FLOWN ON APOLLO 9
1ST FLIGHT OF
LUNAR MODULE
Jim McDivitt
APOLLO 9 CDR

APOLLO 9	
LM G&N DICTIONARY	
PART NO	S/N
SKB 32100016-301	1001

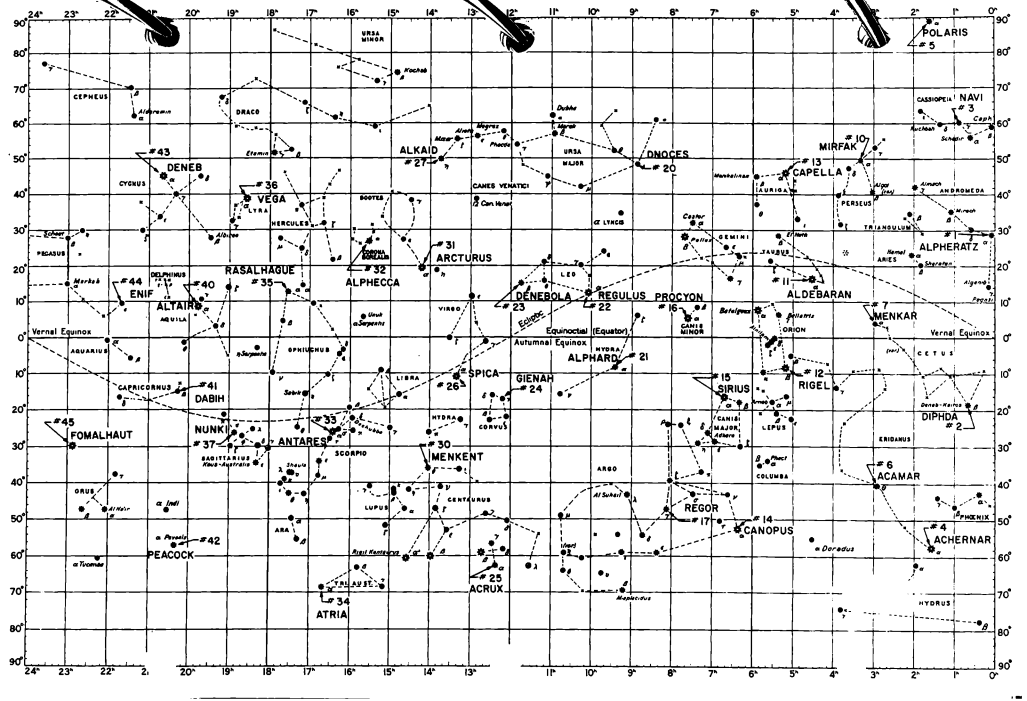
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

APOLLO IX LM-3
FINAL
FLIGHT CREW G&N DICTIONARY

PREPARED BY
GUIDANCE & CONTROL
SECTION
FLIGHT CREW SUPPORT
DIVISION

FEBRUARY 24, 1969

MANNED
SPACECRAFT CENTER
HOUSTON, TEXAS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RIGEL
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ACAMAR
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REGOR
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PROCYON
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DNOCES
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VEGA
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DENEB
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ENIF
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ALTAIR
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RASALHAGUE
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ANTARES
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NUNKI
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DABIH
#41
FOMALHAUT
#45
PEACOCK
#42
ATRIA
#34
ACRUX
#25
MENKENT
#30
Vernal Equinox
Autumnal Equinox
Equinoctial (Equator)
Ecliptic
URSA MINOR
CEPHEUS
DRACO
CYGNUS
LYRA
HERCULES
BOOTES
CANES VENATICI
URSA MAJOR
CASSIOPEIA
PERSEUS
ANDROMEDA
TRIANGULUM
PEGASUS
AQUARIUS
CAPRICORNUS
AQUILA
DELPHINUS
OPHIUCHUS
SERPENS
LIBRA
VIRGO
LEO
GEMINI
AURIGA
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ORION
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ERIDANUS
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CANIS MAJOR
CANIS MINOR
HYDRA
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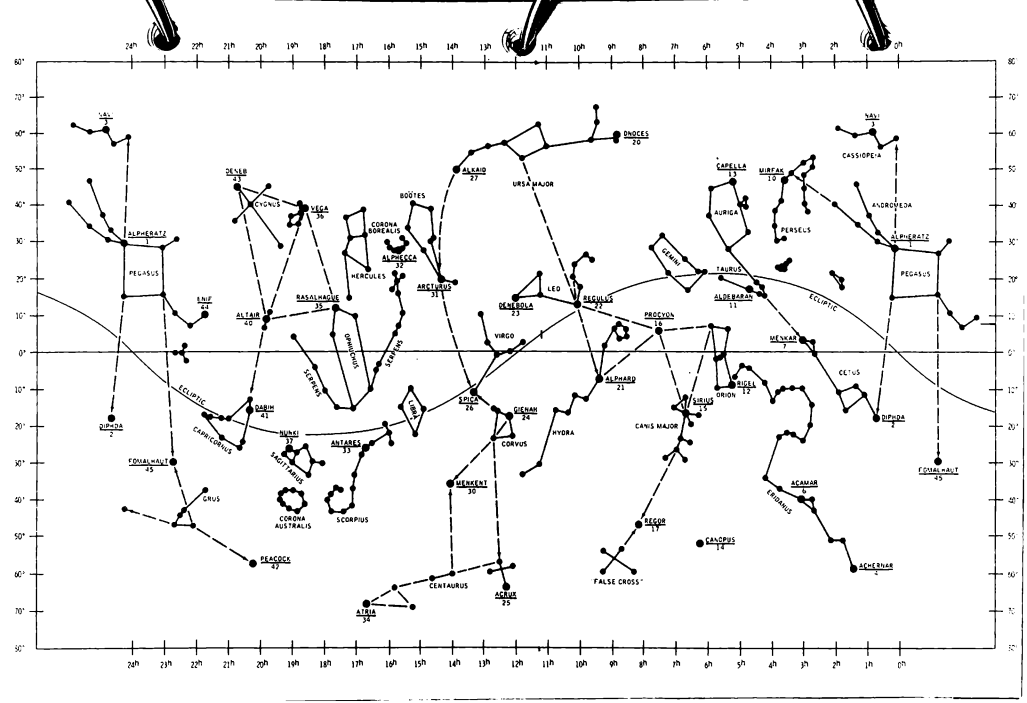
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80° 70° 60° 50° 40° 30° 20° 10° 0° 10° 20° 30° 40° 50° 60° 70° 80°
VAU 1
ALPHERATZ 1
PEGASUS
ENIF 44
DIPHDA 2
FOMALHAUT 45
GRUS
PEACOCK 47
DENEB 43
CYGNUS
VEGA 36
ALTAIR 40
DABIH 41
CAPRICORNUS
NUNKI 37
SAGITTARIUS
CORONA AUSTRALIS
SCORPIUS
ANTARES 33
RASALHAGUE 35
OPHIUCHUS
SERPENS
SERPENS
BOÖTES
CORONA BOREALIS
HERCULES
ALPHECCA 39
ARCTURUS 31
ALKAID 27
DUBHE 20
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REGULUS 27
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ATRIA 34
GIENAH 24
CORVUS
HYDRA
ALPHARD 21
PROCYON 10
ECLIPTIC
CAPELLA 13
AURIGA
MIRFAK 19
PERSEUS
GEMINI
TAURUS
ALDEBARAN 11
SIRIUS 15
RIGEL 12
ORION
CANIS MAJOR
REGOR 17
CANOPUS 14
FALSE CROSS
CASSIOPEIA
ANDROMEDA
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MENKAR 7
CETUS
DIPHDA 2
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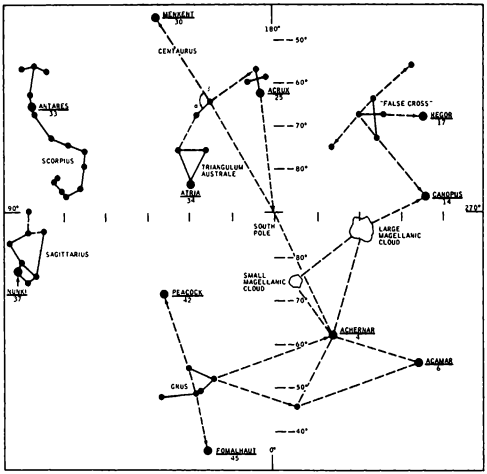
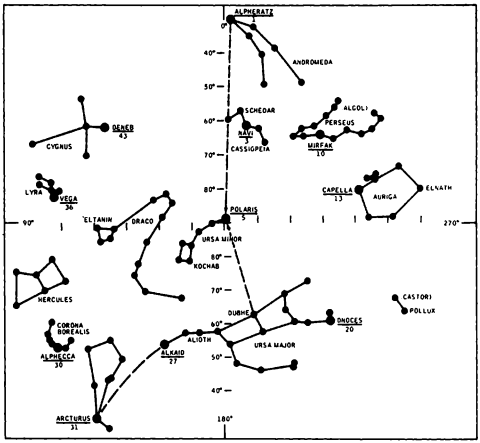
ACAMAR 6
ERIDANUS
ACHERNAR 1



SOUTHERN STARS



NORTHERN STARS

STAR LIST

STAR NAME (NO) (Numerical)		STAR NAME (Alphabetical)	(NO)
00	Planet	Acamar	6
1	Alpheratz	Achernar	4
2	Diphda	Acrux	25
3	Navi	Aldebaran	11
4	Achernar	Alkaid	27
5	Polaris	Alphard	21
6	Acamar	Alphecca	32
7	Menkar	Alpheratz	1
10	Mirfak	Altair	40
11	Aldebaran	Antares	33
12	Rigel	Arcturus	31
13	Capella	Atria	34
14	Canopus	Canopus	14
15	Sirius	Capella	13
16	Procyon	Dabih	41
17	Regor	Deneb	43
20	Dnoces	Denebola	23
21	Alphard	Diphda	2
22	Regulus	Dnoces	20
23	Denebola	Earth	47
24	Gienah	Enif	44
25	Acrux	Fomalhaut	45
26	Spica	Gienah	24
27	Alkaid	Menkar	7
30	Menkent	Menkent	30
31	Arcturus	Mirfak	10
32	Alphecca	Moon	50
33	Antares	Navi	3
34	Atria	Nunki	37
35	Rasalhague	Peacock	42
36	Vega	Planet	00
37	Nunki	Polaris	5
40	Altair	Procyon	16
41	Dabih	Rasalhague	35
42	Peacock	Regor	17
43	Deneb	Regulus	22
44	Enif	Rigel	12
45	Fomalhaut	Sirius	15
46	Sun	Spica	26
47	Earth	Sun	46
50	Moon	Vega	36

NO.	PROGRAMS
00	LGC Idle
06	LGC Power Down
20	Rendezvous Navigation
21	Ground Track Determination
25	Preferred Tracking Attitude
27	LGC Update
30	External ΔV
32	CSI Pre-Thrust
33	CDH Pre-Thrust
34	TPI Pre-Thrust
35	TPM Pre-Thrust
40	DPS
41	RCS
42	APS
47	ΔV Monitor
51	IMU Orientation Determination
52	IMU Realign

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VERBS	
01	Display Octal Comp 1 in R1
02	Display Octal Comp 2 in R1
03	Display Octal Comp 3 in R1
04	Display Octal Comp 1&2 in R1&R2
05	Display Octal Comp 1,2&3 in R1,R2&R3
06	Display Decimal Comp 1 or 1&2 or 1,2,&3 in R1 or R1&R2 or R1, R2&R3
07	Display DP Decimal in R1&R2
11	Monitor Octal Comp 1 in R1
12	Monitor Octal Comp 2 in R1
13	Monitor Octal Comp 3 in R1
14	Monitor Octal Comp 1&2 in R1&R2
15	Monitor Octal Comp 1,2&3 in R1,R2&R3
16	Monitor Decimal Comp 1 or 1&2 or 1,2,&3 in R1 or R1&R2 or R1, R2&R3
17	Monitor DP Decimal in R1&R2
21	Load Component 1 in R1
22	Load Component 2 in R2
23	Load Component 3 in R3
24	Load Component 1&2 in R1&R2

25	Load Component 1,2&3 in R1,R2&R3
27	Display Fixed Memory
30	Request Executive
31	Request Waitlist
32	Recycle
33	Proceed
34	Terminate
35	Test Lights
36	Request Fresh Start
37	Change Program
40	Zero CDU's (Specify N20 or N72)
41	Coarse Align CDU's (Specify N20 or N72)
42	Fine Align IMU
43	Load FDAI Error Needles
44	Terminate Continuous Designate (V41N72)
45	Display W-Matrix RMS Errors
47	Initialize AGS (R47)
48	Load DAP Data (R03)
49	Start Crew Defined Maneuver (R62)
50	Please Perform
52	Mark X-Reticle
53	Mark Y-Reticle
54	Mark X or Y-Reticle
55	Increment LGC Time (Decimal)
56	Terminate Tracking (P20&P25)
60	Mode I Attitude Error Display (DAP Follow Error)
61	Command LR to Position 2
62	Start RR/LR Self Test (R04)
63	Mode II Attitude Error Display (Error WRT N22)
65	Disable U,V Jets
66	Set LM State Vector into CSM State Vector
69	Cause Restart
70	Update Liftoff Time
71	Universal Update Load Block Addresses
72	Universal Update Load Singular Addresses
73	Update LGC Time (Octal)
74	Initiate Eraseable Dump via Downlink
75	Enable U,V Jets
76	Set Min Impulse Mode in DAP
77	Set Rate Command/Attitude Hold Mode in DAP
78	Start LR Spurious Test (R77)

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79	Stop LR Spurious Test (R77)
80	Update LM State Vector
81	Update CSM State Vector
82	Request Orbit Parameter Display (R30)
83	Rendevous Parameter Display (R31)
84	Start Target V (R32)
89	Start Rendezvous Final Attitude Maneuver (R63)
90	Request Rendezvous Out of Plane Display (R36)
91	Compute Banksum
92	Start IMU Performance Test (non-flight)
93	Enable W-Matrix Initialization
95	Inhibit State Vector Update (P20 or P22)
96	Interrupt Integration and Go to P00
99	Enable Engine Ignition

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NOUN LIST (v) - Can Be Called At Any Time For Valid Data

01(v)	Address to be Specified (Frac)	.XXXXX
02(v)	Address to be Specified (Whole)	XXXXX.
03	Address to be Specified (Degree)	.01°
05	Angular Error/Difference	.01°
06	Option Code	Octal
07	Flag Word Operator	Octal
08(v)	Alarm Data	Octal
09(v)	Alarm Codes	Octal
10(v)	Channel To Be Specified	Octal
14	Checklist (Internal to LGC)	XXXXX.
15	Increment Address	Octal
16	Time of Event	hrs,min,.01sec
18	Desired Maneuver to FDAI RPY Angles	.01°
19	Bypass Trim Maneuver to FDAI RPY Angles	.01°
20(v)	ICDU Angles Y,P,R (OG,IG,MG)	.01°
21(v)	PIPA Pulses	Pulses
22	New ICDU Angles Y,P,R,(OG,IG,MG)	.01°
24	Delta Time For LGC Clock	hrs,min,.01sec
25	Checklist (Used with V50)	Octal
26	Prio/Delay, ADRES, BBCON	Octal Octal
27(v)	Self Test ON/OFF	
30	TIG CSI	hrs,min,.01sec
31	TIG CDH	hrs,min,.01sec

