



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MIT

APOLLO 17

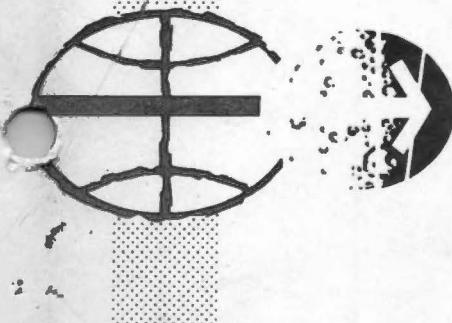
ALL LAUNCH DATES

CHANGE A

# CSM G&C CHECKLIST

PREPARED BY

FLIGHT PROCEDURES BRANCH  
CREW PROCEDURES DIVISION



MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS

NOVEMBER 10, 1972

APOLLO 17

CSM G&C CHECKLIST

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STAR LIST

<u>STAR NAME</u> (Numerical)		<u>STAR NAME</u> (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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VERB LIST (Decimal)

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

- 55 Increment CMC Time (Decimal)  
\*56 Terminate Tracking (P20)  
57 FULTKFLG Display  
\*58 Reset Stick Flag and set V50 N18 flag  
59 Please Calibrate  
\*60 Set N17 = N20  
\*61 Display DAP att error  
\*62 Display total att error (N22-N20)  
\*63 Display total astro att error (N17-N20)  
64 Start S-band ant routine (R05)  
\*65 Verify Prelaunch Align Optics (CSM)  
\*66 Set CSM State Vector into LM State Vector  
67 W-Matrix RSS Error Display  
\*69 Restart  
70 Update Liftoff Time (P27)  
71 Univ Update-BLOCK ADR (P27)  
72 Univ Update-SINGLE ADR (P27)  
73 Update CMC Time (Octal) (P27)  
\*74 Initialize erasable dump via downlink  
\*75 Backup Liftoff  
\*78 Update prelaunch azimuth  
\*80 Update LM State Vector  
\*81 Update CSM State Vector  
82 Start Orbit Param Disp (R30)  
83 Start REND Param Display No. 1 (R31)  
85 Start REND Param Display No.2 (R34)  
\*86 Reject REND backup sighting mark  
\*87 Set VHF range flag  
\*88 Reset VHF range flag  
89 Start REND Final ATT Routine (R63)  
90 Request REND out of plane display (R36)  
91 Compute Banksun  
\*93 Enable W matrix initialization  
\*94 Enable CISLUNAR Tracking recycle  
\*96 Terminate integration and go to P00  
    (Select P00 by V37 after use of V96)  
97 SPS Thrust Fail (R40)  
99 Enable engine ignition  
\*Callable with other extended verb in use  
and does not lock out other extended verbs

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NOUN LIST (Decimal)

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

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

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

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

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

### V05 N09 ALARM CODES

- 00110 Mark reject has been entered but  
ignored  
Continue
- 00113 No inbits (chan 16)  
Continue; if alarm recurs use MDC DSKY.
- 00114 More marks made than desired  
Continue
- 00115 V41 N91 keyed with OPTICS MODE not  
in CMC  
OPTICS MODE - CMC and OPTICS ZERO - OFF
- 00116 Optics switch altered before 15 sec  
zero time elapsed  
OPTICS ZERO - ZERO (15 sec).
- 00117 V41 N91 keyed but CMC has reserved  
OCDU (from start of gimbal test in  
P40 until termination of TVC  
functional allocation of the  
"optics" CDU Driving Output)  
V41 N91 not yet available

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- 00120 Optics torque has been requested but optics have not been zeroed since last FRESH START or RESTART OPTICS ZERO - OFF then ZERO (15 sec).
- 00121 In 0.05 sec following mark, an ICDU changed by more than 0.033° Repeat MK.
- (m)00205 PIPA saturated  
Use SCS control (G&N 12).
- 00206 The IMU zero routine has been entered with both the GMBL LOCK It and NO ATT It on
- (m)00207 Coarse align to 0,0,0 Reselect V40E  
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 STDN. (G&N 12).
- (m)00211 Coarse align error  
If P51(3)/52(4) in progress record gyro torquing angles and perform fine align check in P52(4).  
Otherwise, see G/1-24. (G&N 12).
- (m)00212 PIPA fail, but PIPA is not being used  
PIPA check (G&N 6/7).
- (m)00213 IMU not operating with turn-on request  
See 00210
- 00214 Program using IMU when turned OFF  
See 00210 or exit program.
- (m)00217 IMU coarse align or pulse torque difficulty has occurred  
If code 211 also, perform 211 cure only  
Reinitiate current program.  
If alarm recurs, terminate use of ISS (G&N 12).
- 00220 IMU orientation unknown  
Align or if aligned set REFSMMAT flag.
- 00401 Desired middle gimbal angle is excessive  
Call N22 - maneuver if MGA < 85° or realign IMU.
- 00402 Second MINKEY pulse torque must be done

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- 00404 Target out of view (90 deg test)  
(G/3-6,3-11,6-3,7-16)
- 00405 Acceptable star pair is not available  
(G/6-3,6-6)
- 00406 Rend navigation not operating  
Select P20 (opt. 0 or 4) or continue.
- 00421 W-matrix overflow  
Notify STDN but continue.  
W-matrix automatically reinitialized at  
next mark.
- 00600 No solution on first iteration in P31 or  
P32/72  
(G/4-6,4-8)
- 00601 Post CSI Perigee/lune alt <85nm/ 5.8nm  
(G/4-6,4-8)
- 00602 Post CDH Perigee/lune alt <85nm/ 5.8nm  
(G/4-6,4-8)
- 00603 Time from TIG (CSI) to TIG (CDH)  
<10 min  
(G/4-6,4-8)
- 00604 Time from TIG (CDH) to TIG (TPI)  
<10 min  
(G/4-6,4-8)
- 00605 Number of iterations exceeds loop  
maximum  
(G/4-6,4-8,4-15,4-16)
- 00606 ΔV (CSI) has been >1000 fps for last  
two iterations  
(G/4-6,4-8)
- 00611 No TIG for given ELEV angle  
(G/4-10,4-12)
- 00612 State vector in wrong sphere of influence  
at TIG  
(G/4-15)
- 00613 Reentry angle out of limits  
(G/4-16)
- (m)00777 ISS warning caused by PIPA fail  
(G&N 6).
- 01102 CMC self test error  
(G/2-3)
- (m)01105 Downlink too fast  
Rset. If alarm recurs DOWNLINK FAILURE.  
(G&N 12).

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- (m)01106 Uplink too fast  
Rset. If alarm recurs UPLINK FAILURE.  
(G&N 12).
- (m)01107 Phase table failure-assume erasable  
memory is destroyed  
If Comm: 1. V74 CMC DOWNLINK  
2. P27 As Necessary.  
3. V48 As Necessary (V46).  
4. Reestablish REFSMMAT via  
P51 As Necessary.  
If FRESH START recurs, CMC  
FAILURE (SSR-3).  
If no Comm, pg G/9-1
- 01301 Arcsin or arccos input is greater than  
one  
Notify STDN, continue.
- (m)01407 VG increasing  
(G&N 12).
- 01426 IMU unsatisfactory  
Realign or use SCS.
- 01427 IMU reversed  
Note FDAI operation is inverted.
- 01520 V37 request not permitted at this time  
Wait till COMP ACTY lt.  
not on continuously - reselect V37 or  
if P62-67, select P00 and then desired  
program.
- 01600 Overflow in drift test  
This is gnd test alarm only.
- 01601 Bad IMU torque abort  
See 01600
- 01703 Insufficient time for integration.  
TIG slipped  
(G/5-3,5-16)
- (m)03777 ISS warning caused by ICDU fail  
(G&N 6)
- (m)04777 ISS warning caused by ICDU & PIPA fail  
(G&N 6)
- (m)07777 ISS warning caused by IMU fail  
(G&N 6)
- (m)10777 ISS warning caused by IMU & PIPA  
fail (G&N 6)

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- (m)13777 ISS warning caused by IMU & ICDU fail  
(G&N 6)
- (m)14777 ISS warning caused by IMU,ICDU & PIPA  
fail  
(G&N 6)
- \*\*20430 Orbital integration has been  
terminated to avoid possible  
infinite loop.  
Notify STDN.  
Probable S.V. uplink required
- \*\*20607 No solution to conic subroutine  
Reselect program.
- \*\*20610 Alt at specified TIG in P37 < 400K ft  
Reselect P37 and decrease TIG.
- \*\*21204 Negative or zero time waitlist call.  
If ave-g or ext. vb. on, continue.  
Otherwise reselect program.
- \*\*21206 Second job attempts to go to sleep via  
keyboard and display program  
See 21204.
- \*\*21210 Second attempt is made to stall  
Reselect program  
Do not attempt use of IMU while CMC is  
using it.
- \*\*21302 SQRT called with negative argument  
See 21204
- \*\*21501 Keyboard and display alarm during  
internal use  
See 21204
- \*\*21502 Illegal flashing display  
See 21204
- \*\*21521 P01 selected and P11 has already been  
performed  
Select correct program
- \*31104 Delay routine busy  
Reselect extended verb or continue with  
program.  
Notify STDN.
- \*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
  - \*31211 Illegal interrupt of extended verb  
Reselect extended verb after optics  
marking is completed.  
(m) - Malf procedure indicated
  - \*\*(2xxxx) - Generates restart (no lt), F37  
(POODOO)
  - \*(3xxxx) - Restart (no lt) and program  
continues (i.e. attempted  
recovery)(BAILOUT)
- NOTE - All \*\*alarms act as \*type if  
they occur when Ave-g is  
on or display type ex-  
tended verb is active

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V50 N25 CHECKLIST CODES

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

V04 N06 (N12) OPTION CODES

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

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## MONITOR DATA IN ERASABLE MEMORY

1 V11 NO1E (OCTAL ADD) E  
 2 11 01 R1 DATA R3 OCTAL ADD  
 3 N15E (For next succeeding word)  
 4 ENTR (For each succeeding word)

### FLAG WORD SET/RESET

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

### CHANGE DATA IN ERASABLE MEMORY

F 21 01 V21 NO1E (ADDRESS) E  
     R3 ADDRESS  
     Load New Data in R1 E  
     N15E (For next succeeding word)  
     ENTR (For each succeeding word)

\*To determine code:

Find bit in chart

Number above bit (4,2 or 1) is code.

(Used in correct octal position)

For more than one bit, add codes.

Examples:

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

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## FLAGWORD BIT ASSIGNMENTS

APOLLO

FLAGWORD	ADDRESS	4	2	1	4	2	1	4	2	1	4	2	1	4	2	1	
		BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	
0	74		JSWITCH	MIDFLAG	MOONFLAG	FARMOR NORMFOR	ZMEASURE	NEEDLFLG	IMUSE	RNDVZFLG	SGTMK RSJFLAG	F2RTE	CYC61FLG	FREEFLAG	AMOONFLG	P20FLAG	
1	75	ZJETSFLG NJETSFLG	STHFLAG	ERADCOMP ERADFLAG	NODOPO1	RCSBURN ENG2FLAG	LMTRG TARG1FLG	LMKTRG TARG2FLG	CSMUPDAT VEHUFHFLG	UPDATFLG	IDLEFAIL	TRACKFLG	MARKFLG	ITER1SW SLOPESW	GUESSW	AVEGFLAG	
2	76	DRIFTFLG	R2TMARK	22DSPFLG	P21FLAG	STEERSW	SKIPVHF	IMPULSW	XDELFLG	FIRSTFLG HAVEELEV ETPIFLAG	FINALFLG	IMACTFLG AVFLAG	PFRATFLG	P24MKFLG	CALCMAN2	NODOV37 INDOFLAG1	
3	77	V50N18FL	GLOKFAIL	REFSMFLG	LUNLAT0 LUNAFLAG	P22MKFLG	VFLAG	POOFLAG	PRECIFLG	CULTFLAG	ORBWFLAG	STATEFLG	CONCINT INTYPFLG	CSMIN1SW ·VINIFLAG	9DINWWMAT ·D60RFLG	WMATINT ·DMMOFLAG1	
4	100	MARKDLE ·RKDIFLG	PRIODILE	NORMIDLE	NRMIDFLG	PDSFLAG	MARKWAIT ·MWAITFLG	NORMWAIT ·NWAITFLG	MRKWTKEY ·MRKNVFLG	NRMWTKEY ·NRMNVFLG	PROWKKEY PRONVFLG	PINBRFLG	RUPTMARK ·MRUPTFLG	RUPTNORM ·MRUPTFLG	MKOVNORM ·MKOVFLAG1	VNFLAG	XDSFLAG
5	101	DSKYFLAG	RETROFLG	SLOWFLG	P23CALIB V59FLAG	FS1NCR ·INCORFLG	NEWIFLAG	DMENFLG	CMCCOMP ·COMPUTER	ENGONGFLG	3AXISFLG	BKUPL0 ·GRRBKFLG		NOSOLNSW ·SOLNSW	MGLVFLAG	RENDWFLG	
6	102	DAPBIT1	DAPBIT2	ENTRYDSP STRUSSLW	CMDAPARM	GAMDIFSW	GONEPAST	RELVELSW	EGSW LNKNOWN ·RKNOWNFLG	NOSWITCH	HIND	INRLSW	LATSW	05GSW	CMDSTBY	GYMDIF	
7	103	TERMIFLG	ITSWITCH	IGNFLAG	ASTNFLAG	TIMRFLAG	NORMSW	RVSW	GONEBYIG ·GONEBYI		V37FLAG		UPLOADFL	VERIFLAG	LMATICH ·ATTCHFLG	TFFSW	
8	104	RPQFLAG	NEWLMFLG	NEWIFLG	CMOONFLG	LMOONFLG	ADVTRK	UTFLAG	SURFFLAG	INFINFO	ORDERSW	APSESW	COGAFLAG	V960NFLG	R67FLAG	360SW	
9	105	SWTOVER	P24FLAG	VB2EMFLG	MAXDBFLG	V9dFLAG	SAVECFLG	VHFRFLAG	VHFSOURC ·SOURCFLG	R22CAFLG	N22ERNDS ·N22ORN17	QUITFLAG	R31FLAG	MIDIFLAG	MIDAVFLG	AVEMIDSW	
10	106	PCMANFLG	INTINUSE ·INTFLG	INTGRAB REINIFLG	REJCFLG	MDSUPFLG	BURNFLAG	RANGFLAG	P35FLAG	AUTOSEQ		MANEUFLG	PIV93FLG	TPIMNFLG	FULTKFLG	PCFLAG	
11	107	S321F1	S321F2	S321F3A	S321F3B				AZIMFLAG	HAFLAG	CSISFLAG						

## MONITOR OF INPUT/OUTPUT CHANNELS

V11 N1OE

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

### CHANNEL SET/RESET

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

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

2 F 22 07 (LOAD BIT CODE)\* ENTR

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

\*To determine code:

Find bit in chart

Number above bit (4,2 or 1) is code.

(Used in correct octal position)

For more than one bit, add codes.

Examples:

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

### SC CONT/MODE AND OPTICS MODE OVERRIDE

V21 N1E, 374E, A0ODO ENTR

A=0: Use switches (SC CONT and CMC MODE)

A=1: CMC FREE

A=2: CMC HOLD

A=3: CMC AUTO

A=5,6 or 7: SCS

D=0: Use switches (OPTICS)

D=1: OPT CMC

D=2: OPT ZERO

D=3: OPT MAN

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## **CMC INPUT/OUTPUT CHANNELS**

CHANNEL	NAME	4 BIT 15	2 BIT 14	1 BIT 13	4 BIT 12	2 BIT 11	1 BIT 10	4 BIT 9	2 BIT 8	1 BIT 7	4 BIT 6	2 BIT 5	1 BIT 4	4 BIT 3	2 BIT 2	1 BIT 1			
CP	1 L																		
	2 Q																		
	3 HISCALAR																		
	4 LOSCALAR																		
OUT																			
	5 PYJETS																		
	6 ROLLJETS																		
CP	7 SUPERBNK																		
	10 OUTO	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 BIT 1			
	11 DSALMOUT																		
OJT	12 CHAN12	ISS TURNON DELAY COMPLETE	SIV B CUTOFF	SIV B INJ. SEQ START		DISABLE OPTICS DAC	ZERO OPTICS	SIV B TAKEOVER ENABLE	TVC ENABLE		ENABLE IMU ERROR COUNTER	ZERO IMU CDU'S	COARSE ALIGN ENABLE	ENABLE OPT ERROR COUNTER	ZERO OPTICS CDU'S				
	13 CHAN13	ENABLE TRAP	RESET TRAP 32	RESET TRAP 31B	RESET TRAP 31A	ENABLE STANDBY	TEST ALARMS		BMMAG CTR ENABLE	DNLINK WD ORD	BLOCK INLINK	INHIBIT COLINK	RNG UNIT ACTV.	RNG UNIT SEL. A	RNG UNIT SEL. B	RNG UNIT SEL. C			
	14 CHAN14	DRIVE CDUX	DRIVE CDUY	DRIVE CDUZ	DRIVE CDUT	DRIVE CDUS	GYRO ACTV	GYRO	GYRO	GYRO	GYRO ENABLE						OUTLINK ACTV		
IN	15 MNKEY IN												MKEYS	MKEY4	MKEY3	MKEY2	MKEY1		
	16 NAVKEY IN												MARK REJECT	MARK	NKEYS	NKEY4	NKEY3	NKEY2	NKEY1
	30 *CHAN30	TEMP IN LIMITS	ISS TURNON REQUEST	IMU FAIL	IICDU FAIL	IMU CAGE	SC CONTROL OF SAT	IMU OPERATE		OPTICS CDU FAIL		LIFT-OFF	SIV B SEPARATE OR ABORT	SPS READY	SM/CM SEPARATE	ULLAGE THRUST PRESENT			
	31 *CHAN31	G & N AUTOPILOT CONTROL	FREE	HOLD	-Z TRANS	+Z TRANS	-Y TRANS	+Y TRANS	-X TRANS	+X TRANS	RHC -ROLL	RHC +ROLL	RHC -YAW	RHC +YAW	RHC -PITCH	RHC +PITCH			
OUT	32 *CHAN32		PROCEED				IM ATTACHED					MNIM -ROLL	MNIM +ROLL	MNIM -YAW	MNIM +YAW	MNIM -PITCH	MNIM +PITCH		
	33 *CHAN33	OSC ALARM	COMPUTER WARNING	PIPA FAIL	DNLK TOO FAST	UPLINK TOO FAST	BLOCK UPLINK					CMC CTR OPTICS	ZERO OPTICS		RANGE DATA GOOD				
	34 DNTM1								FIRST OF TWO WORDS										
	35 DNTM2								SECOND OF TWO WORDS										
* INVERTED LOGIC		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			

\* INVERTED LOGIC

VHF RNG DSKY DISPLAY

VHF RNG - on (up)

P20 - running in opt 0 or 4

V87E

V16 N02E

3703E

R1=XXX.XX nm

(max R1 = 163.83;

if R1 neg, RNG = 327.67 - |R1| )

G&N RECOVERY PROCEDURES

## Recoveries:

if P06 inadvertently selected: (with  
F 50 25 00062)

1. a. Press PRO to STBY, press PRO again to F 37
- or b. V37E 00E
2. V37E 51E, PRO (set DRIFT flag)  
V37E 00E
3. V25 N7E, 77E, 10000E, 1E (set REFSMMAT flag)

if V36 inadvertently keyed in:

1. V37E 51E, PRO (set DRIFT flag)  
V37E 00E
2. V46
3. Perform General System Checkout as necessary

if GO JAM performed to exit RESTART loop:  
V74 when convenient, do procedure for inadvertent V36if Run-away PIPA during ave.-G:V36E before PRO on N85 or N83  
to preserve CSM state vector.

