APOLLO 13	
CSM G&C CHECKLIST	
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APOLLO 13

CSM G&C CHECKLIST

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CSM 109

APOLLO FLIGHT DATA FILE

CSM G&C CHECKLIST

Basic 3/9/70 Change 3/27/70

LIST OF EFFECTIVE PAGES

* INDICATES CURRENT CHANGE

PAGE NUMBER	ISSUE
Title	Basic
G/TC-1 thru G/TC-4	Basic
G/1-1 thru G/1-25	Basic
*G/1-26	3/27/70
G/1-27 thru G/1-32	Basic
G/2-1 thru G/2-5	Basic
G/3-1 thru G/3-12	Basic
G/4-1 thru G/4-10	Basic
*G/4-11	3/27/70
G/4-12 thru G/4-18	Basic
G/5-1 thru G/5-15	Basic
G/6-1 thru G/6-10	Basic
G/7-1 thru G/7-7	Basic
*G/8-1	3/27/70
G/8-2	Basic
*G/8-3	3/27/70
G/8-4 and G/8-5	Basic
G/9-1 thru G/9-6	Basic
G/10-1 thru G/10-21	Basic
G/11-1 and G/11-2	Basic
G/12-1 and G/12-2	Basic
G/13-1 thru G/13-4	Basic
*G/13-5 and G/13-6	3/27/70
*G/13-6A (new page)	3/27/70
G/13-7 and G/13-8	Basic

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STAR LIST

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

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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 (N20)
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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NOUN LIST (Decimal)

01	Specify Machine Address (Fract) (R1,R2,R3)	.XXXXX
02	Specify Machine Address (Whole) (R1,R2,R3)	
03	Specify Machine Address (can be R1,R2,R3)	.01°
05	Angular Error/Diff	.01°
06	Option Code (R1 & R2)	OCTAL
07	BIT operator: Address,BIT ID, Action	OCTAL
08	Add +1 of error	OCTAL
	B BANK + SUPERBANK	OCTAL
	No of SELF TEST errors	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
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)	
26	Prio/Delay, ADRES, BBCON(R1,R2 & R3)	OCTAL
27	Self-Test on/off sw	
29	X SM LAUNCH Azimuth	.01°
30	Target Code(Gyrocomp verif)	
32	Time from Perigee	hrs,min,.01sec
33	Time of Ignition (GETI)	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	GETI-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)	.1 NM
	Perigee Alt (HP)	.1 NM
	ΔV (Required)	.1 FPS
43	Lat	.01°
		(+ North)
	Long	.01°
		(+ East)
	Alt	.1 NM
44	Apogee Alt (HA)	.1 NM
	Perigee Alt (HP)(N50)	.1 NM
	TFF	min-sec
45	Marks	XXBXX
	TF GETI of next burn	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	.1 NM
	ΔV	.1 FPS
	SOURCE CODE (1 optics,2 VHF)	0000X.
50	ΔR (miss distance)	.1 NM
	PERIGEE (HP)	.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°

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57	ΔR offset (SOR) (+ indicates behind target)	.1 NM
58	HP alt (post TPI)(SOR for P38)	.1 NM
	ΔV (TPI)(SOR for P38)	.1 FPS
	ΔV (TPF)(SOR FINAL for P38)	.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	.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

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70	Star Code(before mark)		OCTAL
	LMK Data		OCTAL
	Horiz data		OCTAL
71	Star code (after mark)		OCTAL
	LMK Data		OCTAL
	Horiz data		OCTAL
72	Δ ang		.01°
	Δ alt		.1 NM
	Search option		
73	ALT (P21)		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
79	PTC/Orb Rate		.0001°/sec
	PTC/Orb deadband		.01°
	PTC/Orb Code		XXXXX
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
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		.01 NM
90	REND out of	Y	.01 NM
	Plane para	Y DOT	.1 FPS
		PSI	.01°
91	OCDU Angles Shaft (R1)		.01°
	Trunnion (R2)		.001°

ALARM CODES

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92	New OCDU Angles Shaft (R1)	.01°
	Trunnion (R2)	.001°
93	Delta Gyro Angles X,Y,Z	.001°
94	OCDU ANGLES (R56 & R23)	
	R1 SHAFT	.01°
	R2 TRUNNION	.001°
95	Pref att ICDU angles	.01°
96	+X axis att ICDU angles	.01°
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

00112 Mark reject with no marks being accepted
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

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.

00122 Marking not called for
Continue.

00124 P17 (77) TPI search unsuccessful
(G/3-1)

(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 V40 N20E.

(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/1-25 (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
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.

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

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

00406 Rend navigation not operating
Select P20 or continue.

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

00600 No solution on first iteration in P32/72
(G/4-2)

00601 Post CSI Perigee/lune alt <85nm/ 5.8nm
(G/4-2)

00602 Post CDH Perigee/lune alt <85nm/ 5.8nm
(G/4-2)

00603 Time from TIG (CSI) to TIG (CDH) <10 min
(G/4-2)

00604 Time from TIG (CDH) to TIG (TPI) <10 min
(G/4-2)

00605 Number of iterations exceeds loop maximum
(G/4-2,4-7,4-8)

00606 ΔV (CSI) has been >1000 fps for last two iterations
(G/4-2)

00611 No TIG for given ELEV angle
(G/4-4,4-5)

00612 State vector in wrong sphere of influence at TIG
(G/4-7)

00613 Reentry angle out of limits
(G/4-8)

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

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

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

(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
Copy N08, notify MSFN, continue.

(m)01407 VG increasing
(G/5-6,L/7-6) (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

01602 Bad optics during verification
See 01600

01703 Insufficient time for integration.
TIG slipped
(G/5-4,5-14,L/7-5)

(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&N6)

(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.

**21103 Unused CCS branch executed
Copy N08, notify MSFN, initiate V36 recovery

**21204 Negative or zero time waitlist call.
If ave-g 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 device 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 V92 keyed (P07) during P00 or P01 selected and P11 has already been performed
See 21204

*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

*31203 Waitlist overflow - too many tasks
See 31201

*31207 No vac area for marks
Rset
Reselect program
If alarm recurs, consult MSFN.

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

(m) - Malf procedure indicated
**(2xxxx) - Generates restart, F37 (no lt)
*(3xxxx) - Restart (no lt) and program continues (i.e. attempted recovery)

NOTE - All **alarms act as *type if they occur when Ave-g is on

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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
00041	Switch	CM/SM SEP to UP
00062	Key	CMC to STBY
00202	Perform	PGNS AUTO 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
00003	Specify tracking Attitude	1=Preferred, 2=+X-axis
00005	Specify SOR Phase	1=First, 2=Second
00007	Specify Propulsion System	1=SPS, 2=RCS

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FLAG WORD LISTING

TITLE	ADDRESS	BIT	WHEN SET	WHEN RESET
RNDZ	00074	7	P20 initiated	P20 terminated
UPDATE	00075	7	State vector update by marks allowed	State vector updating by marks not allowed
Track	00075	5	RNDZ Tracking allowed	Rendezvous tracking not allowed
Pref Att	00076	4	Pref Att computed	Preferred S/C attitude not computed
Steer	00076	11	Steering to be done	Steering omitted
REFSMMAT	00077	13	REFSMMAT good	REFSMMAT not good
IMU	00074	8	IMU in use	IMU not in use
State Vector	00075	8	CSM State vector updated	LM state vector updated
Terminate	00103	15	Terminate R52,R53	Do not terminate

Trunnion drive	00074	4	Trunnion driven to calculated value	Trunnion driven to ∿50°
Target 1	00075	10	LM sighting	Not sighting LM
Target 2	00075	9	LMK Sighting	Sighting star
W-matrix(RNDV)	00101	1	W-matrix for rendezvous navigation is valid	W-matrix for rendezvous navigation is invalid
W-Matrix (ORB)	00077	6	P22,P23 W-matrix valid	P22,P23, W-matrix invalid
3 axis	00101	6	MNVR Specified by 3 axes	Maneuver specified by 1 axis
External ΔV	00076	8	Ext ΔV VG comp	Lambert VG computations
Active vehicle	00076	5	LM active	CSM active
Final comp.	00076	6	Final RNDZ comp	Interim pass through rendezvous program computations
Sighting mark	00074	6	V51 initiated	V51 not initiated

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Stick flag	00075	14	RHC out of detent	RHC in detent (auto maneuver enabled)
CMOON flag	00104	12	Permanent CSM SV in Lunar Sphere of Influence	Permanent CSM SV in Earth Sphere of Influence
LMOON flag	00104	11	Permanent LM SV in Lunar Sphere of Influence	Permanent LM SV in Earth Sphere of Influence

NON-FLAGS

IMODES 30	1320	9	IMU not operating	IMU operating

OCTAL-TO-BINARY CONVERSION

ABCDE = OCTAL WORD

BINARY BIT SET = 1
RESET = 0

OCTAL DIGIT		A			B			C			D			E		
BINARY BIT		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
OCTAL DIGIT =	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1
	2	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
	3	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
	4	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
	5	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1
	6	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0
	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CHANNEL		ISCMC CORE LOC	NAME	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	60101	L			SHFT PULSE			CP REGISTER L, BITS 16-1									
	2	60102	Q			SHFT PULSE			CP REGISTER Q, BITS 16-1									
	3	60103	HISCALAR			SHFT PULSE			HIGH-ORDER SCALER CHANNEL. BITS 14-1									
	4	60104	LOSCALAR			SHFT PULSE			LOW-ORDER SCALER CHANNEL. BITS 14-1									
OUT	5	60105	PYJETS							S/M →	+X-YW	-X+YW	-X-YW	+X+YW	+X-P	-X+P	-X-P	+X+P
										C/M →	-YW-X+P	+YW-X-P	-YW-X-P	+YW-X+P	-P+Z	+P-X-YW	-P+Z	+P-X+YW
	6	60106	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	60107	SUPERBNK									FE7	FE6	FE5				
OUT	10	60110	OUT0	RELAY ADRS 4	RELAY ADRS 3	RELAY ADRS 2	RELAY ADRS 1	RELAY BIT 11	RELAY BIT 10	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 BIT1
	11	60111	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	60112	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	60113	CHAN13	ENABLE T6RUPT	RESET TRAP 32	RESET TRAP 31B	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	60114	CHAN14	DRIVE CDUX	DRIVE CDUY	DRIVE CDUZ	DRIVE CDU T	DRIVE CDU S	GYRO ACTY	**GYRO c	**GYRO a	**GYRO b	GYRO ENABLE					OUTLINK ACTY
IN	15	60115	MNKEY IN											MKEY5	MKEY4	MKEY3	MKEY2	MKEY1
	16	60116	NAVKEY IN									MARK REJECT	MARK	NKEY5	NKEY4	NKEY3	NKEY2	NKEY1
	30	60130	*CHAN30	TEMP IN LIMITS	ISS TURNON REQUEST	IMU FAIL	ICDU FAIL	IMU CAGE	S/C CONTROL OF SAT	IMU OPERATE		OPTICS CDU FAIL		LIFTOFF	SIV B SEPARATE, OR ABORT	SPS READY	SM/CM SEPARATE	ULLAGE THRUST PRESENT
	31	60131	*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	60132	*CHAN32		PROCEED			LM ATTACHED					MNIM -ROLL	MNIM +ROLL	MNIM -YAW	MNIM +YAW	MNIM -PITCH	MNIM +PITCH
	33	60133	*CHAN33	OSC ALARM	COMPUTER WARNING	PIPA FAIL	DNLK TOO FAST	UPLNK TOO FAST	BLOCK UPLINK					CMC CTR OPTICS	ZERO OPTICS		RNG DATA GOOD	
OUT	34	60134	DNTM1							FIRST OF TWO WORDS								
	35	60135	DNTM2							SECOND OF TWO WORDS								
				15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

* INVERTED LOGIC

**

GYRO SELECT							
a	b	c	GYRO	a	b	c	GYRO
0	0	0/1	No Axis	0	1	1	-X
0	1	0	+X	1	0	1	-Y
1	0	0	+Y	1	1	1	-Z
1	1	0	+Z				

CSM 109

Basic Date 3/9/70

Changed

FLAG WORD & CHANNEL SET/RESET

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

1 V25N 07E

F 21 07 (LOAD FLAG WORD ADDRESS OR CHANNEL NUMBER)E

2 F 22 07 (LOAD CODE FOR BIT TO BE CHANGED)ABCDE ENTR

	A			B			C			D			E		
BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
CODE	4	2	1	4	2	1	4	2	1	4	2	1	4	2	1

3 F 23 07

(SET BIT) Key 1E

(RESET BIT) Key 0E

4 (to Verify) V01 N01E (FLAG Word ADD) ENTR

or V01 N10E (CHANNEL NUMBER) ENTR

5 F 01 01(10) R1 FLAG WORD OR CHANNEL (ABCDE)

R3 FLAG WORD ADDRESS OR CHANNEL NUMBER

EXAMPLE: To cause UPLINK ACTY LT

Key:

V25N 07E This sets bit 3 of

11E Channel 11

4E Verification should show E $\geq$ 4

1E

EXAMPLE: To set REFSMMAT flag:

Key:

V25N 07E This sets bit 13 of

77E flagword 3

10000E Verification should show A odd

1E

Basic Date 3/9/70
Changed

OCTAL-TO-DECIMAL CONVERSION

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

REVIEW DATA IN ERASABLE MEMORY

1 V01 N01E (OCTAL ADD) E

2 F 01 01 R1 DATA R3 OCTAL ADD

3 N15E (For next succeeding word)

4 ENTR (For each succeeding word)

TO CHANGE DATA IN ERASABLE MEMORY

1 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)

MONITOR OF INPUT/OUTPUT CHANNELS

1 V11 N10E

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

Basic Date 3/9/70
Changed

RCS DAP ATT DBD INCREASE

CMC - on
ISS - on & aligned
SCS - operating
RCS DAP ACTIVATED

1 SC CONT - CMC/AUTO

2 V79E

3 F 06 79 RATE, DB, CODE (.0001°/sec, .01°, +XXXXX)
Load R1 = +00000
R2 = Desired Dead Band
(Min: .4°; Max: 30°)
R3 = +00000

4 MAN ATT (R) - ACCEL CMD
MAN ATT (P,Y) - RATE CMD

5 PRO

6 MAN ATT (R) - RATE CMD

7 TO RETURN TO R03 DEADBAND:
V46E (DB center shifted)
or S/C CONT - SCS then CMC (DB center shifted)
or V37EXXE (DB center not shifted)
or V48E
PRO,PRO,PRO (DB center not shifted)

Basic Date 3/9/70
Changed

VHF RNG DSKY DISPLAY

VHF RNG - on (up)
P20 - running

1 V87E
V06 N02E
3703E
R1=XXX.XX nm
(max R1 = 163.83;
if R1 neg, RNG = 327.67 - R1)

CSM 109

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 V30 or 31 inadvertently keyed in:
RECORD N26, NOTIFY MSFN, V74E
Perform General System Checkout

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

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 POO 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

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

f. P00 will be displayed.

g. Key RSET

V41 N91 COARSE ALIGN OCDU's

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

1 V41N 91E

Basic Date 3/9/70
Changed

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2	F 21 92	SHAFT, TRUN NEW OCDU (.01°,.001°) Load desired shaft and trun
3	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		V40 N20E NO ATT lt - off Wait 20 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

Basic Date 3/9/70
Changed

V48 - DAP DATA LOAD & ACTIVATE PROCEDURE

1 V48E

F 04 46 R1 ABCDE*
R2 ABCDE

	VEHICLE CONFIG	QUAD A/C FOR $\ddot{X}$	QUAD B/D for $\ddot{X}$	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 = $\pm 0.5^0$ 1 = $\pm 5.0^0$	0 = 0.05^0/sec 1 = 0.2^0/sec 2 = 0.5^0/sec 3 = 2.0^0/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:
CMC MODE - FREE
V46E

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

Basic Date 3/9/70
Changed 3/27/70

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

V55 - CMC TIME UPDATE

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

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

Basic Date 3/9/70
Changed

V67 - W-MATRIX ERROR DISPLAY

1 V67E

F 06 99 POS ERR,VEL ERR,OPT CODE (ft,.1fps)

R3 00001=Rend
00002=Orbital
00003=Cislunar
00000=No Reinitialization

Load desired data
PRO

V74 CMC DOWNLINK

1 V74E (Places erasable memory on downlink)

V79 - DAP PTC/Orb rate

PTC - pg G/8-2
ORB RATE-pg G/8-4

Basic Date 3/9/70
Changed

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

Basic Date 3/9/70
Changed

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 POO)

V83E (or 85E) - perform routine

V37E OOE

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

1 V87E (starts VHF range sampling)

2 V88E (TERMINATE)

or V37E XXE

Basic Date 3/9/70
Changed

V89 - RENDEZVOUS FINAL ATTITUDE

Note: This routine will change N17 cells
CMC - on
ISS - on
SCS - operating

1		V37E OOE V62E	
2	F 04 06	V89E R1 00003 SPECIFY TRACKING ATTITUDE R2 00001 (PREF) 00002 (+X AXIS) PRO	
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 In ROLL PRO To 5 (BYPASS) ENTR	(.01°)

Basic Date 3/9/70
Changed

V90 - OUT-OF-PLANE DISPLAY

1 V90E

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
PRO

3 F 06 90 Y,YDOT,PSI (.01nm,.1fps,.01°)
(RECYCLE) V32E to 2
(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

Basic Date 3/9/70
Changed

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

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 *

Basic Date 3/9/70
Changed

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
T1:04
Record (X) R1 ____ (Y) R2 ____ (Z) R3 ____ (±XXXAB)

