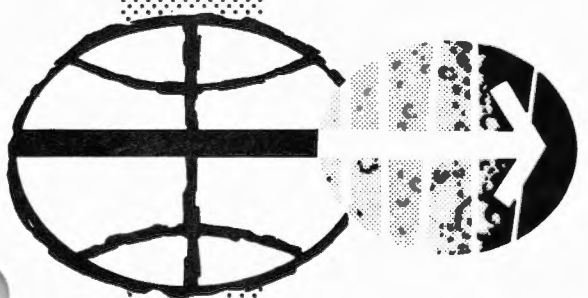
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MSC INTERNAL NOTE MSC-07486

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

D. T. Gregory

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

NOMENCLATURE

AGS	Abort Guidance System
AOS	Acquisition of Signal
AOT	Alignment Optical Telescope
APS	Ascent Propulsion System
ASC	Ascent
BP	Barber Pole
CB	Circuit Breaker
CDR	Commander
CDU	Coupling Data Unit
COAS	Crew Optical Alignment System
CR	Crossrange
CSM	Command and Service Module
CWEA	Caution and Warning Electronics Assembly
DES	Descent
DET	Digital Event Timer
DPS	Descent Propulsion System
DSKY	Display and Keyboard
E	Enter
ED	Explosive Devices
EPS	Electrical Power System
FDAI	Flight Director Attitude Indicator
FPS	Feet Per Second
FTP	Full Throttle Position
GET	Ground Elapsed Time
H	Altitude
HA	Apocynthion Altitude
H DOT	Altitude Rate
HE	Helium
HP	Pericynthion Altitude
IMU	Inertial Measurement Unit
LDG	Landing
LGC	LM Guidance Computer

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

		CDR	LMP
110:15			
		SYSTEMS ACTIVATION COMPLETE (PER ACT. CHKLST)	
		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 00E (P00)	
		KEY V60E (DISPLAY VEHICLE RATES)	
		YAW LEFT 60 DEGREES	
		PITCH UP 90 DEGREES	
		*SEQUENCE CAMERA - ON (1 MIN) *	
+3		FDAI (0, 280/013, 0) (CSM IN FWD WINDOW)	
110:30			

	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/H
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	LMP
110:35	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	*LM/DAC/10/CEX (T/1.8, 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 *
110:41	AOS REV 12	*S-BAND ANT - FWD * *VERIFY COMM * *CHECK S-BAND ANT ANGLES * * PITCH + 9 * * YAW -37 * *S-BAND ANT - SLEW UNTIL * * SIGNAL STRENGTH > 3.0 * *S-BAND TRACK MODE - AUTO * *VHF B TRANSMITTER - OFF * *BIOMED - LEFT * *TELEMETRY PCM SW - HI * *UPLINK SQUELCH - OFF *
	VOICE N20 ANGLES AND TIME TO MSFN	
	DPS THROTTLE CHECK	*CB(16) STAB/CONT: ENG ARM - CLOSE*
	THROT CONT - MAN/CDR TTCA (BOTH) - THROTTLE (MIN)	
		*VERIFY MSFN CONTACT *
110:43		

CDR LMP

110:43

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

MAN THROT - LMP

*REPEAT TEST FOR LMP TTCA *

ENGINE ARM - OFF

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

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

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
HELIUM 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
HELIUM MON: AMB PRESS 200-1110
: SUPCRIT PRESS 1070 - 1570

110:47

CDR LMP

110:47 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) *
*02/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) ABORT CONSTANTS *
*662 _____(-33007) *
*673 _____(-54456) *
*574R DESCENT STAGE (+ NOT STAGED) *
*604R LUNAR SURFACE FLAG *
(+NOT ON SURFACE) *
*612R STAGING COUNTER (+0 NOM) *

110:50

	CDR	LMP
110:50		*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) *
	MSFN UPDATE	
		*COPY AGS K FACTOR ____:____:____ *
		*KEY V47E (INITIALIZE AGS) *
	F 06 16	*KEY V25E AND LOAD AGS K FACTOR UPDATE *
		*414+1 UPDATE AGS
	F 06 16	*PRO *
	06 16	*UPDATE IN PROGRESS *
		*414R (+00000 COMPLETE) *
	F 50 16	*UPDATE COMPLETE *
	DSKY BLANKS	*PRO *
		*400+3 AGS ALIGN *
		*400R (+00000 COMPLETE) *
		*KEY V83E (RNDZ PARAMETERS) *
	F 16 54 R, RDOT, THETA SET ORDEAL	
		*317R (RANGE) *
		*440R (RANGE RATE) *
		*COMPARE WITH N54 VALUES *
110:55		

CDR LMP

110:55

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

111:03

CDR LMP

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 Ṙ DOES NOT AGREE WITHIN 7 FPS, EITHER PGNS OR THE RR HAS FAILED. CONTACT MSFN.

