G&C

NATIONAL AERONAUTICS AND SPACE ADMINIST

APOLLO 14

CSM 110

BASIC

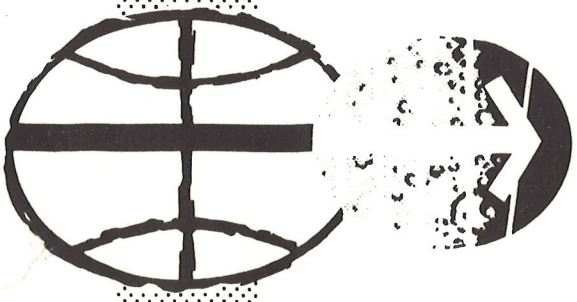
CSM G&C CHECKLIST

PREPARED BY

GUIDANCE & CONTROL SECTION

SPACECRAFT SYSTEMS BRANCH

FLIGHT CREW SUPPORT DIVISION



MANNED SPACECRAFT (

HOUSTON, TEXAS

JULY 1, 1970

CHANGE B
1/13/71

REVISED 10/22/70

CHANGE A 12/17/70

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APOLLO 14

CSM G&C CHECKLIST

CHANGE B

JANUARY 13, 1971

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CSM G&C CHECKLIST

LIST OF EFFECTIVE PAGES

BASIC DATE 7/1/70
REVISED 10/22/70
CHANGE 12/17/70
CHANGE A 12/17/70
CHANGE B 1/13/71

* INDICATES CURRENT CHANGE

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LIST OF EFFECTIVE PAGES (CONT)

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LIST OF EFFECTIVE PAGES (CONT)

CONTENTS

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Front

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CMC GENERAL

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STAR LIST

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

Back

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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 (N20)
41 Coarse Align CDU (N20 & N91)
42 Fine Align IMU
43 Load FDAI ATT Error needles
*44 Set Surface Flag
*45 Reset Surface Flag
*46 Activate DAP
*47 Set LM State Vector into CSM State Vector
48 Load DAP (R03)
49 Start Crew Defined MNVR(R62)
50 Please Perform
51 Please Mark
*52 Marked on offset landing site
53 Please Mark alternate LOS
54 Start REND backup sighting mark (R23)

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55 Increment CMC Time (Decimal)
*56 Terminate Tracking (P20)
57 Start REND sighting mark (R21)
*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
*76 Set preferred att flag (pref track axis)
*77 Reset preferred att flag (X axis)
*78 Update prelaunch azimuth
79 Start DAP PTC/ORB RATE Routine
*80 Update LM State Vector
*81 Update CSM State Vector
82 Start Orbit Param Disp (R30)
83 Start REND Param Display (R31)
85 Start REND Param Display No.2 (R34)
*86 Reject REND backup sighting mark
*87 Set VHF range flag
*88 Reset VHF range flag
89 Start REND Final ATT Routine (R63)
90 Request REND out of plane display (R36)
91 Compute Banksum
*93 Enable W matrix initialization
*94 Enable CISLUNAR Tracking recycle
*96 Terminate integration and go to P00
(Select P00 by V37 after use of V96)
97 SPS Thrust Fail (R40)
99 Enable engine ignition

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

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NOUN LIST (Decimal)

01	Specify Machine Address (Fract) (R1,R2,R3)	.XXXXX
02	Specify Machine Address (Whole) (R1,R2,R3)	XXXXX.
03	Specify Machine Address (can be R1,R2,R3)	.01°
05	Angular Error/Diff	.01°
06	Option Code (R1 & R2)	OCTAL
07	BIT operator: Address,BIT ID, Action	OCTAL
08	Add +1 of error	OCTAL
	B BANK + SUPERBANK	OCTAL
	No of SELF TEST errors	OCTAL
09	Alarm Codes	OCTAL
10	Channel to be Specified (R1)	OCTAL
11	TIG (CSI)	hrs,min,.01sec
12	Option code (R1&R2)	OCTAL
13	TIG (CDH)	hrs,min,.01sec
15	Increment Machine Address (R1)	OCTAL
16	Time of event	hrs,min,.01sec
17	Astronaut total att	R,P,Y .01°
18	Auto Maneuver	R,P,Y .01°
20	Present ICDU Angles	R,P,Y .01°
21	PIPA PULSES X,Y,Z	Pulses
22	New ICDU Angles	R,P,Y .01°
24	Delta CMC Clock Time	hrs,min,.01sec
25	Checklist (please perform)	
26	Prio/Delay, ADRES, BBCON(R1,R2 & R3)	OCTAL
27	Self-Test on/off sw	
29	X SM LAUNCH Azimuth	.01°
30	Target Code(Gyrocomp verif)	
32	Time from Perigee	hrs,min,.01sec
33	Time of Ignition (GETI)	hrs,min,.01sec
34	Time of Event	hrs,min,.01sec
35	Time from Event	hrs,min,.01sec
36	Time of CMC Clock	hrs,min,.01sec
37	GETI-TPI	hrs,min,.01sec
38	State Vector Time	hrs,min,.01sec
39	Δ Time of Transfer	hrs,min,.01sec

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40	TF GETI/TFC	min-sec
	VG	.1 FPS
	ΔV (Accumulated)	.1 FPS
41	Target	Azimuth .01°
		Elevation .001°
		Ident 0000X
42	Apogee Alt (HA)(RLS/Pad)	.1 NM
	Perigee Alt (RLS/Pad)	.1 NM
	ΔV (Required)	.1 FPS
43	Lat	.01°
		(+ North)
	Long	.01°
		(+ East)
	Alt (RLS/Pad)	.1 NM
44	Apogee Alt (HA) (RLS/Pad)	.1 NM
	Perigee Alt (HP)(N50)(RLS/Pad)	.1 NM
	TFF	min-sec
45	Marks	XXBXX
	TF GETI of next burn	min-sec
	MGA	.01°
46	DAP Config (R1&R2)	OCTAL
47	CSM weight	LBS
	LM Weight	LBS
48	Pitch Trim	.01°
	Yaw Trim	.01°
49	ΔR	.1 NM
	ΔV	.1 FPS
	SOURCE CODE (1 optics,2 VHF)	0000X.
50	ΔR (miss distance)	.1 NM
	PERIGEE (HP)(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 To Splash	.1 NM
	VIO, Predicted Iner Vel	FPS
	TFE, time from .05G	min-sec
64	Drag Acceleration	.01 G
	VI, Inertial Velocity	FPS
	RTOGO to Target	.1 NM
65	Sampled CMC Time (fetched in interrupt)	hrs,min,.01 sec
66	Beta, CMD Bank Angle	.01°
	CRSRNG Error	.1 NM
	DNRNG Error	.1 NM
67	RTOGO to Target	.1 NM
	Lat, Present Position	.01° (+ North)
	Long, Present Position	.01° (+ East)
68	Beta, CMD Bank Angle	.01°
	VI, Inertial Vel.	FPS
	H Dot, Alt Rate	FPS
69	Beta	.01°
	DL	.01 G
	VL	FPS
70	Star Code(before mark)	OCTAL
	LMK Data	OCTAL
	Horiz data	OCTAL

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ALARM CODES

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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
79	PTC/Orb Rate		.0001°/sec
	PTC/Orb deadband		.01°
	PTC/Orb Code		XXXXX
80	TF GETI/TFC		min-sec
	VG		FPS
	ΔV (Accumulated)		FPS
81	ΔVX,Y,Z (lcl vert)		.1 FPS
82	ΔVX,Y,Z (LV) CDH		.1 FPS
83	ΔVX,Y,Z (Body Control Axis)		.1 FPS
84	ΔVX,Y,Z (Other Vehicle)		.1 FPS
85	VGX,Y,Z (Body Control Axis)		.1 FPS
87	Opt Calib Data - Shaft (R1)		.01°
	Trunnion(R2)		.001°
88	Planet	X	.XXXXX
		Y	.XXXXX
		Z	.XXXXX
89	Landmark - Lat		.001° (+ North)
	Long/2		.001° (+ East)
	Alt (Mean lunar radius)		.01 NM
90	REND out of	Y	.01 NM
	Plane para	Y DOT	.1 FPS
		PSI	.01°
91	OCDU Angles Shaft (R1)		.01°
	Trunnion (R2)		.001°
92	New OCDU Angles Shaft (R1)		.01°
	Trunnion (R2)		.001°
93	Delta Gyro Angles X,Y,Z		.001°

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94	OCDU ANGLES (R56 & R23)		
		R1 SHAFT	.01°
		R2 TRUNNION	.001°
95	Pref att ICDU angles		.01°
96	+X axis att ICDU angles		.01°
97	System Test Inputs		XXXXX.
			XXXXX.
			XXXXX.
98	System Test Results		XXXXX.
			.XXXXX
			XXXXX.
99	POS ERR		1 FT
	VEL ERR		.1 FPS
	OPTION Code		0000X

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V05 N09 ALARM CODES

00110 Mark reject has been entered but ignored
Continue

00112 Mark reject with no marks being accepted
Continue

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

00114 More marks made than desired
Continue

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

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

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

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

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

00122 Marking not called for
Continue.

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

00206 The IMU zero routine has been entered with both the GMBL LOCK lt and NO ATT lt on
Coarse align to 0,0,0 Reselect V40 N20E.

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

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

(m)00211 Coarse align error
If P51(3)/52(4) in progress record gyro torquing angles and perform fine align check in P52(4).
Otherwise, see G/1-26. (G&N 12).

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

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

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

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

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

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

00404 Target out of view (90 deg test)
(G/3-5,3-10,6-3)

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

00406 Rend navigation not operating
Select P20 or continue.

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

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

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

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

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

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

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

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

00611 No TIG for given ELEV angle
(G/4-3,4-5)

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

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

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

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

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

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

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

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

(m)01407 VG increasing
(G/5-6,L/7-6)) (G&N 12).

01426 IMU unsatisfactory
Realign or use SCS.

01427 IMU reversed
Note FDAI operation is inverted.

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

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

01601 Bad IMU torque abort
See 01600

01602 Bad optics during verification
See 01600

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

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

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

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

(m)10777 ISS warning caused by IMU & PIPA fail (G&N6)

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

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

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

**20607 No solution to conic subroutine
Reselect program.

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

**21103 Unused CCS branch executed
Copy NO8, notify MSFN, initiate V36 recovery

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

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

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

**21302 SQRT called with negative argument
See 21204

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

**21502 Illegal flashing display
See 21204

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

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

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

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*31202 Executive overflow - no core sets
See 31201
*31203 Waitlist overflow - too many tasks
See 31201
*31207 No vac area for marks
Rset
Continue
If alarm recurs, consult MSFN.
*31211 Illegal interrupt of extended verb
Reselect extended verb after optics marking is completed.
(m) - Malf procedure indicated
**(2xxxx) - Generates restart, F37 (no lt)(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

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V50 N25 CHECKLIST CODES

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

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V04 N06 (N12)OPTION CODES

R1 Code	Purpose	Input for R2
00001	Specify IMU Orientation	1=PREF, 2=NOM 3=REFS, 4=LDG SITE
00002	Specify vehicle	1=CSM, 2=LM
00003	Specify tracking Attitude	1=Preferred, 2=+X-axis
00007	Specify Propulsion System	1=SPS, 2=RCS

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FLAG WORD LISTING

TITLE	ADDRESS	BIT	CODE (NO7)	WHEN SET	WHEN RESET
Drift	00076	15	(40000)	Drifting flight gyro compensation performed	Drifting flight gyro compensation not performed
RNDZ	00074	7	(100)	P20 initiated	P20 terminated
UPDATE	00075	7	(100)	State vector update by marks allowed	State vector updating by marks not allowed
Track	00075	5	(20)	RNDZ Tracking allowed	Rendezvous tracking not allowed
Pref Att	00076	4	(10)	Pref Att computed	Preferred S/C attitude not computed
Steer	00076	11	(2000)	Steering to be done	Steering omitted
REFSMMAT	00077	13	(10000)	REFSMMAT good	REFSMMAT not good
IMU	00074	8	(200)	IMU in use	IMU not in use

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State Vector	00075	8	(200)	CSM State vector updated	LM state vector updated
Terminate	00103	15	(40000)	Terminate R52,R53	Do not terminate
Target 1	00075	10	(1000)	LM sighting	Not sighting LM
Target 2	00075	9	(400)	LMK Sighting	Sighting star
W-matrix (RNDZ)	00101	1	(1)	W-matrix for rendezvous navigation is valid	W-matrix for rendezvous navigation is invalid
W-Matrix (ORB)	00077	6	(40)	P22,P23 W-matrix valid	P22,P23, W-matrix invalid
3 axis	00101	6	(40)	MNVR Specified by 3 axes	Maneuver specified by 1 axis
External ΔV	00076	8	(200)	Ext ΔV VG comp	Lambert VG computations
Active vehicle	00076	5	(20)	LM active	CSM active

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Final comp.	00076	6	(40)	Final RNDZ comp	Interim pass through rendez-vous program computations
Sighting mark	00074	6	(40)	V51 initiated	V51 not initiated
Stick flag	00075	14	(20000)	RHC out of detent	RHC in detent (auto maneuver enabled)
CMOON flag	00104	12	(4000)	Permanent CSM SV in Lunar Sphere of Influence	Permanent CSM SV in Earth Sphere of Influence
LMOON flag	00104	11	(2000)	Permanent LM SV in Lunar Sphere of Influence	Permanent LM SV in Earth Sphere of Influence
NON-FLAGS					
IMODES30	1334	9	(400)	IMU not operating	IMU operating

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MSC FORM 2206 (REV MAR 70)

OCTAL-TO-BINARY CONVERSION

ABCDE = OCTAL WORD

BINARY BIT SET = 1
RESET = 0

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

G
1-18

Color _____

Basic Date 7/1/70

Changed _____

Basic Date 7/1/70 Changed _____

CMC IMPUT/OUTPUT CHANNELS

CHANNEL		ISCMC CORE LOC	NAME	BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1
CP	1	60101	L			SHFT PULSE			CP REGISTER L, BITS 16-1									
	2	60102	Q			SHFT PULSE			CP REGISTER Q, BITS 16-1									
	3	60103	HISCALAR			SHFT PULSE			HIGH-ORDER SCALER CHANNEL, BITS 14-1									
	4	60104	LOSCALAR			SHFT PULSE			LOW-ORDER SCALER CHANNEL, BITS 14-1									
OUT	5	60105	PYJETS							S/M →	+X-YW	-X+YW	-X-YW	+X+YW	+X-P	-X+P	-X-P	+X+P
										C/M →	-YW-X+P	+YW-X-P	-YW-X-P	+YW-X+P	-P+Z	+P-X-YW	-P+Z	+P-X+YW
	6	60106	ROLLJETS							S/M →	+Y-R	-Y+R	-Y-R	+Y+R	+Z-R	-Z+R	-Z-R	+Z+R
										C/M →					-R-YW+Z	+R+YW-Z	-R-YW-Z	+R+YW+Z
CP	7	60107	SUPERBNK									FE7	FE6	FE5				
OUT	10	60110	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 BIT1
	11	60111	DSALMOUT			SPS ENGINE ON			CAUTION RESET	TEST CORRECTOR OUTBIT		OPERATOR ERROR LAMP	VN FLASH	KEY REL LAMP	TEMP CAUTION LAMP	UPLINK ACTY LAMP	COMP ACTY LAMP	ISS WARNING
	12	60112	CHAN12	ISS TURNON DELAY COMPLETE	SIV B CUTOFF	SIV B INJ. SEQ START		DISABLE OPTICS DAC	ZERO OPTICS	SIV B TAKEOVER ENABLE	TVC ENABLE		ENABLE IMU ERROR COUNTER	ZERO IMU CDU'S	COARSE ALIGN ENABLE		ENABLE OPT ERROR COUNTER	ZERO OPTICS CDU'S
	13	60113	CHAN13	ENABLE T&UPT	RESET TRAP 32	RESET TRAP 31B	RESET TRAP 31A	ENABLE STANDBY	TEST ALARMS		SMAG CTR ENABLE	DNLINK WD ORD	BLOCK INLINK	INHIBIT COPLINK	RNG. UNIT ACTY.	RNG UNIT SEL. A	RNG UNIT SEL..B	RNG UNIT SEL. C
	14	60114	CHAN14	DRIVE CDUR	DRIVE CDUY	DRIVE CDUZ	DRIVE CDU T	DRIVE CDU S	GYRO ACTY	**GYRO c	**GYRO a	**GYRO b	GYRO ENABLE					OUTLINK ACTY
IN	15	60115	MNKEY IN											PKEY5	MKEY4	MKEY3	MKEY2	MKEY1
	16	60116	NAVKEY IN									MARK REJECT	MARK	NKEY5	NKEY4	NKEY3	NKEY2	NKEY1
	30	60130	*CHAN30	TEMP IN LIMITS	ISS TURNON REQUEST	IMU FAIL	ICDU FAIL	IMU CAGE	S/C CONTROL OF SAT	IMU OPERATE		OPTICS CDU FAIL		LIFTOFF	SIV B SEPARATE, OR ABORT	SPS READY	SM/CM SEPARATE	ULLAGE THRUST PRESENT
	31	60131	*CHAN31	G & N AUTOPILOT CONTROL	FREE	HOLD	-Z TRANS	+Z TRANS	-Y TRANS	+Y TRANS	-X TRANS	+X TRANS	RHC -ROLL	RHC +ROLL	RHC -YAW	RHC +YAW	RHC -PITCH	RHC +PITCH
	32	60132	*CHAN32		PROCEED			LM ATTACHED					MHIM -ROLL	MHIM +ROLL	MHIM -YAW	MHIM +YAW	MHIM -PITCH	MHIM +PITCH
	33	60133	*CHAN33	OSC ALARM	COMPUTER WARNING	PIPA FAIL	CMC TOO FAST	UPLINK TOO FAST	BLOCK UPLINK					CMC CTR OPTICS	ZERO OPTICS		RNG DATA GOOD	
OUT	34	60134	DNTM1							FIRST OF TWO WORDS								
	35	60135	DNTM2							SECOND OF TWO WORDS								
				15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

