

CONTENTS OF
LUMINARY ID

R. A. LARSON

8/26/70
~~7/8/70~~

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LUMINARY Memo #148

To: Distribution
From: B. McCoy
Date: 11 May 1970
Subject: Call It LUMINARY 1D

Revision 163 of Luminary was released on 5/5/70 for manufacture. It contained a total of 39 PCRs, 6 PCNs, 15 ACBs and 6 Anomalies. On the following pages is a detailed description of each implementation or a reference made where appropriate.

The following is a list of the Fixed Memory changes showing the total number left of words in each bank.

<u>Bank No.</u>	<u>1C</u>	<u>1D</u>	<u>Bank No.</u>	<u>1C</u>	<u>1D</u>
0	2	2	22	4	5
1	0	2	23	6	3
2	10	1	24	0	17
3	14	14	25	16	3
4	24	2	26	2	0
5	3	0	27	4	0
6	5	5	30	9	15
7	12	1	31	5	6
10	1	1	32	0	94
11	3	3	33	6	174
12	4	4	34	57	131
13	15	15	35	33	33
14	2	2	36	6	10
15	15	21	37	6	4
16	1	2	40	17	3
17	0	0	41	23	18
20	0	0	42	7	7
21	0	13	43	1	5

total 1C remaining 313

total 1D remaining 616

ANOMALY

L-1D-01 - SS

02 - SS

~~03~~ - Re-release

04 - PCR 287

05' - PCR 287

06 - SS

07 - SS

08 PCR - 1028

~~09~~

10 - SS

11 - PCR 986.2 W_B mis-scaled

12 - ACB - L 15'

13 - PCR - 1028 $LRWH \neq LRWH_T$

14 - SS

15' - SS

16

17

18

19

20 - SS

PCR/PCN

IMPLEMENTATION/COMMENTS

286

RLS and TLAND were placed in sequence for V71 uplink format. RLS begins at E4, 1420 and TLAND begins at E4, 1426. AGSK moved to E6, 1771 and VELBIAS is now at E5, 1400.

287/1038

The 526 alarm (Range to CSM > 400 N.M.) was deleted from P22. Instead V16N54 is displayed (range, range rate, θ) if the range rate is negative. If the range is greater than 400 N.M. and the range rate is positive in P22, a flashing Verb 37 results. In P20, if the range is greater than 400 N.M. the alarm light is turned on with code 526 stored. The range and range rate values for Noun 54 are computed and stored for possible monitoring by a V16N54 request from the crew. See memos #133, 133 rev 1, "Implementation of PCR 287" by P. Volante, V. Dunbar.

294

The quantity HIDESCENT was increased to 16,700 kg for the heavier LMs.

296

In P68, GSAVE (the 'G' vector saved for gravity measurements in P57) is the unit vector of RN (post landing navigated state vector) in Nav Base coordinates.

298

LR position change will now give a 523 alarm after 10 seconds if antenna did not reach position #2. Instruction change was simply CAF FOURTEEN to CAF FOUR. Also see Luminary Memo #146 "The New R12" by R. Covelli. (also PCR 1022)

306

DVTOTAL, the accumulated Delta Velocity during Average-G, was placed in word 78 of the Descent/Ascent Downlist.

307

TSIGHT, the AOT Marktime, was placed in word 99 of the Lunar Surface Align Downlist; CURSOR was placed in 100A and SPIRAL in 100B.

310

Coding was introduced to inhibit the 511 alarm until the antenna has been out of the desired position 5 consecutive passes through SERVICER (10 seconds). A counter (511CTR) is set to four when the antenna is first detected out of either position (or in both positions simultaneously) and it is decremented every succeeding pass the antenna remains out of position. Its location is E7, 1622. (See PCR 1022)

314

The Guidance Thrust Command is time associated with a particular PIPTIME. GTC and GTCTIME are in the same "snapshot" on the Descent/Ascent downlist and located in words 5a and 6a/6b respectively. GTCTIME is E7, 1752.

315.2

A new channel (77) was created to serve as a Hardware Restart indicator. It replaced CADRFLASH +1 in all Downlists. The first half of the word (channel 76) is a spare.

821.2

AZO is the angle between the x-axis of the Basic Reference Coordinate System and the x-axis of the Earth-Fixed Coordinate System at July 1, 1969. It was placed into fixed memory since it remains essentially the same for a given year.

872.4

A TIG countdown is started prior to the attitude maneuver in P41. It continues until TIG -35. A job, DYNMDISP, is scheduled immediately after P41 is called; it computes TFI and then calls itself every second. P41 proceeds on with DYNMDISP in the background, like CLOCKTASK in P40, 42. If V16N40E is used to monitor TFI, then V16N85E must be keyed if the VG display is desired again.

874.2

As in Colossus the astronaut does not have to key leading zeroes to a decimal load. For example a decimal load of +50 will reappear as +00050; +E will reappear as +00000E.

892

R29, the Ascent RR Designate Routine, was deleted from Luminary.

896

In an effort to save valuable time during the Powered Descent, the LR velocity readings are centered around PIPTIME. For details see Luminary Memo #146 "The New R12" by R. Covelli. The Radar Read routine used by the LR & RR was rewritten.

897

PCR 775 provided the capability to compensate for a Hardware failure in the Doppler Ranging Unit of the Landing Radar, a precautionary measure. This coding was removed.

CHANGE

898

In Luminary 1B the LR velocity readings were not taken until the S/C Inertial Velocity was 2000 fps. In Luminary 1C this limit was changed to 6000 fps, effectively removed. In Luminary 1D it was removed entirely, so that now LR velocity readings will start as soon as the velocity data good appears after R12 begins. Also see Luminary memo #146 "The New R12" by R. Covelli.

899

Erasable "TET" (N38) which is the time to which state vector is being integrated in each time step was put on the following downlists: Coast and Align, Lunar Surface Align and Rendezvous/Prethrust. It could aid the ground controllers to detect integration loops.

942

A value of 50 ft (scaled meters B-10) was placed into fixed memory; LR updates are inhibited below this altitude. This number (HLROFFF - Single Precision) is loaded into the least significant half of a Double Precision word (HLROFF) at the start of P63 (FLAGORGY); therefore, HLROFF can be externally changed to a different value after P63 is called. In routine MUNRETURN, HCALC (most significant half) is check to see if it is < 3000 ft (bit 1 = 0). If so,

HCALC +1 (least significant half) is subtracted from HLROFF. A plus result will reset LRINHFLG (flagword 11 bit 8). Later in the position update (NOREASON) and also in the velocity update (VUPDAT) this bit is checked. If it is reset, SERVICER continues without any LR updates (effectively a V58). HLROFF is E7, 1451.

944 LATVEL and FORVEL, the cross pointer lateral & forward velocity, are now on the Descent/ascent downlist in word 12, in that order.

945 In Flagword 11, bits 13 and 14 will now be set to indicate when at least one failure of the Altitude and Velocity Reasonability tests respectively have occurred. They are reset whenever their respective reasonability tests are passed.

970.2 Recently built gyros have a large bias shift that is dependent upon the polarity of the last torquing on the gyro. Coding was added to the IMU Pulse torquing routine to eliminate this bias shift. For details call R. Lones at MIT 864-6900 X821-529.