KEY V34E

VHF A XMTR - VOICE

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

41 BB KEY V16N72E
16 72 VERIFY ANT DRIVEN TO DESIRED ANGLES
CB(11) PGNS: RNDZ RDR - OPEN
CB(11) AC BUS A: RNDZ RDR - OPEN
KEY V44E (TERMINATE DESIGNATION)

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

111:05

	CDR	LMP
111:05	UPDATE FROM MSFN	*COPY CSM CIRC P76 *
		*COPY PADS FOR: *
		* NO PDI+12 ABORT *
		* PDI *
		* PDI EARLY ABORT *
		* PDI LATE ABORT *
		* T2 ABORT *
		* T3 TIG *
		* SHE PRESSURE *
111:07	(SUNSET)	*SET DET TO COUNT DN TO DOI-2 *
	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	FDAI ANGLES (REQUEST MNVR)	
	PRO (AUTO MNVR)	
DSKY BLANKS		
F 50 18	FDAI ANGLES (REQUEST MNVR)	
	ENTR (BYPASS MNVR)	
F 01 71	00216	
	PGNS MODE CONT - ATT HOLD	
	PRO	
F 54 71	MARK 1ST STAR (UP TO 5 MK SETS IN ANY ORDER)	
	PRO	
111:15 F 01 70	00211 LOAD 2ND STAR (ALDEBARAN)	
	PRO	

CDR LMP

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 LMP

111:20

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

KEY 00E (P00)
AOT DETENT - CL
CB(11) AC BUS A: AOT LAMP - OPEN

MSFN UPLINK, MSFN UPDATE

*UPDATA 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 *
06 16 *UPDATE IN PROGRESS *
*414R (+00000 COMPLETE) *
F 50 16 *UPDATE COMPLETE *
DSKY BLANKS *PRO *
*400+3 AGS ALIGN *
*400R (+00000 COMPLETE) *

KEY V83E (RNDZ PARAMETERS)
F 16 54 R, RDOT, THETA
SET ORDEAL

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

111:25

CDR LMP

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

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

AGS CALIBRATION

*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 $\leq$ 0.075°/SEC

111:35

CDR LMP

111:35

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

MONITOR ICDU LIMITS

OGA +00000 / +04500		
IGA +04500 / +09000	}	LIMITS
MGA +00000 / +04500		

BEFORE LIMITS ARE EXCEEDED, 400+0.
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 *
* $\overline{\Delta MAX}$ = ±.039 *
*544R _____ X GYRO DRIFT COMPENSATION CONSTANT *
*545R _____ Y GYRO DRIFT COMPENSATION CONSTANT *
*546R _____ Z GYRO DRIFT COMPENSATION CONSTANT *
* $\overline{\Delta MAX}$ = ±2.00 *

GO/NO GO FOR DOI - 2

111:48

CDR LMP

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 *

DOI - 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

		CDR	LMP
111:50		KEY N40E	
	16 50	TFI, VG, ΔVM	
		CHECK DET, VG	
			*410+5 (EXTERNAL ΔV ROUTINE) *
			*373+TIG *
			*450-VGX *
			*451+0 *
			*542+VGZ *
			*310R (TFI) *
			*CHECK DET *
			*370R (ΔV TO BE GAINED) *
			*CHECK VG *
			*500R *
		(SUNRISE)	
111:55		CSM CIRCULARIZATION	
		DOI - 2 5 MIN MAX SLIP	
	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 ΔV	
		KEY V25E - CSM ΔV	
112:05		PRO	