32	Time From Perigee	hrs,min,.01sec
33	TIG	hrs,min,.01sec
34	Time Of Event	hrs,min,.01sec
35	Time To Go To Event	hrs,min,.01sec
36(v)	LGC Clock Time	hrs,min,.01sec
37	TIG TPI	hrs,min,.01sec
40	Time From Ignition/Cutoff	min-sec
	VG	
	ΔV(Accumulated)	.1fps
41	Target Azimuth	.01°
	Target Elevation	.001°
42	ΔV (Required)	.1fps
	Perigee	.1nm
	ΔV (Required)	.1nm
43	Latitude (+North)	.01°
	Longitude (+East)	.01°
	Altitude	.1nm
44	Apogee	.1nm
	Perigee	.1nm
	TFF	min-sec
45(v-R1)	Marks	XXXXX.
	TTI Of Next Burn	min-sec
	MGA	.01°
46(v)	Digital Autopilot Configuration	Octal
47(v)	LM Weight	lbs
	CSM Weight	lbs
48(v)	Engine Gimbal Pitch Trim (+ Only)	.01°
	Engine Gimbal Roll Trim (+ Only)	.01°
49	Change to SV ΔR From Radar Update	.1nm
	Change to SV ΔV From Radar Update	.1fps
50	ΔAlt. CDH	.1nm
	ΔTime (CDH-CSI or TPI-CDH)	min-sec
	ΔTime (TPI-CDH or TPI-NOM TPI)	min-sec
52	Central Angle of Active Vehicle	.01°
54	Range	.01nm
	Range Rate	.1fps
	Theta	.01°
55	No. of Apsis Crossings	Apsis
	Elevation Angle	.01°
	Central Angle	.01°
58	Perigee Alt. (Post TPI)	.1nm
	ΔV TPI	.1fps
	ΔV TPF	.1fps

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59	ΔV Fwd/Aft (+Fwd)	.1fps
	ΔV Rt/Left (+Rt)	.1fps
	ΔV Up/Dn (+Dn)	.1fps
65(v)	Sampled LGC Time	hrs,min,.01sec
66(v-R2)	LR Slant Range	ft
	LR Antenna Position	00001/00002
67	LR VX	fps
	VY	fps
	VZ	fps
70	AOT Detent/Star Code	Octal
71	AOT Detent/Star Code	Octal
72(v-R2)	RR Trunnion Angle	.01°
	RR Shaft Angle	.01°
73	Desired RR Trunnion Angle	.01°
	Desired RR Shaft Angle	.01°
78	RR Range	.01nm
	RR Range Rate	fps
80	Data Indicator	XXXXX.
	Omega	.01°
81	ΔVX (LV) (+ Fwd)	.1fps
	ΔVY (LV) (+ Rt)	.1fps
	ΔVZ (LV) (+ Dn)	.1fps
82	ΔVX (LV) (+ Fwd)	.1fps
	ΔVY (LV) (+ Rt)	.1fps
	ΔVZ (LV) (+ Dn)	.1fps
83	ΔVX (LV) (+ Up)	.1fps
	ΔVY (LV) (+ Rt)	.1fps
	ΔVZ (LV) (+ Fwd)	.1fps
84	ΔVX (LV) (Other Vehicle)	.1fps
	ΔVY (LV) (Other Vehicle)	.1fps
	ΔVZ (LV) (Other Vehicle)	.1fps
85	VGX (LM) (+ Up)	.1fps
	VGY (LM) (+ Rt)	.1fps
	VGZ (LM) (+ Fwd)	.1fps
86	VGX (LV) (+ Fwd)	.1fps
	VGY (LV) (+ Rt)	.1fps
	VGZ (LV) (+ Dn)	.1fps
87	Backup Optics LOS Azimuth (+ Rt)	.01°
	Elevation (+ Up)	.01°
88	Celestial Body Vector X	.XXXXX
	Y	.XXXXX
	Z	.XXXXX

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90	Rendezvous Out of Plane Parameter	Y	.01nm
		YDOT	.1fps
		PSI	.01°
93	ΔGyro Torquing Angles	X	.001°
		Y	.001°
		Z	.001°
97	System Test Inputs		XXXXX.
98	System Test Results & Inputs		XXXXX.
			XXXXX.
99	W-Matrix RMS Pos Error		.01nm
	W-Matrix RMS Vel Error		.1fps

V50 N25 CHECKLIST CODES

R1 Code	FUNCTION
00014	Recheck or Exit Fine Align Option
00015	Select Star Acquisition Mode
00062	Power Down LGC
00201	Select RR LGC Mode
00203	Select PGNS, AUTO, & AUTO THROTTLE
00204	Enable Engine Gimbal Trim
00205	Slew RR for Manual Acquisition

V04 N06 OPTION CODES

00001	Specify IMU Orientation	1 = Preferred 2 = Nominal 3 = REFSMMAT
00002	Specify Vehicle	1 = LM 2 = CSM
00003	Specify Tracking Attitude	1 = +Z Axis 2 = + X Axis
00004	Specify Radar	1 = RR, 2 = LR
00006	Specify RR Function	1 = Lock On 2 = Continuous Designate

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V05 N09 ALARM CODES

00105 P AOT Mark System In Use
(Terminate Extended Verb & Reselect P5X)

00107 P More Than 5 Mark Pairs
(Continue)

00111 P Mark Missing
(Start Mark Sequence Over)

00112 P Mark or Mark Reject Not Being Accepted
(Continue)

00113 H No Inbits
(Continue)

00114 H Mark Made But Not Desired
(Mark Correct Axis (X) or (Y))

00115 P No Marks in Last Pair to Reject
(Continue)

00206 P Zero Encode Not Allowed With Coarse Align & Gimbal Lock
(Coarse Align To 0,0,0 Then Reselect V40N20)

00207 P/H ISS Turn on Request Not Present For 90 sec
(CB(11) PGNS: IMU OPR - OPEN & RECLOSE
If Alarm Recurs & NO ISS Warning, Continue)

00210 P/H IMU Not Operating
(CB(11) PGNS: IMU OPR - OPEN & RECLOSE
V36E, Consult MSFN, But Continue)

00211 H Coarse Align Error
(If P51 or P52 in Progress, Record GYRO Torquing Angles and Perform Fine Align Check in P52;
If P51 or P52 Not In Progress, Reduce Spacecraft Drift, Continue)

00212 H PIPA Fail, But PIPA is Not Being Used
(Go to ISS Malfunction Procedures)

00213 H IMU Not Operating With Turn-On Request
(See 00210 Above For Procedure)

00214 P Program Using IMU When Turn OFF
(Exit Program)

00215 P Preferred Orientation Not Specified
(See P52/1)

00217 H Bad Return From Stall (Computer Waiting For IMU, Radar or AOT to be Used) Routine
(Reinitiate Current Program
If Alarm Recurs, ISS Mode Switching Failure)

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00220 P IMU Not Aligned
(Align Or Set REFSMMAT Flag If Aligned)

00401 I Desired Gimbal Angles Yield Gimbal Lock
(Call N22, Manually Mnvr If MGA<85° Or Realign IMU)

00405 I Two Stars Not Available
(See P52/4)

00421 I W-Matrix Overflow (Matrix invalid, scaling exceeded)
(Notify MSFN But Continue, W Matrix Is Automatically Intialized At Next Mark)

00501 I RR Antenna Out of Present Mode Limits
(See P20/7 or 8)

00502 I LOS Outside Limits of Both RR Antenna Modes
(Mnvr & Redo V41N72)

00503 I Radar Antenna Designate Fail
(See P20/8)

00510 P Radar Auto Descrete Not Present
(RDZ RDR - LGC, Continue)

00511 H LR Not in Pos 2 or Repositioning
(LDG ANT - HOVER V16N66E, Verify R2+00002)

00514 P Radar Out of Auto Mode While in Use
(See P20/6)

00515 H RR CDU Fail Discrete Present
(See P20/8)

00520 H/P RADARUPT Not Expected at This Time
(Radar data is received during a time when it is not expected)
(Continue)

00521 I RR Data Good Not Present
(See P20/8)

00522 P LR Position Change
(Continue)

00525 I SV/RR LOS > 3°
(See P20/8)

00526 I Range>400 Miles
(Terminate P20 (V56), Recall When Range<400 mi)

00527 I LOS Outside of Antenna Mode Limits
(MNVR)

00600 I Imaginary Roots on First Iteration
(No solution found for CSI)
(See P32/1)

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00601 I Perigee Altitude (Post CSI) <85NM
(See P32/1)

00602 I Perigee Altitude (Post CDH) <85NM
(See P32/1)

00603 I CSI to CDH Time <10 MIN
(See P32/1)

00604 I CDH to TPI Time <10 MIN
(See P32/1)

00605 I Number of Iterations Exceeds Loop Max
(Program cannot converge on solution for CSI)
(See P32/1)

00606 I ΔV Exceeds Maximum
(See P32/1)

00611 I No TIG For Given Elevation Angle
(See P33/2 Or P34/3)

00777 H PIPA fail caused the ISS Warning
(Go To ISS Malf)

01102 H LGC Self Test Error
(See PGNS TURN ON & SELF TEST/8)

01103 I *Unused CCS Branch Executed
(Program has taken a wrong logic path)
(Copy N08, Notify MSFN, Continue)

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01104 H *Delay Routine Busy
(Routine is already being used & cannot process two requests)
(Reselect Extended Verb Or Continue With Program)

01105 H Downlink Too Fast
(Spurious noise on downlink)
(If Alarm Recurs, Downlink Failure)

01106 H Uplink Too Fast (Spurious noise on uplink)
(If Alarm Recurs, Uplink Failure)

01107 H Phase (Restart) Table Failure
(Restart logic cannot determine the restart phase (point).)
(Perform The Following:
1. V74 LGC DOWNLINK
2. P27 As Necessary
3. V48 As Necessary
4. Revalidate REFSMMAT via P51 or P27)
If FRESH START Recurs, LGC FAILURE

01201 P *Executive Overflow - No Vac. Areas
(Too Many requests for LGC to process)
(Reselect Extended Verb Or Continue With Program)

01202 P *Executive Overflow - No Core Sets
(Too many requests for LGC to process)
(See Code 1201)

01203 I *Waitlist Overflow - Too Many Tasks
(Too many requests for LGC to process)
(See Code 1201)

01206 P *Two Jobs Try To Sleep in PINBALL
(Too many display requests have been made at same time)
(See Code 1201)

01207 P *No Vac Area For Marks
(More than 5 mark pairs have been accepted but there is not room for storage)
(Reselect P51 or P52)

01210 P *Two Routines Using Device at Same Time
(Crewman attempted to use RR or IMU 2 different ways (Ext. Verb, etc.) at same time)
(Reselect Extended Verb When Indicated Device No Longer In Use)

01211 P *Illegal Interrupt of Extended Verb
(Reselect P51 Or P52)

01301 I ARCSIN-ARCCOS Input Angle Too Large
(Data computed by the program is unrealistic)
(Copy N08 Data, Notify MSFN, Continue)

01302 I *SQRT Called With Negative Argument
(Data computed by the program is unrealistic)
(See Code 1301)

01407 P VG Increasing
(See P40/IGN Or P42/IGN)

01501 P *Illegal Internal Use of PINBALL
(See Code 1301)

01502 P *Illegal Flashing Display
(See Code 1301)

01520 P V37 Request Not Permitted At This Time
(Reselect V37)

Basic Date Changed

01600 H Overflow In Drift Test (Gnd Only)
01601 H Bad IMU Torgue (Gnd Only)
01703 P Less than 45 Secs to Ignition
(See P40/3 or P42/3)
01706 P CSM Docked with Ascent Stage Only
(See P40/1 Or P42/1)
01711 I State Vector Integration Not Finished
Prior to TIG-30 sec (Burn cannot be done
at the desired TIG due to lengthy SV
intergration)
(See P4X/4)
02000 P *Previous DAP Computation Still in
Progress at this T5RUPT
(RSET, If Recurs GUID CONT - Cycle AGS
Then PGNS; If Recurs, V36E)
02001 I Jet Failures Have Disabled Y-Z Trans
(Change Thruster Pair Isol Value Or
Use Alternate Control Mode)
02002 I Jet Failures Have Disabled X Trans
(See Code 2001)
02003 I Jet Failures Have Disabled P Rotation
(See Code 2001)
02004 I Jet Failures Have Disabled U-V Rotation
(See Code 2001)
03777 H ICDU Fail Caused the ISS Warning
(Go To ISS Malf)
04777 H ICDU, PIPA Fails Caused the ISS Warning
(Go To ISS Malf)
07777 H IMU Fail Caused The ISS Warning
(Go To ISS Malf)
10777 H IMU, PIPA Fails Caused The ISS Warning
(Go To ISS Malf)
13777 H IMU, ICDU Fails Caused The ISS Warning
(Go To ISS Malf)
14777 H IMU, ICDU, PIPA Fails Caused The ISS Warning
(Go To ISS Malf)

Basic Change

*Generates Restart
P-Procedure Caused Alarm
I-Input Data Caused Alarm
H-Hardware Status Caused Alarm

Alarms for V05N09
R1 First Alarm to Occur
R2 Second Alarm to Occur
R3 Last Alarm to Occur (May Be of The
Form 4XXXX or 5XXXX)

4XXXX Indicates More than 3 Alarms
5XXXX Indicates More Than 3 Alarms Including 1XXXX

SUNDANCE PROGRAM NOTES

1 Do not select another program (except P00) before terminating V41N72. (Antenna will wander).

RECOVERY: Select P00 or V44.

2 Do not select V41N72 after initial failure of the RR to lock-on in the designate routine of P20, the LOSCMFLG (bit 12, flagword 2) should be reset prior to the V41N72 request. (Radar will be designated along computed LM-CSM LOS instead of to N72 input angles.)

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RECOVERY: V37E00E then 76E 04000E 0E.

3 Always complete the auto track maneuver when it is called for by the RR Auto Search Routine in P20 in the normal fashion; i.e., do not terminate the maneuver via V56 or V34. (Attempt to search pattern will not be generated if R24 is attempted again.)

RECOVERY: Reselect the Search Routine via P20. When the V16N80 display comes up, do a V32E and allow the maneuver to take place.

4 If during the data load of the W matrix (N99) in V45 the display is interrupted by a priority display, the ENTER on the data load does not set the V45 flag. (V06N99 does not appear on the DSKY after the ENTER on the data load, a priority display appears instead.)

RECOVERY: Reload data completely when V06N99 Returns or key V32 if correct data is displayed on DSKY.

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5 During any CDU zero, DAP is inactive.

RECOVERY: Wait 10 sec or switch out of PGNCS.

6 P00 integration will be lost if there is a restart during P00 following any P27 update. (Restart light in P00 after a P27, prior to another PXX selection out of P00.)

RECOVERY: Reselect P00.

7 A restart during execution of R00 (Program Change Routine) may cause inability to select a new program. (Unable to select new program following a program using AVE G.)

RECOVERY: Use V30 in the following manner:

V25N26E, 15001E, 2073E, 10003E

V30E

8 If a V05N09 2000 restart occurs without program recovery go to AGS until PGNCS can be re-initialized. (Restart with 2000 in FAILREG.)

RECOVERY: Confer with ground to determine possible erasable damage.

9 There exists in P40 and P42 a 5 ms window in which a response to the flashing V99N4X will cause anomalous program behavior. An ENTER or a V34 response in the time interval will cause a 1502 alarm code and hardware restart along with the termination of CLOKTASK (normal operation for an ENTER or V34 response is flashing V16N4X or flashing V37, respectively.)

RECOVERY: Key ENTR again (if restart occurred) key V5N9, then error reset when convenient.