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

CMC POWER UP PROCEDURE

1 PRO, push 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
F04 46 Load 0 (NO DAP) in left digit of R1
PRO
PRO
PRO
V46E

V37E 06E
F 50 25 00062 CMC PWR DN

PRO, push until STBY lt - on

Basic Date 3/9/70
Changed ____

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CMC SELF CHECK

1 V25 N01E, 1365E
F21 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)
* IF PROG lt – On *
* V05 N09E 01102 SELF *
* TEST ERROR *
*N8E-Rec for MSFN *
(TERM) V21N27E OE

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

OPTICS 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)

Basic Date 3/9/70
Changed

CSM 109

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) - AC1
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

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_____°

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
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

Basic Date 3/9/70
Changed

P17 - TPI SEARCH (P77 LM)
CMC - on (req)

1 V37E (17E or 77E)
F 06 37 GETI (TPI) (hrs,min,.01sec)
Load desired GETI
PRO

2 F 06 72 ΔANG(TPI),ΔALT(TPI),SEARCH OPT
(.01°,.1nm,0000X)
R3=SEARCH OPT 00001<180°
00002>180°
(change GETI TPI) V32E to 1
(change Search opt) V23E
PRO
*F 05 09 00124 alarm code *
V32E, RSET to 1 to adjust
*GETI or SEARCH OPTION *

3 F 06 58 HP,ΔV(TPI),ΔV(TPF) (.1nm,.1fps,.1fps)
(RECYCLE) V32E to 1 to adjust
GETI or Search option
PRO

4 F 06 55 R1=Perigee Code, R3=CENTANG(0000X,.01°)
00001, perigee between TPI and TPF
00002, perigee after TPF
(RECYCLE) V32E to 1 to adjust
GETI or Search option
PRO

5 F 37 XXE

Basic Date 3/9/70
Changed

P20 - RENDEZVOUS NAVIGATION

CMC - on (req)
ISS - on and aligned (req)
SCS - on (des)
BMAG MODE (3) - RATE 2
G/N OPT PWR - on (verify)
OPT ZERO - ZERO (verify)
OPT MODE - CMC
Note: For VHF RNG display see p G/1-21

1 V37E 20E
F 50 18 Request MNVR to FDAI RPY angles (.01°)

(AUTO) SC CONT - CMC
CMC MODE - AUTO
PRO
06 18 RPY (.01) to 1 when MNVR complete
(MAN) SC CONT - SCS
PRO To 1
or V62E
RHC - MNVR To 1

When attitude OK:
CMC MODE - AUTO
ENTR
OPTIC ZERO - OFF
*POSS UPLINK ACTY 1t *
*(Mnvr >10° req'd) *
*To reestablish F 50 18 *
* Key V58E *

Basic Date 3/9/70
Changed

2 V57E (SXT)

F 51 OPT MODE - MAN
OHC - Cntr Target in SXT
MARK (repeat as necessary)

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

OPT ZERO - ZERO

PRO (return to program in process)
(To terminate P20 - V56E)

3 V54E (COAS)

F 06 94 SHAFT, TRUNNION (.01°,.001°)
PRO

4 F 53 Request Alt LOS MARK
RHC - ALIGN Target in COAS
ENTR (V86E To reject)
POSS F 06 49 ΔR,ΔV,source code
* (.1nm,.1fps,0000X) *
*(REJECT) V32E *
*(ACCEPT) PRO *

PRO (return to Program in process)
(To Terminate P20 - V56E)

To display N49 for every measurement:
V1 N1E
2002E
Rcrd: R1 _____
V21 N1E
2002E
77776E

To return:
V21N1E
2002E
Load previously recorded value

Basic Date 3/9/70
Changed _____

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°)

Basic Date 3/9/70
Changed

P22 - ORBITAL NAVIGATION

CMC - on (req)
ISS - on and aligned (req)
SCS - on (req)
BMAG MODE (3) - RATE 2
G&N PWR OPTICS - on (verify)
COUPLING - RESOLVED
SPEED - MED
OPT ZERO - ZERO (verify)
OPT MODE - CMC
To remove rate limit: V21N1E,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

Basic Date 3/9/70
Changed

CSM 109

```
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 (ORB PARA)              (.1nm,.1fps)
          (RECYCLE) V32E to 2
          (ACCEPT) Hold for 30 sec
               PRO
```

Basic Date 3/9/70
Changed

CSM 109

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

10 F 37 XXE
OPT ZERO - ZERO
To restore rate limit (CDU transient detection): V21N1E,1341E,5E

P23 OPTICS CALIBRATION

CMC - on
OPT ZERO - ZERO (verify)
OPT MODE - MAN

1 V37E 23E (IMU NOT ALIGNED - to 3)
F 05 70 STAR ID(ABCDE)/LMK ID/HOR ID
Insure R1 DE≠00, R2=00000, R3=00XX0
(X=1 or 2)
PRO

2 F 50 25 00202 MNVR/CALIB REQUEST
ENTR

3 F 59 PERFORM OPTICS CALIB
OPT MODE - MAN (verify)
OPTICS COUPLING - DIRECT
SPEED - LOW
OPT ZERO - OFF
SUPERIMPOSE LLOS TO SLOS
MARK

4 F 06 87 R2 TRUNNION ANGLE BIAS (.001°)
(repeat until 2 measurements agree within .003°)
For manual load:
V22 N94E
XXXXXE
(ACCEPT) PRO
(REJECT) MARK to 4

5 F 51 V37E XXE
OPT ZERO - ZERO

Basic Date 3/9/70
Changed

P23 - CISLUNAR MIDCOURSE NAV MEASUREMENT

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

1 V37E 23E

2 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 5 (DE=00 to 4)
STAR/LMK PRO

3 F 06 89 LAT, LONG/2, ALT (LMK) (.001°+N/E, .01nm)
PRO (DE≠00 to 5)

4 F 06 88 CELESTIAL BODY VECTOR
LOAD DESIRED VECTOR
PRO

5 F 50 25 00202 MNVR/CALIB REQUEST
(MNVR) PRO
(CALIB) ENTR to 8

Basic Date 3/9/70
Changed

CSM 109

6	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 7 (MAN) V62E MNVR to 6 (BYPASS) ENTR to 8 (CALIB COMPLETED to 10)
7	06 18	AUTO MNVR FDAI R, P, Y (.01°) AUTO MNVR COMPLETE RETURN TO 6
8	F 59	REQUEST OPTICS CALIB (BYPASS) OPT MODE - CMC (verify) OPT ZERO - OFF ENTR to 10 (CALIB) OPT MODE - MAN OPT COUPLING - DIR SPEED - LOW OPT ZERO - OFF SUPERIMPOSE LLOS ON SLOS MARK
9	F 06 87	R2 TRUN BIAS (.001°) For manual load: V22 N94E XXXXXE (RECALIB) MARK to 9 (INCORP CALIB) OPT MODE-CMC PRO
10	06 92	AUTO OPT SHF/TRUN (.01°,.001°) (MNVR) V94E to 6 (MARK) MNVR SC TO POSITION LMK/HOR IN FOV OPT MODE - MAN

Basic Date 3/9/70
Changed

11 F 51
MARK REQUEST
(MNVR)* V94E to 6
(MARK)
SUPERIMPOSE STAR ON LMK/HOR MARK

12 F 50 25
00016 TERM MARKS
(REJECT) MARK REJECT to 11
(TERM) PRO

13 F 05 71
R1 000DE STAR ID
R2 00C00 LMK ID
R3 00CDO HOR ID

(STAR/HOR) PRO to 16 (DE=00 to 15)
(STAR/LMK)PRO to 14

14 F 06 89
LAT, LONG/2 ALT(LMK) (.001°+N/E,.01nm)
PRO (DE≠00 to 16)

15 F 06 88
CELESTIAL BODY VECTOR
Verify vector
PRO

16 F 06 49
ΔR ΔV (SV PARA) (.1nm,.1 fps)
(REJECT) V37E 23E
(UPDATE) PRO

17 F 37

* If this is first P23 MARK since last:
CSM S.V. Uplink
or P20
or Reinitialization of P23 W-matrix by V93 or V67
or Alarm code 421

Then key V93E prior to mark

Basic Date 3/9/70
Changed

P27 CMC UPDATE

CMC - on (req)

Auto Update:

1 V37E 00E

UP TLM (2) - ACCEPT

UPLINK ACTY lt - on

POSS LOS before completion
*If V33 N02 showing: *
* Key ENTR *
* UPLINK ACTY lt - out *
* P00 displayed *
*If V21 N01 *
*or V21 N02 *
* Key V34E *
* UPLINK ACTY lt - out *
* P00 displayed *
*UP TLM (2) - BLOCK *

Update complete:

UPLINK ACTY lt - out

V37E 00E

UP TLM (2) - BLOCK

Basic Date 3/9/70
Changed

CSM 109

Voice Transmission Update:

1 V37E 00E

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

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 Displayed

Basic Date 3/9/70
Changed

P30 EXTERNAL ΔV

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

1		V37E 30E	
	F 06 33	GETI	(hrs,min,.01sec)
		Load desired GETI	
		PRO	
2	F 06 81	ΔVXYZ(LV)	(.1fps)
		Load desired ΔV's	
		PRO	
3	F 06 42	HA,HP,ΔV(REQ)	(.1nm,.1nm,.1fps)
		Set ΔV Counter	
		PRO	
4	F 16 45	M,TFI,MGA	(MKS,min-sec,.01°)
		Set DET	
		PRO (MGA Set to -00002 IF REFSMMAT FLAG NOT SET)	
5	F 37		

P31 GENERAL LAMBERT PRETHRUST

TARG PARAMS - LOADED FROM GND (P27)

1		V37E 31E	
	F 06 33	GETI	(hrs,min,.01sec)
		Load desired GETI	
		PRO	
2	F 06 81	ΔVXYZ(LV)	(.1fps)
		PRO	
3	F 06 42	HA,HP,ΔV(REQ)	(.1nm,.1nm,.1fps)
		Set ΔV Counter	
		PRO	

4 F 16 45 M,TFI,MGA (MKS,min-sec,.01°)
Set DET
PRO (MGA Set to -00002 IF
REFSMMAT FLAG NOT SET)

5 F 37

P32 CSI PRETHRUST (P72 LM)

1 V37E (32E or 72E)
F 06 11 TIG (CSI) (hrs,min,.01sec)
PRO

2 F 06 55 APSIS CDH,TPI ELEVATION ANGLE,(+0000N,.01°)
CENTRAL ANGLE,Passive Vehicle (ω t)
(For CDH N π from CSI, load non-zero
in R3)
PRO

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

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

```
*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 1 Adjust        *
*         Inputs                *
```

PRETHRUST(P30's & 70's)

Basic Date 3/9/70
Changed

CSM 109

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

6 F 06 81 ΔV XYZ(LV)CSI (.1fps)
(For Out-of-Plane Corr in Final Comp ONLY)
V90E
F 04 12 R1 00002 Specify Vehicle
R2 00001 CSM
00002 LM
PRO
F 06 16 GET EVENT (hrs,min,.01sec)
PRO
F 06 90 Y,YDOT,PSI (.01nm,.1fps,.01°)
Record Y DOT _____
PRO
Insert -Y DOT in R2 of ΔV (CSI)
PRO

7 F 06 82 ΔV XYZ(LV)CDH (.1fps)
PRO (If Recycling to 4)

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

9 F 37

P72 - Transmit mnvr Parameters to LM

P33 CDH PRETHRUST (P73 LM)

1 V37E (33E or 73E)
F 06 13 TIG(CDH) (hrs,min,.01sec)
PRO

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

Basic Date 3/9/70
Changed _____

```
                    *F 05 09 00611 NO TIG FOR*
                    *       SPECIFIED ANGLE *
                    *  (REDO)V32E to 1      *
                    *       PRO to 3        *
                    *CMC will use last      *
                    *  calculated value of  *
                    *  TIG (TPI)            *
```

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

4 F 06 81 ΔV XYZ(LV)CDH (.1fps)
(For Out-of-Plane Corr in Final Comp ONLY)
V90E
F 04 12 R1 00002 Specify Vehicle
R2 00001 CSM
00002 LM
PRO
F 06 16 GET EVENT (hrs,min,.01sec)
PRO
F 06 90 Y,YDOT,PSI (.01nm,.1fps,.01°)
Record Y DOT
PRO
Insert -Y DOT in R2 of ΔV (CDH)
PRO (If Recycling to 2)

5 F 16 45 MARK,TFI,MGA (marks,min-sec,.01°)
SET EVENT TIMER TO TFI
PRO (MGA Set to -00002 If No
REFSMMAT Set or If P73)

6 F 37

P73 - Transmit mnvr Parameters to LM

P34 TPI PRETHRUST (P74 LM)

1 V37E (34E or 74E)
F 06 37 TIG (TPI) (hrs,min,.01sec)
Load desired TIG
PRO

Basic Date 3/9/70
Changed

CSM 109

2 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

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

F 05 09 (00611 NO SOL)
*PRO To 1 *

4 F 06 37 TIG (TPI) (hrs,min,.01sec)
(IF ELEV ANGLE COMPUTED BY CMC
THIS DISPLAY WILL BE REPLACED
BY F 06 55 AS IN 2 ABOVE)
PRO

5 F 06 58 HP,ΔV(TPI),ΔV(TPF) (.1nm,.1fps,.1fps)
PRO (If Recycle - To 7)
(If Final - To 6)

6 F 06 81 ΔVXYZ(LV)TPI (.1fps)
PRO

Basic Date 3/9/70
Changed

7	F 06 59	ΔVXYZ(LOS)TPI	(.1fps)
		PRO (If Recycle - To 3)	
8	F 16 45	MARKS,TFI,MGA	(marks,min-sec,.01°)
		PRO (MGA SET To -00002 IF NO REFSMMAT SET or If P74)	
9	F 37		
		P74 - Transmit Mnvr Parameters To LM	

P35 TPM PRETHRUST (P75 LM)

1		V37E (35E or 75E)	
	F 16 45	MARK,TFI,-00001	(marks,min-sec)
		(RECYCLE) V32E To 3	
		(FINAL PASS) TERM MARKS	
		PRO	
2	F 06 81	ΔVXYZ(LV)TPM	(.1fps)
		PRO	
3	F 06 59	ΔVXYZ(LOS)TPM	(.1fps)
		PRO (If Recycle - To 1)	
4	F 16 45	MARKS,TFI,MGA	(marks,min-sec,.01°)
		PRO (MGA SET TO -00002 IF NO REFSMMAT SET or If P75)	
5	F 37		
		P75 - Transmit Mnvr Parameters To LM	

Basic Date 3/9/70
Changed

P37 RETURN TO EARTH PGM

(LONG CONTROL CANNOT BE DONE WHEN TIME TO ENTRY IS <4 HRS)

Perform the following once:
V1N1E
3376E
Verify R1= 01603(1185.6nm)

1 V37E 37E
F 06 33 TIG (hrs,min,.01sec)
Load desired TIG
PRO

2 F 06 60 BLANK,ΔV DESIRED, GAMMA EI DESIRED
Load desired ΔV: (fps,.01°)
PAD ΔV IF ON TLC
0. IF ON TEC
Load R3=0
R2 XXXXX
PRO

*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 F 06 61 IMPACT LAT, IMPACT LONG (.01°)
If Impact LONG <12° from desired:
Record Impact LONG as θc1 _____.____°
PRO
If Impact LONG>12° from desired:
TEC:N40E Record R2 as ΔVmin___fps
V32E to 1 & use |ΔV| >ΔV min
ΔV neg to move LONG WEST
ΔV pos to move LONG EAST

TLC: V32E to 1
Decrease ΔV to move LONG WEST
Increase ΔV to move LONG EAST

Basic Date 3/9/70
Changed

CSM 109

4 F 06 39 ΔT TRANSFER (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 ΔVXYZ(LV) at TIG
Record R3 as ΔVzcl= _____.___ fps
N40E
Record R2 as ΔVcl=_____fps
KEY RLSE
PRO

*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		*

7 F 06 61 IMPACT LAT,IMPACT LONG (.01°)
Record LONG as θpl =_____.____°
If θ pl, acceptable, PRO to step 15

PRO

8 F 06 39 ΔT TRANSFER
PRO

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

Basic Date 3/9/70
Changed

10 F 06 81 ΔVXYZ(LV) at TIG
Record R1 as ΔVxpl= _____.___ fps
Record R3 as ΔVzpl= _____.___ fps
N40E
R2 XXXX.X Record as ΔVpl =_____.____fps
V32E to 11

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
TEC: Load ΔVc2 =-ΔVc1-10
TLC: Load ΔVc2 =ΔVc1-10
To move EAST from θpl
TLC or TEC: Load ΔVc2=ΔVc1+10
Record ΔVc2_____fps
R2 XXXXX.
PRO
F 05 09 SAME AS IN 2
*V32E. RSET to 11 *

Basic Date 3/9/70
Changed _____

13 F 06 61 IMPACT LAT, IMPACT LONG (.01°)
Record LONG as θc2 = _____.___°

Compute K:

