LM RENDEZVOUS PROCEDURES

G MISSION

FINAL REVISION A

JUNE 20, 1969

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
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<td>--------------------------------------------------</td>
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<tr>
<td>ACQ</td>
<td>Acquisition</td>
</tr>
<tr>
<td>ADJ</td>
<td>Adjust</td>
</tr>
<tr>
<td>AGS</td>
<td>Abort Guidance System</td>
</tr>
<tr>
<td>AOH</td>
<td>Apollo Operations Handbook</td>
</tr>
<tr>
<td>AOS</td>
<td>Acquisition of Signal</td>
</tr>
<tr>
<td>AOT</td>
<td>Alignment Optical Telescope</td>
</tr>
<tr>
<td>APS</td>
<td>Ascent Propulsion System</td>
</tr>
<tr>
<td>ATT</td>
<td>Attitude</td>
</tr>
<tr>
<td>BU</td>
<td>Backup</td>
</tr>
<tr>
<td>CALIB</td>
<td>Calibration</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit Breaker</td>
</tr>
<tr>
<td>CDH</td>
<td>Constant Delta Height</td>
</tr>
<tr>
<td>CDR</td>
<td>Commander</td>
</tr>
<tr>
<td>CM</td>
<td>Command Module</td>
</tr>
<tr>
<td>CMC</td>
<td>Command Module Computer</td>
</tr>
<tr>
<td>CMD</td>
<td>Command Module Commander's Position</td>
</tr>
<tr>
<td>CMP</td>
<td>Command Module Pilot</td>
</tr>
<tr>
<td>COAS</td>
<td>Crew Optical Alignment Sight</td>
</tr>
<tr>
<td>CSI</td>
<td>Concentric Sequence Initiation</td>
</tr>
<tr>
<td>CSM</td>
<td>Command and Service Module</td>
</tr>
<tr>
<td>CT</td>
<td>Cease Tracking</td>
</tr>
<tr>
<td>DAP</td>
<td>Digital Autopilot</td>
</tr>
<tr>
<td>DH</td>
<td>Delta Height</td>
</tr>
<tr>
<td>DOI</td>
<td>Descent Orbit Insertion</td>
</tr>
<tr>
<td>DPS</td>
<td>Descent Propulsion System</td>
</tr>
<tr>
<td>DSKY</td>
<td>Display and Keyboard</td>
</tr>
<tr>
<td>DV</td>
<td>Delta Velocity</td>
</tr>
<tr>
<td>DWN</td>
<td>Down</td>
</tr>
<tr>
<td>EMS</td>
<td>Entry Monitor System</td>
</tr>
<tr>
<td>ET</td>
<td>Event Timer</td>
</tr>
<tr>
<td>FDAI</td>
<td>Flight Director Attitude Indicator</td>
</tr>
<tr>
<td>FPS</td>
<td>Feet Per Second</td>
</tr>
<tr>
<td>FWD</td>
<td>Forward</td>
</tr>
<tr>
<td>GDC</td>
<td>Gyro Display Coupler</td>
</tr>
<tr>
<td>GET</td>
<td>Ground Elapsed Time</td>
</tr>
<tr>
<td>GETI</td>
<td>Ground Elapsed Time of Ignition</td>
</tr>
<tr>
<td>GMBL</td>
<td>Gimbal</td>
</tr>
<tr>
<td>GND</td>
<td>Ground (Mission Control)</td>
</tr>
<tr>
<td>HA</td>
<td>Apogee Altitude</td>
</tr>
<tr>
<td>HGA</td>
<td>High-Gain Antenna</td>
</tr>
<tr>
<td>HOR</td>
<td>Horizon</td>
</tr>
<tr>
<td>HORIZ</td>
<td>Horizontal</td>
</tr>
<tr>
<td>HP</td>
<td>Perigee Altitude</td>
</tr>
<tr>
<td>IMU</td>
<td>Inertial Measurement Unit</td>
</tr>
<tr>
<td>INS</td>
<td>Insertion</td>
</tr>
<tr>
<td>IT</td>
<td>Initiate Tracking</td>
</tr>
<tr>
<td>LGC</td>
<td>LM Guidance Computer</td>
</tr>
<tr>
<td>LM</td>
<td>Lunar Module</td>
</tr>
<tr>
<td>LMP</td>
<td>Lunar Module Pilot</td>
</tr>
</tbody>
</table>
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
<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANG</td>
<td>Antigua Near Space Support Station</td>
</tr>
<tr>
<td>BDA</td>
<td>Bermuda Near Space Support Station</td>
</tr>
<tr>
<td>CRO</td>
<td>Carnarvon Near Space Support Station</td>
</tr>
<tr>
<td>CYI</td>
<td>Canary Near Space Support Station</td>
</tr>
<tr>
<td>GYM</td>
<td>Guaymas Near Space Support Station</td>
</tr>
<tr>
<td>HSK</td>
<td>Honesuckle Deep Space Support Station</td>
</tr>
<tr>
<td>HTV</td>
<td>Huntsville Near Space Support Station</td>
</tr>
<tr>
<td>MAD</td>
<td>Madrid Deep Space Support Station</td>
</tr>
<tr>
<td>MER</td>
<td>Mercury Near Space Support Ship</td>
</tr>
<tr>
<td>MIL</td>
<td>MILA Near Space Support Station</td>
</tr>
<tr>
<td>RED</td>
<td>Redstone Near Space Support Ship</td>
</tr>
<tr>
<td>TEX</td>
<td>Corpus Christi Near Space Support Station</td>
</tr>
<tr>
<td>VAN</td>
<td>Vanguard Near Space Support Ship</td>
</tr>
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</table>
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 revision A "LM Rendezvous Procedures Document" will serve as an H mission preliminary "LM Rendezvous and Procedures Document." After reviewed 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-fifth CSM revolution with insertion at 124:30:44.2 and end at approximately 127:43:35.7 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 ordeals pitch angle for significant events during each lunar orbit.
FIGURE 2-1
G MISSION RENDEZVOUS
(CSM-CENTERED RELATIVE MOTION)
MISSION G
LUNAR ORBIT RENDEZVOUS
ATTITUDE TIME HISTORY FOR THE LM

