APOLLO 15	
CSM G & C CHECKLIST	
PART NO.	S/N
SKB32100115-310	1001

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STAR LIST

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

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

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CMC GENERAL

VERB LIST (Decimal)

01 Display Oct Compnt 1 (R1)
02 Display Oct Compnt 2 (R1)
03 Display Oct Compnt 3 (R1)
04 Display Oct Compnt 1, 2 (R1, R2)
05 Display Oct Compnt 1, 2, 3 (R1,R2,R3)
06 Display Decimal (R1 or R1, R2 or R1,R2,R3)
07 Display DP Decimal - (R1,R2)
11 Monitor Oct Compnt 1 (R1)
12 Monitor Oct Compnt 2 (R1)
13 Monitor Oct Compnt 3 (R1)
14 Monitor Oct Compnt 1, 2 (R1, R2)
15 Monitor Oct Compnt 1, 2, 3 (R1,R2,R3)
16 Monitor Decimal (R1 or R1,R2 or R1,R2,R3)
17 Monitor DP Decimal - (R1,R2)
21 Load Compnt 1 (R1)
22 Load Compnt 2 (R2)
23 Load Compnt 3 (R3)
24 Load Compnt 1, 2 (R1, R2)
25 Load Compnt 1, 2, 3 (R1, R2, R3)
27 Display Fixed Memory
30 Request Executive
31 Request Waitlist
32 Recycle Prog
33 Proceed Without DSKY inputs
34 Terminate Function
35 Test Lights
36 Request Fresh Start
37 Change Prog (Major Mode)
*40 Zero ICDU
41 Coarse Align CDU (N20 & N91)
42 Fine Align IMU
43 Load FDAI ATT Error needles
*44 Set Surface Flag
*45 Reset Surface Flag
*46 Activate DAP
*47 Set LM State Vector into CSM State Vector
48 Load DAP (R03)
49 Start Crew Defined MNVR(R62)
50 Please Perform
51 Please Mark
*52 Marked on offset landing site
53 Please Mark alternate LOS
54 Start REND backup sighting mark (R23)

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55 Increment CMC Time (Decimal)
*56 Terminate Tracking (P20)
57 FULTKFLG Display
*58 Reset Stick Flag and set V50 N18 flag
59 Please Calibrate
*60 Set N17 = N20
*61 Display DAP att error
*62 Display total att error (N22-N20)
*63 Display total astro att error (N17-N20)
64 Start S-band ant routine (R05)
*65 Verify Prelaunch Align Optics (CSM)
*66 Set CSM State Vector into LM State Vector
67 W-Matrix RSS Error Display
*69 Restart
70 Update Liftoff Time (P27)
71 Univ Update-BLOCK ADR (P27)
72 Univ Update-SINGLE ADR (P27)
73 Update CMC Time (Octal) (P27)
*74 Initialize erasable dump via downlink
*75 Backup Liftoff
*78 Update prelaunch azimuth
*80 Update LM State Vector
*81 Update CSM State Vector
82 Start Orbit Param Disp (R30)
83 Start REND Param Display No. 1 (R31)
85 Start REND Param Display No.2 (R34)
*86 Reject REND backup sighting mark
*87 Set VHF range flag
*88 Reset VHF range flag
89 Start REND Final ATT Routine (R63)
90 Request REND out of plane display (R36)
91 Compute Banksum
*93 Enable W matrix initialization
*94 Enable CISLUNAR Tracking recycle
*96 Terminate integration and go to P00
(Select P00 by V37 after use of V96)
97 SPS Thrust Fail (R40)
99 Enable engine ignition

*Callable with other extended verb in use and does not lock out other extended verbs

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NOUN LIST (Decimal)

01	Specify Machine Address (Fract) (R1,R2,R3)	.XXXXX
02	Specify Machine Address (Whole) (R1,R2,R3)	XXXXX.
03	Specify Machine Address (R1,R2,R3)	.01°
05	Angular Error/Diff	.01°
06	Option Code (R1 & R2)	OCTAL
07	BIT operator: Address,BIT ID, Action	OCTAL
08	Alarm Data	OCTAL
09	Alarm Codes	OCTAL
10	Channel to be Specified (R1)	OCTAL
11	TIG (CSI)	hrs,min,.01sec
12	Option code (R1&R2)	OCTAL
13	TIG (CDH)	hrs,min,.01sec
14	VC/O (R1) (P15)	FPS
15	Increment Machine Address (R1)	OCTAL
16	Time of event	hrs,min,.01sec
17	Astronaut total att	R,P,Y .01°
18	Auto Maneuver	R,P,Y .01°
20	Present ICDU Angles	R,P,Y .01°
21	PIPA PULSES X,Y,Z	Pulses
22	New ICDU Angles	R,P,Y .01°
24	Delta CMC Clock Time	hrs,min,.01sec
25	Checklist (please perform)	OCTAL
26	Prio/Delay, ADRES, BBCON(R1,R2 & R3)	OCTAL
27	Self-Test on/off sw	OCTAL
29	X SM LAUNCH Azimuth	.01°
30	Target Code(Gyrocomp verif)	
31	Time of rdvz W-mat.init.	hrs,min,.01sec
32	Time from Perigee	hrs,min,.01sec
33	Time of Ignition (TIG)	hrs,min,.01sec
34	Time of Event	hrs,min,.01sec
35	Time from Event	hrs,min,.01sec
36	Time of CMC Clock	hrs,min,.01sec
37	TIG (TPI)	hrs,min,.01sec
38	State Vector Time	hrs,min,.01sec
39	Δ Time of Transfer	hrs,min,.01sec

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40	TF GETI/TFC	min-sec
	VG	.1 FPS
	ΔV (Accumulated)	.1 FPS
41	Target	Azimuth .01°
		Elevation .001°
		Ident 0000X
42	Apogee Alt (HA)(RLS/Pad)	.1 NM
	Perigee Alt (HP) (RLS/Pad)	.1 NM
	ΔV (Required)	.1 FPS
43	Lat	.01° (+ North)
	Long	.01° (+ East)
	Alt (RLS/Pad)	.1 NM
44	Apogee Alt (HA) (RLS/Pad)	.1 NM
	Perigee Alt (HP)(N50)(RLS/Pad)	.1 NM
	TFF	min-sec
45	Marks	XXBXX
	TF GETI	min-sec
	MGA	.01°
46	DAP Config (R1&R2)	OCTAL
47	CSM weight	LBS
	LM Weight	LBS
48	Pitch Trim	.01°
	Yaw Trim	.01°
49	ΔR	.01 NM
	ΔV	.1 FPS
	SOURCE CODE (1 optics,2 VHF)	0000X.
50	ΔR (miss distance)	.1 NM
	Perigee Alt (HP)(RLS/Pad)	.1 NM
	TFF	min-sec
51	RHO	.01°
	GAMMA	.01°
52	CENTANG (active veh)	.01°
53	RANGE	.01 NM
	RANGE RATE	.1 FPS
	PHI (lcl horiz)	.01°
54	Range	.01 NM
	Range Rate	.1 FPS
	Theta (lcl horiz)	.01°
55	Precision offset	CODE
	E(ELEV ANGLE)	.01°
	CENTANG (passive veh)	.01°

58	HP alt (post TPI) (RLS/Pad)	.1 NM
	ΔV (TPI)	.1 FPS
	ΔV (TPF)	.1 FPS
59	ΔV LOS 1	.1 FPS
	ΔV LOS 2	.1 FPS
	ΔV LOS 3	.1 FPS
60	G Max	.01 G
	V Pred	FPS
	Gamma EI	.01°
61	Impact Lat	.01° (+ North)
	Impact Long	.01° (+ East)
	Head Up/Down	+/-00001 (+ Heads up)
62	VI-Inertial Vel Mag	FPS
	H Dot-Alt Rate	FPS
	H-Alt (RLS/Pad)	.1 NM
63	RTGO from 0.05 G To Splash	.1 NM
	VIO, Predicted Iner Vel	FPS
	TFE, time from .05G	min-sec
64	Drag Acceleration	.01 G
	VI, Inertial Velocity	FPS
	RTOGO to Target	.1 NM
65	Sampled CMC Time (fetched in interrupt)	hrs,min,.01 sec
66	Beta, CMD Bank Angle	.01°
	CRSRNG Error	.1 NM
	DNRNG Error	.1 NM
67	RTOGO to Target	.1 NM
	Lat, Present Position	.01° (+ North)
	Long, Present Position	.01° (+ East)
68	Beta, CMD Bank Angle	.01°
	VI, Inertial Vel.	FPS
	H Dot, Alt Rate	FPS
69	Beta	.01°
	DL	.01 G
	VL	FPS
70	Star Code(before mark)	OCTAL
	LMK Data	OCTAL
	Horiz data	OCTAL

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71	Star code (after mark)	OCTAL
	LMK Data	OCTAL
	Horiz data	OCTAL
73	ALT (P21) (RLS/Pad)	10 NM
	VEL (P21)	FPS
	GAMMA (P21)	.01°
74	BETA, CMD Bank Angle	.01°
	VI, Inertial Velocity	FPS
	Drag Acceleration	.01 G
75	ΔH (CDH)	.1 NM
	ΔT	min-sec
	ΔT	min-sec
78	Axis YAW	.01°
	Axis PITCH	.01°
	OMICRON	.01°
79	P20 opt 2 rate	.0001°/sec
	P20 deadband	.01°
80	TF GETI/TFC	min-sec
	VG	FPS
	ΔV (Accumulated)	FPS
81	ΔVX,Y,Z (lcl vert)	.1 FPS
82	ΔVX,Y,Z (LV) CDH	.1 FPS
83	ΔVX,Y,Z (Body Control Axis)	.1 FPS
84	ΔVX,Y,Z (Other Vehicle)	.1 FPS
85	VGX,Y,Z (Body Control Axis)	.1 FPS
86	ΔVX,Y,Z (lcl vert)	FPS
87	Opt Calib Data - Shaft (R1)	.01°
	Trunnion(R2)	.001°
88	Planet X	.XXXXX
	Y	.XXXXX
	Z	.XXXXX
89	Landmark - Lat	.001° (+ North)
	Long/2	.001° (+ East)
	Alt (Mean lunar radius)	.01 NM
90	REND out of Y (Active)	.01 NM
	Plane para Y DOT (Active)	.1 FPS
	Y DOT (Passive)	.1 FPS
91	OCDU Angles Shaft (R1)	.01°
	Trunnion (R2)	.001°
92	New OCDU Angles Shaft (R1)	.01°
	Trunnion (R2)	.001°

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NAVIGATION

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93	Delta Gyro Angles X,Y,Z	.001°
94	OCDU ANGLES (R56 & R23)	
	R1 SHAFT	.01°
	R2 TRUNNION	.001°
95	TF GETI/TFC (P15)	min-sec
	VG (P15)	FPS
	VI (P15)	FPS
96	Y (CSM)	.01 NM
	Y DOT (CSM)	.1 FPS
	Y DOT (LM)	.1 FPS
97	System Test Inputs	XXXXX.
		XXXXX.
		XXXXX.
98	System Test Results	XXXXX.
		.XXXXX
		XXXXX.
99	POS ERR	1 FT
	VEL ERR	.1 FPS
	OPTION Code	0000X.

V05 N09 ALARM CODES

00110 Mark reject has been entered but ignored
Continue

00113 No inbits (chan 16)
Continue; if alarm recurs use MDC DSKY.

00114 More marks made than desired
Continue

00115 V41 N91 keyed with OPTICS MODE not in CMC
OPTICS MODE - CMC and OPTICS ZERO - OFF

00116 Optics switch altered before 15 sec zero time elapsed
OPTICS ZERO - ZERO (15 sec).

00117 V41 N91 keyed but CMC has reserved OCDU (from start of gimbal test in P40 until termination of TVC functional allocation of the "optics" CDU Driving Output)
V41 N91 not yet available

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00120 Optics torque has been requested but optics have not been zeroed since last FRESH START or RESTART
OPTICS ZERO - OFF then ZERO (15 sec).

00121 In 0.05 sec following mark, an ICDU changed by more than 0.033°
Repeat MK.

(m)00205 PIPA saturated
Use SCS control (G&N 12).

00206 The IMU zero routine has been entered with both the GMBL LOCK lt and NO ATT lt on
Coarse align to 0,0,0 Reselect V40E

(m)00207 ISS turn-on request not present for 90 sec
Redo IMU turn on (G&N 12).

(m)00210 The IMU is not operating
Redo IMU turn on. If alarm recurs, perform fresh start (V36E).
Consult MSFN. (G&N 12).

(m)00211 Coarse align error
If P51(3)/52(4) in progress record gyro torquing angles and perform fine align check in P52(4).
Otherwise, see G/1-24. (G&N 12).

(m)00212 PIPA fail, but PIPA is not being used
PIPA BIAS check (G&N 6/8).

(m)00213 IMU not operating with turn-on request
See 00210

00214 Program using IMU when turned OFF
See 00210 or exit program.

(m)00217 IMU coarse align or pulse torque difficulty has occurred
If code 211 also, perform 211 cure only
Reinitiate current program.
If alarm recurs, terminate use of ISS (G&N 12).

00220 IMU orientation unknown
Align or if aligned set REFSMMAT flag.

00401 Desired middle gimbal angle is excessive
Call N22 - maneuver if MGA < 85° or realign IMU.

00402 Second MINKEY pulse torque must be done

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00404 Target out of view (90 deg test)
(G/3-7,3-11,6-3,7-16)

00405 Acceptable star pair is not available
(G/6-3,6-6)

00406 Rend navigation not operating
Select P20 (opt. 0 or 4) or continue.

00421 W-matrix overflow
Notify MSFN but continue.
W-matrix automatically reinitialized at next mark.

00600 No solution on first iteration in P31 or P32/72
(G/4-6,4-8)

00601 Post CSI Perigee/lune alt <85nm/ 5.8nm
(G/4-6,4-8)

00602 Post CDH Perigee/lune alt <85nm/ 5.8nm
(G/4-6,4-8)

00603 Time from TIG (CSI) to TIG (CDH) <10 min
(G/4-6,4-8)

00604 Time from TIG (CDH) to TIG (TPI) <10 min
(G/4-6,4-8)

00605 Number of iterations exceeds loop maximum
(G/4-6,4-8,4-15,4-16)

00606 ΔV (CSI) has been >1000 fps for last two iterations
(G/4-6,4-8)

00611 No TIG for given ELEV angle
(G/4-10,4-12)

00612 State vector in wrong sphere of influence at TIG
(G/4-15)

00613 Reentry angle out of limits
(G/4-16)

(m)00777 ISS warning caused by PIPA fail
(G&N 6).

01102 CMC self test error
(G/2-3)

(m)01105 Downlink too fast
Rset. If alarm recurs DOWNLINK FAILURE.
(G&N 12).

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(m)01106 Uplink too fast
Rset. If alarm recurs UPLINK FAILURE.
(G&N 12).

(m)01107 Phase table failure-assume erasable memory is destroyed
If Comm: 1. V74 CMC DOWNLINK
2. P27 As Necessary.
3. V48 As Necessary (V46).
4. Reestablish REFSMMAT via P51 As Necessary.
If FRESH START recurs, CMC FAILURE (SSR-3).
If no Comm, pg G/9-1

01301 Arcsin or arccos input is greater than one
Notify MSFN, continue.

(m)01407 VG increasing
(G&N 12).

01426 IMU unsatisfactory
Realign or use SCS.

01427 IMU reversed
Note FDAI operation is inverted.

01520 V37 request not permitted at this time
Wait till COMP ACTY lt.
not on continuously - reselect V37 or if P62-67, select P00 and then desired program.

01600 Overflow in drift test
This is gnd test alarm only.

01601 Bad IMU torque abort
See 01600

01703 Insufficient time for integration.
TIG slipped
(G/5-3,5-18)

(m)03777 ISS warning caused by ICDU fail
(G&N 6)

(m)04777 ISS warning caused by ICDU & PIPA fail
(G&N 6)

(m)07777 ISS warning caused by IMU fail
(G&N 6)

(m)10777 ISS warning caused by IMU & PIPA fail (G&N 6)

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(m)13777 ISS warning caused by IMU & ICDU fail
(G&N 6)

(m)14777 ISS warning caused by IMU,ICDU & PIPA fail
(G&N 6)

**20430 Orbital integration has been terminated to avoid possible infinite loop.
Notify MSFN.
Probable S.V. uplink required

**20607 No solution to conic subroutine
Reselect program.

**20610 Alt at specified TIG in P37 < 400K ft
Reselect P37 and decrease TIG.

**21204 Negative or zero time waitlist call.
If ave-g or ext. vb. on, continue.
Otherwise reselect program.

**21206 Second job attempts to go to sleep via keyboard and display program
See 21204.

**21210 Second attempt is made to stall
Reselect program
Do not attempt use of IMU while CMC is using it.

**21302 SQRT called with negative argument
See 21204

**21501 Keyboard and display alarm during internal use
See 21204

**21502 Illegal flashing display
See 21204

**21521 P01 selected and P11 has already been performed
Select correct program

*31104 Delay routine busy
Reselect extended verb or continue with program.
Notify MSFN.

*31201 Executive overflow - no vac area
Reselect Extended Verb and/or Continue Program.

*31202 Executive overflow - no core sets
See 31201

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*31203 Waitlist overflow - too many tasks
See 31201

*31211 Illegal interrupt of extended verb
Reselect extended verb after optics marking is completed.

(m) - Malf procedure indicated

**(2xxxx) - Generates restart (no lt), F37 (POODOO)

*(3xxxx) - Restart (no lt) and program continues (i.e. attempted recovery)(BAILOUT)

NOTE - All **alarms act as *type if they occur when Ave-g is on or display type extended verb is active

V50 N25 CHECKLIST CODES

R1 Code	ACTION	FUNCTION
00013	Key in	Gyro Torque Option (P52,54)
00014	Key in	Fine Align Option
00015	Perform	Celestial Body Acq
00016	Key in	Terminate Mark Sequence
00017	Perform	MINKEY Rendezvous
00020	Perform	MINKEY PC pulse torquing
00041	Switch	CM/SM SEP to UP
00062	Key	CMC to STBY
00202	Perform	3-axis MNVR
00204	Key in	Engine gimbal test opt

V04 N06 (N12) OPTION CODES

R1 Code	Purpose	Input for R2
00001	Specify IMU Orientation	1=PREF, 2=NOM 3=REFS, 4=LDG SITE
00002	Specify vehicle	1=CSM, 2=LM
00004	Specify FULTKFLG setting	0=VHF and optics, 1=VHF or optics
00007	Specify Propulsion System	1=SPS, 2=RCS
00024	Specify P20 mode	0=Rndz., VECPOINT 1=Celestial body, VECPOINT 2=Rotate 4=Rndz., 3-axis 5=Celestial body, 3-axis

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MONITOR DATA IN ERASABLE MEMORY

1		V11 N01E (OCTAL ADD) E
2	F 11 01	R1 DATA R3 OCTAL ADD
3		N15E (For next succeeding word)
4		ENTR (For each succeeding word)

FLAG WORD SET/RESET

1		V25N 07E
	F 21 07	(LOAD FLAG WORD ADDRESS) E
2	F 22 07	(LOAD BIT CODE)* ENTR
3	F 23 07	
		(SET BIT) Key 1E
		(RESET BIT) Key 0E

*To determine code:
Find bit in chart
Number above bit (4,2 or 1) is code.
(Used in correct octal position)
For more than one bit, add codes.

Examples:

Bit	Code
3	4
6	40
7	100
15&13	50000

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CHANGE DATA IN ERASABLE MEMORY

	V21 N01E (ADDRESS) E
F 21 01	R3 ADDRESS
	Load New Data in R1 E
	N15E (For next succeeding word)
	ENTR (For each succeeding word)

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FLAGWORD BIT ASSIGNMENTS

7 100
15&13 50000

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FLAGWORD BIT ASSIGNMENTS

FLAGWORD	ADDRESS	4	2	1	4	2	1	4	2	1	4	2	1	4	2	1
		BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1
0	74		JSWITCH	MIDFLAG	MOONFLAG	FARHOR (NORFHOR)	ZMEASURE	NEEDLEFLG	IMUSE	RNDVZFLG	SGTMK (R53FLAG)	F2RTE	CYC61FLG	FREEFLAG	AMOONFLG	P29FLAG
1	75	2JETSFLG (NJETSFLG)	STIKFLAG	ERADCOMP (ERADFLAG)	NODOPO1	RCSBURN (ENG2FLG)	LMTRG (TARG1FLG)	LMKTRG (TARG2FLG)	CSMUPDAT (VEHUPFLG)	UPDATFLG	IDLEFAIL	TRACKFLG	MARKFLG	ITER1SW (SLOPESW)	GUESSW	AVEGFLAG
2	76	DRIFTFLG	R21MARK	22DSPFLG	P21FLAG	STEERSW	SKIPVHF	IMPULSW	XDELVFLG	FIRSTFLG HAVEELEV (ETPIFLAG)	FINALFLG	LMACTFLG (AVFLAG)	PFRATFLG	P24MKFLG	CALCMAN2	NODOV37 (NODOFLAG)
3	77	V50N18FL	GLOKFAIL	REFSMFLG	LUNLATLO (LUNAFLAG)	P22MKFLG	VFLAG	POOFLAG	PRECIFLG	CULTFLAG	ORBWFLAG	STATEFLG	CONICINT (INTYPFLG)	CSMINTSW (VINTFLAG)	9D1MWMAT (D60R9FLG)	WMATINT (D1MOFLAG)
4	100	MARKIDLE (MRKIDFLG)	PRIOIDLE (PRIODFLG)	NORMIDLE (NRMIDFLG)	PDSPFLAG	MARKWAIT (MWAITFLG)	NORMWAIT (NWAITFLG)	MRKWTKEY (MRKNVFLG)	NRMWTKEY (NRMNVFLG)	PROWTKEY (PRONVFLG)	PINBRFLG	RUPTMARK MRUPTFLG	RUPTNORM (NRUPTFLG)	MKOVNORM (MKOVFLAG)	VNFLAG	XDSPFLAG
5	101	DSKYFLAG	RETROFLG	SLOWFLG	P23CALIB (V59FLAG)	FSTINCRP (INCORFLG)	NEWTFLAG	DMENFLG	CMCCOMP (COMPUTER)	ENGONFLG	3AXISFLG	BKUPLO (GRRBKFLG)		NOSOLNSW (SOLNSW)	MGLVFLAG	RENDWFLG
6	102	DAPBIT1	DAPBIT2	ENTRYDSP STRULLSW	CMDAPARM	GAMDIFSW	GONEPAST	RELVELSW	EGSW (KNOWNFLG) LDNKNOWN	NOSWITCH	HIND	INRLSW	LATSW	.05GSW	CMDSTBY	GYMDIF
7	103	TERMIFLG	ITSWITCH	IGNFLAG	ASTNFLAG	TIMRFLAG	NORMSW	RVSW	GONEBYTG (GONEBY)		V37FLAG		UPLOCKFL	VERIFLAG	LMATTCH (ATTCHFLG)	TFFSW
8	104	RPOFLAG	NEWLMFLG	NEWIFLG	CMOONFLG	LMOONFLG	ADVTRK	UTFLAG	SURFFLAG	INFINFLG	ORDERSW	APSESW	COGAFLAG	V96ONFLG	R67FLAG	360SW
9	105	SWTOVER	P24FLAG	V82EMFLG	MAXDBFLG	V94FLAG	SAVECFLG	VHFRFLAG	VHFSOURC (SOURCFLG)	R22CAFLG	N22ERNDS (N220RN17)	QUITFLAG	R31FLAG	MID1FLAG	MIDAVFLG	AVEMIDSW
10	106	PCMANFLG	INTINUSE (INTFLAG)	INTGRAB (REINTFLG)	REJCTFLG	HDSUPFLG	BURNFLAG	RANGFLAG	P35FLAG	AUTOSEQ		MANEUFLG	PTV93FLG	TPIMNFLG	FULTKFLG	PCFLAG
11	107	S32.1F1	S32.1F2	S32.1F3A	S32.1F3B				AZIMFLAG	HAFLAG	CSISFLAG					

MONITOR OF INPUT/OUTPUT CHANNELS

V11 N10E
F 11 10 (LOAD CHANNEL ADDRESS) E
R1 Octal Contents of Specified Channel

CHANNEL SET/RESET

Note: Only channel no's <30 may be used

1 V25N 07E
F 21 07 (LOAD CHANNEL NUMBER) E

2 F 22 07 (LOAD BIT CODE)* ENTR

3 F 23 07
(SET BIT) Key 1E
(RESET BIT) Key 0E

*To determine code:
Find bit in chart
Number above bit (4,2 or 1) is code.
(Used in correct octal position)
For more than one bit, add codes.

