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LUMINARY IE

R.A. LARSON MIT/DL

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MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: R. L. Pearson		1.2 ORGANIZATION: NASA		1.3 DATE: 4/9/71	1.4 ORIGINATOR CONTROL NO. L71-1	MIT REPORT NO. L-1E-06	
1.5 DESCRIPTION OF ANOMALY: A V78 during P63 N62 display prior to average-G results in P.A. 1201 and clobbers the LM velocity vector.						PROGRAM LUM PROGRAM REVISION 209	
1.6 DESCRIPTION OF RUN: LUM testing with LMS-2 load tapes.						CONTINUED ON PAGE	
- MIT ANALYSIS -							
2.1 CAUSE: R77 Flag is set, preventing R12 radar reads from being completed and average -G state vector updating from being done.						CONTINUED ON PAGE 2	
2.2 RECOGNITION: Program alarm 31201 (0r 31202) - positive HDOT for a short time after ignition.						CONTINUED ON PAGE	
2.3 MISSION EFFECT: Large state vector errors (about 250 ft in altitude and 50 fps in alt. rate) resulting in a downrange error of about 5000 ft at touchdown.						CONTINUED ON PAGE	
2.4 AVOIDANCE PROCEDURE: Terminate R77 before the start of average - G in P63						CONTINUED ON PAGE	
2.5 RECOVERY PROCEDURE: State vector update						CONTINUED ON PAGE	
2.6 PROGRAM CORRECTION: Have P63 clear R77 flag and turn off R77 at the start of average - G or lock R77 out of P 63, not just R12						CONTINUED ON PAGE	
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Do not fix; work-around.						CONTINUED ON PAGE	
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3.1 NASA DIRECTION: CONTINUED ON PAGE				4.1 CLOSING ACTION TAKEN: CONTINUED ON PAGE			
3.2 NASA/MSD SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION:	4.4 DATE:		

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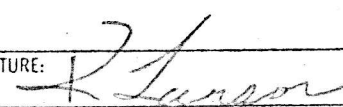
1.1 ORIGINATOR: R. L. Pearson	1.2 ORGANIZATION: NASA	1.3 DATE: 4/9/71	1.4 ORIGINATOR CONTROL NO. L71-1	REPORT NO. L-1E-06
PROGRAM LUM				PROGRAM REVISION 209

2.1 Continued

The R12 jobs in Servicer Loop while waiting for the landing radar reads to be completed. Since they never are, an additional job (and VAC area) is accumulated for each Servicer Pass until the 31201 bailout clears out R77 and the stacked up Servicer jobs. Since the LM state vector is not updated for about 12 seconds, a vertical error of about 50 fps in velocity is introduced.

MIT/IL SOFTWARE ANOMALY REPORT

MIT REPORT NO.
L-1E-07
PROGRAM
LUM
PROGRAM REVISION
209

1.1 ORIGINATOR: R. L. Pearson	1.2 ORGANIZATION: NASA	1.3 DATE: 4/9/71	1.4 ORIGINATOR CONTROL NO. L71-4		
1.5 DESCRIPTION OF ANOMALY: An inadvertent proceed on the V16N80 display in P20 caused the program to "get lost". Recovery could only be accomplished by recalling the program. <div style="text-align: right;">CONTINUED ON PAGE</div>					
1.6 DESCRIPTION OF RUN: Apollo 15 training on LMS-2. <div style="text-align: right;">CONTINUED ON PAGE</div>					
- MIT ANALYSIS -					
2.1 CAUSE: A window exists (about .1 seconds out of every 6 seconds) during the R24 automatic search routine, when a PRO response to the V16N80 display results in two independent jobs attempting to designate the RR <div style="text-align: right;">CONTINUED ON PAGE</div>					
2.2 RECOGNITION: No track light stays on, DSKY blanks, tracker fail light goes on. <div style="text-align: right;">CONTINUED ON PAGE</div>					
2.3 MISSION EFFECT: None <div style="text-align: right;">CONTINUED ON PAGE</div>					
2.4 AVOIDANCE PROCEDURE: Do not key PRO to V16N80 display unless R1 =11111 <div style="text-align: right;">CONTINUED ON PAGE</div>					
2.5 RECOVERY PROCEDURE: Reselect P20 <div style="text-align: right;">CONTINUED ON PAGE</div>					
2.6 PROGRAM CORRECTION: Have PRO response to V16N80 display check for RR lockon before continuing. <div style="text-align: right;">CONTINUED ON PAGE</div>					
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Do not fix <div style="text-align: right;">CONTINUED ON PAGE</div>					
2.8 RECOMMENDED RE-TESTING: N. A. <div style="text-align: right;">CONTINUED ON PAGE</div>		2.9 MIT/IL SIGNATURE: 	2.10 DATE: 5-19-71		
3.1 NASA DIRECTION: <div style="text-align: right;">CONTINUED ON PAGE</div>		4.1 CLOSING ACTION TAKEN: <div style="text-align: right;">CONTINUED ON PAGE</div>			
3.2 NASA/MSD SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION:	4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1E-08
PROGRAM LUMINARY 1E
PROGRAM REVISION LUMINARY 209

1.1 ORIGINATOR: P. Weissman	1.2 ORGANIZATION: MIT/CSDL	1.3 DATE: 4/14/71	1.4 ORIGINATOR CONTROL NO.
1.5 DESCRIPTION OF ANOMALY: DAP interrupt could occur in the middle of the ZATTEROR zeroing sequence or STOPRATE.			
CONTINUED ON PAGE			
1.6 DESCRIPTION OF RUN: EYEBALL. Similar to COMANCHE, viz. COM 33 Anomaly			
CONTINUED ON PAGE			
- MIT ANALYSIS -			
2.1 CAUSE: ZATTEROR and STOPRATE called without INHINT from NOGO and NOGO-2 in KALCMANU.			
CONTINUED ON PAGE 2			
2.2 RECOGNITION: None			
CONTINUED ON PAGE			
2.3 MISSION EFFECT: Negligible			
CONTINUED ON PAGE 2			
2.4 AVOIDANCE PROCEDURE: None			
CONTINUED ON PAGE			
2.5 RECOVERY PROCEDURE: None			
CONTINUED ON PAGE			
2.6 PROGRAM CORRECTION: INHINT before calls to these 2 routines at NOGO and NOGO-2.			
CONTINUED ON PAGE			
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): No further action			
CONTINUED ON PAGE			
2.8 RECOMMENDED RE-TESTING: None			
CONTINUED ON PAGE			
2.9 MIT/IL SIGNATURE: <i>Russell A. Laro</i>		2.10 DATE: 4-29	
3.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:	
CONTINUED ON PAGE		CONTINUED ON PAGE	
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:
			4.3 ORGANIZATION
			4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Weissman	1.2 ORGANIZATION: MIT	1.3 DATE: 4/14/71	1.4 ORIGINATOR CONTROL NO. LUMINARY 1E PROGRAM REVISION LUMINARY 209
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2.1 Continued

Circumstances of calls:

ZATTEROR-interrupt maneuver if mode found to no longer be AUTO.

STOPRATE

- 1) 401 alarm (Desired MGA $> 70^0$)
- 2) Total maneuver less than 0.25^0

2.3 Mission Effect (Cont)

An interruption to the ZATTEROR execution by the DAP could cause the DAP to use inconsistent set of errors and error rates for one pass, but the effect is trivial, especially under the circumstances (an automatic maneuver has been manually interrupted.)

The 2 calls to STOPRATE are made when no maneuver has been started yet, so all the parameters are zero anyway. The calls seem to be a matter of extra conservative design.

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INSTRUMENTATION LABORATORY FIELD SITE
EASTERN TEST RANGE

C. S. DRAPER
DIRECTOR

SERIAL: 71-6
FILE: LM-10 Workbook
DATE: 9 April 1971

MEMO TO: R. O'Donnell
FROM: R. Gilbert
SUBJECT: LUMINARY 1E (210) vs LUMINARY 1D (178)

- P12 -

1. FLRCS flag (FLAGWRD9 BIT 10) is set to 0 at the beginning of P12. This flag need not be reset via DSKY if, during a previous P12, ENTER was inserted on a flashing V99. It is still necessary to reset P7071 flag (13F9) if P71 is called on surface prior to P12.

2. ASCENT NOUN Changes -

NOUN 77	R1 XXbXX	M/S	TTGO	
	R2 XXXX.X	FPS	VGX (BODY)	was XXXX.X FPS YDOT
	R3 XXXX.X	FPS	VI	was SPARE
NOUN 94	R1 XXXX.X	FPS	VGX (BODY)	was SPARE
	R2 XXXX.X	FPS	HDOT	was SPARE
	R3 XXXXX.	FT	H	was SPARE

- P2X -

1. PRIO DISP lamp lights when an internal PRIORITY DISPLAY is on the DSKY or waiting in the background if the DSKY is being used externally. The following are PRIORITY DISPLAYS:

P20, P25	V50N18
P20, P22	V06N05
P20	V06N49
	V50N72
	V05N09 ALARMS 501, 503, 514, 525
	V16N80
P22	V05N09 ALARMS 503, 514, 525, 530

The light is turned off by PRO, V32E, V33E, V34E, V36E, V37EXXE, V56E, or hardware or software restart.

- P2X Continued -

2. RENDEZVOUS NOUN change

NOUN 49	R1	XXX.XX	NM	DELTA R	was R1 XXXX.X NM
	R2	XXXX.X	FPS	DELTA V	
	R3	XXXXX.		SOURCE	

Nouns 49, 54, 78, and 90 now all have R1 scaled XXX.XX NM and R2 scaled XXXX.X FPS.

3. PGNC/AGS RR DATA TRANSFER - During R22, the LGC sends, via the downlist, RR RANGE, RR RANGE RATE, TRUNNION, and SHAFT angles to the AGS and sets a code word called AGSCODE, also on the downlist, to indicate the validity of the data as well as whether the data is HI or LO SCALE.

AGSCODE	20000	no new data
	57777	new data - RR HI SCALE
	17777	new data - RR LO SCALE

Under normal operating conditions, new data is sent approximately every 65 seconds. (See MIT/KSC Memo 71-5).

4. VO6N18 has been deleted from R60 to allow EXTENDED VERBS during an AUTO maneuver. Restrictions on EXTENDED VERBS with displays (e.g. V82, V83) during P20 or P22 include:
- If V83, for example, is called during the first maneuver in P20 and the RR MODE switch is not in LGC when E is depressed on V50N18, it will be necessary to exit V83 to allow the V50N25 R1 = 00201 display.
 - If, in P22, the RANGE is greater than 400 NM and closing and a V83 is displaying RANGE and RANGE RATE in addition to the cyclic display, it will be necessary to exit V83 when the range becomes less than 400 NM. V83 could be recalled almost immediately.
5. V50N72 following LOCK-ON in R21 now updates the RR TRUNNION and SHAFT angle displays in R1 and R2 every second. The V50 is "pasted" over a V16N72 monitor.
6. If P20 is called prior to P63, it is no longer necessary to load the LR weighting function LRWH1, location 1315 in LUMINARY 210, prior to PDI. Thus, as long as the NOUPDATE MODE (V95) is in, no reloading whatsoever is required. W-MATRIX initialization destroys the descent targets if incorporations take place.
7. P25 will control spacecraft attitude even though the range to the CSM is greater than 566 NM.
8. P22 will not flash V37 following the overhead pass of the CSM when RR LOCK-ON is lost. V37FOOE, for example, should be inserted to terminate P22.

- P3X -

1. NOUN 81, DELTAV in local vertical coordinates, is displayed on all passes in P34(74) and P35(75). NOUN 59, DELTA V LOS, is no longer displayed during these prethrust programs. NOUN 59 data is calculated following PRO on VO6N81 and is callable via DSKY.

- P4X -

1. AUTO THROTTLE (CHANNEL 30 BIT 5) is assumed under conditions as described under P6X. Applicable during PGNCs/AUTO and AUTO THROTTLE check just after R60.
2. If the burn time calculated at TIG - 5 seconds is less than 6 seconds, the NOTHROT flag (FLAGWRD5 BIT 12) is set. Previously the LGC would command maximum throttle at zoomtime even though the engine was off.
3. A V37EXXE prior to ullage coming on will now prevent the LGC from commanding ullage. (P40, 42, 63) **ALMOST**

- P5X -

1. ROD INPUTS are handled as follows:
 - a) AVERAGEG ON - Valid ROD input
 - b) P57 or P52 (surface technique - V32E on V50N25 R1 = 00015) MARK X if V52 flashing and MARK Y if V53 flashing
 - c) P51 and P52 - ALARM 113
2. R53 and R57 were re-designed. Among the changes were:
 - a) Inflight alignments - X MARKS and Y MARKS need not be taken in pairs.
 - b) Surface technique - CURSOR and SPIRAL MARKS need not be taken in pairs.
 - c) ALARM 107, more than 5 mark pairs, was deleted. A 6th MARK will replace the 5th MARK.
 - d) ALARM 114, MARK made but not desired was deleted. This indicated that 2 X MARKS, or 2 Y MARKS were taken in succession.
 - e) Star vector determination equations were re-coded.

Attached diagram illustrates responses to displays in R53 for MARKING on catalog star.

NOTE: In R59, if the VO6N79 display of the desired CURSOR and SPIRAL angles are for a detent other than the one desired, load V21NLE 373E 32533 and then PRO. As of the date of this memo, this procedure hasn't been formally blessed for flight use.

- P6X -

1. DESCENT NOUN changes.

NOUN 63	R1	XXXXX.	FT	DELTAH	was R1	XXXX.X	FPS	VI
	R2	XXXX.X	FPS	HDOT				
	R3	XXXXX.	FT	H				

- P6X Continued -

NOUN 68	R1	XXXX.X	NM	HOR:RANGE	was R1 XXXX.X	<u>FPS</u>	SLANT RANGE
	R2	XXbXX	M/S	TGO			
	R3	XXXX.X	FPS	VI	was R3 XXXXX.	FT	DELTAH

2. Alignment option, V50N25 R1 = 00014, deleted. PRO on V06N61 results in R60 with 1 degree deadband.

3. TRUDELH was added to the DESCENT/ASCENT downlist.

Word 3a, 3b TRUDELH = H_{LR} - H_{PGNCS}
 Word 4a, 4b DELTAH = H_{LR} - H_{PGNCS} - $H_{TERRAIN}$ (N63 R1)

4. LPD scaling is: AZIMUTH $\pm 1^\circ$ was $\pm 2^\circ$
 ELEVATION $\pm 1^\circ$ was $\pm 1/2^\circ$

5. The slope in the LR reasonability test was increased to .25 from .125. This number will reject updates that cause guidance interference problems but will accept values that won't cause guidance interference problems.
6. ABORT (CHANNEL 30 BIT 1) and ABORT STAGE (CHANNEL 30 BIT 4) INPUT discretes are not checked if BIT 1 of location CHANBKUP is 1. CHANBKUP loaded by V22N46E 1 E (11E if AUTO THROTTLE discrete is to be backed up). Applicable during R11.
7. AUTO THROTTLE (CHANNEL 30 BIT 5) is assumed if BIT 4 of location CHANBKUP is 1. CHANBKUP loaded by V22N46E 1OE (11E if ABORT and ABORT STAGE to be backed up). Applicable during PGNCs/AUTO and AUTO THROTTLE check just prior to V06N62 and during P66. (Also P40)
8. ALT/ALT RATE and FORWARD/LATERAL VELOCITY commands are sent from the LGC during AVERAGEG regardless of the position of the MODE SELECT switch. The DISPLAY INERTIAL DATA INPUT discrete (CHANNEL 30 BIT 6) is not checked. For ALT/ALT RATE commands to get to the meters requires MODE SELECT switch in PGNCs and RNG-ALT MON switch in ALT/ALT RATE. For FORWARD/LATERAL VELOCITY commands to get to cross-pointers requires MODE SELECT switch in PGNCs and RATE/ERR MON switch in LDG RDR/CMPTR.
9. V57E results in a flashing V06N63 display while V58 results in a static V06N63 display during P63.
10. The polarity of the LATERAL VELOCITY cross-pointer using data sent via the LGC is reversed. This is a hardware change.

- P77 -

1. P77, LM TARGET DELTA V, updates the LM state vector if, for instance, the LM performs a burn without AVERAGEG on. In P77, the NOUN 33 display is followed by the NOUN 81 display as opposed to the NOUN 84 in P76.

- PXX -

1. ALARM 1520 results if V37EXXE is inserted during
 - a) ISS CDU ZERO following V40N20E.
 - b) V47 is performed in program other than P12, P20, P22, P4X, P5X, P6X, P70, and P71 and ISS CDU ZERO is in progress.

The ISS CDU ZERO routine in these cases takes 10.56 seconds. ALARM 1520 results if V37EXXE is inserted, as in previous LUMINARY releases, during

- c) ISS CDU ZERO following V36E or other FRESH START.
- d) TURN-ON SEQUENCE or IMU CAGE.
- e) NODO flag (1F2) is set.

- VERBS -

1. V30 or V31E with R1 of NOUN 26 = 0 results in OPERATOR ERROR. NOUN 26 now uses unshared erasable locations 2371,2,3. NOUN 26 is loaded with V25 and displayed with V05.
2. V35E now lights the PRIO DISP and NO DAP lights on the DSKY. (BITS 1 and 2, respectively, of DSPTAB +11D).
3. V41N72E while a REMODE or REPOSITION is in progress will result in the routine delaying the V21N73 display until the REMODE or REPOSITION is complete. A second V41N72E in the belief that the first one did not get in will result in OPERATOR ERROR. V41N72E may be inserted, without an intervening V44E, after PRO is inserted on the V04N12 R1 = 00006 display. RADMODES, location 110, BITS 14 and 11 indicate that a REMODE and/or REPOSITION is in progress (V11N1E 110E). Patience.
4. V44E plays the same REMODE/REPOSITION game as V41N72 inasmuch as waiting for the completion of the REMODE or REPOSITION. Additional V44's while the routine is looping will eventually lead to ALARM 31202 although no OPERATOR ERROR will result. A V44E while no other displays are active on the DSKY will result in the DSKY blanking when the routine has terminated a CONTINUOUS DESIGNATE presently running. V44E is not necessary if a V41N72E is to be inserted immediately thereafter. V44E is also not necessary if the RR MODE switch is in AUTO TRACK or SLEW and/or the RR CB's are pulled.
5. V47E - The NODO flag (FLAGWRD2 BIT 1) is not set so V37EXXE may be called prior to the V50N16 display, usually when downlink is received by AGS, although ALARM 1520 results if called during the ISS CDU ZERO.
6. V48E has V04N46 displayed instead of V01N46. R2 has CHANBKUP, the location containing the back-up flags for DESCENT. It is desirable to load this location to 00000 when new ropes are installed. V48E need not be called to load NOUN 46. CHANBKUP is on all downlists. (See P6X)
7. V56E was recoded so that it can perform properly if it is necessary to call it again if it was interrupted by a RESTART.

- VERBS Continued -

8. V57E - Sets LR UPDATE flag and results in static VO6N63 display in P63.
V57E has no displays associated with it.
V58E - Resets LR UPDATE flag and results in flashing VO6N63 display in P64.
9. V63E - NOUN change

NOUN 78	R1 XXX.XX	NM	RANGE	
	R2 XXXX.X	FPS	RANGE RATE	was XXXXX. FPS
	R3 XXbXX	M/S	TTOTIG	

The RADSAMP routine calls itself using the word ADRES rather than CADR which caused problems in the LMS but not in the LGC.

- DAP -

1. NO DAP lamp lights when
 - a) PGNCs is in PULSE MODE, ATT HOLD and V76E.
 - b) PGNCs MODE CONTROL switch is in OFF position.
 - c) IMU is OFF or TURN-ON sequence is in progress.
 - d) IMU is being caged.
 - e) ISS CDU ZERO is in progress or ISS is in COARSE ALIGN.
 - f) Ground testing - IMODES33 (location 1300) BIT 6 is set.
2. DAP continues to function and FINDCDUW, powered flight steering routine, issues commands if input discrete from GUID CONT switch (CHANNEL 30 BIT 10) indicates AGS. Exceptions are:
 - a) The actual CDU's rather than the desired CDU's (CDUD) will be used to set up the coordinate frame for the thrust direction filter.
 - b) The DAP will reinitialize when the GUID CONT input discrete indicates PGNCs.
3. CH5MASK and CH6MASK (locations 1257 and 1260), RCS JET INHIBIT flags, are on the Coast and Align, Rendezvous and Prethrust, and Lunar Surface downlists. They are not on the AGS Initialization and Update, Orbital Maneuvers, and Descent/Ascent downlists.
4. All MAJOR MODE changes and RESTARTS (hardware and software) set up a 1/ACCS job.
5. The ATTITUDE ERROR needles will be reinitialized when the PGNCs MODE CONTROL switch is switched from OFF. The ATTITUDE ERROR needles previously were reinitialized when the IMU became "usable" but not when going to ATT HOLD or AUTO from OFF.
6. The mass-dependent calculations in 1/ACCS were updated for the DESCENT configuration by changing various "constants." The addition of the Rover and associated enlargement of the DPS tanks in LM 10 caused appreciable change in the mass properties.

- DAP Continued -

7. The present bounds on the ASCENT and DESCENT masses are

	RO3	minimum unstaged mass in N47	14,462 lbs.
	RO3	minimum ASCENT mass in N47	4,850 lbs.
HIASCENT	1/ACCS	maximum ASCENT mass	8,858 lbs.min.(E-load)
LOASCENT	1/ACCS	minimum ASCENT mass	4,850 lbs.
HIDESCENT	1/ACCS	maximum unstaged mass	36,817 lbs.
LODESCENT	1/ACCS	minimum unstaged mass	5,604 lbs. + HIASCENT

8. If inhibit X-AXIS override is removed or the PGNCS MODE CONTROL switch is moved to ATT HOLD after previously been moved from ATT HOLD to AUTO before the MANUAL RATE COMMAND has properly terminated and while X-AXIS override is inhibited, no unexpected jet firings will occur about the YAW AXIS.
9. A hardware or software restart during an ISS CDU ZERO, except the V37EXXE which results in ALARM 1520, requires that the ISS CDU ZERO be again executed, V40N20E, to re-enable the DAP.

- MISCELLANEOUS -

1. Constants in fixed memory were updated for the 1971-72 year. These are the locations that must be changed on IMS when running with previous load tapes.

AZO	(2)	STAR TABLE (222)	KONMAT	(8)
BDOT	(2)		RATESP	(12)
NODIO	(2)		VAL67	(12)
NODDOT	(2)			
FSUBO	(2)			
FDOT	(2)			

CSTODAY, the number of centiseconds in 24 hours, was rescaled from B33 to B32.

2. AIMCADR and AIMCADR +1 were placed on the AGS Initialization and Update, Rendezvous and Prethrust, Orbital Maneuvers, and Descent/Ascent downlists. V5N8E displays these quantities in R1 and R2. R1 contains the address and R2 the bank information to indicate where the ALARM originated in the program.
3. A POODOO will turn into a BAILOUT, ALARM code remains same, if location EXTVBACT indicates that an EXTENDED VERB may have caused the ALARM. If the ALARM then returns, the POODOO logic will be executed.
4. A POODOO ALARM, not caused while an EXTENDED VERB is running, will now clear the RENDEZVOUS (7FO), TRACK (5F1), and P25 (9FO) flags. This prevents the possibility of P20 being requested but not executed.
5. Gyro torquing is not performed, or is terminated if presently torquing, if the ISS is in COARSE ALIGN or being CAGED.

R53

V52 N71 FLASHING
MARK X
MARK Y
RODV53 N71 FLASHING
MARK X
MARK Y
RODMARK X
MARK Y
MARK REJ
RODALARM
112V01 N71
R1 00XX
R2 blank
R3 blankX DETENT CODE
YY STAR CODEDATA E
V32E
DSKY
PRO
V33E
DETENT
CODE
1-6
7LOAD - OCTAL ONLY
MUST LOAD DESIRED DETENT
CODE HERE
V34 ON ANY R53 FLASHING
DISPLAY RESULTS IN
FL 37MARK X
MARK Y
MARK REJ
RODALARM
112V06 N87
R1 +XXX.XX° AZ
R2 +XXX.XX° EL
R3 blank

LOAD-DECIMAL ONLY

DATA E
V32E
DSKY
PRO
V33E
P52
P5XINITIALLY,
R2=R3=0P52-SURFACE TECHNIQUE
V32E ON V50 N25
R1 00015

V54 N71 FLASHING

MARK X (R2) A=1 Increment B B<5
(R3) C=0MARK Y (R2) A=0
(R3) C=1 Increment D D<5Marks after 5th replace
5th mark.MARK REJ (R2 & R3) if A=0=0
Alarm 115
(R2) If A=1, B>0
decrement B
(R2) If A=1, B=0
Alarm 115(R3) If C=1, D>0
Decrement D
(R3) If C=1, D=0
Alarm 115

ROD ALARM 113

V54 N71
R1 00XX
R2 A000B
R3 0000DX DETENT CODE
YY STAR CODE
A,C MARK REJ POINTER
B,D X,Y MARKS
INITIALLY, R2=R3=0If A=0 & C=0 then
A=0 & C=1
If A=1, then
A=0 & C=1
If C=1, then
A=1 & C=0MARK DATA FOR 1ST STAROK
IF CURRENTLY MARKING ON
2ND STARV32E
DSKY
PROSWITCH MARK
REJECT POINTERV21 N79
R1 Blank
R2 Blank
R3 BlankV22 N79
R1 Blank
R2 Blank
R3 BlankMARK X
MARK Y
MARK REJ
RODALARM
112LOAD - DECIMAL ONLY
ENTER - OP ERROR, DISPLAY REMAINS SAME
PRO - USES PRESENT N79 DATAIF INADVERTENT MARK, DO
V PRO PRO MARK REJMARK X
MARK Y
MARK REJ
RODALARM
112LOAD CORRECT DATA HERE IF INCORRECTLY
LOADED ABOVEENTER - KEY REL LIGHT WITH DATA
IN R1, R2, AND R3PRO
DSKY
DATA E
V33E
V PRO
V 32EE OP ERROR
E
DSKY
DATA E
V33E
V PRO
V 32EV06 N79
R1+XXX.XX° Cursor
R2 blank
R3 BlankV06 N79
R1 blank
R2+XXX.XX° Spiral
R3 blankDATA E
V33E
DSKY
PRO
V33EE KEY REL
E
DSKY
DATA E
V33E
PRO
V33EV52 N71
R1 00XX
R2 1000B
R3 0000DV53 N71
R1 00XX
R2 0000B
R3 1000DX DETENT CODE
YY STAR CODE
B X MARKS
D Y MARKSV32E
DSKY
PROE
DSKY
V32E
PROR53
NO
P50
and
D>0
YESALARM
111NO
pairs
rejected
YESREJECTED IF - STAR within 2° of AOT OPTICS AXIS
STAR greater than 28.5° from AOT OPTICS AXIS
MORE than 28 iterations required to converge to
solution
SIGN OF ITERATION STEP changes more than onceV50 N25
R1 00016
R2 0000N
R3 blankMARK X
MARK Y
MARK REJ
RODALARM
112DSKY
V33E
ProN - NUMBER PAIRS REJECTED
R53PRO - IGNORE BAD PAIRS
DO NOT PRO IF ALL PAIRS REJECTED
No harm done unless PRO on V06 N87EXIT
R53

R. Larson
Date 13 April 1971

MIT/CSDL MISSION SUPPORT DEVELOPMENT PLAN

FOR MISSION "J-1"

(APOLLO 15)

LUMINARY 1E

Russell H. Larson 4-13
LUMINARY Project Manager's Signature Date

R. W. Butler 4/12
Director, Mission Development Approval Date

This plan consists of 23 pages.

PREFACE

The LUMINARY 1E Program (LUMINARY 210) is being Performance Tested to support the Mission "J-1" objectives. The Mission "J-1" vehicles are CSM 112 and LM 10.

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PART 1

LM PROGRAM SUMMARY

PROGRAM DEVELOPMENT SUMMARY FOR LUMINARY 1E

Date 4/13/71

Item No.	DESCRIPTION	Required Date	Predicted Date	Actual Date	COMMENTS
1	FLIGHT PROGRAM LUMINARY 210 Release FSRR			3/22/71	
2	GSOP Status		6/3/71		
3	Level 6 Performance Test Plan		4/29/71		See Page 2-1-1
4	Level 6 AGC Performance Testing			5/12/71	See Luminary Memo #214
	Start	4/19/71	4/19/71		Assuming Receipt of Data Pack from MSC on 4/19/71
	Completion	5/27/71	5/27/71		
	Documentation	6/2/71	6/2/71		
5	RTCC Compatibility Testing Complete	6/2/71	6/2/71		
6	Mission Procedural Test Plan	4/12/71	4/12/71	4/6/71	Preliminary See DG Memo #1713
7	Mission Procedural Verification Testing				
	Start	4/19/71	4/19/71		
	Completion	5/27/71	5/27/71		
	Documentation	6/2/71	6/2/71		

JP 22597-2

PROGRAM DEVELOPMENT SUMMARY FOR LUMINARY 1E

Date 4/13/71

Item No.	DESCRIPTION	Required Date	Predicted Date	Actual Date	COMMENTS
8	System Test Lab Testing Level 5 Completion Documentation	6/3/71	3/26/71 4/16/71	2/29/71	
9	MIT Deliverable Items K-Start Tape Schedule	5/5/71	5/1/71		

JP 22587-2

DEVELOPMENT SUMMARY FOR APOLLO 15 (LM)

Date 4/13/71

ITEM NO.	DESCRIPTION	NASA ISSUE DATE			MIT REC'D DATE			MIT REVIEW COMPLETION			COMMENTS
		Req	Pred	Act	Req	Pred	Act	Req	Pred	Act	
I	Flight Data File Review										Note. These are continuing type reviews. Comments are being transmitted to MSC as they are developed
	a) LM Timeline Book										
	b) LM Data Card Book										
	c) LM System Activation Checklist										
	d) LM G&N Dictionary										
	e) LM Contingency Checklist										
	f) LM Lunar Surface Checklist			3/15			4/5		5/3		
	g) LM Cue Cards										
	h) LM Systems Data										
	i) LM Malfunction Procedure										
II	Crew Procedures Documents										
	a) Apollo Operation Handbook (AOH)		3/31								
	b) LM Rendezvous Procedures		6/28								
	c) LM Descent/Ascent Procedures		6/28								
	d) Lunar Surface Procedures Preliminary		4/19								
	Final		6/28								

PART 2

LM PROGRAM SCHEDULES AND STATUS

PART 2

SECTION 1

LUMINARY GSOP STATUS

GSOP STATUS FOR LUMINARY 1E

Date 4/13/71 113

DESCRIPTION	BLUE COVER DESCRIPTION			PROGRAM	COMMENTS
	REQUIRED DATE	PREDICTED DATE	ACTUAL DATE		
Section 1 - Prelaunch Rev. 1	1/17/69	12/23/68	1/29/69		
Section 2 - Data Links Rev. 11		4/19/71		LNy 1E	
Section 3 - Digital Autopilot Rev. 6			3/5/71	LNy 1E	
Section 4 - Operational Modes Rev. 9		4/29/71		LNy 1E	
Section 5 - Guidance Equations Rev. 10		4/26/71		LNy 1E	
Section 6 - Control Data Rev. 0			12/9/68	LNy 1D	

PART 2

SECTION 2

LEVEL 6 PERFORMANCE TESTING

LEVEL 6 PERFORMANCE TEST DESCRIPTION FOR LUMINARY 1E

Date 4/13/71

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
6.1.0	<u>RENDEZVOUS</u>	P. White
6.1.1	Short Rendezvous - program sequence: P00, P20, P34, P42, P35, P41, P35, P41. Initial Condition: (1) 1σ IMU, Radar, State Vector Errors (2) Normal Astronaut interface from Apollo 15 Data File (3) Apollo 12 O. T., Data Package (4) 10% T-Loss during Average-G.	
6.2.0	<u>ABORTS from DESCENT</u>	C. Schulenberg
6.2.1	Abort at 33Kft. - program sequence: P00, P63, P70, P20, P32.	
6.2.2	Abort at 7Kft. - Abort Stage at DPS depletion - Program sequence: P00, P63, P64, P70, P71, P20, P32.	
6.2.3	Abort Stage after Touchdown - program sequence: P63, P64, P66, P71, P20, P32. Initial Conditions: (1) 1σ IMU, LR Radar, State Vector, (LM), Terrain Profile (+1°) errors (2) Normal Astronaut Interface from Apollo 15 Data File (3) Apollo 15 O. T., Data Package (4) 6.2.1 with 10% T-Loss until Orbit Insertion (5) Yaw LM 40° after the Pitch Maneuver (6) Channel back-up set. (Abort discretes) (7) 6.2.3 with Abort Discrete Present.	
6.3.0	<u>LUNAR SURFACE OPERATIONS & ASCENT</u>	D. Millard
6.3.1	Lunar Surface Alignments - program sequence: P68, P00, P12, P57 (Recycle gravity determination), V41N72, P57 (Planet and Star), P57 (2 stars), P00, V47, V41N20, P06, P57 (AT = 0), P22, P57 (1 star), V64, V63, V48, P57 (1 star), P00, V47, V48, V82, P12 (to TIG), P00.	

LEVEL 6 PERFORMANCE TEST DESCRIPTION FOR LUMINARY 1E

Date 4/13/71

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
6.3.1.1	<p>Inflight Alignments - program sequence: P52 (using P57 sighting), P52 (Planet and star), P52 (2 stars).</p> <p>Initial Conditions: (1) 3σ IMU</p> <p>(2) Apollo 15 O.T., Data Package</p> <p>(3) Normal Astronaut Interface from Apollo 15 Data File.</p>	S. Albert/D. Moore
6.3.2	<p>Ascent from Lunar Surface - program sequence: P00, P12, P20, P34.</p> <p>Initial Conditions: (1) 1σ State Vector, IMU, Radar Errors.</p> <p>(2) YAW LM 40$^{\circ}$ after the pitch maneuver occurs; Targeting for 1 N.M. out-of-plane.</p> <p>(3) Apollo 15 O.T., Data Package</p> <p>(4) Normal Astronaut Interface from Apollo 15 Data File</p>	
6.4.0	<u>LANDING ON LUNAR SURFACE</u>	
6.4.1	Complete Automatic Landing, program sequence: P00, P63, P64, P66, P68, P00.	
6.4.2	Redesignations and Att. - Hold - P66 Landing - program sequence: P00, P63, P64, P66 (at 700 ft.), P00.	
6.4.2.1	NOUN 69: 10K/5K ft; ACA: None	D. Moore
6.4.2.2	NOUN 69: 20K/20K ft.; ACA: 2(-EL), 2(+AZ)	
6.4.2.3	NOUN 69: none, ACA: 2(+EL), 2(-AZ)	
	Initial Conditions: Initial Conditions: same as 6.2.0	
	6.4.2.2 - 10% T-Loss and Abort Discrete Present	
6.5.0	<u>SPECIAL TESTS</u>	D. Moore
6.5.1	LM RCS Deorbit Burn-program sequence: P00, P30, P27, V96, P99, P00	

LEVEL 6 PERFORMANCE TEST DESCRIPTION FOR LUMINARY 1E

Date 4/13/71

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
6.5.2	Docked-DPS Burns - program sequence: P00, P30, P40, P00	C. Work
6.5.2.1	CSM/LM Configuration	
6.5.2.2	CM/LM Configuration	
6.5.3	Abort Stage after Touchdown - Same as 6.2.3 except without Abort Channel backup discrete set	S. Albert/D. Moore
6.5.4	Redesignation and Att. - Hold-P66 Landing - Same as 6.4.2 except without Abort Channel Backup Discretes Set	

LEVEL 6 PERFORMANCE TEST STATUS FOR LUMINARY 1E

Date 4/13/71

TEST NO.	PRIMARY SETUP INPUT PREPARED			ALL RUNS COMPLETED AND RESULTS EVALUATED			SUMMARY MATERIAL PREPARED		
	Required	Predicted	Actual	Required	Predicted	Actual	Required	Predicted	Actual
6.1.1	4/19/71	4/19/71.		5/27/71	5/27/71		6/2/71	6/2/71	
6.2.1	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.2.2	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.2.3	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.3.1	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.3.1.1	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.3.2	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.4.1	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.4.2	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.4.2.1	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	
6.4.2.2	4/19/71	4/19/71		5/27/71	5/21/71		6/2/71	6/2/71	
6.4.2.3	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71	

Date 4/13/71

Date _____

4/13/71

TP#22587-7

PART 2

SECTION 3

LM LEVEL 6 MISSION PROCEDURAL VERIFICATION

MISSION PROCEDURAL VERIFICATION FOR LUMINARY 1E

Date 4/13/71

J1LMV TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
1.0	Earth Orbit Deorbit P30-P99	
2.0	Inflight Alignments P51, P52	
3.0	Lunar Landing P63-P64-P66-P68	
3.1	Aborts from Lunar Landing a P63-P70 b P63-P64-P71 c P63-P64-P70-P71	
3.2	Lunar Surface Activities P57, P22	
4.0	a Ascent P68-P57-P12 b Ascent thru Short Rendezvous P68-P57-P12-P20-P34-P42-P35-P41-P35-P41	
4.1	a Insertion thru Short Rendezvous P20-P34-P42-P35-P41-P35-P41 b Insertion thru Long Rendezvous P20-P32-P41-P33-P41-P34-P41-P35-P41-P35-P41	
5.0	Docked DPS P30-P40	

PART 2

SECTION 4

LM SYSTEM TEST LAB TESTING AND K-START
TAPE SCHEDULES

LEVEL V SYSTEM TEST LAB TESTS FOR LUMINARY 1E

Date 4/13/71

TEST	TITLE	Responsible Engineer	TEST COMPLETE			DOCUMENT APPROVED		
			Req	Pred	Act	Req	Pred	Act
SEV	Extended Verbs	Grace		3/1/71	2/16/71		3/16/71	3/2/71
IOP	IMU Operational Program	Grace		3/1/71	2/16/71		3/16/71	2/22/71
STP2	IMU Performance Test	Grace		3/1/71	2/17/71		3/29/71	2/24/71
AAP. 6	P57 Changes (PCR 1044)	St. Amand		3/26/71	2/22/71		4/9/71	2/26/71
RP1	Radar Changes	Goodwin		3/26/71	2/18/71		4/16/71	
PT	IRIG Torque	Sheridan		3/12/71	2/18/71		3/26/71	4/1/71
SU	Sum Uplink	Sheridan		3/12/71	2/16/71		3/26/71	4/1/71
C77	Channel 77 Restart Monitor	Sheridan		3/12/71	2/25/71		3/26/71	4/1/71
CB	Input Channel Backup (PCR's 1107, 1109, 1110, 1111)	Goodwin		3/19/71	3/16/71		4/9/71	4/13/71
RP2	PGNS-AGS Data Transfer (PCR 324)	Goodwin		2/5/71	2/26/71		4/16/71	
KR	Super Key Release Light (PCR 1091)	Sheridan		3/12/71	2/19/71		3/26/71	4/1/71
AAP	P52 Changes (PCR 1044)	St. Amand		3/26/71	2/29/71		4/9/71	4/1/71
L-26	ACB-26	St. Amand			2/22/71		3/5/71	3/12/71

MISSION "J-1"

K-START TAPE SCHEDULE FOR LUMINARY 1E

Date 4/13/71

ITEM NO.	DESCRIPTION		FINAL DELIVERY		
			Required	Predicted	Actual
	LM 10 TESTING	LUMINARY 1E PAD			
	IMU Performance Test	F10L010-K00081-00	5/5/71	5/1/71	
	Simflight	F10L010-K00078-00	5/5/71	5/1/71	
	Erasable Initialization	F10L010-K00068-00	5/5/71	5/1/71	

PART 2

SECTION 5

LUMINARY 1E ANOMALY STATUS

ANOMALY STATUS REPORT FOR LUMINARY 1E

Date 4/13/71

MSC NO.	DESCRIPTION	Originator/ Date/ Control No.	RECOMMENDED DISPOSITION (Date Submitted to NASA)	NASA DIRECTION/ DATE	CLOSING ACTION TAKEN/DATE
L-1D-22	A hardware or software restart during a RR TURNON sequence may result in an incorrect setting of the mode flag (ANTENFLG)	MIT/CSDL 1/18/71	Program Note for Luminary 1D & subs.	Program Note for Luminary 1D & subs.	Program Note
L-1D-24	P70 or P71 selection prior to P12 leaves P12 with at least 3 flags abnormally set	MSC/FSB 1/14/71	Program Note for Luminary 1D & 1E	Program Note for Luminary 1D & 1E	Program Note

MIT/IL Program Note Report

Name of Program(s): LUMINARY 1D,1E

Originator: P. Rye

Organization: MIT/DL

Date: 3/2/71

Note:

Do not select a new major mode within 10 seconds of RR Turn-on.

If a HARDWARE restart or BAILOUT/POODOO occurs in this time interval, perform recovery procedure.

Recovery: Cycle RR MODE Switch from LGC to SLEW and back.

Comments:

MIT/IL Program Note Report

Name of Program(s): LUMINARY 1E

Originator: P. Rye

Organization: MIT/DL

Date: 3/2/71

Note:

A window of just under 60 microseconds exists such that V37 to terminate P40, P42 or P63 may not prohibit ullage from coming on. This window exists only when V37 is selected just before the following:

P40: TIG - 7.5 sec.

P42: TIG - 6 sec.

P63 TIG - 7.5 sec.

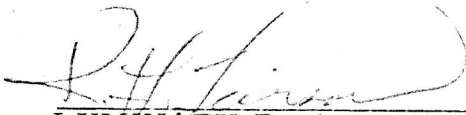
Do not key final ENTER to V37EXX to terminate the above programs within 1/4 seconds of ullage on. Wait until after ullage


Comments:

DEVELOP. PLAN

Date 3/17/71

MIT/CSDL SOFTWARE DEVELOPMENT PLAN
FOR
LUMINARY 1E LGC PROGRAM


3-23-71
LUMINARY Project Date
Manager's Signature


3/23/71
Director Mission Date
Development Approval

This plan consists of 28 pages

PREFACE

The LUMINARY 1E LGC Program
is being prepared to support a
manned Lunar LM Flight of a
Block II G&N System.

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	Level 5 System Test Lab Tests	

SECTION I

PROGRAM DEVELOPMENT SUMMARY

PROGRAM DEVELOPMENT SUMMARY FOR LUMINARY 1E

Date 3/17/71

Item No.	DESCRIPTION	Required Date	Predicted Date	Actual Date	COMMENTS
1	Establishment of Luminary 1E Assy.	9/21/70	9/21/70	9/21/70	
2	Change Design and Coding Start	9/21/70	9/21/70	9/21/70	
3	Level 2/3 Test Plan	11/25/70	11/25/70	10/15/70	(Note: Test Plans are revised as new changes are approved.
4	Level 2/3 Testing Start Completion	10/15/70 12/3/70	10/15/70 12/3/70	10/15/70 2/12/71	
5	Level 4/5 Test Plan	12/1/70	12/1/70	12/1/70	
6	Level 4 Testing Start Completion	12/7/70 1/15/71	12/7/70 1/15/71	12/7/70 1/18/71	Revision 210 Released to rope manufacturing 3/22/71
7	Level 5 Testing Start Completion	1/15/71 2/14/71	1/15/71 2/14/71	1/15/71 2/12/71	
8	GSOP Publication (All PCR/PCNs approved up until program delivery) Section 2 Section 3 Section 4 Section 5		4/12/71 3/26/71 3/31/71 4/12/71	3/5/71	Revision 6
9	Configuration Control FACI Review Week of	12/3/70	12/3/70	12/18/70 2/22/71	FACI mtg at MSC 3/3/71

SECTION II

PROGRAM CHANGE REQUEST/NOTICE STATUS

PCRs/PCNs

PCR STATUS REPORT FOR LUMINARY 1E

Date 3/17/71

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
311	Rendezvous and Prethrust Downlink Change	FSB 2/13/70			Disapproved 5/14/70		
317.2	Rescaling Nouns Containing Range and Range Rate	CB 6/13/70	_____	10 _____	Implement and Provide Detail Evaluation 7/10/70	2, 4	
319	A - Priori Terrain (ΔH on Downlist)	MPAD 7/6/70	_____	2 _____	Implement and Provide Detail Evaluation 8/13/70	2, 4	Only the addition of ΔH to the downlist was approved.
323	Improvements to Ephemerides	FM 7/29/70			Disapproved 8/13/70		
324	PGNCS/AGS RR Data Transfer	FSB 7/27/70	_____	+15	Implement and Provide Detail Evaluation 8/13/70	2, 4	
333	Change Recognition of ROD Inputs	9/23/70	None	5 words	Implement & provide detailed evaluation 9/30/70	2, 4	
334 Rev1	Change DSKY Descent/Ascent Nouns	FCOD 9/28/70	_____	+5	Implement & provide detailed evaluation 11/5/70	2, 4	
335	Remove Alignment Option from P63	FCOD 9/23/70	_____	-3	Implement & provide detailed evaluation 9/30/70	2, 4, 5	
336 RFV1	Allow Extended Verbs During P20 Maneuvers	FCOD 9/28/70	_____	-2	Implement & provide detail evaluation 11/5/70	4, 5	

PCR STATUS REPORT FOR LUMINARY 1E

Date 3/17/71

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
337 Rev1	Illuminate Unused- DSKY Light for N49	FCOD 10/1/70			Disapproved 11/5/70		
338	Change LPD Scaling to 1.0° In All Direc- tions	FCOD 9/28/70	_____	0	Implement & provide detailed evaluation 9/30/70	2, 4	
339	Have P20 F50 72 Display Update	FCOD 9/28/70	_____	+20	Implement & provide detailed evaluation 9/30/70	4	
340	LATVEL Polarity Change	FCOD 9/22/70	_____	0	Disapproved Verbally 10/7/70		(See PCR 343)
341	Landing Radar Reasonability Test	MPAD 9/29/70	_____	+2	Approved 9/30/70 Implement & provide detailed evaluation 11/5/70	5	
343	Disapprove PCR 340	FSD 10/21/70	_____		Approved 11/5/70		
344	Navigation Input Via DSKY	FCOD 10/23/70	_____		Disapproved 11/5/70		
345	Change of Erasable Load	FG 7 10/29/70	_____		Disapproved 11/5/70		
347	Mod.to Code Word Con- figuration for PGNCs/ AGS Data Transfer	FSD 11/25/70		5	Implement & provide detailed evaluation 1/14/71	2	
348	New Target ΔV Program	FCSD 11/25/70		50	Implement & provide detailed evaluation 1/14/71	2, 4	

PCR STATUS REPORT FOR LUMINARY 1E

Date 3/17/71

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
1024	Variable Guidance Period Servicer	Eyles 2/26/70			Disapproved 4/9/70		
1030	Replacement of LOGSUB	Berman 3/11/70			Disapproved 5/14/70		
1044	Re-design of R53 R57	Millard 5/11/70		60 words	Implement and Pro- vide Detail Evalua- tion 8/13/70	4, 5	
1055	Noun for LPD Bias	Gilbert 6/12/70			Disapproved 8/13/70		
*1059	Have Major Mode Changes Set Up a 1/ACCS.	Weissman 7/20/70			Implement & provide Detail Evaluation 11/5/70	3	
1066	Display N81 on all passes in P34/74 and P35/75	Copps 8/3/70		-6	Implement & provide detailed evaluation 9/30/70	4	
*1070	GSOP Change for FDAI Needle Initiali- zation Fix (L-1D-01)	Weissman 7/7/70			Implement & provide Detail Evaluation 9/30/70	3	
1010*	GSOP Sect 5 Editorial Changes	Klawnsnik 3/9/71				5	

PCR STATUS REPORT FOR LUMINARY 1E

Date 3/17/71

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
1072.2	Light KEYREL Light Only When a Noun/Mark/Prio Display is Initiated	MIT 8/26/70			Withdrawn		
1079	ALMCADR on the Telemetry	McCoy 9/2/70		12 0	Implement & provide detailed evaluation 9/30/70	2	
1080	Change time to Perform IMUCDU Zero	Larson 9/8/70			Disapproved 9/30/70		
1082.2	Update Fixed Constants for 1971-1972 Ephemeris Year	Reber 9/14/70		50 0	Implement & provide detailed evaluation 11/5/70	5	
1088	Inhibit Program Change During Critical 8.22 10.36 Seconds After Coarse Align IMU IMU CPU ZERO	Rye 9/25/70		+3	Implement & provide Detailed Evaluation 11/5/70	2.4	
1091	Priority Display Light on DSKY	McCoy 10/2/70		+6	Implement & Provide Detailed Evaluation 11/5/70	4	
1092	Increase Accuracy of Determination of Accelerometer S. F.	Grace 9/23/70		20 words	Disapproved 11/5/70		
1093	Eliminate 481 day TEPHEM Limitation in Solar Lunar Ephemerides	Robertson 10/5/70		Less then 5 fixed	Implement and provide Detailed Evaluation 11/5/70	5	

PCR STATUS REPORT FOR LUMINARY 1E

Date 3/17/71

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
1095	Avoid Imcomplete Close-out of Manual Rate Command Mode (L-1D-07)	MIT 10/7/70		+5 0	Implement & provide Detailed Evaluation 11/5/70	3	
1096	Erasable Memory De-Orbit Program Goes Fixed	MIT 10/8/70			Disapproved 11/5/70		
1097.2	V30, V31 Operator Error Lockout	MIT 10/13/70		+5	Implement & provide Detailed Evaluation 11/5/70	4	
1100	Delete Setting of NODOFLAG in R47	MIT 10/20/70		-2	Implement & provide Detailed Evaluation 11/5/70	4	
1106	Trim Gimbal Control Mode Change	MIT 10/15/70			Disapproved 11/5/70		

*PCN

TP 22587-5

PCR STATUS REPORT FOR LUMINARY 1F

Date 3/17/71

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
1107	Backup of Abort Bits Chan 30 Bits 1 and 4 for on (0)	MIT 10/22/70		+5	Implement & provide Detailed Evaluation 11/5/70	2	
1108	Backup Mark X, Y & MARK REJECT Chan 16 Bits 3, 4, 5.	MIT 10/22/70			Disapproved 11/5/70		
1109	Backup of Off (1) Failures of Auto Throt. Chan 30 Bit 5	MIT 10/22/70		+5	Implement & provide Detailed Evaluation 11/5/70	2	
1110	Backup for Failures of Inertial Data Bit Chan 30 Bit 6	MIT 10/22/70		+5	Implement & provide Detailed Evaluation 11/5/70	2	
1111	Backup Failure of Autopilot Mode & AGS/PGNS Select Switch Chan 30 Bits 10, 13 & 14	MIT 10/22/70		+15	Implement & provide Detailed Evaluation 11/5/70	2	
1112	Backup for on (0) Failures of Trans- lation Commands Chan 31 Bits 7-12	MIT 10/22/70			Disapproved 11/5/70		
1113	Backup Failure of the LPD Bit Chan 31 Bits 1, 2, 5 and 6.	MIT 10/22/70			Withdrawn		

PCR STATUS REPORT FOR LUMINARY 1F

Date 3/17/71

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
1116	Automatic RCS Steering	MIT 10/27/70			Disapproved 11/5/70		
1117.2	Addition to P00D00 Logic; Add Abort GSOP Description	MIT 10/27/70		5	Implement & provide Detailed Evaluation 11/5/70	4	
1121	Replace Acceleration Est. with RCS Inhibit Flags on non- powered Downlists	MIT 10/26/70		0	Implement & provide Detailed Evaluation 11/5/70	2	
1122	"No Control" DSKY Light	MIT 11/2/70			Disapproved 11/5/70		
1124*	Flag Resetting in P00D00 Aborts	MIT 11/12/70		5	Implement & provide Detailed Evaluation 1/14/71	2, 4	
1126*	Set NOTHROTFLAG for DPS Impulse Burns	MIT 11/18/70		2	Implement & provide Detailed Evaluation 1/14/71	2 5	
1127*	Change to Downlink List	MIT 11/25/70		2	Implement & provide Detailed Evaluation 1/14/71	2	
1129*	Update Mass-Dependent Calc. in 1/ACCS	MIT 11/30/70		5	Implement & provide Detailed Evaluation 1/14/71	3	

*PCN

PCR STATUS REPORT FOR

Date 3/17/71

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
1132	Corrections to PCR 1117.2	MIT 12/21/70			Implement & provide Detailed Evaluation 1/14/71	4	
1133*	Revision to Descent Mass Limits	MIT 12/28/70		5	Implement & provide Detailed Evaluation 1/14/71	3	
1134	Revision of PCR 1111	MIT 12/29/70			Implement & provide Detailed Evaluation 1/14/71	2	
1137	Correct Constant for Ascent Guidance	MIT 1/12/71		2	Implement & provide Detailed Evaluation 1/14/71		
1141*	Initialize FLRCS in P12	MIT 1/22/71		2			
1143*	GSOP Section 3 Rev 6 Changes	MIT 2/16/71				3	
1145*	GSOP Section 4 Rev 9 Changes	MIT 3/ /71				4	

SECTION III

PRE-LEVEL 4 TESTING

AND

LEVEL 3 SYSTEM TEST LAB TESTS

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

Date 3/17/71

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
PCR 317.2	Rescaling Nouns Containing Range and Range Rate	Volante/Dunbar		11/16	11/16	12/3	1/20	1/19	195
PCR 319	A-Priori Terrain(ΔH on Downlist)	Albert/Eyles		11/23	12/4	12/3	12/3	12/18	196
PCR 324	PGNCS/AGS RR Data Transfer	Volante/Dunbar		10/22	10/22	12/3	1/20	2/1	195
PCR 333	Change Recognition of ROD Inputs	Millard		11/20	11/20	12/3	1/22	1/18	191
PCR 335	Remove Alignment Option from P63	Albert/Eyles		11/20	11/20	12/3	12/3	12/18	186
PCR 338	Change LPD Scaling to 1.0 ⁰ In All Directions	Albert/Eyles		11/20	11/20	12/3	12/3	12/18	185
PCR 339	Have P20 F50 72 Display Update	Rosenberg/Dunbar		11/20	11/20	12/3	12/3	12/15	190
PCR 334 Rev 1	Change DSKY Descent/Ascent Nouns	Eyles/Albert/ Berman		11/23	11/23	12/3	12/3	12/20	193
PCR 336 Rev 1	Allow Extended Verbs During P20 Maneuvers	Rosenberg / Dunbar		11/20	11/20	12/3	12/3	12/15	193
PCR 340	LATVAL Polarity Change	Eyles						12/18	182
PCR 341	Landing Radar Reasonability Test	Moore/Albert		11/20	11/20	12/3	12/3	12/18	191
PCR 343	Disapproval of PCR 340	Albert/Eyles		11/23	11/23	12/3	12/3	12/18	190
PCR 347	Mod. to Code Word for PGNCS/AGS Data Transfer	Volante/Dunbar			12/4		1/22	1/28	195
PCR 348	New Target - V Program	White			11/20		12/14	12/15	197

