CONTENTS OF LUMINARY IE

R.A. LARSON MIT/OL

R. LARSON

MIT/IL SOFTWARE ANOMALY REPORT 1.3 DATE: ORIGINATOR 1.2 ORGANIZATION: 1.1 ORIGINATOR: LUM CONTROL NO. ROGRAMORGVISION . 4/9/71 NASA 1 - 1R. L. Pearson 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: 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 (Or 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 P63, not just R12 CONTINUED ON PAGE 2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Do not fix; work-around. CONTINUED ON PAGE 2.8 RECOMMENDED RE-TESTING: 2.10 DATE: 2.9 MIT/IL SIGNATURE: CONTINUED ON PAGE 4.1 CLOSING ACTION TAKEN: 3.1 NASA DIRECTION: CONTINUED ON PAGE CONTINUED ON PAGE 4.3 ORGANIZATION: 4.4 DATE: 3.3 ORGANIZATION B. 4 DATE: 4.2 SIGNATURE: 3.2 NASAMSC SIGNATURE:

MIT/IL SOFTWARE ANOMALY REPORT

1.3 DATE: 1.2 ORGANIZATION: ORIGINATOR CONTROL NO. 4/9/71 NASA R. L. Pearson PROGRAM REVISION 209 L71-1

2.1 Continued

The Rl2 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.

LUM

MII	/IL SOFTWARE	ANOMALY REPO	RT MERIPORT NO.
ORIGINATOR: R. L. Pearson	1.2 ORGANIZATION: NASA	1.3 DATE: 1.4 ORIGINA CONTROL L71-4	NO. LUM PROGRAM REVISION .
DESCRIPTION OF ANOMALY:			209
		splay in P20 caused t accomplished by recal	
		1	CONTINUED ON PAGE
DESCRIPTION OF RUN:	. • 4	, · · · · · · · · · · · · · · · · · · ·	
Apollo 15 training	on LMS-2.		
•			CONTINUED ON PAGE
	- MIT	ANALYSIS -	9
automatic searc	sts(about .1 seconds ch routine, when a Pl ent jobs attempting t	out of every 6 second RO response to the V to designate the RR	ls) during the R24 16N80 display results CONTINUED ON PAGE
RECOGNITION: No track light s	tavs on, DSKY blank	s, tracker fail light	goes on.
210 02 010 128	,		CONTINUED ON PAGE
MISSION EFFECT:			•
None	1		8
9 9	0		* CONTINUED ON PAGE
AVOIDANCE PROCEDURE:	o to V16N80 display u	ınless R1 =11111	
Do not key inc	, to violator display		CONTINUED ON PAGE
RECOVERY PROCEDURE:			CONTINUED ON THE
Reselect P20			
Reselect F20			CONTINUED ON PAGE
PROGRAM CORRECTION:			
Have PRO resp	onse to V16N80 displa	ay check for RR lock	on before continuing.
			CONTINUED ON PAGE
7 RECOMMENDED DISPOSITION (F	x, Work-around, etc):		
Do not fix			CONTINUED ON PAGE
RECOMMENDED RE-TESTING:			CONTINUED ON TAGE
N.A.		7	
1	CONTINUED ON PAGE	2.9 MIT/IL SIGNATURE:	2.10 DATE:
NASA DIRECTION:	ONTHISE OF TROE	4.1 CLOSING ACTION TAKEN:	
	8		
* ·			
	CONTINUED ON PAGE		CONTINUED ON PAGE

MII	/IL SOFTWARE	ANOMALYR	EPORT	MSC REPORT NO. L-1E-08
1 ORIGINATOR:	L2 ORGANIZATION:		ORIGINATOR CONTROL NO.	PROGRAM LUMINARY. 1E PROGRAM REVISION
P. Weissman	MIT/CSDL	4/14/71		PROGRAM REVISION LUMINARY 209
	o interrupt could occ		of the	
ZATTEROR Ze	roing sequence or St	IOPRATE.		
, · · · · · · · · · · · · · · · · · · ·				1.
				CONTINUED ON PAGE
.6 DESCRIPTION OF RUN: EYEI	BALL. Similar to C	OMANCHE, viz.	COM 33 A	Anomaly
	,			
				CONTINUED ON PACE
	AALT	ANALYCIC		CONTROLF IN FAS!
.1 CAUSE: ZATTEROR ai		NALYSIS -	from NO	GO and NOGO - 2
in KALCMANU		i williout illillivi	II OIII NO	GO and NOGO-2
				CONTINUED ON PAGE 2
.2 RECOGNITION:				
None			•	
				CONTINUED ON PAGE
.3 MISSION EFFECT: Negligibl	e	· · · · · · · · · · · · · · · · · · ·	*	
				CONTINUED ON PAGE 2
2.4 AVOIDANCE PROCEDURE:		,		CONTINUED OR PAGE T
	None			
	Q.			CONTINUED ON PAGE'.
2.5 RECOVERY PROCEDURE:				
ľ	lone			
2.6 PROGRAM CORRECTION: TATTER	7 T 1 0 11 11 11	0		CONTINUED ON PAGE
INHI	NT before calls to th	iese 2 routines a	t NOGO a	nd NOGO-2.
•	*	5		CONTINUED ON PAGE
2.7 RECOMMENDED DISPOSITION (Fix	, Work-around, etc):	• .	*	
No furth	er action	e e e		
2 0 DECOMMENDED DE TECTIMO			-	CONTINUED ON PAGE
2.8 RECOMMENDED RE-TESTING:				
None	CONTINUED ON PAGE	2.9 MIT/IL SIGNATE:	1011	2.10 DATE:
3.1 NASA DIRECTION:	CONTINUED ON TAGE	4.1. CLOSING ACTION TA	KEN:	
	7			20 K (20)
		0		
		R		
	CONTINUED ON PAGE	A .		CONTINUED ON PAGE

MSC Form 1409 (Rev May 68)

IT/IL SOFTWARE ANOMALY REPORT

	MITTIL SOLIWARL	MINOMINE	KLIOKI	L-1E-08
1.1 ORIGINATOR:	1.2 ORGANIZATION:	L3 DATE:	1.4 ORIGINATOR CONTROL NO.	LUMINARY 1E
P. Weissman	MIT	4/14/71		PROCERMINARY 209

2.1 Continued

Circumstances of calls:

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

STOPRATE

- 1) 401 alarm (Desired MGA > 700)
- 2) Total maneuver less than 0.250

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.

M. Hamilton

Copie, t.

D. Meland
R. Laucon
P. Grey
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

INSTRUMENTATION LABORATORY FIELD SITE

EASTERN TEST RANGE

SERIAL: 71-6

FILE: LM-10 Workbook DATE: 9 April 1971

MEMO TO:

R. O'Donnell

FROM:

R. Gilbert

SUBJECT:

LUMINARY LE (210) vs LUMINARY LD (178)

- Pl2 -

- 1. FIRCS flag (FLAGWRD9 BIT 10) is set to 0 at the beginning of Pl2. This flag need not be reset via DSKY if, during a previous Pl2, ENTER was inserted on a flashing V99. It is still necessary to reset P7071 flag (13F9) if P71 is called on surface prior to Pl2.
- 2. ASCENT NOUN Changes -

NOUN 77	R1 XXbXX R2 XXXX.X R3 XXXX.X	TTOGO VGY (BODY) VI		XXXX.X SPARE	FPS YDOT
NOUN 94	R1 XXXX.X R2 XXXX.X R3 XXXXX.	VGX (BODY) HDOT H	was	SPARE SPARE 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	V 50N18	**				
P20,		v06N05					
P20		v 06n49					
		'V50N72		r			
		vo5N09	ALARMS	501,	503,	514,	525
		V16N8O					
P22		v 05N09	ALARMS	503,	514,	525,	530

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

- P2X Continued -

2. RENDEZVOUS NOUN change

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

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

3. PGNCS/AGS RR DATA TRANSFER - During R22, the LGC sends, via the down-list, 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 R6O to allow EXTENDED VERBS during an AUTO maneuver. Restrictions on EXTENDED VERBS with displays (e.g. V82, V83) during P2O or P22 include:
 - a) 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.
 - b) 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. V37EOOE, for example, should be inserted to terminate P22.

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 R6O.
- 2. If the burn time calculated at TIG 5 seconds is less than 6 seconds, the NOTHROT flag (FIAGWRD5 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 IGC from commanding ullage. (P40, 42, 63)

- P5X -

- 1. ROD INPUTS are handled as follows:
 - a) AVERAGEG ON Valid ROD input
 b) P57 or P52 (surface technique V32E on V50N25 Rl = 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 V21N1E 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 FPS VI was R3 XXXXX. FT DELTAH

- 2. Alignment option, V50N25 Rl = 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 10E (llE 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 BFT 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, IM 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 V40N2OE.
 - b) V47 is performed in program other than Pl2, 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 CHANEKUP, the location containing the back-up flags for DESCENT. It is desireable to load this location to 00000 when new ropes are installed. V48E need not be called to load NOUN 46. CHANEKUP 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 l/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

	R03	minimum unstaged mass in N47 minimum ASCENT mass in N47	14,462 lbs. 4,850 lbs.
HIASCENT	1/ACCS	maximum ASCENT mass	8,858 lbs.min.(E-load) 4,850 lbs.
LOASCENT HIDESCENT	1/ACCS 1/ACCS	minimum ASCENT mass 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, V40N2OE, to re-enable the DAP.

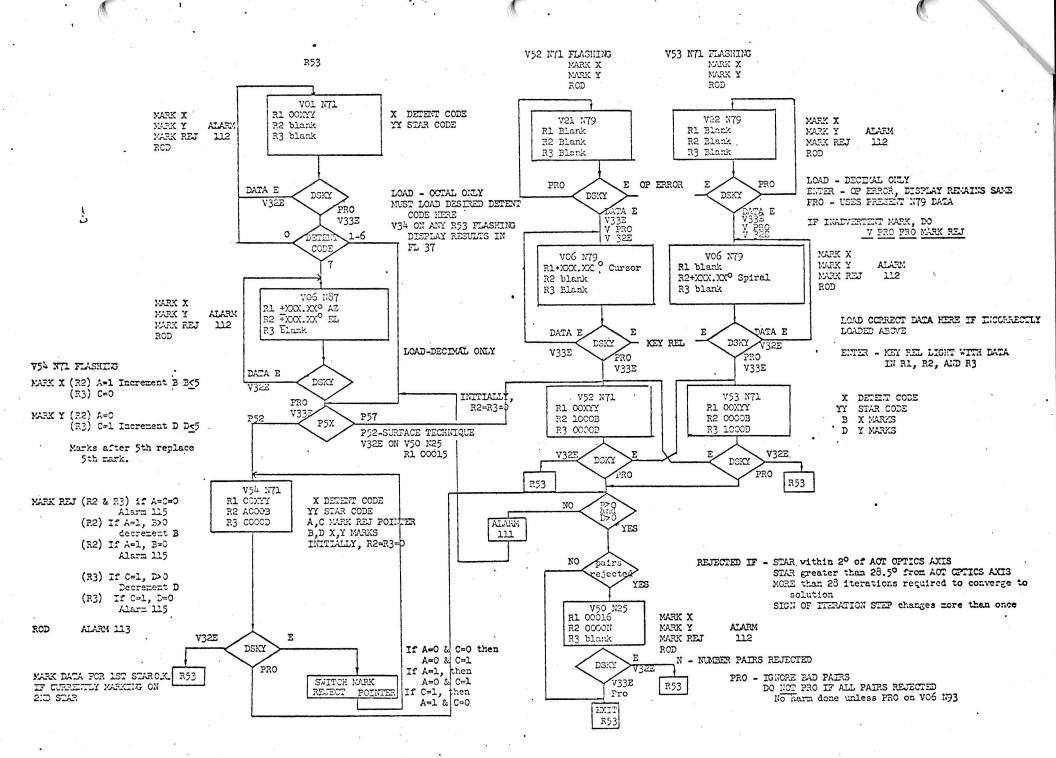
- MISCELLANEOUS -

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

AZO BDOT NODIO	(2) (2)	,, •	STAR T	ABLE (222)	KONMAT RATESP VAL67	(8) (12) (12)
NODDOT	(2)					20	
FSUB0	(2)						
FDOT	(2)	20	i,				

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 AIARM 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 (9F0) 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.



MIT/CSDL MISSION SUPPORT DEVELOPMENT PLAN FOR MISSION "J-1"

(APOLLO 15)

LUMINARY 1E

LUMINARY Project Manager's Signature

Director, Mission Development Approval

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 2	LM Program Schedules and Status 2-0
Section 1	Luminary GSOP Status
Section 2	Level 6 Performance Testing 2-2-0
Section 3	Mission Procedural Verification
Section 4	System Test Lab Testing
Section 5	Luminary Anomaly Status

LM PROGRAM SUMMARY

PROGRAM DEVELOPMENT SUMMARY FOR LUMINARY 1E

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

Date ____4/13/71

PROGRAM DEVELOPMENT SUMMARY FOR LUMINARY 1E

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		
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ITEM			SA ISSI DATE		MI	T REC		MIT REVIEW COMPLETION			COMMENTS
NO.	DESCRIPTION	Req	Pred	Act	Req	Pred	Act	Req	Pred	Act	COMMENTS
I	Flight Data File Review		a 7		* <u>.</u>	+5			=		
	a) LM Timeline Book		*,	•		,					
	b) LM Data Card Book					*			w.	9	
	c) LM System Activation Checklist				ü					80	
	d) LM G&N Dictionary			×			2 2				Note.
	e) LM Contingency Checklist			2						4	These are continuing type reviews. Comments
	f) LM Lunar Surface Checklist			3/15			4/5	w ₁₀	5/3	en _	are being transmitted to MSC as they are developed
	g) LM Cue Cards								z.		
	h) LM Systems Data 🕓			32				a i		-	
	i) LM Malfunction Procedure	п									
II	Crew Procedures Documents										
*	a) Apollo Operation Handbook (AOH)		3/31	8 z			e			v	
	b) LM Rendezvous Procedures		6/28		e					8.	
	c) LM Descent/Ascent Procedures		6/28	ø	•						
	d) Lunar Surface Procedures Preliminary Final		4/19 6/28				9			·	
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LM PROGRAM SCHEDULES AND STATUS

SECTION 1

LUMINARY GSOP STATUS

Date 4/13/71

and the second section of the section of	BLUE	COVER DESCR	IPTION		
DESCRIPTION	REQUIRED DATE	PREDICTED DATE	ACTUAL DATE	PROGRAM	COMMENTS
Section 1 - Prelaunch	V		2 A 2		
Rev. 1	1/17/69	12/23/68	1/29/69	, , , , , , , , , , , , , , , , , , ,	
Section 2 - Data Links	* .				
Rev. 11		4/19/71		LNY 1E	
G				b.	
Section 3 - Digital Autopilot Rev. 6			3/5/71	LNY 1E	
	·	*			
Section 4 - Operational Modes	. *				- 1 - N
Rev. 9		4/29/71	* 8 *	LNY 1E	
	, T		Œ	-	
Section 5 - Guidance Equations	>	4/96/71		LNY 1E	
Rev. 10	e "	4/26/71	,	LINITE	
	,	d .	e .	9 4	
Section 6 - Control Data Rev. 0		8	12/9/68	LNY 1D	
	p.	e i			
				a ' a a a a a a a a a a a a a a a a a a	
		. "		, *	
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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	RENDEZVOUS	P. White
6.1.1	Short Rendezvous - program sequence: P00, P20, P34, P42, P35, P41, P35, P41.	
,	Initial Condition: (1) 1 of 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	ABORTS from DESCENT	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) 1 o IMU, LR Radar, State Vector, (LM), Terrain Profile (+10) 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 400 after the Pitch Maneuver (6) Channel back-up set. (Abort discretes) (7) 6.2.3 with Abort Discrete Present.	
6.3.0	LUNAR SURFACE OPERATIONS & ASCENT	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

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
6.3.1.1	Inflight Alignments - program sequence: P52 (using P57 sighting), P52 (Planet and star), P52 (2 stars).	
	Initial Conditions: (1) 3o IMU	
	(2) Apollo 15 O. T., Data Package (3) Normal Astronaut Interface from Apollo 15 Data File.	
6.3.2	Ascent from Lunar Surface - program sequence: P00, P12, P20, P34.	
	Initial Conditions: (1) 1s State Vector, IMU, Radar Errors. (2) YAW LM 40° after the pitch maneuver occurs; Targetting for 1 N.M. out-of-plane. (3) Apollo 15 O.T., Data Package	
	(4) Normal Astronaut Interface from Apollo 15 Data File	
6.4.0	LANDING ON LUNAR SURFACE	S. Albert/D. Moore
6.4.1	Complete Automatic Landin, 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 6.4.2.2 6.4.2.3	NOUN 69: 10K/5K ft; ACA: None NOUN 69: 20K/20K ft.; ACA: 2(-EL), 2(+AZ) 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	SPECIAL TESTS	D. Moore
6.5.1	LM RCS Deorbit Burn-program sequence: P00, P30, P27, V96, P99, P00	
		The state of the s

Date

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER			
6.5.2	Docked-DPS Burns - program sequence: P00, P30, P40, P00	C. Work			
6. 5. 2. 1 6. 5. 2. 2	CSM/LM Configuration 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				

TEST	PRIMARY SETUP INPUT PREPARED			ALL E AND RE	RUNS COMP SULTS EVA	LETED LUATED	SUMMARY MATERIAL PREPARED			
NO.	Required	Predicted	Actual	Required	Predicted	Actual	Required	Predicted	Actual	
6.1.1	4/19/71	4/19/71.		5/27/71	5/27/71	v z	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	A	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	si .	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	٧	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	a a	6/2/71	6/2/71		
4	-					e .	ū			
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Date

LEVEL 6 PERFORMANCE TEST STATUS FOR LUMINARY 1E

TEST	PRIMARY SETUP INPUT PREPARED			ALL I AND RE	RUNS COMP. SULTS EVA	LETED LUATED	SUMMARY MATERIAL PREPARED			
NO.	Required	Predicted	Actual	Required	Predicted	Actual	Required	Predicted	Actual	
6.5.1	4/19/71	4/19/71		5/27/71	5/27/71	,	6/2/71	6/2/71		
6.5.2	4/19/71	4/19/71	×	5/27/71	5/27/71	1	6/2/71	6/2/71	P. Commission of the Commissio	
6.5.2.1	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71		
6.5.2.2	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71		
6.5.3	4/19/71	4/19/71		5/27/71	5/27/71	3	6/2/71	6/2/71		
6.5.4	4/19/71	4/19/71		5/27/71	5/27/71		6/2/71	6/2/71		
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SECTION 3

LM LEVEL 6 MISSION PROCEDURAL VERIFICATION

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 					
5.0	Docked DPS P30-P40					

SECTION 4

LM SYSTEM TEST LAB TESTING AND K-START
TAPE SCHEDULES

TEST	Responsible Engineer		TEST COMPLETE			DOCUMENT APPROVED			
		0	Req	Pred	Act	Req	Pred	Act	
SEV	Extended Verbs	Grace	41 1	3/1/71	2/16/71	9	3/16/71	3/2/71	
IOP	IMU Operational Program	Grace		3/1/71	2/16/71	8	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	6 · 2 · 1	3/26/71	2/22/71		4/9/71	2/26/71	
RP1	Radar Changes	Goodwin	5	3/26/71	2/18/71		4/16/71	•	
РТ	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	0 = 0 8	3/26/71	4/1/71	
СВ	Input Channel Backup (PCR's 1107, 1109, 1110, 1111)	Goodwin	e a	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	9	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	a	3/26/71	2/29/71		4/9/71	4/1/71	
L-26	ACB-26	St. Amand	e e		2/22/71		3/5/71	3/12/71	
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K-START TAPE SCHEDULE FOR LUMINARY 1E

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

SECTION 5

LUMINARY 1E ANOMALY STATUS

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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 lD & subs.	Program Note for Luminary lD & subs.	Program Note
L-1D-24	P70 or P71 selection prior to P12 leaves P12 with at least 3 flags abnormaly set	MSC/FSB 1/14/71	Program Note for Luminary lD ≦	Program Note for Luminary lD ≦	Program Note
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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 LE

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:

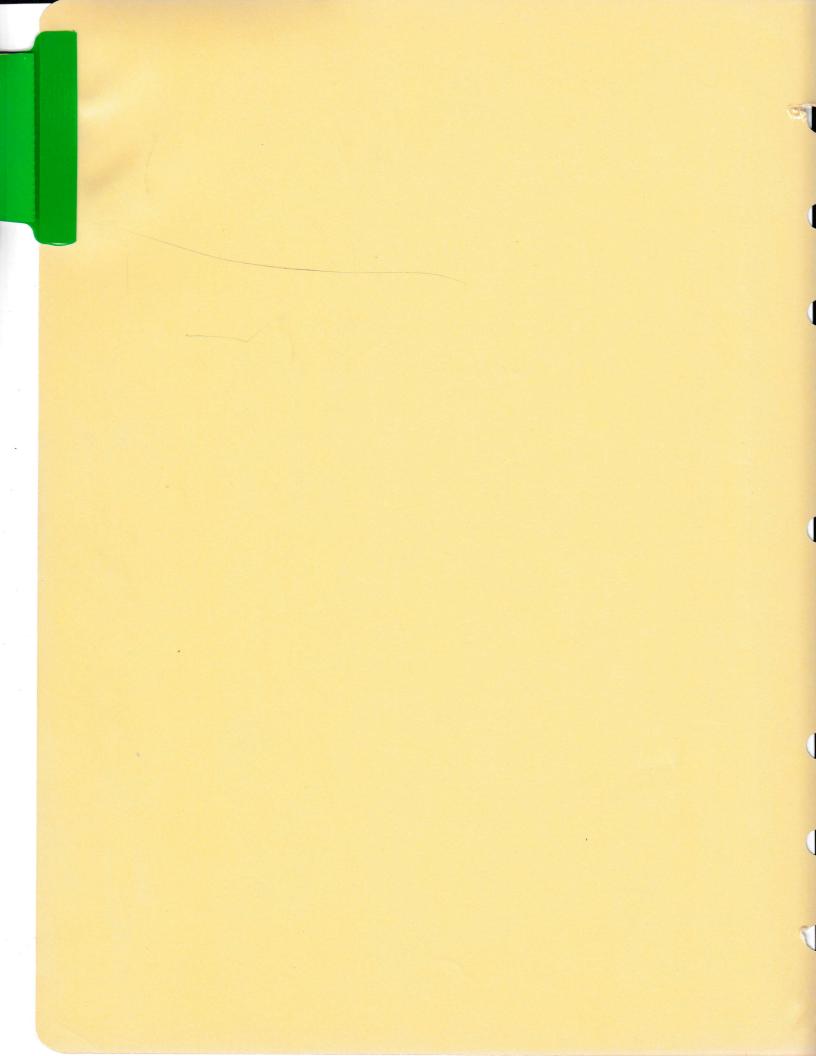
P40: TIG - 7.5 sec.

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:



Oate	3/17/71
-	

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

LUMINARY Project Manager's Signature

Director Mission / 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.

TABLE OF CONTENTS

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	Table of Contents	iii
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	Level 3 System Test Lab Tests	
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	Level 5 System Test Lab Tests	

SECTION I

PROGRAM DEVELOPMENT SUMMARY

PROGRAM DEVELOPMENT SUMMARY FOR LUMINARY 1E

TP 22587-2

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	$ \begin{array}{c c} 12/7/70 \\ 1/15/71 \end{array} $	$ \begin{array}{c c} 12/7/70 \\ 1/15/71 \end{array} $	12/7/70 1/18/71	Revision 210 Released to rope manufacturing 3/22/71
7	Level 5 Testing Start Completion	$\begin{array}{c c} 1/15/71 \\ 2/14/71 \end{array}$	1/15/71 2/14/71	1/15/71 2/12/71	
8	GSOP Publication (All PCR/PCNs approvup until program delivery) Section 2 Section 3 Section 4 Section 5	ed	4/12/71 3/26/71 3/31/71 4/12/71	3/5/71	Revision 6
9	Configuration Control FACI Review Week of	12/3/71	12/3/70	12/18,70 2/22/71	FACI mtg at MSC 3/3/71

SECTION II

 $\begin{array}{c} {\tt PROGRA\!M} \ \ {\tt CHANGE} \ \ {\tt REQUEST/NOTICE} \ \ {\tt STATUS} \\ \\ {\tt PCRs/PCNs} \end{array}$

Date __ 3/17/71 __

PCR STATUS REPORT FOR LUMINARY 1E

PCR	·····································	Originator/	MIT IM	PACT	NASA/SCB	GSOP Section	
No.	DESCRIPTION	Date	Schedule	Storage	DIRECTION	Affected	COMMENTS
311	Rendezvous and Prethrust Downlink Change	FSB 2/13/70			Disapproved 5/14/70		
317.2	Rescaling Nouns Con- taining 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		· 3	Implement and Pro- vide Detail Evaluation 8/13/70	2, 4	Only the addition of Δ H 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 eyaluation 9/30/70	2, 4	
334 Rev1	Change DSKY Descent/Ascent Nour	FCOD s9/28/70		+5	Implement & provide detailed evaluation 11/5/70	2,4	
335	Remove Alignment Option from P63	FC O D 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 eval uation 11/5/70	4, 5	

PCR STATUS REPORT FOR LUMINARY 1E .

PCR		Originator/	MIT IM	PACT	NASA/SCB	GSOP Section	
No.	DESCRIPTION	Date	Schedule	Storage	DIRECTION	Affected	COMMENTS
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	ş	(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 Frasable Load	FG 7 10/29/70			Disapproved 11/5/7)		
	Mod.to Code Word Configuration for PGNCS/ AGS Data Transfer	FSD 11/25/70		5	Implement & provide detailed evaluation 1/14/71	2	
348	New Target 🛆 V Program	n FCSD 11/25/70	and the second second street the second second	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 IM	PACT	NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
1024	Variable Guidance Period Servicer	Eyles 2/26/70			Disapproved 4/9/70		
1030	Replacement of LOGSUB	Berman 3/11/70	ŀ		Disapproved 5/14/70		
1044	Re-design of R53 R57	Millard 5/11/70		60 words	Implement and Provide Detail Evaluation 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		a v	Implement & provide Detail Fvaluation 11/5/70	3	
1066	Display N81 on all passes in P34/74 and P35/75	Copps 8/3/70	, a	-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	Klawsnik 3/9/71				5	

PCR STATUS REPORT FOR

LUMINARY 1E

PCR	indicator e en 1900 de la maria de la m La maria de la	Originator/	MIT IM	PACT	NASA/SCB	GSOP Section	
No.	DESCRIPTION	Date	Schedule	Storage	DIRECTION	Affected	COMMENTS
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		(2-0	Implement & provide detailed evaluation 9/30/70	2	-
1080	Change time to Perform IMUCDU Zero	Larson 9/8/70	·	ų.	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 10,3 Seconds After Coarse Align IMU IMU CPU ZERO	Rye 9/25/70 6		+3	Implement & provide Detailed Evaluation 11/5/70	2.4	
1091	Priority Display Light on DSKY	McCoy 10/2/70		+6	Implement & Provide Detailed Fvaluation 11/5/70	4	
1092	Increase Accuracy of Determination of Accelerometer S. F.	Grace 9/23/70		20 words	Disap roved 11/5/70		
1093	Eliminate 481 day TEPHEM Limitation in Solar Lunar Ephemerides	Robertsd 10/5/70	n	Less then 5 fixed	Implement and provid Detailed Evaluation 11/5/70	e 5	no St. Language and Albania

Date 3/17/71

PCR No.	DESCRIPTION	Originator/	MIT IM	IPACT Storage	NASA/SCB DIRECTION	GSOP Section	COMMENTS
1095	Avoid Imcomplete Close-out of Manual Rate Command Mode (L-1D-07)	MIT 10/7/70		45 O	Implement & provide Detailed Evaluation 11/5/70	Affected 3	COMMENTS
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 N0D0FLAG 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		9	Disapproved 11/5/70	,	
		,			·		
		÷					
			1100				

PCR STATUS REPORT FOR LUMINARY 1E .

PCR No.	DESCRIPTION	Originator/	MIT IM	IPACT Storage	NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
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 Thro Chan 30 Bit 5	MIT t10/22/70		+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	,	* g	Withdrawn		
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Page 2-6

PCR STATUS REPORT FOR LUMINARY 1F '

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PCR	DECODIDATON	Originator/	MIT IM	PACT	NASA/SCB DIRECTION	GSOP Section	COMMENTS
No.	DESCRIPTION	Date	Schedule	Storage	DIRECTION	Affected	COMMIZIVE
1116	Automatic RCS Steerin	g 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 Fst. 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 11/18/77		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-Depende Calc. in l/ACCS	nt MIT * 11/30/70		5	Implement & provide Detailed Evaluation 1/14/71	3	,
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PCR STATUS REPORT FOR

PCR No.	DESCRIPTION	Originator/ Date	MIT IM Schedule	PACT Storage	NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
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		6	Implement & provi de Detailed Evaluation 1/14/71	3	<u>-</u>
1134	Revision of PCR llll	MIT 12/29/70			Implement & provide Detailed Evaluation 1/14/71	2	-
1137	Correct Constant for Ascent Guidance	$^{\rm MIT}_{1/12/71}$		2	Implement & provide Detailed Evaluation 1/14/71		
1141*	Initialize FLRCS in P12	MIT 1/22/71		>			
1143	GSOP Section 3 Rev 6 Changes	MIT 2/16/71		,		, 3	
1145	GSOP Section 4 Rev 9 Changes	MIT 3/ /71	v	P		4	
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SECTION III

PRE-LEVEL 4 TESTING

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LEVEL 3 SYSTEM TEST LAB TESTS

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

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PCR/ ANOM/		Responsible			LEVE	L 4 TE	STINC	j .	FIXED
ACB	DESCRIPTION	Engineer		STAR	Γ	CON	IPLET	red	IN
ACD	- DESCRIPTION	0	Req	Pred	Act	Req	Pred	Act	REV
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(AH on Downlist)	Albert/Fyles		11/23	12/4	 .12/3	12/3	12/18	196
PCR 324	PGNCS/AGS RR Data Transfer	Volante/Dunbar			10/22	. /	7	2/1	195
PCR 333	Change Recognition of ROD Inputs	Millard			11/20			1/18	191
PCR 335	Remove Alignment Option from P63	Albert/Eyles			11/20			12/18	186
PCR 338	Change LPD Scaling to 1.0° In All Directions	Albert/Fyles			11/20			12/18	185
PCR 339	Have P20 F50 72 Display Update	Rosenberg/Dunba	r		11/20			12/15	190
PCR 334 Rev 1	Change DSKY Descent/Ascent Nouns	Eyles/Albert/ Berman	,	•	11/23		,	12/20	1
PCR 336 Rev 1	Maneuvers	Rosenberg _/ Dunbar		11/20	11/20	12/3	12/3	12/15	193
PCR 340 PCR 341	LATVAL Polarity Change Landing Radar Reasonability Test	Eyles Moore/Albert		11/20	11/20	12/3	12/3	12/18 12/18	182 191
PCR 343	Disapproval of PCR 340	Albert/Eyles			3 11/23		,	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
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PCR/		egenetia de la Maria de la casa de la Caracina de L		PRE-	LEVEI	_ 4 TE	STING		FIXED
ANOM/		Responsible Engineer		STAR	Γ	CON	IPLET	ED	IN
ACB	DESCRIPTION	116	Req	Pred	Act	Req	Pred	Act	REV
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		1	11/23	1 '	1	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/	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	Dunbar		11/20		,		1/19	186
	Ephemeris Year		,		,				
CR 1088	Inhibit Program Change During Critical 8.22 Seconds After Coarse Align IMU	Rosenberg/ Edmond	S	11/20	11/20	12/3	1/22	1/22	191
PCR 1091	Priority Display Light on DSKY	Rosenberg/Dunba	r	11/20	11/20	12/3	12/3	12/15	193
PCR 1093	Fliminate 481 Day TFPHFM Limitation	Millard	i	11/20	11/20	12/3	1/22	1/22	192
PCN 1095	Avoid Incomplete Close-out of Manual Rate Command Mode (L-lD-07)	,		(See .	Anoma	ly L-1	D-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
PCK 1107	Backup of Abort bits Chan 30 Bits 1 and 4	Bernikovich			11/19	12/3	•	12/20	196
PCR 11 0 9	Backup of Off (1) Failures of Auto-Throt. Chan 30 Bit 6.	Albert			11/19	12/3		12/20	196
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PCR/ ANOM/	,			PRE-	LEVE	L 4 TI	ESTING	3	FIXED
ACB	DESCRIPTION	Responsible Engineer		STAR	T	COI	MPLET	ΓED	IN
ACB	DESCRIPTION	8	Req	Pred	Act	Req	Pred	Act	REV
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			1/19	191
PCR 1121	Replace Acceleration Est. with RCS Inhibit Flags on non-powered Downlist.	Albert/ Weissma	n	11/23	11/23	12/3	12/3	12/15	196
PCN 1124	Flag Resetting in P00D00 Aborts	٠		(S	ee L-I	D-15)	10. 10.		193
PCN 1127	Change to Downlist for IMU Pulse	Albert	St.		12/1	e e		12/15	197
PCN 1129	Update Mass Dependent Calculations in 1/ACCS	Weissman			12/1	B E	×	12/17	203
PCN 1133	Revision to Descent Mass Limits	Weissman			12/18			1/5	205
PCR 1134	Revision of PCR IIII	Weissman			12/18			1/15	202
PCN 1141	Initialize FLRCS in P12	McCoy	,		2/1			2/8	209
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PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

PCR/			especial survivors and a Survivors	PRE-	LEVEI	_ 4 TE	STINC	T.	FIXED
ANOM/		Responsible Engineer		STAR	Γ	CON	IPLET	ED	IN
ACB	DESCRIPTION	1115111001	Req	Pred	Act	Req	Pred	Act	REV
L-1D-01	'NEEDLER" Initialization Never Takes Place Following DAP Turn-on if IMU Error Counter (CH 12B06) are Enabled	S	(Se	e PCN	1070)	z ,		а	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	Fixe	d in L	umina	ry lD	-		
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						12/18	184
L-1D-07	Manual rate control mode improper ter- mination (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/Rosenber	g	11/20	11/20	12/3	12/3	11/27	181
L-1D-10	Major Mode Changes that Leave the DAP with Improper Data			,	1059)			S.	196
L-1D-11	$W_{ m B}$ is mis-scaled by a factor of 2		1	e PCI	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		11/2	311/23	12/3	1/22	1/22	193
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PCR/	•			PRE-	LEVEI	_ 4 TE	ESTINC	ì	FIXED
ANOM/		Responsible Engineer		STAR'	Γ	COMPLETED			IN
ACB	DESCRIPTION	Ingineer	Req	Pred	Act	Req	Pred	Act	REV
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	Company of the Compan	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	4		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	R2l & R24 do not clear Designate Flag when it finds the LOS outside Mode II limits in P22	Volante		3	12/10)		1/17	208
L-1D-19	Restarts in P20/25 may erroneously display V50Nl6 on DSKY	Volante	N.		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
	x x	and the second s			and the second	1	The state of the s		
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

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PCR/ ANOM/	•	Responsible					STINC		FIXED IN
1	DEGGRIPHION	Engineer		STAR	Γ	CON	IPLET	ED	
ACB	DESCRIPTION	Ü	Req	Pred	Act	Req	Pred	Act	REV
L-26	Insert check for coarse align before attempting gyro torquing	Sys. Test Lab. Rosenberg		11/23	11/23	1 2/ 3	1 2 /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	1 1/ 23	12/3	12/3	10/23	196
L-34	Erasable Clean-up (L-lD-05, L-lD-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	11/1	5 12/3	12/3	11/18	184
L-37	Make bad return from IMUSTALL in 1/ GYRO continue instead of go to END OF	Rosenberg/STL		11/23	11/23	12/3	12/3	1/18	185
L-38	JOB. Rearrange clearing of flags in V55; Change cpde at TRMTRAK1 to interpretive	Rosenberg/ Dunbar		11/20	11/20	12/3	1/20	1/19	190
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PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1E

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PCR/		D		PRE-	LEVE	L 4 TE	ESTINC	3	FIXED IN
ANOM/		Responsible Engineer		STAR	Γ	CON	MPLET	ED	
ACB	DESCRIPTION	25	Req	Pred		Req	Pred	Act	REV
L-39	Change a CADR to an ADRES following a TC TWIDDLE in RADSAMP.	Dunbar/ Rosenberg		11/20	11/20	12/3	12/3	12 /15	182
L-40	Make Room in Bank 10 to implement PCR 339	S. Rosenberg	/		CAN	CELI	FD		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		CAN	CELL	ED			
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		CAN	CELL	ED			
L-45	Clear INTYPFLG prior to INTEGRUS call in P2l 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
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TEST	TITLE	Responsible Engineer	TES	Г СОМРІ	LETE	DOCUN	MENT AP	PROVED
			Req	Pred	Act	Req	Pred	Act
SEV	Extended Verbs (Include L-lD-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	e:	1/29/71	2/24/71
RP1	Radar Changes (L-1D-12 fix test, and ACBL	Goodwin	2/5/71	1/3/71	1/15/71	5 FF	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
СВ	Input Channel Backup (PCR's 1107, 1109, 111 1134)	0 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	12/24/7	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)
АСВ	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						Stringhouse of these delegangles and in some one of string the	

SECTION IV

LEVEL 4 AND 5 TESTING

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LEVEL 5 SYSTEM TEST LAB TESTS

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
	General: all nominal mission sequences are tested (as per Apollo 14 checklis 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	t)
4.1.0	Nominal Mission Sequences	
4.1.1	Short Rendezvous (Hybrid and Digital) Extended Verbs (64, 67, 30, 31, 47, 63)	White/Moore
4.1.2	Nominal Automatic-Descent (Digital Only,	Albert
4.1.3	Descent with Redesignations (N69 & ACA) (Hybrid & Digital) Extended Verbs (57, 59) Load LPD BIAS (Small nonzero)	Albert/Moore
4.1.4	Lunar Surface Alignments (Hybrid & Digital) Extended Verbs (41)	Millard/Moore
4.1.5	Lunar Surface Navigation; Ascent from Lunar Surface (Hybrid &	Dunbar/Moore
4.1.6	Digital) Inflight Alignments (Hybrid & Digital (See 4.2.6))	

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
		,
4.2.0	Contingency Procedures	Bernikovich
4.2.1	Abort from Descent (Digital only)	
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
1 1		

LEVEL 4 AND 5 TESTING FOR LUMINARY 1E

LEVEL V SYSTEM TEST LAB TESTS FOR LUMINARY 1E

TEST	TITLE	Responsible Engineer	TEST	COMPL	ETE	DOCUM	ENT API	PROVED
1 1 1 1 1	111 22	g	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)	D	5/29/71	
AAP.	6 P57 Changes (PCR 1044)	St. Amand		3/26/71	2/22/71		4/9/71	2/26/71
RPl	Radar Changes	Goodwin		3/26/71	2/18/71		4/9/71	1
PT	IRIG Torque	Sheridan		3/12/71	2/18/71	a	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	
СВ	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	2/24/7		4/9/71	*
KR	Super Key Release Light (PCR 1091)	Sheridan		3/12/71	2/19/7		3/26/71	
AAP	P52 Changes (PCR 1044)	St. Amand		3/26/71	2/29/7		4/9/71	
L-26	ACB L-26 (1) Now on Delco Elect responsibility * Included in AAP . 6	St. Amand			2/22/7		3/5/71	3/12/71
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PAT	WHITE
317.2	
1066	
L-10-0	4

Don Eylas	
319 334 335 340 341 + DM 343	
Don Miller 1	
333	

P Rye	
336 339 348 + P WH 1088 1091 1097.2 1100 D, Moore	1107 + w 8 1109 + D E 1110 + D E 1117,2 1127 + S A L-10-15 L-10-20

George Kalen L-10-07 NYLES BARNET

1093

DISAPPROUE APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST 1.0 COMPLETED BY ORIGINATOR 1.2 ORGANICATION 0~16114TOR . William 2/13/70 FSB R. W. Carl Rendezvous and Prethrust Downlink Change Apollo 15 LUMINARY 1.5 PEASON(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. 1.6 DESCRIPTION OF CHANGE See Data Amplification Sheet 2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT 2.2 REMARKS: APPROVED DISAPPROVED C.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF 3.0 MIT VISIBILITY IMPACT EVALUATION: 3.1 SCHEDULE IMPACT 3.2 IMPACT OF PROVIDING DETAILED EVALUATION 3.4 REMARKS: 3.3 STORAGE IMPACT 3.5 MIT CORREINATOR 4.0 SOFTWARE CONTROL BOARD ACTION 4.2 REMARKS PROVIDE IMPLEMENT AND D-1 S-DETAILED FROLIDE DETAILED CHENG CHANGE EVAL. EVALUA 4.3 SOFTWARE CONTROL BOARD SIGN 5.0 MIT DETAILED PROGRAM CHANGE EVALUATION . I MIT COORDINATOR 5.2 MIT EVALUATION 6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION 6.2 REMARKS: DISAPPROVED OR STOP IMPLEMENTATION. IMPLEMENTATION .3 SOFTWARE CONTROL BOARD SIGN OFF

APOLLO SPACECI	RAFT SOFTWARE CONFIGU	RATION	CONTROL BOA	RD	a dame Jumpaka		
	DATA AMPLIFICATION	SHEET			PAGE_	2 OF	2
PROGRAM CHANGE REQUEST	NO. PREPARED BY		DATE	ORGAN	NIZATIO	N	
311	R. W. Carl		4/3/70		SB		
CONTINUATION SECTION: ()	Refer to Block Number and Title o	on Program Cl	hange Request for	n.)			

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

EM 40 - 5 :

COLOSSUS 3 LUMINARY 1E COLOSSUS 3 LUMINARY 1F COLOSSUS 1 LUMINARY 1F COLOSSUS LUMINARY 1F	PCR/PCR # 317.2 ANOMALY # ADR #
MIT Approved PCN MIT Approved ADR A. Coding Begin coding immediately ACTION: Program Supervisor's Approval: Do not code until new GSOP material has bee Mission Design Review Board (MDRB) and di	n approved by the MIT
B. GSOP Preparation Prepare GSOP revisions for MDRB consideration ACTION: Technical Committee Meeting not required. Technical Committee Meeting(s) held on Attendees:	J. SMITH
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	2.4/Lungary 7-20-70

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1.1.31

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1.3 EFFECTIVITY	<u>karaina minupana ara</u>	<u></u>	1.4 TITLE			
Luminary lE (Apollo	15)			ing nouns conta nge rate	ining r	ange
Current scaling of nouns involving range and range rate is inconsistent in three different ways causing crew readout errors.						
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MIT Approved ADR NASA Approved PCN	MIT Approved
A. Coding	Software Anomaly
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Program Supervisor's Approval:	Margart Hamillon
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B. GSOP Preparation	. 10.11
Prepare GSOP revisions for MDRB consideration	Klawsnik Smith
ACTION:	
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C. KSC Testing and Checkout	
Review for possible impact on KSC	
testing and checkout ACTION:	
D. Other Programs Affected	
D. Other Programs Affected Review for corresponding changes in .	
Review for corresponding changes in .	
ACTION:	
Special Instructions	1741
Project Manager	K.F. Larson
Date	8-18-70

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APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST 1.0 COMPLETED BY ORIGINATOR 1.2 ORGANIZATION 1.1 ORIGINATOR ollla. FM4/MPB 7/29/70 B. F. Cockrell 1.4 TITLE OF Improvements to Ephemerides Luminary (Apollo 15) 1.5 REASON(5) 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 2.2 REMARKS: DISAPPROVED APPROVED SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF-3.0 MIT VISIBILITY IMPACT EVALUATION: 3.2 IMPACT OF PROVIDING DETAILED EVALUATION 3.1 SCHEDULE IMPACT 3.4 REMARKS: . & STORAGE IMPACT ROTAVICACOS TIV A. DATE 4.0 SOFTWARE CONTROL BOARD ACTION 4.2 REMARKS PROVIDE DETAILED PROVIDE DETAILED CHANGE DIS-APPRO APPROVED CHANGE EVAL. EVALUATION .3 SOFTWARE CONTROL BOARD SIGN OF DATE 5.0 MIT DETAILED PROGRAM CHANGE EVALUATION 5.2 MIT EVALUATION . 1 MIT COORDINATER 6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION 6.2 REMARKS: DISAPPROVED OR STOP START OR CONTINUE IMPLEMENTATION IMPLEMENTATION .3 SOFTWARE CONTROL BOARD SIGN OFF



Mission Planning and Analysis Division NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Houston, Texas 77058

IN REPLY REFER TO: 70- PM47-149

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 (SIO23, "Fixed Memory Ephemeris Routines for AAP") which would replace the current CMC ephemeris routine; with those of the IGC. 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 SIO23.