* INVERTED LOGIC

**

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

G
1-19

Color _____

(Trim front page on solid crop marks; back page on dash crop marks.)

MSC FORM 2206 (REV MAR 70)

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
1-20

FLAG WORD & CHANNEL SET/RESET
Note: Only channel no's <30 may be used

1 V25N 07E
F 21 07 (LOAD FLAG WORD ADDRESS OR CHANNEL NUMBER) E

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

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

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

4 (to Verify) V01 N01E (FLAG Word ADD) ENTR
or V01 N10E (CHANNEL NUMBER) ENTR

5 F 01 01(10) R1 FLAG WORD OR CHANNEL (ABCDE)
R3 FLAG WORD ADDRESS OR CHANNEL NUMBER

EXAMPLE: To cause UPLINK ACTY LT

Key:
V25N 07E This sets bit 3 of
11E Channel 11
4E Verification should show E ≥ 4
1E

EXAMPLE: To set REFSMMAT flag:
Key:
V25N 07E This sets bit 13 of
77E flagword 3
10000E Verification should show A odd
1E

Changed _____

Basic Date 7/1/70

OCTAL-TO-DECIMAL CONVERSION

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

REVIEW DATA IN ERASABLE MEMORY

```
1                 V01 N01E (OCTAL ADD) E

2  F 01 01        R1 DATA R3 OCTAL ADD

3                 N15E (For next succeeding word)

4                 ENTR (For each succeeding word)
```

TO CHANGE DATA IN ERASABLE MEMORY

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

MONITOR OF INPUT/OUTPUT CHANNELS

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

Changed _____

Basic Date 7/1/70

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
1-22

RCS DAP ATT DBD CHANGE
CMC - on
ISS - on & aligned
SCS - operating
RCS DAP ACTIVATED

1 SC CONT - CMC/AUTO

2 V79E

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

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

5 PRO

6 MAN ATT (R) - RATE CMD

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

Changed 12/17/70

Basic Date 7/1/70

VHF RNG DSKY DISPLAY
VHF RNG - on (up)
P20 - running

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

G&N RECOVERY PROCEDURES

Recoveries:

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

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

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

if GO JAM performed:
V74 when convenient, see V36

if All 8's appear spontaneously on DSKY

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

If OPR ERR, begin again

General System Checkout:

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

OPT ZERO - OFF
OPT ZERO - ZERO

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

G
1-25

Changed 10/22/70

Basic Date 7/1/70

EXT VERBS

V35 - DSKY CONDITION LIGHT TEST
CMC - on

1 Key V37E 00E (required)
DSKY - P00

2 Key V35E

3 Monitor the following events
a. All DSKY condition lts - on

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

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

Wait 5 sec

d. All DSKY warning lts - off

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

f. P00 will be displayed.

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

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

1 V37E00E

2 V41N 91E

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		V40 N20E NO ATT lt - off Wait 20 sec
5		V37E XXE

V42 GYRO TORQUING
CMC MODE - FREE

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

Changed _____

Basic Date 7/1/70

Color _____

G
1-27

V48 - DAP DATA LOAD & ACTIVATE PROCEDURE

1 V48E

F 04 46 R1 ABCDE*
R2 ABCDE

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

PRO

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

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

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

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

Changed _____

Basic Date 7/1/70

rim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
1-28

V49 CREW DEFINED MANEUVER
CMC - on
ISS - on
SCS - operating

1 V37E 00E
V62E

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

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

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

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

V55 - CMC TIME UPDATE

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

V64 HI GAIN ANTENNA POINTING

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

Changed _____

Basic Date 7/1/70

V67 - W-MATRIX ERROR DISPLAY

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

Load desired data
PRO

V74 CMC DOWNLINK

1 V74E (Places erasable memory on downlink)

V79 - DAP PTC/Orb rate

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

Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
1-30

V82 ORBIT PARAMETER DISPLAY

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

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

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

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

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

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

Changed _____

Basic Date 7/1/70

V83 RNDZ PARAMETER DISPLAY #1

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

Changed

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

Basic Date 7/1/70

V87 - SET VHF RNG FLAG

VHF AM B - DUPLEX
VHF RNG - on (up)
P20 - running

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

Color _____

G
1-32

V89 - RENDEZVOUS FINAL ATTITUDE

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

1			V37E 00E V62E	
2			V89E	
	F	04 06	R1 00003 SPECIFY TRACKING ATTITUDE R2 00001 (PREF) 00002 (+X AXIS) PRO	
3	F	06 18	FINAL FDAI RPY ANGLES (AUTO MNVR) PRO (UPDATE DISPLAY) V32E	(.01°)
4	F	50 18	REQ MNVR TO FDAI RPY ANGLES (AUTO) BMAG MODE (3) - RATE 2 SC CONT - CMC CMC MODE - AUTO PRO (MAN) MNVR To 6	(.01°)
5		06 18	AUTO MNVR TO FDAI RPY ANGLES	(.01°)
6	F	50 18	REQ MNVR TO FDAI RPY ANGLES (TRIM) ALIGN SC about pointing axis PRO To 5 (BYPASS) ENTR	(.01°)

Changed 12/17/70

Basic Date 7/1/70

Color _____

Changed 12/17/70

Basic Date 7/1/70

V90 - OUT-OF-PLANE DISPLAY

```
1                V90E
     F 04 12     R1  00002  Specify Vehicle
                 R2  00001  CSM
                     00002  LM
                 PRO

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

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

V91 - COMPUTE BANKSUM
CMC - on (req)

```
1                V37E 00E

2                V91E
     F 05 01     R1 - Sum of all cells in bank
                 R2 - Bank number
                 R3 - Bugger word
                 Verify R1=R2 or R1+R2=77777 (If not, rcd R2
          (NEXT BANK)  PRO
          (TERM)       V34E
```

V93 - ENABLE W-MATRIX INITIALIZATION

```
1                V93E
```

Front Color _____

G
2-1

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 *

Changed

Basic Date 7/1/70

G&C SYSTEMS MANAGEMENT

Back Color _____

G
2-2

MEASUREMENT & LOADING OF PIPA BIAS

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

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

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

4 At T + 1:04 - ENTR
T1:04
Record (X) R1 ____ (Y) R2 ____ (Z) R3 ____ (±XXXAB)

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

Changed 10/22/70

CMC POWER UP PROCEDURE

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

2 F 37 00E

P06 - CMC POWER DOWN PROGRAM

1 V48E
F04 46 Load 0 (NO DAP) in left digit of R1
PRO, PRO, PRO
V46E

V37E 06E
F 50 25 00062 CMC PWR DN

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

Basic Date 7/1/70

Color _____

Changed 12/17/70

CMC SELF CHECK

1 V25 N01E, 1365E
F21 01 E,E,E

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

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

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

(TERM) V21N27E 0E

Basic Date 7/1/70

OPTICS POWER UP PROCEDURE
Verify optics manual drive disengaged

1 G/N PWR OPTICS - on (up)

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

OPTICS POWER DOWN

1 G/N PWR OPTICS - OFF

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

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

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

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

Color _____

G
2-4

SCS POWER UP

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

SCS POWER DOWN

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

Changed _____

Basic Date 7/1/70

Color _____

G
2-5

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____°

Changed 10/22/70

ΔV TEST & NULL BIAS CHECK

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

Basic Date 7/1/70

This is not a minus

100 fps.
.01/100 .001
.01
10

Changed 10/22/70

Basic Date 7/1/70

P20 - RENDEZVOUS NAVIGATION

CMC - on (req)
ISS - on and aligned (req)
SCS - on (des)
BMAG MODE (3) - RATE 2
G/N OPT PWR - on
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - CMC
Note: For VHF RNG display
see p G/1-22

1 V37E 20E
(If Pointing Error <10°, to 2 or 3:
vehicle mnvrs with no displays)
F 50 18 Request MNVR to FDAI RPY angles (.01°)

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

When attitude OK:
CMC MODE - AUTO
ENTR
OPTIC ZERO - OFF
*POSS UPLINK ACTY lt *
*(Mnvr >10° req'd) *
*To reestablish F 50 18 *
* Key V58E *

Back Color _____

G
3-2

2 V57E (SXT)
F 51 45 OPT MODE - MAN
OHC - Cntr Target in SXT
MARK (repeat as necessary)

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

OPT ZERO - ZERO

PRO (return to program in process)
(To terminate P20 - V56E
G/N OPT PWR - OFF)

3 V54E (COAS)
F 06 94 SHAFT, TRUNNION (.01°,.001°)
PRO

4 F 53 45 Request Alt LOS MARK
RHC - ALIGN Target in COAS
ENTR (V86E To reject)
POSS F 06 49 ΔR,ΔV,source code
* (.1nm,.1fps,0000X) *
*(REJECT) V32E *
*(ACCEPT) PRO *

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

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

To return:
V21N1E
2002E
Load previously recorded value

Changed 10/22/70

Basic Date 7/1/70

P21 GROUND TRACK DETERMINATION
CMC - on (req)

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

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

Changed

Basic Date 7/1/70

Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
3-4

P22 - ORBITAL NAVIGATION

CMC - on (req)
ISS - on and aligned (req)
SCS - on (req)
BMAG MODE (3) - RATE 2
G&N PWR OPTICS - on
COUPLING - RESOLVED
SPEED - MED
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - CMC
To remove rate limit: V21N1E,1346E,E

Changed 10/22/70

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)

Basic Date 7/1/70

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

Color _____


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

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

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

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

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

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

Changed 12/17/70

Basic Date 7/1/70

Color _____

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

10 F 37 XXE
OPT ZERO - ZERO
G/N PWR OPTICS - OFF
To restore rate limit (CDU transient detection): V21N1E,1346E,5E

Changed 10/22/70

P23 - CISLUNAR MIDCOURSE NAV MEASUREMENT

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

1 V37E 23E

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

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

4 F 06 88 CELESTIAL BODY VECTOR
Load desired vector
PRO

Basic Date 7/1/70

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	

Changed _____

Basic Date 7/1/70

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
3-8

9	F 05 70	R1 00DE STAR ID R2 00C00 LMK ID R3 00CD0 HOR ID	
		STAR/ENH	STAR/LNH	STAR/EL
		00DE 00000 00110	00DE 00000 00210	00DE 00100 00000
		STAR/EFH	STAR/LFH	STAR/LL
		00DE 00000 00120	00DE 00000 00220	00DE 00200 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		

Changed 10/22/70

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FORM 2206 (REV MAR 70)

NASA-MSC

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	
		(TERM) PRO	
18	F 05 71	R1 00ODE STAR ID	
		R2 00C00 LMK ID	
		R3 00CD0 HOR ID	
		(STAR/HOR) PRO to 21 (DE=00 to 20)	
		(STAR/LMK)PRO to 19	
19	F 06 89	LAT, LONG/2, ALT(LMK)	(.001°+N/E,.01nm)
		PRO (DE≠00 to 21)	
20	F 06 88	CELESTIAL BODY VECTOR	
		Verify vector	
		PRO	
21	F 06 49	ΔR ΔV (SV PARA)	(.1nm,.1 fps)
		(REJECT) V37E 23E	
		(UPDATE) PRO	
22	F 37	XXE	
		OPT ZERO - ZERO	
		G/N PWR OPTICS - OFF	

Changed 10/22/70

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Color _____

G
3-10

P24 RATE-AIDED OPTICS TRACKING

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

1		V37E 24E
2	F 06 89	LAT, LONG/2, ALT (.001°,.001°,.01nm) LOAD LMK COORDS OPT ZERO - OFF MNVR to SIGHTING ATT Roll to keep shaft axis > 10° from plane defined by X-axis & LOS to LMK (For 60nm alt, LMK > 10nm from gnd track requires no roll) PRO
3	06 92	AUTO OPT SHFT/TRUN (.01°,.001°) *F 05 09 00404 (TRUN >90°)* * MNVR to acquire * * PRO * * or V34E, F 37 * OPTICS MODE - MAN
4	F 51	MARK REQUEST MARK (as often as desired) To terminate: PRO
5	F 37	XXE OPT ZERO - ZERO G/N PWR OPTICS - OFF

Changed 12/17/70
Changed 7/1/70
Basic Date
Basic Date

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Color _____

G
3-11

Changed 10/22/70

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P27 CMC UPDATE
CMC - on (req)

Auto Update:

1 V37E 00E
UP TLM (2) - ACCEPT
UPLINK ACTY lt - on
POSS LOS before completion
*If V33 N02 showing: *
* Key ENTR *
* UPLINK ACTY lt - out *
* P00 displayed *
*If V21 N01 *
*or V21 N02 *
* Key V34E *
* UPLINK ACTY lt - out *
* P00 displayed *
*UP TLM (2) - BLOCK *

Update complete:
UPLINK ACTY lt - out
V37E 00E
UP TLM (2) - BLOCK

Voice Transmission Update:

1 V37E 00E

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

3 P27 Displayed

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

Color _____

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

Changed 12/17/70

7 P00 Displayed

P20 with GDC REFSMMAT

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

1 V25N20E
Load present GDC angles

2 V37E20E

3 Display pref. track att.
V16N95E (R,P,Y) (.01°)

4 Mnvr to Roll 0° or 180°, Yaw 0°
and Pitch shown in N95
V25N20E
Load present GDC angles

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5		OPT ZERO - OFF V57E
6	F 51 45	PLEASE MARK V25N7E, 75E, 400E, 1E (Select alt. var.) MARK (repeat as necessary) * POSS F 06 49 ΔR, ΔV, source code * * (.1nm, .1fps, 0000X)* * (REJECT) V32E * * (ACCEPT) PRO * PRO (return to program in process) (To Terminate P20 - V56E G/N OPT PWR - OFF)

Changed

PRETHRUST
(P30's & 70's)

P30 EXTERNAL ΔV

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

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

Basic Date 7/1/70

P32 CSI PRETHRUST (P72 LM)

1		V37E (32E or 72E)	
	F 06 11	TIG (CSI)	(hrs,min,.01sec)
		PRO	
2	F 06 55	APSIS CDH,TPI ELEVATION ANGLE,(+0000N,.01° CENTRAL ANGLE,Passive Vehicle (ωt) (For CDH N π from CSI, load non-zero in R3)	
		PRO	
3	F 06 37	TIG (TPI)	(hrs,min,.01sec)
		PRO	

Back

Color _____

G
4-2

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

