LM
DESCENT/ASCENT
PROCEDURES
MISSION J-3

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
OCTOBER 16, 1972
LM DESCENT/ASCENT PROCEDURES
MISSION J-3
OCTOBER 16, 1972

PREPARED BY: Charles O. Lewis
CHARLES O. LEWIS
AST, LAUNCH & ENTRY PROCEDURES SECTION

APPROVED BY: J.W. Bilodeau
J.W. BILODEAU
CHIEF, CREW PROCEDURES DIVISION

DONALD K. SLAYTON
CHAIRMAN, CREW PROCEDURES CONTROL BOARD
ACKNOWLEDGMENTS

Acknowledgment is made to Mr. Nathan Laurence, TRW Systems Group, ASPO TASK-81, C-3 for assistance in preparation of this document.
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1-1</td>
</tr>
<tr>
<td>2. DESCENT</td>
<td>2-1</td>
</tr>
<tr>
<td>2.1 Detailed Procedures - Undocking to PDI</td>
<td>2-1</td>
</tr>
<tr>
<td>2.2 Powered Descent Monitoring</td>
<td>2-22</td>
</tr>
<tr>
<td>3. POWERED DESCENT ABORTS</td>
<td>3-1</td>
</tr>
<tr>
<td>4. POWERED ASCENT</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1 Nominal Ascent Monitoring</td>
<td>4-2</td>
</tr>
<tr>
<td>4.2 Manual Ascent</td>
<td>4-4</td>
</tr>
<tr>
<td>APPENDIX</td>
<td></td>
</tr>
<tr>
<td>DPS Burn Cue Card</td>
<td>A-1</td>
</tr>
<tr>
<td>APS Burn Cue Card</td>
<td>A-2</td>
</tr>
<tr>
<td>Procedures for Use of LPD</td>
<td>A-3</td>
</tr>
<tr>
<td>PDI Summary Data Abort Card</td>
<td>A-4</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>AGS</td>
<td>Abort Guidance System</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>ASC</td>
<td>Ascent</td>
</tr>
<tr>
<td>BP</td>
<td>Barber Pole</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit Breaker</td>
</tr>
<tr>
<td>CDR</td>
<td>Commander</td>
</tr>
<tr>
<td>CDU</td>
<td>Coupling Data Unit</td>
</tr>
<tr>
<td>COAS</td>
<td>Crew Optical Alignment System</td>
</tr>
<tr>
<td>CR</td>
<td>Crossrange</td>
</tr>
<tr>
<td>CSM</td>
<td>Command and Service Module</td>
</tr>
<tr>
<td>CWEA</td>
<td>Caution and Warning Electronics Assembly</td>
</tr>
<tr>
<td>DES</td>
<td>Descent</td>
</tr>
<tr>
<td>DET</td>
<td>Digital Event Timer</td>
</tr>
<tr>
<td>DPS</td>
<td>Descent Propulsion System</td>
</tr>
<tr>
<td>DSKY</td>
<td>Display and Keyboard</td>
</tr>
<tr>
<td>E</td>
<td>Enter</td>
</tr>
<tr>
<td>ED</td>
<td>Explosive Devices</td>
</tr>
<tr>
<td>EPS</td>
<td>Electrical Power System</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>FTP</td>
<td>Full Throttle Position</td>
</tr>
<tr>
<td>GET</td>
<td>Ground Elapsed Time</td>
</tr>
<tr>
<td>H</td>
<td>Altitude</td>
</tr>
<tr>
<td>HA</td>
<td>Apocynthion Altitude</td>
</tr>
<tr>
<td>H DOT</td>
<td>Altitude Rate</td>
</tr>
<tr>
<td>HE</td>
<td>Helium</td>
</tr>
<tr>
<td>HP</td>
<td>Pericynthion Altitude</td>
</tr>
<tr>
<td>IMU</td>
<td>Inertial Measurement Unit</td>
</tr>
<tr>
<td>LDG</td>
<td>Landing</td>
</tr>
<tr>
<td>LGC</td>
<td>LM Guidance Computer</td>
</tr>
</tbody>
</table>
NOMENCLATURE (Continued)

LM Lunar Module
LMK Landmark
LMP LM Pilot
LPD Landing Point Designator
LR Landing Radar
LV Local Vertical
MSFN Manned Spaceflight Network
N Noun
NM Nautical Miles
NOM Nominal
NOR Normal Operating Range
PB Push Button
PDI Powered Descent Initiation
PGNS Primary Guidance Navigation and Control System
R Range or Readout
RCS Reaction Control System
R DOT Range Rate
RLS Radius of Landing Site
ROD Rate of Descent
RR Rendezvous Radar
SOV Solenoid Operated Valve
SV State Vector
SW Switch
TB Talkback
TFF Time to Free Fall
TFI Time from Ignition
TGO Time to Go
TIG Time of Ignition
TM Tape Meter
TTCA Thrust and Translation Control Assembly
V Verb or Velocity
VGX Velocity To Go in X Direction
NOMENCLATURE (Continued)

VGY  Velocity To Go in Y Direction
VGZ  Velocity To Go in Z Direction
VI   Inertial Velocity
VX   Velocity in X Direction
VY   Velocity in Y Direction
VZ   Velocity in Z Direction
1.0 INTRODUCTION

The LM Descent/Ascent Procedures document presents detailed crew procedures for the J-3 mission phase beginning with undocking and ending with touchdown (including powered descent aborts), and for powered ascent.

These procedures are those currently being used (in checklist form) by the Apollo 17 crew in training for the J-3 mission. Any changes to these procedures prior to flight are subject to approval by the Crew Procedures Control Board.

Comments and questions regarding this document should be directed to C. O. Lewis, Flight Procedures Branch, CG42, Extension 3291.
2.1 DETAILED PROCEDURES - UNDOCKING TO PDI

110:15

CDR LMP

SYSTEMS ACTIVATION COMPLETE (PER ACT. CHKLIST)

PREPARE FOR UNDOCKING

-10

CHECK ATTITUDE FOR UNDOCKING - FDAI (0, 180/284, 060)

KEY V48E (LOAD DAP)

F 04 46 22012
PRO

F 06 47 LM WT 36744 CSM WT ___
PRO

F 06 48 PITCH ROLL
KEY V34E (DO NOT TRIM)

KEY V06N20E

06 20 COPY LM AND CSM ANGLES AND TIME

-1

KEY V37E47E (THRUST MONITOR)

F 16 83 DELTA V'S - LM

110:28

CSM UNDOCKING AND SEPARATION

KEY V77E
TRIM TO .1 FPS
PRO

F 37 BB

KEY OOE (POO)
KEY V60E (DISPLAY VEHICLE RATES)
YAW LEFT 60 DEGREES
PITCH UP 90 DEGREES

+3

FDAI (0, 280/013, 0) (CSM IN FWD WINDOW)
CDR LMP

110:30

*VHF ANT - FWD
*CHECK LUNAR SOUNDER VHF ANT DPLY *
*SEQUENCE CAMERA - OFF *

HELMETS AND GLOVES - OFF (OPTIONAL)
*SUIT GAS DIVERTER - EGRESS *
*CABIN GAS RETURN - EGRESS *

**LANDING RADAR CHECKOUT**

CB(11) PGNS: LDG RDR - CLOSE
CHECK TEMP (60-95 DEG F)
X-PNTRS - HI MULT
MODE SEL - LR
TM SW - H/Å
LDG ANT - AUTO
RDR TEST - LDG
POWER SIGNAL LIGHT OUT
TEST MON - ALT XMTR (2.1-5.0)
   - VEL XMTR (2.1-5.0)
   - AGC
X-PNTRS PEGGED UP, LEFT:
TM ALT - (8000 ± 100 FT)
TM ALT RT - (-480 ± 2 FPS)

KET V63E (LR SELF-TEST)
F 04 12 00004 00002 PRO
F 16 66 +08286±10 (RNG), +00001 (ANT POS) PRO
F 16 67 -00495±2 VX
   +01862±2 VY
   +01331±2 VZ

110:35
CDR

KEY V34E (TERMINATE)
RDR TEST - OFF
TM ALT - 0
POWER SIGNAL LIGHT ON
X-PNTRS - CENTERED
CB(11) PGNS: LDG RDR - OPEN

CAMERA SETTINGS FOR CABIN PHOTOS

AOS REV 12

* LM/DAC/10/CEx (T/2.8, 1/60, 2 FT) *
* 6 FPS, .125 MAG N, (2 MIN) *
* LM/DC/60/HCEx (F5.6, 1/2 - 1/8, FOCUS) 5 FT, MAG A *