Do procedure for inadvertent V36.

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if All 8's appear spontaneously on DSKY

1. V99 N99
2. V25 N01E
3. 00000E
4. +99999E
5. +99999E
6. +99999 CLR,CLR,CLR
7. 00000E
8. 00000E
9. 00000E

If OPR ERR, begin again

General System Checkout:

Get to P00 by one of the following:

1. V37E 00E
2. V96E
3. V36E, wait 15 sec, V96E
4. Simultaneously press & hold 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 (use 2 stars)  
If nominal, continue; if not, perform P51
5. CMC Self Test

MNVR COMPLETION TIME

1. During auto mnvr  
V4 N1E  
3316E  
Record R1 & R2
2. V24 N25E  
Load step 1 R1 & R2 (octal)
3. V6 N34E (hrs, min, .01 sec)  
MNVR Completion time minus 1 sec

V35 - DSKY CONDITION LIGHT TEST  
CMC - on

Note: CMC lt. on opens PIPA suspension loop which generates alarm 212 and may cause PIPA bias shift.

- 1 Key V37E OOE (required)  
DSKY - POO
  - 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  
(except PROG if IMU on)
  - e. ISS lt - off  
CMC lt - off  
V, N quits Flashing
  - f. POO will be displayed.
  - g. Key RSET  
(Don't call ave. G for 15 sec)

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EXT VERBS

V41 N91 COARSE ALIGN OCDU's  
CMC - on  
G/N PWR OPTICS - on  
OPT MODE - CMC  
OPT ZERO - OFF

EXT VERBS

- 1 V37E00E  
2 V41N 91E  
3 F 21 92 SHAFT, TRUN NEW OCDU (.01°,.001°)  
Load desired shaft and trun  
4 41 OPTICS DRIVE TO SPECIFIED ANGLES

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

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

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V42 GYRO TORQUING  
CMC MODE - FREE

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

V48 - DAP DATA LOAD & ACTIVATE PROCEDURE

1

V48E

F 04 46

R1 ABCDE\*

R2 ABCDE

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

PRO

2 F 06 47 CSM WT, LM WT (1bs,1bs)  
 Load correct values\*  
 PRO

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

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

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

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1-26

V49 CREW DEFINED MANEUVER

CMC - on  
ISS - on  
SCS - operating

- 1 V37E 00E  
V62E
- 2 F 06 22 V49E  
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 (.01°)  
(TRIM) PRO To 4  
(BYPASS) ENTR

V54 BACKUP OPTICS MARK

P20 - running in opt. 0 or 4  
and tracking

- 1 V54E
- \*PROG ALARM \*  
\*V5 N9E - 00406 \*  
\*Not rend tracking\*
- 2 F 06 94 Backup SHAFT, TRUN (.01°,.001°)  
Load angles  
PRO

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- 3 F 53 45 PERFORM BACKUP MARK  
MARKS, TFI, MGA or code  
(marks,min-sec,.01°)  
RHC - Align target on alt. LOS  
ENTR (V86E to reject - within 7 sec)
- \*POSS F 06 49 ΔR, ΔV, source code\*  
\*(.01NM,.1fps,0000X)\*  
\*(REJECT) V32E \*  
\*(ACCEPT) PRO \*

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

V55 - CMC TIME UPDATE

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

V57 DISPLAY FULTKFLG CONDITION

- 1 V57E
- 2 F 04 12 R1 00004 Specify FULTKFLG setting  
R2 00000 VHF and Optics working  
00001 VHF or Optics working  
Load desired value in R2  
(If display erased upon ENTR,  
verify by repeating V57)

PRO

V64 HI GAIN ANTENNA POINTING

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

DATE

V67 - W-MATRIX ERROR DISPLAY

V67E

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

Load desired data  
PRO

V74 CMC DOWNLINK

V74E (Places erasable memory on downlink)

V82 ORBIT PARAMETER DISPLAY

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

V82E (If AVE G On, Go To 3)

F 04 12 R1 00002 Specify Vehicle  
R2 00001 CSM  
00002 LM  
PRO

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

Load desired time (present time,  
use all zeroes)

PRO

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

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

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

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V83 RNDZ PARAMETER DISPLAY #1

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

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

V85 - RNDZ PARAMETER DISPLAY #2  
Note: See V83 restrictions

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

V87 - SET VHF RNG FLAG

VHF AM B - DUPLEX

VHF RNG - on (up)

P20 - running in opt. 0 or 4

1            V87E (starts VHF range sampling)

2            V88E (TERMINATE)  
or V37E XXE

DATE        8/30/12

V89 - RENDEZVOUS FINAL ATTITUDE

CMC - on  
ISS - on  
SCS - operating

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

G  
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## V90 - OUT-OF-PLANE DISPLAY

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

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

**V91 - COMPUTE BANKSUM**

**CMC - on (req)**

- 1 V37E OOE

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

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IMU POWER UP PROCEDURE

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

- 1 G/N IMU PWR - on (up)  
NO ATT lt - on (90 sec)  
NO ATT lt - out  
Wait 15 sec (To allow PIPA inhibit  
reset)
- 2 V37E XXE
  - \*If CMC not available: \*
  - \* G/N IMU PWR - on(up) \*
  - \* Wait 90 sec \*
  - \* IMU CAGE - on(up) 5 sec,\*  
\* then release \*

IMU POWER DOWN PROCEDURE

CMC MODE - FREE

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

Wait 5 min prior  
to power up

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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                   06 21      V06 N21 (do not ENTR)  
                   XYZ PIPA COUNTS
- 4                   Record     At T + 1:04 - ENTR  
                   (X) R1 \_\_\_\_ (Y) R2 \_\_\_\_ (Z) R3 \_\_\_\_ (+000AB)
- 5                   F 21 01    V21N 01E (use same sign as above)  
                   1452 E (CALCULATED X BIAS) E,E,(+AB000)  
                   1454 E (CALCULATED Y BIAS) E,E  
                   1456 E (CALCULATED Z BIAS) E

CMC POWER UP PROCEDURE

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

2                   F 37      00E

P06 - CMC POWER DOWN PROGRAM

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

V37E 06E  
 F 50 25    00062 CMC PWR DN

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

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CMC SELF CHECK

- 1 F 21 01 V25 N01E, 1365E  
E,E,E
- 2 15 01 V15 N01E, 1365E  
R1 NUMBER OF ERRORS  
R2 NUMBER OF TESTS STARTED  
R3 NUMBER OF E-MEM TESTS SUCCESSFUL
- 3 V21 N27E 10E SELF TEST FIXED & ERASABLE  
(4E SELF CHECKS ERASABLE  
5E SELF CHECKS FIXED)
- 4 15 01 TEST SUCCESSFUL WHEN R2>3 (78 sec minimum)  
\* IF PROG 1t - On \*  
\* V05 N09E 01102 SELF \*  
\* TEST ERROR \*  
\*N8E-Rec for STDN \*  
(TERM) V21N27E 0E

OPTICS POWER UP PROCEDURE

Verify optics manual drive disengaged  
OPT ZERO - OFF  
OPT MODE - MAN  
G/N PWR OPTICS - on (up)  
OHC - Drive trun  $<10^\circ$   
OPT ZERO - ZERO (15 sec)

OPTICS POWER DOWN

- 1 G/N PWR OPTICS - OFF

SCT MANUAL DRIVE PROCEDURE  
Verify G&N PWR OPTICS - OFF

- 1 Insert tool E and rotate  $\sim 1$  rev CCW  
to engage drive (socket backs out)
- 2 Drive optics either direction  
( $\sim 1$  rev/degree)
- 3 To disengage, push and rotate  
 $\sim 1$  rev CW(button will remain flush)

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  
 $\alpha$ /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 \_\_\_\_ °

EMS ΔV TEST & NULL BIAS CHECK

EMS MODE - STBY

EMS FUNC - ΔV SET/VHF RNG

SET ΔV ind to 1586.8 fps

EMS MODE - NORMAL

EMS FUNC - ΔV TEST

SPS THRUST Lt - on/off (10 sec)

ΔV ind. stops at -0.1 to -41.5

EMS MODE - STBY

EMS FUNC - ΔV SET/VHF RNG

SET ΔV ind to - 100.0 fps

CMC MODE - FREE (Until meas complete)

or BMAG MODE (3) - RATE 2

EMS FUNC - ΔV (wait 5 sec)

Start DET

00:00 EMS MODE - NORM

01:40 EMS MODE - STBY

If ΔV &lt; 1 fps, do not bias

If ΔV > 1 fps but < 10 fps, bias  
if desired

If ΔV &gt; 10 fps, EMS is NO-GO

\*Bias check is invalidated by EMS

FUNC - OFF\*

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SPS GIMBAL DRIVE TEST (EMP 522)

CMC - ON  
DAP - LOADED

1 TVC Prep

Logic 2/3 pwr - on  
Sig Cond/Dr Bias (2) - AC1  
FDAI/GPI pwr - 1  
TVC Servo pwr 1 - AC1/MNA  
SC CONT - CMC  
SCS TVC (2) - Rate Cmd  
Mn Bus Tie (2) - on  
Gmb1 Mot P1,Y1 - Start/On  
LV/SPS IND - GPI  
TVC Gmb1 Dr (2) - 1

2 V25 N1 E

3044E, 1E, E, E

3 V25 N26E

1E  
2366E  
40066E

4 V31E

Monitor GPI Response  
00, 20, -20, 00, 02, -02, 00, Trim

5 TERMINATE

V25 N26E  
E,E,E, (R1, R2, R3 Blank)  
Gmb1 Mot (2) - OFF  
TVC Servo pwr 1 - OFF  
Mn Bus Tie (2) - OFF

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P20 - OPTIONS

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

P20 - UNIVERSAL TRACKING

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

DATE	8/30/72	V37E 20E
1	F 04 06	R1 00024 TRACKING OPTION R2 00000 Load 1 or 5 in R2 PRO
2	F 06 78*	AXIS YAW, AXIS PITCH, OMICRON (.01°) Load values (OMICRON ignored for opt 1) Sim. Bay: 90°, 52.25° OMICRON SEF: 180° BEF: 0° PRO
3	F 06 79*	R2 DEADBAND (.01°) Load d.b. PRO
4	F 01 70	R1 000DE STARCODE Load code PRO (DE ≠ 00 to 6)
5	F 06 88	CELESTIAL BODY VECTOR Load vector PRO

6 (Req'd Mnvr <10°, to 7)  
 F 50 18 MNVR request (.01°)

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

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

(MAN) RHC - MNVR to N18 angles

When att. acceptable

SC CONT - CMC  
 CMC MODE - AUTO

ENTR

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

CMC continues tracking center of celestial body  
 \*CMC will react to changes in N78 and N79 (May  
 take 4 sec)

To terminate P20 - V56E

#### P20 - UNIVERSAL TRACKING

Options 0 & 4 - Rendezvous  
 (0:VECPPOINT; 4:3-axis)

CMC - on (req)

ISS - on and aligned (req)

SCS - on (des)

BMAG MODE (3) - RATE 2

OPT ZERO - OFF

OPT MODE - MAN

G/N OPT PWR - on

OHC - Drive trun <10°

OPT ZERO - ZERO (15 sec)

OPT MODE - CMC

Note: For VHF RNG display  
 see p G/1-20

1 V37E 20E

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

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

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

4 F 50 18 MNVR request (.01°)

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

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

(MAN) RHC - MNVR to N18 angles

When att. acceptable

SC CONT - CMC  
CMC MODE - AUTO

ENTR

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

OPT ZERO - OFF

CMC continues LM attitude and optics tracking  
\*CMC will react to changes made to N78 and N79  
(May take 18 sec)

To start VHF marks - V87E (V88E to stop)  
MARK at will (Reject within 7 sec)

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

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

To terminate P20 - V56E  
OHC - Drive trun <10°  
OPT ZERO - ZERO  
G/N OPT PWR - OFF

Note: To display N49 for each measurement:

V1 N1E  
2002 E  
Rcrd: R1 \_\_\_\_\_  
V21 E  
2002 E  
77776 E

To return:  
V21 N1E  
2002 E  
Load previously recorded value

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

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3 F 06 43 LAT,LONG,ALT (.01°,.01°,.1nm)  
(RECYCLE) V32E to 2 (Increment GET 10 min)  
(EXIT) PRO

4 F 37 XXE

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

P22 - ORBITAL NAVIGATION

CMC - on (req)  
ISS - on and aligned (req)  
SCS - on (req)  
BMAG MODE (3) - RATE 2  
OPT ZERO - OFF  
OPT MODE - MAN  
G&N PWR OPTICS - on  
OHC - Drive trun <10°  
COUPLING - RESOLVED  
SPEED - MED  
OPT ZERO - ZERO (15 sec)  
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)

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- 2 F 05 70 (lunar orbit only)  
R2 ABCDE 1mk code  
Load 1mk 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
- 3 F 06 89 LAT,LONG/2,ALT (.001°,.001°,.01nm)  
Load 1mk 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 1mk 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 1mk 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

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G  
3-7

- 7 F 06 89 LAT,LONG/2,ALT (.001°,.001°,.01nm)  
PRO
- 8 F 06 49 ΔR,ΔV (SV PARA) (.01nm,.1fps)  
(RECYCLE) V32E to 2  
(ACCEPT) Hold for 30 sec  
PRO
- 9 F 06 89 LAT,LONG/2,ALT LMK ID (.001°,.001°,.01nm)  
(DON'T STORE) PRO to 2  
(STORE-CODE 01) V32E to 2  
(terminate Prog) V34E
- 10 F 37 XXE  
OHC - Drive trun <10°  
OPT ZERO - ZERO  
G/N PWR OPTICS - OFF  
To restore rate limit (CDU transient  
detection): V21N1E,1341E,5E

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P23 - CISLUNAR MIDCOURSE NAV MEASUREMENT  
(EMP 514)

CMC - on

SCS - on

ISS - on &amp; aligned

OPT ZERO - OFF

OPT MODE - MAN

G/N PWR OPTICS - on (30 min prior)

OHC - Drive trun &lt;10°

OPT ZERO - ZERO (15 sec)

OPT MODE - CMC

Manual Update EMP 514 (p.G/3-12)

PURP	V	7	1
GET	:	:	
304 01	INDEX	0	6
305 02	0	2	4
306 03	0	6	0
307 04	7	7	4
310 05	0	1	5
311 06	0	5	2
			0
			5

\*Do Not Call\*

\*P32/72 \*

\*P33/73,P22 \*

V25 N26E, Load:

R1 10000

R2 01444

R3 14005

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1

V37E 23E

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

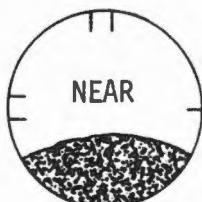
G  
3-9

- 3 F 01 70 R1 000DE STAR CODE  
Load desired code  
PRO (to 5 if DE $\neq$ 00)
- 4 F 06 88 CELESTIAL BODY VECTOR  
Load desired vector  
PRO
- 5 F 50 18 REQUEST MNVR TO FDAI R,P,Y (.01°)  
(AUTO) SC CONT-CMC  
CMC MODE - AUTO  
BMAG MODE (3) -RATE 2  
PRO to 6  
(MAN) V62E  
MNVR to 5  
  
(BYPASS) ENTR to 7
- 6 06 18 AUTO MNVR FDAI R, P, Y (.01°)  
AUTO MNVR COMPLETE RETURN TO 5
- 7 F 59 REQUEST OPTICS CALIB  
(BYPASS) ENTR to 9  
(CALIB) OPT MODE - MAN  
OPT COUPLING - DIR  
SPEED - LOW  
OPT ZERO - OFF  
SUPERIMPOSE LLOS ON SLOS  
MARK
- 8 F 06 87 R2 TRUN BIAS (.001°)  
(Repeat until 2 measurements agree within .003°)  
For manual load:  
V22 N94E  
XXXXXE  
(RECALIB) MARK to 8  
(INCORP  
CALIB) PRO

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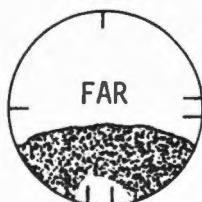
9 F 05 70

R1 00ODE STAR ID  
 R2 00COO LMK ID  
 R3 00CDO HOR ID



STAR/ENH STAR/LNH STAR/EL

00ODE	00ODE	00ODE
00000	00000	00100
00110	00210	00000



STAR/EFH STAR/LFH STAR/LL

00ODE	00ODE	00ODE
00000	00000	00200
00120	00220	00000

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

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

11 F 06 88 CELESTIAL BODY VECTOR  
 LOAD DESIRED VECTOR  
 PRO

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

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

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

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- 15 06 92 AUTO OPT SHFT/TRUN (.01°,.001°)  
(MNVR) V94E to 12  
(MARK) MNVR SC TO POSITION LMK/HOR  
IN FOV  
OPT MODE - MAN
- 16 F 51 MARK REQUEST  
(MNVR) V94E to 12  
(MARK) SUPERIMPOSE STAR ON LMK/HOR  
MARK
- 17 F 50 25 00016 TERM MARKS  
(REJECT) MARK REJECT to 16 (Noun + R1 not  
blanked)  
(TERM) PRO
- 18 F 05 71 R1 00ODE STAR ID  
R2 00C00 LMK ID  
R3 00CDO HOR ID  
  