```
*F 05 09                          *
* 00600 No Intersection on        *
*       First Iteration           *
* 00601 hp+CSI <85nm/5.8nm        *
* 00602 hp+CDH <85nm/5.8nm        *
* 00603 TIG(CDH)-TIG(CSI)         *
*         <10 min                 *
* 00604 TIG(TPI)-TIG(CDH)         *
*         <10 min                 *
* 00605 NO SOL IN 15 Tries        *
* 00606 ΔV(CSI)>1000fps in 2      *
*       Iterations                *
*       V32E to 1 Adjust          *
*         Inputs                  *
```

Changed _____

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

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

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

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

9    F 37

               P72 - Transmit mnvr Parameters to LM

               P33 CDH PRETHRUST  (P73 LM)

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

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

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

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

Changed _____

Basic Date 7/1/70

Color _____

G
4-4

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

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

6 F 37

P73 - Transmit mnvr Parameters to LM

P34 TPI PRETHRUST (P74 LM)

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

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

Changed 12/17/70

Basic Date 7/1/70

Color _____

G
4-5

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

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

Changed 12/17/70

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

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

6 F 06 81 ΔVXYZ(LV)TPI (.1fps)
PRO

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

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8 F 16 45 MARKS,TFI,MGA (marks,min-sec,.01°)
SET EVENT TIMER TO TFI
PRO (MGA SET To -00002 IF NO
REFSMMAT SET or If P74)

9 F 37
P74 - Transmit Mnvr Parameters To LM

Color _____

G
4-6

P35 TPM PRETHRUST (P75 LM)

1 V37E (35E or 75E)
F 16 45 MARK,TFI,-00001 (marks,min-sec)
(RECYCLE) V32E To 3
(FINAL PASS) TERM MARKS
PRO

2 F 06 81 ΔVXYZ(LV)TPM (.1fps)
PRO

3 F 06 59 ΔVXYZ(LOS)TPM (.1fps)
PRO (If Recycle - To 1)

4 F 16 45 MARKS,TFI,MGA (marks,min-sec,.01°)
PRO (MGA SET TO -00002 IF NO
REFSMMAT SET or If P75)

5 F 37
P75 - Transmit Mnvr Parameters To LM

To change ATIGINC:
V24N1E
2021E

6 min: 00002E
06240E

10 min: 00003E
25140E

3 min: 00001E
03120E

Changed _____

Basic Date 7/1/70

Color _____

G
4-7

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=01605 (1187.5 NM)

Changed 10/22/70

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

2 F 06 60 BLANK,ΔV DESIRED, GAMMA EI DESIRED
R2 XXXXX
Load desired ΔV: (fps,.01°)
PAD ΔV IF ON TLC
0. IF ON TEC
Load R3=0
PRO
*F 05 09 00612 State vector in *
* Lunar Influence *
* 00605 Solution not *
* Convergent *
*V32E, RSET TO 1 *
* 20607 Conic Routine *
* Failed *
* 20610 State vector is *
* below 400K ft *
* altitude *
*F 37 37E to 1 *

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3 F 06 61 IMPACT LAT, IMPACT LONG (+E) (.01°)
If Impact LONG <12° from desired:
Record Impact LONG as θcl _____._____°
PRO
If Impact LONG>12° from desired:
TEC:N40E Record R2 as ΔVmin__fps TLC: V32E to 1
V32E to 1 & use |ΔV| >ΔV min Decrease ΔV to
Load ΔV neg to move LONG WEST move LONG WEST
Load ΔV pos to move LONG EAST Increase ΔV to
move LONG EAST

Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
4-8

```
4    F 06 39   ΔT TRANSFER (TIG to EI)   (hrs,min,.01sec)
               PRO
          (RECYCLE) V32E To 1

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

6    F 06 81   ΔVXYZ(LV) at TIG
               Record R3 as ΔVzcl= _____.___ fps
               N40E
               Record R2 as ΔVcl=_____fps
               KEY RLSE
               PRO
                    *F 05 09  00605 Solution not  *
                    *               Convergent    *
                    *         00613 Flt Path Ang  *
                    *               not reached   *
                    *RSET V32E to 1               *
                    *         20607 Conic Routine *
                    *               Failed        *
                    *F 37 37E to 1                *

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

               PRO

8    F 06 39   ΔT TRANSFER
               PRO

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

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

Changed _____

Basic Date 7/1/70

Color _____

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

12 F 06 60 BLANK,ΔV DESIRED, GAMMA EI DESIRED
To move West from θpl
TEC: Load ΔVc2 =-ΔVc1-10
TLC: Load ΔVc2 =ΔVc1-10
To move EAST from θpl
TLC or TEC: Load ΔVc2=ΔVc1+10
Record ΔVc2_____fps
R2 XXXXX.
PRO
F 05 09 SAME AS IN 2
*V32E. RSET to 11 *

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

Compute K:

N81E Record R3 as

$\Delta Vzc2 =$ _____.___ fps

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

K= +. _____

Compute Δθ LONG = θd - θpl = ± _____.__°
Obtain from chart ΔVo= ± _____ fps
Make sign of ΔVo same as Δθ LONG
Compute ΔVd:
$\Delta Vzd = \Delta Vzpl + \Delta Vo$

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

Make sign of ΔVd same as ΔVzd

ΔVd = _____

Changed _____

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(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
4-10

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

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

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

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

Changed 10/22/70

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

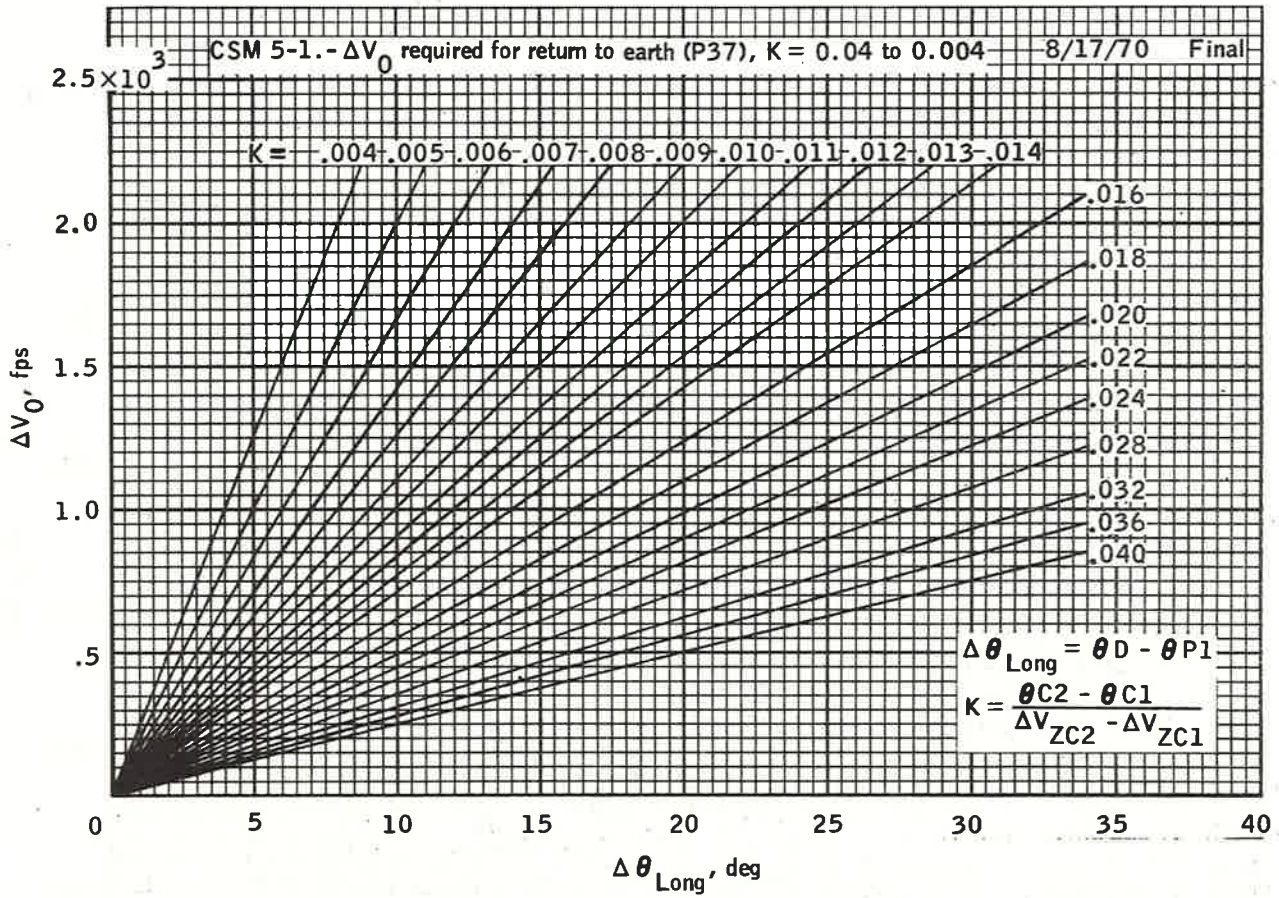
20 F 16 45 MARK,TFI,MGA (mark,min-sec,.01°)
PRO (MGA SET TO -00002 If No
REFSMMAT SET)

21 F 37 (40E or 41E)

Basic Date 7/1/70

OBTAIN ENTRY REFSMMAT (No Comm)
(Use only after final MCC)
1. Record 400K time from final P37 solution.
(Step 1 TIG + FNL N39)
2. Use 400K time for T-align P52 (Option 2).

Basic Date 7/1/70 Changed 10/22/70



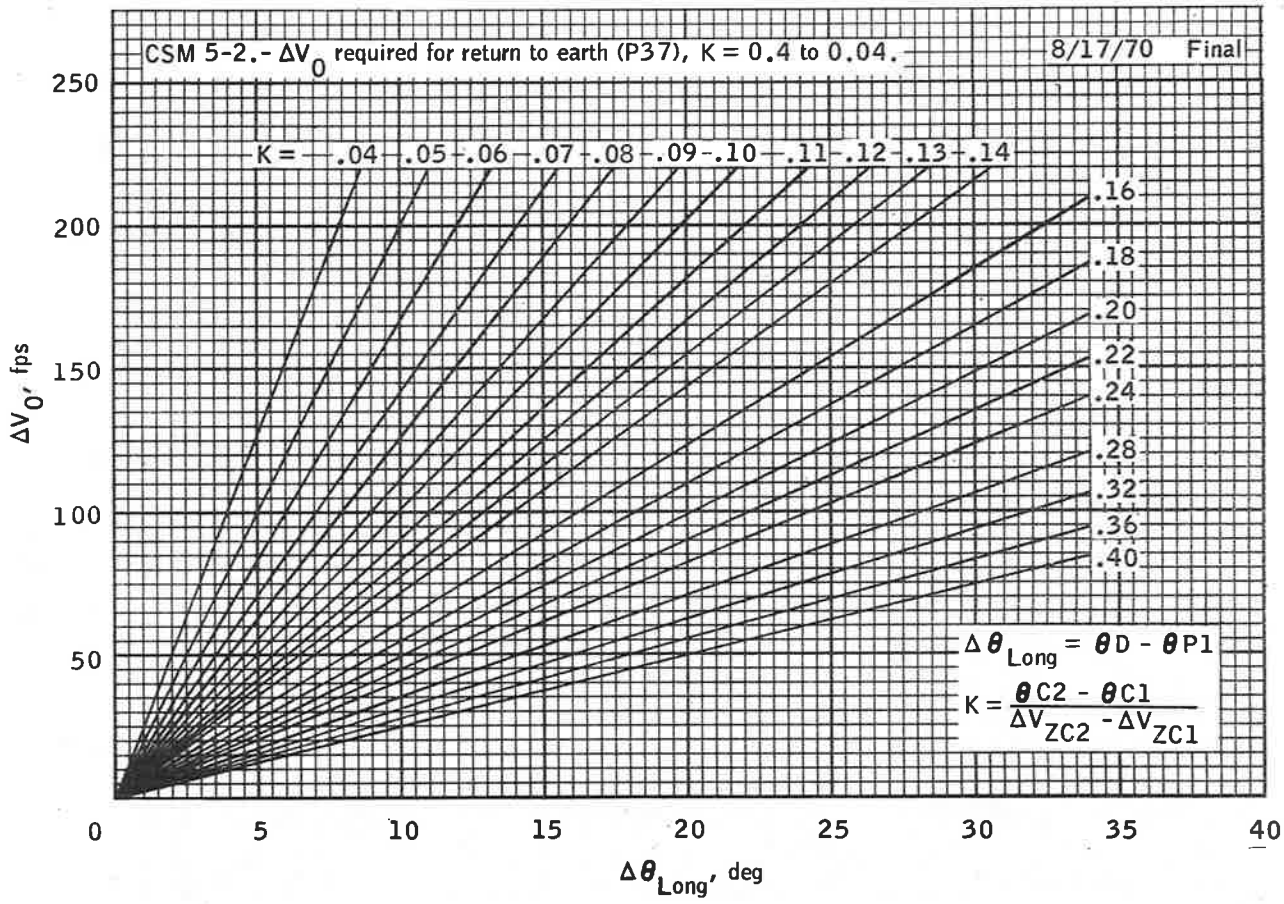
ΔV_0 required for return to earth (P37), K = 0.04 to 0.004.