VOICE N20 ANGLES AND TIME TO MSFN

DPS THROTTLE CHECK

* CB(16) STAB/CONT: ENG ARM - CLOSE *

* VERIFY MSFN CONTACT *
110:43

CDR

ENG STOP - PUSH
ENG ARM - DES
(DES REG LT - ON)
TTCA - MIN
  CHECK THRUST CMD (6.6 % - 13.4 %)
TTCA - SOFT STOP
  CHECK THRUST CMD (46.2% - 59.2%)
TTCA - MAX
  CHECK THRUST CMD (93.6% - 100+%)  
TTCA - MIN
ADJUST FRICTION

LMP

MAN THROT - LMP
ENGINE ARM - OFF
  *REPEAT TEST FOR LMP TTCA *

*CYCLE CWEA *
  * (DES REG LT - OFF) *

ENG STOP - RESET
THROT CONT - AUTO/CDR
TTCA (BOTH) - JETS

110:47

DPS PRESSURIZATION AND CHECKOUT

PRPLNT TEMP/PRESS MON - DES 1 & 2
  FUEL 50°-75°F  50-130 PSI
  OXID 50°-75°F  30 - 80 PSI
HELIX MON: SUPCRIT PRESS 1070-1570
  : AMB PRESS 1495 - 1750
DES He REG 1 tb - GRAY, REG 2 tb - bp
MASTER ARM - ON
DES PRPLNT ISOL VLV - FIRE
He PRESS/DES START - FIRE
MASTER ARM - OFF
PRPLNT TEMP/PRESS MON: DES 1 & 2
  FUEL & OXID 50°-90°F 200-250 PSI
HELIX MON: AMB PRESS 200-1170
  : SUPCRIT PRESS 1070 - 1570
**AGS ACTIVATION**

*AGS STATUS - STBY (MASTER ALARM, AND AGS WARNING LT - ON)*

*CB(16) STAB/CONT: AEA - CLOSE (AGS WARNING LT - OFF)*

CB(11) AC BUS B: AGS - CLOSE

*RECORD TIME : : :
*AGS STATUS - OPERATE (MASTER ALARM AND AGS WARNING LT - ON)*
*O2/H2O QTY MON - C/W RESET
*ATT MON (LMP) - AGS
*412R+1 SELF TEST SATISFACTORY
*+3 LOGIC TEST FAILURE
*+4 MEMORY TEST FAILURE
*+7 LOGIC AND MEMORY TEST FAILURE
*000 +888888 (OPR ERR LT - ON)
*123 -45679 (DO NOT ENTR)
*KEY V16N65E

F 16 65 LGC TIME (HRS, MINS, .01 SEC.)

*SET AGS TIME USING 110 HR BIAS*
*377 (+00450)*
*616+0 (ULLAGE COUNTER)*
*224 (+60457)*
*225 (+29364)*
*226 (+60366)*
*305 (+00642)*
*662 (-33007)*
*673 (-54456)*
*574R DESCENT STAGE (+ NOT STAGED)*
*604R LUNAR SURFACE FLAG (+NOT ON SURFACE)*
*612R STAGING COUNTER (+O NOM)*
**MSFN UPDATE**

110:50

**CDR**

110:55

**LMP**

*232R + 00600 (INSRT ALT) *
*233R + 00250 (VERT STEER PITCHOVER H) *
*464R + 00500 (PITCHOVER STEER HDOT) *
*465R + 00195 (TARG INSERTION HDOT) *
*623R + 00000 (Z-AXIS STEERING) *
*514R - 60000 (YAW STEERING, UNIT X) *
*515R - 44223 (YAW STEERING, UNIT Y) *
*516R + 00000 (YAW STEERING, UNIT Z) *

*COPY AGS K FACTOR ______:______:______ *

*KEY V47E (INITIALIZE AGS) *
*KEY V25E AND LOAD AGS K FACTOR UPDATE *
*414+1 UPDATE AGS *
*PRO *
*UPDATE IN PROGRESS *
*414R (+00000 COMPLETE) *
*UPDATE COMPLETE *

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

*KEY V83E (RNDZ PARAMETERS) *

*317R (RANGE) *
*440R (RANGE RATE) *
*COMPARE WITH N54 VALUES *

**DSKY BLANKS**
CDR

**AGS CONT CHECK**

MODE CONT (AGS) - ATT HOLD
GUID CONT - AGS
MNVR TO FDAI ANGLES (0, 315/330, 0)

*CAMERA SETTINGS FOR REV 12 TCA *
*LM3/DAC/10/CEX (T/2.8, 1/250,∞) *
* 1 FPS,.05 MAG N, (5 MIN) *
*LM/DC/60/HCEX (f5.6, 1/125,∞) *
* 5 FR, MAG A *

*SEQUENCE CAMERA - ON (110:56) *

REV 12 LS TCA ___:___:__(111:01)

*SEQUENCE CAMERA - OFF *

**RENDEZVOUS RADAR CHECKOUT**

GUID CONT - PGNS
CB(11) AC BUS A: RNDZ RDR - CLOSE
WAIT 30 SECONDS
CB(11) PGNS: RNDZ RDR - CLOSE

*VHF A XMTR - VOICE/RNG *

TEMP MONITOR - RNDZ RDR (10° TO 75°)
RATE/ERROR MONITOR - RNDZ RDR
RNDZ RDR MODE - SLEW
PERFORM MANUAL LOCK ON
NO TRACK LITE - OUT
RNDZ RDR MODE - LGC
NO TRACK LITE - ON
TM - RNG/RNG RT
CDR

111:03

KEY V63E (RR SELF-TEST)
F 04 12 00004 00001
PRO
NO TRACK LITE - OUT AFTER 10 SECONDS
F 16 72 TRUN, SHFT ANGLES
PRO
F 16 78 R, RDOT, TFI

COMPARE N78, TAPE METER, AND VHF. IF
R DOES NOT AGREE WITHIN .27 NM AND R
DOES NOT AGREE WITHIN 7 FPS, EITHER
PGNS OR THE RR HAS FAILED. CONTACT
MSFN.

KEY V34E

KEY V41N72E
F 21 73 SHAFT, TRUN
KEY TRUN (+00000E), SHFT (+28300E)
F 04 12 00006, 00002
PRO

KEY V44E (TERMINATE DESIGNATION)

RR MODE - SLEW
RATE/ERROR MON - LDG RDR/CMPTR
TM - H/H

LMP

111:05
**UPDATE FROM MSFN**

111:05

*COPY CSM CIRC P76*
*COPY PADS FOR:*
* NO PDI+12 ABORT*
* PDI*
* PDI EARLY ABORT*
* PDI LATE ABORT*
* T2 ABORT*
* T3 TIG*
* SHE PRESSURE*
* SET DET TO COUNT DN TO DOI-2*

111:07

(SUNSET)

**IMU FINE ALIGN**

Key V76E
Key V37E52E (IMU REALIGN)
CB(11) AC BUS B: AOT LAMP - CLOSE
AOT - DETENT F/0.0°
PGNS MODE CONT - AUTO

| F 04 06 | 00001 00003 (REFSMMAT) | PRO |
| F 50 25 | 00015 (SELECT 1ST STAR) | ENTR |
| F 01 70 | 00216 LOAD 1ST STAR (PROCYON) | PRO |
| F 50 18 | FDIA ANGLES (REQUEST MNVR) | PRO (AUTO MNVR) |
| DSKY BLANKS | | |
| F 50 18 | FDIA ANGLES (REQUEST MNVR) | ENTR (BYPASS MNVR) |
| F 01 71 | 00216 | PRO |
| F 54 71 | MARK 1ST STAR (UP TO 5 MK SETS IN ANY ORDER) | PRO |
| F 01 70 | 00211 LOAD 2ND STAR (ALDEBARAN) | PRO |

111:15
111:15

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

DSKY BLANKS
F 50 18 FDAI ANGLES (REQUEST MNVR)
ENTR (BYPASS MNVR)
F 01 71 00211
PGNS MODE CONT - ATT HOLD
PRO
F 54 71 MARK 2ND STAR (UP TO 5 MK SETS IN ANY ORDER)
PRO
F 06 05 STAR ANGLE DIFFERENCE
PRO
F 06 93 X, Y, Z GYRO TORQUING ANGLES (.001 DEGREE)
RECEIVE MSFN GO FOR TORQUING
PRO
RECORD GET FOR IMU DRIFT CHECK
F 50 25 00014 PLEASE FINE ALIGN
(ENTR FOR NO COAS CAL)

**COAS CALIBRATION**

PRO
F 50 25 00015 SELECT STAR
ENTR
F 01 70 00011 LOAD CALIBRATION STAR (ALDEBARAN)
PRO
F 06 87 AZIMUTH, ELEVATION OF COAS
KEY 24E, +00000(AZ), +00000(EL)
PRO
PGNS MODE CONT - AUTO
F 50 18 FDAI ANGLES (REQUEST MNVR)
PRO (AUTO MNVR)