Bedford F. Cockrell

APPROVED BY:

James C. McPherson, Chief Mathematical Physics Branch

RTS

Attachments

Distribution: (See attached list)

FM4:BFCockrell:rmr

DAD RWV



5522.7-70-21

INTEROFFICE CORRESPONDENCE

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. Philoo-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,

$$\underline{X}_{EM} = \underline{c}_{o} + \underline{c}_{1}t_{m} + \dots + \underline{c}_{9}t_{m}^{9}$$
 (1)

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
- $\Omega_{
 m I}$ 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_{T} , about the new x-axis through the angle i (=5°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°8' = .9962) is:

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

where

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

a, $OMEGA_a$, $PHASE_2$, 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 (reso and veso) evaluated at temporal and a circular orbit approximation with the use of the angular velocity ($\omega_{\rm ES}$) evaluated at temporal approximated as a constant during the mission.

$$\frac{\mathbf{r}_{ES}}{\mathbf{r}_{ESO}} = \frac{\mathbf{r}_{ESO}}{\mathbf{r}_{ESO}} \cos \left(\omega_{ES} t_{M}\right) + \left[\frac{\mathbf{r}_{ESO}}{\mathbf{r}_{ESO}} \times \text{UNIT} \left(\underline{\mathbf{v}}_{ESO} \times \underline{\mathbf{r}}_{ESO}\right)\right] \sin \left(\omega_{ES} t_{M}\right)$$

$$\frac{\mathbf{v}_{ES}}{\mathbf{v}_{ESO}} = \frac{\mathbf{v}_{ESO}}{\mathbf{v}_{ESO}}$$
(4)

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:

$$\underline{\mathbf{u}}_{ES} = \text{UNIT} \begin{bmatrix} \cos (\text{LOS}) \\ \mathbf{K}_{1} \sin (\text{LOS}) \\ \mathbf{K}_{3} \sin (\text{LOS}) \end{bmatrix} = \text{UNIT} (\underline{\widetilde{\mathbf{u}}}_{ES})$$
 (5)

where,

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 $\ell = \ell - \Gamma' (\Gamma' = mean longitude of the moon's perigee measured in the ecliptic plane from the equinox to the ascending node of the moon's orbit and then along the orbit) and <math>D = \ell - L$. 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.

Pata wire generated for the following launch dates:

Launch Date	Coordinates	Clock Zero
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 accuray 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:

LOM =
$$LOM_o + LOM_R t - [a sin (OMEGA_a t + PHASE_a) + b sin (OMEGA_b t + PHASE_b) + c_1 sin (OMEGA_1 t + PHASE_1)]$$
 (7)

The error perpendicular to the orbit plane could be corrected by modifying $\underline{u}_{\rm FM}$ to include a final y-axis rotation through the angle:

$$c_2 \sin \left(OMEGA_2 t + PHASE_2\right)$$
 (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

left an out-of-plane error with an rms of 0.30 mrad. A value for the \mathbf{c}_1 term of

-.012176008
$$\sin (OMEGA_1^t + PHASE_1)$$

OMEGA₁ = 4.9261375 $rad/sec \approx 2D$

PHASE₁ = 5.0585394 $radian \approx 2D$

reduced the error in the orbit plane to an rms of about 3.75 mrsd. 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 c₁ 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:

$$\underline{\mathbf{r}}_{ES} = \mathbf{r}_{ESO} \, \underline{\mathbf{u}}_{ES}$$

$$\underline{\mathbf{v}}_{ES} = \mathbf{v}_{ESO} \, \mathbf{UNIT} \left[\begin{pmatrix} 0 \\ -K_3 \\ K_1 \end{pmatrix} \times \underline{\mathbf{u}}_{ES} \right]$$
(11)

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

 $v_{\rm ESO}$ = 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.

RESULT:

The constants for computing \underline{u}_{ES} and \underline{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 Apollo LGC Proposed AA	(14.5 day span) (12 month span) P (18 month span;	~ 700 meters ~ 11 mrad
r r o p o o c a r a r	March 1972 launch)	4.26 mrad
Proposed AA		4.30 mrad
D 1 7 C	July 1972 launch)	E 01
Proposed LG		5.01 mrad
Proposed LG	C (NBY 1973)	3.57 mrad
Proposed LG	C (NBY 1974)	3.93 mrad

Sun's Position

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

Prepared by:

Mission Analysis Section

Approved by:

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

Approved by:

R. K. Petersburg, Manager Systems Evaluation Department

FJR:ckh Attachment

Table of Lunar-Solar Ephem Constants

		*				
	•	NBY 1972 (AAP March 1972 Launch Date)	NBY 1973 (AAP July 1972 Launch Date)	NBY 1972 (Apollo)	NBY 1973 (Apollo)	NBY 1974 (Apollo)
Κ.	1	.916815277	.916770797	.917460	.917128324	.91713458
-K	-	041915207	040561188	038649526	045469469	030895764
K.		.397610118	.397534851	.397840	.397695305	.397679139
K		.078973674	.082191389	.081046308	.080911556	.084545343
L	OM _R	2.66169237E-6	2.66175580E-6	2.66141960E-6	.266151493E-5	.266155777E-5
	os _R	1.99095586E-7	1.99098765E-7	1.990984E-7	.199233952E-6	.199227631E-6
	ON _R	-1.17564381E-8	-9.52992264E-9	-1.1756438E-8	125304593E-7	109787942E-7
	OMO	3.35941954	5.84565454	3.36054770	5.85008721	1.81900454
	os_0	1.71812631	1.73105355	1.71750123	1.72885940	1.72478782
	OMO	5.55303226	5.14539021	5.58026185	5.21028842	4.87760331
	a	.110126647	.109746317	.110181651	.110088280	.109694152
PH	HASE	.158763560	1.92385096	.167774235	1.94982119	3.50537130
OM	ÆGA a	2.63915793E-6	2.64003514E-6	2.63833482E-6	.263782294E-5	.263769407E-5
	b	.022398308	.022233476	.021831169	.0229161424	.023003363
	HASE _b	3.03046541	022168116	3.18224870	.063511323	2.96236179
OM	EGA _b	2.28820002E-6	2.28653265	2.28269913E-6	.228502742E-5	.228665889E-5
	c	.033518516	.033511773	.033501623	.032476401	.032496805
	HASE	.064915422	056917517	071370601	120843930	122305953
OM.	1EGA _C	1.99009067E-7	1.99087665E-7	1.991075E-7	.203065775E-6	.202763784E-6
	c ₁	011828792	010886412	011469346	010682826	011283943
	HASE c	3.16152543	1.93399742	3.16667984	1.99692403	4.99267136
O)	MEGA _C ,	4.92787460E-6	4.92451089E-6	4.93103849	4.91887156E-6	4.90663348E-6

Differential Correction, Least Squares Fitting Routine

The pasic 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

$$\delta \underline{\mathbf{y}} = \begin{bmatrix} \frac{\partial \underline{\mathbf{y}}}{\partial \underline{\mathbf{x}}} \end{bmatrix} \quad \delta \underline{\mathbf{x}} \tag{A-1}$$

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

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

where:
$$A = \left(\frac{\partial \underline{x}}{\partial \underline{x}}T\right)$$
.

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

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

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

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

For
$$\underline{\mathbf{u}}_{ES}$$
:
$$\underline{\mathbf{x}} = \begin{bmatrix} LOS_{O} \\ LOS_{R} \times 10^{6} \\ C \\ OMEGA_{C} \times 10^{6} \\ PHASE_{C} \\ K_{1} \\ K_{3} \end{bmatrix}$$

$$y_{\mathbf{i}} = \sqrt{1 - (\underline{\mathbf{u}}_{ES}_{ACT_{\mathbf{i}}} \cdot \underline{\mathbf{u}}_{ES}_{EST_{\mathbf{i}}})^{2}}, \quad \mathbf{i} = 1, N$$

$$(A-4)$$

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/(10⁶ 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 pasic 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:

Let
$$\underline{u}_E$$
 = UNIT $(\underline{\widetilde{u}}_E)$ $(\underline{u}_E = \underline{u}_{EM} \text{ or } \underline{u}_{ES}$, 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:

$$\frac{\partial x_{i}}{\partial x_{i}} = -\frac{(\underline{u}_{E} \cdot \underline{u}_{A}) \underline{u}_{A}}{y} \cdot \frac{\partial \underline{u}_{E}}{\partial x_{i}},$$

where:

$$\frac{\partial x_{\mathbf{1}}}{\partial \underline{u}_{\mathbf{E}}} = \frac{1}{\left|\underline{\widetilde{u}}_{\mathbf{E}}\right|} \left[\frac{\partial x_{\mathbf{1}}}{\partial x_{\mathbf{1}}} - \underline{u}_{\mathbf{E}} \left(\underline{u}_{\mathbf{E}} \cdot \frac{\partial \underline{\widetilde{u}}_{\mathbf{E}}}{\partial x_{\mathbf{1}}} \right) \right].$$

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

$$\frac{9x^{!}}{9x} = -\frac{\lambda |\overline{\underline{n}^{E}}|}{(\overline{n}^{E} \cdot \overline{n}^{V})} \left[\overline{n}^{V} - (\overline{n}^{V} \cdot \overline{n}^{E}) \overline{n}^{E}\right] \cdot \frac{9x^{!}}{9\overline{\underline{n}^{E}}},$$

where $\frac{\partial \underline{u}_E}{\partial x_1}$ 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.

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

$$\varepsilon = -\underline{\delta} \cdot \underline{u}_A$$
Then: $\underline{u}_A \cdot \underline{u}_E = 1 - \varepsilon$

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

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

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

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:

$$\frac{\partial y}{\partial x_{i}} = \frac{(1-\epsilon)^{2}}{\sqrt{1-\frac{\epsilon}{2}} \left| \underline{\widetilde{u}}_{E} \right|} \left[\text{UNI}\underline{T} \left(\delta \right) - \frac{\sqrt{2\epsilon}}{2(1-\epsilon)} \underline{u}_{A} \right] \cdot \frac{\partial \underline{\widetilde{u}}_{E}}{\partial x_{i}}$$

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

$$\operatorname{Truit}\left(\frac{\partial x}{\partial x^{\mathbf{I}}}\right) = \frac{1}{\left|\widetilde{\underline{u}}^{\mathbf{E}}\right|} \left[\left(\frac{\partial x^{\mathbf{I}}}{\partial \widetilde{\underline{u}}^{\mathbf{E}}}\right) \cdot \left(\frac{\partial x^{\mathbf{I}}}{\partial \widetilde{\underline{u}}^{\mathbf{E}}}\right) - \left(\overline{\underline{u}}^{\mathbf{A}} \cdot \frac{\partial x^{\mathbf{I}}}{\partial \widetilde{\underline{u}}^{\mathbf{E}}}\right)^{2}\right]^{\frac{1}{2}}$$

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



INTEROFFICE CORRESPONDENCE

5522.7-70-77

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

"Guidance System Operations Plan for Manned LM Earth Reference: 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; \underline{u}_{EM} and \underline{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:

Mission Analysis Section

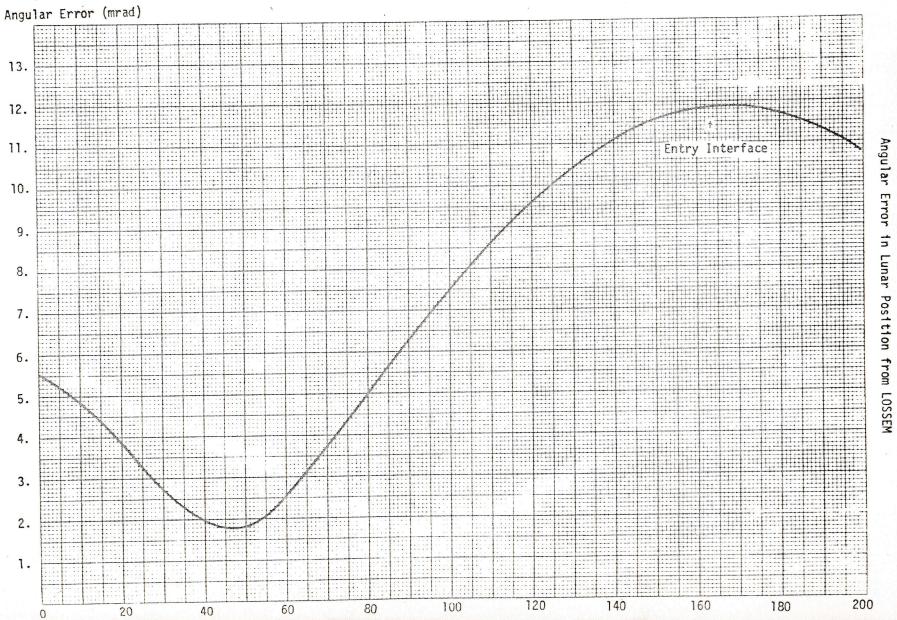
Approved by:

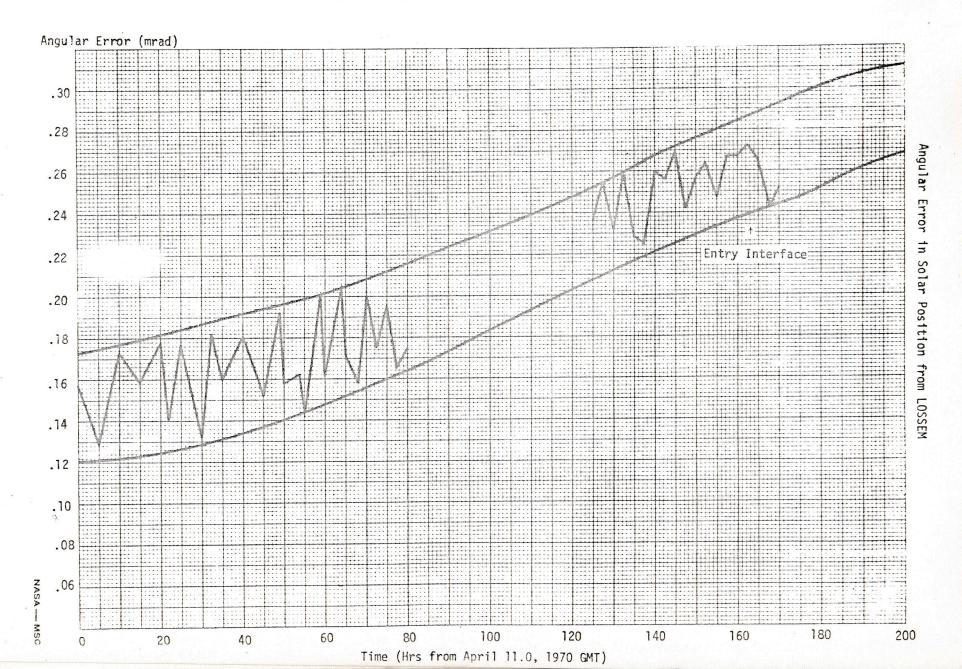
P. E. Hong, Manager MSC/TRW Task A-164

Approved by:

R. K. Petersburg, Manager Systems Evaluation Department

FJR:mvr Attachments





MIT/DL PROGRAM CHANGE ROUTING SLIP	(PCR)PCN # 324
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MIT Approved PCN MIT Approved ADR NASA Approved PCN NASA Approved PCN A. Coding Begin coding immediately ACTION Program Supervisor's Approval Do not code until new GSOP material has had mission Design Review Board (MDRB) and	Software Anomaly MIT Approved Software Anomaly Pat White : Virginia Dunbar : Margart dametro peen approved by the MIT
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B. GSOP Preparation Prepare GSOP revisions for MDRB consideration ACTION Technical Committee Meeting not required Technical Committee Meeting(s) held on Attendees:	
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D. Other Programs Affected Review for corresponding changes in	
ACTION Special Instructions	
Project Manager	L. H. Larson
Date	8-18-70

(F. 31)

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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.

- 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

- RR Trunnion Angle CDU
- A composite code word
- The following additional restrictions and requirements are placed on the transmitted data of (2) above.
 - 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.
 - 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 PCP 347 corresponds to an IGC computer word without the parity bit.

AGE DIT 15 14 _ - - -Bit No. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 AO 1 1 1 1 1 1 1 1 1 1 1 1 Set A100000000000000 Reset

> 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.

- 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.
- The radar data should remain unchanged on the downlink for at least two seconds after the code word is placed in the set configuration.
- 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 IGC downlist contains 100 downlink words. Each downlink word is composed of a "word order code bit," two 16-bit IGC 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 IGC 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 (77340g)
2	1	CSM State Vector $R_{\rm X}$	CSM State Vector $R_{\rm X}$
. 3	1	CSM State Vector Ry	CSM State Vector Ry
14	1	CSM State Vector R_{Z}	CSM State Vector $R_{\rm Z}$
5	1	CSM State Vector $V_{\mathbf{X}}$	CSM State Vector V_X
6	: 1	CSM State Vector Vy	CSM State Vector V_y
7	1	CSM State Vector $V_{\rm Z}$	CSM State Vector $V_{\rm Z}$
8	l	CSM State Vector Time	CSM State Vector Time
9	- 1	MARKTIME	MARKTIME
10	l	MKCDUY	MKCDUZ
11	1	MKCDUX	No. of Marks
12	1	*RR Trunnion CDU	RR Shaft CDU
13	1	*RR SHAFT CDU	~ Garbage ~
#17	1	T_{F}	T_{F}
25/14	and the same	*RR Range (Raw Data)	RR Range Rate (Raw Data)
16-13	5 1	*RR Range Rate (Raw Data)	~ Garbage ~
17 /	6 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 la 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-bit integer) X (75.04) for high scale

OY

(15-bit integer) X (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-bit integer minus 17000) X (-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 LGC downlist.
 - c. IGC in P2O or P2O 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 (P2O subroutine which takes an RR mark about once per minute) actively running.

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ins Entrollytin	190 180	1.4 TITLE OF CHANGE			
Apollo 15 and Subs - Luminary Change DSKY DESCENT/ASCENT NOUNS					
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.					
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					
DECISION FOR VIS	SIBILIT	OR FLIGHT SOFTWARE BRANC Y IMPACT ESTIMATE BY MIT	СН		
2.1 APPROVED DISAPPROVED	2.2 REA	MARKS:			
2.3 SOFTWARE CONTROL BOARD OF FLIGHT SOFTWARE BRANCH SIGN OFF	-				
DATE	-				
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.: SCHEDULE IMPACT		3.2 IMPACT OF PROVIDING DETAILED	EVALUATION		
2.3 STORAGE IMPACT	3.4 REN	ARKS:			
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWAR	E CONT	ROL BOARD ACTION			
PROVIDE DETAILED DIS- CHANGE EVAL. PROVIDE DETAILED DIS- CHANGE EVAL. PROMIDE DIS- CHANGE EVAL.	4.2 RF	MARKS			
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			
: 47 [
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 START OR CONTINUE DISAPPROVED OR STOP ************************************	6.2 REM	ARKSı			
6.3 SOFTWARE CONTROL BOARD SEGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET PAGE ROGRAM CHANGE REQUEST NO. PREPARED BY 334 Rev. 1 ONTINUATION SECTION: (Refew 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 $V_{\rm T}$ 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, H, H b. On call in descent N68: Horizontal Range, TGo, VI c. In Pl2, P70, and P71, N94: AVGx, H, H (AVGx = Rl of N85) d. On call in ascent N77: T_{GO} , ΔVGy , VI ($\Delta VGy = R2$ 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 b. V58E should reset the LR INH flag (current logic) c. 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.)

N63 N68

H HORIZ T GO

UI

REMARKS:

IT/DL PROGRAM CHANGE ROUTING SLIP	(PCR/PCN # 335
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 ZEUMINARY 1E	* *
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
MIT Approved PCN NASA Approve	d PCR NASA Approved
MIT Approved ADR NASA Approve	Coffusion Anomaly
MII Approved Tibit	MIT Approved Software Anomaly
A. Coding	Software Anomaly
Begin coding immediately	An Cyle
	CTION:
Program Supervisor's A	approval: ///arguit of Hamlin
Do not code until new GSOP materia	al has been approved by the MIT
Mission Design Review Board (MDI	RB) and distributed.
B. GSOP Preparation	
	18.0 4
Prepare GSOP revisions for MDRE consideration	() 1()
A	CTION: () () ()
Technical Committee Meeting not r	required.
	114 00
Technical Committee Meeting(s) he Attendees:	etc ou
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	17
Project N	Janager Lussell H. Janson
	Date 10-5-70
	•

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST 335							
1.0 COMPLETED BY ORIGINATOR							
1.1 rachalpatow	1.7.1	1.2 GAGANIZA	LION	APPROVAL		DATE	
Haise/Kaiser	9/23/70	FCOD					
***		a	1.4 TITLE	OF CHANGE			
Apollo 15 and Subs	- Luminary		Remove	Alignmen	t Option	From P63	
An alignment will no This option current option and an Enter	ly exists and	l invites a	an opera				
			9				
Delete JMU Fine Ali	gn option fro	om P63, i.e	e., FL V	50N25 dis	play		
	SOFTWARE CON DECISION FOR	VISIBILIT	Y IMPACT	HT SOFTWATE	ARE BRAN E BY MIT	CH	
AppRess 5	DISAPPROVED	P.C REN	AARKS:				
TO SETMANT ON TROLE BOARD OF	CLIGHT SOFTWARE						
3.0 MIT VISIBILITY IMPACT EV	ALUATION:	1.4				· · · · · · · · · · · · · · · · · · ·	
**** *********************************			3.2 IMPACT	OF PROVIDE	NG DETAILED	EVALUATION	-
tes proposed Treach		3.4 REV	IARKS:		•		
2.0 VI/ 1 _{2.0} 9715,5100						¥	
4.41				v			
	4.0 SOF	TWARE CONT	ROL BOAR	D ACTION			
1.1 MPLEMENT AND PRO		4.2 RE	MARKE	• • • • • • • • • • • • • • • • • • • •	**************************************		
CHANGE EVAL.	APPR	OVED					
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9/	30/70		×	e e			
	5.0 MIT DETA	ILED PROGR	AM CHANG	E EVALUAT	TION		
21 VIII (1940)NATSÄ #		E.2 MIT	EVALUATION	,			
			, ř				
	6.0 SOFTWARE DETAIL	CONTROL E ED PROGRAM	BOARD DE	CISION ON EVALUATI	MIT		
	ISABEROVEE OR STO	1 2 2 2	THE RESERVE AND ADDRESS OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS NAMED I				
5.3 SOFTMARE CONTROL FUNRD 31	ON OFF					**************************************	
DATE				, , , , , , , , , , , , , , , , , , ,			

MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN # 336 Row 1
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
GCOHODEO O	
COLORDO CIA	
COLOSSUS LUMINARY	
MIT Approved PCN NASA Approved PCR	NASA Approved Software Anomaly
MIT Approved ADR NASA Approved PCN	
	MIT Approved Software Anomaly
A. Coding	00
Begin coding immediately	F. Fye
ACTION:	0
Program Supervisor's Approval: 7/	January A. Damille
Do not code until new GSOP material has been	approved by the MIT
Mission Design Review Board (MDRB) and dis	tributed.
B. GSOP Preparation	
	KLAWSNIK/J. SMITH
consideration ACTION:	
Technical Committee Meeting not required.	•
Technical Committee Meeting(s) held on	<u> </u>
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	
O CONTON	
ACTION:	
Special Instructions Project Manager	Level (H. Level)
Date	11-5-70
Date	
	• · · · · · · · · · · · · · · · · · · ·

APOLLO SPACECRAFT SOFTWARE CONT PROGRAM CHANGE	
1.0 COMP	PLETED BY ORIGINATOR
1.1 ORIGINATOR DATE 1.2 C	ORGANIZATION APPROVAL PATE
2, , .	FCOD The Di Harse 10/23/70
1.3 LEFECTIVITY	(Delete 06 18 Display in R60)
Apollo 15 and Subs - Luminary	Allow Extended Verbs During P20 Maneuvers
The timeline is very tight after LM I Tweak/Bailout maneuver, P20 Initiation justment all needed within the same t	Insertion particularly on the M=l rendezvous with a on, Apogee-Perigee Determination, and Ordeal Adtime frame. For better time optimization it is
and after a PRO to maneuver the 50 18	re maneuver the 50 18 display should be flashing 8 should be replaced by the running program's oun the 50 18 should be replaced by a blank display.
DECISION FOR VIS	L BOARD OR FLIGHT SOFTWARE BRANCH SIBILITY IMPACT ESTIMATE BY MIT
2.1 APPROVED DESTAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	
3.0 MIT VISIBILITY IMPACT EVALUATION:	
3.: SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR	
DATE	
	RE CONTROL BOARD ACTION
PROVIDE DETAILED DETAILED DETAILED CHANGE EVAL.	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD STON OFF	
11-5-70	
5.0 MIT DETAILED	D PROGRAM CHANGE EVALUATION
5.1 MET COORDINATOR	5.7 MIT EVALUATION
PATE	
6.0 SOFTWARE CO DETAILED	ONTROL BOARD DECISION ON MIT PROGRAM CHANGE EVALUATION
START OR CONTINUE DISSPROVED OR STOP IMPLEMENTATION	6.2 REMARKS;
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

RAM	CHANGE REQUEST 1		LIFICATION S	DAT	ſ	ORGANIZATION		
	336 Rev. 1		1.		*			
INU	ATION SECTION: (R	efer to Block Num	mber and Title on	Program Change	Request form.)			
				ж.				
.5	desirable t	o be able to	call extended	d verbs, i.e	e. v82/v83,	while P20	is	
	maneuvering	the vehicle	•					
.6	At the comp	oletion of the	e maneuver the	e 50 18 disp	olay should	again flash	1.	
	Noun 18 sho	ould remain c	allable during	g the maneuv	ær.			
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DISAPPROVED

NUMBER (Completed by FSB)

APOLLO SPACECRAFT SOFTWARE CO PROGRAM CHANG	NFIGURA E REQUE	TION CO	NTROL B	OARD	337 Re	ev. l
1.0 CO	MPLETED	Y ORIGIN	ATOR			
	2 ORGANIZAT	NAME AND ADDRESS OF THE OWNER, WHEN PERSON AND POST	APPROVAL		DAT	E
Haise/Kaiser 10/1/70	FCOD		Jw:	Hais		
3 EFFECTIVITY		1.4 TITLE OF	F CHANGE			
Apollo 15 and Subs - Luminary		Illumina	ate Unuse	d DSKY	Light for	· N49
Currently if a noun is called over crew from being aware of a N49 requestops.	N45 the west. Ur	resulting til the	g Key Rel crew is m	ease li	ght obscure all up	ures the odating
Light an unused DSKY light whenever it when the logic is exited. Addi- tested by V35 and to those cleared	tionally by ERRO	, that li	ght shoul V37 logic	d be ad , and V	ded to the 56.	tinguish nose
2.0 SOFTWARE CONTR DECISION FOR V	OL BUARU ISIBILIT	Y IMPACT	ESTIMATE	BY MIT	n	
APPROVED DISAPPROVED	2.2 REI	ICANAM				
.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF						
DATE						
3.0 MIT VISIBILITY IMPACT EVALUATION:						A PART OF THE PART
CHEDULE IMPACT	,	3.2 IMPACT	OF PROVIDIN	G DETAILED	EVALUATION	
.3 STORAGE IMPACT	3.4 RE	MARKSI	, , , , , , , , , , , , , , , , , , ,			
.5 MIT COORDINATOR						
DATE						
4.0 SOFT	YARE CONT	ROL BOARI	D ACTION			
OF THE PROVIDE DETAILED CHANGE EVALUATION	4.2 R	MARKS				
.3 SOFTWARE CONTROL BOARD SIGN OFF				« .	x	
11/5/76						
5.0 MIT DETAIL				ION		
.I MIT COORDINATOR	5.2 MI	T EVALUATION	N.	•		
DATE						
6.0 SOFTWARE DETAIL	CONTROL ED PROGR	BOARD DE M CHANGE	CISION ON EVALUATI	I MIT ON		
START OR CONTINUE DISAPPROVED OR STO	P 6.2 RE	MARKSI				
5.3 SOFTWARE CONTROL BOARD SIGN OFF					- 100 m 1	
DATE						

T/DI PROGRAM CHANGE ROUTING SLIP	PCR/PCN# 338
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 CLUMINARY 1E	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
MIT Approved PCN MIT Approved ADR NASA Approved PCR NASA Approved PCN	NASA Approved Software Anomaly
MIII Approved Abre	MIT Approved
A. Coding	Software Anomaly
Begin coding immediately	On Cile
ACTION:	
	11.
Program Supervisor's Approval: /	Janail H, Hamelin
Do not code until new GSOP material has been Mission Design Review Board (MDRB) and dis	approved by the MIT tributed.
B. GSOP Preparation	·
	125 16
Prepare GSOP revisions for MDRB consideration ACTION:	(Scosmile .
Technical Committee Meeting not required.	
Technical Committee Meeting(s) held on	
	·
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	June 184 Line
Date	10.5 - 70
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APOLLO SPACECRA	PROGRAM CHA	NGE REQU	EST		BOARD	NUMBER (Comp 338	leted by FSB)
		COMPLETED		_			
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Haise/Kaiser	9/28/70	FCOD					
r. C. C. C. C. P. C. C. C.			1.1.11111	of that			9
Apollo 15 and Subs	- Luminary		Change :	LPD Scal	ling to 1	.0° In All	Direction
The crews estimati point is visually Currently the chan	seen as a numbe ge resulting fr	er of degr	ees from	the N64	Displaye	ed LPD Angl	.e.
Make each ACA inpu	t in every dire	ection rep	resent or	ne degre	e LPD cha	inge.	
2	.O SOFTWARE CON DECISION FOR	VISIBILI	TY IMPACT				
аррынуну	CISAPPROVED	. 2 . 2 RE	MAPKSI			S	
BENCH START	OR FLIGHT SOFTWAR	Ε					
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3.0 MIT VISIBILITY IMPAC	T FVALUATION:		SAMPAN TANKAR SAM		e Constituent		
2			I.O IMPAC	T DE FRONT	DING CETALLE	D EVALUATION	
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3.3 FICKASE IMPACT		3.4 RI	MARKS:		•		
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	4.0 SOF	TWARE CON		RD ACTIO	IN .		
HADLEMENT AND PROVIDE DETAILER THAN SERVAL.	PROVICE TETALLED DIS THANGE F.AELATION		EMARKS				
1.4 \$0#TA1PF . @"." of # 226					*		
NATE:	9/30/20						* a
	5.0 MIT DET	AILED PROG	RAM CHAN	GE EVALU	IATION		
MIT OF SECTIONS		5.2 MI	T EVALUATI	27			
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	6.0 SOFTWAR	RE CONTROL	BOARD D	ECISION	ON MIT		Alexandra State of Transport
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E.P. SOFTWARE CONTROL BUAR	FD 5135 055		, *			· v	
DATE				8 2 4	¥ 8		
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GRAM CHANGE REQUEST NO.	PREPARED BY		,	TE	ORGANITATION	
TINUATION SECTION: (Refe	r to Block Number	and Title on	Program Change	Request Toim.	,1	
interpreting	e and 2 degree his LPD angle the needed AC	e error to	then eithe	requires the r divide or	e crewman aft multiply by	cer two
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JARKS:				***************************************		
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MIT/191. PROGRAM CHANGE ROUTING SLIP	(PCR/PCN # 339
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 ZEUMINARY 1E	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
MIT Approved PCN NASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
	MIT Approved Software Anomaly
A. Coding	Software Anomaly
Begin coding immediately	P. Fye
ACTION:	8
	1 / 1/2/201
Program Supervisor's Approval:	,
Do not code until new GSOP material has b Mission Design Review Board (MDRB) and	een approved by the MIT distributed.
B. GSOP Preparation	6
	1331
Prepare GSOP revisions for MDRB consideration	J. O Sout
ACTION:	ClowsulC .
Technical Committee Meeting not required	1.
Technical Committee Meeting(s) held on	
Attendees:	
C. KSC Testing and Checkout	
Review for possible impact on KSC testing and checkout ACTION:	
A 50 - 1 - 1	
D. Other Programs Affected Review for corresponding changes in	
Review of corresponding changes in	
AC'TION	
Special Instructions	D 1141
muchale mechanger Date	10 15 - 70
mustyale medanjalo Date	10 3 - 70
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Lummany. Mil	

APOLLO SPACECRAFT P	SOFTWARE C ROGRAM CHAN	ONFIGUR GE REQU	ATION (CONTROL	BOARD		Completed by FSBV
	1.0 C	OMPLETED	BY ORIG	INATOR			
The transfer of the state of th	The second of th	.2 ORGANIZA		APPROVAL		D	ATE
Haise/Kaiser	9/28/70	FCOD					*
Page Collectivity			1.4 TITLE	OF CHANGE			
Apollo 15 & Subs - Lu	uminary	,	Have	P20 F50 7	72 Displa	y Updat	e
Increasing confidence after LM Insertion be comparing AGS aquisit	efore commenci- tion steering	ng update error nee	es is red edles, R	quired. R FDAI ne	This is eedles, a	accomplind N72	ished by on DSKY.
Mechanize F50 72 disp							RR A+
3	SOFTWARE CONTI DECISION FOR V	ISIBILIT	Y IMPACT	GHT-SOFTW T ESTIMAT	ARE BRAN E BY MIT.	CH	
APPHONES -	[154PPR: 15D	. 2 - 2 RT	VARKS:				
BRAN HOLDINGS	FLIGHT SOFTWARE						
3.0 MIT VIS'BILITY IMPACT EV	ALUATION:			and the specific			
STEENEDART IMPYS.			3.2 IMPACT	T OF ERVIOL	INC DETAILED	EVALUATIO	D.V.
2:.3 STORAGE IMPACT		3.4 RE	IARKS:		*		
R WIS CONTRACTOR							
8-A7-C				,			
	4.0 SOFTWARE CONTROL BOARD ACTION						
THE IMPLEMENT AND DETAIL OF THE CHANGE EVAL.	ILEO DIS-	4.2 RE	MARKS				The second secon
1.3 SUFTWARE CONTROL BIMED ST	97 (FF				ep st		all control of the co
C A T E	9/30/70			£			And the state of t
	5.0 MIT DETAIL	ED PROGR	AM CHANG	E EVALUA	TION		na distribution
5.1 MIT COORDINATOR		5.2 MIT	FNALUATION	N .			
CATE						*	Section 1986
	6.0 SOFTWARE DETAILE	U PROGRAM	1 CHANGE	CISION DA EVALUATI	N MIT		
L IMPLEMENTATION 14	SAPPRIVED OR STOP IPLEMENTATION	6.0 REM	ARKS:			5)	
. 3 SCETAARE CONTRAL BOARD SID	SV CFF	·					
CATE				, p		8 V	

OGRAM CHANGE REQUEST NO.		PAGE 2 OF 2
339	Haise/Kaiser	
NTINUATION 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	ta for
	5 er .	
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		a *
		·
Planain vivila esti valviala liqua va esta vast esquela representa escuente appeara que succes		
MASKS:		

MIT DL. PROGRAM CHANGE ROUTING SLIP	PCR/FCN # 340
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 CLUMINARY 1E THIS	PCR SHOULD NOT
COLOSSUS 3A LUMINARY 1F	APLEMENTED. SEE
COLOCCIIC	TARKS BELOW.
KEP	THERE BELLEVILLE
MIT Approved PCN UNASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
Parameter 1	MIT Approved Software Anomaly
A. Coding	> 6/2
Begin coding immediately	John you
ACTION:	
Program Supervisor's Approval	Margart H. Humeler
Do not code until new GSOP material has b	, , , , , , , , , , , , , , , , , , , ,
Mission Design Review Board (MDRB) and	distributed.
To GGOTO Decembrican	
B. GSOP Preparation	125 1
Prepare GSOP revisions for MDRB consideration	The Sun The
ACTION	: Lowsent
Technical Committee Meeting not required	d.
Technical Committee Meeting(s) held on	
Attendees:	
C. KSC Testing and Checkout	1 H
Review for possible impact on KSC	
testing and checkout ACTION	:
D. Other Programs Affected	
Review for corresponding changes in	
ACUTON	
ACTION Special Instructions	
This PCR is with - Project Manager Dates brown (10-7-70) by with disapproval	Lusull Jones
Date	10-5-70
brawn (10-7-10) Deg	
Tourbal disapproval	
17:1	
+	•

APOLLO SPACECRAFT	SOFTWARE	CONFIGURA	TION CON	ITROL BOARI	D 3140	apleted by FSB)
PI	ROGRAM CHAI	NGE REQUE COMPLETED	31		2,40	
	1.0	COMPLETED TO SECOND AT		pes , N	- 1	
Haise/Kaiser	9/22/70	FCOD				
- Naise/ Raisei			1.5 11718 25 1		HANGE	
Apollo 15 & Subs - 3	Luminary		LATVEL	, Polarity Cł		
The polarity of the	LGC paramet	er LATVEL	should be	changed so	that it is o	compatible
with other X-pointe	r inputs.		ζ			*
Reverse the sign of	the LGC par	ameter LAT	VEL. The	attached il	lustration :	shows the
present crew respon	se and the p	roposed cr	ew respons	se to the X-	pointer pre	sentation.
2.0	COLLMINE CO.	ATDOL BOAR	OR FLIGH	T SOFTWARE E ESTIMATE BY	BRANCH	
7.1	DISAPPROVED	2.2 RE	MARKS:			
APEROLED 2.3 SOFTMARE CONTROL BOARD C		RE		•		* *
BRANCH SIGN OFF					æ	
PATE	pq.					
3.0 MIT VISIBILITY IMPACT E	VALUATION:			The state of the s		9
A.S SCHETULE IMPAGE			2.2 IMPACT	OF PROVIDING DE	TAILED EVALUATI	ON
3.3 STORAGE IMPACT		3.4 R	EMARKS:			
3.5 MIT CCORPINATER						
DATE						
	4.0 \$9	OFTWARE CON		DACTION		
MERCATE DETAILED CH	T 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	PPROVED V	ERBALLY	DISAPPROL	IEO 10-7-	70.
1.3 SOFTWARE ONTROL BOARD	SION OFF					
PATE	9/30/7	0				
	5.0 MIT DE	TAILED PRO	GRAM CHANG	E EVALUATION	N	
T.1 WIT GOORDINATOR		5.2	MIT EVALUATIO	N		
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	0.00.7	ADE DOUTED	ם חמגוום ו	CISIUN UN M	11	
	b.U SOFTW DET			CISION ON M EVALUATION		
START OR CONTINUE	INPLEMENTATION	STOP	REMARKS			
IMPLEMENTATION						
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PATE			The state of the s	and an arrange to the second	A STATE OF THE STA	

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AZ RT/LAT VEL

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ELEV RT		,
FWD VEL	-	

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CONTROLLER OPERATION TO NULL

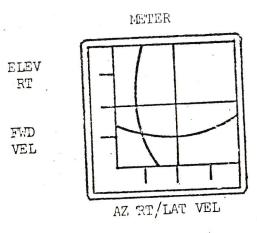
LR & PNGS

PITCH DN ROLL RIGHT

AGS RNDZ RADAR

FITCH DN ROLL LEFT

PROPOSED



LR, FNGS, AGS RNDZ RADAR

PITCH DN ROLL LEFT

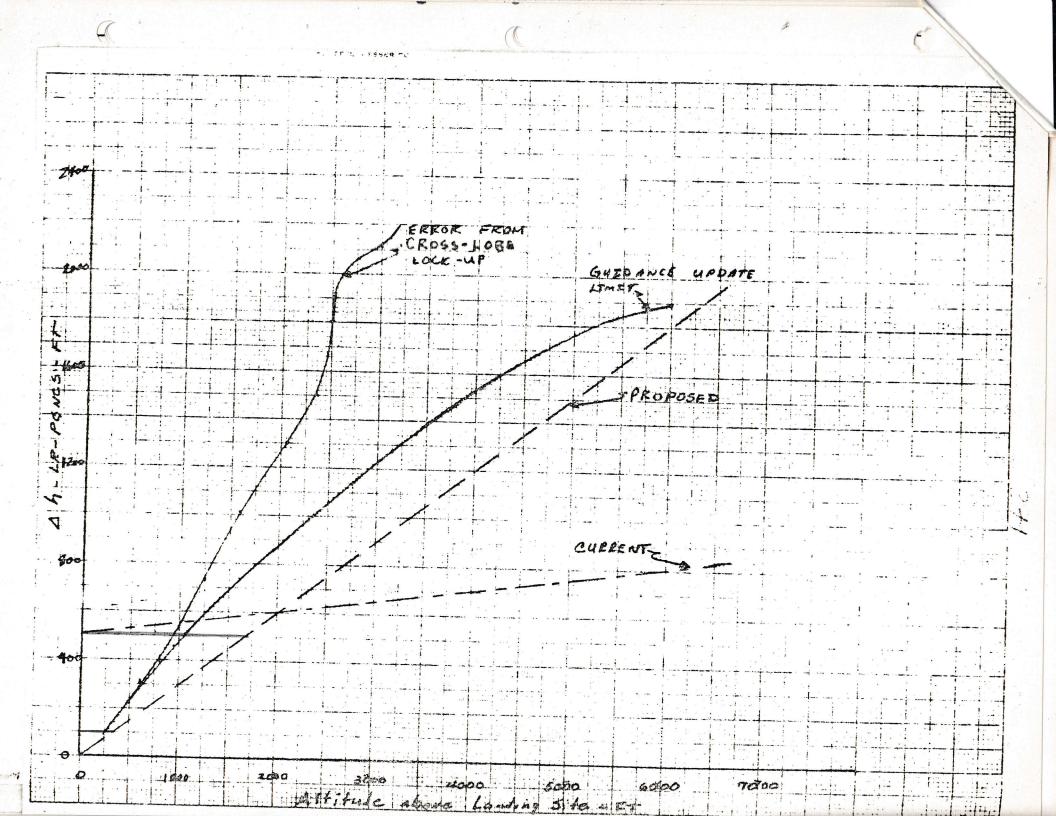
MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/P85 # 341
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
	NASA Approved Software Anomaly
	MIT Approved Software Anomaly
A. Coding Begin coding immediately	Dove Moor
ACTION:	Don Eyler
	Mario of Holan ola
Program Supervisor's Approval:	1 / 1
Do not code until new GSOP material has been Mission Design Review Board (MDRB) and dist	approved by the MII tributed.
B. GSOP Preparation	
Prepare GSOP revisions for MDRB	KLAWEN IK/J. SMITH
Technical Committee Meeting not required.	
Technical Committee Meeting(s) held on	
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	7 ind
Project Manager	usull Fl Jarson
Date	11-6-70
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APOLLO SPACECRAFT SOFTWARE PROGRAM CHA	CONFIGURA ANGE REQUE	ST ST 341
1.0	COMPLETED	BY ORIGINATOR
J. H. Alphin 9/29/70	MPAD	R. Moleles 10/16/70
Apollo 15 LUMINARY		Landing Radar Reasonability Test
especially if the lunar terra	ty test can in model is	lock out valid altitude updating, inhibited (V68) during the approach
See attached page.	8	
2.0 SOFTWARE CO DECISION FO	R. VISIBILIT	OR FLIGHT SOFTWARE BRANCH Y IMPACT ESTIMATE BY MIT
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	T SOFTWARE CONFIGURATION DATA AMPLIFICATION SHEET		PAGE 2 OF 2		
PROGRAM CHANGE REQUEST NO.	PREPARED BY	DATE	ORG AN I ZATION		
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



APOLLO SPACECRAFT	SOFTWARE CO	NEIGUR	ATION	CONTR	OL BO	ARD	NUMBER ((Completed by FSB)
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the +Z axis by utilizing the COAS or RR FDAI needles.	INUATION SECTION (Refer	to Block Number and Title on Program Cha	nge Request form.)	
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DATE:

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

345

PREPARED BY:

C. Hackler 10/29/70

ORGANIZATION:

EG7

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

1.6 (continued) Description of Change

RANGEV AR

RATEVAR

RMAX

XAMV

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.