ΔV_0 vs $\Delta\theta$ LONG

MSC FORM 2206 A (REV MAR 70)

Front Color

G
4-11



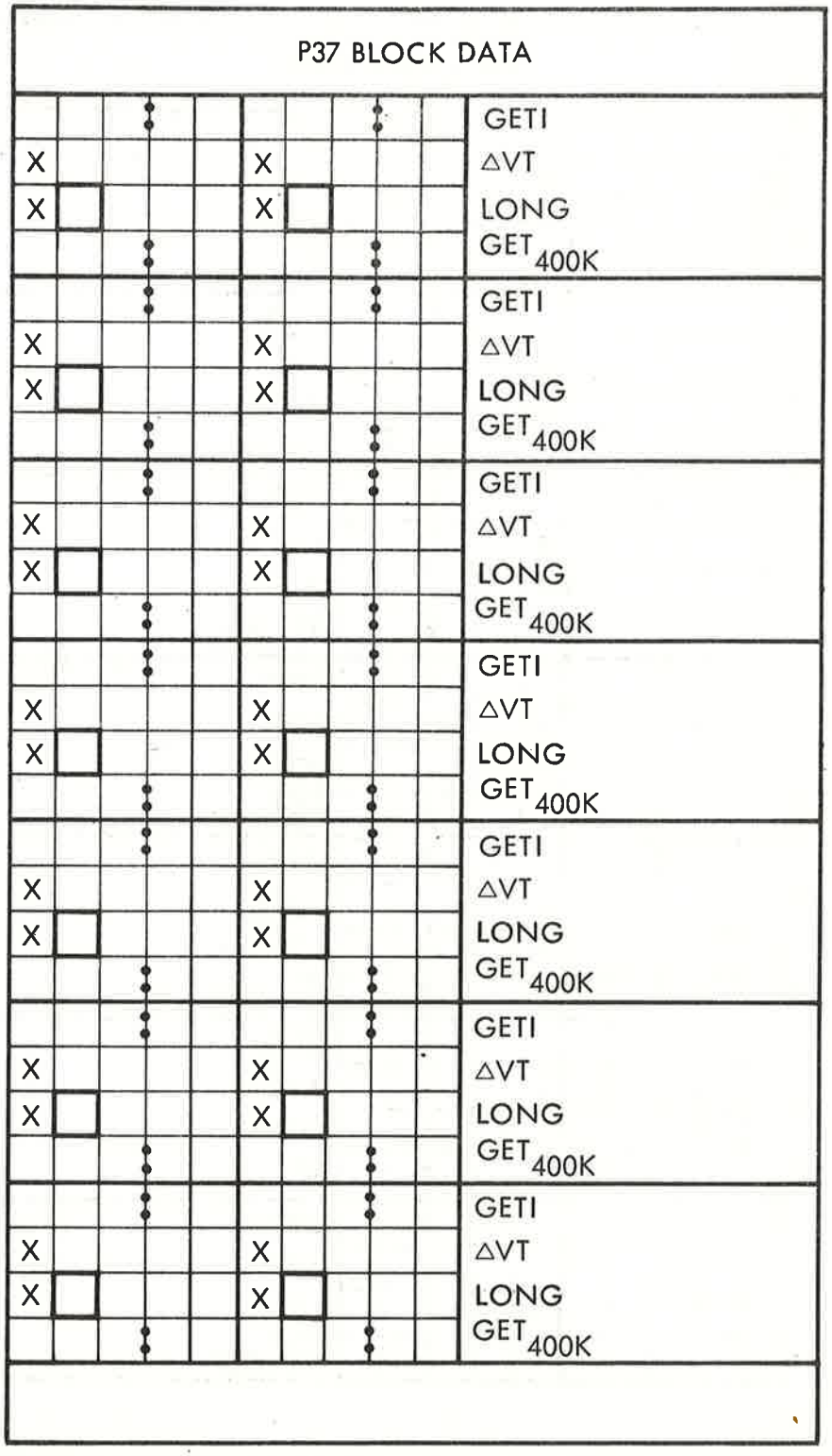
ΔV_0 required for return to earth (P37), K = 0.4 to 0.04.

Basic Date 7/1/70

Changed 10/22/70

Front Color _____

G
4-13



Changed _____

Basic Date 7/1/70

P37 BLOCK DATA

MSC FORM 2206 A (REV MAR 70)

Back

Color _____

G
4-14

P37 BLOCK DATA	
	GETI
X X	ΔVT
X X	LONG GET 400K
	GETI
X X	ΔVT
X X	LONG GET 400K
	GETI
X X	ΔVT
X X	LONG GET 400K
	GETI
X X	ΔVT
X X	LONG GET 400K
	GETI
X X	ΔVT
X X	LONG GET 400K
	GETI
X X	ΔVT
X X	LONG GET 400K
	GETI
X X	ΔVT
X X	LONG GET 400K

Changed _____

Basic Date 7/1/70

C FORM 2206B (REV MAR 70)

NASA-MSC

Color _____

G
4-15

P76 - TARGET ΔV

1		V37E 76E	
	F 06 33	TIG	(hrs,min,.01sec)
		Load TIG	
		PRO	
2	F 06 84	ΔV XYZ	(.1fps)
		Load ΔV	
		PRO	
3	F 37	00E	
		V82E (check LM parameters)	
4	F 04 12	R1 00002 Specify vehicle	
		Load R2 - 00002	
		PRO	
5	F 06 16	GET EVENT	(hrs,min,.01sec)
		PRO	
6	F 16 44	HA,HP,TFF	(.1nm,min-sec)
		R3 - 59B59HP > 49.4nm/35K ft	
		PRO	

Changed _____

Basic Date 7/1/70

P40-SPS THRUSTING

Check for water in tunnel area
Prethrust Program Complete
CMC & ISS - on
Cycle CRYO FANS
SCS - OPERATING
TEST C/W LAMPS
Perform EMS ΔV TEST & NULL
BIAS CHECK, pg G/2-5
Set ΔVC
EMS FUNC - ΔV
SPS GAUGING - ACl
PUGS MODE - NORMAL
OXID FLOW vlv - PRI
BMAG MODE (3) - RATE 2
CMC MODE - FREE
AUTO RCS SELECT(16)-as req'd
LOAD DAP
ROT CONTR PWR NORM (2) - AC/DC
Set DET
V37E 00E
SC CONT - CMC/AUTO

MNVR TO PAD BURN ATT

1			V62E	
2			V49E	
3	F	06 22	DESIRED FINAL GMBL ANGLES LOAD MNVR PAD GMBL ANGLES PRO	(.01°)
4	F	50 18	REQ MNVR TO FDAI RPY ANGLES (AUTO) PRO (MAN) SC CONT - SCS MNVR To 6	(.01°)
5		06 18	AUTO MNVR TO FDAI RPY ANGLES	(.01°)
6	F	50 18	REQ TRIM TO FDAI RPY ANGLES (AUTO TRIM) PRO To 5 (BYPASS) ENTR	(.01°)

Back

Color _____

G
5-2

7		BORESIGHT & SXT STAR CHECK OPT MODE - CMC OPT ZERO - OFF	
8		V41 N91E	
9	F 21 92	SHAFT, TRUN LOAD SXTS angles	(.01°,.001°)
10	41	OPTICS DRIVE CHECK SXT STAR OPT ZERO - ZERO CHECK BORESIGHT STAR (If avail)	
11		V37E 40E (TFI available via N40, N45 or N35)	
12	F 50 18	REQUEST MNVR TO FDAI RPY ANGLES (AUTO) BMAG MODE (3) - RATE 2 SC CONT - CMC/AUTO PRO To 13 (MAN/DAP) BMAG MODE (3) - RATE 2 SC CONT - CMC/HOLD MNVR To 14 (MAN/SCS) SC CONT - SCS MNVR To 14	(.01°)
13	06 18	AUTO MNVR TO FDAI RPY ANGLES	(.01°)

Changed _____

Basic Date 7/1/70

C FORM 2206B (REV MAR 70)

NASA-MSC

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

TVC CHECK & PREP
cb STAB CONT SYS (Pnl 8) - close
cb SPS (12) - close
SET ΔVC (verify)
EMS FUNCT - ΔV (verify)
MAN ATT (3) - RATE CMD
LIMIT CYCLE - on (up)
ATT DB - MIN
RATE - LOW
TRANS CONT PWR - ON
SCS TVC (2) - RATE CMD
ΔVCG - LM/CSM or CSM
TVC GMBL DRIVE P&Y - AUTO

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

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

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

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
5-4

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

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

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

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

(REJECT) ENTR

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

FDAI SCALE - 5/5
LIMIT CYCLE - OFF
RATE - HIGH
UPDATE DET
SPS He vlvs (2) - AUTO (verify)
Check N2 A and N2 B

58:00 Note GN_2 TK A drop
(-02:00) ΔV THRUST A(B) - NORMAL
THC - ARMED
RHC (2) - ARMED
TAPE RCDR - HBR/RCD/FWD/CMD RESET

59:25
(-00:35) DSKY BLANKS

Changed _____

Basic Date 7/1/70

FORM 2206 (REV MAR 70)

NASA-MSC

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
5-5

Changed 12/17/70

Basic Date 7/1/70

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

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

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

               MONITOR ΔVM (R3) COUNTING UP

  59:55
(-00:05)
   F 99 40     ENG ON ENABLE REQUEST
       (AUTO IGN)    PRO AT TFI >0 Sec
       (BYPASS IGN) ENTR to 19 (perform switching in
                                                    18)
                        EXIT - V37E 00E

17 00:00       IGN          *IF SCS: THRUST PB - PUSH*

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

                        *F 97 40 SPS Thrust fail    *
                        *ΔV THRUST B(A)-NORMAL      *
                        *(RESTART) PRO to IGN       *
                        *(RECYCLE) ENTR to TIG-05sec*
                        *             then V69E     *

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

rim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
5-6

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

00:XX ECO

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

Changed _____

18 F 16 40 TFC (STATIC), VG, ΔVM (min-sec,.1fps)
ΔV THRUST A&B - OFF
VERIFY THRUST OFF
SPS INJ VLVS (4) - CLOSED
SPS He vlvs tb (2) - bp
GMBL MTRS (4) - OFF (LMP Confirm)
TVC SERVO PWR 1&2 - OFF
MN BUS TIE (2) - OFF
PRO

19 F 16 85 VG XYZ (CM) (.1fps)
NULL RESIDUALS (TEI & MCC)
RECORD ΔV COUNTER & RESIDUALS ΔVC _____
EMS FUNC - OFF VGX _____
EMS MODE - STBY VGY _____
RHC & THC - LOCKED VGZ _____
ATT DB - MAX
TRANS CONT PWR - OFF
ROT CONTR PWR DIRECT (2) - OFF
cb DIRECT ULLAGE (2) - open
cb SPS P1 & Y1 - open
BMAG MODE (3) - RATE 2
PCM BIT RATE - LOW
PRO

Basic Date 7/1/70

20 F 37 V82E

Front Color _____

G
5-7

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

R3-59B59HP >49.4 nm/35K ft

PRO

22 F 37 00E

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

BURN STATUS REPORT

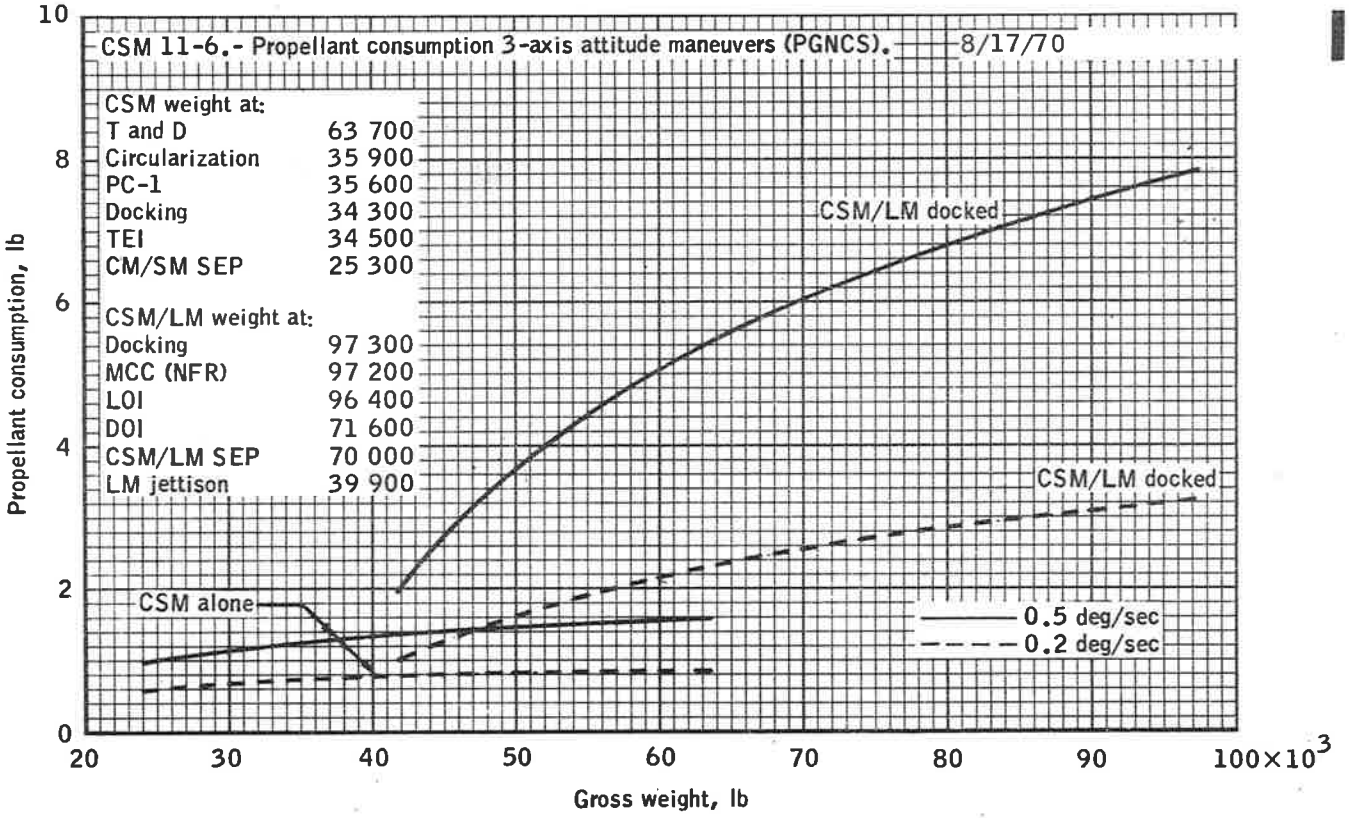
_____ ΔTIG	_____ VI
_____ BT	_____ HDOT
_____ VGX	_____ H
_____ R	_____ ΔVC
_____ P	_____ FUEL
_____ Y	_____ OXID
	_____ UNBAL

REMARKS

Changed _____

Basic Date 7/1/70

PROP CONS

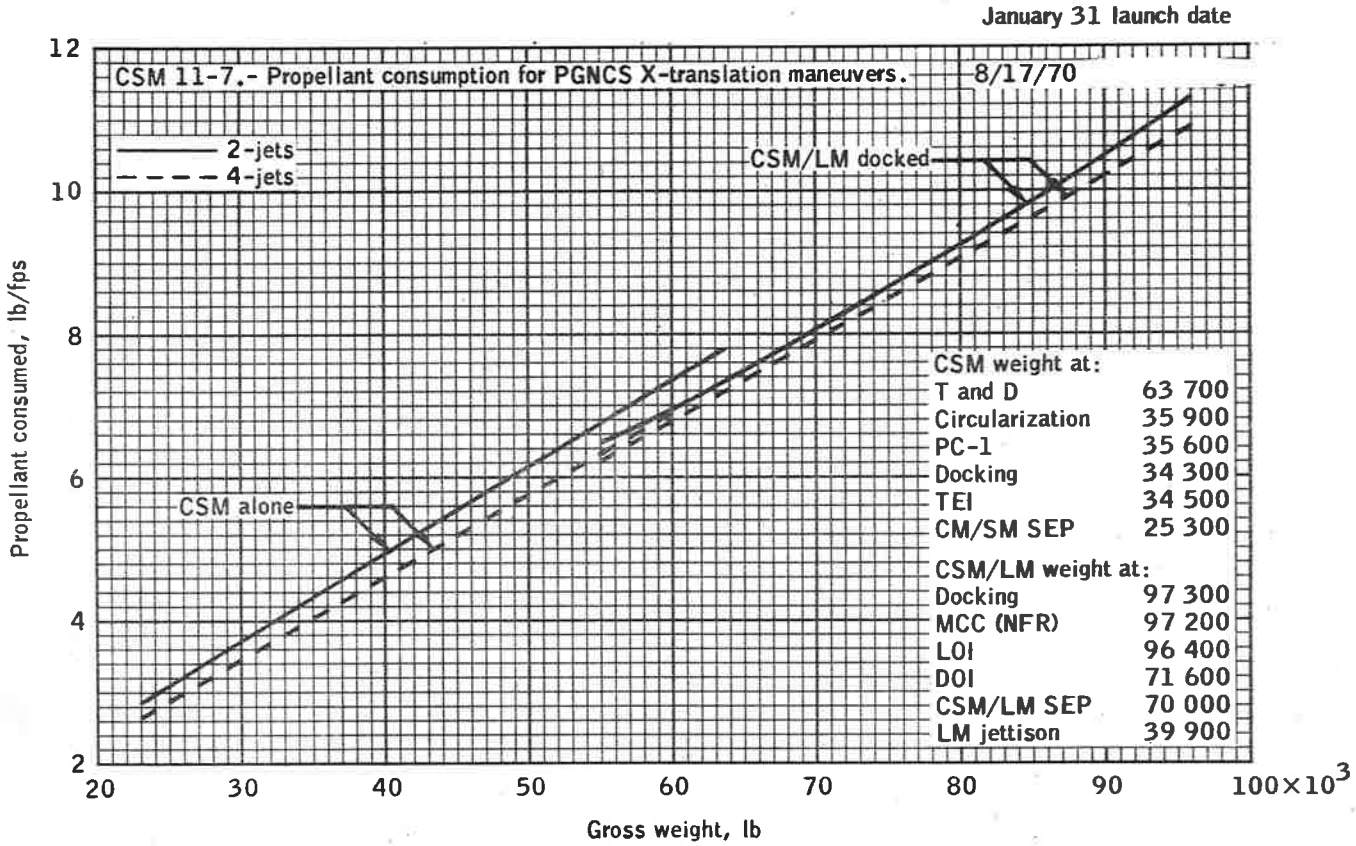


Propellant consumption 3-axis attitude maneuvers (PGNCS).