DSKY BLANKS
F 50 18 FDAI ANGLES (REQUEST MNVR)

111:20
CDR

PGNS MODE CONT - ATT HOLD
NULL ERROR NEEDLES
COPY COAS ERRORS BIAS AZ

KEY OOE (POO)
AOT DETENT - CL
CB(11) AC BUS A: AOT LAMP - OPEN

MSFN UPLINK, MSFN UPDATE

*UPDATE LINK - DATA
*UPLINK CSM/LM S.V., E-MEMORY
** DESCENT TARGETING

*COPY AND LOAD GYRO DRIFT COMP, PIPA
* BIAS
* (REF. P2 DATA CARD BOOK)

UPDATE AGS

KEY V47E (INITIALIZE AGS)
F 06 16
*414+1 UPDATE AGS
*PRO
*UPDATE IN PROGRESS
*414R (+00000 COMPLETE)

F 50 16
DSKY BLANKS

F 16 54
R, RDOT, THETA
SET ORDEAL

*317R (RANGE)
*440R (RANGE RATE)
*COMPARE WITH N54 VALUES

111:25
111:25

**MNVR TO AGS CAL ATT**

- KEY V49E
- F 06 22 OGA, IGA, MGA
  - KEY V25E AND LOAD +02250, +06750, +02250
  - F 06 22 +02250, +06750, +02250
- PRO
- F 50 18 +02400(R), +07700(P), +33900(Y)
- PGNS MODE CONT - AUTO
- PRO
- DSKY BLANKS
- F 50 18 (MNVR IS COMPLETED)
  - FDAI (24, 77, 339)

ENTR

**AGS CALIBRATION**

- *VHF ANT - AFT*
- *VHF B XMTR - DATA*
- *VHF CHECK WITH CSM*

- *READ AND RECORD INITIAL CALIBRATION NUMBERS*
  - *540R X ACCELEROMETER BIAS COMPENSATION*
  - *541R Y ACCELEROMETER BIAS COMPENSATION*
  - *542R Z ACCELEROMETER BIAS COMPENSATION*
  - *544R X GYRO DRIFT COMPENSATION CONSTANT*
  - *545R Y GYRO DRIFT COMPENSATION CONSTANT*
  - *546R Z GYRO DRIFT COMPENSATION CONSTANT*

- PGNS MODE CONT - ATT HOLD
  - *VERIFY 25 MIN SINCE TURN ON*

- KEY V60E (DISPLAY VEHICLE ATTITUDE RATES)
- KEY V76E (MIN IMPULSE)
- KEY V16EN20E

- 16 20 YAW, PITCH, ROLL (PRESENT ICDU'S)
- NULL VEHICLE RATES TO ≤ 0.075°/SEC

111:35
CDR

LMP

111:35

*400+6 (INFLIGHT CALIBRATION)
*START WATCH
*400R

MONITOR ICDU LIMITS

\[
\begin{align*}
\text{OGA} & : +00000 / +04500 \\
\text{IGA} & : +04500 / +09000 \\
\text{MGA} & : +00000 / +04500
\end{align*}
\]

LIMITS

BEFORE LIMITS ARE EXCEEDED, 400+6.
IF TIME IS LESS THAN 5 MINUTES
REPEAT AGS CALIBRATION.
IF TIME CRITICAL AND 647R > 00034,
ACCEPT CALIBRATION.

*CHECK ECS, RCS, EPS, APS
*CYCLE CWEA CB
*400R (+00000 CAL COMPLETE)
*READ AND RECORD CALIBRATION NUMBERS
*540R — X ACCELEROMETER BIAS COMPENSATION
*541R — Y ACCELEROMETER BIAS COMPENSATION
*542R — Z ACCELEROMETER BIAS COMPENSATION
* \( \Delta \text{MAX} = \pm 0.039 \)
*544R — X GYRO DRIFT COMPENSATION CONSTANT
*545R — Y GYRO DRIFT COMPENSATION CONSTANT
*546R — Z GYRO DRIFT COMPENSATION CONSTANT
* \( \Delta \text{MAX} = \pm 2.00 \)

GO/NO GO FOR DOI - 2

111:48
CDR

111:48

**CONFIGURE COMM FOR LOS**

- MATCH INDICATED ANGLES
- TRACK MODE SLEW
- S-BAND ANT - FWD
- SLEW S-BAND TO AOS ANGLES
- PITCH -33
- YAW +54
- TELEMETRY PCM SW - LO
- UPLINK SQUELCH - ENABLE
- COMMUNICATION CHECK WITH CSM

LMP

**DO1 - 2 PREP**

- KEY V37E30E (EXTERNAL ΔV)
- F 06 33 TIG
- KEY V25E - LOAD TIG
- PRO
- F 06 81 ΔV X, Y, Z (LV)
- KEY V25E - LOAD ΔV
- PRO
- F 06 42 HA, HP, ΔV
- PRO
- F 16 45 MARKS, TFI, MGA
- SET DET TO TFI
- PRO
- F 37 KEY V37E41E (RCS THRUST)
- F 50 18 AUTO MNVR FDAI - R, P, Y
- ENTR (BYPASS MNVR)
- 16 85 VG (BODY; UP, RT, FWD)
- MNVR TILL ALL VG APPEARS NEGATIVE IN R1 (0,085,0)
- KEY V77E

111:50
111:50
16 50 TFI, VG, ∆VM
CHECK DET, VG

*410+5 (EXTERNAL ∆V ROUTINE) *
*373+TIG *
*450-VGX *
*451+0 *
*542+VGZ *
*310R (TFI) *
*CHECK DET *
*370R (∆V TO BE GAINED) *
*CHECK VG *
*500R *

(SUNRISE)

111:55

CSM CIRCULARIZATION

16 85 DISPLAY RESTORED VIA LGC AT TIG-30
112:01(T=0) F 16 85 NULL VG'S TO .2 FPS
KEY V82E (ORBITAL PARAMETERS DISPLAY)
16 44 HA, HP, TFF
CHECK HP (7.2)
PRO
F 37 KEY 76E (UPDATE CSM SV)
F 06 33 CSM CIRC TIG
KEY V25E - CSM ACTUAL CIRC TIG
PRO
F 06 84 CSM ∆V
KEY V25E - CSM ∆V
PRO

112:05
CDR

112:05

F 37 BB
KEY 00E (POO)
KEY V82E (ORBIT PARAMETER)

112:05

F 04 12 VEHICLE CODE
KEY V22E 00002E (CSM)
F 04 12 00002, 00002, BLANK
PRO
F 16 44 APOLUNE ALT, PERILUNE ALT, TIME OF FREE FALL
CHECK CSM APOLUNE (70.3) AND PERILUNE (54.3)
PRO (TERMINATE)
KEY V47E (INITIALIZE AGS)
F 06 16 *414+1 UPDATE AGS
*PRO
06 16 *UPDATE IN PROGRESS·
*414R (+00000 COMPLETE)
*UPDATE COMPLETE
*PRO
F 50 16 DSKY BLANKS
KEY V83E (RNDZ PARAMETERS
F 16 54 R, RDOT, THETA

*TELEMETRY PCM SW - HI
*414+1 UPDATE AGS
*PRO
*UPDATE IN PROGRESS·
*414R (+00000 COMPLETE)
*UPDATE COMPLETE
*PRO

F63 IGNITION ALGORITHM TEST

KEY V37E63E (BRAKING)
F 06 61 TGO _____, TFI, CR
KEY N33E (DISPLAY TIG)
06 33 TIG

*RESET DET TO COUNT DN TO PDI
112:10

CDR

VERIFY TIG
KEY RLSE
F 06 61 TGO, TFI, CR
PRO
F 50 18 0, 108, XXX (R,P,Y FDAI ANGLES)
(REQUEST MNVR)
PGNS MODE CONT - AUTO
PRO (AUTO MNVR)

DSKY BLANKS
F 50 18 (MNVR IS COMPLETED)
YAW TO 290 DEG
0, 108, 290 (R,P,Y FDAI ANGLES)
ENTR (BYPASS MNVR)
F 06 62 KEY V34E (TERMINATE)
F 37 BB
KEY OOE (P00)

KEYV48E
F 04 46 22112, 00011
(DAP CONFIGURATION, CHANBKUP)
PRO
F 06 47 LM WT, CSM WT
KEY V34E

LMP

112:15

CAMERA SETTING (PDI)

*LM3/DAC/10/CEX-WDG (T/2.8, 1/500, ∞) *
* 12 FPS, .75 MAG N, (6 MIN) *
*CAMERA SETTING (EARTH RISE) *
*LM/DC/60/HCEX (f16, 1/250, ∞) *
* 5 FR, MAG A *