979 Program alarm 521 was a redundant indication of RR data good loss, so it was removed.

982 For Lunar Surface Alignments, Cursor/Spiral angles are now available for all celestial bodies, not just catalogued stars. Thus any body specified by N88 will be accompanied by a N79 display. The setting up of BESTI and the check for a catalog star were removed. Routine PLANET now interrogates N70 (R1).

983

N88 will now accept unit vectors instead of the half unit vector. Prior to unitizing, N88 (location STARAD) is divided by $(3)^{-1/2}$ to insure the unit operation will not overflow.

986.2

Fixed Memory Ephemeris constants were updated to 1970-1971 year.

988/1037/1035

P66 is essentially the same as it was in Luminary 1C (LM131 rev 1) which was done so as to keep changes only in one rope module for the re-release of Luminary 1C. Differences: a PRO to the V06N60 sets P66PROFL (Flagwrđ 0, bit 1). This inhibits FINDCDU from sending RCS commands if the ENGARM switch is off. PCN 1037 removes a "Stoprate" and the resetting of REDFLAG (Flagwrđ 6 bit 6) from P66 initialization. It also adds a "Stoprate" when a 01466 alarm occurs. Therefore should the situation arise via high TLOSS etc, that P66 is having difficulty in emitting sufficient throttle commands, a 1466 alarm will occur preceded by RCS jet activity to stop any vehicle rates. PCN 1035. The Terrain Model will be terminated when P66 is started; NOTERFLG (Flagwrđ 1, bit 11) is set which causes Servicer to bypass Terrain Model computations.

990

Fixes Anomaly L-1C-04. A one second cycle was set up in V44 logic to wait for a Remode to be completed (checks bit 14 of RADMODES) before terminating a continuous designation of the RR.