(STAR/HOR) PRO to 21 (DE=00 to 20)  
(STAR/LMK) PRO to 19
- 19 F 06 89 LAT, LONG/2, ALT(LMK) (.001°+N/E,.01nm)  
PRO (DE#00 to 21)
- 20 F 06 88 CELESTIAL BODY VECTOR  
Verify vector  
PRO
- 21 F 06 49 ΔR,ΔV (SV PARA) (.01nm,.1 fps)  
(REJECT) V37E 23E  
(UPDATE) PRO
- 22 F37 V30E, Key Rel  
Key 23E  
F59 Entr to 16

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3-11

23

Terminate (final pass complete)

F37

V30E, Key Rel  
V25 N26 E  
E,E,E (R1,R2,R3 Blank)  
OHC - Drive trun <10°  
OPT ZERO - ZERO  
G/N PWR OPTICS - OFF

P24 RATE-AIDED OPTICS TRACKING

CMC - on (req)  
ISS - on and aligned  
SCS - on  
BMAG MODE (3) - RATE 2  
OPT ZERO - OFF  
OPT MODE - MAN  
G&N PWR OPTICS - on  
OHC - Drive trun <10°  
OPT ZERO - ZERO (15 sec)  
OPT MODE - CMC  
TVC SERVO PWR 1 & 2 - OFF (verify)  
GMBL MTRS (4) - OFF (verify)

1

V37E 24E

2

F 06 89

LAT, LONG/2, ALT (.001°,.001°,.01nm)  
LOAD LMK COORDS  
OPT ZERO - OFF  
MNVR to SIGHTING ATT  
Roll to keep shaft axis > 10° from  
plane defined by X-axis & LOS to  
LMK (For 60nm alt, LMK > 10nm from  
gnd track requires no roll)  
PRO

3

06 92

AUTO OPT SHFT/TRUN (.01°,.001°)  
\*F 05 09 00404 (TRUN >90°)\*  
\* MNVR to acquire \*  
\* PRO \*  
\* or V34E, F 37 \*  
OPTICS MODE - MAN

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

5 F 37 XXE  
OHC - Drive trun <10°  
OPT ZERO - ZERO  
G/N PWR OPTICS - OFF

P27 CMC UPDATE  
CMC - on (req)

Auto Update:

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

Update complete:

UPLINK ACTY 1t - out  
UP TLM (MDC) - BLOCK

Voice Transmission Update:

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

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

3 P27 Displayed

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- 4 F 21 01 R3 UPDATE BUFFER ADD (initially 304)  
R1 Data E (R3 Increments)  
Repeat Step 4 for all data
- 5 F 21 02 R3 330  
(Verify Data) V1 N1E  
R3 304E  
R1 Verify Data  
N15E (R3 305)  
R1 Verify Data  
Consecutive ENTR's display  
remaining comps. Note  
octal ident (01-24) of  
comps which need change  
KEY REL To 6
- 6 F 21 02 R3 330  
(CHANGE) Load octal ident, XXE to 4  
(ACCEPT UPDATE) Key Verb, then PRO
- 7 P00 or P20 Displayed
- P29 TIME OF LONGITUDE  
CMC-on (req)
- DATE 8/30/72
- 1 V37E29E
- 2 F 04 06 R1 00002 Specify Vehicle  
R2 00001, CSM  
00002, LM  
PRO
- 3 F 06 34 GET BASE TIME (hrs,min,.01 sec)  
Load time from which  
CMC will begin search (all 0's for  
present time)  
PRO
- 4 F 06 43 R2 DESIRED LONG (.01°)  
Load long  
PRO

- 5 F 06 34 GET LONG (hrs,min,.01 sec)  
(Change long) V32E to 4  
(see lat.) PRO
- 6 F 06 43 LAT, LONG, ALT (.01°,.01°,.1nm)  
(Recycle) V32E to 2  
(Term) PRO
- 7 F 37

P20 with GDC REFSMMAT

CMC - on (req)  
IMU - off  
GDC - on and REFSMMAT Known (pg G/7-13)  
SCS - operating  
OPT ZERO - OFF  
OPT MODE - MAN  
G/N OPT PWR - on  
OHC - Drive trun <10°  
OPT ZERO - ZERO (15 sec)  
OPT MODE - CMC

- 1 V25N20E  
Load present GDC angles
- 2 Perform P20 opt 4 (p. G/3-2)  
Return after PRO on N79
- 3 Display desired att.  
V16N18E (R,P,Y) (.01°)
- 4 Mnvr to Roll 0° or 180°, Yaw 0°  
and Pitch shown in N18  
V25N20E  
Load present GDC angles
- 5 OPT ZERO - OFF  
MARK (repeat as necessary)  
\* POSS F 06 49 ΔR, ΔV, source code \*  
\* (.01nm, .1fps, 0000X)\*  
\* (REJECT) V32E \*  
\* (ACCEPT) PRO \*
- (To Terminate P20 - V56E  
G/N OPT PWR - OFF)

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MK BUTTON FAILED OPEN (EMP 505)

May be used with P20,22,23,24,51 & 52

1

V25 N26E  
1E  
2165E  
16067E

2

When ready to mark:

Key V31

Use ENTR to mark (must be LEB DSKY)

Use MK REJ to reject

Notes: As long as 31 remains in verb window,  
ENTR may be used to mark. This will  
be true in e.g. P24 unless MK REJ.  
In general MK REJ will place 51 in verb  
windows. V31 must then be rekeyed.

3

TERMINATE  
V25 N26E  
E,E,E (R1,R2,R3 Blank)

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MANUAL RANGE INPUT (EMP 515)

1

AUTO UPDATE

V37E OOE

UPTLM (2) - ACCEPT

UPLINK ACTY lt - on

STDN will uplink EMP 515 (p.G/3-17)

UPLINK ACTY lt - out

UPTLM (MDC) - BLOCK

\*DO NOT CALL P27, P40, P41, \*

\*P52/54 (opt. 2 or 4) or P52\*

\*for Minkey plane change \*

2

V88E

3

V5 N26E, Verify:

R1 26001

R2 00306

R3 70067

4

When last mark incorp (N45 R1 increments),

V21 N2E

3703E

+XXX.XXE (future value range  $\leq$  163.83 nmi.)

or

-(327.67-XXX.XX)E (future value range  
 $>$  163.83 nmi)

5

V30 (DO NOT ENTR)

6

When actual range = future value range

Key Entr

repeat, to 4

7

TERMINATE:

V25 N2E

E,E,E (R1,R2,R3 Blank)

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OPTICS TO BODY ANGLES (EMP 517)

1

V96E

2

AUTO UPDATE

V37E OOE

UPTLM (2) - ACCEPT

UPLINK ACTY 1t - on

STDN will uplink EMP 517 (p.G/3-17)

UPLINK ACTY 1t - out

UPTLM (MDC) - BLOCK

\*Do not call other CMC \*

\*programs or extended verbs\*

3

V5 N26E, verify:

R1 14001

R2 00605

R3 00000

4

V24 N94E, load specified angles

R1 + XXX.XX Shaft (.01 deg)

R2 + XX.XXX Trunnion (.001 deg)

5

V16 N78E (Monitor Computed Body Angles)

6

V30E

R1 + XXX.XX axis YAW (.01 deg)

R2 - XXX.XX axis PITCH (.01 deg)

R3 - XXX.XX OMICRON (.01 deg)

DATE

7

TERMINATE

V25 N26E

E,E,E (R1,R2,R3 Blank)

3-16b

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DATE \_\_\_\_\_

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3-17

EMP 515  
MANUAL  
RANGE  
INPUT

EMP 517  
OPTICS <S  
TO  
BODY <S

PURP	V	7	1	V		V	7	1
GET	:	:		:	:		:	:
304 01	INDEX	1	6	INDEX		INDEX	2	3
305 02	0	0	3	0	6	0	0	4
306 03	0	0	0	0	6	0	0	0
307 04	3	0	0	2	5	0	6	0
310 05	5	3	0	6	2	7	7	6
311 06	0	5	5	6	1	0	3	2
312 07	0	0	0	5	7	7	7	4
313 10	3	4	7	5	7	2	6	5
314 11	0	4	6	3	6	4	6	0
315 12	2	6	0	3	6	1	4	2
316 13	0	1	7	3	1	0	0	2
317 14	0	5	5	4	7	5	7	3
320 15	0	0	0	5	7	0	3	0
321 16	0	2	7	4	2	7	7	3
322 17						2	6	5
323 20						2	6	1
324 21						0	3	4
325 22						7	7	7
326 23						0	5	0
327 24								5

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P24 COAS MARKING (Hi Alt)(EMP 500)

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

1 MNVR TO LMK TRK PAD ATT  
V49E

2 AUTO UPDATE:

V37E OOE  
UP TLM (2) - ACCEPT  
UPLINK ACTY lt - on  
STDN UPLINKS:  
LMK POSITION IN RLS IF LMK NOT PRIME  
BACKUP MARK ROUTINE (pg G/3-20)

UPDATE COMPLETE:

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

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

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

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

6 V22 N79E DEADBAND (.01°)  
+50E

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- 7 V37E 24E
- 8 F 06 89 LAT, LONG/2, ALT (.001°,.001°,.01nm)  
LOAD LMK COORDS  
PRO
- 9 F 51 MARK REQUEST  
V21 N1E  
3374E  
OE ZERO R61CNTR
- V44E SET SURFFLAG
- V25 N7E  
75E  
1020E SET TRACKFLG AND LMTRG  
1E  
Manually fly roll to zero
- 10 If MNVR <10°, to 11  
F 50 18 MNVR REQUEST (.01°)  
PRO  
When mnvr complete - ENTR
- 11 F 51 MARK REQUEST
- V30E CALL ERASABLE PROG
- 12 F 53 BACKUP MARK REQUEST
- 13 AFTER ACQUISITION:  
CMC MODE - FREE  
TRACK LMK WITH RHC  
PRO for MARK  
ENTER for MARK REJ
- 14 TO TERMINATE PROG:  
V34E
- F 51 V37E 00E  
V45E (RESET SURFFLAG)  
V25 N26E  
E,E,E (R1,R2,R3 Blank)

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## COAS MARKING ROUTINE (EMP 500)

PURP	V	7	1	V	7	1	V	7	1
304 01	INDEX	2	4	INDEX	2	4	INDEX	1	5
305 02	0	3	6	0	3	6	0	3	6
306 03	3	1	6	6	1	0	0	0	6
307 04	0	4	6	3	6	3	0	0	2
310 05	2	6	0	3	6	5	2	3	5
311 06	2	0	5	7	6	3	4	7	7
312 07	0	2	0	5	2	0	5	2	2
313 10	0	1	6	1	2	0	2	2	0
314 11	0	1	6	3	4	0	1	6	0
315 12	0	0	0	0	4	4	0	0	7
316 13	3	1	7	2	5	7	4	7	6
317 14	5	4	3	5	7	1	0	0	0
320 15	3	1	7	2	7	0	1	6	0
321 16	5	4	3	6	1	0	5	5	6
322 17	3	0	0	3	3	0	0	0	3
323 20	5	4	3	5	6	0	5	5	6
324 21	3	0	0	3	4	0	0	0	5
325 22	5	4	3	6	0	1	1	7	5
326 23	3	0	0	3	2	0	1	6	5
327 24	5	4	3	6	2	3	4	1	7

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

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P24 FROZEN OPTICS (Hi Alt) (EMP 508)

1

Record frozen shaft and trun  
TPACS and voice to ground:

SHAFT \_\_\_\_\_  
TRUN \_\_\_\_\_

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

2

MNVR TO LMK TRK PAD ATT  
V49E

3

AUTO UPDATE:

V37E OOE  
UP TLM (2) - ACCEPT  
UPLINK ACTY 1t - on  
STDN UPLINKS RLS  
UPDATE COMPLETE:  
UPLINK ACTY 1t - off  
UP TLM (MDC) - BLOCK

4

GROUND VOICES N78 PAD:

YAW \_\_\_\_\_  
PITCH \_\_\_\_\_

5

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

XXX.XXE  
XXX.XXE  
+OE

6

V22 N79E DEADBAND  
+50E

DATE 8/30/12

- 7 V37E 24E
- 8 F 06 89 LAT, LONG/2, ALT (.001°,.001°,.01nm)  
LOAD LMK COORDS  
PRO
- 9 F 51 MARK REQUEST  
V21 N1E  
3374E  
OE ZERO R61CNTR
- V44E SET SURFFLAG
- V25 N7E  
75E  
1020E SET TRACKFLG AND LMTRG  
1E
- 10 F 50 18 If MNVR <10°, to 11  
MNVR REQUEST (.01°)  
PRO  
When mnvr complete - ENTR
- 11 F 51 MARK REQUEST
- 12 AFTER ACQUISITION:  
CMC MODE - FREE  
TRACK LMK WITH MIC  
MARK as desired
- 13 TO TERMINATE PROG:  
V37E OOE  
V45E (RESET SURFFLAG)

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P30 EXTERNAL ΔV

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

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

DATE 8/30/72PRETHRUST  
(P30's & 70's)

## MINKEY SEQUENCER

- 31.1       $\Delta V$  mag. < 7 fps, perform P41 (CMC begins  
               at step 4)  
 $\Delta V$  mag.  $\geq$  7 fps, perform P40 (CMC begins  
               at step 4)

31.2      Perform P76

31.3      Go to P32, step 2

32.1       $\Delta V$  mag. < 7 fps, perform P41 (CMC begins  
               at step 4)  
 $\Delta V$  mag.  $\geq$  7 fps, perform P40 (CMC begins  
               at step 4)

32.2      Perform P76

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

36.1      If  $\Delta V$  mag. = 0, go to 36.2

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

PKEI THRUST  
(P30's & 70's)

(.01°)

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F 50 25    00020 MINKEY PULSE TORQUE  
Align GDC to Roll: 90 or 270  
Pitch: 0 or 180  
Yaw: 0

(TORQUE) LIMIT CYCLE - ON  
ATT DB - MIN  
RATE - LOW  
BMAG MODE (3) - ATT 1/RATE 2  
SC CONT - SCS  
PRO  
(16 20 during torque)  
Torque complete:  
 $\Delta V < 7$  fps - P41 (step 4)  
 $\Delta V \geq 7$  fps - P40 (step 4)

(BYPASS) ENTR  
Perform P41 (step 4)

- 36.2              Perform P76
- 36.3              If pulse torque not done, go to P33  
                     step 2.
- 36.4              If desired: Manually MNVR back to  
                     original GDC att.  
                    If all gimbal angle changes for mnvr  
                    back to rend. att  $< 10^\circ$ , go to 36.5

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

(REJECT) ENTR to 36.5

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

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36.5      52 in MM lights

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

F 50 25 00020 MINKEY PULSE TORQUE  
SC CONT - SCS  
BMAG MODE (3) - ATT 1/RATE 2  
PRO  
(16 20 during torque)

Torque complete: BMAG MODE (3) - RATE 2  
Go to P33, Step 2

33.1       $\Delta V$  mag.  $< 7$  fps, perform P41 (CMC begins at step 4)  
 $\Delta V$  mag.  $\geq 7$  fps, perform P40 (CMC begins at step 4)

33.2 Perform P76

33.3 Go to P34, step 2

34.1       $\Delta V$  mag.  $< 7$  fps, perform P41 (CMC begins  
at step 4)  
 $\Delta V$  mag.  $\geq 7$  fps, perform P40 (CMC begins  
at step 4)

### 34.2 Perform P76

34.3 Go to P35, step 2

35.1       $\Delta V$  mag < 7 fps, perform P41 (CMC begins at step 4)  
 $\Delta V$  mag.  $> 7$  fps, perform P40 (CMC begins at step 4)

### 35.2 Perform P76

35.3            MCC2 complete, go to P79 step 2  
                MCC2 not complete, go to P35, step 2

P31 HAM PRETHRUST

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

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- 7 F 16 45 MARKS, TFI, -00001 (marks,min-sec)  
(RECYCLE) V32E  
(FINAL COMP) TERM MARKS  
PRO
- \*F 05 09 \*  
\* 00600 No Intersection on \*  
\* First Iteration \*  
\* 00601 Post CSI hp<85/5.8nm\*  
\* 00602 Post CDH hp<85/5.8nm\*  
\* 00603 TIG(CDH) - TIG(CSI) \*  
\* <10 min \*  
\* 00604 TIG(TPI) - TIG(CDH) \*  
\* <10 min \*  
\* 00605 NO SOL IN 15 TRIES \*  
\* 00606 ΔV(CSI)>1000fps in 2\*  
\* Iterations \*  
\* V32E To 3: Adjust \*  
\* Inputs \*
- 8 F 06 90 Y(Active),YDOT(Active),YDOT(Passive)  
.01nm,.1fps,.1fps  
PRO
- 9 F 06 81 ΔV XYZ (LV) HAM (.1fps)  
PRO (If recycle - To 7)
- 10 F 16 45 MARKS,TFI,MGA (marks,min-sec,.01°)  
(MGA = -00002 if no REFSMFLG)  
SET EVENT TIMER  
PRO (If MINKEY, to Sequencer 31.1)
- 11 F 37

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P32 CSI PRETHRUST (P72 LM)

1

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

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

2

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

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

3

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

4

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

5

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

6

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

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

- 7 F 06 75 ΔH(CDH),ΔT(CDH-CSI),ΔT(TPI-CDH)  
PRO (.1nm,min-sec)
- 8 F 06 90 Y(Active), YDOT(Active), YDOT (Passive)  
.01nm,.1fps,.1fps  
PRO
- 9 F 06 81 ΔV XYZ(LV)CSI (.1fps)  
Change if desired  
PRO (If MINKEY: recycle, to 6  
final pass, to 11)
- 10 F 06 82 ΔV XYZ(LV)CDH (.1fps)  
PRO (If Recycling to 6)
- 11 F 16 45 MARKS,TFI,MGA (marks,min-sec,.01°)  
(MGA Set to -00002 If No  
REFSMFLG or If P72)  
SET EVENT TIMER TO TFI  
PRO (If MINKEY, to Sequencer 32.1)
- 12 F 37

P72 - Transmit mnvr Parameters to LM

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P36 - PLANE CHANGE PRETHRUST

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

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P33 CDH PRETHRUST (P73 LM)  
P32(72) COMPLETE