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

Date 3/17/71

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
CR 1044	Re-design of R53 - R57	Millard		11/23	11/23	12/3	12/3	12/3	194
CN 1059	Have Major Mode Changes Set Up-a 1/ACCS	Weissman		11/23	11/23	12/3	12/3	1/5	196
CN 1070	GSOP Change for FDAI Needle Initialization Fix (L-1D-01)	Weissman		11/23	11/23	12/3	12/3	12/1	182
PCR 1066	Display N81 On All Passes in P34/74 and P35/ 75	White		11/19	11/9	12/3	11/20	11/16	185
PCR 1079	ALMCAR on the Telemetry	Albert		11/20	11/20	12/3	12/3	12/15	192
CR 1082.2	Update Fixed Constants for 1971 - 1972 Ephemeris Year	Dunbar		11/20	11/20	12/3	1/22	1/19	186
CR 1088	Inhibit Program Change During Critical 8.22 Seconds After Coarse Align IMU	Rosenberg/ Edmonds		11/20	11/20	12/3	1/22	1/22	191
PCR 1091	Priority Display Light on DSKY	Rosenberg/Dunbar		11/20	11/20	12/3	12/3	12/15	193
PCR 1093	Eliminate 481 Day TFPHEM Limitation	Millard		11/20	11/20	12/3	1/22	1/22	192
PCN 1095	Avoid Incomplete Close-out of Manual Rate Command Mode (L-1D-07)			(See Anomaly L-1D-07)					
CR 1097.2	V30, V31 Operator Error Lockout	Rosenberg		11/20	11/20	12/3	12/3	12/15	192
PCR 1100	Delete Setting of NODOFLAG in R47	Rosenberg		11/20	11/20	12/3	12/3	12/15	191
PCR 1107	Backup of Abort bits Chan 30 Bits 1 and 4	Bernikovich			11/19	12/3		12/20	196
PCR 1109	Backup of Off (1) Failures of Auto-Throt. Chan 30 Bit 6.	Albert			11/19	12/3		12/20	196

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

Date 3/17/71

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
PCR 1110	Backup for Failure of Inertial Data Bit Chan 30 Bit 6	Albert			11/20	12/3		12/28	196
PCR 1111	Backup Failure of Auto-pilot Mode & AGS/ PGNS Select Switch Chan 30 Bits 10, 13, & 14.	Weissman			11/20	12/3		1/15	202
PCR 1117.2	Addition to P00D00 Logic.	Dunbar		11/20	11/20	12/3	1/20	1/19	191
PCR 1121	Replace Acceleration Est. with RCS Inhibit Flags on non-powered Downlist.	Albert/ Weissman		11/23	11/23	12/3	12/3	12/15	196
PCN 1124	Flag Resetting in P00D00 Aborts				(See L-1 D-15)				193
PCN 1127	Change to Downlist for IMU Pulse	Albert			12/1			12/15	197
PCN 1129	Update Mass Dependent Calculations in 1/ACCS	Weissman			12/1			12/17	203
PCN 1133	Revision to Descent Mass Limits	Weissman			12/18			1/5	205
PCR 1134	Revision of PCR 1111	Weissman			12/18			1/15	202
PCN 1141	Initialize FLRCS in P12	McCoy			2/1			2/8	209

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

Date 3/17/71

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
L-1D-01	"NEEDLER" Initialization Never Takes Place Following DAP Turn-on if IMU Error Counters (CH 12 B06) are Enabled	_____	(See PCN 1070)						184
L-1D-02	Core Set Overflow (31202) Alarm will result from a Bad Return Pulse Torquing.	Sys. Test Lab.		11/20	11/20	12/3	12/3	1/18	184
L-1D-03	Velocity Update During Descent (P63 & 64) Fail the Reasonableness Test Shortly After LR Lock-on.	McCoy	Fixed in Luminary 1D						
L-1D-04	P25 will not control Space craft altitude if range to CSM is greater than 566 N. M.	Volante/Dunbar		11/20	10/10	12/3	12/3	11/30	184
L-1D-05	Certain verb routines should not be requested if P20 or P22 is running. (L-34)	Rosenberg/ White		11/23	11/23	12/3	12/3	12/16	181
L-1D-06	"DVTOTAL" incremented twice in one SERVICER Cycle	Adler/Moore		11/23	11/23	12/3	12/3	12/18	184
L-1D-07	Manual rate control mode improper termination (PCR 1095)	Weissman		11/23	11/23	12/3	12/3	12/1	199
L-1D-08	Padload "LRWH" Shares Erasable memory location with RM of P20 (L-34)	Dunbar/Rosenberg		11/20	11/20	12/3	12/3	11/27	181
L-1D-10	Major Mode Changes that Leave the DAP with Improper Data	_____	(See PCN 1059)						196
L-1D-11	W _B is mis-scaled by a factor of 2	_____	(See PCR 1082.2)						186
L-1D-12	Selection of V41N72 while an RR reposition or remode is in progress results in incorrect operation of V41N72.	Volante/Dunbar		11/23	11/23	12/3	1/22	1/22	193

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

Date 3/17/71

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
L-1D-14	Set Flagword 5 Bit 12 for Impulsive Burns	Adler/Moore		11/23	11/23	12/3	12/3	12/15	190
L-1D-15	Reset RNDVZFLG (P25FLAG) in P00D00 Sequence.(PCN 1124)	Rosenberg/ Dunbar		11/20	11/20	12/3	1/22	1/19	193
L-1D-16	Fixed Memory Constant VINJNOM is 5509.3 fps instead of 5509.5 fps	Volante			12/10			1/12	201
L-1D-17	Flashing V37 which Terminate P22 when the Range is greater than 400 N.M and the Range-Rate is Positive may not occur.	Volante			12/10			1/17	208
L-1D-18	R21 & R24 do not clear Designate Flag when it finds the LOS outside Mode II limits in P22	Volante			12/10			1/17	208
L-1D-19	Restarts in P20/25 may erroneously display V50N16 on DSKY	Volante			12/30			1/17	208
L-1D-20	Erroneous clearing of REINTFLG by BAILOUT Logic				1/6			1/14	205
L-1D-21	An RR antenna reposition initiated by R25 just after starting P20 or P22 can cause P20/P22 to loop	McCoy			2/1			2/12	209
L-1D-23	A yaw transient of about 5 degrees at the end of P64 can occur.	Albert			2/1			2/12	209
L-1D-25	Exiting P63, P40 or P42 with a V37 between AVEGON time of auto-ullage initiate may not kill the waitlist call to initiate ullage.	Moore			1/23			1/26	209

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

Date 3/17/71

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
L-26	Insert check for coarse align before attempting gyro torquing	Sys. Test Lab. Rosenberg		11/23	11/23	12/3	12/3	1/15	185
L-28	Remove LRPOS initialization from P63	Albert		11/23	11/23	12/3	12/7	12/18	184
L-29	Change two lines of coding at locations MOONSPOT & MOONSPOT + 1	Moore/Albert		11/23	11/23	12/3	12/3	12/18	190
L-30	In SERVICER, move the tag MOONSPOT to the "TC TMPTOSPT" instruction	Moore/Albert		11/23	11/23	12/3	12/3	12/18	190
L-31	Set a list of labels = to each location that is in the Downlink lists	Rosenberg		11/20	11/20	12/3	12/3	12/15	184
L-32	Put a list in the Downlink Log Section using the new instruction "CHECKS="	Rosenberg		11/20	11/20	12/3	12/3	12/15	184
L-33	Load the "trap" of the DAP state estimator with a value that is 1 bit off from the GSOP value	Weissman		11/23	11/23	12/3	12/3	10/23	196
L-34	Erasable Clean-up (L-1D-05, L-1D-06)	Rosenberg		11/23	11/23	12/3	12/14	12/16	191
L-35	Change coding in LLGE to store triple precision in OLDPIPAX	Albert		11/20	11/20	12/3	12/7	12/18	184
L-36	Define a tag TMPDV = GDT/2 for use by S34/35.5	White		11/16	11/16	12/3	12/3	11/18	184
L-37	Make bad return from IMUSTALL in 1/ GYRO continue instead of go to END OF JOB.	Rosenberg/STL		11/23	11/23	12/3	12/3	1/18	185
L-38	Rearrange clearing of flags in V56; Change cpde at TRMTRAK1 to interpretive	Rosenberg/ Dunbar		11/20	11/20	12/3	1/20	1/19	190

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1F

Date 3/17/71

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
L-39	Change a CADR to an ADRES following a TC TWIDDLE in RADSAMP.	Dunbar/ Rosenberg		11/20	11/20	2/3	12/3	12 /15	182
L-40	Make Room in Bank 10 to implement PCR 339	S. Rosenberg				CANCELLED			186
L-41	Avoid reading the GTS Drive bits in order to determine whether or not the engine gimbals are being driven	P. Weissman		11/23	11/23	12/3	12/3	1/6	196
L-42	Append a(+/-) N to relative addresses	D. Densmore				CANCELLED			
L-43	Enable the redesignation trap at the time of the PROCEED to V06N64 instead of at start of P64	D. Eyles		11/23			12/7	12/18	196
L-44	Make T5ADR Single precision since it always goes to F16 in E6	D. Densmore				CANCELLED			
L-45	Clear INTYPFLG prior to INTEGRUS call in P21 recycle option	S. Rosenberg		12/3				12/15	196
L-46	Delete INHINT before WAITLIST call in AOTMARK	D. Densmore		12/10				12/18	200
L-47	Re-code the P-axis minimum impulse routine more efficiently	P. Weissman		12/11				1/6	202

LEVEL III SYSTEM TEST LAB TESTS FOR LUMINARY IE

Date 3/17/71

TEST	TITLE	Responsible Engineer	TEST COMPLETE			DOCUMENT APPROVED		
			Req	Pred	Act	Req	Pred	Act
SEV	Extended Verbs (Include L-1D-02 fix test and ACBL-37, PCR 1088)	Grace	2/5/71	12/10/70	1/18/71		2/5/71	(1)
IOP	IMU Operational Program	Grace	2/5/71	12/10/70	12/30/70		1/29/71	(1)
STP2	IMU Performance Test	Grace	2/5/71	2/5/71	12/22/70		1/29/71	2/24/71
STP3	IRIG Scale Factor	Grace	2/5/71	2/5/71	12/22/70		1/29/71	(2)
AAP. 6	P57 Changes (PCR 1044)	St. Amand	2/5/71	12/4/70	1/6/71		1/29/71	2/24/71
RP1	Radar Changes (L-1D-12 fix test, and ACBL -38)	Goodwin	2/5/71	1/3/71	1/15/71		1/29/71	(1)
PT	IRIG Torque	Sheridan	2/5/71	1/15/71	1/11/71		1/29/71	2/24/71
SU	Sum Uplink	Sheridan	2/5/71	1/15/71	12/28/70		1/29/71	2/24/71
C77	Channel 77 Restart Monitor	Sheridan	2/5/71	1/15/71	12/31/70		1/29/71	2/24/71
CB	Input Channel Backup (PCR's 1107, 1109, 1110 1134)	Goodwin	2/5/71	1/22/71	1/19/71		2/5/71	(1)
RP2	PGNS-AGS RR Data Transfer (PCR 324)	Goodwin	2/5/71	12/24/70	1/6/71		1/29/71	(1)
AAP	MARKRUPT Change Test (PCR 333)	St Amand	2/5/71	12/4/70	1/14/71		1/29/71	2/24/71
KR	Super Key Release Light (PCR 1091)	Sheridan	2/5/71	1/15/71	1/15/71		1/29/71	2/26/71
AAP	P52 Changes (PCR 1044)	St Amand	2/5/71	12/4/70	1/15/71		1/29/71	(1)
ACB	ACB L - 26	St Amand			1/15/71		1/29/71	(1)
(1) These reports could not be completed before Level 5 testing was completed so only a Level 5 Test Report will be issued (2) Now a Delco Electronics Responsibility								

SECTION IV
LEVEL 4 AND 5 TESTING
AND
LEVEL 5 SYSTEM TEST LAB TESTS

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
	<p>General: all nominal mission sequences are tested (as per Apollo 14 checklist) selected contingency procedures are tested (as per Apollo 14 checklist) Restarts, Extended Verbs and DSKY monitors are included where use is expected. (Hybrid Test Facility) no initial state or instrument errors Downlink Verification DAP Control Verification</p>	
4.1.0	Nominal Mission Sequences	
4.1.1	Short Rendezvous (Hybrid and Digital)	White/Moore
	Extended Verbs (64, 67, 30, 31, 47, 63)	
4.1.2	Nominal Automatic-Descent (Digital Only),	Albert
4.1.3	Descent with Redesignations (N69 & ACA) (Hybrid & Digital)	Albert/Moore
	Extended Verbs (57, 59)	
	Load LPD BIAS (Small nonzero)	
4.1.4	Lunar Surface Alignments (Hybrid & Digital)	Millard/Moore
	Extended Verbs (41)	
4.1.5	Lunar Surface Navigation; Ascent from Lunar Surface (Hybrid & Digital)	Dunbar/Moore
4.1.6	Inflight Alignments (Hybrid & Digital (See 4.2.6))	

LEVEL 4 AND 5 TESTING FOR LUMINARY IE

Date 3/17/71

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
4.2.0	Contingency Procedures	
4.2.1	Abort from Descent (Digital only)	Bernikovich
4.2.2	Abort Stage from Descent (Hybrid and Digital)	Bernikovich/Moore
4.2.3	AGS Rendezvous (Digital only)	White
	program sequences: P20, P34, P42, (No Burn) P77, P20, P35	
4.2.4	LM Passive Rendezvous (Digital only)	White
4.2.5	Docked DPS burn + PTC (Hybrid)	Moore/Weissman
4.2.6	NO-PDI + 12 ABORT (HYBRID FACILITY)	Moore
	program sequence: P52, P30, P63, P30, P40	
4.2.7	Earth Orbit LM RCS DEORBIT (DPS) (HYBRID FACILITY)	Moore

TP 22587-4

LEVEL 4 AND 5 TESTING FOR LUMINARY IE

Date 3/17/71

TEST No.	REV No.	LEVEL 4 TESTING						LEVEL 5 TESTING					
		START			COMPLETE			START			COMPLETE		
		Req	Pred	Act	Req	Pred	Act	Req	Pred	Act	Req	Pred	Act
4.1.1a		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/9/71
4.1.1b		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/9/71
4.1.2		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/18/71	1/15/71		1/23/71	2/14/71		2/12/71
4.1.3a		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/15/71	1/15/71		1/23/71	2/14/71		2/12/71
4.1.3b		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/18/71	1/15/71		1/23/71	2/14/71		2/10/71
4.1.4a		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/9/71
4.1.4b		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/15/71	1/15/71		1/23/71	2/14/71		2/11/71
4.1.5a		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/11/71
4.1.5b		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/15/71	1/15/71		1/23/71	2/14/71		2/12/71
4.1.6a		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/9/71
4.1.6b		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/18/71	1/15/71		1/23/71	2/14/71		2/9/71
4.2.1		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/15/71	1/15/71		1/23/71	2/14/71		2/10/71
4.2.2a		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/11/71
4.2.2b		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/15/71	1/15/71		1/23/71	2/14/71		2/12/71
4.2.3		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/12/71
4.2.4		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/9/71
4.2.5		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/9/71
4.2.6		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	1/13/71	1/15/71		1/23/71	2/14/71		2/11/71
4.2.7		12/7/70	12/7/70	12/7/70	1/15/71	1/15/71	—	1/15/71		1/23/71	2/14/71		2/11/71

a - Hybrid test; b - Digital test

JP 22587-5

LEVEL V SYSTEM TEST LAB TESTS FOR LUMINARY 1E

Date 3/17/71

TEST	TITLE	Responsible Engineer	TEST COMPLETE			DOCUMENT APPROVED		
			Req	Pred	Act	Req	Pred	Act
SEV	Extended Verbs	Grace		3/1/71	2/16/71		3/16/71	3/2/71
IOP	IMU Operational Program	Grace		3/1/71	2/16/71		3/16/71	2/22/71
STP2	IMU Performance Test	Grace		5/1/71	2/17/71		5/29/71	2/24/71
STP3	IRIG Scale Factor	Grace		5/1/71	(1)		5/29/71	
AAP. 6	P57 Changes (PCR 1044)	St. Amand		3/26/71	2/22/71		4/9/71	2/26/71
RP1	Radar Changes	Goodwin		3/26/71	2/18/71		4/9/71	
PT	IRIG Torque	Sheridan		3/12/71	2/18/71		3/26/71	
SU	Sum Uplink	Sheridan		3/12/71	2/16/71		3/26/71	
C77	Channel 77 Restart Monitor	Sheridan		3/12/71	2/25/71		3/26/71	
CB	Input Channel Backup (PCR's 1107, 1109, 1110, 1111)	Goodwin		3/19/71	3/16/71		3/19/71	
RP2	PGNS-AGS RR Data Transfer (PCR 324)	Goodwin		2/5/71	2/26/71		4/17/71	
AAP	MARKRUPT Change Test (PCR 333)	St. Amand		3/26/71	2/24/71		4/9/71	* _____
KR	Super Key Release Light (PCR 1091)	Sheridan		3/12/71	2/19/71		3/26/71	
AAP	P52 Changes (PCR 1044)	St. Amand		3/26/71	2/29/71		4/9/71	
L-26	ACB L-26 (1) Now on Delco Elect responsibility * Included in AAP . 6	St. Amand			2/22/71		3/5/71	3/12/71

PCR²/PCN²

PAT WHITE

317.2

324 + VD

1066

L-10-04

Peter Volzen Lu

342 + VD

L-10-12

L-10-16

L-10-17

L-10-18

L-10-19

Don Eyles

319

334

335

338

340

341 + DM

343

Don Millard

333

1044

Peter Weissman

1059

L-10-01

1070

*1095

1111

1121 + SA

1129

1133

1134

Sharon Albanz

1079

P Rye

336

1107 + WS

339

1109 + DE

348 + P WHITE

1110 + DE

1088

1117.2

1091

1127 + SA

1097.2

L-10-15

1100

L-10-20

D. Moore

Virginia Dunbar

1082.2

Peter Adler

L-10-14

Nancy Neuville

1093

NYLES BARNET

L-10-02

George Kelen

L-10-07

DISAPPROVED

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

311

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR R. W. Carl	1.2 DATE 2/13/70	1.3 ORGANIZATION FSB	1.4 APPROVAL <i>L. E. Williams</i>	1.5 DATE 4/6/60
------------------------------	---------------------	-------------------------	---------------------------------------	--------------------

1.6 EFFECTIVITY LUMINARY Apollo 15	1.7 TITLE OF CHANGE Rendezvous and Prethrust Downlink Change
---------------------------------------	---

1.8 REASON(S) FOR CHANGE

To provide the AGS with rendezvous radar data in order to provide for an automatic update scheme in the AGS for the nominal mission, thus alleviating the crew workload and providing a safer operation.

1.9 DESCRIPTION OF CHANGE

See Data Amplification Sheet

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. 311	PREPARED BY R. W. Carl	DATE 4/3/70	ORGANIZATION FSB
--	----------------------------------	-----------------------	----------------------------

CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)

1.6 Description of Change

Change the LUMINARY Rendezvous and Prethrust Downlink list to provide raw RR Range, RR Range Rate, RR Shaft CDU, RR Trunnion CDU and RADMODES in the following format.

- (1) Each piece of data must occupy the first register of an LGC downlink word.
- (2) The data must be located in the first 17 words of the list.
- (3) The shaft and trunnion angles must be successively located on the list.
- (4) RADMODES should not be more than one location after the last of the other data words on the list.

A suggested format is:

```

1
2
↓
8
9  RADMODES
10 RR Shaft CDU
11 RR Trunnion CDU
12 RR Range Rate
13 RR Range
↓
17
    
```

REMARKS:

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 317.2

ANOMALY # _____

ADR # _____

☐ COLOSSUS 2E

☐ LUMINARY 1D

☐ COLOSSUS 3

☒ LUMINARY 1E

☐ COLOSSUS 3A

☐ LUMINARY 1F

☐ COLOSSUS _____

☐ LUMINARY _____

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

7-20-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 317.2	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR Haise		DATE 6/15/70	1.2 ORGANIZATION CB		APPROVAL
1.3 EFFECTIVITY Luminary 1E (Apollo 15)			1.4 TITLE OF CHANGE Rescaling nouns containing range and range rate		
1.5 REASON(S) FOR CHANGE Current scaling of nouns involving range and range rate is inconsistent in three different ways causing crew readout errors.					
1.6 DESCRIPTION OF CHANGE Rescale nouns containing range and range rate so that range is quantized nearest hundreth nautical mile and range rate is quantized nearest tenth foot per second. Nouns in question are 49 and 78.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS <i>Rescale R1 of N49 and R2 of N78 only</i>		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE <i>7/10/70</i>					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

XXX. XX NM
XXXX.X fps

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR PCN # 319
ANOMALY #
ADR #

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS <u> </u>	<input type="checkbox"/> LUMINARY <u> </u>

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Don Cyles

Program Supervisor's Approval: Margaret Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Klausnik/Smith

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on
Attendees:

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION:

D. Other Programs Affected

☐ Review for corresponding changes in

ACTION:

Special Instructions

Project Manager R. H. Larson

Date 8-18-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 319	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR J. H. Alphin	DATE 7/6/70	1.2 ORGANIZATION MPAD	APPROVAL R. Nohles	DATE 7/7/70	
1.3 EFFECTIVITY Apollo 15 LUMINARY			1.4 TITLE OF CHANGE A Priori Terrain		
1.5 REASON(S) FOR CHANGE The science sites (e.g., Martin Hills) require more slopes (minimum of 10) near the landing site to minimize LRM errors and true ΔH is needed for monitoring safety of flight for rougher sites.					
1.6 DESCRIPTION OF CHANGE Add more slopes to the a priori terrain and add true ΔH (H_{measured} - H_{PGNCS}) to downlist. MUST BE HOMOGENEOUS WITH REGULAR ΔH. 8/13/70					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IN ACT			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF <i>[Signature]</i>					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

ΔH ON DOWNLIST

DISAPPROVED

NUMBER (Completed by FSB)

323

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR	DATE	1.2 ORGANIZATION	APPROVAL	DATE
B. F. Cockrell	7/29/70	FM4/MPR	12.11.01.6	8/3/70

1.3 TITLE OF CHANGE	1.4 TITLE OF CHANGE
Luminary (Apollo 15)	Improvements to Ephemerides

1.5 REASON(S) FOR CHANGE
See attached memorandum.

1.6 DESCRIPTION OF CHANGE
See attached memorandum.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DISAPPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	



Mission Planning and Analysis Division
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

IN REPLY REFER TO: 70-FM47-149

June 2, 1970

MEMORANDUM TO: FS5/Chief, Flight Software Branch

FROM : FM4/Chief, Mathematical Physics Branch

SUBJECT : The LM and Skylab CMC Lunar-Solar Ephemerides (LOSSEM)

1. References:

a. "Guidance System Operations Plan for Manned LM Earth Orbital and Lunar Missions Using Program LUMINARY 1C (Rev 130)," Section 5, "Guidance Equations," MIT Instrumentation Lab, November 1969.

b. TRW IOC 5522.7-70-21, "Method for Approximate Location of the Moon-Earth-Sun," F. J. Rich, February 13, 1960.


c. TRW IOC 5522.7-70-77, "Angular Error in Lunar and Solar Positions Predicted by LOSSEM during Apollo 13," F. J. Rich, May 7, 1970.

2. This memorandum presents results of an analysis of the LM Guidance Computer (LGC) ephemeris routines, and discusses modifications for their improvement. The modified ephemeris routine would occupy a minimal amount of fixed memory storage and would improve the accuracy of the LM backup alignments. The recommendations would also apply to the Skylab CMC.

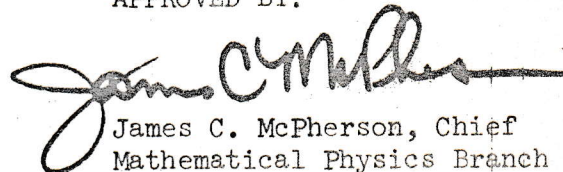
3. The ephemeris routines used by the LGC generate the location of the moon and Sun relative to the earth. For the moon, the routine computes an earth-moon unit vector by explicit evaluation of a rotation of a unit vector through four fundamental angles measured from the position of the equinox at the NBY epoch. When compared to data read from the JPL ephemeris at even intervals for 12 months, the RMS of errors (JPL-LGC) is 11 mrad with a maximum of 17 mrad. By adding one term in the expression defining the longitude of the moon, this RMS can be reduced to ≈ 4 mrad for NBY 1973. (See page 7, reference b, attached).

4. The results presented in reference c (attached) demonstrate the need for improvement in the ephemeris routines used by the LM. During the Apollo 13 abort an LM inertial platform alignment was made using the Sun and moon. To do this the LGC required unit vectors to the Sun and moon. The angular error of these vectors in LOSSEM was .26 mrad and 11.71 mrad, respectively, at 6 hours before entry interface.

5. For the Skylab CMC a PCR has been submitted (SLO23, "Fixed Memory Ephemeris Routines for AAP") which would replace the current CMC ephemeris routines with those of the LGC. At the present time the Software Control Board has approved this PCR for detailed change evaluation. In order to improve the Skylab CMC capabilities for back-up alignments, the recommendations of reference b. should be implemented as part of PCR SLO23.


Bedford F. Cockrell

APPROVED BY:


James C. McPherson, Chief
Mathematical Physics Branch


RTS

Attachments

Distribution: (See attached list)

FM4:BFCockrell:rnr

Drd *RWV*
DMD RWV



5522.7-70-21

INTEROFFICE CORRESPONDENCE

TO: R. W. Vander Stucken
Work Package Manager
MSC/TRW Task AA-35

CC: See Distribution

DATE: 13 February 1970

SUBJECT: Method for Approximate Location of the Moon-
Earth-Sun

FROM: F. J. Rich
BLDG. H3 ROOM 1023 EXT. 27

- References:
- (1) Guidance System Operations Plan for Manned LM Earth Orbital and Lunar Missions Using Program LUMINARY 1C (Rev 130) "Section 5, Guidance Equations", MIT/Instrumentation Laboratory, November 1969.
 - (2) McOuat, H., "Approximation Method of Sun-Moon Location," Guidance Monitor System Note # 13. 8 December 1965.
 - (3) McOuat, Harry, "New LOSSEM Numbers," LUMINARY Memo # 119, 30 October 1969.
 - (4) Rich, Frederick J., "LOSSEM Constants for NBY 1971, 1972, 1973 and 1974," TRW IOC 5522.7-70-15, 23 January 1970.
 - (5) "Apollo Guidance Computer Specifications for AAP Missions," PHO-TR442. Philco-Ford Corp., WDL Division. 12 December 1969.

SUMMARY

This memorandum reviews the methods used by the Apollo Command Module Computer (CMC) and LM Guidance Computer (LGC) to generate the location of the moon and sun relative to the earth. It is recommended that a modified version of the ephemeris routine used by the LGC be used for the CMC for AAP. This modified ephemeris routine would occupy a minimal amount of fixed memory storage, would occupy no unshared erasable memory storage, and would be fast and accurate enough for AAP requirements.

CURRENT APOLLO LUNAR-SOLAR EPHEMERIDES

The Lunar Ephemeris

The current CMC generates the earth-moon vector with a ninth order polynomial,

$$\underline{X}_{EM} = \underline{c}_0 + \underline{c}_1 t_m + \dots + \underline{c}_9 t_m^9 \quad (1)$$

Attachment

where $t_m = t - t_{MO}$

t = specified time

t_{MO} = time at the center of the range over which the lunar position polynomial is valid

The lunar position polynomial is valid for 14.5 days covering an Apollo mission. The accuracy is such that the rms of the error (due to the approximation) in position is 150 to 700 meters and the maximum error is 250 to 1100 meters.

The LGC lunar ephemeris routine generates only an earth-moon unit vector. This is done by an explicit evaluation of a rotation of a unit x - vector through the fundamental angles.

- B - mean obliquity, angle between the celestial equator at NBY and the ecliptic
- i - inclination of the moon's orbit to the ecliptic plane
- F - longitude of the moon measured in the orbit plane from the mean ascending node of the lunar orbit
- Ω_I - longitude of the mean ascending node of the lunar orbit measured in the ecliptic plane from the equinox at NBY
- L - mean longitude of the sun measured in the ecliptic plane from the equinox (used for solar ephemeris)

Note that all the fundamental angles are measured from position of the equinox at the NBY (Nearest Besslian Year) epoch instead of at the mean of date as in standard practice in astronomy.

The earth-moon vector is the result of rotating about the x -axis (measured from the earth's center of mass to the vernal equinox) through the angle B, about the z -axis through the angle Ω_I , about the new x -axis through the angle i ($=5^{\circ}8'$), and about the z -axis through the angle F. The result given in the GSOP (Reference 1) after making the approximation $\cos i = 1.0$ ($\cos 5^{\circ}8' = .9962$) is:

$$\underline{u}_{EM} = \text{UNIT} \begin{bmatrix} \cos (\text{LOM}) \\ K_1 \sin (\text{LOM}) - K_2 \sin (\text{LOM}-\text{LON}) \\ K_3 \sin (\text{LOM}) + K_4 \sin (\text{LOM}-\text{LON}) \end{bmatrix} = \text{UNIT} (\underline{\tilde{u}}_{EM}) \quad (2)$$

where

$$\begin{aligned} K_1 &= \cos B & K_3 &= \sin B \\ K_2 &= \sin B \sin i & K_4 &= \cos B \sin i \\ \text{LOM}_o &= \text{LOM}_o = \Omega_{I_o} + F_o & \text{LOM}_R &= \dot{\Omega}_I + F \\ \text{LON}_o &= \Omega_{I_o} & \text{LON}_R &= \dot{\Omega}_I \\ \text{LOM} &= \text{LOM}_o + \text{LOM}_R t - \left[a \sin (\text{OMEGA}_a t + \text{PHASE}_a) + b \sin (\text{OMEGA}_b t + \text{PHASE}_b) \right] \\ \text{LON} &= \text{LON}_o + \text{LON}_R t \end{aligned} \quad (3)$$

t = specified time measured from July 1.0, the start of NBY.

a , OMEGA_a , PHASE_a , etc. are the magnitude, rate, and phase angle of correction factors.

The Solar Ephemeris

The CMC generates the earth-sun position vector from the earth-sun position and velocity vectors (\underline{r}_{ESO} and \underline{v}_{ESO}) evaluated at t_{MO} and a circular orbit approximation with the use of the angular velocity (ω_{ES}) evaluated at t_{MO} . The velocity of the earth-sun vector is approximated as a constant during the mission.

$$\underline{r}_{ES} = \underline{r}_{ESO} \cos (\omega_{ES} t_M) + \left[\underline{r}_{ESO} \times \text{UNIT} (\underline{v}_{ESO} \times \underline{r}_{ESO}) \right] \sin (\omega_{ES} t_M) \quad (4)$$

$$\underline{v}_{ES} = \underline{v}_{ESO}$$

The solar ephemeris is accurate, for the 14.5 days covering an Apollo mission, to about 10^{-3} A.U. in position.

The LGC solar ephemeris generates only a unit earth-sun vector that is the result of rotating about the x-axis through the angle B and about the z-axis through the angle L. The result given in the GSOP is:

$$\underline{u}_{ES} = \text{UNIT} \begin{bmatrix} \cos (\text{LOS}) \\ K_1 \sin (\text{LOS}) \\ K_3 \sin (\text{LOS}) \end{bmatrix} = \text{UNIT} (\underline{\tilde{u}}_{ES}) \quad (5)$$

where,

$$\begin{aligned} \text{LOS}_0 &= L_0 & \text{LOS}_R &= L \\ \text{LOS} &= \text{LOS}_0 + \text{LOS}_R t - c \sin (\text{OMEGA}_c t + \text{PHASE}_c) \end{aligned} \quad (6)$$

COMMENTS ON THE CURRENT EPHEMERIDES

The last two terms in the expression for LOM and the last term in the expression for LOS are included to approximate the true position of the moon and sun instead of the mean position. They were determined empirically in Reference 2 by "eyeballing" a plot of the error function before the terms were included, but they do have a real physical meaning. The a and c terms have periods of approximately 27.55 days and 365.25 days respectively, the sidereal periods of the moon and the earth. They arise from the eccentricities of the respective orbits. The b term has a period of approximately 32.11 days which corresponds approximately to the second term in Brown's series for the position of the moon. The term in Brown's series is $\sin(\ell - 2D)$, where $\ell = \odot - \Gamma'$ (Γ' = mean longitude of the moon's perigee measured in the ecliptic plane from the equinox to the ascending node of the moon's orbit and then along the orbit) and $D = \odot - L$. Clearly this represents a perturbation of the sun on the earth-moon system.

The constants K_1 , K_2 , etc used in the LGC ephemeris routine are computed in an NBY coordinate system and are good for a span of one year (when a new coordinate system comes into use). For a one year span the error in location of the moon has an rms of 10 to 12 mrad., and in location of the sun of 0.25 mrad.

PROPOSED LUNAR-SOLAR EPHEMERIDES FOR AAP

Recommendations

It is recommended that, for AAP, the CMC use ephemeris routines based upon the existing LGC Apollo ephemeris routines. The data for these routines should be valid for at least 18 months from the anticipated AAP-1 launch in order to cover the entire AAP program plus any unanticipated slips in the launch date. The coordinate system that is in use (in the RTCC) at that time should be continued throughout all AAP missions.

This approach will eliminate any requirements for uplink of erasable ephemeris data during a mission, will save erasable storage, and will provide improved accuracy for the solar ephemeris. The lower lunar ephemeris accuracy is not important for AAP. Existing LGC coding from the LUMINARY programs may be used virtually unchanged, reducing the programming effort required.

Data were generated for the following launch dates:

<u>Launch Date</u>	<u>Coordinates</u>	<u>Clock Zero</u>
March 1972	NBY 1972	July 1.0, 1971
July 1972	NBY 1973	July 1.0, 1972

The Lunar Ephemeris

The LGC lunar ephemeris routine seems to meet all the requirements for an AAP lunar ephemeris except that its accuracy is not very good. The rms of the error in location was approximately equal to the diameter of the moon (0.5°) and the maximum errors during a one year span were greater than one degree (17 mrad.). A plot of the error in location in the direction of the orbit plane and perpendicular to the orbit plane was made. The error in the orbit plane was an irregular function but seemed to have a period of 14.5 - 15.0 days. The error perpendicular to the moon's orbit plane was almost a regular function with a period of about 32 days.

The error in the moon's orbit plane could be corrected by an additional term in the expression for LOM:

$$\text{LOM} = \text{LOM}_0 + \text{LOM}_R t - \left[a \sin (\text{OMEGA}_a t + \text{PHASE}_a) + b \sin (\text{OMEGA}_b t + \text{PHASE}_b) + c_1 \sin (\text{OMEGA}_1 t + \text{PHASE}_1) \right] \quad (7)$$

The error perpendicular to the orbit plane could be corrected by modifying u_{EM} to include a final y-axis rotation through the angle:

$$c_2 \sin (\text{OMEGA}_2 t + \text{PHASE}_2) \quad (8)$$

The value of the c_1 and c_2 terms were obtained by estimating their value from the plot and Brown's series and using a differential correction, least squares fit program to obtain the best possible values. Using the values for the other constants from Reference 4 for NBY 1971, it was found that a c_2 term of

$$-.0025568 \sin (F-2D) \quad (9)$$

left an out-of-plane error with an rms of 0.30 mrad. A value for the c_1 term of

$$-.012176008 \sin (\text{OMEGA}_1 t + \text{PHASE}_1) \quad (10)$$

$$\text{OMEGA}_1 = 4.9261375 \text{ rad/sec} \approx 2D$$

$$\text{PHASE}_1 = 5.0585394 \text{ radian} \approx 2D$$

reduced the error in the orbit plane to an rms of about 3.75 mrad. Since the in-plane (c_1) term is an order of magnitude greater than the out-of-plane (c_2) term and the residual orbit plane error is larger than the c_2 term, it was decided to not use the c_2 term unless additional terms are used to fit the orbit plane error.

When the accuracy over a long span was considered, it was found that, for a three year span (chosen for testing purposes only) starting with July 1.0 at the start of NBY, the present LGC ephemeris equations with the constants given in References 2 and 3 have errors with rms of 17 to 22 mrad. By using a differential correction, least squares fitting program (see Appendix), the size of the error in most cases could not be reduced significantly. By including the third orbit plane term (7), the errors for the three year span could be reduced to an rms of about 9 mrad. Thus the c_1 term should be used in an AAP version of the LGC ephemeris equations.

The Solar Ephemeris

The solar ephemeris (4) used by the CMC for the solar position is only moderately accurate for spans of 14.5 days used for Apollo and would have a maximum angular error of 30 mrad over a one year span. The velocity of the sun is a crude approximation and is worthless for spans much longer than 14.5 days. Reference 5 proposes a method of computing the velocity of the sun from the unshared erasable memory load which would have a maximum angular error of 30 mrad. The solar ephemeris (5) used by the LGC is at least as accurate as that used by the CMC, depending on the length of the span, and requires less computer storage.

It is recommended that equation 4 be replaced by equation 5 plus:

$$\begin{aligned} \underline{r}_{ES} &= r_{ESO} \underline{u}_{ES} \\ \underline{v}_{ES} &= v_{ESO} \text{ UNIT} \left[\begin{pmatrix} 0 \\ -K_3 \\ K_1 \end{pmatrix} \times \underline{u}_{ES} \right] \end{aligned} \quad (11)$$

where r_{ESO} = mean earth-sun distance = 1.0 astronomical unit

v_{ESO} = mean velocity of the apparent sun

It is estimated that this method will require 30 fixed memory locations, compared to 33 fixed memory and 14 unshared erasable locations for equation 4 in the CMC currently, and the angular error in position will have an rms between 0.06 mrad and 0.25 mrad.

RESULTS

The constants for computing u_{ES} and u_{EM} as proposed above are given in the attached table. The constants were evaluated by fitting the proposed equation to ephemeris data read from the JPL ephemeris tape for the length of the AAP mission span. This was done using nominal launch dates of March 1972 and July 1972. The units in the table are radians and radian/sec.

In the event that it becomes feasible to implement the proposed ephemeris routine into LUMINARY, the constants for NBY 1972, NBY 1973, and NBY 1974 from July 1.0 to July 1.0 were evaluated and are also presented in the table.

The rms of the errors are summarized below:

Moon's Position

Apollo CMC	(14.5 day span)	~ 700 meters
Apollo LGC	(12 month span)	~ 11 mrad
Proposed AAP	(18 month span; March 1972 launch)	4.26 mrad
Proposed AAP	(18 month span; July 1972 launch)	4.30 mrad
Proposed LGC	(NBY 1972)	5.01 mrad
Proposed LGC	(NBY 1973)	3.57 mrad
Proposed LGC	(NBY 1974)	3.93 mrad

Sun's Position

Apollo CMC	(14.5 day span)	~ 0.001 A.U.
Apollo LGC	(12 month span)	~ 0.25 mrad
Proposed AAP	(18 month span; March 1972 launch)	0.11 mrad
Proposed AAP	(18 month span; July 1972 launch)	0.12 mrad
Proposed LGC	(NBY 1972)	0.25 mrad
Proposed LGC	(NBY 1973)	0.06 mrad
Proposed LGC	(NBY 1974)	0.06 mrad

Prepared by:

F. J. Rich
F. J. Rich
Mission Analysis Section

Approved by:

J. B. Clifford, Jr.
J. B. Clifford, Manager
MSC/TRW Task AA-35

Approved by:

R. K. Petersburg
R. K. Petersburg, Manager
Systems Evaluation Department

FJR:ckh
Attachment

Table of Lunar-Solar Ephemeris Constants

	NBY 1972 (AAP March 1972 Launch Date)	NBY 1973 (AAP July 1972 Launch Date)	NBY 1972 (Apollo)	NBY 1973 (Apollo)	NBY 1974 (Apollo)
K_1	.916815277	.916770797	.917460	.917128324	.91713458
$-K_2$	-.041915207	-.040561188	-.038649526	-.045469469	-.030895764
K_3	.397610118	.397534851	.397840	.397695305	.397679139
K_4	.078973674	.082191389	.081046308	.080911556	.084545343
LOM_R	2.66169237E-6	2.66175580E-6	2.66141960E-6	.266151493E-5	.266155777E-5
LOS_R	1.99095586E-7	1.99098765E-7	1.990984E-7	.199233952E-6	.199227631E-6
LON_R	-1.17564381E-8	-9.52992264E-9	-1.1756438E-8	-.125304593E-7	-.109787942E-7
LOM_O	3.35941954	5.84565454	3.36054770	5.85008721	1.81900454
LOS_O	1.71812631	1.73105355	1.71750123	1.72885940	1.72478782
LON_O	5.55303226	5.14539021	5.58026185	5.21028842	4.87760331
a	.110126647	.109746317	.110181651	.110088280	.109694152
$PHASE_a$	.158763560	1.92385096	.167774235	1.94982119	3.50537130
$OMEGA_a$	2.63915793E-6	2.64003514E-6	2.63833482E-6	.263782294E-5	.263769407E-5
b	.022398308	.022233476	.021831169	.0229161424	.023003363
$PHASE_b$	3.03046541	-.022168116	3.18224870	.063511323	2.96236179
$OMEGA_b$	2.28820002E-6	2.28653265	2.28269913E-6	.228502742E-5	.228665889E-5
c	.033518516	.033511773	.033501623	.032476401	.032496805
$PHASE_c$	.064915422	-.056917517	-.071370601	-.120843930	-.122305953
$OMEGA_c$	1.99009067E-7	1.99087665E-7	1.991075E-7	.203065775E-6	.202763784E-6
c_1	-.011828792	-.010886412	-.011469346	-.010682826	-.011283943
$PHASE_{c_1}$	3.16152543	1.93399742	3.16667984	1.99692403	4.99267136
$OMEGA_{c_1}$	4.92787460E-6	4.92451089E-6	4.93103849	4.91887156E-6	4.90663348E-6

Appendix

Differential Correction, Least Squares Fitting Routine

The basic approach to the problem of finding the best set of values in a least squares sense is to define a set of errors y and to drive y to zero. Let y be a function of the set of independent variables: then

$$\delta y = \begin{bmatrix} \frac{\partial y}{\partial x^T} \end{bmatrix} \delta x \quad (A-1)$$

represents the change in y due to a change in x . If y is of higher dimension than x , the choice of x which gives a least squared value of δy may be found by iterating using the equation:

$$\delta x^{(1)} = (A^T A)^{-1} A^T \delta y^{(1)} \approx (A^T A)^{-1} A^T y^{(1)} \quad (A-2)$$

$$\text{where: } A = \begin{pmatrix} \frac{\partial y}{\partial x^T} \end{pmatrix}.$$

$$y^{(1)} \approx 0 + \delta y^{(1)}$$

For the generation of the constants for the lunar and solar ephemeris, the variables used are:

$$\text{For } u_{EM}: \quad x = \begin{bmatrix} K_1 \\ K_2 \\ K_3 \\ K_4 \\ LOM_0 \\ LOM_R \times 10^6 \\ A \\ B \\ OMEGA_A \times 10^6 \\ PHASE_A \\ OMEGA_B \times 10^6 \\ PHASE_B \\ LON_0 \\ LON_R \times 10^6 \end{bmatrix} \quad (A-3)$$

$$y_i = \sqrt{1 - (u_{EM_{ACT_i}} \cdot u_{EM_{EST_i}})^2}, \quad i = 1, N$$

For \underline{u}_{ES} :

$$\underline{x} = \begin{bmatrix} \text{LOS}_0 \\ \text{LOS}_R \times 10^6 \\ C \\ \text{OMEGA}_C \times 10^6 \\ \text{PHASE}_C \\ K_1 \\ K_3 \end{bmatrix} \quad (\text{A-4})$$

$$y_i = \sqrt{1 - (\underline{u}_{ES_{ACT_i}} \cdot \underline{u}_{ES_{EST_i}})^2}, \quad i = 1, N$$

The quantity being minimized is thus the sum of the squares of the sines of the angular errors between the actual and estimated vectors. The actual vectors are taken from the JPL DE-19 ephemeris tape, converted to NBY coordinates.

The program was written in such a way that, while all of the variables of \underline{x} in A-3 and A-4 are required to compute \underline{u}_{EM} and \underline{u}_{ES} , any subset of \underline{x} could be used in A-2. Note that K_1 and K_3 appear in both A-2 and A-3. Experience has shown that the best procedure is to compute K_1 and K_3 with \underline{u}_{ES} and then to solve for the lunar vector using a subset of A-3 not containing K_1 and K_3 . To avoid numerical difficulties, the rates in the program are taken to be radians/(10^6 sec). All partial differentials are computed analytically and will not be shown here.

No detailed description of the program will be presented; it is a basic least squares fit which uses analytic partial derivatives and which allows the user to solve for any subset of the parameters.

The forms of the partial derivatives are of interest, however:

$$\text{Let } \underline{u}_E = \text{UNIT}(\tilde{\underline{u}}_E) \quad (\underline{u}_E = \underline{u}_{EM} \text{ or } \underline{u}_{ES}, \text{ see eqs 2 and 5})$$

$$\underline{u}_A = \text{actual vector from tape,}$$

$$y = \sqrt{1 - (\underline{u}_E \cdot \underline{u}_A)^2}.$$

Then:

$$\frac{\partial y}{\partial x_i} = - \frac{(\underline{u}_E \cdot \underline{u}_A) \underline{u}_A}{y} \cdot \frac{\partial \underline{u}_E}{\partial x_i},$$

where:

$$\frac{\partial \underline{u}_E}{\partial x_i} = \frac{1}{|\tilde{\underline{u}}_E|} \left[\frac{\partial \tilde{\underline{u}}_E}{\partial x_i} - \underline{u}_E \left(\underline{u}_E \cdot \frac{\partial \tilde{\underline{u}}_E}{\partial x_i} \right) \right].$$

Substituting the equation for $\frac{\partial \underline{u}_E}{\partial x_1}$ into the equation for $\frac{\partial y}{\partial x_1}$ yields

$$\frac{\partial y}{\partial x_1} = - \frac{(\underline{u}_E \cdot \underline{u}_A)}{y |\underline{\tilde{u}}_E|} \left[\underline{u}_A - (\underline{u}_A \cdot \underline{u}_E) \underline{u}_E \right] \cdot \frac{\partial \underline{\tilde{u}}_E}{\partial x_1},$$

where $\frac{\partial \underline{\tilde{u}}_E}{\partial x_1}$ may be easily computed from the earlier equations for \underline{u}_{ES} and \underline{u}_{EM} .

The above equation has the disadvantage that it approaches the indeterminate form 0/0 as \underline{u}_E approaches \underline{u}_A . The following changes were made to reduce the problem.

$$\text{Define: } \underline{\delta} = \underline{u}_E - \underline{u}_A$$

$$\epsilon = -\underline{\delta} \cdot \underline{u}_A$$

$$\text{Then: } \underline{u}_A \cdot \underline{u}_E = 1 - \epsilon$$

$$\underline{u}_A - (\underline{u}_A \cdot \underline{u}_E) \underline{u}_E = -\underline{\delta} (1 - \epsilon) + \epsilon \underline{u}_A$$

$$y = \sqrt{\epsilon(2 - \epsilon)}$$

$$|\underline{\delta}| = \sqrt{2\epsilon}$$

By making the indicated substitutions, the only subtraction of nearly equal quantities is made to form $\underline{\delta}$ from \underline{u}_E and \underline{u}_A . This change delays the onset of numerical problems, and results in the following equation:

$$\frac{\partial y}{\partial x_1} = \frac{(1 - \epsilon)^2}{\sqrt{1 - \frac{\epsilon}{2}} |\underline{\tilde{u}}_E|} \left[\text{UNIT}(\underline{\delta}) - \frac{\sqrt{2\epsilon}}{2(1 - \epsilon)} \underline{u}_A \right] \cdot \frac{\partial \underline{\tilde{u}}_E}{\partial x_1}$$

This form remains well behaved as $\underline{u}_E \rightarrow \underline{u}_A$; however, in the limit, it is necessary to use the equation for $\left(\frac{\partial y}{\partial x_1}\right)$ derived from L' Hôpital's rule:

$$\lim_{\underline{u}_E \rightarrow \underline{u}_A} \left(\frac{\partial y}{\partial x_1} \right) = \frac{1}{|\underline{\tilde{u}}_E|} \left[\left(\frac{\partial \underline{\tilde{u}}_E}{\partial x_1} \right) \cdot \left(\frac{\partial \underline{\tilde{u}}_E}{\partial x_1} \right) - \left(\underline{u}_A \cdot \frac{\partial \underline{\tilde{u}}_E}{\partial x_1} \right)^2 \right]^{\frac{1}{2}}$$

It is apparent that this last equation is merely the magnitude of the component of $\frac{\partial \underline{\tilde{u}}_E}{\partial x_1}$ which lies normal to \underline{u}_A .

JMD *MPM*
DMD MPM

TRW
SYSTEMS GROUP

INTEROFFICE CORRESPONDENCE

5522.7-70-77

TO: M. P. Meyers
Work Package Manager
MSC/TRW Task A-164

cc: Distribution A-164.7

DATE: 7 May 1970

SUBJECT: Angular Error in Lunar and Solar Positions
Predicted by LOSSEM during Apollo 13

FROM: F. J. Rich

BLDG. H-3 ROOM 2077 EXT. 298

Reference: "Guidance System Operations Plan for Manned LM Earth
Orbital and Lunar Missions Using LUMINARY IC (Rev 130),"
Section 5 Guidance Equations (Rev. 9) November, 1969.

This memorandum presents the results of comparing the earth-moon and earth-sun unit vectors computed by the LOSSEM routine in LUMINARY IC against the true unit vectors. The LOSSEM predicted vectors were obtained from a simulation of the equations in Section 5.5.4 of the Reference. (Note that the Reference still contains an error in the formulation; u_{EM} and u_{ES} must be unitized before being used.) The true vectors were taken from the JPL 19 ephemeris tape and transformed to NBY 1970 coordinates.

The error in predicting the lunar and solar position with respect to the earth by the LGC is required as an aid in analyzing the navigation and telemetry data taken during the Apollo 13 mission abort phase. The standard procedure is to use the CMC which has erasable ephemerides that are more accurate than LOSSEM.

The attached graphs show the angle between the LOSSEM computed unit vectors and the true unit vectors. Note that time on both graphs is given in hours from midnight GMT prior to the launch. Launch occurred shortly after 19 hours GMT, April 11, 1970. The angular error for the earth-moon vector at entry interface was 11.82 mrad. The angular error at 6 hours prior to entry interface was 11.71 mrad. The angular error for the earth-sun vector near entry interface is 0.26 mrad with a random variation of 0. to 0.02 mrad. The smooth curve shown is the limits of the variation. The line segments shown are straight line connections of discrete data points and are only included for illustration.