N81E Record R3 as

ΔVcz2= _____.___ fps

$$K = \left| \frac{\theta c2 - \theta c1}{\Delta Vzc2 - \Delta Vzc1} \right|$$

K= +. _____

Compute Δ θLONG = θd - θpl = ± _____.___°
Obtain from chart ΔVo= ± _____ fps
Make sign of ΔVo same as Δ θLONG
Compute ΔVd:
ΔVzd = ΔVzpl + ΔVo

$$\Delta Vd = (\Delta Vzd^2 + \Delta Vxpl^2)^{1/2}$$

Make sign of ΔVd same as ΔVzd

ΔVd = _____

Basic Date 3/9/70
Changed

14 V32E to step 1 & use ΔVd in R2 of N60
(Step 2)

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

17 F 06 81 ΔVXYZ(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 if not performed just
prior to P37 call
PRO

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

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

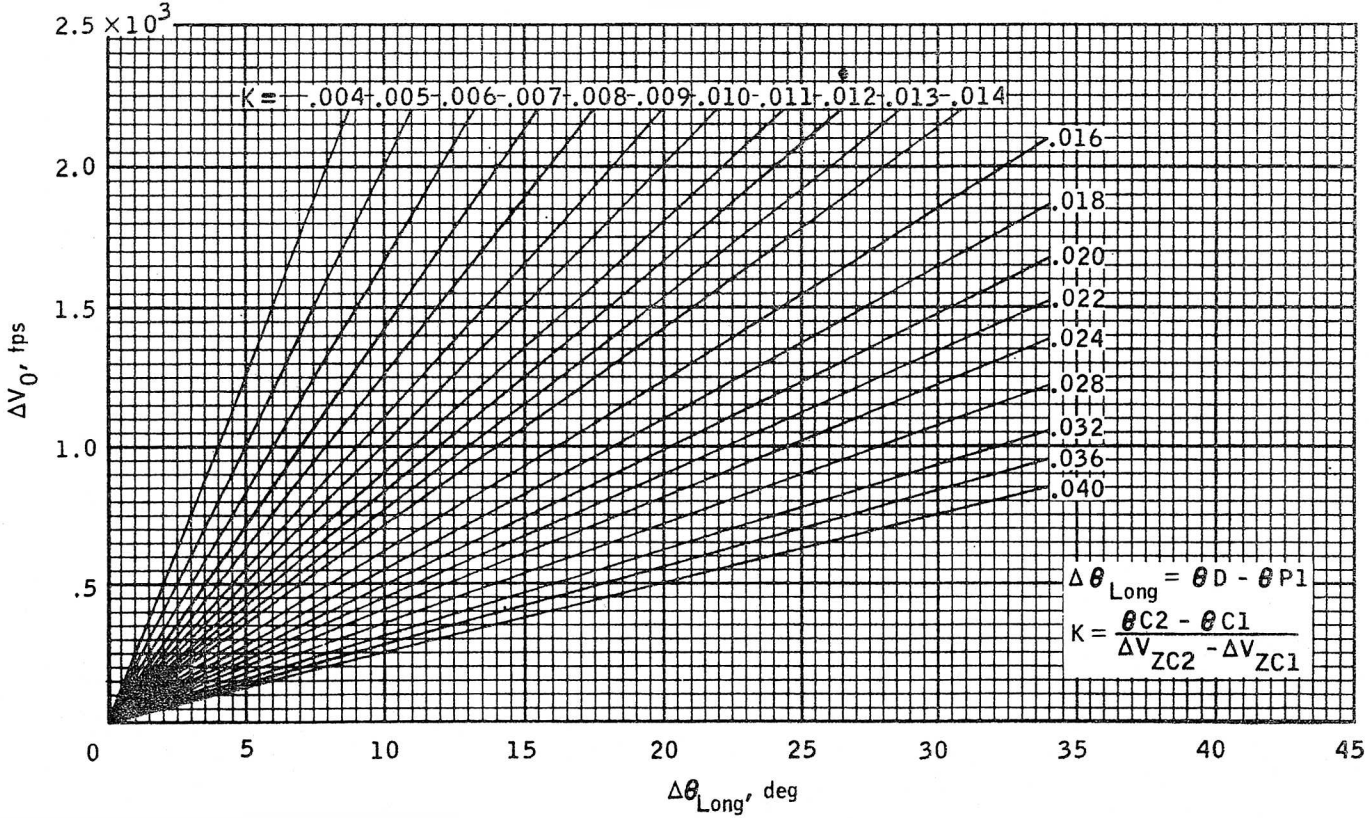
21 F 37 (40E or 41E)

Basic Date 3/9/70
Changed 3/27/70

OBTAIN ENTRY REFSMMAT (No Comm)

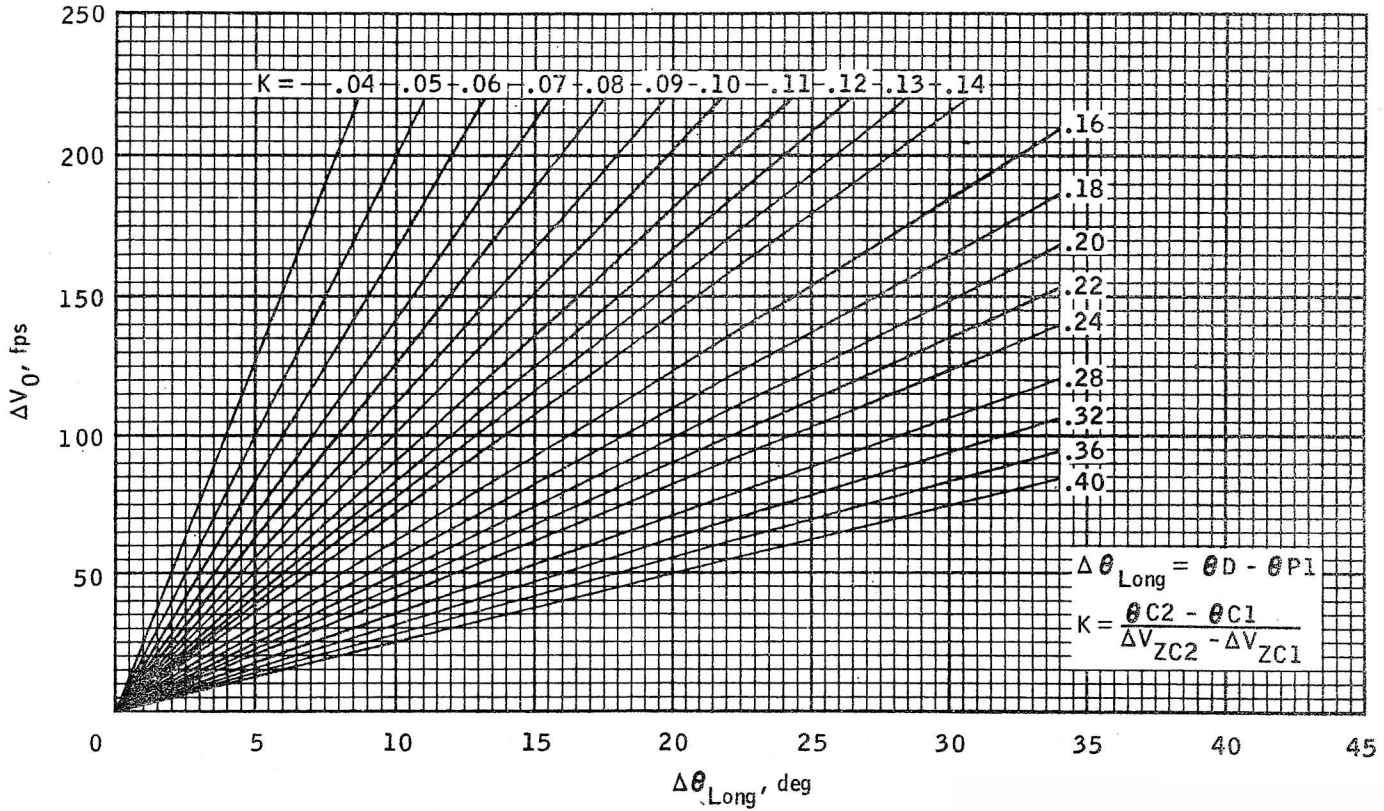
1. Record 400K time from final P37 solution (Step 1 TIG + FNL N39)
2. Use 400K time for T-align P52 (Option 2).
   NOTE: P37 MCC used to compute T-align must be performed prior to step 2.

Basic Date 3/9/70
Changed



ΔV_0 versus $\Delta\theta_{Long}$, K = .04 to .004.

ΔV_0 vs $\Delta\theta$LONG



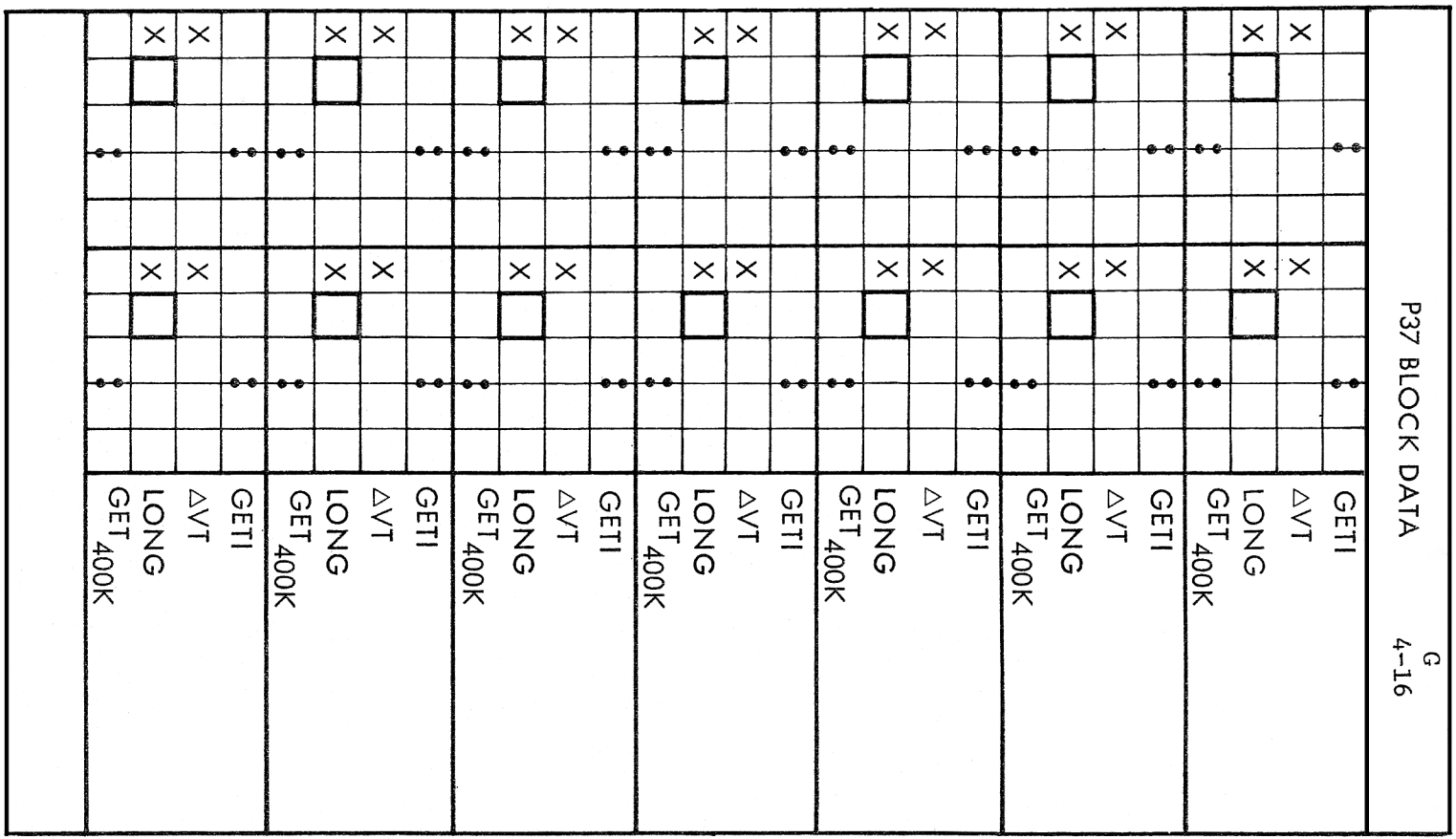
ΔV_0 versus $\Delta\theta_{Long}$, K = .4 to .04.

CSM 109

Basic Date 3/9/70
Changed _____

P37 BLOCK DATA	G 4-15
	GETI
X	ΔVT
X	LONG GET 400K
	GETI
X	ΔVT
X	LONG GET 400K
	GETI
X	ΔVT
X	LONG GET 400K
	GETI
X	ΔVT
X	LONG GET 400K
	GETI
X	ΔVT
X	LONG GET 400K
	GETI
X	ΔVT
X	LONG GET 400K
	GETI
X	ΔVT
X	LONG GET 400K

Basic Date 3/9/70
Changed



CSM 109

Basic Date 3/9/70
Changed

P38 SOR TARGETING (P78 LM)

1		V37E (38E or 78E)
	F 06 33	TIG (SOR) (hrs,min,.01sec) Load desired TIG PRO
2	F 06 55	R3 ωt (.01°) Load desired ωt PRO
3	F 04 06	R1 00005 Specify Phase Option R2 0000X X=1 or 2 PRO (To 6 If R2=2)
4	F 06 57	ΔR SOR (.1nm) Load desired ΔR PRO
5	F 06 34	SOR TIME (hrs,min,.01sec) PRO
6	F 16 45	MARK,TFI,-00001 (mark,min-sec,.01°) (RECYCLE) V32E (FINAL PASS) PRO (Terminate Marks)
7	F 06 58	HP(SOR),ΔV(SOR),ΔV(SOR-FINAL) PRO (.1nm,.1fps,.1fps)
8	F 06 81	ΔVXYZ(LV) (.1fps) PRO (If Recycle - To 6)
9	F 16 45	MARKS,TFI,MGA (marks,min-sec,.01°) PRO (MGA SET TO -00002 IF NO REFSMMAT SET OR P78)
10	F 37	

P78 - Transmit Mnvr Parameters To LM

Basic Date 3/9/70
Changed

CSM 109

P39 STABLE ORBIT MID (P79 LM)

1 V37E (39E or 79E)

2 F 16 45 MARK,TFI,-00001 (mark,min-sec,.01°)
(RECYCLE) V32E
(FINAL PASS) PRO (Terminate Marks)

3 F 06 81 ΔVXYZ(LV) (.1fps)
PRO (If Recycle - To 2)

4 F 16 45 MARK,TFI,MGA (mark,min-sec,.01°)
PRO (MGA SET TO -00002
IF NO REFSMMAT SET or P79)

5 F 37

P79 - Transmit Mnvr Parameters To LM

P76 - TARGET ΔV

1 V37E 76E
F 06 33 TIG (hrs,min,.01sec)
Load TIG
PRO

2 F 06 84 ΔV XYZ (.1fps)
Load ΔV
PRO

3 F 37 00E

V82E (check LM parameters)

4 F 04 12 R1 00002 Specify vehicle
Load R2 - 00002
PRO

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

6 F 16 44 HA,HP,TFF (.1nm,min-sec)
R3 - 59B59HP > 49.4nm/35K ft
PRO

Basic Date 3/9/70
Changed

CSM 109

P40-SPS THRUSTING

Check for water in tunnel area
Prethrust Program Complete
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
PUGS MODE - NORMAL
OXID FLOW v1v - PRI
BMAG MODE (3) - RATE 2
CMC MODE - FREE
AUTO RCS SELECT(16)-as req'd
LOAD DAP
ROT CONTR PWR NORM (2) - AC/DC
Set DET

V37E 00E
SC CONT - CMC/AUTO

MNVR TO PAD BURN ATT

1 V62E

2 V49E

3 F 06 22 DESIRED FINAL GMBL ANGLES (.01°)
LOAD MNVR PAD GMBL ANGLES
PRO

Basic Date 3/9/70
Changed

THRUSTING (P40's)

4	F	50	18	REQ MNVR TO FDAI RPY ANGLES (.01°) (AUTO) PRO (MAN) SC CONT - SCS MNVR To 6	
5		06	18	AUTO MNVR TO FDAI RPY ANGLES (.01°)	
6	F	50	18	REQ TRIM TO FDAI RPY ANGLES (.01°) (AUTO TRIM) PRO To 5 (BYPASS) ENTR	
7				BORESIGHT & SXT STAR CHECK OPT MODE - CMC OPT ZERO - OFF	
8				V41 N91E	
9	F	21	92	SHAFT, TRUN (.01°,.001°) LOAD SXTS angles	
10		41		OPTICS DRIVE CHECK SXT STAR OPT ZERO - ZERO CHECK BORESIGHT STAR (If avail)	
11				V37E 40E	
12	F	50	18	REQUEST MNVR TO FDAI RPY ANGLES (.01°) (AUTO) BMAG MODE (3) - RATE 2 SC CONT - CMC/AUTO PRO To 13 (MAN/DAP) BMAG MODE (3) - RATE 2 SC CONT - CMC/HOLD MNVR To 14 (MAN/SCS) SC CONT - SCS MNVR To 14	
13		06	18	AUTO MNVR TO FDAI RPY ANGLES (.01°)	

Basic Date 3/9/70
Changed

CSM 109

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

TVC CHECK & PREP
cb STAB CONT SYS (Pnl 8) - close
cb SPS (12) - close
SET ΔVC (verify)
EMS FUNCT - ΔV (verify)
MAN ATT (3) - RATE CMD
LIMIT CYCLE - on (up)
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.