Examples:

Bit	Code
3	4
6	40
7	100
15&13	50000

SC CONT/MODE AND OPTICS MODE OVERRIDE

V21 N1E, 374E, A00D0 ENTR

A=0: Use switches (SC CONT and CMC MODE)
A=1: CMC FREE
A=2: CMC HOLD
A=3: CMC AUTO
A=5,6 or 7: SCS
D=0: Use switches (OPTICS)
D=1: OPT CMC
D=2: OPT ZERO
D=3: OPT MAN

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7 100
15&13 50000

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CMC INPUT/OUTPUT CHANNELS

CHANNEL		NAME	4	2	1	4	2	1	4	2	1	4	2	1	4	2	1
			BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1
CP	1	L			SHFT PULSE			CP REGISTER L, BITS 16-1									
	2	Q			SHFT PULSE			CP REGISTER Q, BITS 16-1									
	3	HISCALAR			SHFT PULSE			HIGH ORDER SCALER CHANNEL BITS 14-1									
	4	LOSCALAR			SHFT PULSE			LOW ORDER SCALER CHANNEL BITS 14-1									
OUT	5	PYJETS							S/M	+Y -YW	-Y +YW	-X -YW	+X +YW	+X -P	-Y +P	X -P	+Y +P
									C/M	-YW -Y +P	+YW -X -P	-YW -X -P	+YW -X +P	-P +Z	+P -X -YW	-P +Z	+P -Y +YW
	6	ROLLJETS							S/M	+Y -R	-Y +R	-Y -R	+Y +R	+Z -R	-Z +R	-Z -R	+Z +R
									C/M					-R -YW +Z	+R +YW -Z	-R -YW -Z	+R +YW +Z
CP	7	SUPERBNK									FE7	FE6	FE5				
OUT	10	OUT0	RELAY ADRS 4	RELAY ADRS 3	RELAY ADRS 2	RELAY ADRS 1	RELAY BIT 11	RELAY BIT10	RELAY BIT 9	RELAY BIT 8	RELAY BIT 7	RELAY BIT 6	RELAY BIT 5	RELAY BIT 4	RELAY BIT 3	RELAY BIT 2	RELAY BIT 1
	11	DSALMOUT			SPS ENGINE ON			CAUTION RESET	TEST CONNECTOR OUTBIT		OPERATOR ERROR LAMP	VN FLASH	KEY REL LAMP	TEMP CAUTION LAMP	UPLINK ACTY LAMP	COMP ACTY LAMP	ISS WARNING
	12	CHAN12	ISS TURNON DELAY COMPLETE	SIV B CUTOFF	SIV B INJ SEQ START		DISABLE OPTICS DAC	ZERO OPTICS	SIV B TAKEOVER ENABLE	TVC ENABLE		ENABLE IMU ERROR COUNTER	ZERO IMU CDU'S	COARSE ALIGN ENABLE		ENABLE OPT ERROR COUNTER	ZERO OPTICS CDU'S
	13	CHAN13	ENABLE T6RUPT	RESET TRAP 32	RESET TRAP 31R	RESET TRAP 31A	ENABLE STANDBY	TEST ALARMS		BMAG CTR ENABLE	DNLNK WD ORD	BLOCK INLINK	INHIBIT COPLINK	RNG UNIT ACTY	RNG UNIT SEL A	RNG UNIT SEL B	RNG UNIT SEL C
	14	CHAN14	DRIVE CDUY	DRIVE CDUY	DRIVE CDUZ	DRIVE CDUT	DRIVE CDUS	GYRO ACTY	GYRO	GYRO	GYRO	GYRO ENABLE					OUTLINK ACTY
IN	15	MNKEY IN											MKEY5	MKEY4	MKEY3	MKEY2	MKEY1
	16	NAVKEY IN									MARK REJECT	MARK	NKEY5	NKEY4	NKEY3	NKEY2	NKEY1
	30	• CHAN30	TEMP IN LIMITS	ISS TURNON REQUEST	IMU FAIL	ICDU FAIL	IMU CAGE	S/C CONTROL OF SAT	IMU OPERATE		OPTICS CDU FAIL		LIFT-OFF	SIV B SEPARATE OR ABORT	SPS READY	SM/CM SEPARATE	ULLAGE THRUST PRESENT
	31	• CHAN31	G & N AUTOPILOT CONTROL	FREE	HOLD	-Z TRANS	+Z TRANS	-Y TRANS	+Y TRANS	-X TRANS	+X TRANS	RHC -ROLL	RHC +ROLL	RHC -YAW	RHC +YAW	RHC -PITCH	RHC +PITCH
	32	• CHAN32		PROCEED			LM ATTACHED					MNIM -ROLL	MNIM +ROLL	MNIM -YAW	MNIM +YAW	MNIM -PITCH	MNIM +PITCH
	33	• CHAN33	OSC ALARM	COMPUTER WARNING	PIPA FAIL	DNLK TOO FAST	UPLNK TOO FAST	BLOCK UPLINK					GMC CTR OPTICS	ZERO OPTICS			
OUT	34	DNTM1							FIRST OF TWO WORDS								
	35	DNTM2							SECOND OF TWO WORDS								
• INVERTED LOGIC			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

VHF RNG DSKY DISPLAY

VHF RNG - on (up)
P20 - running in opt 0 or 4

V87E
V16 N02E
3703E
R1=XXX.XX nm
(max R1 = 163.83;
if R1 neg, RNG = 327.67 - R1)

G&N RECOVERY PROCEDURES

Recoveries:

if P06 inadvertently selected: (with F 50 25 00062)
1. a. Press PRO to STBY, press PRO again to F 37
or b. V37E 00E
2. V25 N7E, 76E, 40000E, 1E (set DRIFT flag)
3. V25 N7E, 77E, 10000E, 1E (set REFSMMAT flag)

if V36 inadvertently keyed in:
1. V25 N7E, 76E, 40000E, 1E (set DRIFT flag)
2. V48
3. V46
4. Perform General System Checkout as necessary

if GO JAM performed:
V74 when convenient, see V36

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if All 8's appear spontaneously on DSKY

1. V99 N99
2. V25 N1E
3. 00000E
4. +99999E
5. +99999E
6. +99999 CLR,CLR,CLR
7. 00000E
8. 00000E
9. 00000E

If OPR ERR, begin again

General System Checkout:

Get to P00 by one of the following:
1. V37E 00E
2. V96E
3. V36E V96E
4. Simultaneously press RSET and MARK REJECT (GO JAM), wait 15 sec, V37E 00E

OPT ZERO - OFF
OPT ZERO - ZERO

Check for Reasonableness
1. V82 with both options
2. V83
3. P21 NAV CHECK
4. P52 check auto optics positioning
   If nominal, continue; if not, perform P51
5. CMC Self Test

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CMC GENERAL

ALARM CODES

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V35 - DSKY CONDITION LIGHT TEST

CMC - on

1 Key V37E 00E (required)
DSKY - P00

2 Key V35E

3 Monitor the following events

a. All DSKY condition lts - on

b. ISS warning lt - on
CMC warning lt - on

c. All DSKY numerical windows display "8".
Sign positions in R1,R2, R3 show +,
V, N windows flash

Wait 5 sec

d. All DSKY warning lts - off

e. ISS lt - off
CMC lt - off
V, N quits Flashing

f. P00 will be displayed.

g. Key RSET
(Don't call ave. G for 15 sec)

V41 N91 COARSE ALIGN OCDU's

CMC - on
G/N PWR OPTICS - on
OPT MODE - CMC
OPT ZERO - OFF

1 V37E00E

2 V41N 91E

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3	F 21 92	SHAFT, TRUN NEW OCDU (.01°,.001°) Load desired shaft and trun
4	41	OPTICS DRIVE TO SPECIFIED ANGLES

V41 N20 COARSE ALIGN ICDU's
CMC - on
ISS - on

1		V41N 20E
2	F 21 22	NEW ICDU ANGLES RPY (.01°) Load desired ICDU angles
3	41	NO ATT lt - on *POSS PROG ALARM * *V5 N9E 211 Coarse align error* *Repeat V41 N20 *
4		V40E NO ATT lt - off Wait 10 sec
5		V37E XXE

V42 GYRO TORQUING
CMC MODE - FREE

1		V42E
	F 21 93	LOAD DELTA GYRO ANGLES (XYZ) (.001°) (In flight - 90° max)
2	42	NO ATT lt - off Monitor Gyro Torquing on FDAI

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V48 - DAP DATA LOAD & ACTIVATE PROCEDURE

1 V48E

F 04 46 R1 ABCDE*
R2 ABCDE

	VEHICLE CONFIG	QUAD A/C FOR $\bar{X}$	QUAD B/D FOR $\bar{X}$	ERR DEADBAND	RATE SELECT
R1	0 = No DAP 1 = CSM 2 = CSM & LM 3 = CSM & SIVB 6 = CSM & LM (Ascent Stg only)	0 = Fail A/C 1 = Use A/C	0 = Fail B/D 1 = Use B/D	0 = ±0.5° 1 = ±5.0°	0 = 0.05°/sec 1 = 0.2°/sec 2 = 0.5°/sec 3 = 2.0°/sec
	Roll Quad Select	Quad A	Quad B	Quad C	Quad D
R2	0 = Use B/D 1 = Use A/C	0=Fail 1=Use	0=Fail 1=Use	0=Fail 1=Use	0=Fail 1=Use

PRO

2 F 06 47 CSM WT, LM WT (lbs,lbs)
Load correct values*
PRO

3 F 06 48 TRIM ENGINE GMBL (.01°)
Load correct values
PRO

4 If activation req'd (Changing to or from NO DAP or CSM & SIVB DAP):
CMC MODE - FREE
V46E

* For SPS burn w/Ascent Stage, A=1, & load total mass in R1 of N47

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NAVIGATION

PRETHRUST (P30's&70's)

S ΔV_0 vs $\Delta\theta$ LONG

G&C SYSTEMS MANAGEMENT

V49 CREW DEFINED MANEUVER

CMC - on
ISS - on
SCS - operating

1 V37E 00E
V62E

2 V49E
F 06 22 NEW ICDU ANGLES RPY (.01°)
Load desired angles
PRO

3 F 50 18 REQ MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) BMAG MODE (3) - RATE 2
SC CONT - CMC
CMC MODE - AUTO
PRO
(MAN) MNVR - To 5

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

5 F 50 18 REQ TRIM MNVR TO FDAI RPY ANGLES
(TRIM) PRO To 4
(BYPASS) ENTR

V54 BACKUP OPTICS MARK

P20 - running in opt. 0 or 4
and tracking

1 V54E

*PROG ALARM *
*V5 N9E - 00406 *
Not rend tracking

2 F 06 94 Backup SHAFT, TRUN (.01°,.001°)
Load angles
PRO

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3 F 53 45 PERFORM BACKUP MARK
MARKS, TFI, MGA or code
(marks,min-sec,.01°)
RHC - Align target on alt. LOS
ENTR (V86E to reject - within 10 sec)

POSS F 06 49 ΔR, ΔV, source code
* (.01NM,.1fps,0000X)*
*(REJECT) V32E *
*(ACCEPT) PRO *

When marking complete:
PRO (return to Program in process)

V55 - CMC TIME UPDATE

1 V55E
F 21 24 LOAD Δ CMC TIME (hrs,min,.01sec)

V57 DISPLAY FULTKFLG CONDITION

1 V57E

2 F 04 12 R1 00004 Specify FULTKFLG setting
R2 00000 VHF and Optics working
00001 VHF or Optics working
Load desired value in R2
(If display erased upon ENTR,
verify by repeating V57)

PRO

V64 HI GAIN ANTENNA POINTING

1 V64E
F 06 51 RHO, GAMMA (.01°,.01°)
HGA TRACK - MAN
Set in required P&Y Angles
S BD ANT - HI GAIN
HGA TRACK - AUTO
PRO

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V67 - W-MATRIX ERROR DISPLAY

```
1              V67E
     F 06 99   POS ERR, VEL ERR, OPT CODE    (ft,.1fps)
                                R3  00001=Rend
                                  (must do V93E to reinit.)
                                    00002=Orbital
                                    00003=Cislunar
                                    00000=No Reinitialization

                   Load desired data
                   PRO
```

V74 CMC DOWNLINK

```
1              V74E (Places erasable memory on downlink)
```

V82 ORBIT PARAMETER DISPLAY

```
          Note:  If high CMC activity (e.g.P4Xw.Lambert)
                    POSS PROG ALARM and restart (no light)
                    -code 31201 or 31202 stored

1              V82E (If AVE G On, Go To 3)
     F 04 12   R1 00002 Specify Vehicle
               R2 00001 CSM
                  00002 LM
               PRO

2    F 06 16   GET EVENT                (hrs,min,.01sec)
               Load desired time (present time,
                                  use all zeroes)
               PRO

3    F 16 44   HA, HP, TFF          (.1nm,.1nm,min-sec)
          (RECYCLE)  V32E To 2 (Not Nec If AVE G On)
          (ΔR-miss dist DISP-P11 & P00) N50E To 4
          (TF PER)  N32E To 5
          (EXIT)   PRO

4    F 16 50   ΔR (miss dist), HP, TFF(.1nm,.1nm,min-sec)
               KEY RLSE To 3

5    F 16 32   TIME FROM PER (Useful only if TFF=-59B59)
                                        (hrs,min,.01sec)
               KEY RLSE To 3
```

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V83 RNDZ PARAMETER DISPLAY #1

Note: If high CMC activity (e.g.P3X or P7X w P20), POSS PROG ALARM and restart (no light)-code 31201 or 31202 stored
If alt above earth or moon >432 nm:
P23 running - do not key V83 (or 85)
P23 not running:
Wait for no integration (COMP ACTY not on continuously)
V96E (selects P00)
V83E (or 85E) - perform routine
V37E 00E

1		V83E
	F 16 54	RANGE,RANGE RATE,THETA (.01nm,.1fps,.01°)
		PRO

V85 - RNDZ PARAMETER DISPLAY #2

Note: See V83 restrictions

1		V85E
	F 16 53	RANGE, RANGE RATE, PHI (.01nm,.1fps,.01°)
		PRO

V87 - SET VHF RNG FLAG

VHF AM B - DUPLEX
VHF RNG - on (up)
P20 - running in opt. 0 or 4

1	V87E (starts VHF range sampling)
2	V88E (TERMINATE)
	or V37E XXE

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V89 - RENDEZVOUS FINAL ATTITUDE

CMC - on
ISS - on
SCS - operating

1		V37E 00E V62E	
2	F 06 78	V89E AXIS YAW, AXIS PITCH Load axis to be pointed at LM PRO	(.01°)
3	F 06 18	FINAL FDAI RPY ANGLES (AUTO MNVR) PRO (UPDATE DISPLAY) V32E	(.01°)
4	F 50 18	REQ MNVR TO FDAI RPY ANGLES (AUTO) BMAG MODE (3) - RATE 2 SC CONT - CMC CMC MODE - AUTO PRO (MAN) MNVR To 6	(.01°)
5	06 18	AUTO MNVR TO FDAI RPY ANGLES	(.01°)
6	F 50 18	REQ MNVR TO FDAI RPY ANGLES (TRIM) ALIGN SC about pointing axis PRO To 5 (BYPASS) ENTR	(.01°)

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V90 - OUT-OF-PLANE DISPLAY

```
1                V90E
     F 06 16     GET EVENT                (hrs,min,.01sec)
                 Load desired time (present time,
                                   use all zeroes)
                 PRO

2    F 06 96     Y(CSM),YDOT(CSM),YDOT(LM)
                                        (.01nm,.1fps,.1fps)
          (RECYCLE) V32E to 1
          (EXIT)    PRO
```

V91 - COMPUTE BANKSUM
CMC - on (req)

```
1                V37E 00E

2                V91E
     F 05 01     R1 - Sum of all cells in bank
                 R2 - Bank number
                 R3 - Bugger word
                 Verify R1=R2 or R1+R2=77777 (If not, rcd
                        R2)

          (NEXT BANK)  PRO
          (TERM)       V34E
```

V93 - ENABLE W-MATRIX INITIALIZATION

```
1                V93E
```

EXT VERBS

ALARM CODES

CMC GENERAL

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IMU POWER UP PROCEDURE

LOGIC POWER 2/3-on
FDAI POWER - BOTH
FDAI SELECT - 1/2
CMC MODE - FREE

1 G/N IMU PWR - on (up)
NO ATT lt - on (90 sec)
NO ATT lt - out
Wait 15 sec (To allow PIPA inhibit reset)

2 V37E XXE
*If CMC not available: *
* G/N IMU PWR - on(up) *
* Wait 90 sec *
* IMU CAGE - on(up) 5 sec,*
* then release *

IMU POWER DOWN PROCEDURE

CMC MODE - FREE

G/N IMU PWR - OFF
ISS warning
*RSET *

MEASUREMENT & LOADING OF PIPA BIAS

1 DET - RESET
SC RATES <0.1°/sec
CMC MODE - FREE

2 V25N 21E, E,E,E/Start Event Timer

3 V06 N21 (do not ENTR)
06 21 XYZ PIPA COUNTS

4 At T + 1:04 - ENTR
Record (X) R1 ____ (Y) R2 ____ (Z) R3 ____ (±000AB)

5 V21N 01E (use same sign as above)
F 21 01 1452 E (CALCULATED X BIAS) E,E,(±AB000)
1454 E (CALCULATED Y BIAS) E,E
1456 E (CALCULATED Z BIAS) E

CMC POWER UP PROCEDURE

1 PRO, hold (~5 sec) until STBY lt - out
(repeat, if necessary)
CMC warning, RESTART, PROG ALARM
*RSET and continue *

2 F 37 00E

P06 - CMC POWER DOWN PROGRAM

1 V48E
F 04 46 Load 0 (NO DAP) in left digit of R1
PRO, PRO, PRO
V46E

V37E 06E
F 50 25 00062 CMC PWR DN

PRO, hold (~5 sec) until STBY lt - on
(repeat, if necessary)

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CMC SELF CHECK

1 V25 N01E, 1365E
F 21 01 E,E,E

2 V15 N01E, 1365E
15 01 R1 NUMBER OF ERRORS
R2 NUMBER OF TESTS STARTED
R3 NUMBER OF TESTS SUCCESSFUL

3 V21 N27E 10E SELF TEST FIXED & ERASABLE
(4E SELF CHECKS ERASABLE
5E SELF CHECKS FIXED)

4 15 01 TEST SUCCESSFUL WHEN R2≥3 (78 sec minimum)
* IF PROG lt - On *
* V05 N09E 01102 SELF *
* TEST ERROR *
*N8E-Rec for MSFN *
(TERM) V21N27E 0E

OPTICS POWER UP PROCEDURE

Verify optics manual drive disengaged

1 G/N PWR OPTICS - on (up)

2 OPT ZERO - OFF
OPT ZERO - ZERO (15 sec)

OPTICS POWER DOWN

1 G/N PWR OPTICS - OFF

SCT MANUAL DRIVE PROCEDURE

Verify G&N PWR OPTICS - OFF

1 Insert tool E and rotate ∿1 rev CCW to engage drive (socket backs out)

2 Drive optics either direction (∿1 rev/degree)

3 To disengage, push and rotate ∿1 rev CW(button will remain flush)

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NAVIGATION

PRETHRUST (P30's&70's)

S ΔV_0 vs $\Delta\theta$ LONG

P37 BLOCK DATA

SCS POWER UP

AUTO RCS SELECT (16) - OFF
BMAG MODE (3) - RATE 2
CMC MODE - FREE
SC CONT - CMC
cb SCS LOGIC PWR (4) - close
ΔV CG - as required
LOGIC PWR 2/3 - on (up)
SIG COND/DRIVER BIAS PWR (2) - ACl
SCS ELEC PWR - GDC/ECA (88 watts)
FDAI PWR - OFF (verify)
BMAG PWR (2) - ON (145 watts)
FDAI PWR - BOTH (58 watts)
AUTO RCS SELECT (16) - enable

SCS POWER DOWN

EMS FUNCTION - OFF
EMS MODE - STBY
FDAI SCALE - 5/1
FDAI SELECT-1/2
FDAI SOURCE - ATT SET
ATT SET - GDC
MAN ATT (3) - MIN IMP
ATT DB - MAX
RATE - LOW
AUTO RCS SELECT (16) - OFF
TRANS CONTR PWR - OFF
RHC PWR NORMAL (2) - OFF
RHC PWR DIRECT (2) - OFF
CMC MODE - FREE
BMAG MODE (3) - RATE 2
SCS TVC (2) - RATE CMD
.05G sw - OFF
α/Pc sw - Pc
TVC GMBL DRIVE (P&Y) - AUTO
BMAG PWR (2) - WARMUP (105 watts)
TVC SERVO PWR (2) - OFF
FDAI PWR - OFF
LOGIC PWR 2/3 - OFF
SCS ELEC PWR - OFF
SIG COND/DRIVER BIAS PWR (2) - OFF

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SCS ATTITUDE REFERENCE COMPARISON

CMC - on
IMU - on
SCS - operating
If SIVB SEPARATED: Damp vehicle rates

1 Key V16 N20E (present IMU angs)

2 FDAI SELECT - 1
FDAI SOURCE - ATT SET
ATT SET - GDC
ATT SET dials - null FDAI 1 error needles
Key VERB when nulled (freeze display)
Record from DSKY:
R____°, P____°, Y____°
Record ATT SET dials:
R____°, P____°, Y____°

EMS ΔV TEST & NULL BIAS CHECK

EMS MODE - STBY
EMS FUNC - ΔV SET/VHF RNG
SET ΔV ind to 1586.8 fps
EMS MODE - NORMAL
EMS FUNC - ΔV TEST
SPS THRUST Lt - on/off (10 sec)
ΔV ind. stops at -0.1 to -41.5
EMS MODE - STBY
EMS FUNC - ΔV SET/VHF RNG
SET ΔV ind to - 100.0 fps
CMC MODE - FREE (Until meas complete)
or BMAG MODE (3) - RATE 2
EMS FUNC - ΔV (wait 5 sec)
Start DET
00:00 EMS MODE - NORM
01:40 EMS MODE - STBY
If ΔV <1 fps, do not bias
If ΔV >1 fps but <10 fps, bias if desired
If ΔV >10 fps, EMS is NO-GO
Bias check is invalidated by EMS FUNC - OFF

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G&C SYSTEMS MANAGEMENT | EXT VERBS | ALARM CODES | CMC GENERAL

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P20 - OPTIONS

0 - Rendz, VECPOINT, p. G/3-2
1 - Celestial body, VECPOINT, p. G/3-1
2 - Rotate, p. G/8-1
4 - Rendz, 3-axis, p. G/3-2
5 - Celestial body, 3-axis, p. G/3-1

P20 - UNIVERSAL TRACKING

Options 1 & 5 - Celestial Body
(1:VECPOINT; 5:3-axis)
CMC - on (req)
ISS - on and aligned (req)
BMAG MODE (3) - RATE 2

1		V37E 20E
	F 04 06	R1 00024 TRACKING OPTION R2 00000 Load 1 or 5 in R2 PRO
2	F 06 78*	AXIS YAW, AXIS PITCH, OMICRON (.01°) Load values (OMICRON ignored for opt 1) Sim. Bay: 90°, 52.25° OMICRON SEF: 180° BEF: 0° PRO
3	F 06 79*	R2 DEADBAND (.01°) Load d.b. PRO
4	F 01 70	R1 000DE STARCODE Load code PRO (DE ≠ 00 to 6)
5	F 06 88	CELESTIAL BODY VECTOR Load vector PRO

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6 (Req'd Mnvr < 10°, To 7)
F 50 18 MNVR request (.01°)
(AUTO) SC CONT - CMC
CMC MODE - AUTO
PRO

06 18 RPY (.01°) to 6 when MNVR complete

(MAN) RHC - MNVR to N18 angles

When att. acceptable

SC CONT - CMC
CMC MODE - AUTO

ENTR

7 *POSS UPLINK ACTY 1t *
*(Mnvr >10° req'd) *
To reestablish F 50 18
* Key V58E *

CMC continues tracking center of celestial body
*CMC will react to changes in N78 and N79 (May take 2 sec)

To terminate P20 - V56E

P20 - UNIVERSAL TRACKING
Options 0 & 4 - Rendezvous
(0:VECPOINT; 4:3-axis)
CMC - on (req)
ISS - on and aligned (req)
SCS - on (des)
BMAG MODE (3) - RATE 2
G/N OPT PWR - on
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - CMC
Note: For VHF RNG display
see p G/1-20

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```
1                V37E 20E

     F 04 06     R1 00024 TRACKING OPTION
                 R2 00000
                 Load 0 or 4 in R2
                 PRO

2    F 06 78*    AXIS YAW, AXIS PITCH, OMICRON        (.01°)
                 Load values (OMICRON ignored for Opt. 0)
                 PRO

3    F 06 79*    R2 DEADBAND                          (.01°)
                 Load d.b.
                 PRO
                 (If required mnvr <10°, go to 5)

4    F 50 18     MNVR request                         (.01°)

        (AUTO)   SC CONT - CMC
                 CMC MODE - AUTO
                 PRO

       06 18     RPY (.01°) to 4 when MNVR complete

        (MAN)    RHC - MNVR to N18 angles

       When att. acceptable

                 SC CONT - CMC
                 CMC MODE - AUTO

                 ENTR

5                     *POSS UPLINK ACTY lt   *
                      *(Mnvr >10° req'd)     *
                      *To reestablish F 50 18*
                      *  Key V58E            *

                 OPT ZERO - OFF
```

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THRUSTING (P40's)

PRETHRUST (P30's&70's)

S ΔV_0 vs $\Delta\theta$ LONG

P37 BLOCK DATA

CMC continues LM attitude and optics tracking
*CMC will react to changes made to N78 and N79
(May take 18 sec)
To start VHF marks - V87E (V88E to stop)
MARK at will (Reject within 10 sec)

```
*POSS F 06 49 ΔR, ΔV, source code*
*              (.01nm,.1fps,0000X)*
*(REJECT) V32E                    *
*(ACCEPT) PRO                     *
```

For backup marks, see V54 (p G/1-26)

To terminate P20 - V56E
OPT ZERO - ZERO
G/N OPT PWR - OFF

Note: To display N49 for each measurement:

V1 N1E
2002 E
Rcrd: R1 _____
V21 E
2002 E
77776 E

To return:
V21 N1E
2002 E
Load previously recorded value

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P21 GROUND TRACK DETERMINATION
CMC - on (req)

1		V37E 21E
	F 04 06	R1 00002, Specify Vehicle R2 00001, CSM or 00002, LM PRO
2	F 06 34	GET LAT,LONG (hrs,min,.01sec) Load desired GET (for present time, use all zeroes) PRO
3	F 06 43	LAT,LONG,ALT (.01°,.01°,.1nm) (RECYCLE) V32E to 2 (Increment GET 10 min) (EXIT) PRO
4	F 37	XXE

NOTE: Additional Information is available by V6 N73E
N73 Alt,VEL,GAMMA(10nm,fps,.01°)

P22 - ORBITAL NAVIGATION