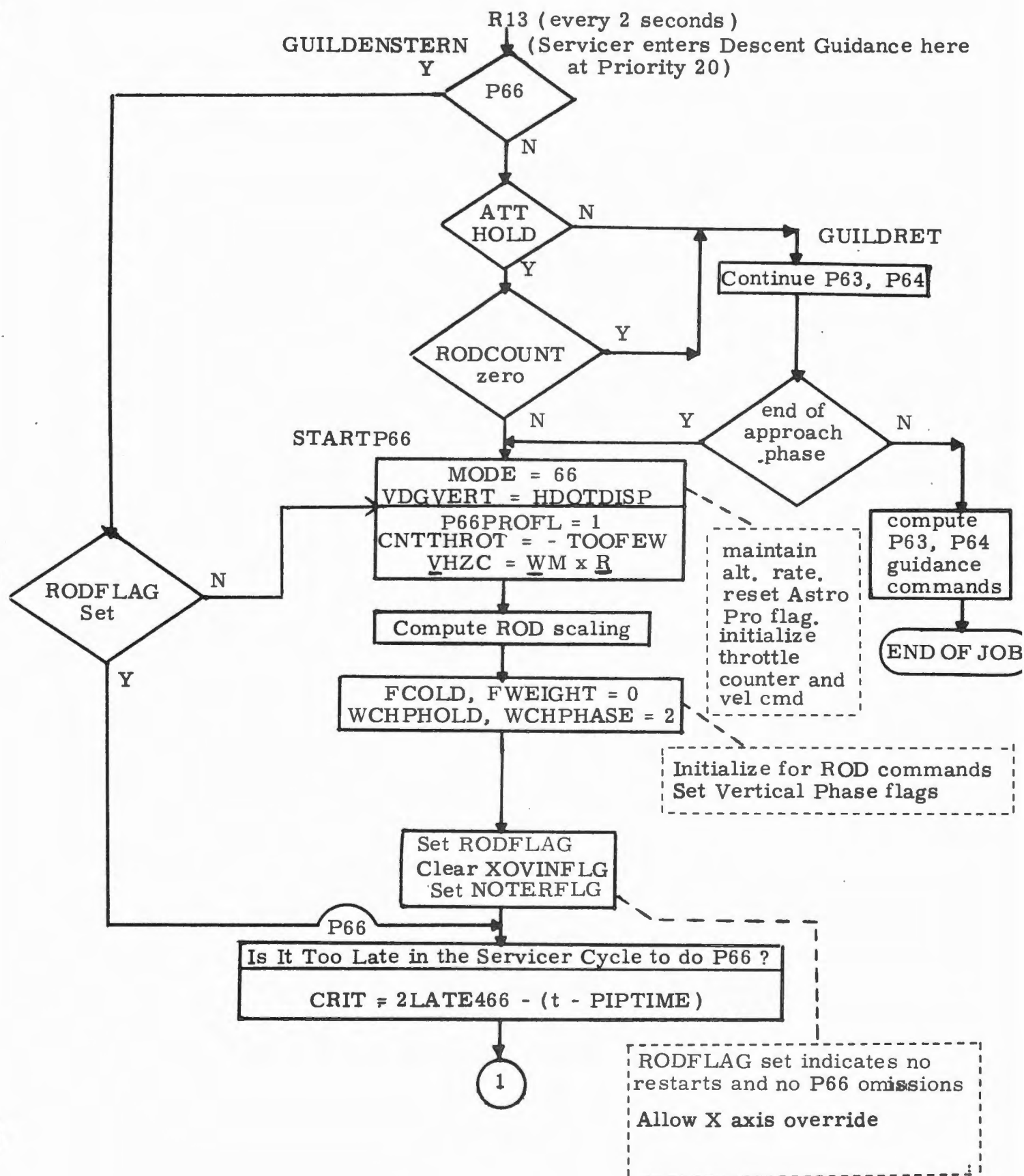
991.2

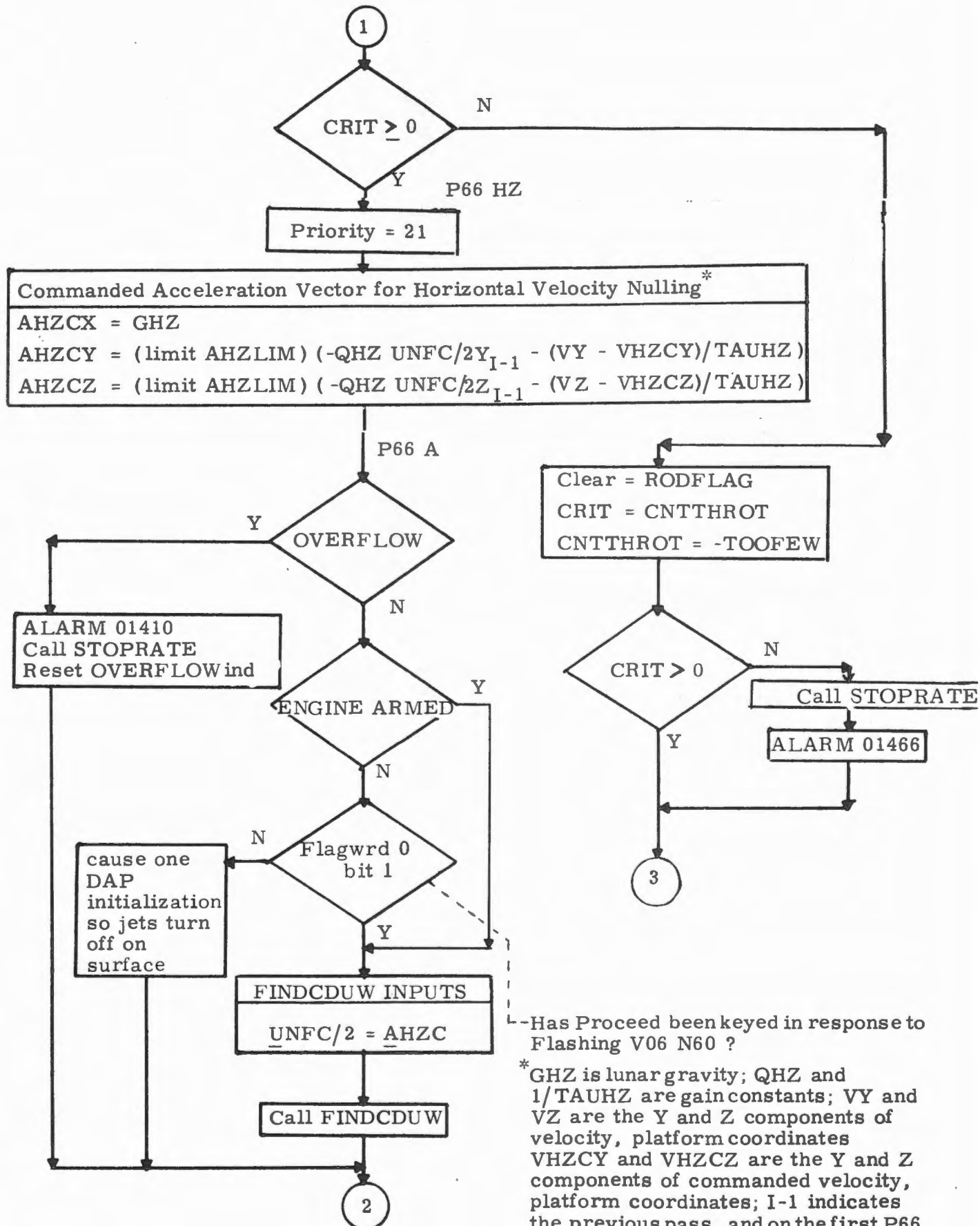
The UPRUPT routine interrogates NODOP07BIT (Flag 3 bit 11) which is set by any V37EXXE after earth launch. If it is "0" the Uplink telemetry code (KEYTEMP1) is added to the previous summation of codes and forms a new sum (UPSUM). Next a counter (located at UPSUM +1) is

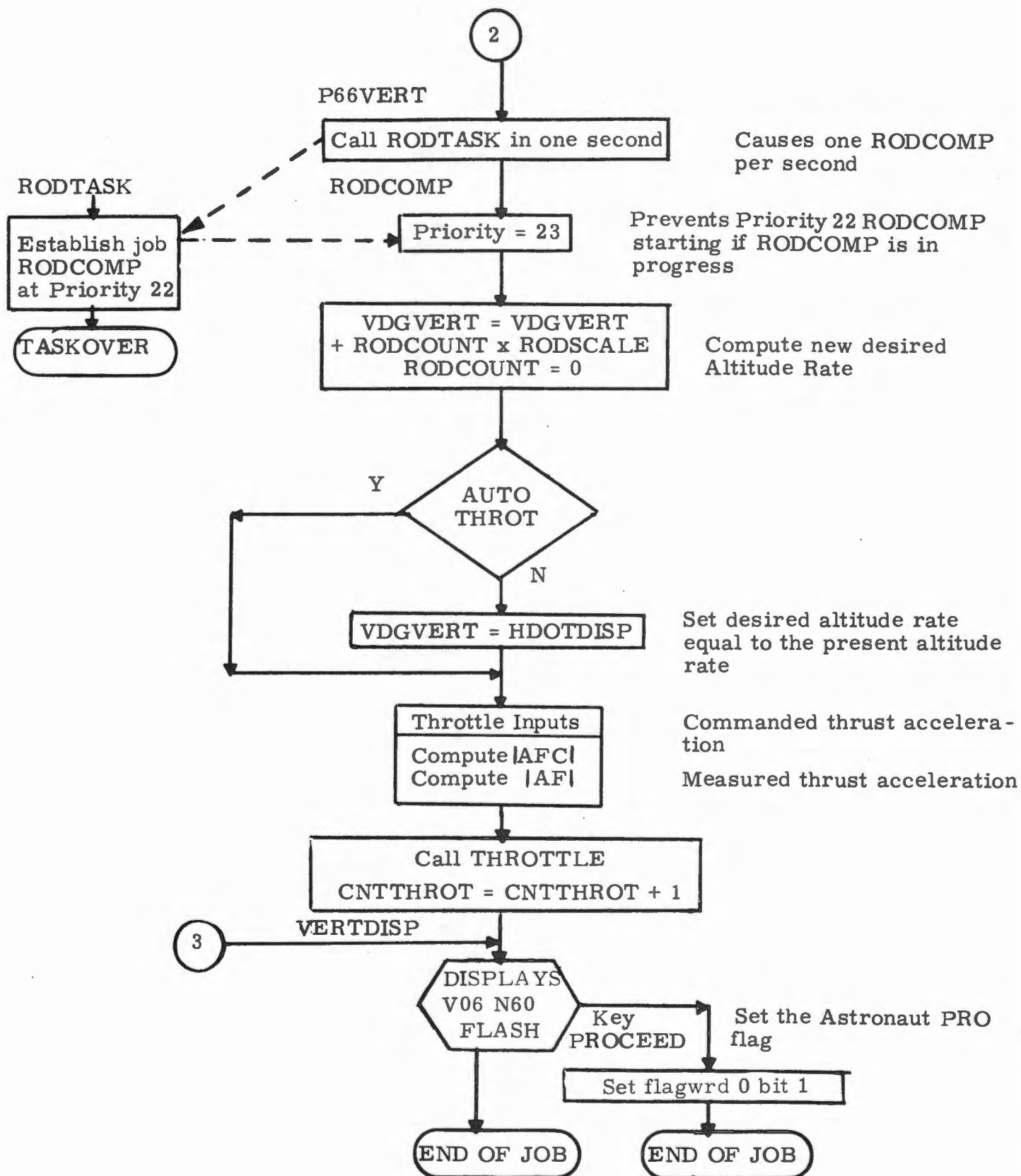
Handwritten notes:
 This don't we put
 V44 not it permit it
 don't back inside the
 to limit

incremented to show the total number of uplink codes received. If NODOP07BIT is "1" no summing takes place.

UPSUM, UPSUM +1 share with ABDELV, location 1245.







996/1036

The selection of P07 (V92) is now contingent on NODOP07BIT (Flag 3 bit 11) being "0". If it is "1" the Operator Error light is illuminated. A Fresh Start will not disturb this bit so that V36 can be used to terminate P07; therefore, P07 can be called again without manually resetting NODOP07BIT. However, if V37 is used, e. g. Sim Flights before launch, the bit must be reset before P07 can be called.