COAS TO OVERHEAD WINDOW
VERIFY LOOSE GEAR STOWED
RESTRAINTS ATTACHED
VERIFY FDAI'S INERTIAL
112:15

**PRE-PDI ECS CHECKOUT**

HELMETS AND GLOVES ON

* Cabin Repress - Close
* Suit Gas Diverter - Egress
* Cabin Gas Return - Egress
* Press Regs A & B - Egress

**PRE-PDI SWITCH SETTING CHECK**

CB(11) EPS: INV 1 - CLOSE
* Select Inv 1
CB(11) STAB/CONT: AELD - CLOSE
CB(11) STAB/CONT: ABORT STAGE - CLOSE
RESET ENG STOP PB
SET WINDOW BARS

CB(16) STAB/CONT: AELD - CLOSE
* CB(16) STAB/CONT: ABORT STAGE - CLOSE
* Cycle CWEA CB
* BATS 5 & 6 Norm Feed - ON
* Record Get _____:____:____

THROT CONT - AUTO
CDR TTCA - THROTTLE - MIN
*RMP TTCA - THROTTLE - SOFT STOP

RATE SCALE - 25°/SEC
ATT/TRANSL - 4 JETS
CHECK DPS, APS, RCS, ECS, EPS, RECORD APS DATA
CHECK SWITCH GUARDS
PRPLNT QTY MON - DES 1
CHECK DPS CONFIG CARD (SEE APPENDIX)

**CHECK PDI RULES**

AUDIO MODE (BOTH - VOX)
CDR

112:35 AOS REV 13

* S-BAND ANT - FWD
* VERIFY COMM
* CHECK S-BAND ANT ANGLES
* PITCH -33
* YAW +54
* S-BAND ANT - SLEW UNTIL
* SIGNAL STRENGTH > 3.0
* S-BAND TRACK MODE - AUTO
* SET S-BAND ANT ANGLES
* PITCH -24
* YAW - 3
* VHF B TRANSMITTER - OFF
* BIOMED - LEFT
* TELEMETRY PCM SW - HI
* UPLINK SQUELCH - OFF
* CHECK ED BATTs AND REPORT
* VOICE ASC BATT ON TIME TO MSFN

LMP

MSFN UPLINK, UPDATE

* UPDATE LINK - DATA
* UPLINK LM S.V., RLS
* UPDATE LINK - VOICE BU
* COPY, LOAD AGS RLS (231)

UPDATE AND CONFIGURE AGS

KEY V47E (INITIALIZE AGS)

F 06 16
06 16

112:40

* 414+1 UPDATE AGS
* PRO
* UPDATE IN PROGRESS
* 414R (+00000 COMPLETE)
112:40  F 50 16  

DSKY BLANKS
KEY V83E (RENNZVOUS PARAMETERS)
F 16 54  R, RDOT, THETA

112:45  F 50 18  

POWERED DESCENT INITIATION
KEY V25N69E (BACKUP RLS IF NO UPLINK)

KEY V37E63E (BRAKING)
F 06 61  TG, TFI, CR

PGNS MODE CONT - AUTO
AGS MODE CONT - AUTO

VERIFY FDAI
-5 (112:45) CB(11) PGNS: LDG RDR - CLOSE
CHECK ALT XMTR
-4 PRO (FINAL TRIM)

DSKY BLANKS
F 50 18 (MNVR IS COMPLETED)
ENTR 06 62 VI, TFI, DELTA VM
VERIFY DET WITH TFI

PDI GO/NO GO FROM MSFN
COMM CHECK WITH CSM
RESET WATCH
MASTER ARM - ON
MODE SEL - PGNS

-2:00

-0:35 DSKY BLANKS FOR 5 SEC
-0:30 06 62 ENGINE ARM - DESCENT

-0:07.5 AUTO ULLAGE IF NO ULLAGE, +X TRANSL - PUSH (DO NOT BACK UP AUTO START)

-0:05 F 99 62 ENABLE IGNITION
PRO 06 62 VI, TFI, DELTA VM

0:0 (112:49:38) ENGINE START (PDI)
06 63 ΔH, H, H

IF NO IGNITION : START PB - PUSH
### 2.2 POWERED DESCENT MONITORING

<table>
<thead>
<tr>
<th>CDR</th>
<th>TFI</th>
<th>PITCH</th>
<th>ΔH MAX</th>
<th>H (MAX) - HDOT</th>
<th>H</th>
<th>DPS</th>
<th>S-BD</th>
<th>LMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINE START</td>
<td>0:00</td>
<td>108</td>
<td>67.0</td>
<td>56500</td>
<td>95</td>
<td>-33/54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THRUST - 10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RATES, ERRORS &lt; 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DES ENG CMD OVRD - ON</td>
<td>0:05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MASTER ARM - OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THROTTLE UP (FTP)</td>
<td>0:26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T/W &gt; 1.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RATES, ERRORS &lt; 5</td>
<td>0:30</td>
<td>108</td>
<td>66.0</td>
<td>54500</td>
<td>95</td>
<td>-23/55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td>1:00</td>
<td>98</td>
<td>69.0</td>
<td>52400</td>
<td>95</td>
<td>-23/55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPY N69 FROM MSFN</td>
<td>1:30</td>
<td>93</td>
<td>69.0</td>
<td>50300</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V21N69E, LOAD R1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RECEIVE GO FOR ENTR</td>
<td>2:00</td>
<td>89</td>
<td>68.0</td>
<td>48300</td>
<td>87</td>
<td>-8/55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTR (N63 RETURNS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td>2:30</td>
<td>85</td>
<td>65.0</td>
<td>46300</td>
<td>82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td>3:00</td>
<td>82</td>
<td>63.0</td>
<td>44400</td>
<td>76</td>
<td>3/53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YAW RIGHT TO 340° @ 4:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR ALT LT - OUT</td>
<td>3:30</td>
<td>79</td>
<td>62.0</td>
<td>42500</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VERIFY AH WITHIN LIMITS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RECEIVE MSFN GO FOR ACCEPT</td>
<td>4:00</td>
<td>77</td>
<td>63.0</td>
<td>40600</td>
<td>66</td>
<td>11/51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V57E (06 63 STATIC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VERIFY CONVERGENCE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PITCH, ROLL YAW - NOM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