	CDR	LMP
112:05	F 37 BB	
	KEY 00E (P00)	
	KEY V82E (ORBIT PARAMETER)	
	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)	
		*TELEMETRY PCM SW - HI *
	KEY V47E (INITIALIZE AGS)	
	F 06 16	*414+1 UPDATE AGS *
		*PRO *
	06 16	*UPDATE IN PROGRESS *
		*414R (+00000 COMPLETE) *
	F 50 16	*UPDATE COMPLETE *
	DSKY BLANKS	*PRO *
	KEY V83E (RNDZ PARAMETERS	
	F 16 54 R, RDOT, THETA	
		*317R (RANGE) *
		*440R (RANGE RATE) *
		*COMPARE WITH N54 VALUES *
		*TELEMETRY PCM SW - LO *
		*373 (TIG)_____(+01696) *
		*410+0
	P63 IGNITION ALGORITHM TEST	
	KEY V37E63E (BRAKING)	
	F 06 61 TGO ____, TFI, CR	
		*RESET DET TO COUNT DN TO PDI *
	KEY N33E (DISPLAY TIG)	
	06 33 TIG	
112:10		

	CDR	LMP
112:10	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)	
06 62	KEY V34E (TERMINATE)	
F 37 BB		
	KEY 00E (P00)	
	KEYV48E	
F 04 46	22112, 00011	
	(DAP CONFIGURATION, CHANBKUP)	
	PRO	
F 06 47	LM WT, CSM WT	
	KEY V34E	
	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		

	CDR	LMP
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	
		*VHF ANT - FWD *
	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 *
-35		*BATS 5 & 6 NORM FEED - ON *
		*RECORD GET ____:____:____ *
	THROT CONT - AUTO	
	CDR TTCA - THROTTLE - MIN	
		*LMP 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)	
112:35		

	CDR	LMP
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 *
	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		*414+1 UPDATE AGS *
		*PRO *
06 16		*UPDATE IN PROGRESS *
		*414R (+00000 COMPLETE) *
112:40		

	CDR	LMP
112:40	F 50 16	*UPDATE COMPLETE *
		*PRO *
	DSKY BLANKS	
	KEY V83E (RENDEZVOUS PARAMETERS)	
	F 16 54 R, RDOT, THETA	
		*317R (RANGE) *
		*440R (RANGE RATE) *
		*COMPARE WITH N54 VALUES *
		*240+(DATA FROM LOC 231 RLS) *
		*254+01944 (AGS T2 ABORT TIME) *
		*262-00143 (Z COMP. - LUNAR VEL) *
		*400+3 AGS ALIGN *
		*400R (+00000 COMPLETE) *
		*400+1 GUIDANCE STEERING *
	MODE SEL - AGS	
	POWERED DESCENT INITIATION	
	KEY V25N69E (BACKUP RLS IF NO UPLINK)	
-8	KEY V37E63E (BRAKING)	
	F 06 61 TG, TFI, CR	
	PGNS MODE CONT - AUTO	
	AGS MODE CONT - AUTO	
		*RESET DET *
	PRO	
	F 50 18 FDAI ANGLES (0, 108, 290)	
	VERIFY FDAI	
112:45		

		CDR	LMP
-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	
-2:00		MASTER ARM - ON MODE SEL - PGNS	
			*471R *
-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, $\dot{H}$, H	
		IF NO IGNITION : START PB - PUSH	

2.2 POWERED DESCENT MONITORING

POWERED DESCENT

CDR	TFI	PITCH	ΔH MAX	(MAX) -HDOT	H	DPS	S-BD	LMP
ENGINE START THRUST - 10% RATES, ERRORS < 5	0:00	108		67.0	56500	95	-33/54	
DES ENG CMD OVRD - ON	0:05							
MASTER ARM - OFF THROTTLE UP (FTP) T/W > 1.6 RATES, ERRORS < 5	0:26							367R
	0:30	108		66.0	54500	95		CHECK DPS, RCS
PITCH, ROLL, YAW - NOM	1:00	98		69.0	52400	95	-23/55	ΔH, HDOT, H - NOM H, HDOT AGS = H, HDOT PGNS V LAT AGS = ZERO PGNS BALL = AGS BALL
COPY N69 FROM MSFN V21N69E, LOAD R1 RECEIVE GO FOR ENTR	1:30	93		69.0	50300	92		CHECK DPS, RCS
ENTR (N63 RETURNS) PITCH, ROLL, YAW - NOM	2:00	89		68.0	48300	87	-8/55	ΔH, HDOT, H - NOM H, HDOT AGS = H, HDOT PGNS V LAT AGS = ZERO PGNS BALL = AGS BALL
	2:30	85		65.0	46300	82		CHECK DPS, RCS
PITCH, ROLL, YAW - NOM	3:00	82		63.0	44400	76	3/53	ΔH, HDOT, H - NOM H, HDOT AGS = H, HDOT PGNS V LAT AGS = ZERO PGNS BALL = AGS BALL
YAW RIGHT TO 340° @ 4:00 LR ALT LT - OUT VERIFY ΔH WITHIN LIMITS	3:30	79		62.0	42500	71		CHECK DPS, RCS
RECEIVE MSFN GO FOR ACCEPT V57E (06 63 STATIC) VERIFY CONVERGENCE PITCH, ROLL YAW - NOM	4:00	77		63.0	40600	66	11/51	HDOT, H - NOM HDOT AGS = HDOT PGNS V LAT AGS = ZERO PGNS BALL = AGS BALL REPORT ED BATTS

