY 00E (P00)

      ****
      * TPI *
      ****

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

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

ΔVX(LV) _____

ΔVY(LV) _____

ΔVZ(LV) _____

KEY RELEASE

F 50 18 FDAI ANGLES

BORESIGHT ON CSM
  VIA PULSES
-5*   *304R COPY TGT LOS ANGLE
      COPY R, ROOT 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 0R
                     KEY 00E (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)
```

```
+16         KEY V37E20E (ACQUIRE RADAR)
       F 50 18 FDAI ANGLES

            V95E (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 00
            KEY 00E (P00)

            *****冬工＊
            * 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 ROOT
              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 ROOT

              VERIFY TAPE METER WITH DSKY
```

```
+-------------------------------+
|  BRAKING:                     |
|     30 FPS - 6000 FT          |
|     20 FPS - 3000 FT          |
|     10 FPS - 1500 FT          |
|      5 FPS -  500 FT          |
+-------------------------------+
```