10 If you use V96 then at some future time return to V37E00E and allow integration.

11 The W matrix should not be initialized to magnitudes greater than 325 ft/sec and 8.5 NM.

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12 In P51 and P52 the permissible values of R1 of N70 and/or N71 are 0-508 for the star code. Anything else will cause indeterminate program transfer.

RECOVERY: Confer with ground, perform E memory dump to determine possible erasable memory damage.

13 If V37 is attempted within approximately 20 seconds of a fresh start, ISS turn-on, or restart with the IMUSE flag reset, a PIPA FAIL will go undetected.

RECOVERY: Perform extended verb V42E ,E,E,E.

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14 Marks should not be taken on the V01N71 display in P51 & P52. (Flashing V54N71 with possible alarm 107, too many marks, after legitimate marking sequence.)

RECOVERY: Begin P51 & P52 again and mark only during request for marks (V54,V53,V52).

15 Use V55 (LGC clock align) only in P00. (Restart.)

RECOVERY: Restart recovery procedure.

16 Do not select a mission program via V37 after selecting P20 until the first auto maneuver (V50N18) display in P20. (RR may acquire in Mode II due to the fact that an attitude maneuver was not performed.)

RECOVERY: Self recovery in 2-4 minutes; RR will reacquire in Mode I after auto attitude maneuver.

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17 Noun 17 should not be loaded.

RECOVERY: Reload erasable cells that are invalidated; V21N01E, 1351E, 46761E.

18 A hardware restart removes track enable; if P20 is in progress, it will be forces back to the beginning of the designate and call auto track maneuver routine.

19 When a Fresh Start occurs, the REFSMFLG is reset. This flag should be manually set if it is desired to use the REFSMMAT that remains in the LGC after the Fresh Start.

20 Do not select V92 during P00. (a. 07 appears in program lights; b. the DAP is turned off for 10 seconds; c. the W matrix will be zero or over-written; d. flashing V06N41.)

RECOVERY: Select P00 via V37E00E, key V93.

21 Do not enter another program (except P00) before terminating V41N72 with a V44E.

22 Do not exit P20 with V34E or V56E on AUTO MANEUVER ROUTINE during the SEARCH ROUTINE.

23 Do not select another program after V37E20E until V50N18 complete.

24 Do not select another program during gimbal drive in V48.

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3

P06 PGNS PWR DOWN

1 V37E 06E
F 50 25 00062 POWER DOWN LGC
PRO Until STBY Lt - ON

P20 RENDZ NAV

1 V37E 20E
(TO TERM-V56E)
V80E LM SV UPDATE (V81E CSM, V95E NONE)

2 F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) GUID CONT - PGNS
MODE CONT - AUTO
PRO
(MAN) ENTR To 4

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3 06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)

4 F 50 19 BYPASS TRIM MNVR TO FDAI RPY ANGLES (.01°)
(TRIM) PGNS - AUTO
ENTR To 3
(BYPASS)PRO To 5 (RR Search To 9)
(Man Acq To 7)

Basic Data Changed

5 RR MODE: LGC To 8
SLEW or AUTO To 6

6 F 50 25 00201 (or F 05 09 00514) RR ACQ MODE
(AUTO) RR MODE LGC (15 sec)
PRO To 5
(MAN) ENTR (NOT ALLOWED FOR 00514)

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7 F 50 25 00205 SLEW RR For LOCK-ON
(LOCK) RR-LGC;
No Track Lt - OUT (15 sec)
PRO To 5
(NO LOCK) MNVR
ENTR To 2

F 05 09 501 RR OUT OF MODE LIMITS
* (REQUEST MNVR) V32E To 2*

8 NO TRACK LITE

OUT DSKY BLANKS, RR TAKING MARKS

```
*F 05 09 00525 SV/RR△LOS>3°      *
*        PRO                     *
*F 06 05 SV/RR△LOS          (.01)*
*    (REJECT) CK SIDE LOBE       *
*             Rendz RR MODE LGC  *
*             V32E To 8          *
*    (UPDATE) PRO To 5 or below  *
*F 06 49 +△SV,△R,△V(.1NM,.1fps) *
*    (UPDATE) PRO To 5           *
*    (REREAD or MAN ACQ)V32E To 5*
*F 50 18 (MNVR REQUEST) Go To 2  *
```

ON NO LOCK

F 05 09 00503 RR NO DATA GOOD 42sec(or Desig. Fail)
(REDESIG) V32E To 5
(SEARCH) PRO To 9

```
*V05N09E 00521(or 00515) DATA NOT GOOD*
*              Key Rel To 8           *
*        00501 R25 LIMITS, RR To +Z   *
```

9 F 16 80 RR AUTO SEARCH, SEARCH CODE,
R1 0-SEARCH 42sec/scan
1-LOCK ON
R2 Ω -Angle between RR LOS & LM +Z (.01°)
(LOCK) PRO To 2
(NO LOCK) (MAN ACQ) RR-SLEW, Slew For LOCK-ON
RR MODE-LGC NO TRACK Out - To 9
(MNVR) V32E To 2

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P21 GROUND TRACK DETERMINATION

1		V37E 21E	
	F 04 06	R1 00002, SPECIFY VEHICLE	
		R2 00001 LM	
		00002 CSM	
		PRO	
2	F 06 34	GET LAT, LONG	(hrs,min,.01sec)
		PRO	
3	F 06 43	LAT, LONG, ALT	(.01°,.1nm)
		V32E (Increment GET 10 Min) To 2	
		PRO	
4	F 37		

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P25 PREFERRED TRACKING ATT

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1		V37E 25E	
		(TO TERM-V56E)	
	F 50 18	REQUEST MNVR TO FDAI RPY ANGLES	(.01°)
		(AUTO) GUID CONT - PGNS	
		MODE CONT - AUTO	
		PRO	
		(MAN) ENTR To 3	
2	06 18	AUTO MNVR TO FDAI RPY ANGLES	(.01°)
3	F 50 19	BYPASS TRIM MNVR TO FDAI RPY ANGLES	(.01°)
		(TRIM) ENTR To 2	
		(BYPASS) PRO (P25 Continues To Run In Background)	

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P27 LGC MANUAL UPDATE

1 (NOTE: For Auto Update: If V33N02 Displayed Key PRO
If V21N02 or N01 Displayed
Key V34E)

2 V37E 00E

3 IF AGS OPERATING, DEDA 563 + 00000E

4 V70E LOAD LIFT OFF TIME
or V71E LOAD CONSECUTIVE DATA
or V72E LOAD SINGULAR DATA
or V73E INCREMENT LGC TIME
(Update Form Will Format Index Number,
Address, Data & Component Identifier
To Be Usable With The Following Pro-
cedure)

5 F 21 01 R3 ADDRESS (Initially 306)
LOAD DATA IN R1 E (R3 Increments)

6 F 21 01 Repeat Step 5 For All Data

7 F 21 02 R3 Goes To 301 When Data Load Complete

TO REVIEW DATA
V01N01E, 306E
R1 Data
N15E (R3 307)
ENTR Verify Data For Remaining Comps.
KEY REL Go To 7

TO CHANGE DATA
Load Comp Identifier E
Correct Data E
Go To 7

TO ACCEPT UPDATE
PRO

8 P00 Displayed

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P30 EXTERNAL ΔV

1		V37E 30E	
	F 06 33	TIG PRO	(hrs,min,.01sec)
2	F 06 82	ΔVXYZ(LV) PRO	(.1fps)
3	F 06 42	HA, HP, ΔV PRO	(.1nm,.1fps)
4	F 16 45	M, TFI, MGA DET - Set PRO (MGA Set To -00002 If No REFSMMAT Set)	(marks,min-sec,.01°)
5	F 37		

CSI P32 PRETHRUST

1		V37E 32E	
	F 06 30	TIG (CSI) PRO	(hrs,min,.01sec)
2	F 06 55	APSIS CDH, TPI ELEVATION ANGLE PRO	(+0000X,.01°)
3	F 06 37	TIG (TPI) PRO	(hrs,min,.01sec)
4	F 16 45	M, TFI, -00001 DET - Set (RECYCLE) V32E To 5 (FINAL PASS) PRO (Terminate Marking)	(marks,min-sec)

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```
                *F 05 09 00600 No Intersection on     *
                *              First Iteration        *
                *        00601 hp+CSI<85 nm           *
                *        00602 hp+CDH<85 nm           *
                *        00603 TIG(CDH)-TIG(CSI)<10min*
                *        00604 TIG(TPI)-TIG(CDH)<10min*
                *        00605 NO SOL IN 15 Tries     *
                *        00606 ΔV(CSI)>1000fps in 2   *
                *              Iterations             *
                *V32E To 1     Adjust Inputs          *

5  F 06 50 ΔH(CDH),ΔT (CDH-CSI),ΔT(TPI-CDH) (.1nm,min-sec)
           PRO

6  F 06 81 ΔVXYZ  (LV) CSI                          (.1fps)
                (For Out-of-Plane Corr in Final Comp ONLY
                     V90E
                 F 06 16 GET EVENT          (hrs,min,.01sec)
                     PRO
                 F 06 90 Y,YDOT,PSI       (.01nm,.1fps,.01°)
                     Record Y DOT_______
                     PRO
                 Insert Y DOT in R2 ofΔV CSI)
                 PRO

7  F 06 82 ΔVXYZ (LV) CDH                           (.1fps)
           PRO (If Recycling To 4)

8  F 16 45  M, TFI, MGA                 (marks,min-sec,.01°)
           DET - Set
           PRO (MGA Set To -00002 If No
                REFSMMAT Set)

9  F 37
```

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P33 CDH PRE-THRUST

1 V37E 33E
F 06 31 TIG (CDH) (hrs,min,.01sec)
PRO

2 F 16 45 M, TFI, -00001 (marks,min-sec)
(RECYCLE) V32E To 3
(FINAL PASS) PRO (Terminate Marking)

F 05 09 00611 NO TIG FOR SPECIFIED
* (REDO) V32E To 1 ANGLE*
* PRO USE LAST ΔT(CDH/TPI/TPI) *
* To 3 *

3 F 06 50 ΔH(CDH),ΔT(TPI-CDH), ΔT(TPI-NOMTPI)
PRO (.1nm,min-sec)

4 F 06 81 ΔVXYZ (LV) CDH (.1fps)
(For Out-of-Plane Corr in Final Comp ONLY
V90E
F 06 16 GET EVENT (hrs,min,.01sec)
PRO
F 06 90 Y, YDOT, PSI (.01nm,.1fps,.01°)
Record Y DOT_____
PRO
Insert Y DOT in R2 of ΔV CDH)
PRO (If Recycling To 2)

5 F 16 45 M, TFI, MGA (marks,min-sec,.01°)
DET - Set
PRO (MGA Set To -00002 If No
REFSMMAT Set)

6 F 37

P34 TPI PRETHRUST

1 V37E 34E
F 06 37 TIG (TPI) (hrs,min,.01sec)
PRO

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2 F 06 55 R2 ELEVATION ANGLE, R3 ωt. (.01°,.01°)
(00000 In R2 To Calc Elevation
Angle At TIG Time)

3 F 16 45 M, TFI, -00001 (marks,min-sec)
(RECYCLE) V32E To 4
(FINAL PASS) PRO (Terminate Marking)

F 05 09 00611 NO TIG FOR SPECIFIED
* ANGLE *
*PRO To 1 *

4 F 06 37 TIG (TPI) (hrs,min,.01sec)
PRO
(If Elevation Angle Computed By LGC
This Display Will Be Replaced By F 06 55
PRO To 5)

5 F 06 58 HP, ΔV(TPI), ΔV(TPF) (.1nm,.1fps)
PRO (If Recycling To 7)

6 F 06 81 ΔVXYZ (LV) TPI (.1fps)
PRO

7 F 06 59 ΔVXYZ (LOS) TPI (.1fps)
PRO (If Recycling To 3)

8 F 16 45 M, TFI, MGA (marks,min-sec,.01°)
DET - Set
PRO (MGA Set To -00002 If No
REFSMMAT Set)

9 F 37

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P35 TPM PRE-THRUST

1		V37E 35E	
	F 16 45	M, TFI, -00001	(marks,min-sec)
		(RECYCLE) V32E-To 3	
		(FINAL PASS) PRO (Terminate Marking)	
2	F 06 81	ΔVXYZ (LV) TPM	(.1fps)
		PRO	
3	F 06 59	ΔVXYZ (LOS) TPM	(.1fps)
		PRO (If Recycling To 1)	
4	F 16 45	M, TFI, MGA	(marks,min-sec,.01°)
		DET - Set	
		PRO (MGA Set To -00002 If No REFSMMAT Set)	
5	F 37		

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P40 DPS THRUST

THR CONT		-AUTO
MAN THROT		-CDR
BAL CPL		-ON
ENG GMBL		-Verify ENABLE
DES ENG CMD OVRD		-Verify OFF
TTCA (LMP)		-JETS
TTCA (CDR)		-THROT (MIN SETTING)
PRPLNT QTY MON		-DES 1
PRPLNT TEMP/PRESS MON		-DES 1
HELIUM MON		-SUPCRIT PRESS
DAP		-SET

1 V37E 40E
*F 05 09 01706 *
* P40 SELECTED *
* BUT LM STAGED *
V34E(Select P42)

F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) GUID CONT - PGNS
MODE CONT - AUTO
PRO
(MAN) ENTR To 3

2 06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)

3 F 50 19 BYPASS TRIM MNVR TO FDAI RPY ANGLES (.01°)
(TRIM) ENTR To 2
(BYPASS) PRO

*F 50 25 R1 00203 *
* GUID CONT - PGNS *
* MODE CONT - AUTO *
* THR CONT - AUTO *
* PRO *

F 05 09 01703 TFI<45 sec
*(TERMINATE) V34E *
*(TIG IN 45 sec) PRO *

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```
4    06 40  TFI, VG,  VM                        (min-sec,.1fps)
               *F 05 09 01711  SV INTEGRATION NOT*
               *    FINISHED PRIOR TO TIG - 30   *
               *(TERM P40) V34E                  *
            MASTER ARM-ON (1st Burn)
            Verify DET - Set
-:35 DSKY BLANKS
            ENG ARM - DES

-:30 06 40  (AVE G ON)

-:15        VERIFY ΔVM (R3) < 00005

-:07.5      Verify +X ULLAGE

-:05 F99 40 ENG ON ENABLE
            (AUTO)    PRO (IGN WHEN TFI≤:00sec)
            (BYPASS) ENTR To DPS OFF

IGN  06 40 TFC, VG, ΔVM                        (min-sec,.1fps)

               *NO TIG or EARLY CUTOFF:  *
               *   To TIG-05 sec         *
               *(For IGN) Correct Anomaly*
               *          PRO            *
               *(BYPASS)  ENTR To DPS OFF*

               *PROG Lt - ON             *
               *V05 N09E 01407 VG        *
               *         INCREASING       *
               *(Terminate Burn or Switch*
               *  To AGS)                 *

DPS OFF
   F 16 40  TFC, VG, ΔVM                       (min-sec,.1fps)
            ENG ARM - OFF
            PRO

5  F 16 85  VG XYZ (LM)                                (.1fps)
            NULL COMPONENTS
            PRO
```

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6 F 37 MASTER ARM -OFF (Master Alarm - On)
ENG GMBL -OFF
PRPLNT QTY MON -OFF
PRPLNT TEMP/PRESS MON -OFF
HELIUM MON -OFF

P41 RCS THRUST

TTCA (CDR) -JETS
DET -Set
DAP -Set

1 V37E 41E
F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) GUID CONT - PGNS
MODE CONT - AUTO
PRO
(MAN) ENTR To 3

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2 06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)

3 F 50 19 BYPASS TRIM MNVR TO FDAI RPY ANGLES (.01°)
(TRIM) ENTR To 2
(BYPASS) PRO

4 16 85 VG XYZ (LM) (.1fps)