1013

was implemented into LUMINARY 1D essentially the same as for LUMINARY 1C. It assures against stacking of jobs when TLOSS is present by omitting one horizontal and two vertical P66 commands. If there are too few vertical commands for proper ROD control, alarm 01466 is given. See Luminary Memo #14, "Automatic P66" by Allan Klumpp.

1015

Immediately on keying V90E, V37FLBIT bit is checked to see if Average G is on. If so, the Operator Error light is illuminated.

1021

now has precomputed LR position transformation matrices in Fixed Memory (VZBEAMNB) eliminating the computation time and to facilitate coding of PCR 1022. Routine POSINDEX sets the Interpreter Index Register X1 in accordance with the LR Position (location LRPOS):
Position 1 - LRPOS = 2 , X1 = -24D , X2 = 0
Position 2 - LRPOS = 1 , X1 = 0 , X2 = 0
Thus, when POSUPDAT and VELUPDAT routines use the LR measurement data, it is transformed in accordance with X1 from NB to SM coordinates. Four padloads were ~~deleted~~; LRALPHA, LRALPHA2, LRBETA1, LRBETA2. Also see Luminary Memo #146 "The New R12" by R. Covelli.

1022

The handling of the LR position alarm has been made very simple. In R12 channel 33 bits 6 and 7 are checked to see if there had been a change in position from the previous Servicer pass. If both or neither position discrettes are present Servicer continues without any LR updates (Terrain model also bypassed), ~~If this situation exists for 5 passes (10 seconds)~~ 511 alarm is given and will be given once, ~~every 10 seconds until~~ the situation is corrected, *LR updates will continue to be processed*

If either position 1 or 2 discrettes are present it is checked against the present position (indicated by LRPOS). If they are different, Servicer continues with no updates. If they are the same, updates may be performed. Routine HIGATJOB is called to reposition the LR to position #2 at the beginning of the approach phase (P64). After the antenna has reached position #2 or after 10 seconds, "LRPOS" is set equal to 1 to indicate (reverse logic) that the new position is to be 2. If the antenna did not reach position #2 *after 10 sec* the 511 alarm will be given as described above. If the position is #2, normal updating continues. Note: the 523 alarm has been eliminated from R12 although it still exists for V59.

1025

72 .017 86/sec/10R ft
The LM navigated state vector was updated for any gravity effects on altitude after the LR updates. This was deemed to be insignificant and was removed. A call to MUNGRAV was removed from routine RVBOTH.

1027/1035

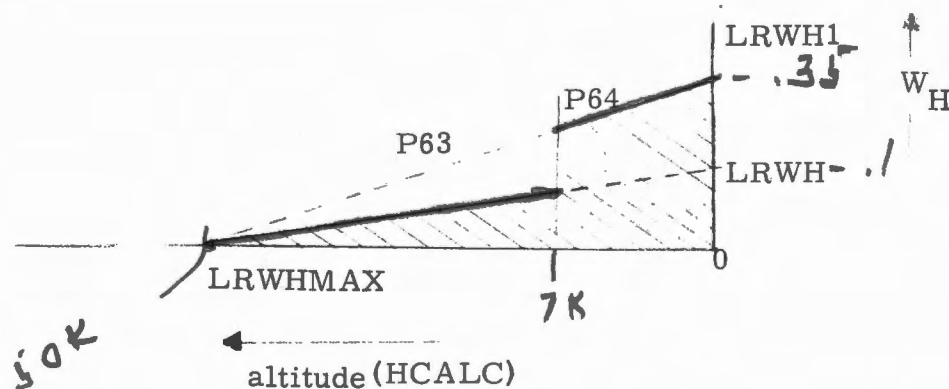
An a priori Terrain Model was implemented into Luminary to smooth the trajectory over rugged lunar terrain and to reduce the LPD errors and fuel consumption. It uses 5 segments, a slope and a range-to-landing site (abscissae), for each. The terrain not falling into the segmented region

(the model covers a region from some specified abscissae (range) to the landing site) will be modelled by a constant altitude, equal to the altitude at the last abscissae. The slopes and abscissae are specified in E memory by SLOPE0, 1, 2, 3, 4 and ABSC0, 1, 2, 3, 4. SLOPE[#] and ABSC[#] correspond to the segment nearest the landing site (loc E5, 1527 and E5, 1522 respectively, scaled B-6 and B-18 respectively). For more details see Luminary Memo # by Allan Klumpp, Don Eyles, and Bruce McCoy.

147

1028/1039

A new padload (LRWH1, E7, 1756) was created to allow for a two-segmented altitude weighting function. The present scheme is as shown below.



given by equation $W_H = LRWH (1 - HCALC/LRWHMAX)$.

LRWH is set equal to LRWH1 in P64.

W_H is altitude weighting function.

LRWH, LRWH1, and LRWHMAX are erasable to set the slope.

HCALC estimated altitude.

1029

Due to the extensive analysis done prior to Apollo 13 on TLOSS it was found that the ground controllers could possibly determine what percentage of the computer duty cycle was not being used or what percentage was not available

due to TLOSS. It was also thought possible that the post flight data could be used to calibrate LMS configuration time (presently it runs faster than the actual AGC). Two erasables were defined and are on all downlists (specified on PCR). SERVDURN (loc 1355) is loaded with the present LGC time (least significant half) just prior to the Average G Exit point (after navigation, prior to guidance). DUMLOOPS (loc 1356) is a counter which is incremented each time DUMMYJOB finds no job to be serviced - idle time. It will quit counting when a job is called, starting again when it is finished. Data will be published at a later date specifying the time between DUMLOOP increments.