367R CHECK DPS, RCS

ΔH, HDOT, H - NOM

H, HDOT AGS = H, HDOT PGNS

V LAT AGS = ZERO

PGNS BALL = AGS BALL

CHECK DPS, RCS

ΔH, HDOT, H - NOM

H, HDOT AGS = H, HDOT PGNS

V LAT AGS = ZERO

PGNS BALL = AGS BALL

CHECK DPS, RCS

ΔH, HDOT, H - NOM

H, HDOT AGS = H, HDOT PGNS

V LAT AGS = ZERO

PGNS BALL = AGS BALL

CHECK DPS, RCS

ΔH, HDOT, H - NOM

H, HDOT AGS = H, HDOT PGNS

V LAT AGS = ZERO

PGNS BALL = AGS BALL

REPORT ED BATTs
<table>
<thead>
<tr>
<th>CDR</th>
<th>TFI</th>
<th>PITCH</th>
<th>$\Delta H$</th>
<th>MAX $\Delta H$</th>
<th>H</th>
<th>DPS</th>
<th>S-BD</th>
<th>LMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPY N69 FROM MSFN</td>
<td>4:30</td>
<td>76</td>
<td>66.0</td>
<td>(MAX) - HDOT</td>
<td>38800</td>
<td>61</td>
<td></td>
<td>CHECK DPS, RCS</td>
</tr>
<tr>
<td>V2XN69E, LOAD</td>
<td>5:00</td>
<td>75</td>
<td>+19800</td>
<td>70.0</td>
<td>36200</td>
<td>55</td>
<td>-19/14</td>
<td>LR VEL LT - OUT</td>
</tr>
<tr>
<td>RECEIVE GO FOR ENTR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HDOT, H - NOM</td>
</tr>
<tr>
<td>ENTR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PGNS BALL = AGS BALL</td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td>5:30</td>
<td>73</td>
<td>+19800</td>
<td>84.0</td>
<td>34000</td>
<td>50</td>
<td></td>
<td>CHECK DPS, RCS</td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td>6:00</td>
<td>72</td>
<td>+19800</td>
<td>85.0</td>
<td>31100</td>
<td>45</td>
<td>-17/13</td>
<td>HDOT, H - NOM</td>
</tr>
<tr>
<td>AUTO YAW TO ZERO AT 30K</td>
<td>6:30</td>
<td>72</td>
<td>+19800</td>
<td>(516.0)</td>
<td></td>
<td></td>
<td></td>
<td>PGNS BALL = AGS BALL</td>
</tr>
<tr>
<td>N68E, CHECK TGO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CHECK DPS, RCS</td>
</tr>
<tr>
<td>KEY RLSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HDOT, H - NOM</td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td>7:00</td>
<td>67</td>
<td>+19800</td>
<td>103.0</td>
<td>30800</td>
<td>39</td>
<td></td>
<td>PGNS BALL = AGS BALL</td>
</tr>
<tr>
<td>COPY THROTTLE DN FROM MSFN</td>
<td>7:30</td>
<td>63</td>
<td>+16000</td>
<td>107.0</td>
<td>23900</td>
<td>30</td>
<td></td>
<td>CHECK DPS, RCS</td>
</tr>
<tr>
<td>N92, MONITOR CMD THRUST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HDOT, H - NOM</td>
</tr>
<tr>
<td>VERIFY THROTTLE DN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PGNS BALL = AGS BALL</td>
</tr>
<tr>
<td>KEY RLSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CHECK DPS, RCS</td>
</tr>
<tr>
<td>PGNS MODE CNTL - ATT HOLD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NULL ERROR NEEDLES</td>
</tr>
<tr>
<td>EVALUATE MANUAL CONTROL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PGNS MODE CNTL - AUTO</td>
</tr>
<tr>
<td>H, HOOT PGNS = H, HOOT AGS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EVALUATE MANUAL CONTROL</td>
</tr>
<tr>
<td>NULL ERROR NEEDLES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EVALUATE MANUAL CONTROL</td>
</tr>
<tr>
<td>COPY N69 FROM MSFN</td>
<td>8:00</td>
<td>57</td>
<td>+11200</td>
<td>133.0</td>
<td>19500</td>
<td>27</td>
<td>-20/9</td>
<td>HDOT, H - NOM</td>
</tr>
<tr>
<td>V2XN69E, LOAD R3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PGNS BALL = AGS BALL</td>
</tr>
<tr>
<td>RECEIVE GO FOR ENTR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>223+00130 (DO NOT ENTR)</td>
</tr>
<tr>
<td>ENTR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CHECK DPS, RCS</td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td>8:30</td>
<td>56</td>
<td>+8400</td>
<td>(348.0)</td>
<td>143.0</td>
<td>15000</td>
<td>24</td>
<td>ENTR (223) @ 13,000 FT</td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td>9:00</td>
<td>56</td>
<td>+8000</td>
<td>(288.0)</td>
<td>154.0</td>
<td>10700</td>
<td>21</td>
<td>360 - (PGNS HDOT)E</td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HDOT, H - NOM</td>
</tr>
<tr>
<td>PITCH, ROLL, YAW - NOM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H, HDOT PGNS = H, HDOT AGS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEQUENCE CAMERA - ON</td>
</tr>
</tbody>
</table>

Powered Descent

2-23
<table>
<thead>
<tr>
<th>CDR</th>
<th>H</th>
<th>(MAX) - HDOT (5000)</th>
<th>DPS</th>
<th>VH (362)</th>
<th>LMP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7000</td>
<td>225.0</td>
<td>169.0</td>
<td>18</td>
<td>258.0</td>
</tr>
<tr>
<td></td>
<td>6000</td>
<td>206.0</td>
<td>152.0</td>
<td>18</td>
<td>240.0</td>
</tr>
<tr>
<td></td>
<td>5000</td>
<td>184.0</td>
<td>132.0</td>
<td>17</td>
<td>223.0</td>
</tr>
<tr>
<td></td>
<td>4000</td>
<td>161.0</td>
<td>110.0</td>
<td>16</td>
<td>200.0</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>134.0</td>
<td>88.0</td>
<td>15</td>
<td>173.0</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>103.0</td>
<td>63.0</td>
<td>14</td>
<td>138.0</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>63.0</td>
<td>35.0</td>
<td>12</td>
<td>85.0</td>
</tr>
<tr>
<td>PGNS MODE CNTL - ATT HOLD</td>
<td>500</td>
<td>35.0</td>
<td>17.0</td>
<td>11</td>
<td>43.0</td>
</tr>
<tr>
<td>SLOW DESCENT WITH ROD SW</td>
<td>400</td>
<td>28.0</td>
<td>14.0</td>
<td>11</td>
<td>31.0</td>
</tr>
<tr>
<td>(P66)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MANEUVER TO LANDING SITE</td>
<td>300</td>
<td>20.0</td>
<td>9.0</td>
<td>10</td>
<td>16.0</td>
</tr>
<tr>
<td>NULL LATERAL VELOCITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF DUST SEVERE:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[PGNS MODE CNTL - AUTO]</td>
<td>200</td>
<td>12.0</td>
<td>5.0</td>
<td>9</td>
<td>-5.0</td>
</tr>
</tbody>
</table>

SLOW TO 3 FPS PRIOR TO LDG
LUNAR CONTACT: ENG STOP - PUSH
3.0 POWERED DESCENT ABORTS

AUTO

Aborts from powered descent may be controlled by PGNS or AGS, and may be on the DPS or APS engine, depending on what failure has caused the abort. All aborts are targeted for an insertion altitude of 60,000 feet above the landing site radius, an altitude rate of +19.5 fps, and an insertion velocity which is variable as a function of the CSM-LM phase angle at the time of abort. However, limiting factors are imposed which result in the following deviations from nominal:

1. Insertion altitude varies from about 54,000 feet to 60,000 feet during the first two minutes of powered descent for DPS, and during the first three minutes for APS.

2. Insertion altitude may be as high as 72,000 feet for an abort on DPS at 9 minutes into the descent. Some dispersions will occur for aborts after 6 minutes.

The LM has DPS insertion capability for aborts prior to PDI + 6 minutes. After that time, abort staging is required to make orbit. However, all aborts prior to landing are started on the DPS, if possible, because of the higher thrust/weight ratio. The DPS is allowed to burn to propellant depletion prior to abort staging.

Because of the variety of initial conditions from which an abort may occur, it is not possible for the crew to closely monitor the abort trajectory. However, targeting can be verified and convergence on the target conditions monitored.

MANUAL

Manual aborts may be flown from powered descent by following the pitch profiles shown on Page 3-4. Manual aborts require that the abort be initiated from a nominal descent trajectory.
POWERED DESCENT ABORTS

DPS

GUID CONT - PGNS OR AGS
PGNS - ATT HOLD
THROTTLE - MAX
ABORT PB - PUSH
V22N46EE NO P70, V37E70E
NOTE ABORT TIME
MODE CONTROL (PGNS, AGS) - AUTO
MONITOR VERTICAL RISE (< 25K FT), PITCHOVER
YAW RT 30°
623+1
VERIFY S-BD LOCK-ON OR AFT OMNI

(Prop Depletion - Abort Stage, and Perform APS Starred Items)

APS

GUID CONT - PGNS OR AGS
ABORT STAGE - PUSH
PGNS - ATT HOLD
*V22N46EE NO P71, V37E71E
NOTE ABORT TIME
MODE CONT (PGNS, AGS) - AUTO
*ENG ARM - ASC
*ENG START - PUSH
MONITOR VERTICAL RISE (< 25K FT), PITCHOVER
YAW RT 30°
623+1
*ASC FEED 2(2) - OPEN
*MAIN SOV (2) - CLOSE
VERIFY S-BD LOCK-ON OR AFT OMNI
*DES 02 - CLOSE
*ASC #1 02 - OPEN
*H2O SEL - ASC
*H2O DES - CLOSE
*H2O ASC - OPEN
*PROP TEMP PRESS - ASC
*HE MON - ASC
*THROT/JETS - JETS

VERIFY TARGETING
N76 E (VX, VZ, ΔR)
VERIFY TARGETING PER PDI SUMMARY DATA (ABORT) CARD (SEE APPENDIX)
N 77 E (TGO, VY)
VERIFY TGO PER ABORT CARD
KEY RLSE
500 R (VGX)
VERIFY PGNS VGX = AGS VGX
CHECK TRIM SOURCE WITH MSFN
INSERTION CHECKLIST

DPS

VGX = 200 FPS: DES ENG CMD OVRD - OFF

DPS SHUTDOWN WITH VGX > 30 - ABORT STAGE

VGX = 0: ENGINE STOP - PUSH
ENG ARM - OFF
ABORT - RESET
PRPLNT QTY MON - OFF

APS

*VGX = 500 FPS: RCS MAIN SOV (2) - OPEN
ASC FEED 2 (2) - CLOSE

EARLY APS SHUTDOWN - BURN PGNs RESIDUALS
OR AGS VGX WITH RCS. AGS TO ATT HOLD
AT VGX = 15 FPS

*VGX = 200 FPS: ENG ARM - OFF

*VGX = 0: ABORT STAGE - RESET
ENG STOP - PUSH

410+5 LOAD AGS VG'S
PRO (VGX, VGY, VGZ)