Y/II. PROGRAM CHANGE ROUTING S	ANOMALY #
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COLOSSUS 2D LUMINARY	
COLOSSUS 2E LUMINARY	7 1D
COLOSSUS 2F LUMINARY	Y 1E
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	NASA Approved PCN Software Anomaly
	MIT Approved Software Anomaly
A. Coding	5111
Begin coding immed	iately T. Volance
	ACTION: V. Dunkar
Program	Supervisor's Approval: By de to M Humbo
	GSOP material has been approved by the MIT
Mission Design Revie	ew Board (MDRB) and distributed.
B. GSOP Preparation	
Prepare GSOP revisi	ons for MDRB J. KLAWSHIK
consideration	ACTION:
Technical Committee	Meeting not required.
Technical Committee	Meeting(s) held on
Attende	es:
C. KSC Testing and Checkout	
Review for possible i	impact on KSC
testing and checkout	ACTION:
D. Other Programs Affected	
Review for corresponding	g changes in
	ACTION:
Special Instructions	
	Project Manager L. Ho Laurson
	Date 11-30-70
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(Rev 10/69)

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HT/DL PROGRAM CHANGE ROUTING SLIP	PCR/DEN# 348
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	
COLOSSUS 3A DLUMINARY 1F	
COLOSSUS LUMINARY_	
MIT Approved PCN NASA/Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Coftmans Anomala
	MIT Approved
A. Coding	Software Anomaly
Begin coding immediately	P. Rye.
ACTION	: P. White
Program Supervisor's Approval	: Bune Wells to M Hambion
Do not code until new GSOP material has h	
Mission Design Review Board (MDRB) and	distributed.
B. GSOP Preparation	
Prepare GSOP revisions for MDRB	J. KLAWSNIK/J. SMITH
consideration	
ACTION	
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Technical Committee Meeting(s) held on	
Attendees:	
C. KSC Testing and Checkout	
Review for possible impact on KSC	
testing and checkout ACTION:	State of the Control
D. Other Programs Affected	
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Project Manager	Title down
Date	12 100

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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)						
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APOLLO SPACECRAFT	SOFTWARE ROGRAM CHA			ONTROL BO	ARD NUMBE	R (Completed by FSB)
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COLOSSUS LUMINARY	
	•
MIT Approved PCN NASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
I will approved and	MIT Approved
A. Coding	Software Anomaly
Begin coding immediately	GSOP ONLY
ACTION:	
ACTION:	
Program Supervisor's Approval:	
On not code until new GSOP material has been	
Mission Design Review Board (MDRB) and dis	stributed.
B. GSOP Preparation	
	14. 4
Prepare GSOP revisions for MDRB consideration	KLAWSNIK/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 Management	1111
Project Manager	UMULTI Lavo
Date	12 27-10

R. hauso

MIT-PCN

Page 1 of 9

APOLLO SPACECRAFT	SOFTWARE (CONFIGURA NGE REOUL	ATION C	ONTROL E	BOARD	100	Completed b	y FSB)
1.0 COMPLETED BY ORIGINATOR								
1.1 ORIGINATOR	DATE	1.2 ORGANIZA		APPROVAL	1 .	\cap	DATE	
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1.3 EFFECTIVITY		s :	1.4 TITLE	10	Lumina	y 1D	Editorial	
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PAGE 2 OF

PROGRAM CHANGE

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

P12/Assumption 14

P12/200

P12/240

P12/355

P12/1402

P12/1530

P20/Assumption 10

P20/45

P20/1098

P20/1269-1270

P22/Assumption 4

P22/1187-1200

Name of Change

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

Removal of "R3-BLANK".

Change down-range speed from 5509.5 to

5509.3 fps.

Change down-range speed from 5509.5 to

5509.3 fps.

Delete setting of vertical rise flag.

Insert "Set RCS flag."

"D from above" moved up to "set deadband to

R03 value."

Delete reference to Section V.

Delete reference to Section V.

Change "Small angle" to Shaft angle".

Delete extraneous zeroes.

Add "Note: If V95E is entered before

P22 is selected, V81E must be performed to

allow state vector updating.

Correct the use of the verb "display" and

the nouns "displays".

PAGE 3 OF 9

 PREPARED BY: <u>J. B. Smith</u>

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".

		PAGE 4 OF CHIMINATURE
PROGRAM CHANGE REQUEST NO/009	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)

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".

Add "for aborts from the descent orbit injection 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."

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

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

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.

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

P63/Assumption 16

P63/Assumption 19

P63/Assumption 30

P64/Assumption 2

P64/Assumption 9

PAGE 5 OF 9

 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)

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

P64/372-374

P68/130

P70/Assumption 13

P70/Assumption 20

P70/Assumption 18

P70/142

P70/160

P70/330

P70/250-260

P70/280-290

P70/370

P70/430-435

Add resumption of static display of V06N64.

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

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

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

Delete "R3-BLANK"

Insert 'RESTART DRIFT FLAG"

Insert "SET 1.0 DEGREE DEADBAND"

Insert "INITIALIZE APS ENGINE DATA"

Initialize P70/P71 flag and FINDCDUW

Initialize DPS engine and target data

Initialize target data

Define THETA critical as Pad loaded value.

PAGE 6 OF

PROGRAM CHANGE

DATE:

PREPARED BY: J. B. Smith

12/15/70

ORGANIZATION:

MIT/CSDL

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

P70/490

P70/995

P71/Assumption 12

P71/Assumption 15

P71/930

P72/110-145

P72/226

P72/252

P72/377

P72/391

P73/150

P74/550

P74/846

P75/330

R00/215-275

Set APS abort continuation flag.

ZERO DPS AUTO THROTTLE.

Delete "With the exceptions indicated in

assumption (10) above,"

Delete "R3-BLANK".

Zero DPS auto throttle.

Insert option for initial TIG (CSI) = 00000,

letting TIG (CSI) be computed rather than entere

Change 5.4.2. to 5.4.2.

Change 5.4.2.2 to 5.4.2

Change 5.4.2.2 to 5.4.2

Change 5.4.2.2 to 5.4.2

Change 5.4.2.2 to 5.4.2

Change 5.4.2.4 to 5.4.2

Change 5.4.2.4 to 5.4.2

Change 5.4.2.5 to 5.4.2

Change R00 to take care of alterations due

to deletion of R29.

PAGE 7 OF 9

PROGRAM CHANGE REQUEST NO. ____/009 PREPARED BY: J.B. Smith ORGANIZATION: MIT/CSDL

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".

Delete "AND NO MARKS ALLOWED FLAG" reset.

REMARKS

R30/305

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -PAGE PROGRAM CHANGE PREPARED BY: J. B. Smith ORGANIZATION: MIT/CSDL 1009 REQUEST NO. 12/15/70DATE: 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. Change "...DISPLAY PRESENT AOT DETENT R51/150-170 OR BACKUP OPTICAL SYSTEM LOS DEFINI TION: " 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." Change OPT EL by deletion of "THE PRESENT R52/190DETENT" Add "RESET MARK IN PROGRESS FLAG" R53/225R53/295Change OPT EL definition by deletion of "THE PRESENT DETENT" R53/350Add "RESET MARK IN PROGRESS FLAG" R53/495Add "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. R57/130Add V34E as another response to V06N88 Display R59/15-45Logic 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.

RESET MARK IN PROGRESS FLAG.

R57/340,505

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD -DATA AMPLIFICATION SHEET -

PAGE 9 OF 9

PROGRAM CHANGE
REQUEST NO. ____/009

PREPARED BY: <u>J. B. Smith</u>

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"

DISAPPROVED

APOLLO SPACECRAFT	RUGRAM CHA	War Kryur	.01	BOARD	NUMBER (Completed)	
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PROGRAM CHANGE REQUEST NO.	PREPARED BY	DATE	ORG AN IZA	TION	
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 TIOSS 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.

DISAPPROVED
Page 1 of 14

APOLLO SPACECRAFT	SOFTWARE ROGRAM CHA	CONFIGURA NGE REOUE	TION C	CONTROL BOARD		(Completed by FSB
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See attached Luminary						
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.3 SOFTWARE CONTROL BOARD SIGN				<i>,</i>		
CATE						

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

PCR 1030 FAGE 20F4

MAR 1 8 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_{gup}). 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.

$$\log (1 - Tgo/T_{Bup}) = -\frac{Tgo}{T_{Bup}} - 1/2(\frac{Tgo}{T_{Bup}})^2 - 1/3(\frac{Tgo}{T_{Bup}})^3 - \cdots$$

For the kind of vehicles we are familiar with, $Tgo/T_{\mbox{Bup}}$ 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

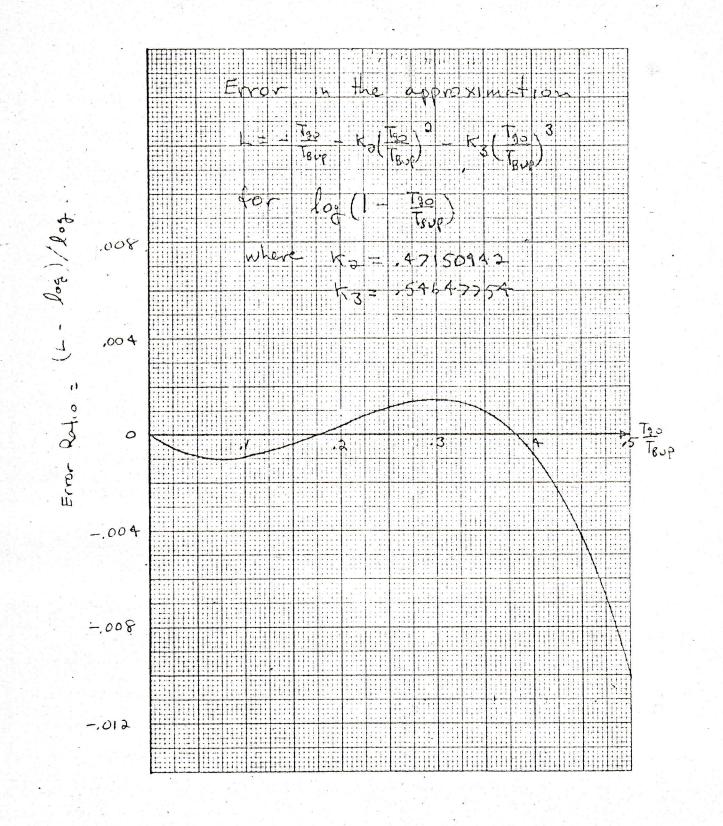
$$L = -\frac{Tgo}{T_{Bup}} - .47150942 \left(\frac{Tgo}{T_{Bup}}\right)^2 - .54647754 \left(\frac{Tgo}{T_{Bup}}\right)^3$$

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

	old	
DLO.	AD	DSU
		TBUP
		TGO

old		new	
DDV	CALL -	EXIT	
	TBUP	TC	POLY
	LOGSUB	DEC.	2
SL	PUSH	2DEC	0
	5	2DEC	-1.0
	(8 reg)		
		2DEC	-0.47150942
	LOGSUB (38 reg)	2DEC	-0.54647754
	= 46 reg	TC	INTPRET
		PUSH	
		10	6 reg

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



MIT/	DL PROGRAM CHANGE ROUTING SLIP	PCD PCN # 1044
===		ANOMALY #
Image: Control of the	COLOSSUS 2E LUMINARY 1D COLOSSUS 3 LUMINARY 1E COLOSSUS 3A LUMINARY 1F COLOSSUS LUMINARY	ADR:#
	MIT Approved PCN MIT Approved ADR NASA Approved PCN NASA Approved PCN A. Coding Begin coding immediately	NASA Approved Software Anomaly MIT Approved Software Anomaly MULAN
	ACTION:	
	Program Supervisor's Approval:	Mayart Hamillon
	Do not code until new GSOP material has be Mission Design Review Board (MDRB) and	een approved by the MIT
	B. GSOP Preparation Prepare GSOP revisions for MDRB consideration ACTION	Klawsmik Smith
6-17	Technical Committee Meeting not required	1.
	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	
Γ	Special Instructions Project Manager	R. H. Larson
	Date	8-18-70

(Fay

		NUMBER (Completed by FSU)
APOLLO SPACECRAFT SO	TWARE CONFIG RAM CHANGE RE	URATION CONTROL BOARD 1021
	1.0 COMPLET	ED BY ORIGINATOR
DATE	1.2 ORGA	120100
D. Millard . 5/1	1/70 MIT/	11.4 TITLE OF CHANGE
1.3 EFFECTIVITY		Re-design of R53-R57
LUMINARY 1E	and the second section of the second	The control of the co
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	inotion equa	tions used in P57 to provide capability of
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APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD -DATA AMPLIFICATION SHEET -

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PROGRAM CHANGE 10111	DATE: 5/11/70		
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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).

REMARKS

THE CHARLES STARK DRAPER LABORATORY A DIVISION OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY 68 ALBANY STREET CAMBRIDGE, MASSACHUSETTS 02139

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

$$\underline{\mathbf{u}}_{\mathrm{YP}} = \left[\mathrm{SMNB} \right]_{\mathrm{S}} \left[\mathrm{NBSM} \right]_{\mathrm{C}} \underline{\mathbf{u}}''_{\mathrm{YPN}}$$

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 $\underline{u}_{\mathrm{SP}}$ 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 $\underline{u}_{\rm SP}$ can be expressed in terms of θ as:

$$\underline{\mathbf{u}}_{\mathrm{SP}} = \begin{bmatrix} \cos\theta & \sin\theta/12 \end{bmatrix} \underline{\mathbf{u}}_{\mathrm{X}}^{"} - \begin{bmatrix} \sin\theta & \sin\theta/12 \end{bmatrix} \underline{\mathbf{u}}_{\mathrm{Y}}^{"} + \begin{bmatrix} \cos\theta/12 \end{bmatrix} \underline{\mathbf{u}}_{\mathrm{Z}}^{"}$$

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)

$$\underline{\mathbf{u}}^{"}_{\mathbf{Y}} = -\sin(\text{SROT}) \, \underline{\mathbf{u}}_{\mathbf{XPN}} + \cos(\text{SROT}) \, \underline{\mathbf{u}}_{\mathbf{YPN}}$$

$$\underline{u}_{Z}^{""} = \underline{u}_{OAN}$$

$$\underline{\mathbf{u}}^{\mathbf{u}}_{\mathbf{X}} = \underline{\mathbf{u}}^{\mathbf{u}}_{\mathbf{Y}} \times \underline{\mathbf{u}}^{\mathbf{u}}_{\mathbf{Z}}$$

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

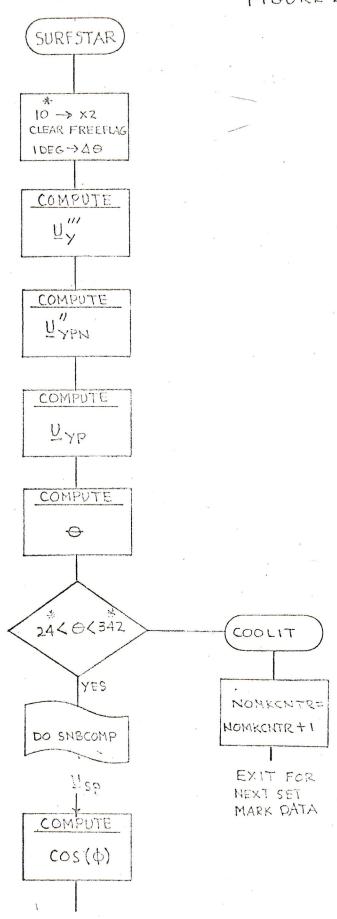
$$\underline{\mathbf{u}}_{\mathrm{YP}} \cdot \underline{\mathbf{u}}_{\mathrm{SP}} = 0$$

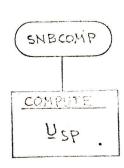
This is accomplished by the iteration loop in Figure 2 where the initial value of $\underline{u}_{\rm SP}$ is based on an initial guess for θ of

$$\theta = SROT - YROT$$

The final solution for \underline{u}_{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

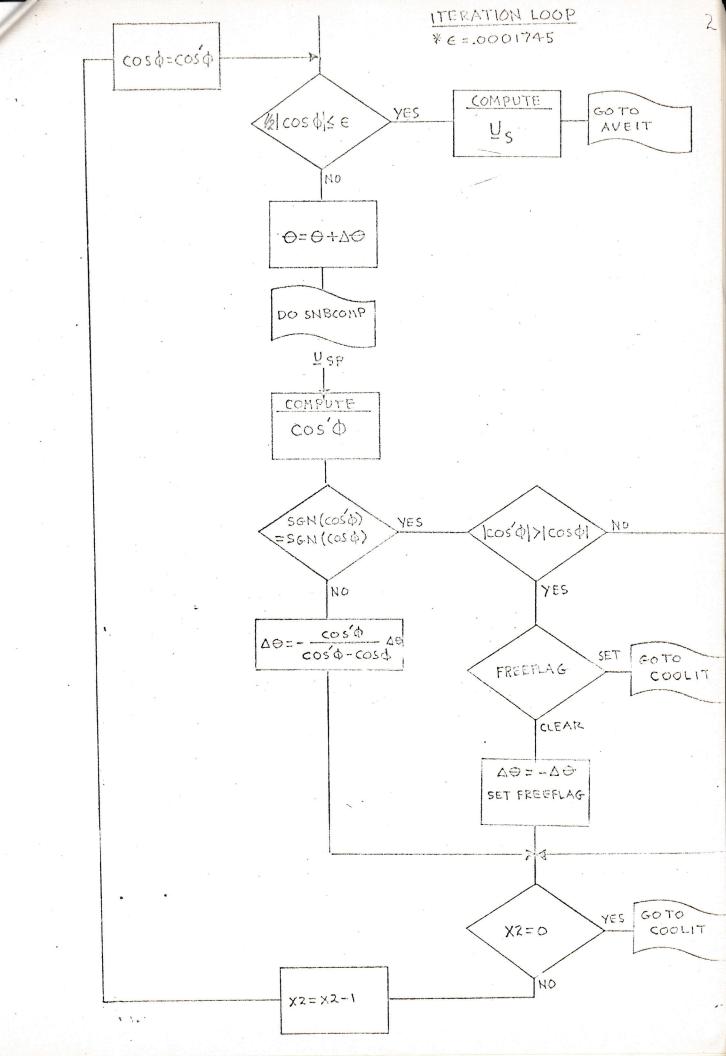
$$\underline{\mathbf{u}}_{\mathbf{S}} = \begin{bmatrix} \mathbf{N}\mathbf{B}\mathbf{S}\mathbf{M} \end{bmatrix}_{\mathbf{S}} \underline{\mathbf{u}}_{\mathbf{S}\mathbf{P}}$$

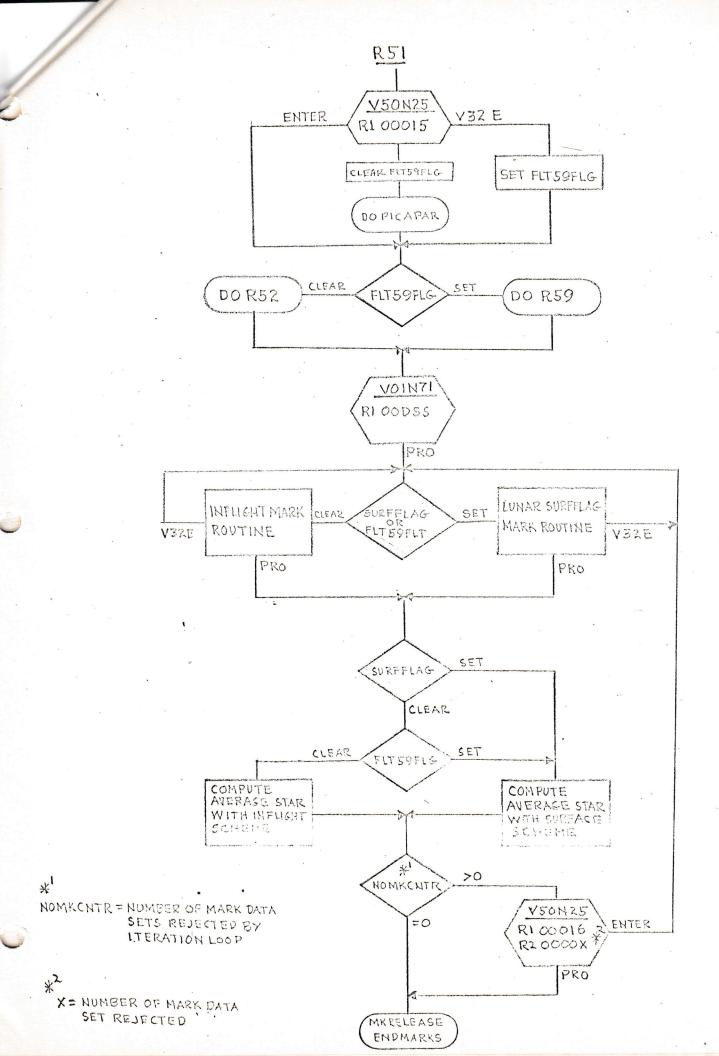


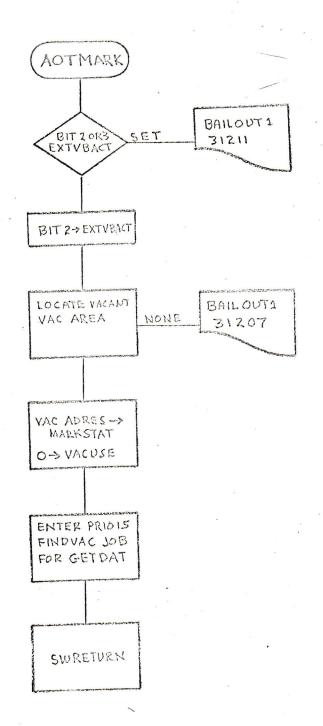


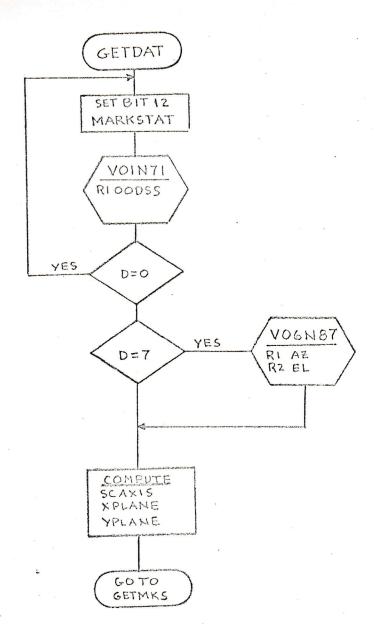
*

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

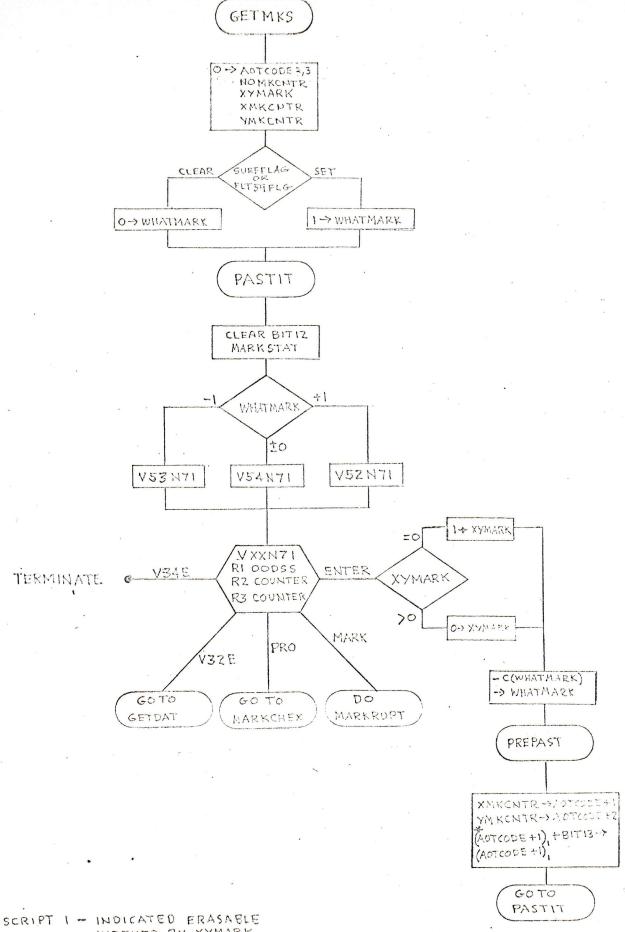






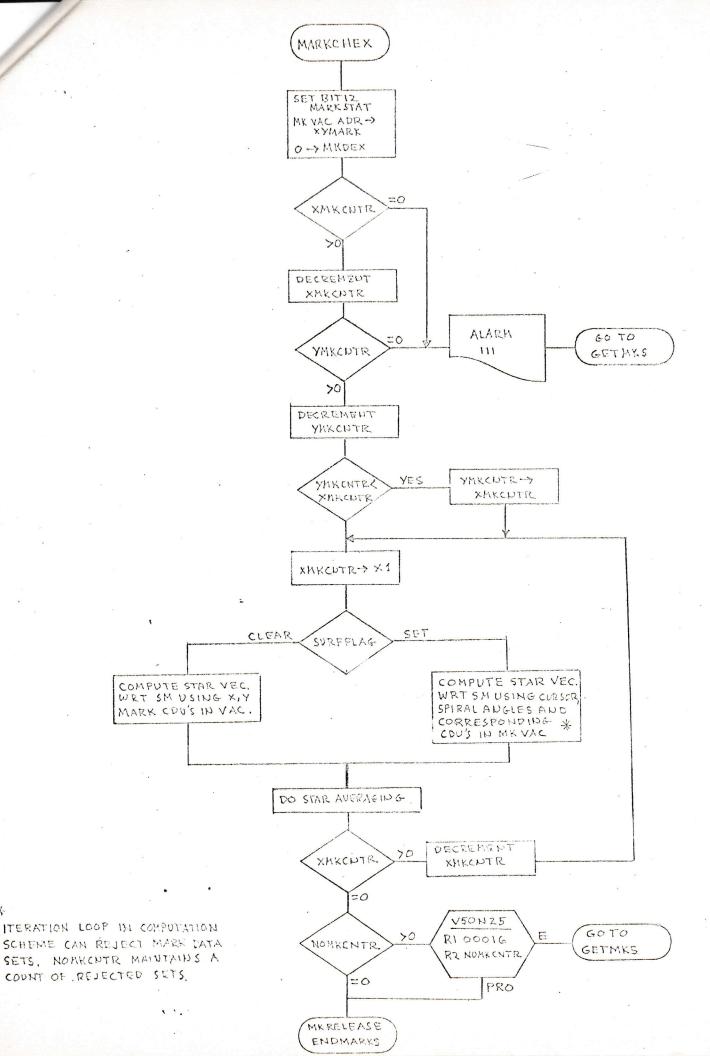


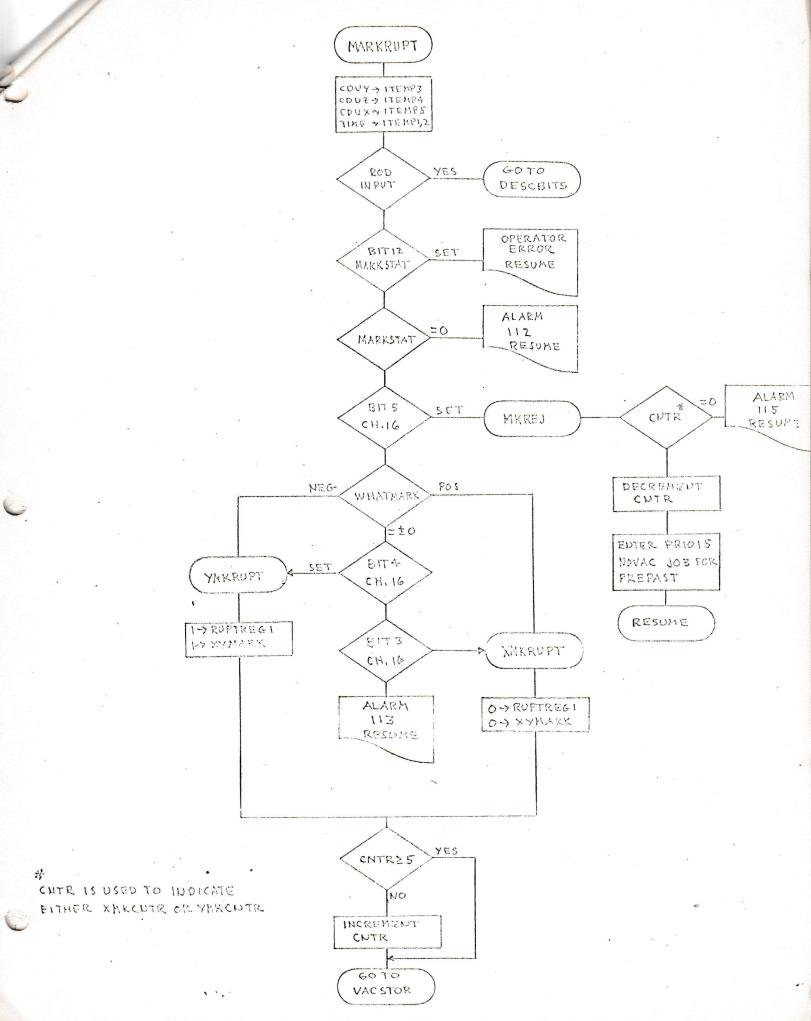
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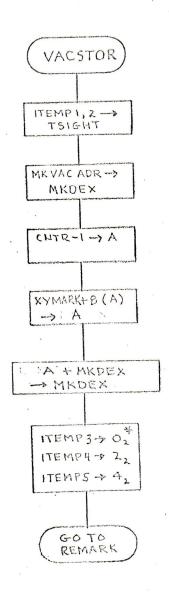


SUBSCRIPT I - INDICATED ERASABLE INDEXED BY XYMARK

9 14.

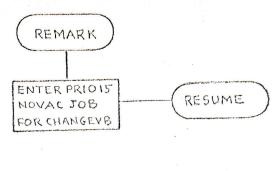


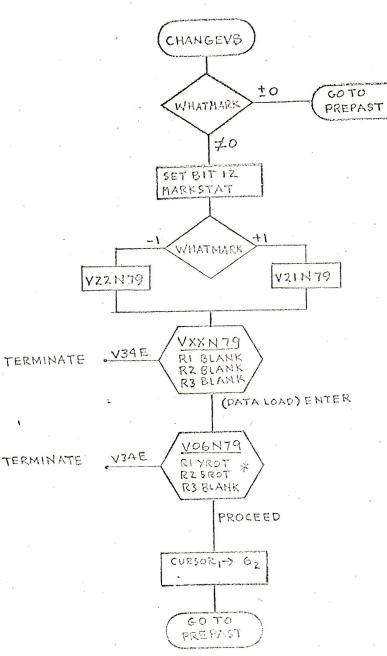




* SUBSCRIPT 2 - INDICATED STORAGE LOCATION INDEXED BY MKDEX

V 1, "





IF XYMARK = 0, BLANK RZ, R3
IF XYMARK = 1, BLANK RI, R3

DISAPPROVED

Page 1 of 1

APOLLO SPACECRAFT SOFTWARE CONF PROGRAM CHANGE	IGURATION CONTROL BOARD	NUMBER (Completed by FSB)
	ETED BY ORIGINATOR	
R. GILBERT 6-12-70 MI	L. H. Lars	J 7-6-70
LUMINARY IE	NOUN for LPD BIAS	3
CHECKLIST must be updated each fli changes, for NO3 load.	ght, if address of AZBIAS and	d/or ELBIAS
UTILIZE NOUN 57 to load AZBIAS at Requires no additional fixed or erasa Suggested change has been checked	ble memory locations. out on LMS.	t.
2.0 SOFTWARE CONTROL DECISION FOR VIS	BOARD OR FLIGHT SOFTWARE BRANI BILITY IMPACT ESTIMATE BY MIT	
APPROVED CISAPPROVED 1.3 STETMARE CONTROL BOARD OF FLIGHT SOFTWARE BEANCH SIGN OFF	T.L DEVADAS:	
3.0 MIT VISIBILITY IMPACT EVALUATION:	e	
3.: 5CHF., [11094."	3.2 INPACT OF PROVIDING DETAILE	D EVALUATION
3.5 VIT CORDINATOR)	3.4 REWARKS:	
7-6-70		
4.0 SOFTWAR	E CONTROL BOARD ACTION	
PROVICE PROVICE DETAILED DETAILED CHANGE CHANGE EVAL. 21.3 SOFTMARE CONTROL BOARD SIGN CFF	1.7 REMARKS	anne-Calauline à citrate et le contract de cui de carrier de la contract de cui de carrier de carri
8/13/7°		
5.0 MIT DETAILED	PROGRAM CHANGE EVALUATION	er og det skale for det skale
5.1 MIT COORDINATOR	5.2 MIT EVALUATION	
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START OR CONTINUE DISAPPROVED OR STOP IMPLEMENTATION IMPLEMENTATION 6.3 SOFTWARE CONTROL BOARD SIGN OFF	6.2 REMARKS	
D A T E		

MIT/DL PROGRAM CHANGE ROUTING SLIP		per/pcn # 1059
	MIT-PCN	ANOMALY #
OLOSSUS 2E LUMINARY. 1D	ILL L OLV	ADR #
COLOSSUS 3 CLUMINARY 1E	F	
COLOSSUS 3A DLUMINARY 1F	:	
COLOSSUS LUMINARY		i e e e e e e e e e e e e e e e e e e e
T NASA	Approved PCR	NASA Approved
MIT Approved PCN NASA MIT Approved ADR NASA	Approved PCN	Software Anomaly
MIII Approved Tibit		MIT Approved Software Anomaly
A. Coding		Oto Waria
Begin coding immediately		revec was
	ACTION: _	An Elder
Program Super	visor's Approval: _	Margarit H. Hamelon
Do not code until new GSOF Mission Design Review Boa	P material has been ard (MDRB) and d	en approved by the MIT istributed.
B. GSOP Preparation		
Prepare GSOP revisions for	or MDRB	
consideration	ACTION:_	
Technical Committee Meet	ing not required.	
Technical Committee Meet	ing(s) held on _	
Attendees:		
	e g	
C. KSC Testing and Checkout Review for possible impact	t on KSC	
testing and checkout	ACTION:_	
D. Other Programs Affected		
Review for corresponding cha	nges in	
	ACTION:	
Special Instructions		1/14/-/
	Project Manager_ Date	10-7-70
	Date_	
		· ·

MIT-PCN 1-10-10 Page 1 of 10

OLLO SPACECRAFI	ROGRAM CHA	NGE REOUE	ST	MINOL BOMILD	1059
		COMPLETED B	STORY TO SHOW THE PARTY OF THE	VATOR	
1.1 ORIGINATOR	DATE	1.2 ORGANIZAT		APPROVAL	DATE
P. S. Weissman	8/26/70	MIT/D		DE CHANCE	
1.3 EFFECTIVITY		: 1, 1		ajor modes cha	nges set up a
LUMINARY 1E			1/ACCS		
1:) There are "humb	er of window	ws during v	which a	change in major	modes would wipe . See Anomaly
out a waiting 1/A	CCS job, le	aving the L	ME WILL	e.	
L-1D-10. 2.) Make room in Ba	ink 5 for Iter	m 1.			
1 & DESCRIPTION OF CHANGE		4 0	job to do	o 1/ACCS.	(Cont. 'd on Pg2)
1.) Have all major n 2.) Delete the settin	g of bits in F	CSFLAGS	(interna CFLAG	2, to cause the	initialization of the
				HT SOFTWARE BRAN	
2.0	DECISION FOR	RVISIBILIT	Y IMPACI	ESTIMATE BY MIT	
2.1 APPROVED	DISAPPROVED	2.2 REM	1ARKS :		-
2.3 SOFTWARE CONTROL BOARD	OR FLIGHT SOFTWAR	R E			
BRANCH SIGN OFF			*	•	
DATE					
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DATE 9-11-70					
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DATE	11/5/70				
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	e y cuerm	ARE CONTROL	BOARD D	ECISION ON MIT	
	DETA	AILED PROGR	AM CHANG	E EVALUATION .	
6.1 START OR CONTINUE	DISAPPROVED OR	STOP 6.2 KI			
6.3 SOFTWARE CONTROL BOARD	H. Maria Maria Company	/			
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APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD -DATA AMPLIFICATION SHEET -

					PAGE	OF
*						
PROGRAM CHANGE		PREPARED BY:			ORGANIZATION	: MIT/DL
REQUEST NO. 1	059	DATE:	8/26/70			
				R. Olaska		

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

PCN 1059' Pg 3 of 10

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

- The channel bits that command on the RCS jets and trim-gimbal drives are cleared. (This is done by the hardware in a restart.)
- 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 I/ACCS IS SET UP

3. The ACCEPT Registration of the Control of the Co so that all the outputs of 1/ACCS will be recomputed to the time but become

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, end are decided as X-axis override 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)

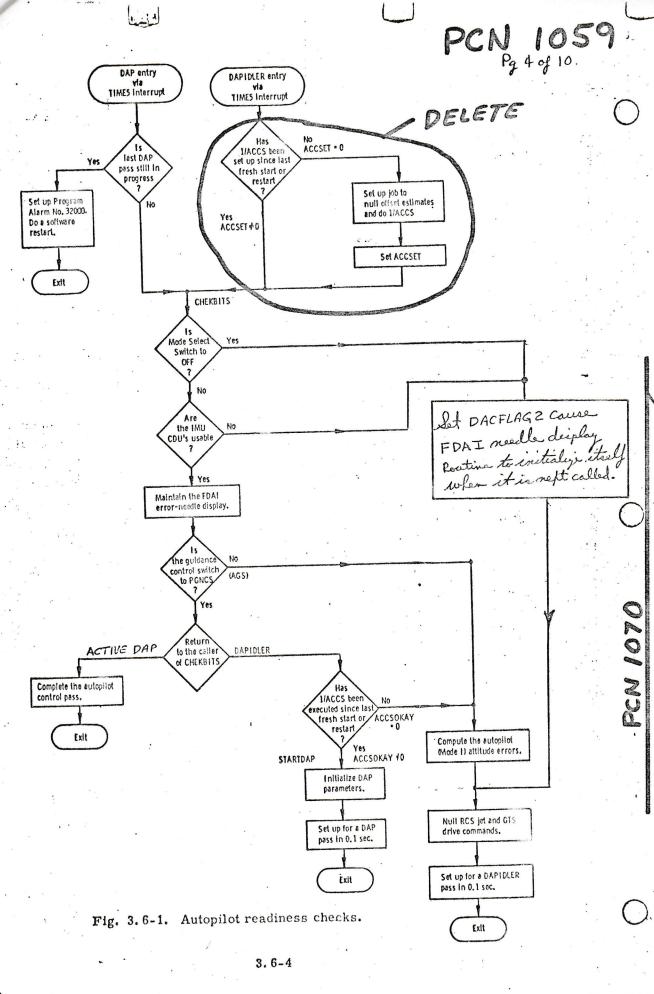
When the LM DAP is switched off or when it cannot function because its inputs are not available, a program named DAPIDLER is called to monitor the conditions which turn the LM DAP off. Until these conditions disappear, DAPIDLER keeps the output commands to the RCS and the trim gimbal systems nulled and 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:

- The IMU CDU's are not usable. 1.
- The PGNCS attitude mode control switch has been turned to OFF by the crew. 2.
- The use of the abort guidance system (AGS) has been selected by the crew.
- 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 Green START RESTART ROUTINE). Dillibian pass and a free beart of 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.



GSOP # R-567 PCR # 801.2. DobbA.F.

June 1970

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 padloaded 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-cocked 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.

	T	Meaning	
	Bit/Location	Set	Cleared
Tag	11/DAPBOOLS	X-axis translation to use 4 jets.	X-axis translation to use 2 jets.
ACC4OR2X	13 RCS LAGS	A job to do 1/ACCs has been let up since the last resh part or restart	Sefup a job in DAPIDLER to accommod
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 $\pi/2^7$ rad/sec 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/FLGWRD10	LM staged or on lunar surface.	LM unstaged and not on lunar surface.
AUTRATE1 AUTRATE2	1/DAPBOOLS	KALCMANU maneuver rates chos 00 indicates 0.2 deg/sec 01 indicates 0.5 deg/sec 10 indicates 2.0 deg/sec 11 indicates 10.0 deg/sec	sen by crew:
CALLGMB	L 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.

		Meaning		
Tag	Bit/Location	Set	Cleared	
RCSFLAGS	Autopilot flag word containing the following bits:			
NCOL DITOD		Bit 1 - YZTACK		
		Bit 2 - DACFLAG1	· · · · · · · · · · · · · · · · · · ·	
		Bit 3 - DACFLAG2		
¥	The state of the s	Bit 4 - DSPLYALT		
		Bit 5 - CALLGMBL		
		Bit 6, 7, 8 - (unused)	,	
	The same of the sa	Bit 9 - JUSTIN	•	
		Bit 10 - PBIT		
		Bit 11 - QRBIT		
		Bit 12 - SKIPP	w.	
		Bit 13 ACOSET	16 .	
		Bit,14, 15 - (unused)		
		13.		
RHCSCALE	7/DAPBOOLS	Normal (20 deg/sec) rotational-hand- Fine (4 deg/sec) rotational-hand-		
RHCSCALE	17BA BOOLS	controller scaling selected by crew.	controller scaling selected by crew.	
			`	
SENSETYP		X-translational sense desirable during U and V rotations:		
SENSETTE		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	Skip control of P axis in next pass.	
Ultil 2		pass.		
			0 indicates control about the corre-	
SKIPU		4 indicates control about the corre-	U indicates control about the corre	
SKIPV		sponding axis is to be exercised in	sponding axis is not to be re-evaluate	
		the current DAP pass.	in the current DAP pass because a	
			short (<150 millisec), non-zero firing	
		4	was started in the last pass.	
		*	Exercise normal RCS control.	
SNUFFBIT	13/FLAGWRD5	Inhibit RCS control about the U. V	Exercise normal new control.	
		axes during unstaged powered flight.		