41
11.8
328
41
483.8
483.8 μ sec
2K CTS/sec

McLary

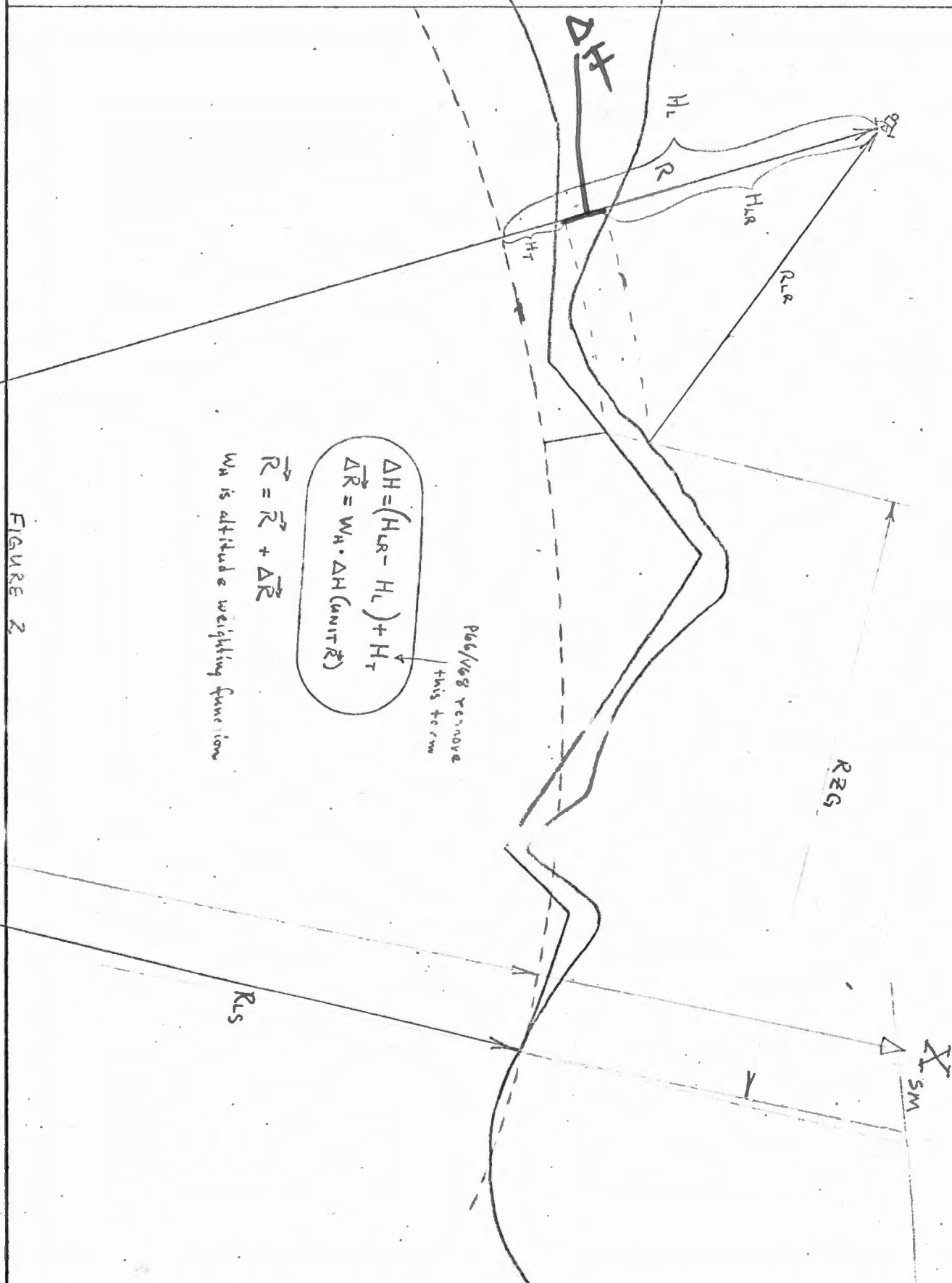
SHEET _____
OF _____



INSTRUMENTATION LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASS.

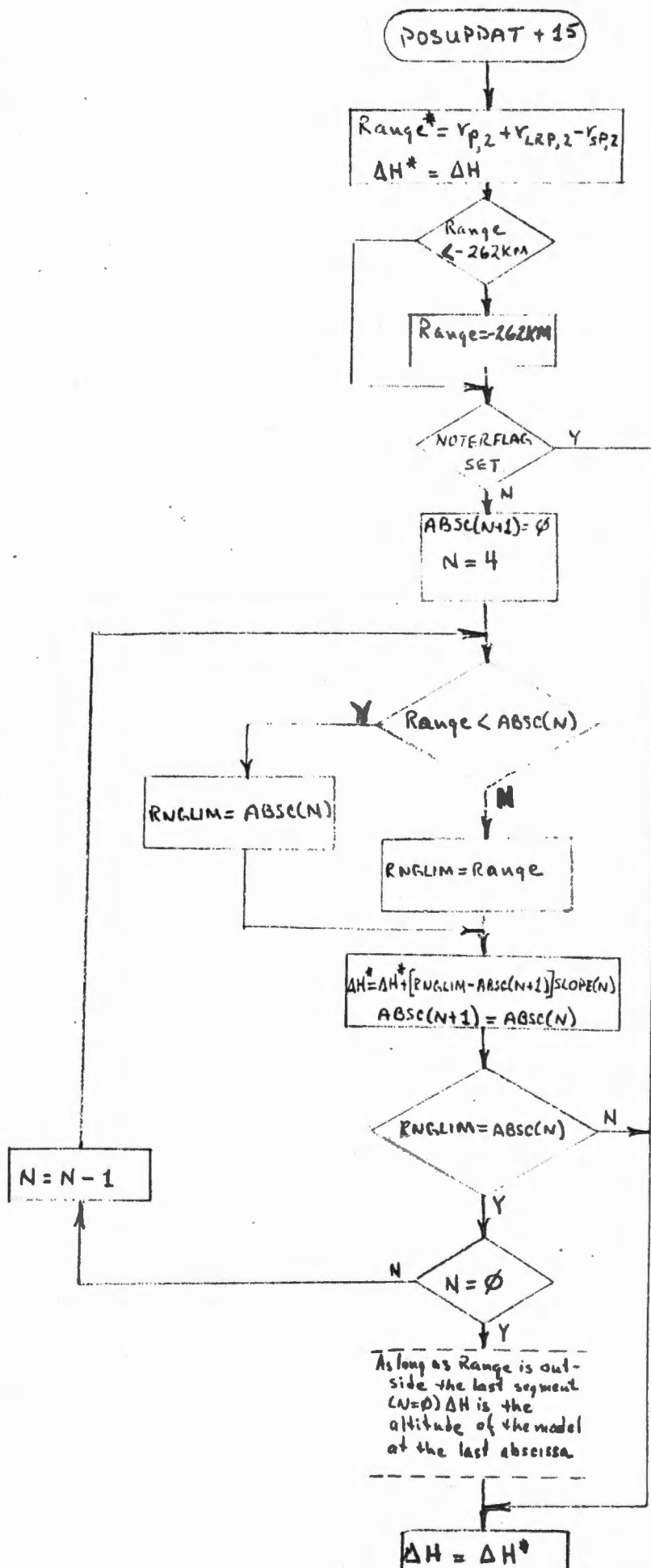
DATE:

OF _____



WITH PEN 1039

A PRIORI TERRAIN MODEL



Range is a negative number equal to the Z component in platform coord of the vector from the landing Site to the point of intersection of the LR altitude beam with the lunar Surface.

V6K or P66 terminate terrain computations

Initialize for 5 possible passes; 4 denotes segment nearest the landing Site

If the Range is not within the segment for this pass, ΔH^* is the altitude of the model at the abscissa. ΔH^* is then used to build the remaining segments

If the Range is within the segment for this pass, ΔH is the altitude of the model at this Range

WAS THIS THE LAST SEGMENT?