FOR NO VOICE (TRIM < 2 FPS)
PGNS, AGS DIFFER < 10 FPS, TRIM
ACTIVE SYSTEM
PGNS, AGS DIFFER > 10 FPS, TRIM
SYSTEM THAT AGREES WITH RR

NULL VGX WITH TTCA (< 2 FPS)
RECORD GET
RESTART WATCH
PRO
POO
ENG STOP - RESET
CHECK MSFN FOR TWEAK
V82E
PRO (HA, HP, TFF) - RECORD
PRO
POO
315R (HA) - RECORD
403R (HP) - RECORD
## FDAI AND OVERHEAD WINDOW ANGLES FOR MANUAL DESCENT ABORT

### DPS/APS

<table>
<thead>
<tr>
<th>Time</th>
<th>Pitch Rate</th>
<th>FDVAI</th>
<th>OHW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00</td>
<td>260/0</td>
<td>4:30</td>
<td>0/LV</td>
</tr>
<tr>
<td>2:24</td>
<td>SD(FDAI)</td>
<td>4:44</td>
<td>300/36</td>
</tr>
<tr>
<td>2:36</td>
<td>SD(OHW)</td>
<td>6:26</td>
<td>270/5</td>
</tr>
<tr>
<td>7:32</td>
<td>250/0</td>
<td>14:30</td>
<td>250/0</td>
</tr>
<tr>
<td>8:19</td>
<td>SD</td>
<td>14:43</td>
<td>SD</td>
</tr>
<tr>
<td>1:30</td>
<td>0/0</td>
<td>5:00</td>
<td>0/LV</td>
</tr>
<tr>
<td>1:44</td>
<td>300/0</td>
<td>5:14</td>
<td>300/36</td>
</tr>
<tr>
<td>2:30</td>
<td>260/0</td>
<td>6:58</td>
<td>270/5</td>
</tr>
<tr>
<td>3:20</td>
<td>250/0</td>
<td>9:03</td>
<td>270/5</td>
</tr>
<tr>
<td>2:00</td>
<td>0/LV</td>
<td>6:00</td>
<td>0/LV</td>
</tr>
<tr>
<td>2:14</td>
<td>300/36</td>
<td>6:14</td>
<td>300/36</td>
</tr>
<tr>
<td>3:00</td>
<td>300/0</td>
<td>7:34</td>
<td>270/10</td>
</tr>
<tr>
<td>3:18</td>
<td>260/0</td>
<td>9:04</td>
<td>250/0</td>
</tr>
<tr>
<td>3:36</td>
<td>250/0</td>
<td>10:39</td>
<td>270/10</td>
</tr>
<tr>
<td>3:46</td>
<td>SD</td>
<td>11:39</td>
<td>SD</td>
</tr>
<tr>
<td>3:00</td>
<td>0/LV</td>
<td>6:30</td>
<td>0/LV</td>
</tr>
<tr>
<td>3:14</td>
<td>300/36</td>
<td>6:44</td>
<td>300/36</td>
</tr>
<tr>
<td>3:24</td>
<td>270/0</td>
<td>8:34</td>
<td>270/11</td>
</tr>
<tr>
<td>5:10</td>
<td>250/0</td>
<td>11:04</td>
<td>250/0</td>
</tr>
<tr>
<td>5:57</td>
<td>SD(FDAI)</td>
<td>12:47</td>
<td>SD</td>
</tr>
<tr>
<td>6:06</td>
<td>SD(OHW)</td>
<td>14:47</td>
<td>SD</td>
</tr>
<tr>
<td>3:30</td>
<td>0/LV</td>
<td>7:00</td>
<td>0/LV</td>
</tr>
<tr>
<td>3:44</td>
<td>300/36</td>
<td>7:14</td>
<td>300/36</td>
</tr>
<tr>
<td>5:24</td>
<td>270/0</td>
<td>9:06</td>
<td>270/14</td>
</tr>
<tr>
<td>5:54</td>
<td>250/0</td>
<td>12:26</td>
<td>250/0</td>
</tr>
<tr>
<td>6:50</td>
<td>SD(FDAI)</td>
<td>12:53</td>
<td>SD</td>
</tr>
<tr>
<td>7:02</td>
<td>SD(OHW)</td>
<td>13:53</td>
<td>SD</td>
</tr>
<tr>
<td>4:00</td>
<td>0/LV</td>
<td>7:30</td>
<td>0/LV</td>
</tr>
<tr>
<td>4:14</td>
<td>300/36</td>
<td>7:44</td>
<td>300/36</td>
</tr>
<tr>
<td>5:56</td>
<td>270/0</td>
<td>9:38</td>
<td>270/14</td>
</tr>
<tr>
<td>6:38</td>
<td>250/0</td>
<td>13:38</td>
<td>250/0</td>
</tr>
<tr>
<td>7:34</td>
<td>SD(FDAI)</td>
<td>13:53</td>
<td>SD</td>
</tr>
<tr>
<td>7:40</td>
<td>SD(OHW)</td>
<td>13:53</td>
<td>SD</td>
</tr>
</tbody>
</table>

### ALL PITCH RATES 5°/SEC

<table>
<thead>
<tr>
<th>Time</th>
<th>Pitch Rate</th>
<th>FDVAI</th>
<th>OHW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00</td>
<td>260/0</td>
<td>4:30</td>
<td>0/LV</td>
</tr>
<tr>
<td>2:18</td>
<td>SD(FDAI)</td>
<td>5:10</td>
<td>300/36</td>
</tr>
<tr>
<td>2:36</td>
<td>SD(OHW)</td>
<td>6:26</td>
<td>270/10</td>
</tr>
<tr>
<td>8:26</td>
<td>250/0</td>
<td>14:30</td>
<td>250/0</td>
</tr>
<tr>
<td>8:51</td>
<td>SD</td>
<td>15:05</td>
<td>SD</td>
</tr>
<tr>
<td>1:30</td>
<td>0/LV</td>
<td>5:00</td>
<td>0/LV</td>
</tr>
<tr>
<td>2:19</td>
<td>260/0</td>
<td>5:10</td>
<td>300/36</td>
</tr>
<tr>
<td>3:32</td>
<td>SD(FDAI)</td>
<td>7:08</td>
<td>270/10</td>
</tr>
<tr>
<td>3:52</td>
<td>SD(OHW)</td>
<td>9:20</td>
<td>250/0</td>
</tr>
<tr>
<td>9:46</td>
<td>SD</td>
<td>15:50</td>
<td>SD</td>
</tr>
<tr>
<td>2:00</td>
<td>0/LV</td>
<td>6:30</td>
<td>0/LV</td>
</tr>
<tr>
<td>2:40</td>
<td>300/0</td>
<td>6:10</td>
<td>300/36</td>
</tr>
<tr>
<td>3:10</td>
<td>260/0</td>
<td>7:54</td>
<td>270/12</td>
</tr>
<tr>
<td>4:24</td>
<td>SD(FDAI)</td>
<td>10:14</td>
<td>250/0</td>
</tr>
<tr>
<td>4:34</td>
<td>SD(OHW)</td>
<td>10:42</td>
<td>SD</td>
</tr>
<tr>
<td>3:30</td>
<td>0/LV</td>
<td>6:30</td>
<td>0/LV</td>
</tr>
<tr>
<td>3:40</td>
<td>300/0</td>
<td>7:10</td>
<td>300/36</td>
</tr>
<tr>
<td>4:22</td>
<td>270/0</td>
<td>9:34</td>
<td>270/14</td>
</tr>
<tr>
<td>5:28</td>
<td>250/0</td>
<td>12:02</td>
<td>250/0</td>
</tr>
<tr>
<td>6:09</td>
<td>SD</td>
<td>12:33</td>
<td>SD</td>
</tr>
<tr>
<td>3:00</td>
<td>0/LV</td>
<td>6:30</td>
<td>0/LV</td>
</tr>
<tr>
<td>3:40</td>
<td>300/0</td>
<td>7:10</td>
<td>300/36</td>
</tr>
<tr>
<td>4:22</td>
<td>270/0</td>
<td>9:34</td>
<td>270/14</td>
</tr>
<tr>
<td>5:28</td>
<td>250/0</td>
<td>12:02</td>
<td>250/0</td>
</tr>
<tr>
<td>6:09</td>
<td>SD</td>
<td>12:33</td>
<td>SD</td>
</tr>
<tr>
<td>3:30</td>
<td>0/LV</td>
<td>7:00</td>
<td>0/LV</td>
</tr>
<tr>
<td>4:10</td>
<td>300/0</td>
<td>7:40</td>
<td>300/36</td>
</tr>
<tr>
<td>5:00</td>
<td>270/0</td>
<td>10:24</td>
<td>270/14</td>
</tr>
<tr>
<td>6:30</td>
<td>250/0</td>
<td>12:56</td>
<td>250/0</td>
</tr>
<tr>
<td>7:02</td>
<td>SD</td>
<td>13:28</td>
<td>SD</td>
</tr>
<tr>
<td>4:00</td>
<td>0/LV</td>
<td>7:30</td>
<td>0/LV</td>
</tr>
<tr>
<td>4:40</td>
<td>300/0</td>
<td>8:10</td>
<td>300/36</td>
</tr>
<tr>
<td>5:40</td>
<td>270/5</td>
<td>11:12</td>
<td>270/14</td>
</tr>
<tr>
<td>7:28</td>
<td>250/0</td>
<td>13:48</td>
<td>250/0</td>
</tr>
<tr>
<td>7:56</td>
<td>SD</td>
<td>14:19</td>
<td>SD</td>
</tr>
</tbody>
</table>