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

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

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

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

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

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

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

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

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

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- 7 F 06 81  $\Delta V$  XYZ(LV)CDH (.1fps)  
PRO (If Recycling to 4)
- 8 F 16 45 MARKS,TFI,MGA (marks,min-sec,.01°)  
(MGA Set to -00002 If No  
REFSMFLG or If P73)  
SET EVENT TIMER TO TFI  
PRO (If MINKEY, to Sequencer 33.1)
- 9 F 37
- P73 - Transmit mnvr Parameters to LM
- P34 TPI PRETHRUST (P74 LM)
- 1 V37E (34E or 74E)  
(If no REFSMFLG or P74, to 3)
- F 50 25 00017 MINKEY OPTION  
(ACCEPT) PRO  
(REJECT) ENTR
- 2 (If req'd. mnvr <10°, to 3)  
F 50 18 Request MNVR to RPY angles (.01°)  
(ACCEPT) SC CONT - CMC  
CMC MODE - AUTO  
PRO  
(REJECT) ENTR to 3
- DATE 8/30/72
- 06 18 MNVR in progress (.01°)  
When MNVR complete: MINKEY to 3  
Non - MINKEY to 2
- 3 F 06 37 TIG (TPI) (hrs,min,.01sec)  
Load desired TIG  
PRO
- 4 F 06 55 PRECISION OFFSETS, ELEV ANGLE, wt  
(0000X,.01°,.01°)  
Load desired values  
(+00000 in R2 to CALC ELEV  
ANGLE AT TIG TIME)  
PRO

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

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

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

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

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

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

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

11 F 37 P74 - Transmit Mnvr Parameters To LM

P35 TPM PRETHRUST (P75 LM)

P34(74) COMPLETE

V37E (35E or 75E)

(If no REFSMFLG or P75, to 3)

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

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- 2 (If req'd. mnvr <10°, to 3)  
F 50 18 Request MNVR to RPY angles (.01°)  
(ACCEPT) SC CONT - CMC  
CMC MODE - AUTO  
PRO  
(REJECT) ENTR to 3
- 06 18 MNVR in progress (.01°)  
When MNVR complete: MINKEY to 3  
Non - MINKEY to 2
- 3 F 16 45 MARKS,TFI,-00001 (marks,min-sec)  
(RECYCLE) V32E  
(FINAL PASS) TERM MARKS  
PRO
- 4 F 06 81 ΔV XYZ(LV)TPM (.1fps)  
PRO (If recycle - to 3)
- 5 F 16 45 MARKS,TFI,MGA (marks,min-sec,.01°)  
(MGA SET TO -00002 IF NO  
REFSMFLG or If P75)  
PRO (If MINKEY, to Sequencer 35.1)
- 6 F 37 P75 - Transmit Mnvr Parameters To LM

To change ATIGINC:  
V24N1E  
2021E

6 min: 00002E  
06240E

10 min: 00003E  
25140E

3 min: 00001E  
03120E

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P79 RNDZ FINAL PROGRAM

- 1 V37E 79E
- 2 F 50 18 (All gimbal angle errors <10°, to 3)  
Request MNVR to RPY angles (.01°)  
(X-axis track)
- SC CONT - CMC  
CMC MODE - AUTO  
PRO
- 06 18 MNVR in progress (.01°)  
When MNVR complete: to 3
- 3 F 16 54 RANGE,RANGE RATE,THETA(.01nm,.1fps,.01°)  
(Ext. vbs. locked out)  
PRO
- 4 F 37
- P37 RETURN TO EARTH PGM  
~~(LONG CONTROL CANNOT BE DONE WHEN TIME  
TO ENTRY IS <4 HRS: Lunar return only)~~
- Perform the following once:  
V1N1E  
3012E  
Verify R1 = 01457 (1075 nm)
- 1 V37E 37E  
F 06 33 TIG (hrs,min,.01sec)  
Load desired TIG  
PRO
- 2 F 06 60 BLANK,ΔV DESIRED, GAMMA EI DESIRED  
(fps,.01°)  
Load desired ΔV:  
PAD ΔV IF ON TLC  
0. IF ON TEC  
Load R3=0 (Good if VEI > 31 K fps)  
PRO

11/10/72  
DATE

G

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

3

INITIAL CONIC SOLN

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

If Impact LONG &gt; 12° from desired:

TEC:N40E Record R2 as  $\Delta V_{min}$  (fps) TLC: V32E to 1  
 V32E to 1 & use  $|\Delta V| > \Delta V_{min}$  Decrease  $\Delta V$  to  
 Load  $\Delta V$  neg to move LONG WEST move LONG WEST  
 Load  $\Delta V$  pos to move LONG EAST Increase  $\Delta V$  to  
 move LONG EAST

Continue recycles til &lt; 12° from desired LON

If Impact LONG &lt; 12° from desired:

Record Impact LONG as  $\theta_{cl}$  (.01°)Record last  $\Delta V$  DESIRED as  $\Delta V_{inl}$  (fps)

PRO

4

F 06 39  $\Delta T$  TRANSFER (TIG to EI) (hrs,min,.01sec  
PRO  
(RECYCLE) V32E To 1

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5

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

6

F 06 81  $\Delta V$  XYZ(LV) at TIG  
Record R3 as  $\Delta V_{zcl}$  (.1fps)  
N40E  
Record R2 as  $\Delta V_{cl}$  (.1fps)  
Make sign of  $\Delta V_{cl}$  same as  $\Delta V_{inl}$   
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 \*

## INITIAL PRECISION SOLN

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

PRO

8 F 06 39 ΔT TRANSFER  
 PRO

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

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

## LONG. ITERATION

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

12 F 06 60 BLANK,ΔV DESIRED, GAMMA EI DESIRED  
 To move WEST from opl:  
 Load  $\Delta V_{in2} = \Delta V_{cl-10}$   
 (If  $\Delta V_{in1} = 0$  for TEC,  
 $\Delta V_{in2} = -\Delta V_{cl-10}$ )  
 To move EAST from opl:  
 Load  $\Delta V_{in2} = \Delta V_{cl+10}$   
 Record  $\Delta V_{in2}$  (.1fps)  
 R2: Load  $\Delta V_{in2}$  (fps)  
 PRO

\*F 05 09 SAME AS IN 2\*  
 \*V32E. RSET to 11 \*

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

N81E Record R3 as  $\Delta V_{zc2}$  (.1fps)

$$\text{Compute } K = \frac{|\theta_{c2} - \theta_{c1}|}{|\Delta V_{zc2} - \Delta V_{zc1}|}$$

Compute  $\Delta\theta$  LONG =  $\theta_d - \theta_{p1}$  (.01°)  
 Obtain from chart  $\Delta V_o$  (fps)

Make sign of  $\Delta V_o$  same as  $\Delta\theta$  LONG  
 Compute  $\Delta V_d$ :

If TLC and  $\Delta V_{zp1} > 3\Delta V_{xp1}$ :

$$\Delta V_d = \Delta V_{c1} + \Delta V_o$$

V32E to step 1 and use

$\Delta V_d$  in R2 of N60

Otherwise:

$$\underline{\Delta V_{zd}} = \Delta V_{zp1} + \Delta V_o$$

14

$$\Delta V_d = (\Delta V_{zd}^2 + \Delta V_{xp1}^2)^{1/2}$$

To solve for  $\Delta V_d$ :

V37E 30E, Use present time in N33.

Load N81:

$$R1 = \Delta V_{xp1}$$

$$R2 = 0 \text{ (should be)}$$

$$R3 = \Delta V_{zd} \text{ (.1fps)}$$

PRO and rcrd  $\Delta V_d$  (.1fps)  
 from N42 R3.

Make sign of  $\Delta V_d$  same as  $\Delta V_{zd}$   
 V37E 37E to step 1 and use  $\Delta V_d$   
 in R2 of N60

FINAL SOLN

15 F 06 39 AT 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

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- 17 F 06 81 ΔV XYZ(LV) TIG (.1fps)  
(OPTION) N40E - VG MAG avail  
in N40 and N80  
KEY REL  
PRO
- 18 F 04 06 THRUST OPTION  
R1 00007  
R2 0000X  
X=1 (SPS)  
2 (RCS)  
Perform R03 (V48) if not performed just  
prior to P37 call  
PRO
- 19 F 06 33 TIG (hrs,min,.01sec)  
PRO
- 20 F 16 45 MARKS,TFI,MGA (00 00,min-sec,.01°)  
(MGA SET TO -00002 If No  
REFSMMAT SET)  
PRO
- 21 F 37 (40E or 41E)
- OBTAIN ENTRY REFSMMAT (No Comm)  
(Use only after final MCC)
1. Record 400K time from final P37  
solution.  
(Input TIG + FNL N39)
  2. Use 400K time for T-align P52  
(Option 2).  
\*If PROG ALARM 401, Yaw 45°\*  
\* and V32E

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4-19

P76 - ΔV UPDATE (P77 CSM)

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

8/30/12

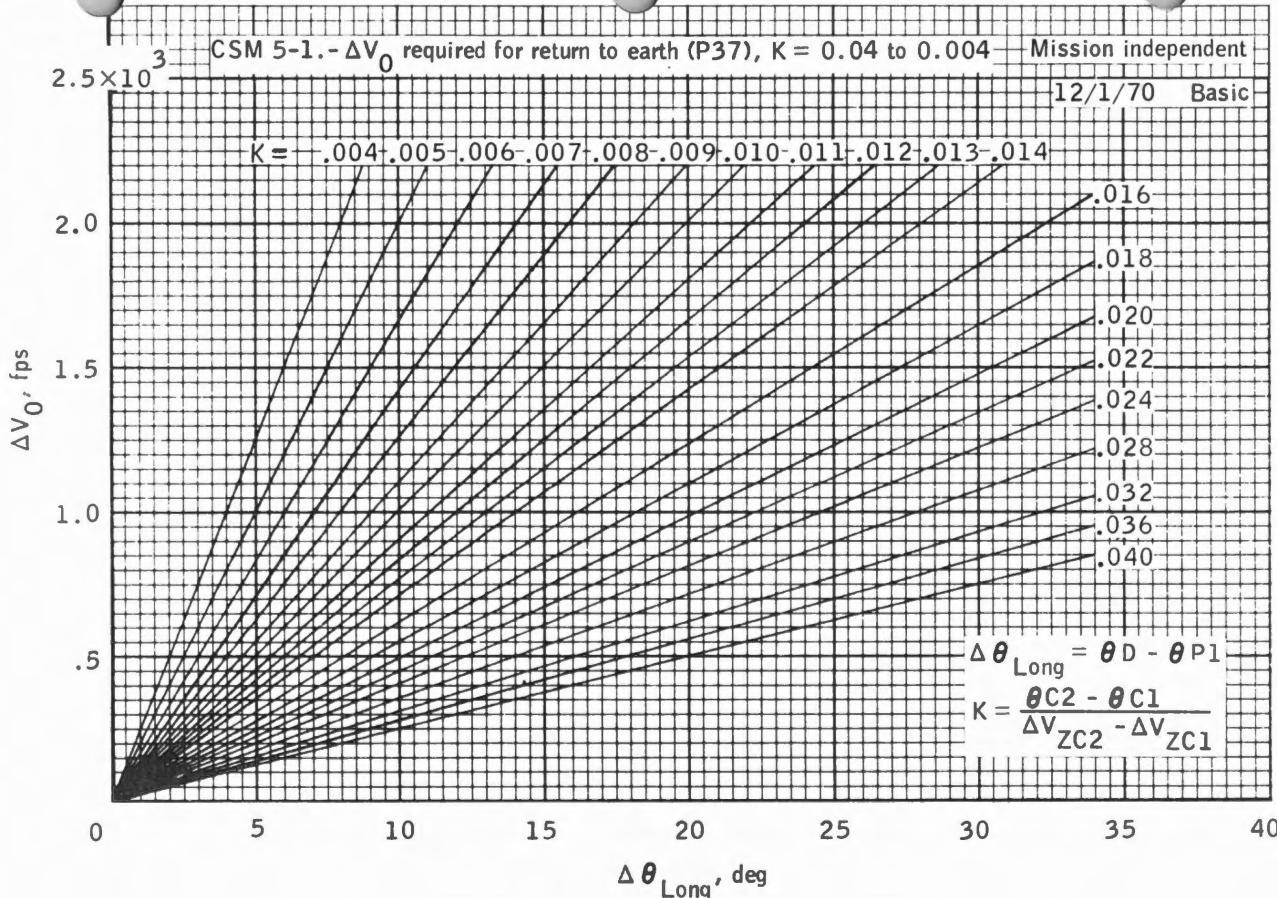
DATE

## P37 LONGITUDE ITERATION

PARAMETER	STEP	1	2	3	
$\Delta V_{min}$	3	_____.	_____.	_____.	fps
$\theta_{c1}$	3	_____.-	_____.-	_____.-	°
$\Delta V_{in1}$	3	_____.	_____.	_____.	fps
$\Delta V_{zc1}$	6	_____.-	_____.-	_____.-	fps
$\Delta V_{c1}$ (Same sign as $\Delta V_{in1}$ )	6	_____.-	_____.-	_____.-	fps
$\theta_{p1}$	7	_____.-	_____.-	_____.-	°
$\Delta V_{xp1}$	10	_____.-	_____.-	_____.-	fps
$\Delta V_{zp1}$	10	_____.-	_____.-	_____.-	fps
$\Delta V_{in2}$	12	_____.-	_____.-	_____.-	fps
$\theta_{c2}$	13	_____.-	_____.-	_____.-	°
$\Delta V_{zc2}$	13	_____.-	_____.-	_____.-	fps
$ \theta_{c2} - \theta_{c1} $	13	_____.-	_____.-	_____.-	°
$ \Delta V_{zc2} - \Delta V_{zc1} $	13	_____.-	_____.-	_____.-	fps
K	13	_____.	_____.	_____.	
$\theta_d$ (desired long)	13	_____.-	_____.-	_____.-	°
$\theta_d - \theta_{p1}$ ( $\Delta \theta$ long)	13	_____.-	_____.-	_____.-	°
$\Delta V_o$ (from chart)	13	_____.0	_____.0	_____.0	fps
$\Delta V_{zd}$	13	_____.-	_____.-	_____.-	fps
$\Delta V_d$	13/14	_____.-	_____.-	_____.-	fps

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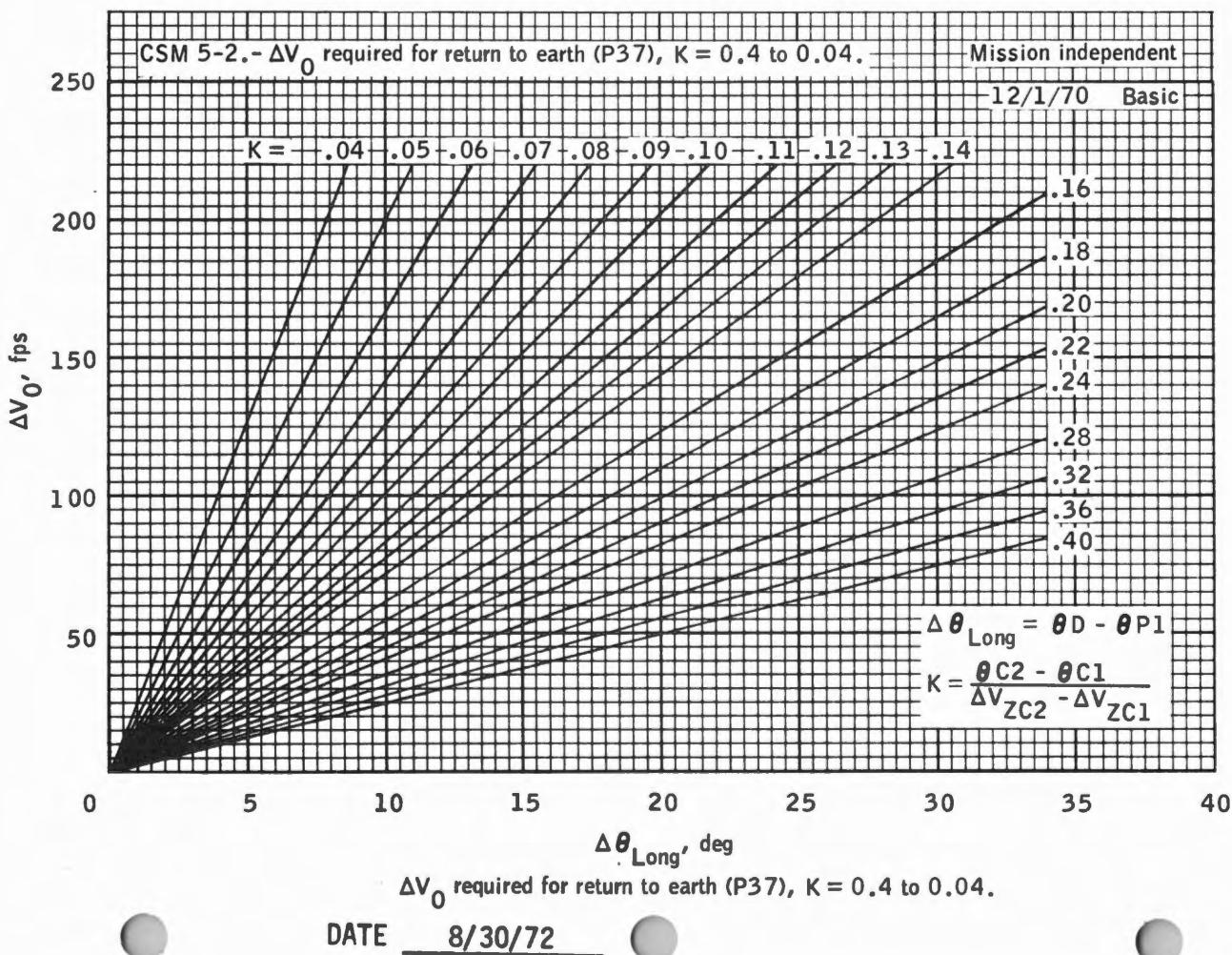
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$\Delta V_0$  required for return to earth (P37), K = 0.04 to 0.004.