Basic Date 3/9/70
Changed

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
(BYPASS) BMAG MODE (3) - ATT1/RATE 2 (verify)
ENTR

15 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

16 06 40 TFI, VG, ΔVM (min-sec,.1fps)
PROG ALARM - TIG Slipped
*V5N9E 01703 *
*KEY RLSE TO 16 *

FDAI SCALE - 5/5
LIMIT CYCLE - OFF
RATE - HIGH
UPDATE DET
SPS He vlvs (2) - AUTO (verify)

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

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

Basic Date 3/9/70
Changed

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

59:XX ULLAGE AS REQ
(-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 19
EXIT - V37E 00E

17 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

Basic Date 3/9/70
Changed

*PROG ALARM *
V5 N9E 01407 VG INC
*LOI & TEI: *
* THC-CW, FLY MTVC *
*DOI & MCC: *
* ΔV THRUST A&B-OFF*

00:XX ECO

*EMER SPS CUTOFF: *
ΔV THRUST A&B - OFF
*LOI - BT +10 sec *
*DOI - BT +1 sec *
*TEI - BT +2 sec & *
* ΔV CTR <-40 fps *

18 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

19 F 16 85 VG XYZ (CM) (.1fps)
NULL RESIDUALS (TEI & MCC)
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
cb DIRECT ULLAGE (2) - open
cb SPS P1 & Y1 - open
BMAG MODE (3) -RATE 2
PCM BIT RATE - LOW
PRO

Basic Date 3/9/70
Changed _____

CSM 109

20 F 37 V82E

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

R3-59B59HP >49.4 nm/35K ft

PRO

22 F 37 00E

23 When COMP ACTY lt not on continuously:
V66E (If LM S.V. not needed)

BURN STATUS REPORT

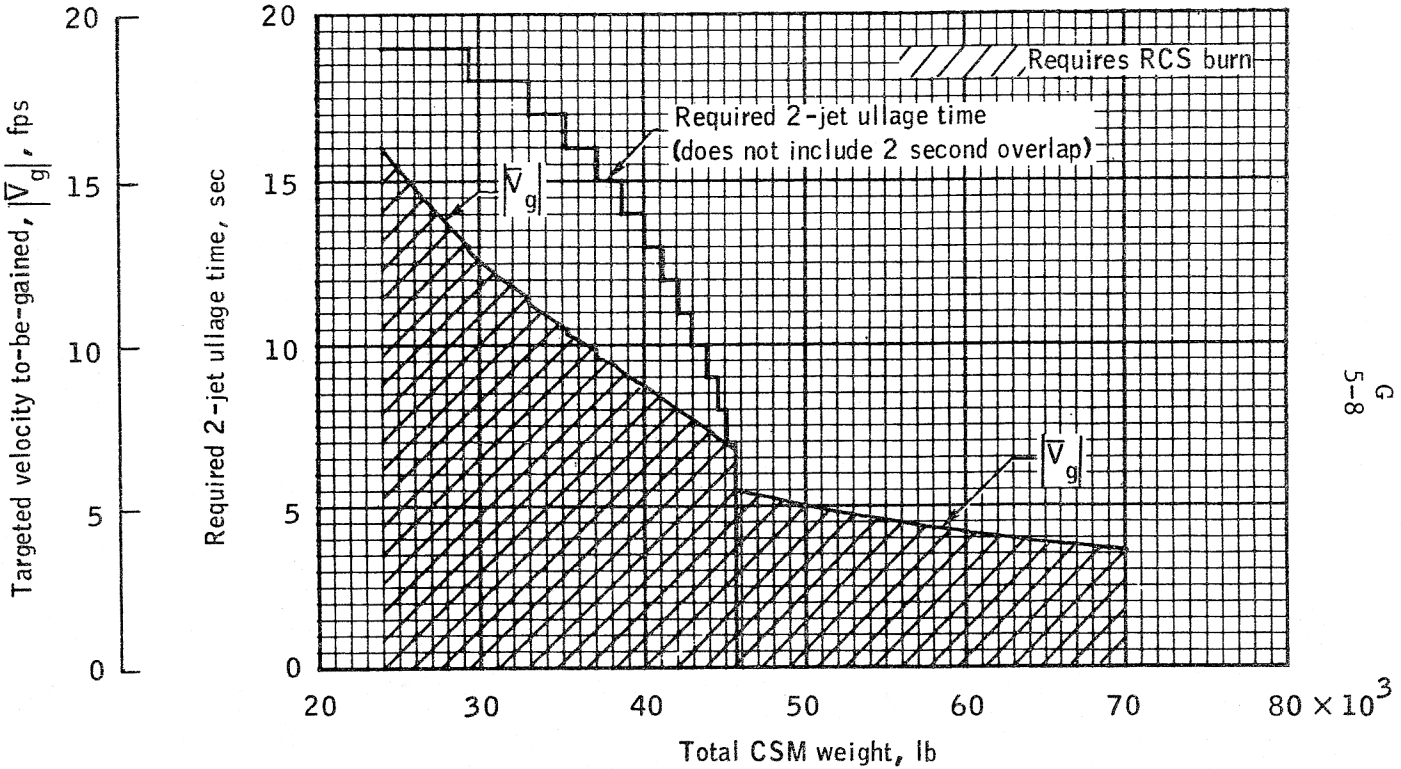
_____ ΔTIG	_____ VI
_____ BT	_____ HDOT
_____ VGX	_____ H
_____ R	_____ ΔVC
_____ P	_____ FUEL
_____ Y	_____ OXID
	_____ UNBAL

REMARKS

Basic Date 3/9/70
Changed _____

CSM 109

SPS vs RCS CRITERIA

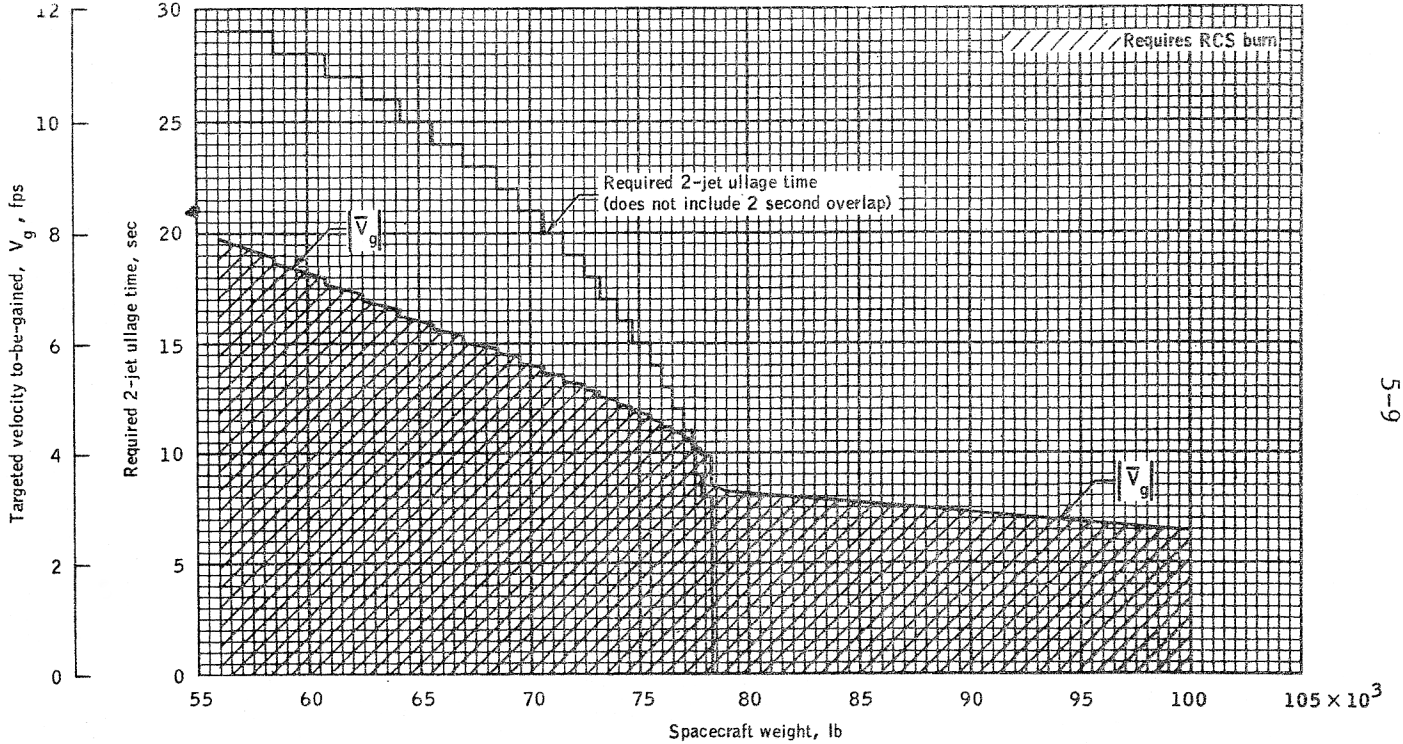


SPS versus RCS criteria (CSM alone).

CSM 109

Basic Date 3/9/70
Changed _____

Basic Date 3/9/70
Changed

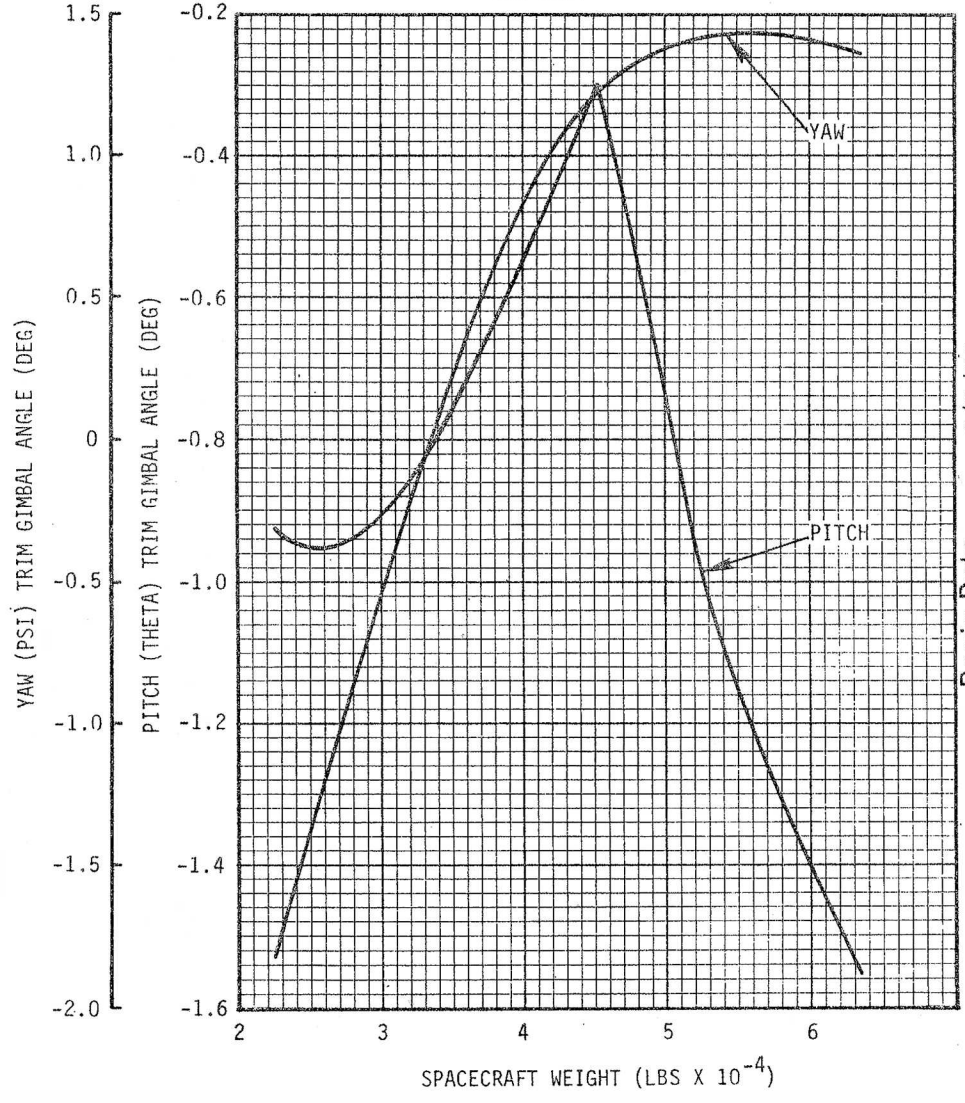


SPS versus RCS criteria (CSM/LM docked)

GIMB ANGS vs WT

GIMB ANGS vs WT

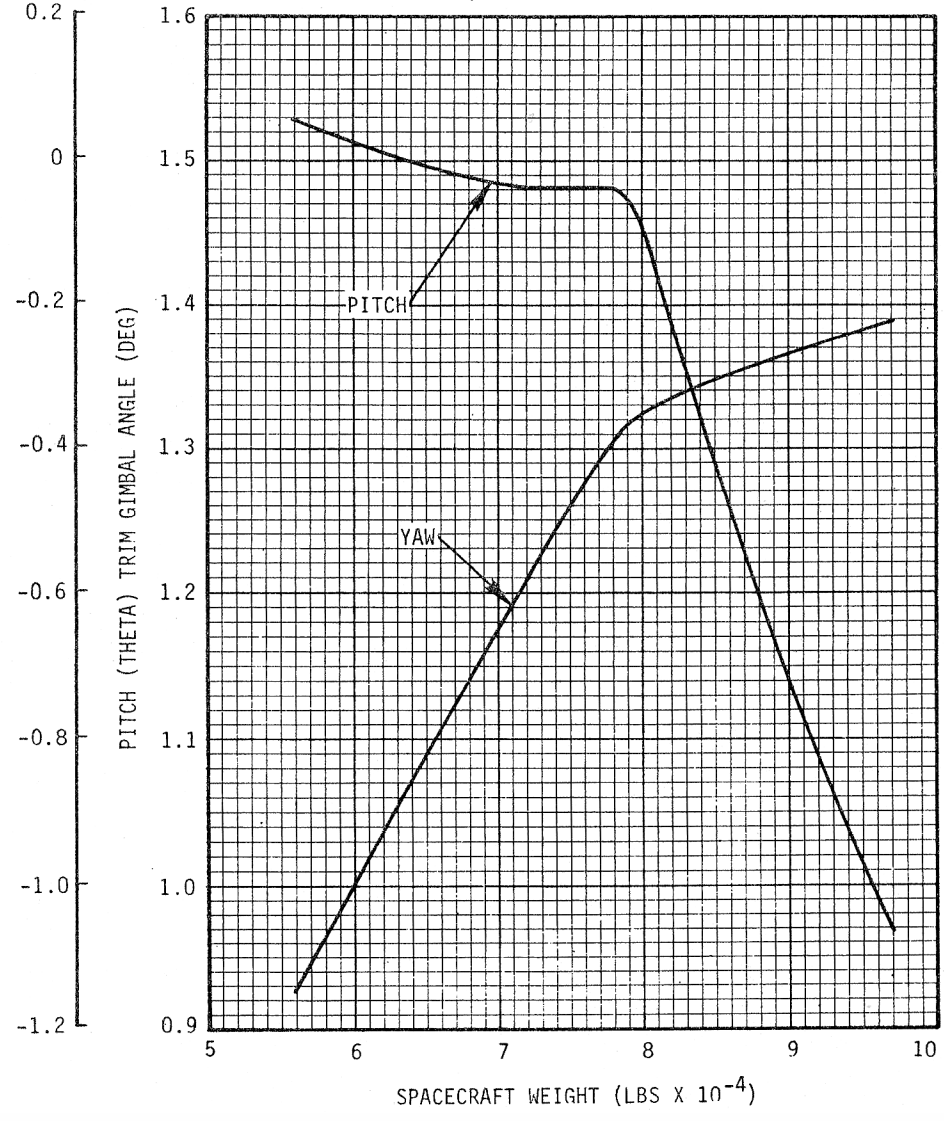
CSM 14-2 SPS ENGINE TRIM GIMBAL ANGLES
VERSUS SPACECRAFT WEIGHT
CSM ONLY



Basic Date 3/9/70
Changed

CSM 109

CSM 14-1 SPS ENGINE TRIM GIMBAL ANGLES
VERSUS SPACECRAFT WEIGHT
CSM/LM DOCKED



Basic Date 3/9/70
Changed

CSM 109

P41 - RCS THRUSTING

Prethrust Program Complete
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
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
V62E

2 V49E

3 F 06 22 DESIRED FINAL GMBL ANGLES (.01°)
LOAD MNVR PAD GMBL ANGLES
PRO

Basic Date 3/9/70
Changed

4	F	50	18	REQ MNVR TO FDAI RPY ANGLES	(.01°)
				(AUTO) PRO	
				(MAN) SC CONT - SCS	
				MNVR To 6	
5		06	18	AUTO MNVR To FDAI RPY ANGLES	(.01°)
6	F	50	18	REQ TRIM To FDAI RPY ANGLES	(.01°)
				(AUTO TRIM) PRO To 5	
				(BYPASS) ENTR	
7				BORESIGHT & SXT STAR CHECK	
				OPT MODE - CMC	
				OPT ZERO - OFF	
8				V41 N91E	
9	F	21	92	SHAFT, TRUN	(.01°,.001°)
				LOAD SXTS angles	
10		41		OPTICS DRIVE	
				CHECK SXT STAR	
				OPT ZERO - ZERO	
				CHECK BORESIGHT STAR (If avail)	
11				V37E 41E	
12	F	50	18	REQUEST MNVR TO FDAI RPY ANGLES	(.01°)
				(AUTO) BMAG MODE (3) - RATE 2	
				SC CONT - CMC/AUTO	
				PRO To 13	
				(MAN/DAP) BMAG MODE (3) - RATE 2	
				SC CONT - CMC/HOLD	
				MNVR To 14	
				(MAN/SCS) SC CONT - SCS	
				MNVR To 14	
13		06	18	AUTO MNVR TO FDAI RPY ANGLES	(.01°)