FIGURE 2-2
MISSION 6
LUNAR ORBIT Rendezvous
ATTITUDE TIME HISTORY FOR THE LM

FIGURE S-5
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 124:35.

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 124:50, CSI targeting parameters are loaded in the PGNS and AGS. A period of rendezvous radar marking will then take place from 124:50 to 125:09. 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 125:13 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 executed. 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 125:21:19. 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 125:24 approximately three minutes after the LM CSI burn, the LM targeting parameters are loaded in both the PGNS and AGS for the CDH maneuver then when marks equal four the W matrix will be set to (2000, 2, 5). 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 125:52 the CDH targeting parameters are loaded in both the PGNS and AGS for 126:19:37. 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 126:14 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 126:22, 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 126:52 and the burn attitude is bypassed since the LM is burning along the plus Z-axis with the thrust direction established by resolving all delta V components into the third register.

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 (127:13:08). If MCC1 is to be executed, 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 (127:28:08) 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 tape meter. 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 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 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 33 126:58:08 TIG OF TPI

Expanded, this means; Load flashing verb 06 noun 33 with the quantity 126 hours, 58 minutes and 8 seconds; the time of ignition of the RCS engine TPI maneuver. Procedurally, this is done by keying verb 25 enter, loading +00126 in register 1, +00058 in register 2, and +00800 in register 3.

If numeric 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 DELTA 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
RADAR TEST SW-OFF
ENG ARM-OFF
DEADBAND-MIN
THROT/JET-JET
CB/PGNS IMU OPR-CLOSE
ATT CONT-MODE CONT(3)
TTC/TRANSL-ENABLE(CDR)

****************************************************************************** *
* X POINTER-LO MULT                                                      *
* R/R MODE-AUTO TRACK                                                    *
* MODE SEL-AGS                                                          *
* RNG/ALT MON-RGN/RNGRT                                                  *
* ABORT STAGE-RESET                                                     *
* STOP-RESET                                                            *
* PGNS MODE CONT-ATT HOLD                                               *
* AGS MODE CONT-ATT HOLD                                                *
* ATT/TRANSL-2 JETS                                                     *
* BAL CPL-ON                                                             *
* RATE ERR MON-RNDZ RDR(CDR)                                            *
* ACA/4 JET-DISABLE(CDR)                                                *
* TTC/TRANSL-DISABLE(LMP)                                              *
* ACA/4 JET-DISABLE(LMP)                                                *
****************************************************************************** *

KEY OOE (POO)
(DOWNLINK LM STATE VECTOR)

KEY V63E (RR SELF TEST)
RR MODE-LGC
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 AUTO TRACK ENABLE)
KEY V40E (LOAD DAP)
F 01 46 1(2) 2002
PRO
F 06 47 LMWT CMWT
PRO

KEY V4IN72E (COARSE ALIGN R/R)
F 24 73 +000-000TRUN +23.700SHFT
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)

EXT LGT-TRACK
CB HEATER AOT-CLOSE
CB AOT LAMP-CLOSE

+4
KEY V37E52E (IMU REALIGN)

*410+1 CSI ROUTINE
*373+0321.3 CSI TIME
*275+0418.1 TPI TIME
*605+00777 COTANGENT OF LOS TO CSM
*416+1 (ONE-HALF ORBITAL PERIOD)
*623+0 Z-AXIS PARALLEL TO CSM ORBIT
*451+0 OUT-OF-PLANE VELOCITY

F 04 06 00001 00003 (REFSMMA) 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)
F 50 18 FDAI ANGLES (AUTO MNVR)
F 50 18 FDAI ANGLES (REQUEST MNVR) ENTR (BYPASS MNVR)
F 01 71 002DE

+6
SUNSET
KEY V76E (PGNS PULSE)
PGNS MODE CONT-ATT HOLD PRO

+9
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)
F 50 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

+13
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)
F 01 71 002DE

VERIFY ALIGNMENT VIA AOT

KEY V34E (TERMINATE)
F 37 BB

KEY V48E (LOAD DAP)
F 01 46 1(2) 1012 PRO
F 06 47 LMWT CMWT
+17
F 37 BB

CB AOT LAMP-OPEN
*31OR TIME TO CSI

-35
RESET ET

(12448)
CB AC BUS A RNDZ RDR-CLOSE
(WAIT 30 SEC)
CB PGNS RNDZ RDR-CLOSE

KEY V95E (NO SV UPDATE)