Attachment

Prepared by:

F. J. Rich
F. J. Rich
Mission Analysis Section

Approved by:

P. E. Hong
P. E. Hong, Manager
MSC/TRW Task A-164

Approved by:

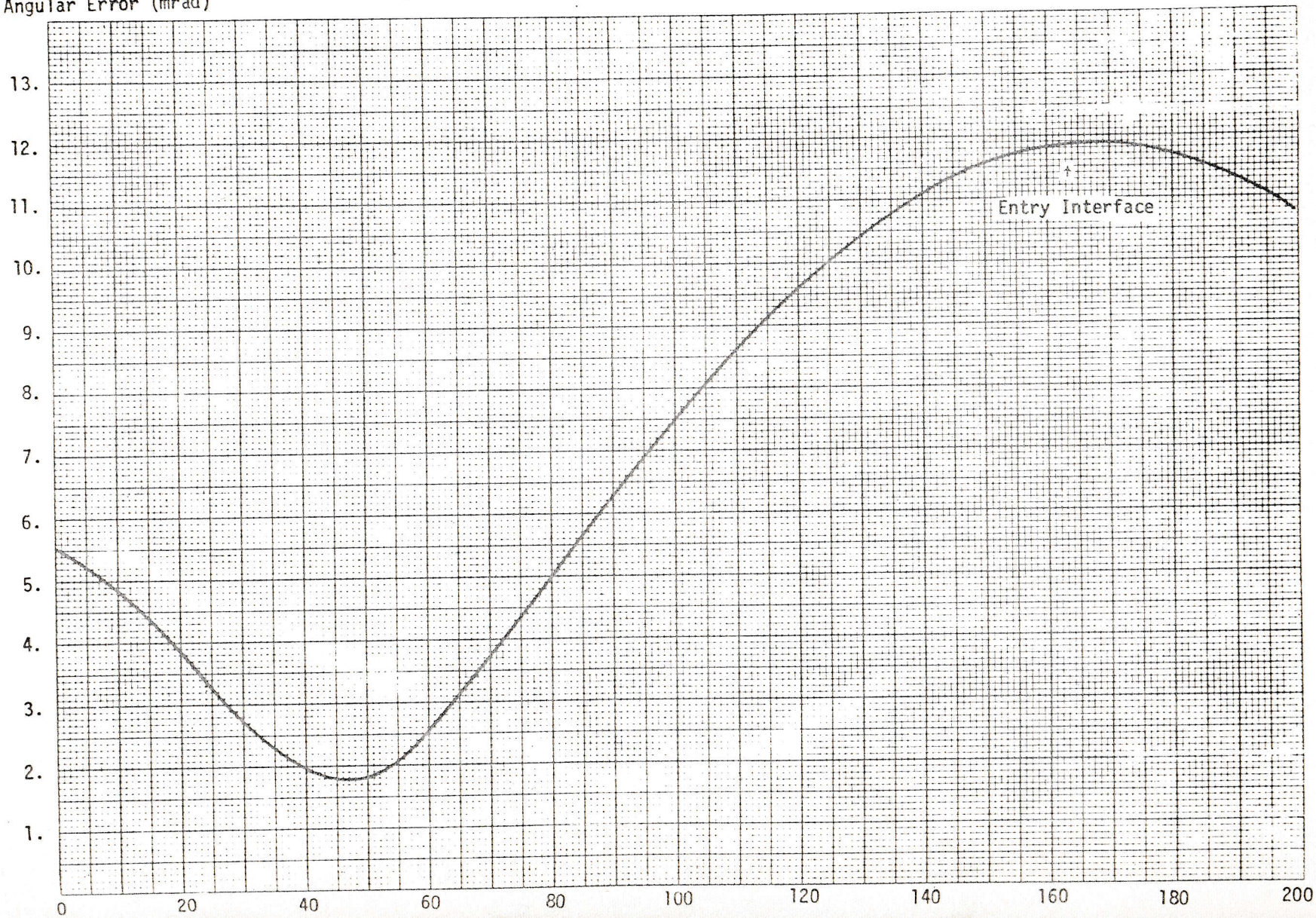
R. K. Petersburg
R. K. Petersburg, Manager
Systems Evaluation Department

FJR:mvr
Attachments

NO. 340R-10 1/2 DIETZGEN GRAPH PAPER
10 X 10 PER HALF INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

Angular Error (mrad)

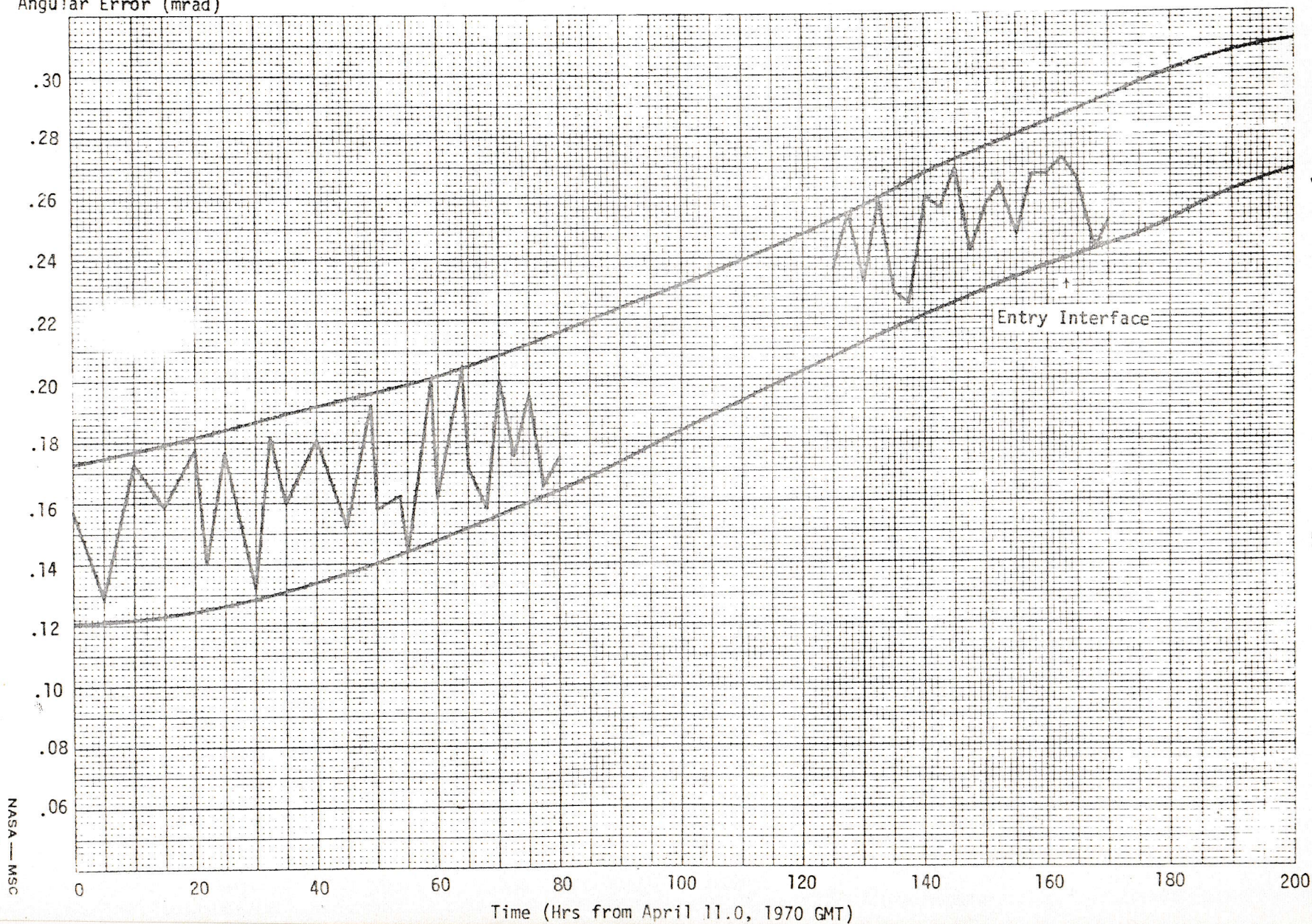


Angular Error in Lunar Position from LOSSEM

NO. 340R-10 1/2 DIETZGEN GRAPH PAPER
10 X 10 PER HALF INCH

EUGENE DIETZGEN CO
MADE IN U. S. A.

Angular Error (mrad)



Angular Error in Solar Position from LOSSSEM

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 324

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Pat White

Program Supervisor's Approval: Margaret Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Klausnik/Smith

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 8-18-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

see also 347

324

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR FS5/ R. W. Carl	DATE 7-27-70	1.2 ORGANIZATION Flight Software	APPROVAL	DATE
1.3 EFFECTIVITY Luminary Apollo 15		1.4 TITLE OF CHANGE PGNCS/AGS RR data transfer		

1.5 REASON(S) FOR CHANGE

To provide the Abort Guidance System with Rendezvous Radar data via the PGNCS to AGS downlink telemetry line for the AGS Automatic RR update program.

1.6 DESCRIPTION OF CHANGE

Changes should be made in accordance with the interface description given in the attachment to this PCR.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 8/13/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

Interface Description

PGNCS/AGS RR Data Transfer

A. Introduction

This document describes the requirements and agreements reached on the software interface between the IM Guidance Computer (IGC) of the Primary Guidance, Navigation and Control System (PGNCS) and the Abort Electronics Assembly (AEA) of the Abort Guidance System (AGS) for the PGNCS to AGS Rendezvous Radar (RR) data transfer for the AGS Automatic RR Update Program.

B. AGS Requirements

The data requirements of the AEA software for the Automatic RR Update Program are discussed in this section.

1. RR data will be obtained via the PGNCS to AGS, downlink transfer link. Data is transmitted serially over the PGNCS Downlink Telemetry line at a rate of fifty 40-bit words per second when in the high bit rate mode (see section D). The Downlink Telemetry Register of the AEA is an 18 bit shift register which is loaded by the Instrumentation Subsystem and permits the loading of only the first 18 bits of the 40 bit downlink word. After an appropriate command has been given to the AEA via the DEDA, the PGNCS Downlink Input Subroutine interrogates the PGNCS Downlink Stop Pulse Discrete. When the Stop Pulse Discrete is found, the subroutine loads the contents of the Downlink Telemetry Register into the AEA. A search is made for the correct Downlist I.D. word. When the correct I.D. word is found, the next 16 words are read and stored in a buffer area of the AEA. Only the most significant 16 bits of the 18 bit Downlink Telemetry Register are considered by AEA software to contain information. For the above reasons the following general restrictions are placed on any data transmitted to the AEA via the PGNCS downlink transfer link.
 - a. Any pertinent data must be found in the first 16 bits of the 40-bit PGNCS downlink word.
 - b. Any pertinent data must be found in the first 17 downlink words of the 100 downlink words of an IGC downlist.
2. The following data is required by the AEA for the Automatic RR update program.
 - a. Downlist ID word
 - b. Raw RR Range Data
 - c. Raw RR Range Rate Data
 - d. RR Shaft Angle CDU

e. RR Trunnion Angle CDU

f. A composite code word

3. The following additional restrictions and requirements are placed on the transmitted data of (2) above.

a. The Shaft and Trunnion Angle CDU's must be located consecutively on the list. They may appear in either order, but the first one must be in an even numbered word where the Downlist ID word is word number 1 of the list.

b. The composite code word must be the last of the data transmitted. It will consist of a special 14-bit flag with set and reset configurations and 1 bit to indicate high and low scaling of the RR Range data. The set and reset configurations of this word should be as shown below. The word length corresponds to an IGC computer word without the parity bit.

AGC BIT IS 14 - - - - -

Bit No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Set	A	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Reset	A	1	0	0	0	0	0	0	0	0	0	0	0	0	0

where A = 1 for high range scaling
A = 0 for low range scaling
and the configuration of
A does not matter in the
reset configuration.

c. The composite code word should be placed in the set configuration approximately once per minute, immediately after the reading of range and range rate and placing this data along with the shaft and trunnion angle data on the downlink. The code word should be placed in the set configuration only if the RR data good discrete was present during the radar reading and a hardware restart had not occurred since the last radar reading. The code word should be placed in the reset configuration no sooner than two seconds after being placed in the set configuration and no later than two seconds before being placed in the set configuration again.

d. The radar data should remain unchanged on the downlink for at least two seconds after the code word is placed in the set configuration.

C. IGC Downlink Description for Automatic AGS RR Updating

The details of the IGC downlink list which will provide RR data to the AEA are enumerated in this section.

1. General Downlink Description

Each LGC downlist contains 100 downlink words. Each downlink word is composed of a "word order code bit," two 16-bit LGC computer words (15 data bits plus an odd parity bit per word), plus seven "filler bits" to total a 40 bit downlink word. The downlist is transmitted at a rate of 50 40-bit downlink words per second when in high bit rate mode (see section D).

The first word in each list is the Downlist ID word and the sync register. The first and fifty-first words on the downlist have a word order code bit of zero. All other words on the list have a word order code bit of one.

2. The LGC downlist which will transmit RR data to the AEA of the AGS is the Rendezvous and Pre-thrust Downlist.
3. The first 17 words of the Rendezvous and Pre-Thrust Downlist will be as follows.

Word No.	WOC	First Register	Second Register
1	0	*List ID (777758)	Sync bits (773408)
2	1	CSM State Vector R_x	CSM State Vector R_x
3	1	CSM State Vector R_y	CSM State Vector R_y
4	1	CSM State Vector R_z	CSM State Vector R_z
5	1	CSM State Vector V_x	CSM State Vector V_x
6	1	CSM State Vector V_y	CSM State Vector V_y
7	1	CSM State Vector V_z	CSM State Vector V_z
8	1	CSM State Vector Time	CSM State Vector Time
9	1	MARKTIME	MARKTIME
10	1	MKCDUY	MKCDUZ
11	1	MKCDUX	No. of Marks
12	1	*RR Trunnion CDU	RR Shaft CDU
13	1	*RR SHAFT CDU	~ Garbage ~
14 17	1	T_F	T_F
15 14	1	*RR Range (Raw Data)	RR Range Rate (Raw Data)
16 15	1	*RR Range Rate (Raw Data)	~ Garbage ~
17 16	1	*AGS RR Composite Code Word	~ Garbage ~

* Data pertinent to AGS Automatic RR update program.

4. A description of the data pertinent to AGS Automatic RR updating is provided here.

- a. Word number 1a is the Downlist ID word of the Rendezvous and Pre-thrust Downlist. It will have the value 77775 (octal).
- b. Words 12a and 13a are RR Trunnion and Shaft CDU's, respectively. These are unsigned 15-bit fractions scaled degrees/360.
- c. Word 15a is RR Range (Raw Data). Treated as a 15 bit integer the following computation must be performed to convert to units of feet:

$(15\text{-bit integer}) \times (75.04)$ for high scale

or

$(15\text{-bit integer}) \times (9.38)$ for low scale

- d. Word 16a is RR Range Rate (Raw Data). Treated as a 15 bit integer the following computation must be performed to convert to units of feet per second:

$(15\text{-bit integer minus } 17000) \times (-0.6278)$

A negative quantity indicates closing.

- e. Word 17a is the AGS Composite Code word. It will contain the values as discussed in paragraphs B.3.b and B.3.c.

D. General Operating Requirements

- 1. The following will be necessary to cause transfer of RR data from the PGNCS to the AGS.
 - a. Telemetry high bit rate (IGC).
 - b. An astronaut entry via the DEDA enabling the AGS routines which pick the RR data off the IGC downlist.
 - c. IGC in P20 or P20 in the background of a program that uses the Rendezvous and Pre-thrust Downlist with the RR in IGC and locked on, data good discrete present and R22 (P20 subroutine which takes an RR mark about once per minute) actively running.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 333

ANOMALY # _____

ADR # _____

- | | |
|--|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input checked="" type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☐ MIT Approved PCN☐ MIT Approved ADR☒ NASA Approved PCR☐ NASA Approved PCN☐ NASA Approved Software Anomaly☐ MIT Approved Software AnomalyA. Coding☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.☐ Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

10-3-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

333

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR C. T. Hackler	DATE 9-23-70	1.2 ORGANIZATION EG7	APPROVAL <i>DeGhetto</i>	DATE 9/23/70
---------------------------------	-----------------	-------------------------	-----------------------------	-----------------

1.3 EFFECTIVITY LUM 1E (Apollo 15)	1.4 TITLE OF CHANGE Change recognition of ROD inputs
---------------------------------------	---

1.5 REASON(S) FOR CHANGE
No inflight alignment can be made if ROD switch fails on.

1.6 DESCRIPTION OF CHANGE
Recognize ROD inputs as being valid only during Ave G.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 5 words	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 9/30/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 334 Rev 1

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

334 Rev. 1

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR Haise/Kaiser	DATE 9/28/70	1.2 ORGANIZATION FCOD	APPROVAL <i>JW Haise</i>	DATE
--------------------------------	-----------------	--------------------------	-----------------------------	------

1.3 EFFECTIVITY Apollo 15 and Subs - Luminary	1.4 TITLE OF CHANGE Change DSKY DESCENT/ASCENT NOUNS
--	---

1.5 REASON(S) FOR CHANGE Current displays do not provide the priority of information needed by the crew during descent and ascent. The VI currently displayed in N63 is redundant to H/H for trajectory control. The same is true with respect to VI during ascent where as AVGx is needed to backup engine auto shutdown.

1.6 DESCRIPTION OF CHANGE With the changes described below AH should be automatically displayed in P63. It should be +99999 until valid LR altitude data is received (current logic). The display itself should be flashing, indicating that the crew has not enabled LR update. V57E

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 11-5-70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. PREPARED BY

DATE

ORGANIZATION

334 Rev. 1

CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)

1.6 should do so, and cause N63 to stop flashing. Conversely, V58E should cause the display to begin flashing again. In P64/P66 there should be no such DSKY flash indication of V57/V58.

N68 should be on call; however, it should contain the V_I that used to be in N63 as well as the ground-track distance to the computed landing site.

The new normal ascent/abort display (N94) should contain the quantity used to insure proper cutoff (i.e. ΔVGx). N77 R2 should be changed to display ΔVGy in body coordinates instead of Vy in local vertical coordinates.

Note:

I. Change Nouns as follows:

- In P63, N63: ΔH , \dot{H} , H
- On call in descent N68: Horizontal Range, T_{Go} , V_I
- In P12, P70, and P71, N94: ΔVGx , \dot{H} , H ($\Delta VGx = R1$ of N85)
- On call in ascent N77: T_{Go} , ΔVGy , V_I ($\Delta VGy = R2$ of N85)
- N85 should remain callable in ascent/abort programs ~~and descent programs other than P63.~~

II. Change V57 Logic as follows:

- V57E should set the LR INH flag
- V58E should reset the LR INH flag (current logic)
- V57E should not generate any display
- In P63, if LR INH flag is reset, N63 should flash (A PRO, V34E, V32E, etc. response to N63 should be ignored.)

REMARKS:

N63

ΔH

\dot{H}

H

N68

H HORIZ

T_{Go}

V_I

N94

ΔVGx

\dot{H}

H

N77

T_{Go}

ΔVGy

V_I

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 335

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☒ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

10-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

335

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR	1.2 DATE	1.3 ORGANIZATION	1.4 APPROVAL	1.5 DATE
Haise/Kaiser	9/23/70	FCOD		

1.6 DESCRIPTION	1.7 TITLE OF CHANGE
Apollo 15 and Subs - Luminary	Remove Alignment Option From P63

An alignment will never be a requirement in the time frame that P63 is called up. This option currently exists and invites an operator error as a Proceed takes the option and an Enter bypasses it, as desired.

1.8 DESCRIPTION OF ACTION
Delete IMU Fine Align option from P63, i.e., FL V50N25 display

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1	<input type="checkbox"/> APPROVED	<input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF			
DATE			

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 VISIBILITY IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1	<input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL.	<input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION	<input type="checkbox"/> DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF				
DATE				
9/30/70				

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1	<input type="checkbox"/> START OR CONTINUE IMPLEMENTATION	<input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF			
DATE			

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 336 Rev 1

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☒ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: _____

Date: 11-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

336 Rev. 1

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR Haise/Kaiser	DATE 9/28/70	1.2 ORGANIZATION FCOD	APPROVAL <i>Frederic W. Haise</i>	DATE 10/23/70
1.3 EFFECTIVITY Apollo 15 and Subs - Luminary		1.4 TITLE OF CHANGE (Delete 06 18 Display in R60) Allow Extended Verbs During P20 Maneuvers		

1.5 REASON(S) FOR CHANGE

The timeline is very tight after LM Insertion particularly on the M=1 rendezvous with a Tweak/Bailout maneuver, P20 Initiation, Apogee-Perigee Determination, and Ordeal Adjustment all needed within the same time frame. For better time optimization it is

1.6 DESCRIPTION OF CHANGE

Delete 06 18 display from R60. Before maneuver the 50 18 display should be flashing and after a PRO to maneuver the 50 18 should be replaced by the running program's nominal verb/noun or if no nominal noun the 50 18 should be replaced by a blank display.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 11-5-70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

336 Rev. 1

CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)

- 1.5 desirable to be able to call extended verbs, i.e. V82/V83, while P20 is maneuvering the vehicle.
- 1.6 At the completion of the maneuver the 50 18 display should again flash. Noun 18 should remain callable during the maneuver.

REMARKS:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

337 Rev. 1

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR Haise/Kaiser	DATE 10/1/70	1.2 ORGANIZATION FCOD	APPROVAL <i>JW Haise</i>	DATE
--------------------------------	-----------------	--------------------------	-----------------------------	------

1.3 EFFECTIVITY Apollo 15 and Subs - Luminary	1.4 TITLE OF CHANGE Illuminate Unused DSKY Light for N49
--	---

1.5 REASON(S) FOR CHANGE
Currently if a noun is called over N45 the resulting Key Release light obscures the crew from being aware of a N49 request. Until the crew is made aware all updating stops.

1.6 DESCRIPTION OF CHANGE
Light an unused DSKY light whenever the N49 display routine is entered. Extinguish it when the logic is exited. Additionally, that light should be added to those tested by V35 and to those cleared by ERROR RESET, V37 logic, and V56.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 11/5/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 338

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☒ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

10-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

338

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR	1.2 DATE	1.3 ORGANIZATION	1.4 APPROVAL	1.5 DATE
Haise/Kaiser	9/28/70	FCOD		

1.6 ITEM TITLE	1.7 TITLE OF CHANGE
Apollo 15 and Subs - Luminary	Change LPD Scaling to 1.0° In All Directions

1.8 DESCRIPTION OF CHANGE
The crews estimation of the Guidance Systems Landing Target relative to his desired point is visually seen as a number of degrees from the N64 Displayed LPD Angle. Currently the change resulting from an ACA (hand controller) inputs nets $\frac{1}{2}$ degree in

1.9 RECOMMENDATION OF CHANGE
Make each ACA input in every direction represent one degree LPD change.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 VISIBILITY IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT ORIGINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 9/30/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT ORIGINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> STOP OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

338

CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)

- 1.5 Up/Down range and 2 degrees Crossrange. This requires the crewman after interpreting his LPD angle error to then either divide or multiply by two to determine the needed ACA inputs.

REMARKS:

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 339

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☐ MIT Approved PCN☐ MIT Approved ADR☒ NASA Approved PCR☐ NASA Approved PCN☐ NASA Approved Software Anomaly☐ MIT Approved Software AnomalyA. Coding☒ Begin coding immediatelyACTION: P. RyeProgram Supervisor's Approval: Margaret L. Hamilton☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☐ Prepare GSOP revisions for MDRE considerationACTION: J. B. Smith
J. Klawnsnik☐ Technical Committee Meeting not required.☐ Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

investigate mechanism
2 VSD monitor in
digital routine for
Luminary. mhl

Project Manager Russell H. LarsonDate 10-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

Number (Completed by FSH)

339

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR Haise/Kaiser	1.2 DATE 9/28/70	1.3 ORGANIZATION FCOD	1.4 APPROVAL	1.5 DATE
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1.6 PROJECT TITLE Apollo 15 & Subs - Luminary	1.7 TITLE OF CHANGE Have P20 F50 72 Display Update
--	---

Increasing confidence in PGNS/AGS State Vectors as well as determining RR bias problems after LM Insertion before commencing updates is required. This is accomplished by comparing AGS aquisition steering error needles, RR FDAI needles, and N72 on DSKY.

1.8 DESCRIPTION OF CHANGE Mechanize F50 72 display to be updated Replace with a verb-16 R1-RR A+ R2-RR A5
--

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT.

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 HERSELF IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 9/30/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

339

Haise/Kaiser

CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)

- 1.5 Currently the N72 data is a "SNAPSHOT" and hence meaningless data for purposes of comparison to realtime AGS and RR information.

REMARKS:

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 340

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

**THIS PCR SHOULD NOT
BE IMPLEMENTED. SEE
REMARKS BELOW.**

☐ MIT Approved PCN☐ MIT Approved ADR☒ NASA Approved PCR☐ NASA Approved PCN☐ NASA Approved
Software Anomaly☐ MIT Approved
Software AnomalyA. Coding☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.☐ Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: _____

Date: _____

This PCR is with-
drawn (10-7-70) by
verbal disapproval
V.L.

Russell H. Turner
10-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

FORM 1 (Completed by FSB)

340

1.0 COMPLETED BY ORIGINATOR

Haice/Kaiser

9/22/70

FCOD

Apollo 15 & Subs - Luminary

LATVEL Polarity ^{CHANGE} Charge

The polarity of the LGC parameter LATVEL should be changed so that it is compatible with other X-pointer inputs.

Reverse the sign of the LGC parameter LATVEL. The attached illustration shows the present crew response and the proposed crew response to the X-pointer presentation.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

☐ APPROVED

☐ DISAPPROVED

3. SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE
BRANCH SIGN OFF

DATE

2.2 REMARKS:

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT

3.2 IMPACT OF PROVIDING DETAILED EVALUATION

3.3 STORAGE IMPACT

3.4 REMARKS:

3.5 MIT COORDINATOR

DATE

4.0 SOFTWARE CONTROL BOARD ACTION

☒ IMPLEMENT AND
PROVIDE DETAILED
CHANGE EVAL.

☐ PROVIDE
DETAILED
CHANGE
EVALUATION

☐ DIS-
APPROVED

4.2 REMARKS

VERBALLY DISAPPROVED 10-7-70.

4.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

9/30/70

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR

5.2 MIT EVALUATION

DATE

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

☐ START OR CONTINUE
IMPLEMENTATION

☐ DISAPPROVED OR STOP
IMPLEMENTATION

6.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

6.2 REMARKS:

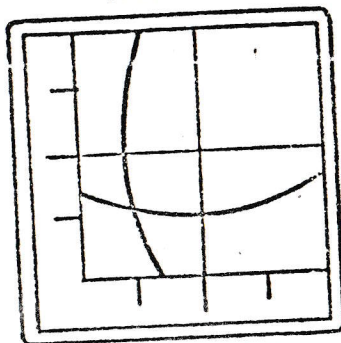
PCR # 340

PRESENT

ELEV
RT

FWD
VEL

METER



AZ RT/LAT VEL

SENSOR INPUT

LR &
PNGS

AGS
RNDZ RADAR

CONTROLLER
OPERATION TO NULL

PITCH DN
ROLL RIGHT

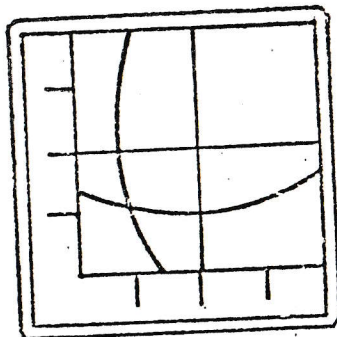
PITCH DN
ROLL LEFT

PROPOSED

ELEV
RT

FWD
VEL

METER



AZ RT/LAT VEL

LR, PNGS,
AGS
RNDZ RADAR

PITCH DN
ROLL LEFT

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 341
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

11-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

341

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR # J. H. Alphin	DATE 9/29/70	1.2 ORGANIZATION MPAD	APPROVAL R. Nobiles	DATE 10/16/70
----------------------------------	-----------------	--------------------------	------------------------	------------------

1.3 EFFECTIVITY Apollo 15 LUMINARY	1.4 TITLE OF CHANGE Landing Radar Reasonability Test
---------------------------------------	---

1.5 REASON(S) FOR CHANGE
The landing radar reasonability test can lock out valid altitude updating, especially if the lunar terrain model is inhibited (V68) during the approach phase.

1.6 DESCRIPTION OF CHANGE
See attached page.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 11-5-70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

341

J. H. Alphin

9/29/70

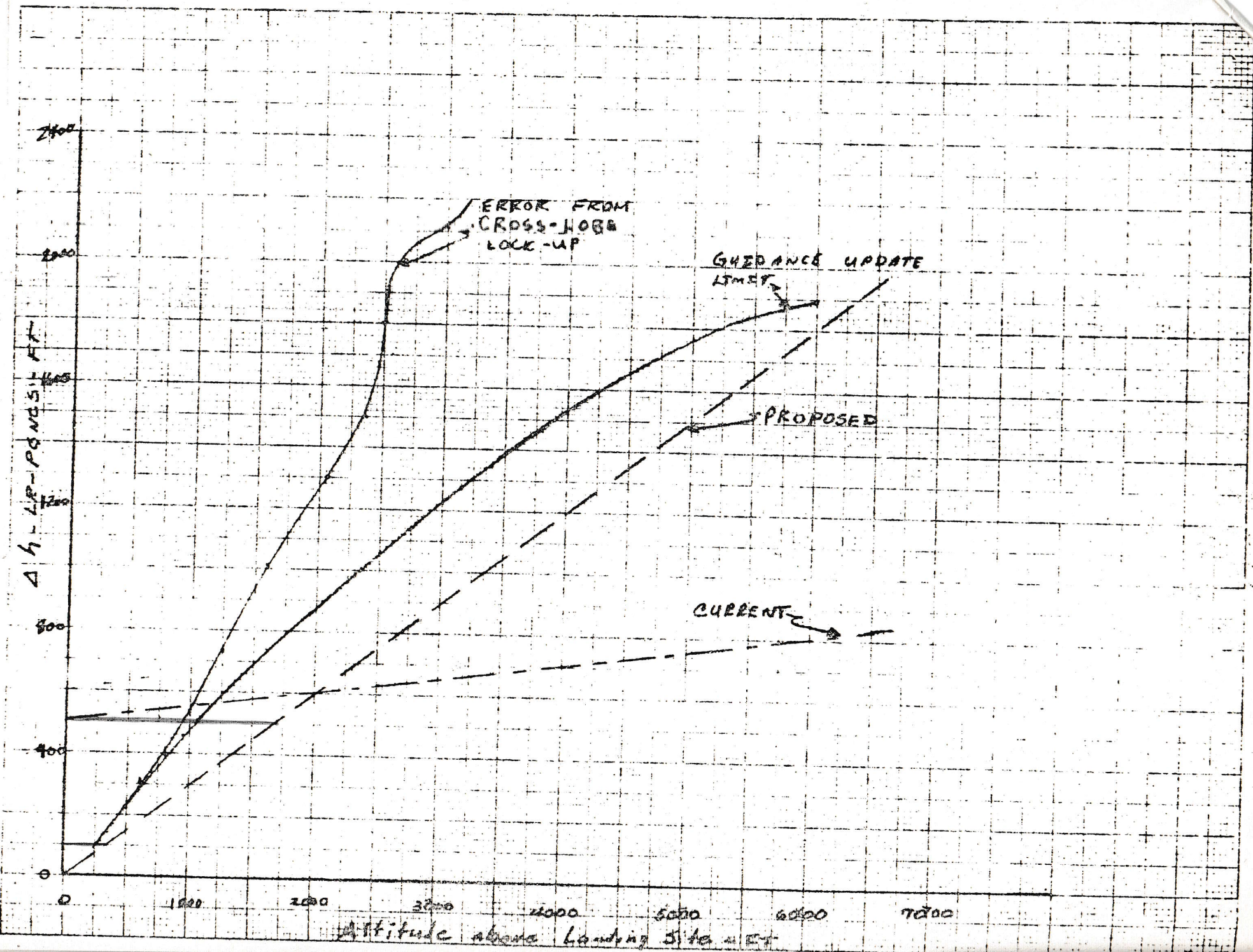
MPAD

CONTINUATION SECTION. (Refer to Block Number and Title on Program Change Request form.)

1.6 DESCRIPTION OF CHANGE

Increase the slope in the landing radar reasonability test so that less chance for lock out will occur. The recommended slope is 0.25 instead of the present 0.125. This number would reject updates which cause guidance interface problems, but would accept values that would not cause interface problems. The current slope excludes many cases that are acceptable from a guidance standpoint. In addition, this reasonability test will protect for cross lobe lock up

REMARKS:



APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				<small>NUMBER (Completed by FSB)</small> <div style="font-size: 1.2em; margin-top: 5px;">343</div>	
1.0 COMPLETED BY ORIGINATOR					
<small>1.1 ORIGINATOR</small> T. Price	<small>DATE</small> 10/21/70	<small>1.2 ORGANIZATION</small> FSD	<small>APPROVAL</small> <i>John S. Williams</i>	<small>DATE</small> 10/28/70	
<small>1.3 EFFECTIVITY</small> LUMINARY 1E & Subs.			<small>1.4 TYPE OF CHANGE</small> Disapprove PCR 340		
<small>1.5 REASON(S) FOR CHANGE</small> PCR 340 approved a polarity change of the LGC parameter LATVEL commanded to the x-pointers. Since that time a hardware change has been made to reverse that polarity.					
<small>1.6 DESCRIPTION OF CHANGE</small> Do not implement PCR 340					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
<small>2.1</small> <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			<small>2.2 REMARKS:</small> MIT/SDL has been verbally directed not to implement PCR 340. (10/17/70)		
<small>2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF</small>					
<small>DATE</small>					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
<small>3.1 SCHEDULE IMPACT</small> 0			<small>3.2 IMPACT OF PROVIDING DETAILED EVALUATION</small>		
<small>3.3 STORAGE IMPACT</small>			<small>3.4 REMARKS:</small>		
<small>3.5 MIT COORDINATOR</small> <i>R. H. Larson</i>					
<small>DATE</small> 11-5-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
<small>4.1</small> <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			To be consistent with a hardware change.		
<small>4.2 SOFTWARE CONTROL BOARD SIGN OFF</small> <i>Herb Lundgren</i>					
<small>DATE</small> Nov 5 1970					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
<small>5.1 MIT COORDINATOR</small>			<small>5.2 MIT EVALUATION</small>		
<small>DATE</small>					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
<small>6.1</small> <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			<small>6.2 REMARKS:</small>		
<small>6.3 SOFTWARE CONTROL BOARD SIGN OFF</small>					
<small>DATE</small>					

DISAPPROVED

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

Completed by FSB)

344

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR Haise/Kaiser	1.2 DATE 10-23-70	1.3 ORGANIZATION FCOD	1.4 INITIALS <i>Frederic W. Haise</i>	1.5 DATE 10/23/70
1.6 EFFECTIVITY Apollo 15 & Subs - Luminary		1.7 TITLE OF CHANGE NAVIGATION INPUTS VIA DSKY		

1.8 REASON(S) FOR CHANGE
To provide means of acquiring PGNS rendezvous solutions in event of PGNS/RR interface failures, radar gyro failure (side lobe lockon), or even complete RR failure.

1.9 DESCRIPTION OF CHANGE
Provide capability of navigation utilizing manual inputs of range and range rate and/or line of sight information. Should include option of range and range rate from radar or range only from CSM VHF ranging or line of sight information via manually boresighting

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
2.4 DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	
3.4 MIT COORDINATOR	
3.5 DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DISAPPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
4.4 DATE 11/5/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
5.3 DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
6.4 DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. PREPARED BY

344

DATE

ORGANIZATION

CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)

1.6 the +Z axis by utilizing the COAS or RR FDAI needles.

REMARKS:

DISAPPROVED

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

345

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR C. Hackler	1.2 DATE 10/29/70	1.3 ORGANIZATION EG7	1.4 APPROVAL <i>[Signature]</i>	1.5 DATE 10/29/70
------------------------------	----------------------	-------------------------	------------------------------------	----------------------

1.6 EFFECTIVITY LUM 1E	1.7 TITLE OF CHANGE Change of Erasable Load
---------------------------	--

1.8 REASON(S) FOR CHANGE
Make room for needed erasable storage.

1.9 DESCRIPTION OF CHANGE
Change following variables from erasable to fixed memory. (See page 2.)

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 DISCRETE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> REVIEW DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DISAPPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 11/5/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE
REQUEST NO. 345

PREPARED BY: C. Hackler
DATE: 10/29/70

ORGANIZATION:
EG7

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.6 (continued) Description of Change

RANGEVAR
RATEVAR
RMAX
VMAX
SHAFTVAR
TRUNVAR
LOWCRIT
HIGHCRIT
LRVMAX
LRVF
LRWVZ,Y,X*
LRWVFX,Y,Z**
LRWVFF
MINFORCE
MAXFORCE
YLIM
COSTHETAI
COSTHETA2
VELBIAS***
LRHMAX
ZOOMTIME
WSHAFT
WTRUN

*Use one constant for all the variables.

**Use one constant for all the variables.

***Change on 13-14 from 11-12.

REMARKS

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 347
ANOMALY # _____

- | | |
|--------------------------------------|---|
| <input type="checkbox"/> COLOSSUS 2C | <input type="checkbox"/> LUMINARY 1B |
| <input type="checkbox"/> COLOSSUS 2D | <input type="checkbox"/> LUMINARY 1C |
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 2F | <input checked="" type="checkbox"/> LUMINARY 1E |

☐ MIT Approved PCN

☒ ^{VERBALLY} NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: P. Volante
V. Dunbar

Program Supervisor's Approval: 3 Mdy to M Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: J. KLAWSNIK

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____


ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 11-30-70

1.0 COMPLETED BY ORIGINATOR

1.1 DESIGNATOR: T. Price	DATE 11/25/70	1.2 ORGANIZATION: FSD	APPROVED 	DATE 11/25/70
1.3 EFFECTIVE DATE: LUMINARY 1E		1.4 TITLE OF CHANGE: Modification to code word configuration for PONCE/AGS data transfer		

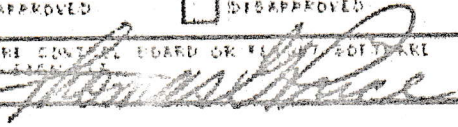
1.5 REASON(S) FOR CHANGE

Because of coding problems in the AGS program, transfer of RR data is not accomplished when range is less than 50 n.m. Impact to fix in AGS program is significant

1.6 DESCRIPTION OF CHANGE

Change configuration of code word set pattern from A01111111111111 (See PCR 324) to A01111111111110. The reset configuration will remain as in PCR 324, A10000000000000.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input checked="" type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS: Verbal approval given 11/25/70
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGNATURE: 	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR:	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION:

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN-OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR:	5.2 MIT EVALUATION:
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN-OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 348
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA ^{VERGAL} Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: P. Rye
P. White

Program Supervisor's Approval: Bureau Mgr for W Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: J. KLAWSNIK/J. SMITH

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 12-1-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSH)

348

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR	DATE	1.2 ORGANIZATION	APPROVAL	DATE
F. Haise/T. Kaiser	11/25/70	FCSD/CB	<i>[Signature]</i>	11/30/70

1.3 EFFECTIVITY	1.4 TITLE OF CHANGE
LUMINARY 1E	New target. - ΔV program for LGC

- 1.5 REASON(S) FOR CHANGE
1. To allow updating of LM S.V. for cases where LM must perform burn with ave-g not on.
 2. Compatibility with Col. 3 (PCR 325)

1.6 DESCRIPTION OF CHANGE

Provide a program which will allow updating of LM S.V. as P76 allows updating of CSM S.V.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1	<input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF		<i>Verbal approval given</i> <i>11/30/70</i>
DATE		

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1	<input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF		
DATE		

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1	<input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF		
DATE		

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSO) 348	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR F. Haise/T. Kaiser		DATE 11/25/70	1.2 ORGANIZATION FCSD/CB		APPROVAL <i>Eric R. Goto</i>
					DATE 11/29/70
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE New target - AV program for LGC		
1.5 REASON(S) FOR CHANGE					
1. To allow updating of LM S.V. for cases where LM must perform burn with ave-g not on.					
2. Compatibility with Col. 3 (ICR EPR)					
1.6 DESCRIPTION OF CHANGE Provide a program which will allow updating of LM S.V. as P76 allows updating of CSM S.V.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS: <i>Verbal approval given</i>		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF			<i>11/30/70</i>		
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF <i>W. J. Tindall</i>					
DATE <i>1/13/71</i>					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/DL PROGRAM CHANGE ROUTING SLIP

R. Hanson
~~DSR~~/PCN # 1009
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input checked="" type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☒ MIT Approved PCN☐ NASA Approved PCR☐ NASA Approved Software Anomaly☐ MIT Approved ADR☐ NASA Approved PCN☐ MIT Approved Software AnomalyA. Coding

☐ Begin coding immediately

GSOP ONLY

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

J. KLAWNSNIK/J. SMITH.

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special InstructionsProject Manager Russell H. LarsonDate 12-29-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1009

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR J. B. Smith	DATE 12/15/70	1.2 ORGANIZATION MIT/CSDL	APPROVAL <i>R. H. Laro</i>	DATE 12-29-70
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1.3 EFFECTIVITY

LUMINARY 1D

1.4 TITLE OF CHANGE
Luminary 1D Editorial
Changes to Section 4.

1.5 REASON(S) FOR CHANGE

Editorial Changes

G SOP

1.6 DESCRIPTION OF CHANGE

See Amplification Sheet

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT2.1 ☐ APPROVED ☐ DISAPPROVED

2.2 REMARKS:

2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE
BRANCH SIGN OFF

DATE

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT

3.2 IMPACT OF PROVIDING DETAILED EVALUATION

3.3 STORAGE IMPACT

3.4 REMARKS:

3.5 MIT COORDINATOR

DATE

12-29-70

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☐ IMPLEMENT AND
PROVIDE DETAILED
CHANGE EVAL. ☐ PROVIDE
DETAILED
CHANGE
EVALUATION ☐ DIS-
APPROVED

4.2 REMARKS

4.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR

5.2 MIT EVALUATION

DATE

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION6.1 ☐ START OR CONTINUE
IMPLEMENTATION ☐ DISAPPROVED OR STOP
IMPLEMENTATION

6.2 REMARKS:

6.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

PAGE 2 OF 9

PROGRAM CHANGE
REQUEST NO. 1009

PREPARED BY: J. B. Smith
DATE: 12/15/70

ORGANIZATION:
MIT/CSDL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

Program/Line
P12/Assumption 11

Name of Change
Exchange reference to R10 and Average-G
and cite exceptions in Assumption 7.

P12/Assumption 14

Removal of "R3-BLANK".

P12/200

Change down-range speed from 5509.5 to
5509.3 fps.

P12/240

Change down-range speed from 5509.5 to
5509.3 fps.

P12/355

Delete setting of vertical rise flag.

P12/1402

Insert "Set RCS flag."

P12/1530

"D from above" moved up to "set deadband to
R03 value."

P20/Assumption 10

Delete reference to Section V.

P20/45

Delete reference to Section V.

P20/1098

Change "Small angle" to Shaft angle".

P20/1269-1270

Delete extraneous zeroes.

P22/Assumption 4

Add "Note: If V95E is entered before
P22 is selected, V81E must be performed to
allow state vector updating."

P22/1187-1200

Correct the use of the verb "display" and
the nouns "displays".

REMARKS

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 3 OF 9

PROGRAM CHANGE

REQUEST NO. 1009

PREPARED BY: J. B. Smith

DATE: 12/15/70

ORGANIZATION:

MIT/CSDL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

P25/50

Reset Rendezvous flag.

P32/110-150

Put in TIG (CSI) = 00000 so that it can be
computed if the astronaut chooses.

P34/585

Change reference from Section 5.4, 2, 4, to 5.4.

P34/885

Change reference from Section 5.4, 2, 4, to
5.4, 2.

P40/660-690

Change direction of the "Yes" decision out
of the compare of TG.

P40/Assumption 7

Delete "With the exceptions indicated in
assumption (6), above."

P41/Assumption 4

Delete "with the exceptions indicated in
assumption (3) above"

P41/125

Change reference from Section 5.3, 3, 3, 3, to
Section 5.3, 3.

P42/Assumption 7

Delete "with the exceptions indicated in
assumption (6) above".

P42/350-360

Add to MONITOR DSKY "NOTE: VERB-
NOUN FLASH MAY ALSO REQUEST AUTO
THROTTLE MODE IF DPS HAS NOT BEEN
STAGED)."

P52/200

Correction of spelling of the word "defined".

P57/Assumption 8

"attitude deadband" changed to "maximum
deadband".

REMARKS

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 4 OF 9

PROGRAM CHANGE REQUEST NO. <u>1009</u>	PREPARED BY: <u>J. B. Smith</u> DATE: <u>12/15/70</u>	ORGANIZATION: <u>MIT/CSDL</u>
---	--	----------------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

P57/960-980

Change the note to read "NOTE: P68
DEFINES THE ACTUAL LANDING SITE
VECTOR REACHED AS THE GRAVITY
VECTOR, THEN V06N04 in P57, WHEN
DISPLAYED FOR THE FIRST TIME,
SHOWS THE ANGLE BETWEEN THE ACTUAL
LANDING SITE AND THE PRETARGETED
LANDING SITE VECTORS".

P63/Assumption 16

Add "for aborts from the descent orbit in-
jection or the descent coast it is assumed
that sufficient time exists to perform a
TPI maneuver (see terminal phase initiation
(TPI) program (P34))to intercept the CSM
directly."

P63/Assumption 19

Delete "with the exceptions indicated in
assumption (17) above"

P63/Assumption 30

In the discussion of THRCMD, change the R1
display to +00057 rather than +00055.

P64/Assumption 2

Delete LUM 1C assumption and substitute
"If circularization has not occurred, the
CSM is in a 9X60 (miles) orbit around the
moon. The CSM is maintaining a preferred
tracking attitude for optical tracking of the
LM.

P64/Assumption 9

Delete "This program assumes the throttle
control to be in auto (the DPS receives
the sum of the manual and PGNCs commanded
settings) and the manual throttle to be set

REMARKS

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

PAGE 5 OF 9

PROGRAM CHANGE
REQUEST NO. 1009

PREPARED BY: J. B. Smith

DATE: 12/15/70

ORGANIZATION:
MIT/CSDL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

P64/372-374

at a level less than that required by the LGC.
and add "The throttle control may be set
to auto or manual. The DPS receives the sum
of the manual and PGNCs commanded settings."

P68/130

Add resumption of static display of V06N64.

P70/Assumption 13

Delete the word "initially" in "initially
designated landing site" in the definition
of ALT.

P70/Assumption 20

Delete "with the exceptions indicated in
assumption (11) above,"

P70/Assumption 18

The contents of R1 of V06 N76 should be
'DOWNRANGE VELOCITY (VHF)'

P70/142

Delete "R3-BLANK"

P70/160

Insert "RESTART DRIFT FLAG"

P70/330

Insert "SET 1.0 DEGREE DEADBAND"

P70/250-260

Insert "INITIALIZE APS ENGINE DATA"

P70/280-290

Initialize P70/P71 flag and FINDCDUW

P70/370

Initialize DPS engine and target data

P70/430-435

Initialize target data

Define THETA critical as Pad loaded value.

REMARKS

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

PAGE 6 OF 9

PROGRAM CHANGE
REQUEST NO. 1009

PREPARED BY: J. B. Smith

DATE: 12/15/70

ORGANIZATION:
MIT/CSDL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

P70/490	Set APS abort continuation flag.
P70/995	ZERO DPS AUTO THROTTLE.
P71/Assumption 12	Delete "With the exceptions indicated in assumption (10) above,"
P71/Assumption 15	Delete "R3-BLANK".
P71/930	Zero DPS auto throttle.
P72/110-145	Insert option for initial TIG (CSI) = 00000, letting TIG (CSI) be computed rather than entered
P72/226	Change 5.4.2. to 5.4.2.
P72/252	Change 5.4.2.2 to 5.4.2
P72/377	Change 5.4.2.2 to 5.4.2
P72/391	Change 5.4.2.2 to 5.4.2
P73/150	Change 5.4.2.2 to 5.4.2
P74/550	Change 5.4.2.4 to 5.4.2
P74/846	Change 5.4.2.4 to 5.4.2
P75/330	Change 5.4.2.5 to 5.4.2
R00/215-275	Change R00 to take care of alterations due to deletion of R29.

REMARKS

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 7 OF 9

PROGRAM CHANGE REQUEST NO. <u>1009</u>	PREPARED BY: <u>J. B. Smith</u> DATE: <u>12/15/70</u>	ORGANIZATION: <u>MIT/CSDL</u>
---	--	----------------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

R00/375-385	Reset IMUSE flag after check of P25 and rendezvous flags.
R01/Assumption 2	Add "except channels 7 and 77" as in PCR 302.2
R03/82-90	In discussion of 4 jet translation, delete references to RCS systems.
R03/482-488	Change "VERB 50 (BUT NOT N)" to "(V50 N48)"
R04/524-528	Change "THE TRACKER FAIL ALARM IS ACTUATED" to "THE ALT OR VEL LIGHT IS ENERGIZED."
R12/Assumption 4	Alter definitions of V57 and V58 to read "V57E enables the use of good LR data" "V58E Prevents the use of all LR data"
R12/690	Alter re-entry point for "YES" side of decision block.
R22/150	Wait 2 seconds to proceed if surface flag is set.
R22/667	Change 5.2.4.2.2 to 5.2.4
R30/170	Insert "RESET THE NO MARKS ALLOWED FLAG".
R30/305	Delete "AND NO MARKS ALLOWED FLAG" reset.

REMARKS

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 8 OF 9

PROGRAM CHANGE REQUEST NO. <u>1009</u>	PREPARED BY: <u>J. B. Smith</u> DATE: <u>12/15/70</u>	ORGANIZATION: <u>MIT/CSDL</u>
---	--	----------------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

R31/30-250	Check surface flag, MUNFLAG, and Average-G flag settings earlier in program and end looping.
R51/150-170	Change "...DISPLAY PRESENT AOT DETENT OR BACKUP OPTICAL SYSTEM LOS DEFINITION:" and "OPT AZ-THE AZIMUTH OF THE PRESENT DETENT OR OPTICAL SYSTEM IN USE." to "DISPLAY OPTICAL SYSTEM LOS DEFINITION: " and "OPT AZ-THE AZIMUTH OF THE OPTICAL SYSTEM IN USE."
R52/190	Change OPT EL by deletion of "THE PRESENT DETENT"
R53/225	Add "RESET MARK IN PROGRESS FLAG"
R53/295	Change OPT EL definition by deletion of "THE PRESENT DETENT"
R53/350	Add "RESET MARK IN PROGRESS FLAG"
R53/495	Add "RESET MARK IN PROGRESS FLAG"
R57/620-660	Logic change in checking MARK X and MARK Y activity and program alarm 00113.
R57/810	Logic change on program re-entry position.
R57/130	Add V34E as another response to V06N88 Display
R59/15-45	Logic change sending loop up to check REFSMMAT flag setting instead of going to the V01N70 display.
R51/200	Delete auto optics selection of Star No. 1.
R51/136	Change "IA" to "IS".
R57/28-65	Delete program alarm and storage of alarm code 00112.
R57/340,505	RESET MARK IN PROGRESS FLAG.

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

PAGE 9 OF 9

PROGRAM CHANGE
REQUEST NO. 1009

PREPARED BY: J. B. Smith
DATE: 12/15/70

ORGANIZATION:
MIT/CSDL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

R65/25-60

Logic change sending loop to RR DATA GOOD
DISCRETE check and delete setting of R04
flag.

V36/45, 68

Delete reset 1/ACCJOB flag and ACCSOKAY
flag.

V36/225

Initialize IMODES33; set no PIPA fail bit;
set downlink and uplink ok bits; reset all other
bits.

V59/30-40

Change "And COMPLEMENT BIT 14 of "QSW"
to "AND QSW TO -1"

REMARKS

TP#21812

DISAPPROVED

Pg-1012

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1024

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR

EYLES

DATE

2/26/70

1.2 ORGANIZATION

MIT

APPROVAL

DATE

1.3 EFFECTIVITY

LUMINARY 1E (Apollo 15)

1.4 TITLE OF CHANGE

Variable Guidance Period Servicer

1.5 REASON(S) FOR CHANGE

To reduce powered flight TLOSS difficulties.

1.6 DESCRIPTION OF CHANGE

See attached sheet.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1

☐

APPROVED

☐

DISAPPROVED

2.2 REMARKS:

2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE
BRANCH SIGN OFF

DATE

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT

3.2 IMPACT OF PROVIDING DETAILED EVALUATION

3.3 STORAGE IMPACT

3.4 REMARKS:

3.5 MIT COORDINATOR

DATE

4-7-70

4.0 SOFTWARE CONTROL BOARD ACTION

4.1

☐ IMPLEMENT AND
PROVIDE DETAILED
CHANGE EVAL.☐PROVIDE
DETAILED
CHANGE
EVALUATION☒DIS-
APPROVED

4.2 REMARKS

4.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

4/9/70

DISAPPROVED

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR

5.2 MIT EVALUATION

DATE

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1

☐ START OR CONTINUE
IMPLEMENTATION☐DISAPPROVED OR STOP
IMPLEMENTATION

6.2 REMARKS:

6.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

OLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

1024

EYLES

2/26/70

MIT

CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)

1.6 Description of Change

Rewrite Servicer to be independent of guidance period and run end-to-end, starting over as soon as finished. This results in a much simpler organization and makes it impossible for the Servicer job to overlap itself. Give all the other jobs that must run during powered flight a higher priority than Servicer's so they will be executed. Include logic in Servicer for insuring a minimum guidance period of 2 seconds to allow a full downlist to be sent for each Servicer cycle and to make the new Servicer run at 2 seconds, like the old one, in the absense of TLOSS or extra computations to stretch it longer. Issue alarm 555 whenever guidance period exceeds 4 seconds.

Modify other powered flight programs to run with this Servicer.

REMARKS:

Besides safety this change serves economy by minimizing the elaborate TLOSS testing that will have to be done in the future, once this rope is qualified over a wide range of TLOSS, and in addition permits greater flexibility both in the use of programs and in making modifications. See Luminary memo 138.

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1030

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR L. BERMAN	DATE 3/11/70	1.2 ORGANIZATION MIT/CSD Lab.	APPROVAL	DATE
------------------------------------	------------------------	---	----------	------

1.3 EFFECTIVITY LUMINARY 1E	1.4 TITLE OF CHANGE Replacement of Logsub.
---------------------------------------	--

1.5 REASON(S) FOR CHANGE
Logsub is used only by Ascent guidance and provides more precision than necessary. A quicker, cheaper method would be desirable.

1.6 DESCRIPTION OF CHANGE
See attached Luminary Memo #141.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT Saves 30 fixed.	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	
3.4 REMARKS:	
3.5 MIT COORDINATOR <i>Russell H. Lerman</i>	
DATE 3-19-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

Massachusetts Institute of Technology
C. S. Draper Laboratory
Cambridge, Massachusetts

PCR 1030
PAGE 2 OF 4

MAR 18 1970

LUMINARY Memo #141

To: Distribution
From: L. Berman
Date: 10 March 1970
Subject: Replacement of LOGSUB in Luminary

The Ascent Guidance Equations in LUMINARY require the generation of a logarithm, specifically $\log(1 - T_{go}/T_{Bup})$. To do this, a 7th order polynomial is used, with POLY doing the actual work. The setup for POLY is done in a section called LOGSUB.

It turns out that LOGSUB is not used anywhere else in LUMINARY. Since the accuracy of a 7th order polynomial is not needed in the guidance, it makes sense to replace it with a simpler procedure.

$$\log(1 - T_{go}/T_{Bup}) = - \frac{T_{go}}{T_{Bup}} - 1/2 \left(\frac{T_{go}}{T_{Bup}}\right)^2 - 1/3 \left(\frac{T_{go}}{T_{Bup}}\right)^3 \dots$$

For the kind of vehicles we are familiar with, T_{go}/T_{Bup} is normally not larger than about .5 (anything significantly larger means you have very little payload). Thus a short series should work adequately. With a little computation I have found

$$L = - \frac{T_{go}}{T_{Bup}} - .47150942 \left(\frac{T_{go}}{T_{Bup}}\right)^2 - .54647754 \left(\frac{T_{go}}{T_{Bup}}\right)^3$$

to look reasonable. Its error, $(L - \log)/\log$, is shown on the attached figure. Maximum error for $T_{go}/T_{Bup} \leq .5$ is about 1%, and for a LM-type vehicle, the equivalent error in T_{go} is reduced to .01 sec by the time T_{go} is reduced to 15 sec.

old
DLOAD DSU
TBUP
TGO

new
DLOAD DDV
TGO
TBUP

<u>old</u>		<u>new</u>	
DDV	CALL	EXIT	
	TBUP	TC	POLY
	LOGSUB	DEC	2
SL	PUSH	2DEC	0
	5	2DEC	-1.0
	(8 reg)	2DEC	-0.47150942
	+	2DEC	-0.54647754
	LOGSUB (38 reg)	TC	INTPRET
	= 46 reg	PUSH	
			16 reg

A saving of 30 registers is seen (also some time saving), all in BANK 30, so that coding changes would be simple.