POWERED DESCENT

CDR	TFI	PITCH	ΔH MAX	(MAX) -HDOT	H	DPS	S-BD	LMP
COPY N69 FROM MSFN V2XN69E, LOAD RECEIVE GO FOR ENTR	4:30	76		66.0	38800	61		CHECK DPS, RCS LR VEL LT - OUT
ENTR PITCH, ROLL, YAW - NOM	5:00	75	+19800	70.0	36200	55	-19/14	HDOT, H - NOM PGNS BALL = AGS BALL
	5:30	73	+19800	84.0	34000	50		CHECK DPS, RCS
PITCH, ROLL, YAW - NOM	6:00	72	+19800	85.0	31100	45	-17/13	HDOT, H - NOM PGNS BALL = AGS BALL
				(516.0)				
AUTO YAW TO ZERO AT 30K N68E, CHECK TGO KEY RLSE	6:30	72	+19800	103.0	30800	39		CHECK DPS, RCS
				(480.0)				
PITCH, ROLL, YAW - NOM COPY THROTTLE DN FROM MSFN N92, MONITOR CMD THRUST	7:00	67	+19800	106.0	26900	34	-27/-3	HDOT, H - NOM PGNS BALL = AGS BALL
				(450.0)				
VERIFY THROTTLE DN KEY RLSE PGNS MODE CNTL - ATT HOLD EVALUATE MANUAL CONTROL NULL ERROR NEEDLES PGNS MODE CNTL - AUTO COPY N69 FROM MSFN V23N69E, LOAD R3 RECEIVE GO FOR ENTR	7:30	63	+16000	107.0	23900	30		CHECK DPS, RCS
				(402.0)				
ENTR PITCH, ROLL, YAW - NOM	8:00	57	+11200	133.0	19500	27	-20/-9	HDOT, H - NOM PGNS BALL = AGS BALL 223+00130 (DO NOT ENTR)
				(348.0)				
	8:30	56	+ 8400	143.0	15000	24		CHECK DPS, RCS ENTR (223) @ 13,000 FT 360 - (PGNS HDOT)E
				(288.0)				
PITCH, ROLL, YAW - NOM	9:00	56	+ 8000	154.0	10700	21	-19/-10	HDOT, H - NOM H, HDOT PGNS = H, HDOT AGS PGNS BALL = AGS BALL SEQUENCE CAMERA - ON

POWERED DESCENT

CDR	H	(MAX) -HDOT	DPS	VH (362)	LMP
VERIFY P64 (TR-LPD, HDOT, H) DETERMINE LANDING SITE PRO TO REDESIGNATE SEE LPD PROCEDURES FOR REDESIGNATION TECHNIQUE (SEE APPENDIX)	7000	(225.0) 169.0	18	258.0	HDOT, DPS - NOM CALL OUT LPD ANGLE VERIFY MODE SEL - PGNS
	6000	(206.0) 152.0	18	240.0	
	5000	(184.0) 132.0	17	223.0	MONITOR H, HDOT AND CALL OUT LPD ANGLES TO SUPPORT REDESIGNATIONS, TILL MANUAL TAKEOVER
	4000	(161.0) 110.0	16	200.0	
	3000	(134.0) 88.0	15	173.0	NOTE AGS HDOT BIAS
	2000	(103.0) 63.0	14	138.0	
	1000	(63.0) 35.0	12	85.0	
PGNS MODE CNTL - ATT HOLD SLOW DESCENT WITH ROD SW (P66)	500	(35.0) 17.0	11	43.0	X-POINTER (BOTH) - LO MULT CALL OUT H, HDOT, DPS TILL LDG
MANEUVER TO LANDING SITE NULL LATERAL VELOCITY	400	(28.0) 14.0	11	31.0	DES QTY LT - START STOP WATCH CALL BINGO FUEL AT 1 + 31
IF DUST SEVERE: PGNS MODE CNTL - AUTO	300	(20.0) 9.0	10	16.0	BINGO FUEL - LAND WITHIN 20 SEC OR ABORT
SLOW TO 3 FPS PRIOR TO LDG LUNAR CONTACT: ENG STOP - PUSH	200	(12.0) 5.0	9	-5.0	