Basic Date 7/1/70

Changed 12/17/70

Basic Date 7/1/70 Changed 12/17/70



Propellant consumption for PGNCS X-translation maneuvers.

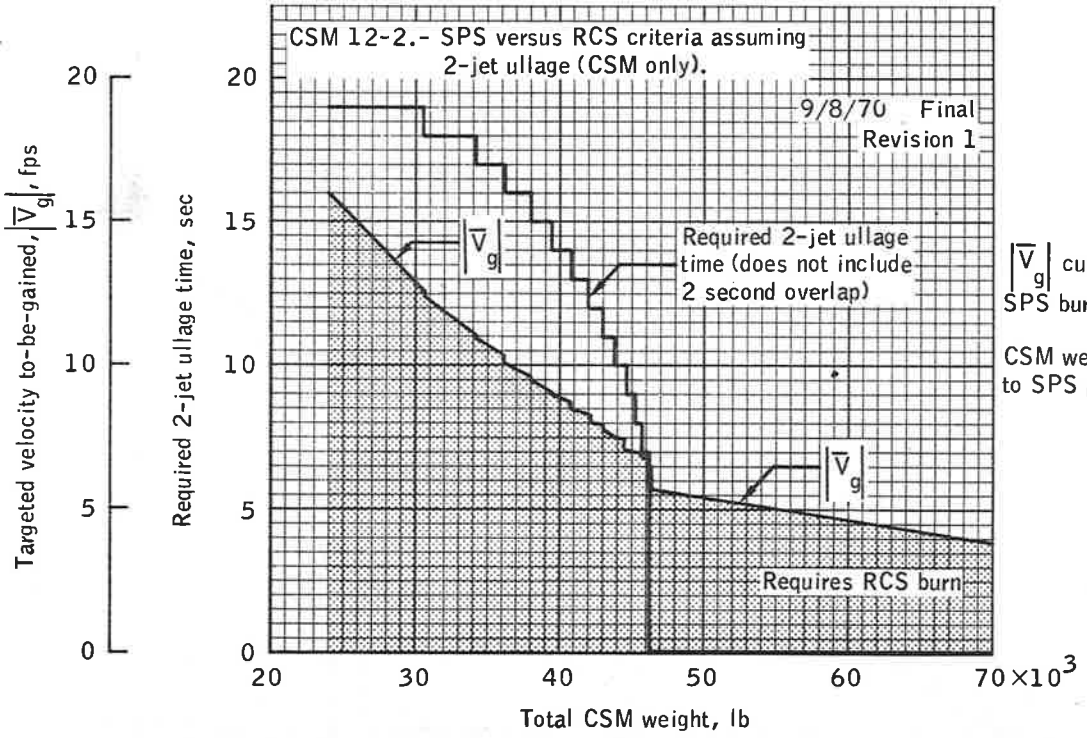
SPS vs RCS CRITERIA

MSC FORM 2206 A (REV MAR 70)

Front

Color

G
5-9

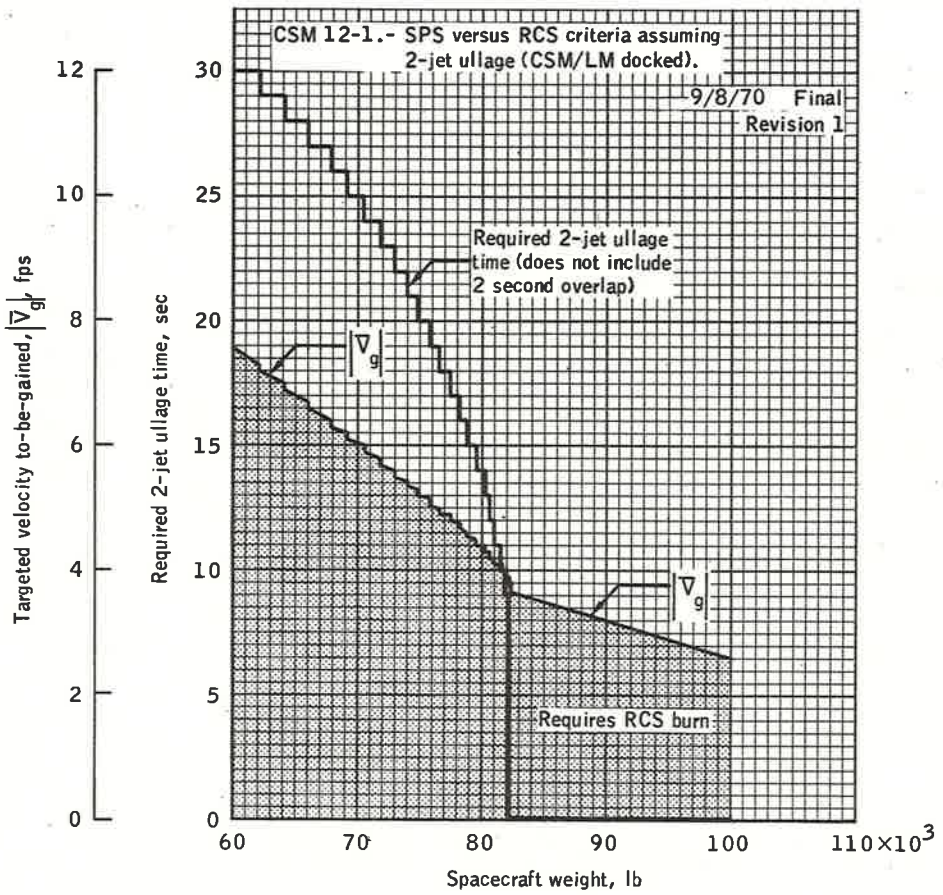


SPS versus RCS criteria assuming 2-jet ullage (CSM only).

Basic Date 7/1/70

Changed 10/22/70

Basic Date 7/1/70 Changed 10/22/70



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

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

G
5-11

Color

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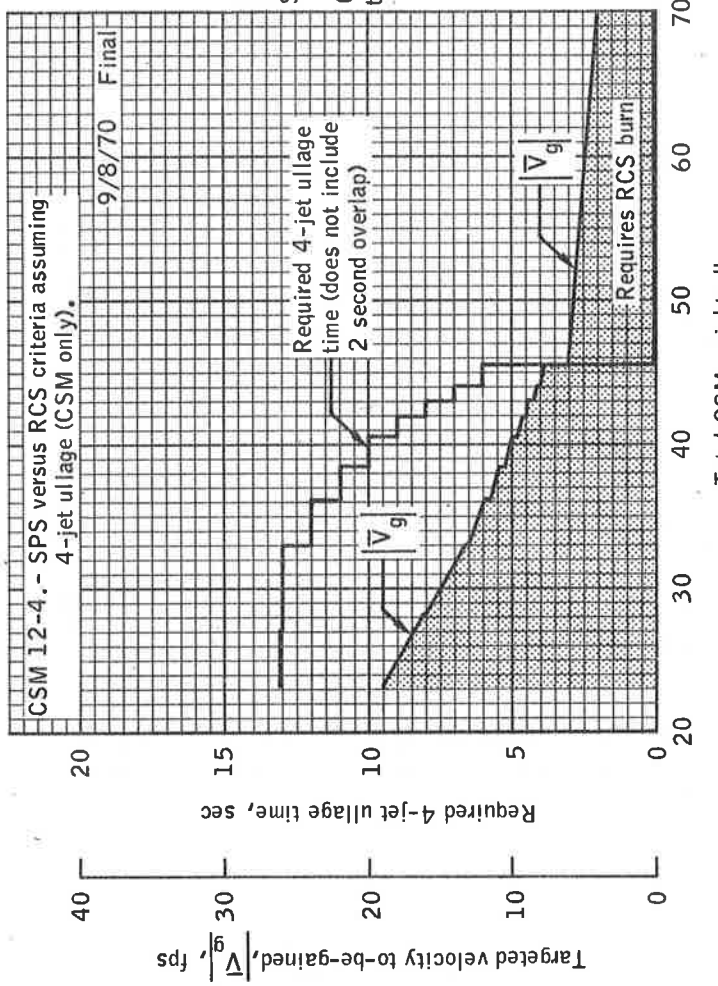
MSC FORM 2206 (REV MAR 70)

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
5-12

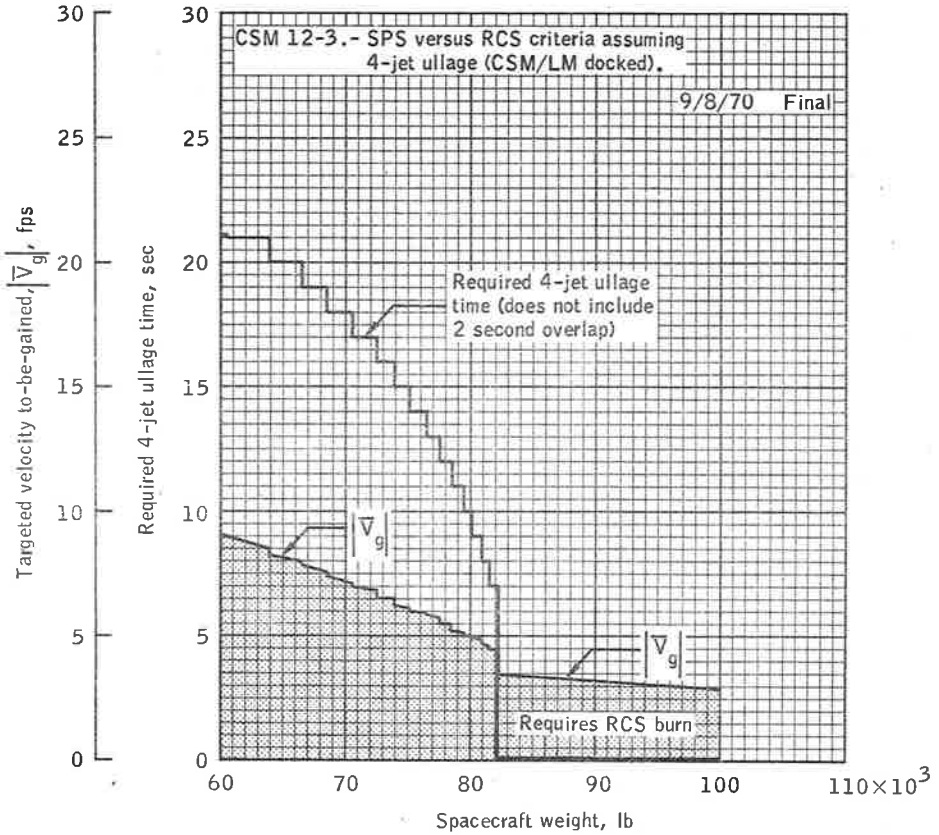


SPS versus RCS criteria assuming 4-jet ullage (CSM only).

Basic Date 7/1/70 Changed 10/22/70

MSC FORM 2206 A (REV MAR 70)

Basic Date 7/1/70 Changed 10/22/70



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/LM docked).

GIMB ANGS vs WT

Front

Color

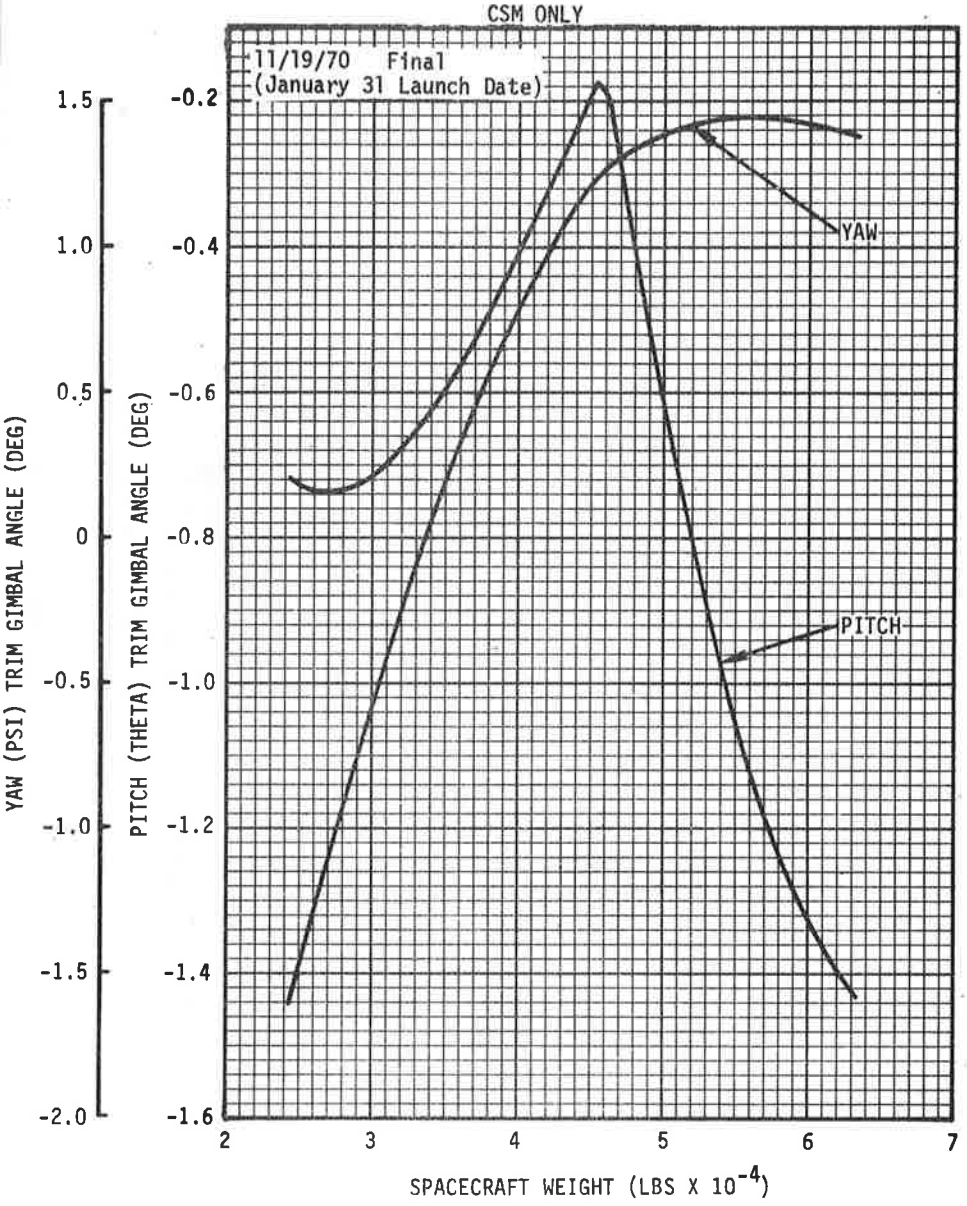
G
5-13

Back

Color _____

G
5-14

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



Changed 12/17/70

Basic Date 7/1/70

FORM 2206B (REV MAR 70)