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

INITIALIZE DCHNLIST PCINTER TO RETRANS-MIT CURRENT COMMLIST AT NEXT 2C MS COMNRUPT.

LPDATE STATUS OF LR
POSITION FLAG.
SET RR AUTO MODE AND
COU NOT FAILED FLAGS

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

RESET 1/COJOB
CONTROL EID IN
FL SF LAGS. 0

DISABLE TIME 6 CLCCK

RESTORE STATUS OF CHANNEL 13 BITS **\$**20

#30

840

#50

\$60

2 %

V36/LUMINARY

1044

\$210

#220

\$230

\$240

\$250

RESET EXTENDED VERB ACTIVITY INTERLUCK INITIALIZE IML FLAGS RESET CISPLAY/ASTRC-NAUT INTERFACE FLAGS INITIALIZE RACAR READ INITIALIZE IMODES 33 FLAG; SET NC PIPA FAIL BIT; SET DOWN-LINK AND UPLINK CK Set up a job to calculate RCS control authorities and other DAP parameters. BITS; RESET ALL OTHER BITS CLEAR SELF CHECK ERROR REGISTERS SET ENGINE OFF (BIT 14 IN CHANNEL 11)

R 9410

V36/LUMI NARY

INTTALZE®ATITOSE

INITIALIZE DAP

INITIALIZE DOWNLINK

PERMIT AGS IN IT IAL-IZATION

+03 +EDIT ZERO UPCATE STATE VECTOR INDICATOR

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

IS ISS IN COARSE ALIGN MODE AND IN GIMBAL LOCK?

• N

∉260

6270

#230

.0290

62 M

V36/LUMINARY

CN 103/0

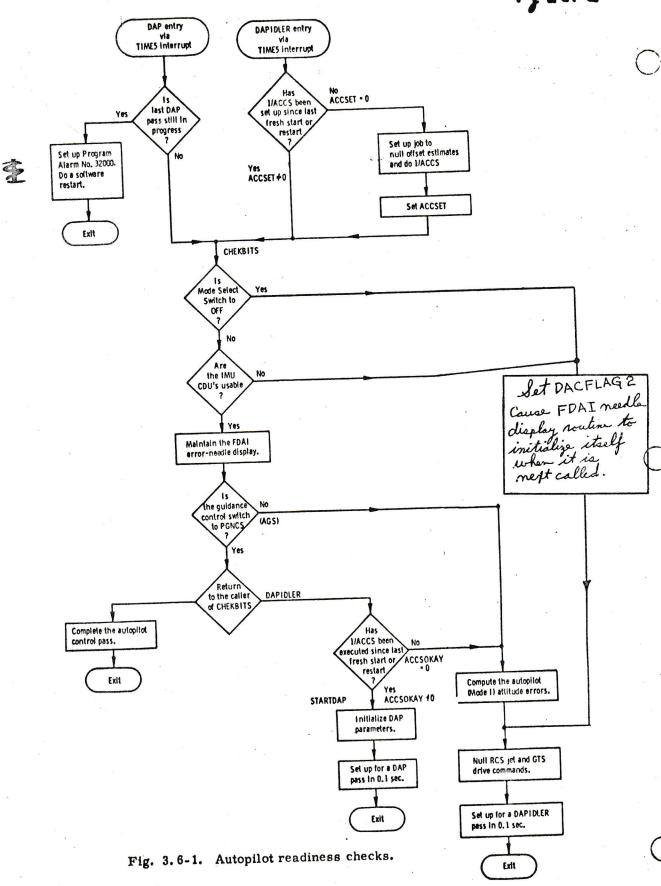
MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN # 1066
	ANOMALY #
COLOSSUS 2E LUMINARY ID	ADR #
COLOSSUS 3 Z LUMINARY 1E	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	•
MIT Approved PCN ASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
I mil Approved ABR	MIT Approved
A. Coding	Software Anomaly
Begin coding immediately	fat white
ACTION:	
Program Supervisor's Approval:	Maran Hamle
Do not code until new GSOP material has be	een approved by the MIT
Mission Design Review Board (MDRB) and	distributed.
B. GSOP Preparation	
Designation of the state of the	1.05
Prepare GSOP revisions for MDRB consideration	J. Dunt
ACTION:	1 Cowsii C.
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 Drawn a Affected	
D. Other Programs Affected Review for corresponding changes in	
Review for corresponding changes in	
ACTION:	
Special Instructions	12
Lian NS9 ON Project Manager Date	10:5-70
CALL	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST						
	The second managed to the second seco	COMPLETED		NATOR		PATE
S. Copps	8/3/70	MIT/DL	ı			
LUMINARY IE	And an in the second se		Display P74, P	7 N81 On Å11	Passes Iı	n P34, P35,
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. Display N81 2. Eliminate d	during all p isplay of N5	easses thr 9 during F	ough P34 234, P35	4, P35, P74, 6, P74, P75.	P75.	
2.0	SOFTWARE CON DECISION FOR	K AIZIBILI	IT IMPAUL	GHT SOFTWARE CESTIMATE BY	BRANCH MIT	
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3.0 MIT VISIBILITY IMPACT	FVALUATION:					
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9/30/90						
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5.1 MIT CCORDINATOR 5.2 MIT EVALUATION						
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION						
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6.3 SOFTWARE CONTROL BUARS						
DATE						

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST					
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P. Weissman 7 July 1970 MI' Luminary 1E	1.4 TITLE	of CHANGE GSOP (le Initialization)	Change for FDAI Fix (L-1D-01)		
with respect to the FDAI needle diswhen the DAP is off as when it is d	splay and the	e calculation of a	attitude errors		
Update GSOP page 3.6-4 (see attached page).					
2.0 SOFTWARE CONTROL DECISION FOR VISI	BILITY IMPAC	GHT SOFTWARE BRAI T ESTIMATE BY MI	VCH T		
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.1 MIT COORDINATOR	5.2 MIT EVALUATI	ION			
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6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
START OR CONTINUE DISAPPROVED OR STOP	6.2 REMARKS:				
6.3 SOFTWARE CONTROL BOARD SIGN OFF	,				
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MSC Form 288 (Jul 68)		0 =			



PCN 1070



TIDL PROGRAM CHANGE ROUTING SLIP	PCR/PCN # 1079
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 CHUMINARY 1E	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
MIT Approved PCN NASA Approved	PCR NASA Approved
MIT Approved ADR NASA Approved	
	MIT Approved Software Anomaly
A. Coding	P/ All +
Begin coding immediately	Shain flhus
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Program Supervisor's Ap	/· \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \
Do not code until new GSOP material Mission Design Review Board (MDR)	has been approved by the MIT 3) and distributed.
Wilssion Bessen Treview Zenta (met 2)	
B. GSOP Preparation	1 00 11
Prepare GSOP revisions for MDRB	3 Junity
consideration	TION: () Consum k
Technical Committee Meeting not re	quirea.
Technical Committee Meeting(s) held	d on
Attendees:	
C. KSC Testing and Checkout	
Review for possible impact on KSC	SETON.
testing and checkout AC	CTION:
D. Other Programs Affected	
Review for corresponding changes in .	
	YEN CAT.
Special Instructions	TION:
Project Ma	mager Lusult Town
	Date 10-5-70

APOLLO SPACECRAFT	SOFTWARE OROGRAM CHAN	ONFI IGE R	GURAT EQUES	ION C	ONTROL	BOARD	1079	
			TED BY					
McCoy	9/2/70	M	ir/cs	DL	*************************************			
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6.3 SOFTWARE CONTROL BOARD	SIGN OFF					•		
DATE		1	4				1	

		PAGEOF
PROGRAM CHANGE REQUEST NO. 1079	PREPARED BY: McCoy DATE: 9/2/70	ORGANIZATION: MIT/CSDL

CONTINUATION 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".

DISAPPROVED

Page 1 of 7

APOLLO SPACECRAFT	SOFTWARE	CONFIGUR	ATION C	CONTROL BOARD	NUMBER (Completed by FSB
	ROGRAM CHA	NGE REQU	EST		1080
	NAMES OF TAXABLE PARTY OF TAXABLE PARTY.	COMPLETED	THE RESERVE AND ADDRESS OF THE PERSON NAMED IN		Y
1.1 ORIGINATOR	DATE	1.2 ORGANIZA		APPROVAL	DATE
R. Larson	9/8/70	MIT/C			
LUMINARY 1E		a 8	_	ge time to perfor zero.	rm IMUCDU
To make Luminary to provide better Clabout 2 second addi	DU Glitch Cl	heck durir	colossus ng Satur	program which	was changed tit also provides
See Data Amplificat	ion Sheet	. ,			
2.0	SOFTWARE CON DECISION FOR	TROL BOARD	OR FLIC Y IMPACT	GHT SOFTWARE BRAI F ESTIMATE BY MI	NCH T
2.1	DISAPPROVED	2.2 RE			
7.3 SOFTWARE CONTROL BOARD OF		E	••		
DATE					
					P-100
3.0 MIT VISIBILITY IMPACT EV	ALUATION:				, ,
SCHEDULE IMPACT			3.2 IMPAC	T OF PROVIDING DETAIL	ED EVALUATION
3.3 STORAGE IMPACT		3.4 RE	MARKSI		
3.5 MIT COORDINATOR	$\overline{}$				
DATE Lar	1-2		* .		
9-28-7	0				
	4.0 SOF	TWARE CONT	ROL BOAF	RD ACTION	
CHANGE EVAL. CHAN	ILED MIDIS.	ROVED 4.2 RE	MARKS		
1.3 SOFTHARE CONTROL BOARD SI	GN OFF				
CATE 9	132/70				
	5.0 MIT DETA	ILED PROGR	AM CHANT	GE EVALUATION	
.1 MIT COORDINATOR		5.2 MI	EVALUATIO	ON .	
DATE	2		THE SECOND SECOND		
	6.0 SOFTWAR DETAI		and the last of th	CISION ON MIT	
	ISAPPROVED OR ST MPLEMENTATION	TOP 6.2 RE	WARKS: .		
.3 SOFTWARE CONTROL BOARD SI	GN OFF	100			
DATE			9		

DATE:

PAGE	2	OF	7	
				_

 PREPARED BY:

R. Larson 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."

1261 V40N20/LUM DISPLAY. #180 IS ISS TURN-EN CR CAGING IN PROGRESS? PRESS ALARM RESET TO RESET PROGRAM ALARM EX IT ZERO LGC ICDU CCUNTERS \$200 RESET ICCU ZERO DI SCRETE WAIT APPROXIMATELY MAIT 10 SEC & SEC. \$210 .IS ISS TURN-ON OR CAGING IN PROGRESS? #220 EX IT V40120/LUN

Nichtandal F

I MODES 30

Word Number

Bit

81a (Cont'd)

Meaning

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.

Value of bit 11 of channel 30. A 0 indicates an IMU cage command has been generated by the crew.

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.

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 02148 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.

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 10.56 seconds after cage command removed, 10.56 seconds

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 15208 will be generated). If bit is 1, an error exit will be forced from the internal IMU routines.

IMODE30

W	ord	Nun	'n	b	е	r	
	81						, i
• ;	(Cor	it a)					

Bit

Contents

Meaning

- Set to 1 to inhibit the generation of alarm 02128 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 θ 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.)
- 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.
- 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 10.56) seconds when IMU CDU zero is commanded separate
- from T4RUPT package (by V40N20 or prelaunch or IMU tests).
 - Set to 1 to indicate failure of the IMU turn-on delay sequence (alarm 0207_8 will also be generated).
- 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 by a fresh start. Set to 16000 + 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.

Meaning Bit

- Not used.
 - 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 33

Word Number
81b
(Cont'd)

89

Contents

Meaning

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 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.

Bit

- 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.
- 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 / 2²⁸.
- 83-88 Repeat of words 33-38 of this list.
 - 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.

CHANNEL 12

	Word	I	lu	mt	e	r
	91 (Con		1		6.	
	10011		.,	4		
	-	÷.		٠.;	1.	
L	1					

ord Number	* = *.	Contents
91b Cont'd)	Bit	Meaning
	15	ISS turn-on delay complete. Set 1 at end of 90 second ISS turn-on delay and reset θ about 10.24 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 0.50 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.
Talah Marin berasa sanga Kantan sangan salah Panjan sangan salah Penjan sangan Sangan sangan Penjan sangan Sangan sangan	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).

T/DL PROGRAM CHANGE ROUTING SLIP	(PCR/PCN # 1082.2
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLORDO	
COLOSSUS 3A LUMINARY 1F COLOSSUS LUMINARY	
MIT Approved ADR NASA Approved I NASA Approved I	
MIT Approved ADR NASA Approved	MIT Approved Software Anomaly
A. Coding Begin coding immediately	Virginia Cumban
	TION:
Program Supervisor's App	proval: //ayaut W. Hamilton
Do not code until new GSOP material Mission Design Review Board (MDRB	has been approved by the MIT
B. GSOP Preparation	1 2 5 1 (
Prepare GSOP revisions for MDRB	TION: Lawsun C
Technical Committee Meeting not rec	
Technical Committee Meeting(s) held Attendees:	on
C. KSC Testing and Checkout	
Review for possible impact on KSC	TION:
D. Other Programs Affected	
Review for corresponding changes in	
	CTION:
Special Instructions Project Ma	nager Line IH Larm
I Tojet. v Ivia	Date 10-5-70
	100

APOLLO SPACECRAFT	SOFTWARE ROGRAM CHA			CONTROL BOA	ARD I	(Completed by FSB)
		COMPLETED		NATOR		
1.1 ORIGINATOR	DATE	1.2 ORGANIZA	TION	APPROVAL		DATE
J.M. Reber	9-14-70	MIT		g.m. R	eber 	15 Sept 1970
1.3 EFFECTIVITY			Updat	of CHANGE e Fixed Con	stants for	1971-1972
LUMINARY 1E				neris Year		
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Update PIOS for use in BF		lata, Star	Table,	and LOSSEN	I Ephemer	ides
2.0	SOFTWARE CON DECISION FOR	VISIBILIT	Y IMPAC	GHT SOFTWARE T ESTIMATE B		
APPROVED	DISAPPROVED	2.2 RE	MARKS			
2.3 SOFTWARE CONTROL BOARD (R FLIGHT SOFTWAR	E				
DATE						
3.0 MIT VISIBILITY IMPACT E	VALUATION:			transaction of the contraction that the second of the contraction of t		
3.: SCHEDULE IMPACT			3.2 IMPAC	T OF PROVIDING D	DETAILED EVALUA	ATION
7.3 STORAGE IMPACT	/	3.4 RE	MARKSI			
3.5 MIT CORPLINATOR	ran					
PATE 9-23 -	70					
	4.0 \$01	FTWARE CON	TROL BOA	RD ACTION		
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	ALUATION	F	CR to	ke submi	Hed to e	eliminate
PATE / CC.	-4 K	`	Teph	nem scalin	y restri	ction
9/30/70	,					
	5.0 MIT DET			GE EVALUATIO	I N	
5.1 MIT COORDINATOR		5.2 MI	T EVALUATI	ON	2.	
DATE						
	6.0 SOFTWAI			ECISION ON M E EVALUATION	IIT	
5 START OR CONTINUE IMPLEMENTATION	DISAPPROVED OR S	STOP 6.2 R	MARKSI	w .		
6.3 SOFTWARE CONTROL BOARD	SIGN OFF					
DATE						

DL PROGRAM CHANGE ROUTING SLI	<u>P</u>	PCR/PCN #
The Triest		ANOMALY #
OLOSSUS 2E LUMINARY. 11	D	ADR #
COLOSSUS 3 LUMINARY II	\mathbf{E}	
COLOSSUS 3A LUMINARY 13	F	
COLOSSUS LUMINARY		
MIT Approved PCN NA	SA Approved PCR	NASA Approved
MIT Approved ADR NA	SA Approved PCN	Software Anomaly
		MIT Approved Software Anomaly
A. Coding	.	V. DUNBAR
Begin coding immediat	ely	V. DONBITT
	ACTION:	
	Annormal	Margart H. Hamil
Program Su	pervisor's Approval.	a approved by the MIT
Do not code until new G Mission Design Review	SOP material has bee Board (MDRB) and di	stributed.
B. GSOP Preparation		
Prepare GSOP revision	s for MDRB	J. KLAWSMIK
consideration	ACTION: _	
Technical Committee N	Meeting not required.	
Technical Committee N	Meeting(s) held on	
a read Fasting and Checkout		
C. KSC Testing and Checkout Review for possible in	pact on KSC	
testing and checkout	ACTION:_	
D. Other Programs Affected Review for corresponding	changes in	·
Review or corresponding	Changes	
	ACTION:	
Special Instructions	m - land Managon	P. A. Laison Kusa
	Project Manager _ Date _	10-9-70
THOTE:	. Date_	
Pages 2-13 have been submitted to MSC as the		
submitted to MSC as he		
detribeing Correctation of		
		144

APOLLO SPACECRAFT	SOFTWARE (CONFIGURA NGE REOUE	TION C	ONTROL B	OARD		(Completed by FSB) 3
		COMPLETED		NATOR			
1.1 ORIGINATOR	DATE	1.2 ORGANIZAT		APPROVAL	1). 1.2.		15 Lpt 1970
J.M. Reber	9-14-70	MIT	DL	g111. 1	TELED		13 april 10
LUMINARY 1E			Update	e Fixed C neris Yea	onstant: r	s for	1971-1972
To update the Ephe and Subsequent)	meri s Data	for the fu	ı t ure M	ainline Ap	oollo La	unche	es. (Apollo 15
Update PIOS for use in BF	RCS 1972.0						ides
2.0	SOFTWARE CON DECISION FOR	R VISIBILI	TY IMPAC	GHT SOFTWA T ESTIMATE	RE BRAN BY MIT	С Н	
APPROVE	DISAPPROVED	2.2 RE	VARASI				
BRANCH SITN OFF	RR FUIGHT SCETWAS	9 8					
3.0 MIT VISIBILITY IMPACT E	VALUATION:		13224	T OF "PHO. 101"	NG DETAILE	D EVAC	A-10.
17.5 Y			3.2 15745				
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	4.0 \$0	IFTWARE CON		RD ACTION			
PROVIDE DETAILES DE	ALL ATION	5.	n - r.	be sub be sub	4.11	40	th constants eliminate
	5.0 MIT DET	TAILED PRO	RAM CHAI	IGE EVALUA	TION		
5.1 MIT COORDINATOR		5.2	IT EVALUAT	ICN			N
AYE			Mark parch lab rate had			The state of the s	
	6.0 SOFTWI	ARE CONTRO	RAM CHÂN	DECISION O GE EVALUAT	HON TON		
TART OR CONTINUE IMPLEMENTATION	CISAPPROVED OR IMPLEMENTATION	STOP 6.2	DATA	ATTA	CHED		
11/5/70	and the second second		A SULL CALLS	and the state of the same			NASA — M

PAGE 2 OF 13

PROGRAM CHANGE REQUEST NO. 1082.2 PREPARED BY: J.M. Reber
DATE: 9-14-70

ORGANIZATION:

MIT/DL

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

PIOS EPHEMERIS CONSTANTS FOR 1971-1972

GSOP UNITS

 $^{\mathrm{AZ}}0$

+4.85898502016 E+0

rad

B₀

+4.09157363336 E-1

rad

rad

-7.19758599677 E-14 +5.52185714700 E+0 rad/U-sec.

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m U}}^{
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m U}$

-1.07047013100 E-8 +4.11720655556 E+0 rad/U-sec.

Fo

+4.11720655556 E+0 +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

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PROGRAM CHANGE REQUEST NO. 1082.2

PREPARED BY: J.M. Reber
DATE: 9-14-70

ORGANIZATION:

_____ MIT/DL

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

Source: J.M. Reber: MIT/DL

Catalogue No. (octal)	Star Name	Vis. Mag			
1	α Andromedae (Alpheratz)	2.1	+. 9747608555	+.0264803244	+. 4339307948
$\hat{\mathbf{z}}$	β Ceti (Diphda)	2.2	+ 9342466124		3113400137
3	y Cassiopeiae (Navi)	2.2	+ 4773424940		+28709182540
4	α Eridani (Achernar)	0.6	+.4918322686		3422520048
5	α Ursae Minoris (Polaris)	2.1	+.0128995818		+,9998862983
6	θ Eridani (Acamar)	3.4	+.5448995598		6493349473
7	α Ceti (Menkar)	2.8	+.7028937840		+.0694227718
10	α Persei (Mirfak)	1.9	+.4101921571		+.7633734305
11	α Tauri (Aldebaran)	1.1	+.3502769546		+, 2832502918
12	β Orionis (Rigel)	0.3	+. 2007345455		1431958012
13	α Aurigae (Capella)	0.2	+ . 1367280274		+.7189922632
14	α Carinae (Canopus)	-0.9	0616090037		1952609559
15	α Canis Majoris (Sirius)	-1.6	-,1824340636		2869738089
16	α2 Canis Minoris (Procyon)	0.5	4122762536		+.0923326629
17	γ Velorum (Regor)	1.9	3613649792		734363447
20	Ursae Majoris (Dnoces)	3.1	4661511162	+.4772744503	+.744924315
21	α Hydrae (Alphard)	2.2	7745052221		148439475
22	α Leonis (Regulus)	1.3	8610673209		+. 209697490
23	β Leonis (Denebola)	2.2	-, 9657334290	+.0521664164	+.254239279
24	y Corvi (Gienah)	2.8	9524366380	C597677121	298818123
25 .	α Crucis (Acrux)	1.6	4521486548	C495728431	890563937
26	α Virginis (Spica)	1.2	9168160791	3506241694	191078436
27	η Ursae Majoris (Alkaid)	1.9	5812217431	2911759648	+. 759866986
30	θ Centauri (Menkent)	2.3	6895375091	4185354938	591071951
31	α Bootis (Arcturus)	0.2	7860186221		+.330966061
32	α Coronae Borealis (Alphecca)	2.3	5324545035		+ . 451000437
33	α Scorpii (Antares)	1.2	3511952476	8242322268	-,444183174
34	α Trianguli Austr. (Atria)	1.9	11429CC725	34002C1762	933447405
35	α Ophiuchi (Rasalhague)	2.1	1120382967	9695442116	+.217787606
36	α Lyrae (Vega)	0.1	+.1219537054	7702168243	+.626013847
37	σ Sagittarii (Nunki)	2.1	+. 2074286490	8718956797	4435890883
40	α Aquilae (Altair)	0.9	+.4540867784	8777450759	+.152868503
41	β Capricorni (Dabih)	3.2	+. 5524232365	7930716636	256643534
42	α Pavonis (Peacock)	2.1	+.3205423120	- 4434583652	837016908
43	α Cygni (Deneb)	1.3	+.4542117996	539C33793C	+. 709319540
44	Pegasi (Enif)	2.5	+.8141988673	5553601830	+.1692736300
45	α Piscis Austr. (Fomalhaut)	1.3	+.8345006310	2388718657	496536935
					P.S.
				COURCE	. 5 -
				SOURCE:	± 68

R. White, MIT/DL P. Canepa, MIT/DL 1082.2

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							FIGHT			CL I-		
0-4-1-4	Ma No						MIN		DG !	MIN .	SEC	
Catalog (octal	gue No.		Star Name	Vis. Mag								
	. /		Andromedae (Alpheratz)	2.1		0	6	56.0	+28	56	9	
1		α	Ceti (Diphda)	2.2		Č.	42	11.0	-18	8	24	
2		β	Cassiopeiae (Navi)	2.2		0	55	0.1	+60	33	56	
3		γ	Eridani (Achernar)	0.6		1	36	40.2	-57	22	43	
4		α	Ursae Minoris (Polaris)	2.1		2	4	45.8	+89.	8	10	
5		α	Eridani (Acamar)	3.4		2	57	11,8	-40	24	58	
6		8		2.8		3	0	48.7	+ 3	58	51	
7		α	Ceti (Menkar) Persei (Mirfak)	1.9		3	22	18.7	+49	45	47	
10		α	Persel (William)	1.1		4	34	18,6	+16	27	15	
11		α	Tauri (Aldebaran)	0.3		5	13	11.5	- 8	13	58	
12	•	β	Orionis (Rigel)	0.2		5	14	37.0	+45	58	17	
13		α	Aurigae (Capella)	-0.9		6	23	19.7	-52	40	48	
14		α	Carinae (Canopus)	-1.6		6	43	54.9	-16	40	37	
15		α	Canis Majoris (Sirius)	0.5		7	37	50.1	+ 5	17	52	
16		α_2	Canis Minoris (Procyon)	1.9		8	8	40.0	-47	15	12	
17		γ	Velorum (Regor)	3.1		8	57	17.8	+48	9	9	
20		L	Ursae Majoris (Dnoces)	2.2		9	26	12.5	- 8	32	11	
21		α	Hydrae (Alphard)	1.3	,	0	6	52.8	+12	6	17	
. 22		α	Leonis (Regulus)	2.2		1	47	37.8	+14	43	43	
23	9	β	Leonis (Denebola)	2.8		. 2	14	21.7	-17	23	12	
24		γ	Corvi (Gienah)				25	1.5	-62	56	39	
25		α	Crucis (Acrux)	1.6		12	23	42.8	-11	0	57	
26		α	Virginis (Spica)	1.2		13		26.2	+49	27	9	
27		η	Ursae Majoris (Alkaid)	1.9		13	46		- 36	13	59	
30		θ	Centauri (Menkent)	2.3		14	5	1.6	+19	19	39	
31		α	Bootis (Arcturus)	0.2		4	14	23 0	+26	48	28	
32		α	Coronae Borealis (Alphecca)	2.3		15	33	30.0	- 26	22	17	
33		α	Scorpii (Antares)	1.2		16	27	41.1	-68	58	43	
34	•	α	Trianguli Austr. (Atria)	1.9		16	45	41,0	+12	34	45	
35		α	Ophiuchi (Rasalhague)	2.1		17	33	38.0	+38	45	24	
36		α	Lyrae (Vega)	0.1		18	35	59,3		19	59	
37		σ	Sagittarii (Nunki)	2.1		18	53	31.6	-26	47	36	
40		α	A :1 (A 14 - i -)	0.9		19	49	25.0	+ 8	52	16	
41		β	. 15	3.2		20	19	26.2	-14		35	
42		α	D (D ale)	2.1		2C	23	26,5	-56	49	46	
43		α	C : (D 1)	1.3		20	40	28.5	+ 45	10	45	
43			Daniel (Enif)	2.5		21	42	48.5	+ 9	44		
45		α	Ti . A (Towns 1 hout)	1.3		22	56	6.3	-29	46	16	

FOR INFORMATION ONLY

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PROGRAM CHANGE REQUEST NO. 1082.2 PREPARED BY: J.M. Reber ORGANIZATION: MIT/DL

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

LOSSEM EPHEMERIS NUMBERS FOR 1971-1972

KONMAT	+8	0.917456380	B-1	K1=COS (OBL)
	+10	-0.035679339	B-1	- K2≂SIN (OBL) SIŅ (IM)(-l)
	+14	0.397836387	B-1	K3=SIN (OBL)
	+16	0.082280652	B-1	K4=COS (OBL) SIN (IM)
RATESP	+0	0.036600997	B+4	LOMR
and the state of t	+2	0.002737803	B+4	LOSR
	+4	-0.000147200	B+4	LONR
	+6	0.534104635		LOMO
	+8	0.273331484		LOSO
	+10	0.878830860		LONO
TIAL CE	+0	0.017519236	B+1	AMOD
VAL67		0.024523430		AARG
	+2	0.024323430		
	+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. McOuat: MIT/DL

PAGE 7 OF 13 PROGRAM CHANGE PREPARED BY: ORGANIZATION: REQUEST NO. ____ 1082.2 DATE: CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE ON PROGRAM CHANGE REQUEST FORM) OCTAL 2DEC* -1.703706128 E-11 B28* REV/CS. NODDOT 77565 1 42175 1 +4.253263471 E-9 E27* PEV/CS. 22211 0 FOOT 2DFC* 3 1636 1 -1.145531390 E-16 B28* REV/CS. 77777 -2DEC* BDOT 77767 1 +8.788308600 E-1 B 6* REV. 2DEC* 34 176 1 NODIO 30363 1 +6.552737750 E-1 B C* REVO F SUBO 2476 1 0 (133) REV. 2DEC* +6.511941688 E-2 6 (* 02352 1 BSUBO 35251 :: +1.160576171 E-7 B23* PEV/CS. 37116 WEARTH 2DEC* 32631 1 REVS. 3:576 AZ() +7.733314844 E-1 B

FOR INFORMATION ONLY

REMARKS

10326 1

TP#21812

PAGE 8 OF 13

PROGRAM CHANGE REQUEST NO. 10	82.2	PREP	DATE:		OR	GANIZ	ATION:	
CONTINUATION SECTION			UMBER AND TITLE E REQUEST FORM)					
00151 1 25431 0		2DEC	+•(128995818 B	-1 S1	AR	5	X	
20.177 1	−a ≨arana seesa ea ar	2DEC	A.C. 78096275 B	s-1 S	TAR	5	Y	
37176 0 17777 0 02143 0		2DEC	+.9998862988 E	3-1 S	TAR	5	Z .	
07675 1		2DEC	+.4918322686	8-1 S	TAP	4	X	
02702 0 03420 1 01470 0	,	2DEC	+.2207092653	s-1 S	TAR	4	Y	
62414 1 50541 1		2DEC	8422523048	3-1 S	TAR	4	Z	
07506 0		2DEC	+.4773424940 E	3-1 S	TAP	3	X	
14361 0 01674 0 36075 u		2DEC	+.1168141178	9-1 S	TAR	3	Υ	
15736 1 21775 1		2DEC	+.8709182540	3-1 S	TAR	3	Z	
16745 0		2DEC	+.9342466124	3-1 S	TAR	2	- X	
13112 1 02620 1 31757 0	9	2DEC	+.1739271765	3-1 S	TAR	2	Y	
73011 0		2DE C	3113400137	8-1 S	TAR	2	Z	
67352 0 15776 0		2DEC	+.8747608555	3-1 · S	TAR	1	<u>X</u> _	
01237 0 00330 1 35521 1	2.0	2DEC	+.0264873244	3-1 \$	TAR	1	Υ .	
07573 1 21256 C		2DEC	+.4838307948	3-1 S	TAR	1	Z	
16004 1	CATLOG	DEC	7172					

FOR INFORMATION ONLY

ROGRAM CHANGE REQUEST NO. 1082.2					ORGANIZATION:		
CONTINUATION SECTION (REFER	TO BLOCK NUMBE						
75 151 1	2DEC	182434.636 B-1	STAR	13	X		
6.0.1.0							
17127 1	2DEC	+.9404062129 8-1	STAR	13	Υ		
31661 1 73321 0	2DEC	2869738085 B-1	STAR	13	۲.		
43422 1	2020		3.77				
77 1/ 7 0	. 2DEC	0616090080 B-1	STAR	12	X	0	
51442 1 11514 1	2DEC	+.6031289258 B-1	STAR	12	Y	A I A A C COURT A A C COURT A A C COURT A A C C COURT A A C C C C C C C C C C C C C C C C C	
32502 1						4	
63215 1	2DEC	7952608559 B-1	STAR	12	Z	(
72140 0	2DEC	+.1367280274 B-1	STAP	11	X		
12335	2020		3,7	• •		40	
12716 1	2DEC	+.6814364033 8-1	STAR	11	Y	4	
12356 1 13401 0	2DE C	+.7189922632 B-1	STAR	11	Z	2	
374.4 .		1.1107722032	3171			-	
3154 1	2DEC	+.2007345455 B-1	STAR	10	X	•	
15267 ()	2DEC	+.9691236271 B-1	STAR	70	-Y		
01743 O	1000		31711	•		4	
75552 1	2DEC	1431958012 B-1	STAR	10	Z	6	
76050 0 05465 0	2DEC	+.35(2769546 B-1	STAR	9	X		
17001 0	2020		O TAIN				
16221 1	2DEC	+.8927957521 8-1	STAR	5	7		
27572 1	2DEC	+.2832502918 8-1	STAR	9	Z	C	
14273 1	2020	1020323112310 0 1	JIMI			•	
66449 1	2DEC	+.4101921571 B-1	STAR	8	X	O ORDER	
11323 0		+.4989947555 B-1				100	
37767 7	ZDEC	F. 4909941333 B-1	STAR	8			
14155 0	2DEC	+.7633784305 B-1	STAR	8 -	Z		
23.47	2056	. 7624027246 0 3	CTAO		· ·		
13176 G	2DEC	+.702893784C B-1	STAR	7	X		
13247 1	SDEC	+.7078988678 8-1	STAR	7	Y		
03342 1				-			
(1)70 1	2DEC	+ • (694227718 B-1	STAR	7	<u> </u>		
266.7 1 10557 1	2DEC	+.5448995598 B-1	STAR	6	X ,		
32115 7			2 5 version 27 50 8000 50				
10404 0	2DE C	+.5317389073 B-1	STAR	6	Υ		
00124 0 65500 1	2DEC	6483349473 B-1	STAR	6	Z		
727.3 0	2000	JOINSON TO I	JIEN				

			PAGE_	10 of 13
PROGRAM CHANGE REQUEST NO	PREPARE	DATE:	ORGANIZAT	ION:
CONTINUATION SECTION (REFER TO		SER AND TITLE REQUEST FORM)		
73617 1	2DEC	-44521486548 B-1	STAR 21	X
77742 0 77151 1	2DEC	0495728431 B-1	STAR 21	<u>Y</u>
74615 0 61600 0 62003 1	2DEC	8905639377 B-1	STAR 21	Z **
60605 1	2DEC	9524366386 B-1	STAR 20	X
64345 1 77026 0	2DEC_	0597677121 B-1	STAR 20	Y
542:) 1 73160 1 42475 1	2DEC	2988181236 8-1	STAR 20	Y Z X Y S
60430 0	2DEC	9657334280 B-1	STAR 19	×
66614 1 07653 1	2DEC_	+. [521664164 B-1	STAR 19	Y
13:72 / 04042 0 27232 1	2DEC	+.254239279(B-1	STAR 19	
62162 0	2DEC	8610673205 8-1	STAR 18	×
44274) 07322)	2DEC	+.4632386329 8-1	STAR 18	Y Brown
33165 0	2DEC	+.2096974905 B-1	STAR 18	Z X X X Z Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q
32741 1 63467 1	2DEC	7745052221 8-1	STAR 17	
50064 C 11655 1	2DEC	+.6149043688 B-1	STAR 17	Y
11373) 75477 1	2DEC	1484394758 B-1	STAR 17	z oz
77366 1	2DEC	4661511162 B-1	STAR 16	X
51217 1 07505 3	2DEC	+.4772744503 8-1	STAR 16	Y
325 4 1 13726 0 15341 0	2DEC	+.7449243154 8-1	STAR 16	Z
72157 1	2DEC	3613649782 8-1	STAR 15	X
66255 0 11142)	2DEC	+.5745656444 B-1	STAR 15	<u>Y</u>
32737 : 642 : 1 43116 1	2DEC	7343634472 8-1	STAR 15	Z
71316 C	2DEC	4122762536 8-1	STAR 14	Χ.
64201 C 164 C 1	2DEC	+.9063680102 8-1	STAR 14	Y
36737 1 11364 1	2DEC	+•×923326629 B-1	STAR 14	Z

P#21812

				PAGE 11 0	F <u>/</u>	3_
PROGRAM CHANG	1082.Z	PREPARED BY: DATE:		ORGANIZATION:		
CONTINUATION	76152 0	2DEC .	1120382967 B-1	STAR 29	X	
	45051 1 67371 1	2DEC	9695442116 B-1	STAR 29	Υ,	
	57632 1 03370 0	2DEC	+.2177876068 8-1	STAR 29	Z	
	03556 1 76127 1	2DEC	1142900725 B-1	STAR 28	X	
	67425 72436 J	2DEC	3400201762 B-1	STAR 28	Υ	>
	61577 3	2DEC	9334474056 8-1	STAR 28	Z	dienes.
	46271 1 72303 1	2DEC	3511952476 B-1	STAR 27	X	0
	40213 1 62637 1	2DEC	8242322268 B-1	STAR 27	Y	2
	74355 1	3 2		STAP 27		0
	70711 1 46567 1	ZDEC	4441881743 8-1			
	67366 A 44175 1	2DEC	5324545035 8-1	STAR 26	X	S
	64424 1	2DEC	7163035719 B-1	STAR 26	Y	Š
	41241 0 37156 1	SDEC	+.451r004372 B-1	STAR 26		OL.
	23036 0 63330 1	2DFC	7860186221 8-1	STAR 25	X	0
	75735 1 67512 ')	2DEC	5221457573 8-1	STAR 25	Y	NTONATI
	62476 0 J5227 D	2UEC	+.33,966,611 B-1	STAR 25	T	-
	10611 0 64757 0	2DEC	6895375791 B-1	STAR 24	X	OL
	517 1 71233 0 53334 0	20 E C	4185354938 B-1	STAR 24	٧	ũ
	66425 1 76017 0	ZDEC	591:719617 8-1	STAR 24		
	66 54 6 7	2DEC	5812217481 B-1	STAR 23	X	
	73255 1 65757 1	2DEC	2911759648 8-1	STAR 23	4	
	14120 1	2DEC	+.7598669864 8-1	STAR 23		
	32444 1 61251 1	2DEC	9168160791 B-1	STAR 22	×	
	56124 72307 0 65764 1	2DEC	35^6241694 B-1	STAR 22	Y	
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FOR INFORMATION ONLY

PROGRAM CHANGE REQUEST NO. CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE ON PROGRAM CHANGE REQUEST FORM) 1082.2 PREPARED BY:

ORGANIZATION:

-DATA AMPLIFICATION SHEET -

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PEN #
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Do not code until new GSOP material has be Mission Design Review Board (MDRB) and	distributed.
B. GSOP Preparation	J. KLAWSMIK/J.SMITH
Prepare GSOP revisions for MDRB	V. KEHWSKI AJ J. SHITTI
consideration ACTION:	
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Attendees:	
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C. KSC Testing and Checkout	
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. В.	GSOP Preparation	
	Prepare GSOP revisions for MDRB	J. KLAWSNIK/J. SMITH
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PROGRAM CHANGE	PREPARED BY: B. McCoy
REQUEST NO. 1051	DATE: 10/2/70

ORGANIZATION: MIT/CSDL

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.

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Page 1 of 1

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MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PM# 1093
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B. GSOP Preparation	
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consideration	N:
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APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD -DATA AMPLIFICATION SHEET -

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PROGRAM CHANGE REQUEST NO.

PREPARED BY: William Robertson 10-5-70

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

REASON FOR CHANGE 1.5

Currently there is a 512 day limitation of the $\underline{\operatorname{sum}}$ of $\operatorname{t}_{\operatorname{GET}}$ (Ground Elapsed Time) and tEPHEM (Time between July 1 and the launch date) in the LM Lunar-Solar Ephermerides Routine, Since $t_{
m GET}$ may be as large as a little over 30 days, tephem 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 $t_{\ensuremath{\mathbf{EPHEM}}}$ to be larger than 366 days as the Basic Reference Coordinate System was changed once a year on July 1 and $t_{
m EPHEM}$ 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).

DESCRIPTION OF CHANGE 1.6

Change the internal coding of the Lunar-Solar Ephemerides Routine so that the quantity (($t_{GET} + t_{EPHEM}$)/8640000) is scaled in days at 2¹⁰ rather than 2⁹ as currently. After such a change the new limitation on tephem would be 2 10 -30 = 994 days = about 2 years 8 months, which is about a month more than the cur- ${f rent}$ scaling limitation on ${f t}_{{f EPHEM}}$ in the Planetary Inertial Orientation Routine (963.2 days).

In order to gain any advantage by using negative tephem'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.

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

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

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

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.

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 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° = 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 (optornistic) angular accuracy of the routine for the moon is about 0.25 = 900 arc sed which is also about twelve times the sun's accuracy above.

Hence the new max mum roundoff error in angular position after the incorporation of the PCR is a nin about two orders of magnitude smaller than the currently existing error described to the great simplification of the "truth".