3.0 POWERED DESCENT

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
PERFROM 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 O_2 - CLOSE
*ASC #1 O_2 - OPEN
*H_2O SEL - ASC
*H_2O DES - CLOSE
*H_2O 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

1:00	260/0
2:24	SD(FDAI)
2:36	SD(OHW)

1:30	0/0
1:44	300/0
2:30	260/0
3:20	SD

2:00	0/LV
2:14	300/36
3:00	300/0
3:18	260/0
4:16	SD

2:30	0/LV
2:44	300/36
3:46	300/0
4:02	260/0
5:12	SD

3:00	0/LV
3:14	300/36
4:34	270/0
5:10	250/0
5:57	SD(FDAI)
6:06	SD(OHW)

3:30	0/LV
3:44	300/36
5:24	270/0
5:54	250/0
6:50	SD(FDAI)
7:02	SD(OHW)

4:00	0/LV
4:14	300/36
5:56	270/0
6:38	250/0
7:34	SD(FDAI)
7:40	SD(OHW)

4:30	0/LV
4:44	300/36
6:26	270/5
7:32	250/0
8:19	SD

5:00	0/LV
5:14	300/36
6:58	270/5
8:20	250/0
9:03	SD

5:30	0/LV
5:44	300/36
7:34	270/10
9:04	250/0
9:46	SD

6:00	0/LV
6:14	300/36
8:04	270/11
9:50	250/0
10:39	SD

6:30	0/LV
6:44	300/36
8:34	270/11
11:04	250/0
11:47	SD

7:00	0/LV
7:14	300/36
9:06	270/14
12:26	250/0
12:53	SD

7:30	0/LV
7:44	300/36
9:38	270/14
13:38	250/0
13:53	SD

8:00	0/LV
8:14	300/36
10:16	270/15
14:30	250/0
14:43	SD

8:30	0/LV
8:44	300/36
11:12	270/15
15:18	250/0
15:31	SD

9:00	0/LV
9:14	300/36
12:10	270/16
16:04	250/0
16:18	SD

9:30	0/LV
9:44	300/36
12:56	270/16
16:44	250/0
16:58	SD

10:00	0/LV
10:14	300/36
13:16	270/16
17:32	SD

10:30	0/LV
10:44	300/36
13:48	270/16
18:05	SD

11:00	0/LV *
11:20	308/39
12:00	305/38
12:30	302/36
CONT MANUAL ASCENT ANGLES	

ALL PITCH RATES
5°/SEC

* ESTABLISH POSITIVE HDOT, THEN ABORT STAGE

APS

1:00	260/0
2:18	SD/(FDAI)
2:36	SD(OHW)

1:30	0/LV
2:10	260/0
3:32	SD(FDAI)
3:52	SD(OHW)

2:00	0/LV
2:40	300/0
3:10	260/0
4:24	SD(FDAI)
4:34	SD(OHW)