Error in the approximation

$$L = -\frac{T_{90}}{T_{BVP}} - K_2 \left(\frac{T_{90}}{T_{BVP}}\right)^2 - K_3 \left(\frac{T_{90}}{T_{BVP}}\right)^3$$

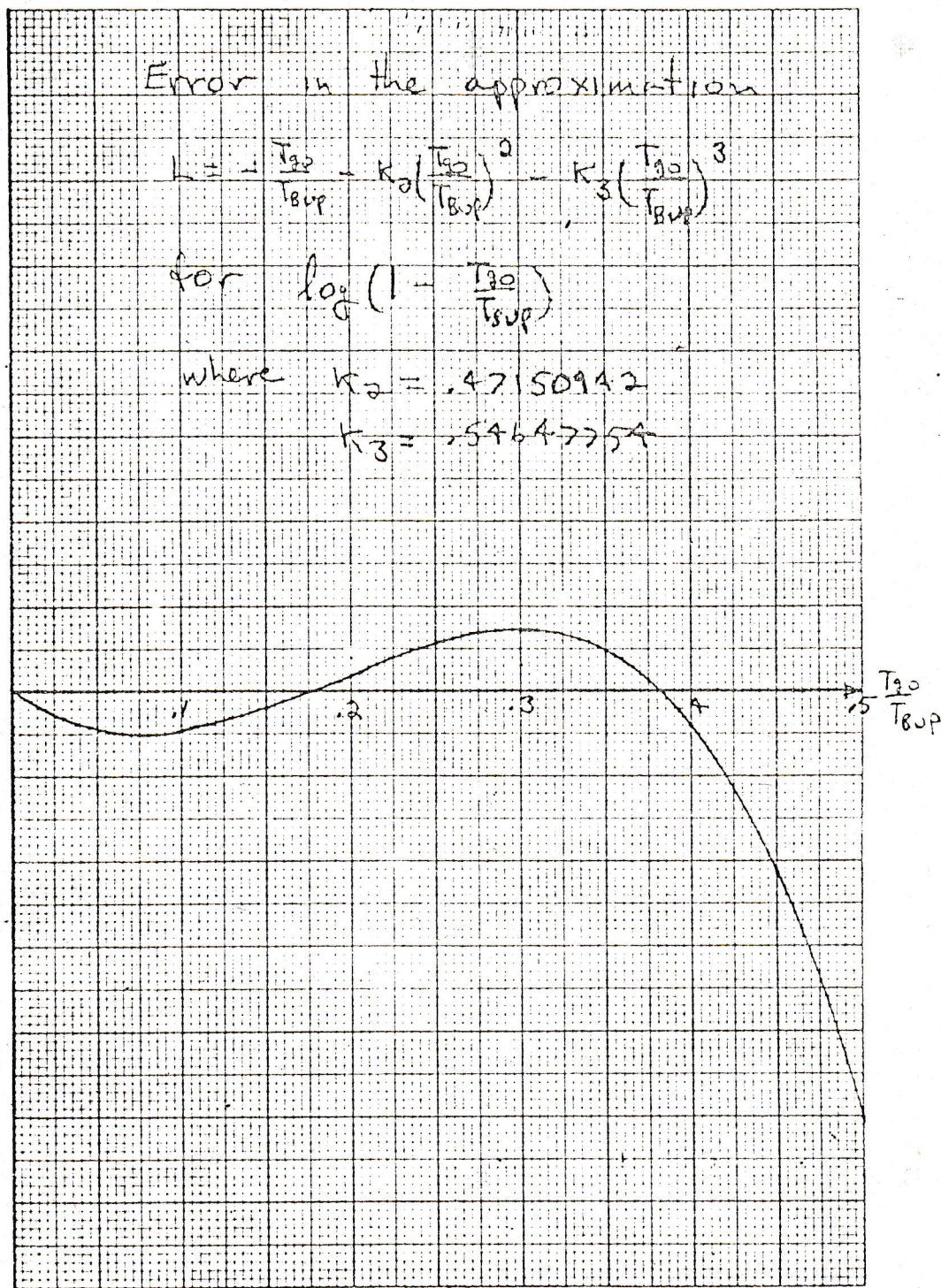
for $\log\left(1 - \frac{T_{90}}{T_{BVP}}\right)$

where $K_2 = .47150942$

$K_3 = .54647754$

Error Ratio = $(L - \log) / \log$

.008
.004
0
-.004
-.008
-.012



MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1044

ANOMALY # _____

ADR # _____

☐ COLOSSUS 2E
☐ COLOSSUS 3
☐ COLOSSUS 3A
☐ COLOSSUS _____

☐ LUMINARY 1D
☒ LUMINARY 1E
☐ LUMINARY 1F
☐ LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

R. H. Larson
8-18-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1044

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR D. Millard	DATE 5/11/70	1.2 ORGANIZATION MIT/DL	APPROVAL	DATE
1.3 EFFECTIVITY LUMINARY 1E		1.4 TITLE OF CHANGE Re-design of R53-R57		

1.5 REASON(S) FOR CHANGE Eliminate requirement of taking X and Y marks in pairs during inflight alignments and the restriction of taking cursor and spiral sighting in pairs in a fixed sequence during surface alignments.

1.6 DESCRIPTION OF CHANGE Recode R57 and R53 to include following changes:
Recode star vector determination equations used in P57 to provide capability of taking cursor and spiral sighting marks in any sequence.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 60 WORDS	3.4 REMARKS: This does not change the averaging technique
3.5 MIT COORDINATOR H. Larson	
DATE 5-13-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input checked="" type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DISAPPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input checked="" type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 8/13/70	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE
REQUEST NO. 1044

PREPARED BY: D. Millard
DATE: 5/11/70

ORGANIZATION: MIT/DL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.6

Provide AGC generated load request for cursor and spiral key in to eliminate astronaut key in of load verb.

Add display in R2 and R3 under mark request verbs to indicate the number of X and Y marks accumulated during P52 and the number of cursor and spiral marks accumulated in P57.

Provide surface mark verbs V53N71 and V52N71 to indicate whether cursor or spiral mark is being made.

Provide ENTER under surface mark verb display so astronaut can specify cursor or spiral marks are to be made.

Provide PROCEED instead of V32 ENTER under V06N79 to recycle for more surface marks.

Delete displays V53N71, V52N71 from inflight marking.

Delete alarm 107 (5 mark alarm).

Delete alarm 114 (mark not desired). ~~10~~

REMARKS

8 August 1970

STAR VECTOR DETERMINATION FOR PCR 1044

In the proposed modification of P57 a cursor mark defines a plane containing both the star and the line-of-sight of the center of the AOT field-of-view being used. The unit vector \underline{u}''_{YPN} defining the normal to this plane in navigation base coordinates is given in Eq. 6.3.9 of the GSOP. A spiral mark defines a spiral surface which also contains the star. The line of intersection of the above plane and spiral surface represents the direction of the star. However, since the orientation of the plane can change in navigation base coordinates because of lunar rotation and vehicle shifts, it is necessary to correct for any such changes in orientation of the plane between the times of the cursor and spiral marks before using it with the spiral surface. To obtain the correct orientation \underline{u}_{YP} of this cursor plane at the time of the spiral mark the following computation is made

$$\underline{u}_{YP} = [\text{SMNB}]_S [\text{NBSM}]_C \underline{u}''_{YPN}$$

where the subscripts S and C correspond to the CDU's recorded during the spiral and cursor marks.

To mathematically express the spiral surface in a form convenient to the language of the LGC, use is made of a unit vector \underline{u}_{SP} which sweeps along the spiral as a function of the angle θ as shown in Figure 1.

In the triple primed coordinate system of Figure 1 the vector \underline{u}_{SP} can be expressed in terms of θ as:

$$\underline{u}_{SP} = \begin{bmatrix} \cos \theta & \sin \theta/12 \end{bmatrix} \underline{u}''_X - \begin{bmatrix} \sin \theta & \sin \theta/12 \end{bmatrix} \underline{u}''_Y + \begin{bmatrix} \cos \theta/12 \end{bmatrix} \underline{u}''_Z$$

To obtain \underline{u}_{SP} in navigation base coordinates the coordinate axes vectors \underline{u}''_X , \underline{u}''_Y and \underline{u}''_Z must be expressed in navigation base coordinates. Given the AOT reticle rotation angle SROT at the time of the spiral mark,

the above coordinate axes vectors can be expressed in terms of vectors which are already computed in navigation base coordinates by the LGC as follows: (see GSOP for vector rotation)

$$\underline{u}'''_Y = -\sin(\text{SROT}) \underline{u}_{\text{XPN}} + \cos(\text{SROT}) \underline{u}_{\text{YPN}}$$

$$\underline{u}'''_Z = \underline{u}_{\text{OAN}}$$

$$\underline{u}'''_X = \underline{u}'''_Y \times \underline{u}'''_Z$$

To obtain the line of intersection of the cursor plane and spiral surface a value of $\underline{u}_{\text{SP}}$ must be computed which satisfies

$$\underline{u}_{\text{YP}} \cdot \underline{u}_{\text{SP}} = 0$$

This is accomplished by the iteration loop in Figure 2 where the initial value of $\underline{u}_{\text{SP}}$ is based on an initial guess for θ of

$$\theta = \text{SROT} - \text{YROT}$$

The final solution for $\underline{u}_{\text{SP}}$ represents the direction of the star in navigation base coordinates and must be transformed to IMU stable member coordinates as follows before being averaged with any other estimates of the direction to that star

$$\underline{u}_S = [\text{NBSM}]_S \underline{u}_{\text{SP}}$$

Figure 1

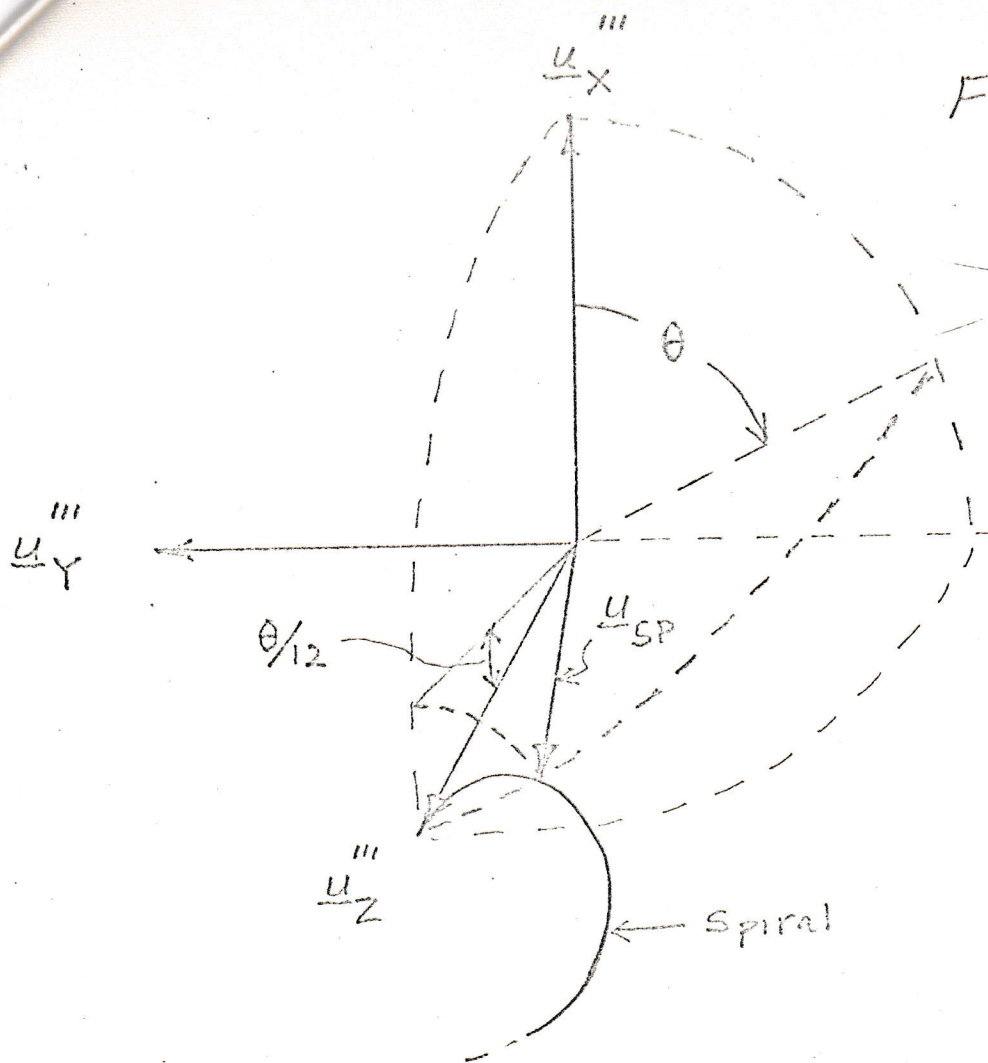
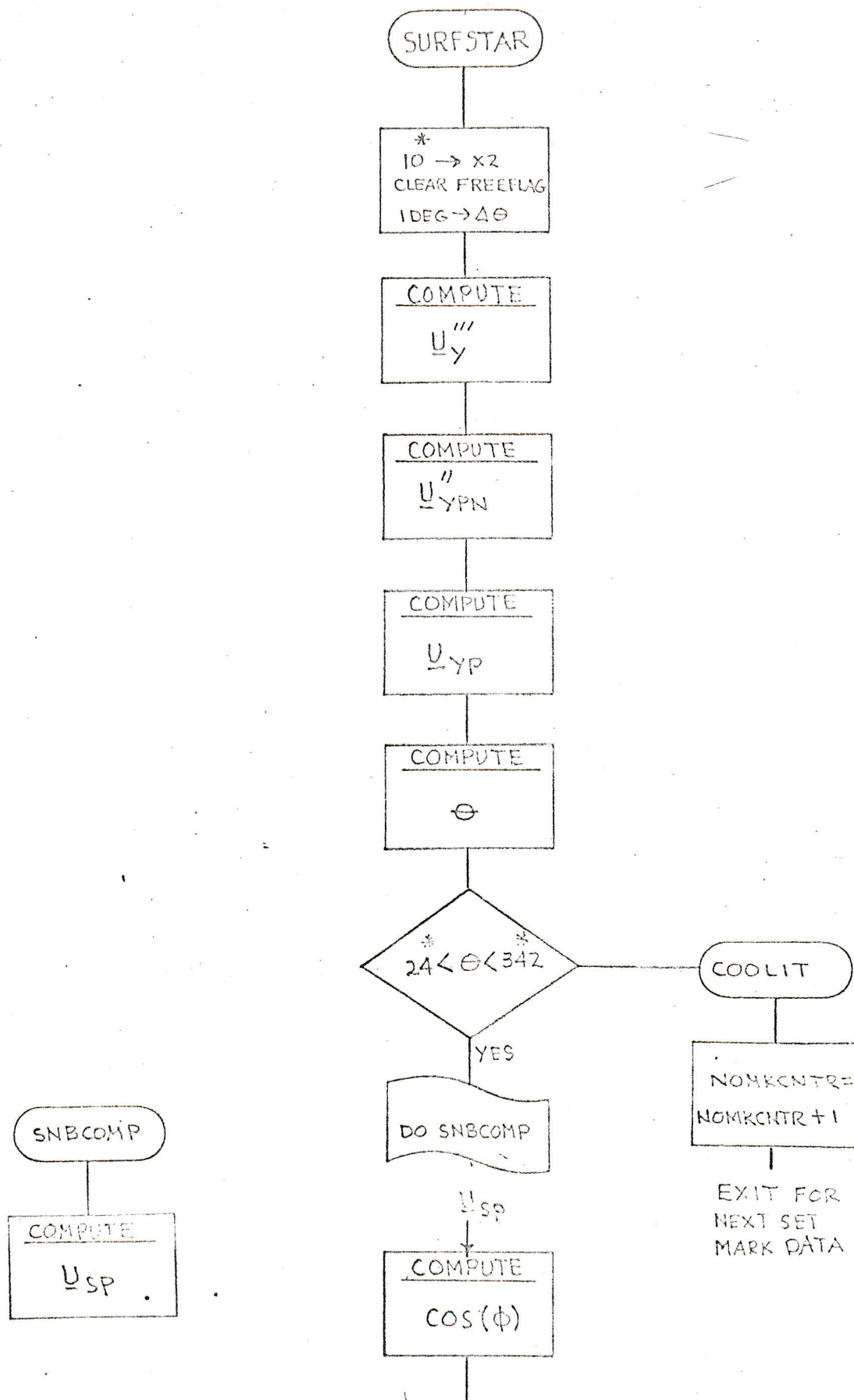
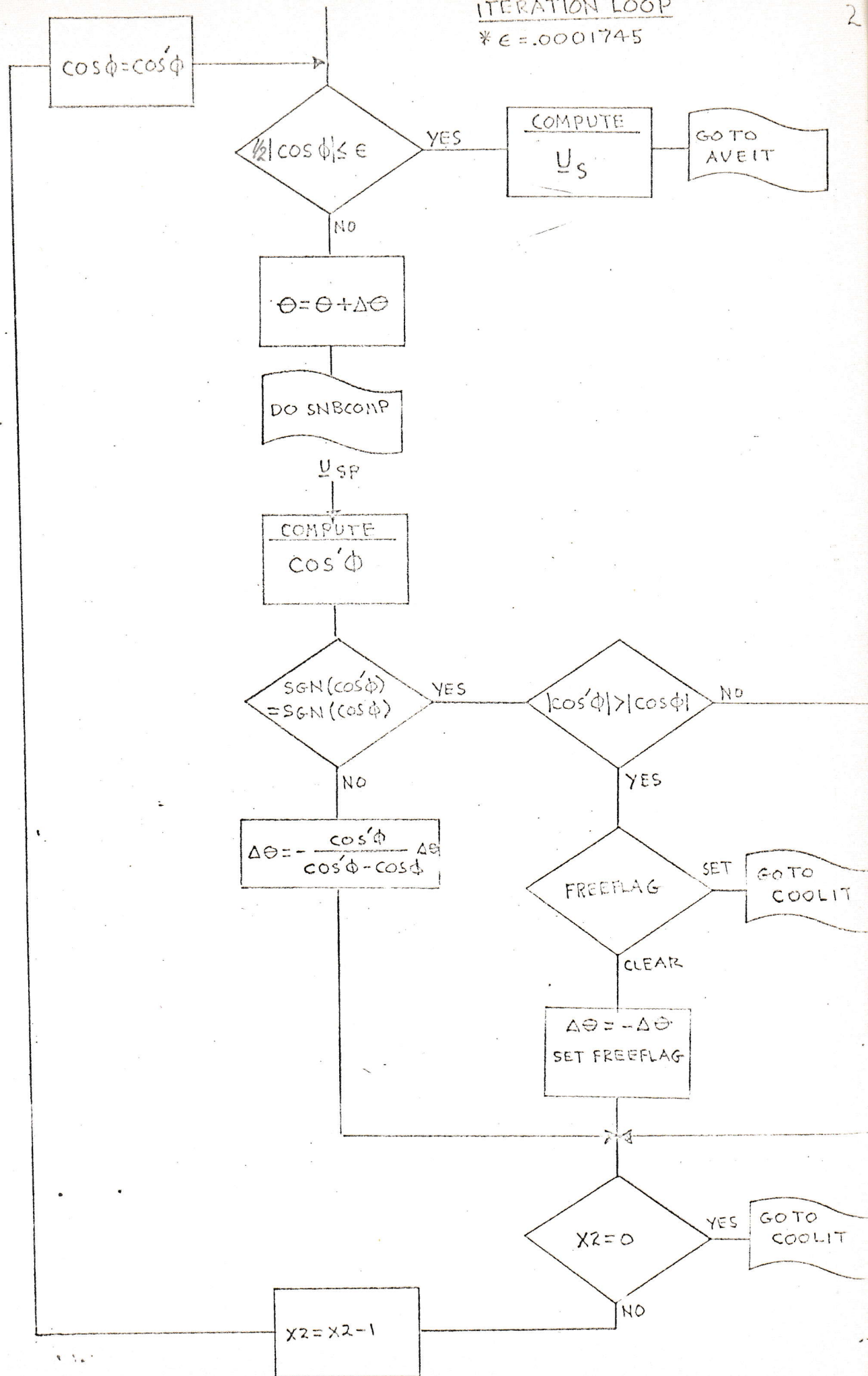


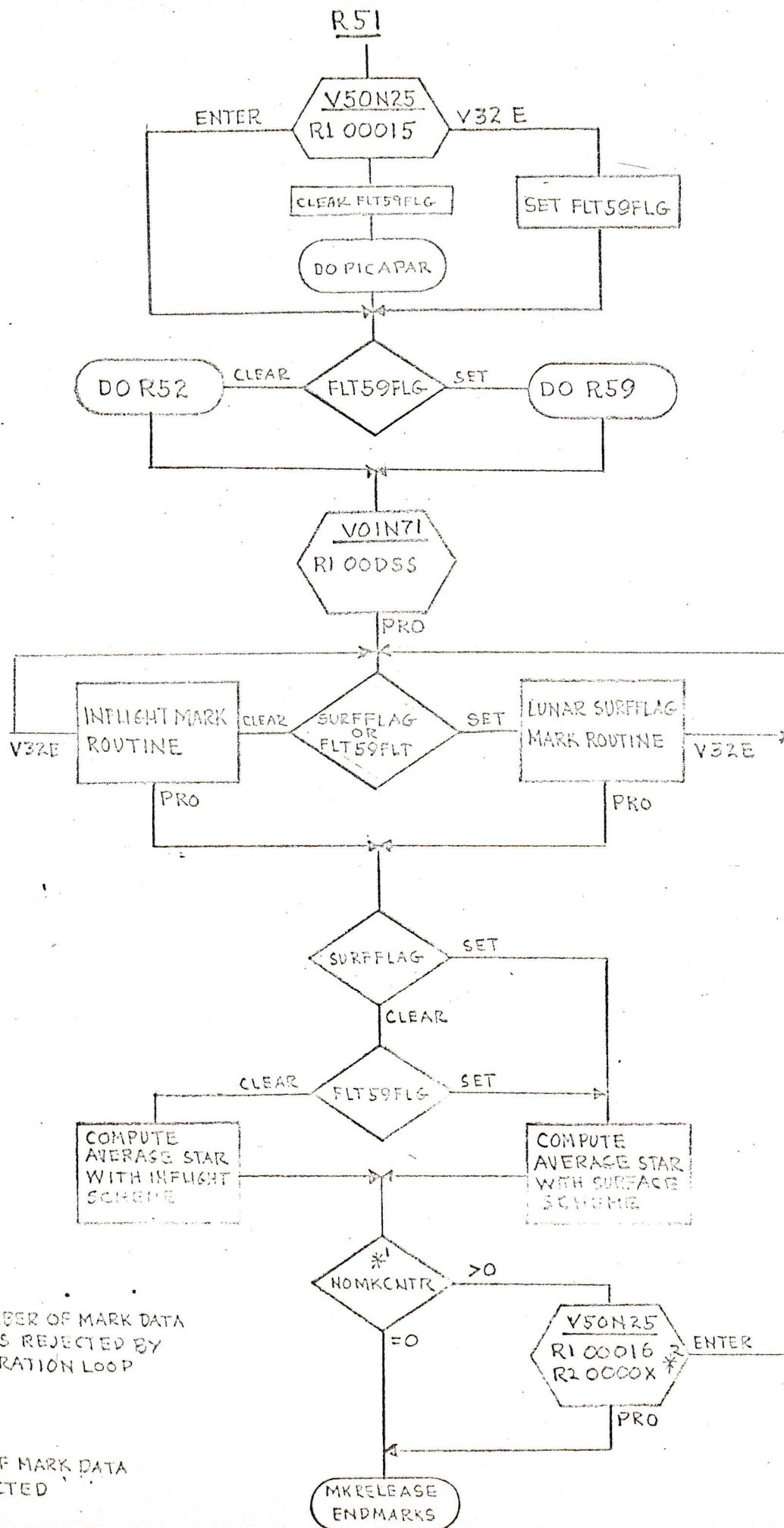
FIGURE 2



*
THE VALUES SHOWN ARE BEING
USE DURING INITIAL TESTING.
STUDY WILL DETERMINE IF THEY
SHOULD BE CHANGED.

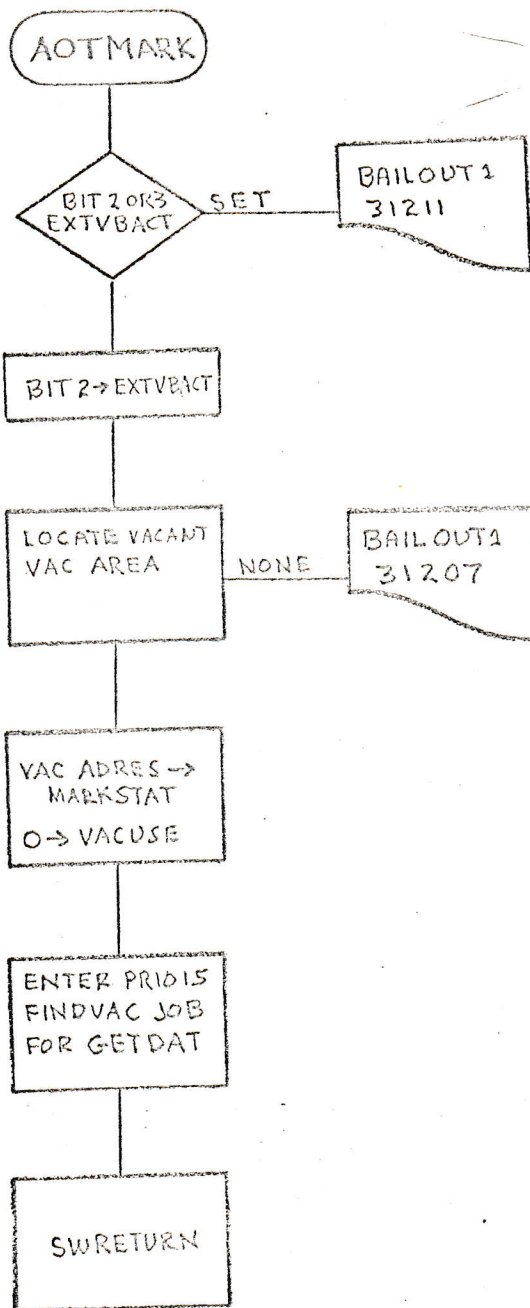
* $\epsilon = .0001745$

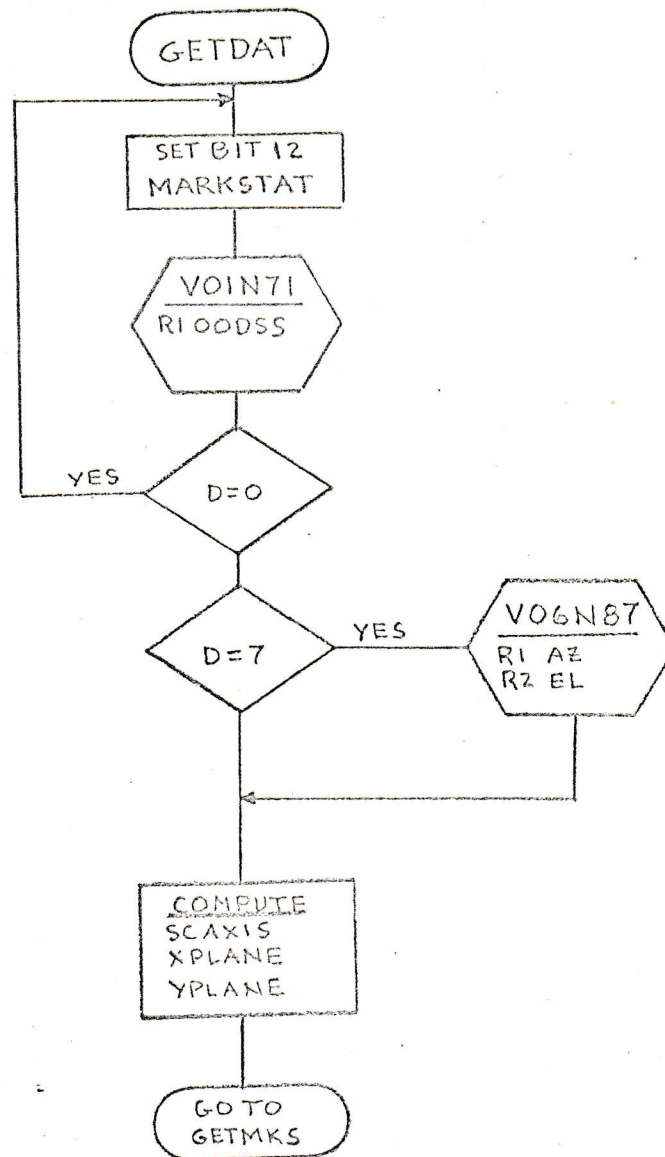


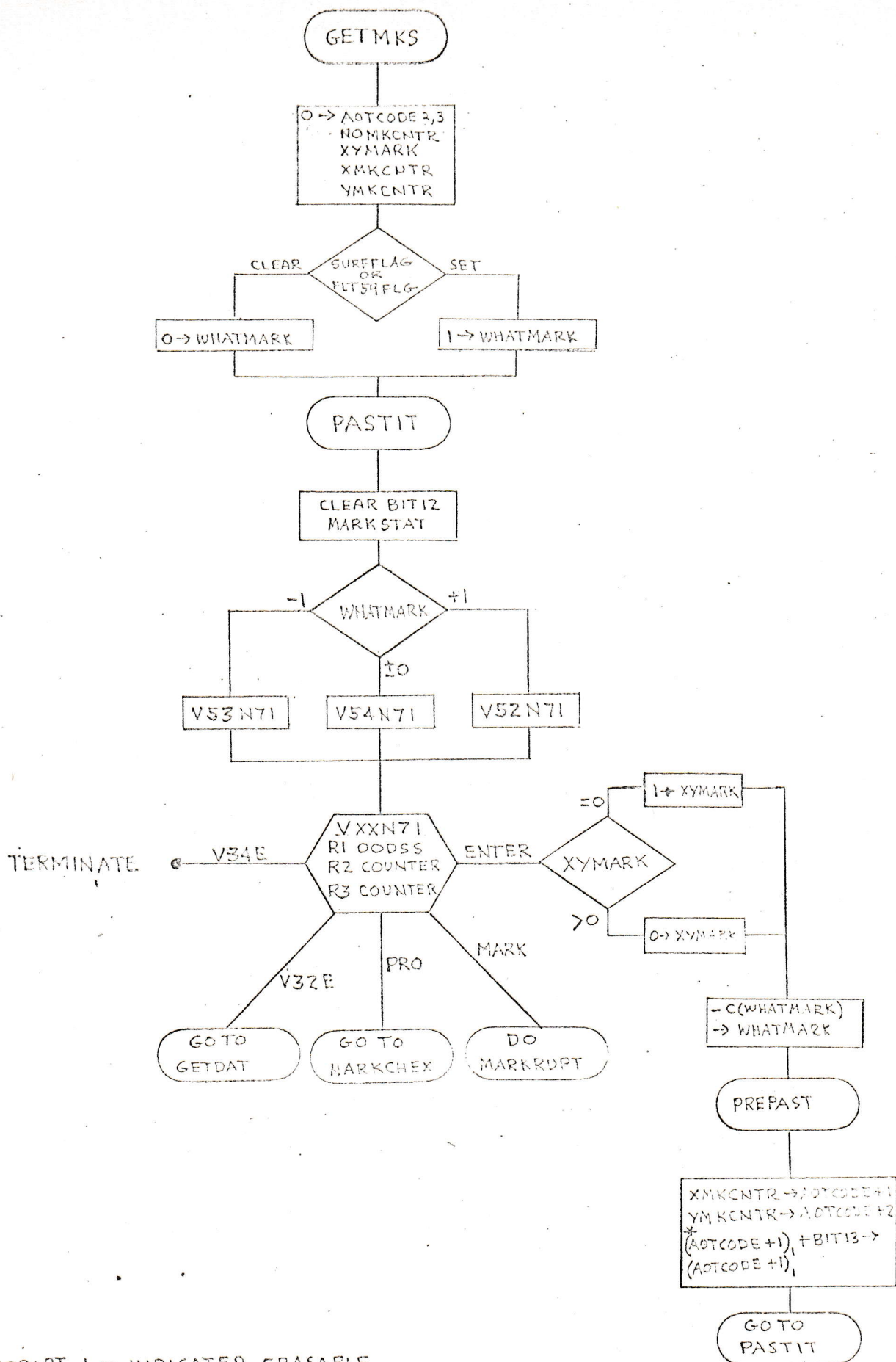


*¹
NOMKCNTN = NUMBER OF MARK DATA
SETS REJECTED BY
ITERATION LOOP

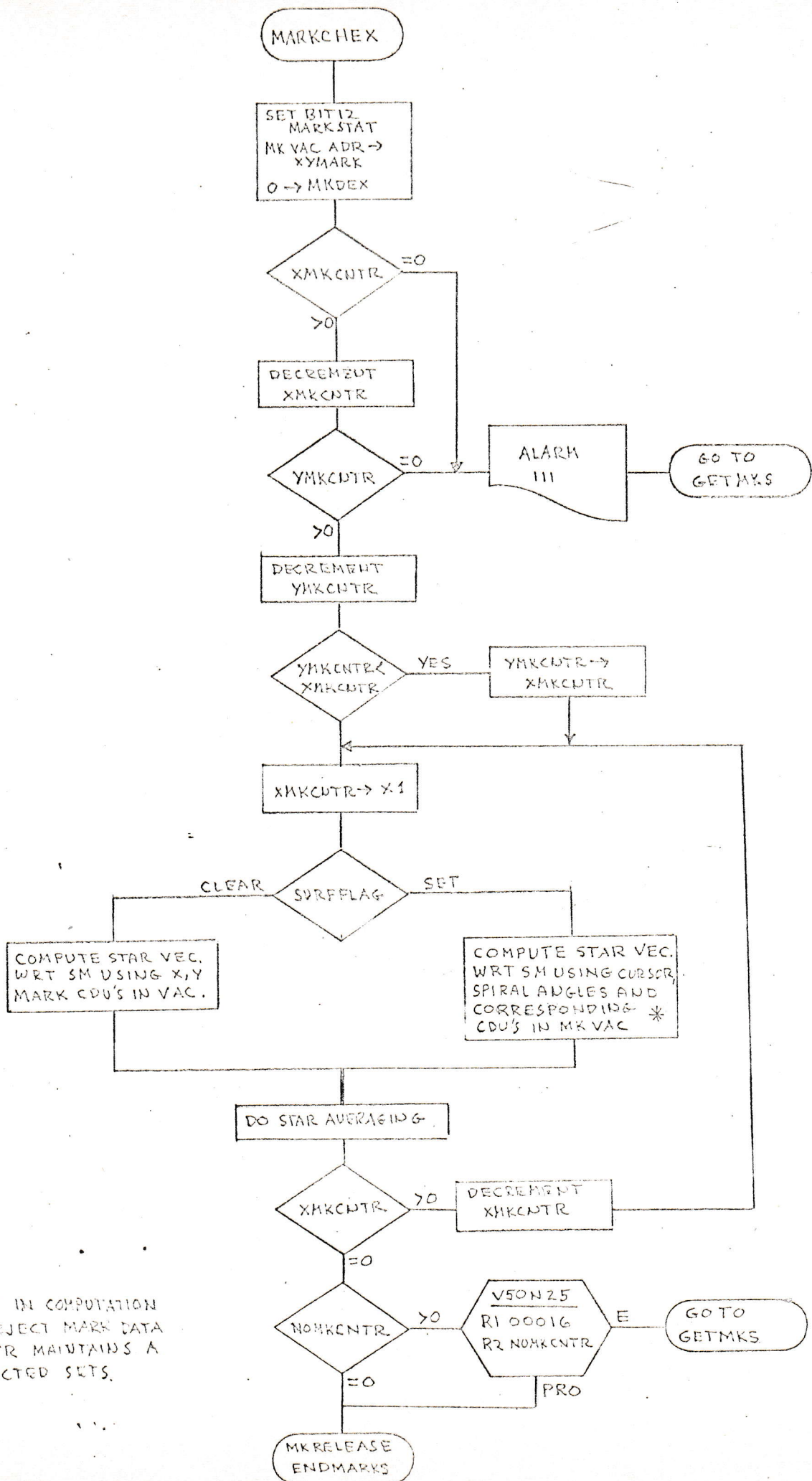
*²
X = NUMBER OF MARK DATA
SET REJECTED



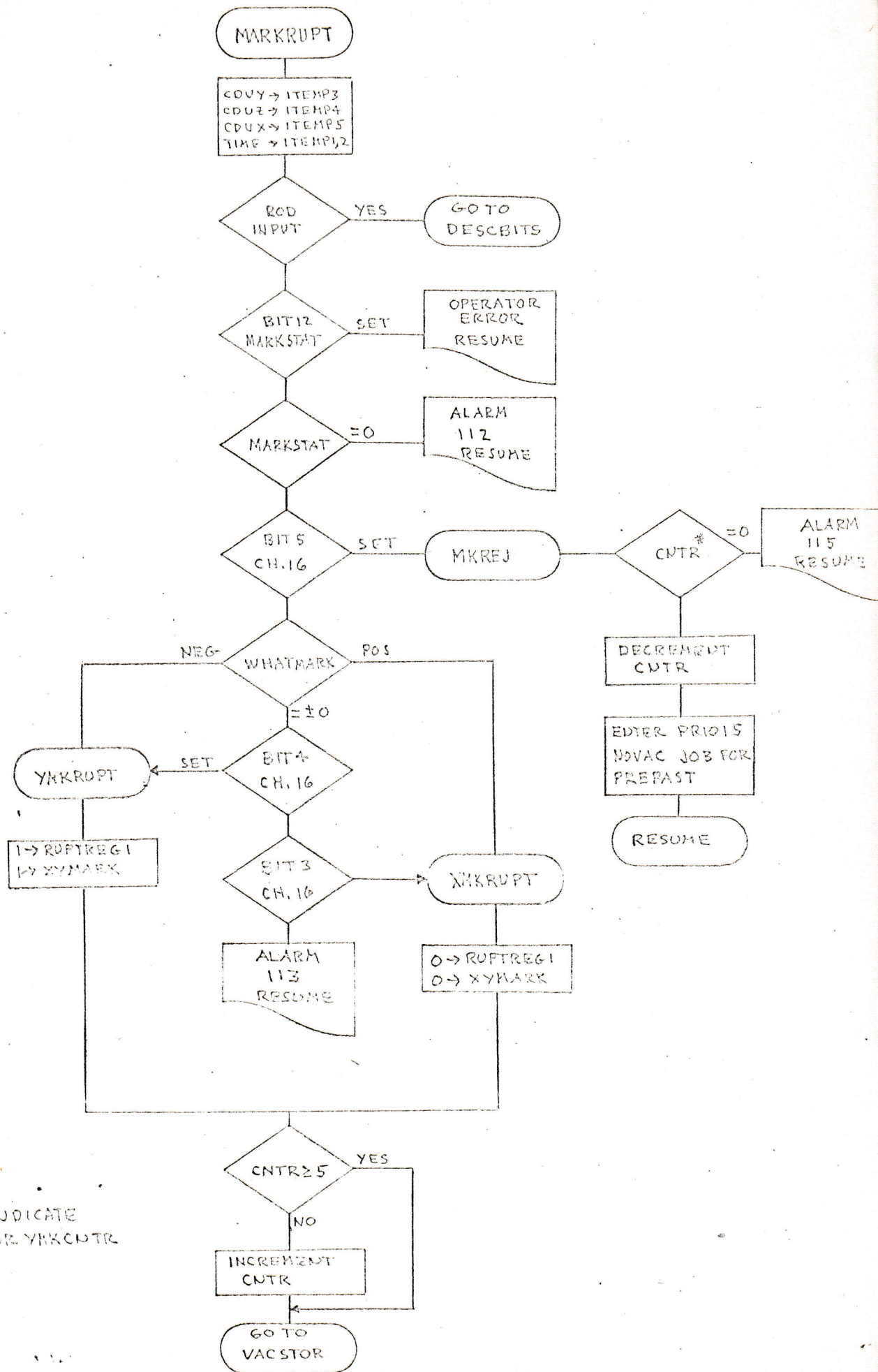




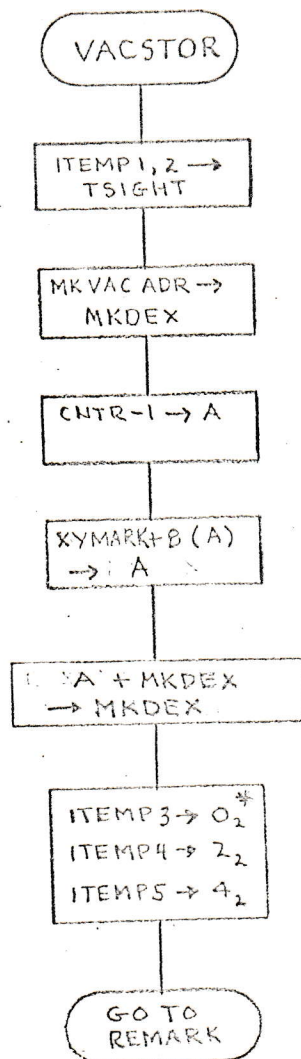
*
SUBSCRIPT 1 - INDICATED ERASABLE
INDEXED BY XYMARK



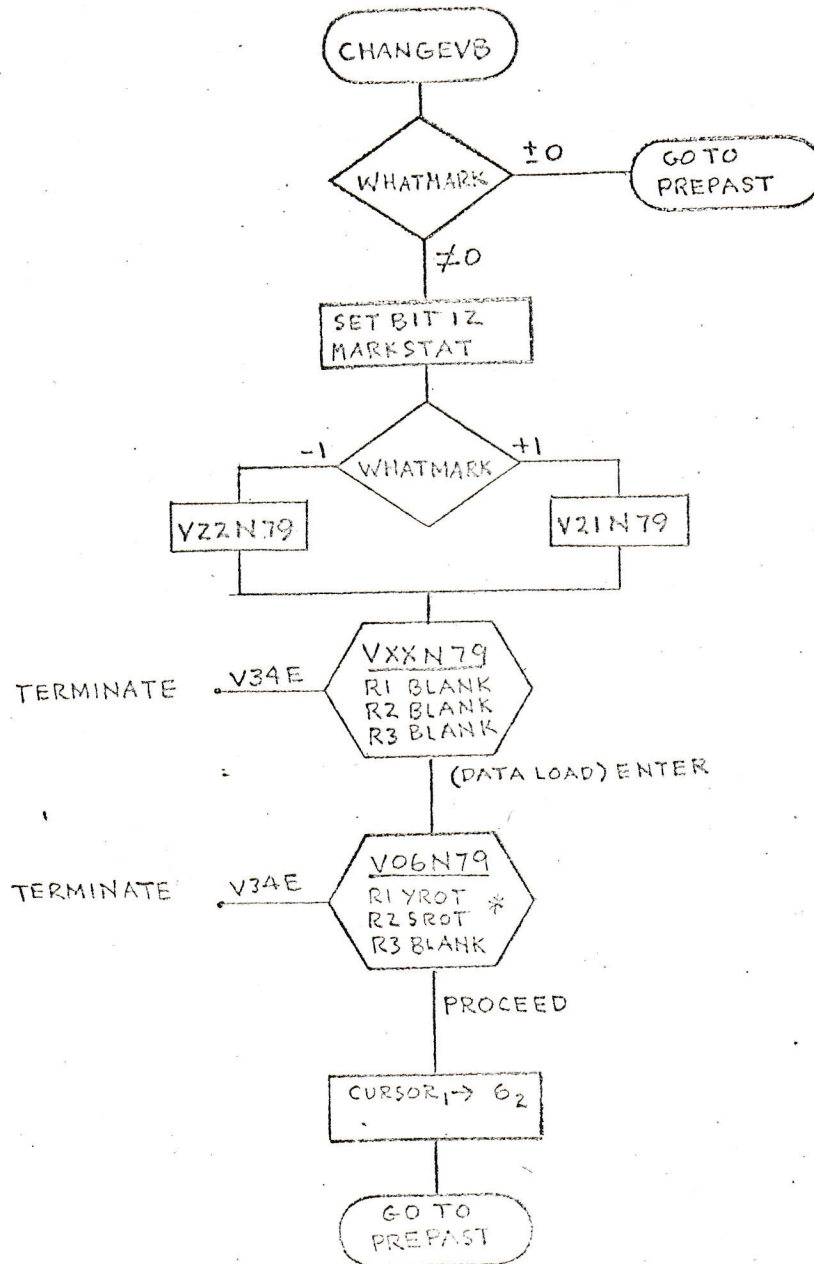
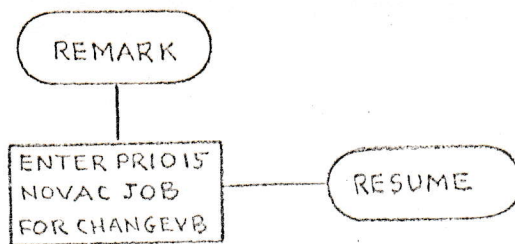
*
ITERATION LOOP IN COMPUTATION
SCHEME CAN REJECT MARK DATA
SETS. NOMKCNTR MAINTAINS A
COUNT OF REJECTED SETS.



*
CNTR IS USED TO INDICATE
EITHER XMKCNTR OR YMKCNTR



*
SUBSCRIPT 2 - INDICATED STORAGE
LOCATION INDEXED
BY MKDEX



*

IF XYMARK = 0, BLANK R2, R3

IF XYMARK = 1, BLANK R1, R3

DISAPPROVED

Page 1 of 1

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1055	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR R. GILBERT		DATE 6-12-70	1.2 ORGANIZATION MIT	APPROVAL <i>R. H. Larson</i>	DATE 7-6-70
1.3 EFFECTIVITY LUMINARY IE			1.4 TITLE OF CHANGE NOUN for LPD BIAS		
1.5 REASON(S) FOR CHANGE CHECKLIST must be updated each flight, if address of AZBIAS and/ or ELBIAS changes, for NO3 load.					
1.6 DESCRIPTION OF CHANGE UTILIZE NOUN 57 to load AZBIAS and ELBIAS if required in flight. Requires no additional fixed or erasable memory locations. Suggested change has been checked out on LMS.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATION <i>R. H. Larson</i>					
DATE 7-6-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 8/13/70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/DL PROGRAM CHANGE ROUTING SLIP

MIT-PCN

PCR/PCN # 1059

ANOMALY # _____

ADR # _____

☐ COLOSSUS 2E
☐ COLOSSUS 3
☐ COLOSSUS 3A
☐ COLOSSUS _____

☐ LUMINARY 1D
☒ LUMINARY 1E
☐ LUMINARY 1F
☐ LUMINARY _____

☒ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☐ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: _____

Date: 10-7-70

OLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1059

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR P. S. Weissman	DATE 8/26/70	1.2 ORGANIZATION MIT/DL	APPROVAL	DATE
----------------------------------	-----------------	----------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1E	1.4 TITLE OF CHANGE Have major modes changes set up a 1/ACCS job.
--------------------------------	--

- 1.5 REASON(S) FOR CHANGE
1.) There are a number of windows during which a change in major modes would wipe out a waiting 1/ACCS job, leaving the DAP with improper data. See Anomaly L-1D-10.
2.) Make room in Bank 5 for Item 1.

- 1.6 DESCRIPTION OF CHANGE
1.) Have all major mode changes set up a job to do 1/ACCS. (Cont. 'd on Pg 2)
2.) Delete the setting of bits in RCSFLAGS (internal DAP flagword) from the fresh start coding. This setting of bit 3, DACFLAG 2, to cause the initialization of the

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT -9 FIXED	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. Larson</i>	
DATE 9-11-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 11/5/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

PAGE ____ OF ____

PROGRAM CHANGE
REQUEST NO. 1059PREPARED BY: P.S. Weissman
DATE: 8/26/70

ORGANIZATION: MIT/DL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

- 1.6 FDAI needle display will be done in the DAP when IMODES 33/bit 6 is found set. The clearing of other bits in RCSFLAG is incidental and unnecessary.

REMARKS

The following steps are carried out in the fresh start and restart routines in order to accomplish the functions that have been described:

1. The channel bits that command on the RCS jets and trim-gimbal drives are cleared. (This is done by the hardware in a restart.)
2. In a fresh start, various parameters and flags related to the mission phase are initialized and values for the highest ascent mass (HIASCENT) and the state-estimator filter gains are assumed for use until an erasable load is performed.
A JOB TO DO 1/ACCS IS SETUP
3. ~~The ACCSET flag is cleared to force 1/ACCS call on the first pass through DAPIDLER, so that all the outputs of 1/ACCS will be recomputed before the LM DAP becomes active.~~
4. A TIME5 interrupt is set up to do DAPIDLER (see description below).

A restart may be triggered by either the hardware or the program. The former turns on the DSKY "restart" light; the latter turns on the "program alarm" light.* Otherwise, the two sequences are almost identical. A change in major mode, Verb 37, is similar to a restart in that it drastically alters the configuration of the mission-oriented programs. However, it leaves the LM DAP almost untouched - merely ensuring that it is set up for non-powered flight using the deadband last selected by the crew, ~~and so on~~. X-axis over-ride is enabled, ~~THE COMMANDED RATES ARE ZERO, AND THERE IS NO ULLAGE REQUEST.~~
A CHANGE IN MAJOR MODE ALSO SETS UP A JOB TO DO 1/ACCS.

3.6.1.2 DAP Idling and Start-Up (see Fig. 3.6-1)

When the LM DAP is switched off or when it cannot function because its inputs are not available, a program named DAPIDLER is called to monitor the conditions which turn the LM DAP off. Until these conditions disappear, DAPIDLER keeps the output commands to the RCS and the trim gimbal systems nulled and employs TIME5 to recycle itself every 0.1 sec. When all of the inhibitions are removed, DAPIDLER initiates the STARTDAP sequence.

The conditions that can cause the LM DAP to idle are the following:

1. The IMU CDU's are not usable.
2. The PGNCs attitude mode control switch has been turned to OFF by the crew.
3. The use of the abort guidance system (AGS) has been selected by the crew.
4. The 1/ACCS routine has not been executed since the last fresh start or restart. (A job to do 1/ACCS is set up in the ~~fresh start or restart routine~~ ^{FRESH START/RESTART ROUTINE})
~~DAPIDLER pass after a fresh start or a restart.~~

At the beginning of every normal LM DAP pass, the first three conditions listed above are checked for and DAPIDLER is entered if any of them exists.

*Not all program alarms, however, cause restarts.

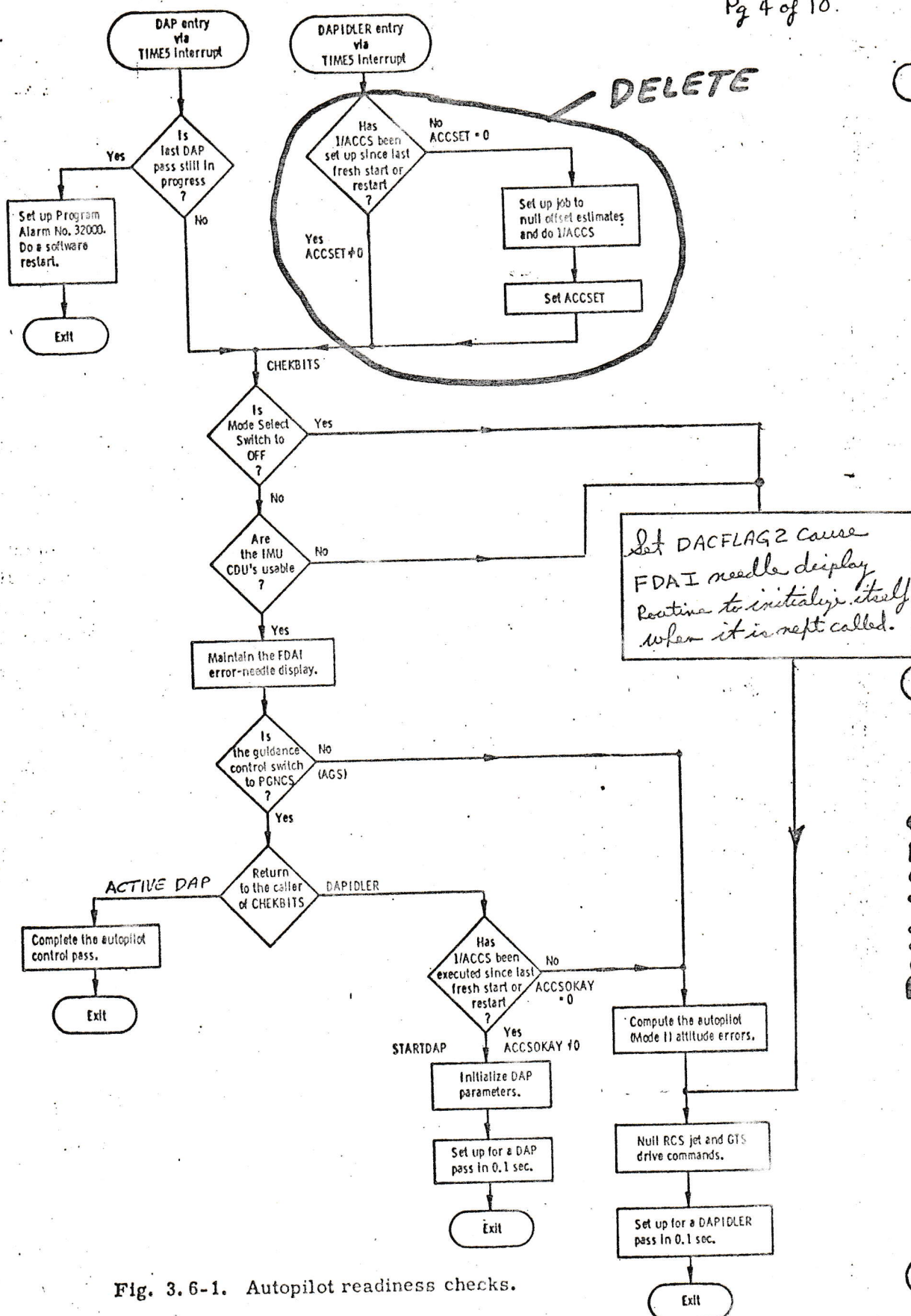


Fig. 3.6-1. Autopilot readiness checks.

3.6-4

☒ Revised

☐ Added

GSOP # R-567

PCR # 801.2

Rev. 5

Date June 1970

PCN 1070

The 1/ACCS Routine

Another part of the SERVICER program is the 1/ACCS routine, the primary function of which is to compute the control effectiveness of the LM DAP as a function of the vehicle mass, the unfailed jets, the configuration, and other such factors. In addition to being executed as part of the SERVICER program every 2 seconds during powered-flight mission phases, 1/ACCS is called several times during a mission when certain discrete events occur, such as restarts, fresh starts, ~~detection of disabled jets~~, data load by crew (Routine 03), resetting of the attitude deadband, and the turning-off of the main engine. Also, prior to lunar lift-off, the ignition logic of the powered-ascent program (P12) loads the bias angular accelerations of the state estimator from the prior estimates given in pad-loaded erasables IGNAOSQ and IGNAOSR. This is followed by an execution of 1/ACCS that establishes the proper ascent control effectiveness.

The first thing done in 1/ACCS is a determination of the vehicle configuration on the basis of APSFLAG and CSMDOCKD. The LM mass limits and the mass-to-inertia coefficients to be used in 1/ACCS itself are selected on this basis.

Next, the mass of the LM alone is separated out as follows:

- a) For the LM-alone case, LM mass = total mass.
- b) For the CSM-docked case, LM mass = total mass - CSM mass.

The LM mass, which is displayed and loaded in Routine 03, is therefore kept updated during burns as though it were maintained directly in the SERVICER program.

There is a check on the LM mass in the 1/ACCS routine that serves to keep this critical parameter within a reasonable range despite any possible error in the initialization, in the Routine 03 load, or in SERVICER maintenance. It also results in an automatic correction of the mass when staging occurs, since the old, descent value is too high for the ascent stage alone.