F 05 09 01711 SV INTEGRATION
NOT FINISHED PRIOR TO TIG-30
*(TERM P41) V34E *

-:35 DSKY BLANKS

-:30 16 85 (AVE G ON)

-:00 LM-3
F 16 85 VG XYZ (LM) (.1fps)
NULL COMPONENTS
PRO

5 F 37

P42 APS THRUST — Ref. 6

```
          LM                      -STAGED
          HELIUM MON              -ASC PRESS 1
          PRPLNT TEMP/PRES MON    -ASC
          TTCA (CDR)              -JETS
          DAP                     -Set

1         V37E 42E
              *F 05 09 01706   *
              *  P42 SELECTED  *
              *  BUT NOT STAGED*
              *V34E(Select P40)*
  F 50 18 REQUEST MNVR TO FDAI RPY ANGLES          (.01°)
          (AUTO) GUID CONT - PGNS
                 MODE CONT -AUTO
                 PRO
          (MAN) ENTR To 3

2   06 18 AUTO MNVR TO FDAI RPY ANGLES             (.01°)

3 F 50 19 BYPASS TRIM MNVR TO FDAI RPY ANGLES      (.01°)
          (TRIM) ENTR To 2
          (BYPASS) PRO

              *F 50 25 R1 00203          *
              *     GUID CONT - PGNS     *
              *     MODE CONT - AUTO     *
              *     PRO                  *

              *F 05 09 01703 TFI< 45 sec *
              *(TERMINATE) V34E          *
              *(TIG IN 45 sec) PRO       *

4   06 40 TFI,VG,ΔVM                    (min-sec,.1fps)
              *F 05 09 01711 SV INTEGRATION  *
              *NOT FINISHED PRIOR TO TIG-30  *
              *(TERM P42) V34E               *
          Verify DET - Set

-:35 DSKY BLANKS
          ENG ARM-ASC
```

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-:30 06 40 (AVG G ON)

-:15 Verify ΔVM (R3) <00005

-:05 F99 40 ENG ON-ENABLE
-:03.5 Verify +X ULLAGE
(V34E NO ULLAGE To 6)
(AUTO) PRO (IGN WHEN TFI ≤:00 sec)
(BYPASS) ENTR To APS OFF

IGN 06 40 TFI, VG, ΔVM (min-sec,.1fps)
*NO TIG OR EARLY CUTOFF: *
* TO TIG-05 sec *
(FOR IGN) Correct Anomaly
* PRO *
*(BYPASS) ENTR To APS OFF *

*PROG Lt - On *
*V05 N09E 01407 *
* VG INCREASING *
(Terminate Burn or Switch
* To AGS) *

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APS OFF
F 16 40 TFC, VG, ΔVM (min-sec,.1fps)
ENG ARM -OFF
PRO

5 F 16 85 VG XYZ (LM) (.1fps)
NULL COMPONENTS
PRO
HELIUM MON - OFF

6 F 37

P47 ΔV MONITOR

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1 V37E 47E
(60 sec Delay)
F 16 83 ΔV XYZ (LM) (.1fps)
(EXIT) PRO
(RECYCLE) V32E

2 F 37

P51 IMU ORIENTATION

CB(11) AC BUS B: AOT LAMP - Close

1 V37E 51E
F 50 25 R1 00015 MNVR TO ACQ STARS
(To Coarse Align IMU To 0,0,0-ENTR
41 22 All Zeros)
PRO

2 F 01 71 R1 00CDE (C)DETENT (DE)STAR CODE
(DETENT CODE) 1-L, 2-F, 3-R
4-RR(AZ+12000,EL+04500)
CL(AZ+18000,EL+04500)
LR(AZ+24000,EL+04500)
5-COAS(AZ+00000,EL+00000)
PRO
(For Detent Code 4 or 5
F 06 87 AZ,EL (.01°)
PRO)

3 F 54 71 MARK X(52) and Y(53)
PRO
(For DE=00
F 06 88 CELESTIAL BODY VECTOR
Load Ground Values
PRO)
(After 1st Star) To 2
(After 2nd Star) To 4

4 F 06 05 R1 STAR ANGLE DIFFERENCE (.01°)
(RECYCLE) V32E - To 1
PRO

5 F 37 CB(11) AC BUS B: AOT LAMP - Open

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P52 IMU REALIGN

```
1           CB(11) AC BUS B:  AOT LAMP - Close
            V37E52E
    F 04 06 R1 00001 IMU ALIGN OPT
            R2 00001 PREF (0,0,0 Specified Attitude) PRO To 3
                  2 NOM (LV At Specified Time) PRO To 2
                  3 REFSMMAT PRO To 4
               *F 05 09 00215 PREF ORIENT  *
               *        NOT SPECIFIED      *
               *(PREF) Select P40,41,42     *
               *       To Define PREF       *
               *(NOM or REFS) V32E, Go To 1*

2   F 06 34 GET ALIGN                        (hrs,min,.01sec)
            (0,0,0 For Present Time)
            PRO

3   F 06 22 NEW ICDU ANGLES OG,IG,MG                    (.01°)
            (IF MGA > 75° Mnvr Then V32E To 3)
            PRO NO ATT Lt-On Then Off

4   F 50 25 R1 00015 SELECT STAR ACQUISTION MODE
            Mnvr If Necessary
            (PICAPAR) PRO
               *F 05 09 00405 NO PAIR  *
               *(CREW SPECIFY) PRO To 5*
               *(PICAPAR) V32E To 4    *
            (MAN ACQ) ENTR

5   F 01 70 R1 00CDE (C)DETENT (DE)STAR CODE
            (DETENT CODE) 1-L, 2-F, 3-R
                          4-RR(AZ+12000,EL+04500)
                            CL(AZ+18000,EL+04500)
                            LR(AZ+24000,EL+04500)
                          5-COAS(AZ+00000,EL+00000)
            PRO
               (For Detent Code 4 or 5
                F 06 87 AZ,EL                      (.01°)
                        PRO)
               (For DE=00
                F 06 88 CELESTIAL BODY VECTOR
                        Load Ground Values
                        PRO)
```

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6	F	50	18	REQUEST MNVR TO FDAI RPY ANGLES (.01°) (AUTO) GUID CONT - PGNS MODE CONT - AUTO PRO (MAN) ENTR To 8
7		06	18	AUTO MNVR TO FDAI RPY ANGLES (.01°)
8	F	50	19	BYPASS TRIM MNVR TO FDAI RPY ANGLES (.01°) (TRIM) ENTR To 7 (BYPASS)PRO
9	F	01	71	R1 OOCDE (C)DETENT (DE) STAR CODE PRO (For Detent Code 4 or 5 F 06 87 AZ,EL (.01°) PRO)
10	F	54	71	MARK X(52) and Y(53) PRO (For DE=00 F 06 88 CELESTIAL BODY VECTOR Load Ground Values PRO) (After 1st Star) To 5 (After 2nd Star) To 11 (Redefine Star) ENTR To 9
11	F	06	05	STAR ANGLE DIFFERENCE (.01°) (REJECT) V32E To 13 (ACCEPT) PRO
12	F	06	93	ΔGYRO ANGLES X,Y,Z (.001°) (TORQUE) V76E Then PRO (BYPASS) V32E
13	F	50	25	R1 00014 RECHECK or EXIT FINE ALIGN (RECHECK) PRO To 4 (EXIT) ENTR
14	F	37		CB(11) AC BUS B: AOT LAMP - Open

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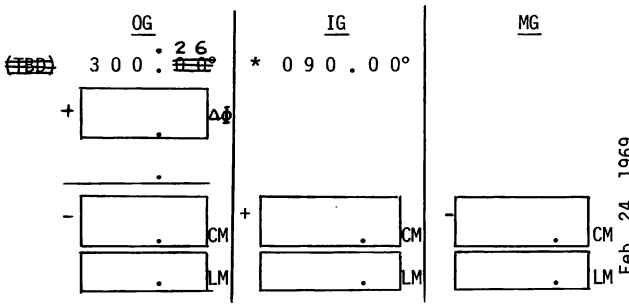
LM DOCKED IMU ALIGNMENT

1 Verify CSM In MIN DB ATT HOLD Until Coarse Align Complete

2 Calculate LM Gimbal Angles:



3 V41N20E COARSE ALIGN IMU
F 21 22 LOAD ICDU ANGLES OG, IG, MG (.01°)
(NO ATT Lt - On, FDAI Torques)
*PROG Lt - On *
*V05N09E 00211 COARSE *
* ALIGN ERROR, GO*
* To 3 *

4 V40N20E ZERO CDU (NO ATT Lt - OFF)
Notify CSM ATT HOLD No Longer Required

5 V25N07E
F 21 07 SET REFSMFLG
77E, 10000E, 1E
V01N01E, 77E, Confirm Bit 13 Set

6 V37E51E, PRO, V37E00E

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Changed

7 V06N20E

06 20 On CSM MARK - ENTER
Copy OG, IG, MG, CSM & LM

OG	IG	MG
. CM	. CM	. CM
. LM	. LM	. LM

Voice Angles to MSFN

8 Copy Ground Calculated Gyro Torquing Angles

X_____, Y_____, Z_____

9 V42E FINE ALIGN IMU
F 21 93 LOAD GYRO TORQUING ANGLES X,Y,Z (.001°)

10 V16N93E
16 93 MONITOR TORQUING

* IF REFSMMAT ARE TO BE MADE ALIKE USE 180°

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V41N20 COARSE ALIGN IMU

1 V41N20E
F 21 22 LOAD NEW ICDU ANGLES O,I,M (.01°)

2 41 COARSE ALIGN
NO ATT Lt - ON
FDAI Torques
*PROG Lt - On *
V05N09E R1 00211 COARSE
* ALIGN ERROR *
*Compare N22 With N20 *
*Repeat V41N20 *

V41N72 COARSE ALIGN RR

1 RNDZ RDR - LGC

2 (If P20 Has Failed To Designate And V41N72 LOCKON Option Is Desired, LOSCMFLG Must Be Reset)

3 V41N72E
F 21 73 LOAD RR TRUNNION, SHAFT ANGLES (.01°)

4 F 04 06 R1 00006 SPECIFY RR FUNCTION
R2 00001 LOCK ON CSM
00002 CONT DESIG
PRO
(TERM CONT DESIG) V44E

V42 GYRO TORQUING

1 V42E
F 21 93 LOAD ΔGYRO ANGLES (XYZ) (.001°)

2 Gyro Torquing (NO ATT Lt - OFF)

V43 FDAI BIAS CHECK

1 MODE CONT - OFF

2 V37E00E

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3		V43E
	F 21 22	LOAD NEW ICDU ANGLES YPR (.01°) FDAI Needles Deflect ENTR
4	F 21 22	LOAD (-) NEW ICDU ANGLES YPR (.01°)
5	43	FDAI Needles Return To 0,0,0

V45 W-MATRIX ERROR DISPLAY

1		V45E
	F 06 99	POS ERR, VEL ERR (.01nm,.1fps) (REINITIAL) V24E PRO

V47 AGS INITIALIZATION

1		V16N65E
	16 65	LGC TIME (hr,min,.01sec) 377 + GET-PGNS/AGS BIAS TIME (.1min) ENTR-(At Correct PGNS Time)
2		V47E
	F 06 16	GET OF AGS CLOCK Load PGNS/AGS BIAS TIME
3		414 + 10000E
4		PRO (32 sec Elapse Before Step 6 Appears If CDU Zero Is Issued, otherwise 20 sec)
5		414R (+00000 Indicates Completion)
6	F 50 16	DOWNLINK COMPLETE PRO
7		400 + 30000E IMU ALIGN
8		RATE/ERR MON (LMP) - LDG RDR/CMPTR ATTITUDE MON (LMP) - AGS
9		V83E
	F 06 54	R,RDOT, THETA (.01nm,.1fps,.010)

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10		440R RDOT	(fps)
11		Compare DSKY/DEDA RDOT To Be Within 2.5 fps PRO	

V48 DAP SET

1		V48E	
	F 01 46	DAP CONFIGURATION (ABCDE) (CONFIG) A 0-LM, 1-LM/CSM (X-TRANS) B 0-RCS A, 1-RCS B, 2-RCS A&B (SCALE) C 0-Fine(4°/sec, 1-Normal(20°/sec) (ATTDB) D 0-.3°,1-5° (RATE) E 0-.2°/sec, 1-.5°/sec, 2-2°/sec 3-10°/sec	
		PRO (TERM) V34E	
2	F 06 47	LM WT, CSM WT PRO	(lb)
3	F 06 48	ENGINE GIMBAL TRIM PITCH, ROLL R1 & R2 Must Be Positive Verify MSFN Contact ENG GMBL - ENABLE Verify MODE CONTROL - AUTO Verify MAN THROT - CDR TTCA (CDR)-THROT (Up) MIN ENG ARM - DES (TRIM) PRO (Master Alarm, GDA/RCCA Caution Lt-On When Gimbals Reach Limits) (EXIT) V34E	(.01°)
4	F 50 48	TRIM COMPLETE ENG ARM - OFF (GDA/RCCA Caution Lt-Off) PRO MSFN Verifies Final GDA Position (If Gimbal Angles Differ From Desired Values By more than 0.1° Repeat V48)	

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V49 CREW DEFINED MANEUVER

1		V37E00E	
2		V49E	
	F 06 22	NEW ICDU ANGLES YPR PRO	(.01°)

3 F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) GUID CONT - PGNS
MODE CONT - AUTO
PRO
(MAN) ENTR To 5

4 06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)

5 F 50 19 BYPASS TRIM MNVR TO FDAI RPY ANGLES
(TRIM) ENTR To 4
(BYPASS)PRO

V74 E-MEMORY DUMP

1 V21N01E 333E
F 21 01 R3 333
R1 20000 E For 4 DUMPS (83.2 sec)
or 10000 E For 2 DUMPS (41.6 sec)
or 04000 E For 1 DUMP (20.8 sec)

2 Verify MSFN Contact
V74E

V82 ORBIT PARAMETER DISPLAY

1 V82E (GO To 2 If AVE G-On)
F 04 06 R1 00002 SPECIFY VEHICLE
R2 00001 LM
00002 CSM
PRO

2 F 16 44 HA,HP,TFF (.1nm,min-sec)
(UPDATE) V32E (Not Required If AVE G-On)
(TERM) PRO

V83 RNDZ PARAMETER DISPLAY

1 V83E
F 06 54 R, RDOT, THETA (.01nm,.1fps,.01°)
PRO

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V84 TARGET△V

1		V84E	
	F 06 84	△V XYZ (LV)	(.1fps)
		PRO	
2	F 06 33	TIG	(hrs,min,.01sec)
		PRO	
3		If P20 Running V80E	

V89 RENDEZVOUS FINAL ATTITUDE

1		V37E00E	
2		V89E	
	F 04 06	R1 00003 SPECIFY TRACKING ATTITUDE	
		R2 00001 (+Z AXIS)	
		00002 (+X AXIS)	
		PRO	
3	F 06 18	FINAL FDAI RPY ANGLES	(.01°)
		(AUTO MNVR) PRO	
		(RECALCULATE) V32E To 3	
4	F 50 18	REQUEST MNVR TO FDAI RPY ANGLES	(.01°)
		(AUTO) GUID CONT - PGNS	
		MODE CONT - AUTO	
		PRO	
		(MAN) ENTR To 6	
5	06 18	AUTO MNVR TO FDAI RPY ANGLES	(.01°)
6	F 50 19	BYPASS TRIM MNVR TO FDAI RPY ANGLES	(.01°)
		(TRIM) ENTR To 5	
		(BYPASS)PRO	