2:30	0/LV
3:10	300/0
4:00	250/0
5:18	SD

3:00	0/LV
3:40	300/36
4:22	270/0
5:28	250/0
6:09	SD

3:30	0/LV
4:10	300/36
5:00	270/5
6:30	250/0
7:02	SD

4:00	0/LV
4:40	300/36
5:40	270/5
7:28	250/0
7:56	SD

4:30	0/LV
5:10	300/36
6:22	270/10
8:26	250/0
8:51	SD

5:00	0/LV
5:40	300/36
7:08	270/10
9:20	250/0
9:46	SD

5:30	0/LV
6:10	300/36
7:54	270/12
10:14	250/0
10:42	SD

6:00	0/LV
6:40	300/36
8:44	270/14
11:08	250/0
11:37	SD

6:30	0/LV
7:10	300/36
9:34	270/14
12:02	250/0
12:33	SD

7:00	0/LV
7:40	300/36
10:24	270/14
12:56	250/0
13:28	SD

7:30	0/LV
8:10	300/36
11:12	270/14
13:48	250/0
14:19	SD

8:00	0/LV
8:40	300/36
12:06	270/14
14:26	250/0
15:05	SD

8:30	0/LV
9:10	300/36
13:00	270/14
15:02	250/0
15:50	SD

9:00	0/LV
9:40	300/36
13:54	270/14
15:34	250/0
16:31	SD

9:30	0/LV
10:10	300/36
14:30	270/14
16:12	250/0
17:07	SD

10:00	0/LV
10:40	300/36
14:30	270/14
17:00	250/0
17:37	SD

10:30	0/LV
11:10	300/36
14:48	270/14
17:50	250/0
18:09	SD

11:00	0/LV *
11:20	308/39
12:00	305/38
12:30	302/36
CONT MANUAL ASCENT ANGLES	

4.0 POWERED ASCENT

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

POWERED ASCENT

CDR	TFI		OHW*	VGX	HDOT	H	SBD	HE	LMP
ENG START ENG START-PUSH(IF AUTO IGN) VERTICAL RISE, YAW TO 0,0,0 PITCH DN TO 308°	0:00			1070.0	0.0	0	77/-66	3050	NO C&W LIGHTS
	0:10			890.0	52.0	300		2970	AGS HDOT = 50 FPS S-BD LOCK-ON 640+0
	0:30	308	40	4820.0	88.0	1600		2830	360+PGNS Ḣ
YAW RT 30° PITCH - NOM ROLL - ZERO N 76 E (VH, VV, R) CHECK TARGETING	1:00	305	38	4650.0	123.0	5000	141/-52	2640	623+1 S-BD LOCK-ON
N 77 E (TGO, VY) CHECK GUIDANCE KEY RLSE	1:30	302	36	4470.0	149.0	9100		2470	
PITCH - NOM ROLL, YAW - NOM	2:00	299	34	4250.0	168.0	13900	145/-47	2300	VGX, HDOT, H -NOM H, HDOT AGS=H,HDOT PGNS VOP AGS = VOP PGNS
	2:30	296	32	4000.0	181.0	19200		2140	AGS ERRORS - ZERO PGNS BALL = AGS BALL
SAME AS 2 MIN CHK	3:00	293	30	3720.0	188.0	24700	148/-42	1980	SAME AS 2 MIN CHK
	3:30	289	27	3400.0	188.0	30400		1820	
SAME AS 2 MIN CHK	4:00	286	25	3060.0	183.0	36000	152/-37	1670	SAME AS 2 MIN CHK STOP CAMERA
	4:30	282	22	2680.0	173.0	41300		1520	

* 0° YAW

POWERED ASCENT

CDR	TFI		OHW*	VGX	HDOT	H	SBD	HE	LMP
SAME AS 2 MIN CHK	5:00	278	20	2270.0	157.0	46300	156/-31	1380	SAME AS 2 MIN CHK 500 R
	5:30	274	17	1840.0	136.0	50700		1240	VGX AGS = VGX PGNS
SAME AS 2 MIN CHK	6:00	269	14	1370.0	111.0	54400	160/-24	1100	SAME AS 2 MIN CHK
COPY MSFN TRIM SOURCE	6:30	265	11	870.0	83.0	57300		970	VGX AGS = VGX PGNS
VGX = 200, ENG ARM-OFF (IF AUTO IGN)	7:00	260	8	330.0	52.0	59300	164/-20	840	VGX = 500 FPS: MAIN SOV (2) - OPEN ASC FEED 2(2) - CLOSE
VGX = 0, ABORT STAGE-RESET	7:18	257	6	0.0	32.0	60100	166/-15	770	

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)

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

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 OVRD 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 OVRD - 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]