The following limits on the LM mass have been implemented:

Highest descent mass = 36,740 lb

Lowest descent mass = 3858 lb + HIASCENT

Highest ascent mass = HIASCENT

Lowest ascent mass = 4850 lb

HIASCENT was made a pad-loaded erasable quantity so that it can reflect the ascent fuel loading used in each particular flight. Its value for a fully loaded ascent stage is about 11,133 lb, and it is so initialized in a fresh start (to be over-written by the erasable load shortly thereafter). HIASCENT should not be less than 7265 lb, in order that the minimum descent mass will not be too low. When the LM mass is found to violate a limit, its value is changed to equal the limit (maximum or minimum); the total mass is changed correspondingly.

☒ Revised

☐ Added

GSOP # R-567

PCR # 294

Rev. 5

Date June 1970

Tag	Bit/ Location	Meaning	
		Set	Cleared
ACC4OR2X	11/DAPBOOLS	X-axis translation to use 4 jets.	X-axis translation to use 2 jets.
ACCSFT	13/RCSFLAGS	A job to do 1/ACCS has been set up since the last fresh start or restart.	Set up a job in DAPIDLER to do 1/ACCS.
ACCSOKAY	3/DAPBOOLS	Control-authority values from 1/ACCS usable.	Restart or fresh start since last 1/ACCS; outputs suspect.
ACCSWU ACCSWV	— —	+1 or -1 indicates 1-jet net acceleration less than $\pi/27$ rad/sec ² in rotational sense corresponding to sense of flag.	0 indicates 1-jet control authority in both directions exceeds the minimum.
ALLOWGTS	—	Thrust offset small enough to use GTS attitude control law.	Thrust offset too large to use GTS attitude control law.
AORBSYST*	5/FLAGWRD5	Prefer P-axis jet couples 7, 15 and 8, 16.	Prefer P-axis couples 4, 12 and 3, 11.
AORBTRAN	10/DAPBOOLS	Prefer B-system jets for X translation.	Prefer A-system jets for X translation.
APSFLAG	13/FLAGWRD10	LM staged or on lunar surface.	LM unstaged and not on lunar surface.
AUTRATE1 AUTRATE2	1/DAPBOOLS 2/DAPBOOLS	KALCMANU maneuver rates chosen by crew: 00 indicates 0.2 deg/sec 01 indicates 0.5 deg/sec 10 indicates 2.0 deg/sec 11 indicates 10.0 deg/sec	
CALLGMBL	5/RCSFLAGS	Requests setting of gimbal-drive bits in Channel 12 (i.e., perform ACDT + C12).	Do not set gimbal-drive bits in channel 12 (i.e., do not perform ACDT + C12).
CH5MASK CH6MASK	— —	{ Jets which have been disabled by crew; in channel 5(6) format.	

*Not related to fuel systems; bit is automatically alternated between set and cleared.
Table 3.6-1. Selected flag definitions.

Tag	Bit/Location	Meaning	
		Set	Cleared
RCSFLAGS		Autopilot flag word containing the following bits: Bit 1 - YZTACK Bit 2 - DACFLAG1 Bit 3 - DACFLAG2 Bit 4 - DSPLYALT Bit 5 - CALLGMBL Bit 6, 7, 8 - (unused) Bit 9 - JUSTIN Bit 10 - PBIT Bit 11 - QRBIT Bit 12 - SKIPP Bit 13 - ACCSET Bit 14, 15 - (unused)	
RHCSCALE	7/DAPBOOLS	Normal (20 deg/sec) rotational-hand-controller scaling selected by crew.	Fine (4 deg/sec) rotational-hand-controller scaling selected by crew.
SENSETYP		X-translational sense desirable during U and V rotations: 0 indicates balanced couples 1 indicates -X translational sense 2 indicates +X translational sense TJETLAW requires SENSETYP = 0 for P axis	
SKIPP	12/RCSFLAGS	Perform control of P axis in next pass.	Skip control of P axis in next pass.
SKIPU SKIPV		4 indicates control about the corresponding axis is to be exercised in the current DAP pass.	0 indicates control about the corresponding axis is not to be re-evaluated in the current DAP pass because a short (<150 millise), non-zero firing was started in the last pass.
SNUFFBIT	13/FLAGWRD5	Inhibit RCS control about the U, V axes during unstaged powered flight.	Exercise normal RCS control.

Table 3.6-1. Selected flag definitions (continued).

INITIALIZE DOWNLIST
PCINTER TO RETRANS-
MIT CURRENT DOWNLIST
AT NEXT 20 MS
DOWNRUPT.

UPDATE STATUS OF LR
POSITION FLAG.
SET RR ALTC MODE AND
CDU NOT FAILED FLAGS

SET TIME 3 = 37777,
TIME 4 = 37775,
TIME 5 = 37774

RESET 1/4 COUOB
CONTROL EIT IN
PC SF LAGS.

DISABLE TIME 6 CLCK

RESTORE STATUS OF
CHANNEL 13 BITS

820

830

840

850

860

PCN 1059
Pg 8 of 10

RE SET EXTENDED VERB
ACTIVITY INTERLOCK

#210

INITIALIZE IML FLAGS

#220

RESET DISPLAY/ASTRO-
NAUT INTERFACE FLAGS

INITIALIZE RACAR
READ

#230

INITIALIZE IMODES33
FLAG; SET NC PIPA
FAIL BIT; SET DOWN-
LINK AND UPLINK CK
BITS; RESET ALL
OTHER BITS

#240

CLEAR SELF CHECK
ERROR REGISTERS

#250

SET ENGINE OFF (BIT
14 IN CHANNEL 11)

*Set up a job to
calculate RCS control
authorities and other
DAP parameters.*

PCN 1059
Pg 9 of 10

1049

1453
Y36/LUMINARY

INITIALIZE ATTITUDE
ERROR DISPLAY FLAG

#260

INITIALIZE DAP

#270

INITIALIZE DOWNLINK
WITH POO DOWNLIST

#280

PERMIT AGS INITIAL-
IZATION

#290

♦♦
♦03
♦EDIT
♦♦

ZERO UPDATE STATE
VECTOR INDICATOR

#300

ZERO OUTBIT CHANNELS
5, 6, 12, 13, AND 14

IS ISS IN COARSE
ALIGN MODE AND IN
GIMBAL LOCK?

-N

-Y

Y36/LUMINARY

PCN 1059
Pg 10 of 10

PCR/PCN # 1066

ANOMALY # _____

ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN☐ MIT Approved ADR☒ NASA Approved PCR☐ NASA Approved PCN☐ NASA Approved Software Anomaly☐ MIT Approved Software AnomalyA. Coding☒ Begin coding immediatelyACTION: Pat WhiteProgram Supervisor's Approval: Margaret Hamilton☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☐ Prepare GSOP revisions for MDRB considerationACTION: J. B. Smith
J. K. Lawren☐ Technical Committee Meeting not required.☐ Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected☐ Review for corresponding changes in _____

ACTION: _____

Special InstructionsProject Manager Summit H. LarsonDate 10-5-70

Leave N59 ON
CALL

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER Completed by FSB 1066
1.0 COMPLETED BY ORIGINATOR				
1.1 ORIGINATOR S. Copps	DATE 8/3/70	1.2 ORGANIZATION MIT/DL	APPROVAL	DATE
1.3 EFFECTIVITY LUMINARY IE		1.4 TITLE OF CHANGE Display N81 On All Passes In P34, P35, P74, P75.		
1.5 REASON FOR CHANGE To allow data comparison with CSM(Colossus 3). With the introduction of MINKEY sequencing in Colossus 3 N59 is no longer displayed and instead N81 is displayed on all passes through P34, P35, P74, and P75.				
1.6 DESCRIPTION OF CHANGE 1. Display N81 during all passes through P34, P35, P74, P75. 2. Eliminate display of N59 during P34, P35, P74, P75.				
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT				
<input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED		2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF				
DATE				
3.0 MIT VISIBILITY IMPACT EVALUATION:				
3.1 SOFTWARE IMPACT		3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 SOFTWARE IMPACT -6 words		3.4 REMARKS:		
3.5 MIT COORDINATION R.H. Larson				
DATE 8-25-70				
4.0 SOFTWARE CONTROL BOARD ACTION				
<input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED		4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF				
DATE 9/30/70				
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION				
5.1 MIT COORDINATOR		5.2 MIT EVALUATION		
DATE				
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION				
<input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION		6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF				
DATE				

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1070

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR P. Weissman	1.2 DATE 7 July 1970	1.3 ORGANIZATION MIT/DL	1.4 APPROVAL <i>GSOP</i>	1.5 DATE
-------------------------------	-------------------------	----------------------------	-----------------------------	----------

1.6 TITLE OF CHANGE
Luminary IE1.7 TITLE OF CHANGE
GSOP Change for FDAI
Needle Initialization Fix (L-1D-01)

1.8 DESCRIPTION OF CHANGE The fix to Anomaly L-1D-01 consists of executing the same coding with respect to the FDAI needle display and the calculation of attitude errors when the DAP is off as when it is disabled by bit-6 of IMODES33.

1.9 DESCRIPTION OF CHANGE Update GSOP page 3.6-4 (see attached page).

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
2.4 DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 0 WORDS	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R.H. Larson</i>	
3.6 DATE 8-24-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DISAPPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
4.4 DATE 9/30/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
5.3 DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
6.4 DATE	

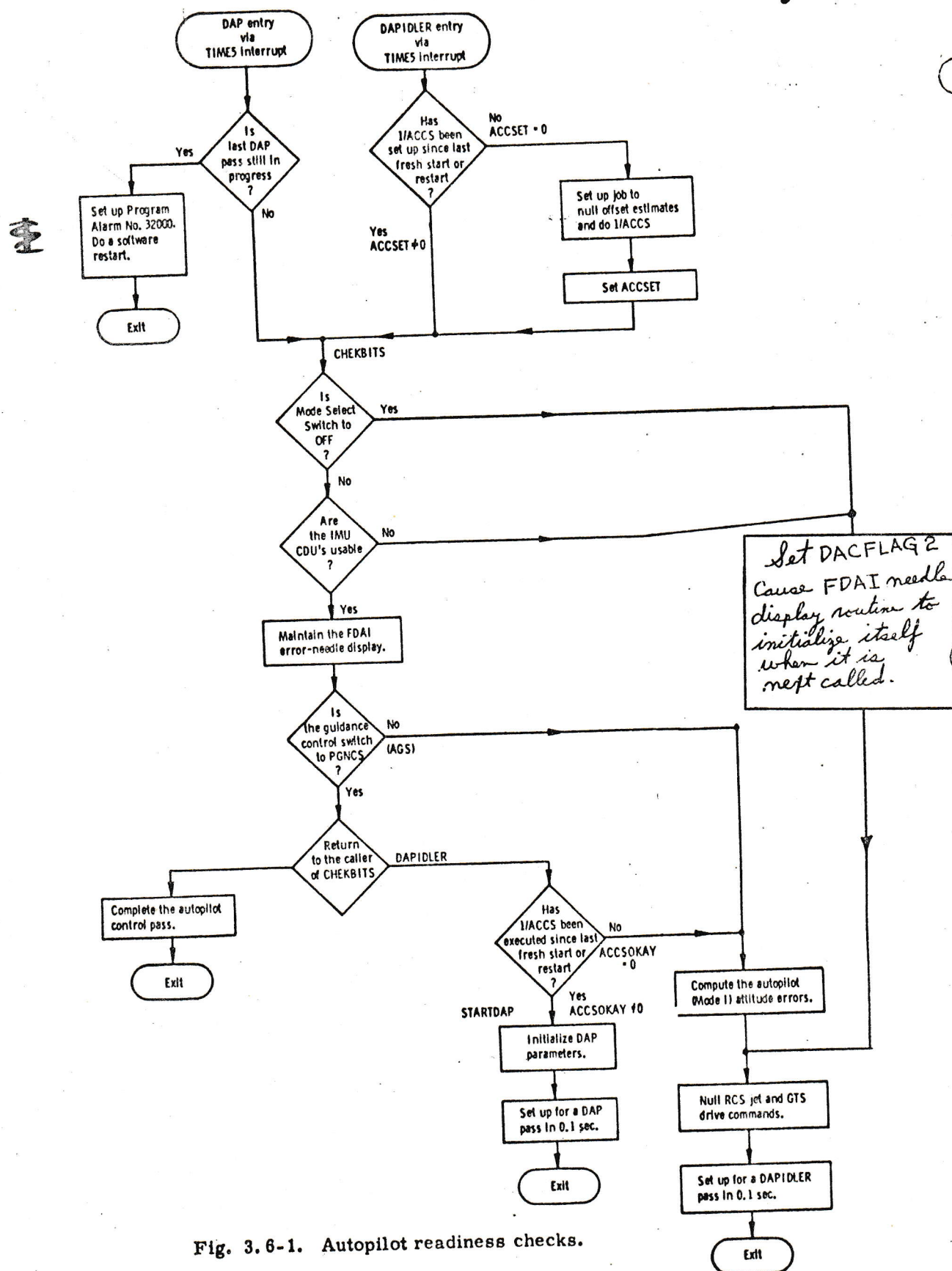


Fig. 3.6-1. Autopilot readiness checks.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1079

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☐ MIT Approved PCN

☐ MIT Approved ADR

☒ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

10-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) <div style="border: 1px solid black; padding: 2px; display: inline-block;">1079</div>	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR <div style="border: 1px solid black; padding: 2px;">McCoy</div>		1.2 DATE <div style="border: 1px solid black; padding: 2px;">9/2/70</div>		1.3 ORGANIZATION <div style="border: 1px solid black; padding: 2px;">MIT/CSDL</div>	
1.4 EFFECTIVITY <div style="border: 1px solid black; padding: 2px; text-align: center;">LUMINARY 1E</div>			1.5 TITLE OF CHANGE <div style="border: 1px solid black; padding: 2px;">ALMCADR on the telemetry</div>		
1.6 DESCRIPTION OF CHANGE ALMCADR ("Alarm Complete Address") is loaded with the address (41) of the instruction calling the alarm routine. It is extremely useful (sometimes mandatory) in finding the source of an alarm or software restart. It is equivalent to the already telemetered RSBBO which is valid for hardware restarts. (Continued Pg 2)					
1.7 DESCRIPTION OF CHANGE Put ALMCADR in word 2 of Descent & Ascent List, word 99 in Orbital Maneuvers List, word 67 in Rendezvous & Prethrust List, word 68 in AGS Initialization & Update List; not in Coast & Align List or Surface Downlists.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF			2.4 DATE		
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 MIT EVALUATION			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR <div style="border: 1px solid black; padding: 2px; font-family: cursive;">R. H. Larson</div>			3.6 DATE <div style="border: 1px solid black; padding: 2px; font-family: cursive;">9-11-70</div>		
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF			4.4 DATE <div style="border: 1px solid black; padding: 2px; font-family: cursive;">9/30/70</div>		
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
5.3 DATE			5.4 REMARKS:		
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF			6.4 DATE		

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE ____ OF ____

PROGRAM CHANGE
REQUEST NO. 1079PREPARED BY: McCoyDATE: 9/2/70ORGANIZATION:
MIT/CSDLCONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.5 Continued

ALMCADR is only requested where it replaces a current "Spare".

REMARKS

DISAPPROVED

Page 1 of 7

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1080	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR R. Larson		DATE 9/8/70	1.2 ORGANIZATION MIT/CSDL		APPROVAL DATE
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Change time to perform IMUCDU zero.		
1.5 REASON(S) FOR CHANGE To make Luminary compatible with the Colossus program which was changed to provide better CDU Glitch Check during Saturn. In Luminary it also provides about 2 second additional DAP on-time.					
1.6 DESCRIPTION OF CHANGE See Data Amplification Sheet					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>R. Larson</i>					
DATE 9-28-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS-APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 9/30/70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 7

PROGRAM CHANGE
REQUEST NO. 1080

PREPARED BY: R. Larson
DATE: 9/8/70

ORGANIZATION:
MIT/CSDL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.6 Continued

Change the time delay in performing an IMU CDU zero from "10.24 seconds to 7.9 seconds." This is described in Section 4 of the GSOP in the V40N20 description and should be changed to read approximately 8 seconds. It is also described in Section 2 of the GSOP under IMODES33 Bit 5, IMODES30 Bits 6, 4 & 3 and Channel 12 Bit 15. That description should be changed to read "about 8.22 seconds."

REMARKS

TI #21812

#180

1190

#200

210

220

V40N 20/LUM

PCR 1080
Pg 3 of 7

PRESS ALARM
RESET TO RESET
PROGRAM ALARM

EX IT
V40

IS ISS TURN-IN CR
CAGING IN PROGRESS?

N. Y.
EX IT
V40

ZERO LGC ICCU
CCOUNTERS

RESET ICDU ZERO
DISCRETE

WAIT 10 SEC

WAIT APPROXIMATELY
8 SEC.

IS ISS TURN-ON OR
CAGING IN PROGRESS?

N Y.
EX IT

IMODES 30ContentsWord Number81a
(Cont'd)BitMeaning

- 12 Value of bit 12 of channel 30. A 0 indicates an IMU CDU fail indication has been produced. If this bit becomes 0 while bit 3 of this word is also 0, bit 1 of channel 11 (ISS warning) is set 1.
- 11 Value of bit 11 of channel 30. A 0 indicates an IMU cage command has been generated by the crew.
- 10 Value of bit 13 of channel 33. A 0 indicates a PIPA fail indication has been produced. This bit has the same value as bit 13 of IMODES33. Set 1 if an error reset key code is received (DSKY or uplink). If this bit becomes 0 while bit 1 of this word is also 0, bit 1 of channel 11 (ISS warning) is set 1.
- 9 Value of bit 9 of channel 30. A 0 indicates IMU turned on and operating with no malfunctions. If bit becomes 1 while IMUSE (bit 8 of flagword 0) is 1, alarm 0214_g will be generated.
- 8 Used to control sequencing of IMU turn-on. Set 1 if bit 7 of this word is 1 and reset zero 0.48 second later, before the IMU turn-on sequencing is started. Used to achieve a 0.48-second wait before acting on IMU turn-on information.
- 7 Used to control sequencing of IMU turn-on, set 1 based on values of bits 14, 9 and 2 of this word. Reset zero 0.48 second later. Can be set 1 if ISS initialization requested since last fresh start, IMU turn-off, or turn-on delay complete.
- 6 A 1 indicates that IMU initialization is being carried out. Set 1 during turn-on sequence, if a cage command is received, or if IMU zeroing is done in T4RUPT. Set 0 about 8.22 (10.56) seconds after cage command removed, (10.56) seconds after start of zeroing in T4RUPT, or about 100 seconds after start of turn-on sequence. If bit is 1, verb 37 input will not be processed (alarm 1520_g will be generated). If bit is 1, an error exit will be forced from the internal IMU routines.

IMODE30Word NumberContents81a
(Cont'd)BitMeaning

- 5 Set to 1 to inhibit the generation of alarm 0212_g if a PIPA fail signal occurs. Not used unless bit 1 of this word is 1. Set 1 during IMU turn-on sequence and reset 0 about 4 seconds after bit 6 is reset 0. (If bit 10 of this word is 0, an alarm will be generated when Average-G is stopped regardless of the value of bit 5.)
- 4 Set to 1 to inhibit generation of an ISS warning based on receipt of an IMU fail signal. Reset 0 when bit 6 is set 0. Set 1 when IMU coarse align started and set 0 about 5.12 seconds after mode change to fine align. Set 1 for 10.56 8.22 seconds when IMU CDU zero commanded.
- 3 Set to 1 to inhibit generation of an ISS warning based on receipt of an IMU fail signal. Set 1 when bit 6 of this word is set 1 and set 0 when bit 6 is set 0. Also set 1 for 8.22 10.56 seconds when IMU CDU zero is commanded separate from T4RUPT package (by V40N20 or prelaunch or IMU tests).
- 2 Set to 1 to indicate failure of the IMU turn-on delay sequence (alarm 0207_g will also be generated).
- 1 Set to 1 to inhibit generation of an ISS warning based on receipt of a PIPA fail signal. Bit set 1 when bit 6 of this word is set 1. Bit set 0 when Average-G started and set 1 when Average-G ends.

81b

IMODES33. A flagword which monitors various channel 32, channel 33 and IMU conditions. Also monitors Verb 35 "lamp test". Set to 16040_g by a fresh start. Set to 16000_g + the contents of bit 6 by a restart. An error reset key code sets bits 13, 12, and 11 to 1 and does not affect other bits. Updated every 0.48 second by T4RUPT program except for bit 14 which is updated every 0.12 second.

BitMeaning

- 15 Not used.
- 14 Value of bit 14 of channel 32. A 0 indicates Proceed Key depressed. A change from a 1 to a 0 will cause a job to be established that has the same program logic effect as Verb 33. It should be noted that in the case of a response to a V21, V22 and V23, the logic for a Proceed is not the same as for a V33E.

IMODES 33Word Number81b
(Cont'd)ContentsBitMeaning

- 5 Set to 1 in IMU zeroing routine external to T4RUPT (by V40N20 or prelaunch or IMU tests). Remains set to 1 for an interval of about 10.56 ^{8.22} seconds while zeroing taking place. Bit 6 of this word is set to 1 at the same time as bit 5.
- 4-2 Not used.
- 1 Set to 1 when Verb 35 "lamp test" received. Reset to 0 about 5 seconds later. A 1 inhibits resetting of lights to 0 in T4RUPT during lamp test.
- 82 TIG. Targeted time of ignition. Calculated during pre-burn programs (P30s, P70s). Updated in P12, P40, P41, P42 or P63 by MIDTOAVE routine if integration cannot be completed in time (1703 alarm). After ignition TIG is set to time of engine cutoff (PIPTIME + TGO). See also pg. 2-106 for use on Descent/Ascent List. Scaled centiseconds / 2^{28} .
- 83-88 Repeat of words 33-38 of this list.
- 89 Y, Z MOMENT OFFSETS. Calculated angular acceleration about Y and Z body axes due to the fact that the main engine is not exactly aligned with the center of gravity. During powered flight these are calculated every 0.1 second at the beginning of the DAP cycle; otherwise these are zeroed in every DAP cycle. Also zeroed at discrete times, such as fresh start and engine off. Scaled (degrees/second²)/90. Expected range is ± 35 degrees/second².

Word Number 91b (Cont'd)	Contents
Bit	Meaning
15	ISS turn-on delay complete. Set 1 at end of 90 second ISS turn-on delay and reset 0 about <u>10.24</u> ^{7.9} seconds later.
14	Rendezvous radar enable. A 1 in this bit enables rendezvous radar range and angle trackers to acquire target (lock on). Set 1 when rendezvous radar antenna is within 0.5° of target.
13	Landing radar position command. If this bit is set 1 and the antenna position switch is in LGC position, the LR antenna will move to position 2 (Hover). Removing the discrete will not return the antenna to position 1.
12*	Minus roll gimbal trim. A 1 in this bit will cause the descent engine to rotate positively about the +Z axis causing the vehicle to rotate negatively about the +Z axis if the engine is thrusting.
11*	Plus roll gimbal trim. A 1 in this bit will cause the descent engine to rotate negatively about the +Z axis causing the vehicle to rotate positively about the +Z axis if the engine is thrusting.
10*	Minus pitch gimbal trim. A 1 in this bit will cause the descent engine to rotate positively about the +Y axis causing the vehicle to rotate negatively about the +Y axis if the engine is thrusting.
9*	Plus pitch gimbal trim. A 1 in this bit will cause the descent engine to rotate negatively about the +Y axis causing the vehicle to rotate positively about the +Y axis if the engine is thrusting.
8	Display inertial data. A 1 in this bit commands the rendezvous radar CDU DACs to switch to the forward and lateral velocity meters during landing.
7	Not used.

*These bits will issue commands of opposite polarity to the names. (Missile vs gimbal polarity problem).

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1082.2

ANOMALY # _____

ADR # _____

☐ COLOSSUS 2E
☐ COLOSSUS 3
☐ COLOSSUS 3A
☐ COLOSSUS _____

☐ LUMINARY 1D
☒ LUMINARY 1E
☐ LUMINARY 1F
☐ LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☐ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☒ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

10-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1082.2	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR J. M. Reber		DATE 9-14-70	1.2 ORGANIZATION MIT/DL		APPROVAL <i>J. M. Reber</i>
					DATE 15 Sept 1970
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Update Fixed Constants for 1971-1972 Ephemeris Year		
1.5 REASON(S) FOR CHANGE To update the Ephemeris Data for the future Mainline Apollo Launches. (Apollo 15 and Subsequent)					
1.6 DESCRIPTION OF CHANGE Update PIOS Ephemeris data, Star Table, and LOSSEM Ephemerides for use in BRCS 1972.0					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>[Signature]</i>					
DATE 9-23-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS: PCN to be submitted with constants PCR to be submitted to eliminate Tephem scaling restriction		
4.3 SOFTWARE CONTROL BOARD SIGN OFF <i>[Signature]</i>					
DATE 9/30/70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1082.2
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: Margaret H. Hamelin

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. A. Larson KSC

Date 10-9-70

* NOTE:

Pages 2-13 have been submitted to MSC as the detail implementation of

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1082.2	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR J.M. Reber	DATE 9-14-70	1.2 ORGANIZATION MIT/DL	APPROVAL <i>J.M. Reber</i>	DATE 15 Sept 1970	
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Update Fixed Constants for 1971-1972 Ephemeris Year		
1.5 REASON(S) FOR CHANGE To update the Ephemeris Data for the future Mainline Apollo Launches. (Apollo 15 and Subsequent)					
1.6 DESCRIPTION OF CHANGE Update PIOS Ephemeris data, Star Table, and LOSSEM Ephemerides for use in BRCS 1972.0					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SUMMARY IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>[Signature]</i> 9-23-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS: PCN to be submitted with conclusions per to be submitted to eliminate Tephem scaling error		
4.3 SOFTWARE CONTROL BOARD SIGN OFF <i>[Signature]</i> 9/30/70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input checked="" type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS: DATA ATTACHED		
6.3 SOFTWARE CONTROL BOARD SIGN OFF <i>[Signature]</i> 11/5/70					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 13

PROGRAM CHANGE REQUEST NO. <u>1082.2</u>	PREPARED BY: <u>J.M. Reber</u> DATE: <u>9-14-70</u>	ORGANIZATION: <u>MIT/DL</u>
---	--	--------------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

PIOS EPHEMERIS CONSTANTS FOR 1971-1972

GSOP UNITS

AZ_0	+4.85898502016 E+0	rad
B_0	+4.09157363336 E-1	rad
B	-7.19758599677 E-14	rad/U-sec.
Ω_{I0}	+5.52185714700 E+0	rad
$\dot{\Omega}_I$	-1.07047013100 E-8	rad/U-sec.
F_0	+4.11720655556 E+0	rad
\dot{F}	+2.67240425480 E-6	rad/U-sec.

Calculated using ΔT (1.0 July 1971) = 41.5 sec.

and AT (1972.0) = 42.0 sec.

Source: J.M. Reber; MIT/DL

REMARKS

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 3 OF 13

PROGRAM CHANGE REQUEST NO. <u>1082.2</u>	PREPARED BY: <u>J. M. Reber</u> DATE: <u>9-14-70</u>	ORGANIZATION: <u>MIT/DL</u>
---	---	--------------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

PIOS EPHEMERIS CONSTANTS FOR 1971-1972

AGC UNITS

AZO	+7.733314844 E-1	B 0	revs.
BSUBO	+6.511941688 E-2	B 0	rev.
BDOT	-1.145531390 E-16	B28	rev/cs.
NODIO	+8.788308600 E-1	B 0	rev.
NODDOT	-1.703706128 E-11	B28	rev/cs.
FSUBO	+6.552737750 E-1	B 0	rev.
FDOT	+4.253263471 E-9	B27	rev/cs.

Source: J. M. Reber : MIT/DL

REMARKS

TP#21812

Catalogue No.
(octal)

Star Name

Vis. Mag

X

Y

Z

1	α	Andromedae (Alpheratz)	2.1	+08747608555	+0264803244	+04338307948
2	β	Ceti (Diphda)	2.2	+09342466124	+01739271769	-03113400137
3	γ	Cassiopeiae (Navi)	2.2	+04773424940	+01168141178	+08709182540
4	α	Eridani (Achernar)	0.6	+04918322686	+02207092653	-03422520048
5	α	Ursae Minoris (Polaris)	2.1	+00128995818	+00078096205	+0998862983
6	θ	Eridani (Acamar)	3.4	+05448995598	+05317389073	-06483349473
7	α	Ceti (Menkar)	2.8	+07028937840	+07078988678	+00694227718
10	α	Persei (Mirfak)	1.9	+04101921571	+04989947555	+07633734305
11	α	Tauri (Aldebaran)	1.1	+03502769546	+08927907521	+02832502918
12	β	Orionis (Rigel)	0.3	+02007345455	+09691236271	-01431958012
13	α	Aurigae (Capella)	0.2	+01367280274	+06814364033	+07189922632
14	α	Carinae (Canopus)	-0.9	-00616090030	+06031289258	-01952609559
15	α	Canis Majoris (Sirius)	-1.6	-01824340636	+09404062129	-02869738069
16	α_2	Canis Minoris (Procyon)	0.5	-04122762536	+09063680102	+00923326629
17	γ	Velorum (Regor)	1.9	-03613649792	+05745656444	-07343634472
20	ι	Ursae Majoris (Dnoces)	3.1	-04661511162	+04772744503	+07449243154
21	α	Hydrae (Alphard)	2.2	-07745052221	+06149043689	-01484394758
22	α	Leonis (Regulus)	1.3	-08610673209	+04632386329	+02096974909
23	β	Leonis (Denebola)	2.2	-09657334290	+00521664164	+02542392790
24	γ	Corvi (Gienah)	2.8	-09524366380	-00597677121	-02988181236
25	α	Crucis (Acrux)	1.6	-04521486548	-00495728431	-08905639377
26	α	Virginis (Spica)	1.2	-09168160791	-03506241694	-01910784362
27	η	Ursae Majoris (Alkaid)	1.9	-05812217481	-02911759648	+07598669864
30	θ	Centauri (Menkent)	2.3	-06895375091	-04185354938	-05910719617
31	α	Bootis (Arcturus)	0.2	-07860186221	-05221457573	+03309660611
32	α	Coronae Borealis (Alphecca)	2.3	-05324545035	-07163035719	+04510004372
33	α	Scorpii (Antares)	1.2	-03511952476	-08242322268	-04441881743
34	α	Trianguli Austr. (Atria)	1.9	-01142900725	-03400201762	-09334474056
35	α	Ophiuchi (Rasalhague)	2.1	-01120382967	-09695442116	+02177876069
36	α	Lyrae (Vega)	0.1	+01219537054	-07702168243	+06260136474
37	σ	Sagittarii (Nunki)	2.1	+02074286490	-08718956797	-04435890882
40	α	Aquilae (Altair)	0.9	+04540867734	-08777450759	+01528685033
41	β	Capricorni (Dabih)	3.2	+05524232365	-07930716636	-02566435348
42	α	Pavonis (Peacock)	2.1	+03205423120	-04434583652	-08370169081
43	α	Cygni (Deneb)	1.3	+04542117996	-05390337930	+07093195408
44	ϵ	Pegasi (Enif)	2.5	+08141988673	-05553601830	+01692786800
45	α	Piscis Austr. (Fomalhaut)	1.3	+08345006310	-02388718657	-04965369357

SOURCE:

R. White, MIT/DL
P. Canepa, MIT/DL

PCR/0682.2
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Catalogue No. (octal)	Star Name	Vis. Mag	FIGHT ASCENSION			DECLI- NATION		
			HF	MIN	SEC	DG	MIN	SEC
1	α Andromedae (Alpheratz)	2.1	0	6	56.0	+28	56	9
2	β Ceti (Diphda)	2.2	0	42	11.0	-18	8	24
3	γ Cassiopeiae (Navi)	2.2	0	55	0.1	+60	33	56
4	α Eridani (Achernar)	0.6	1	36	40.2	-57	22	43
5	α Ursae Minoris (Polaris)	2.1	2	4	45.8	+89	8	10
6	θ Eridani (Acamar)	3.4	2	57	11.8	-40	24	58
7	α Ceti (Menkar)	2.8	3	0	48.7	+3	58	51
10	α Persei (Mirfak)	1.9	3	22	18.7	+49	45	47
11	α Tauri (Aldebaran)	1.1	4	34	18.6	+16	27	15
12	β Orionis (Rigel)	0.3	5	13	11.5	-8	13	58
13	α Aurigae (Capella)	0.2	5	14	37.0	+45	58	17
14	α Carinae (Canopus)	-0.9	6	23	19.7	-52	40	48
15	α Canis Majoris (Sirius)	-1.6	6	43	54.8	-16	40	37
16	α_2 Canis Minoris (Procyon)	0.5	7	37	50.1	+5	17	52
17	γ Velorum (Regor)	1.9	8	8	40.0	-47	15	12
20	ι Ursae Majoris (Dnoces)	3.1	8	57	17.8	+48	9	9
21	α Hydrae (Alphard)	2.2	9	26	12.6	-8	32	11
22	α Leonis (Regulus)	1.3	10	6	52.8	+12	6	17
23	β Leonis (Denebola)	2.2	11	47	37.8	+14	43	43
24	γ Corvi (Gienah)	2.8	12	14	21.7	-17	23	12
25	α Crucis (Acrux)	1.6	12	25	1.5	-62	56	39
26	α Virginis (Spica)	1.2	13	23	42.8	-11	0	57
27	η Ursae Majoris (Alkaid)	1.9	13	46	26.2	+49	27	9
30	θ Centauri (Menkent)	2.3	14	5	1.6	-36	13	59
31	α Bootis (Arcturus)	0.2	14	14	23.0	+19	19	39
32	α Coronae Borealis (Alphecca)	2.3	15	33	30.0	+26	48	28
33	α Scorpis (Antares)	1.2	16	27	41.1	-26	22	17
34	α Trianguli Austr. (Atria)	1.9	16	45	41.0	-68	58	43
35	α Ophiuchi (Rasalhague)	2.1	17	33	38.0	+12	34	45
36	α Lyrae (Vega)	0.1	18	35	59.3	+38	45	24
37	σ Sagittarii (Nunki)	2.1	18	53	31.6	-26	19	59
40	α Aquilae (Altair)	0.9	19	49	25.0	+8	47	36
41	β Capricorni (Dabih)	3.2	20	19	26.2	-14	52	16
42	α Pavonis (Peacock)	2.1	20	23	26.5	-56	49	35
43	α Cygni (Deneb)	1.3	20	40	28.5	+45	10	46
44	ϵ Pegasi (Enif)	2.5	21	42	48.5	+9	44	45
45	α Piscis Austr. (Fomalhaut)	1.3	22	56	6.3	-29	46	16

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PCR 1082 2
850713

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CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

LOSSEM EPHEMERIS NUMBERS FOR 1971-1972

<u>KONMAT</u>	+8	0.917456380	B-1	K1=COS (OBL)
	+10	-0.035679339	B-1	- K2=SIN (OBL) SIN (IM)(-1)
	+14	0.397836387	B-1	K3=SIN (OBL)
	+16	0.082280652	B-1	K4=COS (OBL) SIN (IM)
<u>RATESP</u>	+0	0.036600997	B+4	LOMR
	+2	0.002737803	B+4	LOSR
	+4	-0.000147200	B+4	LONR
	+6	0.534104635		LOMO
	+8	0.273331484		LOSO
	+10	0.878830860		LONO
<u>VAL67</u>	+0	0.017519236	B+1	AMOD
	+2	0.024523430		AARG
	+6	0.003473642	B+1	BMOD
	+8	0.540564756		BARG
	+10	0.031250000	B+1	1/32
	+12	0.005320572	B+1	CMOD
	+14	-0.011706923		CARG

Source: H. McQuat: MIT/DL

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OCTAL

77665 1	NGDDOT	2DEC*	-1.703706128 E-11	B28*	REV/CS.
42175 1					
22211 0	FDDT	2DEC*	+4.253263471 E-9	B27*	REV/CS.
00626 1					
77777 0	BDDT	2DEC*	-1.145531390 E-16	B28*	REV/CS.
77767 1					
34576 1	NGDIO	2DEC*	+8.788308600 E-1	B 0*	REV.
30363 1					
24780 0	FSUBO	2DEC*	+6.552737750 E-1	B 0*	REV.
00133 0					
02052 1	BSUBO	2DEC*	+6.511941688 E-2	B 0*	REV.
35250 0					
37116 0	WEARTH	2DEC*	+1.160576171 E-7	B23*	REV/CS.
32631 1					
30576 0	AZO	2DEC*	+7.733314844 E-1	B *	REVS.
10326 1					

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REMARKS

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CATALOG

00151 1	2DEC	+.128995818 B-1	STAR 5	X
25431 0				
00077 1	2DEC	+.078096205 B-1	STAR 5	Y
37176 0				
17777 0	2DEC	+.9998862988 B-1	STAR 5	Z
02143 0				
07675 1	2DEC	+.4918322686 B-1	STAR 4	X
02702 0				
03420 1	2DEC	+.2207092653 B-1	STAR 4	Y
01470 0				
62414 1	2DEC	-.8422520048 B-1	STAR 4	Z
50541 1				
07506 0	2DEC	+.4773424940 B-1	STAR 3	X
14361 0				
01674 0	2DEC	+.1168141178 B-1	STAR 3	Y
36075 0				
15736 1	2DEC	+.8709182540 B-1	STAR 3	Z
21775 1				
16745 0	2DEC	+.9342466124 B-1	STAR 2	X
13112 1				
02620 1	2DEC	+.1739271769 B-1	STAR 2	Y
31757 0				
73011 0	2DEC	-.3113400137 B-1	STAR 2	Z
60052 0				
15776 0	2DEC	+.8747608555 B-1	STAR 1	X
01237 0				
00330 1	2DEC	+.0264803244 B-1	STAR 1	Y
35521 1				
07573 1	2DEC	+.4838307948 B-1	STAR 1	Z
21256 0				
16004 1	CATALOG	DEC 7172		

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REMARKS

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CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
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75151 1	2DEC	-.182434.636 B-1	STAR 13	X
61011 0				
17127 1	2DEC	+.94140.62125 B-1	STAR 13	Y
31661 1				
73321 0	2DEC	-.2865738085 B-1	STAR 13	Z
43422 1				
77177 0	2DEC	-.06160.90080 B-1	STAR 12	X
51442 1				
11514 1	2DEC	+.6031289258 B-1	STAR 12	Y
32502 1				
63215 1	2DEC	-.795260.8555 B-1	STAR 12	Z
47166 0				
02140 0	2DEC	+.1367280274 B-1	STAR 11	X
12335 0				
12716 1	2DEC	+.6814364033 B-1	STAR 11	Y
12356 1				
13401 0	2DEC	+.7189922632 B-1	STAR 11	Z
37444 0				
03154 1	2DEC	+.2007345455 B-1	STAR 10	X
15267 0				
17403 0	2DEC	+.9691236271 B-1	STAR 10	Y
01743 0				
75552 1	2DEC	-.1431958012 B-1	STAR 10	Z
76353 0				
05465 0	2DEC	+.3502769546 B-1	STAR 9	X
17001 0				
16221 1	2DEC	+.8927907521 B-1	STAR 9	Y
27572 1				
04420 0	2DEC	+.2832502918 B-1	STAR 9	Z
14273 1				
06440 1	2DEC	+.4101921571 B-1	STAR 8	X
11323 0				
17767 0	2DEC	+.4989947555 B-1	STAR 8	Y
30366 1				
14155 0	2DEC	+.7633784305 B-1	STAR 8	Z
23447 0				
13176 0	2DEC	+.7128937840 B-1	STAR 7	X
03307 0				
13247 1	2DEC	+.7078988678 B-1	STAR 7	Y
03342 1				
01070 1	2DEC	+.61694227718 B-1	STAR 7	Z
26617 1				
10557 1	2DEC	+.5448995558 B-1	STAR 6	X
32115 0				
10404 0	2DEC	+.5317389073 B-1	STAR 6	Y
00124 0				
65500 1	2DEC	-.6483349473 B-1	STAR 6	Z
72713 0				

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CCTAL					
73617 1	2DEC	-.4521486548	B-1	STAR 21	X
77742 0					
77151 1	2DEC	-.0495728431	B-1	STAR 21	Y
74615 0					
61611 0	2DEC	-.8905639377	B-1	STAR 21	Z
60003 1					
60605 1	2DEC	-.9524366380	B-1	STAR 20	X
64345 1					
77026 0	2DEC	-.0597677121	B-1	STAR 20	Y
54210 1					
73160 1	2DEC	-.2988181236	B-1	STAR 20	Z
42475 1					
60430 0	2DEC	-.9657334280	B-1	STAR 19	X
66614 1					
00653 1	2DEC	+.0521664164	B-1	STAR 19	Y
13072 0					
04042 0	2DEC	+.2542392750	B-1	STAR 19	Z
27232 1					
62162 0	2DEC	-.8610673205	B-1	STAR 18	X
44274 0					
07322 0	2DEC	+.4632386329	B-1	STAR 18	Y
33165 0					
03265 0	2DEC	+.2096974909	B-1	STAR 18	Z
32741 1					
63467 1	2DEC	-.7745052221	B-1	STAR 17	X
50064 0					
11655 1	2DEC	+.6149043688	B-1	STAR 17	Y
11373 0					
75477 1	2DEC	-.1484394758	B-1	STAR 17	Z
77366 1					
70425 0	2DEC	-.4661511162	B-1	STAR 16	X
51217 1					
07505 0	2DEC	+.4772744503	B-1	STAR 16	Y
32541 1					
13726 0	2DEC	+.7449243154	B-1	STAR 16	Z
15341 0					
72157 1	2DEC	-.3613649782	B-1	STAR 15	X
66255 0					
11142 0	2DEC	+.5745656444	B-1	STAR 15	Y
32737 0					
64211 1	2DEC	-.7343634472	B-1	STAR 15	Z
43116 1					
71316 0	2DEC	-.4122762536	B-1	STAR 14	X
64201 0					
16411 1	2DEC	+.9063680102	B-1	STAR 14	Y
45737 1					
01364 1	2DEC	+.923326629	B-1	STAR 14	Z
14350 1					

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PROGRAM CHANGE REQUEST NO. <u>1082.2</u>		PREPARED BY: _____ DATE: _____		ORGANIZATION:	
CONTINUATION	76152 0	2DEC	-.1120382967 B-1	STAR 29	X
	45051 1				
	67371 1	2DEC	-.9695442116 B-1	STAR 29	Y
	57632 1				
	03370 0	2DEC	+.2177876068 B-1	STAR 29	Z
	03556 1				
	76127 1	2DEC	-.1142900725 B-1	STAR 28	X
	67425				
	72436 0	2DEC	-.3400201762 B-1	STAR 28	Y
	61577 0				
	61741 0	2DEC	-.9334474056 B-1	STAR 28	Z
	46271 1				
	72303 1	2DEC	-.3511952476 B-1	STAR 27	X
	45213 0				
	62537 1	2DEC	-.8242322268 B-1	STAR 27	Y
	74356 1				
	70711 1	2DEC	-.4441881743 B-1	STAR 27	Z
	46567 1				
	67366 0	2DEC	-.5324545035 B-1	STAR 26	X
	44175 1				
	64424 1	2DEC	-.7163035719 B-1	STAR 26	Y
	41241 0				
	07156 1	2DEC	+.4511003372 B-1	STAR 26	Z
	23136 0				
	63330 1	2DEC	-.7860186221 B-1	STAR 25	X
	75735 1				
	67512 0	2DEC	-.5221457573 B-1	STAR 25	Y
	62476 0				
	05227 0	2DEC	+.3309880611 B-1	STAR 25	Z
	10611 0				
	64757 0	2DEC	-.6895375091 B-1	STAR 24	X
	517 1				
	71233 0	2DEC	-.4185354936 B-1	STAR 24	Y
	53334 0				
	66425 1	2DEC	-.5910719617 B-1	STAR 24	Z
	76017 0				
	66546 0	2DEC	-.5812217481 B-1	STAR 23	X
	64151				
	73256 1	2DEC	-.2911759648 B-1	STAR 23	Y
	65757 1				
	14120 1	2DEC	+.7598669864 B-1	STAR 23	Z
	32444 1				
	61251 0	2DEC	-.9168160791 B-1	STAR 22	X
	56124				
	72307 0	2DEC	-.3506241654 B-1	STAR 22	Y
	65764 1				
	74742 0	2DEC	-.191784362 B-1	STAR 22	Z
	65735 0				

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CONTINUATION	OCTAL					
	15264 0	2DEC	+.8345006310	B-1	STAR 37	X
	07253 1					
	74133 0	2DEC	-.2388718657	B-1	STAR 37	Y
	45130 1					
	70234 1	2DEC	-.4965369357	B-1	STAR 37	Z
	53644 1					
	15015 1	2DEC	+.8141988672	B-1	STAR 36	X
	35262 1					
	67072 0	2DEC	-.5553601830	B-1	STAR 36	Y
	57521 0					
	02552 1	2DEC	+.1692786800	B-1	STAR 36	Z
	27310 0					
	07210 0	2DEC	+.4542117956	B-1	STAR 35	X
	34714 1					
	67300 0	2DEC	-.5390337930	B-1	STAR 35	Y
	47414 0					
	13262 0	2DEC	+.7093195408	B-1	STAR 35	Z
	27671 1					
	05101 1	2DEC	+.3205423120	B-1	STAR 34	X
	34175 0					
	70717 1	2DEC	-.4434583652	B-1	STAR 34	Y
	46031 1					
	62467 0	2DEC	-.8370169081	B-1	STAR 34	Z
	45023 1					
	10655 0	2DEC	+.5524232365	B-1	STAR 33	X
	16340 1					
	63237 1	2DEC	-.7930716636	B-1	STAR 33	Y
	45012 0					
	73711 1	2DEC	-.2566435348	B-1	STAR 33	Z
	62337 1					
	07207 0	2DEC	+.4540867784	B-1	STAR 32	X
	34100 1					
	61751 0	2DEC	-.8777450759	B-1	STAR 32	Y
	60311 1					
	02344 0	2DEC	+.1528685033	B-1	STAR 32	Z
	11437 1					
	03243 1	2DEC	+.2074286490	B-1	STAR 31	X
	10132 0					
	62031 1	2DEC	-.8718956797	B-1	STAR 31	Y
	55616 0					
	70716 0	2DEC	-.4435890882	B-1	STAR 31	Z
	43617 0					
	01747 1	2DEC	+.1219537054	B-1	STAR 30	X
	01335 0					
	63532 0	2DEC	-.7702168243	B-1	STAR 30	Y
	54217 1					
	12010 0	2DEC	+.6260138474	B-1	STAR 30	Z
	11614 1					

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TP#21812

KONMAT +100	2DEC	+0.917496380	B-1	K1 COS(CBL)	16533	31537
KONMAT +100	2DEC	-0.025679339	B-1	-K2 SIN(BLSINIM	77333	66677
KONMAT +140	2DEC	+0.397336337	B-1	K3 SIN(CBL)	06273	02330
KONMAT +160	2DEC	+0.092280652	B-1	K4 COS(BLSINIM	01242	01302
RATESP +000	2DEC	+0.036600957	B+4	L0MR	22572	27325
RATESP +020	2DEC	+0.002737803	B+4	L1SR	01315	26265
RATESP +040	2DEC	-0.000147200	B+4	L0NR	77731	55144
RATESP +060	2DEC	+0.534104635		L0MO	21056	30515
RATESP +080	2DEC	+0.273331484		L0SO	10576	10326
RATESP +100	2DEC	+0.878830860		L0NO	34076	30363
VAL67 +000	2DEC	+0.017519236	B+1	A000	01076	02200
VAL67 +020	2DEC	+0.024523430		AARG	00621	31256
VAL67 +040	2DEC	+0.036291713	B+1	1/27	02245	06475
VAL67 +060	2DEC	+0.013473642	B+1	BMOD	00161	32301
VAL67 +080	2DEC	+0.540564756		BARG	21230	23473
VAL67 +100	2DEC	+0.021250000	B+1	1/32	02000	00000
VAL67 +120	2DEC	+0.005320572	B+1	CMOD	00256	13014
VAL67 +140	2DEC	-0.011706923		CARG	77500	46146

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MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1088
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date 11-10-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				Version (Completed by FSD) 1088	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR P. Rye	DATE 9/25/70	1.2 ORGANIZATION MIT/CSDL	APPROVAL V37 LOCKOUT	DATE	
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Inhibit program change during critical 10.56 seconds after IMU zero.		
1.5 REASON FOR CHANGE The DAP is disabled during V40N20 IMU zero; a hardware or software restart causes the DAP re-enabling task to be lost. DAP is not re-established unless V40 is repeated.					
1.6 DESCRIPTION OF CHANGE Lock out V37 when Bit 5 of IMODES33 = 1 (flight program alarm, store alarm code 01520, 01520). This bit is set to 1 for 10.56 seconds after V40 requested IMU zero has taken place.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS: The problem still exists for hardware restarts and for software restarts other than V37. In those cases V40N20 must be repeated to re-establish the DAP.		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF			DATE		
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 SOFTWARE IMPACT			3.4 REMARKS		
+ 4 words <i>R. H. Larson</i> DATE 10-23-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input checked="" type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DISAPPROVED <input type="checkbox"/>			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF			DATE		
DATE 11-5-70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION <input type="checkbox"/>			6.2 REMARKS		
6.3 SOFTWARE CONTROL BOARD SIGN OFF			DATE		
DATE					

PROG NOTE
DOES

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1091
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

11-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				Form (Completed by TSB) 1091	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR McCoy	DATE 10/2/70	1.2 ORGANIZATION MIT/CSDL	APPROVAL	DATE	
1.3 EFFECTIVITY LUMINARY 1E (Apollo 15)			1.4 TITLE OF CHANGE Priority Display Light on DSKY		
1.5 REASON(S) FOR CHANGE See Data Amplification Sheet					
1.6 DESCRIPTION OF CHANGE See Data Amplification					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT + 6 WORDS			3.4 REMARKS		
3.5 MIT COORDINATOR #10 J. Larson					
DATE 10-7-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11-5-70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. <u>1091</u>	PREPARED BY: <u>B. McCoy</u> DATE: <u>10/2/70</u>	ORGANIZATION: <u>MIT/CSDL</u>
---	--	----------------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.5 Reason(s) for Change

When P20 is running in the background of a targeting program (P34), a Priority display may go unnoticed by the astronaut if he is using the DSKY because the Key Release light is already being used. Once the astronaut uses the DSKY while a display is on the DSKY, the Key Release light comes on; then if a Priority display is attempted by the LGC, the astronaut would be unaware of it waiting to be displayed. The Priority displays in P20 are V50N18, V05N09 (with alarms 501, 503, 514 & 525) V06N05, V16N80, V50N72 and V06N49. Until these displays are answered, P20 is idling (navigation stops). A DSKY light indicating that a Priority display has been internally attempted would allow recognition of this condition. This light has the further advantage of indicating to the astronaut that he must wait at least two seconds before this type of display can accept a response, and also that extended verbs are not allowed while this type display is on the DSKY.

1.6 Description of Change

When the LGC attempts to display a Priority display, turn on an available DSKY light. It is to be set and subsequently reset by the DSKY light test routine (V35). It will be reset when the Priority display is answered by a PRO, V33E, V32E, V34E, and when V37XXE, V56E or V36E are used.

REMARKS

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1092	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR Ed Grace		DATE 9/23/70	1.2 ORGANIZATION MIT/DL		APPROVAL DATE
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Increase Accuracy of Determination of Accelerometer S. F.		
1.5 REASON(S) FOR CHANGE NASA Contract #NAS 9-10749 (measurement of lunar gravity) requires that the accelerometer scale factor be known more accurately before launch.					
1.6 DESCRIPTION OF CHANGE Change PIPA scale factor test to increase accuracy of determination of accelerometer S. F.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 20 WORDS			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>Russell H. Larson</i>					
DATE 10-7-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS- APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11/5/70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1093
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

11-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				1093	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR William Robertson		DATE 10-5-70	1.2 ORGANIZATION MIT/DL		APPROVAL
1.3 EFFECTIVITY LUMINARY IE (Apollo 15)			1.4 TITLE OF CHANGE Eliminate 481 day TEPHEM limitation in Lunar-Solar Ephemerides		
1.5 REASON(S) FOR CHANGE SEE ATTACHED DATA AMPLIFICATION SHEET					
1.6 DESCRIPTION OF CHANGE SEE ATTACHED DATA AMPLIFICATION SHEET					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT Less than 5 fixed memory words			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>Russell H. Larson</i>					
DATE 10-8-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11-5-70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. <u>1093</u>	PREPARED BY: <u>William Robertson</u> DATE: <u>10-5-70</u>	ORGANIZATION: <u>MIT/DL</u>
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CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.5 REASON FOR CHANGE

Currently there is a 512 day limitation of the sum of t_{GET} (Ground Elapsed Time) and t_{EPHEM} (Time between July 1 and the launch date) in the LM Lunar-Solar Ephemerides Routine. Since t_{GET} may be as large as a little over 30 days, t_{EPHEM} is limited to 481 days. The limitation is due entirely to the present AGC interpretive coding and scaling of this routine. In the past, there was never any need for t_{EPHEM} to be larger than 366 days as the Basic Reference Coordinate System was changed once a year on July 1 and t_{EPHEM} was measured from the new July 1.

However if (1) the BRCS is to be held fixed for more than a year (the subject of several separate PCR's), and if (2) it is undesirable* to use negative t_{EPHEM} 's, then the 481 day coding limitation should be removed so as to allow the LM Lunar-Solar Ephemerides Routine to be computationally capable of operating over several years (it is already mathematically capable of doing so).

1.6 DESCRIPTION OF CHANGE

Change the internal coding of the Lunar-Solar Ephemerides Routine so that the quantity $((t_{GET} + t_{EPHEM})/8640000)$ is scaled in days at 2^{10} rather than 2^9 as currently. After such a change the new limitation on t_{EPHEM} would be $2^{10} - 30 = 994$ days = about 2 years 8 months, which is about a month more than the current scaling limitation on t_{EPHEM} in the Planetary Inertial Orientation Routine (963.2 days).

*In order to gain any advantage by using negative t_{EPHEM} 's, it is necessary to go to a 72-73 Coordinate System for Apollo 15, so that t_{EPHEM} would be measured from July 1, 1972. This would impact the MIT/DL Digital Simulator.

TP#21812

+ 2 yr 8 mo = MAR 74 NO GOOD

1093

Massachusetts Institute of Technology
Charles Stark Draper Laboratory
Cambridge, Massachusetts

MEMO

TO: LUMINARY and SKYLAB Program Managers
FROM: William M. Robertson
DATE: October 8, 1970
SUBJECT: Accuracy Degradation Caused by the Implementation of PCR's 1093 and SL402, "Eliminate 481 day limitation on TEPHEM in Lunar-Solar Ephemerides".