V90 OUT-OF-PLANE DISPLAY

1		V90E	
	F 06 16	GET EVENT	(hrs,min,.01sec)
		PRO	

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2 F 06 90 Y,YDOT,PSI (.01nm,.1fps,.01°)
(RECYCLE) V32E To 1
(EXIT) PRO

V91 SHOW-BANKSUM

1 V37E00E

2 V91E
F 05 01 R1 SUM OF BANK
R2 BANK NUMBER
R3 BUGGER WORD

Verify R1=R2 or Complement of R2, If
Not, Record For MSFN
R1 _____
R2 _____
R3 _____
PRO For Next Bank
(TERM) V34E

LANDING RADAR SELF TEST

1 X-POINTER (Both) - HI MULT
RATE/ERR MON-LDG RDR/CMPTR
TEMP MON - LDG (▷49°) TBD
RNG/ALT MON - ALT/ALT RT
LDG ANT - DES
MODE SEL - LDG RDR
CB(11) PGNS: LDG RDR - Close
(X-POINTER Will Oscillate Then
Up And Right Off Scale)

2 RADAR TEST - LDG (Alt And Alt Rt Tapes Drive)
TEST MONITOR - ALT XMTR (2.1 To 5.0v) (3.6v)
- VEL XMTR (2.1 To 5.0v) (3.8v)
ALT/ALT RT MON - +8094 To +8457 ft
-433 To -465 fps (~~8300~~ 8280/-450)

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3 LDG ANT - HOVER (10sec)
ALT/ALT RT - +7818 To +8169ft/-441 To -457fps
(8000/~~-457~~ -450)

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4 LDG ANT - DES (Wait 10 sec)

5 V62E INITIATE RDR SELF TEST
F 04 06 R1 00004 SPECIFY RDR
R2 00002 LDG RDR
PRO

6 F 16 66 SLANT RANGE, ANT POSITION (ft)
R1 +08165 To +08418 (+08286)
R2 +00001
PRO

7 F 16 67 LDR RDR VEL X,Y,Z (fps)
R1 -00230 To -00264 (-00247 6)
R2 +00924 To +00954 (+00930)
R3 +00643 To +00689 (+00665 6)

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8 V34E

9 LDG ANT - AUTO

10 V61E COMMAND ANT TO POS 2 (27sec)
ALT/ALT RT MON - +7818 To +8169 ft/-441
To -457 fps (8000/-450)

11 V62E INITIATE RDR SELF TEST
F 04 06 R1 00004 SPECIFY RADAR
R2 00002 LDG RDR
PRO

12 F 16 66 SLANT RNG, ANT POSITION 92 (ft)
R1 +08156 To +08418 (+08275)
R2 +00002

13 LDG ANT - AUTO
V34E

14 RADAR TEST - OFF
CB(11) PGNS: LDG RDR-Open (Master Alarm-ON)

RNDZ RDR SELF TEST

1 Verify CSM RCS Thruster B3 And Transponder-OFF
RDZ RDR ANT - Released
X-POINTERS (Both) - HI MULT
RATE/ERR MON (Both - RNDZ RADAR
ATTITUDE MON (Both) - PGNS
MODE SEL - LDG RADAR
RNG/ALT MON - RNG/RNG RATE
SHFT/TRUN - +50°
RDZ RDR - SLEW
TEMP MONITOR - RNDZ (+10° To +150°)

2 CB(11) AC BUS A: RNDZ RDR-Close(Wait 30 sec)
PGNS: RNDZ RDR-Close(NO TRACK Lt-On)

3 SLEW LEFT TO 0°, 0°
SLEW RATE - LO
SHFT/TRUN - +5°
SLEW ANTENNA UP, DOWN, LEFT, RIGHT TO VERIFY
SLEW

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4 RDZ RDR - AUTO TRACK (MASTER ALARM & RNDZ RDR Caut Lt-On)
RADAR TEST - RNDZ (Rng Rt Tape Drives X-Pointers And FDAI Needles Vary Between Limits. After 12sec, Rng Tape Drives, NO TRACK & RNDZ RDR Caut Lt - Out)

5 TEST MONITOR - AGC (0.7 To 3.5V)(1.5)
- XMTR PWR (2.1 To 4.8V)(~~3.8~~) 2.8
- SHAFT ERR(1.5 To 3.5V)(1.5-1.8)
- TRUN ERR (1.5 To 3.5V)(1.6-~~1.8~~)
- AGC 1.7

RDZ RDR-SLEW
SLEW ANTENNA TO 0°,0°
RDZ RDR-LGC(NO TRACK Lt-On)

6 F 04 06 V62E START RNDZ RDR SELF TEST
R1 00004 SPECIFY RADAR
R2 00001 RNDZ RADAR
PRO

F 50 25 R1 00201 SELECT
* LGC CONTROL *
* RNDZ RDR - LGC *
* PRO *

NO TRACK Lt - Out After 12 sec

7 F 16 72 RR TRUNNION AND SHAFT (.01°)
R1 Varying @1/2 cps
R2 Varying @1/2 cps
PRO

8 16 78 RANGE, RANGE RATE 71 (.01nm,fps)
R1 +18900 To +19800 (+195~~64~~)
R2 -00459 To -00541 (-0049~~3~~) -5
RNG/RNG RT - +189 To +198nm/-459 To -541 fps
(196/-~~489.5~~) -493

9 V34E

10 RADAR TEST - OFF (NO TRACK Lt-On, X-PNTR-Center)

11 V40N72E RRCDU ZERO (10sec)

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12
V41N72E
N73 R1+04000
R2+04000
N06 R2 00002
V16N72E (Verify FDAI Needles Up & Right)
V44E (TERM DESIG)

13
V41N72E
N73 R1-00400
R2-00400
N06 R2 00002
V16N72E (Verify FDAI Needles)
V44E (TERM DESIG)

14
V41N72E
N73 R1+00000
R2+00000
N06 R2 00002
V16N72E (VERIFY FDAI NEEDLES)
V44E (TERM DESIG)

15
V41N72E
N73 R1+18000
R2+19400
N06 R2+00002
V16N72E
CB(11) PGNS: RNDZ RDR - Open
AC BUS A: RNDZ RDR - Open
V44E (TERM DESIG)

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PGNS TURN ON & SELF TEST

1		CB(11) PGNS: LGC/DSKY - Close If STBY Lt-On,PRO V36E V21N01E, 3000E, 2176E,E 3011E, 2011E, E 1642E, 37777E V66E
2		CB(11) PGNS: IMU OPR - Close (NO ATT Lt-On For 90 sec)
3	F 88 88	V35E DSKY LIGHT CHECK (Master Alarm, LGC,Iss Warning and all DSKY Lts-On for 5 sec) Key RSET When NO ATT Lt-OFF +20 sec, V37E00E
4	F 21 01	V25N01E 1365E E, E, E
5	15 01	V16N01E, 1365E R1, R2, R3 All Zero
6		V21N27E 10E (Self Test Both Fixed And Erasable Memory) (4E Self Tests Erasable) (5E Self Tests Fixed)
7	15 01	KEY REL R1 Number of Errors R2 Number of Tests Started R3 Number of Tests Successful Test Successful When R2≥3 (78 sec) *PROG Lt - On * *V05N09E 01102 SELF * * TEST ERROR * *N08E Record For MSFN * * R1 _____ * * R2 _____ * * R3 _____ *
8		V21N27E, 0E (Terminate Self Test)

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PIPA BIAS CHECK

1 DET - Zero
Rates <.1°/sec With No Thruster Firing

2 V25N21E, E, E/DET - START

3 V06E
06 21 XYZ PIPA PULSE(Pulses)

4 At T+32 sec - ENTR
T+32 sec (X)R1___(Y)R2___(Z)R3___(+XXXAB)

5 V06N01E,1452E(R1-Review X BIAS)E,E(±AB000)
1454E(Review Y BIAS) E
1456E(Review Z BIAS)

6 V21N01E
F 21 01 LOAD 1452E(Calculated X BIAS)E,E(±AB000)
1454E(Calculated Y BIAS)E,E
1456E(Calculated Z BIAS)E

PGNS ORDEAL INITIALIZATION

1 CB(11) AC BUS B: ORDEAL - Close
FLIGHT DISPLAYS: ORDEAL - Close
FDAI 1 or 2 - ORB RATE
EARTH/LUNAR - EARTH

2 V82E
F 04 06 R1 00002 SPECIFY VEHICLE
R2 00001 LM
PRO

3 F 16 44 HA,HP,TFF (.1nm,.1nm)
Average HA & HP
ALT SET - Set
PRO

4 V83E
F 06 54 R, RDOT, THETA (.01nm,.1fps,.01°)
MODE - HOLD/FAST
SLEW - To THETA
MODE - OPR/SLOW
PRO

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LGC CLOCK INITIALIZATION

1		V37E00E	
2		V25N36E	
	F 21 36	LOAD CSM TIME	(hr,min,.01sec)
		ON CSM MARK - ENTR	
3		V06N65	
		ON CSM MARK - ENTR	
	06 65	SAMPLED LGD TIME	(hr,min,.01sec)
		COMPUTE CSM/LMΔTIME	
		PERFORM SEVERAL TIMES THEN	
4		V55E	
	F 21 24	LOADΔLGC CLOCK TIME	(hr,min,.01sec)

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REVIEW DATA IN ERASABLE MEMORY

1 Perform During Any Flashing Display

2 V01N01E, OCTAL ADD E
F 01 01 R3 OCTAL ADD, R1 DATA

3 N15E (For Next Succeeding Address)
ENTR (For Each Succeeding Address)
(TERM) KEY REL

TO CHANGE DATA IN ERASABLE MEMORY

1 V21 N01E ADD E
F 21 01 R3 ADD
Load New Data In R1 E

2 N15E For Next Succeeding Address.
Load New Data E
ENTR And Load New Data For Each Succeeding Address

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MONITOR OF INPUT/OUTPUT CHANNELS

1 V11N10E
F 11 10 LOAD CHANNEL ADD E
R1 Octal Contents Of Specified Channel

LOAD OUTPUT CHANNELS

1 V21N10E
F 21 10 LOAD CHANNEL ADD E
R1 Load Octal Data E

FLAG WORD SET/RESET

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1 V25 N07E
F 21 07 (Load FLAGWORD ADD) E

2 F 22 07 (Load Code For Bit To Be Changed) E

	A			B			C			D			E	
BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
CODE	40000	20000	10000	04000	02000	01000	00400	00200	00100	00040	00020	00010	00004	00002	00001

3 F 23 07 (Load 1-SET/0-RESET) E

4 TO VERIFY LOAD

VO1NO1E, FLAGWORD ADD ENTR
01 01 R3 FLAGWORD ADD
R1 FLAGWORD CONTENT

BINARY-TO-OCTAL CONVERSION

000-0	100-4
001-1	101-5
010-2	110-6
011-3	111-7

OCTAL-TO-DECIMAL CONVERSION

1-1	11-9	21-17	31-25	41-33
2-2	12-10	22-18	32-26	42-34
3-3	13-11	23-19	33-27	43-35
4-4	14-12	24-20	34-28	44-36
5-5	15-13	25-21	35-29	45-37
6-6	16-14	26-22	36-30	46-38
7-7	17-15	27-23	37-31	47-39
10-8	20-16	30-24	40-32	50-40

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FLAG WORD LISTING

FLAG NAME	ADDRESS	BIT	WHEN SET	WHEN RESET
P25FLAG	0074	9	P25 is operating	P25 is not operating
IMU	0074	8	IMU in use	IMU not in use
Rendezvous	0074	7	P20 initiated (Radar in use)	P20 terminated (Radar not in use)
Lock On	0074	5	RR Lock-ON desired	RR Lock-ON not desired
State Vector	0075	8	CSM State Vector Updated (V81 sets this flag)	LM State Vector Updated (V80 resets this flag)
Update	0075	7	State Vector updating by marks allowed	State vector updating by marks not allowed
Track	0075	5	Rendezvous Tracking allowed	Rendezvous Tracking not allowed
LOS CM Flag	0076	12	LOS Being Computed (R21)	LOS not being computed (R21)
Manual Acquire	0076	13	Enable manual acquisition of CSM by RR	Enable auto acquisition of CSM by RR

External Delta V	0076	8	External Delta V VG Computation	Lambert VG Computations
Final	0076	6	Final pass through rendezvous program computations	Interim pass through rendezvous program computations
Active vehicle	0076	5	LM Active Vehicle	CSM active Vehicle
Preferred Attitude	0076	4	Preferred attitude Computed	Preferred attitude not computed
Auto/manual	0077	15	Do maneuver manually	Do maneuver using KALCMANU
REFSMMAT	0077	13	REFSMMAT good	REFSMMAT not good
No throttle	0101	12	Inhibit full throttle	Permit full throttle
3 Axis	0101	6	Maneuver specified by 3 axes	Maneuver specified by 1 axis
W Matrix	0101	1	W Matrix valid for flight navigation	W Matrix invalid for flight navigation
NTARGFLG	0102	3	Astronaut Loaded ΔV	Astronaut Did Not Load ΔV

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V45 FLAG	0103	8	Astronaut Loaded Initial W Matrix Values	Astronaut Did Not Load Initial W Maxtrix Values
NON FLAGS				
RR Mode	1101	14	LOS within limits of other RR Antenna mode	RR mode set to 2
Designate	1101	10	Desired LOS within limits of present RR mode. Drive CDU's.	Desired LOS not within the limits of the present RR mode. Do not drive CDU's.
ACA Mode (Min Imp)	1102	15	Minimum impulse mode enabled (V76)	Rate Command mode enabled (V77)
AOT Mark Reject	1314	13	Use of Mark Reject button	Use of Mark X or Y
AOT Y Mark	1314	11	After use of Mark Y button	After both X&Y Marks made or a Mark Reject
AOT X Mark	1314	10	After X Mark Made	After both X&Y Marks made or a Mark reject

CHANNEL LISTING

CHANNEL	BIT	FUNCTION
5 OUTPUT	1	JET B4U ON
	2	JET A4D ON
	3	JET A3U ON
	4	JET B3D ON
	5	JET B2U ON
	6	JET A2D ON
	7	JET A1U ON
	8	JET B1D ON
6	1	JET B3A ON
	2	JET B4F ON
	3	JET A1F ON
	4	JET A2A ON
	5	JET B2L ON
	6	JET A3R ON
	7	JET A4R ON
	8	JET B1L ON
11 OUTPUT	1	ISS WARNING
	13	ENGINE ON
	14	ENGINE OFF
12 OUTPUT	1	ZERO RRCDU
	4	COARSE ALIGN ENABLE
	5	ZERO ICDU
	9	+PITCH GMBL TRIM CMD
	10	-PITCH GMBL TRIM CMD
	11	+ROLL GMBL TRIM CMD
	12	-ROLL GMBL TRIM CMD
	13	LR POS CMD
	14	RR AUTO TRACK ENABLE
	15	ISS TURN ON DELAY COMPLETE
16 INPUT	3	MARK X
	4	MARK Y
	5	MARK REJECT
	6	+RATE OF DESCENT
	7	-RATE OF DESCENT