KEY V67E (RESET W MATRIX)
F 06 99 +10000 +00100 +00015 PRO
F 37 BB

KEY 20E (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

  (WAIT 20 SEC TO READ R/R DATA AT LEAST ONCE)
  KEY V80E (UPDATE LM SV)
  KEY V67E (WHEN MARK=1)
F 06 99 MONITOR CONVERGENCE
  PRO

******************************************************************************
* CSI TARGETING *
******************************************************************************

(124$50) KEY V37E32E (CSI)

F 06 11  ___$___$___ LOAD TIG CSI FROM DATA PAD
  (NOM 125$21$19)
  PRO
F 06 55 +000001N +026.60E +130.00 OMEGAT
  (CDH 180 DEG AFTER CSI)
  PRO
F 06 37  ___$___$___ LOAD TIG TPI FROM DATA PAD
  (NOM 126$58$08)
  PRO
F 16 45 MKS TFI -00001

-30*

COPY 1ST RDOT FOR CSI BU

KEY V47E (INITIALIZE AGS)
F 06 16 GET OF AGS 0 TIME (120$00$00)
  TELEMETRY PCM SW-HI
  *414+1 UPDATE AGS
  PRO
06 16 UPDATE IN PROGRESS
  *414R (+00000 COMPLETE)
F 50 16 UPDATE COMPLETE
  PRO
F 16 45 MKS TFI -00001

KEY V83E (RENDEZVOUS PARAMETERS)
F 16 54 R RDOT THETA
  SET ORDEAL
  PRO
F 16 45 MKS TFI -00001
*400+3 AGS ALIGN
*400R (00000 COMPLETE)
*400+2 Z-AXIS STEERING
*507+0 Z-AXIS BORESIGHT

*310R TIME TO CSI

*267R _______ VELOCITY TO BE GAINED CSI

*402R _______ DELTA H

*371R _______ PREDICTED VEL TO BE GAINED CDH

*372R _______ TIME CSI/CDH

-22

KEY V32E (MARKS=10)

F 06 75 DELTA H DELTA T CSI/CDH DELTA T CDH/TPI

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

DELTA VX(LV) _______ (NOM 49.5)
DELTA VY(LV) _______ (NOM 0.0)
DELTA VZ(LV) _______ (NOM 0.0)

PRO

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

DELTA VX(LV) _______ (NOM -1.1)
DELTA VY(LV) _______ (NOM 0.0)
DELTA VZ(LV) _______ (NOM 4.1)

-20*

COPY 2ND RDOT FOR CSI BU

PRO

F 16 45 MKS TFI -00001

TEMP/PRESS MON SEL - FUEL MAN
A AND B PRESS 181 +-3 PSIG

TEMP/PRESS MON SEL - PRPLNT
A AND B TEMP IND 40 TO 100 DEG 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)

KEY V90E (OUT-OF-PLANE)

F 06 16 $ $ $ $ LOAD TIG CSI FROM DATA PAD
(NOM 125$21219)

PRO

F 06 90 Y YDOT PSI
N90 CSM

YDOT ______

PRO

F 16 45 MKS TFI -00001

-12

PRO (FINAL COMP)

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

F 06 75 DELTA H DELTA TCSI/CDH DELTA TCDH/TPI

PRO

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

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

DELTA VX(LV) ________ (NOM 49.5)

DELTA VY(LV) ________ (NOM 0.0)

DELTA VZ(LV) ________ (NOM 0.0)

PRO

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

CDH(82)

DELTA VX(LV) ________ (NOM -1.1)

DELTA VY(LV) ________ (NOM 0.0)

DELTA VZ(LV) ________ (NOM 4.1)

PRO
F 16 45 MKS TFI MGA

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

-7 KEY V47E (INITIALIZE AGS)
  F 06 16 GET OF AGS O TIME (120.00.00)
  TELEMETRY PCM SW-HI
  *414+1 UPDATE AGS
  PRO
  06 16 UPDATE IN PROGRESS
  *414R (+00000 COMPLETE)
  F 50 16 UPDATE COMPLETE
  PRO

F 16 45 MKS TFI MGA

KEY V83E (RENNZVOUS PARAMETERS)
F 16 54 R RDOT THETA
SET ORDEAL
PRO

F 16 45 MKS TFI MGA

*317R _______ RANGE

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

*277R _______ LOS ANGLE
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
06 86 DELTA V'S-LV

<table>
<thead>
<tr>
<th>AGS(N86)</th>
<th>CHART</th>
</tr>
</thead>
<tbody>
<tr>
<td>DELTA VX(LV)</td>
<td></td>
</tr>
<tr>
<td>DELTA VY(LV)</td>
<td>V333V AT 100</td>
</tr>
<tr>
<td>DELTA VZ(LV)</td>
<td></td>
</tr>
</tbody>
</table>

O
KEY RELEASE
16 85 DELTA V'S-BODY

PGNS MODE CONT-ATT HOLD
PULSE TO DRIVE R1 AND R2 TO ZERO
PGNS MODE CONT-AUTO

*400+0 ATT HOLD
*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

*502R DELTA VZ (NOM 49.5)