Distribution

S. Copps

R. Larson

G. Levine

W. Ostanek

M. Reber

R. White

H. McOuat

AIT/DL PROGRAM CHANGE ROUTING SLIP	PCR PCN # 1095
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Begin coding immediately	Jolle Veissvar
ACT	ION:
	Maria + 1 Ham Ota
Program Supervisor's Appr	1, 1,
Do not code until new GSOP material h	has been approved by the MIT
Mission Design Review Board (MDRB)	and distributed.
B. GSOP Preparation	
Prepare GSOP revisions for MDRB consideration	
ACT	ION:
Technical Committee Meeting not req	uired.
I technical commission	•
Technical Committee Meeting(s) held	on
Attendees:	
C. KSC Testing and Checkout	
Review for possible impact on KSC	CION.
testing and checkout ACT	TION:
D. Other Programs Affected	
D. Other Programs Affected Review for corresponding changes in AC'	TION:
D. Other Programs Affected Review for corresponding changes in AC' Special Instructions	1) just
D. Other Programs Affected Review for corresponding changes in AC'	nager Junell H. Jarran
D. Other Programs Affected Review for corresponding changes in AC' Special Instructions	1) 1461
D. Other Programs Affected Review for corresponding changes in AC' Special Instructions	nager Junell H. Jarran

MIT-PCN

1-10-07 Page 1 of 1

APOLLO SPACECRAFT	SOFTWARE OR ROGRAM CHAN	CONFIGURA NGE REQUE	ATION C	ONTROL BO	ADD	OSS
		COMPLETED		NATOR .		
P.S. Weissman	10/7/70	1.2 ORGANIZA MIT/		APPROVAL		DATE
LUMINARY 1E			rate c	ommand m	node (And	out of manual maly L-ID-07)
Change GSOP to refl the mode control swi command mode has b	tch is moved been properl	y termina	ted and	while X-ax	is overr	ide is inhibited.)
1) Clear OURRCBIT ride is inhibited. 2) in the X-axis overri	Clear QRB de mode.	IT (RCSF.	LAG5/D	10 11) 11 10 11	s set dur	and X-axis over ing rate damping
2.0	SOFTWARE CON DECISION FOR	RVISIBILI	Y IMPAC	GHT SUFIWAR T ESTIMATE	BY MIT	
2.1 APPROVED	DISAPPROVED	,	MARKSI		-	• .
2.3 SOFTWARE CONTROL BOARD (BRANCH SIGN OFF	OR FLIGHT SOFTWAR	RE				
DATE	M. 1 o. 3 (1)			* ************************************		
3.0 MIT VISIBILITY IMPACT E	VALUATION:	<u>.</u>			organization of the Constitution of the Consti	•
3.: SCHEDULE IMPACT			3.2 IMPAC	T OF PROVIDING	DETAILED E	ALUATION
3.3 STORAGE IMPACT		3.4 RI	MARKS:			
3.5 MIT COORDINATOR						
- Lisull H.	Laren					
10-7-7	70					
	4.0 80	FTWARE CON	TROL BOA	RD ACTION		
PROVIDE DETAILED OF	OVIDE TAILED DIS		REMARKS			
4.3 SOFTWARE CONTROL, BOARD					5 E = 10	
DATE						
	5.0 MIT DET	AILED PROG	RAM CHAN	IGE EVALUAT	ION	
5.1 MIT COORDINATOR		5.2 M	IT EVALUAT	ION		restandand des mes vicini insulation de de la Provincia nación de Propriedo Adel Particio Managlio vicino y Australia.
DATE						, 7
	6.0 SOFTWA	RE CONTROL ILED PROGR	BOARD D	DECISION ON SE EVALUATI	MITON	
5 1 START OR CONTINUE IMPLEMENTATION	DISAPPROVED OR	1 6 2 5	EMARKS:			
6.3 SOFTWARE CONTROL BOARD	SIGN OFF					
DATE						i we

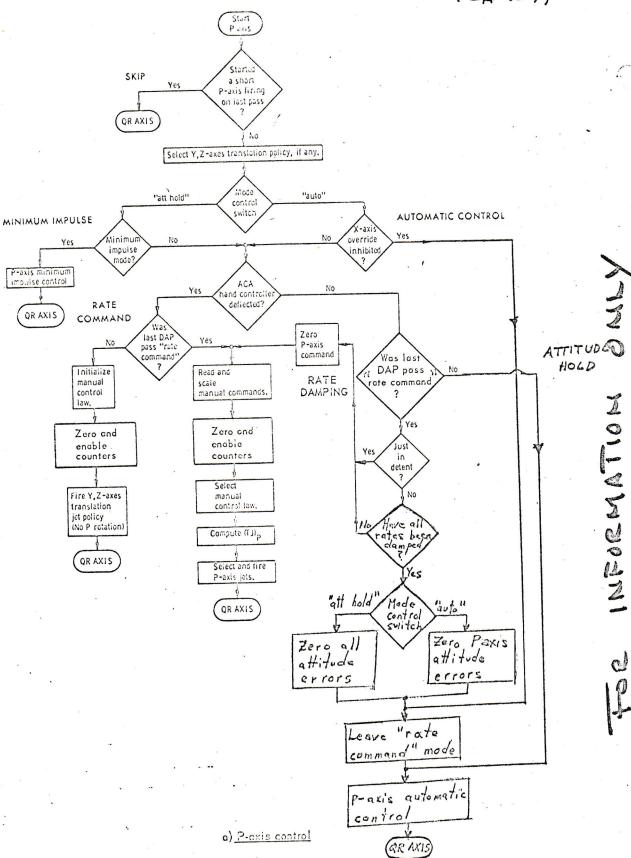


Fig. 3.6-5. Selection of manual and automatic modes (page 1 of 3).

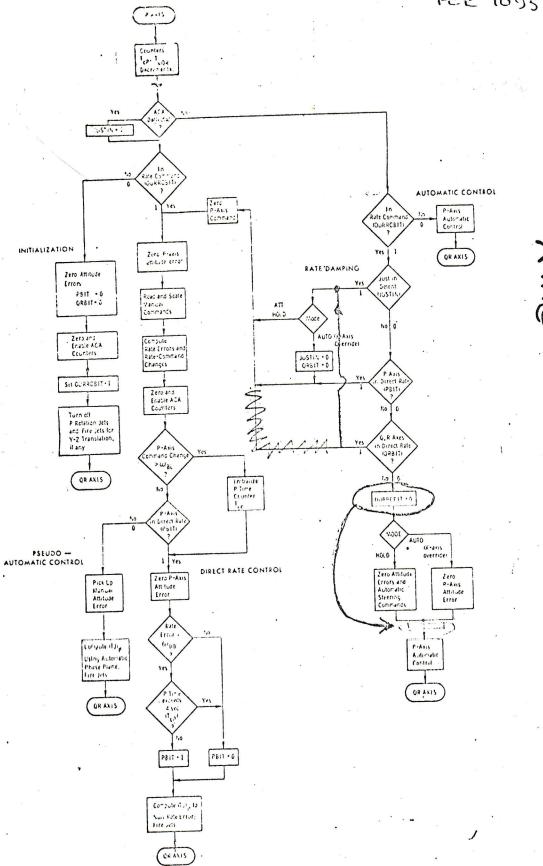


Fig. 3.4-16 Manual rate control logic for the P axis.

ATTACHMENT TO

NESEMATION

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

$$\left|\omega_{\rm eD}\right| < \omega_{\rm DB} \\ \left|\omega_{\rm eU^{\dagger}}\right| < \omega_{\rm DB} \\ \left|\omega_{\rm eV^{\dagger}}\right| < \omega_{\rm DB}$$

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

CDUXD = CDUX $\theta_{do} = \theta_{o}$

CDUYD = CDUY or $\theta_{di} = \theta_{di}$

CDUZD = CDUZ · $\theta_{dm} = \theta_{m}$

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



APOLLO SPACECRAFT	ROGRAM CHA	NGE REQUE	:51		NUMBER (Completed)	I by FSB)
	1.0	COMPLETED	BY ORIGI	NATOR		
1.1 ORIGINATOR	DATE	1.2 ORGANIZAT	10N .	APPROVAL	DATE	
МсСоу	10/8/70	MIT/SI		OF CHANCE		charactery party and a second contract of the
Luminary 1E				able Memory D Fixed	e-orbit Progra	am
consuming procedu	res in loadin	g/verifyin	g Erasa			
flag settings to exec	cute an RCS	automatic	ally-gui		naneuver.	
2.0	SOFTWARE CON DECISION FOR	R VISIBILIT	Y IMPACT	GHT SOFTWARE BRA I ESTIMATE BY MI	T .	
APPROVED .	CISAPPROVED	3.2 RE	*******			
1.3 SHETWARE CONTROL BOARD C	R FLIGHT SCFTWAR	Ε			, .	
A 7 :						
3.0 MIT VISIBILITY IMPACT E	VALUATION:		AT THE A COLUMN			
	TACUALIUM.		12 2 111242	T OF PROVIDING DETAI	LED EVALUATION	V. San Kada
3.1 SCHEPULE IMPACT			3.2 IMPAC	TO PROVIDING DETAIL	ELS ETALOATION	
36 fixe	Q	3.4 RE	MARKS:			
3.5 WIT 200ROINATOR RATE DATE	an)					
10-14-76					e tracije i se se positivi i da se sna se se s	
	4.0 50	FTWARE CON.	TROL BNA	RD ACTION		
PROVIDE DETAILED DE	A V (2 L.		EMARKS			•
4.3 SOFTMARE CONTROL BOARD	ALCATION Stan OFF					n
A DATE	1.1					
	11/5/70			er skal skal skal skal skal skal skal skal		Total to write should
	5.0 MIT DET	AILED PROG	RAM CHAN	GE EVALUATION	*	
5.1 MIT COORDINATOR		1 5.2 MI	T EVALUATI	ON		
OATE			34			
	6.0 SOFTWA	RE CONTROL ILED PROGR	BOARD D AM CHANG	ECISION ON MIT E EVALUATION		
START OR CONTINUE	DISAPPROVED OR	Ten a	EMARKS:			
6.3 SOFTWARE CONTROL BOARD	IMPLEMENTATION					
0.3 SOFTMAKE CONTROL BOARD	SIGN OFF					
L'ATT						

APS PROCRAM (PAS)

REV 01 08/07/69

PURPOSE:

- (1) TO COMPUTE A PREFERRED TMU ORIENTATION AND A VEHICLE ATTITUDE FOR A LM 🚐 THRUSTING MANEUVER.
- (2) TO DO THE VEHICLE MANEUVER TO THE THRUSTING ATTITUDE.
- (3) TO CONTROL THE PENCS DURING COUNTDOWN, IGNITION, THRUSTING, AND THRUST TERMINATION OF A PENCS CONTROLLED AND PLANTAGE PERCENTAGE AND PROPERTY OF A PENCS CONTROLLED AND PROPERTY OF A PENCS MANFUVER .

- ASSUMPTIONS: (1) THE TARGET PARAMETERS HAVE BEEN CALCULATED AND STORED IN THE LGC BY PRIOR EXECUTION OF A PRE-THRUSTING PROGRAM.
 - (2) THE REQUIRED STEFRING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRE-THRUST PROGRAM, WHICH FITHER RESET (MASTEER*) 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 AND 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 MASTEER", 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 PGNCS WILL CONTROL THE TOTAL VEHICLE ATTITUDE AND GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS (SEE ASSUMPTION(7)) FOR DISPLAY ON THE FDAL. 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 PONCS WILL HOLD THE VEHICLE ATTITUDE AND WILL GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS FOR DISPLAY ON THE FOAL. 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 PES 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 PGNCS 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 PRICE WILL NOT BE RESPONSIBLE IF REGISTER OVERFLOWS OCCUR WITHIN THE LGC.

- (7) THE PONCS CAN GENERATE TWO TYPES OF ATTITUDE ERRORS FOR DISPLAY ON THE FDAI;
 - MCDE I SELECTED BY EXTENDED VERB 61. AUTOPILOT FOLLOWING ERROES USED AS A MONITOR OF THE DAP'S ABILITY TO TRACK AUTOMATIC STEERING COMMANDS.
 - MODE II SELECTED BY EXTENDED VERB 62. TOTAL ATTITUDE ERROPS 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

PROG

DISPLAYS REFER TO SECTION & DE 8567, PARA. 2.2.6.

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

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 THPUSTING 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 POUTINE (RU3) MAY HAVE BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM.
- (11) LGC AND CPFW PROCEDURES IN CASES OF LGC-ASSUMED THRUST FAILURE ARE DEFINED BY THE OPS/APS THRUST FAIL ROUTINE (R40). THIS ROUTINE IS CALLED AT APPS IGNITION BY THIS PROGRAM.
- (12) THE LOC WILL NEITHER DESIGNATE NOR READ THE RENDEZVOUS PADAR (PR) 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 SELFCTED MANUALLY BY DSKY ENTRY.

rec	GROUND	CREW		
		• CPFW • PROGRAM • SELECTION •		
TART APS PROGRAM OCT DISPLAY P42	•	KEY IN ARE RES PROGRAM (PAGE) PG 9 V37F 42E 98E		
		•		
	•	MONITOR DSKY: ORSERVE DISPLAY DE P# 44		
• s e	,	•		
		•		

DCR 1096 P3 403 24

DO IMU STATUS CHECK
ROUTINE (E '2)

POUTINE (R'2)

#130

SET ASS DELTA V THRESHOLD FOR USE BY R40.

#140

SET DELTA V COUNTER = 4 FDR USF : BY R40

#150

COMPUTE INITIAL
THRUST DIRECTION AND
INITIAL VALUE OF VG
VECTOR AND STORE
VG(LV) IN NAI AND
NA6 FUR POSSIBLE
MANUAL SELECTION:

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

#160

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

PAZZLUMINARY

VGY(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 SELENOCENTRIC (LUNAR ORBIT) RADIUS VECTOR, AND V IS VEHICLE INERTIAL VELOCITY VECTOR AT TIG. (NOTE: NAI WILL NOW DIFFER FROM NAI DISPLAY OF P30, P32, AND P33 BECAUSE OF ROTATION OF VG VECTOR).

COMPUTE PREFERRED INU ORIENTATION:

X = UNIT(T)

 $Y = UNIT(T \times R)$

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

WHERE:

T = THE INITIAL

- THRUST VECTOR
AT IGNITION

99 340 P42/LUHINARY

#170

#180

#190 .

#200

#210

97 341 P42/LUMINARY

#220

#230

#240

#250

#260

R = THE GEOCENTRIC - (FAPTH OPPII) OR SELENDCENT-RIC (LUNAR ORBII) RACIUS VECTOR AT TIG. (NOTE: IF T X R IS

SMALL (REFFR SECTION 5.3.3.3.3 OF R567), THEN Y = -SM

UNIT (T X V).

WHERE V = VEHICLE

INERTIAL VELOCITY AT TIG.)

STORE DESIRED ATTI-TUDE SPECIFICATION FOR USE BY ATTITUDE MANEUVER ROUTINE (R60). THE FINAL ATTITUDE WILL BE COMPUTED DURING RES 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-

		•				
FLAG		•				#270
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•	w.	•			*	#290
ESET 3-AXIS FLAG		•				,
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* •		•				
•		:				#300
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DO ATTITUDE MANEUVER ROUTINE (R60)		ROUTINE (R60)	ANE OVI A			
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•		•				
•		•				#310
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HAVE PGNS CONTROL	•	•				
AND AUTO ATTITUDE	•	•				#320
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	•	•				P42/LUMINARY

#330

#340

#350

#360

#370

PCR 1096 Pr By 24

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. PERFORM PGNS	•		EASE PERFO NTROL AND				
CONTROL AND AUTO ATTITUDE	•		TITUDE CON				
. CONTRUL MODE	•		DE SELECTI				
. SELECTION:							
. V50N25	•		V	. N			
R1-01213	•	•	•				
R2-BLANK	•			•			
R3-BLANK				•			
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P42/LUMINARY

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	MODES SEL DURING TH THRUSTING MAN FUVER?	E • •			
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•		• • •	*		
	SET GUIDA CONTROL S TO PGNS A	WITCH	• *		
•	ATTITUDE TROL SWIT	CON- • •			
WAIT FOR KEY-					
BOARD ENTRY	•				
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TERMINATE FLASH UPON RE- CEIPT OF PRO-	KFY IN EN	TER			
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AND APS OFF	d	•			
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P48/LUMINARY

HOLD

MON .

..... DISPLAY ON DSKY:

V. A N4. R1 - TFT

02 - VG RS - DELTA VM TET - TIME FROM APS IGNITION. IN

FST SEC. MAX

SIGN IS - BEFORE NOMINAL TIG, + THEREAFTEP .

#430

#440

#450

#460

#470

MONITOR DSKY: OBSERVE DISPLAY OF TEL, VG AND DELTA VM

MIN, SEC TO MEAR-UPDATE EVENT TIMER TE DESTRED READING IS 5CRES.

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

DELTA VM-MEASUFFE DELTA V MAGNITUDE IN FPS TO WEAKEST .1 FPS. THIS DISPLAY WILL PE THE UNTIL TIG-30 SEC AND THEN SHOULD CHANGE CNLY DIE TO PIPA BIAS UNTIL HILLAGE IS STARTED.

SET TOFC! = TIG-25 SECUNDS

•		•		
ON STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41) (NOTE: ENTER R41 AT "A".)	•	DO STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41) PREFEVE THAT THE COMPUTER ACTIVITY LIGHT IS ON UNTIL COMPLETION OF R41.		#480
.TIG SLIP.		•	*	
•		•		
• •		DIS ARM.		
(NOTE: R4) WILL DEFINE TIG TO BE		ABM APS		#490
THE TIME TO WHICH R41 DID INTEGRATE THE LM STATE VEC-		•		
• TOR PLUS 30 • SECONDS•)		•		
•		:		#500
•		CHECK STATUS OF C/W		#300
WAIT UNTIL TIG		•		
•		•		
•		•		#510
BLANK THE DSKY DIS-		MONITOR DSKY:		
PLAY (V,N,R),R2, AND R3).	•	AT TIG -35 SEC 08+ SERVE DSKY DISPLAY TO GO BLANK FOR 5 SECONDS.		
			-	#520
•		•		
WAIT UNTIL TIG		•		
•		•		
Car have than that that the than take that the than the than the test than the test the		•		

PSE/LUMINAR

#530

#540

#550

#560

#570

RETURN VJANAJ DIS-MONITOP DSKY: AT TEI = - 0.829 OBSERVE RETURN OF VIENAS DISPLAYS TO INDICATE THAT AVER-AGE G INTEGRATION HAS STARTED. IS THE PRESENT PROGRAM PAR 199 (NOTE: IF TIG HAS BEEN SLIPPED BY R41, THE TEL DISPLAY (R1) AT THIS TIME WILL BE REFERRED TO THE NEW TIG.) SET THE APS FLAG IS THE PRESENT PROGRAM P447 PERFORM DPS START AVERAGE G STAGING IF IT HAS . INTEGRATION. NOT ALREADY BEEN DONE CALL 1/ACCS AND INITIALIZE THE DAP. (NOTE: NORMALLY THE DAP IS INITIALIZED BY DATA SELECTED VIA RO3. 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

PSZ/LUMINAPY

#580

MONITOR DSKY:
IN THE PERIOD FROM
THE =-00830 UNTIL
THE =-10815
DOFS DELTA VM BECOME
GREATER THAN .5 FPS
INDICATING EXCESSIVE
PIPA BIAS ERROR?

#590

GO TO BACKUP

#600

WAIT UNTIL TIG= -5 SEC.

#610

FROM R40

#620

RESET IGNITION FLAG

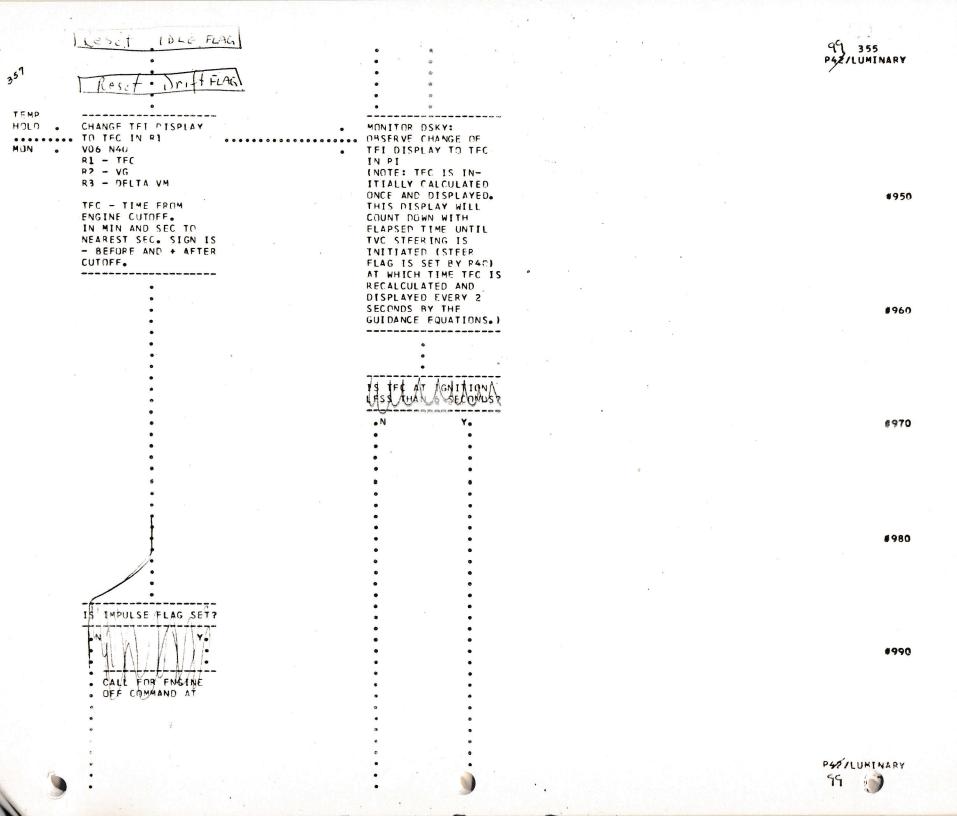
RESET ASTRONAUT FLAG

#630

RESET IMPULSE ALAD TIG -

COMMAND RCS THRUST

PSE/LUMINARY



CALCULATED CUTOFF TIME. ISEE "O" HELDWI / CHOTES PONCS WILL
CHATEL PONCS WILL
VEHICLE ATTITUDE
HOLD THROUGHOUT
THRUSHING MANEUVER) RESET IGNITION FLAG RESET ASTRONAUT FLAG RESET PAPULSE FLAG WAIT Q.5 SECONDS RESET ULLAGE

#1000 #1019 #1020 #1030

PSZ/LUMINARY

#1040

358

PARUMINARY

MONITOR AZE ROS
THRUSTINGS
1. PSKY:
PI-TEC
SHOULD BE
DECREASING.

6110)

P2-VS SHOULD BE DECREASING.

R3-DELTA VM SHOULD INCREASE.

2. FDA1-ATT. ERROR SHOULD BE LESS THAN OR FQUAL TO XX DEGREE.

41110

ATT RATES SHOULD BE LESS THAN OR EQUAL TO XX DEGREE/SEC.

36 ARS CHANGER DEFS-SURE LEGS SHOULD BE NORMAL.

01120

IDENTIFY EARLY, NORMAL, OR LATE EN-GINE CUTOFF FROM AS-SESSMENT OF DSKY DISPLAYS.

61130

.E . L . A .. 0 (7 6 R . T o 💐 . E . 1 O C .U . U . 7 . T · 17 . 0

The state of the s

95 359 PASILUMINARY

61140

PUSH ENGINE STOP PUSH+ BUTTON

#1150

GO TO BACK-UP PROCE-DURES

61160

41170

61180

SFE DPS/APS ...
THRUST FAIL ...
ROUTINE (R4N) ...
FOR REQUIRED ...
RESPONSE ...

IS TO LESS THAM 4
SECONDS?

OF NO.

CONTINUE GUIENNOS

CONTROL

MAND AT COMPUTED

COMMAND AND ALL ATTITHOS HAVES

SET IDLE FLAS

WALT UNTIL COMPUTED
TIME OF CUTOFF

FROM

COMMAND ENGINE OFF

COMMAND ZERO ATTI-TUDE RATES

TO PREVIOUS VALUE

01197

01300

61210

41550

61230

01240

PARTICUMINARY

SETNED BY P. ... MAINTAIN VG COMPUTATIONS AFTER CUTOFF FOR POSSIBLE NULLING BY PCS TRIMMING MANEUVER (NOTE: SEF ASSUMP-TION (2) ABOVE). COMMAND ZERO ATT-ITUDE RATES SET DEAD-BAND TO PREVIOUS VALUE DE-FINED BY PFSET ULLAGE

DISARM APS

61257

61260

81270

01207

01290

PINTHARY

				3 8	P42/LUMINARY
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	VILLAGE .		•		#1300
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HOLD .		-			
			MONITOR DSKY:		
MON e	FLASH VERB-NOUN TO		OBSERVE VERB-NOUN		
4014 8	REQUEST PROCEED.		FLASH TO REQUEST	v v	
	HOLD DISPLAY OF TEC	•	PROCEED AND DISPLAY		#1320
	AT ITS FINAL VALUE:	•	OF TEC, VG, AND		
	V16 N40	•	DELTA VM		
	R1 - TFC	•		•	
	R2 - VG	•	•		
	R3 - DELTA VM	•	•		
		•	. •		
,	INOTE: SEE ASSUMP-	•	•		
	TION (2) ABOVE).	•	•		
	CAT AND BASE MAD HAVE MAD MAD MAD MAD MAD MAD MAD NAME AND MAD MAD MAD MAD MAD MAD MAD MAD MAD MA	•		•	#1330
	•	•	RECORD THESE VALUES		#13317
	•	•	AS DESIRED.		
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	TOD VEVOOADD	• •	KEY IN PROCEED		
	WAIT FOR KEYBOARD		VET 1M FROCED		
	ENTRY TERMINATE FLASH UPON	• •	•		
	RECEIPT OF PROCEED.	•			#1340
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364			• • • •		P42/LUMINARY

P42/LUMINARY

Pg 22 g 24

RFCYCLE, OF TERMINATE

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.C .M .Y
.F .I .C
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COMMAND ZERO ATT-ITUDE FRRORS

SET C.3 DEGREES DEADBAND

MOLO • FLASH VERB-NOUN TO
REJUEST RESPONSE AND
DISPLAY COMPONENTS
OF VG(LM):
V16 N85

P1-VGX(LM) R2-VGY(LM) P1-VG/(LM) MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF VG(LM) COMPENENTS

#1357

61360

61370

91380

01397

PATI TINAH

COMPENENTS OF THE PRESENT VG VECTOR RESOLVED ALTHE THE LM . X . Y . AND Z AXES . THE VG VECT'R WILL BE UPDATED BY THE STEERING LOOPS DURING EACH COMPUTA-TION CYCLE. IN FPS TO NEAREST .1 FPS. (NOTE: SEE ASSUMP-TION (2) ARTYFI. WAIT FOR KEYHOARD ENTRY TERMINATE FLASH UPON . RECEIPT OF PROCEED,

> RECYCLE, OR TERMINATE

TO NULL OUT VG
COMPONENTS COMMAND
MANUAL TRANSLATIONS
AND HOTATIONS.
(NOTE: THIS MANEUVER
IS AT THE OPTION OF
THE CREW.)

6140

THE ORBITAL PARAME-TER DISPLAY ROUTINE (R3C) MAY BE SELECT-ED AT THIS TIME (VP2E) TO MONITOR CONTINOUSLY UPDATED VALUES OF APO ALT, PER ALT, AND TEF.