$\Delta V_0$  vs  $\Delta \theta_{\text{LONG}}$

$\Delta V_0$  vs  $\Delta\theta$  LONG



## P37 BLOCK DATA

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	GETI △VT LONG GET 400K
	GETI △VT<br

## P37 BLOCK DATA

	GETI
	$\Delta VT$
	LONG GET 400K
	GETI
	$\Delta VT$
	LONG GET 400K
	GETI
	$\Delta VT$
	LONG GET 400K
	GETI
	$\Delta VT$
	LONG GET 400K
	GETI
	$\Delta VT$
	LONG GET 400K
	GETI
	$\Delta VT$
	LONG GET 400K

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P40 SPS THRUSTING

Prethrust Program Complete  
 Verify SIM BASIC and PRE SPS  
 BURN SIM PREP (CUE CARD)  
 CMC & ISS - on  
 SCS - OPERATING  
 TEST C/W LAMPS  
 Perform EMS  $\Delta V$  TEST & NULL  
 BIAS CHECK, pg G/2-5  
 Set  $\Delta V$ C  
 EMS FUNC -  $\Delta V$   
 SPS GAUGING - AC1  
 PUG MODE - NORM  
 OXID FLOW v1v - PRI  
 BMAG MODE (3) - RATE 2  
 CMC MODE - FREE  
 AUTO RCS SELECT(16)-as req'd  
 LOAD DAP (check roll jets)  
 ROT CONTR PWR NORM (2) - AC/DC  
 Set DET

V37E 00E  
 SC CONT - CMC/AUTO

- |   |   |  |        |
|---|---|--|--------|
| 1 | <u>MNVR TO PAD BURN ATT</u>                     |  |        |
|   | V49E  |  |        |
| 2 | <u>PERFORM BORESIGHT &amp; SXT STAR CHECK</u>   |  |        |
|   | V41 N9TE  |  |        |
| 3 | V37E 40E<br>(TFI available via N40, N45 or N35) |  |        |
| 4 | F 50 18   | REQUEST MNVR TO FDAI RPY ANGLES (.01°) | (.01°) |
|   | (AUTO)  | BMAG MODE (3) - RATE 2                 |        |
|   |   | SC CONT - CMC/AUTO                     |        |
|   | PRO   |  |        |
| 5 | 06 18   | AUTO MNVR TO FDAI RPY ANGLES           | (.01°) |

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

TVC CHECK & PREP

cb STAB CONT SYS (all) - close (Pn1 8)  
 cb SPS (12) - close  
 SET ΔVC (verify)  
 EMS FUNC - ΔV (verify)  
 MAN ATT (3) - RATE CMD  
 ATT DB - MIN  
 RATE - LOW  
 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  
 TAPE RCDR - HBR/RCD/FWD/CMD RESET  
 SPS He v1vs (2) - AUTO (verify)  
 Check N2 A and N2 B  
 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

Verify GPI returns to 0,0(CMC)or trim  
(SCS)

(TRIM)

ROT CONT PWR NORM (2) - AC/DC  
ROT CONT PWR DIRECT (2) - MNA/MNB  
BMAG MODE (3) - RATE 2  
PRO  
BMAG MODE (3) - ATT1/RATE 2  
ENTR

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

Monitor GPI Response:  
00,20,-20,00,02,-02,00, Trim

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

(REJECT) ENTR

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

FDAI SCALE - 5/1  
RATE - HIGH  
UPDATE DET

59:00 EMS MODE - NORMAL  
(-01:00) TRANS CONT PWR - ON  
AV THRUST A(B) - NORMAL  
THC - ARMED  
RHC (2) - ARMED

59:25 DSKY BLANKS  
(-00:35)

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59:30 (AVE G ON)  
(-00:30)

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

59:XX ULLAGE  
(-00:XX)

\*If no ULLAGE:  
\* DIR ULLAGE PB - PUSH\*  
\* Control Att with RHC\*

MONITOR  $\Delta$  VM (R3) COUNTING UP

59:55  
(-00:05)

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

9 00:00 IGN \*IF SCS: +X & THRUST PB - PUSH\*

06 40 TFC, VG,  $\Delta$  VM (min-sec, .1fps, .1fps)

\*F 97 40 SPS Thrust fail \*  
\* $\Delta$ V THRUST B(A)-NORMAL \*  
\*(CONT GUID) PRO to 06 40 \*  
\*(RECYCLE) ENTR to TIG-05sec\*

00:03 SPS THRUST Lt - ON  
 $\Delta$ V THRUST B(A) - NORMAL (BT >10 sec)  
\*IF SCS: +X & THRUST PB - PUSH\*

MONITOR THRUSTING

Pc 95-105 psia

EMS COUNTING DOWN

SPS INJ VLVS (4) - OPEN

SPS He vlvs tb-gray

SPS FUEL/OXID PRESS - 170-195 psia

PUGS - BALANCED

DATE 8/30/72

XX:XX ECO

10 F 16 40 TFC (STATIC), VG,  $\Delta$ VM (min-sec,.1fps)  
 $\Delta$ V 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&amp;2 - OFF

PRO

11 F 16 85 VG XYZ (CM) (.1fps)

NULL RESIDUALS

RHC &amp; THC - LOCKED

TRANS CONT PWR - OFF

ROT CONTR PWR DIRECT (2) - OFF

cb DIRECT ULLAGE (2) - open

cb SPS P1 &amp; Y1 - open

RECORD  $\Delta$ V COUNTER & RESIDUALS  $\Delta$ VC

EMS FUNC - OFF VGX \_\_\_\_\_

EMS MODE - STBY VGY \_\_\_\_\_

PRO (IF MINKEY, to Sequencer VGZ \_\_\_\_\_  
 3X.2)

ATT DB - MAX

BMAG MODE (3) - RATE 2

MN BUS TIE (2) - OFF

PCM BIT RATE - LOW

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12 F 37 V82E

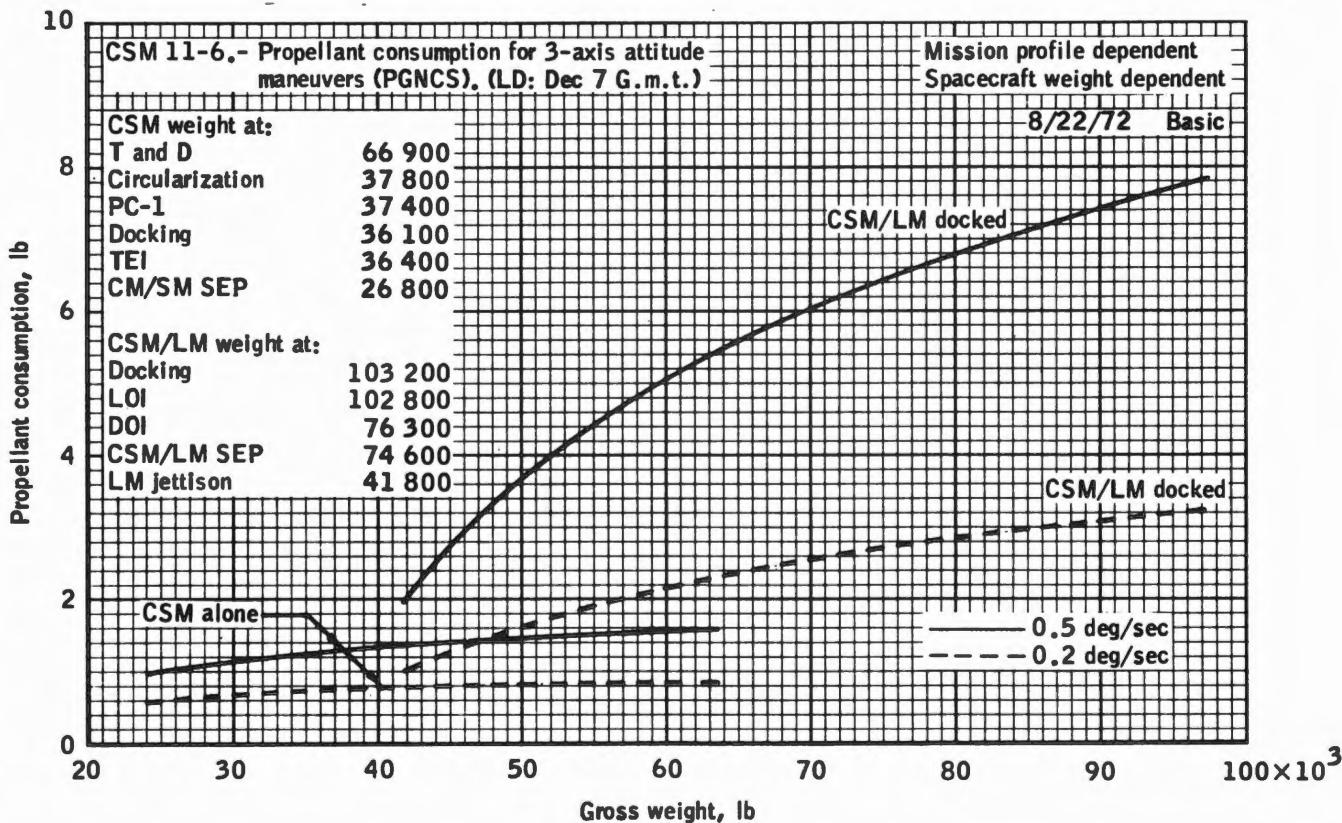
13 F 16 44 HA,HP,TFF (.1nm,min-sec)

PRO

14 F 37 00E

PROP CONS

## PROP CONS



Propellant consumption 3-axis attitude maneuvers (PGNCS).

DATE 8/30/72

DATE 8/30/72

CSM 11-17.- SM RCS propellant translation cost.  
 (LD: Dec 7 G.m.t.)

## SM RCS PROPELLANT TRANSLATION COST

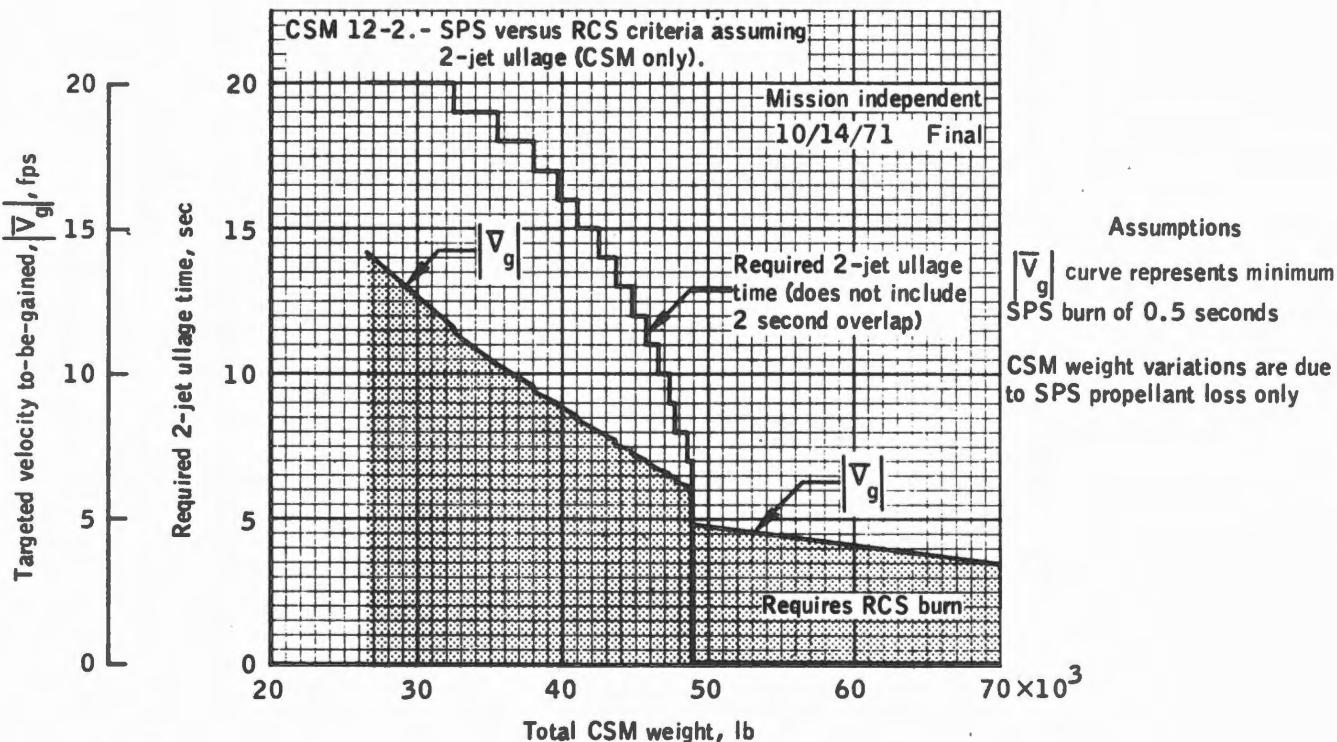
APOLLO 17

(CSM 114/LM-12)

Mission phase	Typical S/C weight (1b)	+X jet G&C (1b/fps)	+X jet SCS (1b/fps)	2 jet A/C G&C (1b/fps)	2 jet A/C SCS (1b/fps)	2 jet B/D G&C (1b/fps)	2 jet B/D SCS (1b/fps)	+Y or +Z G&C (1b/fps)
Translunar	103 000	11.7	13.3	12.0	13.3	12.4	13.3	--
Lunar orbit docked	75 000	8.6	9.3	8.7	9.3	8.8	9.3	--
Lunar orbit undocked	36 500	4.0	4.7	4.1	4.7	4.3	4.7	5.0
Transearth	26 900	3.1	3.8	3.2	3.8	3.4	3.8	3.5

5  
6

# SPS vs RCS CRITERIA

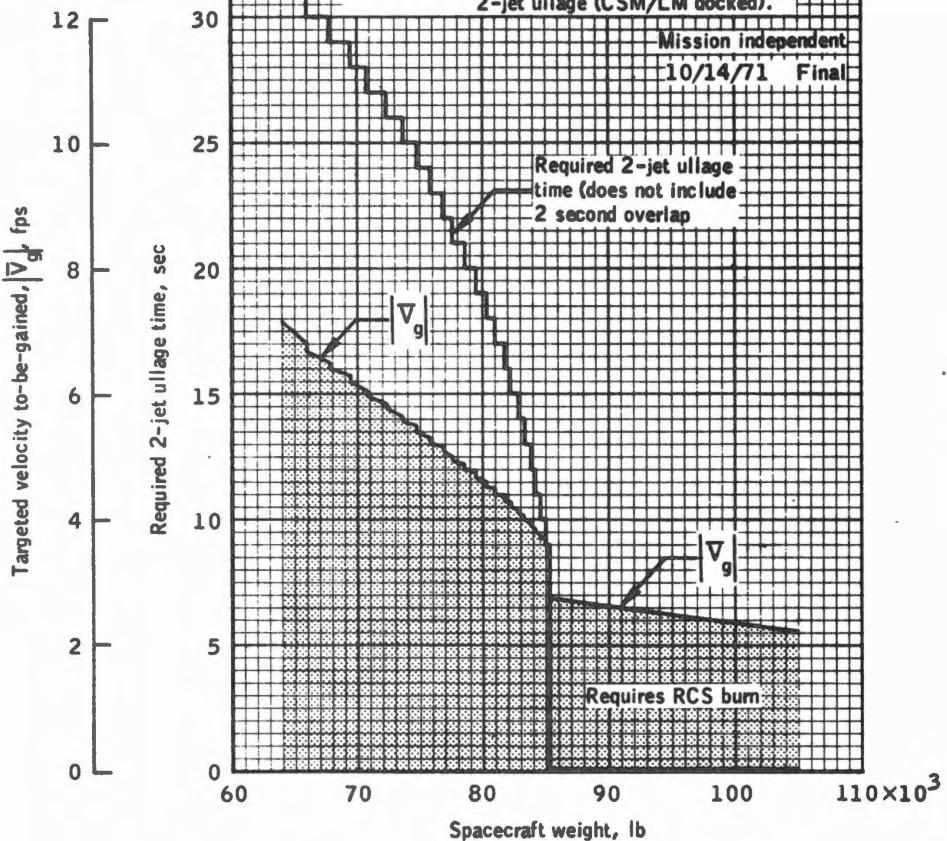


SPS versus RCS criteria assuming 2-jet ullage (CSM only).

DATE 8/30/72CSM 12-1 - SPS versus RCS criteria assuming  
2-jet ullage (CSM/LM docked).