-$35

DSKY BLANKS FOR 5 SEC

KEY V77E (RATE COMMAND)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD

*407+1 FREEZE EXTERNAL DELTA V
*502R DELTA VZ

-0 F 16 85 DELTA V'S-BODY

(12521819) BURN +Z

NULL DELTA V'S

VERIFY AGS RESIDUALS

*500R 501R 502R
DELTA VX DELTA VY DELTA VZ

VERIFY PGNS RESIDUALS

CSI(N85)

DELTA VX(LM)

DELTA VY(LM)

DELTA VZ(LM)

PRO

F 37 BB
CDH TARGETING

KEY V76E (PGNS PULSE)
PGNS MODE CONT-AUTO
*400+2 Z-AXIS STEERING

(125%=24)
KEY 33E (CDH PRE-THRUST)
+4
SUNRISE

*410+2 CDH ROUTINE

F 06 13 ___________ TIG CDH (NOM 125%19%3)7
-120 $00 $00 (AGS 0 TIME)

_________ (CONVERT TO MINUTES)

ENTER IF YOU DON'T TARGET CSI

*373R ___________ (NOM 37%9%6)
*310R TIME TO CDH

*477R ___________ PREDICTED ALT RATE AT CDH
*402R ___________ DELTA H
*450R ___________ DELTA VX
*452R ___________ DELTA VZ

PRO
F 16 45 MKS TFI -00001

-52
RESET ET

KEY V67E (RESET W MATRIX WHEN MARKS = 4)
F 06 99 02000 00020 00005
PRO

F 16 45 MKS TFI -00001

KEY V32E (MARKS = 3)
F 06 75 DELTA HCDH DELTA TCDH/TPI DELTA TTPI/TPI
PRO
F 06 81 DELTA VCDH-LV
CDH(N81)

DELTA VX(LV)  (NOM -1.1)
DELTA VY(LV)  (NOM 0.0)
DELTA VZ(LV)  (NOM 4.1)

PRO

F 16 45 MKS TFI -00001

-47

KEY V90E (OUT-OF-PLANE)

::: TIG CDH (NOM 126919837)
-30°00 TIME FROM CDH

F 06 16 :::: LOAD TIG PLANE CHANGE
(NOM 125949937)

PRO

F 06 90 Y YDOT PSI N90 CSM

YDOT

PRO

F 16 45 MKS TFI - 00001

-42

KEY V32E (MARKS=10)

F 06 75 DELTA HCDH DELTA TCDH/TPI DELTA TTP/ 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

KEY V34E (TERMINATE)

F 37 BB
PLANE CHANGE TARGETING

KEY 30E (EXTERNAL DELTA V)

---$--- TIG CDH (NOM 126$19$37)
-30$00 TIME FROM CDH

F 06 33 ---$--- LOAD TIG PLANE CHANGE
(NOM 125$49$37)
PRO
F 06 81 DELTA V'S-LV (CDH)

-36*

COPY 1ST RDOT FOR CDH BU

KEY V90E (OUT-OF-PLANE)

F 06 16 ---$--- LOAD TIG PLANE CHANGE
(NOM 125$49$37)
PRO
F 06 90 Y YDOT PSI
N90
CSM
YDOT

PRO
F 06 81 DELTA V'S-LV

COPY YDOT FROM CSM AND LOAD NEGATIVE IN R2
FOR PLANE CHANGE
CDH(81)

DELTA VX(LV) (NOM 0.0)

DELTA VY(LV) (NOM 0.0)

DELTA VZ(LV) (NOM 0.0)

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)
*400+0 ATT HOLD
*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 FOR 5 SEC

KEY V77E (RATE COMMAND)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
*407+1 FREEZE EXTERNAL DELTA V
*501R DELTA VY

-30 F 16 85 NULL DELTA V*S

PRO

F 37 BB

KEY V76E (PGNS PULSE)
PGNS MODE CONT-AUTO
*400+2 Z-AXIS STEERING

(125$52) KEY 33E (CDH PRE-THRUST)

*410+2 CDH ROUTINE

F 06 13 ___:___:___ TIG CDH (NOM 126$19$37)
-120 :00 :00 (AGS 0 TIME)

_________ (CONVERT TO MINUTES)

*373R _______ (NOM 379.6)
*310R TIME TO CDH

*477R _______ PREDICTED ALT RATE AT CDH

*402R _______ DELTA H

*450R _______ DELTA VX

*452R _______ DELTA VZ

PRO

F 16 45 MKS TFI -00001
KEY V93E (REINIT W MATRIX WHEN MARKS = 4)
COPY 2ND RDOT FOR CDH BU

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

KEY V32E (MARKS = 5)

TEMP/PRESS MON SEL - FUEL MAN
A AND B PRESS 181 +/− 3 PSIG

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

TEMP/PRESS MON SEL - HEL
A AND B PRESS IND _______ PSIG

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

KEY V90E (OUT-OF-PLANE)

F 06 16 ___:_:_:_ LOAD TIG CDH FROM DATA PAD
(NOM 126±19±37)

PRO
F06 90 Y YDOT PSI
N90 CSM

YDOT

PRO
F16 45 MKS TFI -00001

-12
PRO (FINAL COMP)
F06 75 DELTA HCDH DELTA TCDH/TPI DELTA TTI/TPI

F06 81 DELTA VCDH-LV

COPY YDOT FROM CSM AND LOAD NEGATIVE IN R2

CDH(N81)