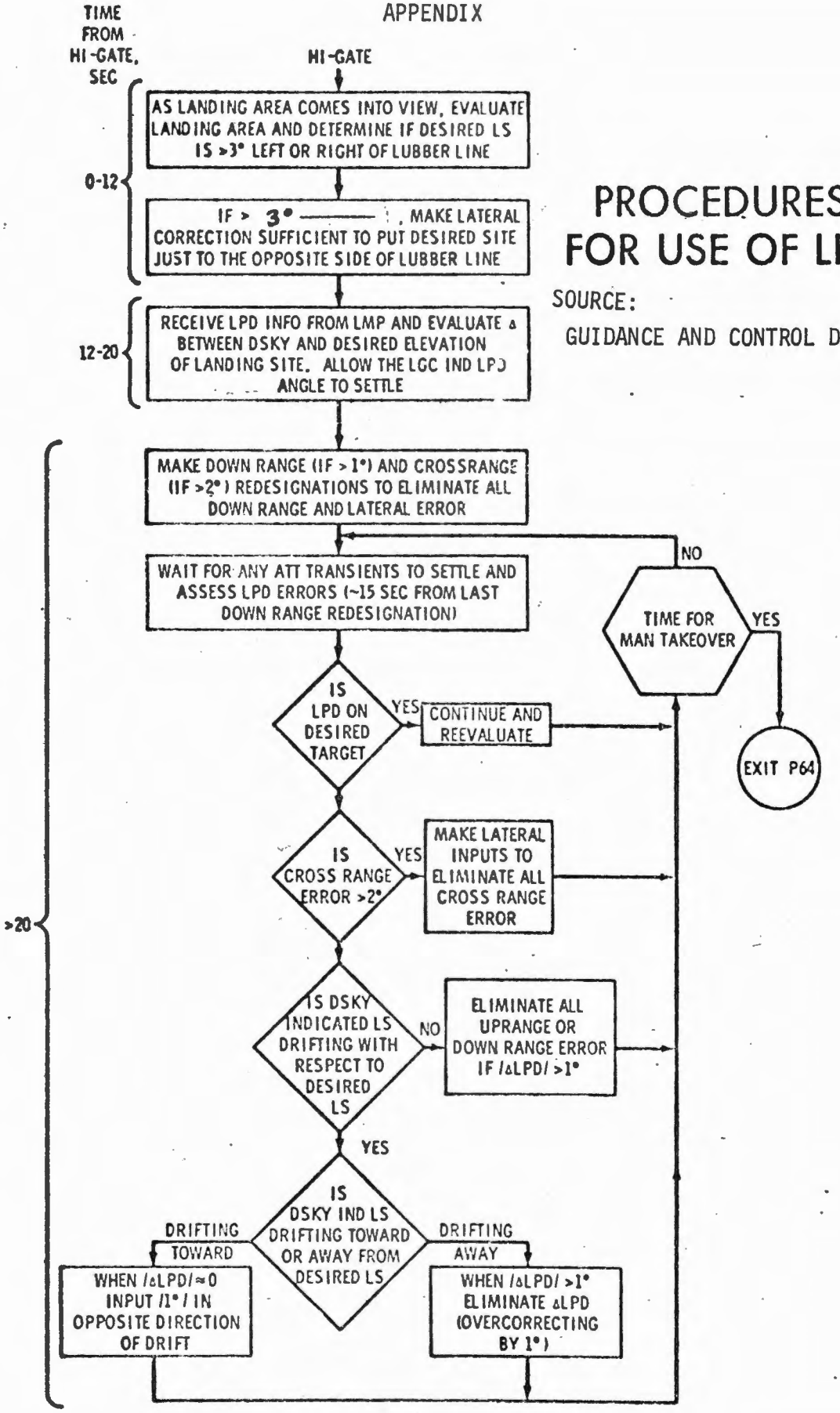
-:10 ABORT STAGE PB - PUSH (T=0 FOR AGS)
ENG ARM - ASC
-:05 PRO