Basic Date 3/9/70
Changed

14 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 To 13
(BYPASS) ATT DB - MIN
RATE - LOW
MAN ATT (3) - RATE CMD
BMAG MODE (3) - ATT1/RATE 2
GDC ALIGN
ENTR

15 06 85 VG X,Y,Z (.1fps)

* PROG Alarm 1t *
* V5N9E - 01703 - TIG SLIPPED *
* KEY RLSE To 15 *

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

59:25
(-00:35) DSKY BLANKS

59:30
(-00:30)
16 16 85 VG X,Y,Z (AVE G ON)
TAPE RCDR - HBR/RCD/FWD/CMD RESET
LIMIT CYCLE - OFF
EMS MODE - NORMAL

00:00
17 F 16 85 VG X,Y,Z
NULL COMPONENTS
RECORD ΔV COUNTER & RESIDUALS ΔVC_____
TAPE RCDR - off (ctr) VGX_____
PCM BIT RATE - LOW VGY_____
HAND CONTROLLERS - LOCKED VGZ_____
EMS FUNC - OFF
EMS MODE - STBY
TRANS CONT PWR - OFF
BMAG MODE (3) - RATE 2
PRO

Basic Date 3/9/70
Changed

18 F 37 V82E

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

* R3-59B59 HP>49.4 nm/35K ft *

PRO

20 F 37 00E

21 When COMP ACTY lt not on continuously:
V66E (If LM S.V. not needed)

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 XXE

Basic Date 3/9/70
Changed

CSM 109

P51 - IMU ORIENTATION

CMC - on
ISS - on
SCS - operating
BMAG MODE (3) - RATE 2
G/N PWR OPTICS - on (verify)
OPT ZERO - ZERO (verify)
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°)
(RECYCLE) V32E to 1
(ACCEPT) PRO

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

Basic Date 3/9/70
Changed

CSM 109

ALIGNMENTS (P50's)

P52 IMU REALIGN

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

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)
(hr,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
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
Load vector
PRO to 8 after 1st MARK
to 15 after 2nd MARK

Basic Date 3/9/70
Changed

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

(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
OPT ZERO - ZERO
XXE

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
PRO

4 F 53 PLEASE MARK
Center Target
ENTR

Basic Date 3/9/70
Changed

CSM 109

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°)
(RECYCLE) V32E to 1
(ACCEPT) PRO

9 F 37 XXE

Basic Date 3/9/70
Changed

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)
(hr,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

10   F 06 94   ALT LOS OPT ANGS SHAFT, TRUN(.01°,.001°)
          Load angles
          PRO

11   F 53      PLEASE MARK
          Center Target
          ENTR

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

Basic Date 3/9/70
Changed

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

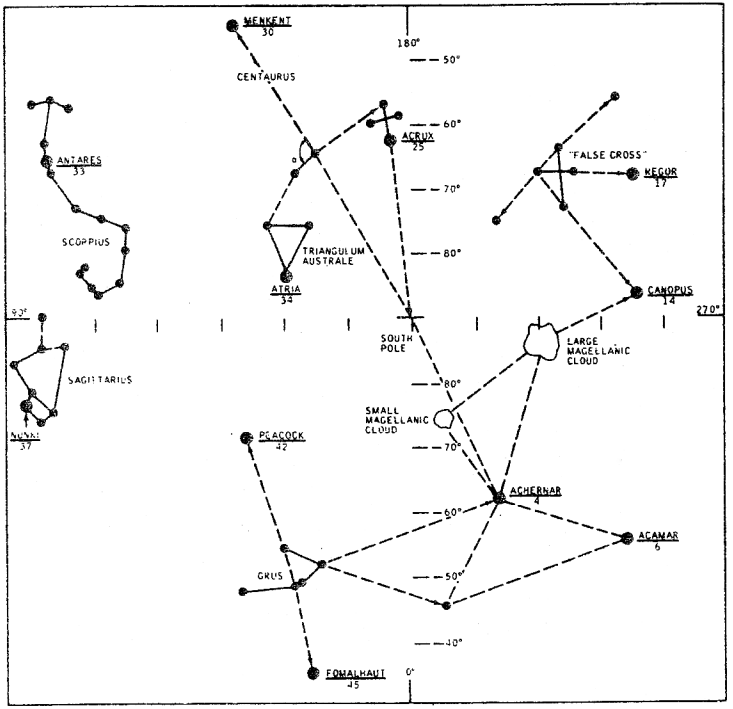
15 F 06 05 STAR ANGLE DIFFERENCE (.01°)
(REJECT) V32E to 17
(ACCEPT) PRO

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

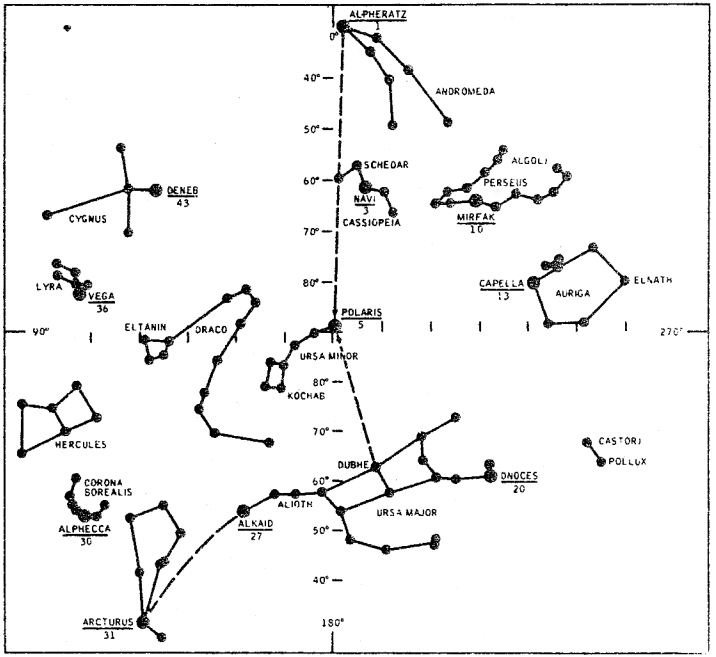
17 F 50 25 00014 ALIGNMENT CHECK
(RECHECK) PRO to 7
(BYPASS) ENTR

18 F 37 XXE

Basic Date 3/9/70
Changed



SOUTHERN STARS

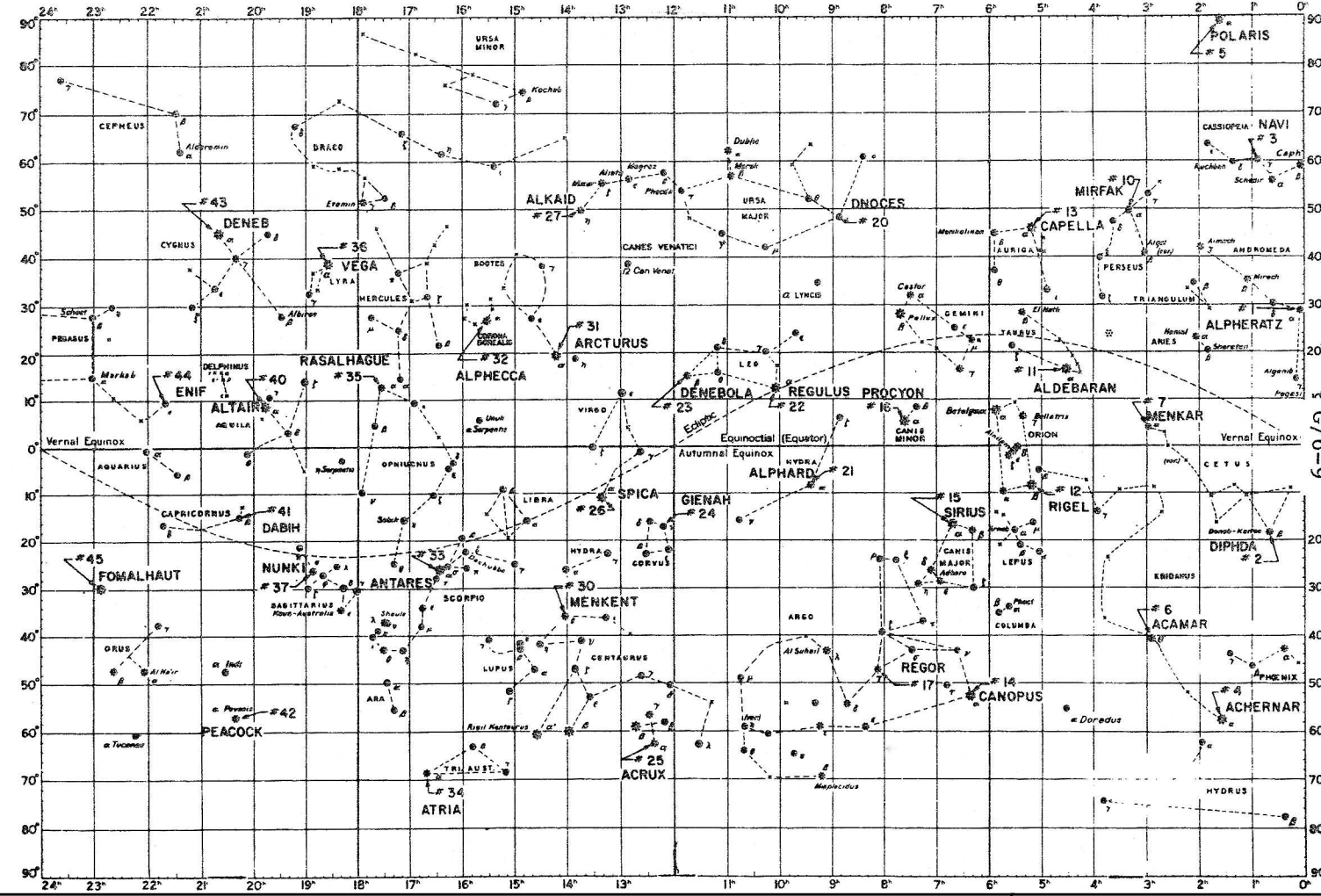


NORTHERN STARS

CSM 109

Basic Date 3/9/70

Changed _____


POLARIS
#5
URSA MINOR
Kochab
CEPHEUS
Alderamin
DRACO
Eltanin
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DENEB
CYGNUS
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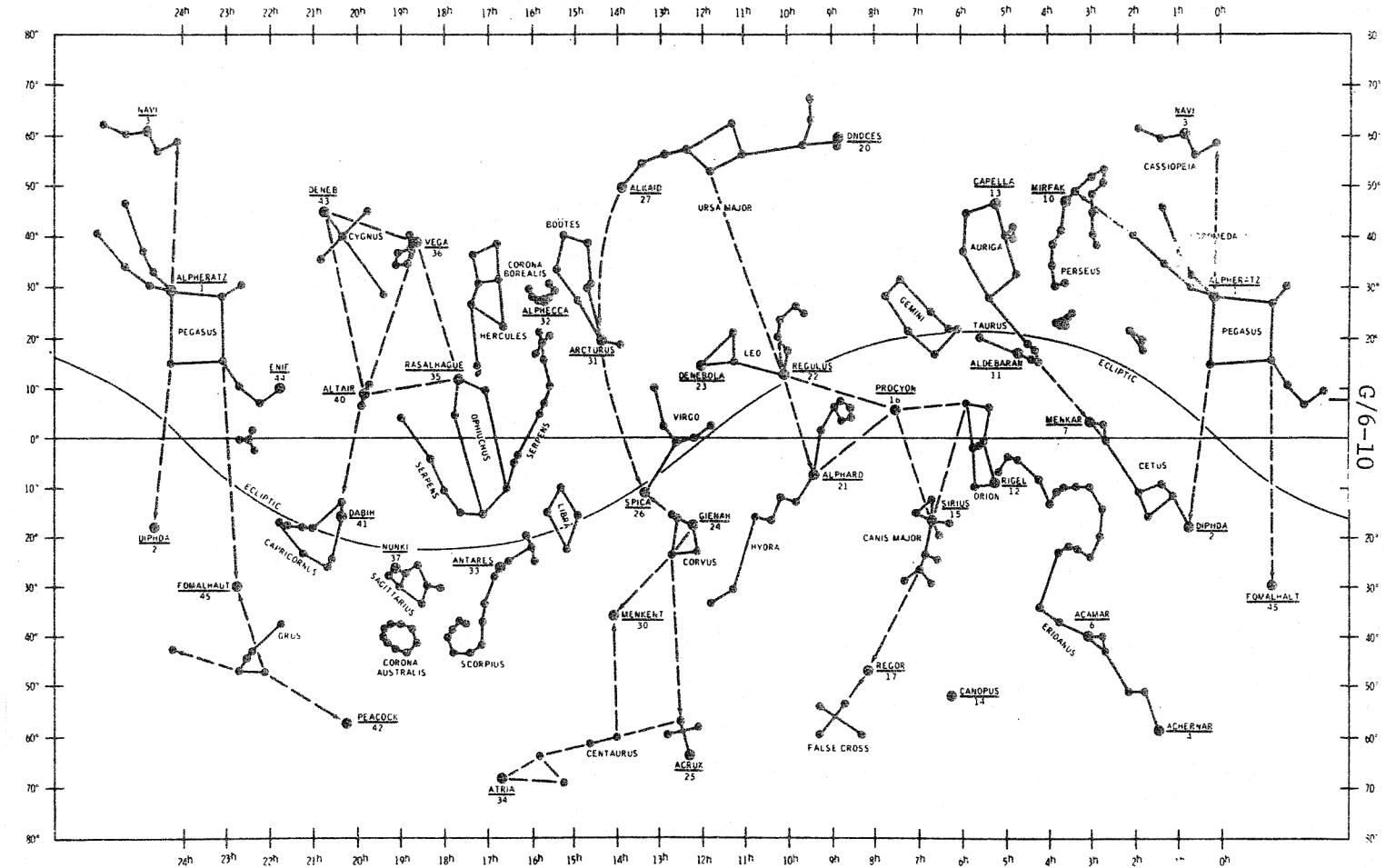
VEGA
LYRA
Albireo
Sadr
PEGASUS
Markab
#44
ENIF
DELPHINUS
#40
ALTAIR
AQUILA
#35
RASALHAGUE
OPHIUCHUS
Unuk
Sarin
Sabik
#41
DABIH
CAPRICORNUS
AQUARIUS
Vernal Equinox
#45
FOMALHAUT
GRUS
Al Nair
Peacock
#42
PEACOCK
Tucanae
#37
NUNKI
SAGITTARIUS
Kaus Australis
Shaula
#33
ANTARES
SCORPIO
ARA
Rasalgethi
TRIANGULUM AUST.
#34
ATRIA
LUPUS
Rigil Kentaurus
CENTAURUS
#25
ACRUX
#30
MENKENT
HYDRA
CORVUS
#26
SPICA
LIBRA
#24
GIENAH
Ecliptic
Equinoctial (Equator)
Autumnal Equinox
#23
DENEBOLA
LEO
#22
REGULUS
VIRGO
#32
ALPHECCA
CORONA BOREALIS
#31
ARCTURUS
BOOTES
Izar
ALKAID
#27
Mizar
Alioth
Megrez
Phecda
Dubhe
Merak
URSA MAJOR
DNOCES
#20
CANES VENATICI
12 Can Venat
α LYNCIS
Castor
Pollux
GEMINI
PROCYON
#16
CANIS MINOR
ALPHARD
#21
HYDRA
#15
SIRIUS
CANIS MAJOR
Adhara
LEPUS
Rigel
ORION
Betelgeuse
Bellatrix
#12
RIGEL
#11
ALDEBARAN
TAURUS
Menkalinan
#13
CAPELLA
AURIGA
#10
MIRFAK
PERSEUS
Algol (var)
CASSIOPEIA
#3
NAVI
Caph
Ruchbah
Schedir
ANDROMEDA
Almach
Mirach
TRIANGULUM
#7
MENKAR
ARIES
Hamal
Sheratan
ALPHERATZ
Algenib
Pegasi
CETUS
Menkar (var)
Baten Kaitos
#2
DIPHDA
ERIDANUS
#6
ACAMAR
PHOENIX
#4
ACHERNAR
HYDRUS
ARGO
Al Suhail
COLUMBA
Phact
#17
REGOR
#14
CANOPUS
Canopus
Miaplacidus
Naos
Avior
Suhail
Markeb
Sadalmelik
Deneb Algedi
Nashira
Dabih
Fomalhaut
Enif
Altair
Tarazed
Alshain
Sadr
Gienah
Algorab
Spica
Vindemiatrix
Zavijava
Denebola
Regulus
Algieba
Rasalhague
Alphecca
Arcturus
Izar
Kochab
Pherkad
Alkaid
Mizar
Alioth
Megrez
Phecda
Merak
Dubhe
Dnoces
Capella
Menkalinan
Mirfak
Algol
Atik
Hamal
Sheratan
Mesarthim
Alpheratz
Caph
Schedir
Ruchbah
Navi
Polaris
Diphda
Menkar
Acamar
Achernar
Canopus
Rigel
Aldebaran
Alnilam
Alnitak
Mintaka
Betelgeuse
Bellatrix
Sirius
Adhara
Procyon
Pollux
Castor
Alhena
Wezen
Aludra
Naos
Suhail
Avior
Miaplacidus
Regor
Phact
Alphard
Ecliptic
Equinoctial (Equator)
Autumnal Equinox
Vernal Equinox
G/G-6