DELTA VX(LV) (NOM -1.1)

DELTA VY(LV) (NOM 0.0)

DELTA VZ(LV) (NOM 4.1)

PRO
F16 45 MKS TFI MGA

-10*

COPY 3RD RDOT FOR CDH BU

COMPUTE CDH BU

TRANSMIT TGT DELTA V'S TO CSM AND SYNC COUNTDOWN

-7
KEY V47E (INITIALIZE AGS)
F06 16 GET OF AGS O TIME (120000000)

TELEMETRY PCM SW-HI

*414+1 UPDATE AGS

PRO
F06 16 UPDATE IN PROGRESS

*414R (+00000 COMPLETE)

F50 16 UPDATE COMPLETE

PRO
F16 45 MKS TFI MGA

KEY V83E
F16 54 R RDOT THETA

SET ORDEAL

PRO
F16 45 MKS TFI MGA

*317R RANGE
*440R _______ RANGE RATE
*400+3 AGS ALIGN
*400R (00000 COMPLETE)

*277R _______ LOS ANGLE

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
06 86 DELTA V'S-LV

AGS(N86) CHART

DELTA VX(LV) _______ _______
DELTA VY(LV) _______ _______
DELTA VZ(LV) _______ _______

KEY RELEASE
16 85 DELTA V'S-BODY

*400+0 ATT HOLD
*410+5 EXTERNAL DELTA V
*450 451 452 LOAD
*407+0 ROTATE EXTERNAL DELTA V RF
*500R _______ DELTA VX

-135 DSKY BLANKS FOR 5 SEC

KEY V77E (RATE COMMAND)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
*407+1 FREEZE EXTERNAL DELTA V
*500R DELTA VX

-0 F 16 85 DELTA V'S-BODY

(126@19@37) NULL DELTA V'S

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

CDH(N85)

DELTA VX(LM) ____________
DELTA VY(LM) ____________
DELTA VZ(LM) ____________

PRO
F 37 BB

************************************************************
* TPI TARGETING *
************************************************************

KEY V76E (PGNS PULSE)
PGNS MODE CONT-AUTO
*400+2 Z-AXIS STEERING

(126;22) KEY 34E (TPI)

-36
RESET ET

F 06 37 __________ LOAD TIG TPI FROM DATA PAD
(NOM 126;58;08)
PRO
F 06 55 +000000 +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

TPI(N59)

DELTA V F/A __________ (NOM 24.8)
DELTA V R/L __________ (NOM 0.0)
DELTA V D/U __________ (NOM 0.0)
PRO

F 16 45 MKS TFI -00001

RESET ET

*410+T TPI SEARCH ROUTINE
*307+043.00 DELTA T TRANSFER
*310+026.00 TFI TPI AT R

*303 R ______ THETA AT TPI
*267 R ______ DELTA V TPI
*371 R ______ DELTA V TPI + DELTA V TPF

SUNSET

** KEY V32E (MARKS = 10) **

F 06 37 ___ $ ___ TIG TPI
PRO 12 B 00 00 00 00 00 00 00

F 06 58 HP DELTA V TPI DELTA V TPF
PRO 00 00 00 00 00 00 00 00

F 06 59 DELTA V'S-LOS TPI(N59)

DELTA V F/A

DELTA V R/L

DELTA V D/U

F 16 45 MKS TFI -00001

TEMP/PRESS MON SEL - FUEL MAN
A AND B PRESS 181 + - 3 PSIG
TEMP/PRESS MON SEL - PRPLNT
A AND B TEMP IND 40 TO 100 DEG 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/H20 QUANTITY - NOMINAL
KEY V90E (OUT-OF-PLANE)

F 06 16 __8__ LOAD TIG TPI FROM DATA PAD
(NOM 126158108)
PRO
F 06 90 Y YDOT PSI N90 CSM

YDOT _____ _____
PRO
F 16 45 MKS TFI -00001
RESET ET

-13 *310+013.00 TFI TPI
*303R ______ THETA AT TPI
-12 PRO (FINAL COMP)
F 06 37 __8__ TIG TPI

TRANSMIT TIG OF TPI TO CSM
PRO
F 06 58 HP DELTA VTP1 DELTA VTPF
PRO
F 06 81 DELTA V*S-LV

COPY CSM YDOT AND LOAD NEGATIVE IN R2
TPI(N81)

DELTA VX(LV) ________ (NOM 22.0)
DELTA VY(LV) ________ (NOM 0.0)
DELTA VZ(LV) ________ (NOM -11.1)

PRO
F 06 59 DELTA V*S LOS TPI(N59)

DELTA V F/A ________ (NOM 24.8)
DELTA V R/L ________ (NOM 0.0)
DELTA V D/U ________ (NOM 0.0)

PRO
F 16 45 MKS TFI MGA
RESET ET

PRO
F 37 BB

-10
KEY V47E (INITIALIZE AGS)
F 06 16 GET OF AGS O TIME (120000000)
TELEMETRY PCM SW-HI
*414+1 UPDATE AGS
PRO
06 16 UPDATE IN PROGRESS
*414R (+00000 COMPLETE)
F 50 16 UPDATE COMPLETE
PRO
F 37 BB