:00 ENG ON
+:01 ENG START - PUSH

SOURCE: LM CUE CARDS

PROCEDURES FOR USE OF LPD

SOURCE:
GUIDANCE AND CONTROL DIVISION



APPENDIX

PDI SUMMARY DATA ABORT CARD

8/30/72 Final

PAGE	ABORT	INS			BOOST	HAM	CSI		CDH			TPI	AIM		
	TIME PDI+	TIME PDI+	N76	HA/HINS	TIME INS+	TIME INS+	TIME INS+	ΔVX	TIME INS+	ΔVX	ΔVZ	TIME PDI+	TIME PDI+	ΔVX	ΔVZ
	NO 1+12	NA	NA	NA	NA	NA	1+07+00*	58.4	2+09+35*	-126.1	8.4	2+47+26	12+00	106.5	-50.0
	NO 1+12Δ	NA	NA	NA	NA	NA	1+07+00*	49.4	2+09+15*	-118.2	13.1	2+47+25	12+00	93.0	-50.0
	1+00	2+05	5656.2	132.6/53784.	NA	NA	0+55+00	57.2	1+57+08	-115.2	-42.4	2+47+30	NA	NA	NA
	2+00	4+00	5651.9	131.8/58323.				55.5	1+57+03	-113.0	-38.2				
	3+00	5+43	5646.3	128.3/60018.				54.7	1+56+54	-108.5	-31.4				
	4+00	7+18	5639.5	122.9/60023.				54.4	1+56+39	-101.6	-22.5				
	5+00	8+49	5630.0	115.3/60030.				54.4	1+56+18	-92.1	-11.3				
	6+00	10+13	5617.5	105.5/60039.				54.5	1+55+51	-79.8	1.5				
	7+00	12+35	5596.3	91.9/64950.				53.1	1+55+14	-61.8	17.7				
	8+00	14+27	5571.5	76.4/71046.				51.5	1+54+31	-41.4	32.6				
	9+00	16+06	5546.3	59.3/74249.				50.7	1+53+45	-18.2	45.2				
	10+00	17+18	5564.0	71.7/72715.	50+00	1+50+00	2+40+00	38.9	3+39+14	-32.3	-59.4	4+46+26	NA	NA	NA
	11+00	18+21	5559.6	65.7/67727.				41.8	3+39+01	-26.1	-43.6				
	12+00	19+24	5555.9	59.9/62049.				44.5	3+38+49	-19.8	-29.3				
	13+00	20+27	5547.3	52.7/60251.				46.4	3+38+32	-11.5	-12.3				
	14+00	21+27	5539.8	47.2/60250.				47.2	3+38+19	-4.8	.1				
	15+00	22+26	5532.2	41.8/60248.				47.9	3+38+05	2.2	11.8				
	16+00	23+26	5524.6	36.3/60246.				48.2	3+37+51	9.3	22.1				
	17+00	24+25	5517.0	30.9/60244.				48.5	3+37+37	16.7	31.4				
	T2-1	7+22Ω	5515.7	30.0/60154.	50+00	3+50+00	4+40+00	42.9	5+37+23	22.9	55.1	6+45+14	NA	NA	NA
	NO 2+12	NA	NA	NA	1+12+00*	2+12+00*	3+12+00*	47.4	4+15+07*	-141.9	29.0	4+51+40	12+00	122.5	-50.0
	NO 2+12Δ	NA	NA	NA	1+12+00*	2+12+00*	3+12+00*	38.6	4+14+40*	-130.0	37.6	4+51+39	12+00	110.0	-50.0
	1+00	2+07	5676.9	149.7/54128.	1+00+00	2+00+00	3+00+00	47.3	4+02+55	-136.4	-18.8	4+51+49	NA	NA	NA
	2+00	4+02	5672.6	149.1/59080.				45.1	4+02+51	-134.8	-15.8				
	3+00	5+44	5669.5	147.1/60019.				44.6	4+02+45	-131.8	-8.7				
	4+00	7+20	5666.3	144.5/60024.				44.2	4+02+37	-128.2	.5				
	5+00	8+50	5661.7	140.7/60031.				43.8	4+02+26	-123.4	11.7				
	6+00	10+15	5655.9	136.0/60040.				43.5	4+02+13	-117.2	25.2				
	7+00	12+41	5665.0	146.4/65188.	NA	NA	0+55+00	50.4	1+57+38	-127.8	-57.1	2+52+54	NA	NA	NA
	8+00	14+33	5641.5	130.9/71212.				49.9	1+56+57	-109.7	-32.3				
	9+00	16+11	5617.9	113.9/74326.				50.0	1+56+12	-89.3	-8.6				
	10+00	17+20	5602.3	100.8/72751.				50.9	1+55+37	-72.9	7.4				
	11+00	18+23	5590.1	88.7/67752.				52.3	1+55+05	-57.5	20.2				
	12+00	19+25	5578.4	76.7/62072.				53.8	1+54+33	-41.9	31.1				
	13+00	20+28	5560.6	62.5/60253.				54.3	1+53+54	-22.9	42.0				
	14+00	21+27	5545.8	51.6/60250.				54.2	1+53+25	-8.0	48.4				
	15+00	22+26	5530.8	40.8/60247.				54.0	1+52+56	7.3	53.6				
	T2-2	7+22Ω	5515.7	30.0/60154	50+00	1+50+00	2+40+00	48.4	3+37+34	17.8	32.9	4+51+43	NA	NA	NA

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

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972—779-470/734