NASA-MSC

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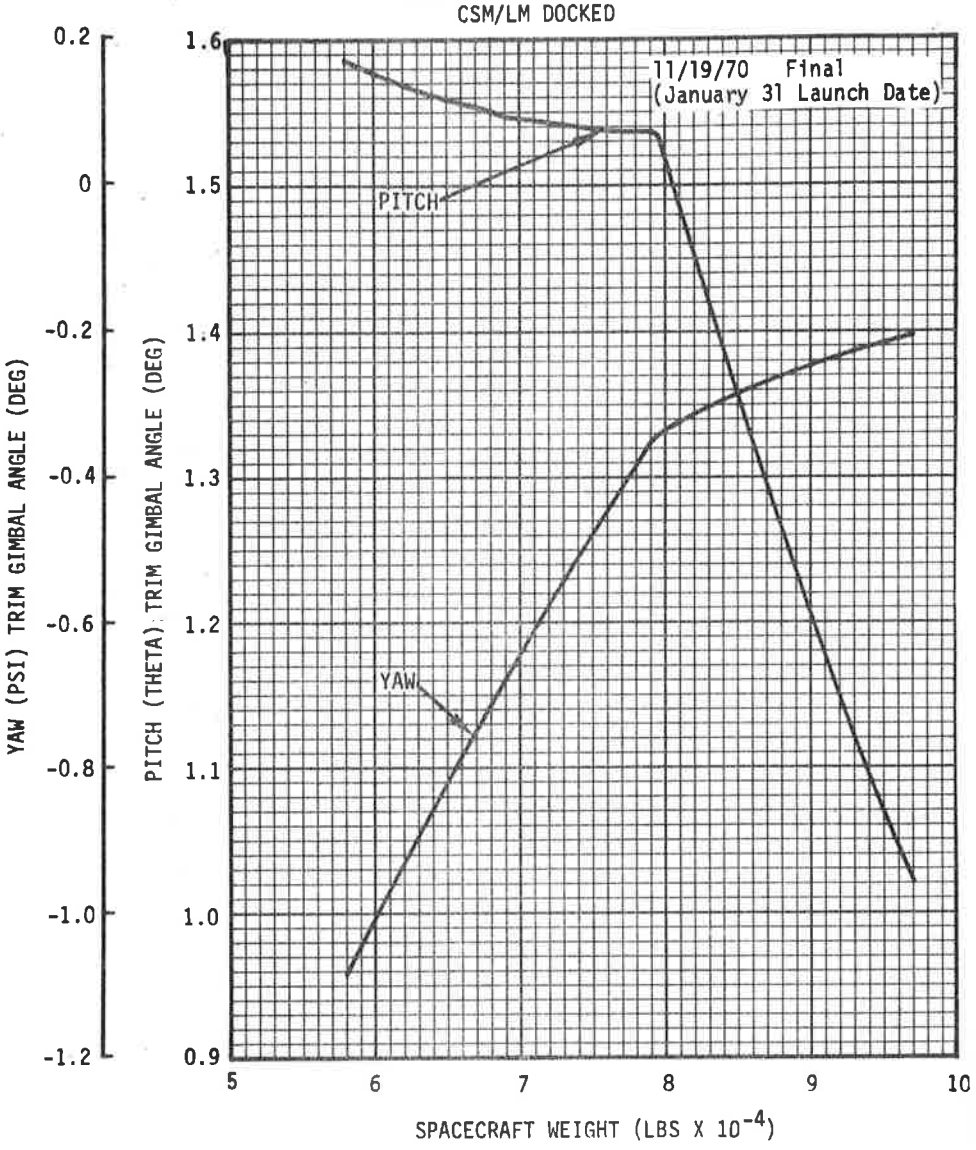
Color _____

G
5-15

Changed 12/17/70

Basic Date 7/1/70

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



(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
5-16

P41 - RCS THRUSTING

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

1 MNVR TO PAD BURN ATTITUDE
V62E

2 V49E

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

Changed _____

Basic Date 7/1/70

C FORM 2206 (REV MAR 70)

NASA-MSC

4	F 50 18		REQ MNVR TO FDAI RPY ANGLES	(.01°)
		(AUTO)	PRO	
		(MAN)	SC CONT - SCS	
			MNVR To 6	
5	06 18		AUTO MNVR To FDAI RPY ANGLES	(.01°)
6	F 50 18		REQ TRIM To FDAI RPY ANGLES	(.01°)
		(AUTO TRIM)	PRO To 5	
		(BYPASS)	ENTR	
7			BORESIGHT & SXT STAR CHECK	
			OPT MODE - CMC	
			OPT ZERO - OFF	
8			V41 N91E	
9	F 21 92		SHAFT, TRUN	(.01°,.001°)
			LOAD SXTS angles	
10	41		OPTICS DRIVE	
			CHECK SXT STAR	
			OPT ZERO - ZERO	
			CHECK BORESIGHT STAR (If avail)	
11			V37E 41E	
			(TFI available via N40, N45 or N35)	
12	F 50 18		REQUEST MNVR TO FDAI RPY ANGLES	(.01°)
		(AUTO)	BMAG MODE (3) - RATE 2	
			SC CONT - CMC/AUTO	
			PRO To 13	
		(MAN/DAP)	BMAG MODE (3) - RATE 2	
			SC CONT - CMC/HOLD	
			MNVR To 14	
		(MAN/SCS)	SC CONT - SCS	
			MNVR To 14	
13	06 18		AUTO MNVR TO FDAI RPY ANGLES	(.01°)

Changed _____

Basic Date 7/1/70

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Color _____

G
5-18

14 F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO TRIM) BMAG MODE (3) - RATE 2
ALIGN SC ROLL
SC CONT - CMC/AUTO
PRO To 13
(BYPASS) ATT DB - MIN
RATE - LOW
MAN ATT (3) - RATE CMD
BMAG MODE (3) - ATT1/RATE 2
GDC ALIGN
ENTR

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

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

Changed _____

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

59:25
(-00:35)
DSKY BLANKS

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

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

Basic Date 7/1/70

18	F 37		V82E
19	F 16 44		HA,HP,TFF (.1nm,min-sec)
			* R3-59B59 HP>49.4 nm/35K ft *
			PRO
20	F 37		00E
21			When COMP ACTY lt not on continuously: V66E (If LM S.V. not needed)

Changed _____

P47 Thrust Monitor Program

CMC - on
ISS - on & aligned

1			V37E 47E
	F 16 83		ΔV XYZ(CSM) (.1fps)
			VI,HDOT,H available by N62E
			*KEY RLSE to return to N83 *
		(RECYCLE)	V32E
		(TERM)	PRO
2	F 37		XXE

Basic Date 7/1/70

Changed 10/22/70

Basic Date 7/1/70

G
6-1

P51 - IMU ORIENTATION
CMC - on
ISS - on
SCS - operating
BMAG MODE (3) - RATE 2
G/N PWR OPTICS - on
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - MAN

1			V37E 51E
	F	50 25	00015 MNVR TO ACQ STARS (Coarse Align IMU To 0,0,0) - ENTR to 2 (BYPASS) PRO to 3
2		41 22	DESIRED GIMBAL ANGLES (0,0,0) NO ATT lt - on then off, to 1
3	F	51	PLEASE MARK OPT ZERO - OFF MARK
4	F	50 25	00016 TERMINATE MARKS PRO
5	F	01 71	00ODE STAR CODE Load desired code PRO to 3 after 1st MARK (to 6 if DE=00) to 7 after 2nd MARK (to 6 if DE=00)
6	F	06 88	CELESTIAL BODY VECTOR Load desired vector PRO to 3 after 1st MARK to 7 after 2nd MARK
7	F	06 05	STAR ANGLE DIFFERENCE (.01°) N 05 LIMITS 2 stars: SXT $\leq$ + 00003 SCT $\geq$ + 00011 Star/planet: SXT $\leq$ + 00018 SCT $\geq$ + 00021 (RECYCLE) V32E to 1 (ACCEPT) PRO
8	F	37	52E - bypass ZERO OPTICS or XXE OPT ZERO - ZERO

Back Color _____

G
6-2

P52 IMU REALIGN
CMC - on
ISS - on
SCS - operating
BMAG MODE (3) - RATE 2
G/N PWR OPTICS - on
OPT ZERO - OFF then ZERO (15 sec)
OPT MODE - CMC

1			V37E 52E
	F 04 06		R1 00001 IMU ALIGN OPTION
			R2 00001 PREF PRO to 4
			2 NOM PRO to 2
			3 REFSMMAT PRO to 7
			4 LDG SITE PRO to 2
2	F 06 34		GET ALIGN (0,0,0 initially) (hr,min,.01sec)
			Load desired GET
			TO SPECIFY PRESENT TIME - PRO on (0,0,0)
			PRO (NOM go to 4)
3	F 06 89		LAT, LONG/2, ALT (.001°,.001°,.01nm)
			Load ldg site coords
			PRO
4	F 06 22		NEW ICDU ANGLES OG, IG, MG (.01°)
			(IF MG>+70°, MNVR) V32E - to 4
			PRO
5	F 50 25		00013 GYRO TORQUE
			(COARSE) PRO - NO ATT lt - on then off - to 7
			(TORQUE) CMC MODE - FREE
			ENTR
6	16 20		ICDU ANGLES (.01°)
			When torque complete - go to 17
7	F 50 25		00015 STAR SELECT
			(MNVR If Neccessary)
			(PICAPAR) PRO

Changed 10/22/70

Basic Date 7/1/70

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
6-3

*F 05 09 00405 NO PAIR *
(CREW SPECIFY) PRO - to 8
*(PICAPAR) MNVR-V32E to 7 *

(MAN ACQ) ENTR

8 F 01 70 OOODE 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 *

Changed 12/17/70

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

Basic Date 7/1/70

13 F 01 71 OOODE 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

Color _____

15 F 06 05 STAR ANGLE DIFFERENCE (.01°)
N 05 LIMITS
2 stars: SXT ≤ + 00003
SCT ≤ + 00011

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

(REJECT) V32E to 17
(ACCEPT) PRO

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

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

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

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

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

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

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

Changed 10/22/70

Basic Date 7/1/70

```
4    F 53        PLEASE MARK
                 Center Target
                 ENTR

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

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

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

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

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

9    F 37        XXE


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

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

Changed 10/22/70

Basic Date 7/1/70

Color _____

G
6-6

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

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

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

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

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

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

(MAN ACQ) ENTR

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

9 F 06 88 CELESTIAL BODY VECTOR
Load desired vector
PRO

Changed _____

Basic Date 7/1/70

(Trim front page on solid crop marks; back page on dash crop marks.

Color _____

G
6-7

Changed 12/17/70

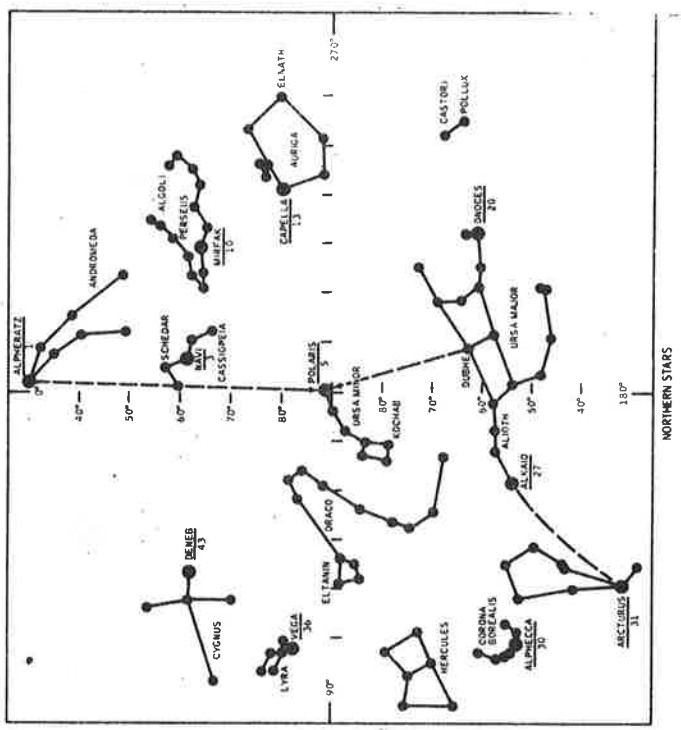
Basic Date 7/1/70

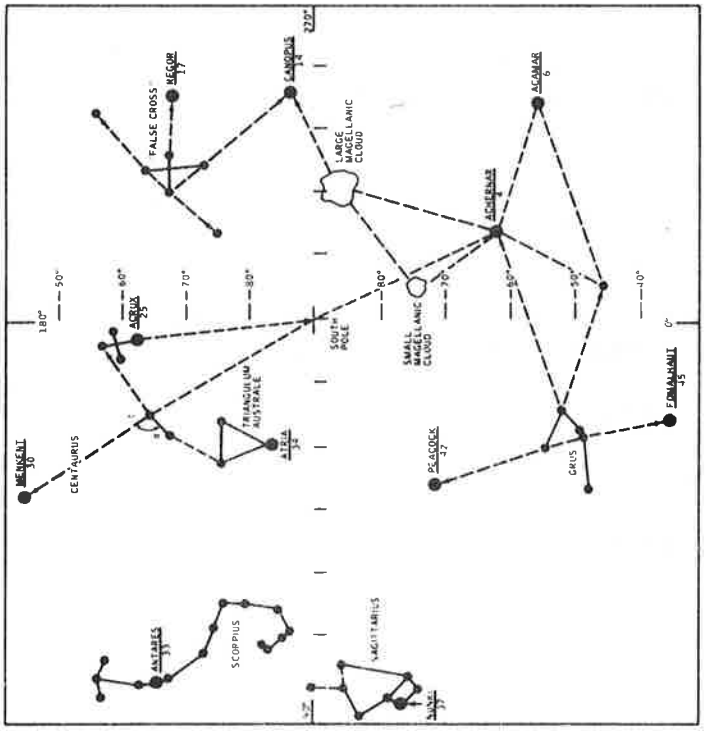
```
10   F 06 94   ALT LOS OPT ANGS SHAFT, TRUN(.01°,.001°)
               Load angles
                    COAS Nom:  Shaft +00000
                               Trun  +57470
               PRO