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

-9*
*277R COPY TGT LOS ANGLE

*310+00800

*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 FDAO ANGLES (REQUEST MNVR)
ENTR (BYPASS MNVR)

16 85 DELTA V'S-BODY

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

AGS(N86) CHART

DELTA VX(LV) ________ ________
DELTA VY(LV) ________ ________
DELTA VZ(LV) ________ ________
KEY RELEASE
16 85 DELTA V'S-BODY

-5*

*277R COPY TGT LOS ANGLE
COPY R, RDOT FROM TAPE METER FOR BU'S

*400+0 ATT HOLD
*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

*502R ______ DELTA VZ (NOM 24.8)

-35

DSKY BLANKS FOR 5 SEC

KEY V77E (RATE COMMAND)
PAGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
*407+1 FREEZE EXTERNAL DELTA V
*502R DELTA VZ

-0  F 16 85 DELTA V'S-BODY

(126@58@08) BURN +Z

VERIFY AGS RESIDUALS

*500R 501R 502R
DELTA VX ______ DELTA VY ______ DELTA VZ ______

VERIFY PGNS RESIDUALS

TPI(N85)

DELTA VX(LM) ______

DELTA VY(LM) ______

DELTA VZ(LM) ______

PRO

F 37 BB
KEY V76E (PGNS PULSE)
PGNS MODE CONT-AUTO
*400+2 Z-AXIS STEERING

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
TELEMETRY PCM SW-LO

*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

MCC1(81)

DELTA VX(LV) ________ (NOM 0.0)
DELTA VY(LV) ________ (NOM 0.0)
DELTA VZ(LV) ________ (NOM 0.0)

PRO
F 06 59 DELTA V*S-LOS

MCC1(59)

DELTA V F/A ________
DELTA V R/L ________
DELTA V D/U ________

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 FOR 5 SEC

KEY V77E (RATE COMMAND)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
*407+1 FREEZE EXTERNAL DELTA V
*472R DELTA VZ

+15 F 16 85 NULL DELTA V'S

PRO

F 37 BB

*********************************************************************************************
* MCC2 TARGETING                          *
*********************************************************************************************

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)

+23

SUNRISE

+24*

*277R COPY TGT LOS ANGLE

+27' PRO (COMPUTE MCC FOR TPI+30)

F 06 81 DELTA V'S-LV
DELTA VX (LV)            (NOM 0.0)
DELTA VY (LV)            (NOM 0.0)
DELTA VZ (LV)            (NOM 0.0)

PRO
F 06 59 DELTA VS-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 FDAO ANGLES (REQUEST MNVR)
ENTR (BYPASS MNVR)
16 85 DELTA VS-BODY

+29125
DSKY BLANKS FOR 5 SEC
KEY V77E (RATE COMMAND)
PGNS MODE CONT-ATT HOLD
AGS MODE CONT-ATT HOLD
*407+1 FREEZE EXTERNAL DELTA V
*472R DELTA VZ

+30 F 16 85 NULL DELTA VS

PRO
F 37 BB

KEY 00E (POO)
KEY V48E (LOAD DAP)
F 01 46 11002
PRO
F 06 47 LMWT CMWT
PRO

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                     *
*********************************************************************************

RENEZVOUS

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-CMPT(LMP)
ATTITUDE MON-AGS(LMP)
SHFT/TRUN=-5 DEG
RADAR TEST SW-OFF
ENG GMBL-OFF
ENG ARM-OFF
DEADBAND-MAX
THROT/JET-JET
CB/PGNS IMU OPR-CLOSE
R/R MODE-AUTO TRACK
ATT CONT-MODE CONT(3)
TTCA/TRANS-ENABLE(CDR)

******************************************************************************
* X POINTER-LO MULT
* MODE SEL-AGS
* RNG/ALT MON-RNG/RNGRT
* ABORT STAGE-RESET
* STOP-RESET
* PGNS MODE CONT-OFF
* AGS MODE CONT-AUTO
* ATT/TRANS-2 JETS
* BAL CPL-ON
* RATE ERR MON-RNDZ RDR(CDR)
* ACA/4JET-DISABLE(CDR)
* TTCA/TRANS-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
AGS MODE CONT-ATT HOLD
R/R MODE - SLEW
SLEW RATE - LD
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 TARGETING *
********************************************************************************

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

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

+6
SUNSET

*410+1 CSI ROUTINE
*373+0321.3 CSI TIME
*275+0418.1 TPI TIME
*605+00777 COTANGENT OF LOS TO CSM
*416+1 (ONE-HALF ORBITAL PERIOD)
*623+0 Z-AXIS PARALLEL TO CSM ORBIT
*451+0 OUT-OF-PLANE VELOCITY
*310R TIME TO CSI

RESET ET

*267R _______ VELOCITY TO BE GAINED CSI
*402R _______ DELTA H
*371R _______ PREDICTED VEL TO BE GAINED CDH
*372R _______ TIME 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

-310R TIME TO CSI

RESET ET

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

-30*
COPY 1ST RDOT FOR 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 ________ PREDICTED VEL TO BE GAINED CDH
*372R ________ TIME 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 2ND RDOT FOR 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 40 TO 100 DEG 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