STAR CHARTS



G/9-10

CSM 109

Basic Date 3/9/70

Changed _____

RAPID IMU REALIGN

NOTE: This procedure assumes a good GDC alignment

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

2 V40 N20
Verify R,P,Y on GDC Ball - ENTR
(Releases Platform And Recovers PGNS Control Modes)

3 V25 N7E, 76E,
40000E, 1E (Sets Drift Flag)

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

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)

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

4 F 06 89 LAT, LONG/2,ALT (LOAD R1: +35000 FOR +ΔVy or -35000 FOR -ΔVy)

5 F 06 22 NEW ICDU ANGLES

6	F	50	25	R=00013 CMC MODE-FREE ENTR TO GYRO TORQUE
7		16	20	UNTIL TORQUING COMPLETE
8	F	50	25	R1=00014 ALIGNMENT CHECK 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)
14	F	06	34	GET ALIGN (LOAD TIME OBTAINED FROM MSFN)
15	F	06	89	LAT, LONG/2,ALT (LAT WILL BE CHANGED BACK TO STORED RLS)
16	F	06	22	NEW ICDU ANGLES
17	F	50	25	R=00013 CMC MODE-FREE ENTR TO START TORQUING
18		16	20	UNTIL TORQUING COMPLETE
19	F	50	25	R1=00014 ALIGNMENT CHECK PRO (TO SELECT 2 STARS IF TIME PERMITS) ENTR (TO LEAVE P52)

INITIALIZATION PROCEDURES

Basic Date 3/9/70
Changed

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 - Arcturus (31)
R line - Denebola (23)

or

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

Basic Date 3/9/70
Changed

CSM 109

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

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

6 V37E XXE

Basic Date 3/9/70
Changed

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

Basic Date 3/9/70
Changed

CSM 109

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 - ZERO (verify)

1		V37E 52E	
2	F 04 06	00003 PRO	
3	F 50 25	00015 ENTR	
4	F 01 70	000DE STAR CODE LOAD BORESIGHT STAR CODE OPT ZERO - OFF PRO	
5	06 92	SHAFT, TRUN Center target MARK with VERB key Record SHAFT, TRUN ____,____ (REPEAT) KEY RLSE (EXIT) V37E XXE OPT ZERO - ZERO	(.01°,.001°)

Basic Date 3/9/70
Changed

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)

DOCKED IMU ALIGN

ATT DB - MIN
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 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)

GENERAL V79 PROPERTIES

1 Max att DB: 30°
Min att DB: .4°

2 Max rate: 8.9999°/sec
Min rate: 0 may be loaded but forced firing will occur unles appropriate jet is disabled

3 To Terminate V79 PTC/ORB RATE:
Select one of the following ACTIONS then enable all necessary jets via AUTO RCS SELECT and MAN ATT sw's

EFFECT / ACTION	ZERO COMMANDED RATE	RETURN TO D.B. SPECIFIED IN R03	ZERO ATTITUDE ERROR
V46E	X	X	X
CYCLE S/C CONT SW - CMC-SCS-CMC	X	X (D.B.Center Shifted)	X
CMC MODE-HOLD	X		X
V37EXXE	X	X (D.B. Center not shifted)	
KALCMANU	*		X
RHC out-of-detent	X		X
V48E, PRO, PRO, PRO		X (D.B. Center not shifted)	

*KALCMANU Generates new commanded rates

Basic Date 3/9/70
Changed 3/27/70

PTC/ORB RATE

CSM 109

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 F 50 18	AUTO MANEUVER
5		Damp vehicle rates: ENTR Disable all jets on two adjacent quads Wait 20 minutes for rates to damp MAN ATT (PITCH & YAW) - ACCEL CMD MAN ATT (ROLL) - RATE CMD
6		V79E
7	F 06 79	Rate,Deadband,Code(.0001°/sec,.01°,+XXXXX) Load desired values in R1 and R2 and +00000 in R3 Enable all jets PRO
8		MAN ATT (ROLL) - ACCEL CMD MAN ATT (PITCH & YAW) - RATE CMD

PTC/ORB RATE

Basic Date 3/9/70
Changed

CSM 109

9 To disable RCS:
AUTO RCS SEL (16) - OFF
ROT CONTR PWR DIR (2) - OFF

To exit G&N PTC

1. MAN ATT (3) - ACCEL CMD
   AUTO RCS SEL (12) - MNA/B
2. Verify DAP load
3. Select new desired att:
   V49E
   F 06 22 New ICDU angles
   SC CONT - SCS, then CMC
   PRO
   F 50 18
4. Start auto manevuer:
   PRO within 180° (in direction of roll)
   of new att
   MAN ATT (3) - RATE CMD

For simple termination: See "GENERAL V79 PROPERTIES"

Basic Date 3/9/70
Changed 3/27/70

PASSIVE THERMAL CONTROL (SCS)

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

1 DEADBAND - MIN
RATE - LOW
LIMIT CYCLE - ON(up)
MAN ATT (3) - RATE CMD
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 DEADBAND - MAX
MAN ATT (ROLL) - ACCEL CMD or MIN IMP
FDAI SCALE - 5/1

CSM 109

4 Initiate Desired Roll Rate

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

TERMINATE PTC

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

PITCH ORBIT RATE MANEUVER (G&N)

Note: V79 orb rate is designed to operate most efficiently at 7.25° roll. A roll angle of 180° will yield the proper rate for low values (∿.05°/sec) but will use ∿ 6 times as much fuel as roll=0°.

1 V79E

2 F 06 79 RATE, DB, CODE (.0001°/sec,.01°,+XXXXX)
Load desired values in R1&R2
& non-zero in R3
PRO

3 To Terminate: See "GENERAL V79 PROPERTIES"

Basic Date 3/9/70
Changed

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

Basic Date 3/9/70
Changed

ERASABLE LOAD UPDATE

IN THE EVENT OF PROG ALARM 1107 PERFORM THE
FOLLOWING:
V74E (WAIT 3 MIN) (DUMP E MEMORY)
V36E
V48E (LOAD DAP AS DESIRED - USE
V46E LATEST KNOWN WEIGHTS)
V25N07E 77E 10000E 1E (SET REFSMMAT)
V1N1E 104E (VERIFY CMOON FLAG AND LMOON FLAG)
(BITS 11 and 12 should be 0 in
EARTH SPHERE AND 1 IN MOON SPHERE)
P52-OPTION 3-AUTO OPTICS
AUTO OPTICS SUCCESSFUL, REFSMMAT
VALID
AUTO OPTICS UNSUCCESSFUL, DO P51
V16 N65 VERIFY CMC CLOCK (UPDATE)

VERIFY E MEMORY (MAY BE USED WHEN DESIRED)
V1N1E
XXXXE (LOAD OID 2 OF UPDATE)
N15E, READ R1,E REPEAT FOR UPDATES A-L

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

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

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.

OID	A	B	C	D	E	F	G
	V71	V71	V71	V71	V71	V71	V71
01	00021	00015	00010	00013	00023	00023	00024
02	01452	01706	01345	01767	02000	02021	02042
03	77316	00011	06510	00001	00137	00001	00003
04	74561	03366	07025	24315	00763	03120	02526
05	77143	11000	00620	00000	00023	00001	00015
06	74705	30623	00000	22274	00001	03120	00107
07	77667	37367	27340	00552	00000	00311	00022
10	71220	00000	37723	02210	00000	31177	35751
11	77646	23066		25231	00471	77700	00012
12	77332	00000		12160	00364	55774	24655
13	76617	26474		03363	04400	77762	00077
14	00710	37777			77772	55732	25776

CSM 109 Basic Date 3/9/70
Changed _____

CSM 109

Basic Date 3/9/70

Changed _____

OID	A	B	C	D	E	F	G
	V71	V71	V71	V71	V71	V71	V71
15	00023	37777			46750	00011	77747
16	00665				77773	14374	50503
17	77731				57473	11272	77764
20	00000				00006	77767	75066
21	77615				06361	77461	00010
22					00002	00006	32477
23					26244	07520	77616
24							55641

OID	H	I	J	K	L	M	S.V.
	V71	V71	V71	V71	V71	V72	V71
01	00024	00024	00022	00023	00021	00017	
02	02064	02106	02130	03000	03025	00110	
03	77703	02200	00104	00436	37777	01164	
04	50475	26131	30027	02732	00000	01341	
05	77433	10341	17316	00000	00000	00005	
06	73503	33317	12110	00000	54360	01477	
07	77501	77034	07464	77777	21075	00000	
10	77051	65247	05025	77777	37777	02377	
11	77621	77617	03227	42757	60465	00142	
12	53532	73321	30062	11463	00000	03021	
13	76161	77302	67162	05605	54360	01000	
14	64227	43346	44435	74133	21075	03022	

CSM 109

Basic Date 3/9/70

Changed _____

CSM 109

Basic Date 3/9/70
Changed _____

OID	H	I	J	K	L	M	S.V.
	V71	V71	V71	V71	V71	V72	V71
15	00476	67237	16760	00075	37777	00232	
16	02346	71001	16057	00005	57142	03376	
17	00213	73231	06373	00123	33106	01603	
20	01672	43753	07034	00175	50741		
21	00643	72065	00531	17433	31162		
22	27314	42562	10621	04500			
23	04076	00471		00334			
24	21423	15165					

LM OR CSM S.V. READOUT

1 V83E

2 After Integration : V05N01E

CSM S.V.

2254E

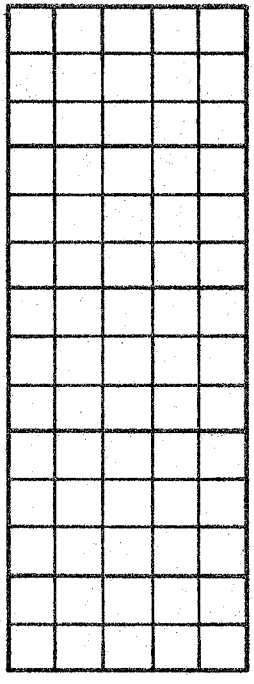
E,2257E

E,2262E

E,2265E

E,2342E

PRO



LM S.V.

2224E

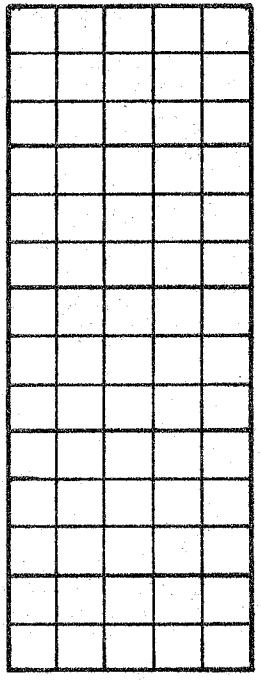
E,2227E

E,2240E

E,2243E

E,2342E

PRO



3 Transmit S.V. & Time Tag
To LM

LM OR CSM S.V. LOADING

1 V37E00E
V71E
21E
1501E
(CSM S.V.) 00002E, Plus Xmited Pad
(LM S.V.) 77775E, Plus Xmited Pad
V33E

Basic Date 3/9/70
Changed

CSM 109

I. Loss of communications navigation procedures for abort from translunar coast at 8:00 hrs GET.

A. Make abort burn

B. Reinitialize the W matrix. Use extended verb 67 and at the V06N99 display, load:

R1 + 80000 (80,000 ft)
R2 + 00070 (7 ft/sec)
R3 + 00003 (Cislunar Navigation Code)

C. Determine the return length and look at the corresponding table below in H for the schedule to be followed. For all return lengths less than 20 hours, Schedule 1 should be used. For all return lengths greater than 20 hours, Schedule 2 should be used.

D. Times given for each batch of data are referenced to entry interface. (P-37 may be used to determine the time reference.)

E. Start tracking with the first batch of data following the current time.

F. Calibrate optics at the beginning of each batch and every half hour while navigation sightings are in progress. The sextant calibration will be repeated until agreement of at least two checks (not necessarily sequential ones) are within 1 bit (.003°).

G. Large ΔR, ΔV values may be expected at the following times:

1. At the initiation of tracking (the first mark on each star of the first batch of data taken).

2. After a long period of no sightings.

3. During the last 6 hours before entry interface.

If a large state vector correction (greater than 50 nautical miles in position and 50 feet per second in velocity) is displayed during the V06N49 display in P23, the mark should be rejected, the star reselected, and the mark repeated. If the large correction occurs again, it should be accepted and incorporated.

H. Sighting schedules for aborts from translunar coast at 8:00 hours GET due to a communications loss

TLC ABORT

Table I

Sighting Schedule for an Abort from Translunar Coast
at 8:00 Hours, Short Return (GMT of EI=April 12, 17 hrs., 57 min.)

Time	Star	Horizon	R3
EI-14	33 (Antares)	EF	00120
	37 (Nunki)	EF	00120
	44 (Enif)	EN	00110
	* 45 (Formalhaut)	EN	00110
	*125	EF	00120
EI-11.5	37 (Nunki)	EF	00120
	44 (Enif)	EN	00110
	45 (Formalhaut)	EN	00110
	* 77	EF	00120
	*125	EF	00120
EI-9	37 (Nunki)	EF	00120
	44 (Enif)	EN	00110
	77	EF	00120
	* 45 (Formalhaut)	EN	00110
	* 76	EF	00120
EI-7	37 (Nunki)	EF	00120
	44 (Enif)	EN	00110
	77	EF	00120
	* 45 (Formalhaut)	EN	00110
	*221	EN	00110
EI-5	37 (Nunki)	EF	00120
	2 (Diphda)	EN	00110
	214	EF	00120
	44 (Enif)	EN	00110
	224	EN	00110
EI-2.5	1 (Alpheratz)	EN	00110
	2 (Diphda)	EN	00110
	126	EN	00110
	*224	EN	00110
	*223	EN	00110

Basic Date 3/9/70
Changed

CSM 109

* Alternate Sightings

Table II

Sighting Schedule for an Abort from Translunar Coast
at 8:00 Hours, Long Return (GMT of EI=April 13, 18 hrs., 32 min.)

EI-	Star	Horizon	R3
EI-38	33 (Antares)	EF	00120
	45 (Formalhaut)	EN	00110
	44 (Enif)	EN	00110
	* 40 (Altair)	EN	00110
EI-35	33 (Antares)	EF	00120
	37 (Nunki)	EF	00120
	45 (Formalhaut)	EN	00110
	44 (Enif)	EN	00110
	40 (Altair)	EN	00110
EI-27	37 (Nunki)	EF	00120
	45 (Formalhaut)	EN	00110
	77	EF	00120
	44 (Enif)	EN	00110
	76	EF	00120
EI-24	37 (Nunki)	EF	00120
	44 (Enif)	EN	00110
	76	EF	00120
	* 45 (Formalhaut)	EN	00110
	* 77	EF	00120
EI-21	37 (Nunki)	EF	00120
	44 (Enif)	EN	00110
	77	EF	00120
	* 45 (Formalhaut)	EN	00110
	*212	EF	00120
EI-12	37 (Nunki)	EF	00120
	2 (Diphda)	EN	00110
	214	EF	00120
	42 (Peacock)	EF	00120
	126	EN	00110
EI-9.5	37 (Nunki)	EF	00120
	2 (Diphda)	EN	00110
	214	EF	00120
	* 40 (Altair)	EF	00120
	*126	EN	00110

*Alternate Sightings

Basic Date 3/9/70
Changed

CSM 109

Table II

(Continued)

EI-7	1	(Alpheratz)	EN	00110
	2	(Diphda)	EN	00110
	40	(Altair)	EF	00120
	*221		EF	00120
	*126		EN	00110
EI-5	1	(Alpheratz)	EN	00110
	2	(Diphda)	EN	00110
	221		EF	00120
	126		EN	00110
	224		EN	00110
EI-2.5	1	(Alpheratz)	EN	00110
	221		EF	00120
	126		EN	00110

* Alternate Sightings

Basic Date 3/9/79
Changed

CSM 109

II. Loss of communications navigation procedures for aborts from lunar orbit.

A. Aborts from lunar orbit due to communications loss:

1. Make the abort burn.

2. Reinitialize W matrix. Use extended verb 67 and at the V06N99 display, load:

R1 + 30000 (30,000 ft)
R2 + 00300 (30. ft/sec)
R3 + 00003 (Cislunar Navigation Code)

3. Determine the day of entry of the abort and look at the table in 8 below for the schedule to be followed. For aborts returning on April 20, Schedule 1 should be used. For aborts returning on April 21, Schedule 2 should be used.

4. Time is referenced from TEI time for the first 35 hours, and EI time thereafter. This is done to provide for varying return lengths.

5. Calibrate optics at the beginning of each batch and every half hour while navigation sightings are in progress. The sextant calibration will be repeated until agreement of at least two checks (not necessarily sequential ones) are within 1 bit (.003°).

6. Large state vector corrections may be expected at the following times:

a. At the initiation of tracking (for the first mark on each star of the first batch of data).

b. At the first switch of reference bodies.

c. After a long period of no sightings.

d. During the last hours of the TE coast when the vehicle is near the earth.

If a large state vector correction (greater than 50 nautical miles in position and 50 feet per second in velocity) is displayed during the V06N49 display in P23, the mark should be rejected and repeated. If the large correction occurs again, it should be accepted and incorporated. (Corrections this large should not be expected in cases other than a and b above.)