```
                CMC - on (req)
                ISS - on and aligned (req)
                SCS - on (req)
                BMAG MODE (3) - RATE 2
                G&N PWR OPTICS - on
                COUPLING - RESOLVED
                SPEED - MED
                OPT ZERO - OFF then ZERO (15 sec)
                OPT MODE - CMC
                To remove rate limit:  V21N11E,1341E,E

1           V37E 22E
    F 06 45 R3=MAX MGA                          (.01°)
        (REJECT)  R3>60° to P52
                  R3<60° IMU ALIGNED
            MNVR To SIGHTING ATTITUDE
                     Roll to keep shaft axis >10° from
                     plane defined by X axis & LOS to
                     LMK (For 60nm alt, LMK >10nm from
                     gnd track requires no roll)
        (MAN)     OPT MODE - MAN
                  OPT ZERO - OFF
            PRO (To 3 for earth orbit)
        (AUTO)    OPT ZERO - OFF
        PRO (To 3 for earth orbit)

2   F 05 70 (lunar orbit only)
            R2 ABCDE lmk code
            Load lmk code: SITE  = 10001
                           KNOWN = 10000
                           UNKN  = 20000
              A=1(known), 2(unknown)
              B=INDEX OF OFFSET designator
              C=not used
        DE=LMK ID (0,1, 5X are legal)
            IF A=2
                OPT MODE - MAN
            PRO to 5
        or  IF A=1 & DE≠00
            PRO to 4 (To 5 if OPTICS - MAN)
        or  IF A=1 & DE=00
            PRO to 3
```

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```
3    F 06 89   LAT,LONG/2,ALT       (.001°,.001°,.01nm)
               Load lmk coords
               PRO (To 5 if OPTICS - MAN)

4      06 92   SHAFT,TRUN NEW OCDU        (.01°,.001°)
                         *F 05 09 00404       (TRUN>90°)*
                         *   MNVR to acquire            *
                         *     PRO                      *
                         *  or V34E, F 37               *
               Establish proper pitch rate
                    OPTICS MODE - MAN

5    F 51      MARK REQUEST (Avoid lmk near horiz)
               MARK
                 After sufficient MARKS:
                         *After 5 MARKS:            *
                         *F 50 25 00016 TERM MARKS*
               PRO

6    F 05 71   R2 ABCDE LMK DATA
               Load lmk code (if nec)
                 A=1  if KNOWN LMK
                 A=2  if UNKNOWN LMK
                 B=INDEX OF OFFSET DESIGNATOR
                    (If only 1 mark made, insure B=0)
                 C=Not used in P22
                DE=LMK ID NO. (0,1 are valid)
               PRO - if A=2 (or A is 1 & DE = 01) to 8

7    F 06 89   LAT,LONG/2,ALT       (.001°,.001°,.01nm)
               PRO

8    F 06 49   ΔR,ΔV (SV PARA)            (.01nm,.1fps)
          (RECYCLE) V32E to 2
          (ACCEPT) Hold for 30 sec
               PRO

9    F 06 89   LAT,LONG/2,ALT LMK ID
                                      (.001°,.001°,.01nm)
          (DON'T STORE)     PRO to 2
          (STORE-CODE 01)   V32E to 2
          (terminate Prog) V34E
```

10 F 37 XXE

OPT ZERO - ZERO
G/N PWR OPTICS - OFF

To restore rate limit (CDU transient detection): V21N11E,1341E,5E

P23 - CISLUNAR MIDCOURSE NAV MEASUREMENT

CMC - on
SCS - on
ISS - on & aligned
G/N PWR OPTICS - on (30 min prior)
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - CMC

1 V37E 23E

2 F 50 25 R1 00015 ACQ CALIBRATION STAR
(MAN MNVR) Mnvr veh. to point LLOS at body
ENTR to 7
(AUTO MNVR) PRO

3 F 01 70 R1 000DE STAR CODE
Load desired code
PRO (to 5 if DE≠00)

4 F 06 88 CELESTIAL BODY VECTOR
Load desired vector
PRO

5 F 50 18 REQUEST MNVR TO FDAI R,P,Y (.01°)
(AUTO) SC CONT-CMC
CMC MODE - AUTO
BMAG MODE (3) -RATE 2
PRO to 6
(MAN) V62E
MNVR to 5

(BYPASS) ENTR to 7

6 06 18 AUTO MNVR FDAI R, P, Y (.01°)
AUTO MNVR COMPLETE RETURN TO 5

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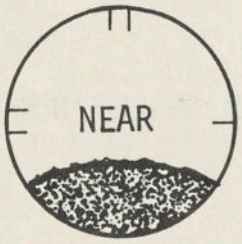
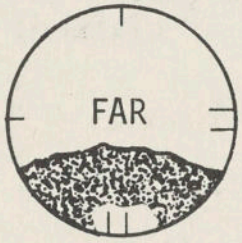
7 F 59 REQUEST OPTICS CALIB
(BYPASS) ENTR to 9
(CALIB) OPT MODE - MAN
OPT COUPLING - DIR
SPEED - LOW
OPT ZERO - OFF
SUPERIMPOSE LLOS ON SLOS
MARK

8 F 06 87 R2 TRUN BIAS (.001°)
(Repeat until 2 measurements agree within .003°)
For manual load:
V22 N94E
XXXXXE
(RECALIB) MARK to 8
(INCORP CALIB) PRO

9 F 05 70 R1 000DE STAR ID
R2 00C00 LMK ID
R3 00CD0 HOR ID



STAR/ENH	STAR/LNH	STAR/EL
000DE	000DE	000DE
00000	00000	00100
00110	00210	00000



STAR/EFH	STAR/LFH	STAR/LL
000DE	000DE	000DE
00000	00000	00200
00120	00220	00000

STAR/HOR PRO TO 12 (DE=00 to 11)
STAR/LMK PRO

10 F 06 89 LAT, LONG/2, ALT (LMK)(.001° +N/E,.01nm)
PRO (DE≠00 to 12)

11 F 06 88 CELESTIAL BODY VECTOR
LOAD DESIRED VECTOR
PRO

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THRUSTING (P40's)
PRETHRUST (P30's&70's)
S ΔV_0 vs $\Delta\theta$ LONG
P37 BLOCK DATA

```
12   F 50 25   00202 3-AXIS MNVR REQUEST
               (3-AXIS)  PRO
               (VECPOINT)ENTR

13   F 50 18   REQUEST MNVR TO FDAI R,P,Y          (.01°)
               (AUTO)     SC CONT - CMC
                          CMC MODE - AUTO
                          BMAG MODE (3) - RATE 2
                          PRO to 14
               (MAN)      V62E
                          MNVR to 13
               (BYPASS)   OPT MODE - CMC
                          OPT ZERO - OFF
                          ENTR to 15

14     06 18   AUTO MNVR FDAI R, P, Y                (.01°)
               AUTO MNVR COMPLETE RETURN TO 13

15     06 92   AUTO OPT SHFT/TRUN            (.01°,.001°)
               (MNVR)     V94E to 12
               (MARK)     MNVR SC TO POSITION LMK/HOR
                            IN FOV
                          OPT MODE - MAN

16   F 51      MARK REQUEST
               (MNVR)     V94E to 12
               (MARK)     SUPERIMPOSE STAR ON LMK/HOR
                          MARK

17   F 50 25   00016 TERM MARKS
               (REJECT) MARK REJECT to 16 (Noun + R1 not
                                           blanked)
               (TERM)   PRO

18   F 05 71   R1  000DE STAR ID
               R2  00C00 LMK ID
               R3  00CD0 HOR ID

               (STAR/HOR) PRO to 21 (DE=00 to 20)
               (STAR/LMK) PRO to 19

19   F 06 89   LAT, LONG/2, ALT(LMK)   (.001°+N/E,.01nm)
               PRO (DE≠00 to 21)
```

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20	F 06 88	CELESTIAL BODY VECTOR Verify vector PRO
21	F 06 49	ΔR,ΔV (SV PARA) (.01nm,.1 fps) (REJECT) V37E 23E (UPDATE) PRO
22	F 37	XXE OPT ZERO - ZERO G/N PWR OPTICS - OFF

<u>P24 RATE-AIDED OPTICS TRACKING</u>

CMC - on (req)
ISS - on and aligned
SCS - on
BMAG MODE (3) - RATE 2
G&N PWR OPTICS - on
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - CMC
TVC SERVO PWR 1 & 2 - OFF (verify)
GMBL MTRS (4) - OFF (verify)

1		V37E 24E
2	F 06 89	LAT, LONG/2, ALT (.001°,.001°,.01nm) LOAD LMK COORDS OPT ZERO - OFF MNVR to SIGHTING ATT Roll to keep shaft axis > 10° from plane defined by X-axis & LOS to LMK (For 60nm alt, LMK > 10nm from gnd track requires no roll) PRO
3	06 92	AUTO OPT SHFT/TRUN (.01°,.001°) *F 05 09 00404 (TRUN >90°)* * MNVR to acquire * * PRO * * or V34E, F 37 * OPTICS MODE - MAN

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THRUSTING (P40's)

PRETHRUST (P30's&70's)

S ΔV_0 VS $\Delta\theta$ LONG

P37 BLOCK DATA

4 F 51 MARK REQUEST
MARK (as often as desired)
To terminate:
PRO

5 F 37 XXE
OPT ZERO - ZERO
G/N PWR OPTICS - OFF

P27 CMC UPDATE
CMC - on (req)

Auto Update:

1 V37E 00E (Not nec. if P20 opt 1,2,5 in foreground)
UP TLM (2) - ACCEPT
UPLINK ACTY lt - on
POSS LOS before completion
*If V33 N02 showing: *
* Key ENTR *
* UPLINK ACTY lt - out *
* P00 or P20 displayed *
*If V21 N01 *
*or V21 N02 *
* Key V34E *
* UPLINK ACTY lt - out *
* P00 or P20 displayed *
*UP TLM (MDC) - BLOCK *

Update complete:
UPLINK ACTY lt - out
UP TLM (MDC) - BLOCK

Voice Transmission Update:

1 V37E 00E (Not nec. if P20 opt 1,2,5 in foreground)

2 V70E LIFT-OFF TIME UPDATE
or V71E LOAD DATA CONSEC ADD
or V72E LOAD DATA IN NON CONSEC
or V73E CMC TIME UPDATE

3 P27 Displayed

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4 F 21 01 R3 UPDATE BUFFER ADD (initially 304)
R1 Data E (R3 Increments)
(If change - To 6)
Repeat Step 4 for all data

5 F 21 02 R3 330
(Verify Data) V1 N1E
R3 304E
R1 Verify Data
N15E (R3 305)
R1 Verify Data
Consecutive ENTR's display remaining comps. Note octal ident (01-24) of comps which need change
KEY REL To 6

6 F 21 02 R3 330
(CHANGE) Load octal ident, XXE to 4
(ACCEPT UPDATE) Key Verb, then PRO

7 P00 or P20 Displayed

P29 TIME OF LONGITUDE
CMC-on (req)

1 V37E29E

2 F 04 06 R1 00002 Specify Vehicle
R2 00001, CSM
00002, LM
PRO

3 F 06 34 GET BASE TIME (hrs,min,.01 sec)
Load time from which CMC will begin search (all 0's for present time)
PRO

4 F 06 43 R2 DESIRED LONG (.01°)
Load long
PRO

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5 F 06 34 GET LONG (hrs,min,.01 sec)
(Change long) V32E to 4
(see lat.) PRO

6 F 06 43 LAT, LONG, ALT (.01°,.01°,.1nm)
(Recycle) V32E to 2
(Term) PRO

7 F 37

P20 with GDC REFSMMAT

CMC - on (req)
IMU - off
GDC - on and REFSMMAT Known (pg G/7-13)
SCS - operating
G/N OPT PWR - on
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - CMC

1 V25N20E
Load present GDC angles

2 Perform P20 opt 4 (p. G/3-2)
Return after PRO on N79

3 Display desired att.
V16N18E (R,P,Y) (.01°)

4 Mnvr to Roll 0° or 180°, Yaw 0°
and Pitch shown in N18
V25N20E
Load present GDC angles

5 OPT ZERO - OFF
MARK (repeat as necessary)
* POSS F 06 49 ΔR, ΔV, source code *
* (.01nm,.1fps,0000X)*
* (REJECT) V32E *
* (ACCEPT) PRO *

(To Terminate P20 - V56E
G/N OPT PWR - OFF)

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P24 MARK BUTTON FAILED (Low Alt.)
CMC - on (req)
ISS - on and aligned (req)
G&N PWR OPTICS - on
OPT MODE - CMC
OPT ZERO - OFF then ZERO (15 sec)
SC CONT - CMC
CMC MODE - AUTO
TVC SERVO PWR 1&2 - OFF (verify)
GMBL MTRS (4) - OFF (verify)

1 MNVR TO LMK TRK PAD ATT
V49E

2 AUTO UPDATE:
V37E00E
UP TLM (2) - ACCEPT
UPLINK ACTY lt - on
GND will uplink routine for failed MARK button (pg. G/3-17)

Update complete:
UPLINK ACTY lt - out
UP TLM (MDC) - BLOCK
*DO NOT CALL: *
*P21, P22, P23, P29 *
P3X, P4X, P5X, P6X, P7X

3 V5 N26E, verify:
R1: 14000
R2: 01603
R3: 16067

4 V37E 20E

5 F 04 06 R1 00024 TRACKING OPTION
R2 00000
LOAD 2 in R2
PRO

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```
6    F 06 78   AXIS YAW, AXIS PITCH, OMICRON      (.01°)
               LOAD: R1 +09000
                     R2  XXX.XX (LMK PAD ROLL ANGLE)
                     R3 +00000
               PRO

7    F 06 79   RATE, DEADBAND          (.0001°/sec,.01°)

               LOAD: R1 -20000
                     R2 +00050

               PRO

8    F 06 34   START TIME              (hrs,min,.01 sec)
               LOAD LMK PAD T2 TIME
               PRO

9              V37E 24E
               OPT ZERO - OFF
               OPT TEL TRUN - SLAVE TO SXT
               OPT COUPLING - RSLV
               OPT SPEED - HI

10   F 06 89   LAT, LONG/2, ALT     (.001°,.001°,.01nm)
               LOAD LMK COORDS
               PRO

11 AT T2 -30 SEC: OPT MODE - MAN
                  V30E (Start erasable prog.)

12   F 53      BACKUP MARK REQUEST
               PRO for MARK
               ENTER for MARK REJ

13        TO TERMINATE PROGRAM:

               V34E

     F 51
               PRO

14   F 37
```

NAVIGATION

ALARM CODES

EXT VERBS

G&C SYSTEMS MANAGEMENT

DATE 5/24/71

DATE 5/24/71

FAILED MARK BUTTON MARKING ROUTINE

PURP			V	7	1			V	7	1			V	7	1
304 01	INDEX			2	4	INDEX			2	4	INDEX			1	5
02	0	3	6	0	3	0	3	6	2	5	0	3	6	4	7
03	3	1	6	6	1	0	0	0	0	6	0	1	6	5	2
04	0	4	6	3	6	3	0	0	2	5	4	4	7	7	4
05	2	6	0	3	6	5	2	3	5	5	6	1	7	5	3
06	2	0	5	7	6	3	4	7	7	0	5	4	1	5	4
07	0	2	0	5	2	0	5	2	2	3	0	0	0	0	6
10	0	1	6	1	2	0	2	2	0	4	5	0	1	5	4
11	0	1	6	3	4	0	1	6	0	3	4	1	5	4	0
12	0	0	0	0	4	4	0	0	7	5	5	0	1	5	4
13	3	0	0	3	6	7	4	7	6	5	5	3	5	4	0
14	5	4	3	5	7	1	0	0	0	0	0	1	6	0	3
15	3	0	0	3	5	0	1	6	0	3	1	5	2	0	0
16	5	4	3	6	1	0	5	5	6	1					
17	3	0	0	3	3	0	0	0	3	2					
20	5	4	3	5	6	0	5	5	6	1					
21	3	0	0	3	4	0	0	0	5	2					
22	5	4	3	6	0	1	1	7	5	3					
23	3	0	0	3	2	0	1	6	5	0					
24	5	4	3	6	2	3	4	1	7	2					

DUE TO ERASABLE CONFLICTS, THE FOLLOWING PROGRAMS MUST NOT BE EXERCISED BETWEEN THE TIME THAT THE ERASABLE PROGRAM IS UPLINKED AND THE TIME THAT THE ERASABLE PROGRAM IS NO LONGER NEEDED: P21, P22, P23, P29, P3X, P4X, P5X, P6X, AND P7X.

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P24 COAS MARKING (Hi Alt)

CMC - on (req)
ISS - on and aligned
G&N PWR OPTICS - off
OPT ZERO - ZERO → SC CONT - CMC
CMC MODE - AUTO
BMAG MODE (3) - RATE 2
MAN ATT (3) - MIN IMP

1 MNVR TO LMK TRK PAD ATT
V49E

2 AUTO UPDATE:
V37E 00E
UP TLM (2) - ACCEPT
UPLINK ACTY lt - on
GROUND UPLINKS:
LMK POSITION IN RLS IF LMK NOT 15-1
BACKUP MARK ROUTINE (pg G/3-20)

UPDATE COMPLETE:
UPLINK ACTY lt - out
UP TLM (MDC) - BLOCK
*DO NOT CALL: P21, P22, *
P23,P29,P3X,P4X,P5X,P6X,P7X

3 V5 N26E VERIFY N26:
R1 14000
R2 01603
R3 16067

4 V24 N94E ALT LOS OPT ANGS SHAFT, TRUN
(.01°,.001°)
LOAD ANGLES
(Nom: +0E, +57470E)

5 V25 N78E AXIS YAW, AXIS PITCH, OMICRON
(.01°)
+0E, +0E, +0E

6 V22 N79E DEADBAND (.01°)
+50E

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NAVIGATION
ALARM CODES
EXT VERBS
G&C SYSTEMS MANAGEMENT

```
7                V37E 24E

8     F 06 89    LAT, LONG/2, ALT      (.001°,.001°,.01nm)
                 LOAD LMK COORDS
                 PRO

9     F 51       MARK REQUEST
                 V21 N1E
                 3374E
                    0E     ZERO R61CNTR

                 V44E      SET SURFFLAG

                 V25 N7E
                     75E
                   1020E   SET TRACKFLG AND LMTRG
                      1E

10               If MNVR <10°, to 11
      F 50 18    MNVR REQUEST                          (.01°)
                 PRO
                 When mnvr complete - ENTR

11    F 51       MARK REQUEST

                 V30E      CALL ERASABLE PROG

12    F 53       BACKUP MARK REQUEST

13               AFTER ACQUISITION:
                 CMC MODE - FREE
                 TRACK LMK WITH RHC
                 PRO for MARK
                 ENTER for MARK REJ

14               TO TERMINATE PROG:
                 V34E

      F 51
                 V37E 00E
                 V45E (RESET SURFFLAG)
```

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THRUSTING (P40's)

PRETHRUST (P30's&70's)

S ΔV_0 vs $\Delta\theta$ LONG

P37 BLOCK DATA

COAS MARKING ROUTINE

PURP				V	7	1				V	7	1				V	7	1
304	01	INDEX			2	4	INDEX				2	4	INDEX				1	5
	02	0	3	6	0	3	0	3	6	2	5	0	3	6	4	7		
	03	3	1	6	6	1	0	0	0	0	6	0	1	6	5	2		
	04	0	4	6	3	6	3	0	0	2	5	4	4	7	7	4		
	05	2	6	0	3	6	5	2	3	5	5	6	1	7	5	3		
	06	2	0	5	7	6	3	4	7	7	0	5	4	1	5	4		
	07	0	2	0	5	2	0	5	2	2	3	0	0	0	0	6		
	10	0	1	6	1	2	0	2	2	0	4	5	0	1	5	4		
	11	0	1	6	3	4	0	1	6	0	3	4	1	5	4	0		
	12	0	0	0	0	4	4	0	0	7	5	5	0	1	5	4		
	13	3	1	7	2	5	7	4	7	6	5	5	3	5	4	0		
	14	5	4	3	5	7	1	0	0	0	0	0	1	6	0	3		
	15	3	1	7	2	7	0	1	6	0	3	1	5	2	0	0		
	16	5	4	3	6	1	0	5	5	6	1							
	17	3	0	0	3	3	0	0	0	3	2							
	20	5	4	3	5	6	0	5	5	6	1							
	21	3	0	0	3	4	0	0	0	5	2							
	22	5	4	3	6	0	1	1	7	5	3							
	23	3	0	0	3	2	0	1	6	5	0							
	24	5	4	3	6	2	3	4	1	7	2							

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DUE TO ERASABLE CONFLICTS, THE FOLLOWING PROGRAMS MUST NOT BE EXERCISED BETWEEN THE TIME THAT THE ERASABLE PROGRAM IS UPLINKED AND THE TIME THAT THE ERASABLE PROGRAM IS NO LONGER NEEDED: P21, P22, P23, P29, P3X, P4X, P5X, P6X, and P7X.

P24 FROZEN OPTICS (Hi Alt)

1 Record frozen shaft and trun
TPACS and voice to ground:
SHAFT _____
TRUN _____

CMC - on (req)
ISS - on and aligned
G&N PWR OPTICS - ON
OPT ZERO - OFF
OPT MODE - MAN
SC CONT - CMC
CMC MODE - AUTO
BMAG MODE (3) - RATE 2

2 MNVR TO LMK TRK PAD ATT
V49E

3 AUTO UPDATE:
V37E 00E
UP TLM (2) - ACCEPT
UPLINK ACTY lt - on
GROUND UPLINKS RLS

UPDATE COMPLETE:
UPLINK ACTY lt - off
UP TLM (MDC) - BLOCK

4 GROUND VOICES N78 PAD:
YAW _____
PITCH _____

5 V25 N78E AXIS YAW, AXIS PITCH, OMICRON (.01°)

XXX.XXE
XXX.XXE
+0E

6 V22 N79E DEADBAND
+50E

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```
7                V37E 24E

8     F 06 89    LAT, LONG/2, ALT      (.001°,.001°,.01nm)
                 LOAD LMK COORDS
                 PRO

9     F 51       MARK REQUEST
                 V21 N1E
                   3374E
                      0E  ZERO R61CNTR

                 V44E     SET SURFFLAG

                 V25 N7E
                     75E
                   1020E  SET TRACKFLG AND LMTRG
                      1E

10               If MNVR <10°, to 11
      F 50 18    MNVR REQUEST                          (.01°)
                 PRO
                 When mnvr complete - ENTR

11    F 51       MARK REQUEST

12               AFTER ACQUISITION:
                 CMC MODE - FREE
                 TRACK LMK WITH MIC
                 MARK as desired

13               TO TERMINATE PROG:
                 V37E 00E
                 V45E (RESET SURFFLAG)
```

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P30 EXTERNAL ΔV

If uplinked REFSMMAT, do P52 (OPT 1) before P30

1		V37E 30E	
	F 06 33	TIG	(hrs,min,.01sec)
		Load desired TIG	
		PRO	
2	F 06 81	ΔV XYZ(LV)	(.1fps)
		Load desired ΔV's	(Do not use all 0's)
		PRO	
3	F 06 42	HA,HP,ΔV(REQ)	(.1nm,.1nm,.1fps)
		Set ΔV Counter	
		PRO	
4	F 16 45	MARKS,TFI,MGA	(marks,min-sec,.01°)
		(MGA Set to -00002 IF REFSMMAT FLAG NOT SET)	
		Set DET	
		PRO	
5	F 37		

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MINKEY SEQUENCER

31.1 ΔV mag. <7 fps, perform P41 (CMC begins at step 4)
ΔV mag. ≥7 fps, perform P40 (CMC begins at step 4)

31.2 Perform P76

31.3 Go to P32, step 2

32.1 ΔV mag. <7 fps, perform P41 (CMC begins at step 4)
ΔV mag. ≥7 fps, perform P40 (CMC begins at step 4)

32.2 Perform P76

32.3 R1 of N55 (P32) < 4, Go to P36, step 2
= 4, Go to P31, step 2
> 4, Go to P32, step 2

36.1 If ΔV mag. = 0, go to 36.2

52 in MM lights
F 06 22 New ICDU angles (.01°)
(RECOMP) MNVR; V32E
(ACCEPT) PRO

F 50 25 00020 MINKEY PULSE TORQUE

(TORQUE) CMC MODE - FREE
PRO
(16 20 during torque)
Torque complete:
CMC MODE - AUTO
ΔV <7 fps - P41 (step 4)
ΔV ≥7 fps - P40 (step 4)

(BYPASS) ENTR
Perform P41 (step 4)

36.2 Perform P76

36.3 If pulse torque not done, go to P33 step 2.

36.4 If all gimbal angle changes for mnvr back to rend. att < 10°, go to 36.5

F 50 18 Request MNVR to RPY angles (.01°)
(ACCEPT) SC CONT - CMC
CMC MODE - AUTO
PRO
(REJECT) ENTR to 36.5

06 18 MNVR in progress (.01°)
MNVR complete, to 36.5

36.5 52 in MM lights

F 06 22 New ICDU angles (.01°)
(RECOMP) MNVR; V32E
(ACCEPT) PRO

F 50 25 00020 MINKEY PULSE TORQUE
CMC MODE - FREE
PRO
(16 20 during torque)