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30 (INVERTED) INPUT	1	ABORT
	2	STAGE VERIFY
	3	ENG ARM
	4	ABORT STAGE
	5	AUTO THROTTLE
	6	DISPLAY INERTIAL DATA
	7	RR CDU FAIL
	9	IMU OPERATE
	10	G&N CONTROL OF S/C
	11	IMU CAGE
	12	ICDU FAIL
	13	IMU FAIL
	14	ISS TURN ON REQUEST
	15	TEMP IN LIMITS
31 (INVERTED) INPUT	1	+PITCH MIN IMPULSE
	2	-PITCH MIN IMPULSE
	3	+YAW MIN IMPULSE
	4	-YAW MIN IMPULSE
	5	+ROLL MIN IMPULSE
	6	-ROLL MIN IMPULSE
	7	+X TRANSLATION
	8	-X TRANSLATION
	9	+Y TRANSLATION
	10	-Y TRANSLATION
	11	+Z TRANSLATION
	12	-Z TRANSLATION
	13	ATTITUDE HOLD
	14	AUTO STAB
	15	ACA OUT OF DETENT
32 (INVERTED) INPUT	1	JETS A4D & A4R FAILED
	2	JETS A3U & A3R FAILED
	3	JETS B4U & B4F FAILED
	4	JETS B3D & B3A FAILED
	5	JETS B1D & B1L FAILED
	6	JETS A1U & A1F FAILED
	7	JETS B2U & B2L FAILED
	8	JETS A2D & A2A FAILED
	9	GIMBAL NOT ENABLED
	10	GIMBAL FAILED
	14	PROCEED

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33 (INVERTED) INPUT		
	2	RR PWR ON/AUTO
	3	RR RNG SCALE LOW
	4	RR DATA GOOD
	5	LR DATA GOOD
	6	LR POSITION 1
	7	LR POSITION 2
	8	LR VELOCITY DATA GOOD
	9	LR RNG SCALE LOW
	10	BLOCK UPLINK
	11	UPLINK TOO FAST
	12	DOWNLINK TOO FAST
	13	PIPA FAIL
	14	LGC WARNING
	15	OSCILLATOR ALARM

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SYMBOL	ADDRESS	FUNCTION
NBD X	1460	X GYRO DRIFT BIAS
NBD Y	1461	Y GYRO DRIFT BIAS
NBD Z	1462	Z GYRO DRIFT BIAS
P BIAS X	1452	X PIPA BIAS
P BIAS Y	1454	Y PIPA BIAS
P BIAS Z	1456	Z PIPA BIAS
CH5 MASK	1264	Bits Of CH5 MASK Indicate Jet Failures In Pitch Or Roll
CH6 MASK	1265	Bits Of CH6 MASK Indicate Jet Failures In Yaw
REDOCTR	1205	Contains Number of Restarts
TEPHEM	1706	Ephemeris Time
HIASCENT	3000	Ascent Stage Mass
XSMD	3573	Starting Address For REFSMMAT
DKDB	3011	Docked Dead Band
TETTHIS	1642	LM State Vector Time Log
ALM CADR	1363	Contains Address Prior To Failure
ALM CADR+1	1364	Contains Address of Failure
ERCOUNT	1365	No of Errors Encountered
RRECT LEM	1626	Starting Address of Permanent LM SV
RRECT CSM	1554	Starting Address of Permanent CSM SV

AGS BACK-UP ALIGNMENT

RNDZ ALIGN

(If CSM & Horizon In View At The Same Time, Go To Step 2)

1 Pitch Down To Horizon & Fly 0° Roll In Plane
400+5E (Body Axis Align)
400+0E (Release Align)

2 Pitch Up & Sight On CSM, 0° Roll
400+5E (Body Axis Align)
400+0E (Release Align)

3 Pitch Down To Horizon 0° Roll & Yaw
400+5E (Body Axis Align)
400+0E (Release Align)

4 Adjust ORDEAL

120 nm	-	345.5°
130 nm	-	344.5°
140 nm	-	344.0°

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STAR ALIGN

1	Maneuver To Place Star Set In AOT (FWD DETENT) (Any 2 APOLLO NAV STARS May Be Used)
2	Position ~~Prime~~ One Star In Center Of Reticle
3	ATT HOLD - Narrow DB
4	Rotate Reticle To Place Either ±X, ±Y Line On Star #2
5	400 + 50000E 400 + 00000E
6	Record & Report To MSFN Star Set Including Centered Star, ID Line, AOT Counter
7	Maneuver To FDAI Angles From MSFN
8	At New Attitude 400 + 50000E 400 + 00000E

Basic Date 24 Feb. 1969 Changed

AGS RR ACQUISITION AND STATE VECTOR UPDATE

1	GUID CONT	- AGS
	RNG/ALT MON	- RNG/RNG RT
	RATE/ERR MON	- LDR RDR/CMPTR
	ATT MON	- AGS
	SHFT/TRUN	- +5°
	RDZ RDR	- SLEW
	ATTITUDE CONT (3)	- PULSE
	MODE CONTROL	- AUTO
	DEAD BAND	- MIN
2	400 +2 ACQUISITION STEERING	
3	Manually Null FDAI	
4	RATE/ERR MON-RNDZ RADAR	
5	Slew Null FDAI, Then Search For Strongest Signal And Check For Side Lobe	
6	RDZ RDR - AUTO TRACK	
7	415 +1 STORE Z-AXIS COSINES ENTR (When FDAI's centered)	
8	316 +(RADAR RANGE)E (Must Be Entered Within 30sec Repeat At 3min Intervals For 5 Data Points)	(.1nm)
9	503 ± (RADAR RANGE RATE)E (Enter Range Rate Only Once For Each Set Of Updates)	(fps)

Basic Date Changed Feb. 24, 1969

AGS MANUAL STATE VECTOR UPDATE

1	Record LM Data And Time	
2	240 +(LM X Position)	(1000ft)
3	241 +(LM Y Position)	(1000ft)
4	242 +(LM Z Position)	(1000ft)
5	260 +(LM X Velocity)	(fps)
6	261 +(LM Y Velocity)	(fps)
7	262 +(LM Z Velocity)	(fps)
8	254 +(LM Epoch Time)	(.1min)
9	414 +20000E Update State Vector	
10	414R (+00000 When Update Complete)	
11	Record CSM Data And Time	
12	244 +(CSM X Position)	(1000ft)
13	245 +(CSM Y Position)	(1000ft)
14	246 +(CSM Z Position)	(1000ft)
15	264 +(CSM X Velocity)	(fps)
16	265 +(CSM Y Velocity)	(fps)
17	266 +(CSM Z Velocity)	(fps)
18	272 +(CSM Epoch Time)	(.1min)
19	414 +30000E Update State Vector	
20	414R (+00000 When Update Complete)	

Basic Date Feb. 24, 1969
Changed

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AGS TURN-ON AND SELF TEST

1 AGS STATUS - STBY
CB(16) STAB/CONT: AEA - Close
AGS STATUS - OPERATE (Master Alarm & AGS Warning Lt On Then Off)

2 6666 (OPR ERR Lt - On)

3 000 +88888

4 123 -45679

5 412R +1 SELF TEST SATISFACTORY
+3 LOGIC TEST FAILURE
+4 MEMORY TEST FAILURE
+7 LOGIC AND MEMORY TEST FAILURE
(To Reinitiate Test Set 412+0)

6 574R(+) DESCENT STAGE FLAG (+Not Staged)

7 604R(+) LUNAR SURFACE FLAG (+Not On Lunar Surface)

8 612R (+00000) STAGING SEQ COUNTER (+00000 For Att Hold At Abort Stage)

Basic Date Feb. 24, 1969
Changed

AGS CALIBRATION

1 Read And Record
540R X ACCEL BIAS COEFF_____(Octal)
541R Y ACCEL BIAS COEFF_____(Octal)
542R Z ACCEL BIAS COEFF_____(Octal)

544R X GYRO DRIFT COEFF_____(.01°/hr)
545R Y GYRO DRIFT COEFF_____(.01°/hr)
546R Z GYRO DRIFT COEFF_____(.01°/hr)

2 Verify AGS In Standby/Operate For 25 min, PGNS-On, LM Thrusters Disabled, Rates .1°/sec, RPY ICDUs Torqued Beyond 11.25° And Will Not Pass Thru 0°, 45°, 90°, etc. (CSM OG=82.5°, IG=22.5°, MG=22.5° Will Give The Desired Starting Attitude)

3 CSM Establish AGS Calibration Attitude, Minimize Rates, Go CMC Mode-Free
V16N20E Monitor ICDU Angles (All Angles Should Be Approx. 22°,67°,112°,157°, 202°,247°,292°, or 337°)

LM ICDUs:	R	112.5°
	P	202.5°
	Y	022.5°
FDAI ANGLES:	R	132.7°
	P	339.8°
	Y	301.4°

4 V40N20E ZERO ICDUS

5 400 +6E CALIBRATE GYRO & ACCEL
Read And Record After 32sec
540R X ACCEL BIAS COEFF_____(Octal)
541R Y ACCEL BIAS COEFF_____(Octal)
542R Z ACCEL BIAS COEFF_____(Octal)
(If BIAS Changes>4 Counts, AGS Failed)
CSM Reset Wide Deadband Attitude Hold Monitor via V16N20E

6 If It Appears That The Gimbal Angles Will Pass Thru 0°, 45°, 90°, 135°, 180°, 225°, 270°, or 325°, Exit Calibration By 400 + 0E)

7 400R + 0 When GYRO & ACCEL CALIBRATE COMPLETE

8 Read And Record After 5 min 2 sec
544R X GYRO DRIFT COEFF_____(.01°/hr)
545R Y GYRO DRIFT COEFF_____(.01°/hr)
546R Z GRYO DRIFT COEFF_____(.01°/hr)
(If GYRO DRIFT>2.5°/hr, AGS Failed)

Basic Date Feb. 24, 1969
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AGS ORDEAL INITIALIZATION

1 POWER - ON
FDAI 1 and/or 2 - ORB RATE
EARTH/LUNAR - EARTH

2 315R Ha LM (.1nm)
403R Hp LM (.1nm)

3 ALT SET - Set To Ave Of Ha & Hp

4 Verify LM Pointed +Z In Direction Of Orbit Travel

5 304R THETA (.01°)
(THETA Reads (+) Pitching Up To 90° Then (+) Back Down To 0° (180° Actual THETA). Pitching Down THETA Reads Up (-) To 90° (270°) Then (-) Back Down To 0° (180°)

6 MODE - HOLD/FAST
SLEW - Set To Theta
MODE - OPR/SLOW

Basic Date Changed Feb. 24, 1969

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AGS ΔV MONITOR

1 GUID CONT - AGS
MODE CONTROL - ATT HOLD
ATTITUDE CONTROL (3) - MODE CONT
DEADBAND - MIN
TTCA (Both) - JETS

2 Mnvr Vehicle To Desired Attitude (Align One Of The Spacecraft Body Axes In The Desired Thrust Direction)

3 400+00000E
MODE CONTROL - AUTO
404+0E
405+0E
406+0E

4 Monitor ΔV Along Thrust Axis
470 R ΔVX (fps)
471 R ΔVY (fps)
472 R ΔVZ (fps)

5 Thrust Along Desired Axis Using TTCA

AGS EXTERNAL ΔV

1 MODE CONTROL - ATT HOLD
GUID CONT - AGS

2 410 +0E (Resets Guidance Mode Logic If previous Burn Was AGS EXT ΔV
410 +5E EXTERNAL ΔV

For Local Vertical Comps:
450 + ΔVX(LV)E (fps)
451 + ΔVY(LV)E (fps)
452 + ΔVZ(LV)E (fps)

For Body Axis Comps:
404 +0E (Zeros 470)
405 +0E (Zeros 471)
406 +0E (Zeros 472)

3 (Inertial Attitude Must Be Maintained Throughout Burn)
267R VG
DET - Set

4 411 +0E DES ENG OR RCS
+1E ASC ENG

5 400 +1E GUIDANCE STEERING

6 ATTITUDE CONTROL (3) - PULSE
MODE CONTROL - AUTO
Maneuver To Burn Attitude Then
ATTITUDE CONTROL (3) - MODE CONT
407 + 0E

7 If Local Vertical Comps Were Used:
501R ΔVGY(LM) (fps)
502R ΔVGZ(LM) (fps)
500R ΔVGX(LM) (fps)

If Body Axis Comps Were Used:
470R ΔVX (fps)
471R ΔVY (fps)
472R ΔVZ (fps)

Basic Date Feb. 24, 1969
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CONFIGURATION	DES	ASC	RCS
TTCA (CDR)	THROT	JETS	JETS
THR CONT	MAN	-	-
MAN THROT	CDR	-	-
ENG ARM	DES	ASC	OFF
X-TRANSL	2 JET	2 JET	2 JET
BAL CPL	ON	ON	ON
PRPLNT QTY MON	DES	OFF	-
PRPLNT TEMP/PRESS	DES	ASC	-
HELIUM MON	SUPCRIT	PRESS]	-
DEAD BAND	MIN	MIN	MIN
ENGINE STOP	-	-	DEPRESS
ABORT(STAGE)PB	PUSH	PUSH	PUSH
~~ABORT PB~~	~~-~~	~~-~~	~~PUSH~~
MASTER ARM	ON	ON	OFF

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9	-15	407 +1E (For RCS Not Burn +X)
10	-06	Start Ullage ENG GMBL - ENABLE
11	00	IGNITION
12		When Burn Complete ABORT(STAGE)PB - RELEASE NULL 500, 501, 502 (fps)
13		MASTER ARM - OFF ENG ARM - OFF ENG GMBL - OFF BAL CPL - ON TTCA (CDR) - JETS DEAD BAND - MAX PRPLNT QTY MON - OFF PRPLNT TEMP/PRESS MON - OFF HELIUM MON - OFF

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AGS CSI

1		MODE CONT - ATT HOLD GUID CONT - AGS
2		275 +(TIG CSI) E (.1min) 277 +(TIG TPI) E (.1min) 605 +(TAN LOS TPI)E(10250 For 27.5°) 416 +0 CDH 1st Apsis (or 180° From CDH If 417 +1) +1 CDH 2nd Apsis (or 360° From CDH If 417 +1) (CSI ROUTINE Not Usable Prior To TIG CSI - 20 min) 410 +1 CSI ROUTINE
3		457R ITERATION ERROR (If +00002 Set 410 + OE And Retarget)

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4	463R HDOT CSI (If 463 + 00010 Set 417±1E(CDH At CSI + 180 Per 416)	(fps)
5	313R TFI CSI DET - Set 267R ΔV CSI	(.01min) (fps)
6	If Time Available 317R RANGE 440R RDOT 371R ΔV CDH 402R Δh CDH 276R TIG CDH 373R ΔT CSI To CDH 274R ΔT CDH To TPI (Must Be Positive)	 (.1nm) (fps) (fps) (.1nm) (.1min) (.1min) (.1min)
7	410 +5 E EXT ΔV 450R ΔVX CSI 263R ΔVY CSI 451R(ΔVY CSI)E(Same Sign As 263) 452R ΔVZ CSI	 (fps) (fps) (fps) (fps)
8	411 +0 E DES ENG OR RCS BURN +1 E ASC ENG BURN	
9	400 +1 E GUIDANCE STEERING	
10	ATTITUDE CONTROL (3) - PULSE MODE CONTROL - AUTO Maneuver To Burn Attitude ATTITUDE CONTROL (3) - MODE CONT 407 + 0E	
11	501R ΔVGY(LM) 502R ΔVGZ(LM) 500R ΔVGX(LM)	(fps) (fps) (fps)

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	CONFIGURATION	DES	ASC	RCS
12	TTCA (CDR)	THROT	JETS	JETS
	THR CONT	MAN	-	-
	MAN THROT	CDR	-	-
	ENG ARM	DES	ASC	OFF
	X-TRANSL	2 JET	2 JET	2 JET
	BAL CPL	ON	ON	ON
	PRPLNT QTY MON	DES 1	OFF	-
	PRPLNT TEMP/PRESS	DES 1	ASC	-
	HELIUM MON	SUPCRIT	PRESS 1	-
	DEAD BAND	MIN	MIN	MIN
	ENGINE STOP	-	-	DEPRESS
	ABORT STAGE PB	PUSH	PUSH	-
	MASTER ARM	ON	ON	-