KEY IN PROCEED

61410

#1420

400 to = 4십

61437

81447

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366

PASTEUMINARY

PAZILUMINARY

91457

#1460

\$1470

81480

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90 E 00
              FRUM
              ARINE
ZERO RENDEZVOUS
TRACKING MARK
COUNTER
SET DEADBAND
TO PREVIOUS VALUE
DEFINED BY RO3.
DO FINAL AUTOMATIC
                                     DO FINAL AUTOMATIC
                   ..... PEQUEST TERMINATE
REQUEST TERMINATE
                                       ROUTINE (R 0)
ROUTINE (ROC)
       EXIT PA2
                                            FXIT P47
```

CHANGE CONTROL NOTES

REV OO PCR 31
REV O1 PCR 85,86,11,4,14/,1/4,154,4 1,413,7 1,413
REV OOLUW 1A) PCR 647,649
REV O1(LUM 18) PCR 334, F1 [1 P14]



MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PEN # 1097.2 REV.1
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	
COLOBOO	· · ·
COLORDO	
COLOSSUS LUMINARY	
	C TAGA Annuand
MIT Approved PCN NASA Approved PCR	NASA Approved Software Anomaly
MIT Approved ADR NASA Approved PCN	MIT Approved
	Software Anomaly
A. Coding	D. P. C.
Begin coding immediately	T, Fy
ACTION:	
	Man allenta
Program Supervisor's Approval:	(/): '
Do not code until new GSOP material has b	een approved by the MIT
Mission Design Review Board (MDRB) and	distributed.
- ggop Purposition	
B. GSOP Preparation	J. KLAWSNIK JJ. SMITH
Prepare GSOP revisions for MDRB	U. KENWINIK JOISIN
consideration ACTION:	
- 1 Mooting not required	1
Technical Committee Meeting not required	••
Technical Committee Meeting(s) held on	. <u></u> ,
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	
ACTION Special Instructions	-
Project Manager	Lynell Taren
Date	
PUCAGO V M	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST NUMBER (Completed by F									
1.0 COMPLETED BY ORIGINATOR									
M. Hamilton	11/2/70	MIT/DL		DY1	Jarso	2	11-2-70		
1.3 HIFECTIVITY I.4 TITLE OF CHANGE Provide V30, V31 Operator									
Luminary 1E Error Lockout									
Provide V30, V31 lockout when the N26 program operation is not valid.									
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 APPROVED DISAPPROVED									
2.3 SOFTMARE CONTROL BOARD C BRANCH SIGN OFF	R FLIGHT SCFTWAR	E							
CATE				or e	. (
3.0 MIT VISIBILITY IMPACT E	VALUATION:				ľ				
3.1 SCHELLAS IMPACT				T OF PROVID	ING DETAIL	ED EVALUA	ATION		
Less than 10 words.									
Less than 10 words. N26 is now unshared									
11-7-70	Ò								
	4.0 \$0	FTWARE CON		RD ACTION	1				
PROVIDE CETAILED DE CH	ALLATION		i MARK :	a.					
44.3 SOFTMARE CONTHOL BOARD	SLIN OFF								
11-5	-70			TO SECULO SERVICIONE PLAN	The second second				
5.0 MIT DETÄILED PROGRAM CHANGE EVALUATION									
5.1 MIT COORDINATOR		5 . 2 M	IT EVALUATIO	ON					
LATE							· ·		
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION									
5.1 START OR CONTINUE	DISAPPROVED OR	1 2 P	EMARKS	· ·					
6.3 SOFTWARE CONTROL BOARD					3				
DATE									

MIT	DL PROGRAM CHANGE ROUTING SLIP	PCR/PRN #
		ANOMALY #
_	COLOSSUS 2E LUMINARY 1D	ADR #
6	COLOSSUS 3 LUMINARY 1E	
H	COLOSSUS 3A LUMINARY 1F	
H	COLOSSUS LUMINARY	
	MIT Approved PCN NASA Approved PCR	NASA Approved
		Software Anomaly
	MIT Approved ADR NASA Approved PCN	MIT Approved
	A. Coding	Software Anomaly
	Begin coding immediately	f. Fre
	ACTION: _	10 -11
	Program Supervisor's Approval: 🖊	Jana H. Hamely
	Do not code until new GSOP material has bee	n approved by the MIT
	Mission Design Review Board (MDRB) and di	stributed.
	B. GSOP Preparation	
	Prepare GSOP revisions for MDRB	J. SMITH
	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	•
	Titeview is corresponding	
	ACTION:_	
	Special Instructions	1) 1849
	Project Manager	11 - 1 - 7
	Date _	11-6-70
-		

APOLLO SPACECRAFT	SOFTWARE	CONFIGUR	ATION C	ONTROL BOARD	Nowself (Completed by 130)	
PROGRAM CHANGE REQUEST 1.0 COMPLETED BY ORIGINATOR						
1,1 GRIGINATICH	DATE	1.2 ORGANIZA		APPROVAL	DATE	
P. Rye	10/20/70	MIT/CS				
LUMINARY 1F				setting of NOE	OOFLAG in R47.	
but leaves the NODOFLAG set, requiring selection of V96F or V37F00F or reselection of V47E before another major mode change.						
1.6 OFSCHIPTION OF SHANGE I	Delete code v	which sets	NODOF	FLAG in R47.	T - MET - THE METERS OF THE STATE OF THE STA	
	SOFTWARE CON DECISION FOR	VISIBILIT	Y IMPACT	HT SOFTWARE BRA ESTIMATE BY MI	N C H T	
APPROVED DARG C	DISAPPROVED		Ex ptance o		tion of AGS ould be made before the case of a re-	
241:		start		, C. LEANE OF III	. mc case of a re-	
3.0 MIT VISIBILITY IMPACT EV	ALUATION:					
J.: SCHF [V04]*		v	3.2 IMPACT	OF PROVIDING DETAIL	ED EVALUATION	
-4 fixed words	\sim	3.4. RE	MARKS!	Er 19		
LA Jan	70		G	200		
	NAME AND ADDRESS OF TAXABLE PARTY AND ADDRESS OF TAXABLE PARTY AND ADDRESS OF TAXABLE PARTY AND ADDRESS OF TAXABLE PARTY.	TWARE CONT	ROL BOAR	DACTION		
PROVIDE CETABLES DET	AILED DISA	4.0 RE	MARKS	Per die Michael Marchael Cape galent et alle andere de ante e utable a		
4.3 BOFTMARE CONTROL BIART S						
11-5	-70					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION						
5.1 WIT COORDINATOR	-	5.2 11	EVALUATIO	* * *		
DAYE						
	DETAI	LED PROGRA	BOARD DE M CHANGE	CISION ON MIT EVALUATION		
INPLEVENTATION L	CISAPPROVED OR ST	OP 6.3 424	AARKS I			
5.3 SOFTWARE CONTROL BOARD S	IGN OFF					
JATE						

MSC Form 288 (Jul 68) TP#21812

DISAPPROVER

Page 1 of 3

APOLLO SPACECRAFT	SOFTWARE	CONFIGUR	ATION C	NTROL BOA	RD NUMBE	(Completed by FSB)
P	ROGRAM CHAI	NGE KEYU	LUI			7100
SPECIFIC LAN		COMPLETED	BY ORIGI	NATUR		DATE
ORIGINATOR	DATE					
C. Work	15 Oct. 197	0 MIT				
3 EFFECTIVITY			Thim of	of change imbal contr	ol mode (change
Luminary 1E			1 rim g	Illibai collu	or mode.	
Trim gimbal contro GTS attitude contro descent in a lunar 1 6 OF SCRIPTION OF CHANGE GTS acceleration no situations except th docked mode or who 2.0 APPROVED DATE TO STEWARE CONTROL BOARD BRANCH SIGN OFF	anding. Con alling contro ose in which en the RCS i SOFTWARE CO DECISION FO	atrolling to the state of the s	he attitu overn tri tude cont sabled.	m gimbal u rol is mand	lar rate v se in all latory, i trim g	with the RCS powered desce
3.0 MIT VISIBILITY IMPACT 3.1 SCHEDULE IMPACT 3.3 STORAGE IMPACT Save about 20 wor 3.5 MIT COORDINATOR		3.4	3.2 IMPA	T OF PROVIDING	DETAILED EVA	NLUATION
DATE	4.0.5	DETWARE CO	NTROL BO	ARD ACTION		
PROVIDE DETAILED D	BOVIDE DE LA PROPERTIE DE LA P		HEMAUR !	5	avergen either seer a var verd eine een een een een een een een een ee	
DATE						
	5.0 MIT DE			NGE EVALUATI	0 N	
	5.0 MIT DE		GRAM CHA	NAME AND ADDRESS OF THE OWNER, WHEN PERSON ADDRESS OF THE OWNER, WHEN PERSON AND ADDRESS OF THE OWNER, WHEN	ON	
DATE 5.1 MIT COORDINATOR	0.0.000	5.2	MIT EVALUA	DECISION ON	HIT	
DATE 5.1 MIT COORDINATOR	0.0.000	ARE CONTR AILED PRO	MIT EVALUA	TION	HIT	
DATE 5.1 MIT COORDINATOR DATE 6	6.0 SOFTW DET DISAPPROVED OF IMPLEMENTATION	ARE CONTR AILED PRO	MIT EVALUA DL BOARD GRAM CHAN	DECISION ON	HIT	

75C Form 288 (Jul 68)

TP#21812

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD -DATA AMPLIFICATION SHEET -

PREPARED BY:	ORGANIZATION:	
DATE:	2.0	
DAID.		_

PAGE 2 OF 3

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

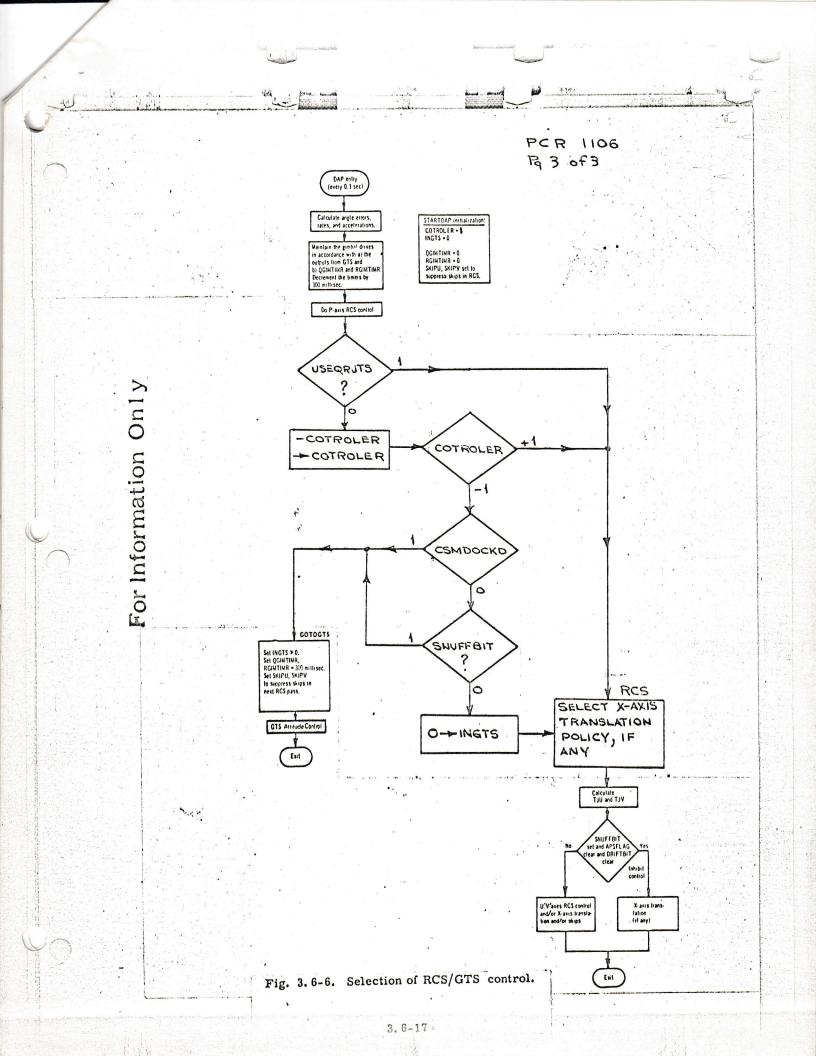
Block 1.5, Reasons for change, cont.

PROGRAM CHANGE REQUEST NO.

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.



MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PON #
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
Total Assessed DCD	NASA Approved
MIT Approved PCN MASA Approved PCR	Software Anomaly
MIT Approved ADR NASA Approved PCN	MIT Approved
	Software Anomaly
A. Coding	P
Begin coding immediately	- Nye
ACTION:	Bernikowich
Program Supervisor's Approval:	Bure McConfo M. Hamlton
Do not code until new GSOP material has be	een approved by the MIT
Mission Design Review Board (MDRB) and	distributed.
B. GSOP Preparation	
Prepare GSOP revisions for MDRB	J. KLAWSNIK
consideration ACTION:	
Technical Committee Meeting not required	
Technical Committee Meeting(s) held on Attendees:	
Mitonasos	
C. KSC Testing and Checkout	
Review for possible impact on KSC testing and checkout ACTION:	· · · · · · · · · · · · · · · · · · ·
testing and checkout	•
D. Other Programs Affected	
Review for corresponding changes in	
ACTION	
Special Instructions Project Manager	Vine (14 Time)
Date	11-6-70
Date	

MANAGEMENT OF SHIP SHIP SHIP SHIP SHIP SHIP SHIP SHIP	HOLDER REDUCE	multaneararavan-	ADMINISTRA OF STREET	Thomas (Completed by FSB)
APOLLO SPACECRAFT		CONFIGURATION IGE REQUEST	CONTROL BOARD	1107
	1.0	COMPLETED BY OR	GINATOR	The second of the second secon
1.1 OHIGIVAÇOR	DATE	T.V GHOANIZATION	APPROVAL	3140
G. Edmonds, Jr.	22 Oct. 1970	MIT/DL		
1.3 (474-114114		Rook	UP of About hite	Channel 30 Bits 1
LUMINARY 1E		and 4	for on (0)	Chamier 30 Bits 1
If either of these bits	fail on (0) u	ndesired abort	will be initiated	whenever a
landing program is ru	inning.			
1.6 DESCRIPTION OF SHANSE		Company of the Compan		
Provide logic which c	an be set by	the Astronaut	which will cause	the programs
to ignore these bits.	a stict	which says	lese or le	grene ch 30/1,4
2.0	SUFTWARE CON DECISION FOR	TRUL BOARD OR F VISIBILITY IMP	IGHT SOFTWARE BRI OT ESTIMATE BY M	480K
2.1 APPROVED	DISAPPROVED	2.2 REWARKS	ACCOMPANIES OF THE PARTY OF THE	
7.3 SOFTWARE CONTROL BOARD OF BRANCH SIGN OFF				
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DATE		a vigan (Carlotte and Carlotte		
3.0 MIT VISIBILITY IMPACT EV	ALUATION:			
3.1 SCHEDULE IMPACT		3.2 IM	ACT OF PROVIDING DETAI	LEG EVALUATION
3.3 STORAGE IMPACT		3.4 HEMARKS	A GANGER (THE AMERICAN PROPERTY SERVICE STREET, SERVICE SERVIC	The second secon
3.5 MT COORDINATOR	Hanso			
DATE	- 70			
	PASERSON PROFIT RESIDENCE PROFIT PROF	TWARE CONTROL B	ARD ACTION	
4.1 PROV	ice '	4.2 REMARKS		THE PARTY OF THE P
PROVIDE DETAILED DETA	ILED DIS-	ONED		State of the state
4.3 SOFTMARE CONTROL BOARD ST	Control Contro			
11-5	-70			
THE RESIDENCE OF THE PROPERTY	A THE REAL PROPERTY OF THE PARTY OF THE PART	LED PROGRAM CH	NGE EVALUATION	
5. I MIT COORDINATOR		5.2 MIT EVALUA		
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	6.0 SOFTWARE DETAIL	CONTROL BOARD ED PROGRAM CHAI	DECISION ON MIT	
	SAPPROVED OR STO			
3.3 SOFTMARE CONTROL BOARD SI	APLIMENTATION			
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The second of th		LATER AND LATER REPORT		

DIS APPROVED
Page 1 of 1

NOTE OF THE PROPERTY OF THE PR	ONELCUDA	TION C	ONTOOL	OARD	NUMBER (C	ompleted by FSB
APOLLO SPACECRAFT SOFTWARE CO PROGRAM CHANG	GE REQUE	ST	UNIKUL D	UARD	110	8
1.0 00	OMPLETED	BY ORIGI	NATOR			
1,1 0,10,142,101	. 2 ORGANIZAT		APPROVAL		D	ATE
G. Edmonds, Jr. 22 Oct. 1970	MIT/DL	1.4 TITLE	OF CHANGE			
LUMINARY 1E		Back to Chann	ip Mark X el 16 Bits	3,4,5		
Failure of any of these bits will particle. Memo No. 1563 for more detail.	revent IN	IU align	ments us	ing the	AOT. (See STG
A back up procedure not involving provided.	the use	of Mark	X,Y or I	Mark re	ject wil	ll be
2.0 SOFTWARE CONT DECISION FOR	VISIBILIT	Y IMPACT	HT SOFTWA ESTIMATE	RE BRAN	CH	
APPROVED DISAPPROVED	2.2 RE	MARKSI				
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH-SIGN OFF			*			
DATE	÷		NAMES OF THE OWNER, WHEN THE PARTY AND THE P		na zwia wasa iliyotik il	
3.0 MIT VISIBILITY IMPACT EVALUATION:						
3.1 SCHI'DULE IMPACT .		3.2 IMPAC	T OF PROVIDI	IG DETAILE	EVALUATI	ON
3.3 STORAGE IMPACT	3.4 RE	MARKSI				
3.5 MIT COORDINATOR						
DATE						
4.0 SOFT			RD ACTION			
PROVIDE DETAILED DETAILED CHANGE EVAL.		MARK 5				
DATE						4
11/5/70						
5.0 MIT DETAI		T EVALUATI		TION	1	
DATE	CONTROL	DOADD D		LMIT		the second and the
6.0 SOFTWARE DETAIL	V 4 2 25	M CHANG	EEVALUAT	ON		
START OR CONTINUE DISAPPROVED OR STI			× 1 1 2			
DATE				en e		

MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
J. Oldeber 11	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
MIT Approved PCN VNASA Approved PCR	NASA Approved Software Anomaly
MIT Approved ADR NASA Approved PCN	production.
	MIT Approved Software Anomaly
A. Coding	0
Begin coding immediately	fye
ACTION:	C. Of
ACTION.	2 0 1 1 111 14
Program Supervisor's Approval:	Drie Molay for M. Harullon
Do not code until new GSOP material has be	een approved by the MIT
Mission Design Review Board (MDRB) and o	distributed.
B. GSOP Preparation	
Prepare GSOP revisions for MDRB	J. KLAWSNIK
consideration ACTION:	
ACTION.	
Technical Committee Meeting not required.	•
Technical Committee Meeting(s) held on Attendees:	
Attendees.	
C. KSC Testing and Checkout	*
Review for possible impact on KSC	
testing and checkout ACTION:	•
D. Other Brown a Affected	and the second
D. Other Programs Affected Review for corresponding changes in	
Review of corresponding changes in	
ACTION:	
Special Instructions	D will C
Project Manager	Sussell H. Land
Date	11-19-70

APOLLO SPACECRAFT	SOFTWARE ROGRAM CHA	CONFIGUR	ATION C		DARD	NOVER (COMP)	Cred by FSB)
A MANAGEMPELATORY CONTRACTOR OF THE CONTRACTOR O	THE RESIDENCE OF THE PARTY OF THE PERSON OF	COMPLETED	POWER WALLEST P. CO. P.	I. A. T. O. R	MINISTER STORY	ASSAULT A STANSON	POTENTIAL PROPERTY OF
1.1 OFIGINATUR	LATE	1.2 ORGANICA	TION	APPROVAL	~~~~~~~	DATE	
	22 Oct. 1970	MIT/E	-				
LUMINARY 1E			Back up Channe	of change o of off (1) 1 30 Bit 5	failur	es of Auto	Throttle
If this bit fails off (1)	Auto Thrott	le in desc	ent will	not be pos	sible.		
Provide logic which with has failed off (1).	a lit w	hick say	pu	Ch 30/5	or an	oune aut	ough Thotto
2.0	SOFTWARE CON DECISION FOR	TROL BOARD VISIBILIT	Y IMPACT	HT SOFTWARE ESTIMATE E	BRANC BY MIT	1	THE RESERVE OF THE PROPERTY OF
	DISAPPROVED				1.4		
3.0 MIT VISIBILITY IMPACT EV	ALUATION:	ACCUPATION OF THE PROPERTY OF		CONCRETE STREET, ST. ACCUSATION OF STREET, ACCUSATIO			
3.: SCHEDULE IMPACT			3.2 IMPACT	OF PROVIDING	DETAILED	EVALUATION	Company and the second
3.5 MIT COORDINATUR DY DATE 10-26-	Lanso	Thi		DONE in	P63, 6	54.	
	4.0 SOF	TWARE CONT	ROL BOARD	KOTTON (
CHANGE EVAL. CHAN	GE APPR	4.2 RE	MARKS				Starty-ware blanker and a starty could be under a
DATE 11-5.	. 70				e e		
	5.0 MIT DETAI	LED PROGR	AM CHANGE	EVALUATIO	N		DESCRIPTION OF T
5.1 MIT COORDINATOR		5.2 MIT	EVALUATION				
	6.0 SOFTWARE DETAIL	CUNTROL I	BOARD DEC	ISION ON M EVALUATION	i I		
	ISAPPROVED OR STO	7	ARKSI			The first of the second se	
5.3 SOFTWARE CONTROL BOARD SI	GN OFF			¥			
		ivise sievenin			32372200-64		V PRVYANIVANASSISSI ARKASINI

VIII IIII I IIII IIII OIIIII OIIIII	PCR/PSX #
MIT LDL PROGRAM CHANGE ROUTING SLIP	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	
	*
COLOSSUS LUMINARY	
MIT Approved PCN NASA Approved PCR	NASA Approved Software Anomaly
MIT Approved ADR NASA Approved PCN	MIT Approved
	Software Anomaly
A. Coding	\mathcal{O}
Begin coding immediately	- Me
ACTION:	Eiles
1	B Solon la M Squitton
Program Supervisor's Approval:	
Do not code until new GSOP material has be	een approved by)the MIT
Mission Design Review Board (MDRB) and	distributed.
B. GSOP Preparation	
	J. KLAWSHIK
Prepare GSOP revisions for MDRB consideration	1 Is microsoft to
ACTION:	
Technical Committee Meeting not required	
Technical Committee Meeting(s) held on	
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MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PSN #
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Date	11-17-70

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G. Edmonds, Jr.	22 Oct. 1970	MIT/	DL	AFPROVAL	12		CATE
LUMINARY 1	E		Pilot 1		AGS/PG	NS se	e of Auto lect switch bit , Bits 13, 14
Failure of these bits	will preven	t selection	of des	sired auto	pilot co i	nfigura	ation.
Provide logic which regardless of the act					select th	ie desi	red modes
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1.3 EFFECTIVITY			Back u	of CHANGE	(0) failur	es of tr	anslation
LUMINARY 1	E		comma	ands Char	nnel 31 E	3its 7-12	2.
On (0) failure of these and so preclude use o	bits will caff the PGNS.	ause the P	GNS to	always tu	irn on tr	anslatio	n jets
Provide logic which of the beignored.	can be set by	y the Astr	onaut w	hich will	cause th	ese bits	
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1.3 EFFECTIVITY	1.3 EFFECTIVITY Back up failure of the LPD bit Channel 31								
	LUMINARY 1E Bits 1, 2, 5 and 6.								
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.									
Provide logic which can be set by the Astronaut to cause the program to ignore these bits.									
2.0	SOFTWARE CON DECISION FOR	VISIBILIT	Y IMPACT	HT SOFTWARE BY I	RANCH MIT				
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Page 1 of 2

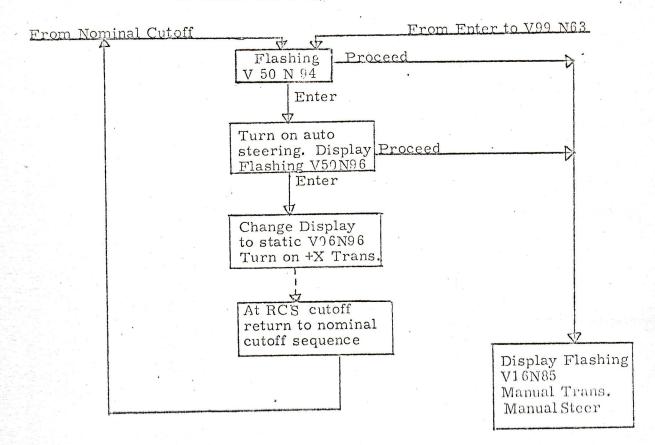
NUMBER (Completed by FSB) APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD 1116 PROGRAM CHANGE REQUEST 1.0 COMPLETED BY ORIGINATOR DATE 1.2 ORGANIZATION 1. 1 ORIGINATOR DATE 10/27/70 MIT/DL L. Berman 1.4 TITLE OF CHANGE 1.3 EFFECTIVITY Automatic RCS Steering Luminary 1E 1.5 REASON(E) FOR CHANGE 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 2.2 REMARKS DISAPPROVED APPROVED 3.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF 3.0 MIT VISIBILITY IMPACT EVALUATION: 3.2 IMPACT OF PROVIDING DETAILED EVALUATION 3.1 SCHEDULE IMPACT 30 fixed 3.4 REMARKS 3.6 MIT COORDINATOR CATE 4.0 SOFTWARE CONTROL BOARD ACTION 4.2 REMARKS PROVICE DIS. DETAILED PROVIDE DETAILED CHANGE EVALUATION CHANGE EVAL. 4.3 SOFTHARE CONTROL BOARD SIGN OFF DATE 5.0 MIT DETAILED PROGRAM CHANGE EVALUATION 5.2 MIT EVALUATION 5.1 MIT COORDINATOR DATE 6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION 6.2 REMARKS DISAPPROVED OR STOP START OR CONTINUE IMPLEMENTATION IMPLEMENTATION 6.3 SOFTWARE CONTROL BOARD SIGN OFF

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD -DATA AMPLIFICATION SHEET -

PROGRAM CHANGE REQUEST NO. PREPARED BY: L. Berman ORGANIZATION: MIT/DL

PAGE 2 OF 2

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



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APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
-DATA AMPLIFICATION SHEET -

	Hamilton	PAGE 2 OF 3
PROGRAM CHANGE REQUEST NO. 1117.2	PREPARED BY: Rye. Barnert, DATE: 10/27/79	ORGANIZATION: MIT

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 truned 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

PRELIMINARY

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD -DATA AMPLIFICATION SHEET -

PROGRAM CHANGE REQUEST NO. 1117.2 PREPARED BY: Ryc. Barnert 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.

MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PRT #
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
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MIT Approved ADR NASA Approved PCN	Software Anomaly
	MIT Approved Software Anomaly
A. Coding	
Begin coding immediately	1. Weissman
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Program Supervisor's Approval:	11/Well A. Hamey
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B. GSOP Preparation	
Prepare GSOP revisions for MDRB	J. KLAWSHIK
consideration ACTION:	
Technical Committee Meeting not required.	•
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A. Coding	Software Anomaly
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Program Supervisor's Appro	oval: / work / Kitamana
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B. GSOP Preparation	
Prepare GSOP revisions for MDRB	J. KLAWSNIK J. SHITH.
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6.3 SOFTWARE CONTROL BOARD S	IGN OFF						

T/DL PROGRAM CHANGE ROUTING SLIP	Det/PCN# 1126
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	
	1/17 000
COLOSSUS LUMINARY.	MIT-PCN
MIT Approved PCN MIT Approved ADR NASA Approved PCN NASA Approved PCN	NASA Approved Software Anomaly MIT Approved Software Anomaly
A. Coding	GSOP ONLY
Begin coding immediately	GOOF ONE
ACTION:	
Program Supervisor's Approval:	
Do not code until new GSOP material has b	een approved by the MIT
Mission Design Review Board (MDRB) and	distributed.
B. GSOP Preparation	
Prepare GSOP revisions for MDRB	J. KLAWSNIK
consideration ACTION:	
Technical Committee Meeting not required	
Technical Committee Meeting(s) held on Attendees:	
G yra Manting and Chapleout	4 44 5 5
C. KSC Testing and Checkout Review for possible impact on KSC	
testing and checkout ACTION:	And the second s
D. Other Programs Affected	
Review for corresponding changes in	
A CITION.	
ACTION: Special Instructions	
Project Manager	X41. June
Date	11-23-70

1 4 E

MIT-PCN

Page 1 of 3

APOLLO SPACECRAF	T SOFTWARE	CONFIGURAT	ION CONTRO	L BOARD		(Completed by FS
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	6.0 SOFTWARE DETAIL	CONTROL BOA ED PROGRAM C	RD DECISION HANGE EVALU	OH MIT		
START OR CONTINUE IMPLEMENTATION	DISAPPROVED OR STO	OP 6.2 REMARKS				
3 SOFTWARE CONTROL BOARD	SIGN OFF					

Contents

Mill to

MIT-PCN PCR 1126 Pg 20F3

Word	Number
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(Con	t'd)

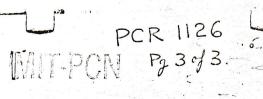
Flagword

,

Meaning
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 success-
ful conclusion of a priority or normal display after having been
used to bypass internal checks that otherwise would cause a
program abort.

- 5 MRUPTFLG. Set to 1 if a mark/extended verb display or display attempt has been interrupted by a priority display.
- 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.
- 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).
- 2 Not used.
- 1 XDSPFLAG. Set to 1 to indicate that a mark display status exists. This will lock out normal displays.
 - 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.
- 14 Not used.
- 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.
- NOTHROTL. Bit is set to 1 to indicate that the length of the burn for P40 (based on 10% throttle) is 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 centiseconds 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 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. 2-44



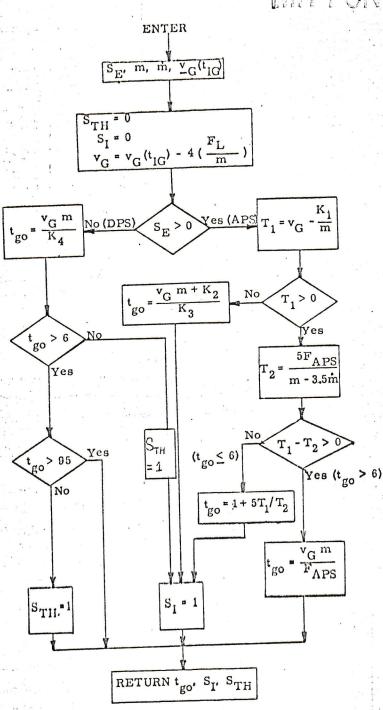


Figure 3.3-11 Time-to-go Predictor Routine

	1/27
MIT/DL PROGRAM CHANGE ROUTING SLIP	Der/PCN #
	ANOMALY #
COLOSSUS 2E LUMINARY 1D	ADR #
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
A. Coding	Software Anomaly
A. Coding	D0.00 R
Begin coding immediately	No of T
ACTION:	Sharm Hebert
Program Supervisor's Approval:	Margart A damela
Do not code until new GSOP material has be	/ /,
Mission Design Review Board (MDRB) and	distributed.
B. GSOP Preparation	J. KLAWSNIK
Prepare GSOP revisions for MDRB consideration	V. KLHWSPIK
ACTION:	
Technical Committee Meeting not required	• 이번 보고 되는 어떻게 되고 깨끗했다.
Technical Committee Meeting(s) held on Attendees:	
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C. KSC Testing and Checkout Review for possible impact on KSC	
testing and checkout ACTION:	
D. Other Programs Affected	
Review for corresponding changes in	The second secon
ACTION:	
Special Instructions	D41
Project Manager-	11-71-70
Date	11-30-70

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APOLLO SPACECRAFT	SOFTWARE ROGRAM CHA	CONFIGURA NGE REQUE	ATION EST	CONTROL	BOARD	NUMBER (Comp 112)	Teted by FSB)
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APOLLO SPACECRAFT	SOFTWARE ROGRAM CHA	CONFIGURA NGE REQUI	ATION CONTROL BOARD NUMBER (Completed by ESI 1/29
	1.0	COMPLETED	BY ORIGINATOR
1.1 ORIGINATOR	DATE	1.2 ORGANIZA	TION APPROVAL DATE
Work/Weissman	11/30/70	MIT/DL	The Harrier III
1.3 EFFECTIVITY			Update mass-dependent calculations
LUMINARY 1E			in 1/ACCS
1.5 REASON(S) FOR CHANGE			
		See page	2
1.6 DESCRIPTION OF CHANGE		C	2
		See page	3
2.0	SOFTWARE CON DECISION FOR	RVISIBILI	O OR FLIGHT SOFTWARE BRANCH TY IMPACT ESTIMATE BY MIT
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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
Paxis	a = 0.0065443852 b = 0.000032 c = -0.006923
For Use in the Jet-Acceleration Q axi Calculations Associated with the LM Ascent Configuration	a = 0.0035784354 b = 0.162862 c = 0.002588
R axi	a = 0.0056946631 b = 0.009312 c = -0.023608
For Use in the Jet-Acceleration Calculations Associated with the LM Descent Configuration R axi	b = 0.0 $c = .0460344$ $a = .0014551624$ $b = .0183742$ $e =0605832$ $a = .0008936540$ $6 = .0226132$ $c =0680959$
For Use in the Descent-Engine Moment-Arm Calculation	a=.0197118964 .6=.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, a is scaled at $(\pi/4)$ 2¹⁶ kg rad/sec, b is scaled at $\pi/4$ rad/sec, and
 - c is scaled at 216 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	Ded/PCN #
	ANOMALY #
COLOSSUS 2E LUMINARY 1D COLOSSUS 3 LUMINARY 1E COLOSSUS 3A LUMINARY 1F	ADR#
COLOSSUS LUMINARY	
MIT Approved PCN MIT Approved ADR NASA Approved PCN NASA Approved PCN A. Coding	NASA Approved Software Anomaly MIT Approved Software Anomaly
Begin coding immediately	NO CODING CHANGE
ACTION:	
Program Supervisor's Approval:	
Do not code until new GSOP material has b Mission Design Review Board (MDRB) and	een approved by the MIT
B. GSOP Preparation	
Prepare GSOP revisions for MDRB consideration ACTION:	J. KLAWSNIK/J.B. 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	Dui104/1
Date_	12-29-70

APOLLO SPACECRAFT P		CONFIGURATION (NGE REQUEST	CONTROL BOARD	NUMBER (Completed by FSB) 1/32
	1.0	COMPLETED BY ORIG	INATOR	
1.1 ORIGINATOR	DATE	1.2 ORGANIZATION	APPROVAL .	DATE
Rye/Barnert	12/21/70	MIT/DL	L.H. Lynn	D 12-29-70
1.3 EFFECTIVITY		I . 4 TITLE	Correc	tion to PCR 1117.2
LUMINARY 1E		GSOP I	n to P00D00 Log Description"	
1.5 REASON(S) FOR CHANGE TO	correct an	error in the "Des	scription of Char	nge'' in
PCR 1117.2.				
1.6 DESCRIPTION OF CHANGE	<u></u>		_	
	ee Amplifica	tion Sheet.	*	i
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	DECISION FOR	TROL BOARD OR FLI	T ESTIMATE BY MIT	i u n
APPROVED	DISAPPROVED	2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OF BRANCH SIGN OFF	R FLIGHT SOFTWAR			
DATE				
DATE				
3.0 MIT VISIBILITY IMPACT EV	ALUATION:	1.		
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		<u> </u>		
3.3 STORAGE IMPACT		3.4 REMARKS:		
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DATE	Larson			a a
12-29-70	2			
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PROVIDE DETAILED DETA	ILED DIS-	4.2 REMARKS		
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DATE			* .	
4	5.0 MIT DETA	ILED PROGRAM CHAN	GE EVALUATION	
5.1 MIT COORDINATOR		5.2 MIT EVALUATIO	ON .	3
DATE			•	*
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	ISAPPROVED OR ST	OP 6.2 REMARKS;		
6.3 SOFTWARE CONTROL BOARD SI			•	
•				¥ .
DATE				

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. 1/32

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.

	PCR
IT DL PROGRAM CHANGE ROUTING SLIP	DER/=== # _//34
	ANOMALY #
COLOSSUS 2E LUMINARY ID	ADR #
COLOSSUS 3 LUMINARY 1E	The state of the s
TCOLOSSUS 3A DLUMINARY 1F	1133 follows 1134
	the state of the s
COLOSSUS LUMINARY	In this book only
VERBAL	
MIT Approved PCN NASA Approved	
MIT Approved ADR NASA Approved	PCN Software Anomaly
	MIT Approved
A. Coding	Software Anomaly
Begin coding immediately	P. (Uliman
	and the second s
AC	TION:
Program Supervisor's Ap	proval: Manual Hannes
Do not code until new GSOP material	The state of the s
Mission Design Review Board (MDRI	
B. GSOP Preparation	
Prepare GSOP revisions for MDRB	J. KLAWSNIK
consideration	Conference and an analysis of the second and a second and
AC	TION:
Technical Committee Meeting not rec	quired.
Technical Committee Meeting(s) held	l on
Attendees:	
C. KSC Testing and Checkout	
Review for possible impact on KSC	
	TION:
	•
D. Other Programs Affected	
Review for corresponding changes in	
A C1	TION
Special Instructions	TION:
Project Man	nager / / / /
	Date 12 - 30 - 70
	12 30 (0

APOLLO SPACECRAFT	SOFTWARE O	CONFIGURA NGE REQUE	ATION EST	CONTROL	BOARD	NUMBER 1134	(Completed by FSB)
		COMPLETED		INATOR			
1.1 ORIGINATOR	DATE	1.2 ORGANIZAT		APPROVAL			DATE
P.S. Weissman	12/29/70	MIT/DI	٠	24	Turso	\mathcal{L}	12-30-70
1.3 EFFECTIVITY	1		1.4 TITL	E OF CHANGE	Revision	n of Po	CR 1111:
LUMINAR	Y 1E		cwitch	185			Iode Control
PCR 1111 as origin	void the subs	stantial im	pact r	equired f ailures d	or imple uring po	ementi wered	ng and testing flight
that are not dealt w	ith by the or	iginal PCF	R 1111.				
1.6 DESCRIPTION OF CHANGE	Dogo 2						
	See Page 2	1					
2.0	SOFTWARE CON DECISION FOR	RVISIBILII	Y IMPA	IGHT SOFT CT ESTIMA	WARE BRA TE BY MI	N C H T	
2.1 APPROVED	DISAPPROVED	2.2 RE	MARKS:				
2.3 SOFTWARE CONTROL BOARD BRANCH SIGN OFF	OR FLIGHT SOFTWAR	RE .	e s				
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3.0 MIT VISIBILITY IMPACT	EVALUATION:	the second secon					
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3.3 STORAGE IMPACT		3.4 R	EMARKS:	lap	mou	al.	loy
3.5 MIT WORDINATOR H.	Lorson	> W	Tim	el ap	on 11	-13	-70
DATE 12 -30 - 70		V	,		٠		
		FTWARE CON	TROL BO	TARD ACTIO	0 N		COLUMN TO THE PROPERTY OF THE
PROVIDE DETAILED C	ROVIDE ETAILED DI HANGE VALUATION		REMARKS				
4.3 SOFTWARE CONTROL BOARD					<i>v</i> .		
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5.1 MIT COORDINATOR		5.2 M	III EVALUA	*.			
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6.1 START OR CONTINUE	DISAPPROVED OR	STOP 6.2 F	REMARKSI				
6.3 SOFTWARE CONTROL BOARD	SIGN OFF			•			
DATE .					* * .		

PAGE 2 OF 2

PROGRAM CHANGE 1/34

PREPARED BY: P. Weissman

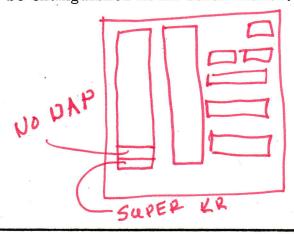
DATE: 12/29/70

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

IT/DL PROGRAM CHANGE ROUTING S	SLIP	PCR/PCN # 1133
		ANOMALY #
COLOSSUS 2E LUMINARY	' 1D	ADR #
COLOSSUS 3 LUMINARY	1E	<i>y</i> .
COLOSSUS 3A LUMINARY	7 1F	
COLOSSUS LUMINARY		
•	*	•
MIT Approved PCN	NASA Approved PCR	NASA Approved
MIT Approved ADR	NASA Approved PCN	Software Anomaly
		MIT Approved Software Anomaly
A. Coding		0 1 .
Begin coding immedi	ately	Vassman
	ACTION:	
Program	Supervisor's Approval:	January W. Hamisto
	GSOP material has been	
	w Board (MDRB) and dis	
B. GSOP Preparation	* *	
Prepare GSOP revision consideration	ns for MDRB	J. KLAWSNIK
Consideration	ACTION:	
Technical Committee	Meeting not required.	
Technical Committee 1 Attendees		
Attendee	·	v
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C. KSC Testing and Checkout		
Review for possible in testing and checkout	npact on KSC ACTION:	
2 .		
D. Other Programs Affected		
Review for corresponding	changes in	
	ACTION:	•
Special Instructions	ACTION:	
Special Instructions	ACTION:	usiell H. Jano
Special Instructions	1	2-30-70
Special Instructions	Project Manager	150 TO
Special Instructions	Project Manager	2-30-70

APOLLO SPACECRAFT P	SOFTWARE (CONTRO	L BOARD		(Completed by FSI
	1.0 (COMPLETED	BY ORI	GINATOR			
1.1 ORIGINATOR	DATE	1.2 ORGANIZ	ATION	APPROVA	L /	\sim	DATE
P. S. Weissman	12/28/70	MIT/D		K.H.	Luca		12-30-70
1.3 EFFECTIVITY	*		Revis	sion of d	escent ma	ass lin	nits to
LUMINARY 1	E				PCR 112		
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. Change LODESCI (5604 lb) 2. Change the lower							
	SOFTWARE CON DECISION FOR	TROL BOAR	D OR FL	IGHT SOF	TWARE BRAN	CH	
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3.1 SCHERCLE IMPACT VINE	v		3.2 IMP	ACT OF PROV	IDING DETAILE	D EVALUA	TION
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LIS WIT GORDINATOR	1			- Pm	is o	n 12	pproval -28-70
12-30-70			y				
7	4.0 SOF	TWARE CON	TROL BO	ARD ACTI	0 N		
PROVIDE DETAILED CHANGE EVAL.	AILED DIS- NGE APPR	0VED 4.2 6	HARKE	· 2			
4.3 SOFTHARE CONTROL BOARD S	ISV OFF						
CATE							
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION							
5.1 MIT COORDINATOR		5 • 2 M	IT EVALUAT	.lon			
CATE				is at			
	6.0 SOFTWAR	CONTROL ED PROGR	BOARD	DECISION	ON MIT		
6 START OR CONTINUE	ULIAII	T 6 2 D	EMARKS,	UC CVALU	AIIUN		
IMPLEMENTATION	IMPLEMENTATION			•			
6.3 SOFTWARE CONTROL BOARD S	IGN OFF			•			
DATE .							

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 padloaded 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.

16100 46 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. 817 16

The following limits on the LM mass have been implemented:

16700 KG Highest descent mass = 33, 730 lb Lowest descent mass = 3858 1b + 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 4265 b, 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

MITTOL PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY #
COLOSSUS 2E LUMINARY ID	ADR #
C COLOSSUS 3 CLUMINARY 1E	SSINET
	SSUED
COLOSSUS LUMINARY // Z	2/71
MIT Approved PCN NASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
	MIT Approved
A. Coding	Software Anomaly
Begin coding immediately	GSOP ONLY
ACTION:	
Program Supervisor's Approval: _	
Do not code until new GSOP material has been Mission Design Review Board (MDRB) and d	
B. GSOP Preparation	
	J. KLAWSWIK / J. SMITH.
Prepare GSOP revisions for MDRB consideration	V. Kenson V. John J. J.
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 Pregrams Affected	
D. Other Programs Affected Review for corresponding changes in	
ACTION:	
Special Instructions	1 1011
Project Manager	isself Jans
Date	1-12-71

APOLLO SPACECRAFT	SOFTWARE ROGRAM CHA	CONFIGURA NGE REQUA	ATION C	ONTROL BOARD	NUMBER (Completed by ISB)
	1.0	COMPLETED	BY ORIGI	Properties and the second seco	
1.1 ORIGINATOR	DATE	1.2 ORGANIZA	TION	APPROVAL	DATE
P. Volante 1-12-71 MIT 114 7174 OF CHANGE					
LUMINA	RY IE	MICRIA SAN ESCRICA (SANO) AND CONTRACTOR CON	1	t constant for a	scent guidance.
	SOP correc	tion			
The required injection 4(Pl2) shou				To the second se	'
2.0	SOFTWARE CON DECISION FOR	TROL BOARD VISIBILIT	OR FLIG Y IMPACT	HT SOFTWARE BRAN ESTIMATE BY MIT	
APPROVED	CISAPPROVED	0.0 RE	VARAS;		
BRANCH SIGN OFF	A FLIGHT SOFTMAR	É		÷	
241		PROCEEDINGS - AND PROCESS - CO.		· · · · · · · · · · · · · · · · · · ·	
3.0 MIT VISIBILITY IMPACT E	VALUATION:				
3.1 (HF.: (F TVPA 1		Charles State Ch	3.2 INPACT	T OF PROVIDING DETAILE	C EVALUATION
A. C. STORAGE 19PA '		3.4 RE	MARKSI		
Line Met	23.00				
1-12-7/					
ACCUMATION OF THE PROPERTY OF	4.0 SDF	TWARE CONT	TROL BOAF	RD ACTION	
PROVIDE CETAILET CHE	ALLED DIS		MARKS	•	
4.3 SOFTMARE CONTROL BOARD S	1 1 055				
A VE		And the second s			
	5.0 MIT DET	AILED PROGR	RAM CHANG	GE EVALUATION	
5.1 MIT COORDINATOR		5.2 WI	T EVALUATIO	an commencent account in commence as a distinct of the commence of the commenc	
DATE					· · · · · · · · · · · · · · · · · · ·
THE RESIDENCE OF THE PROPERTY	6. Ú SOFTWAR DETAK	RE CONTROL LED PROGR	BOARD DE	ECISION ON MIT E EVALUATION	
START OR CONTINUE	CISAPPROVED OR S	7	ARKSI	a acusto successor un companyo de comp	
6.3 SOFTWARE CONTROL BOARD	10. 12. 14. 14. 14. 14. 14. 14. 14. 14. 14. 14	-	5		
DATE					
MSC Form 788 (Jul 68) 111		THERESIZE			

PROGRAM CHANGE REQUEST NO. 1137 PREPARED BY: P. Volante ORGANIZATION: MIT		· · · · · · · · · · · · · · · · · · ·	PAGE 2 OF	2
	11.27	1-12-71	ORGANIZATION:	MIT

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

1.6 See Anomaly L-ID-16; this was fixed in Luminary 1E. The GSOP for 1D was changed to reflect the incorrect value of the Luminary 1D assembly

REMARKS

MIT/DL PROGRAM CHANGE ROUTING SLIP	POPTRON # 11114
	PCR/PCN # //4/ ANOMALY #
COLOSSUS 2E LUMINARY 1D	ANOMALY #ADR #
COLOSSUS 3 LUMINARY 1E	ADA #
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
MIT Approved PCN NASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
A. Coding	MIT Approved Software Anomaly
Begin coding immediately	L. Bliman
ACTION: _	
Program Supervisor's Approval:	M. Hamelor
Do not code until new GSOP material has been	
Mission Design Review Board (MDRB) and di	istributed.
B. GSOP Preparation	
Prepare GSOP revisions for MDRB consideration	J. KLAWSMIK/E, OLSSON
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	
Special Instructions ACTION:	
Project Manager	14/
Date /	Hilan
Date 1	

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APOLLO SPACECRAFT	SOFTWARE O			CONTROL	BOARD	NUMBER (Completed by FSB)
	1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINAT,OR		1.2 ORGANIZAT	THE RESERVE OF THE PERSON NAMED IN	APPROVAL	e /	PATE
В. МсСоу	1/22/71	MIT/DI		144	Lars	on/1-22-71
1.3 EFFECTIVITY			1.4 TITL	E OF CHANGE		
LUMINARY 1E				alize FLF		
IMSERTION based			Enter	to V99) v	will caus	e P12 to target
	Notice that the second			NAMES OF TAXABLE PARTY OF TAXABLE PARTY.		
1.6 DESCRIPTION OF CHANGE C	lear FLRCS	in P12 b	efore t	targetting	Ţ.	
	*					,
	SOFTWARE CON DECISION FOR	VISIBILIT	Y IMPAI	IGHT SOFT	WARE BRAN TE BY MIT	IC H
2.1 APPROVED	DISAPPROVED	2.0 RE	MARKSI			
2.3 SOFTWARE CONTROL BOARD OF BRANCH SIGN OFF		:				
DATE					* *	
3.0 MIT VISIBILITY IMPACT EV	'ALUATION:					
5.50LB	B	Value of the last	3.2 115	ACT OF PROCE	DING DETAILS	ED EVALUATION
3.: SCHEDULE IMPACT	AY5"	Management of the state of the		PROVI	,,,, DETAILE	
	JORD	3.4 RI	MARKS:			
3.5 MIT CORDINATOR	Luna					
DATE 1-22-71	A CONTRACTOR OF THE PARTY OF TH		and the second second			
	4.0 SDF	TWARE CONT	ROL BO	ARD ACTIO	N	
PROVIDE DETAILED DETA	1115		EMARKS			
	LUATION					
CATÉ						
	5.0 MIT DETA				ATION	
5.1 MIT COORDINATOR		5.2 MI	T EVALUAT	TION		
DATE						
			00.5	DECLOS	0 N 11 - 2	
Residence of the second of the	6.0 SOFTWAR DETAI	LED PROGRA	AM CHAN	GE EVALUA	TION	No. of Contract Contr
	DISAPPROVED OR ST	TOP 6.2 RE	MARKSI		-	
6.3 SOFTWARE CONTROL BOARD S	IGN OFF					
DATE						

MIT/DL PROGRAM CHANGE ROUTING SLIP	PR/PCN #
	ANOMALY #
COLOSSUS 3 LUMINARY 1E	ADR #
COLOSSUS _ LUMINARY _	
SKYLARK _	
MIT Approved PCN NASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
	MIT Approved
A. Coding	Software Anomaly
Begin coding immediately	GSOF ONLY
ACTION:	10
Program Supervisor's Approval:	
	on annexed by the MIT
Do not code until new GSOP material has been Mission Design Review Board (MDRB) and d	istributed.
B. GSOP Preparation	I W Amadile
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	
Poviow for possible impact on KSC	
Review for possible impact on KSC testing and checkout ACTION:	
testing and checkout ACTION:_	
D. Other Programs Affected	
testing and checkout ACTION:_	
D. Other Programs Affected Review for corresponding changes in	
D. Other Programs Affected Review for corresponding changes in ACTION:	0
D. Other Programs Affected Review for corresponding changes in	R. Laisan KWS
D. Other Programs Affected Review for corresponding changes in ACTION: ACTION:	R. Lirean XWS 2/18/71