Torque complete: CMC MODE - AUTO
Go to P33, Step 2

33.1 ΔV mag. <7 fps, perform P41 (CMC begins at step 4)
ΔV mag ≥ 7 fps, perform P40 (CMC begins at step 4)

33.2 Perform P76

33.3 Go to P34, step 2

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34.1	ΔV mag. <7 fps, perform P41 (CMC begins at step 4) ΔV mag. ≥ 7 fps, perform P40 (CMC begins at step 4)
34.2	Perform P76
34.3	Go to P35, step 2
35.1	ΔV mag <7 fps, perform P41 (CMC begins at step 4) ΔV mag. ≥7 fps, perform P40 (CMC begins at step 4)
35.2	Perform P76
35.3	MCC2 complete, go to P79 step 2 MCC2 not complete, go to P35, step 2

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P31 HAM PRETHRUST

1		V37E 31E (If no REFSMFLG, To 3)
	F 50 25	00017 MINKEY OPTION
	(ACCEPT)	PRO
	(REJECT)	ENTR
2		(Req'd Mnvr <10°, To 3)
	F 50 18	Request MNVR To RPY angles (.01°)
	(ACCEPT)	SC CONT - CMC CMC MODE - AUTO PRO
	(REJECT)	ENTR To 3
	06 18	MNVR in progress (.01°) When MNVR complete: MINKEY To 3 Non - MINKEY To 2
3	F 06 11	TIG (CSI) (hrs,min,.01sec) Load if needed PRO
4	F 06 55	APSIS CDH,TPI ELEVATION ANGLE(+0000N,.01°) CENTRAL ANGLE, Passive Vehicle (ωt) (For CDH $N\pi$ from CSI, load non-zero in R3) Load data PRO
5	F 06 37	TIG (TPI) (hrs,min,.01sec) Load data PRO
6	F 06 33	TIG (HAM) (hrs,min,.01sec) PRO

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```
7    F 16 45   MARKS, TFI, -00001        (marks,min-sec)
     (RECYCLE)    V32E
     (FINAL COMP) TERM MARKS
                  PRO
                         *F 05 09                        *
                         *  00600 No Intersection on     *
                         *        First Iteration        *
                         *  00601 Post CSI hp<85/5.8nm*
                         *  00602 Post CDH hp<85/5.8nm*
                         *  00603 TIG(CDH) - TIG(CSI)   *
                         *          <10 min              *
                         *  00604 TIG(TPI) - TIG(CDH)   *
                         *          <10 min              *
                         *  00605 NO SOL IN 15 TRIES    *
                         *  00606 ΔV(CSI)>1000fps in 2*
                         *        Iterations             *
                         *      V32E To 3: Adjust        *
                         *        Inputs                 *

8    F 06 90   Y(Active),YDOT(Active),YDOT(Passive)
                                  (.01nm,.1fps,.1fps)
               PRO

9    F 06 81   ΔV XYZ (LV) HAM                   (.1fps)
               PRO (If recycle - To 7)

10   F 16 45   MARKS,TFI,MGA        (marks,min-sec,.01°)
                 (MGA = -00002 if no REFSMFLG)
               SET EVENT TIMER
               PRO (If MINKEY, to Sequencer 31.1)

11   F 37
```

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P32 CSI PRETHRUST (P72 LM)

```
1                V37E (32E or 72E)
                 (If no REFSMFLG or P72, to 3)

  F 50 25        00017 MINKEY OPTION
     (ACCEPT) PRO
     (REJECT) ENTR

2                (If req'd. mnvr < 10°, to 3)
  F 50 18        Request MNVR to RPY angles        (.01°)
     (ACCEPT) SC CONT - CMC
                 CMC MODE - AUTO
                 PRO
     (REJECT) ENTR to 3

    06 18        MNVR in progress                  (.01°)
                 When MNVR complete:  MINKEY to 3
                                      Non - MINKEY to 2

3   F 06 11      TIG (CSI)                (hrs,min,.01sec)
                 Load if needed
                 PRO

4   F 06 55      APSIS CDH,TPI ELEVATION ANGLE,(+0000N,.01°)
                   CENTRAL ANGLE,Passive Vehicle (ωt)
                   (For CDH Nπ from CSI, load non-zero
                   in R3)
                 Load data
                 PRO

5   F 06 37      TIG (TPI)                (hrs,min,.01sec)
                 Load data
                 PRO

6   F 16 45      MARKS,TFI,-00001         (marks,min-sec)
       (RECYCLE)  V32E (MINKEY to 8)
       (FINAL PASS)  TERM MARKS
                 PRO (MINKEY to 8)
```

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```
*F 05 09                          *
* 00600 No Intersection on        *
*       First Iteration           *
* 00601 hp+CSI <85nm/5.8nm        *
* 00602 hp+CDH <85nm/5.8nm        *
* 00603 TIG(CDH)-TIG(CSI)         *
*         <10 min                 *
* 00604 TIG(TPI)-TIG(CDH)         *
*         <10 min                 *
* 00605 NO SOL IN 15 Tries        *
* 00606 ΔV(CSI)>1000fps in 2      *
*       Iterations                *
*       V32E to 3 Adjust          *
*         Inputs                  *
```

7 F 06 75 ΔH(CDH),ΔT(CDH-CSI),ΔT(TPI-CDH)
PRO (.1nm,min-sec)

8 F 06 90 Y(Active), YDOT(Active), YDOT (Passive)
(.01nm,.1fps,.1fps)
PRO

9 F 06 81 ΔV XYZ(LV)CSI (.1fps)
Change if desired
PRO (If MINKEY: recycle, to 6
final pass, to 11)

10 F 06 82 ΔV XYZ(LV)CDH (.1fps)
PRO (If Recycling to 6)

11 F 16 45 MARKS,TFI,MGA (marks,min-sec,.01°)
(MGA Set to -00002 If No
REFSMFLG or If P72)
SET EVENT TIMER TO TFI
PRO (If MINKEY, to Sequencer 32.1)

12 F 37

P72 - Transmit mnvr Parameters to LM

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P36 - PLANE CHANGE PRETHRUST

1		V37E 36E (If no REFSMFLG, to 3)	
	F 50 25	00017 MINKEY OPTION	
	(ACCEPT)	PRO	
	(REJECT)	ENTR	
2		(Req'd Mnvr <10°, to 3)	
	F 50 18	Request MNVR to RPY angles	(.01°)
	(ACCEPT)	SC CONT - CMC CMC MODE - AUTO PRO	
	(REJECT)	ENTR to 3	
	06 18	MNVR in progress When MNVR complete: MINKEY to 3 non-MINKEY to 2	(.01°)
3	F 06 33	TIG (PC) PRO	(hrs,min,.01sec)
4	F 16 45	MARKS,TFI,-00001 (RECYCLE) V32E (FINAL COMP) TERM MARKS PRO	(marks,min-sec)
5	F 06 90	Y(Active),YDOT (Active),YDOT (Passive) PRO	(.01nm,.1fps,.1fps)
6	F 06 81	ΔV XYZ (LV) PC PRO (If recycle - to 4)	(.1fps)
7	F 16 45	MARKS, TFI, MGA (MGA = -00002 if no REFSMFLG) SET EVENT TIMER PRO (If MINKEY, to sequencer 36.1)	(marks,min-sec,.01°)
8	F 37		

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THRUSTING (P40's)

PROP CONS

S ΔV_0 vs $\Delta\theta$ LONG

P37 BLOCK DATA

P33 CDH PRETHRUST (P73 LM)

```
1              V37E (33E or 73E)
               (If no REFSMFLG or P73, to 3)

     F 50 25   00017 MINKEY OPTION
          (ACCEPT) PRO
          (REJECT) ENTR

2              (If req'd. mnvr <10°, to 3)
     F 50 18   Request MNVR to RPY angles        (.01°)
          (ACCEPT) SC CONT - CMC
                   CMC MODE - AUTO
                   PRO

          (REJECT) ENTR to 3

       06 18   MNVR in progress                  (.01°)
               When MNVR complete:  MINKEY to 3
                                    Non - MINKEY to 2

3    F 06 13   TIG(CDH)                 (hrs,min,.01sec)
               PRO

4    F 16 45   MARKS,TFI,-00001         (marks,min-sec)
          (RECYCLE) V32E (MINKEY to 6)
          (FINAL PASS) TERM MARKS
               PRO (MINKEY to 6)

                         *F 05 09 00611 NO TIG FOR*
                         *        SPECIFIED ANGLE *
                         *  (REDO)V32E to 3       *
                         *        PRO to 5        *
                         *          (6 if MINKEY) *
                         *CMC will use last       *
                         *  calculated value of   *
                         *  TIG (TPI)             *

5    F 06 75   ΔH(CDH),ΔT(TPI-CDH),ΔT(TPI-NOMTPI)
               PRO                        (.1nm,min-sec)

6    F 06 90   Y(Active), YDOT(Active), YDOT(Passive)
                                   (.01nm,.1fps,.1fps)
               PRO
```

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```
7    F 06 81   ΔV XYZ(LV)CDH                    (.1fps)
               PRO (If Recycling to 4)

8    F 16 45   MARKS,TFI,MGA       (marks,min-sec,.01°)
                 (MGA Set to -00002 If No
                     REFSMFLG or If P73)
               SET EVENT TIMER TO TFI
               PRO (If MINKEY, to Sequencer 33.1)

9    F 37

               P73 - Transmit mnvr Parameters to LM
```

P34 TPI PRETHRUST (P74 LM)

```
1              V37E (34E or 74E)
               (If no REFSMFLG or P74, to 3)
     F 50 25   00017 MINKEY OPTION
          (ACCEPT) PRO
          (REJECT) ENTR

2              (If req'd. mnvr <10°, to 3)
     F 50 18   Request MNVR to RPY angles        (.01°)
          (ACCEPT) SC CONT - CMC
                   CMC MODE - AUTO
                   PRO
          (REJECT) ENTR to 3

       06 18   MNVR in progress                  (.01°)
               When MNVR complete:  MINKEY to 3
                                    Non - MINKEY to 2

3    F 06 37   TIG (TPI)                (hrs,min,.01sec)
               Load desired TIG
               PRO

4    F 06 55   PRECISION OFFSETS, ELEV ANGLE, ωt
                                     (0000X,.01°,.01°)
               Load desired values
               (+00000 in R2 to CALC ELEV
                ANGLE AT TIG TIME)
               PRO
```

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THRUSTING (P40's)

PROP CONS

S ΔV_0 vs $\Delta\theta$ LONG

P37 BLOCK DATA

```
5    F 16 45   MARKS,TFI,-00001          (marks,min-sec)
          (RECYCLE)    V32E (TIG option, to 7)
          (FINAL PASS) TERM MARKS
               PRO (TIG option, to 7)

                         *F 05 09 (00611 NO SOL)*
                         *PRO To 3              *

6    F 06 37   TIG (TPI)                 (hrs,min,.01sec)
               PRO (If not MINKEY final pass, to 8)

7    F 06 55   PRECISION OFFSETS, ELEV ANGLE, ωt
                                     (0000X,.01°,.01°)
               PRO

8    F 06 58   HP,ΔV(TPI),ΔV(TPF)   (.1nm,.1fps,.1fps)
               PRO

9    F 06 81   ΔV XYZ(LV)TPI                   (.1fps)
               PRO (recycle, to 5)

10   F 16 45   MARKS,TFI,MGA       (marks,min-sec,.01°)
                 (MGA SET To -00002 IF NO
                     REFSMFLG or If P74)
               SET EVENT TIMER TO TFI
               PRO (If MINKEY, to Sequencer 34.1)

11   F 37
               P74 - Transmit Mnvr Parameters To LM

               P35 TPM PRETHRUST (P75 LM)

1              V37E (35E or 75E)
               (If no REFSMFLG or P75, to 3)
     F 50 25   00017 MINKEY OPTION
          (ACCEPT) PRO
          (REJECT) ENTR
```

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```
2                (If req'd. mnvr <10°, to 3)
    F 50 18      Request MNVR to RPY angles          (.01°)
        (ACCEPT) SC CONT - CMC
                 CMC MODE - AUTO
                 PRO
        (REJECT) ENTR to 3

      06 18      MNVR in progress                    (.01°)
                 When MNVR complete:  MINKEY to 3
                                      Non - MINKEY to 2

3   F 16 45      MARKS,TFI,-00001          (marks,min-sec)
        (RECYCLE) V32E
        (FINAL PASS)  TERM MARKS
                 PRO

4   F 06 81      ΔV XYZ(LV)TPM                       (.1fps)
                 PRO (If recycle - to 3)

5   F 16 45      MARKS,TFI,MGA       (marks,min-sec,.01°)
                   (MGA SET TO -00002 IF NO
                      REFSMFLG or If P75)
                 PRO (If MINKEY, to Sequencer 35.1)
6   F 37
                 P75 - Transmit Mnvr Parameters To LM

                 To change ATIGINC:
                           V24N1E
                            2021E

                 6 min:    00002E
                           06240E

                 10 min:   00003E
                           25140E

                 3 min:    00001E
                           03120E
```

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P79 RNDZ FINAL PROGRAM

1		V37E 79E
2		(All gimbal angle errors <10°, to 3)
	F 50 18	Request MNVR to RPY angles (.01°) (X-axis track)
		SC CONT - CMC CMC MODE - AUTO PRO
	06 18	MNVR in progress (.01°) When MNVR complete: to 3
3	F 16 54	RANGE,RANGE RATE,THETA(.01nm,.1fps,.01°) (Ext. vbs. locked out) PRO
4	F 37	

P37 RETURN TO EARTH PGM

(LONG CONTROL CANNOT BE DONE WHEN TIME TO ENTRY IS <4 HRS: Lunar return only)

Perform the following once:
V1N1E
3012E
Verify R1 = 01515 (1114.5 nm)

1		V37E 37E
	F 06 33	TIG (hrs,min,.01sec) Load desired TIG PRO
2	F 06 60	BLANK,ΔV DESIRED, GAMMA EI DESIRED (fps,.01°) Load desired ΔV: PAD ΔV IF ON TLC 0. IF ON TEC Load R3=0 PRO

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```
*F 05 09  00612 State vector in*
*               Lunar Influence*
*         00605 Solution not   *
*               Convergent     *
*V32E, RSET TO 1               *
*         20607 Conic Routine  *
*               Failed         *
*         20610 State vector is*
*               below 400K ft  *
*               altitude       *
*F 37 37E to 1                 *
```

3 INITIAL CONIC SOLN

F 06 61 IMPACT LAT, IMPACT LONG (+E) (.01°)

If Impact LONG>12° from desired:

TEC:N40E Record R2 as ΔVmin (fps) TLC: V32E to 1

V32E to 1 & use |ΔV| >ΔV min Decrease ΔV to

Load ΔV neg to move LONG WEST move LONG WEST

Load ΔV pos to move LONG EAST Increase ΔV to move LONG EAST

Continue recycles til <12° from desired LONG

If Impact LONG <12° from desired:

Record Impact LONG as θcl (.01°)

Record last ΔV DESIRED as ΔVinl (fps)

PRO

4 F 06 39 ΔT TRANSFER (TIG to EI) (hrs,min,.01sec)

PRO

(RECYCLE) V32E To 1

5 F 06 60 BLANK,V PRED,GAMMA EI (fps,.01°)

PRO

(RECYCLE) V32E To 1

6 F 06 81 ΔV XYZ(LV) at TIG

Record R3 as ΔVzcl (.1fps)

N40E

Record R2 as ΔVcl (.1fps)

Make sign of ΔVcl same as ΔVinl

KEY RLSE

PRO

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THRUSTING (P40's)

PROP CONS

S ΔV_0 vs $\Delta\theta$ LONG

P37 BLOCK DATA

```
                    *F 05 09  00605 Solution not *
                    *               Convergent   *
                    *         00613 Flt Path Ang *
                    *               not reached  *
                    *RSET V32E to 1              *
                    *         20607 Conic Routine*
                    *               Failed       *
                    *F 37 37E to 1               *
```

INITIAL PRECISION SOLN

```
7    F 06 61   IMPACT LAT,IMPACT LONG                (.01°)
               Record LONG as θpl (.01°)
               If θpl acceptable, PRO to step 15

               PRO

8    F 06 39   ΔT TRANSFER
               PRO

9    F 06 60   BLANK,VPRED,GAMMA EI            (fps,.01°)
               PRO

10   F 06 81   ΔV XYZ(LV) at TIG
               Record R1 as ΔVxpl (.1fps)
               Record R3 as ΔVzpl (.1fps)
               V32E to 11
```

LONG. ITERATION

```
11   F 06 33   TIG                        (hrs,min,.01sec)
               Load same value used initially
               PRO

12   F 06 60   BLANK,ΔV DESIRED, GAMMA EI DESIRED
               To move WEST from θpl:
                 Load ΔVin2 = ΔVcl-10
                   (If ΔVin1 = 0 for TEC,
                    ΔVin2 = -ΔVcl-10)
               To move EAST from θpl:
                 Load ΔVin2=ΔVcl+10
               Record ΔVin2 (.1fps)
               R2: Load ΔVin2 (fps)
               PRO
                    *F 05 09    SAME AS IN 2*
                    *V32E.  RSET to 11      *
```

DATE 5/24/71

13 F 06 61 IMPACT LAT, IMPACT LONG (.01°)
Record LONG as $\underline{\theta c2}$ (.01°)

N81E Record R3 as $\underline{\Delta Vzc2}$ (.1fps)

Compute $K = \dfrac{|\theta c2 - \theta c1|}{|\Delta Vzc2 - \Delta Vzc1|}$

Compute $\underline{\Delta\theta \text{ LONG}} = \theta d - \theta p1$ (.01°)
Obtain from chart $\underline{\Delta Vo}$ (fps)
Make sign of ΔVo same as $\Delta\theta$ LONG
Compute ΔVd:
If TLC and $\Delta Vzp1 > 3\Delta Vxp1$:
$\Delta Vd = \Delta Vc1 + \Delta Vo$
V32E to step 1 and use
ΔVd in R2 of N60
Otherwise:
$\underline{\Delta Vzd} = \Delta Vzp1 + \Delta Vo$

14 $\underline{\Delta Vd} = (\Delta Vzd^2 + \Delta Vxp1^2)^{1/2}$
To solve for ΔVd:
V37E 30E, Use present time in N33.
Load N81:
R1 = $\Delta Vxp1$ (should be)
R2 = 0 (should be)
R3 = ΔVzd (.1fps)
PRO and rcrd ΔVd (.1fps)
from N42 R3.
Make sign of ΔVd same as ΔVzd
V37E 37E to step 1 and use ΔVd
in R2 of N60

FINAL SOLN

15 F 06 39 ΔT TRANSFER (hrs,min,.01sec)
(RECYCLE) V32E To 1
PRO

16 F 06 60 BLANK, V PRED, GAMMA EI (fps,.01°)
(RECYCLE) V32E To 1
PRO

DATE 5/24/71

DATE 5/24/71

THRUSTING (P40's)
PROP CONS
S ΔV_O vs $\Delta\theta$ LONG
P37 BLOCK DATA

```
17   F 06 81   ΔV XYZ(LV) TIG                    (.1fps)
          (OPTION) N40E - VG MAG avail
                     in N40 and N80
                   KEY REL
                PRO

18   F 04 06   THRUST OPTION
                R1 00007
                R2 0000X
                     X=1 (SPS)
                       2 (RCS)
                Perform R03 (V48) if not performed just
                  prior to P37 call
                PRO

19   F 06 33   TIG                        (hrs,min,.01sec)
                PRO

20   F 16 45   MARKS,TFI,MGA        (00 00,min-sec,.01°)
                (MGA SET TO -00002 If No
                 REFSMMAT SET)
                PRO