-12
*415+1 (NO BORESIGHT)
*503-XXXX. X RANGE RATE
(LOS OF MSFN)
S-BAND - SLEW TO P = +90, Y = 0
S-BAND - FWD (OR AFT)
S-BAND - DN VOICE BU
BIOMED OFF

*267R VELOCITY TO BE GAINED CSI

*402R DELTA H

*371R PREDICTED VEL TO BE GAINED CDH

*372R TIME CSI/CDH

*263R OUT OF PLANE VELOCITY

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

-10* COPY RANGE AND 3RD ROOT FOR CSI BURN

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

COMPUTE CSI 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 LOS ANGLE

SET ORDEAL

*317R RANGE

*440R RANGE RATE

*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 49.5)

-20
DEADBAND-MIN
(DEFLECT RHC OUT OF DETENT)
AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT
*407+1 FREEZE EXTERNAL DELTA V
*502R DELTA VZ

SET ET COUNTING UP AT ZERO

(125:21:19) BURN +Z

NULL DELTA V'S

VERIFY AGS RESIDUALS
*500R 501R 502R
DELTAVX DELTAVY DELTAVZ

CDH TARGETING

DEADBAND-MAX
ATT CONT(3)-PULSE
AGS MODE CONT-AUTO
*400+2 Z-AXIS STEERING

+3
*410+2 CDH ROUTINE

+4
SUNRISE

*373R (NOM 379.6)
*310R TIME TO CDH

-52
RESET ET

*477R PREDICTED ALT RATE AT CDH
*402R DELTA H
*450R DELTA VX
*452R DELTA VZ
*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
    SET ET COMPL AT 30D
    *415+1
    *316+XXXX.X RANGE

-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
    COPY 1ST ROOT FOR CDH BU

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

-36*  COPY 1ST ROOT FOR CDH BU

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

-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

-30+20  DEADBAND-MIN
    (DEFLECT RHC OUT OF DETENT)
    AGS MODE CONT-ATT HOLD
    ATT CONT(3)-MODE CONT
    *407+1 FREEZE EXTERNAL DELTA V
*50IR DELTA VY

-30 NULL DELTA V'S

DEADBAND-MAX
ATT CONT (3)-PULSE
AGS MODE CONT-AUTO
*400+2 Z-AXIS STEERING

*410+2 CDH ROUTINE

*373R __________ (NOM 379.6)
31OR TIME TO CDH

*477R __________ PREDICTED 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

*415+1 (NO BORESIGHT)

*503-XXXX.X RANGE RATE

-23* COPY 2ND RDOT FOR CDH BU

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

TEMP/PRESS MON SEL - FUEL MAN
A AND B PRESS 181 +/3 PSIG

TEMP/PRESS MON SEL - PRPLNT
A AND B TEMP IND 40 TO 100 DEG F
A AND B PRESS IND 100 +/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 SFL 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

-10*
COPY 3RD RDOT FOR 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 ______ LOS ANGLE
SET ORDEAL
*317R _______ RANGE
*440R _______ RANGE RATE

*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

-320
DEADBAND-MIN
(DEFLECT RHC OUT OF DETENT)
AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT
*407+1 FREEZE EXTERNAL DELTA V
*500R DELTA VX

SET ET COUNTING UP AT ZERO

(126:19:37) NULL DELTA V'S

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

*****************************************************************************
* TPI TARGETING
*****************************************************************************

DEADBAND-MAX
ATT CONT(3)-PULSE
AGS MODE CONT-AUTO
*400+2 Z-AXIS STEERING

*417+1 (RADAR FILTER INITIALIZED)
*415+1 (NO BORESIGHT)
*503-XXXX.X RANGE RATE
BORESIGHT ON CSM
*415+1
*316-XXXX.X RANGE
+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 = 26.6 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

-23
SUNSET

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

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

*303R THETA AT TPI
*410+4 (WHEN 303 = 26.6 DEG)
*310R TFI TPI
RESET ET

*267R DELTA V TPI
DELTAV TPI + DELTAV TPF

\[ 371R \]

\[ 415+1 \text{ (NO BORESIGHT)} \]
\[ 503-XXXX.X \text{ RANGE RATE} \]
\[ \text{BORESIGHT ON CSM} \]
\[ 415+1 \]
\[ 316+XXXX.X \text{ RANGE} \]

\[ 415+1 \text{ (NO BORESIGHT)} \]
\[ 503-XXXX.X \text{ RANGE RATE} \]
\[ \text{TEMP/PRESS MON SEL - FUEL MAN} \]
\[ \text{A AND B PRESS 181 +3 PSIG} \]
\[ \text{TEMP/PRESS MON SEL - PRPLNT} \]
\[ \text{A AND B TEMP IND 40 TO 100 DEG F} \]
\[ \text{A AND B PRESS IND 181 +3 PSIA} \]
\[ \text{TEMP/PRESS MON SEL - HEL} \]
\[ \text{A AND B PRESS IND ________ PSIA} \]

A QUANTITY IND ________ PERCENT REMAINING

B QUANTITY IND ________ PERCENT REMAINING

\[ \text{TEMP MON SEL RCS QUAD 1, 4, 2, 3 (120 - 190 DEG F)} \]