SUMMARY

It is concluded that the accuracy degradation caused by the implementation of this PCR is roughly two orders of magnitude smaller than the average actual error already existing in the Lunar-Solar Ephemerides Routines due to the great simplification of these routines from the "truth".

TIME GRANULARITY

Currently (i.e. in LUMINARY ID of Apollo 14 and previous ropes), the quantity

$$((t_{GET} + t_{EPHEM} \text{ in csec}) / 8640000)$$

is scaled at $2^9 = 512$ days. Thus the granularity (the value represented by the least significant bit) is

$$2^{-28} (512 \text{ days}) (86400 \text{ sec/day})$$

which is 0.16478 seconds. The maximum error due to roundoff is half this amount or about 8.2 centiseconds.

When the scaling is changed to $2^{10} = 1024$ days, the granularity becomes 0.32956 seconds and the maximum roundoff error about 16.5 centiseconds.

- FOR INFORMATION ONLY -

CASE OF THE SUN

As the sun moves about 360° /year or about 1° /day, the current maximum roundoff error (8.2 csec) implies a sun position angular error of about

$$8.2 \text{ csec} \frac{3600 \text{ arc sec}}{86400 \text{ time sec}} = \frac{1}{3} \text{ arc sec},$$

and the rescaled maximum roundoff error will be of course about $2/3$ arc sec.

Since the current angular accuracy of the routine for the sun is about $0.02^\circ = 72$ arc-seconds, the new maximum roundoff error is approximately two orders of magnitude smaller.

CASE OF THE MOON

As the moon moves about 360° /month or about 12° /day, the corresponding figures for the moon are about twelve times what they are for the sun above. Thus the current maximum roundoff error (8.2 csec) implies a moon position angular error of about 4 arc sec, and a rescaled maximum roundoff error of about 8 arc sec.

But the current (optimistic) angular accuracy of the routine for the moon is about $0.25^\circ = 900$ arc sec, which is also about twelve times the sun's accuracy above.

Hence the new maximum roundoff error in angular position after the incorporation of the PCR is again about two orders of magnitude smaller than the currently existing error due to the great simplification of the "truth".

Distribution

S. Copps
R. Larson
G. Levine
W. Ostanek
M. Reber
R. White
H. McQuat

— FOR INFORMATION ONLY —

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1095

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☒ MIT Approved PCN

☐ MIT Approved ADR

☐ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☐ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

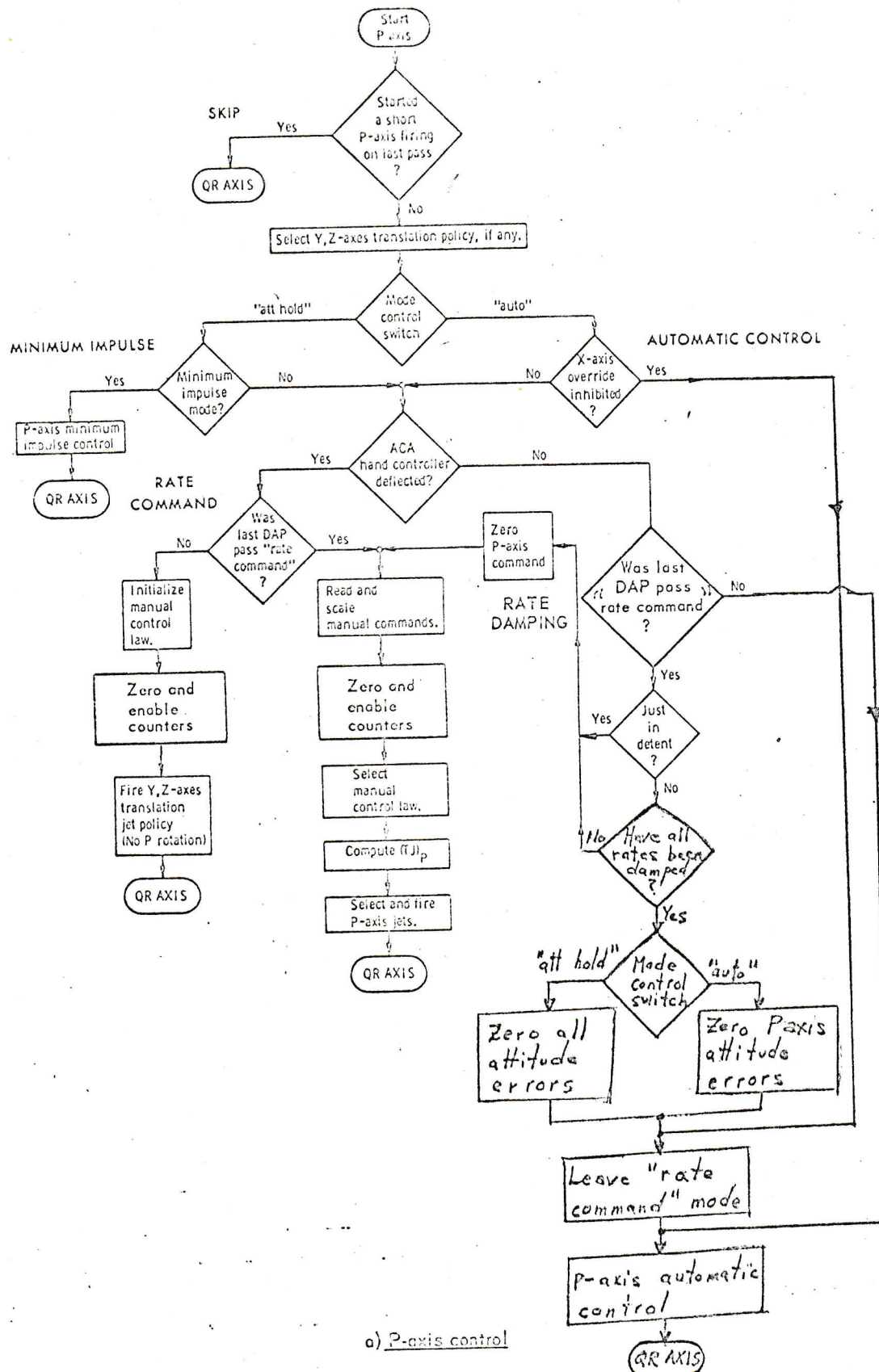
10-7-70

MIT-PCN

650P
L-ID-07

Page 1 of 1

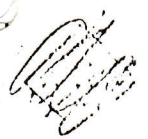
APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1095	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR P. S. Weissman		DATE 10/7/70	1.2 ORGANIZATION MIT/DL	APPROVAL	DATE
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Avoid incomplete close-out of manual rate command mode (Anomaly L-ID-07)		
1.5 REASON(S) FOR CHANGE Change GSOP to reflect fix for Anomaly L-ID-07 (Prevents spurious yaw firings if the mode control switch is moved from AUTO to ATT HOLD before the manual rate command mode has been properly terminated and while X-axis override is inhibited.)					
1.6 DESCRIPTION OF CHANGE 1) Clear OURRCBIT (DAPBOOLS/bit 12) whenever AUTO is selected and X-axis override is inhibited. 2) Clear QRBIT (RCSFLAGS/bit 11) if it is set during rate damping in the X-axis override mode.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>Russell H. Lawrence</i>					
DATE 10-7-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					



ATTITUDE HOLD
ONLY
FOR INFORMATION

a) P-axis control

Fig. 3.6-5. Selection of manual and automatic modes (page 1 of 3).



3. 4-32

Rate damping is completed when both PBIT and QRBIT are zero. (As indicated above, in X-axis override, QRBIT is automatically zero.) This implies that

$$|\omega_{cP}| < \omega_{DB}$$

$$|\omega_{cU}| < \omega_{DB}^*$$

$$|\omega_{cV}| < \omega_{DB}$$

or that the 4-sec limits have been exceeded. When this is found to be true, ~~QRBIT is reset to zero so that on the next and subsequent passes automatic control will be resumed.~~

At this point, the DAP checks the mode switch to see if X-axis override is in effect. If it is, the desired outer gimbal angle (CDUXD) is set equal to the present gimbal angle (CDUX), and the logic exits to P-axis automatic control. If, however, three-axis manual rate control is in effect, the DAP sets

*Although the discussion in this subsection concerns the P, U', V' axes, it should be noted that in the CSM-docked configuration the U' and V' axes are respectively coincident with the stationary U and V axes.

3.4-37

$$\begin{array}{ll} \text{CDUXD} = \text{CDUX} & \theta_{do} = \theta_o \\ \text{CDUYD} = \text{CDUY} & \text{or } \theta_{di} = \theta_i \\ \text{CDUZD} = \text{CDUZ} & \theta_{dm} = \theta_m \end{array}$$

and zeroes the automatic-steering inputs. The logic then exits to P-axis automatic control.

Q, R Axes

IN EITHER CASE, OURRCBIT IS CLEARED TO SHOW THAT THE MANUAL RATE COMMAND IS NO LONGER ACTIVE. The logic of the Q, R-axes control is similar to that of the P axis, except that

FOR INFORMATION ONLY

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSH)

1096

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR McCoy	DATE 10/8/70	1.2 ORGANIZATION MIT/SDL	APPROVAL	DATE
-------------------------	-----------------	-----------------------------	----------	------

1.3 EFFECTIVITY Luminary 1E	1.4 TITLE OF CHANGE Erased Memory De-orbit Program Goes Fixed
--------------------------------	--

1.5 REASON(S) FOR CHANGE To keep Flight Controllers from using tedious and time consuming procedures in loading/verifying Erasable Program

1.6 DESCRIPTION OF CHANGE provide V37 leadin, WHICH table, associated constants and flag settings to execute an RCS automatically-guided/thrusted maneuver.
--

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 36 fixed	3.4 REMARKS:
3.5 MIT COORDINATOR R.A. Larson	
DATE 10-14-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 11/5/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

PCS
 P44
 ABS PROGRAM (P44)

REV 01 08/07/69

PURPOSE:

- (1) TO COMPUTE A PREFERRED IMU ORIENTATION AND A VEHICLE ATTITUDE FOR A LM ~~ABS~~ THRUSTING MANEUVER.
- (2) TO DO THE VEHICLE MANEUVER TO THE THRUSTING ATTITUDE.
- (3) TO CONTROL THE PGNS DURING COUNTDOWN, IGNITION, THRUSTING, AND THRUST TERMINATION OF A PGNS CONTROLLED ~~ABS~~ PCS MANEUVER.

ASSUMPTIONS: (1) THE TARGET PARAMETERS HAVE BEEN CALCULATED AND STORED IN THE LGC BY PRIOR EXECUTION OF A PRE-THRUSTING PROGRAM.

(2) THE REQUIRED STEERING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRE-THRUST PROGRAM, WHICH EITHER RESET ("ASTEER") OR SET (EXT DELTA V) THE EXTERNAL DELTA V FLAG. FOR EXTERNAL DELTA V STEERING, VG IS CALCULATED ONCE FOR THE SPECIFIED TIME OF IGNITION. THEREAFTER BOTH DURING ~~ABS~~ THRUSTING AND UNTIL THE CREW NOTIFIES THE LGC THAT RCS TRIM THRUSTING HAS BEEN COMPLETED, THE LGC UPDATES VG ONLY AS A RESULT OF ACCELEROMETER INPUTS.

FOR STEERING CONTROL WHEN USING "ASTEER", THE VELOCITY REQUIRED IS CALCULATED FROM FIGURE 3.3-13A IN SECTION 5 OF THE LUMINARY 1A GSOP. THE LAMBERT ROUTINE PERIODICALLY RE-COMPUTES THE INTERCEPT TRAJECTORY SEMI-MAJOR AXIS FOR THE "ASTEER" CALCULATIONS. THE INTERVAL BETWEEN LAMBERT SOLUTIONS IS CONTROLLED BY AN ERASABLE LOADED VALUE (UT).

(3) THE IMU IS ON AND MUST BE AT A KNOWN ORIENTATION BEFORE THIS PROGRAM MAY BE COMPLETED. IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR A MINIMUM OF 15 MINUTES PRIOR TO A THRUSTING MANEUVER.

(4) THE EVENT TIMER IS SET TO COUNT TO ZERO AT TIG.

(5) ENGINE IGNITION MAY BE SLIPPED BEYOND THE ESTABLISHED TIG IF DESIRED BY THE CREW OR IF STATE VECTOR INTEGRATION CANNOT BE COMPLETED IN TIME.

(6) IF A THRUSTING MANEUVER IS PERFORMED WITH THE GUIDANCE CONTROL SWITCH IN PGNS AND THE MODE CONTROL SWITCH IN AUTO, THE PGNS WILL CONTROL THE TOTAL VEHICLE ATTITUDE AND GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS (SEE ASSUMPTION(7)) FOR DISPLAY ON THE FOAI. THE CREW MAY EXERCISE CONTROL AROUND THE YAW AXIS ONLY WITH THE ACA (X-AXIS OVERRIDE) IF THE X-AXIS OVERRIDE CAPABILITY IS PERMITTED BY THE PROGRAM IN PROCESS. THIS MANUAL CONTROL WILL BE IN THE RATE COMMAND/ATTITUDE HOLD MODE.

IF A THRUSTING MANEUVER IS PERFORMED WITH THE GUIDANCE CONTROL SWITCH IN PGNS AND THE MODE CONTROL SWITCH IN ATTITUDE HOLD THE PGNS WILL HOLD THE VEHICLE ATTITUDE AND WILL GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS FOR DISPLAY ON THE FOAI. THE CREW MAY EXERCISE MANUAL ATTITUDE CONTROL ABOUT ALL VEHICLE AXES WITH THE ACA IN EITHER THE RATE COMMAND OR MINIMUM IMPULSE MODE DEPENDING UPON THE STATUS OF THE PULSES FLAG. HOWEVER IT IS STRONGLY RECOMMENDED THAT POWERED FLIGHT NOT BE ATTEMPTED IN THE MINIMUM IMPULSE MODE. THE PULSES FLAG IS SET OR RESET BY EXTENDED VERBS 76 (MINIMUM IMPULSE) AND 77 (RATE COMMAND) RESPECTIVELY. THE PULSES FLAG IS ALSO RESET BY P63 AT DPS IGNITION. WITH THE EXCEPTION OF THE P63 CASE, MODE SELECTION IS ALWAYS BASED UPON THE LAST ENTRY MADE IN THE DSKY. DURING A THRUSTING MANEUVER IN THE PGNS/ATTITUDE HOLD MODE THE PGNS WILL NOT BE RESPONSIBLE IF REGISTER OVERFLOWS OCCUR WITHIN THE LGC.

IN THE EVENT THAT THE GUIDANCE CONTROL SWITCH IS CHANGED FROM PGNS TO AGS DURING A THRUSTING MANEUVER, THE LGC WILL CONTINUE COMPUTATION OF POSITION AND VELOCITY, THE DESIRED THRUST VECTOR, AND THE DESIRED ATTITUDE ERRORS, HOWEVER THE PGNS WILL NOT BE RESPONSIBLE IF REGISTER OVERFLOWS OCCUR WITHIN THE LGC.

(7) THE PGNS CAN GENERATE TWO TYPES OF ATTITUDE ERRORS FOR DISPLAY ON THE FOAI:

MODE I - SELECTED BY EXTENDED VERB 61. AUTOPILOT FOLLOWING ERRORS USED AS A MONITOR OF THE DAP'S ABILITY TO TRACK AUTOMATIC STEERING COMMANDS.

MODE II - SELECTED BY EXTENDED VERB 62. TOTAL ATTITUDE ERRORS USED TO ASSIST CREW IN MANUALLY MANEUVERING THE VEHICLE.

DISPLAY SELECTION IS ALWAYS BASED UPON THE LAST ENTRY MADE IN THE DSKY. FOR A MORE DETAILED DESCRIPTION OF THESE

PLUMINARY

99

DISPLAYS REFER TO SECTION 3 OF R547, PARA. 3.2.6.

(8) THE X-AXIS OVERRIDE OPTION PROVIDES THE CREW WITH THE ABILITY TO EXERCISE MANUAL CONTROL ABOUT THE LM X AXIS WITH THE ATTITUDE CONTROLLER EVEN THOUGH THE PGNC'S ATTITUDE CONTROL MODE IS AUTO. WHEN THE CONTROLLER IS RETURNED TO DETENT THE PGNC'S DAMPS THE YAW RATE, STORES THE YAW ATTITUDE WHEN THE YAW RATE IS DAMPED, AND THEN MAINTAINS THAT ATTITUDE.

THE X-AXIS OVERRIDE OPTION IS ALWAYS AVAILABLE TO THE CREW, HOWEVER IT SHOULD NOT BE EXERCISED WHEN THE LGC IS SPECIFYING A DESIRED YAW ATTITUDE, I.E.: DURING THE ATTITUDE MANEUVER TO THE THRUSTING ATTITUDE (SEE R60).

(9) FOR EACH BURN AN IGNITION TOTAL ALLOWABLE TIME DELAY WILL BE SPECIFIED IN THE MISSION RULES. THIS DELAY TIME IS THE TOTAL TIME WHICH THE THRUSTING MANEUVER MAY BE DELAYED BEYOND THE LGC CALCULATED TIME OF IGNITION. IF ENGINE RE-STARTS ARE INVOLVED, THE ACCOUNTING OF THIS TOTAL TIME DELAY IS UP TO THE CREW.

(10) THE LOAD DAP DATA ROUTINE (RD3) MAY HAVE BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM.

(11) LGC AND CREW PROCEDURES IN CASES OF LGC-ASSUMED THRUST FAILURE ARE DEFINED BY THE OPS/APS THRUST FAIL ROUTINE (R40). THIS ROUTINE IS CALLED AT ~~APS~~ IGNITION BY THIS PROGRAM.

(12) THE ~~LGC WILL NEITHER DESIGNATE NOR READ THE RENDEZVOUS PADAR (PR)~~ ^{ENGINE SHOULD BE RES. DISARMED} DURING THIS PROGRAM.

(13) THIS PROGRAM SHOULD BE SELECTED BY THE ASTRONAUT BY DSKY ENTRY AT LEAST 5 MINUTES BEFORE THE ESTIMATED TIME OF IGNITION.

(14) THIS PROGRAM IS SELECTED MANUALLY BY DSKY ENTRY.

PROG
CONT

LGC

GROUND

CREW

START APS PROGRAM
(~~PR~~) DISPLAY P42
P42

KEY IN ~~APS~~ RES
PROGRAM (~~P42~~) P42
V37E ~~42~~ 998

#19

MONITOR DSKY:
OBSERVE DISPLAY OF
P42 99

#20

#130

#140

#150

#160

DO IMU STATUS CHECK
ROUTINE (R12)

DO IMU STATUS CHECK
ROUTINE (R12)

SET ~~AP~~ DELTA V
THRESHOLD FOR USE
BY R40.

SET DELTA V
COUNTER = 4 FOR USE
BY R40

COMPUTE INITIAL
THRUST DIRECTION AND
INITIAL VALUE OF VG
VECTOR AND STORE
VG(LV) IN N81 AND
N86 FOR POSSIBLE
MANUAL SELECTION:

R1-VGX(LV)
R2-VGY(LV)
R3-VGZ(LV)

VGX(LV)-COMPONENT OF
VG AT TIG ALONG
(RXV)X₀. IN FPS TO
NEAREST .1 FPS.

PC 1096
Pg 5 of 24

VGX(LV)-COMPONENT OF
VG AT TIG ALONG VXR.
IN FPS TO NEAREST
.1 FPS.

VGZ(LV)-COMPONENT OF
VG AT TIG ALONG -R.
IN FPS TO NEAREST
.1 FPS.

WHERE R IS GEOCENT-
RIC (EARTH ORBIT)
OR SELENCENTRIC
(LUNAR ORBIT) RADIUS
VECTOR, AND V IS
VEHICLE INERTIAL
VELOCITY VECTOR AT
TIG.

(NOTE: NR1 WILL NOW
DIFFER FROM NR1
DISPLAY OF P30, P32,
AND P33 BECAUSE OF
ROTATION OF VG
VECTOR).

COMPUTE PREFERRED
IMU ORIENTATION:

X = UNIT(T)
-SM -

Y = UNIT(T X R)
-SM - -

Z = UNIT(X X Y)
-SM -SM -SM

WHERE:

T = THE INITIAL
- THRUST VECTOR
AT IGNITION

#170

#180

#190

#200

#210

R = THE GEOCENTRIC
- (EARTH ORBIT)
OR SELENOCENT-
RIC (LUNAR
ORBIT) RADIUS
VECTOR AT TIG.

(NOTE: IF T X R IS

SMALL (REFER SECTION
5.3.3.3 OF R567),
THEN Y =

-SM
UNIT (T X V).

WHERE V = VEHICLE

INERTIAL VELOCITY AT
TIG.)

.
.
.
.

STORE DESIRED ATTITUDE SPECIFICATION FOR USE BY ATTITUDE MANEUVER ROUTINE (R60). THE FINAL ATTITUDE WILL BE COMPUTED DURING R60 AND WILL POINT THE LM +X AXIS IN THE INITIAL THRUST DIRECTION. HOWEVER, IN ORDER TO CONSERVE RCS FUEL AND NOT CONSTRAIN THE NON-CRITICAL ATTITUDE ABOUT THE THRUST VECTOR, WINGS MAY NOT BE LEVEL IN THE COMPUTED FINAL ATTITUDE.

.
.
.
.

SET PREFERRED-
ATTITUDE-COMPUTED

#220

#230

#240

#250

#260

FLAG

#270

COMMAND ZERO ATTITUDE ERRORS

#280

SET 1 DEGREE DEAD-BAND

#290

RESET 3-AXIS FLAG

#300

DO ATTITUDE MANEUVER ROUTINE (R60)

DO ATTITUDE MANEUVER ROUTINE (R60)

#310

HAVE PGNS CONTROL AND AUTO ATTITUDE

#320

PCR 1096
Pg 8 of 24

99 343
P42/LUMINARY

CONTROL MODES BEEN
SELECTED?

.Y .N
.
.

IS THE APS FLAG
SET?

.Y .N
.
.

HAS THE AUTO
THROTTLE MODE
BEEN SELECTED?

.Y .N
.
.

POSS
HOLD .
.....
SNAP .

FLASH VERB-
NOUN TO RE-
QUEST PLEASE
PERFORM PGNS
CONTROL AND
AUTO ATTITUDE
CONTROL MODE
SELECTION:
V50N25
R1-1213
R2-BLANK
R3-BLANK

MONITOR DSKY:
DOES VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM PGNS
CONTROL AND AUTO
ATTITUDE CONTROL
MODE SELECTION?

.Y .N
.
.
.

HAVE REQUESTED
MODES BEEN
SELECTED?

.N .Y
.
.
.

DO I WISH TO
HAVE THESE

#330

#340

#350

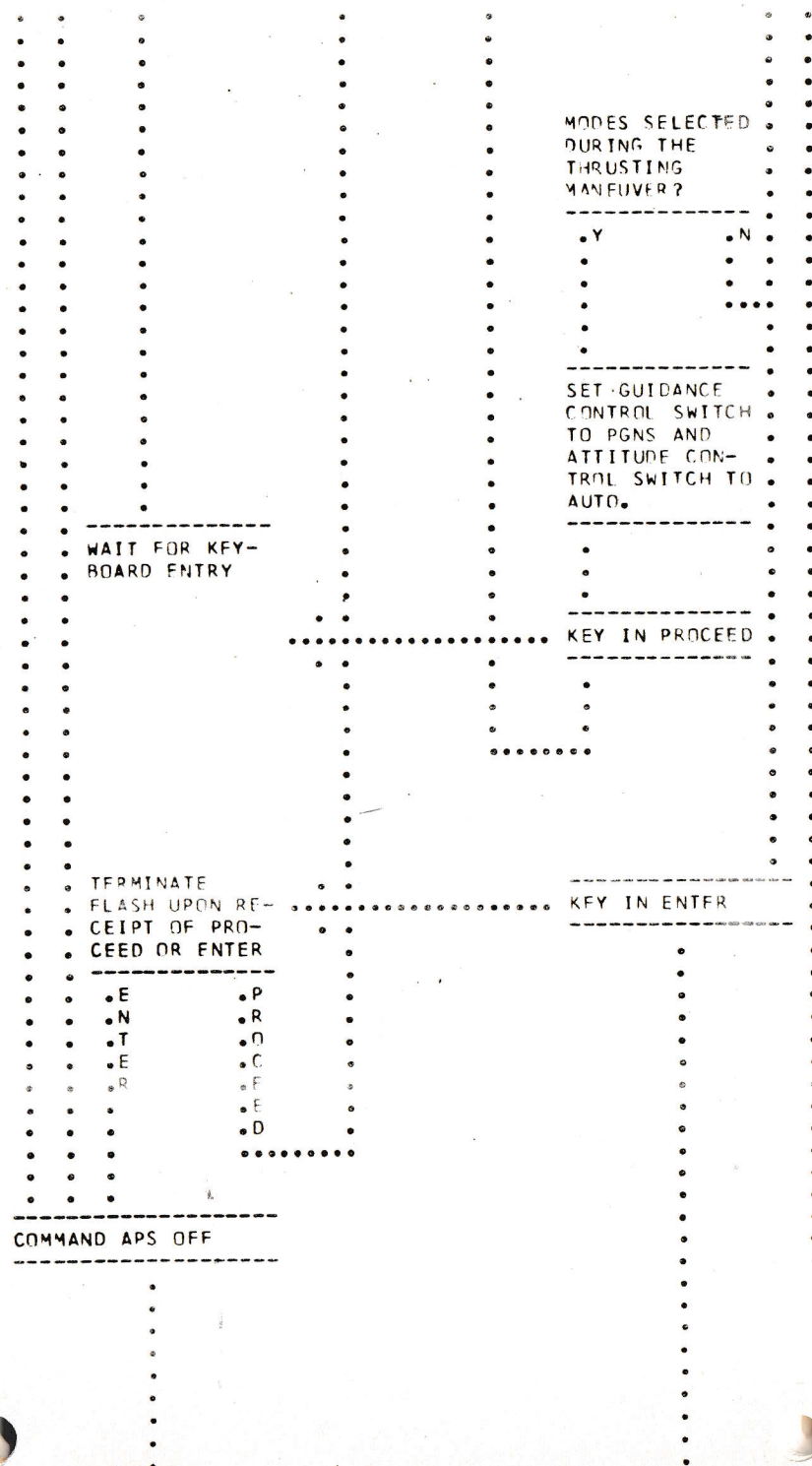
#360

#370

P42/LUMINARY

99

1000
19 90 f 24



#380

#390

#400

#410

#420

PCR 1096
Pg 10 of 24
347

99 345
P42/LUMINARY

TEMP

HOLD

MON

DISPLAY ON DSKY:

V-6 N4-

R1 - TFI

R2 - VG

R3 - DELTA VM

TFI - TIME FROM
APS IGNITION. IN
MIN, SEC TO NEAR-
EST SEC. MAX
READING IS 5999.
SIGN IS - BEFORE
NOMINAL TIG, +
THEREAFTER.

VG - MAGNITUDE OF THE
VELOCITY TO BE
GAINED BY THRUSTING
MANEUVER. IN FPS
TO NEAREST .1 FPS

DELTA VM-MEASURED
DELTA V MAGNITUDE
IN FPS TO NEAREST
.1 FPS. THIS
DISPLAY WILL BE
CLOCK UNTIL TIG-30
SEC AND THEN
SHOULD CHANGE ONLY
DUE TO PIPA BIAS
UNTIL HULLAGE IS
STARTED.

SFT TOFC1 = TIG-30
SECONDS

MONITOR DSKY:

OBSERVE DISPLAY OF
TFI, VG AND DELTA VM

UPDATE EVENT TIMER
IF DESIRED

#430

#440

#450

#460

#470

P42/LUMINARY
99

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DO STATE VECTOR
INTEGRATION (MID TO
AVE) ROUTINE (R41)
(NOTE: ENTER R41
AT "A".)

NO TIG.
TIG SLIP.
SLIP

(NOTE: R41 WILL
DEFINE TIG TO BE
THE TIME TO WHICH
R41 DID INTEGRATE
THE LM STATE VEC-
TOR PLUS 30
SECONDS.)

WAIT UNTIL TIG
-35 SEC

BLANK THE DSKY DIS-
PLAY (V,N,R1,R2, AND
R3).

WAIT UNTIL TIG
-30 SEC.

DO STATE VECTOR
INTEGRATION (MID TO
AVE) ROUTINE (R41)
OBSERVE THAT THE
COMPUTER ACTIVITY
LIGHT IS ON UNTIL
COMPLETION OF R41.

DIS ARM

ARM APS

CHECK STATUS OF C/W
LAMPS

MONITOR DSKY:
AT TIG -35 SEC OB-
SERVE DSKY DISPLAY
TO GO BLANK FOR 5
SECONDS.

#480

#490

#500

#510

#520

PCR 1096
Pg 12 of 24

IS THE PRESENT
PROGRAM ~~PL-23~~ 199

N Y.

SET THE APS FLAG

START AVERAGE G
INTEGRATION.

CALL 1/ACCS AND
INITIALIZE THE DAP.
(NOTE: NORMALLY THE
DAP IS INITIALIZED
BY DATA SELECTED VIA
R03, WHERE THE APS
FLAG IS SET OR RESET.
FOR THIS PROGRAM,
THE APS FLAG IS SET,
CAUSING THE CORRECT
DAP INITIALIZATION
DATA TO BE SELECTED
WITHOUT RECOURSE TO
R03.)

MONITOR DSKY:

AT TFI = - 0.029
ORSERVE RETURN OF
VIMAN4 DISPLAYS TO
INDICATE THAT AVER-
AGE G INTEGRATION
HAS STARTED.
(NOTE: IF TIG WAS
BEEN SLIPPED BY R41,
THE TFI DISPLAY (R1)
AT THIS TIME WILL BE
REFERRED TO THE NEW
TIG.)

IS THE PRESENT
PROGRAM P42?

.Y N.
.
.

PERFORM DPS
STAGING IF IT HAS
NOT ALREADY BEEN
DONE

#530

#540

#550

#560

#570

P42/LUMINAP

13 of 24

#580

MONITOR DSKY:
IN THE PERIOD FROM
TFI ==0830 UNTIL
TFI ==0815
DOES DELTA VM BECOME
GREATER THAN .5 FPS
INDICATING EXCESSIVE
PIPA BIAS ERROR?

#590

GO TO BACKUP
PROCEDURES

#600

WAIT UNTIL TIG=
-5 SEC.

FROM
R40

#610

RESET IGNITION FLAG

#620

RESET ASTRONAUT FLAG

WAIT UNTIL
RESET IMPULSE FLAG TIG-0

#630

COMMAND RCS THRUST

Reset IDLE FLAG

Reset Drift FLAG

TEMP
HOLD
MUN

CHANGE TFI DISPLAY
TO TFC IN R1
V06 N40
R1 - TFC
R2 - VG
R3 - DELTA VM

TFC - TIME FROM
ENGINE CUTOFF.
IN MIN AND SEC TO
NEAREST SEC. SIGN IS
- BEFORE AND + AFTER
CUTOFF.

MONITOR DSKY:
OBSERVE CHANGE OF
TFI DISPLAY TO TFC
IN PI
(NOTE: TFC IS IN-
INITIALLY CALCULATED
ONCE AND DISPLAYED.
THIS DISPLAY WILL
COUNT DOWN WITH
ELAPSED TIME UNTIL
TVC STEERING IS
INITIATED (STEER
FLAG IS SET BY P40)
AT WHICH TIME TFC IS
RECALCULATED AND
DISPLAYED EVERY 2
SECONDS BY THE
GUIDANCE EQUATIONS.)

IS TFC AT IGNITION
LESS THAN 6 SECONDS?

N Y

IS IMPULSE FLAG SET?

N Y
CALL FOR ENGINE
OFF COMMAND AT

#950

#960

#970

#980

#990

PCR 1096
P42

357

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• CALCULATED CUTOFF
• TIME. (SEE "D")
• BELOW
• (NOTE: PGNC'S WILL
• COMMAND INERTIAL
• VEHICLE ATTITUDE
• HOLD THROUGHOUT
• THRUSTING MAN-
• EUVER.)

• RESET IGNITION
• FLAG

• RESET ASTRONAUT
• FLAG

• RESET IMPULSE
• FLAG

• WAIT 0.5 SECONDS

• RESET ULLAGE
• FLAG

#1000

#1010

#1020

#1030

#1040

PCR 1076

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357

99 357
P47/LUMINARY

EXIT
(ENTER THIS IS
NOT A PROXIMITY
SIGNAL FOLLOW)

RESET IGNITION FLAG

RESET ASTRONAUT FLAG

RESET IDLE FLAG

CALL FOR RESET OF
ULLAGE FLAG IN 10
SEC.

THIS BURN IS A
MINIMUM IMPULSE
MANEUVER AND
WILL BE DONE AT
AN INERTIAL
FIXED VEHICLE
ATTITUDE

01050

01060

01070

01080

01090

P47/LUMINARY
99

1. PSKY:

01103

R3-DELTA VM
SHOULD INCREASE.

41112

3. APS CHAMBER PRES-
SURE (PG) SHOULD BE
NORMAL.

01120

• E • N • L
• A • O • A
• R • R • T
• L • M • E
• Y • • C
• C • U • U
• U • T • T
• T • F • F
• F • •

61130

01140

01150

01160

01170

01180

IS TG LESS THAN 4
SECONDS?

Y

N

CONTINUE GUIDANCE
CONTROL

CALL ENGINE IFF COM-
MAND AT COMPUTER

SEE DPS/APS
THRUST FAIL
ROUTINE (R40)
FOR REQUIRED
RESPONSE

PUSH ENGINE
STOP PUSH-
BUTTON

GO TO BACK-
UP PROCE-
DURES

PCR 1096
Pg 18 of 24

REC 1036
Pg 19 of 24

REQUIRED TIME

•
•
•

COMMAND ZERO ATTITUDE RATES

•
•
•

SFT IDLE FLAG

•
•
•
•
•
•

WAIT UNTIL COMPUTED TIME OF CUTOFF

•
•
•
•
•
•
•
•
•
•

FROM
ABOVE

COMMAND ENGINE OFF

•
•
•

COMMAND ZERO ATTITUDE RATES

•
•
•
•

SFT DEADBAND TO PREVIOUS VALUE

01197

01207

01210

01220

01230

01240

PCR 1096
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363

361
P42/LUMINARY
99

DEFINED BY P. 1.

MAINTAIN VG
COMPUTATIONS AFTER
CUTOFF FOR POSSIBLE
NULLING BY PCS
TRIMMING MANEUVER
(NOTE: SEE ASSUMP-
TION (2) ABOVE).

PC
FROM
ABOVE

COMMAND
ZERO ATT-
ITUDE
RATES

SET DEAD-
BAND TO
PREVIOUS
VALUE DE-
FINED BY
P. 1.

RESET
MULLAGE

DISARM APS

01250

01260

01270

01280

01290

P42/LUMINARY

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FLAG

TERMINATE
CALL FOR
SET OF
VILLAGE
FLAG AT
TIG-3.5
SEC YF
CALL NOT
YET DONE

"A"
FROM
ABOVE

HOLD

MON

FLASH VERB-NOUN TO
REQUEST PROCEED.
HOLD DISPLAY OF TFC
AT ITS FINAL VALUE:
V16 N40
R1 - TFC
R2 - VG
R3 - DELTA VM

(NOTE: SEE ASSUMP-
TION (2) ABOVE).

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PROCEED AND DISPLAY
OF TFC, VG, AND
DELTA VM

RECORD THESE VALUES
AS DESIRED.

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT OF PROCEED,

KEY IN PROCEED

#1300

#1310

#1320

#1330

#1340

363
P45/LUMINARY

01357

01367

01370

41380

01397

99

RECYCLE, OR
TERMINATE

• D	• T	• D
• R	• F	• F
• O	• D	• C
• C	• W	• Y
• F	• I	• C
• F	• N	• L
• O	• A	• F
•	• T	•
•	• F	•

GO TO
PAGE
BELOW

COMMAND ZERO ATTITUDE ERRORS

SET 0.3 DEGREES
DEAD BAND

HOLD . FLASH VERB-NOUN TO
 REQUEST RESPONSE AND
 MON . DISPLAY COMPONENTS
 OF VOLUME:

VIA NR5
R1-VGX(LM)
R2-VGY(LM)
R3-VGZ(LM)

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF VG(LM) COMPONENTS

COMPONENTS OF THE
PRESENT VG VECTOR
RESOLVED ALONG THE
LM X, Y, AND Z AXES.
THE VG VECTOR WILL
BE UPDATED BY THE
STEERING LOOPS
DURING EACH COMPUTA-
TION CYCLE. IN FPS
TO NEAREST .1 FPS.
(NOTE: SEE ASSUMP-
TION (2) ABOVE).

TO NULL OUT VG
COMPONENTS COMMAND
MANUAL TRANSLATIONS
AND ROTATIONS.
(NOTE: THIS MANEUVER
IS AT THE OPTION OF
THE CREW.)

01400

THE ORBITAL PARAME-
TER DISPLAY ROUTINE
(R30) MAY BE SELECT-
ED AT THIS TIME
(VP2E) TO MONITOR
CONTINUOUSLY UPDATED
VALUES OF APO ALT,
PER ALT, AND TFF.

01410

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT OF PROCEED,
RECYCLE, OR
TERMINATE

KEY IN PROCEED

01420

•P	•T	•R
•R	•F	•E
•D	•R	•C
•C	•M	•Y
•F	•I	•C
•F	•K	•I
•D	•A	•F
	•T	
	•E	
	

01430

01440



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307

Pg 2A of 2A

365
P42/LUMINARY
49

P42/LUMINARY

4

REF ID:
FROM
ABOVE

ER 74

ABOVE

ZERO RENDEZVOUS
TRACKING MARK
COUNTER

TRACKING MARK

COUNTER

SET DEADBAND
TO PREVIOUS VALUE
DEFINED BY R03.

TO PREVIOUS VALUE

DEFINED BY R03.

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (ROC)

REQUEST TERMINATE

ROUTINE (ROC)

EXIT P42

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R 0)

REQUEST TERMINATE

ROUTINE (R 41)

F x 117 P42

01452

#1460

61470

01480

CHANGE CONTROL NOTES

REV 00 PCR 41
REV 01 PCR 85, 86, 110, 147, 170, 156, 171, 212, 213, 214
REV 00 (LUM 1A) PCR 647, 648
REV 01 (LUM 1A) PCR 330, 331, 332, 333

REV 01 PCR 85, RA, 114, 147, 174, 154, 1, 213, 7, 347

REV 20 (LUM 1A) PCP 647, 1.49

REV 01 (LUM 19) PCB 3700, 01 11 1913L

P42/LUMINARY

2

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1097.2 REV 1

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☒ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

11-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1097.2 Rev 1		
1.0 COMPLETED BY ORIGINATOR						
1.1 ORIGINATOR M. Hamilton		DATE 11/2/70	1.2 ORGANIZATION MIT/DL		APPROVAL <i>[Signature]</i>	
1.3 EFFECTIVITY Luminary 1E		1.4 TITLE OF CHANGE Provide V30, V31 Operator Error Lockout				
1.5 REASON FOR CHANGE Provide V30, V31 lockout when the N26 program operation is not valid.						
1.6 DESCRIPTION OF CHANGE Provide check on R1 (PRIO/DELAY) to exit via operator error logic when R1 = 0.						
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT						
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:			
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF						
DATE						
3.0 MIT VISIBILITY IMPACT EVALUATION:						
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION			
3.3 STORAGE IMPACT Less than 10 words.			3.4 REMARKS: <i>N26 is now unshored</i>			
3.5 MIT COORDINATOR <i>[Signature]</i>						
DATE 11-2-70						
4.0 SOFTWARE CONTROL BOARD ACTION						
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS:			
4.3 SOFTWARE CONTROL BOARD SIGN OFF						
DATE 11-5-70						
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION						
5.1 MIT COORDINATOR			5.2 MIT EVALUATION			
DATE						
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION						
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:			
6.3 SOFTWARE CONTROL BOARD SIGN OFF						
DATE						

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1100

ANOMALY # _____

ADR # _____

☐ COLOSSUS 2E
☐ COLOSSUS 3
☐ COLOSSUS 3A
☐ COLOSSUS _____

☐ LUMINARY 1D
☒ LUMINARY 1E
☐ LUMINARY 1F
☐ LUMINARY _____

☐ MIT Approved PCN

☐ MIT Approved ADR

☒ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly

☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

11-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				Number (Completed by 150) 1100	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR P. Rye	DATE 10/20/70	1.2 ORGANIZATION MIT/CSDL	APPROVAL	DATE	
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Delete setting of NODOFLAG in R47.		
1.5 REASON FOR CHANGE A restart during the execution of R47 terminates the routine but leaves the NODOFLAG set, requiring selection of V96E or V37E00E or resclection of V47E before another major mode change.					
1.6 DESCRIPTION OF CHANGE Delete code which sets NODOFLAG in R47.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS: External verification of AGS acceptance of PGNS data should be made before selection of V37EXXE or in the case of a re-start.		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE 10-20-70					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SUMMARY IMPACT -4 fixed words			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 MIT SIGN OFF <i>[Signature]</i>			3.4 REMARKS: GAEC RUN		
DATE 10-20-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DISAPPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11-5-70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

DISAPPROVED

Page 1 of 3

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1106	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR C. Work		DATE 15 Oct. 1970		1.2 ORGANIZATION MIT/DL	
1.3 EFFECTIVITY Luminary 1E		1.4 TITLE OF CHANGE Trim gimbal control mode change			
1.5 REASON(S) FOR CHANGE Trim gimbal control of LM attitude, angular rate, and angular acceleration (called GTS attitude control) occupies about 6.5% of the total LGC execution time during descent in a lunar landing. Controlling the attitude and angular rate with the RCS					
1.6 DESCRIPTION OF CHANGE GTS acceleration nulling control would govern trim gimbal use in all powered descent situations except those in which GTS attitude control is mandatory, i.e. the CSM-docked mode or when the RCS jets are disabled. As a result, trim gimbal control in					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT Save about 20 words fixed			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION:					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DISAPPROVED			4.2 REMARKS: DIS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 3

PROGRAM CHANGE REQUEST NO. <u>1106</u>	PREPARED BY: _____ DATE: _____	ORGANIZATION: _____
---	-----------------------------------	---------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

Block 1.5, Reasons for change, cont.

jets alone and using the trim gimbals solely for directing the thrust vector through the c.g. (called GTS acceleration nulling control) would release about 2.5% of the total LGC execution time to non-DAP users.

Block 1.6, Description of change, cont.

both the AUTO and ATTITUDE HOLD modes would be identical to control exercised in LUMINARY 1D for the ATTITUDE HOLD mode, acceleration nulling drives executed every two seconds from 1/ACCS.

REMARKS

PCR 1106
Pg 3 of 3

For Information Only

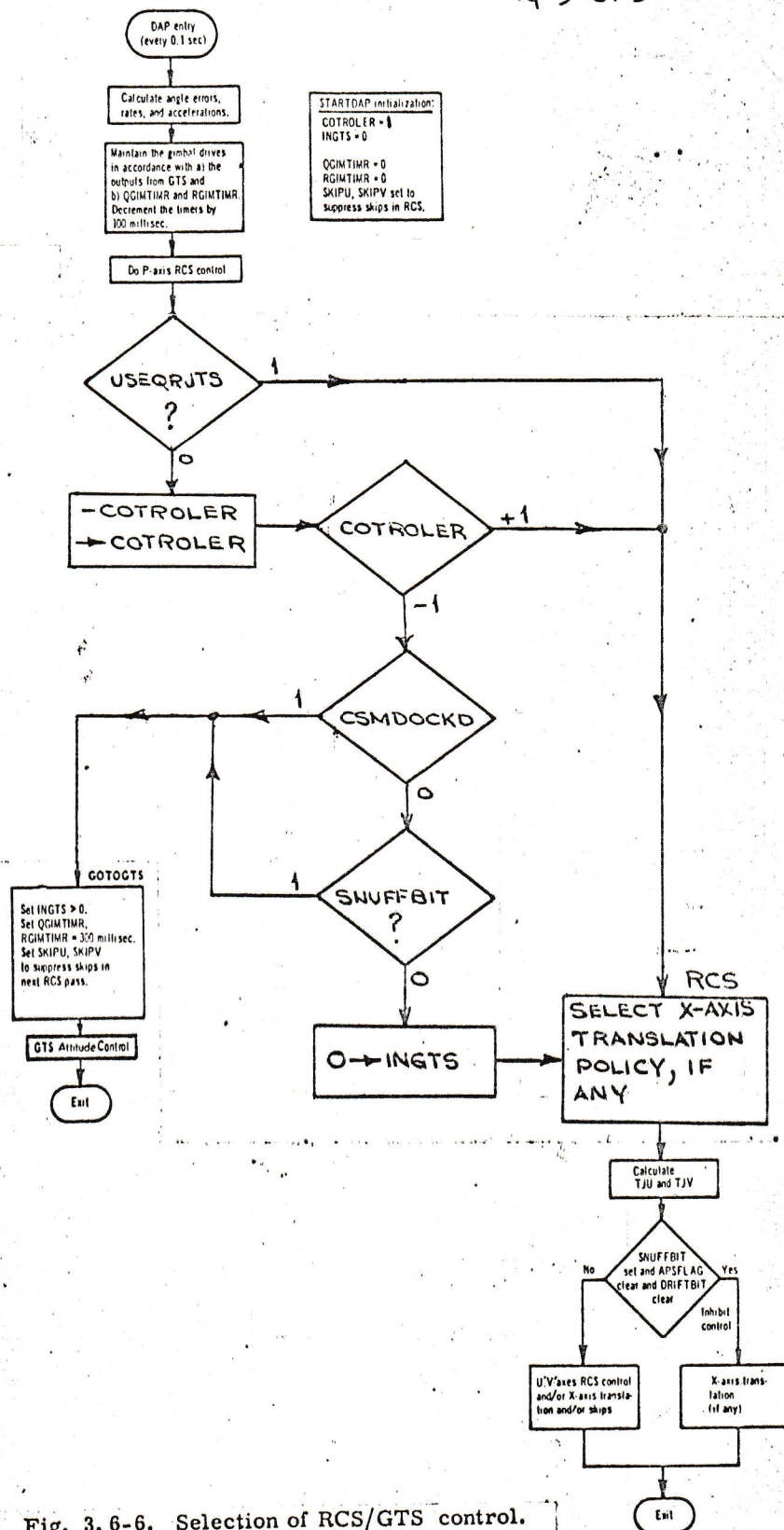


Fig. 3.6-6. Selection of RCS/GTS control.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1107

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☐ MIT Approved PCN

☐ MIT Approved ADR

☒ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

11-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				Revision (Completed by FSO) 1107	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR	DATE	1.2 ORGANIZATION	APPROVAL	DATE	
G. Edmonds, Jr.	22 Oct. 1970	MIT/DL			
1.3 TITLE OF CHANGE			1.4 TITLE OF CHANGE		
LUMINARY 1E			Back up of Abort bits Channel 30 Bits 1 and 4 for on (0)		
1.5 DESCRIPTION OF CHANGE If either of these bits fail on (0) undesired aborts will be initiated whenever a landing program is running.					
1.6 DESCRIPTION OF CHANGE Provide logic which can be set by the Astronaut which will cause the programs to ignore these bits. <i>a bit which says use or ignore ch 30/1,4</i>					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DISAPPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

DISAPPROVED

Page 1 of 1

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1108	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR		DATE	1.2 ORGANIZATION		APPROVAL
G. Edmonds, Jr.		22 Oct. 1970	MIT/DL		
1.3 EFFECTIVITY			1.4 TITLE OF CHANGE		
LUMINARY 1E			Back up Mark X, Y and Mark Reject Channel 16 Bits 3, 4, 5		
1.5 REASON(S) FOR CHANGE Failure of any of these bits will prevent IMU alignments using the AOT. (See STG Memo No. 1563 for more detail.					
1.6 DESCRIPTION OF CHANGE A back up procedure not involving the use of Mark X, Y or Mark reject will be provided.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11/5/70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1109
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Eyles

Program Supervisor's Approval: Bruce McCoy for W. Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: J. KLAWSNIK

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager Russell H. Larsen

Date 11-19-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1109	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR G. Edmonds, Jr.	1.2 DATE 22 Oct. 1970	1.3 ORGANIZATION MIT/DL	1.4 APPROVAL	1.5 DATE	
1.6 EFFECTIVITY LUMINARY 1E			1.7 TITLE OF CHANGE Back up of off (1) failures of <u>Auto Throttle</u> Channel 30 Bit 5		
1.8 REASON(S) FOR CHANGE If this bit fails off (1) Auto Throttle in descent will not be possible.					
1.9 DESCRIPTION OF CHANGE Provide logic which will cause the programs to regard this bit as set even though it has failed off (1). <i>a bit which says use ch 30/5 or assume Auto Throttle</i>					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT <i>5 WORDS</i>			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>P. H. Larson</i>			This is now DONE in P63, 64.		
DATE <i>10-26-70</i>					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE <i>11-5-70</i>					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1110
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Eyles

Program Supervisor's Approval: Bruce McCloy for M. Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: J. Klawnsnik

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager Russell H. Laro

Date 11-19-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				REVISION (Completed by RSN) 1110	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR	DATE	1.2 ORGANIZATION	APPROVAL	DATE	
G. Edmonds, Jr.	22 Oct. 1970	MIT/DL			
1.3 EFFECTIVITY			1.4 TITLE OF CHANGE		
LUMINARY 1E			Back up for failures of the display inertial data bit Channel 30 Bit 6		
1.5 REASON(S) FOR CHANGE					
If this bit fails desired displays will not be available. ALWAYS DISPLAY					
1.6 DESCRIPTION OF CHANGE					
Provide logic which will allow Astronaut to select display despite value of this bit. <i>The LSC will always attempt to display the inertial data.</i>					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
5 WORDS					
3.5 MIT COORDINATOR					
DATE					
10-26-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
11-5-70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1111
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: B. McCoy for M. Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on 11-10-70

Attendees:

G. Edmonds

D. Eyles

B. McCoy

et al

P. Weissman

P. Ryx

R. Larson

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 11-19-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				Number (Completed by 15b) 1111	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR G. Edmonds, Jr.	DATE 22 Oct. 1970	1.2 ORGANIZATION MIT/DL	APPROVAL	DATE	
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Back up failure of Auto Pilot mode and AGS/PGNS select switch bit Channel 30 Bit 10, Channel 31, Bits 13, 14		
1.5 REASON FOR CHANGE Failure of these bits will prevent selection of desired autopilot configuration.					
1.6 DESCRIPTION OF CHANGE Provide logic which can be configured by the Astronaut to select the desired modes regardless of the actual configuration of the bits.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT + 15 40 WORDS			3.4 REMARKS:		
3.5 MIT COORDINATOR V.H. Larson					
DATE 10-26-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DISAPPROVED			4.2 REMARKS Intent approved provided a minimum change is available and jointly agreed to by everyone.		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11-5-70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

DISAPPROVED

Page 1 of 1

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSD) 1112	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR G. Edmonds, Jr.		DATE 22 Oct. 1970		1.2 ORGANIZATION MIT/DL	
		APPROVAL		DATE	
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Back up for on (0) failures of translation commands Channel 31 Bits 7-12.		
1.5 REASON(S) FOR CHANGE On (0) failure of these bits will cause the PGNS to always turn on translation jets and so preclude use of the PGNS.					
1.6 DESCRIPTION OF CHANGE Provide logic which can be set by the Astronaut which will cause these bits to be ignored.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DISAPPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11/5/70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

WITHDRAWN

Page 1 of 1

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1113	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR G. Edmonds, Jr.		DATE 22 Oct. 1970	1.2 ORGANIZATION MIT/DL		APPROVAL DATE
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Back up failure of the LPD bit Channel 31 Bits 1, 2, 5 and 6.		
1.5 REASON(S) FOR CHANGE When one of these bits is set on (0) a monitor is started. If the bit is failed on (0) the monitor will run until the next V37 or restart and will use 3-4% of the available LGC time.					
1.6 DESCRIPTION OF CHANGE Provide logic which can be set by the Astronaut to cause the program to ignore these bits.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR			<i>Withdrawn (done by ACB)</i>		
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

DISAPPROVED

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1116	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR L. Berman		DATE 10/27/70	1.2 ORGANIZATION MIT/DL		APPROVAL
1.3 EFFECTIVITY Luminary 1E			1.4 TITLE OF CHANGE Automatic RCS Steering		
1.5 REASON FOR CHANGE To provide automatic steering and RCS translation for engine fail situations in Ascent where RCS must complete the maneuver - this will yield better propellant utilization than manually steered RCS					
1.6 DESCRIPTION OF CHANGE Additional coding to make proper bypass of thrust magnitude filter, and to provide new procedure as shown on next page.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE:					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 30 fixed			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE:					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS-APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11/5/70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

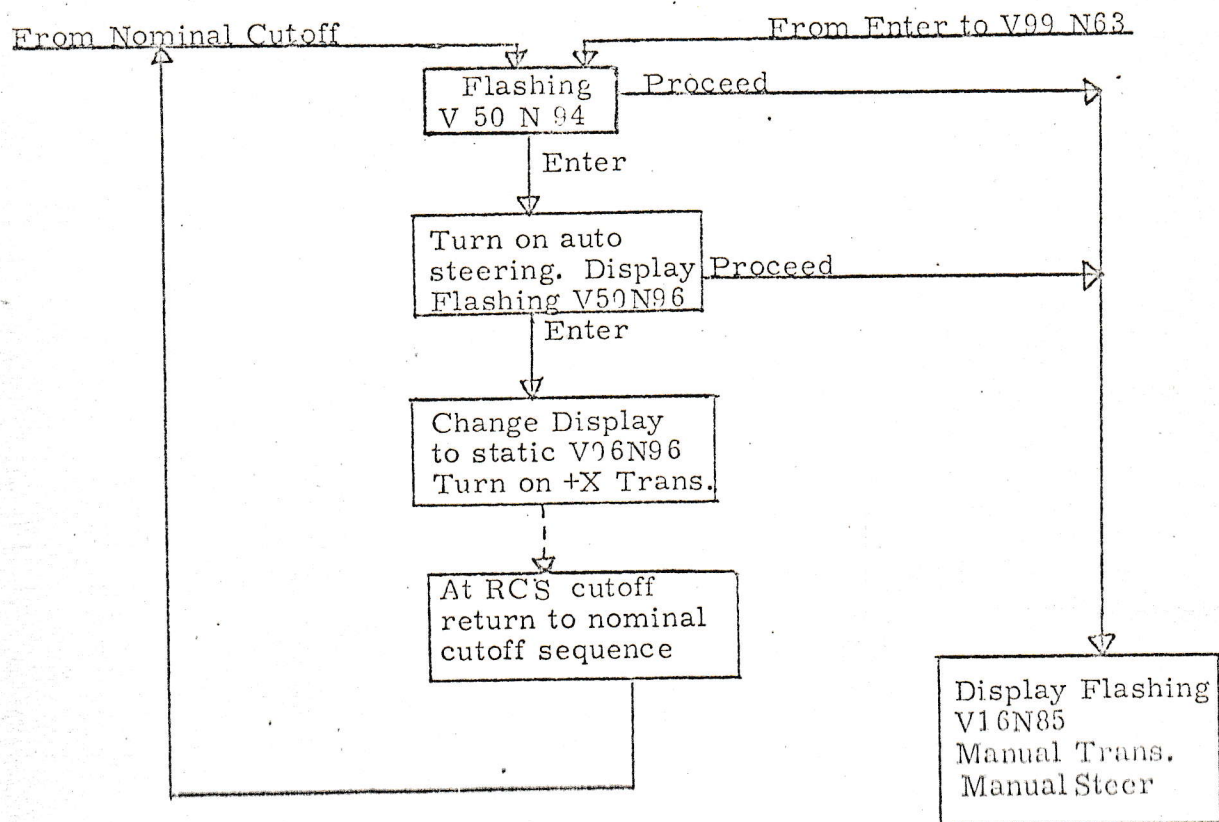
PROGRAM CHANGE
REQUEST NO. 1116

PREPARED BY: L. Berman

DATE: Oct. 27, 1977

ORGANIZATION:
MIT/DL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)



REMARKS

FP#21812

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1117.2

ANOMALY # _____

ADR # _____

☐ COLOSSUS 2E
☐ COLOSSUS 3
☐ COLOSSUS 3A
☐ COLOSSUS _____

☐ LUMINARY 1D
☒ LUMINARY 1E
☐ LUMINARY 1F
☐ LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: _____

Date: 11-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1117.2	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR Rye, Barnert & Hamilton	DATE 10/27/70	1.2 ORGANIZATION MIT	APPROVAL	DATE	
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Addition to POODOO logic; Add ABORT GSOP Description		
1.5 REASON FOR CHANGE Prevent POODOOS caused by extended verbs. Documentation of ABORT logic in the GSOP was not complete.					
1.6 DESCRIPTION OF CHANGE See amplification sheet					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT 0			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 4 words			3.4 REMARKS		
3.5 MIT COORDINATION					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input checked="" type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 11-5-70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATION			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

PRELIMINARY

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD -DATA AMPLIFICATION SHEET -

PAGE 2 OF 3

Hamilton

PROGRAM CHANGE REQUEST NO. <u>1117.2</u>	PREPARED BY: <u>Rye, Barnert,</u> DATE: <u>10/27/70</u>	ORGANIZATION: <u>MIT</u>
---	--	-----------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

Alarm conditions

1. Alarm conditions are indicated by lighting the PROG ALARM light and storing the appropriate alarm code so that it may be examined by keying V05N09E. In some special cases V05N09 is automatically displayed. The light is turned off and R1, R2 of N09 are cleared by the ERROR RESET key. For non-ABORT alarm conditions the normal program flow is not interrupted.