21   F 37      (40E or 41E)

                OBTAIN ENTRY REFSMMAT (No Comm)
                (Use only after final MCC)
                1. Record 400K time from final P37
                     solution.
                     (Step 1 TIG + FNL N39)
                2. Use 400K time for T-align P52
                     (Option 2).
                          *If PROG ALARM 401, Yaw 45°*
                          *  and V32E                 *
```

P76 - ΔV UPDATE (P77 CSM)

1		V37E (76E or 77E)	
	F 06 33	TIG	(hrs,min,.01sec)
		Load TIG	
		PRO	
2	F 06 84(81)	ΔV XYZ	(.1fps)
		Load ΔV	
		PRO (MINKEY, to Sequencer 3X.3)	
3	F 37		

DATE 3/22/71

DATE 3/22/71

P37 LONGITUDE ITERATION

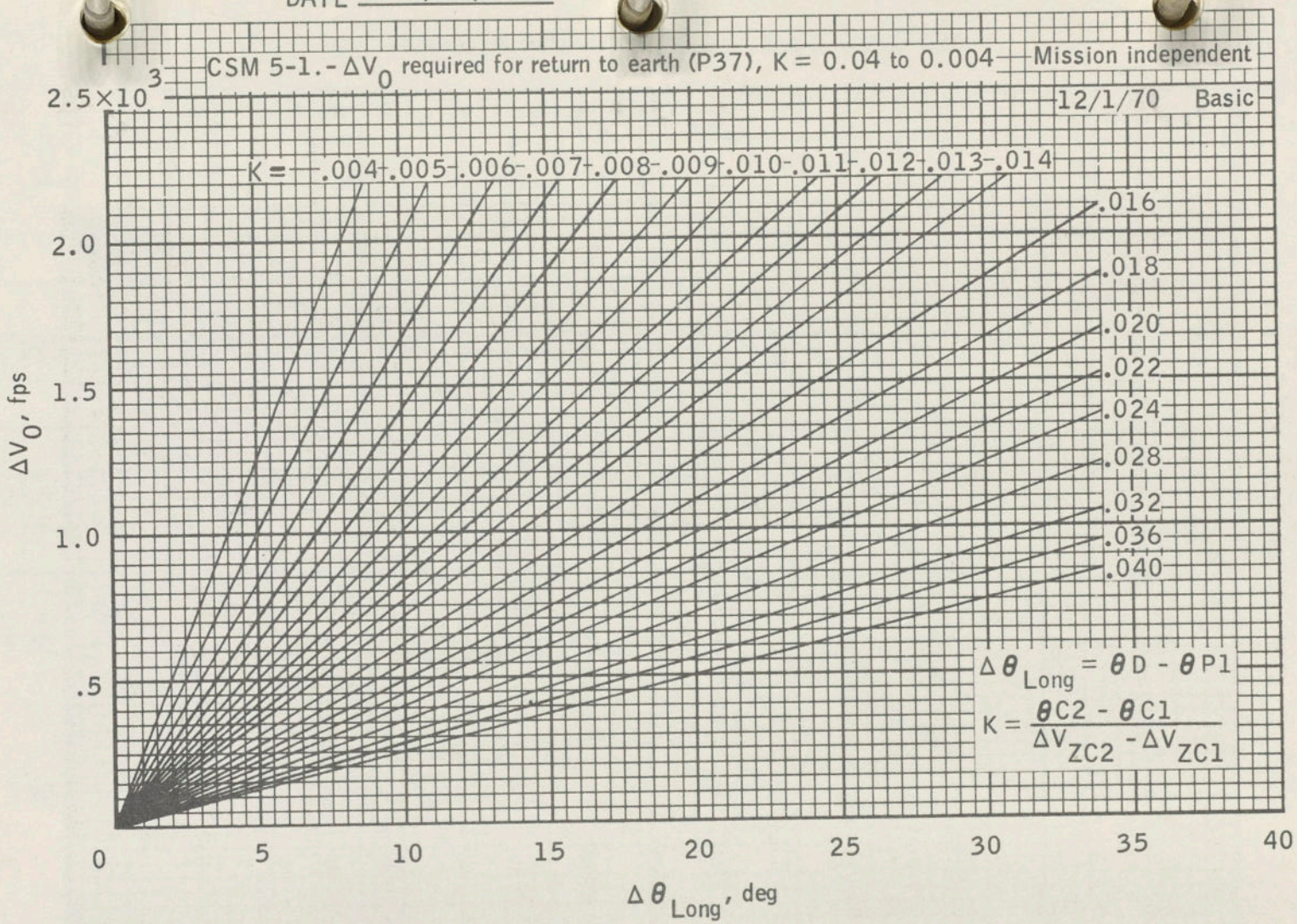
PARAMETER	STEP	1	2	3	
ΔVmin	3	_____.	_____.	_____.	fps
θc1	3	___.__	___.__	___.__	°
ΔVin1	3	_____.	_____.	_____.	fps
ΔVzc1	6	____._	____._	____._	fps
ΔVc1 (Same sign as ΔVin1)	6	____._	____._	____._	fps
θp1	7	___.__	___.__	___.__	°
ΔVxp1	10	____._	____._	____._	fps
ΔVzp1	10	____._	____._	____._	fps
ΔVin2	12	____._	____._	____._	fps
θc2	13	___.__	___.__	___.__	°
ΔVzc2	13	____._	____._	____._	fps
|θc2-θc1|	13	___.__	___.__	___.__	°
|ΔVzc2-ΔVzc1|	13	____._	____._	____._	fps
K	13	._____	._____	._____	
θd(desired long)	13	___.__	___.__	___.__	°
θd-θp1(Δθ long)	13	___.__	___.__	___.__	°
ΔVo(from chart)	13	____.0	____.0	____.0	fps
ΔVzd	13	____._	____._	____._	fps
ΔVd	13/14	____._	____._	____._	fps

DATE 3/22/71

NAVIGATION
PRETHRUST (P30's&70's)
EXT VERBS
G&C SYSTEMS MANAGEMENT

DATE 3/22/71

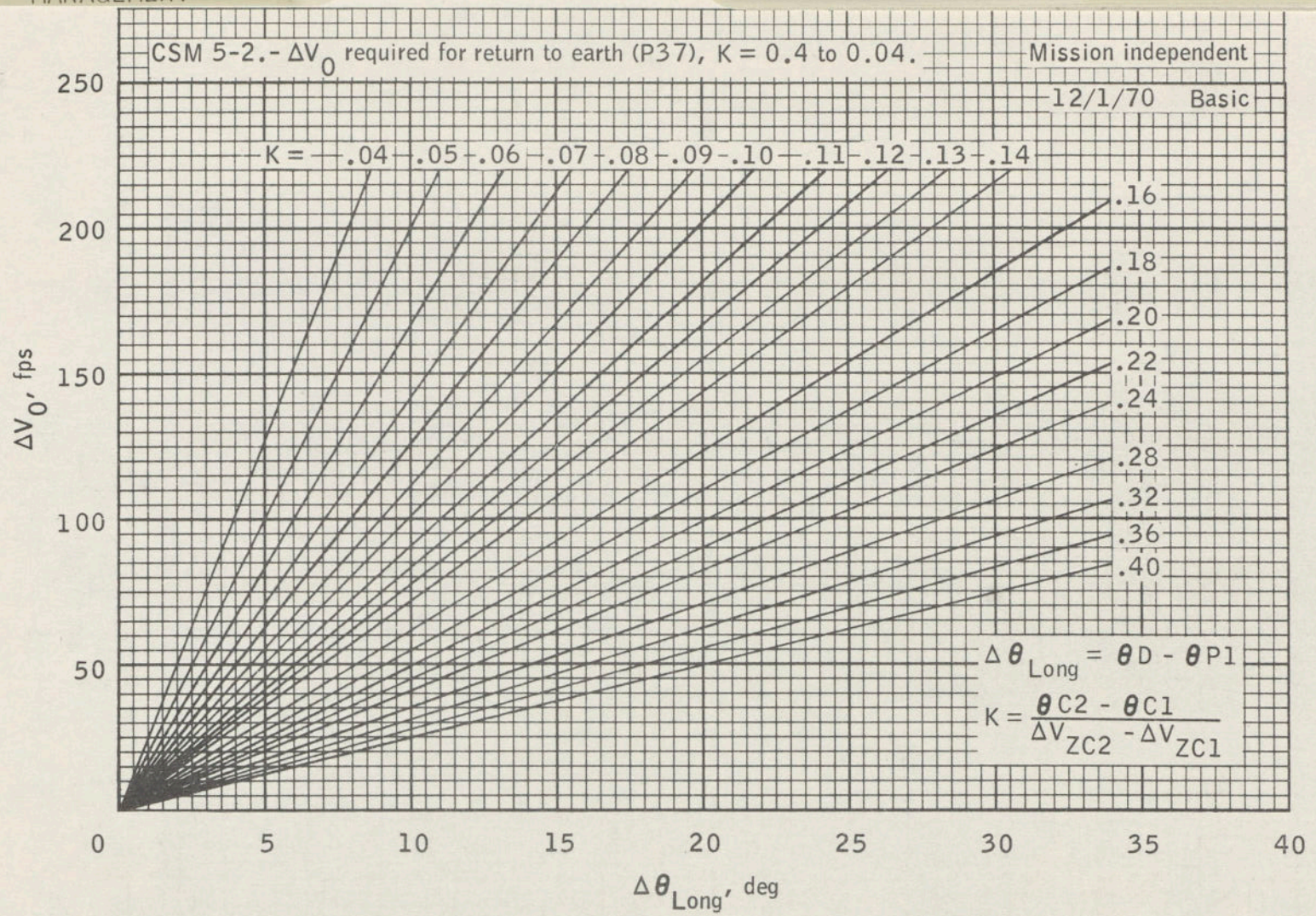
DATE 5/24/71



ΔV_0 required for return to earth (P37), K = 0.04 to 0.004.

G
4-21

P37 BLOCK DATA | S ΔV_0 vs $\Delta\theta$ LONG | PROP CONS | THRUSTING (P40's)



ΔV_0 required for return to earth (P37), K = 0.4 to 0.04.

DATE 5/24/71

DATE 3/22/71

P37 BLOCK DATA

									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}

DATE 3/22/71

DATE 5/24/71

NAVIGATION

PRETHRUST (P30's&70's)

ΔV_O VS $\Delta\theta$ LONG

P37 BLOCK DATA

P37 BLOCK DATA

									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}
									GETI
X					X				ΔVT
X					X				LONG
									GET_{400K}

DATE 3/22/71

P40 SPS THRUSTING

Prethrust Program Complete
Verify SIM PWR DOWN (Nominal) configuration, pg. S/1-~~39~~ 40
CMC & ISS - on
Cycle CRYO FANS
SCS - OPERATING
TEST C/W LAMPS
Perform EMS ΔV TEST & NULL BIAS CHECK, pg G/2-5
Set ΔVC
EMS FUNC - ΔV
SPS GAUGING - AC1
PUG MODE - NORMAL
OXID FLOW vlv - PRI
BMAG MODE (3) - RATE 2
CMC MODE - FREE
AUTO RCS SELECT(16)-as req'd
LOAD DAP (check roll jets)
ROT CONTR PWR NORM (2) - AC/DC
Set DET
V37E 00E
SC CONT - CMC/AUTO

1 MNVR TO PAD BURN ATT
V49E

2 PERFORM BORESIGHT & SXT STAR CHECK
V41 N91E

3 V37E 40E
(TFI available via N40, N45 or N35)

4 F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) BMAG MODE (3) - RATE 2
SC CONT - CMC/AUTO
PRO

5 06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)

DATE 3/22/71

DATE ~~5/24/71~~ 7/14/71

THRUSTING (P40's)
PROP CONS
SPS vs RCS CRITERIA
GIMB ANGS vs WT

6 F 50 18 REQUEST TRIM MNVR TO FDAI RPY ANGLES
ALIGN S/C ROLL (.01°)
GDC ALIGN

TVC CHECK & PREP
cb STAB CONT SYS (all) - close (Pnl 8)
cb SPS (12) - close
SET ΔVC (verify)
EMS FUNC - ΔV (verify)
MAN ATT (3) - RATE CMD

ATT DB - MIN
RATE - LOW
TRANS CONT PWR - ON
SCS TVC (2) - RATE CMD
ΔVCG - LM/CSM or CSM
TVC GMBL DRIVE P&Y - AUTO

+54:00m (-06:00)
MN BUS TIE (2) - ON
TVC SERVO PWR #1 - AC1/MNA
TVC SERVO PWR #2 - AC2/MNB
ROT CONTR PWR NORMAL (2) - AC
ROT CONT PWR DIRECT (2) - OFF
BMAG MODE (3) - ATT1/RATE 2
SC CONT - SCS
RHC #2 - ARMED

55:00m (-05:00)
PRIMARY TVC CHECK
GMBL MOT P1-Y1-START/ON (LMP Confirm)
Verify TRIM CONTROL & SET
Verify MTVC
IF SCS: SCS TVC (2) - AUTO
SC CONT - CMC (SCS)
THC - CW
Verify NO MTVC

SEC TVC CHECK
GMBL MOT P2-Y2-START/ON (LMP Confirm)
SET GPI TRIM
Verify MTVC
THC NEUTRAL
Verify NO MTVC

DATE 3/22/71

```
                    Verify GPI returns to 0,0(CMC) or trim
                      (SCS)
                    ROT CONT PWR NORM (2) - AC/DC
                    ROT CONT PWR DIRECT (2) - MNA/MNB
        (TRIM)      BMAG MODE (3) - RATE 2
                    PRO
                    BMAG MODE (3) - ATT1/RATE 2
                    ENTR

7     F 50 25  00204 GMBL TEST OPTION
        (ACCEPT)    SC CONT - CMC (verify)
                    PRO

                    Monitor GPI Response:
                    00,02,-02,00,02,-02,00, Trim

                         *TEST FAIL:        *
                         *SC CONT - SCS     *
                         *SCS TVC(2) - AUTO*

        (REJECT)    ENTR

8       06 40   TFI, VG, ΔVM              (min-sec,.1fps)
                         *PROG ALARM - TIG Slipped*
                         *V5N9E  01703            *
                         *KEY RLSE TO 8           *

                    FDAI SCALE - 5/5

                    RATE - HIGH
                    UPDATE DET
                    SPS He vlvs (2) - AUTO (verify)
                    Check N2 A and N2 B

  58:00
(-02:00)            ΔV THRUST A(B) - NORMAL
                    THC - ARMED
                    RHC (2) - ARMED
                    TAPE RCDR - HBR/RCD/FWD/CMD RESET

  59:25
(-00:35)      DSKY BLANKS
```

DATE 3/22/71

DATE 5/24/71

ALIGNMENTS (P50'S)

PROP CONS

SPS vs RCS CRITERIA

GIMB ANGS vs WT

```
  59:30        (AVE G ON)
(-00:30)            EMS MODE - NORMAL

     06 40     TFI,VG,ΔVM                    (min-sec,.1fps)
               CHECK PIPA BIAS <2fps for 5 sec

  59:XX        ULLAGE
(-00:XX)
                         *If no ULLAGE:          *
                         *  DIR ULLAGE PB - PUSH*
                         *  Control Att with RHC*

               MONITOR ΔVM (R3) COUNTING UP

  59:55
(-00:05)
    F 99 40    ENG ON ENABLE REQUEST
         (AUTO IGN)    PRO AT TFI >0 Sec
         (BYPASS IGN) ENTR to 11 (Perform switching in 10)
                      EXIT - V37E 00E

9   00:00        IGN        *IF SCS: THRUST PB - PUSH*

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

                         *F 97 40 SPS Thrust fail    *
                         *ΔV THRUST B(A)-NORMAL      *
                         *(RESTART) PRO to IGN       *
                         *(RECYCLE) ENTR to TIG-05sec*