SUIT/CABIN PRESS - NOR
GLYCOL TEMP/PRESS - NOR
\[ O2/H2O \text{ QUANTITY - NOMINAL} \]

\[ 415+1 \text{ (NO BORESIGHT)} \]
\[ 503-XXXX.X \text{ RANGE RATE} \]
\[ \text{BORESIGHT ON CSM} \]
\[ 415+1 \]
\[ 316+XXXX.X \text{ RANGE} \]

\[ 415+1 \text{ (NO BORESIGHT)} \]
\[ 503-XXXX.X \text{ RANGE RATE} \]

\[ 410+3 \text{ TPI SEARCH ROUTINE} \]
\[ 307+043.00 \text{ DELTA T TRANSFER} \]
\[ 310+011.00 \text{ TFI TPI} \]

\[ 303R \text{ THETA AT TPI} \]
\[ 410+4 \text{ (WHEN 303 = 26.60 DEG)} \]

\[ 277R \text{ LOS ANGLE} \]
SET ORDEAL

\[ 310R \text{ TFI TPI} \]
RESET ET
*267R DELTA V TPI

*371R DELTA V TPI + DELTA V TPF

TRANSMIT TIG OF TPI TO CSM

*277R COPY TGT LOS ANGLE

-9*

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

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

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

-5*

*277R COPY TGT LOS ANGLE

COPY R, ROOT FROM TAPE METER FOR BU*S

BORESIGHT ON CSM

*415+1
*316-XXXX XX RANGE

COMPUTE TPI BU

*373R TIG TPI

*267R DELTA V TPI

*371R DELTA V TPI + DELTA V TPF

*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

*502R DELTA VZ (NOM 24.8)

-20

DEADBAND-MIN

(DEFLECT RHC OUT OF DETENT)

AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT

*407+1 FREEZE EXTERNAL DELTA V
*502R DELTA VZ
SET ET COUNTING UP AT ZERO

(126:58:08) BURN +Z

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

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

DEADBAND-MAX
ATT CONT(3)-PULSE
AGS MODE CONT-AUTO
*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
(MONITOR 470 471 472)

+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)
*400+0 ATT HOLD
AGS MODE CONT-ATT HOLD
ATT CONT(3)-MODE CONT
*470R 471R 472R

+15
NULL DELTA V'S
DEADBAND-MAX
ATT CONT(31)-PULSE
AGS MODE CONT-AUTO
*404+0 405+0 406+0
(MONITOR 470 471 472)

+23
SUNRISE

+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(31)-PULSE
*404+0 405+0 406+0
(MONITOR 470 471 472)
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 AND TIMELINES

Complete Rendezvous charts have been constructed for the following cases:

1) PDII + 10 MINUTES (CHART 6.2 through CHART 6.4)
2) NOMINAL ASCENT (CHART 6.10 through CHART 6.15)

A complete set consists of charts for CSI, CDH, TPI, MCC1 and MCC2. For other cases, only the TPI, MCC1 and MCC2 chart is presently available. Further charts for selected points may be constructed as time permits previous to the mission.
NO PDI1 + 12 MINUTES

101:30
- DOI 101:38:49

102:00
- P63

102:30
- PDI1 102:35:19
- ABORT 102:47:19
  - V95, P20
  - V93, V80
  - P32 N = 1

103:00
- P41

103:30
- CS1 103:33:13
  - P33
  - 4 MKS, V67 2K ft, 2 fps,
  - 5 MR

104:00
- P30
- P41
- PC 104:03:35
  - P33 4 MKS, V93

104:30

105:00
- P40
- CDH 104:33:38
- P34 4 MKS, V93

105:30
- P40
- TPI 105:14:21
  - V93, P35
  - P41
- MCC1 105:29:21
  - V93, P35
  - P41
- MCC2 105:44:21
  - P00, P47, V63

106:00
- TPF 105:57:11

106:30

107:00

107:30

108:00

108:30

109:00

109:30

110:00

110:30

MISSION APOLLO 11, JUNE 19, 1969
6-2

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**CSI BACKUP TABLE**

**PDI + 10 Minutes**

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Prepared by FPRB/OPS

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PDII + 10 Minutes

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Prepared by FPMB/OPS

MISSION APOLLO 11, JUNE 19, 1969
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\quad +X3 = .5 \\
\Delta V(LV) = -0.4 \\
\Delta V: Z1 = 31.3 \\
+Z2 = 105.2 \\
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\Delta V(LV) = 0.0 \\
\]

Prepared by FPRB/OPS
MISSION APOLLO 11, JUNE 19, 1969
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CHART 6.11

CDH BACKUP TABLE
NOMINAL ASCENT

Prepared by FPR8/OPS
MISSION APOLLO 11, JUNE 19, 1969
G MISSION TERMINAL PHASE INITIATION

CHART 6.12

MISSION APOLLO 11, JUNE 19, 1969
6-24
7.0 REFERENCES


7.2 Apollo Mission G Spacecraft Operational Trajectory, Volume 1, MSC Internal Note No. 69-FM-98, dated 12 May 1969.


7.5 Guidance System Operations Plan for Manned LM Earth Orbital and Lunar Missions Using Program Luminary 1A; Section Four, PGNCS Operational Modes, Revision 1, dated April 1969.

7.6 GAP Assemble Revision 097 of AGS Program Luminary by NASA 2021112-041, dated 11 April 1969.