Mission independent

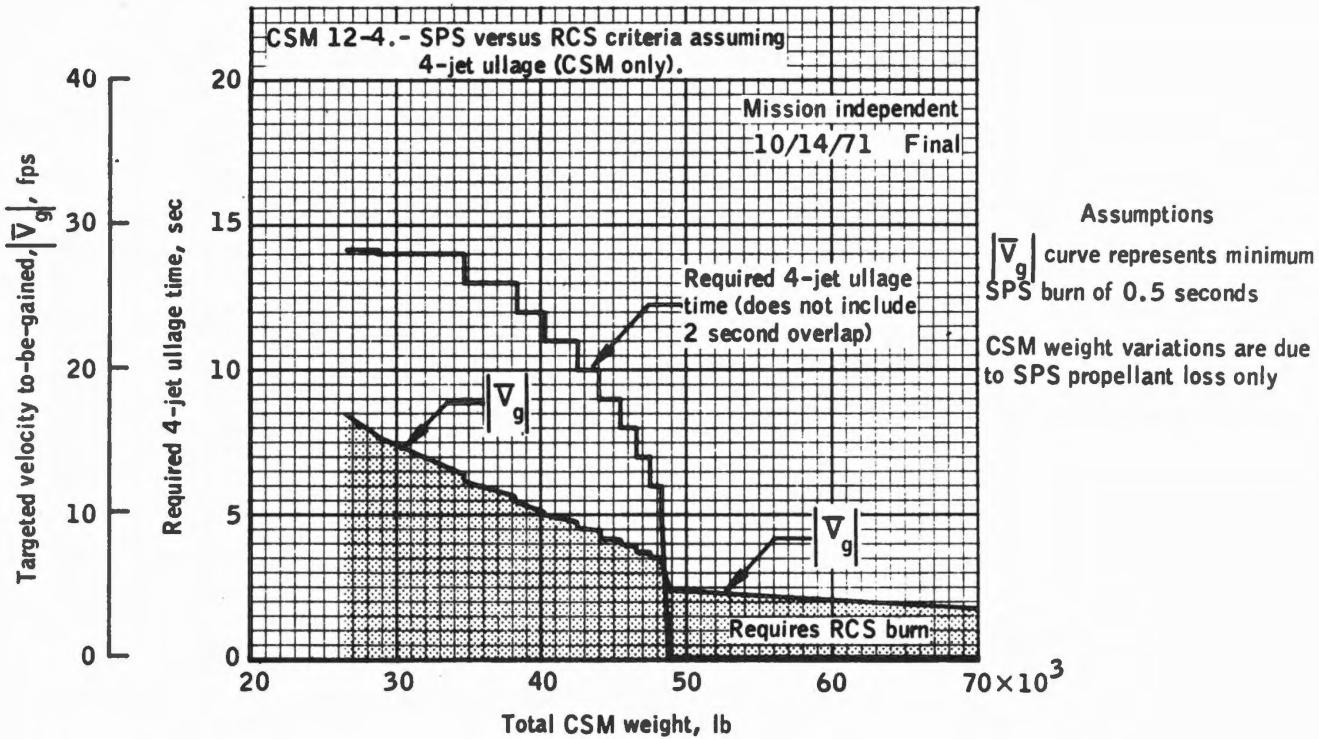
10/14/71 Final

**Assumptions**

Spacecraft weight assumed to consist  
of CSM and fully loaded LM

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

CSM weight variations are due to SPS  
propellant loss only

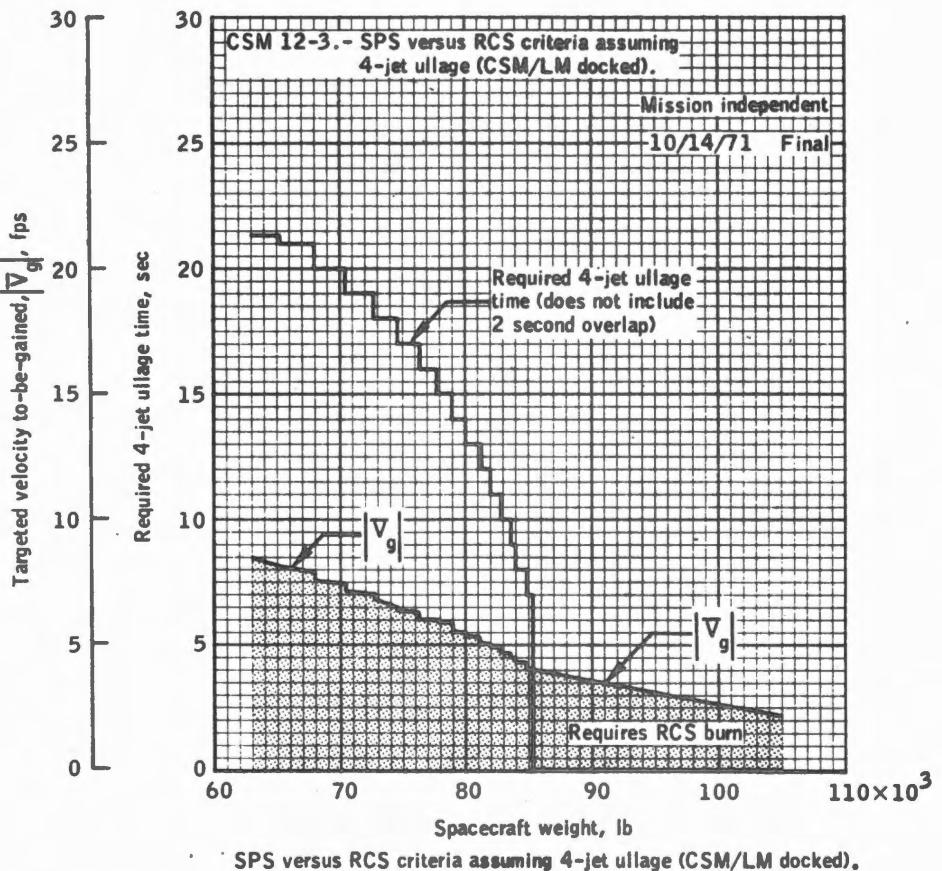


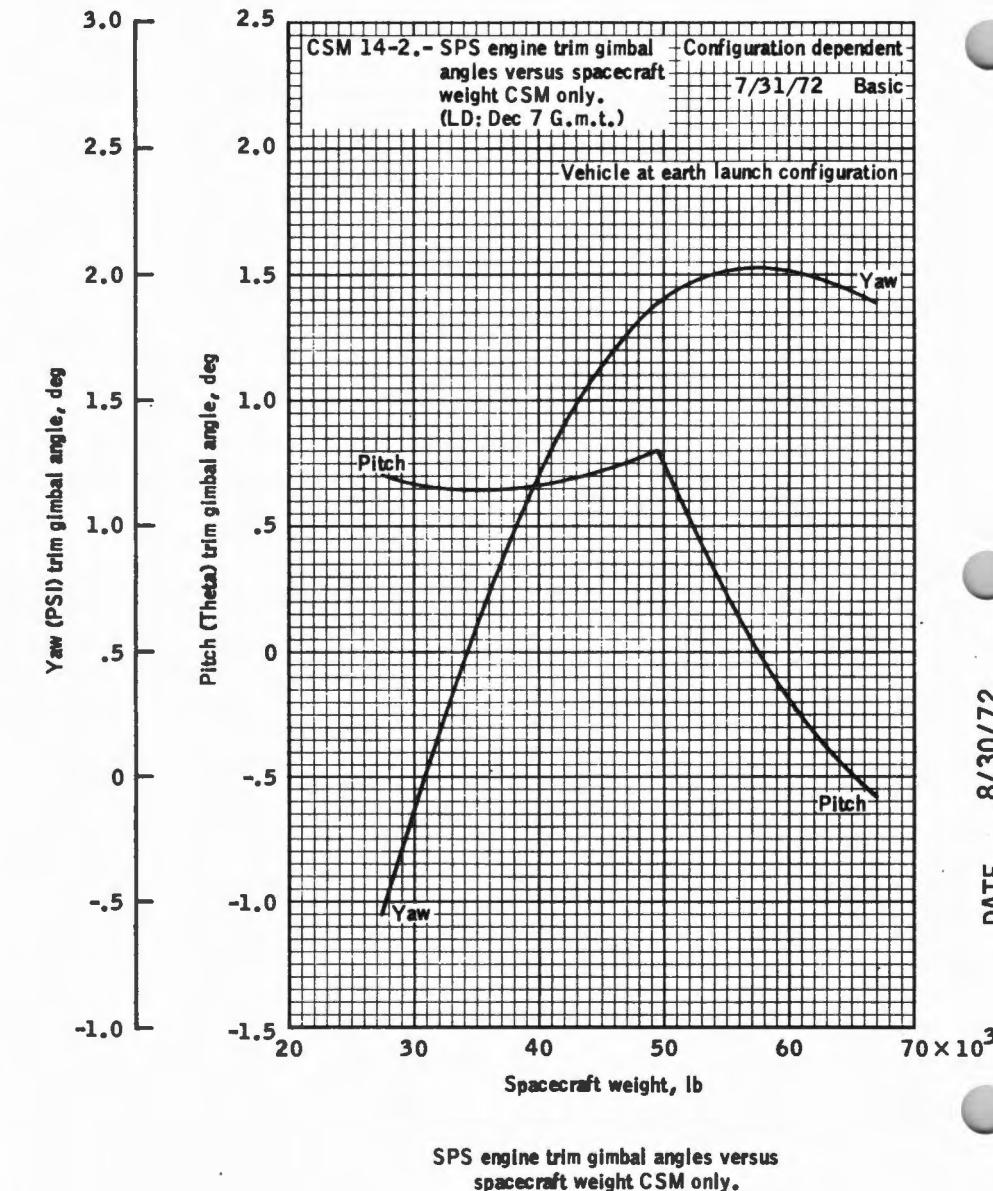
**SPS versus RCS criteria assuming 4-jet ullage (CSM only).**

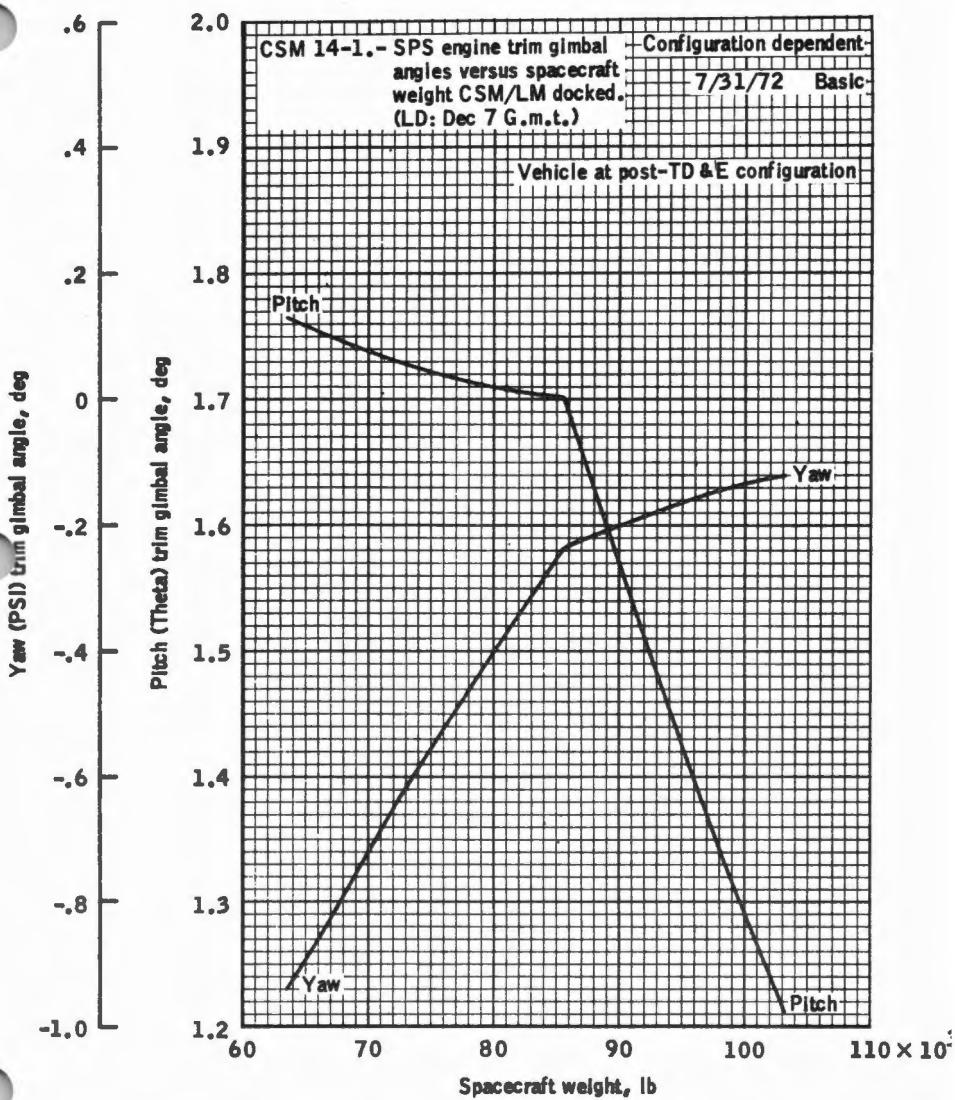
DATE

8/30/72

DATE 8/30/72

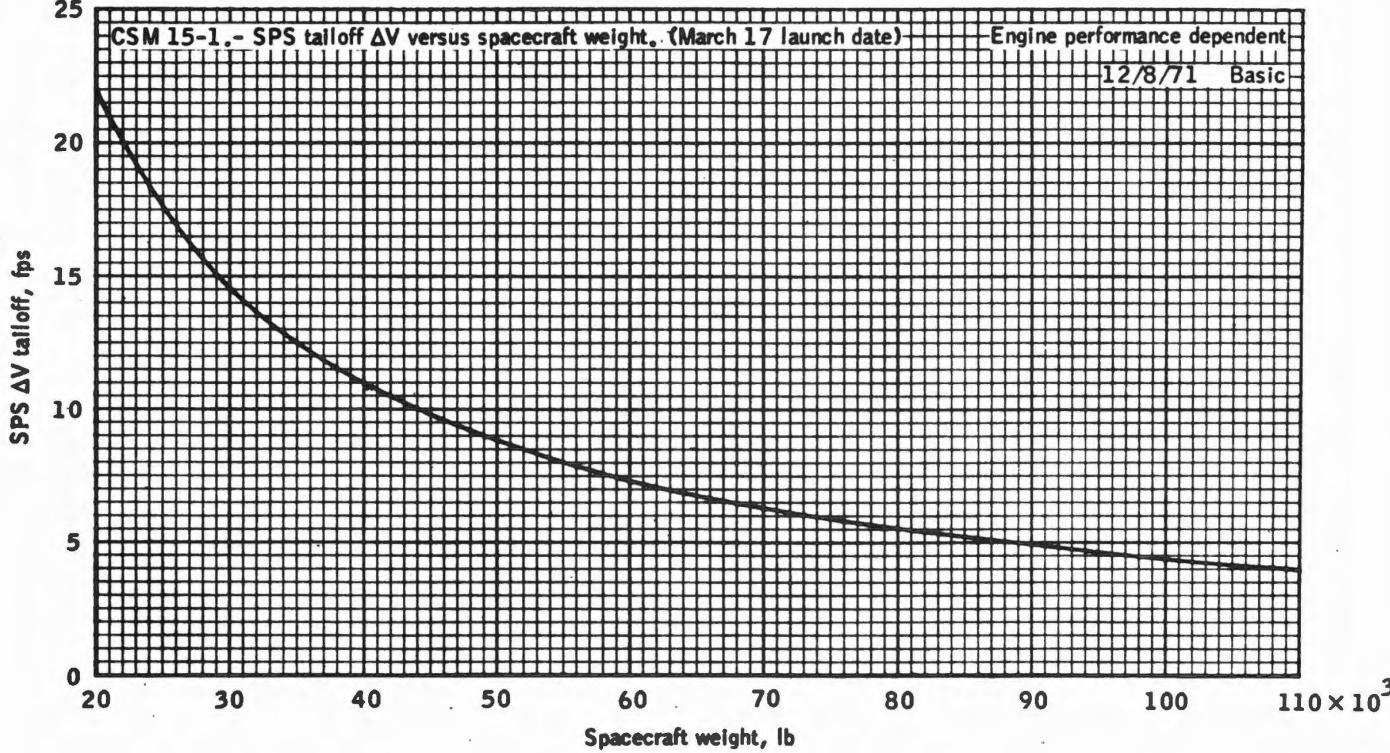






SPS engine trim gimbal angles versus spacecraft weight CSM/LM docked.

25



SPS tailoff  $\Delta V$  versus spacecraft weight.

DATE 8/30/72

P41 - RCS THRUSTING

Prethrust Program Complete  
Verify SIM BASIC CONFIGURATION  
(CUE CARD)  
CMC - on  
ISS - on  
SCS - OPERATING  
TEST C/W LAMPS  
Perform EMS  $\Delta V$  TEST & NULL  
BIAS CHECK, pg G/2-5  
Set  $\Delta V$ C  
EMS FUNC -  $\Delta V$   
BMAG MODE (3) - RATE 2  
CMC MODE - FREE  
AUTO RCS SELECT (16) - as Req'd  
LOAD DAP (check roll jets)  
ROT CONTR PWR NORMAL (2) - AC/DC  
ROT CONTR PWR DIRECT (2) - MNA/B  
Set DET  
V37E OOE  
SC CONT - CMC/AUTO

1

MNVR TO PAD BURN ATTITUDE  
V49E

2

PERFORM BORESIGHT & SXT STAR CHECK  
V41 N91E

3

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

4

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

PRO

5

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

DATE 8/30/72

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

PRO

MAN ATT (3) - RATE CMD  
ATT DB - MIN  
RATE - LOW  
BMAG MODE (3) - ATT/RATE 2  
GDC ALIGN

ENTR

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

\* PROG Alarm It \*  
\* V5N9E - 01703 - TIG SLIPPED \*  
\* KEY RLSE To 7 \*

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

59:25  
(-00:35) DSKY BLANKS

59:30  
(-00:30)

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

DATE 8/30/72

00:00

9 F 16 85

VG X,Y,Z

NULL COMPONENTS

RHC &amp; THC - LOCKED

TRANS CONT PWR - OFF

ROT CONTR PWR DIRECT - OFF

RECORD ΔV COUNTER &amp; RESIDUALS

EMS FUNC - OFF

EMS MODE - STBY

PRO (If MINKEY, to sequencer

3X.2)

ΔVC

VGX

VGY

VGZ

BMAG MODE (3) - RATE 2

TAPE RCDR - off (ctr)

PCM BIT RATE - LOW

10 F 37

V82E

11 F 16 44

HA,HP,TFF

(.1nm,min-sec)

PRO

12 F 37

00E

P47 Thrust Monitor Program

CMC - on

ISS - on &amp; aligned

1

F 16 83

V37E 47E

ΔV XYZ(CSM)

(.1fps)

\*VI,HDOT,H available by N62E\*

\*KEY RLSE to return to N83 \*

(RECYCLE) V32E

(TERM) PRO

2 F 37

00E

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P51 - IMU ORIENTATION

CMC - on  
 ISS - on  
 SCS - operating  
 BMAG MODE (3) - RATE 2  
 OPT ZERO - OFF  
 OPT MODE - MAN  
 G/N PWR OPTICS - on  
 OHC - Drive Trun <10°  
 OPT ZERO - ZERO (15 sec)

- DATE 8/30/72
- |         |  |        |
|---------|--|--------|
| 1       | V37E 51E   |        |
| F 50 25 | 00015 MNVR TO ACQ STARS<br>(Coarse Align IMU To 0,0,0) - ENTR to 2<br>(BYPASS) PRO to 3  |        |
| 2       | 41 22 DESIRED GIMBAL ANGLES (0,0,0)<br>NO ATT lt - on then off, to 1   |        |
| 3       | F 51 PLEASE MARK<br>OPT ZERO - OFF<br>MARK   |        |
| 4       | F 50 25 00016 TERMINATE MARKS<br>PRO   |        |
| 5       | F 01 71 000DE STAR CODE<br>Load desired code<br>PRO to 3 after 1st MARK (to 6 if DE=00)<br>to 7 after 2nd MARK (to 6 if DE=00) |        |
| 6       | F 06 88 CELESTIAL BODY VECTOR<br>Load desired vector<br>PRO to 3 after 1st MARK<br>to 7 after 2nd MARK                         |        |
| 7       | F 06 05 STAR ANGLE DIFFERENCE<br><u>N 05 LIMITS</u><br>2 stars: SXT < + 00003<br>SCT < + 00011                                 | (.01°) |
|         | Star/planet: SXT < + 00018<br>SCT < + 00021  |        |
|         | (RECYCLE) V32E to 1  |        |
|         | (ACCEPT) PRO   |        |

G  
6-2

8 F 37 52E - bypass ZERO OPTICS  
or XXE  
OHC - Drive Trun <10°  
OPT ZERO - ZERO

## P52 IMU REALIGN

CMC - on  
ISS - on  
SCS - operating  
BMAG MODE (3) - RATE 2  
OPT ZERO - OFF  
OPT MODE - MAN  
G/N PWR OPTICS - on  
OHC-Drive Trun <10°  
OPT ZERO - ZERO (15 sec)  
OPT MODE - CMC

Note: MINKEY displays not shown

- 1 V37E 52E

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

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

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

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

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

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- 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)