                     SPS THRUST Lt - ON
   00:03             ΔV THRUST B(A) - NORMAL
                          *IF SCS: +X & THRUST PB - PUSH*
               MONITOR THRUSTING
                 Pc 95-105 psia
                 EMS COUNTING DOWN
                      SPS INJ VLVS (4) - OPEN
                      SPS He vlvs tb-gray
                      SPS FUEL/OXID PRESS - 170-195 psia
                      PUGS - BALANCED
```

DATE 3/22/71

THRUSTING (P40's)

PRETHRUST (P30's&70's)

ΔV_O vs $\Delta\theta$ LONG

P37 BLOCK DATA

	XX:XX	ECO
10	F 16 40	TFC (STATIC), VG, ΔVM (min-sec,.1fps) ΔV THRUST A&B - OFF VERIFY THRUST OFF SPS INJ VLVS (4) - CLOSED SPS He vlvs tb (2) - bp GMBL MTRS (4) - OFF (LMP Confirm) TVC SERVO PWR 1&2 - OFF MN BUS TIE (2) - OFF PRO
11	F 16 85	VG XYZ (CM) (.1fps) NULL RESIDUALS RECORD ΔV COUNTER & RESIDUALS ΔVC _____ EMS FUNC - OFF VGX _____ EMS MODE - STBY VGY _____ RHC & THC - LOCKED VGZ _____ ATT DB - MAX TRANS CONT PWR - OFF ROT CONTR PWR DIRECT (2) - OFF BMAG MODE (3) - RATE 2 cb DIRECT ULLAGE (2) - open cb SPS P1 & Y1 - open PCM BIT RATE - LOW MAP CAMR ON - OFF (except lunar orb.) PAN CAMR PWR - OFF SM/AC PWR - OFF (except lunar orb.) PRO (If MINKEY, To Sequencer 3X.2)
12	F 37	V82E
13	F 16 44	HA,HP,TFF (.1nm,min-sec) PRO
14	F 37	00E

DATE 3/22/71

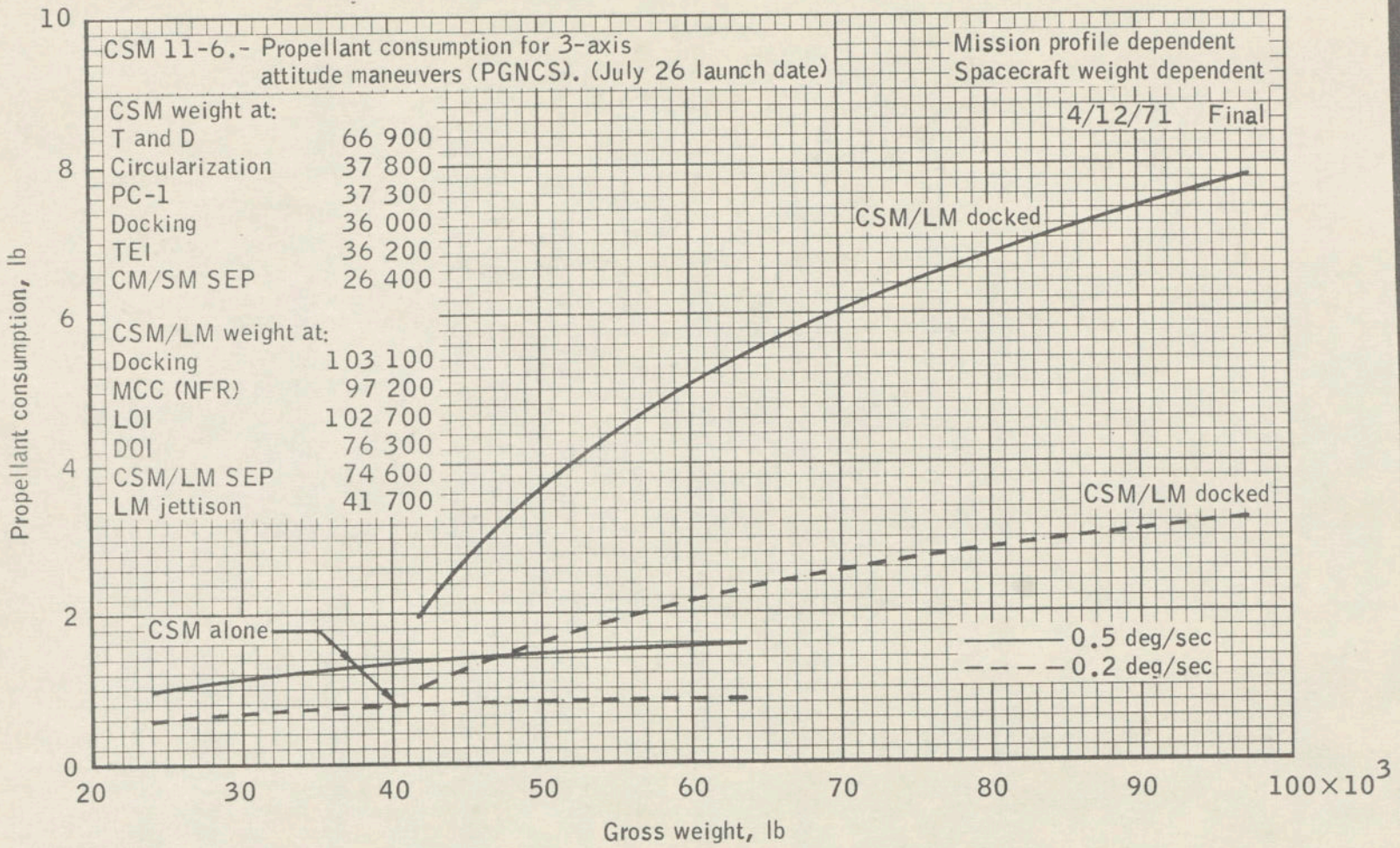
DATE 5/24/71

ALIGNMENTS (P50'S)

PROP CONS

SPS vs RCS CRITERIA

GIMB ANGS vs WT



Propellant consumption 3-axis attitude maneuvers (PGNCS).

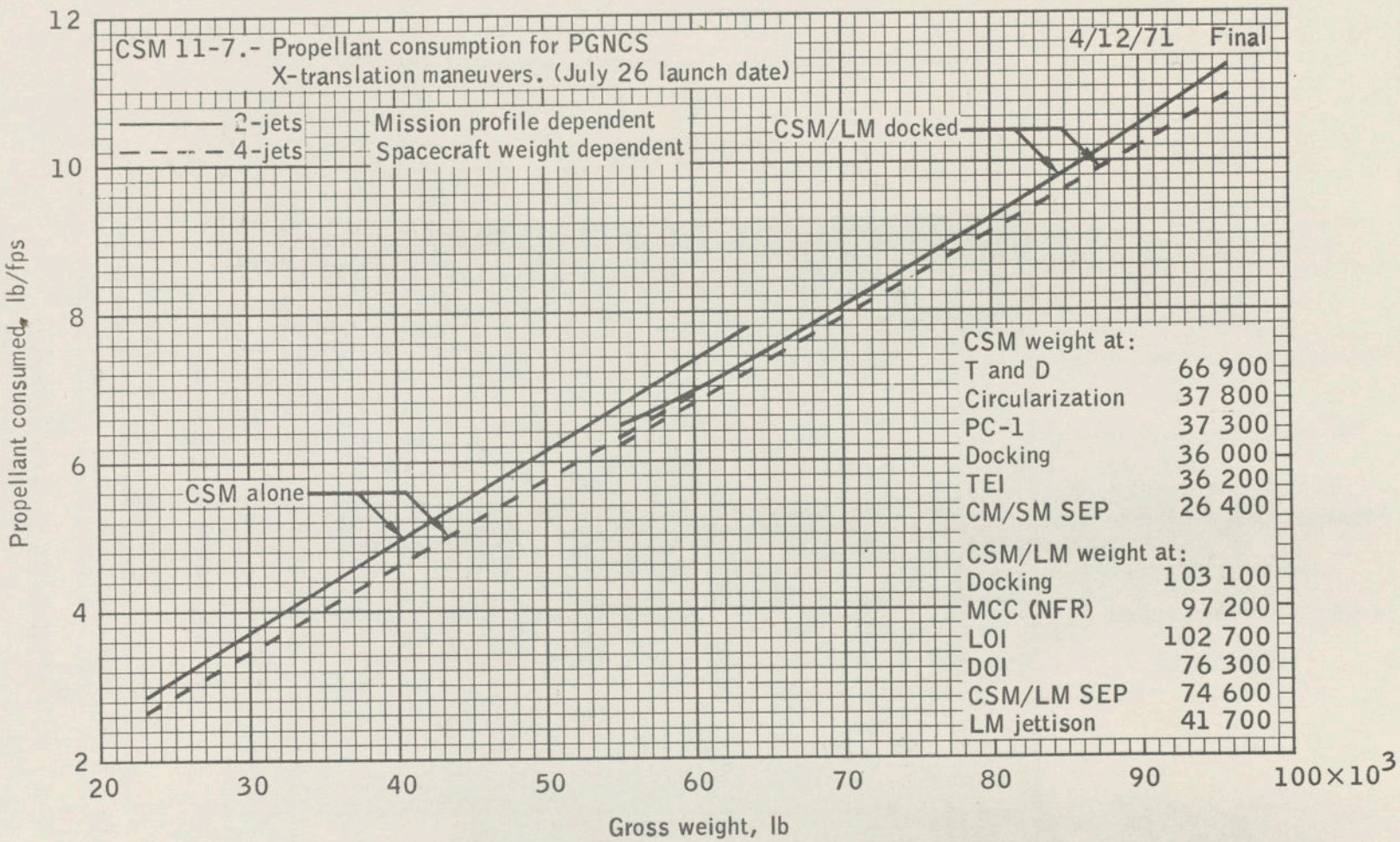
G
5-6

DATE 5/24/71

DATE 5/24/71

DATE 5/24/71

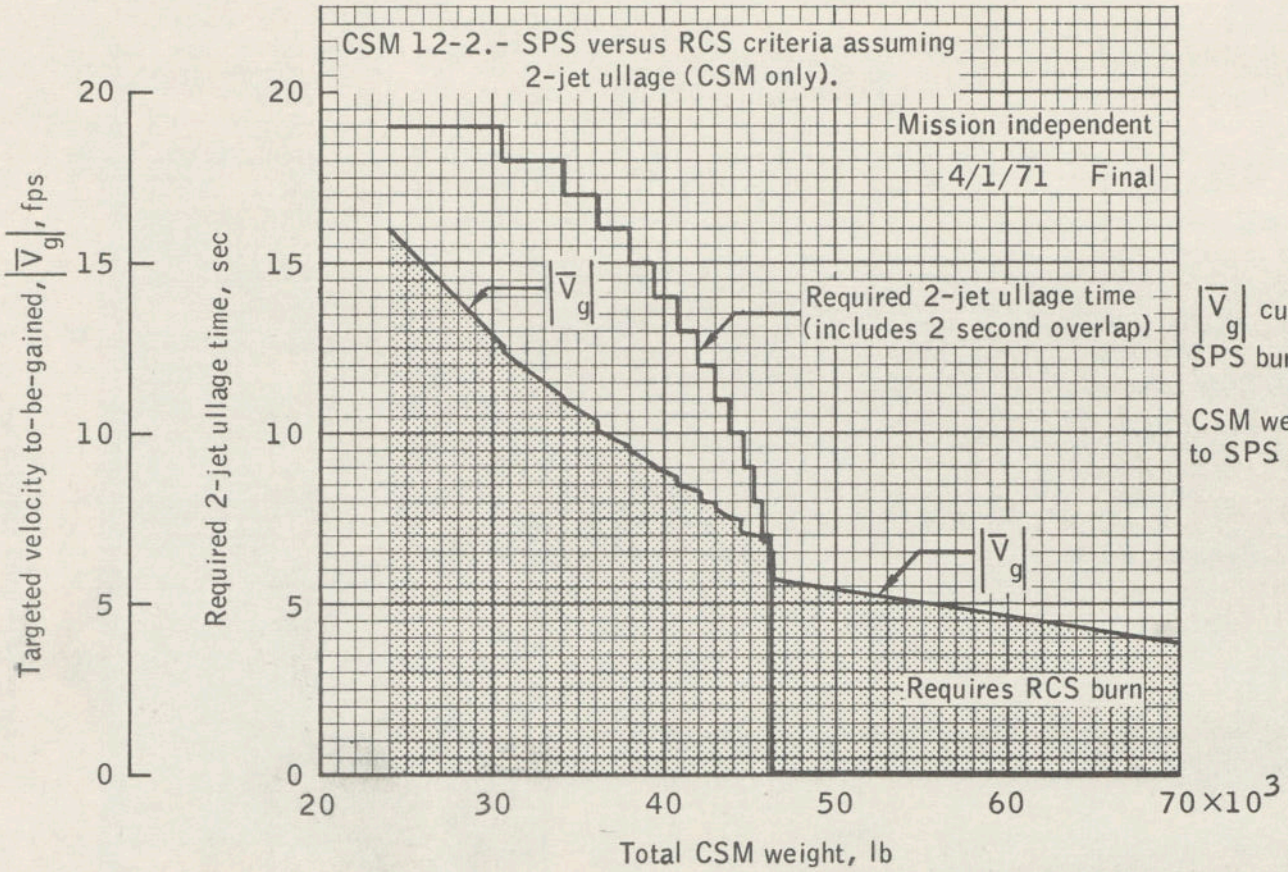
DATE 5/24/71



Propellant consumption for PGNCS X-translation maneuvers.

G
5-7

GIMB ANGS vs WT | SPS vs RCS CRITERIA | STAR CHARTS | ALIGNMENTS (P50'S)



Assumptions

$|\bar{V}_g|$ curve represents minimum SPS burn of 0.5 seconds

CSM weight variations are due to SPS propellant loss only

SPS versus RCS criteria assuming 2-jet ullage (CSM only).

DATE 5/24/71

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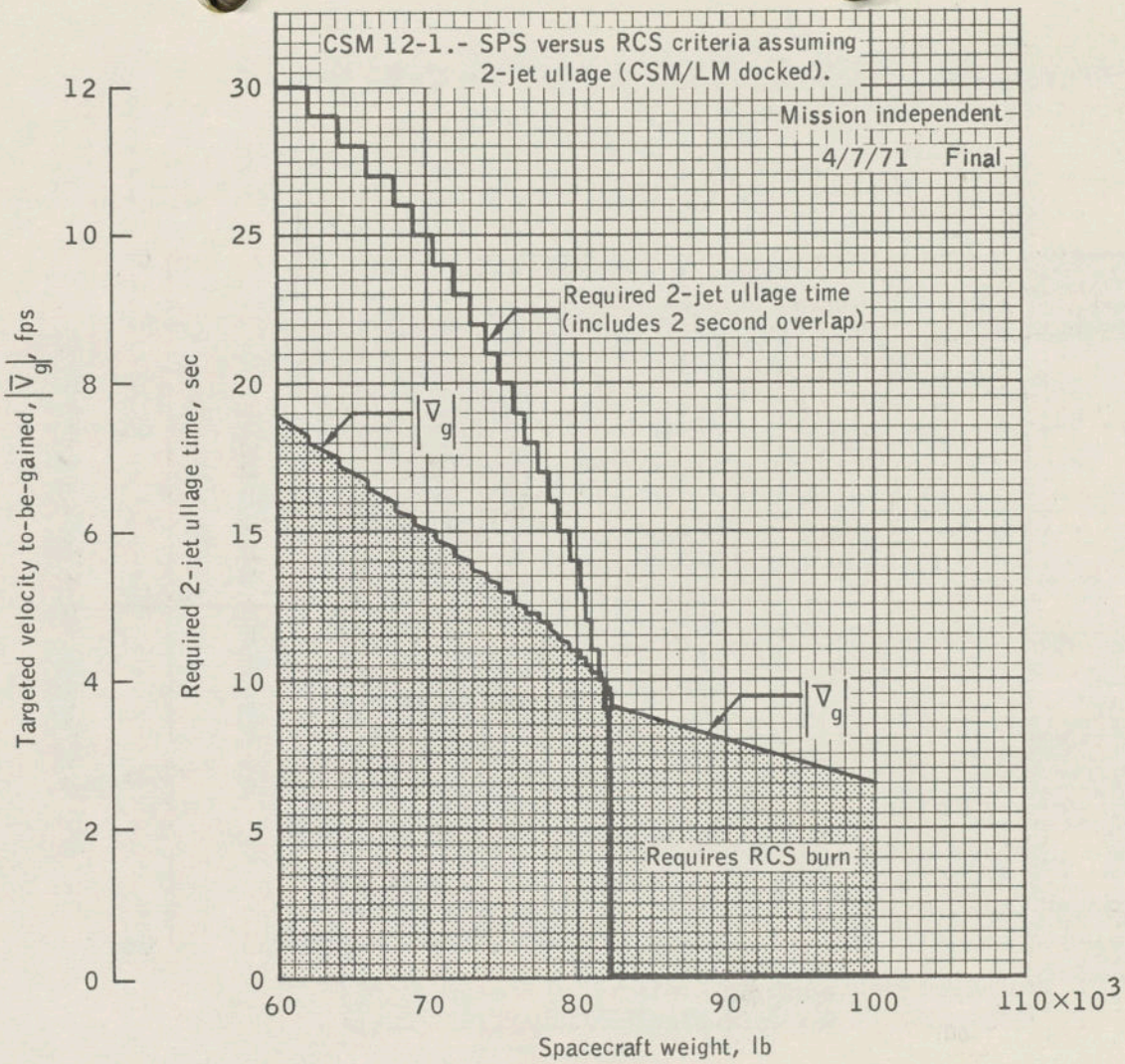


Assumptions

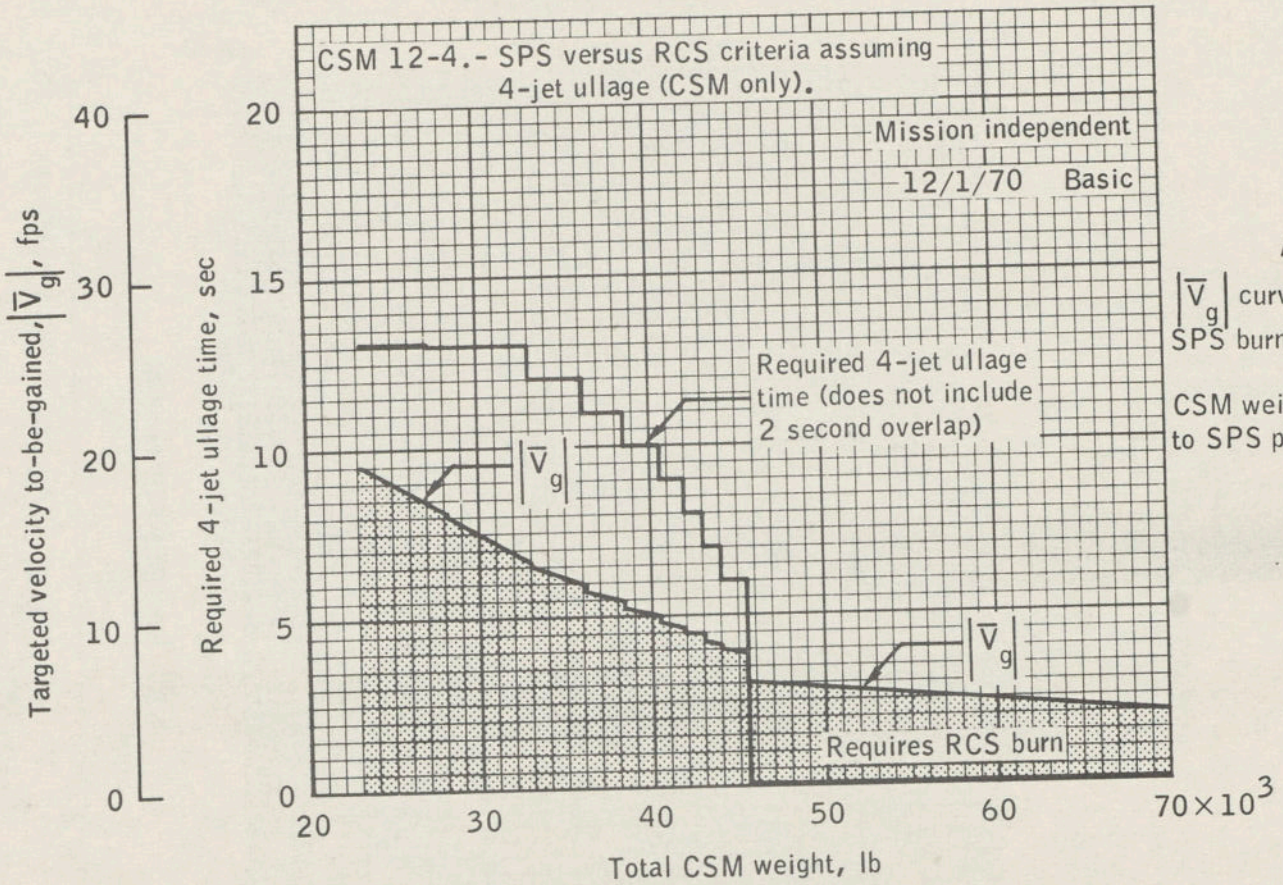
Spacecraft weight assumed to consist of CSM and fully loaded LM

$|\overline{\nabla}_g|$ curve represents minimum SPS burn of 0.5 seconds

CSM weight variations are due to SPS propellant loss only

G
5-9

SPS versus RCS criteria assuming 2-jet ullage (CSM/LM docked).



Assumptions

$|\bar{V}_g|$ curve represents minimum SPS burn of 0.5 seconds

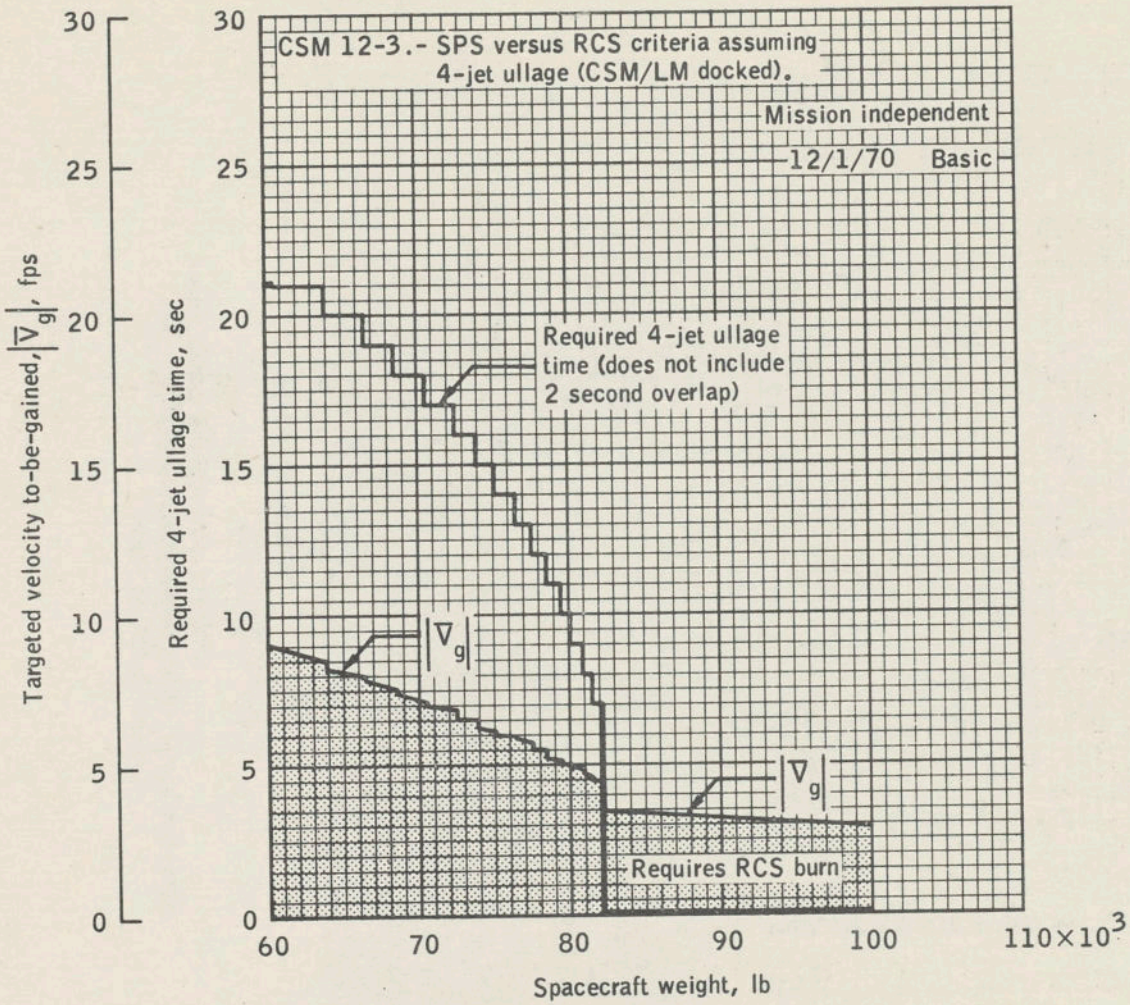
CSM weight variations are due to SPS propellant loss only

SPS versus RCS criteria assuming 4-jet ullage (CSM only).

DATE 5/24/71

DATE 5/24/71

DATE 5/24/71



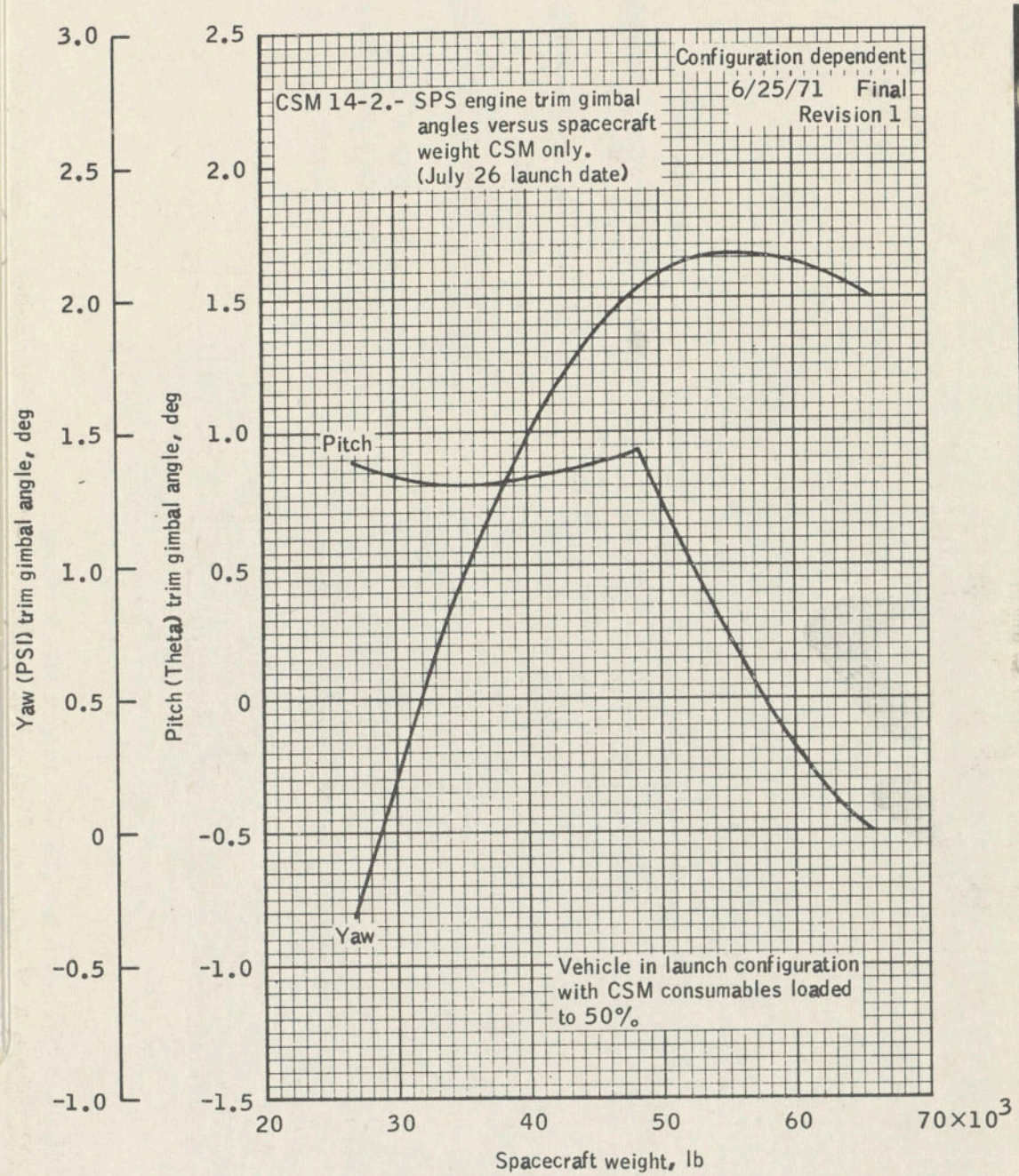
SPS versus RCS criteria assuming 4-jet ullage (CSM/LM docked).

Assumptions

Spacecraft weight assumed to consist of CSM and fully loaded LM

$|\overline{V}_g|$ curve represents minimum SPS burn of 0.5 seconds

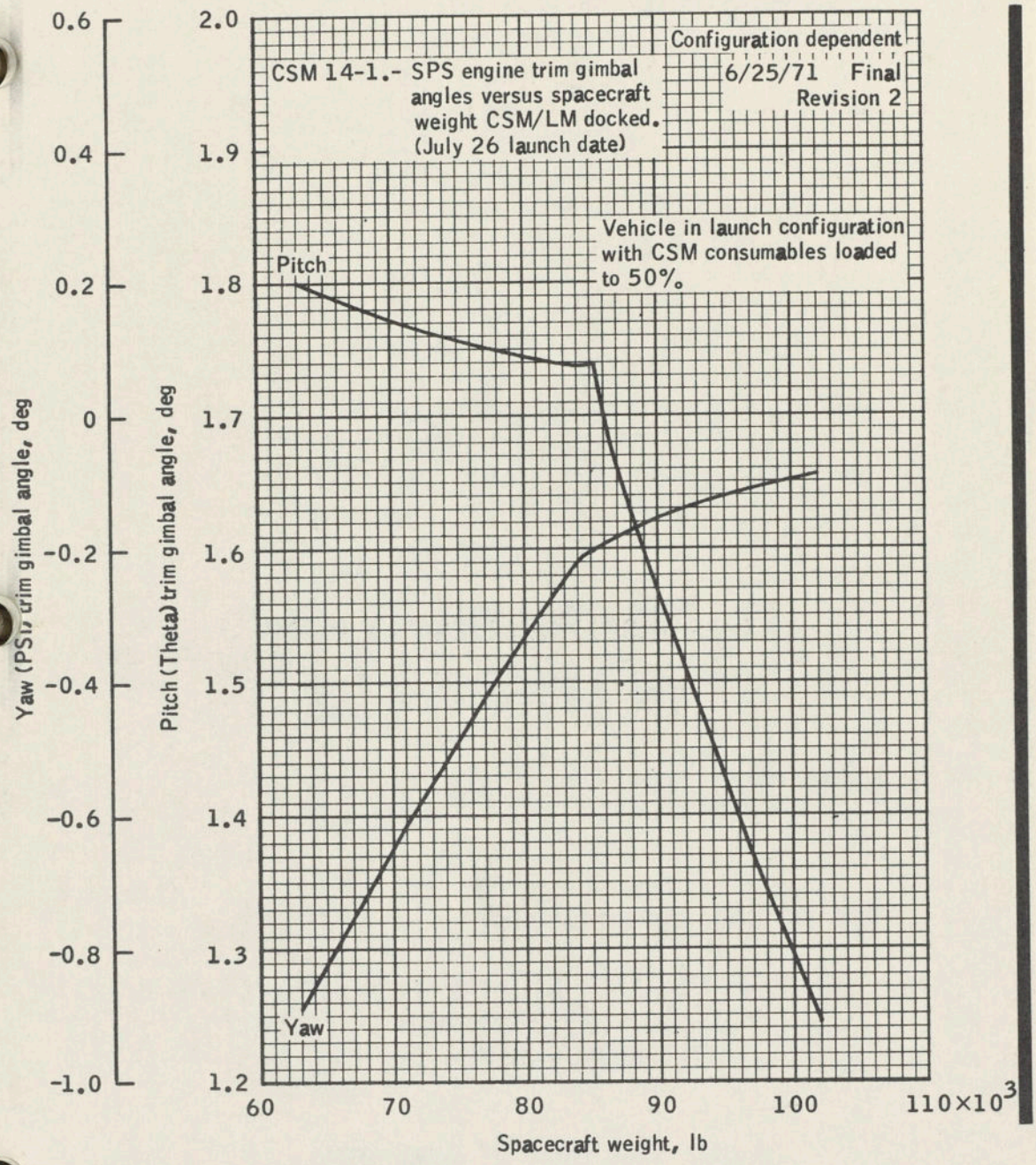
CSM weight variations are due to SPS propellant loss only



SPS engine trim gimbal angles versus spacecraft weight CSM only.

DATE 7/14/71

DATE 7/14/71



SPS engine trim gimbal angles versus spacecraft weight CSM/LM docked.

DATE 7/14/71

DATE 7/14/71

THRUSTING (P40's)

PROP CONS

SPS vs RCS CRITERIA

GIMB ANGS vs WT

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DATE 3/22/71

DATE ~~5/24/71~~ 7/14/71

P41 - RCS THRUSTING

Prethrust Program Complete
Verify SIM PWR DOWN (Nominal) configuration, pg. S/1-~~3940~~
CMC - on
ISS - on
SCS - OPERATING
TEST C/W LAMPS
Perform EMS ΔV TEST & NULL BIAS CHECK, pg G/2-5
Set ΔVC
EMS FUNC - ΔV
BMAG MODE (3) - RATE 2
CMC MODE - FREE
AUTO RCS SELECT (16) - as Req'd
LOAD DAP (check roll jets)
ROT CONTR PWR NORMAL (2) - AC/DC
ROT CONTR PWR DIRECT (2) - MNA/B
Set DET
V37E 00E
SC CONT - CMC/AUTO

1 MNVR TO PAD BURN ATTITUDE
V49E

2 PERFORM BORESIGHT & SXT STAR CHECK
V41 N91E

3 V37E 41E
(TFI available via N40, N45 or N35)

4 F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) BMAG MODE (3) - RATE 2
SC CONT - CMC/AUTO
PRO

5 06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)

DATE 3/22/71

DATE ~~5/24/71~~ 7/14/71

THRUSTING (P40's)

PROP CONS

SPS vs RCS CRITERIA

GIMB ANGS vs WT

```
6     F 50 18   REQUEST MNVR TO FDAI RPY ANGLES  (.01°)
          (AUTO TRIM)  BMAG MODE (3) - RATE 2
                       ALIGN SC ROLL
                       SC CONT - CMC/AUTO
                PRO
                     MAN ATT (3) - RATE CMD
                     ATT DB - MIN
                     RATE - LOW
                     BMAG MODE (3) - ATT1/RATE 2
                     GDC ALIGN
                ENTR

7       06 85   VG X,Y,Z                          (.1fps)

                          * PROG Alarm 1t                 *
                          * V5N9E - 01703 - TIG SLIPPED *
                          * KEY RLSE To 7                 *

   55:00
  (-05:00)            TRANS CONT PWR - on (up)
                      HAND CONTROLLERS - ARMED

   59:25
  (-00:35)            DSKY BLANKS

   59:30
  (-00:30)

8       16 85   VG X,Y,Z (AVE G ON)
                      TAPE RCDR - HBR/RCD/FWD/CMD RESET
                      LIMIT CYCLE - OFF
                      EMS MODE - NORMAL
```

DATE 3/22/71

DATE 5/24/71

```
    00:00
9    F 16 85    VG X,Y,Z
                NULL COMPONENTS
                RECORD ΔV COUNTER & RESIDUALS   ΔVC_____
                     EMS FUNC - OFF             VGX_____
                     EMS MODE - STBY            VGY_____
                     RHC & THC - LOCKED         VGZ_____
                     TRANS CONT PWR - OFF
                     ROT CONTR PWR DIRECT - OFF
                     BMAG MODE (3) - RATE 2
                     TAPE RCDR - off (ctr)
                     PCM BIT RATE - LOW
                     MAP CAMR ON - OFF (except lunar orb.)
                     PAN CAMR PWR - OFF
                     SM/AC PWR - OFF (except lunar orb.)
                PRO  (If MINKEY, to sequencer 3X.2)

10   F 37       V82E

11   F 16 44    HA,HP,TFF                    (.1nm,min-sec)

                PRO

12   F 37       00E
```

P47 Thrust Monitor Program

```
                     CMC - on
                     ISS - on & aligned

1                   V37E 47E
     F 16 83        ΔV XYZ(CSM)                  (.1fps)

                         *VI,HDOT,H available by N62E*
                         *KEY RLSE to return to N83  *

            (RECYCLE)  V32E
            (TERM)     PRO

2    F 37       00E
```

DATE 3/22/71

DATE 5/24/71

ALIGNMENTS (P50'S)

STAR CHARTS

INITIALIZATION PROCEDURES

PTC/ORB RATE

GIMB ANGS vs WT

SPS vs RCS CRITERIA

PROP CONS

THRUSTING (P40's)

DATE 3/22/71

P51 IMU ORIENTATION

CMC - on
ISS - on
SCS - operating
BMAG MODE (3) - RATE 2
G/N PWR OPTICS - on
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - MAN

1 V37E 51E
F 50 25 00015 MNVR TO ACQ STARS
(Coarse Align IMU To 0,0,0) - ENTR to 2
(BYPASS) PRO to 3

2 41 22 DESIRED GIMBAL ANGLES (0,0,0)
NO ATT lt - on then off, to 1

3 F 51 PLEASE MARK
OPT ZERO - OFF
MARK

4 F 50 25 00016 TERMINATE MARKS
PRO

5 F 01 71 000DE STAR CODE
Load desired code
PRO to 3 after 1st MARK (to 6 if DE=00)
to 7 after 2nd MARK (to 6 if DE=00)

6 F 06 88 CELESTIAL BODY VECTOR
Load desired vector
PRO to 3 after 1st MARK
to 7 after 2nd MARK

7 F 06 05 STAR ANGLE DIFFERENCE (.01°)

N 05 LIMITS

2 stars: SXT $\leq$ + 00003
SCT $\leq$ + 00011

Star/planet: SXT $\leq$ + 00018
SCT $\leq$ + 00021

(RECYCLE) V32E to 1
(ACCEPT) PRO

DATE 3/22/71

8 F 37 52E - bypass ZERO OPTICS
or XXE
OPT ZERO - ZERO

P52 IMU REALIGN

CMC - on
ISS - on
SCS - operating
BMAG MODE (3) - RATE 2
G/N PWR OPTICS - on
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - CMC

Note: MINKEY displays not shown

1 V37E 52E
F 04 06 R1 00001 IMU ALIGN OPTION
R2 00001 PREF PRO to 4
2 NOM PRO to 2
3 REFSMMAT PRO to 7
4 LDG SITE PRO to 2

2 F 06 34 GET ALIGN (0,0,0 initially)
(hrs,min,.01sec)
Load desired GET
TO SPECIFY PRESENT TIME - PRO on (0,0,0)
PRO (NOM go to 4)

3 F 06 89 LAT, LONG/2, ALT (.001°,.001°,.01nm)
Load ldg site coords
PRO

4 F 06 22 NEW ICDU ANGLES OG, IG, MG (.01°)
(IF MG>+70°, MNVR) V32E - to 4
PRO

5 F 50 25 00013 GYRO TORQUE
(COARSE) PRO - NO ATT lt - on then off - to 7
(TORQUE) CMC MODE - FREE
ENTR

6 16 20 ICDU ANGLES (.01°)
When torque complete - go to 17

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```
7    F 50 25   00015 STAR SELECT
               (MNVR If Necessary)
               (PICAPAR) PRO
                                *F 05 09 00405 NO PAIR    *
                                *(CREW SPECIFY) PRO - to 8*
                                *(PICAPAR) MNVR-V32E to 7 *

               (MAN ACQ) ENTR

8    F 01 70   000DE STAR CODE
               Load desired code
                    OPT MODE - CMC (verify)
                    OPT ZERO - OFF
               PRO to 10 (to 9 if DE=00)
                                *F 05 09 00404 (TA>90°)*
                                *MNVR - PRO to 10      *

9    F 06 88   CELESTIAL BODY VECTOR
               Load desired vector
               PRO
                                *F 05 09 00404 (TA>90°)*
                                *MNVR - PRO to 10      *

10     06 92   SHAFT, TRUN                    (.01°,.001°)

               (MARK ROUTINE) OPTICS MODE - MAN

11   F 51      PLEASE MARK
               MARK

12   F 50 25   00016 TERMINATE MARKS
               PRO

13   F 01 71   000DE STAR CODE
               Load code (if necessary)
               PRO to 8 after 1st MARK (to 14 if DE=00)
                   to 15 after 2nd MARK (to 14 if DE=00)

14   F 06 88   CELESTIAL BODY VECTOR
               Verify vector
               PRO to 8 after 1st MARK
                   to 15 after 2nd MARK
```

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15 F 06 05 STAR ANGLE DIFFERENCE (.01°)