11   F 53      PLEASE MARK
               Center Target
               ENTR

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

13   F 01 71   00ODE 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
```

rim front page on solid crop marks; back page on dash crop marks.)

Color _____

G/6-8



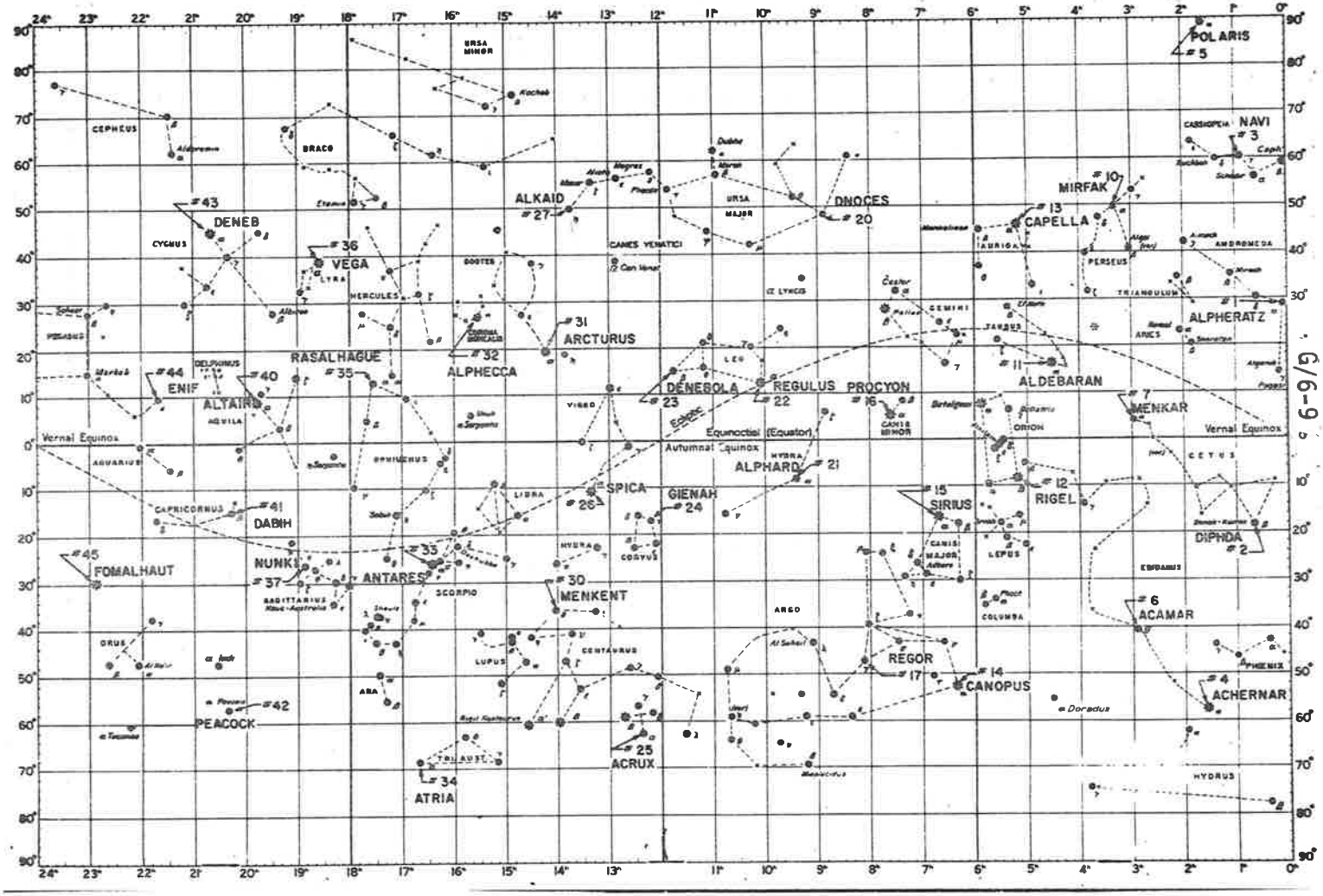


Changed _____

Basic Date 7/1/70

FORM 2206 (REV MAR 70)

NASA-MSC

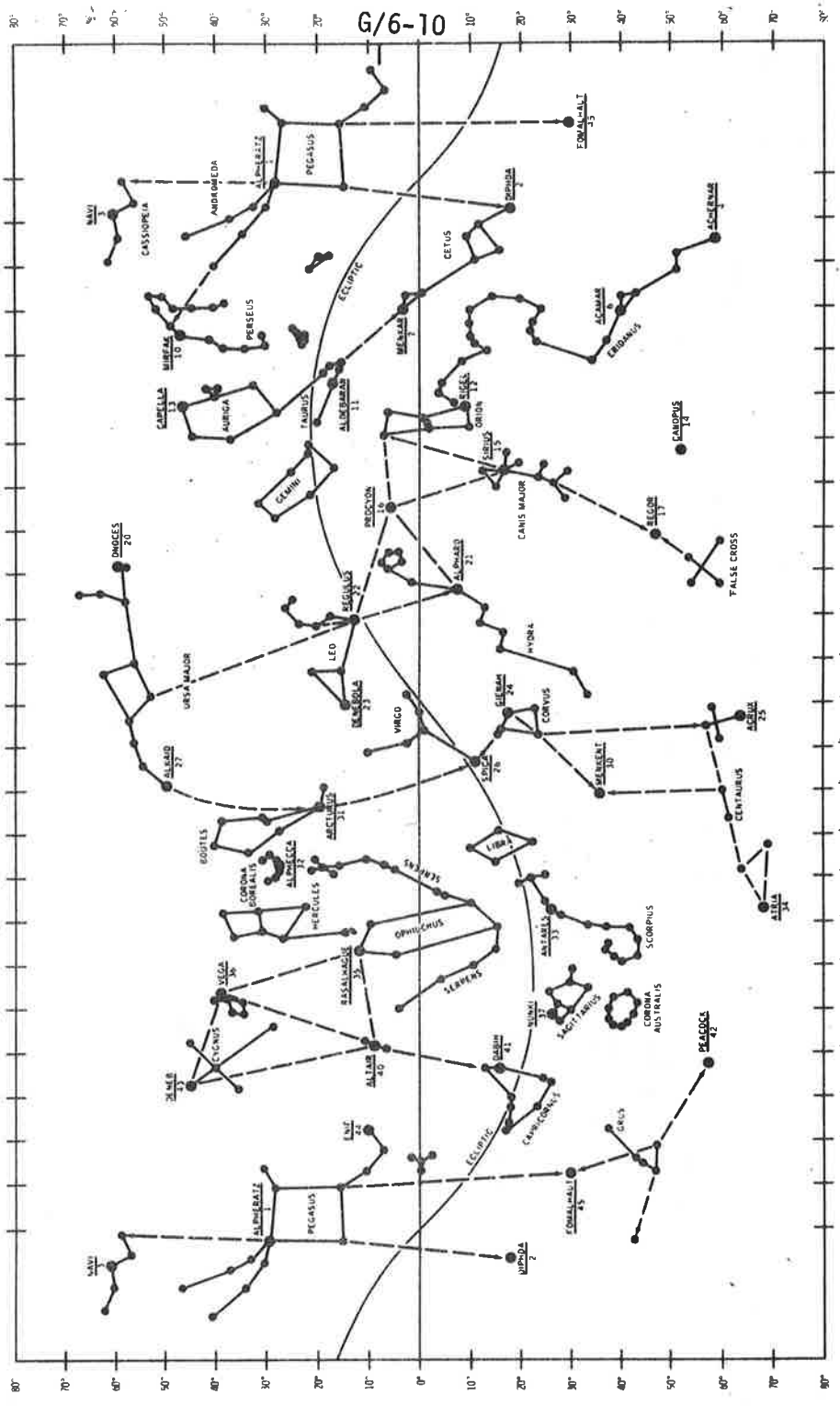


G/6-9

STAR CHARTS

Back

Color _____



Changed _____

Basic Date 7/1/70

FORM 2206B (REV MAR 70)

NASA-MSC

RAPID IMU REALIGN

NOTE: This procedure assumes a good GDC alignment

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

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

3 V37E51E, PRO (Sets Drift Flag)
V37E00E

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

5 Perform P52, Option 3

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

CHANGING LANDING SITE REFSMMAT FOR OUT-OF-PLANE BURNS

1 V37E 52E

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

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

4 F 06 89 LAT, LONG/2,ALT

	Present Pitch	ΔVy	R1
Load R1:	In range: 90°-0°-270°	$\frac{+}{-}$	$\frac{+35000}{-35000}$
	In range: 90°-180°-270°	$\frac{+}{-}$	$\frac{-35000}{+35000}$

5 F 06 22 NEW ICDU ANGLES

Back Color _____

G
7-2

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)
14	F 06 34	GET ALIGN (LOAD TIME OBTAINED FROM MSFN)
15	F 06 89	LAT, LONG/2,ALT (LAT WILL BE CHANGED BACK TO STORED RLS)
16	F 06 22	NEW ICDU ANGLES
17	F 50 25	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)

Changed 12/17/70

Basic Date 7/1/70

G
7-3

GDC ALIGNMENT TO IMU GIMBAL ANGLES

IMU - on
SCS - operating

1 Damp vehicle rates

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

BACKUP GDC AND/OR IMU ALIGNMENT

(IMU or CMC failed)
SCS - operating
RECORD: R,P,Y ALIGN from MSFN

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

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

3 ATT SET dials - R,P,Y ALIGN

4 Mnvr to position stars in SCT
0° mark - Sirius (15)
R line - Rigel (12)

or

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

Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
7-4

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

Changed 10/22/70

IN-PLANE GDC ALIGNMENT

CMC - on
ISS - on
SCS - operating

1		V37E 52E
	F 04 06	00001 Load R2=00002 PRO
2	F 06 34	GET ALIGN 0,0,0 PRO
3	F 06 22	R,P,Y
4		Set ATT SET dials to R,P,Y on DSKY
5		FDAI SELECT - 1 ATT SET - GDC GDC ALIGN - push
6		V37E XXE

Basic Date 7/1/70

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
7-5

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

1		FDAI 1 or 2 - ORB RATE EARTH/LUNAR - as req'd
2		V82E
	F 04 12	00002 SPECIFY VEHICLE 00001 PRO
3	F 06 16	GET EVENT (hrs,min,.01sec) PRO
4	F 16 44	HA, HP (.1nm,.1nm) Calculate Average ALT SET - Set Average PRO
5		V83E
	F 16 54	R,RDOT,THETA (.01nm,.1fps,.01°) MODE - HOLD/FAST SLEW - To THETA MODE - OPR/SLOW PRO

Changed

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

1	FDAI 1 or 2 - ORB RATE EARTH/LUNAR - as req'd
2	MSFN Supply Altitude ALT SET - Set
3	SC +X At the Horizon
4	MODE - HOLD/FAST SLEW FDAI (See table) MODE - OPR/SLOW

7/1/70

Basic Date

'im front page on solid crop marks; back page on dash crop marks.)

Color _____

G
7-6

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

*Angle from +X S/C axis to horiz

Changed 10/22/70

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

1 V37E 52E

2 F 04 06 00003
PRO

3 F 50 25 00015
ENTR

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

Basic Date 7/1/70

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

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/1-28)

ALIGN LM IMU TO CSM IMU

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

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

Changed 10/22/70

Basic Date 7/1/70

Color _____

G
7-8

Changed 10/22/70

Basic Date 7/1/70

Align LM IMU to CSM GDC

SCS - on
GDC - on and aligned

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

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

3 On LM Request, terminate att hold

ALIGN LM AGS TO CSM IMU/GDC

CMC - on
ISS - on and orientation known

or

SCS - on
GDC - on and aligned

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

2 Notify LM when at attitude

3 When LM alignment complete - terminate att hold

Color _____

G
7-9

Align CSM GDC to LM IMU

GDC - on (req)

1 Request LM to Hold Atitude, Min DB

2 Request and copy LM Readout of V06N20 angles:

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

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

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

5 Notify LM att hold not req

Changed 10/22/70

Align CSM GDC to LM AGS

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

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

3 FDAI SELECT - 1
ATT SET - GDC

4 When LM at Attitude:
GDC ALIGN - Push

5 Notify LM Att Hold not req'd

Basic Date 7/1/70

(Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

G
7-10

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° + Δφ - LM (OGA)y
CM (IGA) = LM (IGA)p - 180°
CM (MGA) = 360° - LM (MGA)r

4 V41N20E
Load Gimbal Angles

5 V40N20E
Allow 15 sec before step 7
Notify LM Att Hold Not Req.

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

7 V37E51E
PRO
V37E00E

8 Request MSFN Uplink REFSMMAT
then Perform P52
or
V06N20 On CM Mark - ENTR
Voice Angles to MSFN for calculation of Gyro Torquing Angles.
Perform V42 GYRO TORQUING using ground calculated Torquing Angles (p. G/1-26)

Changed 10/22/70

Basic Date 7/1/70

Color _____

G
7-11

Align CSM IMU TO LM AGS

CMC - on
ISS - on

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

2 When LM at Attitude:
V41N20E
LOAD: R1 = 300° + $\Delta\phi$
R2 = 180°
R3 = 0°

3 V40N20E.
Allow 15 sec before step 5
Notify LM Att Hold not req.

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

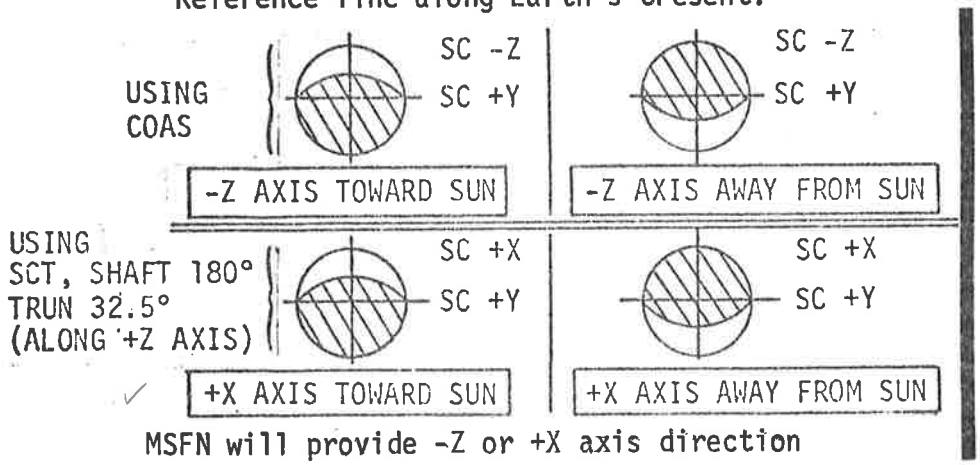
5 V37E51E
PRO
V37E00E

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

Changed 12/17/70

CRESCENT ALIGN

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



MSFN will provide -Z or +X axis direction

Basic Date 7/1/70

Color _____

G
7-12

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

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

4 V40N20, Verify Ref. Line Aligned with Cresent and
optics have not drifted
ENTR
Allow 15 sec before step 6

5 V25N07E, 77E, 10000E, 1E

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

7 Align GDC to IMU, if desired
or
8 ✓ FDAI SELECT - 1
ATT SET - GDC
ATT SET DIALS - 0,0,0 (or angles from MSFN)
Verify Ref line aligned to cresent, 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

Changed 10/22/70

Basic Date 7/1/70

Color _____

G
7-13

GDC REFSMMAT DETERMINATION

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

Changed 12/17/70

1		Acquire Apollo Nav star in optics FDAI Scale - 5/1 Hold att (ATT DB - MIN, RATE - LO) Align GDC to 0,0,0 V25 N20E E,E,E
2		V37E00E V96E
3		Initiate P51 logic as follows: V21N1E 1214E 63E (65 if P53 desired) V25N26E 13001E 3176E 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

Basic Date 7/1/70

Trim front page on solid crop marks; back page on dash crop marks.)

Color _____

6 F 50 25 00016 TERM MARKS
PRO

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

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

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

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

Changed 1/13/71

GDC REFSMMAT REALIGN (P52)

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

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

Basic Date 7/1/70

Color _____

Changed 12/17/70

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

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

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

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

Basic Date 7/1/70

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 00ODE 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

Color _____

G
7-16

9	F 06 88		CELESTIAL BODY VECTOR Load desired vector PRO *F 05 09 00404 (TA > 90°) * *MNVR & reload N20 - PRO to 10*
10	06 92		SHAFT, TRUN (.01,.001°)
			(MARK ROUTINE) OPTICS MODE - MAN
11	F 51		PLEASE MARK
		(If required)	V25N20E Load present GDC angles Null FDAI needles with Min imp then: MARK
12	F 50 25		00016 TERMINATE MARKS PRO
13	F 01 71		00ODE STAR CODE Load code (if necessary) PRO to 8 after 1st MARK (to 14 if DE=00) to 15 after 2nd MARK (to 14 if DE=00)
14	F 06 88		CELESTIAL BODY VECTOR Load vector PRO to 8 after 1st MARK to 15 after 2nd MARK
15	F 06 05		STAR ANGLE DIFFERENCE (.01°) (Expect < .1°, if not V32E to 17) (Accept) PRO
16	F 06 93		TORQUING ANGLES OG,IG,MG (.001°) N93 is indicative of BMAG drift since last alignment If torque angles excessive perform P51 Otherwise: OPT ZERO - ZERO G/N PWR OPTICS - OFF V37EXXE - procedure complete
17	F 50 25		00014 ALIGNMENT CHECK PRO to 7

Changed 12/17/70

Basic Date 7/1/70

Color _____

G
7-17

LM STEERABLE ANT POINTING

1. Select V64 (pg/G/1-28)

2. Mnvr to N51 angles:

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

Changed _____

Basic Date 7/1/70

Front Color _____

G
8-1

GENERAL V79 PROPERTIES

1 Max att DB: 30°
Min att DB: .4°

2 Max rate: 8.9999°/sec
Min rate: 0 may be loaded but forced firing will occur unless appropriate jet is disabled
Initial jet firing will achieve ~80% of requested rate. If all jets are to be disabled after initial firing, should request 1-1/4 times desired rate.

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

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

*KALCMANU Generates new commanded rates

Changed 10/22/70

Basic Date 7/1/70

PTC/ORB RATE

Back Color _____

G
8-2

PASSIVE THERMAL CONTROL (G&N)

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

1		V48E (Select 0.5° DB) V37E 00E V49E
2	F 06 22	Load PTC Attitude R - Present P - 90° (TLC) or 270° Y - 0° (TEC) PRO