*ESTABLISH POSITIVE HDOT, THEN ABORT STAGE*
4.0 POWERED ASCENT

The preparations for powered ascent appear in the Lunar Surface Checklist. This document covers only the time from lift-off through insertion. Targeted insertion conditions are 60,100 feet altitude, +32.2 fps altitude rate, and 5533 fps inertial velocity. These conditions result in a 9.1 by 47.2 NR orbit. During ascent, the crew monitors PGNS and AGS displays and compares them with nominal. The AGS check is used to verify off-nominal PGNS displays and/or to determine if the AGS is performing nominally. Five minutes into ascent, the Rendezvous Radar is turned on and, if communication with MSFN is lost, the RR Range is compared to PGNS and AGS Range to determine the best trim system.
### 4.1 POWERED ASCENT MONITORING

<table>
<thead>
<tr>
<th>Time (HH:MM)</th>
<th>CDR</th>
<th>TFI</th>
<th>OHW*</th>
<th>VGX</th>
<th>HDOT</th>
<th>H</th>
<th>SBD</th>
<th>HE</th>
<th>LMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>ENG START</td>
<td>070.0</td>
<td>0.0</td>
<td>0</td>
<td>77/66</td>
<td>3050</td>
<td>NO C&amp;W LIGHTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0:10</td>
<td>ENG START-PUSH (IF AUTO IGN)</td>
<td>890.0</td>
<td>52.0</td>
<td>300</td>
<td>AGS HDOT = 50 FPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0:30</td>
<td>VERTICAL RISE, YAW TO 0°, 0°, 0°</td>
<td>4820.0</td>
<td>88.0</td>
<td>1600</td>
<td>S-BD LOCK-ON 640+0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td>PITCH DN TO 308°</td>
<td>4650.0</td>
<td>123.0</td>
<td>5000</td>
<td>141/-52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:30</td>
<td>YAW RT 30°</td>
<td>4470.0</td>
<td>149.0</td>
<td>9100</td>
<td>2640</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:00</td>
<td>PITCH - NOM</td>
<td>4250.0</td>
<td>168.0</td>
<td>13900</td>
<td>145/-47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:30</td>
<td>ROLL - ZERO</td>
<td>4000.0</td>
<td>181.0</td>
<td>19200</td>
<td>2140</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:00</td>
<td>N 76 E (VH, VV, R)</td>
<td>3720.0</td>
<td>188.0</td>
<td>24700</td>
<td>1980</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:30</td>
<td>CHECK TARGETING</td>
<td>3400.0</td>
<td>188.0</td>
<td>30400</td>
<td>1820</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:00</td>
<td>N 77 E (TGO, VY)</td>
<td>3060.0</td>
<td>183.0</td>
<td>36000</td>
<td>152/-37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:30</td>
<td>KEY RLSE</td>
<td>2680.0</td>
<td>173.0</td>
<td>41300</td>
<td>1520</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 0° YAW
# Powered Ascent

<table>
<thead>
<tr>
<th>CDR</th>
<th>TFI</th>
<th>OHW*</th>
<th>VGX</th>
<th>HDOT</th>
<th>H</th>
<th>SBD</th>
<th>HE</th>
<th>LMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAME AS 2 MIN CHK</td>
<td>5:00</td>
<td>278</td>
<td>20</td>
<td>2270.0</td>
<td>157.0</td>
<td>46300</td>
<td>156/-31</td>
<td>SAME AS 2 MIN CHK</td>
</tr>
<tr>
<td></td>
<td>5:30</td>
<td>274</td>
<td>17</td>
<td>1840.0</td>
<td>136.0</td>
<td>50700</td>
<td>1240</td>
<td></td>
</tr>
<tr>
<td>SAME AS 2 MIN CHK</td>
<td>6:00</td>
<td>269</td>
<td>14</td>
<td>1370.0</td>
<td>111.0</td>
<td>54400</td>
<td>160/-24</td>
<td>SAME AS 2 MIN CHK</td>
</tr>
<tr>
<td>COPY MSFN TRIM SOURCE</td>
<td>6:30</td>
<td>265</td>
<td>11</td>
<td>870.0</td>
<td>83.0</td>
<td>57300</td>
<td>970</td>
<td></td>
</tr>
<tr>
<td>VGX = 200, ENG ARM-OFF (IF AUTO IGN)</td>
<td>7:00</td>
<td>260</td>
<td>8</td>
<td>330.0</td>
<td>52.0</td>
<td>59300</td>
<td>164/-20</td>
<td>VGX AGS = VGX PGNS</td>
</tr>
<tr>
<td>VGX = 0, ABORT STAGE-RESET</td>
<td>7:18</td>
<td>257</td>
<td>6</td>
<td>0.0</td>
<td>32.0</td>
<td>60100</td>
<td>166/-15</td>
<td>VGX AGS = VGX PGNS</td>
</tr>
</tbody>
</table>

- **ENG STOP - PUSH**
  - PRO (VGX, VGY, VGZ)
  - NULL VGX (< 2 FPS)
  - PRO
  - POO
- **ENG STOP - RESET**
  - MODE CNTL (BOTH) - ATT HOLD
  - CHECK MSFN FOR TWEAK
  - V82E, PRO (HA, HP, TFF)
  - PRO
  - POO

* FOR NO VOICE (TRIM < 2 FPS)
  - PGNS, AGS DIFFER < 10 FPS, TRIM ACTIVE SYSTEM
  - PGNS, AGS DIFFER > 10 FPS, TRIM SYSTEM THAT AGREES WITH RR
  - (10° IN OHW) (0° YAW)

* 0° YAW

---

**POWERED ASCENT**

- VGX = 500 FPS:
  - MAIN SOV (2) - OPEN
  - ASC FEED 2(2) - CLOSE

- RECORD HDOT, H
- RECORD AGS VGX
- COPY GET, RESET WATCH
- RECORD AGS VGX
- RECORD HA, HP
  - 315R, RECORD HA
  - 403R, RECORD HP

---

* 0° YAW
4.2 MANUAL ASCENT

1. RATE DAMPED OR ATT HOLD CONTROL MODE AVAILABLE

   SWITCH CONFIGURATION NOMINAL PER LUNAR SURFACE CHKLST EXCEPT:
   MODE CONTROL (BOTH) - ATT HOLD

   *FLY NOMINAL PROFILE (ADJUST EACH 30 SEC) USING EITHER 8-BALL OR
   OVERHEAD WINDOW FOR ATTITUDE REFERENCE.