N 05 LIMITS

2 stars: SXT ≤ + 00003
SCT ≤ + 00011

Star/planet: SXT ≤ + 00018
SCT ≤ + 00021

(REJECT) V32E to 17
(ACCEPT) PRO

16 F 06 93 TORQUING ANGLES OG, IG, MG (.001°)
(TORQUE) CMC MODE - FREE
PRO
(BYPASS) V32E

17 F 50 25 00014 ALIGNMENT CHECK
(RECHECK) PRO to 7
(BYPASS) ENTR

18 F 37 XXE
OPT ZERO - ZERO
G/N PWR OPTICS - OFF

P53 - BACKUP IMU ORIENT DETERMINATION
CMC - on
ISS - on
SCS - operating
MAN ATT (3) - MIN IMP
COAS LOS DETERMINATION - complete

1 V37E 53E
F 50 25 00015 MNVR To ACQ STARS
(BYPASS) (Coarse Align IMU to 0,0,0) - ENTER to 2
PRO to 3

2 41 22 DESIRED GIMBAL ANGLES (0,0,0)
NO ATT lt - on then off, to 1

3 F 06 94 ALT LOS OPT ANGS SHAFT, TRUN (.01°,.001°)
Load proper angles
COAS NOM: Shaft +00000
Trun +57470

PRO

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```
4    F 53        PLEASE MARK
                 Center Target
                 ENTR

5    F 50 25     00016 TERMINATE MARKS
          (REJECT)  ENTR to 4
                 PRO

6    F 01 71     000DE STAR CODE
                 Load desired code
                 PRO to 3 after 1st MARK (to 7 if DE=00)
                     to 8 after 2nd MARK (to 7 if DE=00)

7    F 06 88     CELESTIAL BODY VECTOR
                 Load desired vector
                 PRO to 3 after 1st MARK
                     to 8 after 2nd MARK

8    F 06 05     STAR ANGLE DIFFERENCE                (.01°)
                      N 05 LIMITS (COAS)

                      2 stars:  ≤ + 00070
                      Star/planet:  ≤ + 00072
          (RECYCLE) V32E to 1
          (ACCEPT)  PRO

9    F 37        XXE


                 P54 - BACKUP IMU REALIGN
                      CMC - on
                      ISS - on
                      SCS - operating
                      MAN ATT (3) - MIN IMP
                      COAS LOS DETERMINATION - complete

1                V37E 54E
     F 04 06     R1 00001  IMU ALIGN OPTION
                 R2 00001  PREF     PRO to 4
                       2   NOM      PRO to 2
                       3   REFSMMAT PRO to 7
                       4   LDG SITE PRO to 2
```

2 F 06 34 GET ALIGN (0,0,0 initially)
(hrs,min,.01sec)
Load desired GET
TO SPECIFY PRESENT TIME - PRO on (0,0,0)
PRO (NOM go to 4)

3 F 06 89 LAT, LONG/2, ALT (.001°,.001°,.01nm)
Load ldg site coords
PRO

4 F 06 22 NEW ICDU ANGLES OG, IG, MG (.01°)
(IF MG>70°, MNVR) V32E to 4
PRO

5 F 50 25 00013 GYRO TORQUE
(COARSE) PRO - NO ATT lt - on
then off - to 7
(TORQUE) CMC MODE - FREE
ENTR

6 16 20 ICDU ANGLES (.01°)
When Torque complete go to 17

7 F 50 25 00015 STAR SELECT
(Mnvr If Necessary)
(PICAPAR) PRO
*F 05 09 00405 NO PAIR *
*(CREW SPECIFY) PRO to 8 *
(PICAPAR) MNVR-V32E to 7

(MAN ACQ) ENTR

8 F 01 70 000DE STAR CODE
Load desired code
PRO to 10 (to 9 if DE=00)

9 F 06 88 CELESTIAL BODY VECTOR
Load desired vector
PRO

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```
10   F 06 94   ALT LOS OPT ANGS SHAFT, TRUN(.01°,.001°)
               Load angles
                    COAS Nom:  Shaft +00000
                               Trun  +57470
               PRO

11   F 53      PLEASE MARK
               Center Target
               ENTR

12   F 50 25   00016 TERMINATE MARKS
          (REJECT)  ENTR to 11
               PRO

13   F 01 71   000DE STAR CODE
               Load code (if necessary)
               PRO to 8 after 1st MARK (to 14 if DE=00)
                   to 15 after 2nd MARK (to 14 if DE=00)

14   F 06 88   CELESTIAL BODY VECTOR
               Verify vector
               PRO to 8 after 1st MARK
                   to 15 after 2nd MARK

15   F 06 05   STAR ANGLE DIFFERENCE                (.01°)
                         N 05 LIMITS (COAS)
                    2 stars:  ≤ + 00070
                    Star/planet:  ≤ + 00072
          (REJECT)  V32E to 17
          (ACCEPT)  PRO

16   F 06 93   TORQUING ANGLES OG, IG, MG            (.001°)
          (TORQUE)  CMC MODE - FREE
                    PRO
          (BYPASS)  V32E

17   F 50 25   00014 ALIGNMENT CHECK
          (RECHECK)  PRO to 7
          (BYPASS)   ENTR

18   F 37      XXE
```

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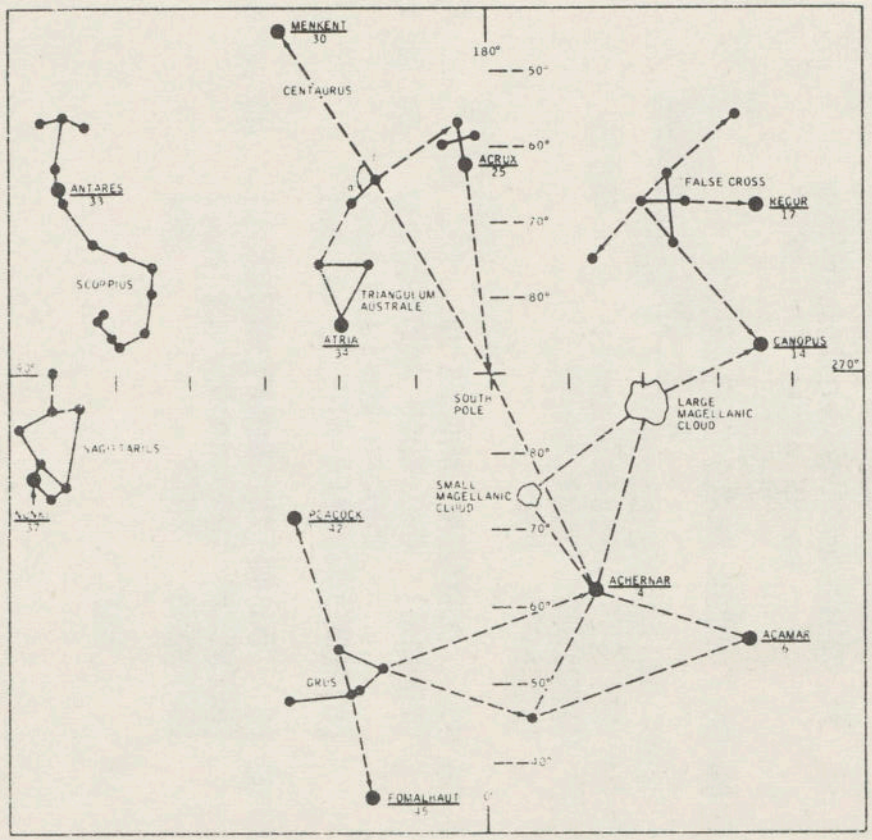
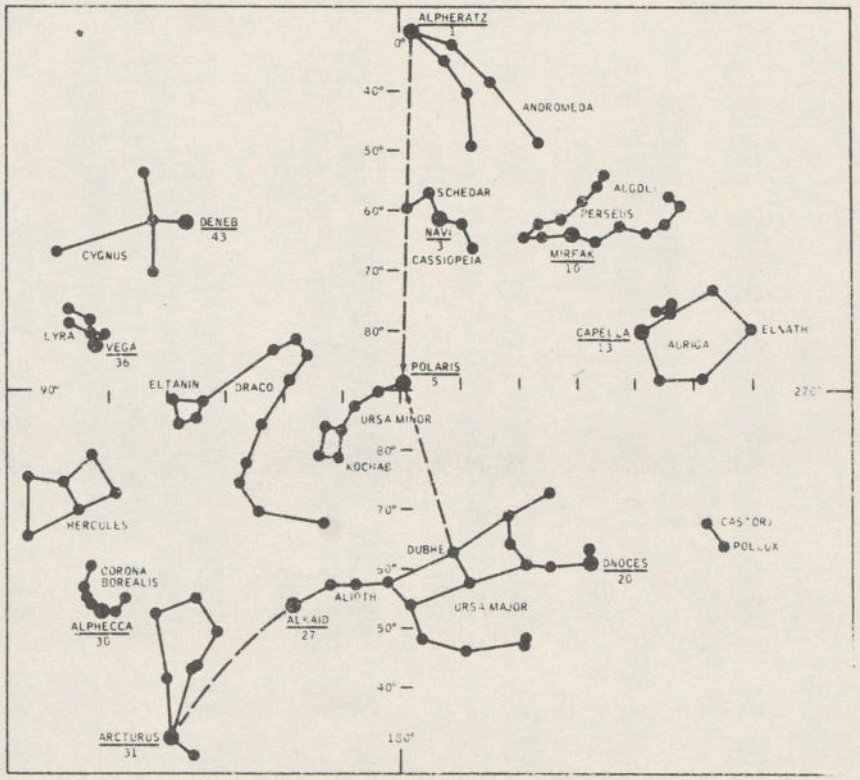
G/6-8



SOUTHERN STARS



NORTHERN STARS

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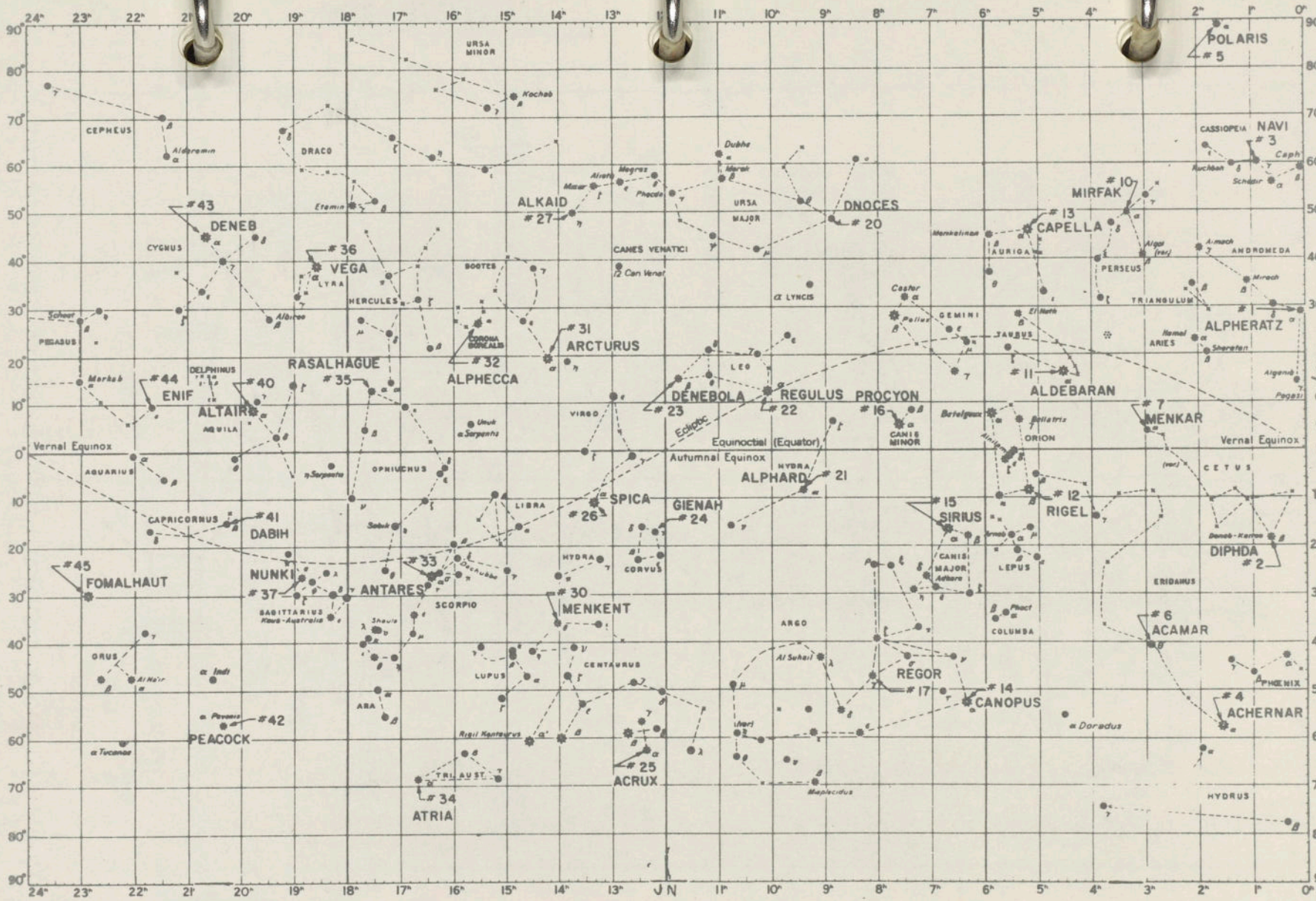


G/G-9

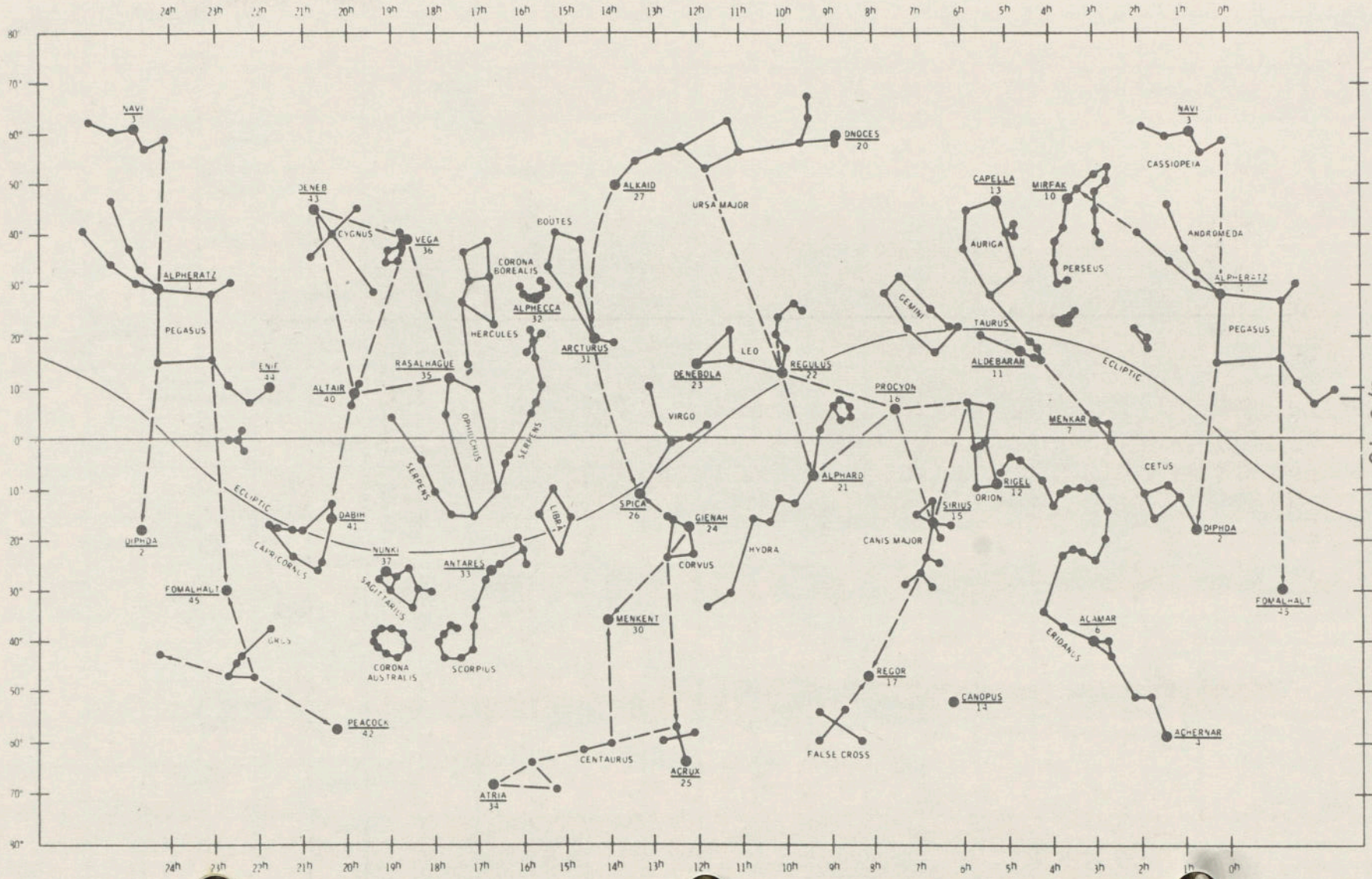
PTC/ORB RATE

INITIALIZATION PROCEDURES

STAR CHARTS

ERASABLE LOAD UPDATE

GIMB ANGS vs WT | SPS vs RCS CRITERIA | STAR CHARTS | ALIGNMENTS (P50'S)



G/6-10

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RAPID IMU REALIGN

NOTE: This procedure assumes a good GDC alignment

1 V41 N20E
Load R,P,Y from GDC Ball

2 V40
Verify R,P,Y on GDC Ball - ENTR
(Releases Platform And Recovers PGNS Control Modes)

3 V25 N07E
77E, 10000E, 1E (Sets REFSMMAT FLAG)

4 V37E 51E, PRO (Sets Drift Flag)
V37E 00E

5 Perform P52, Option 3

NOTE: If Loss of Alignment Is Due To Temporary Loss of DC BUS, Update CMC Clock With V55 To Complete Recovery.

CHANGING LANDING SITE REFSMMAT FOR OUT-OF-PLANE BURNS

1 V37E 52E

2 F 04 06 R1=00001
R2=00004 (LOAD LANDING SITE OPTION)
PRO

3 F 06 34 GET ALIGN
PRO (SPECIFIES PRESENT TIME)

4 F 06 89 LAT,LONG/2,ALT (.001,.001°,.01nm)

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		Present Pitch	ΔVy	R1
	Load R1:	0 ± 90°	±	RLS LAT ±35°
		180 ± 90°	±	RLS LAT ∓35°

5 F 06 22 NEW ICDU ANGLES
PRO

6 F 50 25 R1=00013
CMC MODE-FREE
ENTR TO GYRO TORQUE

7 16 20 UNTIL TORQUING COMPLETE

8 F 50 25 R1=00014 ALIGNMENT CHECK
CMC MODE - AUTO
ENTR

9 P30

10 P40

11 YAW BACK TO 0° (MANUALLY)

12 V37E 52E

13 F 04 06 R1=00001
R2=00004 (LOAD LANDING SITE OPTION)
PRO

14 F 06 34 GET ALIGN (LOAD TIME OBTAINED FROM MSFN)
PRO

15 F 06 89 LAT, LONG/2,ALT (LAT WILL BE CHANGED BACK
PRO TO STORED RLS)

16 F 06 22 NEW ICDU ANGLES
PRO

17	F 50 25	R1=00013 CMC MODE-FREE ENTR TO START TORQUING
18	16 20	UNTIL TORQUING COMPLETE
19	F 50 25	R1=00014 ALIGNMENT CHECK CMC MODE - AUTO PRO (TO SELECT 2 STARS IF TIME PERMITS) ENTR (TO LEAVE P52)

GDC ALIGNMENT TO IMU GIMBAL ANGLES

IMU - on
SCS - operating

1 Damp vehicle rates

2 ATT SET dials - set to IMU angles on FDAI 1
FDAI SELECT - 1
FDAI SOURCE - ATT SET
ATT SET - IMU
ATT SET dials - null FDAI 1 err needles
ATT SET - GDC
GDC ALIGN PB - push until needles nulled
FDAI SEL - 1/2

BACKUP GDC AND/OR IMU ALIGNMENT
(IMU or CMC failed)

SCS - operating
RECORD: R,P,Y ALIGN from MSFN

1 IMU PWR - OFF
Wait ~5 min for gyros to run down before step 8

2 Set SCT to 0° SHFT, 352.5° TRUN
OPTICS PWR - OFF

3 ATT SET dials - R,P,Y ALIGN

4 Mnvr to position stars in SCT
0° mark - Vega (36)
R line - Deneb (43)

or

	NORTH	SOUTH
0° mark -	Navi (3)	Acrux (25)
R line -	Polaris (5)	Atria (34)

5 FDAI SELECT - 1
ATT SET - GDC
GDC ALIGN PB - push until needles nulled

6 ATT SET dials - 0,0,0

7 MNVR to 0,0,0 and null error needles

8 IMU PWR - on (up)
(IMU drives to 0°, 0°, 0°)
Wait 90 sec.

9 Uncage IMU
IMU CAGE - on (up) ~5 sec then release

IN-PLANE GDC ALIGNMENT

CMC - on
ISS - on
SCS - operating

1 V37E 52E
F 04 06 00001
Load R2=00002
PRO

2 F 06 34 GET ALIGN 0,0,0
PRO

3 F 06 22 R,P,Y

4 Set ATT SET dials to R,P,Y on DSKY

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5 FDAI SELECT - 1
ATT SET - GDC
GDC ALIGN - push

6 V37E XXE

PGNS ORDEAL INITIALIZATION
(In-Plane Alignment Req'd)

1 FDAI 1 or 2 - ORB RATE
EARTH/LUNAR - as req'd

2 V82E
F 04 12 00002 SPECIFY VEHICLE
00001
PRO

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

4 F 16 44 HA, HP (.1nm,.1nm)
Calculate Average
ALT SET - Set Average
PRO

5 V83E
F 16 54 R,RDOT,THETA (.01nm,.1fps,.01°)
MODE - HOLD/FAST
SLEW - To THETA
MODE - OPR/SLOW
PRO

SCS ORDEAL INITIALIZATION
(IN-PLANE GDC ALIGNMENT REQ'D)

1 FDAI 1 or 2 - ORB RATE
EARTH/LUNAR - as req'd

2 MSFN Supply Altitude
ALT SET - Set

3 SC +X At the Horizon

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4 MODE - HOLD/FAST
SLEW FDAI (See table)
MODE - OPR/SLOW

LUNAR		EARTH	
Alt(nm)	Angle*	Alt(nm)	Angle*
8	7°	100	14°
60	20°	200	19°
170	32°	500	29°

*Angle from +X S/C axis to horiz

COAS LOS DETERMINATION

CMC - on
ISS - on
SCS - operating
SC CONT - SCS
MAN ATT (3) - MIN IMP
G/N PWR OPTICS - on
OPT MODE - CMC
OPT ZERO - OFF then ZERO (15 sec)

1 V37E 52E

2 F 04 06 00001
00003
PRO

3 F 50 25 00015
ENTR

4 F 01 70 OOODE STAR CODE
LOAD BORESIGHT STAR CODE
OPT ZERO - OFF
PRO

5 06 92 SHAFT, TRUN (.01°,.001°)
Center target
MARK with VERB key
Record SHAFT, TRUN ____,____
(REPEAT) KEY RLSE
(EXIT) V37E XXE
OPT ZERO - ZERO

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CMC/LGC CLOCK SYNC/TEPHEM UPDATE

V16 N65E (On LM request)
(hr,min,.01sec)
Voice CMC time to LM
V05 N01E 1706E (On LM request)
Voice TEPHEM to LM

V55 CMC TIME UPDATE
(See EXT VERBS pg. G/1-27)

ALIGN LM IMU TO CSM IMU

ATT DB - MIN
RATE - LO
LIMIT CYCLE - ON
SC CONT - SCS
MAN ATT (3) - RATE CMD
BMAG MODE (3) - ATT1/RATE2
V06 N20E
Voice ICDU angles to LM*
Terminate attitude hold on LM cmd
V06 N20 (On LM request)
On LM MARK, Key ENTR
Copy ICDU angles and transmit to MSFN

*LM (IGA)p = P20 + 180°
LM (OGA)y = 300° -R20 + ΔØ
LM (MGA)r = 360° -Y20

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Align LM IMU to CSM GDC

SCS - on
GDC - on and aligned

1 On LM Request, hold att.:
ATT DB - MIN
RATE - LO
LIMIT CYCLE - ON
BMAG MODE (3) - ATT 1/RATE 2

2 On LM Request, Read GDC FDAI R,P,Y then
ATT SET dials - Set to FDAI R,P,Y
FDAI SELECT - 1
FDAI SOURCE - ATT SET
FDAI SCALE - 5/1
ATT SET - GDC
Null FDAI 1 error needle using ATT SET dials
Read ATT SET dial angles to LM

3 On LM Request, terminate att hold

ALIGN LM AGS TO CSM IMU/GDC

CMC - on
ISS - on and orientation known

or

SCS - on
GDC - on and aligned

1 Upon LM request, MNVR to
R = 300° + ΔØ
P = 180°
Y = 0°
and hold att., min DB
(If SCS: RATE-LO, LIMIT CYCLE-ON)

2 Notify LM when at attitude

3 When LM alignment complete - terminate att hold

Align CSM GDC to LM IMU

GDC - on (req)