3	F 50 18	BMAG MODE (3) - RATE 2 SC CONT - CMC CMC MODE - AUTO PRO
4	06 18 F 50 18	AUTO MANEUVER
5		Damp vehicle rates: ENTR Disable all jets on two adjacent quads Wait 20 minutes for rates to damp AUTO RCS SEL (2)-MNA or MNB as follows: +ROLL -ROLL A1,C1 A2,C2 or B1,D1 or B2,D2 Remaining AUTO RCS SEL (14) - OFF MAN ATT (ROLL) - RATE CMD
6		V79E
7	F 06 79	Rate,Deadband,Code(.0001°/sec,.01°,+XXXXX) Load desired values in R1 and R2 and +00000 in R3 PRO

Changed 10/22/70

Basic Date 7/1/70

.005 P&Y
.005 R

Color _____

8 Disable RCS:
AUTO RCS SEL (16) - OFF
ROT CONTR PWR DIR (2) - OFF (verify)

→ GNC GO/NO-GO FOR PTC AFTER 20 MIN.

To exit G&N PTC

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

For simple termination: See "GENERAL V79 PROPERTIES"

Changed 10/22/70

PASSIVE THERMAL CONTROL (SCS)

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

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

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

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

Basic Date 7/1/70

Color _____

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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

TERMINATE PTC

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

PITCH ORBIT RATE MANEUVER (G&N)

1 V79E (If POO and no V96E, To 3)

2 F 06 16 START TIME (hrs,min,.01 sec)
LOAD DESIRED GET
(all 0's for present time)
PRO

3 F 06 79 RATE, DB, CODE (.0001°/sec,.01°,+XXXXX)
Load desired values in R1&R2
& non-zero in R3
PRO
(If step 2 not bypassed,
UPLK ACTY - on when mnvr starts)

4 To Terminate: See "GENERAL V79 PROPERTIES"

Warning: While V79 is counting down DO NOT:
(1) Reselect V79 without preceding it by V37EXXE or V96E

(2) Do anything which will cause a F 50 18 on DSKY

Changed 12/17/70

Basic Date 7/1/70

Color _____

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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

Changed _____

Basic Date 7/1/70

ERASABLE LOAD UPDATE

In the event of PROG ALARM 1107, perform the following:
V74E (Wait 42 sec) (DUMP E MEMORY)
V36E
V48E (LOAD DAP as DESIRED - use
V46E latest known weights)
V25N07E 77E 10000E 1E (set REFSMMAT)
V1N1E 104E (verify CMOON FLAG and LMOON FLAG)
(BITS 11 AND 12 SHOULD BE 0 IN
EARTH SPHERE and 1 in MOON SPHERE)

Verify E MEMORY (should be done ASAP)
V1N1E
XXXXE (LOAD OID 2 OF UPDATE)
N15E, READ R1, E REPEAT FOR UPDATES A-L

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

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

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

P52-OPTION 3-AUTO OPTICS
AUTO OPTICS SUCCESSFUL, REFSMMAT VALID
AUTO OPTICS UNSUCCESSFUL, DO P51
V16 N65 verify CMC CLOCK (UPDATE)

Changed 12/17/70

Basic Date 7/1/70

Back Color

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TO CHECK STATE VECTOR CALL P21
AND LOAD PRESENT TIME. WHEN COMP CYCLE
IS COMPLETE
V06 N73E
READ R1 (R1 X 10=CURRENT ALT (NM))
COMPARE TO SOME KNOWN VALUE (E.G., FLIGHT PLAN)
IF ANSWER COMPARES - STATE VECTOR IS OK AND
P23 SHOULD BE USED TO IMPROVE IT.
IF GROSS ERRORS ARE OBSERVED, P23 IS UNLIKELY
TO CORRECT THEM. IN THIS CASE PERFORM
V71 LOAD OF LATEST PAD S.V. - SELECT
P00 TO BRING S.V. TO PRESENT TIME.

Changed

Basic Date 7/1/70

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OID	A	B	C	D	E	F	G
	V71	V71	V71	V71	V71	V71	V71
01	00021	00013	00012	00015	00023	00023	00024
02	01452	01706	01346	01765	02000	02021	02042
03	77143	00006	00005	00001	00137	00001	00001
04	71737	33304	06510	27404	00763	03120	33443
05	00110	07000	07025	00000	00023	00001	00003
06	67635	00000	00620	15514	00001	03120	02115
07	76745	17356	00000	00542	00000	00311	77775
10	72727	00000	33260	02210	00000	31727	70001
11	00477	22764	37723	36321	00471	77700	77777
12	77115	37777	01163	12160	00364	60177	40174
13	00314	37777		03363	04400	77762	77774
14	00000			00233	77772	55276	62760

Basic Date 7/1/70

Changed 1/13/71

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Color

Trim front page on solid crop marks; back page on dash crop marks.)

FORM 2206 (REV MAR 70)

NASA-MSC

Basic Date 7/1/70 Changed 1/13/71

OID	A	B	C	D	E	F	G
	V71	V71	V71	V71	V71	V71	V71
15	77640			00502	53647	00007	00004
16	01371				00002	04312	36300
17	00023				12573	07147	00002
20	00071				00001	77775	15226
21	77706				35676	77411	00077
22					00002	00003	03412
23					27310	31036	77754
24							75526

G
9-5

Color

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MSC FORM 2206 (REV MAR 70)

NAS

OID	H	I	J	K	L	M	S.V.
	V71	V71	V71	V71	V71	V72	V71
01	00024	00024	00022	00023	00021	00017	
02	02064	02106	02130	03000	03025	00736	
03	77771	01077	02375	00436	37777	37777	
04	72235	27652	04715	02732	00000	01477	
05	77461	02631	14650	00000	00000	00000	
06	70714	37371	12113	00000	54360	02377	
07	77510	70643	65411	77777	21075	00142	
10	61414	71747	72642	77777	37777	03021	
11	77622	74315	73351	42757	60465	01000	
12	70025	55007	43037	10510	00000	03022	
13	76777	66437	14427	06477	54360	00232	
14	71317	70077	13747	74470	21075	03376	

Basic Date 7/1/70

Changed 1/13/71

Color

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FORM 2206 (REV MAR 70)

NASA-MSC

Basic Date 7/1/70 Changed 1/13/71

OID	H	I	J	K	L	M	S.V.
	V71	V71	V71	V71	V71	V72	V71
15	01363	75440	14732	01605	37777	00000	
16	04371	54216	02326	00105	57142	03377	
17	00555	76105	05465	00123	33106	00000	
20	13342	73515	20402	00175	50741		
21	04303	76002	00545	17433	31162		
22	36426	71056	36577	04500			
23	01477	04770		00334			
24	27000	07136					

MSC FORM 2206 (REV MAR 70)

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Color

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Color _____

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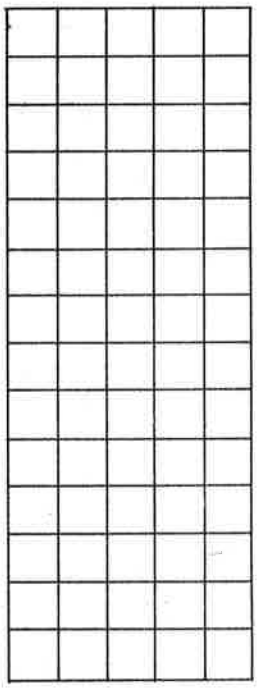
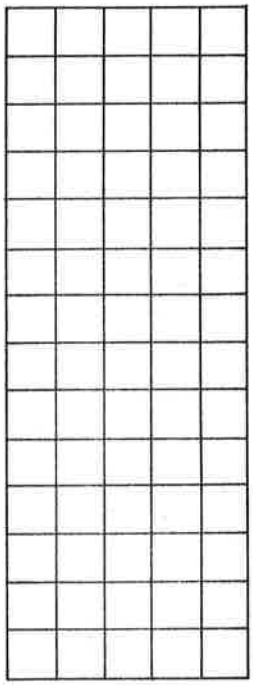
LM OR CSM S.V. READOUT

1 V83E

2 After Integration: V05N01E

CSM S.V.	LM S.V.
2254E	2224E
E,2257E	E,2227E
E,2262E	E,2240E
E,2265E	E,2243E
E,2342E	E,2342E
PRO	PRO





3 Transmit S.V. & Time Tag
To LM

LM OR CSM S.V. LOADING

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

Changed 10/22/70

Basic Date 7/1/70

Basic Date 7/1/70 Changed 10/22/70

CSM 6-1.- Venus unit vectors. 9/8/70 Final

0 HR GET = 1:31:20:20 GMT
LO = 1:31:__:__

TIME (GET) HOURS	VENUS UNIT VECTOR (LAUNCH JAN 31,1971 20.0HR GMT) X(R1)	Y(R2)	Z(R3)
.0	-.08900	-.93419	-.34550
4.0	-.08591	-.93439	-.34575
8.0	-.08282	-.93457	-.34600
12.0	-.07973	-.93475	-.34624
16.0	-.07664	-.93492	-.34648
20.0	-.07355	-.93508	-.34672
24.0	-.07046	-.93523	-.34695
28.0	-.06737	-.93537	-.34718
32.0	-.06428	-.93551	-.34741
36.0	-.06118	-.93563	-.34764
40.0	-.05809	-.93574	-.34786
44.0	-.05499	-.93585	-.34808
48.0	-.05189	-.93595	-.34830
52.0	-.04879	-.93603	-.34851
56.0	-.04569	-.93611	-.34872
60.0	-.04259	-.93618	-.34893
64.0	-.03948	-.93624	-.34914
68.0	-.03638	-.93629	-.34934

TIME (GET) HOURS	VENUS UNIT VECTOR (LAUNCH JAN 31,1971 20.0HR GMT) X(R1)	Y(R2)	Z(R3)
72.0	-.03327	-.93633	-.34954
76.0	-.03016	-.93636	-.34974
80.0	-.02705	-.93639	-.34993
84.0	-.02394	-.93640	-.35012
88.0	-.02083	-.93640	-.35031
92.0	-.01771	-.93640	-.35049
96.0	-.01459	-.93638	-.35067
100.0	-.01148	-.93636	-.35085
104.0	-.00836	-.93633	-.35103
108.0	-.00524	-.93629	-.35120
112.0	-.00211	-.93623	-.35137
116.0	.00101	-.93617	-.35153
120.0	.00414	-.93610	-.35170
124.0	.00727	-.93603	-.35186
128.0	.01040	-.93594	-.35201
132.0	.01353	-.93584	-.35217
136.0	.01667	-.93573	-.35232
140.0	.01980	-.93562	-.35246

PLANET VECTORS

0 HR GET = 1:31:20:20 GMT
LO = 1:31:__:__

TIME (GET) HOURS	VENUS UNIT VECTOR (LAUNCH JAN 31,1971 20.0HR GMT) X(R1)	Y(R2)	Z(R3)
144.0	.02294	-.93549	-.35261
148.0	.02608	-.93536	-.35275
152.0	.02922	-.93521	-.35288
156.0	.03237	-.93506	-.35302
160.0	.03551	-.93489	-.35315
164.0	.03866	-.93472	-.35327
168.0	.04181	-.93454	-.35340
172.0	.04496	-.93435	-.35352
176.0	.04812	-.93415	-.35363
180.0	.05128	-.93393	-.35375
184.0	.05443	-.93371	-.35386
188.0	.05759	-.93348	-.35396
192.0	.06076	-.93325	-.35406
196.0	.06392	-.93300	-.35416
200.0	.06709	-.93274	-.35426
204.0	.07026	-.93247	-.35435
208.0	.07343	-.93219	-.35444
212.0	.07660	-.93190	-.35452

TIME (GET) HOURS	VENUS UNIT VECTOR (LAUNCH JAN 31,1971 20.0HR GMT) X(R1)	Y(R2)	Z(R3)
216.0	.07978	-.93161	-.35460
220.0	.08295	-.93130	-.35468
224.0	.08613	-.93098	-.35475
228.0	.08932	-.93066	-.35482
232.0	.09250	-.93032	-.35489
236.0	.09568	-.92998	-.35495
240.0	.09887	-.92962	-.35501
244.0	.10206	-.92925	-.35506

Basic Date 7/1/70

Changed 10/22/70

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Basic Date 7/1/70 Changed 10/22/70

CSM 6-2.- Mars, Jupiter, Saturn unit vectors. 0 HR GET = 1:31:20:20 GMT LO = 1:31:__:__ 9/8/70 Final

TIME (GET) HOURS	MARS UNIT VECTOR (LAUNCH JAN 31,1971 20.0HR GMT) X(R1)	Y(R2)	Z(R3)
.0	-.41404	-.83881	-.35351
10.0	-.40993	-.84048	-.35432
20.0	-.40582	-.84214	-.35512
30.0	-.40170	-.84378	-.35592
40.0	-.39758	-.84540	-.35671
50.0	-.39345	-.84699	-.35749
60.0	-.38932	-.84857	-.35826
70.0	-.38518	-.85014	-.35903
80.0	-.38104	-.85168	-.35979
90.0	-.37689	-.85320	-.36055
100.0	-.37274	-.85471	-.36129
110.0	-.36858	-.85620	-.36203
120.0	-.36441	-.85767	-.36277
130.0	-.36023	-.85913	-.36350
140.0	-.35605	-.86057	-.36422
150.0	-.35186	-.86199	-.36494
160.0	-.34765	-.86339	-.36565
170.0	-.34344	-.86477	-.36635

TIME (GET) HOURS	MARS UNIT VECTOR (LAUNCH JAN 31,1971 20.0HR GMT) X(R1)	Y(R2)	Z(R3)
180.0	-.33922	-.86614	-.36705
190.0	-.33499	-.86750	-.36774
200.0	-.33075	-.86883	-.36842
210.0	-.32650	-.87015	-.36910
220.0	-.32224	-.87145	-.36977
230.0	-.31797	-.87274	-.37044
240.0	-.31369	-.87401	-.37109
250.0	-.30940	-.87526	-.37175

TIME (GET) HOURS	JUPITER UNIT VECTOR (LAUNCH JAN 31,1971 20.0HR GMT) X(R1)	Y(R2)	Z(R3)
.0	-.45824	-.82167	-.33894
50.0	-.45392	-.82372	-.33978
100.0	-.44974	-.82568	-.34057
150.0	-.44570	-.82755	-.34134
200.0	-.44178	-.82935	-.34207
250.0	-.43797	-.83107	-.34278

TIME (GET) HOURS	SATURN UNIT VECTOR (LAUNCH JAN 31,1971 20.0HR GMT) X(R1)	Y(R2)	Z(R3)
.0	.69562	.67354	.24992
100.0	.69393	.67492	.25091
200.0	.69188	.67660	.25201

MSC FORM 2206 (REV MAR 70)

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Color