APOLLO SPACECRAFT	SOFTWARE ROGRAM CHA	CONFIGURA NGE REQUI	ATION C	CONTROL BOA	RD NUMBER (Completed by FSB)		
		COMPLETED		NATOR			
1.1 ORIGINAT, OR	DATE	1.2 ORGANIZA	TION	APPROVAL	DATE		
J. Klawsnik	2/16/71	MIT/DI		R. Lais	~ KWG 2/18/71		
1.3 EFFECTIVITY			1.4 TITLE	OF CHANGE			
LUMINARY 1E			Section	on 3 Revision	n 6 GSOP Changes		
1.5 REASON(E) FOR CHANGE	To improve	technical	content	of the docum	nent.		
			•				
1.6 DESCRIPTION OF CHANGE			•				
	See Ampl	lification S	Sheet				
2.0				GHT SOFTWARE ESTIMATE BY			
2.1 APPROVED	DISAPPROVED	2.2 RE	With the Party of				
2.3 SOFTWARE CONTROL BOARD O		E					
BRANCH SIGN OFF		,					
DATE			e é		•		
3.0 MIT VISIBILITY IMPACT E	VALUATION:						
3.: SCHEDULE IMPACT	-		3.2 IMPAC	T OF PROVIDING DE	TAILED EVALUATION		
1.3 STORAGE IMPACT		3.4 RE	MARKS:		·		
3.5 MIT COORDINATOR Lars	on Kwg						
2/18/7	7/		12 ×				
1	4.0 SOF	TWARE CONT	ROL BOAF	RD ACTION			
PROVIDE DETAILED DET	VIDE ALLED DIS- NGE APPE	4.2 RE	MARKS				
4.3 SOFTHARE CONTROL BOARD S	IN OFF						
DATE	•						
	5.0 MIT DETAILED PROGRAM CHANGE EVALUATION						
5.1 MIT COORDINATOR		5.2 MI	EVALUATIO	N			
DATE	A						
			*				
	6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION						
	DISAPPROVED OR ST	TOP 6.2 RE	MARKS				
6.3 SOFTWARE CONTROL BOARD S	IGN OFF						
DATE	•		0.2	=			

PAGE	2	OF	2	
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PROGRAM CHANGE 1143	PREPARED BY: J. Klawsnik DATE: 2/16/71	ORGANIZATION: MIT/DL
CONTINUATION SECTION (REFER TO E ON PROGRAM	BLOCK NUMBER AND TITLE I CHANGE REQUEST FORM)	
In addition to changes of an	editorial or format nature, perforn	n 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.

MIT/DL PROGRAM CHANGE ROUTING SLIP	DER/PCN #
	ANOMALY #
COLOSSUS 3 V LUMINARY 1E	ADR #
COLOSSUS _ LUMINARY _	RE ISSUED - 4/8/71
	(NOTE CHANGE TO LAST LINE) ON PAGE Z of THE PCN)
MIT Approved ADR NASA Appr	roved PCR roved PCN MIT Approved Software Anomaly Software Anomaly
A. Coding Begin coding immediately	GSOP only
Begin coding immediately	
	ACTION:
· Program Supervisor	r's Approval:
Do not code until new GSOP mat Mission Design Review Board (I	terial has been approved by the MIT MDRB) and distributed.
B. GSOP Preparation	
Prepare GSOP revisions for MI consideration	ORB J. Klewrik / E. Oleson ACTION:
Technical Committee Meeting n	not required.
Technical Committee Meeting(s	held on
C. KSC Testing and Checkout Review for possible impact on I	KSC , , , , , , , , , , , , , , , , , , ,
testing and checkout	ACTION:
D. Other Programs Affected	
Review for corresponding changes	in
	ACTION:
Special Instructions	
Project	ct Manager
	Date HARA

APOLLO SPACECRAFT SOFTWARE CO PROGRAM CHANG		ONTROL BOARD	NUMBER (Completed by FSB)
	MPLETED BY ORIGI	The second secon	
1.1 ORIGINATOR DATE 1.	2 ORGANIZATION	APPROVAL	DATE
11. Dar Son/11. G2 5 5 7 7	MIT/DL		-) 24-6-71
LUMINARY 1E	Implem DSKY I	Descent/Ascent	R 334 Rev 1 "Change Nouns"
but not as initially specified. This	CR 334 Rev 1 wa PCN is to clar	as accomplished ify the impleme	d in Luminary 1E, entation by MIT/DL.
See Attached She	eet		
2.0 SOFTWARE CONTR DECISION FOR V	OL BOARD OR FLIG ISIBILITY IMPACT	HT SOFTWARE BRAN ESTIMATE BY MIT	СН
2.1 APPROVED DISAPPROVED	2.2 REMARKS:		
2.3 SOFTMARE CONTROL BOARD OR FLIGHT SOFTMARE BRANCH SIGN OFF		· .	
CAT:			
3.0 MIT VISIBILITY IMPACT EVALUATION:			
3.1 SCHELLE INPACT	3.2 INPACT	OF PROVIDING DETAILE	D EVALUATION
1.3 STORAGE IMPACT	3.4 REMARKS:		
2.5 VIT LYORDINATOR		· · · · · · · · · · · · · · · · · · ·	
(AT)			
· 4.0 SOFTW	ARE CONTROL BOAR	D ACTION	•,,
PROVIDE DETAILED DISTANCE CHANGE EVAL. OROVILE DISTANCE CHANGE EVALLATION	4.2 REMARKS		
4.3 SOFTHARE CONTROL BOARD SILV OFF			*
CATE			
5.0 MIT DETAIL	ED PROGRAM CHANG	E EVALUATION	
5.1 MIT COORDINATOR	5.2 MIT EVALUATIO	N	w
CATE			
6.0 SOFTWARE DETAILE	CONTROL BOARD DE D PROGRAM CHANGE	CISION ON MIT EVALUATION	
START OR CONTINUE DISAPPROVED OR STOP	6.2 REMARKSI		
6.3 SOFTWARE CONTROL BOARD SIGN OFF			

		PAGE Z OF C
program change request no	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: VGX (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 #
COLOSSUS 3 CLUMINARY 1 E	ADR #
COLOSSUS LUMINARY	
SKYLARK	3
MIT Approved PCN NASA Approved	
MIT Approved ADR NASA Approved	process of the same of the sam
	MIT Approved
A. Coding	Software Anomaly
Begin coding immediately	GSOP ONLY
AC	CTION:
Program Supervisor's Ap	oproval:
Do not code until new GSOP material	
Mission Design Review Board (MDR)	B) and distributed.
B. GSOP Preparation	•
Prepare GSOP revisions for MDRB	J. KLAWSNIK
consideration	CTION:
AC	,110N
Technical Committee Meeting not re	quired.
Technical Committee Meeting(s) held	d on
Attendees:	
C. KSC Testing and Checkout	
Review for possible impact on KSC	
	CTION:
D. Other Programs Affected	*
Review for corresponding changes in	
	CTION:
Special Instructions	TION:
Project Ma	nager Ly molly Janear
	Date 4-20->/

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST							
	1.0	COMPLETED	BY ORIGI	NATOR			
1.1 ORIGINATOR	DATE	1.2 ORGANIZA	TION	APPROVAL	D	ATE	
P. Volante	4/14/71	MIT		ZHL		4-20	
1.3 EFFECTIVITY				OF CHANGE Add FR		flag	
LUM 1E				ion to section 2			
to eliminate shar:	to eliminate sharing of a flag by P20/P22 N54 computations and R26.						
1.6 DESCRIPTION OF CHANGE A	dd flag desc	ription to	Section	2 GSOP (See pa	age 2 fo	r description	
		107. F.				2 ·	
2.0	SOFTWARE CON DECISION FOR	VISIBILIT	Y IMPACT	HT SOFTWARE BRAN ESTIMATE BY MIT	CH		
2.1 APPROVED	DISAPPROVED	2.2 REN	/ARKS;			× .	
2.3 SOFTWARE CONTROL BOARD O	R FLIGHT SOFTWARE					a e	
CATE	•			,			
3.0 MIT VISIBILITY IMPACT EV	/ALUATION:						
C3.1 SCHEALEE IMPACT			3.2 IMPACT	OF PROVIDING DETAILE	D EVALUATI	ON	
4.3 STORAGE IMPACT		3.4 REN	IARKS:		19	* - " - " -	
3.5 VIT 2080 IVAT 30							
H-20-71		9			2 2 0	* 12	
	4.0 SOF	TWARE CONT	ROL BOAR	D ACTION			
	VIDE ALLED DIS-	4.2 RE	MARKS				
EVAL 4.3 SOFTWARE CONTROL BOARD SI	LUATION					**** ***	
CATE			·	, , , , , , , , , , , , , , , , , , ,		, † , 4.	
	5.0 MIT DETA	ILED PROGR	AM CHANG	E EVALUATION			
5.1 MIT COORDINATOR		5.2 MIT	EVALUATION			5 - 1	
DATE				* * .			
	6.0 SOFTWARE CONTROL BOARD DECISION ON MIT						
6 A START OR CONTINUE	DETAI	LED PROGRA	A CHANGE	EVALUATION			
START OR CONTINUE	MPLEMENTATION	0.5					
6.3 SOFTWARE CONTROL BOARD SI	GN OFF					, =	
DATE						e.	

DATE:

PAG	E	2	OF	2

PROGRAM CHANGE REQUEST NO. 1148

PREPARED BY:

P. Volante

ORGANIZATION:

MIT/CSDL

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.

ANOMALY

L-1D-01 - SS 02 -55 03 - Re-release 04 - PCR 287 05 - PCR 287 06 - 55 07 - 55 08 - PCR 1028 -09 10 - 55 11 - PCR 986.2 WB HT. ISECALIN 12 - ACB L-15 13 - PCR - 1028 14 - 55 13 - 55 16 - 40 17 18 - 55 19 20 - 55

MIT/	IL SOFTWARE A	NOMALY	REPORT	MEC REPORT NO. ILD-Ol
ORIGINATOR:	1.2 ORGANIZATION:	1. 3 · DATE:	I.4 ORIGINATOR	PROGRAM LUMINARY 1D
Garman, J. R.	FSD/FS5	5/12/70	CONTROL NO.	PROGRAM REVISION 163
counters (CH 12 B 06	tion never takes plac) are enabled. This ias (constant except EEDLES.	causes cells	EDRIVE to be	f IMU error e improperly
1.6 DESCRIPTION OF RUN:			energy and the second	
Apollo 13: Crew turnincluded a coarse all properly initialize	ned on LGC with DAP C ign. This left CH 12 when DAP was subseque	2 B 06 set so	that "NEEDLE	on 1 which ER" did not CONTINUED ON PAGE
	Δ ΤΙΜ	NALYSIS -		
2.1 CAUSE:	IVIII P			
Proper initialization	n of the FDAI needle LGC is on, PGNCS mode select s			continued on page 2
2.2 RECOGNITION:	needles; needles not			ached
by the DAP.	needies, needies not	, nuited at th	ic attitude re	CONTINUED ON PAGE
`3 MISSION EFFECT:				
Crew has an incorre	ect indication of the	attitude erro	or.	
CICW Hab all Higgir	you marawatan as may	0 0	11 1 1 1 1 1 1 1 1 1	CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: 1. Do not coarse ali 2. After LGC power not "Off". 2.5 RECOVERY PROCEDURE:	gn with the PGNCS n up (or a verb 43) do	node select s coarse alig	switch "Off'. gn or CDU ze	ro with PGNCS CONTINUED ON PAGE
to "Off",	N20) with the PGNC	S attitude mo	ode select sw	vitch not turned CONTINUED ON PAGE
switch is found "Off	to call for NEEDLE	R in tializat present logic	ion whenever	the mode select
2.7 RECOMMENDED DISPOSITION (Fix,				
Ensure that Apollo Fix in LUMINARY	l4 checklists follow' lE.	'avoidance p	rocedure".	CONTINUED ON PAGE
2.8 RECOMMENDED RE-TESTING. Limited testing on h	nybrid to show that v	ariousseque [2.9 MH/H/ SIGNATU	ences all give	e valid needles.
	CONTINUED ON PAGE	上、长、光、	Lanne	7-8-70
3.1 NASA DIRECTION:	The second secon	4.1 CLOSING ACTIO	ON TAKEN:	
			· ·	
	CONTINUED ON PAGE			CONTINUED ON PAGE
3.2 NASA/MSC SIGNATURE: 3.3	ORGANIZATION 3.4 DATE:	4.2 SIGNATURE:	4.3 00	RGANIZATION: 4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT M7 REPORT L-1D-01

L-1D-01

L-1D-01

Report No. 1.3 Date: 1.4 ORIGINATOR CONTROL NO. LUMINARY 1D PROGRAM REVISION 163

2.1 continued

3. Either I MODES 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/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY # L-IP - 2
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	•
COLOSSUS 3A LUMINARY 1F	. *
the state of the s	RE-1956E
COLOSSUS LUMINARY	• 3
	A DOD
MIT Approved PCN NASA Approve	Software Anomaly
MIT Approved ADR NASA Approve	ed PCN MIT Approved
. A. Caling	Software Anomaly
A. Coding	M O. P. T
Begin coding immediately	Myle Daniel
A	ACTION:
Description of the second second	Approval: Margart A. Hamild
Program Supervisor's A	1 1
Do not code until new GSOP materi Mission Design Review Board (MD)	al has been approved by the MII RB) and distributed.
Wission Design Review Board (MD)	in the second se
B. GSOP Preparation	
Prepare GSOP revisions for MDRI	3
consideration	•
F	ACTION:
Technical Committee Meeting not	required.
Technical Committee Meeting(s) he Attendees:	eld on
Attendees.	
C. KSC Testing and Checkout	
Review for possible impact on KSC testing and checkout	ACTION:
testing and checkout	
D. Other Programs Affected	
Review for corresponding changes in	
	**
	ACTION:
Special Instructions Project N	Maina ger
The animaly were initially	Date 10-6-70
the fact while many	Date 10 C
to fix in 15. It is being	•
in he could to chen the	**************************************
1 The state of the	

IVI	TITL SUFTWAKE	MINOMINE	KEFOKI	ME 113-02
MIGINATOR:	. 1.2 ORGANIZATION:	1.3 DATE:	1.4 ORIGINATOR	PEGMINARY
N. Barnert/P. Rye	MIT/CSDL	5/19/70	CONTROL NO.	PROGRAM REVISION
5 DESCRIPTION OF ANOMALY:				L
It is possible that a	core set overflow (31)	202 Abort) will	result from	a ''bad''
return from pulse t	orquing due to IMU ca	ge or coarse a	ngn. ,	
•		•	•	
		•	•	
		•		CONTINUED ON PAGE
6 DESCRIPTION OF RUN: Satanche Lével 3 te	st			
			, P#	* *
				CONTINUED ON PAGE
•	- MIT A	NALYSIS -		
1 CAUSE:				
	ed if pulse torquing end quing will stack up via		or coarse ali	The same of the sa
1	quing will stack up via	JODSLEEF.		CONTINUED ON PAGE
2 RECOGNITION:				**
31202 Abort				F
				CONTINUED ON PAGE
3 MISSION EFFECT: Software restart ca	used by 31202 abort cl	eans up the pr	oblem, but fu	rther calls
(by gyro compensati	ion during average G)	will refill the	core sets, ca	using repeated
		the state of the s	-	CONTINUED ON PAGE
4_ AVOIDANCE PROCEDURE:				res
	during Average G; or ever cage is pushed.	else set GCON	IPSW negativ	CONTINUED ON PAGE
5 RECOVERY PROCEDURE:			>	
Set GCOMPSW nega	ative (terminates comp	ensation):		
				CONTINUED ON PAGE
6 PROGRAM CORRECTION -				
Clear LGYRO and	wake possible sleeping	jobs before ex	citing pulse to	orquing routine.
				CONTINUED ON PAGE
.7 RECOMMENDED DISPOSITION (Fix, Work-around, etcl:			£ .
Fix for Luminary	E	•		·
	• • •			CONTINUED ON PAGE
8 RECOMMENDED RE-TESTING:			ñ	x
Level 2 test.		ILITAKIAI P.SI	RE:	2.10 DATE:
, • ·	CONTINUED ON PAGE	14.7	Luran	17-8-
1 NASA DIRECTION:	1	4.1 CLOSING ACTIO	N TAKEN:	
			Promise Promis	
				•
	•	· ·		
	CONTINUED ON PAGE			CONTINUED ON PAGE
.2 NASAMSC SIGNATURE:	3.3 ORGANIZATION 3.4 DATE:	4.2 SIGNATURE:	4.3 OF	GANIZATION: 4.4 DATE:
	L			

PAGE 1 OF.

MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY # 1-10-04
COLOSSUS 2E LUMINARY 1D	$\mathrm{ADR}~\#_{_{entropy all and a finite and$
COLOSSUS 3 VLUMINARY 1E	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY	
and the state of t	
MIT Approved PCN MIT Approved ADR NASA Approved PCR NASA Approved PCN A. Coding	NASA Approved Software Anomaly MIT Approved Software Anomaly
A. Coding Begin coding immediately	Pat white
ACTION:	
Program Supervisor's Approval:	Margant damela
O Do not code until new GSOP material has be	en approved by the MIT
Mission Design Review Board (MDRB) and d	istributed.
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	
D. Other Programs Affected Review for corresponding changes in .	
Treview in contraporating changes in	
ACTION:	the commence of
Special Instructions	D41/
Project Manager	7-8-70
	<u> </u>

	TITTL SUFTWARE	ANUMALI KEPU	MSC REPORT NO.
ORIGINATOR:	1.2 ORGANIZATION	1.3 DATT: 1.4 ORIGINA 6/26/70 CONTROL	IOR PROGRAMATINE A TO SZ
P. Volante 1.5 DESCRIPTION OF ANOMALY:	MIT/DL	6/26/70 CONTROL	PROGRAM REVISION
1.5 DESCRIPTION OF ANOMALY:			The Company of the Co
P25 will not contr	ol spacecraft attitude if	range to CSM is grea	ter than 566 N. M.
. 1			CONTINUED ON PAGE
1.6 DESCRIPTION OF RUN:			
N/A			
21,722			
			CONTINUED ON DACE
	MAT. AN		CONTINUED ON PACE
2.1 CAUSE:	AA TIM-	VALYSIS -	
	20/P22 logic is also bein	g applied to P25	
Coaing error - Pa	20/P22 logic is also bein	g appried to 1 20.	CONTINUED ON PAGE
2.2 RECOGNITION:			
	P25, no attitude changes	s occur; possible alar	rm light (code
526)			CONTINUED ON PAGE
2.3 MISSION EFFECT:			
and admitted continues of the superior description of the			
A MARIANA DE CASANZA		•	CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: R63 can be used t	to position Z-axis along l	ine-of-sight	
			CONTINUED ON PAGE
2.5 RECOVERY PROCEDURE:			CONTINUED OF FACE
None			
•			CONTINUED ON PAGE
2.6 PROGRAM CORRECTION:	LG check to LPS20.1 sul	proutine.	
Restore RND V ZII	Ind check to hi bao. 1 ba.		
			CONTINUED ON PAGE
Fix for 1E; work-			
FIX IOI IE, WOIK	around for 15		CONTINUED ON PAGE
2.8 RECOMMENDED RE-TESTING:			Continues of those
P25 with range >	400 N.M.	20 MITHIS CLONATURE &	0.10.017
	CONTINUED ON PAGE	2.9 MIT/ID SIGNATURE:	2.10 DATE: 7-6-70
3.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:	
	CONTINUED ON PAGE		CONTINUED ON PAGE
3.2 NAS MMSC SIGNATURE:	3.3 ORGANIZATION 3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION: 14.4 DATE:

	MIT/IL	2011000000				
MANAGEMENT OF THE PROPERTY OF		2 ORGANIZATION	1.3 DATE 6/22/7		4 ORIGINATOR CONTROL NO.	PROGRAM LUMINARY PROGRAM REVISION
originator: . Volante		MIT/DL	0/22/			PROGRAM REVISION 173
a per operation when the commence of the	MALY:					0 on D22 is
	tonded ve	rb routines sh he CSM is gre	ould not be	requ	ested if PZ	U Or P22 15
he following	extended ve	rb routines sh he CSM is gre 7-test	ater than 40	0 N.	W.	n.
04 (V63)	THI DIL BOTH		V 67 W V 85 M	-ma Iode	trix monito	tion display
05 (V64)	a hand ante	nna	V 00 143	1000	1	
(V82)	Apogee/Per	rigee display ge rate display	7			CONTINUED ON PAGE
(V83) (V47)	AGS initial	ization		-	and the state of t	
DESCRIPTION OF RUI	N:					
-T / Λ						
N/A						CONTINUED ON PAGE
	# # # # # # # # # # # # # # # # # # #					CONTINUED ON TACE
		- N	MIT ANALYSIS -			
1 CAUSE:						
Erasable co	nflict					CONTINUED ON PAGE
Erasable co.	(ILLIO)					Dan/Dag incorrect.
.2 RECOGNITION:	totions	by these routin	nes also nou	n 54	display ın	P20/P22 incorrect.
Incorrect co	mputations	~ J				CONTINUED ON PAGE
2.3 MISSION EFFECT:	date if V47	requested.				CONTINUED ON PAGE
2.3 MISSION EFFECT: Bad AGS up	date if V47	requested.				CONTINUED ON PAGE
Bad AGS up		and the second state of the second se		-		
Bad AGS up		and the second state of the second se	P20/P22 w	ith r	ange > 400	
Bad AGS up 2.4 AVOIDANCE PROC Do not sele	ct extended	requested. verbs while in	P20/P22 w	ith r	ange > 400	
Bad AGS up 2.4 AVOIDANCE PROC Do not sele	ct extended	verbs while in	P20/P22 w	ith r	ange > 400	N.M. CONTINUED ON PAGE
Bad AGS up 2.4 AVOIDANCE PROC Do not sele	ct extended	verbs while in	. P20/P22 w	ith r	ange > 400	
Bad AGS up 2.4 AVOIDANCE PROC Do not sele 2.5 RECOVERY PROCE Terminate	ct extended EDURE: 'extended ve	verbs while in		ith r	ange > 400	N.M. CONTINUED ON PAGE
Bad AGS up 2.4 AVOIDANCE PROC Do not sele 2.5 RECOVERY PROCE Terminate	ct extended EDURE: 'extended ve	verbs while in		ith r	ange > 400	N. M. CONTINUED ON PAGE
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Bad AGS up 2.4 AVOIDANCE PROCE Do not sele 2.5 RECOVERY PROCE Terminate 2.6 PROGRAM CORR Change er: 2.7 RECOMMENDED Work-arou 2.8 RECOMMENDED Select abo	ct extended EDURE: 'extended ve ECTION: asable assig DISPOSITION (Fix, V and for 1D f: RE-TESTING: EXECUTE EXTENDED OVE extended	verbs while in the continued continu	while N54 ic	s bei 7/11 \$16	ng displaye NATURE: ACTION TAKEN:	CONTINUED ON PAGE

AVOIDANCE PROCEDURE: None RECOVERY PROCEDURE: None PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING: Trace DAS instruction after Restart CONTINUED ON PAGE 2.9 MIT/IL/SIGNATURE: 2.10 DATE A1 CLOSING ACTION TAKEN:	ORIGINATOR:	1.2 ORGANIZATION		1.4 ORIGINATOR	L-1D-06
"DVTOTAL", the accumulated measured Delta Velocity from SERVICER, incremented twice in one SERVICER cycle after Restart occurred. **CONTINUES ON PAGE** **PMES P40 simulation at GAC** **CONTINUES ON PAGE** **DAS instruction to DVTOTAL performed twice - no Phase change immediately following, communes on PAGE** **PROCESSION THEORY** **None - downlist quantity may show extra △ V (≈10 fps) if Restart occurred during Powered Plight communes on PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred during Powered Plight **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred during Powered Plight **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist quantity may show extra △ V (≈10 fps) if Restart occurred formulation PAGE** **NONE - downlist position PAGE** **N		MIT/DL	6/29/70	CONTROL NO.	PROGRAM REVISION
INCOMPRESS PAGE ESCRIPTION OF RUN: FMES PAG simulation at GAC CONTINUED ON PAGE CAUSE: DAS instruction to DVTOTAL performed twice - no Phase change immediately following: CONTINUED ON PAGE RECOGNITION: NOTE - AND At end of burn ≠R2 of N40 at start of burn CONTINUED ON PAGE NOTE - AND AT ANALYSIS - CONTINUED ON PAGE CONTINUED ON PAGE AND AND AT ANALYSIS - CONTINUED ON PAGE NOTE - CONTINUED ON PAGE AND AND ANALYSIS - CONTINUED ON PAGE NOTE - CONTINUED ON PAGE RECOGNITION DESCRIPTION CONTINUED ON PAGE CO					Addression to the control of the con
EXECUTION OF RUBE PMES P40 simulation at GAC CONTINUED ON PAGE AND ANALYSIS- CAUSE: DAS instruction to DVTOTAL performed twice - no Phase change immediately following. CONTINUED ON PAGE RECORDINGS: ROOR AND At end of burn #R2 of N40 at start of burn CONTINUED ON PAGE MISSION STECE: None - downlist quantity may show extra \(\triangle \) V (\(\approx 10 \) fps) if Restart occurred during Powered Flight CONTINUED ON PAGE RECOVERY PROCEDURE: None - continue on PAGE PROGRAM CORRECTIONS Add TC QUITK FAZ5 after DAS instruction RECOMMENDED DISPOSITION (FIX, NOW-PROUG, etc). None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TISTING. Trace DAS instruction after Restart CONTINUED ON PAGE CONTINUED ON PAGE 41 CLOSING ACTION LINEAR. CONTINUED ON PAGE	"DVTOTAL", t	he accumulated me vice in one SERVIC	asured Delta V ER cycle after	Velocity from Restart occ	SERVICER, urred.
EXECUTION OF RUIT FMES P40 simulation at GAC CAUSE: DAS instruction to DVTOTAL performed twice - no Phase change immediately following. RECORDINGER: RECORDINGER: MISSION RECT: None - downlist quantity may show extra \(\triangle \) V (\(\triangle \) 10 fps) if Restart occurred during Powered Flight ANOIDANCE PROCEDURE: None - continued on PAGE RECOVERY PROCEDURE: None - continued on PAGE RECOVERY PROCEDURE: None - continued on PAGE RECOVERY PROCEDURE: None - continued on PAGE RECOMMENDED DISPOSITION IFE, Wart-ground, etch None - continued on PAGE RECOMMENDED RETESTING Trace DAS instruction after Restart CONTINUED ON PAGE RECOMMENDED RETESTING Trace DAS instruction after Restart CONTINUED ON PAGE					
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CANSE. DAS instruction to DVTOTAL performed twice - no Phase change immediately following. RECOGNITION: R3 of N40 at end of burn ≠R2 of N40 at start of burn CONTINUED ON PAGE MISSION EFFECT: None - downlist quantity may show extra △ V (≈10 fps) if Restart occurred during Powered Flight CONTINUED ON PAGE AVOIDANCE PROCEDURE: None - CONTINUED ON PAGE RECOVERY PROCEDURE: None - CONTINUED ON PAGE RECOVERY PROCEDURE: None - CONTINUED ON PAGE Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION IFE; Work-sround, etch: None for 1D; fix for 1E CONTINUED ON PAGE Trace DAS instruction after Restart CONTINUED ON PAGE CONTINUED ON PAGE A1 CLOSING ACTION TAXEN: CONTINUED ON PAGE	FMES P40 sim	ulation at GAC			
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DAS instruction to DVTOTAL performed twice - no Phase change immediately following. RECOGNITION:	CAUSE:	- IV\11	1 AIVALISIS -		
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MISSION EFFECT: None - downlist quantity may show extra △ V (≈10 fps) if Restart occurred during Powered Flight AVOIDANCE PROCEDURE: None - CONTINUED ON PAGE RECOVERY PROCEDURE: None, - CONTINUED ON PAGE PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-RESTING: Trace DAS instruction after Restart CONTINUED ON PAGE	RECOGNITION: R3 of N40 at e	nd of burn≠R2 of N	N40 at start of	burn	
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None - downlist quantity may show extra △ V (≈10 fps) if Restart occurred during Powered Flight CONTINUED ON PAGE AVOIDANCE PROCEDURE: None RECOVERY PROCEDURE: None, PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION (Fix, Work-bround, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING Trace DAS instruction after Restart CONTINUED ON PAGE CONTINUED ON PAGE 4.1 CLOSING ACTION TAXEN: CONTINUED ON PAGE	MICCION EESTOT.				CONTINUED ON PAGE
ANOIDANCE PROCEDURE: None RECOVERY PROCEDURE: None PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION (Fig., Work-ground, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING Trace DAS instruction after Restart CONTINUED ON PAGE A1 CLOSING ACTION TAXEN: CONTINUED ON PAGE	None - downlis	st quantity may sho	ow extra △ V (۶	≈10 fps) if Re	estart occurred
None RECOVERY PROCEDURE: None PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E RECOMMENDED RE-TESTING Trace DAS instruction after Restart CONTINUED ON PAGE 2.9 MITTIL SIGNATURE: 2.9 MITTIL SIGNATURE: 2.10 DATE CONTINUED ON PAGE	during Powere	d Flight			CONTINUED ON PAGE
RECOVERY PROCEDURE: None PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING: Trace DAS instruction after Restart CONTINUED ON PAGE 2.9 MITTIL/SIGNATURE: CONTINUED ON PAGE A1 CLOSING ACTION TAKEN: CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE	AVOIDANCE PROCEDURE:				
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None PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING: Trace DAS instruction after Restart CONTINUED ON PAGE	DEADLESS PRODE SUPE				CONTINUED ON PAGE
PROGRAM CORRECTION: Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING: Trace DAS instruction after Restart CONTINUED ON PAGE 2.9 MITTLE SIGNATURE: CONTINUED ON PAGE A1 CLOSING ACTION TAKEN: CONTINUED ON PAGE	RECOVERY PROCEDURE:				
Add TC QUIKFAZ5 after DAS instruction CONTINUED ON PAGE RECOMMENDED DISPOSITION (Fix, Work-around, etc.): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING: Trace DAS instruction after Restart CONTINUED ON PAGE	None,		, , , , , , , , , , , , , , , , , , ,		CONTINUED ON PAGE
RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING: Trace DAS instruction after Restart CONTINUED ON PAGE 2.9 MIT/ILSIGNATURE: CONTINUED ON PAGE NASA DIRECTION: CONTINUED ON PAGE	PROGRAM CORRECTION:	· · · · · · · · · ·			
RECOMMENDED DISPOSITION (Fix, Work-around, etc): None for 1D; fix for 1E CONTINUED ON PAGE RECOMMENDED RE-TESTING: Trace DAS instruction after Restart CONTINUED ON PAGE	Add TC QUIKI	FAZ5 after DAS ins	struction	region de Magnitus de la companya d	
None for 1D; fix for 1E RECOMMENDED RE-TESTING: Trace DAS instruction after Restart CONTINUED ON PAGE					CONTINUED ON PAGE
CONTINUED ON PAGE					
Trace DAS instruction after Restart CONTINUED ON PAGE	None for 1D, 11	A TOT TE			CONTINUED ON PAGE
CONTINUED ON PAGE	RECOMMENDED RE-TESTING	Chan Dand	l o no k		
NASA DIRECTION: 4.1 CLOSING ACTION TAKEN: CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE	Trace DAS ins	struction after Rest		YTURE:	2.10 DATE:
CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE	The control of the co	CONTINUED ON PAG	The second secon	Lasse	Z
IA 2. ODCANIZACION. JA A DATE	NASA DIRECTION:		&1 CLOSING AC	TION TAKEN:	
IA2 ODCANIZACION. 14 A DATE					
LAZ ODCANIZACION. 14 A DATE	**************************************				*, , , , , , , , , , , , , , , , , , ,
LAZ ODCANIZACION. 14 A DATE					
LAZ ODCANIZACION. 14 A DATE	,				
LAZ ODCANIZACION. 14 A DATE					
NASAMSC SIGNATURE: 3.3 ORGANIZATION 13.4 DATE: 4.3 ORGANIZATION: 4.3 ORGANIZATION	The second secon		A STATE OF THE PARTY OF THE PAR	Company of the compan	CONTINUED ON PAGE
	2 NAS WMSC SIGNATURE: 3	.3 ORGANIZATION B.4 DATE:	Q Z SIGNATURE:	6, 3	ONOMITE PART DAIL:

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IIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY # 1-10-07
COLOSSUS 2E LUMINARY 1D	$\mathrm{ADR}~\#_{matrix as an activative transfer to the control of t$
COLOSSUS 3 VLUMINARY 1E	
COLOSSUS 3A CLUMINARY IF	
COLOSSUS	
Agranul Person	
MIT Approved PCN NASA Approved PCR NASA Approved PCN	NASA Approved Software Anomaly LIMIT Approved
A. Coding	Software Anomaly
Begin coding immediately	Clores to Con
ACTION:	And the second s
Program Supervisor's Approval:	Margart Hamlon
Do not code until new GSOP material has b Mission Design Review Board (MDRB) and	peen approved by the MIT 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. Oller Bus manag Affordad	
D. Other Programs Affected Review for corresponding changes in .	
Meview of corresponding changes in	
ACTION	
Special Instructions	DHT
Project Manager Date	7-8-71
Date	Commence of the second

MIT	/IL SOFTWARE	ANOMALY REPO	
1.1 ORIGINATOR:	1.2 ORGANIZATION:	1.3 DATE: 1.4 ORIGIN	
G. R. Kalan	MIT/Draper	Lab 6/18/70 CONTRO	PROGRAM REVISION
1.5 DESCRIPTION OF ANOMALY: If the mode co	ntrol switch is move	ed from the ÁTT. HC	11
the AUTO position be	fore the manual rat	e command mode has	s been properly
terminated and while	X-axis override is	inhibited:	
1) A short RC	S jet firing (. 15 sec	. maximum) may occ ater returned to the	eur about the yaw axis ATT. HOLD position
	-axis override inhib		real forms position
			9
1.6 DESCRIPTION OF RUN:			CONTINUED ON PAGE 2
	nation of coding		
	- MIT	ANALYSIS -	
		nd mode is improper control switch positi	
			CONTINUED ON PAGE 2
2.2 RECOGNITION:	you BCS fining of gu	vitch to ATT HOLD	or automatic removal
	s override inhibition		CONTINUED ON PAGE 2
2.3 MISSION EFFECT: Possible un or automat	expected RCS firing ic removal of X-axi	g or yaw maneuver at s override inhibition	switch to ATT. HOLD
2.4 AVOIDANCE PROCEDURE: Wait at leas after return	st 5 sec before switching ACA to detent f	ching mode control s Collowing manual rate	witch to AUTO position command maneuvers.
2.5 RECOVERY PROCEDURE:			nie wie groei and and and and an and an analysis of the second se
	very procedure nec CA rapidly out of de	essary etent and back in yaw	axis (a natural
		ode control switch is	in AUTO position while
X-axis ove	rride is inhibited.		
a a cooperation of Document	Work around shall		continued on page2
2.7 RECOMMENDED DISPOSITION (Fix Work arou)			
Fix in Lui	ninary 1E		
2.8 RECOMMENDED RE-TESTING:	0 11 1 1 - 0	loop proporty fixed	in Luminour IF
Veri before release.	ty that anomaly has	been properly fixed	
Deloie release.	CONTINUED ON PAGE	2.9 MITTLE SIGNATURE:	2.10 DATE: 7-7-70
3.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:	and the second s
On the second se			
	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:

MII/IL SUFTWARE ANUMALY KEPURI

GINATOR:

G. R. Kalan

1.2 ORGANIZATION:

MIT/Draper Lab

1.3 DATE:

6/18/70

1.4 ORIGINATOR
CONTROL NO.

PROGRAM LUMIN ARY
PROGRAM REVISION
17.3

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 ÅTT. 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:	1.2 ORGANIZATION:	1.3 DATE: 1.4 ORIG	INATOR PROGRAM
<u></u>	B. McCoy	MIT/DL	6/24/70 CONTI	ROL NO. Luminary 1D PROGRAM REVISION
1.5	DESCRIPTION OF ANOMALY:			173
	Padload "LRWH	l" shares erasable men	nory location with I	RM of P20.
-				
				CONTINUED ON PAGE
1.6	DESCRIPTION OF RUN:			OOM MICE ON VINCE
	*			
	Eyeball			
				CONTINUED ON PACE
		MIT AN	ΛΙΥSIS -	CONTINUED ON FACE
2, 1	CAUSE:			
(d)	1.5.1			
	see 1. 5 above			CONTINUED ON PAGE
2.2	RECOGNITION:			
	eyeball			CONTINUED ON PAGE
2.3	MISSION EFFECT:	ed before PDI to track C	'SM the LR weight	ing function in
		y affect navigation.	oly, the Dit weight	
2.4	AVOIDANCE PROCEDURE:	y affect havigation.		CONTINUED ON PAGE
	Lood I DWIII was	or to PDI: V21NOIE3756	DVVVVT	
		or to FDI; VZINOIE3130	LAAAAAL	CONTINUED ON PAGE
2.5	RECOVERY PROCEDURE:			
	Load LRWH1: V	21NOIE3756EXXXXXE		CONTINUED ON PAGE
2.6	PROGRAM CORRECTION:			Acceptance of the second of th
	Move LRWHl to	unshared memory.		
-	7 RECOMMENDED DISPOSITION			CONTINUED ON PAGE
2.				
	Program note for	or lD; fix for lE.		CONTINUED ON PAGE
2. 8	RECOMMENDED RE-TESTING:	g sequence and show no	change in LRWHl	
	piniatate fanding		2.9 MITH SIGNATURE:	2.10 DATE:
	NASA DIRECTION:	CONTINUED ON PAGE	4.1 CLOSING ACTION TAKEN:	17-6-70
5.1	MASA DIRECTION:		a 1 CLOSTING ACTION TAXLIC.	
1			•	
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		CONTINUED ON PAGE		CONTINUED ON PAGE
3, 2	NASWMSC SIGNATURE:	3.3 ORGANIZATION 3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION: 4.4 DATE:
1				

M	IT/IL SOFTWARE	ANOMALY REP	L-10-10
ORIGINATOR:	1.2 ORGANIZATION	1.3 DATE: 1.4 ORIG	INATOR PROGRAM ROLNO. Luminary
P.S. Weissman	MIT/DL	8/24/70 CUNT	PROGRAM REVISION
DESCRIPTION OF ANOMALY:	l of wind	lowe during which a (through 175
A. Ther	e are a number of wind mode would wipe out a	waiting 1/ACCS job.	leaving the DAP with
improper		ı major mode'' means	s a V37, V96, V56 or a
V34 resp	onse to various display	$_{ m PS}$ in P20, P22 and P	25. Each of these wipes
1110	ad : mouting which c	omputes the control	ss and configuration,
•	the trim gimbals on the	a pasis of ventere ma	ss and configuration
DESCRIPTION OF RUN:			
Inspectic	on of coding.		
Inspectio	,,, or coarre		
			CONTINUED ON PACE
			CONTINUED ON PACE
A district annual part of the second	- MIT	T ANALYSIS -	
CAUSE:			
See Desc	cription of Anomaly.		
	* 8		CONTINUED ON PAGE
2 RECOGNITION:		, , , , , , , , , , , , , , , , , , , ,	
See page	3		DATE OF BASE
occ page	<u> </u>		CONTINUED ON PAGE
3 MISSION EFFECT:			
See Reco The only	ognition. case that might be ser	ious is case A3.	CONTINUED ON PAGE
4 AVOIDANCE PROCEDURE:			
See page	3		
200 Pag			CONTINUED ON PAGE
5 RECOVERY PROCEDURE:			
Any prov V34E.	cedure that causes 1/A	CCS to be done. The	e simplest is V48E, Pro, continued on PAGE
TOTAL IN CORRECTION			ting isha act up a job
Have the	e subroutine that wipes ACCS. Any change in a	out the queue of wai major mode will thus	cause a 1/ACCS jsb, to
he done	ON (Fiv Work-around etc):		
2.7 RECOMMENDED DISPUSITION	UMINARY IE; work are	ound in Apollo 14.	(See PCN 1059)
Fix in L	UMINARI IE, WOLK al	1-9 Word	
2.8 RECOMMENDED RE-TESTING		4.0%	•
" a KECOMMENDED KE-1631IMC	••		2.10 DATE:
	CONTANUED ON DA	2.9 MIT/IL SIGNATURE	(8 5
	CONTINUED ON PA	41 CLOSING ACTION TAKEN	Y:
3.1 NASA DIRECTION:		a. ocosino norioni	
			CONTINUED ON PAGE
3.2 NASAMSC SIGNATURE:	CONTINUED ON PA	20105	CONTINUED ON PAGE

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.
PROGRAM
Luminary
Luminary

through 175

1.1 ORIGINATOR: P.S. Weissman

the various discrete inputs.

1.2 ORGANIZATION:
MIT/DL

1.4 ORIGINATOR CONTROL NO.

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

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 occured 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 occurance of this case would have no effect at all on the mission.

MITTIL SOFTWARE ANOMALY REPORT

	WITTE SOLIWARE	ANOMALI	KEFUKI	MSC REPORT NO.
1.1 ORIGINATOR:	1.2 ORGANIZATION:	L3 DATE:	1.4 ORIGINATOR	PROGRAM
P.S. Weissman	MIT/DL	8/24/70	CONTROL NO.	PROCKENI ROTSTON
				through 175

2.2 Recognition

The various cases given in the Description will be treated separately.

- Al) 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 Al except that the expected deadband would always be larger or equal to the deadband in effect.
- A3) Same as Al 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 SOFTWAR	E ANOMALY REPOR	T MSC SEPORY NO
originator: R. Larson	1.2 ORGANIZATION MIT/DL	9/11/70 1.4 ORIGINATO CONTROL N	
The value of	'y: ' W_ is mis-scaled in L	uminary 1D by a factor o	f 2 (See Luminary
MEMO #169			
9 9			
			CONTINUED ON PAGE
DESCRIPTION OF RUN:			
Eyeball (Re	ported in comments to I	MIT from MSC)	* 25
		a a a a a a a a a a a a a a a a a a a	CONTINUED ON PAGE
	- 1	MIT ANALYSIS -	
1 CAUSE:			n' - NTb on
Error in pr	eparation of PCR to cha	nge the LOSSEM Epheme	ris Number.
8.			CONTINUED ON PAGE
2 RECOGNITION:		atom of the moon is co	omputed in
Error when LSPOS	an approximate positio	n vector of the moon is c	CONTINUED ON PAGE
MISSION EFFECT:	7		
Bad alignm	ent if the sun and moon	are used.	CONTINUED ON PAGE
4 AVOIDANCE PROCEDURE			
See 2.5			
			CONTINUED ON PAGE
5 RECOVERY PROCEDURE:	two washes to reason and	ourate Moon position vect	tor if that body
The ground	esired for alignment.	curate Moon position vec	CONTINUED ON PAGE
6 PROGRAM CORRECTION			CONTINUED ON FACE
Correct sc	aling of WB		CONTINUED ON PAGE
.7 RECOMMENDED DISPOS	ITION (Fix, Work-around, etc):		
Fix for Lux Apollo 15.	minary 1E. These num	bers have to be changed f	for a new year for continued on page
.8 RECOMMENDED RE-TES	TING:		
		2.9 MIT/IL SIGNATURE:	2.10 DATE:
•	CONTINUED ON P		111 4 122 / 5/0/4
.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:	
	•		
	CONTINUED ON F	PAGE	CONTINUED ON PAGE
	: 3.3 ORGANIZATION 3.4 DA	U	4.3 ORGANIZATION: 4.4 DATE:

COLOSSUS 3A LUMINARY 1F COLOSSUS 3 LUMINARY 1F COLOSSUS 3 LUMINARY 1F COLOSSUS 1 LUMINARY 1F	PCR/PCN # ANOMALY # L-ID-IZ ADR #
MIT Approved PCN MIT Approved ADR A. Coding Begin coding immediately ACTION:	NASA Approved Software Anomaly MIT Approved Software Anomaly
超級행사 경기 이번 사람이 가는 아이를 가고 있다. 그는 그를 보고 있는 것이 하는 것이 모든 모든 모든 것이다.	500
Program Supervisor's Approval:	Mayant Hamlon
Do not code until new GSOP material has be Mission Design Review Board (MDRB) and of 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	
Plants consistent commentation of the constitution of the constitu	
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	1941 9-18-70

<u> </u>				1 % tax 1	L-1D-12		
I ORIGINATO		1.2 ORGANIZATION	1.3 DATE	1.4 ORIGINATOR CONTROL NO.	PROGRAM LUMINARY		
	OLANTE	MIT/DL	9/17/70		PROGRAM REVISION		
in p whil	rogress resul	72 (RR Coarse alights in incorrect open is in progress with 22.	ration of V41N7	2. Also key	ring in V44		
					CONTINUED ON PAGE		
1.6 DESCRIPT	ION OF RUN:						
N A							
					CONTINUED ON PAGE		
2.1 CAUSE:		- N	MIT ANALYSIS -				
	V72 disables t	the RR error count	er enable outhi	t which stor	s the antenna		
		mode(or reposition			CONTINUED ON PAGE		
	owing the loa	ding of desired ang	gles in N73, N7	2 will show a	actual angles		
not	converging to	desired angles.			CONTINUED ON PAGE		
2.3 MISSION				art der men vier de seu installe dem seus pleur dies andere mei de febben vier von de febben vier von de febben vier von de			
Non	CONTINUED ON PAGE						
2.4 AVOIDANCE PROCEDURE:							
whil	e a reposition	N72 while a reposit n is in progress.			CONTINUED ON PAGE		
2.5 RECOVER Cyc (Wa	y proceoure le RR MODE it at least one	SELECT switch from second before ret	om LGC to SLEV curning to LGC)	Wand then ba	ck to LGC.		
	A CORRECTION:						
Add	checks to V4	l and V44.					
2.7 RECOMM	NOID DISPOSITION (F	ix Work-around etc):		The control of the second Address and the control of the control o	CONTINUED ON PAGE		
		y 1E, workaround f	or Luminory II)			
		y 11.1, WOLKEL OWNER	or indifficity in		CONTINUED ON PAGE		
	ended re-testing: N72 and V44 t	ested during RR re	epositioning 7	/			
	VI M CALLOR V I I U	CONTINUED ON PA	2.9 MITTE SIGNA	THRE!	2 10 DATE 9-18		
3.1 NASA DIR	ECTION:	CONTINUED ON 17	4.1 CLOSING AC	TION TAKEN:	4/10		
	-	CONTINUED ON PA		12.2	CONTINUED ON PAGE ORGANIZATION: 14.4 DATE:		
3 2 NAS WM			E A REAL DIDMAIDRE:	14. 7	CHAINTIE THE PARTY OF A PUBLIC		

TIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY # 1-10-14
COLOSSUS 2E LUMINARY 1D	ADR #
Colossos	
Concessor	
COLOSSUS LUMINARY	
MIT Approved PCN NASA Approved PCR	NASA Approved Software Anomaly
MIT Approved ADR NASA Approved PCN	MIT Approved
	Software Anomaly
A. Coding	DA AID.
Begin coding immediately	Peter Holler
ACTION:	
Program Supervisor's Approval: _	Margart & Hamilton
Do not code until new GSOP material has be	en approved by the MIT
Mission Design Review Board (MDRB) and d	istributed.
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:	
A CC	
D. Other Programs Affected	
Review for corresponding changes in	
ACTION:	
Special Instructions	1/ 1/1/1/
Project Manager	Summer farmer
Date_	10-22-70
And the second of the second o	

Q

MIT/IL SOFTWARE ANOMALY REPORT 1.4 ORIGINATOR 1.3 DATE: 1.2 ORGANIZATION: 1 ORIGINATOR: CONTROL NO. 10/8/70 FS5 C. D. Sykes 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 Bl2) 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+700MTIME. 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: Teset Flagword 5 Bit 12 for impulsive burns CONTINUED ON PAGE 2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for lE CONTINUED ON PAGE 2.8 RECOMMENDED RE-TESTING: 2.10 DATE: Hybrid impulsive burn; show CONTINUED ON PAGE flag is reset. 4.1 CLOSING ACTION TAKEN: 3.1 NASA DIRECTION: CONTINUED ON PAGE CONTINUED ON PAGE 4.3 ORGANIZATION: 4.4 DATE: 4.2 SIGNATURE: 3.3 ORGANIZATION 3.4 DATE: 3.2 NAS NMSC SIGNATURE:

MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY # L-19-15
COLOSSUS 2E LUMINARY 1D	ADR #
The contract of the contract o	
COLOSSUS 3A LUMINARY 1F	
COLOSSUS LUMINARY /	
MIT Approved PCN NASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
	MIT Approved Software Anomaly
A. Coding	o O
Begin coding immediately	P. R.
	- X
ACTION:	
Program Supervisor's Approval:	YMan not A Hainel
Do not code until new GSOP material has been	Y
Mission Design Review Board (MDRB) and d	istributed.
B. GSOP Preparation	
Prepare GSOP revisions for MDRB	(Lee PCN 1124)
consideration	
ACTION:	
Technical Committee Meeting not required.	
Technical Committee Meeting(s) held on	
Attendees:	
C. KSC Testing and Checkout	4
Review for possible impact on KSC	
testing and checkout ACTION:_	
D. Other Programs Affected	
Review for corresponding changes in	
ACTION:	
Special Instructions	
Project Manager	4 Jares
Date	11-12-70

	IVI I I / I L	SOFTWARE	·	MALI	KLIOK	MSC 9 CPP	5-15
ORIGINATOR: N. Barne	ert	I.2 ORGANIZATION MITCSDL		3 DATE: L1/12/70	I. 4 ORIGINATOR CONTROL NO	PROGRAM Lumin PROGRAM Rev.	nary 1D
DESCRIPTION OF ANO	MALY:	.			8		
	4.1	P20 (P25) is r establishment u	unning nless I	in the baRNDVZFI	ckground LG (P25FI	will kill F LAG) is su	P20 (P25) absequentl
							*
						CONTI	NUED ON PAGE
DESCRIPTION OF RUN	V:	And the second s		*			
Eyeball							
					1 2	CONT	INUED ON PACE
		- MI	IT ANALYSI) -		,	
CAUSE: P20 (P2)	5) restart g	roups are clear	red, bu	t RNDVZ	FLG (P25		
	2						INUED ON PAGE
	tation t	20 (P25) will purracking, or ma lly be re-estab	rk nro	essing u	o be berro	IIIICu. I	30(1 20)
MISSION EFFECT:			*		•		
No P20	(P25)				.).	CON	TINUED ON PAGE
4 AVOIDANCE PROCED	OURE:				ř		
None						CON	TINUED ON PAGE
5 RECOVERY PROCEDU	JRE: P00 at P00I	000 V37 request	* ,			CON	TINUED ON PAGE
5 RECOVERY PROCEDU	URE: P00 at P00I	000 V37 request	· · · · · · · · · · · · · · · · · · ·				TINUED ON PAGE
5 RECOVERY PROCEDU Select I	P00 at P00I	, e.c.		0 sequen	ce.		
5 RECOVERY PROCEDU Select I 6 PROGRAM CORRECT Reset F	P00 at P00I	(P25 FLAG) in		0 sequen	ce.	CON	
5 RECOVERY PROCEDU Select I 6 PROGRAM CORRECT Reset F	P00 at P00I	(P25 FLAG) in	P00D0	,	ce.	CON	TINUED ON PAGE
Select I 6 PROGRAM CORRECT Reset F	P00 at P00I	(P25 FLAG) in	P00D0	,	ce.	CON	TINUED ON PAGE
5 RECOVERY PROCEDU Select I 6 PROGRAM CORRECT Reset F	POO at POOI	(P25 FLAG) in	P00D0	,	ce.	CON	TINUED ON PAGE
5 RECOVERY PROCEDU Select I 6 PROGRAM CORRECT Reset F	POO at POOI	(P25 FLAG) in	P00D0			CON	TINUED ON PAGE
Select I Select I 6 PROGRAM CORRECT Reset F	POO at POOI	(P25 FLAG) in -k-around, etc): 1E. (Low PCN)	P00D0	,		CON	TINUED ON PAGE TINUED ON PAGE TINUED ON PAGE
Select I Select I 6 PROGRAM CORRECT Reset F 7 RECOMMENDED DIS Fix for	POO at POOI	(P25 FLAG) in	P00 D0		TURE!	CON	TINUED ON PAGE TINUED ON PAGE TINUED ON PAGE
Select I Select I 6 PROGRAM CORRECT Reset F 7 RECOMMENDED DIS Fix for	POO at POOI	(P25 FLAG) in -k-around, etc): 1E. (Low PCN)	P00 D0	MITTE SIGNA	TURE!	CON	TINUED ON PAGE TINUED ON PAGE TINUED ON PAGE
5 RECOVERY PROCEDU Select I 6 PROGRAM CORRECT Reset F .7 RECOMMENDED DIS Fix for	POO at POOI	(P25 FLAG) in -k-around, etc): 1E. (Low PCN)	P00 D0	MITTE SIGNA	TURE!	CON	TINUED ON PAGE
Select I Select I 6 PROGRAM CORRECT Reset F 7 RECOMMENDED DIS Fix for	POO at POOI	(P25 FLAG) in -k-around, etc): 1E. (Low PCN)	P00 D0	MITTE SIGNA	TURE!	CON	TINUED ON PAGE TINUED ON PAGE TINUED ON PAGE
Select I Select I 6 PROGRAM CORRECT Reset F 7 RECOMMENDED DIS Fix for	POO at POOI	(P25 FLAG) in -k-around, etc): 1E. (Low PCN)	P00 D0	MITTE SIGNA	TURE!	CON	TINUED ON PAGE TINUED ON PAGE TINUED ON PAGE
Select I Select I 6 PROGRAM CORRECT Reset F 7 RECOMMENDED DIS Fix for	POO at POOI	(P25 FLAG) in -k-around, etc): 1E. (Low PCN)	P00 D0	MITTE SIGNA	TURE!	CON	TINUED ON PAGE TINUED ON PAGE TINUED ON PAGE
5 RECOVERY PROCEDU Select I 6 PROGRAM CORRECT Reset F 7.7 RECOMMENDED DIS Fix for	POO at POOI	(P25 FLAG) in -k-around, etc): 1E. (Low PCN) CONTINUED ON PA	P00 D0	MITTE SIGNA	TURE!	CON	TINUED ON PAGE TINUED ON PAGE 2.10 DATE:
5 RECOVERY PROCEDU Select I 6 PROGRAM CORRECT Reset F	POO at POOI	(P25 FLAG) in -k-around, etc): 1E. (Low PCN)	P00 D0 1124 AGE AGE	MITTE SIGNA	TURE!	CON	TINUED ON PAGE TINUED ON PAGE 2.10 DATE: 11-12

MIT/DE PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY #_ L-10-16
COLOSSUS 2E LUMINARY 1D	ADR #
COLOSSUS 3 LUMINARY 1E	• .
COLOSSUS 3A DLUMINARY 1F	
COLOSSUS LUMINARY	
MIT Approved PCN NASA Approved PCR	NASA Approved
MIT Approved ADR NASA Approved PCN	Software Anomaly
	MIT Approved Software Anomaly
A. Coding.	D A Software Anomaly
Begin coding immediately	Telle Volante
ACTION: _	
Program Supervisor's Approval: 1	Margant H. Fleml
Do not code until new GSOP material has bee	V.
Mission Design Review Board (MDRB) and di	
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:	and the second s
Special Instructions) ind
Project Manager	ussell Fl. Jurn
Date	12-10-70

WII	/IL SOFTWARE			17-117-1	
ORIGINATOR:	1.2 ORGANIZATION	1.3 DATE:	1.4 ORIGINATOR CONTROL NO	li Lumim	ary
P. Volante	M.I.T.	12-8-70		PROGRAM REVIS	ibs
DESCRIPTION OF ANOMALY:		3		L	
Fixed Memory co is 5509.3 fps ins	onstant VINJNOM (I tead of 5509.5 fps a	Nominal Injecti as specified in	on Velocity GSOP.	7)	٠,
•				CONTINUED	ON PAGE
6 DESCRIPTION OF RUN:					
None - found by	examining listing.				
			8 .		
•					
				CONTINUED	ON PACE
	- M	NIT ANALYSIS -			
Loss of accur	racy in converting	from FPS to M	./c.s.		
				CONTINUED	ON PAGE
2.2 RECOGNITION:				,	
None					
1,0110			-	CONTINUE	ON PAGE
2.3 MISSION EFFECT:					
None		9 * w		CONTINUE	ON PAGE
2.4 AVOIDANCE PROCEDURE:				CONTINUE	
None	- 4				
None	e .			CONTINUE	ON PAGE
2.5 RECOVERY PROCEDURE:					
		* *			
None	v			CONTINUE	D ON PAGE
2.6 PROGRAM CORRECTION:				*	
Correct Cor	nstant				
				CONTINUE	D ON PAGE
2.7 RECOMMENDED DISPOSITION (
Fix for Apollo	15 (LUM 1E)	/T TINE 117\	ž	CONTINUE	D ON PAGE
	ssary for Apollo 14			CONTINUE	D ON PAGE
2.8 RECOMMENDED RE-TESTING:			,		
Nominal 12 as	scent run	2.9 MITITO SIGN	ATURE:)	2.10 DATE:
	CONTINUED ON P		1, Lu	rom	10-10
3.1 NASA DIRECTION:		4.1 CLOSING A	CTION TAKEN:		
	*				
	* **				
			ss 🔐		
,	*				(*
			D .		
· ·	¥			CONTINH	ED ON PAGE
The state of the s	CONTINUED ON	PAGE (I			
3.2 NASAMSC SIGNATURE:	3.3 ORGANIZATION 3.4 DA			4.3 ORGANIZATION:	4.4 DATE:

MIT/IL PROGRAM CHANGE ROUTING SLI		R/PCN #OMA'LY # L-ID-17
COLOSSUS 2C LUMINARY 1		F
COLOSSUS 2D LUMINARY 1	25 N	
COLOSSUS 2E LUMINARY 1		
COLOSSUS 2F LUMINARY 1		
		e f
	D-1.	NASA Approved Software Anomaly MIT Approved Software Anomaly
	ACTION:	
Program Sup	ervisor's Approval:	mant Hamela
O not code until new GS	OP material has been app Board (MDRB) and distribu	roved by the MIT
B. GSOP Preparation		*
Prepare GSOP revisions consideration	for MDRBACTION:	
Technical Committee Me	eeting not required.	
Technical Committee Me Attendees:	eeting(s) held on	
C. KSC Testing and Checkout		
Review for possible imp testing and checkout	act on KSC ACTION:	
D. Other Programs Affected		F 8
Review for corresponding ch	•	
Cussial Instructions	ACTION:	
Special Instructions	Project Manager	H Jan Den
	Date Date	-10-70
	Date	I land I land

(Rev 10/60)

	· ·	ANUMALY REPO	L-1D-17
	ORGANIZATION:	1.3 DATE: 1.4 ORIGIN	I LUMINARY
P. Volante N. N. P.	MIT	12/10/70	PROGRAM RENIGION
5 DESCRIPTION OF ANOMALY: The flashi	ng verb at willo than 400 n.m. a	and the range-rate is	s positive may not
occur			
		* *	
			CONTINUED ON PAGE
6 DESCRIPTION OF RUN:			CONTINUED ON FACE
Examinatio	n of coding.	·	
			*
	r v v		e e e e e e e e e e e e e e e e e e e
			CONTINUED ON PAGE &
•		VALYSIS -	
Plagword bit is s	hared between	RR predesignate rou	ting of R21 and V16 N
display computat	ions or P22.	· ·	· · · · · · · · · · · · · · · · · · ·
	CCT T : -tdo	limits and no trook	CONTINUED ON PAGE
2.2 RECOGNITION:After RR tracks V37 flash does no	ot appear, but N	154 is computed.	right goes on, the
V V 114511 does in	or appoint, in its		CONTINUED ON PAGE
2.3 MISSION EFFECT: None			
None			
			CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: None			
		1 500 1	CONTINUED ON PAGE
2.5 RECOVERY PROCEDURE: Select desi	ired program w	hen 530 alarm appea	irs in P22.
			CONTINUED ON PAGE
2.6 PROGRAM CORRECTION: Tinghame fl	agword bits in 1	P22	
Ulishare in	agword bits in	. <i></i>	
	<i>*</i>		CONTINUED ON PAGE
2.7 RECOMMENDED DISPOSITION (Fix, Work-ard	ound, etc):	, with but don't	5 fix
Fix for 1E.	diddle	will be son.	CONTINUED ON PACE
O O DECOMMENDED DE TESTINO	1		CONTINUED ON PAGE
2.8 RECOMMENDED RE-TESTING: P22 nomi	nal run		
	CONTINUED ON PAGE	2.9 MITTIL SIGNATURE	2.10 DATE: 12-10
3.1- NASA DIRECTION:	CONTINUED ON TAGE	4.1 CLOSING ACTION TAKEN:	
	" » (a .
		· • • • • • •	· · · · · · · · · · · · · · · · · · ·
		e	R *
		·	
		•	CONTINUED ON PAGE
3.2 NASA/MSC SIGNATURE: 3.3 ORGAN	CONTINUED ON PAGE	4.2 SIGNATURE:	4.3 ORGANIZATION: 4.4 DATE:
3.2 NASAMSC SIGNATURE: 3.3 ORGAN	TATION PAGE		2 *
	1		

MIT/IL PROGRAM CHANGE ROUTING SLIP COLOSSUS 2C LUMINARY 1B COLOSSUS 2D LUMINARY 1C COLOSSUS 2E LUMINARY 1D COLOSSUS 2F LUMINARY 1E	PCR/PCN #ANOMALY #
MIT Approved PCN NASA Approved PCR NASA Approved PCN A. Coding Begin coding immediately	NASA Approved Software Anomaly MIT Approved Software Anomaly
Program Supervisor's Approval: Do not code until new GSOP material has been Mission Design Review Board (MDRB) and dis	
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	$\frac{1}{2}$
Project Manager Date	(.77 Jansen) 12-10-70

- 141	IIIIE ZOLIMA	TE ANUM	ALY RE	PURI	MSC REPORT NO L-1D-1	
.1 ORIGINATOR:	1.2 ORGANIZATION	1.3 0/	II. 1.4 (BIGINATOR	PLUMINA	
P. Volante	MIT	1	, , ,	EUNTROL NO.	PROGRAM BEVI	
.5 DESCRIPTION OF ANOMALY: IT	n P22, if the R21 r	outine (RR	lesignate)	drives		
the anten	na close to the RR landing site, the R	Mode II lim Pantonna n	its as the	CSM is n	noving aw en the mo	ay de
limits and	d the mode center s	several time	es.	are between	cii tiic iiio	uc .
		-				,
			e e			
					CONTINUED	ON PAGE
.6 DESCRIPTION OF RUN: Syst	em test lab run of	P22 without	allowing	RR locko	n.	
			8 9		×	
					CONTINUED	ON PACE
		AAIT AALALVEIC		·	CONTINUED	- Total
1 CAUSE: R21 and I	R24 do not clear de	MIT ANALYSIS -	when it f	inda that	OS outoid	
I(LI ana I	imits in P22, so R2					
141040 11 1					CONTINUED	
2 RECOGNITION: Oscillation	on of antenna trunn	ion and sha	aft angles	varying h	oetween m	ode
	d mode center.					
· · · · · · · · · · · · · · · · · · ·			* pr 1		CONTINUED	
2.3 MISSION EFFECT: None-i	f this situation occu	urs, no tra	cking of t	he CSM c	ould be ob	tained.
					10 N	
2.4 AVOIDANCE PROCEDURE;Sele	of D22 while CSM	is approach	ing landin	a site and	CONTINUED not yet	ON PAGE
	R mode limits.	is approach	ing randin	g bite and	. Hot yet	
					CONTINUED	ON PAGE
2.5 RECOVERY PROCEDURE: Non	10					
NOI	ie .		, U			
					CONTINUED	ON PAGE
2.6 PROGRAM CORRECTION: Fi	x coding to clear de	esignate fla	g.		*	
						8
2.7 RECOMMENDED DISPOSITION (Eiv Work-around atch. Fix i	for Apollo 1	5 (Lum 1	E) work-a	round	ON PAGE
	o 14 - (Lum 1D)	ioi mpono i	o (Ham 1.	L', WOI II	. Cuiia	
2					CONTINUED	ON PAGE
2.8 RECOMMENDED RE-TESTING:	P22 with designate	(R21) attem	nted as C	SM is les	wing mod	e limits
a a	r 22 with designate		SIGNATURE:	/ / /	<u> </u>	10 DATE:
. ,	CONTINUED ON F		12	uson		2-10-7
3.1 NASA DIRECTION:	3	4.1 CLOS	ING ACTION TAK	EN:		
			÷ e			
*				5 E		
	E 90					
* * ₂₀	CONTINUED ON I	PAGE	20 30		CONTINUED	ON PAGE
3.2 NASAMSC SIGNATURE:	3.3 ORGANIZATION 3.4 DA		ATURE:	4.3 OR		4 DATE:
				1		

MIT/DL PROGRAM CHANGE ROUTING SLIP	PCR/PCN #
	ANOMALY # L-10-19
COLOSSUS 2E LUMINARY 1D COLOSSUS 3 LUMINARY 1E	ADR #
COLOSSUS 3A LUMINARY IF COLOSSUS LUMINARY LUMINARY	
MIT Approved PCN MIT Approved ADR NASA Approved PCN NASA Approved PCN A. Coding	NASA Approved Software Anomaly MIT Approved Software Anomaly
Begin coding immediately	P. Volante
ACTION:	
Program Supervisor's Approval:	Jana & Ham Cton
Do not code until new GSOP material has been Mission Design Review Board (MDRB) and dist	approved by the MIT
B. GSOP Preparation	.
Prepare GSOP revisions for MDRB consideration ACTION:	
Technical Committee Meeting not required.	
Technical Committee Meeting(s) held on	
C. KSC Testing and Checkout	
Review for possible impact on KSC testing and checkout ACTION:	
D. Other Programs Affected Review for corresponding changes in	
A CITY ON	
Special Instructions ACTION:	
Project Manager Date	2-36-70

M	IT/IL	SOFT	WARE A	NOMALY	REPOI	ST MOG	REPORT NO. L-1D-19
.1 ORIGINATOR: B. McCoy	1.	2 ORGANIZA MIT/C		1.3 DATE: 12/30/70	1.4 ORIGINAT	NO I	UN 178
5 DESCRIPTION OF ANOMALY: I	Restarts					PREC	BAN JEARION
V50N18 on DSKY	•		7 - 0 - 1 - 1 - 1	011000000			
				,			
					*	C	ONTINUED ON PAGE
6 DESCRIPTION OF RUN: S	imulatio	on at GA	C - Res	start testing	for PCI	R324	
				*			
				٠			
				**		,	ONTINUED ON PAGE
	26.2.2.2.24.0000000000000000000000000000	*******	- AAIT A	NALYSIS -			CHITICLE ON FACE
1 CAUSE: The Resta	art Poin	t in R65		routine LPS	20.1 cal	1 which	computes
RRTARGET. Th	is share	es erasa	able cells	with radar	read data	a. A Re	start
occurring after t							
in RRTARGET. 2 RECOGNITION:	The 15	degree	cneck tne	n talls and l	360 15 St	ibsequen	try carred.
R	estart f	ollowed	by V50N	18 display			
			:			C	ONTINUED ON PAGE
3 MISSION EFFECT:							
N	one		1				
4 AVOIDANCE PROCEDURE:						<u> </u>	ONTINUED ON PAGE
No	one ·				v	C	ONTINUED ON PAGE
.5 RECOVERY PROCEDURE:	Denres	e FNTI	TR nughhi	itton on DSK	V: ignor	0 2001100	14 40
perform n			or pusible	THOM OIL DON	i, ignor	e reques	51 10
			2	· · · · · · · · · · · · · · · · · · ·	21 1	C	ONTINUED ON PAGE
.6 PROGRAM CORRECTION:	Place 5	Restart	Point	before LPS2	0.1		
	* , 1						ONTINUES ON DACE
2.7 RECOMMENDED DISPOSITION	l (Fix, Work-ar	round, etc):					ONTINUED ON PAGE
			og note for	r 1D			
		-	Ü			c	ONTINUED ON PAGE
8 RECOMMENDED RE-TESTING:	Digital	Simulat	tion with	Restart_befo	re and a	fter Res	tart Point.
*				2.9 MITHESIGNATU	RE:		2. 10 DATE:
	-	CONTINU	JED ON PAGE	K.T.	Jan	A,	12-30-7
.1 NASA DIRECTION:				4.1 CLOSING ACTIO	N TAKEN:		94
							*
					St.		
	•				x		
		CONTINU	JED ON PAGE		W 100		ONTINUED ON PAGE
.2 NASA/MSC SIGNATURE:	3.3 ORGA	NIZATION	3.4 DATE:	4.2 SIGNATURE:		4.3 ORGANIZA	ATION: 4.4 DATE:
				H .	17.8	1	ı

MIT/DL PROGRAM CHANGE ROUTING SLIP PCR/PCN # ANOMALY # L-ID-20 ADR # LUMINARY 1D COLOSSUS 2E LUMINARY 1E COLOSSUS 3 COLOSSUS 3A LUMINARY 1F LUMINARY___ COLOSSUS MIT Approved PCN NASA Approved PCR NASA Approved Software Anomaly NASA Approved PCN MIT Approved ADR 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

	MIT/II	SOFTWARE	EANOMALY	REPORT	IMIC REPORT NO.
I. 1 ORIGINATOR:		2 ORGANIZATION:		1.4 ORIGINATOR	PROGRAMI 1D
		MIT/DL	12/31/70	CONTROL NO.	PROGRAM BEVISION
P. Rye .5 DESCRIPTION OF ANOM	ALY: 1. If a		curs during perr	nanent	-[178
integration in another resta tegration pro interrupted o	P00, R22, art point hat cess has been that state OUT occur	or R21 and is been establing or R21 and is been establing permor V90 before	is followed by an ished in the proposition is sible that norm be invalidated. In the integration the integration	ny other regram, and all program	if a second in- n flow will be followed by
	in take plac				CONTINUED ON PAGE
1.6 DESCRIPTION OF RUN:					
	Eye	ball			
					CONTINUED ON PAGE
		- M	IT ANALYSIS -		
2.1 CAUSE: Erroneo	ous clearing	g of REINTFL	G by BAILOUT	logic	
	,				CONTINUED ON PAGE
2.2 RECOGNITION: BA	II.OUT foll	owed by anoth	ner restart duri	ng times sp	
		rogram beha		ing triffed op	, T. J.
		_	-		CONTINUED ON PAGE
2.3 MISSION EFFECT: M	ay need up	link of state v	ector and resel	ection of pr	ogram.
					,
2.4 AVOIDANCE PROCEDUR	r I. Do not	select V37 a	fter BAILOUT 1	n P20 until	integration is
completed.	elect V82, N				shed if a BAILOUT
2.5 RECOVERY PROCEDURE	:		**************************************		
, .	Correct s	tate vector ar	nd reselect prog	ram II nece	essary,
2 (DDOCD IN CODDICTION			-		CONTINUED ON PAGE
2.6 PROGRAM CORRECTION	Do not c	lear REINTFI	LG in BAILOUT		
Ŷ.					CONTINUED ON PAGE
2.7 RECOMMENDED DISPOS	SITION (Fix, Work-a	ound, etc):			CONTINUED ON TAGE
	Fix for LU	JM 1E			
<u> </u>					CONTINUED ON PAGE
2.8 RECOMMENDED RE-TES					
Restart and E	BAILOUT te	ests P20 and I	POO 2.9 MITTIL SIGNATUR	E/4/ 1/100	2. 10 DATE:
3.1 NASA DIRECTION:			4.1 CLOSING ACTION	N TAKEN:	
		-			
		CONTINUED ON PAG	SE		CONTINUED ON PAGE
3.2 NASA/MSC SIGNATURE	: 3.3 ORGA	VIZATION 3.4 DATE:	4.2 SIGNATURE:	4.3 (DRGANIZATION: 4.4 DATE:
,					
MSC Form 1409 (Rev M	lay 68)				



No. 116

L-26

Name of Program(s): Commenche Luminary

A - 3

Name of Program(s): Revenus, SAVANCHE

Originator: Barnet

Organization: MIT

Date: 5-8-70

Description of Change: Dusert check for course align before attempting Zyro Argeing.

Reason: V41N+0 or Guidel lock sitts etaise align +
kusches down drift flag. However AVEG still
does gyo compensation + at AVEGEND drift
flag is set, allowing NBDONLY compensation.
Check within pulse torquing NBDONLY compensation both
problems.

Assigned to: S. Rosenberg.

Comments:

Approved by: Mayard Hamela Date: May 13, 1970 Name of Program(s): Luminary 1D

originator: Densmore
Organization:
Date: 28 May 70
Description of Change: (1) unused constant OCT 777
was delifed. (2) RESTARTS routine was called directly nather than by picking up a CADR Son it. (6) A single constant for
called directly nather than by picking up
a CADR for it. (6) A single constant for
masking during FLAGWRD8 SWINIT
masking during FLAGWED8 SWINIT in halisation replaced adding in bito individually.
Reason: Save 3 words in Bank 5 70
make room for
Cleaning of RIZRDFLG in Gresh Start,
Fix to PCR 896.

Assigned to: Cana Ocume

Comments:

Approved by: Margaret A. Hamilla
Date: 6/10/70

Name of Program(s): Lummary 1 E

Originator: McCay

Organization: WIT/OC

Date: 6/25/70

Description of Change:

1. remove LRPOS initialization from P63 LOG: THE LUNAR LANDING

cardo: 01956 ,01957

2. charge Double to a DDOUBL

LOG: THRUTTLE CONTROL ROLTINES

and: 0136

3. Change DXCH to an XCH LOG: THROTTLE CONTROL ROLLTINES

cond: 0068

1. introlyation not necessary implemented us my, not in 6500

22 3. improve accuracy; coding not right

Assigned to: Don Cole

Comments:

Approved by: Margaret Hameton,
Date: July 8,70

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. Comelli

Comments:

Approved by: Margart damelin

Date: 8/11/70

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. Corelli

Comments:

Approved by: Margart damelon
Date: 8/11/70

Assembly Control Board Request

Redistributed

Redistributed

Name of Program(s): ARTCHIS

Originator: Sunner Rosenserg

Organization: MIT/OL

Date: 12, 1970

Description of Change:

SET A LIST OF LABRLS = TO EACH LOCATION THAT IS IN THE DOWNLINK LISTS AND NOT DIRECTLY REFERENCED IN THE LISTS.

Reason: TO HAVE REFORENCES TO THESE LOCATIONS"

SHOW UP IN DIRECTORY SHOWING THAT THEY

ARE REFERENCED IN DOWNLINK LISTS. MUST BE KEPT

UP TO PATE TO BE EFFECTIVE

Assigned to:

Summer Korenkery

Commonts:

Approved by: Mayant Hamlor
Date: 8/12/70

Assembly Control Board Request

No. A-15

(2-32)

Redistributed

Name of Program(s): ARTEMIS

Originator: SUMNER KOSENBERG

Organization: MIT / DL

AND PARTY

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 CHANCING 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 = OPTHODES + 1 FOR DOWNLINK LIST.

Assigned to: Summer Kosenher

Comments:

Approved by: Margaret Hamilton Date: 8/12/70

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 Warsonan

Comments:

Approved by: M. Kamllon

ate: 2/261

Name of Program(s): LUMIN ARY

Originator: N. Barnert

Organization: MIT

Date: 21 Seft '70

Description of Change: Crasable clean-up',

1.) Change Massibles used for N 90 (R36) so that sharing with N54 is eliminated for material EY

2.) May DELVOV (N84, P76) for share with SERVICER Massibles,

3.) More RANGE, RRATE, + THOTA (N54) so they will be unchared.

4) More LRWH1 to share with INCORP nather than P30.

5.) Delete GMODE, RRYV (mound) + Shiff E 4 configuration Roason: 7.) Reletive in Franche Log Section of the end of the share while togs which share togs which share defined in often log sections.

Reason: Cone of problems which created program notes;

General champs to award future trouble.

Assigned to: N. Barrendon

comments: Make LUMINARY recision with no ofher changes except above; sun representative level of tests to check out.

Approved by: Lynn Man aut A. Hamlin

Name of Program(s): Luminary 1E.

Originator: Barner

Organization: MIT

Date: 9-29-70

Description of Change: Change coding in CLGE

to store triple precision in OLDPIPAX

to avoid confusion and possible Colure problems

Consequent to ensitive order of crasables to instructions. It is now necessary that erasable and instructions be in such an order barbage put down what DELVROD overwards the garbage put down Reason: OLDIPAI (TP) is lecter stored: DELVROD must follow oldpipal in erasable (overlap) the "vector" and it must be initialized after oldpipax problem pointed out by Allan Klumpp.

Assigned to:

Tensmore + Cyles

comments: No words added to do this fix.

STOVE VHZC STORE VHZC
TEMX TLOAD DCOMP
TEMX

Sent !

STOUL OLD PIPA.X ZEROVECS STOUL DELVEOD

Approved by: Margant H. Hamlin Date: Ect. 5, 1970

				1
Name	of	Program(s):	CUMINAR)	1

Originator: Ry

Organization: MIT

Date: 10-5-70

Description of Change: Africe Define a tag

TMPDV = GDT/2 for use

by 534/35.5 which now

uses GDT/2 directly -

Reason: Rooid future errors by specifying user other than SERVICER for that

Assigned to: Ry

Comments:

Approved by: Margant d. Hamels.

Date: Out 6, 1970

Assembly Control Board Request

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 ll could cause bad return; no reason to skip coding because of it, even if real bad return.

Assigned to:

P. Rye

Comments:

Approved by: Margart Hamly
Date: Oct 13 1970

			1	/	1011	1 1 2000000000
Name of	Program(s.):	LUM	N	APEY,	16

Originator: Ryc

Organization:

Date: 10-26-70

Description of Change:

Dhange code at TRMTRAKI to interpretive.

Reason: Druke V56 restart-forof; @ paus Iline do new orde will fit in.

Assigned to:

Comments:

Approved by: Margart A. Samub

Date: 10127/30

Name of Program(s): Luminary 1E

Originator: Densmore

Organization: MIT

Date: 5 OCT 70

Description of Change: Change a CADR to

an ADRES Gollowing a TC TWIDDLE IN RADSAMP.

CADR to incorrect and WAITLIST expects ADRES.

Assigned to: Densmore

Comments:

Approved by: Margaret Hamler
Date: 10/27/70

Name of Program(s): LUMINARY /E
Originator: Densmore
Organization: MIT
Date: 28 OCT 70
Description of Change:
Description of Change: Nelute GOMARK2, MARKFORM, and
GOMARKAR. Indy con what
entries to the Disposer Inter Sace
Routines Yield. 15 words.
Pangana
Roby needed in Bank 16. to
implement PCR 339

Assigned to: Summer Rosenberg

Comments:

Approved by: Margant H. Hametr.
Date: Oct. 29, 1970

Assembly Control Board Request

Name of Program(s): LUMINARY

Originator:

P. S. Weissman

Organization:

MIT/PL 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 alviven. This is presently done in the 1/4ccs routine and the information is feed to the DAF angular rate and acceleration estimator.

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 affect of the gimbal "metion," with a resulting impairment of control.

Assigned to: P. Weessman

Comments:

Approved by: Maryant Achamilh

Date: Ook 30,1970

Assembly Control Board Request

No. A-22 .

Name of Program(s): aflmis (Colonsus 3) and LUMINARY &

Originator: n. Brodlew

Organization: MIT/D.L

Date: JUN 161970 Mov 5, 1970

Description of Change:

append a (+/-) N to relative addresses aran indication that a branch has been made to that location.

Reason: Diminish likelyhood of inserting code between a tag and an untagged branshed to location.

N. Brodem for cocosses D. Denne for Luminary

Commonts:

Approved by: Marganta Sumbr Date: 150.9,1970

Assembly Control Board Request

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:

Comments: ACB millig held with. Pur Laur Bur Mc Cog " Doi Gly or artendes.

Approved by: Mayout Hometo

Date: 11/23/70

Name of Program(s): Luminary 15

Originator: (URISSMan

Organization: MIT

Date: / December 70

Description of Change:

make T5ADR single precision since.

Reason:

An unswitched unshared erosable needed to implement PCR ////

Assigned to: Densmore

Comments:

Approved by: Margant Hamilton

Date: 12/2/10

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 A. Hamila

Date:

12/3/70

Name of Program(s): Luminary 15

Originator: DENSMOLE

Organization: m/T

Date: 12-10-70

Description of Change:

delete INHINT before waitlist call in AOTMARIC (waitlest does INHINI)

Reason: make room (1 word) in bank 7 to implement PCR 1044.

Assigned to: Lava Densure

Comments:

Approved by: Margart Hamels

Date: Dec. 10, 1970

Name of Program(s): LUMINARY IE

Originator:

P. S. Weissman

Organization:

MIT/DL 23C

Date:

12/11/70

more efficiently without changing its

functions or interface.

Reason:

Save words in bond 16 for use of PCR 1111.

Assigned to: Deter Weisman

Comments:

Approved by: Margart H. Hamil

Date: 12/11/70



*** * * * * * * * * * * * * * * * * * *	IL JOITWINE	ANOMALY REPOR	L-1E-01
1 ORIGINATOR: P. Volante	L2 ORGANIZATION: MIT	1.3 DATE: 1.4 ORIGINATO: CONTROL N	PROGRAM Luminary PROGRAM REVISION
5 DESCRIPTION OF ANOMALY:	22 is solveted when	range to to CSM is >4	210
N.M. and closing, the is positive.	en V37 will not flas	h when ranges 400 n.m	and range-rate
			•
			CONTINUED ON PAGE
.6 DESCRIPTION OF RUN: P22 le	vel 3 digital sim.		
		•	
	e c q		CONTINUED ON PAGE
	A TIM -	NALYSIS -	
.1 CAUSE: Coding error			The second secon
.1 CAUSE: Coding error	•		4
			CONTINUED ON PAGE
.2 RECOGNITION: At the conc	lusion of RR tracki	ing in P22 when no trac	k light goes on,
computer activity con			
			CONTINUED OUT PAGE
3 MISSION EFFECT: None			
			CONTRACTO AND DATE
4	ot D22 when range t	o CSM < 400 N M and	CONTINUED ON PAGE
	ct P22 when range t	o CSM < 400 N.M. and	CONTRACTOR OF THE PROPERTY OF
4	ct P22 when range t	o CSM < 400 N.M. and	CONTRACTOR OF THE PROPERTY OF
2.4 AVOIDANCE PROCEDURE: Selec			closing.
.4 AVOIDANCE PROCEDURE: Selec			CONTINUED ON FACE.
2.4 AVOIDANCE PROCEDURE: Select	no track light goes (on, key V37E00E	closing.
2.4 AVOIDANCE PROCEDURE: Select		on, key V37E00E	CONTINUED ON FACE.
2.4 AVOIDANCE PROCEDURE: Select	no track light goes (on, key V37E00E	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: Select 2.5 RECOVERY PROCEDURE: When I	no track light goes o	on, key V37E00E alization properly.	CONTINUED ON PAGE
.4 AVOIDANCE PROCEDURE: Select .5 RECOVERY PROCEDURE: When it .6 PROGRAM CORRECTION: Fix co	no track light goes o	on, key V37E00E	CONTINUED ON PAGE CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: Select 2.5 RECOVERY PROCEDURE: When I	no track light goes o	on, key V37E00E alization properly.	CONTINUED ON PAGE. CONTINUED ON PAGE.
2.4 AVOIDANCE PROCEDURE: Select 2.5 RECOVERY PROCEDURE: When in 2.6 PROGRAM CORRECTION: Fix co	no track light goes o	on, key V37E00E alization properly.	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: Select 2.5 RECOVERY PROCEDURE: When in 2.6 PROGRAM CORRECTION: Fix co	no track light goes o	on, key V37E00E alization properly.	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
.4 AVOIDANCE PROCEDURE: Select .5 RECOVERY PROCEDURE: When I	no track light goes o	on, key V37E00E alization properly. n note #92	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
.4 AVOIDANCE PROCEDURE: Select .5 RECOVERY PROCEDURE: When I	no track light goes of ding - Do flag initia	on, key V37E00E alization properly. m note #92	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
.4 AVOIDANCE PROCEDURE: Select .5 RECOVERY PROCEDURE: When I	no track light goes of ding - Do flag initia	on, key V37E00E alization properly. n note #92	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
.4 AVOIDANCE PROCEDURE: Select .5 RECOVERY PROCEDURE: When I	no track light goes of ding - Do flag initia	on, key V37E00E alization properly. n note #92	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: Select 2.5 RECOVERY PROCEDURE: When I	no track light goes of ding - Do flag initia	on, key V37E00E alization properly. n note #92	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
2.5 RECOVERY PROCEDURE: When I	no track light goes of ding - Do flag initia	on, key V37E00E alization properly. n note #92	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: Select 2.5 RECOVERY PROCEDURE: When I	no track light goes of ding - Do flag initia	on, key V37E00E alization properly. n note #92	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: Select 2.5 RECOVERY PROCEDURE: When I	no track light goes of ding - Do flag initia	on, key V37E00E alization properly. n note #92 2.9 MIT/IL SIGNATURE: CLOSING ACTION TAKEN:	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE (2.10 DATE: 47 - 13
2.4 AVOIDANCE PROCEDURE: Select 2.5 RECOVERY PROCEDURE: When I 2.6 PROGRAM CORRECTION: Fix co 2.7 RECOMMENDED DISPOSITION (Fix, V 2.8 RECOMMENDED RE-TESTING: 3.1 NASA DIRECTION:	no track light goes of ding - Do flag initiation work-around, etch: Program	on, key V37E00E alization properly. n note #92 2.9 MIT/IL SIGNATURE: CLOSING ACTION TAKEN:	CONTINUED ON PAGE CONTINUED ON PAGE CONTINUED ON PAGE 2.10 DAIT: 41-13

	MI	T/IL SOFTWAR	E A	NOMALY	REPORT	MSC REPORT NO. L-1E-02 Rev 1
. 1	ORIGINATOR:	1.2 ORGANIZATION:		1.3 DATE:	L.4 ORIGINATOR CONTROL NO.	Lumnary
	P. Volante	MIT	0	4/13/71	COMMOE NO.	PROGRAM REVISION 210
.5	DESCRIPTION OF ANOMALY: ${ m E}$	xiting P63, P40 or F	942 w	ith a V37 ap	proximately	
	50 microseconds l	oefore ullage on will Average-G integration	resu on not	it in ullage running.	coming on a	nd not being
	ter minatea, with	arvorago a miograni				
	# # # # # # # # # # # # # # # # # # #				•	
					•	
						CONTINUED ON PAGE
1, 6	DESCRIPTION OF RUN:					
	\mathbf{T}	RW A-201 report.		* *	u-1	
		ī			,	CONTINUED ON PAGE
Name of Street,	and the second district, regardly to belong to depressing the second to the second to the second to the second	- N	IIT ANAL	YSIS -		entropies a service establishment of the second
2. 1	CAUSE: Coding erro	or: Killing of ullage			r resetting ι	ıllage bit in
	DAPBOOLS and r	eleasing interupts.				i
	e 2					CONTINUED ON PAGE
2, 2	RECOGNITION: Ullage	on after V37 to exit I	P63,	P40, P42.		
						CONTINUED ON PAGE
2.3	MISSION EFFECT: Degra	ded state vector sinc	e ulla	ige on and A	verage-G no	
	Degrad	aca state vector sine	o arre		. Vozugo d III	
						CONTINUED ON PAGE
2.4	AVOIDANCE PROCEDURE: F	Key V37 prior to TIG	-10 s	econds.		
		,				CONTINUED ON PAGE
2.	5 RECOVERY PROCEDURE: If	avoidance not possib	le, K	ey V37 afte	r ullage com	
		* .		¥ 8		
L	D.		to alr	while inter	munta ana in	CONTINUED ON PAGE
2.	6 PROGRAM CORRECTION: F1	x coding - kill ullage	e lask	wille litter	rupts are m	ilibited.
		*				CONTINUED ON PAGE
2.	7 RECOMMENDED DISPOSITION	(Fix, Work-around, etc):				
		Do not fix.		e e		
L						CONTINUED ON PAGE
2.	8 RECOMMENDED RE-TESTING:		_		. 7 /	,
		CONTINUED ON PA	1	2.9 MIT/IL SIGNATU	RE:	2.10 DATE:
3.	1 NASA DIRECTION:			4.1. CLOSING ACTIO	ON TAKEN:	
l						1.00
l		Δ.				
			ı			•
		CONTINUED ON P.	AGE			CONTINUED ON PAGE
3.	2 NASAMSC SIGNATURE:	3.3 ORGANIZATION 3.4 DAT	E:	4.2 SIGNATURE:	4.3	DRGANIZATION: 4.4 DATE:
1		1	l l			

	MIT	IL SOFTWA	RE ANOMA	LY REPO	RT MS	CREPORY NO. L-1E-03
D. N	ator: Vloore	1.2 ORGANIZATION: MIT	1.3 DATE 4-1:	CONTROL		OGRAM Luminary OGRAM REVISION
.5 DESCRI in P	PTION OF ANOMALY: A V 66 may result in	34E response to a 31502 bailout	the flashing \alarm.	706N60 displ	ау	210
					e V	
		·			•	CONTINUED ON PAGE
	IPTION OF RUN: MIT/C N60 display.	SDL hybrid sim	ulation after t	ouchdown in	P66, ke	yed V34E to
			•	÷		CONTINUED ON PAGE
			-MIT ANALYSIS -			and the second s
	: Conflict in use N60 is redisplay	of DSKY; V34E	selects R00 w	hich tries to	flash V	37, however
						CONTINUED ON PAGE 2
2.2 RECOG	Alarm li	ght on - 31502 co	ode stored.		•	
• • • • • • • • • • • • • • • • • • • •	ION FEETON DT F	DI NICO di sul la sul	in mentaged of	ton the baile	.,+	CONTINUED ON PAGE
2.3 MISSI	ION EFFECT: None.	The N60 display	is restored at	ter the ballo	ut.	
		, * *				CONTINUED ON PAGE
2.4 AVOID	ANCE PROCEDURE: Do no	ot key V34E to N	160 display in	P66.		
						CONTINUED ON PAGE
2.5 RECOV	VERY PROCEDURE: Nor	ie .				
0 (5000	D.III CORDECTION					CONTINUED ON PAGE
2.6 PROG	RAM CORRECTION: Char	nge coding, dele	te call to R00	on V34 respo	onse	
						CONTINUED ON PAGE
2.7 RECOM	MMENDED DISPOSITION (Fix,	, Work-around, etc):	Do not fix.			
						CONTINUED ON PAGE
2 8 DECO	MMENDED RE-TESTING:			. 7		-
L.O RECU						
Z.O RECO		CONTINUED ON	2.9 MIT/IL	SIGNATURE:	fireir	2.10 DATE: 4-13
	DIRECTION:	CONTINUED ON	PAGE	SIGNATURE:	breer	14-13
	DIRECTION:	CONTINUED ON	PAGE	1.7	Lef Lucer	1 H-13
	DIRECTION:	CONTINUED ON	PAGE	1.7	Left Level	1 H-13
	DIRECTION:	CONTINUED ON	PAGE	1.7	Left Level	H-13
	DIRECTION:		L PAGE	1.7	Left Level 12	CONTINUED ON PAGE
3.1 NASA		CONTINUED ON CONTINUED ON ORGANIZATION 3.4	L PAGE	NG ACTION TAKEN:	4.3 ORGANI	CONTINUED ON PAGE

MIT/IL SOFTWARE ANOMALY REPORT

- 11111716	3011111112			L-1E-03
1.1 ORIGINATOR:	1.2 ORGANIZATION:	1.3 DATE:	I, 4 ORIGINATOR CONTROL NO.	PROGRAM Luminary
D. Moore	MIT	4/13/71		PROGRAM REVISION
	Annual reserve and their executive terror and an executive terror and a finite contract terror and the second a			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 reestablished, the bailout does not occur, since the N60 display will replace the V37 flash.

MSC Form 1409A (May 68)

M I	T/IL SOFT	WARE A	NOMALY	REPOR	RT MSC REPORT	W. TE-04
1.1 ORIGINATOR:	1.2 ORGANIZ	ATION:	L3 DATE:	L4 ORIGINATO		arv
P. Volante	MIT		4/12/71	CONTROL N	PROGRAM RE	VISION
L5 DESCRIPTION OF ANOMALY: F when the mark cou is initialized each	222 lunar surfanter is zero, time P22 is s	instead of	tion initialize checking the	es the W- RENDFL	matrix	W-matrix
7.		1)			CONTINUE	D ON PAGE
1.6 DESCRIPTION OF RUN: ${ m TR}$	W A-201 repo	rt				
* 2		J*				
×	28					
					CONTINUE	ED ON PAGE
		- MIT AN	ALYSIS -			and a survey of the last of the
2.1 CAUSE: Coding 6	error	×				AND THE SERVICE STATES OF THE SERVICE STATES
	21 1 01					
					CONTINU	ED ON PAGE
2.2 RECOGNITION: None						
*	a .				CONTINU	ED ON PAGE
2.3 MISSION EFFECT: NTONG	NT i i i -		: D00		CONTINO	CO ON 1710C
None -	- Navigation is	s not done	III P22			
	*				CONTINU	ED ON FAGE
2.4 AVOIDANCE PROCEDURE:	Jone	,				
	VOIIC				CONTINUE	th ou page"
2.5 RECOVERY PROCEDURE:					CONTINU	ED ON PAGE
N	Vone			* .		
		*			CONTINU	ED ON PAGE
2.6 PROGRAM CORRECTION: Ch	neck RENDWF	LAG in P2	2 for W-mat	rix initia	lization.	
P .						
2.7 RECOMMENDED DISPOSITION	(Eiv Work-around etc).	Do not Fiv	- no missio	n effect	CONTINU	ED ON PAGE
4.7 RECOMMENDED DISPOSITION	(FIX, PROFE STOUTIG, ETC):	DO HOU PIX	. no missio	n enect.		
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2.8 RECOMMENDED RE-TESTING:					. \	the metalogical control of the contr
4.			2.9 MIT/IL SIGNATU	IRE: 1 /1 //-	<i>f</i>	2.10 DATE:
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5 D	ESCRIPTION OF ANOMALY: If	an engine fail	occurs in	P70 or P71.	and an	210	
t	enter response is the flashing verb 9 the V99 display is	made to the f 9, instead of	lashing ve	rb 97, noun b	os will be	displayed red at TIG	with after
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6	DESCRIPTION OF RUN:	mp.III. 4 . 001	Danad		w.		
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. 1	CAUSE:						and the second s
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.3	MISSION EFFECT: None						
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2. 4	AVOIDANCE PROCEDURE:	•					
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2.5	RECOVERY PROCEDURE:						
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2.6	PROGRAM CORRECTION:						
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2.7	RECOMMENDED DISPOSITION (Fix, Work-around, etc):				3 3	
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2, 8	RECOMMENDED RE-TESTING:					~	
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MIT/IL SOFTWARE ANOMALY REPORT 1.3 DATE: 1.2 ORGANIZATION: 1.4 ORIGINATOR 1.1 ORIGINATOR: CONTROL NO. PROGRAMORSVISION . R. L. Pearson 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 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 2.9 MITHE SIGNATURE: CONTINUED ON PAGE 3.1 NASA DIRECTION: 4.1 CLOSING ACTION TAKEN: CONTINUED ON PAGE CONTINUED ON PAGE 4.3 ORGANIZATION: 4.4 DATE: 13.3 ORGANIZATION 2 SIGNATURE: 3.2 NASAMSC SIGNATURE:

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			CONTINUES CALLAGE
percanition: NO V37	flashing display after	NO TRACK light goes	on.
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4 AVOIDMICE PROGRAME:	of Tooling Beleef VIII dur b) Answer Kb4 with PR	emp 1933. O to terminate R31 wh	He NO TRACK Hight
	is off.		CONTINUED ON PAGE
5 RECOVERY PROCEDURE:	Terminate V83 (R31)		
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		NAMES OF STREET		
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MIT/IL SOFTWARE ANOMA

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2.1 Continued

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

1) 401 alarm (desired MGA>70⁰) 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 PROJEPORY, NO.

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.1 (ORIGINATOR:	1.2 ORGANIZATION:	1.3 DATE:	1.4 ORIGINATOR CONTROL NO.	PROGRAM LUM
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.5	DESCRIPTION OF ANOMALY:			2	209
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. 6	DESCRIPTION OF RUN:				
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2.1	CAUSE:				
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2.6	PROGRAM CORRECTION:				
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