1 Request LM to Hold Attitude, Min DB

2 Request and copy LM Readout of V06N20 angles:

LM(OGA)y _____.____°
LM(IGA)p _____.____°
LM(MGA)r _____.____°

3 ATT SET dials - Set to
R = 300° + Δϕ - LM (OGA)y
P = LM (IGA)p - 180°
Y = 360° - LM (MGA)r

4 FDAI SELECT - 1
ATT SET - GDC
GDC ALIGN - Push

5 Notify LM att hold not req

Align CSM GDC to LM AGS

1 Request LM MNVR to 0,0,0 on AGS FDAI, min DB

2 ATT Set dials - Set to
R = 300° + Δϕ
P = 180°
Y = 0°

3 FDAI SELECT - 1
ATT SET - GDC

4 When LM at Attitude:
GDC ALIGN - Push

5 Notify LM Att Hold not req'd

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Align CSM IMU to LM IMU

CMC - on
ISS - on
SCS - on

1 Verify LM in MIN DB, ATT HOLD

2 Request and copy LM Readout of V06N20E
LM(OGA)y _____.____°
LM(IGA)p _____.____°
LM(MGA)r _____.____

3 Calculate Gimbal Angles:
CM (OGA) = 300° + $\Delta\phi$ - LM (OGA)y
CM (IGA) = LM (IGA)p - 180°
CM (MGA) = 360° - LM (MGA)r

4 V41N20E
Load Gimbal Angles

5 V40E
Allow 10 sec before step 7
Notify LM Att Hold Not Req.

6 Set REFSMFLG:
V25N7E, 77E, 10000E, 1E

7 V37E51E
PRO
V37E00E

8 Request MSFN Uplink REFSMMAT
then Perform P52 (OPT 3)
or
V06N20 On CM Mark - ENTR
Voice Angles to MSFN for calculation of Gyro Torquing Angles.
Perform V42 GYRO TORQUING using ground calculated Torquing Angles (pg. G/1-24)

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Align CSM IMU TO LM AGS

CMC - on
ISS - on

1 Request LM MNVR to 0,0,0
on AGS FDAI

2 When LM at Attitude:
V41N20E
LOAD: R1 = 300° + ΔØ
R2 = 180°
R3 = 0°

3 V40E
Allow 10 sec before step 5
Notify LM Att Hold not req.

4 Set REFSMFLG:
V25N7E, 77E, 10000E, 1E

5 V37E51E
PRO
V37E00E

6 Request MSFN Uplink REFSMMAT,
then, if desired, perform P52 (OPT 3)

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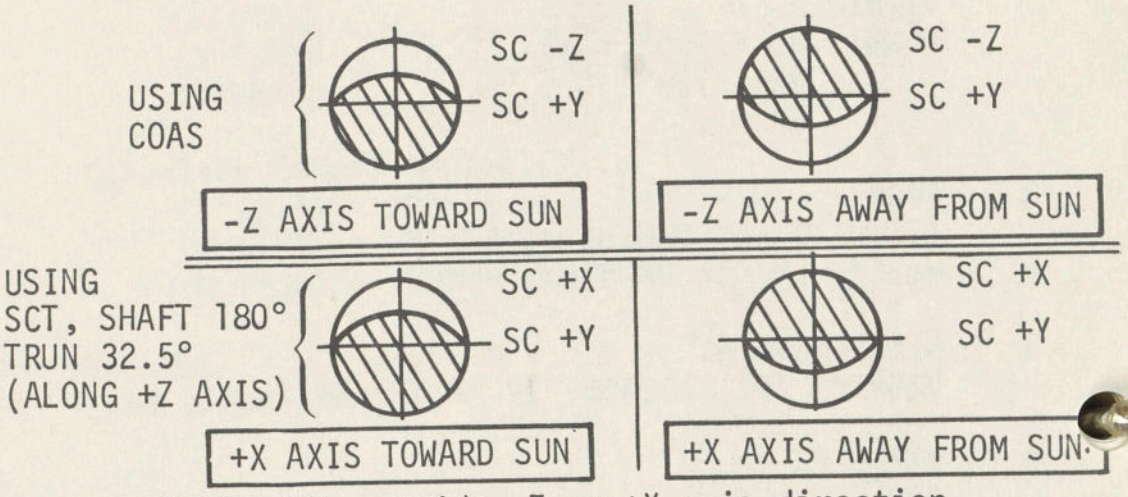
CRESCENT ALIGN

If SCT: Drive optics To 180,32.5
G&N PWR OPT - OFF

1 MNVR to acquire EARTH in Optical System's field-of view. Then MNVR to align required Reference line along Earth's Crescent.



MSFN will provide -Z or +X axis direction

2 (For GDC only, see step 8)
If CMC not avail:
Verify IMU PWR - OFF (5 min)
Go to Step 9

3 V41N20E, load desired angles from MSFN or 0,0,0

4 V40, Verify Ref. Line Aligned with Crescent
ENTR
Allow 10 sec before step 6

5 V25N07E, 77E, 10000E, 1E

6 V37E51E, PRO, V37E00E
Request MSFN uplink REFSMMAT and, if desired, do P52 (OPT 3)

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7 Align GDC to IMU, if desired

or

8 FDAI SELECT - 1
ATT SET - GDC
ATT SET DIALS - 0,0,0 (or angles from MSFN)
Verify Ref line aligned to crescent, then:
GDC ALIGN - Push

9 Do not perform this step if CMC avail:
IMU PWR - ON (up)
Wait 90 sec
IMU CAGE - on (up) ~5 sec then release

GDC REFSMMAT DETERMINATION

GDC - on
CMC - on
IMU - off
G/N PWR OPTICS - on
OPT ZERO - OFF THEN ZERO (15 sec)
OPT MODE - MAN

1 Acquire Apollo Nav star
in optics
FDAI Scale - 5/1
Hold att (ATT DB - MIN, RATE - LO)
Align GDC to 0,0,0
V25 N20E
E,E,E

2 V37E00E
V96E

3 Initiate P51 logic
as follows:
V21N1E
1214E
63E (65 if P53 desired)
V25N26E
13001E
3425E
30005E
V30E
(Note: Major mode lts. on DSKY do not change from 00 to 51)

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ERASABLE LOAD UPDATE

PLANET VECTORS

PTC/ORB RATE

4 F 50 25 00015 ACQ STARS
PRO

5 F 51 PLEASE MARK
If necessary, mnvr and:
V25N20E
Load present GDC angles
OPT ZERO - OFF
Null FDAI needles with Min imp
then:
MARK

6 F 50 25 00016 TERM MARKS
PRO

7 F 01 71 000DE STAR CODE
Load star code
PRO to 5 after 1st MARK (8 if DE = 00)
to 9 after 2nd MARK (8 if DE = 00)

8 F 06 88 CELESTIAL BODY VECTOR
Load vector
PRO to 5 after 1st MARK
to 9 after 2nd MARK

9 F 06 05 STAR ANGLE DIFFERENCE (.01°)
(Expect <.1°)
(RECYCLE) V32E to 4
(ACCEPT) PRO

10 F 37 XXE
OPT ZERO - ZERO
CMC has now calculated
a REFSMMAT for the GDC,
has set REFSMFLG and
DRIFTFLG.

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GDC REFSMMAT REALIGN (P52)

GDC - on and REFSMMAT Known (pg G/7-13)
CMC - on
SCS - operating
IMU - off
G/N PWR OPTICS - on
OPT ZERO - OFF THEN ZERO (15 sec.)
OPT MODE - MAN

1 Acquire nav. target in optics
Hold att (ATT DB-MIN, RATE-LO)
V25N20E
Load GDC angles
V37E52E

2 F 04 06 R1 00001
R2 00001 PREF PRO to 5
2 NOM PRO to 3
3 REFSMMAT PRO to 7
4 LDG SITE PRO to 3

3 F 06 34 GET ALIGN (0,0,0 initially) (hr,min,.01 sec)
Load desired GET
TO SPECIFY PRESENT TIME - PRO on (0,0,0)
PRO (NOM go to 5)

4 F 06 89 LAT, LONG/2, ALT (.001°,.001°,.01nm)
Load ldg site coords
PRO

5 F 06 22 NEW ICDU ANGLES OG,IG,MG (.01°)
(If MG > ± 70°, MNVR and reload N20)
V32E - to 5
Align GDC to new angles
V25N20E
Load new angles
PRO

6 F 50 25 00013 GYRO TORQUE
PRO (NO ATT lt-on then off,
PROG ALM - ignore)

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```
7    F 50 25   00015 ACQ STARS
       (opt 3)   PRO
   (Not opt 3)   OPT ZERO - ZERO
                 G/N PWR OPTICS - OFF
                 V37EXXE - procedure complete

8    F 01 70   000DE STAR CODE
               Load desired code
                    OPT MODE - CMC (verify)
                    OPT ZERO - OFF
               PRO to 10 (to 9 if DE = 00)
                         *F 05 09 00404 (TA > 90°)      *
                         *MNVR & reload N20 - PRO to 10*

9    F 06 88   CELESTIAL BODY VECTOR
               Load desired vector
               PRO
                         *F 05 09 00404 (TA > 90°)      *
                         *MNVR & reload N20 - PRO to 10*

10     06 92   SHAFT, TRUN                        (.01,.001°)

          (MARK ROUTINE) OPTICS MODE - MAN

11   F 51                PLEASE MARK
          (If required)  V25N20E
                         Load present GDC angles
                         Null FDAI needles with
                           min imp, then:
                         MARK

12   F 50 25   00016 TERMINATE MARKS
               PRO

13   F 01 71   000DE STAR CODE
               Load code (if necessary)
               PRO to  8 after 1st MARK (to 14 if DE=00)
                   to 15 after 2nd MARK (to 14 if DE=00)

14   F 06 88   CELESTIAL BODY VECTOR
               Load vector
               PRO to  8 after 1st MARK
                   to 15 after 2nd MARK
```

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15 F 06 05 STAR ANGLE DIFFERENCE (.01°)
(Expect < .1°, if not V32E to 17)
(Accept) PRO

16 F 06 93 TORQUING ANGLES OG,IG,MG (.001°)
N93 is indicative of BMAG drift
since last alignment
If torque angles excessive
perform P51
Otherwise: OPT ZERO - ZERO
G/N PWR OPTICS - OFF
V37EXXE - procedure complete

17 F 50 25 00014 ALIGNMENT CHECK
PRO to 7

LM STEERABLE ANT POINTING

1. Select V64 (pg G/1-27)

2. Mnvr to N51 angles:

R1 = +03000, R2 = 09000 (+Z orien)
R1 = -03000, R2 = 27000 (-Z orien)

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GIMB ANGS vs WT

INITIALIZATION PROCEDURES

STAR CHARTS

ALIGNMENTS (P50'S)

DATE 3/22/71

P20 - Opt 2 (PTC/Orb rate)

1		V37E 20E
	F 04 06	R1 00024 TRACKING OPTION
		R2 00000
		Load 2 in R2
		PRO
2	F 06 78	AXIS YAW, AXIS PITCH, OMICRON (.01°)
		Load values (OMICRON ignored)
		PRO
3	F 06 79	RATE, DEADBAND, Blank (.0001°/sec,.01°)
		Load desired values
		PRO
4	F 06 34	START TIME (hrs,min,.01 sec)
		Load desired GET
		(all 0's for present time)
		PRO
5		Maneuver starts at requested GET

Selection of the following programs will not stop rotation:

P21, P22, P24, P27, P29,
P30
P52,P54
P72-P75

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PASSIVE THERMAL CONTROL (G&N)

RHC - Locked
FDAI SCALE - 5/1
RCS DAP - Activated

1 V48E (Select 0.5° DB)
V37E 00E
V49E

2 F 06 22 Load PTC Attitude R - Present
P - 90° (TLC) or 270°
Y - 0° (TEC)

PRO

3 F 50 18 BMAG MODE (3) - RATE 2
SC CONT - CMC
CMC MODE - AUTO
PRO

4 06 18 AUTO MANEUVER
F 50 18

5 Damp vehicle rates:
ENTR
Disable all jets on two adjacent quads

Wait 20 minutes for rates to damp
AUTO RCS SEL (2)-MNA or MNB as follows:

+ROLL		-ROLL
A1,C1		A2,C2
or B1,D1	or	B2,D2

Remaining AUTO RCS SEL (14) - OFF
MAN ATT (ROLL) - RATE CMD

6 Perform P20, opt-2 (p. G/8-1)
Use 0,0,0 in N78
Use .35°/sec and .5° in N79
Prior to final PRO: cycle CMC
MODE - FREE/AUTO
After one jet firing:
CMC MODE - FREE

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7 Disable RCS and Term. P20
AUTO RCS SEL (16) - OFF
ROT CONTR PWR DIR (2) - OFF (verify)
V56E

To exit G&N PTC to new att:
1. CMC MODE - FREE
2. AUTO RCS SELECT (12) - MNA/B
3. Verify P00
4. CMC MODE - AUTO
(PTC rates will stop)
5. V49E to new att.

PASSIVE THERMAL CONTROL (SCS)

SCS - operating
S/C CONT - SCS
ROT CONTR PWR NORMAL #2 - AC/DC

1 MAN ATT (3) - RATE CMD
LIMIT CYCLE - on(up)
DEADBAND - MIN
RATE - LOW
BMAG MODE (3) - ATT 1/RATE 2

2 AUTO RCS SEL -
Configure for single jet operation
(Wait 20 min to allow rates to damp)

3 FDAI SCALE - 5/1
MAN ATT (ROLL) - ACCEL CMD or MIN IMP
DEADBAND - MAX
RATE - HIGH

4 Enable jet couple in roll
Initiate Desired Roll Rate

5 AUTO RCS SEL (16) - OFF
ROT CONTR PWR DIR (2) - OFF (verify)
BMAG MODE (3) - RATE 2

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ERASABLE LOAD UPDATE

PLANET VECTORS

TERMINATE PTC

AUTO RCS SEL (12) - MNA/B
Null Rates

PITCH ORBIT RATE MANEUVER (G&N)

Note: P20, opt 1 or 5 (p. G/3-1) may also be used to achieve orb rate.

1. Establish initial attitude

2. Perform P20 Opt. 2 (p. G/8-1)

3. To terminate: V56E

PITCH ORBIT RATE MANEUVER (SCS)

ORDEAL - initialized (p G/7-5)
SCS - Operating

1 FDAI SCALE - 5/1

2 Maneuver to desired LCL Vert Att (Roll = 7.25° or 187.25°)

3 BMAG MODE (3) - ATT 1/ RATE 2
DEADBAND - MAX
RATE - LOW
MAN ATT (ROLL, YAW) - RATE CMD
MAN ATT (PITCH) - MIN IMP

4 Establish desired Pitch Rate using MIN IMP & ORDEAL FDAI

5 To terminate:
MAN ATT (PITCH) - RATE CMD

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With active P20 opt. 2, the following MODES of suspension or termination have the affect shown

MODE	DB Centered	DB Source	Rates Nulled
V56E		DAP (R03)	X
V37E00E		DAP (R03)	X
SC CONT-SCS	X	SCS (Return to CMC re-establishes N79 db)	X (Return to CMC re-establishes N79 rate)
CMC MODE-HOLD	Not proper HOLD func. RHC deflection rec-commended for HOLD	N79	(Jet firings pos-sible)
CMC MODE-FREE	X	N79	
RHC deflection	X	N79	X
V46E	X	N79	
V48E, PRO		DAP (R03)	(Jet firings pos-sible)

PTC/ORB RATE

INITIALIZATION PROCEDURES

STAR CHARTS

ALIGNMENTS (P50'S)

DATE 5/24/71

ERASABLE LOAD UPDATE

In the event of PROG ALARM 1107, perform the following:

V74E (Wait 42 sec:HBR) (DUMP E MEMORY)
V36E
V48E (LOAD DAP as DESIRED - use
V46E latest known weights)
V25N07E 77E 10000E 1E (set REFSMFLG)
V1N1E 104E (verify CMOON FLAG and LMOON FLAG)
(BITS 11 AND 12 SHOULD BE 0 IN
EARTH SPHERE and 1 in MOON SPHERE)

Verify E MEMORY (should be done ASAP)

V1N1E
XXXXE (LOAD OID 2 OF UPDATE)
N15E, READ R1, E REPEAT FOR UPDATES A-L

FOR UPDATES M,N and O

V1N1E
1. XXXXE (LOAD EVEN OID'S)
2. READ R1, E (READ ODD OID'S IN R1)
RETURN TO 1

IN CASE OF A DISCREPANCY
LOAD THAT UPDATE AS A NORMAL P27

V37E51E, PRO
V37E00E (Sets drift flag)
OPT ZERO - OFF
OPT ZERO - ZERO

P52-OPTION 3-AUTO OPTICS

AUTO OPTICS SUCCESSFUL, REFSMMAT VALID
AUTO OPTICS UNSUCCESSFUL, DO P51
V16 N65 verify CMC CLOCK (UPDATE)

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TO CHECK STATE VECTOR CALL P21
AND LOAD PRESENT TIME. WHEN COMP CYCLE
IS COMPLETE

V06 N73E
READ R1 (R1 X 10=CURRENT ALT (NM))
COMPARE TO SOME KNOWN VALUE (E.G., FLIGHT PLAN)
IF ANSWER COMPARES - STATE VECTOR IS OK AND
P23 SHOULD BE USED TO IMPROVE IT.
IF GROSS ERRORS ARE OBSERVED, P23 IS UNLIKELY
TO CORRECT THEM. IN THIS CASE PERFORM
V71 LOAD OF LATEST PAD S.V. - SELECT
P00 TO BRING S.V. TO PRESENT TIME.

UPDATES
Col A

			GET
OID	11	00634	30:12
	12	77425	
	~~13~~	~~77317~~	

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6:19 GET

00377

OID	A	B	C	D	E	F	G	H
	V71	V71	V71	V71	V71	V71	V71	V71
01	00021	00013	00012	00011	00023	00023	00024	00024
02	01452	01706	01341	01763	02000	02021	02042	02064
03	03005	00000	00005	01545	00137	00001	77770	00001
04	70750	32251 ~~30560~~	06510	02077	00763	03120	43170	22116
05	77536	26157 ~~10000~~	07025	01571	00023	00001	77725	00334
06	74561	77777	00620	12160	00001	03120	62577	00707
07	77121	67066	00000	03363	00000	00275	00044	77140
10	75031	00000	33260	00233	00000	31473	24360	53571
11	77332	20144	37723	00474	00471	00014	00017	77473
12	77232	37777	01163		00364	03666	25464	47051
13	77317 76664	37777			04400	00135	00131	76500
14	77433				77774	02034	11076	40044

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14	77433				77774	02034	11076	40044

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OID	A	B	C	D	E	F	G	H
	V71	V71	V71	V71	V71	V71	V71	V71
15	77640				51037	00001	00153	76220
16	00000				00011	01566	14761	63735
17	77572				35623	10071	00075	77010
20	00435				77775	77743	17402	61204
21	77731				53053	62121	00400	72766
22					00002	77764	10333	62371
23					31417	57704	77736	01556
24							41353	30733

OID	I	J	K	L	M	N	O	S.V.
	V71	V71	V71	V71	V72	V72	V72	V71
01	00024	00022	00023	00021	00017	00023	00011	
02	02106	02130	03000	03025	00737	02354	00374	
03	00404	75267	00436	37777	37777	00036	00000	
04	36340	65214	02732	00000	01477	02367	01016	
05	02001	64540	00000	00000	00000	00000	00000	
06	13014	52761	00000	54360	02377	02370	01017	
07	07624	14352	77777	21075	00142	33102	00000	
10	10475	14615	77777	37777	03021	02371	01020	
11	04111	05315	42757	60465	01000	00017	00000	
12	34131	32344	10510	00000	03022	02372		
13	12011	61722	06477	54360	00232	00002		
14	35460	77307	74536	21075	03375	02373		

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14	35460	77307	74536	21075	03375	02373		

DATE 7/14/71

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OID	I	J	K	L	M	N	O	S.V.
	V71	V71	V71	V71	V72	V72	V72	V71
15	76250	65167	01515	37777	00000	00005		
16	52231	40623	00100	57142	03376	02374		
17	77704	73251	00123	33106	00000	00005		
20	42605	63661	00175	50741		02375		
21	76611	00522	17433	31162		00026		
22	56670	05467	04500			02376		
23	73016		00334			00003		
24	53455							

LM OR CSM S.V. READOUT

1 V83E

2 After Integration: V05N01E

CSM S.V.		LM S.V.	
2253E		2223E	
E,2256E		E,2226E	
E,2261E		E,2237E	
E,2264E		E,2242E	
E,2333E		E,2333E	
PRO		PRO	

3 Transmit S.V. & Time Tag
To LM

LM OR CSM S.V. LOADING

V37E00E
V71E
21E
1501E
Earth: (CSM S.V.) 00001E, Plus Xmitted Pad
(LM S.V.) 77776E, Plus Xmitted Pad
Lunar: (CSM S.V.) 00002E, Plus Xmitted Pad
(LM S.V.) 77775E, Plus Xmitted Pad
V33E

DATE 3/22/71

DATE 3/22/71

DATE 5/24/71

CSM 6-1.- Venus unit vectors. (July 26 launch date)

Launch day dependent
Launch month dependent

3/7/71 Basic

0 HR GET = 7:26:13:34
LO = 7:26:__:__

VENUS UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
.0	-.40860	.83312	.37277
4.0	-.41188	.83172	.37228
8.0	-.41514	.83032	.37178
12.0	-.41840	.82891	.37128
16.0	-.42166	.82749	.37078
20.0	-.42490	.82605	.37026
24.0	-.42815	.82461	.36975
28.0	-.43138	.82315	.36923
32.0	-.43461	.82169	.36870
36.0	-.43784	.82021	.36817
40.0	-.44105	.81873	.36764
44.0	-.44426	.81723	.36710
48.0	-.44747	.81572	.36656
52.0	-.45067	.81412	.36601
56.0	-.45386	.81268	.36546
60.0	-.45705	.81114	.36490
64.0	-.46023	.80960	.36434
68.0	-.46340	.80804	.36377
72.0	-.46657	.80647	.36320
76.0	-.46973	.80490	.36263
80.0	-.47288	.80331	.36205
84.0	-.47603	.80171	.36146
88.0	-.47917	.80011	.36087
92.0	-.48230	.79849	.36028
96.0	-.48543	.79686	.35968
100.0	-.48854	.79523	.35908
104.0	-.49166	.79358	.35847
108.0	-.49476	.79193	.35786
112.0	-.49786	.79026	.35724
116.0	-.50096	.78858	.35662
120.0	-.50404	.78690	.35600
124.0	-.50712	.78520	.35537
128.0	-.51019	.78350	.35473
132.0	-.51325	.78179	.35409
136.0	-.51631	.78006	.35345
140.0	-.51936	.77833	.35280

VENUS UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
144.0	-.52240	.77658	.35215
148.0	-.52544	.77483	.35150
152.0	-.52847	.77307	.35084
156.0	-.53149	.77130	.35017
160.0	-.53450	.76952	.34950
164.0	-.53751	.76772	.34883
168.0	-.54051	.76592	.34815
172.0	-.54350	.76411	.34747
176.0	-.54649	.76230	.34678
180.0	-.54947	.76047	.34609
184.0	-.55244	.75863	.34539
188.0	-.55540	.75678	.34469
192.0	-.55835	.75492	.34399
196.0	-.56130	.75306	.34328
200.0	-.56424	.75118	.34257
204.0	-.56718	.74930	.34185
208.0	-.57010	.74740	.34113
212.0	-.57302	.74550	.34040
216.0	-.57593	.74359	.33967
220.0	-.57884	.74167	.33894
224.0	-.58173	.73974	.33820
228.0	-.58462	.73780	.33746
232.0	-.58750	.73585	.33671
236.0	-.59037	.73389	.33596
240.0	-.59324	.73192	.33520
244.0	-.59610	.72994	.33444
248.0	-.59895	.72796	.33367
252.0	-.60179	.72596	.33290
256.0	-.60463	.72396	.33213
260.0	-.60746	.72194	.33135
264.0	-.61028	.71992	.33057
268.0	-.61309	.71789	.32978
272.0	-.61590	.71585	.32899
276.0	-.61869	.71380	.32820
280.0	-.62148	.71174	.32740
284.0	-.62427	.70967	.32659
288.0	-.62704	.70759	.32578
292.0	-.62981	.70550	.32497
296.0	-.63257	.70341	.32415
300.0	-.63532	.70130	.32333

CSM 6-2.- Mars, Jupiter, Saturn unit vectors.
(July 26 launch date)

Launch day dependent
Launch month dependent

3/3/71 Basic

0 HR GET = 7:26:13:34
LO = 7:26:__:__

MARS UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	X(R3)
.0	.76546	-.53659	-.35515
20.0	.76334	-.53855	-.35676
40.0	.76118	-.54056	-.35834
60.0	.75899	-.54260	-.35988
80.0	.75680	-.54466	-.36137
100.0	.75461	-.54673	-.36282
120.0	.75243	-.54880	-.36422
140.0	.75027	-.55086	-.36557
160.0	.74814	-.55290	-.36686
180.0	.74603	-.55493	-.36809
200.0	.74395	-.55693	-.36928
220.0	.74189	-.55892	-.37042
240.0	.73984	-.56089	-.37153
260.0	.73780	-.56287	-.37260
280.0	.73575	-.56485	-.37365
300.0	.73366	-.56687	-.37470

JUPITER UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	X(R3)
.0	-.55062	-.77126	-.31935
100.0	-.54975	-.77166	-.31985
200.0	-.54808	-.77257	-.32054
300.0	-.54576	-.77386	-.32138

SATURN UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
.0	.43788	.83768	.32643
40.0	.43565	.83869	.32681
80.0	.43350	.83967	.32716
120.0	.43140	.84061	.32750
160.0	.42937	.84153	.32783
200.0	.42739	.84241	.32815
240.0	.42546	.84327	.32846
280.0	.42357	.84410	.32876

DATE 5/24/71

NASA — MSC

DATE 5/24/71

NASA – MSC