Anomaly

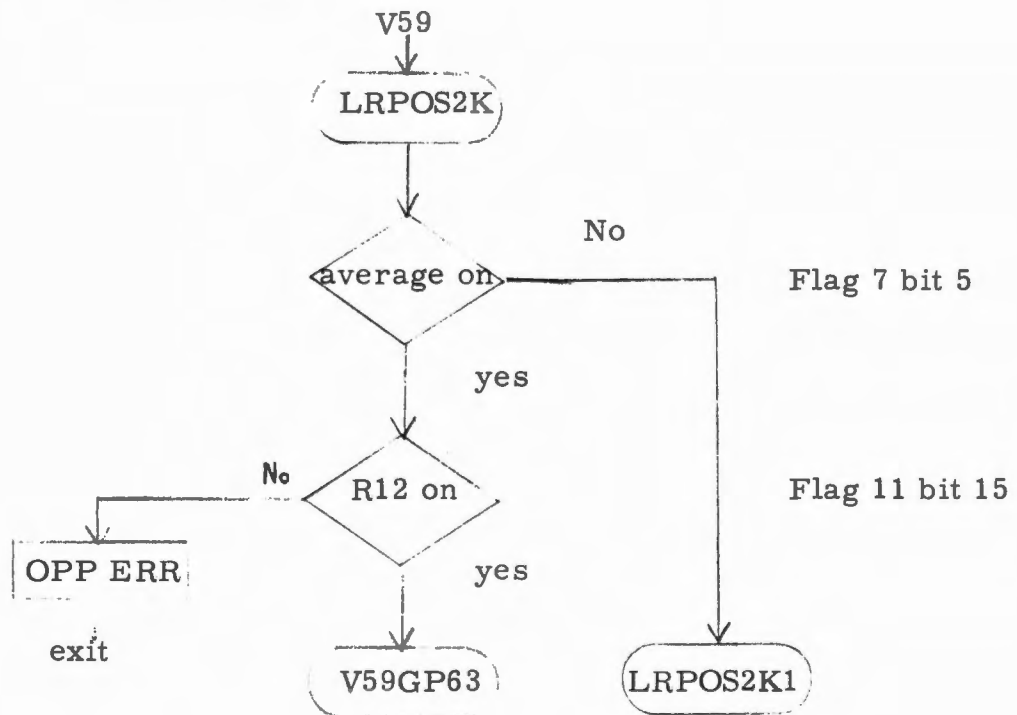
Implementation/Comments

L-1C-01

It was found that a Restart during an EXTERNAL ΔV burn by P40 or P42 could cause a ΔV increment to be subtracted from VG again after the Restart recalled the steering routine S40.8. A Restart point was placed after the subtraction had been made.

L-1C-03

A coding error in V59 leadin caused the DAP estimated attitude errors to be placed on the FDAI needles as well as moving the LR antenna to position #2. It was rewritten as shown below:



Now, V59 can be used in P64 if desirable.

L-1C-04

See PCR 990.

L-1C-05

The computation of HCALC (a Double Precision word), the estimated altitude in a Descent or Ascent, did not assure sign agreement to both halves of the word. It caused the x-axis-override inhibit to occur at an altitude somewhat less (~ 26 kft) than the desired altitude (30 kft). A call to the SIGNAGREE was added in routine RVBOTH where HCALC is calculated for the altitude check.

L-1C-06

It was possible to not navigate some ΔV in P40, 42 or P63 if a V37 was used to terminate ullage or a DPS/APS guided burn because average G was turned off prior to allowing V37 to turn off ullage/the engine. In Luminary 1D a V37 turns off ullage/the engine immediately on finding Average-G on.

L-1C-08

A Restart while the DAP was in the manual rate command mode may cause 1) Temporary nulling of a Q or R axis manually commanded rate while the rotational hand controller is out of the detent position, or 2) Yaw to another attitude if the Restart occurs during rate command initialization.

To correct this, the desired CDU's are set equal to the actual CDU's each pass through Q/R axis in manual rate command mode and OURRCFLG is set after initialization of manual rate command mode is completed.

ACB's

L-11

When PCR 882 was implemented into Luminary 1C the Forward Velocity displayed in NOUN 60 was not computed when the MODE SELECT SW was in a position other than PGNCS. The check for the switch position was moved to a place in SPEEDRUN after Lateral and Forward Velocity are computed, thus, if the switch is in AGS or LDR, LATVEL and FORVEL will be computed for display and return is made to ALT/ALT RATE computations without sending LATVEL/FORVEL to the cross pointers.

L-12

The capability of a service routine (LONGCALL) was expanded to allow a call for a task located in a high super-bank (40-43). This was first implemented into COLOSSUS.

L-13

X

In the Ascent and Descent Programs, an interrupted display (such as V06N63) would cause an extra VAC area to be tied up when it is not really needed. If it was interrupted by an Extended Verb with display it would use 4 VAC areas. A routine (VACRLEAS) was written to change the next display job from one requiring a VAC area to one needing only a Core Set (12 registers instead of 42). The displays involved were the V06N63 displays in P12 and P63, the V06N64 displays in P64 and the N60 display in P66. This reduces the chance of receiving Executive storage overflow (31201, 31202) alarms.

L-14

Three fixed words were needed in bank 1 to implement PCR 872.2. It involved equating GENADR tags to fixed-fixed memory location equivalents.

L-15

Three fixed words were needed in bank 43 to implement PCR 990. Routine CLRADMOD was used to reset bits 14 and 10 of RADMODES which was done previously by 4 instructions. Redundant coding of resetting these bits in RRDESEND was deleted (same 4 instructions above to reset bits 14 and 10 had been followed by a TC CLRADMOD).

L-16

X

It was found in Luminary 1C a possible indeterminate transfer could occur if the TLOSS was high enough in P64 to cause a 1201 or 1202 alarm immediately prior to P66 entrance, occurring during the throttle routine. The problem had been caused by two programs using BANKCALL, the former destroying the return of the latter. A POSTJUMP and associated return interface replaced P66's BANKCALL to the throttle routine.

L-17

A Restart during a DPS throttle recovery caused the throttle commands to the DECA to be terminated because the Restart logic in STARTSUB2 "zeroed" bit 4 of channel 14 (Thrust Drive Enable). STARTSUB2 was changed to prevent the zeroing of this bit. Also, if a Restart occurred after the throttle pulses had been started but before the next phase change (after FINDCDUW) these pulses could be sent twice. A phase change (TC FASTCHNG) was added just after the return from throttle and just prior to FINDCDUW. A PCN 1043 was written to supercede this ACB since it was found after release that GSOP Section 2 was affected in a minute way. A statement was made that a Restart zeros all but bit 6 of channel 14.

L-18

Late changes were made to the Luminary 1C rope which were implemented at the same time AUTOP66 was crowned. One involved improving the logic on overflow checks in Lunar Landing in the Guidance Equations. It was found to be better to skip guidance commands if overflow occurred, regardless of the STEERSW. Another was a logic change in the same area (STEER?): remove the Attitude Hold Check for a decision to do a STOPRATE (tell the DAP to stop all attitude rates). There could be a situation of just switching PGNCS control mode from AUTO to Att Hold between FINDCDUW and the next pass through STEER?. The stoprate would then be bypassed unintentionally.

L-19

470
Don Eyles thought of an ingenious way of reducing duty cycle time (by us) in the very busy P66. By adding a few instructions prior to QUICKTRIG (CDUSPOT = CDU), he used QUICKTRIG and *NBSM* in the P66 VERTICAL computations instead of the CDU*NBSM routine. Both methods are the same, transforming UNITX vector from NB to SM coordinates.