G  
6-4

- 14 F 06 88 CELESTIAL BODY VECTOR  
Verify vector  
PRO to 8 after 1st MARK  
to 15 after 2nd MARK
- 15 F 06 05 STAR ANGLE DIFFERENCE (.01°)  
N 05 LIMITS  
2 stars: SXT  $\leq$  + 00003  
SCT  $\leq$  + 00011  
Star/planet: SXT  $\leq$  + 00018  
SCT  $\leq$  + 00021  
(REJECT) V32E to 17  
(ACCEPT) PRO
- 16 F 06 93 TORQUING ANGLES OG, IG, MG (.001°)  
(TORQUE) CMC MODE - FREE  
PRO  
(BYPASS) V32E
- 17 F 50 25 00014 ALIGNMENT CHECK  
(RECHECK) PRO to 7  
(BYPASS) ENTR
- 18 F 37 XXE  
OHC - Drive Trun <10°  
OPT ZERO - ZERO  
G/N PWR OPTICS - OFF
- P53 - BACKUP IMU ORIENT DETERMINATION  
CMC - on  
ISS - on  
SCS - operating  
MAN ATT (3) - MIN IMP  
COAS LOS DETERMINATION - complete
- 1 F 50 25 V37E 53E  
00015 MNVR To ACQ STARS  
(BYPASS) (Coarse Align IMU to 0,0,0) - ENTER to 2  
PRO to 3

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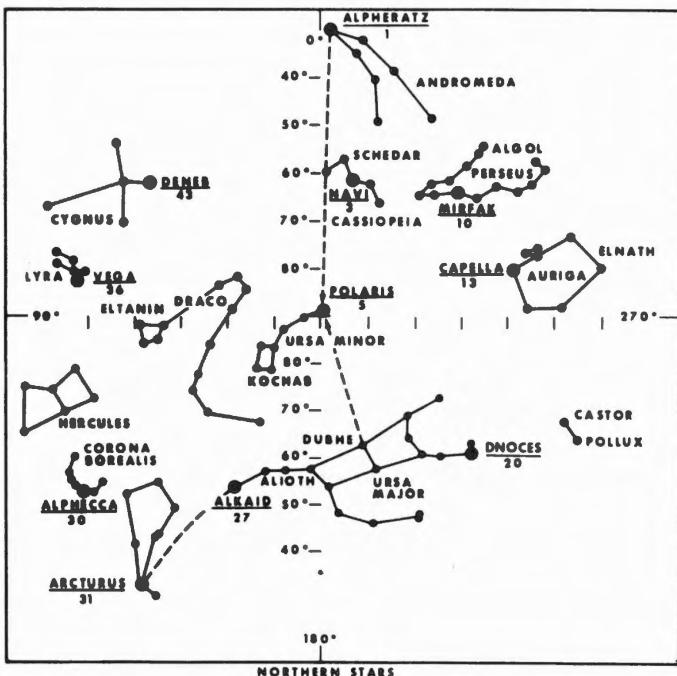
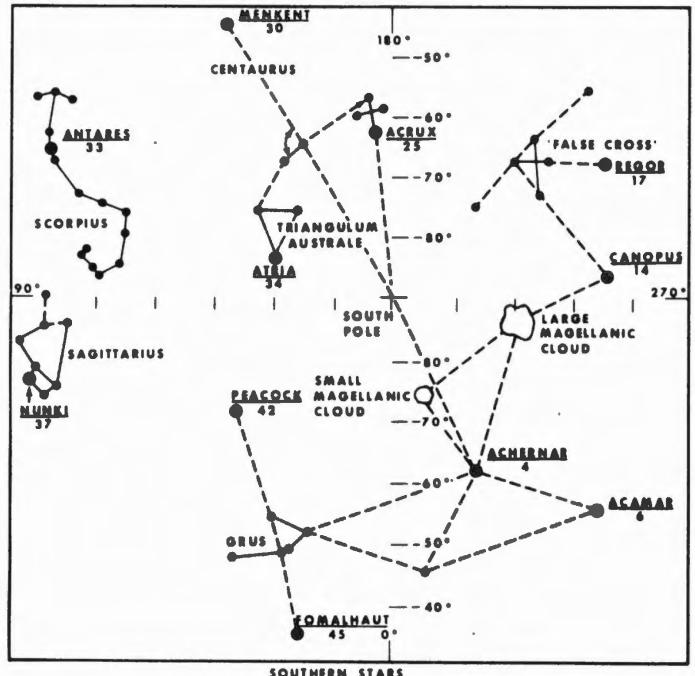
- DATE 8/30/72
- 2 41 22 DESIRED GIMBAL ANGLES (0,0,0)  
NO ATT lt - on then off, to 1
- 3 F 06 94 ALT LOS OPT ANGS SHAFT, TRUN (.01°,.001°)  
Load proper angles  
COAS NOM: Shaft +00000  
Trun +57470  
PRO
- 4 F 53 PLEASE MARK  
Center Target  
ENTR
- 5 F 50 25 00016 TERMINATE MARKS  
(REJECT) ENTR to 4  
PRO
- 6 F 01 71 000DE STAR CODE  
Load desired code  
PRO to 3 after 1st MARK (to 7 if DE=00)  
to 8 after 2nd MARK (to 7 if DE=00)
- 7 F 06 88 CELESTIAL BODY VECTOR  
Load desired vector  
PRO to 3 after 1st MARK  
to 8 after 2nd MARK
- 8 F 06 05 STAR ANGLE DIFFERENCE (.01°)  
N 05 LIMITS (COAS)  
(RECYCLE) V32E to 1  
(ACCEPT) PRO  
2 stars: < + 00070  
Star/planet: ≤ + 00072
- 9 F 37 XXE
- P54 - BACKUP IMU REALIGN  
CMC - on  
ISS - on  
SCS - operating  
MAN ATT (3) - MIN IMP  
COAS LOS DETERMINATION - complete

- 1 F 04 06 V37E 54E  
R1 00001 IMU ALIGN OPTION  
R2 00001 PREF PRO to 4  
2 NOM PRO to 2  
3 REFSMMAT PRO to 7  
4 LDG SITE PRO to 2
- 2 F 06 34 GET ALIGN (0,0,0 initially)  
(hrs,min,.01sec)  
Load desired GET  
TO SPECIFY PRESENT TIME - PRO on (0,0,0)  
PRO (NOM go to 4)
- 3 F 06 89 LAT, LONG/2, ALT (.001°,.001°,.01nm)  
Load 1dg 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 1t - 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)

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- 9 F 06 38 CELESTIAL BODY VECTOR  
Load desired vector  
PRO
- 10 F 06 94 ALT LOS OPT ANGS SHAFT, TRUN(.01°,.001°)  
Load angles  
COAS Nom: Shaft +00000  
Trun +57470  
PRO
- 11 F 53 PLEASE MARK  
Center Target  
ENTR
- 12 F 50 25 00016 TERMINATE MARKS  
(REJECT) ENTR to 11  
PRO
- 13 F 01 71 000DE STAR CODE  
Load code (if necessary)  
PRO to 8 after 1st MARK (to 14 if DE=00)  
to 15 after 2nd MARK (to 14 if DE=00)
- 14 F 06 88 CELESTIAL BODY VECTOR  
Verify vector  
PRO to 8 after 1st MARK  
to 15 after 2nd MARK
- 15 F 06 05 STAR ANGLE DIFFERENCE (.01°)  
N 05 LIMITS (COAS)  
2 stars: < + 00070  
Star/planet: < + 00072  
(REJECT) V32E to 17  
(ACCEPT) PRO
- 16 F 06 93 TORQUING ANGLES OG, IG, MG (.001°)  
(TORQUE) CMC MODE - FREE  
PRO  
(BYPASS) V32E
- 17 F 50 25 00014 ALIGNMENT CHECK  
(RECHECK) PRO to 7  
(BYPASS) ENTR
- 18 F 37 XXE

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DATE



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RAPID IMU REALIGN

NOTE: This procedure assumes a good GDC alignment

- 1 V41 N20E  
Load R,P,Y from GDC Ball
- 2 V40  
Verify R,P,Y on GDC Ball - ENTR  
(Releases Platform And Recovers PGNS Control Modes)
- 3 V25 N07E  
77E, 10000E, 1E (Sets REFSMMAT FLAG)
- 4 V37E 51E, PRO (Sets Drift Flag)
- 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 BURNSDATE 8/30/72

- 1 V37E 52E
- 2 F 04 06      R1=00001  
                  R2=00004 (LOAD LANDING SITE OPTION)  
                  PRO
- 3 F 06 34      GET ALIGN  
                  PRO (SPECIFIES PRESENT TIME)
- 4 F 06 89      LAT, LONG/2, ALT                 (.001, .001°, .01 nm)

		<u>Present Pitch</u>	<u>Δ Vy</u>	<u>R1</u>
	Load R1:	0 $\pm$ 90°	$\pm$	RLS LAT $\pm$ 35°
		180 $\pm$ 90°	$\pm$	RLS LAT $\mp$ 35°
		PRO		
5	F 06 22	NEW ICDU ANGLES PRO		
6	F 50 25	R1=00013 CMC MODE-FREE ENTR TO GYRO TORQUE		
7	16 20	UNTIL TORQUING COMPLETE		
8	F 50 25	R1=00014 ALIGNMENT CHECK CMC MODE - AUTO ENTR		
9	P30			
10	P40			
11		YAW BACK TO 0° (MANUALLY)		
12		V37E 52E		
13	F 04 06	R1=00001 R2=00004 (LOAD LANDING SITE OPTION) PRO		
14	F 06 34	GET ALIGN (LOAD TIME OBTAINED FROM MSFN) PRO		
15	F 06 89	LAT, LONG/2,ALT (LAT WILL BE CHANGED BACK TO STORED RLS) PRO		
16	F 06 22	NEW ICDU ANGLES PRO		

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

GDC ALIGNMENT TO IMU GIMBAL ANGLES

IMU - on  
SCS - operating

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

BACKUP GDC AND/OR IMU ALIGNMENT

(IMU or CMC failed)

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

- 1 IMU PWR - OFF  
Wait ~5 min for gyros to run  
down before step 8
- 2 Set SCT to 0° SHFT, 352.5° TRUN  
OPTICS PWR - OFF
- 3 ATT SET dials - R,P,Y ALIGN

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- 4 Mnvr to position stars in SCT  
0° mark - Sirius (15)  
R line - Rigel (12)
- or
- |           |              |  |              |
|-----------|--------------|--|--------------|
|           | <u>NORTH</u> |  | <u>SOUTH</u> |
| 0° mark - | Navi (3)     |  | Acrux (25)   |
| R line -  | Polaris (5)  |  | Atria (34)   |
- 5 FDAI SELECT - 1  
ATT SET - GDC  
GDC ALIGN PB - push until needles nulled
- 6 ATT SET dials - 0,0,0
- 7 MNVR to 0,0,0 and null error needles
- 8 IMU PWR - on (up)  
(IMU drives to 0°, 0°, 0°)  
Wait 90 sec.
- 9 Uncage IMU  
IMU CAGE - on (up) ~5 sec  
then release
- IN-PLANE GDC ALIGNMENT
- CMC - on  
ISS - on  
SCS - operating
- 1 V37E 52E  
F 04 06 00001  
Load R2=00002  
PRO
- 2 F 06 34 GET ALIGN 0,0,0  
PRO
- 3 F 06 22 R,P,Y
- 4 Set ATT SET dials to R,P,Y on DSKY

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5

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

6

V37E XXE

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

1

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

2

F 04 12 V82E  
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

F 16 54 V83E  
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

STDN Supply Altitude  
ALT SET - Set

3

SC +X At the Horizon

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4

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

LUNAR                    EARTH

<u>Alt(nm)</u>	<u>Angle*</u>	<u>Alt(nm)</u>	<u>Angle*</u>
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  
 OPT ZERO - OFF  
 OPT MODE - MAN  
 G/N PWR OPTICS - on  
 OHC - Drive trun <10°  
 OPT MODE - CMC  
 OPT ZERO - ZERO (15 sec)

- |   |          |  |
|---|----------|--|
| 1 | V37E 52E |  |
| 2 | F 04 06  | 00001<br>00003<br>PRO  |
| 3 | F 50 25  | 00015<br>ENTR  |
| 4 | F 01 70  | 000DE STAR CODE<br>LOAD BORESIGHT STAR CODE<br>OPT ZERO - OFF<br>PRO |

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5 06 92 SHAFT, TRUN (.01°, .001°)  
Center target  
MARK with VERB key  
Record SHAFT, TRUN \_\_\_\_\_  
(REPEAT) KEY RLSE  
(EXIT) V37E XXE  
OPT MODE - MAN  
OHC - Drive trun <10°  
OPT ZERO - ZERO

CMC/LGC CLOCK SYNC/TEPHEM UPDATE  
V16 N65E (On LM request)

(hr,min,.01sec)

Voice CMC time to LM

V05 N01E 1706E (On LM request)

Voice TEPHEM to LM

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

ALIGN LM IMU TO CSM IMU

ATT DB - MIN

RATE - LO

LIMIT CYCLE - ON

SC CONT - SCS

MAN ATT (3) - RATE CMD

BMAG MODE (3) - ATT1/RATE2

V06 N20E

Voice ICDU angles to LM\*

Terminate attitude hold on LM cmd

V06 N20 (On LM request)

On LM MARK, Key ENTR

Copy ICDU angles and transmit to  
MSFN

$$*LM \text{ (IGA)}_p = P20 + 180^\circ$$

$$LM \text{ (OGA)}_y = 300^\circ - R20 + \Delta\theta$$

$$LM \text{ (MGA)}_r = 360^\circ - Y20$$

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Align LM IMU to CSM GDC

SCS - on

GDC - on and aligned

- 1 On LM Request, hold att:  
ATT DB - MIN  
RATE - LO  
LIMIT CYCLE - ON  
BMAG MODE (3) - ATT 1/RATE 2
- 2 On LM Request, Read GDC FDAI R,P,Y then  
ATT SET dials - Set to FDAI R,P,Y  
FDIAI SELECT - 1  
FDIAI SOURCE - ATT SET  
FDIAI SCALE - 5/1  
ATT SET - GDC  
Null FDAOI 1 error needle using ATT SET dials  
Read ATT SET dial angles to LM
- 3 On LM Request, terminate att hold

ALIGN LM AGS TO CSM IMU/GDC

CMC - on

ISS - on and orientation known

or

SCS - on

GDC - on and aligned

- 1 Upon LM request, MNVR to  
 $R = 300^\circ + \Delta\theta$   
 $P = 180^\circ$   
 $Y = 0^\circ$   
and hold att., min DB  
(If SCS: RATE-LO, LIMIT CYCLE-ON)
- 2 Notify LM when at attitude
- 3 When LM alignment complete - terminate att hold

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Align CSM GDC to LM IMU

GDC - on (req)

- 1 Request LM to Hold Attitude, Min DB
- 2 Request and copy LM Readout of V06N20 angles:  
$$\begin{array}{l} \text{LM(OGA)y } \underline{\hspace{1cm}}.{}^\circ \\ \text{LM(IGA)p } \underline{\hspace{1cm}}.{}^\circ \\ \text{LM(MGA)r } \underline{\hspace{1cm}}.{}^\circ \end{array}$$
- 3 ATT SET dials - Set to  
 $R = 300^\circ + \Delta\theta - \text{LM (OGA)y}$   
 $P = \text{LM (IGA)p} - 180^\circ$   
 $Y = 360^\circ - \text{LM (MGA)r}$
- 4 FDAI SELECT - 1  
ATT SET - GDC  
GDC ALIGN - Push
- 5 Notify LM att hold not req

Align CSM GDC to LM AGS

- 1 Request LM MNVR to 0,0,0 on AGS FDAI, min DB
- 2 ATT Set dials - Set to  
 $R = 300^\circ + \Delta\theta$   
 $P = 180^\circ$   
 $Y = 0^\circ$
- 3 FDAI SELECT - 1  
ATT SET - GDC
- 4 When LM at Attitude:  
GDC ALIGN - Push
- 5 Notify LM Att Hold not req'd

Align CSM IMU to LM IMU

CMC - on

ISS - on

SCS - on

- 1 Verify LM in MIN DB, ATT HOLD
- 2 Request and copy LM Readout of V06N20E  
LM(OGA)y \_\_\_\_\_ °  
LM(IGA)p \_\_\_\_\_ °  
LM(MGA)r \_\_\_\_\_ °
- 3 Calculate Gimbal Angles:  
CM (OGA) =  $300^\circ + \Delta\theta - LM (OGA)y$   
CM (IGA) =  $LM (IGA)p - 180^\circ$   
CM (MGA) =  $360^\circ - LM (MGA)r$
- 4 V41N20E  
Load Gimbal Angles
- 5 V40E  
Allow 10 sec before step 7  
Notify LM Att Hold Not Req.
- 6 Set REFSMFLG:  
V25N7E, 77E, 10000E, 1E
- 7 V37E51E  
PRO  
V37EOOE
- 8 Request STDN Uplink REFSMMAT  
then Perform P52 (OPT 3)  
or  
V06N20 On CM Mark - ENTR  
Voice Angles to STDN for calculation  
of Gyro Torquing Angles.  
Perform V42 GYRO TORQUING using ground  
calculated Torquing Angles (p. G/1-24)

Align CSM IMU TO LM AGSCMC - on  
ISS - on

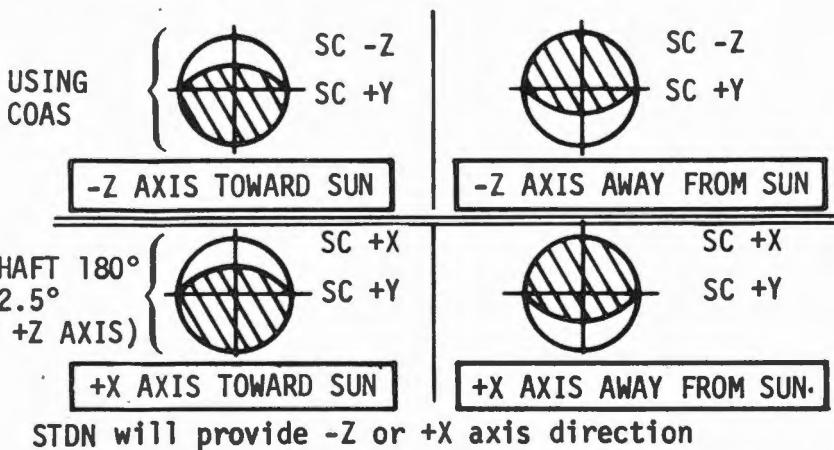
- 1 Request LM MNVR to 0,0,0  
on AGS FDAI
- 2 When LM at Attitude:  
V41N20E  
LOAD: R1 =  $300^\circ + \Delta\theta$   
R2 =  $180^\circ$   
R3 =  $0^\circ$
- 3 V40E  
Allow 10 sec before step 5  
Notify LM Att Hold not req.
- 4 Set REFSMFLG:  
V25N7E, 77E, 10000E, 1E
- 5 V37E51E  
PRO  
V37E00E
- 6 Request STDN Uplink REFSMMAT,  
then, if desired, perform P52 (OPT 3)