13 -15 407 +1E (For RCS Burn Not +X(LM)

14 -08 Start Ullage
ENG GMBL - ENABLE

15 00 IGNITION

16 When Burn Complete:
ABORT(STAGE)PB - RESET
NULL 500, 501, 502 (fps)

17 410 +2E CDH ROUTINE

18 MASTER ARM - OFF
ENG GMBL - OFF
ENG ARM - OFF
BAL CPL - ON
TTCA (CDR) - JETS
DEAD BAND - MAX
PRPLNT QTY MON - OFF
PRPLNT TEMP/PRESS MON - OFF
HELIUM MON - OFF

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AGS CDH

1	MODE CONTROL - ATT HOLD GUID CONT - AGS	
2	410 +2E CDH ROUTINE 276R TIG CDH (Adjust AGS T CDH As Desired For New Solution)	(.1min)
3	313R TFI CDH DET - Set 267R ΔV CDH	(.01min) (fps)
4	If Time Available Check The Following: 317R RANGE 440R RDOT 402R ΔH CDH 423R HDOT CDH	 (.1nm) (fps) (.1nm) (fps)
5	410 +5E EXT ΔV 450R ΔVX CDH 263R ΔVY CDH 451R(ΔVY CDH)E(Same Sign As 263) 452R ΔVZ CDH	 (fps) (fps) (fps) (fps)
6	411 +0E DES ENG OR RCS BURN +1E ASC BURN	
7	400 +1E GUIDANCE STEERING	
8	ATTITUDE CONTROL (3) - PULSE MODE CONTROL - AUTO Maneuver To Burn Attitude Then ATTITUDE CONTROL (3) - MODE CONT 407 + 0E	
9	501R ΔVGY(LM) 502R ΔVGZ(LM) 500R ΔVGX(LM)	(fps) (fps) (fps)

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10	CONFIGURATION	DES	ASC	RCS
	TTCA (CDR)	THROT	JETS	JETS
	THR CONT	MAN	-	-
	MAN THROT	CDR	-	-
	ENG ARM	DES	ASC	-
	X-TRANSL	2 JET	2 JET	2 JET
	BAL CPL	ON	ON	ON
	PRPLNT QTY MON	DES	OFF	OFF
	PRPLNT TEMP/PRESS	DES	ASC	-
	HELIUM MON	SUPCRIT	PRESS 1	-
	DEAD BAND	MIN	MIN	MIN
	ENGINE STOP	-	-	DEPRESS
	ABORT STAGE PB	PUSH	PUSH	PUSH
	MASTER ARM	ON	ON	OFF

11 -15 407 +1E (For RCS BURN NOT +X(LM))

12 -08 Start Ullage
ENG GMBL - ENABLE

13 -00 IGNITION

14 When Burn Complete
ABORT(STAGE)PB - RESET
NULL 500, 501, 502 (fps)

15

MASTER ARM	- OFF
ENG ARM	- OFF
ENG GMBL	- OFF
BAL CPL	- ON
TTCA (CDR)	- JETS
DEAD BAND	- MAX
PRPLNT QTY MON	- OFF
PRPLNT TEMP/PRESS MON	- OFF
HELIUM MON	- OFF

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AGS TPI

1	MODE CONTROL - ATT HOLD GUID CONT - AGS	
2	410 +3E TPI SEARCH 311 +(ΔT RND TRANS)E 314 +00000E NODE AT TPF 313 +(TARGET TFI TPI)E	 (.01min) (.01min) (.01min)
3	303R LOS ANGLE TPI 410 +4E TPI EXECUTE (When 303 Is 027.50°) (TO RETARGET 310 + 3E And 313 (Target TFI TPI) E Then 410 + 4E When 303 Is Desired Value	(.01°)
4	313R TFI TPI DET - Set 267R ΔV TPI	(.01min) (fps)
5	If Time Available: 317R RANGE 440R RDOT 304R THETA 373R TIG TPI 371R ΔVG To RNDZ (If +8 Retarget) 402R Hp TPI	 (.1nm) (fps) (.01°) (.1nm)
6	411 +0E DES ENG OR RCS +1E ASC ENG	
7	400 +1E GUIDANCE STEERING	
8	ATTITUDE CONTROL (3) - PULSE MODE CONTROL - AUTO	
9	Maneuver To Burn Attitude Then ATTITUDE CONTROL (3) - MODE CONT	
10	501R ΔVGY(LM) 502R ΔVGZ(LM) 500R ΔVGX(LM)	(fps) (fps) (fps)

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11 To Execute A Burn Without AGS Steering Perform The Following:

404 +0E
405 +0E
406 +0E

470R △VX(LM) (fps)
471R △VY(LM) (fps)
472R △VZ(LM) (fps)

Execute Burn Holding Constant Attitude

Basic Date Changed Feb. 24, 1969

12

CONFIGURATION TTCA (CDR)	DES THROT	ASC JETS	RCS JETS
THR CONT	MAN	-	-
MAN THROT	CDR	-	-
ENG ARM	DES	ASC	OFF
X-TRANSL	2 JETS	2 JETS	2 JETS
BAL CPL	ON	ON	ON
PRPLNT QTY MON	DES	OFF	-
PRPLNT TEMP/PRESS	DES	ASC	-
HELIUM MON	SUPCRIT	PRESS 1	-
ENGINE STOP	-	-	DEPRESS
ABORT PB	PUSH	PUSH	-
MASTER ARM	ON	ON	OFF

13 -15 407 + 1E MODE CONTROL - ATT HOLD
(For RCS BURN Not In +X)
ENG - ENABLE

14 -03 Start Ullage

15 00 IGNITION

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16 When Burn Complete
ABORT(STAGE)PB - RESET
NULL 500, 501, 502 (fps)

17
MASTER ARM - OFF
ENG ARM - OFF
ENG GMBL - OFF
BAL CPL - ON

TTCA (CDR)	- JETS
DEAD BAND	- MAX
PRPLNT QTY MON	- OFF
PRPLNT TEMP/PRESS MON	- OFF
HELIUM MON	- OFF

AGS TPM

1 No Retargeting
Maintain TPI Conditions
Burn Residuals When Desired

Retargeting (Same Rndz Time)

1 410 +3E TPI SEARCH
311 +(ΔT RNDZ TRANS)E
(033.50 For 1st MCC)
(010.50 For 2nd MCC)
313 +(TFI TPM)E (.01min)
410 + 4E TPI EXECUTE

2 267R ΔVG MDC (fps)

3 If Time Available:
306R ΔTRDZ (.01min)
304R THETA (.01°)

4 To Execute A Burn Without AGS Steering
Perform The Following:

404 +0E
405 +0E
406+0E

470R ΔVX(LM) (fps)
471R ΔVY(LM) (fps)
472R ΔVZ(LM) (fps)

Execute Burn Holding Constant Attitude

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AGS SELECTOR LOGIC LIST

Address	Entry	
400	+00000	Attitude Hold
	+10000	Auto Guidance Steering
	+20000	Acquisition Steering
	+30000	IMU Align
	+40000	Lunar Align
	+50000	Body Axis Align
	+60000	Gyro And Accelerometer Calibration (300 sec,30 sec)
	+70000	Accelerometer Calibration Only(30sec)
407	+00000	Use Rotating External ΔV Reference Frame
	+10000	Freeze External ΔV In Inertial Space And Allow ΔV's To Count
410	+00000	Orbit Insertion Routine
	+10000	CSI Routine
	+20000	CDH Routine
	+30000	TPI Search Routine
	+40000	TPI Execute Routine
	+50000	External ΔV
411	+00000	DPS Or RCS Engine Select
	+10000	APS Engine Selection
412	+00000	Reinitiate Test
	+10000	Test Successful
	+30000	Logic Test Fail
	+40000	Memory Test Fail
	+70000	Logic & Memory Test Fail
413	+00000	Normal Position
	+10000	Store Lunar Azimuth
414	+00000	Navigation Initialization Complete (AUTO)
	+10000	LM And CSM Navigation Initialization Via PGNCS Downlinks
	+20000	LM Navigation Initialization Via DEDA
	+30000	CSM Navigation Initialization Via DEDA

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415	+00000	Normal Position
	+10000	Store Z-axis Direction Cosines In RDR Filter
416	+00000	For CSI Calculation Select CDH At First Apsidal Crossing
	+10000	For CSI Calculation Select CDH At Second Apsidal Crossing
	+20000	For CSI Calculation Select CDH At Third Apsidal Crossing
417	+00000	CDH At Apsidal Crossing Selected By Address 416
	+10000	CDH At 180°, 360° Or 540° From CSI Maneuver Based On Address 416
507	+00000	+Z Body Points To CSM When 400 Set To +20000
	+10000	+Z Body Points In Thrust Direction When 400 Set To +20000
563	+00000	Inhibit AGS Update Via PGNS Downlink
623	+00000	Z Body Parallel To CSM Orbit Plane When In Guidance Steering
	+00000	Z Body Parallel To Plane Defined By WB When In Guidance Steering

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DEDA INPUT/OUTPUT LIST

Address		
047	Sine Of Landing Azimuth Angle	Octal
053	Cosine Of Landing Azimuth Angle	Octal
231	Radial Distance Of Launch Site From Center Of Earth	1000 ft
232	Orbit Insertion Altitude	1000 ft
233	Vertical Pitch Steering Altitude Threshold	1000 ft
240	X Position Comp (LM)	1000 ft
241	Y Position Comp (LM)	1000 ft
242	Z Position Comp (LM)	1000 ft
244	X Position Comp (CSM)	1000 ft
245	Y Position Comp (CSM)	1000 ft

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246	Z Position Comp (CSM)	1000 ft
254	LM Ephemeris Data (Epoch Time)	.1 min
260	X Velocity Comp (LM)	fps
261	Y Velocity Comp (LM)	fps
262	Z Velocity Comp (LM)	fps
264	X Velocity Comp (CSM)	fps
265	Y Velocity Comp (CSM)	fps
266	Z Velocity Comp (CSM)	fps
272	CSM Ephemeris Data (Epoch Time)	.1 min
275	Targeted AGS Time For CSI Maneuver (TIG CSI)	.1 min
276	Absolute Time CDH (TIG CDH)	.1 min
277	Targeted AGS Time For TPI Maneuver (TIG TPI)	.1 min
310	Rendezvous Off/Set Time	.01 min
311	Time From TPI To Rendezvous (ΔT RDZ Transfer)	.01 min
313	Targeted TFI TPI For TPI Search Routine	.01 min
314	Target Time Of Node Prior To Rendezvous	.01 min
316	Radar Range (R)	.1 nm
373	AGS TIG TPI (Or TPM)	.1 min
373	CSI To CDH Coast Time (CSI Only)	.1 min
377	AGS Computer Time	.1 min
404	ΔVX Measured (Use 470 For Readout)	Octal
405	ΔVY Measured (Use 471 For Readout)	Octal
406	ΔVZ Measured (Use 472 For Readout)	Octal
450	ΔVX (LV) (+Fwd)	fps
451	ΔVY (LV) (+Rt)	fps
452	ΔVZ (LV) (+Dn)	fps
456	ΔV For CSI Maneuver (Vo)	fps
464	Vertical Pitch Steering, Attitude Rate Threshold	fps
465	Target Radial Rate At Insertion	fps
466	Target Horizontal Velocity At Insertion	fps
503	Radar Range Rate (RDOT)	fps
514	Components Of Unit Vector Used To Provide Yaw Steering	Octal
515	Out Of CSM Orbit Plane	Octal
516	Steering (400 + 10000)	Octal

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534	X Scale Factor For X Accelerometer	Octal
535	Y Scale Factor For Y Accelerometer	Octal
536	Z Scale Factor For Z Accelerometer	Octal
537	X Axis Gyro Mass Unbalance Compensation Constant	Octal
540	X Accel Bias Comp Coeff	Octal
541	Y Accel Bias Comp Coeff	Octal
542	Z Accel Bias Comp Coeff	Octal
544	X Gyro Bias Comp Coeff	.01°/hr
545	Y Gyro Bias Comp Coeff	.01°/hr
546	Z Gyro Bias Comp Coeff	.01°/hr
547	Lunar Align Azimuth Correction	Octal
574	Section Staging Flag(+ Not Staged)	Octal
604	Lunar Surface Flag(+ Not On Lunar Surface)	Octal
605	Desired Tangent Of LOS At TPI (TAN LOS TPI)	Octal

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DEDA OUTPUT LIST

Address		
211	Present Out-Of CSM Orbit Plane Position	1000 ft
263	VG Component For Out-Of-Plane Steering At CSI, CDH Or TPI VPY	fps
267	Delta Velocity To Be Gained	fps
270	Present VY Out-of CSM Orbit Plane Velocity (VYO)	fps
274	ΔT (CDH - TPI)	.1 min
303	Predicted LOS At tigC (TPI Mode)	.01°
303	LM/CSM Central Angle At CDH (CSI/CDH Mode)	.01°
304	Angle Between Local Horizon And Z Body Axis	.01°
305	Minimum Value Of CSI Iteration Error For This Cycle	.01°

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306	Time From CSI To CDH (CSI Mode) Or Time To Rendezvous (TPI Mode)	.01 min
312	Predicted Time Of Peri Focus	.01 min
313	Time To CSI In CSI Mode, CDH In CDH Mode, TPI In TPI Mode (TIG)	.01 min
315	Predicted Altitude Of LM Apogee	.01 nm
317	LM To CSM Range (R)	.1 nm
337	LM Altitude (h)	.1 nm
340	X Comp Of LM Position	1000 ft
341	Y Comp Of LM Position	1000 ft
342	Z Comp Of LM Position	1000 ft
344	X Comp Of CSM Position	1000 ft
345	Y Comp Of CSM Position	1000 ft
346	Z Comp Of CSM Position	1000 ft
347	Predicted LM Burnout Altitude (Orbit Insertion)	1000 ft
360	X Comp Of LM Velocity	fps
361	Y Comp Of LM Velocity	fps
362	Z Comp Of LM Velocity	fps
364	X Comp Of CSM Velocity	fps
365	Y Comp Of CSM Velocity	fps
366	Z Comp Of CSM Velocity	fps
367	LM Altitude Rate (R DOT)	fps
370	Total Velocity To Be Gained	fps
371	ΔV For CDH (Valid In CSI, Coast)	fps
371	ΔV Direct Trans + Braking (TPI)	fps
373	CSI to CDH ΔT (CSI Only)	.1 min
402	LM Predicted Perigee Altitude (TPI)	.1nm
402	LM Predicted ΔH (CDH)	.1nm
403	LM Perigee Attitude (Hp)	.1nm
423	Predicted Burnout HDOT (Orbit Insertion)	fps
433	LM Velocity	fps
440	Range Rate Between LM And CSM (R DOT)	fps
456	ΔV CSI	fps
457	CSI Velocity Search Increment	fps
463	Predicted HDOT CSI	fps
470	ΔVX Measured (+Up) Use 404 To Zero	fps
471	ΔVY Measured (+Rt) Use 405 To Zero	fps
472	ΔVZ Measured (+Fwd) Use 406 To Zero	fps

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500	ΔVGX (LM) (+Up)	fps
501	ΔVGY (LM) (+Rt)	fps
502	ΔVGZ (LM) (+Fwd)	fps
534	X Accelerometer Scale Factor Comp	Octal
535	Y Accelerometer Scale Factor Comp	Octal
536	Z Accelerometer Scale Factor Comp	Octal