- L-20 Spelling of NEGORKP (an unreferenced erasable) and an insignificant card punch error for NOUN 60 were corrected.
- L-22 The setting and resetting of the R04 flag in R65 was deleted; it had prevented the 521 alarm which was eliminated by PCR 979.
- L-23 EBANKS 2 and 4 contained some erasable assignments that were not being used. Their tags were removed so that the locations may be available for assignment. They were W.IND1 (loc 1257), VACX, Y, Z (locs E4, 1537, 41, 43).
- L-24 EBANK 7 also contained some erasable assignments that shared unnecessarily with RTARG. ZERLINA, ELVIRA, AZINCR1 and ELINCR1 were moved from E7, 1443-46 to E7, 1644-47 replacing their dummy erasables. Other erasables VDGVERT, NIGNLOOP, and NGUIDSUB (E7, 1644-47) used to share with the above dummies, now share with ZERLINA, ELVIRA, AZINCR1 and ELINCR1.
- L-25 R. Covelli found that the Master Ignition Routine (BURN BABY, BURN) could be used by an erasable program (e. g. LM DEORBIT Erasable Program) if some instructions addressing fixed memory were changed to be able to address erasable memory also. For example
- | | |
|-------|-------|
| INDEX | WHICH |
| TCF | 12 |
- is used to transfer control to a location specified by the 12th location of a table (each program has its own table specified by WHICH). If the TCF (Transfer Control to Fixed memory) were to be changed to TC (Transfer Control to either Fixed or erasable) a table such as that used for P40, 41 or 42 could be placed into erasable memory and program flow could

transfer between an erasable memory program and the
Master Ignition Routine.

ABSC0	002523	72325	
ABSC1	002524	76476	
ABSC2	002525	77341	
ABSC3	002526	77640	
ABSC4	002527	77745	
SLOPE0			
SLOPE1	002530	77774	
SLOPE2	002531	00016	
SLOPE3	002532	77765	
SLOPE4	002533	77772	
VIGN	002456	00416	15755
HIGNY	002460	77730	51505
RIGNY	002462	77121	73554
KIGNY/B4	002464	77255	41625
KIGNY/B8	002466	73754	52752
KIGNV/B4	002470	72516	57777
TCGIBRAK	002453	25762	
TCGFBRK	002452	00567	
TENDBRAK	003423	01407	
GAINERAK	002446	37777	37777
RBRFGX	002402	77776	76044
RBRFGZ	002406	77773	75347
VBRFGX	002412	77766	74245
VBRFGZ	002416	77773	45722
ABRFGX	002422	77774	54701
ABRFGZ	002426	77663	77104
VBRFG*	002432	77765	45231
ABPFG*	002436	77067	72634
JBWFG*	002442	77545	63205
DETTTAP	003425	75632	
TCGTAPPH	002455	04704	
TCGTAPPE	002454	00113	
TFNDAPPR	003424	00226	
GAINAPPR	002450	00000	00000
RAPFGX	002404	00000	00624
RAPFGZ	002410	77777	77635
VAPFGX	002414	77777	77400

K2PARM	+ 1	002554	47011	
THETCRIT	+ 0	002555	76362	50553
RAMIN	+ 0	002557	03324	07601
YLIY	+ 0	002561	00016	32446
ABTRDOT	+ 0	002563	00007	23346
COSTHET1	+ 1	002565	00000	00000
COSTHET2	+ 0	002567	06733	07535
IGNAOSQ	+ 0	003012	02363	
IGNAOSR	+ 0	003013	00146	
HIASCENT	+ 0	003000	02324	
TLAND		002026	04347	20441
FLS		002020	00311	31177
PLS	+2	002022	77700	55774
RLS	+4	002024	77762	55732

TAG	Location	Value
VAPFGZ	002420	00000 00372
AAPFGX	002424	00002 14522
AAPFGZ	002430	77774 71233
VAPFG*	002434	00000 01062
AAPFG*	002440	77754 67646
JAPFG*	002444	00612 30716
RODSALE + 1	002534	14370
TAUBOD + 0	002535	11300 00000
LAG/TAU + 0	002537	15164 01420
MINFORCE + 0	002541	00001 27631
MAXFORCE + 0	002543	00013 06551
TAUHZ	002474	07640
OHZ	002475	14632
AHZLIM	002476	00017
HLBOFF	003451	00000 00364
TOOFEN	003464	00003
2LATE466	002477	00000 00226
ZOOMTIME + 0	003422	05050
LEADTIME	003426	77744
LOWCRIT	002472	04130
HIGHCRIT	002473	04471
ELBIAS	001353	00020
AZBIAS	003373	00020
VELBIAS	002400	00005 33212
DLAND + 0	002631	00000 00000
DLAND + 2	002633	00000 00000
DLAND + 4	002635	00000 00000
RPCRTIME + 0	003427	01407
RPCRTOSY + 0	003430	57777
DELOFIX + 0	002503	00000 04606
LRWH + 0	003421	13146
LRWH1	003756	10000
LRHMAX + 0	003420	35610
LRVMAY + 0	002511	01414
LRVF + 0	002512	00116
LRWVZ + 0	002513	11463
LRWVY + 0	002514	11463
LRWVX + 0	002515	11463
LRWVPZ + 0	002516	06315
LRWVPY + 0	002517	06315
LRWVPX + 0	002520	06315
LRWVPF + 0	002521	03146
J1PARM + 0	002545	07011 04633
K1PARM + 0	002547	75524 40475
J2PARM + 0	002551	07013 24073
K2PARM + 0	002553	73337

AGSK	003371	03671
AGSK +1	003372	21200

Pad Load Erasable Changes
Values

Massachusetts Institute of Technology
Charles Stark Draper Laboratory
Cambridge, Massachusetts

LUMINARY MEMO # 155

TO: Distribution

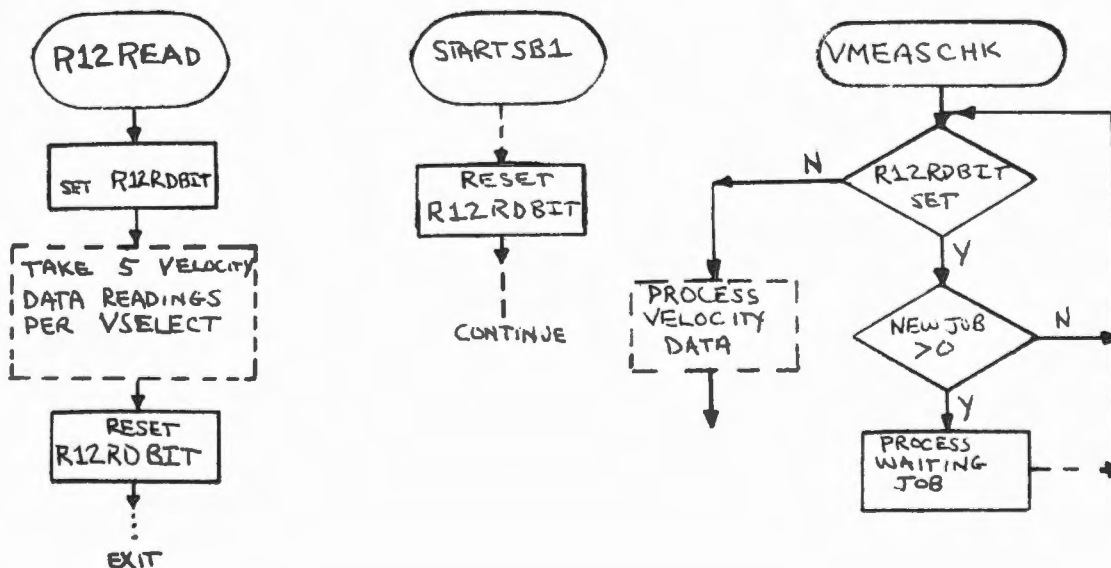
FROM: B. J. McCoy

DATE: 1 June 1970

SUBJECT: Luminary 1D re-release

Due to the bugs that came out of the woodwork after the May 5 release of Luminary 1D, the program was judged to be non-flight worthy. The following bugs were fixed and are listed below. The rope release date for these changes is 16 June 1970.