   6+30 - MAIN SOV (2) - OPEN
   ASC FEED 2(2) - CLOSE
   BURN TO PROP DEPLETION OR CALL FROM MSFN

2. DIRECT CONTROL MODE

   SWITCH CONFIGURATION NOMINAL PER LUNAR SURFACE CHKLST EXCEPT:
   ATT CONTROL (3) - DIRECT, MODE CONTROL (BOTH) - ATT HOLD

   A. *OVERHEAD WINDOW (OHW)

      MARK ANGLES ON OHW
      FLY 7-STEP PITCH PROFILE AS FOLLOWS:

      MAINTAIN YAW AND ROLL ZERO
      00:15 PITCH DOWN TO 38° (OHW)    PITCH RATES -- 5°/SEC
      02:00 PITCH DOWN TO 31° (OHW)
      03:00 PITCH DOWN TO 28° (OHW)
      04:00 PITCH DOWN TO 24° (OHW)
      05:00 PITCH DOWN TO 18° (OHW)
      06:00 PITCH DOWN TO 11° (OHW)
      07:00 PITCH DOWN TO 8° (OHW)

      LMP CONTROLS ROLL AND YAW, CDR CONTROLS PITCH
      6+30 - MAIN SOV (2) - OPEN
      ASC FEED 2(2) - CLOSE
      BURN TO PROP DEPLETION OR CALL FROM MSFN

   B. 8-BALL

      FLY 7-STEP PITCH PROFILE AS FOLLOWS:
      00:15 PITCH DOWN TO 305°    PITCH RATES -- 5°/SEC
      02:00 PITCH DOWN TO 295°
      03:00 PITCH DOWN TO 290°
      04:00 PITCH DOWN TO 285°
      05:00 PITCH DOWN TO 275°
      06:00 PITCH DOWN TO 265°
      07:00 PITCH DOWN TO 260°

      LMP CONTROLS ROLL AND YAW, CDR CONTROLS PITCH
      6+30 - MAIN SOV (2) - OPEN
      ASC FEED 2(2) - CLOSE
      BURN TO PROP DEPLETION OR CALL FROM MSFN

   *REMOVE HELMET AND SUIT, IF REQUIRED, TO VIEW THROUGH OVERHEAD WINDOW
APPENDIX

DPS BURN

CB(11) DECA GMBL AC - CLOSED
CB(16) DISP/ENG OVRD LOGIC - CLOSED
CB(11&16) STAB/CONT (ALL) - CLOSED
   EXCEPT CB(11) AEA - OPEN
RATE SCALE [PDI] - 25°/sec
THR CONT [PDI] AUTO/CDR
ATT/TRANSL - 4 JET
BAL CPL - ON
ENG GMBL - ENABLE
DES ENG CMD OVRD - OFF
ABORT/ABORT STAGE - RESET
DEADBAND - MIN
ATT CONT(3) - MODE CONT
MODE CONT [PDI] PGNS - AUTO
AGS - AUTO
STOP PB (2) - RESET
TTCA (2) - THROT/MIN [PDI] LMP TTCA-SOFT STOP
-2:00 400+1
-1:00 [PDI] MASTER ARM - ON
- :30 ENG ARM - DES
   FOR AGS BURN ABORT PB - PUSH (T=0 FOR AGS)
- :07.5 ULLAGE
- :05 PRO
   [PDI] ONLY
+ :05 DES ENG CMD OVRD - ON

SOURCE: LM CUE CARDS
APPENDIX

APS BURN

CB(16) DISP/ENG OV RD LOGIC - CLOSED
CB(11&16) AEA AND DECA PWR AND
STAB/CONT (ALL) - CLOSED
EXCEPT CB(11) AEA AND DECA PWR AND
CB(16) DES ENG OV RD - OPEN

RATE SCALE - 25°/sec
ATT TRANS - 4 JET
BAL CPL - ON
DEAD BAND MIN
ABORT/ABORT STAGE - RESET
ATT CONT(3) - MODE CONT

MODE CONT - ASCENT - PGNS - AUTO
AGS - AUTO

STOP PB (2) - RESET
TTCA (2) - JETS

-2:00 400+1

[AGS/PGNS]

-1:00 MASTER ARM - ON

[=14 ULLAGE (MANUAL - AGS)]
[=10 STAGE FIRE]

-10 ABORT STAGE PB - PUSH (T=0 FOR AGS)
ENG ARM - ASC
-:05 PRO

:00 ENG ON
+:01 ENG START - PUSH

SOURCE: LM CUE CARDS
APPENDIX

AS LANDING AREA COMES INTO VIEW, EVALUATE
LANDBING AREA AND DETERMINE IF DESIRED LS
IS >= 3° LEFT OR RIGHT OF LUBBER LINE

0-12
IF >= 3° ---- MAKE LATERAL
CORRECTION SUFFICIENT TO PUT DESIRED SITE
JUST TO THE OPPOSITE SIDE OF LUBBER LINE

12-20
RECEIVE LPD INFO FROM LMP AND EVALUATE A
BETWEEN DSKY AND DESIRED ELEVATION
OF LANDING SITE. ALLOW THE LGC AND LPJ
ANGLE TO SETTLE

MAKE DOWN RANGE (IF >= 1°) AND CROSS RANGE
(IF >= 2°) REDELEGATIONS TO ELIMINATE ALL
DOWN RANGE AND LATERAL ERROR

WAIT FOR ANY ATT TRANSIENTS TO SETTLE AND
ASSESS LPD ERRORS (~15 SEC FROM LAST
DOWN RANGE REDELEGATION)

IS LPD ON DESIRED TARGET
YES CONTINUE AND
REEVALUATE

IS CROSS RANGE
ERROR >= 2°
YES MAKE LATERAL
INPUTS TO
ELIMINATE ALL
CROSS RANGE
ERROR

IS DSKY
INDICATED LS
DRIFTING WITH
RESPECT TO
DESIRED LS
NO ELIMINATE ALL
UPRANGE OR
DOWN RANGE ERROR
IF |aLPD| >= 1°

IS DSKY IND LS
DRIFTING TOWARD OR AWAY FROM
DESIRED LS
YES ELIMINATE ALL
LPD (OVERCORRECTING
BY 1°)

WHEN |aLPD| = 0
INPUT 1° IN
OPPOSITE DIRECTION
OF DRIFT

WHEN |aLPD| >= 1°
ELIMINATE LPD
(DRIFTING TOWARD
AWAY FROM
DESIRED LS)

TIME FOR
MAN TAKEOVER
YES

EXIT P64

NO

PROCEDURES
FOR USE OF LPD
SOURCE:
GUIDANCE AND CONTROL DIVISION

A-3
## APPENDIX

### PDI SUMMARY DATA ABORT CARD

<table>
<thead>
<tr>
<th>TIME</th>
<th>INS+</th>
<th>Boost</th>
<th>HAM+</th>
<th>CSI+</th>
<th>CDH+</th>
<th>TPI+</th>
<th>AIM+</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAGE</td>
<td>ABORT</td>
<td>INS+</td>
<td>TIME</td>
<td>POI+</td>
<td>NA/HINS+</td>
<td>TIME</td>
<td>NA/HINS+</td>
</tr>
<tr>
<td>1+00</td>
<td>NA</td>
<td>5656.2</td>
<td>132.6</td>
<td>53784.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>2+00</td>
<td>NA</td>
<td>5651.9</td>
<td>131.1</td>
<td>58323.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>3+00</td>
<td>54+3</td>
<td>5646.3</td>
<td>128.3</td>
<td>60018.</td>
<td>NA</td>
<td>NA</td>
<td>0+55+00</td>
</tr>
<tr>
<td>4+00</td>
<td>7+18</td>
<td>5639.5</td>
<td>122.9</td>
<td>60023.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>5+00</td>
<td>8+49</td>
<td>5630.0</td>
<td>115.3</td>
<td>60030.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>6+00</td>
<td>10+13</td>
<td>5617.5</td>
<td>105.5</td>
<td>60039.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>7+00</td>
<td>12+35</td>
<td>5596.3</td>
<td>91.9</td>
<td>64950.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>8+00</td>
<td>14+27</td>
<td>5571.5</td>
<td>76.4</td>
<td>71046.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>9+00</td>
<td>16+06</td>
<td>5546.3</td>
<td>59.3</td>
<td>74249.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>10+00</td>
<td>17+18</td>
<td>5564.0</td>
<td>71.7</td>
<td>77271.5</td>
<td>50+00</td>
<td>1+50+00</td>
<td>2+40+00</td>
</tr>
<tr>
<td>11+00</td>
<td>18+21</td>
<td>5559.6</td>
<td>65.7</td>
<td>77277.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>12+00</td>
<td>19+24</td>
<td>5555.9</td>
<td>59.9</td>
<td>62049.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>13+00</td>
<td>20+27</td>
<td>5547.3</td>
<td>52.7</td>
<td>60251.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>14+00</td>
<td>21+27</td>
<td>5539.8</td>
<td>42.7</td>
<td>62025.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>15+00</td>
<td>22+26</td>
<td>5532.2</td>
<td>41.8</td>
<td>60248.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>16+00</td>
<td>23+26</td>
<td>5524.6</td>
<td>36.3</td>
<td>60246.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>17+00</td>
<td>24+25</td>
<td>5517.0</td>
<td>30.9</td>
<td>60244.</td>
<td>NA</td>
<td>NA</td>
<td>1+07+00*</td>
</tr>
<tr>
<td>18+00</td>
<td>25+24</td>
<td>5615.7</td>
<td>30.0</td>
<td>60154.</td>
<td>50+00</td>
<td>3+50+00</td>
<td>4+40+00</td>
</tr>
</tbody>
</table>

* INDICATES TIME IS REFERENCED TO POI. * INDICATES TIME IS REFERENCED TO LIFT-OFF. * INDICATES TIME IS REFERENCED TO PDI. Δ ASSUMES NO DOI-2