DEDA ACCESSIBLE CONSTANTS LIST

Address		
216	q Value Set If Over Flow In e	1000 ft
217	Initial P Perturbation	1000 ft
223	Nominal Burnout Altitude Expression For Orbital Insertion	1000 fps
230	(Δp) Limiter	1000 ft
447	Partial Derivitive, ΔT Protector	fps
453	P-Iterator Converge Check	Octal
454	VG Threshold On Engine Cutoff Computations	fps
473	Descent Stage ΔV Capability (VDX)	fps
504	PGNCS/AGS Misalignment Corr	Octal
505	PGNCS/AGS Misalignment Corr	Octal
506	PGNCS/AGS Misalignment Corr	Octal
526	Set Value Of VT If Overflow	Octal
527	Upper Limit On Final Altitude Rate For Orbital Insertion	Octal
550	X Gyro Scale Factor Compensation	Octal
551	Y Gyro Scale Factor Compensation	Octal
552	Z Gyro Scale Factor Compensation	Octal
554	Upper Limit Of rd Jerk	Octal
555	Desired Derivative Of Yaw Acceleration	Octal
557	Desired Derivative Of Yaw Acceleration	Octal
564	Lower Limit On Δ6	Octal
565	Δ6 Upper Limit	Octal
566	Engine Cant Angle In Pitch Plane	Octal

Basic Date — Jan. 1, 1969
Changed — Feb. 25, 1969

602	Engine Cant Angle In Yaw Plane	Octal
607	Scale Factor For h DOT	
613	Sine Of Central Angle Limit In TPI	
616	Ullage Counter Limit	Octal
617	Gyro Calibrate Duration	Octal
620	No. Of P Iterations - 3	Octal
621	Accelerometer Calibrate Time	Octal
622	Staging Time Delay	Octal
624	Altitude And Altitude Rate Constant 200 msec Readout	Octal
625	FDAI Computation Singularity Threshold	Octal
626	X Axis Alignment Gain	Octal
627	Lunar Align Constant	Octal
630	Lunar Align Constant	Octal
631	Lunar Align Stop Criterion	Octal
632	Calibrate Gain	Octal
633	Calibrate Gain	Octal
634	Acceleration Bias Threshold	Octal
635	Accelerometer Calibrate Gain	Octal
636	Gravitational Constant	Octal
637	Gravitational Constant Reciprocal	Octal
640	rd Jerk Lower Limit When LM Not Staged	
641	Filter Velocity Uncertainty Term	Octal
642	Orbit Insertion Steering Constant	Octal
643	Coefficient In Evaluation Of Cost	Octal
644	Decrease $\Delta 6$ Factor	Octal
645	Increase $\Delta 6$ Factor	Octal
646	Error Term In Radar Filter	Octal
647	Velocity To Be Gained Threshold	Octal
650	Cosine At Angle Between Radar And AGS X-Body Axis	
651	Filter Initial Position Error Covariance	Octal
652	Filter Initial Velocity Error Covariance	Octal

Basic Date Changed Jan. 1, 1969

LM-3

653	Radar Error Model	Octal
654	TB Computation Factor	Octal
655	TB Computation Factor	Octal
657	Ascent Engine Cutoff Impulse Compensation	Octal
660	Lower Limit On aT	Octal
661	Ullage Threshold	Octal
662	Cosine At Angle Between Radar And AGS Y-Body Axis	
666	Att Error Output Limit	Octal
673	Product Of Lunar Rotation Rate And 20 msec Compute Cycle Period (Not Used In FP-3)	Octal
674	(-2)Times(2K1) (2K1=Gravity Constant)	Octal

VENUS
UNIT VECTORS

GMT LO ___:___:___

GMT M:D:H	X UNIT VECTOR	Y UNIT VECTOR	Z UNIT VECTOR
02:28:00	.46576	.14713	.10691
02:28:10	.46496	.14872	.10819
02:28:20	.46416	.15027	.10945
03:01:06	.46337	.15179	.11070
03:01:16	.46258	.15328	.11194
03:02:02	.46180	.15473	.11316
03:02:12	.46103	.15614	.11436
03:02:22	.46026	.15752	.11555
03:03:08	.45950	.15887	.11673
03:03:18	.45875	.16018	.11788
03:04:04	.45801	.16145	.11902
03:04:14	.45728	.16268	.12015
03:05:00	.45656	.16388	.12126
03:05:10	.45585	.16504	.12235
03:05:20	.45515	.16616	.12342
03:06:06	.45447	.16725	.12448
03:06:16	.45380	.16829	.12552
03:07:02	.45314	.16930	.12653
03:07:12	.45249	.17027	.12754
03:07:22	.45187	.17120	.12852

VENUS
UNIT VECTORS

GMT LO ___:___:___

GMT M:D:H	X UNIT VECTOR	Y UNIT VECTOR	Z UNIT VECTOR
03:08:08	.45125	.17209	.12948
03:08:18	.45066	.17293	.13043
03:09:04	.45008	.17374	.13135
03:09:14	.44951	.17451	.13225
03:10:00	.44897	.17524	.13314
03:10:10	.44844	.17593	.13400
03:10:20	.44794	.17657	.13484
03:11:06	.44745	.17718	.13566
03:11:16	.44699	.17774	.13646
03:12:02	.44654	.17826	.13723
03:12:12	.44612	.17873	.13799
03:12:22	.44572	.17917	.13872
03:13:08	.44534	.17956	.13943
03:13:18	.44498	.17991	.14011
03:14:04	.44465	.18021	.14077
03:14:14	.44435	.18047	.14140
03:15:00	.44406	.18069	.14201
03:15:10	.44381	.18086	.14260
03:15:20	.44357	.18099	.14316
03:16:06	.44337	.18107	.14369

MARS
UNIT VECTORS

GMT LO ___:___:___

GMT M:D:H	X UNIT VECTOR	Y UNIT VECTOR	Z UNIT VECTOR
02:28:00	-.24066	-.40593	-.16527
02:28:10	-.23925	-.40662	-.16561
02:28:20	-.23784	-.40731	-.16595
03:01:06	-.23644	-.40799	-.16628
03:01:16	-.23504	-.40866	-.16662
03:02:02	-.23364	-.40933	-.16695
03:02:12	-.23224	-.40999	-.16728
03:02:22	-.23084	-.41064	-.16760
03:03:08	-.22945	-.41129	-.16793
03:03:18	-.22806	-.41193	-.16825
03:04:04	-.22668	-.41256	-.16857
03:04:14	-.22530	-.41319	-.16888
03:05:00	-.22392	-.41381	-.16920
03:05:10	-.22254	-.41443	-.16951
03:05:20	-.22117	-.41503	-.16982
03:06:06	-.21980	-.41563	-.17013
03:06:16	-.21844	-.41623	-.17043
03:07:02	-.21708	-.41681	-.17073
03:07:12	-.21572	-.41740	-.17103
03:07:22	-.21437	-.41797	-.17133

MARS
UNIT VECTORS

GMT LO ___:___:___

GMT M:D:H	X UNIT VECTOR	Y UNIT VECTOR	Z UNIT VECTOR
03:08:08	-.21302	-.41854	-.17163
03:08:18	-.21168	-.41910	-.17192
03:09:04	-.21034	-.41965	-.17221
03:09:14	-.20900	-.42020	-.17250
03:10:00	-.20767	-.42074	-.17279
03:10:10	-.20635	-.42128	-.17307
03:10:20	-.20502	-.42181	-.17335
03:11:06	-.20371	-.42233	-.17363
03:11:16	-.20240	-.42285	-.17391
03:12:02	-.20109	-.42336	-.17419
03:12:12	-.19979	-.42386	-.17446
03:12:22	-.19849	-.42436	-.17473
03:13:08	-.19720	-.42485	-.17500
03:13:18	-.19592	-.42533	-.17527
03:14:04	-.19464	-.42581	-.17553
03:14:14	-.19336	-.42628	-.17579
03:15:00	-.19210	-.42675	-.17605
03:15:10	-.19084	-.42720	-.17631
03:15:20	-.18958	-.42766	-.17657
03:16:06	-.18833	-.42810	-.17682

JUPITER
UNIT VECTORS

GMT LO ___:___:___

GMT M:D:H	X UNIT VECTOR	Y UNIT VECTOR	Z UNIT VECTOR
02:28:00	-.49871	-.03592	-.00090
03:02:02	-.49884	-.03411	-.00007
03:04:04	-.49896	-.03225	.00080
03:06:06	-.49908	-.03032	.00168
03:08:08	-.49919	-.02835	.00258
	-.49925	-.02730	+.00310
03:10:10	-.49930	-.02633	.00349
03:12:12	-.49940	-.02427	.00441
03:14:14	-.49948	-.02218	.00535

SATURN
UNIT VECTORS

GMT LO ___:___:___

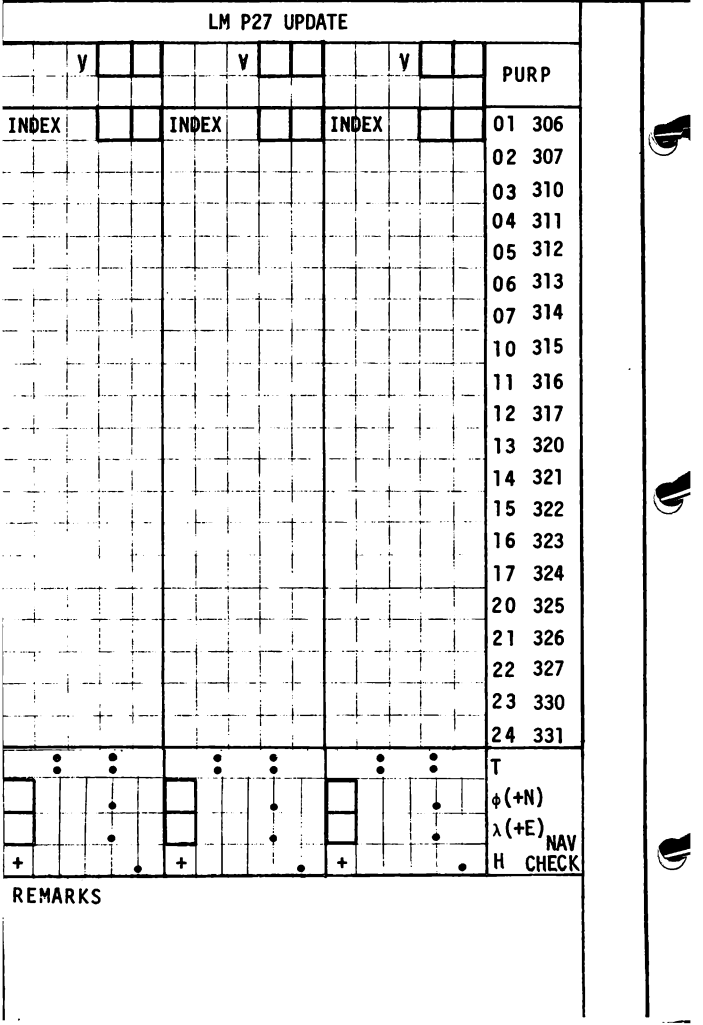
GMT M:D:H	X UNIT VECTOR	Y UNIT VECTOR	Z UNIT VECTOR
02:28:00	.46113	.18441	.05799
03:02:02	.46039	.18600	.05873
03:04:04	.45964	.18763	.05949
03:06:06	.45886	.18927	.06025
03:08:08	.45807	.19094	.06103
03:10:10	.45725	.19264	.06181
03:12:12	.45642	.19435	.06259
03:14:14	.45556	.19609	.06339

LM P27 UPDATE

V	V	V	PURP
INDEX	INDEX	INDEX	01 306
			02 307
			03 310
			04 311
			05 312
			06 313
			07 314
			10 315
			11 316
			12 317
			13 320
			14 321
			15 322
			16 323
			17 324
			20 325
			21 326
			22 327
			23 330
			24 331
			T
			ϕ(+N)
			λ(+E) NAV
+	+	+	H CHECK

REMARKS

P27
UPDAT


LM P27 UPDATE
V
V
V
PURP
INDEX
INDEX
INDEX
01 306
02 307
03 310
04 311
05 312
06 313
07 314
10 315
11 316
12 317
13 320
14 321
15 322
16 323
17 324
20 325
21 326
22 327
23 330
24 331
T
φ(+N)
λ(+E)
NAV
H CHECK
+
+
+
REMARKS

LM P27 UPDATE

V	V	V	PURP
INDEX	INDEX	INDEX	01 306
			02 307
			03 310
			04 311
			05 312
			06 313
			07 314
			10 315
			11 316
			12 317
			13 320
			14 321
			15 322
			16 323
			17 324
			20 325
			21 326
			22 327
			23 330
			24 331
			T
			ϕ(+N)
			λ(+E) NAV
+	+	+	H CHECK

REMARKS

P27
UPDATI

LM P27 UPDATE

V	V	V	PURP
INDEX	INDEX	INDEX	01 306
			02 307
			03 310
			04 311
			05 312
			06 313
			07 314
			10 315
			11 316
			12 317
			13 320
			14 321
			15 322
			16 323
			17 324
			20 325
			21 326
			22 327
			23 330
			24 331
+	+	+	T ϕ(+N) λ(+E) H

NAV CHECK

REMARKS

AGS STATE VECTOR UPDATE

1	2	4	0					2	4	0		
2	2	4	1					2	4	1		
3	2	4	2					2	4	2		
4	2	6	0					2	6	0		
5	2	6	1					2	6	1		
6	2	6	2					2	6	2		
7	2	5	4	+				2	5	4	+	
10	2	4	4					2	4	4		
11	2	4	5					2	4	5		
12	2	4	6					2	4	6		
13	2	6	4					2	6	4		
14	2	6	5					2	6	5		
15	2	6	6					2	6	6		
16	2	7	2	+				2	7	2	+	

REMARKS

AGS S.V. UPDATE

AGS STATE VECTOR UPDATE

1	2	4	0					2	4	0		
2	2	4	1					2	4	1		
3	2	4	2					2	4	2		
4	2	6	0					2	6	0		
5	2	6	1					2	6	1		
6	2	6	2					2	6	2		
7	2	5	4	+				2	5	4	+	
10	2	4	4					2	4	4		
11	2	4	5					2	4	5		
12	2	4	6					2	4	6		
13	2	6	4					2	6	4		
14	2	6	5					2	6	5		
15	2	6	6					2	6	6		
16	2	7	2	+				2	7	2	+	

REMARKS

AGS STATE VECTOR UPDATE

1	2	4	0							2	4	0						
2	2	4	1							2	4	1						
3	2	4	2							2	4	2						
4	2	6	0							2	6	0						
5	2	6	1							2	6	1						
6	2	6	2							2	6	2						
7	2	5	4	+						2	5	4	+					
10	2	4	4							2	4	4						
11	2	4	5							2	4	5						
12	2	4	6							2	4	6						
13	2	6	4							2	6	4						
14	2	6	5							2	6	5						
15	2	6	6							2	6	6						
16	2	7	2	+						2	7	2	+					

REMARKS

*	AGS STATE VECTOR UPDATE																			
1	2	4	0								2	4	0							
2	2	4	1								2	4	1							
3	2	4	2								2	4	2							
4	2	6	0								2	6	0							
5	2	6	1								2	6	1							
6	2	6	2								2	6	2							
7	2	5	4	+							2	5	4	+						
10	2	4	4								2	4	4							
11	2	4	5								2	4	5							
12	2	4	6								2	4	6							
13	2	6	4								2	6	4							
14	2	6	5								2	6	5							
15	2	6	6								2	6	6							
16	2	7	2	+							2	7	2	+						

REMARKS