2. The ABORT type of alarm conditions preclude continuation of normal program flow; in these special cases recovery from the condition is accomplished by the software by means of a "software restart". These ABORT conditions are divided into two classes:

- a. "BAILOUT" alarms, designated by a five-digit alarm code with 3 as the first digit, e. g. 31201.

These alarms cause suspension of non-restartable program activity and continuation of only that program activity which is restartable. This type of alarm condition is generally due to temporary overloading of the system; the BAILOUT procedure will relieve the situation and allow continuation of the program.

- b. "POODOO" alarms, designated by a five-digit alarm code with 2 as the first digit, e. g., 21302.

These alarms are caused by conditions which are less likely to be correctable than the "BAILOUT" alarm conditions, e. g. inconsistencies in

REMARKS

TP#21812

PRELIMINARY

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

Hamilton.

PAGE 3 OF 3

PROGRAM CHANGE REQUEST NO. <u>1117.2</u>	PREPARED BY: <u>Rvc. Barnert</u> DATE: <u>10/27/70</u>	ORGANIZATION: MIT
---	---	----------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

mathematical calculations. Software recovery procedures for POODOOS depend on program environment at the time:

(1) If AVERAGE G is active, the guidance functions are terminated and the "BAILOUT" recovery procedure is followed.*

(2.) If an extended verb is active, the "BAILOUT" recovery procedure is followed.*

(3.) If neither of the above applies, current program flow is terminated and a flashing V37 is displayed, requesting astronaut selection of a new program.

3. Exit from a continuous "BAILOUT" loop can be accomplished by simultaneous depression of the ERROR RESET and MARK REJECT buttons, as in the case of a hardware restart loop. Exit from either a hardware or a software restart loop by means of the above will cause reinitialization of the software by a Fresh Start.

*When a POODOO abort condition triggers a BAILOUT recovery procedure, the POODOO alarm code is retained.

REMARKS

TP#21812

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1121

ANOMALY # _____

ADR # _____

- | | |
|--|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input checked="" type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☒ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

Samuel H. Lerner
11-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1121

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR P. Weissman	DATE 10/26/70	1.2 ORGANIZATION MIT/DL	APPROVAL <i>R. H. Larson</i>	DATE 11-3-70
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1.3 EFFECTIVITY

Luminary 1E

1.4 TITLE OF CHANGE Replace acceleration estimate with RCS inhibit flags on non-powered downlists.

1.5 REASON(S) FOR CHANGE CH5MASK and CH6MASK indicate which RCS jets are to be considered disabled by the autopilot. It is a standard procedure for the crew to modify these flags via the DSKY. In view of the critical nature of these words, it is desirable for the ground to be able to check their contents.

1.6 DESCRIPTION OF CHANGE Replace the angular acceleration estimate ALPHAQ, ALPHAR (word 89) with CH5MASK, CH6MASK in the "coast and align," "rendezvous and pre-thrust" and "lunar surface" downlists. The acceleration estimate is identically zero when these lists are used.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT2.1 ☐ APPROVED ☐ DISAPPROVED

2.2 REMARKS:

2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE
BRANCH SIGN OFF

DATE:

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT

3.2 IMPACT OF PROVIDING DETAILED EVALUATION

3.3 STORAGE IMPACT

3.4 REMARKS:

3.5 MIT COORDINATOR

DATE

11-3-70

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND
PROVIDE DETAILED
CHANGE EVAL. ☐ PROVIDE
DETAILED
CHANGE
EVALUATION ☐ DIS-
APPROVED

4.2 REMARKS:

4.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

11-5-70

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR

5.2 MIT EVALUATION

DATE

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION6.1 ☐ START OR CONTINUE
IMPLEMENTATION ☐ DISAPPROVED OR STOP
IMPLEMENTATION

6.2 REMARKS:

6.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1122

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR P.S. Weissman	DATE 11/2/70	1.2 ORGANIZATION MIT/DL	APPROVAL <i>[Signature]</i>	DATE 11-3-70
1.3 EFFECTIVITY Luminary 1E		1.4 TITLE OF CHANGE "No Control" DSKY Light		

1.5 REASON FOR CHANGE Provide an indication to the crew of whether or not the PGNCs Minimum Impulse mode is in effect; provide an immediate warning of switch or bit failures that turn the autopilot off; make it clear when the DAP is disabled because of IMU moding.

1.6 DESCRIPTION OF CHANGE Light the unused DSKY light whenever the PGNCs autopilot is not controlling the LM attitude, that is, whenever the DAP is idling or is in the Minimum Impulse mode. Extinguish it in all other modes.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SUMMARY IMPACT 14 fixed words.	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 MIT COORDINATOR <i>[Signature]</i>	3.4 REMARKS:
DATE 11-3-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input checked="" type="checkbox"/> DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 11/5/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

~~PCR~~/PCN # 1124
ANOMALY # _____
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

MIT-PCN

☒ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☐ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: Margaret H. Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 11-12-70

MIT-PCN

SEE L-1D-15

Page 1 of 1

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by PSB) 1124	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR Barnert		DATE 10/8/70	1.2 ORGANIZATION MIT		APPROVAL <i>R.H. Larson</i>
					DATE 11-12-70
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Flag Resetting in POODOO Abort		
1.5 REASON(S) FOR CHANGE POODOO Abort kills P20 (P25) but does not reset flags. This is a GSOP change to fix L-1D-15.					
1.6 DESCRIPTION OF CHANGE Reset TRACKFLG RNDVZFLG, P25FLAG in P00D00 Abort.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE:					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>R.H. Larson</i>					
DATE 11-12-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/DL PROGRAM CHANGE ROUTING SLIP

~~PCR~~/PCN # 1126
ANOMALY # _____
ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

MIT-PCN

- | | | |
|--|--|---|
| <input checked="" type="checkbox"/> MIT Approved PCN | <input type="checkbox"/> NASA Approved PCR | <input type="checkbox"/> NASA Approved Software Anomaly |
| <input type="checkbox"/> MIT Approved ADR | <input type="checkbox"/> NASA Approved PCN | <input type="checkbox"/> MIT Approved Software Anomaly |

A. Coding

☐ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

GSOP ONLY

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

J. KLAWNSNIK

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager [Signature]

Date 11-23-78

MIT-PCN

Page 1 of 3

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1126	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR B. McCoy		DATE 11/18/70	1.2 ORGANIZATION MIT/DL		APPROVAL <i>R.H. Larrow</i>
				DATE 11-23-70	
1.3 EFFECTIVITY LUMINARY 1E (Apollo 15)			1.4 TITLE OF CHANGE Set NOTHROTL for DPS Impulse Burns		
1.5 REASON FOR CHANGE Change Sections 2 and 5 of GSOP to conform with correctly documented Section 4. (See Anomaly L-1D-14).					
1.6 DESCRIPTION OF CHANGE See attached GSOP change pages.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT 0			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 0			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>R.H. Larrow</i>					
DATE 11-23-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT-PCN

PCR 1126

Pg 20F3

Word NumberContents39-44
(Cont'd)FlagwordBitMeaning

4

6

PINBRFLG. Set to 1 if it is concluded that "interference" with the internally generated display has taken place (e.g. an enter verb was used but the associated noun was not that requested by the program when the internally generated display was produced), or if a termination for an extended verb/mark routine is performed with bit 14 or bit 13 of this word = 1. Bit reset to 0 upon successful conclusion of a priority or normal display after having been used to bypass internal checks that otherwise would cause a program abort.

4

5

MRUPTFLG. Set to 1 if a mark/extended verb display or display attempt has been interrupted by a priority display.

4

4

NRUPTFLG. Set to 1 if a normal display or display attempt has been interrupted by a priority display or by a mark/extended verb display.

4

3

MKOVFLAG. Set to 1 briefly if a mark/extended verb display is to interrupt a normal display (used to control internal program branching, whereupon it is reset to 0).

4

2

Not used.

4

1

XDSPFLAG. Set to 1 to indicate that a mark display status exists. This will lock out normal displays.

5

15

DSKYFLAG. A 1 means displays sent to DSKY. A 0 means no displays sent to DSKY. Set to 1 (if 0) by subroutine of the Keyrupt routine. Subroutine of T4RUPT program branches according to DSKYFLAG setting.

5

14

Not used.

5

13

SNUFFER. Bit is set to 1 to inhibit RCS control about the U and V axes during unstaged powered flight. Set to 0 by Verb 75. Set to 1 by Verb 65.

5

12

NOTHROTL. Bit is set to 1 to indicate that the length of the burn for P40 (based on 10% throttle) is ^{less than} ~~in the interval of 6 to~~ 95 seconds. If the burn is found greater than 95 seconds, the engine will be throttled to maximum in the number of centi-seconds after ignition contained in ZOOMTIME. Bit is set unconditionally to 0 in S40.13 for P40 and then reset to 1 if the burn length is ^{less than} ~~in the 6-95 second range~~. Bit is set to 1 for P42, although not functional. Bit is also set to 0 at the start of P40 and P63.

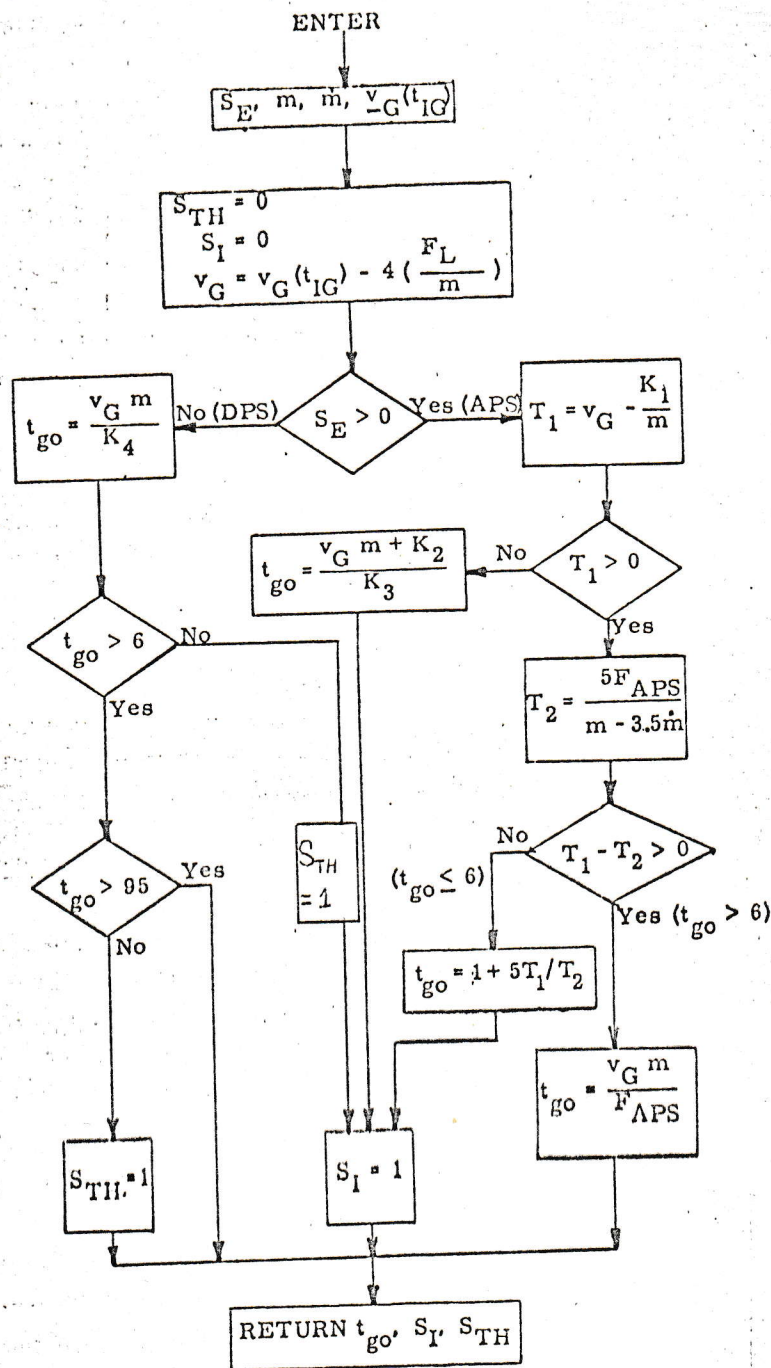


Figure 3.3-11 Time-to-go Predictor Routine

MIT/DL PROGRAM CHANGE ROUTING SLIP

~~PCR~~/PCN # 1127

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☒ MIT Approved PCN

☐ MIT Approved ADR

☐ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly

☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Sharon Albert

Program Supervisor's Approval: Margaret A. Hamel

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: J. Klawnsnik

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R.H. Larson

Date 11-30-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1127	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR R. Larson		DATE 11/24/70	1.2 ORGANIZATION MIT/DL	APPROVAL <i>R.H. Larson</i>	DATE 11-24-70
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Change to downlink list		
1.5 REASON(S) FOR CHANGE Put CHANBKUP on DOWNLINK					
1.6 DESCRIPTION OF CHANGE Modify word 62 of all downlists to transmit CHANBKUP, FAILREG					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE:					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT 0			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>R.H. Larson</i>					
DATE 11-24-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1129	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR Work/Weissman		DATE 11/30/70	1.2 ORGANIZATION MIT/DL		APPROVAL <i>R.H. Larson</i>
				DATE 12-1-70	
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Update mass-dependent calculations in 1/ACCS		
1.5 REASON(S) FOR CHANGE See page 2					
1.6 DESCRIPTION OF CHANGE See page 3					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT None			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT None			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>R.H. Larson</i>					
DATE 12-1-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DISAPPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

1.5 Reasons for change

The control authorities of the RCS jets and the GTS gimbal drives are calculated as functions of mass and of vehicle configuration in the 1/ACCS routine. The constants used in these calculations have not been changed since Apollo 9 (SUNDANCE). The addition of the Rover and the associated enlargement of the DPS tanks in LM 10 have caused appreciable changes in the mass properties. Calculations of the control authorities based upon the latest SODB data for LM 10 shows differences from the values computed in 1/ACCS of up to 11% for the descent LM configuration. This is excessive for a nominal error.

The 1/ACCS values match the SODB data for the staged LM 10 to within 3%. In view of the 10% uncertainty in the SODB data, it is proposed to leave unchanged the constants used in the ascent computations.

Table 3.3-1. The constants used in connection with the generalized hyperbolic equation.

Identification of Constants by Use		Values
For Use in the Jet-Acceleration Calculations Associated with the LM Ascent Configuration	P axis	a = 0.0065443852
		b = 0.000032
		c = -0.006923
	Q axis	a = 0.0035784354
		b = 0.162862
		c = 0.002588
	R axis	a = 0.0056946631
		b = 0.009312
		c = -0.023608
For Use in the Jet-Acceleration Calculations Associated with the LM Descent Configuration	P axis	a = .0071756944
		b = 0.0
		c = .0460844
	Q axis	a = .0014551624
		b = .0183742
		c = -.0605832
	R axis	a = .0008936540
		b = .0226132
		c = -.0680959
For Use in the Descent-Engine Moment-Arm Calculation		a = .0197118964
		b = .1937973
		c = -.0735453
The following scaling is employed in connection with these constants:		
1) The mass m is scaled at 2^{16} kg.		
2) For jet accelerations, which are scaled at $\pi/4$ rad/sec ² ,		
a is scaled at $(\pi/4) 2^{16}$ kg rad/sec ² ,		
b is scaled at $\pi/4$ rad/sec ² , and		
c is scaled at 2^{16} kg.		
3) For jerk accelerations, in which the distance L is scaled at 8 ft,		
a is scaled at $8(2^{16})$ ft kg,		
b is scaled at 8 ft, and		
c is scaled at 2^{16} kg.		

MIT/DL PROGRAM CHANGE ROUTING SLIP

~~PCR~~/PCN # 1132

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

- ☒ MIT Approved PCN
☐ MIT Approved ADR

- ☐ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

- ☐ Begin coding immediately

NO CODING CHANGE

ACTION: _____

Program Supervisor's Approval: _____

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☒ Prepare GSOP revisions for MDRB consideration

J. KLAWSNIK / J. B. SMITH

ACTION: _____

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager Dwight H. Larson
Date 12-29-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1132

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR	DATE	1.2 ORGANIZATION	APPROVAL	DATE
Rye/Barnert	12/21/70	MIT/DL	<i>R. H. Larson</i>	12-29-70

1.3 EFFECTIVITY	1.4 TITLE OF CHANGE
LUMINARY 1E	Correction to PCR 1117.2 "Addition to P00D00 Logic, Add Abort GSOP Description."

1.5 REASON(S) FOR CHANGE To correct an error in the "Description of Change " in
PCR 1117.2.

1.6 DESCRIPTION OF CHANGE

See Amplification Sheet.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>Russell H. Larson</i>	
DATE 12-29-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE
REQUEST NO. 1132

PREPARED BY: Rye/Barnert
DATE: 12/21/70

ORGANIZATION:
MIT/DL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1. 6 Description of Change

Page 3 of 3 on PCR 1117.2 should be amended to read as follows:

mathematical calculations. Software recovery terminates current program flow and a flashing V37 is displayed*, requesting the astronaut to exit the current program.

If "Average G" is active, P00D00 alarms will retain the basic "Average G" cycle (without guidance functions), during the Powered Descent, the Abort monitor is also retained, but the LR navigation (R12) is terminated.

3. Exit from a continuous "BAILOUT" loop can be accomplished by simultaneous depression of the ERROR RESET and MARK REJECT buttons, as in the case of a hardware restart loop. Exit from either a hardware or a software restart loop by means of the above will cause re-initialization of the software by a Fresh Start.

*If an Extended Verb is active, the "BAILOUT" recovery procedure is followed to prevent Extended Verb Routines from terminating mission programs. In this instance, the P00D00 alarm code is retained.

REMARKS

TP#21812

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR
~~PCR~~ # 1134
 ANOMALY #
 ADR #

- | | |
|--------------------------------------|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS | <input type="checkbox"/> LUMINARY |

1133 follows 1134
 in this book only

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- VERBAL
☒ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION:

Program Supervisor's Approval:

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☒ Prepare GSOP revisions for MDRB consideration

ACTION:

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on
 Attendees:

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION:

D. Other Programs Affected

- ☐ Review for corresponding changes in

ACTION:

Special Instructions

Project Manager

Date

Russell H. Larson
 12-30-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1134

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR P.S. Weissman	DATE 12/29/70	1.2 ORGANIZATION MIT/DL	APPROVAL <i>R.H. Larson</i>	DATE 12-30-70
---------------------------------	------------------	----------------------------	--------------------------------	------------------

1.3 EFFECTIVITY LUMINARY 1E	1.4 TITLE OF CHANGE Revision of PCR 1111; Back-up of Guid Select and Mode Control switches
--------------------------------	--

1.5 REASON(S) FOR CHANGE Avoid the substantial impact required for implementing and testing PCR 1111 as originally conceived; also, cover failures during powered flight that are not dealt with by the original PCR 1111.

1.6 DESCRIPTION OF CHANGE

See Page 2

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 ☐ APPROVED ☐ DISAPPROVED

2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF

DATE:

2.2 REMARKS:

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT

3.2 IMPACT OF PROVIDING DETAILED EVALUATION

3.3 STORAGE IMPACT

3.4 REMARKS:

3.5 MIT COORDINATOR

DATE

12-30-70

*Verbal approval by
W Tindall on 11-13-70*

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED

4.2 REMARKS:

4.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE:

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR

5.2 MIT EVALUATION

DATE

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION

6.2 REMARKS:

6.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE
REQUEST NO. 1134

PREPARED BY: P. Weissman

DATE: 12/29/70

ORGANIZATION:
MIT/CSDL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.6 Description of Change

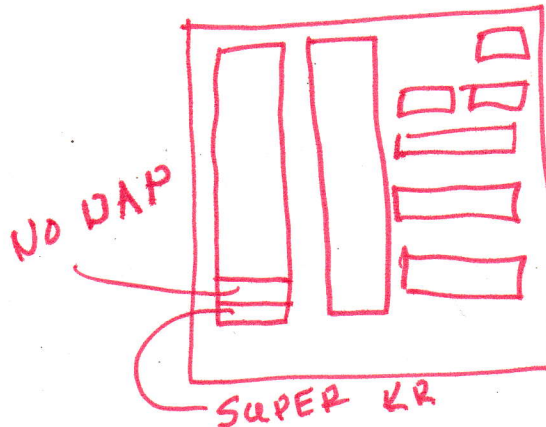
1. Do not use the crew input word, CHANBKUP, to back up either the Guid Select or the Mode Control switch.

2. Cause the autopilot to function and the powered flight steering routine (FINDCDUW) to issue commands without regard to the status of Channel 30 bit 10 (from the Guid Select switch) except for the following:

a) FINDCDUW will continue to set up the coordinate frame for the thrust direction filter on the basis of the CDUs (as opposed to the CDUDs) when AGS is indicated;

b) the autopilot will reinitialize itself when the indication is seen to go from AGS to PGNCS.

3. Light an unused DSKY light (DSPTAB + 11D/bit 2) whenever the PGNCS DAP is not controlling the LM attitude. The light will be lit during the Minimum Impulse mode as well as the Idling mode; it will be extinguished in all other modes.



REMARKS

TP#21812

MIT/DL PROGRAM CHANGE ROUTING SLIP

~~PCR~~/PCN # 1133

ANOMALY # _____

ADR # _____

- | | |
|--|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input checked="" type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☒ MIT Approved PCN

☐ MIT Approved ADR

☐ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly

☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

Russell H. Laroo
12-30-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1133	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR P. S. Weissman		DATE 12/28/70	1.2 ORGANIZATION MIT/DL		APPROVAL <i>R. H. Larson</i>
1.3 EFFECTIVITY LUMINARY 1E		1.4 TITLE OF CHANGE Revision of descent mass limits to go along with PCR 1129			
1.5 REASON(S) FOR CHANGE The new control authority computations of PCR 1129 require a lower bound on the unstaged LM mass value that is slightly higher than the current limit in order to avoid overflow in 1/ACCS.					
1.6 DESCRIPTION OF CHANGE 1. Change LODESCNT, the assumed mass of the descent stage alone, to 2542 kg (5604 lb) 2. Change the lower limit on unstaged mass in 1/ACCS and RO3 to 6560 kg (14462lb)					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT NONE			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.4 STORAGE IMPACT NONE			3.3 REMARKS: <i>Verbal by T. P. on 12-28-70</i>		
3.5 MIT COORDINATOR <i>Russell H. Larson</i>					
DATE 12-30-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

The 1/ACCS Routine

PCN 1133

Pg 2 of 2.

Another part of the SERVICER program is the 1/ACCS routine, the primary function of which is to compute the control effectiveness of the LM DAP as a function of the vehicle mass, the unfailed jets, the configuration, and other such factors. In addition to being executed as part of the SERVICER program every 2 seconds during powered-flight mission phases, 1/ACCS is called several times during a mission when certain discrete events occur, such as restarts, fresh starts, detection of disabled jets, data load by crew (Routine 03), resetting of the attitude deadband, and the turning-off of the main engine. Also, prior to lunar lift-off, the ignition logic of the powered-ascent program (P12) loads the bias angular accelerations of the state estimator from the prior estimates given in pad-loaded erasables IGNAOSQ and IGNAOSR. This is followed by an execution of 1/ACCS that establishes the proper ascent control effectiveness.

The first thing done in 1/ACCS is a determination of the vehicle configuration on the basis of APSFLAG and CSMDOCKD. The LM mass limits and the mass-to-inertia coefficients to be used in 1/ACCS itself are selected on this basis.

Next, the mass of the LM alone is separated out as follows:

- a) For the LM-alone case, LM mass = total mass.
- b) For the CSM-docked case, LM mass = total mass - CSM mass.

The LM mass, which is displayed and loaded in Routine 03, is therefore kept updated during burns as though it were maintained directly in the SERVICER program.

There is a check on the LM mass in the 1/ACCS routine that serves to keep this critical parameter within a reasonable range despite any possible error in the initialization, in the Routine 03 load, or in SERVICER maintenance. It also results in an automatic correction of the mass when staging occurs, since the old, descent value is too high for the ascent stage alone.

The following limits on the LM mass have been implemented:

Highest descent mass = 33,730 lb

Lowest descent mass = ⁵⁶⁰⁴~~3850~~ lb + HIASCENT

Highest ascent mass = HIASCENT

Lowest ascent mass = 4850 lb

HIASCENT was made a pad-loaded erasable quantity so that it can reflect the ascent fuel loading used in each particular flight. Its value for a fully loaded ascent stage is about 11,133 lb, and it is so initialized in a fresh start (to be over-written by the erasable load shortly thereafter). HIASCENT should not be less than ⁸⁸⁵⁰~~7265~~ lb, in order that the minimum descent mass will not be too low. When the LM mass is found to violate a limit, its value is changed to equal the limit (maximum or minimum); the total mass is changed correspondingly.

3.6-8

Revised ☐

LUMINARY 1A

Added ☒

CSOP # R-567

PCN # 717

Rev. 1

Date 5/7/69

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1137

ANOMALY # _____

ADR # _____

☐ COLOSSUS 2E

☐ LUMINARY 1D

☒ COLOSSUS 3

☒ LUMINARY 1E

☐ COLOSSUS 3A

☐ LUMINARY 1F

☐ COLOSSUS _____

☐ LUMINARY _____

REISSUED
1/22/71

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ MIT Approved ADR

☒ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☐ Begin coding immediately

GSOP ONLY

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

J. KLAUSNIK / J. SMITH.

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager [Signature]

Date 1-12-71

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1137	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR P. Volante		DATE 1-12-71	1.2 ORGANIZATION MIT		APPROVAL <i>[Signature]</i>
1.3 EFFECTIVITY LUMINARY 1E		1.4 TITLE OF CHANGE Correct constant for ascent guidance.			
1.5 REASON FOR CHANGE GSOP correction					
1.6 DESCRIPTION OF CHANGE The required injection down-range velocity, Z_D , in section 5.3.5.3, and Section 4(P12) should be changed to 5509.5 FPS (from 5509.3 FPS). (cont.)					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 VISIBILITY IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS		
3.5 MIT COORDINATOR <i>[Signature]</i>					
DATE 1-12-71					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. <u>1137</u>	PREPARED BY: <u>P. Volante</u> DATE: <u>1-12-71</u>	ORGANIZATION: <u>MIT</u>
---	--	--------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

- 1.6 See Anomaly L-1D-16; this was fixed in Luminary 1E. The GSOP for 1D was changed to reflect the incorrect value of the Luminary 1D assembly

REMARKS

TP#21812

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1147

ANOMALY # _____

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☒ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date 1-22-71

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1141	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR B. McCoy		DATE 1/22/71	1.2 ORGANIZATION MIT/DL		APPROVAL <i>Russell H. Larson</i>
1.3 EFFECTIVITY LUMINARY 1E		1.4 TITLE OF CHANGE Initialize FLRCS in P12			
1.5 REASON(S) FOR CHANGE One wrong key stroke (Enter to V99) will cause P12 to target INSERTION based on RCS thrust only.					
1.6 DESCRIPTION OF CHANGE Clear FLRCS in P12 before targetting.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT 12 DAYS			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 1.0 WORD			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>Russell H. Larson</i>					
DATE 1-22-71					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/DL PROGRAM CHANGE ROUTING SLIP

~~PCR~~/PCN # 1143
ANOMALY # _____
ADR # _____

☐ COLOSSUS 3 ☒ LUMINARY 1E
☐ COLOSSUS _____ ☐ LUMINARY _____
☐ SKYLARK _____

☒ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☐ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

GSOP ONLY

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

J. KLAWSNIK

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. Larson KWS

Date 2/18/71

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1143	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR J. Klawnsnik		DATE 2/16/71	1.2 ORGANIZATION MIT/DL		APPROVAL R. Larson KWS
					DATE 2/18/71
1.3 EFFECTIVITY LUMINARY 1E			1.4 TITLE OF CHANGE Section 3 Revision 6 GSOP Changes		
1.5 REASON(S) FOR CHANGE To improve technical content of the document.					
1.6 DESCRIPTION OF CHANGE See Amplification Sheet					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT H			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT H			3.4 REMARKS:		
3.5 MIT COORDINATOR R. Larson KWS					
DATE 2/18/71					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. <u>1143</u>	PREPARED BY: <u>J. Klawnsnik</u> DATE: <u>2/16/71</u>	ORGANIZATION: <u>MIT/DL</u>
---	--	--------------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

In addition to changes of an editorial or format nature, perform the following:

- 3.2-19 Note that the crew can prohibit or allow use of jets via DSKY.
(also 3.6-6)
- 3.3-9 Value for K near bottom of page should be 21.4×10^3 .
- 3.4-37 At bottom of second paragraph, changed sentence in parenthesis to read:
..... is completed about the P axis. (For three-axis control, the JUSTIN bit
will be reset by the Q,R axes, rather than at this point, once the damping process
is also initiated about the Q,R axes). Next, the
- 3.6-6 Note that RCS isolation valves removed on LM-10 and later vehicles.
- 3.6-7 Change #1 to indicate R40.
- 3.6-12,23,24,26 Use XOVINHIB as new name for LPD Phase.
- 3.6-24 Correct the description of PULSES.

REMARKS

TP#21812

PCR/PCN # 1147

ANOMALY # _____

ADR # _____

☐ COLOSSUS 3☒ LUMINARY 1E☐ COLOSSUS _____☐ LUMINARY _____☐ SKYLARK _____

RE ISSUED - 4/8/71

(NOTE CHANGE TO LAST LINE
ON PAGE 2 of THE PCN)
KUG.☒ MIT Approved PCN☐ NASA Approved PCR☐ NASA Approved
Software Anomaly☐ MIT Approved ADR☐ NASA Approved PCN☐ MIT Approved
Software AnomalyA. Coding☐ Begin coding immediately

ACTION: _____

GSOP only

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT
Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☒ Prepare GSOP revisions for MDRB
consideration

ACTION: _____

J. Klawnsnik / E. Olson☐ Technical Committee Meeting not required.☐ Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC
testing and checkout

ACTION: _____

D. Other Programs Affected☐ Review for corresponding changes in _____

ACTION: _____

Special InstructionsProject Manager J. KlawnsnikDate 4-8-71

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1147	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR R. Larson/K. Greene		DATE 4/5/71	1.2 ORGANIZATION MIT/DL		APPROVAL <i>[Signature]</i>
1.3 EFFECTIVITY LUMINARY 1E		1.4 TITLE OF CHANGE Clarification of the Implementation of PCR 334 Rev 1 "Change DSKY Descent/Ascent Nouns"			
1.5 REASON(S) FOR CHANGE The intent of PCR 334 Rev 1 was accomplished in Luminary 1E, but not as initially specified. This PCN is to clarify the implementation by MIT/DL.					
1.6 DESCRIPTION OF CHANGE See Attached Sheet					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT <i>[Signature]</i>			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT <i>[Signature]</i>			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>[Signature]</i>					
DATE 4-6-71					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE
REQUEST NO. 1147

PREPARED BY: Larson/Greene

DATE: 4/5/71

ORGANIZATION:
MIT/DL

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.6 Cont'd

- 1) PCR 334 Rev 1 stated: "The new normal ascent/abort display (N94) should contain the quantity used to insure proper cutoff (i. e. ΔVG_x). N77 R2 should be changed to display ΔVG_y in body coordinates instead of V_y in local vertical coordinates."

The nomenclature ΔVG_x , ΔVG_y , and ΔVG_z was not used in the documentation of this change, $VG_x(LM)$, $VG_y(LM)$ and $VG_z(LM)$ was utilized. The GSOP states: $VG_x(LM)$ components of the present VG vector resolved along the LM X, Y, Z axes. The VG vector will be updated during each computation cycle.

- 2) NOTE I e on PCR 334 Rev 1 read: "N85 should remain callable in ascent/abort programs and descent programs other than P63".

This should read: "N85 should remain callable in ascent and abort programs."

REMARKS

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1148
ANOMALY # _____
ADR # _____

☐ COLOSSUS 3 ☒ LUMINARY 1E
☐ COLOSSUS _____ ☐ LUMINARY _____
☐ SKYLARK _____

☒ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☐ Begin coding immediately

GSOP ONLY

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

J. KLAWSNIK

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager Samuel H. Larson

Date 4-20-71

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1148	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR P. Volante		DATE 4/14/71	1.2 ORGANIZATION MIT		APPROVAL RHL
					DATE 4-20
1.3 EFFECTIVITY LUM 1E			1.4 TITLE OF CHANGE Add FRSTIME flag definition to section 2 GSOP.		
1.5 REASON FOR CHANGE The attempted fix of Anomaly L-1D-17 defined a new flag in order to eliminate sharing of a flag by P20/P22 N54 computations and R26.					
1.6 DESCRIPTION OF CHANGE Add flag description to Section 2 GSOP (See page 2 for description)					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR R. H. Lannon					
DATE 4-20-71					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS- APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. <u>1148</u>	PREPARED BY: <u>P. Volante</u> DATE: <u>4/14/71</u>	ORGANIZATION: <u>MIT/CSDL</u>
---	--	----------------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.6 Continued

Flagword

Bit

1

4

FRSTIME.Bit is set to 1 during P22 when the line of sight is not in Rendezvous Radar Mode 2 coverage (the Predesignate Routine, R26, is necessary). A 1 indicates that LOS has not yet been found inside Mode 2 coverage. Bit is reset to 0 by R26 when line of sight is inside Mode 2 coverage; another line of sight computation is done before continuous designation starts. A 0 indicates that the LOS has been found to be inside Mode 2 coverage by R26. Tested by R26.

REMARKS

TP#21812

ANOMALIES FIXED

ANOMALY

L-1D-01 - SS

02 - SS

03 - Release

04 - PCR 287

05 - PCR 287

06 - SS

07 - SS

08 - PCR 1028

~~09~~

10 - SS

11 - PCR 986.2 WB miscalled

12 - ACB L-15

13 - PCR - 1028

14 - SS

15 - SS

16 - VO

17

18 - SS

19

20 - SS

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1D-01
PROGRAM LUMINARY 1D
PROGRAM REVISION 163

1.1 ORIGINATOR: Garman, J. R.	1.2 ORGANIZATION: FSD/FS5	1.3 DATE: 5/12/70	1.4 ORIGINATOR CONTROL NO.
1.5 DESCRIPTION OF ANOMALY: "NEEDLER" initialization never takes place following DAP turn-on if IMU error counters (CH 12 B 06) are enabled. This causes cells EDRIVE to be improperly loaded and cause a bias (constant except where changed due to DAC overflow) in the ATTITUDE ERROR NEEDLES. <div style="text-align: right;">CONTINUED ON PAGE</div>			
1.6 DESCRIPTION OF RUN: Apollo 13: Crew turned on LGC with DAP OFF. They did a P52 option 1 which included a coarse align. This left CH 12 B 06 set so that "NEEDLER" did not properly initialize when DAP was subsequently turned on. <div style="text-align: right;">CONTINUED ON PAGE</div>			
- MIT ANALYSIS -			
2.1 CAUSE: Proper initialization of the FDAI needle display only occurs when 1. The LGC is on, 2. The PGNCs mode select switch is not "Off", <div style="text-align: right;">CONTINUED ON PAGE 2</div>			
2.2 RECOGNITION: Constant bias in the needles; needles not nulled at the attitude reached by the DAP. <div style="text-align: right;">CONTINUED ON PAGE</div>			
2.3 MISSION EFFECT: Crew has an incorrect indication of the attitude error. <div style="text-align: right;">CONTINUED ON PAGE</div>			
2.4 AVOIDANCE PROCEDURE: 1. Do not coarse align with the PGNCs mode select switch "Off". 2. After LGC power up (or a verb 43) do coarse align or CDU zero with PGNCs not "Off". <div style="text-align: right;">CONTINUED ON PAGE</div>			
2.5 RECOVERY PROCEDURE: Do a CDU zero (V40N20) with the PGNCs attitude mode select switch not turned to "Off". <div style="text-align: right;">CONTINUED ON PAGE</div>			
2.6 PROGRAM CORRECTION: Set RCSFLAGS/bit3 to call for NEEDLER initialization whenever the mode select switch is found "Off" (in addition to the present logic). <div style="text-align: right;">CONTINUED ON PAGE</div>			
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Ensure that Apollo 14 checklists follow "avoidance procedure". Fix in LUMINARY 1E. <div style="text-align: right;">CONTINUED ON PAGE</div>			
2.8 RECOMMENDED RE-TESTING: Limited testing on hybrid to show that various sequences all give valid needles. <div style="text-align: right;">CONTINUED ON PAGE</div>			
3.1 NASA DIRECTION:		2.9 MIT/IL SIGNATURE: <i>K. A. Larson</i>	2.10 DATE: 7-8-70
CONTINUED ON PAGE		CONTINUED ON PAGE	
3.2 NASA/MSR SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:
			4.3 ORGANIZATION:
			4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

REPORT NO.
L-1D-01

1.1 ORIGINATOR:

Garman, J.R.

1.2 ORGANIZATION:

FSD/FS5

1.3 DATE:

5/12/70

1.4 ORIGINATOR
CONTROL NO.PROGRAM
LUMINARY 1D
PROGRAM REVISION 163

2.1 continued

3. Either IMODES 33/bit 6 is set (DAP disabled by IMU routines)
or channel 12/bit 6 is reset (IMU error counters disabled).

This initialization should be done whenever the NEEDLER routine may not have proper knowledge of the voltages to the FDAI needles; thus, it should be done after any IMU coarse align (which uses those same voltages to drive the IMU), a V43 (test of the FDAI needles), or a power-down of the needles' digital-to-analog converter.

As noted in block 1.6, in Apollo 13, P52 was done while the DAP was still "Off". Consequently, the setting and resetting of the two bits mentioned above did not serve to trigger the needed initialization.

MIT/DI, PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-118-02
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input checked="" type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

RE-118-02

<input type="checkbox"/> MIT Approved PCN	<input type="checkbox"/> NASA Approved PCR	<input type="checkbox"/> NASA Approved Software Anomaly
<input type="checkbox"/> MIT Approved ADR	<input type="checkbox"/> NASA Approved PCN	<input checked="" type="checkbox"/> MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 10-6-70

This anomaly was initially
counted with R. Larson's name
to his on 15. It is being
re-counted to show the
anomaly to Roger Barnett.

1.1 ORIGINATOR: N. Barnert/P. Rye		1.2 ORGANIZATION: MIT/CSDL		1.3 DATE: 5/19/70		1.4 ORIGINATOR CONTROL NO.		1.5 PROGRAM LUMINARY					
1.5 DESCRIPTION OF ANOMALY: It is possible that a core set overflow (31202 Abort) will result from a "bad" return from pulse torquing due to IMU cage or coarse align.								PROGRAM REVISION: ALL					
1.6 DESCRIPTION OF RUN: Satanche Level 3 test										CONTINUED ON PAGE			
- MIT ANALYSIS -													
2.1 CAUSE: "LGYRO" not zeroed if pulse torquing ends due to cage or coarse align; subsequent jobs attempting torquing will stack up via JOBSLEEP.												CONTINUED ON PAGE	
2.2 RECOGNITION: 31202 Abort												CONTINUED ON PAGE	
2.3 MISSION EFFECT: Software restart caused by 31202 abort cleans up the problem, but further calls (by gyro compensation during average G) will refill the core sets, causing repeated overflows.												CONTINUED ON PAGE	
2.4 AVOIDANCE PROCEDURE: Do not coarse align during Average G; or else set GCOMPSPW negative. Zero LGYRO whenever cage is pushed.												CONTINUED ON PAGE	
2.5 RECOVERY PROCEDURE: Set GCOMPSPW negative (terminates compensation):												CONTINUED ON PAGE	
2.6 PROGRAM CORRECTION: Clear LGYRO and wake possible sleeping jobs before exiting pulse torquing routine.												CONTINUED ON PAGE	
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Luminary 1E												CONTINUED ON PAGE	
2.8 RECOMMENDED RE-TESTING: Level 2 test.												CONTINUED ON PAGE	
3.1 NASA DIRECTION:						2.9 MIT/IL SIGNATURE: <i>P. H. Larson</i>			2.10 DATE: 7-8-70				
3.2 NASA/IL SIGNATURE:						4.1 CLOSING ACTION TAKEN:			CONTINUED ON PAGE				
3.3 ORGANIZATION			3.4 DATE:			4.2 SIGNATURE:			4.3 ORGANIZATION				
4.4 DATE:			4.5 SIGNATURE:			4.6 ORGANIZATION			4.7 DATE:				

PCR/PCN # _____
ANOMALY # L-10-04
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input checked="" type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR☐ NASA Approved PCR
☐ NASA Approved PCN☐ NASA Approved Software Anomaly
☒ MIT Approved Software AnomalyA. Coding☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.☐ Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: _____

Date: 7-8-70

1.1 ORIGINATOR: P. Volante		1.2 ORGANIZATION: MIT/DL		1.3 DATE: 6/26/70		1.4 ORIGINATOR CONTROL NO.		PROGRAM LUMINARY			
1.5 DESCRIPTION OF ANOMALY:								PROGRAM REVISION 173			
P25 will not control spacecraft attitude if range to CSM is greater than 566 N. M.											
CONTINUED ON PAGE											
1.6 DESCRIPTION OF RUN:											
N/A											
CONTINUED ON PAGE											
- MIT ANALYSIS -											
2.1 CAUSE:											
Coding error - P20/P22 logic is also being applied to P25.											
CONTINUED ON PAGE											
2.2 RECOGNITION:											
After selection of P25, no attitude changes occur; possible alarm light (code 526)											
CONTINUED ON PAGE											
2.3 MISSION EFFECT:											

CONTINUED ON PAGE											
2.4 AVOIDANCE PROCEDURE:											
R63 can be used to position Z-axis along line-of-sight											
CONTINUED ON PAGE											
2.5 RECOVERY PROCEDURE:											
None											
CONTINUED ON PAGE											
2.6 PROGRAM CORRECTION:											
Restore RNDVZFLG check to LPS20.1 subroutine.											
CONTINUED ON PAGE											
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):											
Fix for 1E; work-around for 1D											
CONTINUED ON PAGE											
2.8 RECOMMENDED RE-TESTING:											
P25 with range > 400 N. M.											
CONTINUED ON PAGE					2.9 MIT/DL SIGNATURE: <i>[Signature]</i>						
					2.10 DATE: 7-6-70						
3.1 NASA DIRECTION:					4.1 CLOSING ACTION TAKEN:						
CONTINUED ON PAGE					CONTINUED ON PAGE						
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION:		4.4 DATE:	

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.
L-1D-05

1.1 ORIGINATOR: P. Volante	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 6/22/70	1.4 ORIGINATOR CONTROL NO.	PROGRAM LUMINARY PROGRAM REVISION 173
-------------------------------	-----------------------------	----------------------	-------------------------------	--

1.5 DESCRIPTION OF ANOMALY:

The following extended verb routines should not be requested if P20 or P22 is running and the range to the CSM is greater than 400 N. M.

R04 (V63)	LR/RR self-test	V67	W-matrix monitor
R05 (V64)	S-band antenna	V85	Mode II RR position display
R30 (V82)	Apogee/Perigee display		
R31 (V83)	Range/Range rate display		
R47 (V47)	AGS initialization		

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN:

N/A

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE:

Erasable conflict

CONTINUED ON PAGE

2.2 RECOGNITION:

Incorrect computations by these routines, also noun 54 display in P20/P22 incorrect.

CONTINUED ON PAGE

2.3 MISSION EFFECT:

Bad AGS update if V47 requested.

CONTINUED ON PAGE

2.4 AVOIDANCE PROCEDURE:

Do not select extended verbs while in P20/P22 with range > 400 N. M.

CONTINUED ON PAGE

2.5 RECOVERY PROCEDURE:

Terminate extended verb

CONTINUED ON PAGE

2.6 PROGRAM CORRECTION:

Change erasable assignments to avoid conflict.

CONTINUED ON PAGE

2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):

Work-around for 1D fix in 1E

CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING:

Select above extended verbs in P22 while N54 is being displayed

CONTINUED ON PAGE

2.9 MIT/IL SIGNATURE:



2.10 DATE:

7-6-70

3.1 NASA DIRECTION:

4.1 CLOSING ACTION TAKEN:

CONTINUED ON PAGE

CONTINUED ON PAGE

3.2 NASA/MSC SIGNATURE:

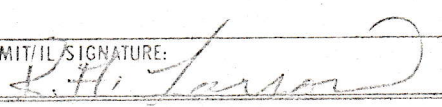
3.3 ORGANIZATION:

3.4 DATE:

4.2 SIGNATURE:

4.3 ORGANIZATION:

4.4 DATE:

1.1 ORIGINATOR: McCoy	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 6/29/70	1.4 ORIGINATOR CONTROL NO.	1.5 DESCRIPTION OF ANOMALY: "DVTOTAL", the accumulated measured Delta Velocity from SERVICER, incremented twice in one SERVICER cycle after Restart occurred.
				CONTINUED ON PAGE
1.6 DESCRIPTION OF RUN: FMES P40 simulation at GAC				
- MIT ANALYSIS -				
2.1 CAUSE: DAS instruction to DVTOTAL performed twice - no Phase change immediately following.				
2.2 RECOGNITION: R3 of N40 at end of burn \neq R2 of N40 at start of burn				
2.3 MISSION EFFECT: None - downlist quantity may show extra ΔV (≈ 10 fps) if Restart occurred during Powered Flight				
2.4 AVOIDANCE PROCEDURE: None				
2.5 RECOVERY PROCEDURE: None				
2.6 PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction				
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E				
2.8 RECOMMENDED RE-TESTING: Trace DAS instruction after Restart				
2.9 MIT/IL SIGNATURE: 				2.10 DATE:
3.1 NASA DIRECTION:				4.1 CLOSING ACTION TAKEN:
CONTINUED ON PAGE				CONTINUED ON PAGE
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION:	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION: 4.4 DATE:

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-10-07

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

R. H. Larson
7-8-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: G. R. Kalan		1.2 ORGANIZATION: MIT/Draper Lab		1.3 DATE: 6/18/70		1.4 ORIGINATOR CONTROL NO.	
						MIT REPORT NO. I-1D-07 PROGRAM Luminary PROGRAM REVISION 173	
1.5 DESCRIPTION OF ANOMALY: If the mode control switch is moved from the ATT. HOLD to the AUTO position before the manual rate command mode has been properly terminated and while X-axis override is inhibited: 1) A short RCS jet firing (15 sec. maximum) may occur about the yaw axis if the mode control switch is later returned to the ATT. HOLD position or if the X-axis override inhibition is removed. <div style="text-align: right;">CONTINUED ON PAGE 2</div>							
1.6 DESCRIPTION OF RUN: Examination of coding							
- MIT ANALYSIS -							
2.1 CAUSE: 1) When the manual rate command mode is improperly terminated by switching to the AUTO mode control switch position while <div style="text-align: right;">CONTINUED ON PAGE 2</div>							
2.2 RECOGNITION: 1) A short yaw RCS firing at switch to ATT. HOLD or automatic removal of X-axis override inhibition. <div style="text-align: right;">CONTINUED ON PAGE 2</div>							
2.3 MISSION EFFECT: Possible unexpected RCS firing or yaw maneuver at switch to ATT. HOLD or automatic removal of X-axis override inhibition.							
2.4 AVOIDANCE PROCEDURE: Wait at least 5 sec before switching mode control switch to AUTO position after returning ACA to detent following manual rate command maneuvers.							
2.5 RECOVERY PROCEDURE: 1) No recovery procedure necessary 2) Move ACA rapidly out of detent and back in yaw axis (a natural reaction).							
2.6 PROGRAM CORRECTION: Reset OURRCBIT whenever mode control switch is in AUTO position while X-axis override is inhibited. <div style="text-align: right;">CONTINUED ON PAGE 2</div>							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Work around in Luminary 1D Fix in Luminary 1E							
2.8 RECOMMENDED RE-TESTING: Verify that anomaly has been properly fixed in Luminary 1E before release. <div style="text-align: center;">CONTINUED ON PAGE</div>							
3.1 NASA DIRECTION:				2.9 MIT/IL SIGNATURE: <i>R. H. Targen</i>		2.10 DATE: 7-7-70	
				4.1 CLOSING ACTION TAKEN:			
CONTINUED ON PAGE				CONTINUED ON PAGE			
3.2 NASA/MSO SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:	
						4.3 ORGANIZATION:	
						4.4 DATE:	

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR:
G. R. Kalan

1.2 ORGANIZATION:
MIT/Draper Lab

1.3 DATE:
6/18/70

1.4 ORIGINATOR
CONTROL NO.

MSC REPORT NO.
L-10-07

PROGRAM
LUMINARY

PROGRAM REVISION
173

1.5 Cont.

2) The LM may yaw to a different attitude (180° max) when the X-axis override inhibition is removed if the direct rate damping phase of the manual rate command mode is active for the Q or R axis at the time of the switch to AUTO. During P 64, for example, if:

1. The Mode Control Switch is moved to the ATT. HOLD position.
2. A 10° /sec pitch rate is commanded with the ACA.
3. The ACA is snapped back into detent position.
4. The Mode Control Switch is moved back to the AUTO position within 1 sec of the return to detent.
5. The yaw attitude is changed due to lateral redesignations.

When P66 is subsequently entered, the X-axis override inhibition is automatically removed. The vehicle will then yaw to the yaw reference attitude that existed when the Mode Control Switch was in the ATT. HOLD position.

2.1 Cont.

X-axis override is inhibited, OURRCBIT remains set. Consequently if the X-axis override inhibition is removed or if the mode control switch is moved back to the ATT. HOLD position, the P-axis manual rate command mode coding is entered immediately without the proper initialization. Thus, the manual P-axis attitude error, DXERROR, remains equal to the change in P-axis attitude since the improper termination of the manual rate command mode. If DXERROR is greater than the deadband, RCS jets may fire for up to 0.150 sec to reduce DXERROR. On the next DAP pass the manual rate command mode will be terminated properly, and the attitude hold mode will be entered.

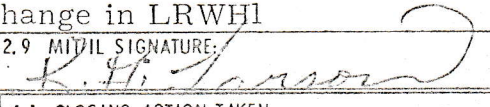
- 2) If the direct rate damping phase of the manual rate command mode is active for the Q or R axis at the time of the switch from the ATT. HOLD to the AUTO mode control switch position while X-axis override is inhibited, QRBIT as well as OURRCBIT remains set and JUSTIN bit remains reset. When the X-axis override inhibition is removed, the P-axis manual rate command coding is immediately entered without initializing DXERROR. As in case 1, the RCS jets will fire to reduce DXERROR. Because JUSTIN is reset and QRBIT is set, however, the manual rate command mode cannot be terminated unless the mode control switch is moved back to the ATT. HOLD position (so that the QR axis manual coding will be exercised and QRBIT will be reset). Consequently, the DAP will yaw the vehicle until DXERROR is reduced to zero, then hold the new yaw attitude in the pseudo auto manual rate command mode.

2.2 Cont.

- 2) Yaw to new attitude at automatic removal of X-axis override inhibition.

2.6 Cont.

Reset QRBIT during rate damping in X-axis override mode.