7. If a W matrix reinitialization occurs after optical sightings are initiated due to a communications loss, the following procedures should be followed.

   a. If the reinitialization does not occur while sightings are being taken, the W matrix should be reinitialized at the next batch to the diagonal value associated with that batch.

   b. If the reinitialization occurs while a batch is in progress, the W matrix should be reinitialized to the diagonal value associated with the batch during which the loss occurred, and the batch restarted immediately. (See II-B-3 for values.)

   c. The current onboard state vector at the time of the W matrix reinitialization is retained.

   d. The remainder of the optical schedule is followed as if the W matrix reinitialization had not occurred.

8. Tables of sighting schedules for aborts from lunar orbit.

Table I

Sighting Schedule for Aborts from Lunar Orbit
GMT of entry interface = April 20, 20 hours

Time	Star	Horizon	R3
TEI+1.5	34 (Atria)	MN	00210
	35 (Rasalague)	MN	00210
	25 (Acrux)	MN	00210
	26 (Spica)	MF	00220
	33 (Antares)	MN	00210
TEI+13	01 (Alpheratz)	EN	00110
	221	EF	00120
	126	EN	00110
	* 02 (Diphda)	EN	00110
	* 45 (Formalhaut)	EF	00120
TEI+16	30 (Menkent)	MN	00210
	31 (Arcturus)	MF	00220
	32 (Alphecca)	MF	00220
TEI+20	01 (Alpheratz)	EN	00110
	126	EN	00110
	221	EF	00120
	* 45 (Formalhaut)	EF	00120
TEI+24	01 (Alpheratz)	EN	00110
	221	EF	00120
	126	EN	00110
	* 45 (Formalhaut)	EF	00120
TEI+28	01 (Alpheratz)	EN	00110
	221	EF	00120
	126	EN	00110
	* 45 (Formalhaut)	EF	00120
EI-28	01 (Alpheratz)	EN	00110
	221	EF	00120
	126	EN	00110
	* 45 (Formalhaut)	EF	00120
EI-23	01 (Alpheratz)	EN	00110
	221	EF	00120
	126	EN	00110
	102	EN	00110
	* 45 (Formalhaut)	EF	00120
EI-20	01 (Alpheratz)	EN	00110
	221	EF	00120
	126	EN	00110
	102	EN	00110
	* 45 (Formalhaut)	EF	00120
EI-8	45 (Formalhaut)	EF	00120
	44 (Enif)	EF	00120
	102	EN	00110

*alternate stars

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Table I - Continued

EI-5		26 (Spica)	MF	00220
		33 (Antares)	MF	00220
		23 (Denebola)	MN	00210
		24 (Gienah)	MN	00210
		30 (Menkent)	MF	00220
EI-2.5		26 (Spica)	MF	00220
		22 (Regulus)	MN	00210
		23 (Denebola)	MN	00210
	*	24 (Gienah)	MN	00210
	*	30 (Menkent)	MF	00220

Table II

Sighting Schedule for Aborts from Lunar Orbit
GMT of entry interface = April 21, 20 hours

Time	Star	Horizon	R3
TEI+1.5	37 (Nunki)	MN	00210
	35 (Rasalague)	MN	00210
	42 (Peacock)	MN	00210
	30 (Menkent)	MF	00220
	34 (Atria)	MN	00210
TEI+13	01 (Alpheratz)	EN	00110
	45 (Formalhaut)	EF	00120
	221	EF	00120
	*126	EN	00110
TEI+15.5	26 (Spica)	MF	00220
	33 (Antares)	MN	00210
	24 (Gienah)	MF	00220
	* 31 (Arcturus)	MF	00220
TEI+20	01 (Alpheratz)	EN	00110
	45 (Formalhaut)	EF	00120
	221	EF	00120
	*126	EN	00110
	*102	EN	00110
TEI+24	01 (Alpheratz)	EN	00110
	45 (Formalhaut)	EF	00120
	221	EF	00120
	*102	EN	00110
	*126	EN	00110
TEI+28	01 (Alpheratz)	EN	00110
	45 (Formalhaut)	EF	00120
	221	EF	00120
	*102	EN	00110
	*126	EN	00110
EI-32	01 (Alpheratz)	EN	00110
	45 (Formalhaut)	EF	00120
	221	EF	00120
	*102	EN	00110
	*126	EN	00110
EI-28	45 (Formalhaut)	EF	00120
	221	EF	00120
	102	EN	00110
	*126	EN	00110
EI-23	45 (Formalhaut)	EF	00120
	221	EF	00120
	102	EN	00110

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* alternate stars

Table II - Continued

EI-20	45 (Formalhaut)	EF	00120
	221	EF	00120
	102	EN	00110
	44 (Enif)	EF	00120
	224	EF	00120
EI-12	44 (Enif)	EF	00120
	103	EN	00110
	224	EF	00120
EI-5	33 (Antares)	MN	00210
	26 (Spica)	MF	00220
	24 (Gienah)	MF	00220
	23 (Denebola)	MF	00220
	30 (Menkent)	MN	00210
EI-2.5	33 (Antares)	MN	00210
	26 (Spica)	MF	00220
	23 (Denebola)	MF	00220

* alternate stars

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B. Communications loss during transearth coast following an abort from lunar orbit.

If you have received the entry pad, then no tracking is performed. If not true, then proceed.

1. Check to see if schedules given in II-A-8 are applicable. If not, go to Section IV. (In general, very short and very long aborts are not covered by the charts.)

2. Start tracking with the first batch of data following the current time.

3. Reinitialize W matrix. Use extended verb 67 and at the V06N99 display, load:

   a. Com loss before Batch 1

   R1 + 30000 (30,000 ft)
   R2 + 00300 (30. ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

   b. Com loss after Batch 1 with no state vector update after TEI:

   R1 + 99000 (99,000 ft)
   R2 + 00020 (2. ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

   c. Com loss after Batch 1 with at least one state vector update after TEI

   R1 + 45000 (45,000 ft)
   R2 + 00006 (0.6 ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

4. General rules in III for loss of communications during transearth coast are applicable. (See III-B, D, E, and G)

III. Loss of communications navigation procedures during nominal transearth trajectory.

<u>If you have received the entry pad, then no tracking is performed.</u> If above not true, then proceed.

A. The schedule provided below in G is references to launch azimuth and TLI opportunity. It is valid for nominal transearth situations between 72° launch azimuth, first TLI opportunity and 96° launch azimuth, second TLI opportunity on April 11.

B. Start tracking with the first batch of data following the current time.

C. Reinitialize the W matrix. Use extended verb 67 and at the V06N99 display, load:

1. Com loss before first batch

   R1 + 30000 (30,000 ft)
   R2 + 00300 (30. ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

2. Com loss after first batch with no state vector update after TEI:

   R1 + 99000 (99,000 ft)
   R2 + 00020 (2. ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

3. Com loss after batch 1 with at least one state vector update after TEI:

   R1 + 45000 (45,000 ft.)
   R2 + 00006 (0.6 ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

D. Calibrate the optics at the beginning of each batch and every half hour while navigation sightings are in progress. The sextant calibration will be repeated until agreement of at least two checks (not necessarily sequential ones) are within 1 bit (.003°).

E. Large state vector corrections may be expected at the following times:

1. At initiation of tracking (For the first mark on each star of the first batch of data)

2. At the first switch of reference bodies

3. After a long period of no sightings

4. During the last hours of the TE coast when the vehicle is near the earth

If a large state vector correction (greater than 50 nautical miles in position and 50 feet per second in velocity) is displayed during the V06N49 display in P23, the mark should be rejected and repeated. If the large correction occurs again, it should be accepted and incorporated. (Corrections this large should not be expected in cases other than 1 and 2 above.)

F. If a W matrix reinitialization occurs after optical sightings are initiated due to a communications loss, the following procedures should be followed.

1. If the reinitialization does not occur while sightings are being taken, the W matrix should be reinitialized at the next batch to the diagonal value associated with that batch.

2. If the reinitialization occurs while a batch is in progress, the W matrix should be reinitialized to the diagonal value associated with the batch during which the reinitialization occurred, and the batch restarted immediately. (See III-C above for values.)

3. The current onboard state vector at the time of the W matrix reinitialization is retained.

4. The remainder of the optical schedule is followed as if the W matrix reinitialization had not occurred.

G. Tables of sighting schedules for loss of communications during nominal transearth coast.

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Table I

Sighting Schedule for the Nominal Transearth Coast for 72° Launch Azimuth, First TLI Opportunity, Through a 96° Launch Azimuth, Second TLI Opportunity, for a Launch on April 11, 1970 (GMT of EI = April 21, 20 hr., 15 min.)

Time	Star	Horizon	R3
TEI+1	37 (Nunki)	MN	00210
	30 (Menkent)	MF	00220
	34 (Atria)	MN	00210
	41 (Dabih)	MN	00210
	35 (Rasalague)	MN	00210
TEI+13	45 (Formalhaut)	EF	00120
	221	EF	00120
	102	EN	00110
	* 44 (Enif)	EF	00120
	*126	EN	00110
TEI+15.5	26 (Spica)	MF	00220
	33 (Antares)	MN	00210
	31 (Arcturus)	MF	00220
	* 24 (Gienah)	MF	00220
	* 25 (Acrux)	MN	00210
TEI+20	221	EF	00120
	102	EN	00110
	45 (Formalhaut)	EF	00120
	* 1 (Alpheratz)	EN	00110
	*126	EN	00110
TEI+24	221	EF	00120
	45 (Formalhaut)	EF	00120
	102	EN	00110
	*126	EN	00110
	* 1 (Alpheratz)	EN	00110
TEI+28	102	EN	00110
	221	EF	00120
	45 (Formalhaut)	EF	00120
	* 1 (Alpheratz)	EN	00110
	*126	EN	00110
EI-32	221	EF	00120
	102	EN	00110
	45 (Formlhaut)	EF	00120
	* 1 (Alpheratz)	EN	00110
	* 44 (Enif)	EF	00120

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EI-28	221		EF	00120
	102		EN	00110
	45	(Formalhaut)	EF	00120
	*126		EN	00110
	* 44	(Enif)	EF	00120
EI-23	45	(Formalhaut)	EF	00120
	221		EF	00120
	102		EN	00110
	* 44	(Enif)	EF	00120
	*126		EN	00110
EI-20	45	(Formalhaut)	EF	00120
	221		EF	00120
	103		EN	00110
	* 44	(Enif)	EF	00120
	*102		EN	00110
EI-10	44	(Enif)	EF	00120
	103		EN	00110
	224		EF	00120
EI-5	33	(Antares)	MN	00210
	26	(Spica)	MF	00220
	24	(Gienah)	MF	00220
	23	(Denebola)	MF	00220
	31	(Arcturus)	MF	00220
EI-2.5	33	(Antares)	MN	00210
	26	(Spica)	MF	00220
	24	(Gienah)	MN	00210
	* 23	(Denebola)	MF	00220
	* 31	(Arcturus)	MF	00220

* Alternate Stars

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IV. Rules for a do-it-yourself sighting schedule.

<u>If you have received the entry pad, then no tracking is performed.</u> If not true, then proceed.

A. General rules

1. A sighting or set is to consist of three marks.

2. Reinitialize W matrix and schedule a tracking interval as soon as possible after the burn; or in the case of the lunar flyby, about 1 hour after perilune. If sightings are performed translunar for any reason, reinitialize the W matrix 1 hour after perilune for transearth sightings. W matrix values are given below in the discussion for each return type. (See B and C.)

3. Star availability is related to GMT <u>not</u> GET. Therefore, a chart which approximates the GMT of a particular situation can be used as a clue to determine stars available.

4. A batch is to consist of a least three star/horizon sighting, although as many as five can be advantageous, particularly following a sleep period.

5. All available stars should be used in the sighting schedule. No more than three marks should be taken on a star within a batch of data.

6. Sightings during the last 10 hours before entry interface are important. Five earth horizon sightings should be scheduled at EI-5 hours and three earth horizon sightings should be scheduled following the MCC at EI-3 hours. <u>If no earth horizon sightings are available, lunar horizon sightings should be used</u>.

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7. Whenever possible, the navigation batches should be scheduled so that, immediately following a time period of length Δt (not to exceed 3 hours) in a non-PTC mode, five times Δt should be spent in a PTC mode (thermal constraints). This rule will be violated most frequently in the following situations: (1) aborts from a translunar trajectory with short return lengths, (2) time critical aborts, (3) the 10-hour period before entry interface.

8. If possible, both near and far horizons should be included in each batch of data.

9. Calibrate the optics at the beginning of each batch and every half hour while navigation sightings are in progress. The sextant calibration will be repeated until agreement of at least two checks (not necessarily sequential ones) are within 1 bit (.003°).

10. Large state vector corrections may be expected at the following times:

    a. At initiation of tracking (for the first mark on each star of the first batch of data.)

    b. At the first switch of reference bodies.

    c. After a long period of no sightings.

    d. During the last 10 hours of before entry interface.

    If a large state vector correction (greater than 50 nautical miles in position and 50 feet per second in velocity) is displayed during the V06N49 display in P23, the mark should be rejected and repeated. If the large correction occurs again, it should be accepted and incorporated. (Corrections this large should not be expected in cases other than a and b above.)

B. Aborts from a translunar trajectory:

1. Make abort burn

2. Read general rules contained in IV-A.

3. Initialize the W matrix. Use extended verb 67 and at the V06N99 display, load:

   R1 + 80000 (80,000 ft)
   R2 + 00070 (7.0 ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

4. Only star/earth horizon marks will be made.

5. If return length $\leq$20 hours, three sets should be scheduled every 2.5 hours with a batch of five sets at EI-5 hours before the last MCC at EI-3 hours, and three sets after the midcourse.

6. If return length $\geq$20 hours, sleep periods of 8 hours may be provided. Astronauts should be awake the last 10 hours before entry interface. Three sets should be scheduled every three hours while awake with five sets scheduled before each sleep period. Five sets should be taken before the last midcourse at TI-3 hours, and three sets after the midcourse.

7. If a W matrix reinitialization occurs after the optical sightings are initiated, the following procedures should be followed:

   a. If the reinitialization does <u>not</u> occur while sightings are being taken, the W matrix should be reinitialized at the next batch to the diagonal value given in B-3.

   b. If the reinitialization occurs while a batch is in progress, the W matrix should be reinitialized to the diagonal value given in B-3 and the batch <u>restarted immediately</u>.

   c. The current onboard state vector at the time of the W matrix reinitialization is retained.

   d. The remainder of the optical schedule is followed as if the W matrix reinitialization had not occurred.

C. Communications loss for flyby, aborts from lunar orbit, etc.

1. Make abort burn or wait until perilune.

2. Read general rules in IV-A.

3. Reinitialize W matrix. Use extended verb 67 and at the V06N99 display, load:

   a. Com loss before Batch 1 (at TEI + 1 hour or perilune + 1 hour):

   R1 + 30000 (30,000 ft)
   R2 + 00300 (30 ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

   b. Com loss after Batch 1 (at TEI + 1 hour or perilune + 1 hour) with no state vector update after TEI:

   R1 + 99000 (99,000 ft)
   R2 + 00020 (2.0 ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

   c. Com loss after Batch 1 (at TEI + 1 hour or perilune + 1 hour) with at least one state vector update after TEI:

   R1 + 45000 (45,000 ft)
   R2 + 00006 (0.6 ft/sec)
   R3 + 00003 (Cislunar Navigation Code)

4. If return length $\geq$ 70 hours

   a. Refer to Table 1 Section III for placement of batches of star/horizon sightings and relate the times given at "TEI +" and "EI-" to the specific transearth situation. For each batch scheduled, take three marks on each available star (up to 5 stars).

   b. Schedule three earth horizon sightings for every 5 hours between TEI + 32 and EI - 40 hours, or if an additional sleep period is needed for very slow returns, schedule five earth horizon sightings before the sleep period and five earth horizon sightings upon awakening.

5. For return lenths < 70 hours

   a. Sleep periods of 8 hours should be provided. Astronauts should be awake the last 10 hours before entry interface.

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b. Three sets of star horizon observations should be scheduled every three hours while awake with five sets scheduled before and after each sleep period.

(1.) A batch of lunar horizon sightings should be taken at TEI + 1 hour or perilune + 1 hour.

(2.) The second batch of data should consist of earth horizon sightings.

(3.) The third batch of data should consist of lunar horizon sightings.

(4.) The remainder of the data should be earth horizon sightings. If no earth horizon sightings are available, lunar horizon sightings should be substituted.

c. Five earth/horizon sets should be scheduled at EI - 5 hours before the MCC at EI = 3 hours. Three sets should be taken after the midcourse. If no earth horizon sightings are available, lunar horizon sightings should be substituted.

6. If a W matrix reinitialization occurs after optical sightings are initiated due to a transearth communications loss, the following procedures should be followed.

a. If the reinitialization does <u>not</u> occur while sightings are being taken, the W matrix should be reinitialized at the next batch to the diagonal value associated with that batch. (W matrices are given in C-3.)

b. If the reinitialization occurs while a batch is in progress, the W matrix should be reinitialized to the diagonal value associated with the batch during which the loss occurred, and the batch <u>restarted immediately</u>.

c. The current onboard state vector at the time of the W matrix reinitialization is retained.

d. The remainder of the optical schedule is followed as if the W matrix reinitialization had not occurred.