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CRESCENT ALIGN

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

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



- 2 (For GDC only, see step 8)  
If CMC not avail:  
Verify IMU PWR - OFF (5 min)  
Go to Step 9
- 3 V41N20E, load desired angles  
from STDN or 0,0,0
- 4 V40, Verify Ref. Line Aligned with Crescent  
ENTR  
Allow 10 sec before step 6
- 5 V25N07E, 77E, 10000E, 1E
- 6 V37E51E, PRO, V37E00E  
Request STDN uplink REFSMMAT and,  
if desired, do P52 (OPT 3)

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- 7 Align GDC to IMU, if desired  
or
- 8 FDAI SELECT - 1  
ATT SET - GDC  
ATT SET DIALS - 0,0,0 (or angles from STDN)  
Verify Ref line aligned to crescent, then:  
GDC ALIGN - Push
- 9 Do not perform this step if CMC avail:  
IMU PWR - ON (up)  
Wait 90 sec  
IMU CAGE - on (up) ~5 sec then release

GDC REFSMMAT DETERMINATION  
(EMP 503)

GDC - on  
CMC - on  
IMU - off  
OPT ZERO - OFF  
OPT MODE - MAN  
G/N PWR OPTICS - ON  
OHC - Drive trun <10°  
OPT ZERO - ZERO (15 sec)

- DATE 8/30/72
- 1 Acquire Apollo Nav star  
in optics  
FDAI Scale - 5/1  
Hold att (ATT DB - MIN, RATE - LO)  
Align GDC to 0,0,0  
V25 N20E  
E,E,E
  - 2 V96E

3 Initiate P51 logic as follows:

V21N1F

1214F

63E (65 if P53 desired)

V25N26E

13001E

3425E

30005E

V30E

(Note: Major mode lts. on DSKY do not change from 00 to 51)

4 F 50 25 00015 ACQ STARS  
PRO

5 F 51 PLEASE MARK  
If necessary, mnvr and:

V25N20E  
Load present GDC angles

**OPT ZERO - OFF**

Null FDAI needles with Min imp  
then:

## MARK

6 F 50 25 00016 TERM MARKS  
PRO

7 F 01 71 00ODE STAR CODE  
Load star code

PRO to 5 after 1st MARK (8 if DE = 00)  
to 9 after 2nd MARK (8 if DE = 00)

8 F 06 88 CELESTIAL BODY VECTOR

## Load vector

PRO to 5 after 1st MARK  
to 9 after 2nd MARK

9 F 06 05 STAR ANGLE DIFFERENCE  
·(Expect  $<1^\circ$ )

(.01°)

(RECYCLE) V32E to 4  
(ACCEPT) PRO

### (ACCEPT) PRO

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10 F 37

00E

OHC - Drive trun &lt;10°

OPT ZERO - ZERO

V25 N26E

E,E,E, (R1,R2,R3 Blank)

CMC has now calculated  
a REFSMMAT for the GDC,  
has set REFSMFLG and  
DRIFTFLG.GDC REFSMMAT REALIGN (P52)

GDC - on and REFSMMAT Known (pg G/7-13)

CMC - on

SCS - operating

IMU - off

OPT ZERO - OFF

OPT MODE - MAN

G/N PWR OPTICS - ON

OHC - Drive trun &lt;10°

OPT ZERO - ZERO (15 sec.)

1

Acquire nav. target in  
optics

Hold att (ATT DB-MIN, RATE-LO)

V25N20E

Load GDC angles

V37E52E

2

F 04 06

R1 00001

R2 00001 PREF PRO to 5

2 NOM PRO to 3

3 REFSMMAT PRO to 7 (P51 preferable)

4 LDG SITE PRO to 3

3

F 06 34

GET ALIGN (0,0,0 initially)

(hr,min,.01 sec)

Load desired GET

TO SPECIFY PRESENT TIME - PRO on (0,0,0)

PRO (NOM go to 5)

4

F 06 89

LAT, LONG/2, ALT (.001°,.001°,.01nm)

Load ldg site coords

PRO

DATE 07/20/12

- 5 F 06 22 NEW ICDU ANGLES OG,IG,MG (.01°)  
(If MG > + 70°, MNVR and reload N20)  
V32E - to 5  
Align GDC to new angles  
V25N20E  
Load new angles  
PRO
- 6 F 50 25 00013 GYRO TORQUE  
PRO (NO ATT lt-on then off,  
PROG ALM - ignore)
- 7 F 50 25 00015 ACQ STARS  
(opt 3) PRO  
(Not opt 3) OPT ZERO - ZERO  
G/N PWR OPTICS - OFF  
V37EXXE - procedure complete
- 8 F 01 70 000DE STAR CODE  
Load desired code  
OPT MODE - CMC (verify)  
OPT ZERO - OFF  
PRO to 10 (to 9 if DE = 00)  
\*F 05 09 00404 (TA > 90°) \*  
\*MNVR & reload N20 - PRO to 10\*
- 9 F 06 88 CELESTIAL BODY VECTOR  
Load desired vector  
PRO  
\*F 05 09 00404 (TA > 90°) \*  
\*MNVR & reload N20 - PRO to 10\*
- 10 06 92 SHAFT, TRUN (.01,.001°)  
(MARK ROUTINE) OPTICS MODE - MAN
- 11 F 51 PLEASE MARK  
(If required) V25N20E  
Load present GDC angles  
Null FDAI needles with  
min imp, then:  
MARK
- 12 F 50 25 00016 TERMINATE MARKS  
PRO

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- 13 F 01 71 000DE STAR CODE  
Load code (if necessary)  
PRO to 8 after 1st MARK (to 14 if DE=00)  
to 15 after 2nd MARK (to 14 if DE=00)
- 14 F 06 88 CELESTIAL BODY VECTOR  
Verify vector  
PRO to 8 after 1st MARK  
to 15 after 2nd MARK
- 15 F 06 05 STAR ANGLE DIFFERENCE (.01°)  
(Expect < .1°, if not V32E to 17)  
(Accept) PRO
- 16 F 06 93 TORQUING ANGLES OG,IG,MG (.001°)  
N93 is indicative of BMAG drift  
since last alignment  
If torque angles excessive  
perform P51  
Otherwise: OHC - Drive trun <10°  
OPT ZERO - ZERO  
G/N PWR OPTICS - OFF  
V37EXXE - procedure complete

- 17 F 50 25 00014 ALIGNMENT CHECK  
PRO to 7

LM STEERABLE ANT POINTING

1. Select V64 (pg G/1-27)
2. Mnvr to N51 angles:

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

P20 - Opt 2 (PTC/Orb rate)

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

Selection of the following programs will  
not stop rotation:

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

DATE 8/30/72

PASSIVE THERMAL CONTROL (G&N)

RHC - Locked

FDI SCALE - 5/1

RCS DAP - Activated

1            V48E (Select 0.5° DB)  
               V37E OOE  
               V49E

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

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

4     06 18      AUTO MANEUVER  
               F 50 18

5            Damp vehicle rates:  
                  ENTR  
                  Disable all jets on two adjacent  
                  quads  
                  Wait for rates to damp (STDN GO or  
                  20 mins)  
                  AUTO RCS SEL (2)-MNA or MNB as follows:  
                  +ROLL          -Roll  
                  A1,C1        A2,C2  
                  or B1,D1      B2,D2  
                  Remaining AUTO RCS SEL (14) - OFF  
                  MAN ATT (ROLL) - RATE CMD

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6            Perform P20, opt-2 (p. G/8-1)  
               Use 0,0,0 in N78  
               Use .42°/sec and .5° in N79  
               Prior to final PRO: cycle CMC  
                  MODE - FREE/AUTO  
               After one jet firing:  
                  MAN ATT (ROLL) - ACCEL CMD

G  
8-3

7

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

To exit G&N PTC to new att:

1. CMC MODE - FREE
2. AUTO RCS SELECT (12) - MNA/B
3. Verify POO
4. MAN ATT (3) - RATE CMD
5. CMC MODE - AUTO  
(PTC rates will stop)
6. V49E to new att.

PASSIVE THERMAL CONTROL (SCS)

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

1

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

2

AUTO RCS SEL -  
Configure for single jet operation  
Wait for rates to damp (STDN GO or  
20 mins)

3

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

4

Enable jet couple in roll  
Initiate Desired Roll Rate

5

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

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TERMINATE PTC

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

PITCH ORBIT RATE MANEUVER (G&N)

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

1. Establish initial attitude
2. Perform P20 Opt. 2 (p. G/8-1)
3. To terminate: V56E

PITCH ORBIT RATE MANEUVER (SCS)

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

- 1 FDAI SCALE - 5/1
- 2 Maneuver to desired LCL Vert  
Att (Roll = 7.25° or 187.25°)
- 3 BMAG MODE (3) - ATT 1/ RATE 2  
DEADBAND - MAX  
RATE - LOW  
MAN ATT (ROLL, YAW) - RATE CMD  
MAN ATT (PITCH) - MIN IMP
- 4 Establish desired Pitch Rate  
using MIN IMP & ORDEAL FDAI
- 5 To terminate:  
MAN ATT (PITCH) - RATE CMD

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

G-85

MODE	DB Centered	DB Source	Rates Nullled
V56E		DAP (R03)	X
V37E00E		DAP (R03)	X
SC CONT-SCS	X	SCS (Return to CMC re-establishes N79 db)	X (Return to CMC re-establishes N79 rate)
CMC MODE-HOLD	Not proper HOLD func. RHC deflection recommended for HOLD	N79	(Jet firings possible)
CMC MODE-FREE/AUTO	X	N79	
RHC deflection	X	Unchanged	X
V46E	X	N79	
V48E, PRO		DAP (R03)	

G  
8-6  
JET MONITOR (EMP 523)

CMC MODE - AUTO or HOLD  
SC CONT - CMC  
RCS DAP - ON  
P20 Opt 1,2, or 5 Selected

1      AUTO UPDATE

UPTLM (2) - ACCEPT  
UPLINK ACTY 1t - ON  
STDN WILL UPLINK EMP 523 (p.G/8-7)  
UPLINK ACTY 1t - OUT  
UPTLM (MDC) - BLOCK  
\*Do not call other CMC \*  
\*programs (V37EXXE) or take\*  
\*VHF marks. Do not call \*  
\*EMP 523 during P23, P24, \*  
\*or Ave-G. \*

2      V5 N26E, verify  
          R1 00001  
          R2 00605  
          R3 00006

3      V31E

4      V16 N45E  
          R1 XXBYY verify XX incrementing  
          \*Poss MASTER ALARM/ISS WARN\*  
          \*V25 N7E \*  
          \*11E \*  
          \*1E \*  
          \*E \*  
          \*RESET MASTER ALARM \*

5      TERMINATE  
          V37E XXE  
          or TERMINATE in P20  
          V37E 30E  
          V37E 20E

6      V25N26E  
          E, E, E      (R1, R2, R3 Blank)

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EMP 523  
JET MONITOR

PURP	V	7	1	V	7	1	V	
GET	:	:		:	:		:	:
304 01	INDEX	2	4	INDEX	2	1	INDEX	
305 02	0	0	6	0	4	0	0	6
306 03	0	0	0	0	0	1	0	0
307 04	3	0	0	0	7	0	0	6
310 05	5	4	7	7	1	0	0	6
311 06	0	5	4	0	2	0	0	6
312 07	0	5	0	1	5	1	0	6
313 10	7	7	7	7	7	0	0	6
314 11	3	0	0	0	7	2	4	7
315 12	5	4	6	0	4	0	5	2
316 13	4	1	6	5	5	0	0	1
317 14	6	0	6	4	4	0	0	6
320 15	5	4	0	0	1	3	4	7
321 16	3	4	7	6	7	0	0	0
322 17	5	4	6	4	5	0	5	0
323 20	5	0	6	4	5	0	0	6
324 21	1	1	5	6	7	7	7	6
325 22	0	0	6	2	5			
326 23	0	0	6	3	2			
327 24	6	0	0	0	1			

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ICDU-TRANSIENT MONITOR (EMP 526)

(Awake Period Use)

P00 or P20 Opt 2 or 5 Selected

1

AUTO UPDATE

UPTLM (2) - ACCEPT

UPLINK ACTY 1t - ON

STDN WILL UPLINK EMP 526

UPLINK ACTY 1t - OUT

UPTLM (MDC) - BLOCK

\*Do not call MINKEY, P20 (Opt 0 or 4),\*

\*P22, P23, P31, P32, P33, P36, or \*

\*CMC Self-check \*

2

V5 N26E, verify

R1 00001

R2 01517

R3 00005

3

V31E

4

V16 N45E

R1 XXBYY verify XX incrementing

\*Poss MASTER ALARM/ISS WARNING \*

\*OPR ERR 1t - ON (ICDU TRANSIENT)\*

\*Key RSET (OPR ERR 1t - OFF) \*

\*V4OE \*

\*V1 N10E, 11E, Read R1 \*

\* 4 or 5 in A = ICDU Z \*

\* 4 or 5 in B = ICDU Y \*

\* 2 or 3 in B = ICDU X \*

\* 6 or 7 in B = ICDU X&Y \*

\*V25 N7E, 11E, 46001E, E \*

\*RESET MASTER ALARM \*

5

TERMINATE or TERMINATE in P20

V74E V74E

V37EXXE V37E30E, V37E20E

6

V25 N26E

E,E,E (R1, R2, R3 Blank)

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JET AND ICDU-TRANSIENT MONITOR (EMP 528)

(Sleep Period Use)

EMP 526 Has Been Uplinked

CMC MODE - AUTO or HOLD

SC CONT - CMC

RCS DAP - ON

P20 Opt 2 or 5 Selected

1

AUTO UPDATE

UPTLM (2) - ACCEPT

UPLINK ACTY 1t - on

STDN WILL UPLINK EMP 528

UPLINK ACTY 1t - OUT

UPTLM (MDC) - BLOCK

\*Do not call MINKEY, P20 (Opt 0 or 4),\*

\*P22, P23, P31, P32, P33, P36, or \*

\*CMC Self-check \*

2

V5 N26E, verify

R1 00001

R2 01522

R3 00005

3

V31E

4

V16 N45E

R1 XXBYY verify XX incrementing

\*Poss MASTER ALARM/ISS WARNING \*

\*OPR ERR 1t - OFF (JET-ON FAILURE)\*

\*OPR ERR 1t - ON (ICDU TRANSIENT) \*

\* Key RSET (OPR ERR 1t - OFF) \*

\* V40E \*

\* V1 N10E, 11E, Read R1 \*

\* 4 or 5 in A = ICDU Z \*

\* 4 or 5 in B = ICDU Y \*

\* 2 or 3 in B = ICDU X \*

\* 6 or 7 in B = ICDU X&amp;Y \*

\*V25 N7E, 11E, 46001E, E \*

\*RESET MASTER ALARM \*

DATE 11/10/72

5

TERMINATE or TERMINATE in P20

V74E V74E

V37E XXE V37E30E, V37E20E

6

V25 N26E

E,E,E (R1, R2, R3 Blank)

ERASABLE LOAD UPDATE

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

V74E (Wait 42 sec:HBR) (DUMP E MEMORY)

V36E

V48E (LOAD DAP as DESIRED - use

V46E latest known weights)

V25N07E 77E 10000E 1E (set REFSMFLG)

V1N1E 104E (verify CMON FLAG and LMOMN FLAG)

(BITS 11 AND 12 SHOULD BE 0 IN

EARTH SPHERE and 1 in MOON SPHERE)

Verify E MEMORY (should be done ASAP)

V1N1E

XXXXE LOAD OID 2 OF UPDATE (SEE FLIGHT PLAN  
SUPPLEMENT for UPDATES)

N15E, READ R1, E REPEAT FOR UPDATES A-L

FOR UPDATES M, N and O

V1N1E

1. XXXXE (LOAD EVEN OID'S)

2. READ R1, E (READ ODD OID'S IN R1)

RETURN TO 1

IN CASE OF A DISCREPANCY

LOAD THAT UPDATE AS A NORMAL P27

V37E51E, PRO (Sets drift flag)

V37E00E

OPT ZERO - OFF

OHC - drive trun <10°

OPT ZERO - ZERO

P52-OPTION 3-AUTO OPTICS (2 stars)

AUTO OPTICS SUCCESSFUL, REFSMMAT VALID

AUTO OPTICS UNSUCCESSFUL, DO P51

V16 N65E verify CMC CLOCK (UPDATE)

G  
9-2

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  
POO TO BRING S.V. TO PRESENT TIME.

DATE 8/30/72

## LM OR CSM S.V. READOUT

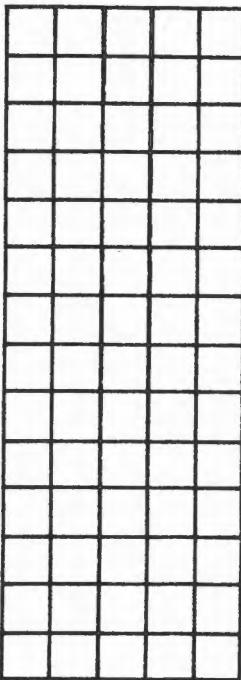
1 V96E, V83E

2 After Integration: V05N01E

CSM S.V.

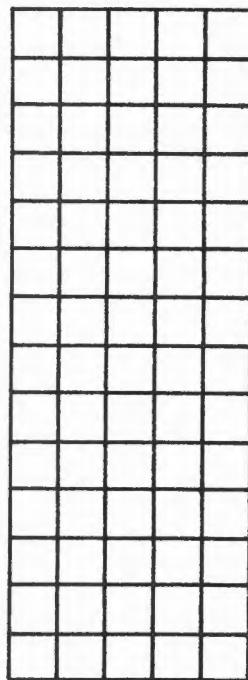
LM S.V.

2253E



2223E

E.2256E



E,2261E

E.2237 E

E.2264E

E.2242E

E,2333E

E,2333E

PRO

PRO

3

Transmit S.V. & Time Tag  
To LM

## LM OR CSM S.V. LOADING

V37E00E

Y71E

21E

1501E

Earth: (CSM S.V.) 00001E, Plus Xmited Pad  
(LM S.V.) 77776E, Plus Xmited Pad  
Lunar: (CSM S.V.) 00002E, Plus Xmited Pad  
(LM S.V.) 77775E, Plus Xmited Pad  
V33E