1.1 ORIGINATOR: B. McCoy		1.2 ORGANIZATION: MIT/DL		1.3 DATE: 6/24/70	1.4 ORIGINATOR CONTROL NO.	MSC REPORT NO. L-1D-08 PROGRAM Luminary 1D PROGRAM REVISION 173
1.5 DESCRIPTION OF ANOMALY: <div style="text-align: center; padding: 20px;"> Padload "LRWH1" shares erasable memory location with RM of P20. </div>						
CONTINUED ON PAGE						
1.6 DESCRIPTION OF RUN: <div style="text-align: center; padding: 20px;"> Eyeball </div>						
CONTINUED ON PAGE						
- MIT ANALYSIS -						
2.1 CAUSE: <div style="text-align: center; padding: 20px;"> see 1.5 above </div>						
CONTINUED ON PAGE						
2.2 RECOGNITION: <div style="text-align: center; padding: 20px;"> eyeball </div>						
CONTINUED ON PAGE						
2.3 MISSION EFFECT: If P20 is selected before PDI to track CSM, the LR weighting function in P64 and P66 may affect navigation.						
CONTINUED ON PAGE						
2.4 AVOIDANCE PROCEDURE: <div style="text-align: center; padding: 20px;"> Load LRWH1 prior to PDI: V21NOIE3756EXXXXXXE </div>						
CONTINUED ON PAGE						
2.5 RECOVERY PROCEDURE: <div style="text-align: center; padding: 20px;"> Load LRWH1: V21NOIE3756EXXXXXXE </div>						
CONTINUED ON PAGE						
2.6 PROGRAM CORRECTION: <div style="text-align: center; padding: 20px;"> Move LRWH1 to unshared memory. </div>						
CONTINUED ON PAGE						
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): <div style="text-align: center; padding: 20px;"> Program note for 1D; fix for 1E. </div>						
CONTINUED ON PAGE						
2.8 RECOMMENDED RE-TESTING: Simulate landing sequence and show no change in LRWH1						
CONTINUED ON PAGE					2.9 MIT/DL SIGNATURE: 	
					2.10 DATE: 7-6-70	
3.1 NASA DIRECTION: <div style="text-align: right;">CONTINUED ON PAGE</div>					4.1 CLOSING ACTION TAKEN: <div style="text-align: right;">CONTINUED ON PAGE</div>	
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION	4.4 DATE:	

MSC REPORT NO.
L-1D-10
PROGRAM
Luminary
PROGRAM REVISION
through 175

MSC Form 1409 (Rev May 68)

MIT/IL SOFTWARE ANOMALY REPORT

I.1 ORIGINATOR: P.S. Weissman	I.2 ORGANIZATION: MIT/DL	I.3 DATE: 8/24/70	I.4 ORIGINATOR CONTROL NO.	MSC REPORT NO. L-1D-10 PROGRAM Luminary PROGRAM REVISION through 175
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It also computes various quantities which effectively determine the placement and curvature of the switch curves in the RCS phase plane on the basis of jet control authorities, the current attitude deadband, the vehicle configuration, whether it is powered or coasting flight, and jet failures. 1/ACCS should be executed whenever any of its inputs change. Hence, it is done in SERVICER after the mass is decremented and a job to do it is set up by the routines which change the deadband and the various discrete inputs.

If one of these jobs is wiped out by a change in major mode, some change in data may not have been effectively assimilated into the autopilot. Specifically,

- 1) abnormal exits from a powered flight program (including a V34 response to a flashing V97 or V99) could leave an improper deadband and/or the powered flight configuration of the RCS control law;
- 2) termination of P20 or P25 could leave a 0.3 degree deadband if R23 or R60 were in progress;
- 3) termination of routine 03 at the second display (N47) by change in major mode would prevent any desired changes to the deadband or the vehicle configuration from being incorporated into the phase plane and the rate estimator;
- 4) a change in major mode immediately after an RCS isolation valve was opened or closed would prevent the proper modification to the RCS phase plane logic. (The window for this is extremely small.)

B. Another problem could arise if a restart occurred in a certain part of the Lunar Surface Navigation Program, P22, with the range greater than 400 nautical miles and a positive range rate. Immediately following such a restart, coding would be entered via the phase table which would terminate P22 and, in the process, wipe out waiting jobs. Since a restart calls for a 1/ACCS job and clears the ACCSOKAY bit (DAPBOOLS/bit 3,) the DAP will idle until the 1/ACCS is done. If the P22 exit comes in while that 1/ACCS is in the queue of waiting jobs, it will wipe it out (together with the rest of the queue). Thus, the DAP will be left idling, waiting for a job which has gotten "lost". It will idle until 1/ACCS is done by some other routine - e.g. RO3 or the initiation of AVERAGEG. Since P22 is only done on the lunar surface, when the DAP is not needed, it seems quite certain that the occurrence of this case would have no effect at all on the mission.

MIT/TL SOFTWARE ANOMALY REPORT

3

I.1 ORIGINATOR: P. S. Weissman	I.2 ORGANIZATION: MIT/DL	I.3 DATE: 8/24/70	I.4 ORIGINATOR CONTROL NO.
			MSC REPORT NO. L-10-10-0 <hr/> PROGRAM Luminary PROGRAM REVISION through 175

2.2 Recognition

The various cases given in the Description will be treated separately.

A1) The crew or the ground might notice the discrepancy in the deadband because either the DAP was allowing the attitude error to grow larger than expected or the DAP was firing to correct attitude errors that were smaller than the expected deadband.

A2) Same as A1 except that the expected deadband would always be larger or equal to the deadband in effect.

A3) Same as A1 for deadband changes. Errors in configuration could result in extremely sloppy control or even instability.

A4) Some extra chattering of the RCS jets.

B) Console light(s) in the Mission Control Center would be lit. Also, if such a lock-out were accomplished and some activity which required the DAP were then carried out without first doing Routine 3 or in some other way causing 1/ACCS to be done, then it would be found that the DAP was not performing its function. One possible lunar surface activity that uses the DAP is an RCS test.

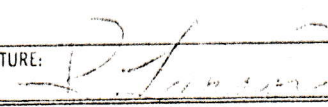
2.4 Avoidance Procedures

The crew can avoid the particular procedures that lead to the difficulties of case A. Specifically, the following should be avoided:

- 1) exits from powered flight programs after the pre-burn attitude is calculated that do not go through the final displays of that program;
- 2) termination of P20 or P25 during the execution of R23 or R60;
- 3) termination of R03 by a change in major mode;
- 4) change in major mode within a second of operating an RCS isolation valve.

There is no avoidance procedure for case B.

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: R. Larson		1.2 ORGANIZATION: MIT/DL		1.3 DATE: 9/11/70		1.4 ORIGINATOR CONTROL NO.	
1.5 DESCRIPTION OF ANOMALY: The value of W_B is mis-scaled in Luminary 1D by a factor of 2 (See Luminary MEMO #169)						MSC REPORT NO. L-1D-11	
						PROGRAM LUMINARY 1D PROGRAM REVISION REV. 178	
CONTINUED ON PAGE							
1.6 DESCRIPTION OF RUN: Eyeball (Reported in comments to MIT from MSC)							
CONTINUED ON PAGE							
- MIT ANALYSIS -							
2.1 CAUSE: Error in preparation of PCR to change the LOSSEM Ephemeris Number.							
CONTINUED ON PAGE							
2.2 RECOGNITION: Error when an approximate position vector of the moon is computed in LSPOS							
CONTINUED ON PAGE							
2.3 MISSION EFFECT: Bad alignment if the sun and moon are used.							
CONTINUED ON PAGE							
2.4 AVOIDANCE PROCEDURE: See 2.5							
CONTINUED ON PAGE							
2.5 RECOVERY PROCEDURE: The ground can transmit a very accurate Moon position vector if that body should be desired for alignment.							
CONTINUED ON PAGE							
2.6 PROGRAM CORRECTION: Correct scaling of W_B							
CONTINUED ON PAGE							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Luminary 1E. These numbers have to be changed for a new year for Apollo 15.							
CONTINUED ON PAGE							
2.8 RECOMMENDED RE-TESTING:							
CONTINUED ON PAGE						2.9 MIT/IL SIGNATURE: 	
3.1 NASA DIRECTION:						2.10 DATE: 9/11/70	
						4.1 CLOSING ACTION TAKEN:	
CONTINUED ON PAGE								CONTINUED ON PAGE
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION:		3.4 DATE:		4.2 SIGNATURE:	
						4.3 ORGANIZATION:	
						4.4 DATE:	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-1D-12

ADR # _____

☐ COLOSSUS 2E

☐ LUMINARY 1D

☐ COLOSSUS 3

☒ LUMINARY 1E

☐ COLOSSUS 3A

☐ LUMINARY 1F

☐ COLOSSUS _____

☐ LUMINARY _____

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved
Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☒ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: Margaret Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Lander

Date 9-18-70

L-ID-12

1.1 ORIGINATOR P. VOLANTE	1.2 ORGANIZATION MIT/DL	1.3 DATE 9/17/70	1.4 ORIGINATOR CONTROL NO.	PROGRAM LUMINARY ID
1.5 DESCRIPTION OF ANOMALY				PROGRAM REVISION 178

Selection of V41N72 (RR Coarse align) while an RR reposition or remode is in progress results in incorrect operation of V41N72. Also keying in V44 while a reposition is in progress will cause erroneous operation of a subsequent V41N72.

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN:

N A.

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE:

V41N72 disables the RR error counter enable outbit, which stops the antenna drive, but the remode(or reposition) flags are not cleared.

CONTINUED ON PAGE

2.2 RECOGNITION:

Following the loading of desired angles in N73, N72 will show actual angles not converging to desired angles.

CONTINUED ON PAGE

2.3 MISSION EFFECT:

None.

CONTINUED ON PAGE

2.4 AVOIDANCE PROCEDURE:

Do not key in V41N72 while a reposition or remode is in progress, or V44 while a reposition is in progress.

CONTINUED ON PAGE

2.5 RECOVERY PROCEDURE:

Cycle RR MODE SELECT switch from LGC to SLEW and then back to LGC. (Wait at least one second before returning to LGC).

CONTINUED ON PAGE

2.6 PROGRAM CORRECTION:

Add checks to V41 and V44.

CONTINUED ON PAGE

2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):

Fix for Luminary 1E, workaround for Luminary 1D.

CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING:

V41N72 and V44 tested during RR repositioning.

CONTINUED ON PAGE

2.9 MIT/UC SIGNATURE:

2.10 DATE:

9-18-70

3.1 NASA DIRECTION:

4.1 CLOSING ACTION TAKEN:

CONTINUED ON PAGE

CONTINUED ON PAGE

3.2 NASA/USC SIGNATURE: <i>Thomas H. ...</i>	3.3 ORGANIZATION FSD	3.4 DATE: 10/7/70	4.2 SIGNATURE:	4.3 ORGANIZATION:	4.4 DATE:
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MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN #

ANOMALY # L-10-14

ADR # _____

☐ COLOSSUS 2E
☐ COLOSSUS 3
☐ COLOSSUS 3A
☐ COLOSSUS _____

☐ LUMINARY 1D
☒ LUMINARY 1E
☐ LUMINARY 1F
☐ LUMINARY _____

☐ MIT Approved PCN

☐ MIT Approved ADR

☐ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly

☒ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

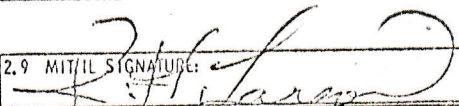
Special Instructions

Project Manager _____

Date _____

10-22-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: C. D. Sykes		1.2 ORGANIZATION: FS5		1.3 DATE: 10/8/70		1.4 ORIGINATOR CONTROL NO.	
						MCC REPORT NO. 1-1D-14 PROGRAM LUMINARY-1D PROGRAM REVISION 178	
1.5 DESCRIPTION OF ANOMALY:							
At TIG-5 in P40, TGO is computed. If TGO is computed to be less than 6 seconds, NO THROTTLE FLG (FW5 B12) should be set as shown on P. 398, line 680 of GSOP Section 4 (Lum Rev 131) to inhibit throttle command to max at TIG+ZOOMTIME. However, this bit is not set in LUMINARY Rev 178 causing the LGC to command max throttle at TIG+ZOOMTIME (although the engine would of course be off).							
CONTINUED ON PAGE							
1.6 DESCRIPTION OF RUN:							
Eyeball of FSB Programmed Guidance Equations Document.							
CONTINUED ON PAGE							
- MIT ANALYSIS -							
2.1 CAUSE:							
Flagbit setting omission							
CONTINUED ON PAGE							
2.2 RECOGNITION:							
Throttle up command seen on Thrust meter							
CONTINUED ON PAGE							
3 MISSION EFFECT:							
None							
CONTINUED ON PAGE							
2.4 AVOIDANCE PROCEDURE:							
None							
CONTINUED ON PAGE							
2.5 RECOVERY PROCEDURE:							
None needed							
CONTINUED ON PAGE							
2.6 PROGRAM CORRECTION:							
Set Flagword 5 Bit 12 for impulsive burns							
CONTINUED ON PAGE							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):							
Fix for 1E							
CONTINUED ON PAGE							
2.8 RECOMMENDED RE-TESTING:							
Hybrid impulsive burn; show flag is reset.				CONTINUED ON PAGE		2.9 MIT/IL SIGNATURE: 	
2.10 DATE:				10-2-2			
3.1 NASA DIRECTION:				4.1 CLOSING ACTION TAKEN:			
CONTINUED ON PAGE				CONTINUED ON PAGE			
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:	
						4.3 ORGANIZATION: 4.4 DATE:	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-10-15
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

11-12-70

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.
E-ID-15

1.1 ORIGINATOR: N. Barnert	1.2 ORGANIZATION MIT/CSDL	1.3 DATE: 11/12/70	1.4 ORIGINATOR CONTROL NO.	PROGRAM Luminary 1D
1.5 DESCRIPTION OF ANOMALY: P00D00 Abort while P20 (P25) is running in the background will kill P20 (P25) and prevent its re-establishment unless RNDVZFLG (P25FLAG) is subsequently cleared.				PROGRAM REVISION Rev. 178
				CONTINUED ON PAGE
1.6 DESCRIPTION OF RUN: Eyeball				
- MIT ANALYSIS -				
2.1 CAUSE: P20 (P25) restart groups are cleared, but RNDVZFLG (P25FLAG) is not reset.				
CONTINUED ON PAGE				
2.2 RECOGNITION: Selection of P20 (P25) will put P20 (P25) in MODE lights but will not cause any computation, tracking, or mark processing to be performed. P20(P25) will not automatically be re-established in the background of targetting programs.				
CONTINUED ON PAGE				
2.3 MISSION EFFECT: No P20(P25)				
CONTINUED ON PAGE				
2.4 AVOIDANCE PROCEDURE: None				
CONTINUED ON PAGE				
2.5 RECOVERY PROCEDURE: Select P00 at P00D00 V37 request				
CONTINUED ON PAGE				
2.6 PROGRAM CORRECTION: Reset RNDVZFLG (P25 FLAG) in P00D00 sequence.				
CONTINUED ON PAGE				
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Luminary 1E. (See PCN 1124)				
CONTINUED ON PAGE				
2.8 RECOMMENDED RE-TESTING:				
CONTINUED ON PAGE				
2.9 MIT/IL SIGNATURE: <i>R. H. Larson</i>		2.10 DATE: 11-12-70		
3.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:		
CONTINUED ON PAGE		CONTINUED ON PAGE		
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-1D-16
ADR # _____

<input type="checkbox"/> COLOSSUS 2E	<input type="checkbox"/> LUMINARY 1D
<input type="checkbox"/> COLOSSUS 3	<input checked="" type="checkbox"/> LUMINARY 1E
<input type="checkbox"/> COLOSSUS 3A	<input type="checkbox"/> LUMINARY 1F
<input type="checkbox"/> COLOSSUS _____	<input type="checkbox"/> LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: Margaret H. Abeneth

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager Russell H. Larson

Date 12-10-70

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-ID-16
PROGRAM Luminary
PROGRAM REVISION 178 & Subs

1.1 ORIGINATOR: P. Volante	1.2 ORGANIZATION M.I. T.	1.3 DATE: 12-8-70	1.4 ORIGINATOR CONTROL NO.
-------------------------------	-----------------------------	----------------------	-------------------------------

1.5 DESCRIPTION OF ANOMALY:

Fixed Memory constant VINJNOM (Nominal Injection Velocity)
is 5509.3 fps instead of 5509.5 fps as specified in GSOP.

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN:

None - found by examining listing.

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE:

Loss of accuracy in converting from FPS to M./C.S.

CONTINUED ON PAGE

2.2 RECOGNITION:

None

CONTINUED ON PAGE

2.3 MISSION EFFECT:

None

CONTINUED ON PAGE

2.4 AVOIDANCE PROCEDURE:

None

CONTINUED ON PAGE

2.5 RECOVERY PROCEDURE:

None

CONTINUED ON PAGE

2.6 PROGRAM CORRECTION:

Correct Constant

CONTINUED ON PAGE

2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):

Fix for Apollo 15 (LUM 1E)

No action necessary for Apollo 14 (LUM 1D)

CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING:

Nominal 12 ascent run

CONTINUED ON PAGE

2.9 MIT/ID SIGNATURE:



2.10 DATE:

12-10-70

3.1 NASA DIRECTION:

CONTINUED ON PAGE

4.1 CLOSING ACTION TAKEN:

CONTINUED ON PAGE

3.2 NASA/MSC SIGNATURE:

3.3 ORGANIZATION

3.4 DATE:

4.2 SIGNATURE:

4.3 ORGANIZATION:

4.4 DATE:

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-1D-17

- | | |
|--------------------------------------|---|
| <input type="checkbox"/> COLOSSUS 2C | <input type="checkbox"/> LUMINARY 1B |
| <input type="checkbox"/> COLOSSUS 2D | <input type="checkbox"/> LUMINARY 1C |
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 2F | <input checked="" type="checkbox"/> LUMINARY 1E |

- | | | |
|---|--|---|
| <input type="checkbox"/> MIT Approved PCN | <input type="checkbox"/> NASA Approved PCR | <input type="checkbox"/> NASA Approved Software Anomaly |
| | <input type="checkbox"/> NASA Approved PCN | <input checked="" type="checkbox"/> MIT Approved Software Anomaly |

A. Coding

☒ Begin coding immediately

Peter Volante

ACTION: _____

Program Supervisor's Approval: Margaret Hamilton

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: R. H. Larson
Date: 12-10-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Volante		1.2 ORGANIZATION: MIT		1.3 DATE: 12/10/70		1.4 ORIGINATOR CONTROL NO.		MSC REPORT NO. L-1D-17	
								PROGRAM LUMINARY	
								PROGRAM DIVISION 178	
1.5 DESCRIPTION OF ANOMALY: The flashing verb 37 which terminates P22 when the range is greater than 400 n. m. and the range-rate is positive may not occur									
CONTINUED ON PAGE									
1.6 DESCRIPTION OF RUN: Examination of coding.									
CONTINUED ON PAGE									
- MIT ANALYSIS -									
2.1 CAUSE: <u>Flagword bit is shared</u> between RR predesignate routing of R21 and V16 N54 display computations or P22.									
CONTINUED ON PAGE									
2.2 RECOGNITION: After RR tracks CSM into mode limits and no track light goes on, the V37 flash does not appear, but N54 is computed.									
CONTINUED ON PAGE									
2.3 MISSION EFFECT: None									
CONTINUED ON PAGE									
2.4 AVOIDANCE PROCEDURE: None									
CONTINUED ON PAGE									
2.5 RECOVERY PROCEDURE: Select desired program when 530 alarm appears in P22.									
CONTINUED ON PAGE									
2.6 PROGRAM CORRECTION: Unshare flagword bits in P22.									
CONTINUED ON PAGE									
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for 1E. <i>fiddle with but don't fix</i>									
CONTINUED ON PAGE									
2.8 RECOMMENDED RE-TESTING: P22 nominal run									
CONTINUED ON PAGE					2.9 MIT/IL SIGNATURE: <i>R.H. Laron</i>				
					2.10 DATE: 12-10-70				
3.1 NASA DIRECTION:					4.1 CLOSING ACTION TAKEN:				
CONTINUED ON PAGE					CONTINUED ON PAGE				
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION:	
								4.4 DATE:	

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-10-13

- | | |
|--------------------------------------|---|
| <input type="checkbox"/> COLOSSUS 2C | <input type="checkbox"/> LUMINARY 1B |
| <input type="checkbox"/> COLOSSUS 2D | <input type="checkbox"/> LUMINARY 1C |
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 2F | <input checked="" type="checkbox"/> LUMINARY 1E |

☐ MIT Approved PCN

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly

☒ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

12-10-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Volante		1.2 ORGANIZATION: MIT		1.3 DATE: 12/10/70	1.4 ORIGINATOR CONTROL NO.	MSC REPORT NO. L-1D-18 PROGRAM LUMINARY PROGRAM REVISION 178
1.5 DESCRIPTION OF ANOMALY: In P22, if the R21 routine (RR designate) drives the antenna close to the RR Mode II limits as the CSM is moving away from the landing site, the RR antenna may oscillate between the mode limits and the mode center several times.						
CONTINUED ON PAGE						
1.6 DESCRIPTION OF RUN: System test lab run of P22 without allowing RR lockon.						
CONTINUED ON PAGE						
- MIT ANALYSIS -						
2.1 CAUSE: R21 and R24 do not clear designate flag when it finds the LOS outside Mode II limits in P22, so R25 calls for a designate after a reposition.						
CONTINUED ON PAGE						
2.2 RECOGNITION: Oscillation of antenna trunnion and shaft angles varying between mode limits and mode center.						
CONTINUED ON PAGE						
2.3 MISSION EFFECT: None- if this situation occurs, no tracking of the CSM could be obtained.						
CONTINUED ON PAGE						
2.4 AVOIDANCE PROCEDURE: Select P22 while CSM is approaching landing site and not yet within RR mode limits.						
CONTINUED ON PAGE						
2.5 RECOVERY PROCEDURE: None						
CONTINUED ON PAGE						
2.6 PROGRAM CORRECTION: Fix coding to clear designate flag.						
CONTINUED ON PAGE						
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Apollo 15 (Lum 1E), work-around for Apollo 14 - (Lum 1D)						
CONTINUED ON PAGE						
2.8 RECOMMENDED RE-TESTING: P22 with designate (R21) attempted as CSM is leaving mode limits.						
CONTINUED ON PAGE				2.9 MIT/IL SIGNATURE: <i>R. H. Larson</i>		2.10 DATE: 12-10-70
3.1 NASA DIRECTION:				4.1 CLOSING ACTION TAKEN:		
CONTINUED ON PAGE				CONTINUED ON PAGE		
3.2 NASA/IL SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:
						4.3 ORGANIZATION:
						4.4 DATE:

MIT/DL PROGRAM CHANGE ROUTING SLIP

R. Larson

PCR/PCN # _____

ANOMALY # L-1D-19

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☐ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☒ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

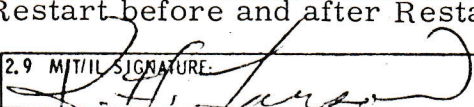
Special Instructions

Project Manager _____

Date _____

12-30-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: B. McCoy	1.2 ORGANIZATION: MIT/CSDL	1.3 DATE: 12/30/70	1.4 ORIGINATOR CONTROL NO.	MIT REPORT NO. L-1D-19
1.5 DESCRIPTION OF ANOMALY: Restarts in P20/25 may erroneously display V50N18 on DSKY.				PROGRAM REVISION Rev 178
CONTINUED ON PAGE				
1.6 DESCRIPTION OF RUN: Simulation at GAC - Restart testing for PCR324				
CONTINUED ON PAGE				
- MIT ANALYSIS -				
2.1 CAUSE: The Restart Point in R65 is after routine LPS20.1 call which computes RRTARGET. This shares erasable cells with radar read data. A Restart occurring after the radar read but before LPS20.1 restarts R65 with bad data in RRTARGET. The 15 degree check then fails and R60 is subsequently called.				
2.2 RECOGNITION: Restart followed by V50N18 display				
CONTINUED ON PAGE				
2.3 MISSION EFFECT: None				
CONTINUED ON PAGE				
2.4 AVOIDANCE PROCEDURE: None				
CONTINUED ON PAGE				
2.5 RECOVERY PROCEDURE: Depress ENTER pushbutton on DSKY; ignore request to perform maneuver.				
CONTINUED ON PAGE				
2.6 PROGRAM CORRECTION: Place Restart Point before LPS20.1				
CONTINUED ON PAGE				
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for 1E; prog note for 1D				
CONTINUED ON PAGE				
2.8 RECOMMENDED RE-TESTING: Digital Simulation with Restart before and after Restart Point.				
CONTINUED ON PAGE				
2.9 MIT/IL SIGNATURE: 				
2.10 DATE: 12-30-70				
CONTINUED ON PAGE				
3.1 NASA DIRECTION:				
CONTINUED ON PAGE				
4.1 CLOSING ACTION TAKEN:				
CONTINUED ON PAGE				
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION
				4.4 DATE:

R. Larson

MIT/DI PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-1D-20

ADR # _____

- | | |
|---|---|
| <input type="checkbox"/> COLOSSUS 2E | <input type="checkbox"/> LUMINARY 1D |
| <input type="checkbox"/> COLOSSUS 3 | <input checked="" type="checkbox"/> LUMINARY 1E |
| <input type="checkbox"/> COLOSSUS 3A | <input type="checkbox"/> LUMINARY 1F |
| <input type="checkbox"/> COLOSSUS _____ | <input type="checkbox"/> LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☐ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☒ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

- ☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.

B. GSOP Preparation

- ☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

- ☐ Technical Committee Meeting(s) held on _____
Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date 1-6-70+1

ACB¹²

Assembly Control Board Request

No. 116
L-26
S-3
A-5

Name of Program(s): *Comanche, Luminary,*
ARTEMIS, SATANCHO

Originator: *Barnett*

Organization: *MIT*

Date: *5-8-70*

Description of Change:

Insert check for coarse align before attempting gyro torquing.

Reason: *VHINSO or Gimbal lock sets coarse align + kushes down drift flag. However AVEG still does gyro compensation + at AVEGEND drift flag is set, allowing NBDONLY compensation. Check within pulse torquing routine avoids both problems.*

Assigned to:

S. Rosenberg

Comments:

Approved by:

Margaret Hamelin

Date:

May 13, 1970

Name of Program(s): Luminary 1D

Originator: Densmore

Organization:

Date: 28 May 70

Description of Change: (1) unused constant OCT 7777 was deleted. (2) RESTARTS routine was called directly rather than by picking up a CADR for it. (3) A single constant for masking during FLAGWORD 8 SWINIT initialization replaced adding in bits individually.

Reason: Save 3 words in Bank 5 to make room for clearing of R12 RDFLG in Fresh Start, Fix to ACR 896.

Assigned to: Eana Densmore

Comments:

Approved by: Margaret H. Hamella

Date: 6/10/70

Assembly Control Board Request

No. 128

Name of Program(s): Luminary 1E

Originator: McCoy

Organization: MIT/DL

Date: 6/25/70

Description of Change:

1. remove LRPOS initialization from P63
LOG: THE LUNAR LANDING

cards: 01956, 01957

2. change DOUBLE to a DDOUBLE

LOG: THROTTLE CONTROL ROUTINES

cards: 0136

3. change DXCH to an XCH

LOG: THROTTLE CONTROL ROUTINES

Reason:

cards: 0068

1. initialization not necessary, implemented wrong, not in GSOP

2 & 3. improve accuracy; coding not right

Assigned to:

Don Cyle

Comments:

Approved by:

Margaret Hammett

Date:

July 8, 70

Assembly Control Board Request

No. L29

Name of Program(s): LUMINARY

Originator: R. Covelli

Organization: Draper Lab

Date: Aug. 11, 1970

Description of Change: Change the two lines of coding
at locations MOONSPOT and MOONSPOT +1

from:	CA	KPIP1	to:	TC	DMP
	TC	SHORTMP			ADRES KPIP1

Reason: To improve the accuracy of the computation
of DVTOTAL. See LUMINARY Memo # 166 by D. Moore
for details. During powered descent, the error in DVTOTAL
would be about 20 feet per second.

Assigned to: R. Conelli

Comments:

Approved by:

Date:

Margaret Hamilton
8/11/70

Assembly Control Board Request

No. L 30

Name of Program(s): LUMINARY

Originator: R. Covelli

Organization: Draper Lab

Date: Aug. 11, 1970

Description of Change: In SERVICER, move the tag "MOONSPOT" from the location where it currently is to the "TC TMPTOSPT" instruction four lines later.

Reason: During the time interval from TIG-30 to TIG in P12, DVTOTAL is needlessly incremented by lunar gravity. This change would make DVTOTAL an accurate measure of the work done by the engine.

Assigned to: R. Covelli

Comments:

Approved by:

Date:

Margaret Hamilton
8/11/70

Assembly Control Board Request

No.

7-14

L-31

Name of Program(s): ARTCMIS

Originator: SUMNER ROSENBERG

Organization: MIT/DL

Date: Aug 12, 1970

Description of Change:

SET A LIST OF LABELS = TO EACH
LOCATION THAT IS IN THE DOWNLINK LISTS
AND NOT DIRECTLY REFERENCED IN THE LISTS.

Reason: TO HAVE REFERENCES TO THESE LOCATIONS
SHOW UP IN DIRECTORY, SHOWING THAT THEY
ARE REFERENCED IN DOWNLINK LISTS. MUST BE KEPT
UP TO DATE TO BE EFFECTIVE.

Assigned to:

Sumner Rosenberg

Comments:

Approved by:

Margaret Hamilton

Date:

8/12/70

Redistributed

Assembly Control Board Request

No.

A-15

L-32

Redistributed

Name of Program(s): ARTEMIS

Originator: SUMNER ROSENBERG

Organization: MIT / DL

Date: AUG 12, 1970

Description of Change:

PUT A LIST IN THE DOWNLINK LOG SECTION,
USING THE NEW INSTRUCTION "CHECK=", TO CHECK
THAT SPECIFIED ERASABLE LOCATIONS ARE NOT MOVED
WITH RESPECT TO THE RELATED LOCATIONS. IF MOVED
WITHOUT CHANGING THE LIST, A CUSS WILL RESULT.

Reason: TO AVOID MOVING ERASABLE LOCATIONS WHICH
MUST BE AT A CERTAIN LOCATION W/R/T ANOTHER.
ie. HOLDFLAG MUST = OPTAODES+1 FOR DOWNLINK LIST.

Assigned to:

Sumner Rosenberg

Comments:

Approved by:

Margaret Hamilton

Date:

8/12/70

Assembly Control Board Request

No. L-33

Name of Program(s): LUMINARY IE
Originator: P.S. Weissman
Organization: MIT/DL
Date: 26 August 1970

Description of Change:

Load the "trap" of the DAP state estimator with a value that is 1 bit off from the GSOP value. This is an error of less than 0.1% and totally insignificant. Furthermore, it will be overwritten by a pad load from the ground following a fresh start.

Reason:

Make room in Bank 5 for PCN 1059.

Assigned to:

Peter Weissman

Comments:

Approved by:

M. Hamilton

Date:

8/26/70

Assembly Control Board Request

No. L 34

Name of Program(s): LUMINARY

Originator: N. Barnett

Organization: MIT

Date: 21 Sept '70

Description of Change: Erasable clean-up:

- 1.) Change masables used for N 90 (R36) so that sharing with N54 is eliminated. ^{from unshared E4}
 - 2.) Move DELVOV (N84, P76) ^{to share with} SERVICER masable ^{(E2).}
 - 3.) Move RANGE, RRATE, + THETA (N54) so they will be unshared.
 - 4.) Move LRWH1 to share with INCORP rather than P20.
 - 5.) Delete unreferenced erasable tags.
 - 6.) Delete GMODE, RQVU (unused) + shift E4 configuration to accommodate above changes.
- Reason: 2.) Redefine in Erasable log section those tags which were defined in other log sections.
3.) Delete obsolete RESAVE + references to it.

Reason: Correct problems which created program notes; general cleanup to avoid future trouble.

Assigned to: N. Barnett

Comments: Make LUMINARY revision with no other changes except above; run representative level of tests to check out.

Approved by: Bruce J. McVey

Date: 9/25/70
Margaret A. Hamilton

Name of Program(s): Luminary 1EOriginator: BarnertOrganization: MITDate: 9-29-70

Description of Change: change coding in LLGE to store triple precision in OLDPIPAX to avoid confusion and possible future problems consequent to sensitive order of erasables & instructions. It is now necessary that erasable and instructions be in such an order that DELVRD overwrites the garbage put down when OLDPIPAX (TP) is vector stored: DELVRD must follow OLDPIPAX in erasable (overlap the "vector") and it must be initialized after OLDPIPAX. Problem pointed out by Allan Klumpp.

Assigned to:

Densmore & Cyles

Comments:

No words added to do this fix.

<u>OLD</u>		<u>NEW</u>
STOVL	VHZC	STORE VHZC
	TEMX	TLOAD DCOMP
VCOMP		TEMX
STOVL		
STOVL		OLDPIPAX
		ZEROVECS
STOVL		DELVRD

Approved by:

Margaret H. Hamelin

Date:

Oct. 5, 1970

Assembly Control Board Request

No. L36

Name of Program(s): LUMINARY

Originator: Ryz

Organization: MIT

Date: 10-5-70

Description of Change: ~~Define~~ Define a tag
TMPDV = GDT/2 for use
by S34/35.5 which now
uses GDT/2 directly -

Reason: Avoid future errors by specifying
user other than SERVICER for that
erasable.

Assigned to: Ryz

Comments:

Approved by: Margaret H. Hammett
Date: Oct 6, 1970

Assembly Control Board Request

No. L-37

Name of Program(s): LUMINARY 1E

Originator: Rye

Organization: MIT

Date: 21 August 1970

Description of Change:

Make bad return from IMUSTALL in 1/GYRO continue
instead of go to ENDOFJOB.

Reason:

Failure of Bit 1 Chan 11 could cause bad return; no reason
to skip coding because of it, even if real bad return.

Assigned to:

P. Rye

Comments:

Approved by:

Date:

Margaret Hamilton

Oct 13 1970

Assembly Control Board Request

No. L-38

Name of Program(s): LUMINARY I

Originator: Rye

Organization: MIT

Date: 10-26-70

Description of Change:

- ① Rearrange clearing of flags in V56;
- ② change code at TRMTRAK1 to interpretive.

Reason: ① Make V56' restart-proof; ② save 1 line so new code will fit in.

Assigned to:

Rye

Comments:

Approved by: Margaret A. Samuel

Date: 10/27/70

Name of Program(s): LUMINARY 1E

Originator: Densmore

Organization: MIT

Date: 5 OCT 70

Description of Change: change a CADR to
an ADRES following a TC TWIDDLE
in RADSAMP.

Reason: Although benign in this instance,
CADR is incorrect and WAITLIST
expects ADRES.

Assigned to: Densmore

Comments:

Approved by: Margaret Hammett
Date: 10/27/70

Name of Program(s): LUMINARY IE

Originator: Densmore

Organization: MIT

Date: 28 OCT 70

Description of Change:

DELETE GOMARK2, MARKFORM, and
GOMARK2R. They are unreferenced
entries to the Display Interface
Routines. Yield: 12/16 words.

Reason:

Room needed in Bank 10 to
implement PCR 339.

Assigned to:

Summer Rosenberg

Comments:

Approved by: Margaret H. Hamilton

Date: Oct. 29, 1970

Assembly Control Board Request

No. L-41

Name of Program(s): LUMINARY
Originator: P. S. Weissman
Organization: MIT/DL 23C
Date: 26 Oct. 1970

Description of Change:

Avoid reading the GTS drive bits in channel 12 in order to determine whether or not the engine gimbals are being driven. This is presently done in the VACCs routine and the information is fed to the DAP angular rate and acceleration estimator.

Reason:

An on-failure of one of these bits would necessitate the disabling of the gimbal drives by the crew. However, since the bit will remain failed on, the rate and acceleration estimate will include the effect of the gimbal "motion," with a resulting impairment of control.

Assigned to:

P. Weissman

Comments:

Approved by:

Margaret A. Hamill

Date:

Oct. 30, 1970

Assembly Control Board Request

No.

A-22
L-42

Name of Program(s): Artemis (Colossus 3) and LUMINARY

Originator: N. Brodeur

Organization: MIT/DL

Date: ~~JUL 1 1970~~ Nov 5, 1970

Description of Change:

append a(+/-)N to relative addresses as an indication that
a branch has been made to that location.

Reason: Diminish likelihood of inserting
code between a tag and an untagged
branch to location.

Assigned to:

N. Brodeur for Colossus
J. Devore for LUMINARY

Comments:

Approved by:

Margaret A. Hamilton

Date:

Nov. 9, 1970

Assembly Control Board Request

No. L-43

Name of Program(s): LUMINARY

Originator: Eyles

Organization: MIT/DL

Date: October 23, 1970

Description of Change:

Enable the redesignation trap at the time of the PROCEED to V06N64 instead of at the start of P64.

Reason:

This prevents an automatic loss of about 3% computation time throughout P64 in the event of a known on-failure of bits 1 or 2 or 5 or 6 of channel 31. Avoiding the PROCEED would in this case prevent the initiation of the redesignation monitor. Since redesignations are ignored until after the the PROCEED, the trap need not be enabled sooner.

Assigned to:

Dr Eyles

Comments:

AKB meeting held with Ron Larson, Bruce McCoy & Don Eyles as attendees.

Approved by:

Margaret Hammett

Date: 11/23/70

Name of Program(s): Luminary 1EOriginator: WeissmanOrganization: MITDate: 1 December 70

Description of Change:

make T5ADR single precision since
it always goes to F16 in E6.

Reason:

An unswitched unshared erasable
needed to implement PCR 1111.

Assigned to:

Densmore

Comments:

Approved by:

Margaret Hammett

Date:

12/2/70

Assembly Control Board Request

No. L-4443-

Name of Program(s): LUMINARY
Originator: McCoy
Organization: MIT/DL
Date: December 3, 1970
Description of Change:

Clear INTYPFLG prior to INTEGRUS call in P21
recycle option

Reason:

Even though the result is not significant, P21 could integrate the base vector with precision integration (say initially) and then conically on re-cycle, depending on setting of INTYPFLG, if for example an extended verb using conic integration is called over the NOUN 43 display.

Assigned to: Rye, Ostanek

Comments: Applies to COLOSSUS, but COLOSSUS is in configuration control. Therefore separate paper work will be done for COLOSSUS.

Approved by:

Mayant H. Hamelin

Date:

12/3/70

Assembly Control Board Request

No. 2-46

Name of Program(s): *Luminary IE*

Originator: *Densmore*

Organization: *MIT*

Date: *12-10-70*

Description of Change:

*delete INHINT before waitlist call
in AOTMARIC (waitlist does INHINT)*

Reason: *make room (1 word) in bank 7
to implement PCR 1044.*

Assigned to:

Dave Densmore

Comments:

Approved by:

Margaret Hamels

Date:

Dec. 10, 1970

Assembly Control Board Request

No. L-47

Name of Program(s): LUMINARY IE

Originator: P. S. Weissman

Organization: MIT/DL 23C

Date: 12/11/70

Description of Change:

Re-code the P-axis minimum impulse routine more efficiently without changing its functions or interface.

Reason:

Save words in bank 16 for use of PCR 1111.

Assigned to:

Peter Weissman

Comments:

Approved by:

Margaret H. Hamel

Date:

12/11/70

ANOMALIES
IN LUM IE

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1E-01
PROGRAM Luminary
PROGRAM REVISION 210

1.1 ORIGINATOR: P. Volante	1.2 ORGANIZATION: MIT	1.3 DATE: 4/13/71	1.4 ORIGINATOR CONTROL NO.		
1.5 DESCRIPTION OF ANOMALY: If P22 is selected when range to CSM is > 400 N.M. and closing, then V37 will not flash when ranges 400 n.m. and range-rate is positive.					
CONTINUED ON PAGE					
1.6 DESCRIPTION OF RUN: P22 level 3 digital sim.					
CONTINUED ON PAGE					
- MIT ANALYSIS -					
2.1 CAUSE: Coding error.					
CONTINUED ON PAGE					
2.2 RECOGNITION: At the conclusion of RR tracking in P22 when no track light goes on, computer activity continues with no display.					
CONTINUED ON PAGE					
2.3 MISSION EFFECT: None					
CONTINUED ON PAGE					
2.4 AVOIDANCE PROCEDURE: Select P22 when range to CSM < 400 N.M. and closing.					
CONTINUED ON PAGE					
2.5 RECOVERY PROCEDURE: When no track light goes on, key V37E00E					
CONTINUED ON PAGE					
2.6 PROGRAM CORRECTION: Fix coding - Do flag initialization properly.					
CONTINUED ON PAGE					
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Program note #92					
CONTINUED ON PAGE					
2.8 RECOMMENDED RE-TESTING:					
CONTINUED ON PAGE					
2.9 MIT/IL SIGNATURE: <i>[Signature]</i>		2.10 DATE: 4-13			
3.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:			
CONTINUED ON PAGE		CONTINUED ON PAGE			
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION:	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION:	4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Volante	1.2 ORGANIZATION: MIT	1.3 DATE: 4/13/71	1.4 ORIGINATOR CONTROL NO.	MSC REPORT NO. L-1E-02 Rev 1 PROGRAM Luminary PROGRAM REVISION 210
1.5 DESCRIPTION OF ANOMALY: Exiting P63, P40 or P42 with a V37 approximately 50 microseconds before ullage on will result in ullage coming on and not being terminated, with Average-G integration not running.				
CONTINUED ON PAGE				
1.6 DESCRIPTION OF RUN: TRW A-201 report.				
CONTINUED ON PAGE				
- MIT ANALYSIS -				
2.1 CAUSE: Coding error: Killing of ullage task is done after resetting ullage bit in DAPBOOLS and releasing interrupts.				
CONTINUED ON PAGE				
2.2 RECOGNITION: Ullage on after V37 to exit P63, P40, P42.				
CONTINUED ON PAGE				
2.3 MISSION EFFECT: Degraded state vector since ullage on and Average-G not on.				
CONTINUED ON PAGE				
2.4 AVOIDANCE PROCEDURE: Key V37 prior to TIG-10 seconds.				
CONTINUED ON PAGE				
2.5 RECOVERY PROCEDURE: If avoidance not possible, Key V37 after ullage comes on.				
CONTINUED ON PAGE				
2.6 PROGRAM CORRECTION: Fix coding - kill ullage task while interrupts are inhibited.				
CONTINUED ON PAGE				
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Do not fix.				
CONTINUED ON PAGE				
2.8 RECOMMENDED RE-TESTING:				
CONTINUED ON PAGE				
2.9 MIT/IL SIGNATURE: <i>R. H. Larson</i>		2.10 DATE: 4-23-71		
3.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:		
CONTINUED ON PAGE		CONTINUED ON PAGE		
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION
				4.4 DATE:

MSC REPORT NO.	L-1E-03
PROGRAM	Luminary
PROGRAM REVISION	210

PAGE 1 OF

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: D. Moore	1.2 ORGANIZATION: MIT	1.3 DATE: 4/13/71	1.4 ORIGINATOR CONTROL NO.	REPORT NO. L-1E-03
				PROGRAM Luminary
				PROGRAM REVISION 210

2.1 Continued

If the attempt to flash V37 occurs after the N60 display is re-established, a 31502 bailout results, since two displays of the same priority are attempting to use the DSKY. If the V37 flash occurs before the N60 display is re-established, the bailout does not occur, since the N60 display will replace the V37 flash.

2

MSC REPORT NO.
L-1E-04

PROGRAM
Luminary

PROGRAM REVISION
210

MSC Form 1409 (Rev May 68)

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1E-05 Rev 1
PROGRAM Luminary
PROGRAM REVISION 210

1.1 ORIGINATOR: P. Volante	1.2 ORGANIZATION: MIT	1.3 DATE: 4/13/71	1.4 ORIGINATOR CONTROL NO.
1.5 DESCRIPTION OF ANOMALY: If an engine fail occurs in P70 or P71, and an enter response is made to the flashing verb 97, noun 63 will be displayed with the flashing verb 99, instead of noun 94. Noun 94 will be restored at TIG after the V99 display is answered.			
CONTINUED ON PAGE			
1.6 DESCRIPTION OF RUN: TRW A-201 Report			
CONTINUED ON PAGE			
- MIT ANALYSIS -			
2.1 CAUSE: Coding Error			
CONTINUED ON PAGE			
2.2 RECOGNITION: N63 with flashing V99 after ENTR to V97 flash in P70 or P71.			
CONTINUED ON PAGE			
2.3 MISSION EFFECT: None			
CONTINUED ON PAGE			
2.4 AVOIDANCE PROCEDURE: None			
CONTINUED ON PAGE			
2.5 RECOVERY PROCEDURE: None			
CONTINUED ON PAGE			
2.6 PROGRAM CORRECTION: None			
CONTINUED ON PAGE			
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Program Note			
CONTINUED ON PAGE			
2.8 RECOMMENDED RE-TESTING: None			
CONTINUED ON PAGE			
2.9 MIT/IL SIGNATURE: <i>[Signature]</i>		2.10 DATE: 4-23-71	
3.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:	
CONTINUED ON PAGE		CONTINUED ON PAGE	
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:
			4.3 ORGANIZATION
			4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: R. L. Pearson		1.2 ORGANIZATION: NASA		1.3 DATE: 4/9/71	1.4 ORIGINATOR CONTROL NO. L71-1	REC REPORT NO. 1-1E-06 PROGRAM LUM PROGRAM REVISION 209
1.5 DESCRIPTION OF ANOMALY: A V78 during P63 N62 display prior to average-G results in P.A. 1201 and clobbers the LM velocity vector.						
CONTINUED ON PAGE						
1.6 DESCRIPTION OF RUN: LUM testing with LMS-2 load tapes.						
CONTINUED ON PAGE						
- MIT ANALYSIS -						
2.1 CAUSE:						
CONTINUED ON PAGE						
2.2 RECOGNITION:						
CONTINUED ON PAGE						
2.3 MISSION EFFECT:						
CONTINUED ON PAGE						
2.4 AVOIDANCE PROCEDURE:						
CONTINUED ON PAGE						
2.5 RECOVERY PROCEDURE:						
CONTINUED ON PAGE						
2.6 PROGRAM CORRECTION:						
CONTINUED ON PAGE						
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):						
CONTINUED ON PAGE						
2.8 RECOMMENDED RE-TESTING:						
CONTINUED ON PAGE					2.9 MIT/IL SIGNATURE:	
CONTINUED ON PAGE					2.10 DATE:	
3.1 NASA DIRECTION:					4.1 CLOSING ACTION TAKEN:	
CONTINUED ON PAGE					CONTINUED ON PAGE	
3.2 NASA/MSD SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:
						4.3 ORGANIZATION:
						4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: R. L. Pearson		1.2 ORGANIZATION: NASA		1.3 DATE: 4/9/71		1.4 ORIGINATOR CONTROL NO. L71-2		1.5 REPORT NO. 1-71-1001	
						PROGRAM JIM		PROGRAM REVISION 209	
1.6 DESCRIPTION OF ANOMALY: A V83 during P22 at range less than 400nmi causes P22 to go to sleep when range is equal to 400 nmi until the V83 is terminated									
NOT AN ANOMALY									
1.7 DESCRIPTION OF RUN: LUM testing with LMS-2 load tapes.									
CONTINUED ON PAGE									
- MIT ANALYSIS -									
2.1 CAUSE: Extended Verb display of N54 prevents the V37 Flashing display from coming up, since the V37 flash is a normal display and the V16N54 is an extended verb.									
CONTINUED ON PAGE									
2.2 RECOGNITION: No V37 flashing display after NO TRACK light goes on.									
CONTINUED ON PAGE									
2.3 AVOIDANCE PROCEDURE: None									
CONTINUED ON PAGE									
2.4 AVOIDANCE PROCEDURE: A) Do not detect V83 during P22. B) Answer N54 with PRO to terminate R31 while NO TRACK light is off.									
CONTINUED ON PAGE									
2.5 RECOVERY PROCEDURE: Terminate V83 (R31)									
CONTINUED ON PAGE									
2.6 PROGRAM CORRECTION: None - This is not an anomaly, but rather a consequence of the DSKY Display priority system.									
CONTINUED ON PAGE									
2.7 RECOMMENDED REVISIONS AND REPAIRS, etc.									
No action									
CONTINUED ON PAGE									
2.8 RECOMMENDED RE-TESTING:									
None					CONTINUED ON PAGE				
2.9 NASA DIRECTION:					2.10 MIT/IL SIGNATURE:				
					2.11 CLOSING ACTION TAKEN:				
CONTINUED ON PAGE					CONTINUED ON PAGE				
2.12 NASA/MSO SIGNATURE:		2.13 ORGANIZATION:		2.14 DATE:		2.15 SIGNATURE:		2.16 ORGANIZATION:	

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: R. L. Pearson		1.2 ORGANIZATION: NASA		1.3 DATE: 4/9/71		1.4 ORIGINATOR CONTROL NO. L71-3		MIT REPORT NO. PROGRAM 7-111 PROGRAM REVISION 209	
1.5 DESCRIPTION OF ANOMALY: A V83 during the maneuver in P20 with the RR switch in slew causes P20 to go to sleep until the V83 is terminated.									
CONTINUED ON PAGE									
1.6 DESCRIPTION OF RUN: LUX testing with LMS-2 load tapes.									
CONTINUED ON PAGE									
- MIT ANALYSIS -									
1.7 CAUSE: The V16N54 display from V83 prevents the V50N25 display (requesting RR switch to LGC) from coming up, since an extended verb display has a higher priority on the DSKY than a normal display.									
CONTINUED ON PAGE									
1.8 RECOGNITION: No V30N25 display from P20 until V83 terminates.									
CONTINUED ON PAGE									
1.9 REASON FOR: None									
CONTINUED ON PAGE									
1.10 AVOIDANCE PROCEDURE: Do not select V83 if RR Mode switch is not in LGC until after V30N25 display is answered.									
CONTINUED ON PAGE									
1.11 RECOVERY PROCEDURE: Terminate V83									
CONTINUED ON PAGE									
1.12 PROGRAM CORRECTION: None-This is not an anomaly, but rather a consequence of the DSKY Display Priority system.									
CONTINUED ON PAGE									
1.13 RECOMMENDED DISPOSITION (To, Work-around, etc.) No action									
CONTINUED ON PAGE									
1.14 RECOMMENDED RE-TESTING: None									
CONTINUED ON PAGE									
1.15 NASA DIRECTION:					1.16 CLOSING ACTION TAKEN:				
CONTINUED ON PAGE					CONTINUED ON PAGE				
1.17 ANALYST SIGNATURE:		1.18 SIGNATURE:		1.19 DATE:		1.20 SIGNATURE:		1.21 DATE:	

NOT AN ANOMALY

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Weissman		1.2 ORGANIZATION: MIT/CSDL		3 DATE: 4/14/71		1.4 ORIGINATOR CONTROL NO.		1.5 PROGRAM LUMINARY. 1E PROGRAM REVISION LUMINARY 209			
1.6 DESCRIPTION OF ANOMALY: DAP interrupt could occur in the middle of the ZATTEROR zeroing sequence or STOPRATE.											
CONTINUED ON PAGE											
1.7 DESCRIPTION OF RUN: EYEBALL. Similar to COMANCHE, viz. COM 33 Anomaly.											
CONTINUED ON PAGE											
- MIT ANALYSIS -											
2.1 CAUSE: ZATTEROR and STOPRATE called without INHINT from NOGO and NOGO-2 in KALCMANU.											
CONTINUED ON PAGE 2											
2.2 RECOGNITION: None											
CONTINUED ON PAGE											
2.3 MISSION EFFECT: Negligible											
CONTINUED ON PAGE											
2.4 AVOIDANCE PROCEDURE: None											
CONTINUED ON PAGE											
2.5 RECOVERY PROCEDURE: None											
CONTINUED ON PAGE											
2.6 PROGRAM CORRECTION: INHINT before calls to these 2 routines at NOGO and NOGO-2.											
CONTINUED ON PAGE											
2.7 RECOMMENDED DISPOSITION (Fix, Work around, etc.) No further action											
CONTINUED ON PAGE											
2.8 RECOMMENDED RE-TESTING: None											
CONTINUED ON PAGE											
2.9 MIT/IL SIGNATURE:					2.10 DATE:						
3.1 NASA DIRECTION:					3.1.1 CLOSING ACTION TAKEN:						
CONTINUED ON PAGE					CONTINUED ON PAGE						
3.2 NASA/MSD SIGNATURE:		3.3 ORGANIZATION:		3.4 DATE:		3.5 SIGNATURE:		3.6 ORGANIZATION:		3.7 DATE:	

MIT/IL SOFTWARE ANOMALY

REPORT

REPORT NO.	L-12-06
PROJECT	LUMINARY 1E
PROJECT REVISION	LUMINARY 200

1.1 ORIGINATOR	1.2 ORGANIZATION	1.3 DATE	1.4 ORIGINATOR CONTROL NO.
P. Weissman	MIT	4/14/7	

2.1 Continued

Circumstances of calls:

ZATTEROR- Interrupt maneuver if mode found to no longer be AUTO.

STOPRATE

- 1) 401 alarm (desired MGA $> 70^0$).
- 2) Total maneuver has than 0.250

2.3 Continued

Mission Effect

Negligible

The 2 calls to STOPRATE are made when no maneuver has been started yet, so all the parameters are zero anyway. The calls seem to be a matter of extra conservative design.

An interruption to the ZATTEROR execution by the DAP could cause the DAP to use incorrect set of errors and error rates for one pass, but the effect is trivial, especially under the circumstances (an automatic maneuver has been manually interrupted).

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: R. L. Pearson		1.2 ORGANIZATION: NASA		1.3 DATE: 4/9/71		1.4 ORIGINATOR CONTROL NO. L71-4		REC REPORT NO. L-71-02		
PROGRAM LUM								PROGRAM REVISION 209		
1.5 DESCRIPTION OF ANOMALY: An inadvertent proceed on the V16N80 display in P20 caused the program to "get lost". Recovery could only be accomplished by recalling the program. <div style="text-align: right;">CONTINUED ON PAGE</div>										
1.6 DESCRIPTION OF RUN: Apollo 15 training on LMS-2. <div style="text-align: right;">CONTINUED ON PAGE</div>										
- MIT ANALYSIS -										
2.1 CAUSE: <div style="text-align: right;">CONTINUED ON PAGE</div>										
2.2 RECOGNITION: <div style="text-align: right;">CONTINUED ON PAGE</div>										
2.3 MISSION EFFECT: <div style="text-align: right;">CONTINUED ON PAGE</div>										
2.4 AVOIDANCE PROCEDURE: <div style="text-align: right;">CONTINUED ON PAGE</div>										
2.5 RECOVERY PROCEDURE: <div style="text-align: right;">CONTINUED ON PAGE</div>										
2.6 PROGRAM CORRECTION: <div style="text-align: right;">CONTINUED ON PAGE</div>										
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): <div style="text-align: right;">CONTINUED ON PAGE</div>										
2.8 RECOMMENDED RE-TESTING: <div style="text-align: right;">CONTINUED ON PAGE</div>										
3.1 NASA DIRECTION: <div style="text-align: right;">CONTINUED ON PAGE</div>					2.9 MIT/IL SIGNATURE: <div style="text-align: right;">CONTINUED ON PAGE</div>					2.10 DATE:
3.2 NASA/OSC SIGNATURE:					3.3 ORGANIZATION		3.4 DATE:		4.1 CLOSING ACTION TAKEN: <div style="text-align: right;">CONTINUED ON PAGE</div>	
4.2 SIGNATURE:		4.3 ORGANIZATION:		4.4 DATE:						