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VENUS HALF-UNIT VECTORS
APRIL 11, 19 HOUR GMT LAUNCH

TIME (GMT) MO DA HR	TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)	TIME (GMT) MO DA HR	TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
4 11 19	.0	.38103	.29788	.12682	4 17 5	130.0	.34089	.33565	.14537
4 12 0	5.0	.37957	.29942	.12757	4 17 10	135.0	.33926	.33701	.14605
4 12 5	10.0	.37810	.30095	.12832	4 17 15	140.0	.33762	.33835	.14672
4 12 10	15.0	.37663	.30248	.12906	4 17 20	145.0	.33598	.33970	.14739
4 12 15	20.0	.37515	.30399	.12980	4 18 1	150.0	.33433	.34103	.14805
4 12 20	25.0	.37366	.30551	.13054	4 18 6	155.0	.33268	.34236	.14871
4 13 1	30.0	.37217	.30701	.13128	4 18 11	160.0	.33102	.34368	.14937
4 13 6	35.0	.37067	.30851	.13201	4 18 16	165.0	.32935	.34499	.15002
4 13 11	40.0	.36916	.31000	.13274	4 18 21	170.0	.32768	.34630	.15068
4 13 16	45.0	.36765	.31148	.13347	4 19 2	175.0	.32600	.34760	.15132
4 13 21	50.0	.36613	.31296	.13419	4 19 7	180.0	.32432	.34889	.15197
4 14 2	55.0	.36460	.31443	.13491	4 19 12	185.0	.32263	.35017	.15261
4 14 7	60.0	.36306	.31590	.13563	4 19 17	190.0	.32093	.35145	.15325
4 14 12	65.0	.36152	.31735	.13635	4 19 22	195.0	.31923	.35272	.15389
4 14 17	70.0	.35997	.31880	.13706	4 20 3	200.0	.31752	.35398	.15452
4 14 22	75.0	.35842	.32025	.13777	4 20 8	205.0	.31581	.35524	.15515
4 15 3	80.0	.35686	.32168	.13847	4 20 13	210.0	.31409	.35648	.15578
4 15 8	85.0	.35529	.32311	.13918	4 20 18	215.0	.31237	.35772	.15640
4 15 13	90.0	.35371	.32453	.13988	4 20 23	220.0	.31064	.35895	.15702
4 15 18	95.0	.35213	.32595	.14058	4 21 4	225.0	.30890	.36018	.15764
4 15 23	100.0	.35055	.32735	.14127	4 21 9	230.0	.30716	.36140	.15825
4 16 4	105.0	.34895	.32875	.14196	4 21 14	235.0	.30542	.36361	.15887
4 16 9	110.0	.34735	.33015	.14265	4 21 19	240.0	.30366	.36381	.15947
4 16 14	115.0	.34575	.33153	.14334	4 22 0	245.0	.30191	.36500	.16008
4 16 19	120.0	.34413	.33291	.14402	4 22 5	250.0	.30014	.36619	.16068
4 17 0	125.0	.34252	.33428	.14470					

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MARS HALF-UNIT VECTORS
APRIL 11, 19 HOUR GMT LAUNCH

TIME (GMT) MO DA HR	TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
4 11 19	.0	.28542	.37462	.16790
4 12 5	10.0	.28334	.37593	.16851
4 12 15	20.0	.28124	.37723	.16910
4 13 1	30.0	.27915	.37852	.16970
4 13 11	40.0	.27704	.37980	.17029
4 13 21	50.0	.27494	.38107	.17087
4 14 7	60.0	.27283	.38233	.17145
4 14 17	70.0	.27071	.38357	.17202
4 15 3	80.0	.26859	.38480	.17259
4 15 13	90.0	.26646	.38603	.17315
4 15 23	100.0	.26434	.38724	.17371
4 16 9	110.0	.26220	.38844	.17426
4 16 19	120.0	.26007	.38963	.17480
4 17 5	130.0	.25793	.39080	.17535
4 17 15	140.0	.25578	.39197	.17588
4 18 1	150.0	.25363	.39312	.17642
4 18 11	160.0	.25148	.39427	.17694
4 18 21	170.0	.24933	.39540	.17747
4 19 7	180.0	.24717	.39652	.17798
4 19 17	190.0	.24501	.39763	.17849
4 20 3	200.0	.24284	.39873	.17900
4 20 13	210.0	.24067	.39982	.17950
4 20 23	220.0	.23850	.40090	.18000
4 21 9	230.0	.23632	.40196	.18050
4 21 19	240.0	.23414	.40302	.18098
4 22 5	250.0	.23195	.40406	.18147

JUPITER HALF-UNIT VECTORS
APRIL 11, 19 HOUR GMT LAUNCH

TIME (GMT) MO DA HR	TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
4 11 19	.0	.38588	.29856	.10910
4 13 21	50.0	.38443	.30026	.10983
4 15 23	100.0	.38296	.30185	.11054
4 18 1	150.0	.38150	.30345	.11126
4 20 3	200.0	.38002	.30504	.11196
4 22 5	250.0	.37854	.30662	.11267

SATURN HALF-UNIT VECTORS
APRIL 11, 19 HOUR GMT LAUNCH

TIME (GMT) MO DA HR	TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
4 11 19	.0	-.42242	-.25034	-.09430
4 13 21	50.0	-.42363	-.24857	-.09353
4 15 23	100.0	-.42484	-.24679	-.09277
4 18 1	150.0	-.42603	-.24502	-.09201
4 20 3	200.0	-.42721	-.24324	-.09125
4 22 5	250.0	-.42837	-.24147	-.09050

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NO COMM LM JETTISON

EARTH ORBIT - (LM/CSM CONTINGENCY DEORBIT)

MNVR TO POSIGRADE/HEADS DOWN ATTITUDE
POSITION 31.7° LINE ON HORIZON

RETRO FIRE - 20 MIN

JETTISON LM
PERFORM -X 4 JET TRANSLATION (24 SEC)
MNVR TO RETRO FIRE ATTITUDE

TRANSLUNAR COAST - (DIRECT ABORT FROM TLC)

PITCH 180° FROM ABORT ATTITUDE

ABORT BURN - 30 MIN

JETTISON LM
PERFORM -X TRANSLATION (ΔV = 1 FPS)
MNVR TO ABORT BURN ATTITUDE

LUNAR ORBIT - (CONTINGENCY TEI)

(PERFORM ≈1 HOUR (NO LATER THAN 30 MIN) PRIOR TO TEI)
MNVR TO LV/LH ATT R = 180° (HEADS DOWN)
P = 000°
Y = 000°
USE P47 OR EMS TO MONITOR SEP MNVR

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NO COMM LM JETT

TEI - 1 HR

JETTISON LM
PERFORM -X TRANSLATION (NET ΔV = 1 FPS RETROGRADE)
MNVR TO TEI ATTITUDE

TRANSEARTH COAST - (LATE LM JETTISON)

(PERFORM ≈1 HOUR TO 45 MIN PRIOR TO EI)
REALIGN IMU TO ENTRY REFSMMAT
MNVR TO INERTIAL ATT R = +0 (ARBITRARY)
P = +196
Y = +45
USE P47 OR EMS TO MONITOR SEP MNVR

EI - 1 HOUR

JETTISON LM
PERFORM -X TRANSLATION (NET ΔV = 3 FPS)
MNVR TO ENTRY ATTITUDE

Basic Date 3/9/70
Changed

CSM 109

LOI 30 MIN DPS ABORT

ΔV Thrust A/B - OFF
SPS INJ vlvs (4) - CLOSED
SPS He tb (2) - bp
GMBL MOTS(4) - OFF (LMP Verify)
TVC SERVO PWR (2) - OFF
SC CONT - SCS
PCM BIT RATE - LOW
EMS MODE - STBY (verify)

RECORD DATA AND COMPUTE PAD

F 97 40
Record TFC _____
VG _____
ΔVM _____
EMS ΔVC _____
ENTR
F 99 40
ENTR
F 16 85
Record VGX _____ R _____
VGY _____ P _____
VGZ _____ Y _____
PRO
F 37 00E
When CMC ACTY lt out:
V66E

	ALTERNATE PAD
ΔVC LOI	
EMS ΔVC(Shutdown)	
ΔVC(Burned)	
ΔVC ABORT(Chart)	

PRIMARY

G&N ΔVM _____
ΔVC ABORT(Chart) _____

GET LOI _____
+30:00
GET TEI ABORT __:__

3/9/70

Basic Date _____
Changed _____

LOI ABORTS

CSM 109

LOI 30 MIN ABORT CHART
NOT APPLICABLE TO
APOLLO 13

CSM 109

Basic Date 3/9/70
Changed

1 MNVR TO PAD BURN ATTITUDE
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
EMS FUNC - OFF
Set ΔVC= +100.0
28:00 EMS FUNC - ΔV
(-02:00) V37E 47E
F 16 83 ΔV XYZ(CSM) (.1fps)

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

29:30
(-00:30) EMS MODE - NORMAL

29:58
(-00:02) CMC MODE - FREE (on LM request)

30:00
(00:00) DPS IGNITION

3/9/70

Basic Date _____
Changed _____

CSM 109

RECORD ΔV COUNTER & RESIDUALS

ΔVC _____
VGX _____
VGY _____
VGZ _____

(RECYCLE) V32E
(TERM) PRO

F 37 XXE

EMS FUNC - OFF
EMS MODE - STBY

Basic Date 3/9/70
Changed _____

LOI 2 HR DPS ABORT

ΔV Thrust A/B - OFF
SPS INJ vlvs (4) - CLOSED
SPS He tb (2) - BP
GMBL MTRS (4) - OFF (LMP verify)
TVC SERVO PWR (2) - OFF
SC CONT - SCS
PCM BIT RATE - LOW
EMS MODE - STBY

RECORD DATA AND COMPUTE PAD

F 97 40
Record TFC _____
VG _____
ΔVM _____
EMS ΔVC _____
ENTR
F 99 40
ENTR
F 16 85
Record VGX _____ R _____
VGY _____ P _____
VGZ _____ Y _____
PRO
V 37 00E
When CMC ACTY lt out, V66E
Perform P52, OPT 3

Basic Date 3/9/70
Changed 3/27/70

ASSIST IN LM ACTIVATION

LM Set MSN TMR to CSM MSN TMR on MARK
Configure for VHF Simplex B and respond to LM comm check
Configure for VHF Simplex A
Verify CSM in min DB and ATT HOLD
V06 N20E; Read CSM ICDU ANGLES to LM
ENTR on LM MARK and note time. Compare CSM & LM ICDU ANGLES

OG	IG	MG
_____CM	_____CM	_____CM
_____LM	_____LM	_____LM

V16 N65E, call CSM time to LM __:__:__

CSM 109

LM ENTR time on CSM MARK
V 06 N65E on LM MARK and compare with
LM N65
CSM Time __:__:__
LM Time __:__:__

V 05N01E 1706E, Call TEPHEM to LM
R1 _____
R2 _____
R3 _____
Maintain wide DB and ATT HOLD for LM RCS check. Copy P-30 Pad

MNVR TO PAD BURN ATTITUDE AND MONITOR BURN

Cycle CRYO FANS
Perform star check if possible
Set DET Counting Up to Burn
BMAG MODE (3) - RATE 2
SC CONT - CMC
CMC MODE - AUTO
MNVR to PAD BURN ATT, then maintain ATT HOLD
-06:00 CMC - FREE (or) SC CONT - SCS with MAN ATT (3) - ACCEL CMD
EMS FUNC - ΔV SET VHF/RNG
Set ΔVC +100.0
TVC SERVO PWR #1 - AC1/MNA
EMS FUNC - ΔV
BMAG MODE (3) - ATT1/RATE 2
-02:00 V37 E 47E, monitor F 16 83 (ΔV XYZ)
-00:30 EMS MODE - NORMAL
00:00 DPS IGNITION
After engine cutoff (and on LM callout)
CMC MODE - AUTO
Record ΔV COUNTER & RESIDUALS

ΔVC	_____	R	_____
VGX	_____	P	_____
VGY	_____	Y	_____
VGZ	_____		

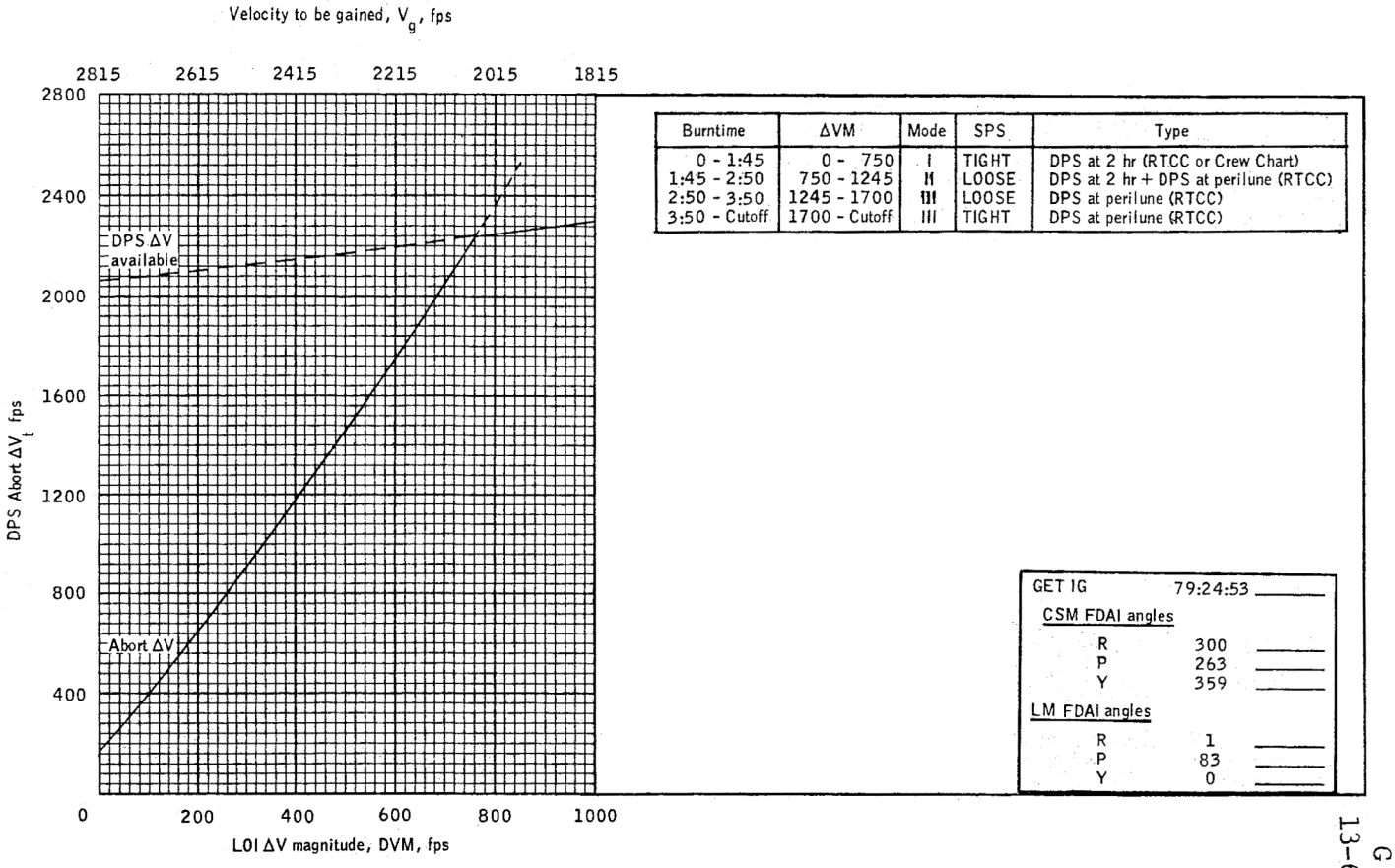
PRO
F 37 XXE
EMS FUNC - OFF
EMS MODE - STBY
TVC SERVO PWR #1 - OFF
BMAG MODE (3) - RATE 2

Basic Date 3/9/70
Changed 3/27/70

CSM 109

CSM 109

Basic Date 3/9/70
Changed 3/27/70



Burntime	ΔVM	Mode	SPS	Type
0 - 1:45	0 - 750	I	TIGHT	DPS at 2 hr (RTCC or Crew Chart)
1:45 - 2:50	750 - 1245	II	LOOSE	DPS at 2 hr + DPS at perilune (RTCC)
2:50 - 3:50	1245 - 1700	III	LOOSE	DPS at perilune (RTCC)
3:50 - Cutoff	1700 - Cutoff	III	TIGHT	DPS at perilune (RTCC)

GET IG	79:24:53	
CSM FDAI angles		
R	300	
P	263	
Y	359	
LM FDAI angles		
R	1	
P	83	
Y	0	

LOI DOCKED APS ABORT
TIG(__:__:__)

	50:00			
	(-10:00)		START DET	
1			MNVR TO PAD BURN ATTITUDE	
			V62E	
2			V49E	
	F	06 22	NEW ICDU ANGLES RPY	(.01°)
			Load desired angels	
			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	
	54:00			
	(-06:00)		CMC MODE - FREE	
			- SCS	
			BMAG MODE(3) - ATT 1/RATE 2	
			V48E, 61102, 01111	
			EMS FUNC - OFF	
			Set ΔVC= +100.0	
			EMS FUNC - ΔV	
	58:00			
	(-02:00)		V37E 47E	
	F	16 83	ΔV XYZ(CSM)	(.1fps)

VI,HDOT,H available by N62
*KEY RLSE to return to N83 *

Basic Date 3/9/79
Changed _____

CSM 109

59:30 (-00:30)		EMS MODE - NORMAL
59:58 (-00:02)		SC CONT - CMC (on LM request) BMAG MODE(3) - RATE 2
00:00		APS IGNITION
		RECORD ΔV COUNTER & RESIDUALS ΔVC _____ VGX _____ VGY _____ VGZ _____
	(RECYCLE)	V32E
	(TERM)	PRO
F 37	XXE	
		EMS FUNC - OFF EMS MODE - STBY