1. Implementation of ACB L 20-
N60 An error was made in reading assembly card numbers: 2234 vs 2334. By coincidence, they are concerned with the same noun (60) in the NOUN Tables (output and input scaling). The fix makes the output scaling 0.5571 fps/bit and the input scaling the way it was originally, though it is not intended for use.
2. Implementation of PCR 988-
The Restart point in P66 was moved down four places to (1) prevent the AstrPro flag from being set by a Restart if it had been reset to turn off RCS jets (2) prevent a possible 1466 alarm if a P66 omission occurred with a Restart.
3. Implementation of PCR 896-
X (LMS/KSC). The landing Radar Velocity Reasonableness test could fail erroneously due to Service being too fast. It starts to process LR velocity data before the complete set of radar readings are taken for a particular velocity beam. The fix is flowed below.



R12RBIT is flagword 11 bit 3. This was concurrently discovered by Robert Force, NASA (LMS/MSC) but has not to this date been seen on the FMES at GAEC. A special case, i.e. no alt data good and a V68 terminating the a priori terrain model computations, produced 9 failures at MIT/CSDL.

4. Elevation angle fake out- *PCN 1048*
 the shortened Rendezvous being used on the LMS's for crew training showed that the elevation angle in P34 (ELEV) shares an erasable cell that could cause a problem. At the time it ~~shared with YDOT~~, the cross axis velocity to which Ascent Guidance is steering. It usually is a very small number; thus, when P34 displays its DP number in NOUN 55, it could appear to the astronaut as +00000. If he wants to compute an Elevation Angle based on a TPI TIG, he probably would not load zeros himself (it looks zero to him, even though it could be a very small non-zero number). This results in a 611 alarm, no Elevation angle for given TIG. The fix put in was to 1) initialize ELEV to zero in P34 before it is displayed and 2) don't share it with YDOT, but where it used to be (in Luminary 1C). (Subsequently reported by R. Force)
5. Implementation of L-1C-01-
 A restart point was inserted in a subroutine (S40.8) which returned to the caller via QPRET, which is in the VAC area. Since a particular VAC will not necessarily correspond to the same job after a restart has occurred, the expected return (QPRET) could be anything and, thus, a random transfer is probable following a restart during subroutine S40.8 of P4X. This was corrected by making a direct transfer back from S40.8 to the calling routine UPDATEVG (X product steering).
6. Implementation of PCR 1013-
 TOO FEW, the erasable governing the occurrence of a 1466 alarm if P66 issues "too few" throttle commands for everyone omitted (by TLOSS) shares with a P30 erasable and also with a Descent thrust/guidance erasable. It could result in an erroneous 1466 alarm should TLOSS be high enough to cause a P66 omission (now >10%). It was moved to an unshared, unswitched erasable location (1354).

Attached are additional Level III and IV tests to be performed as a result of these changes.

The known problems existing in Luminary that will not be fixed until Luminary 1E are as follows:

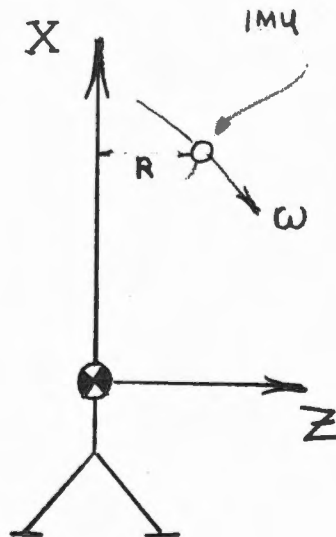
1. Luminary anomalies L-1C-01 and L-1C-02
2. "LRPOS" initialization in P63 is reversed
3. a DDOUBL instead of a DOUBLE in Throttle Control logic-effect is 2.7 lbs thrust
4. a V37 following within 10 sec of a V40N20 (CDU zero) turns off DAP

5. Altitude Rate on tape meter glitches periodically: unresolved
6. Cross Pointer - P66 Auto inconsistency: unresolved
7. "LRWH" overlays "RM" of P20
8. DXCH instead of XCH in Throttle Control Logic - affects only Throttle recovery
9. Display conflict in P20's with extended verbs
10. Predesignate flag in P22 incorrectly used
11. "LRWH" is not updated for P63 - P66 interface: unresolved

Corrections to Memo #148

1. Landing Radar beam on Terrain Model Graphs should have opposite polarity
2. for PCR 1029 SERVDURN is loaded with the difference between TIME 1 and PIPTIME +1 (least significant halves) just prior to Average G exit.
3. for PCR 315.2, channel 76 is not really a spare as such. The channel is available for hardware assignment.
4. for PCR 897 should read ". . .to compensate for a hardware change in the Doppler Ranging Unit. . ."

PCR 1052 was implemented into the re-release to account for the IMU sensing vertical acceleration in P66 when the PIPA's are read while Spacecraft attitude rate is present. The result before the PCR implementation was throttle oscillation commonly referred to as "throttle castellation." Now, when the present acceleration due to thrust is computed (i.e. the PIPA's are read in P66) the pitch rate as determined by the DAP (OMEGAQ) is multiplied by the offset distance the IMU is from the X axis in the Z direction. This quantity is a measure of the Delta Velocity sensed by the PIPA's due to the IMU rotating ("bobbing") around the center of gravity and is subtracted from the total Delta V measured by the PIPA's for that P66 one-second pass. Navigation is in no way affected by the bobbing or the correction.



$$\Delta V_x = \Delta V_x - \omega \cdot R$$

Level III Addendum
Test Plan for Lummary 1D (rev 163+)

Prepared by: McCoy
Date: 5/28/70

1. Test scaling of NOUN 60 R1-ACBL20
 - a. Dump FORVEL (during Descent, for edit) at VERTDISP
 - b. Edit will print out value scaled at 0.5571
 - c. Compare to DSKY at corresponding time
2. Test Restart point in P66 - PCR 988
 - a. cause a Restart in P66 (with 10%) TLOSS) after P66 omission having "PRO"ed on NOUN 60
 - b. show that "P66 PROFL" remains reset and no 1466 alarm occurs
3. Test R12 velocity radar readings PCR 866
 - a. w/o alt data good, w/v68 - show that R12 waits; note time margin and compare duty cycle to run before this fix
 - b. w/ alt data good, w/o v68 - show that R12 doesn't wait; compare duty cycle to run before this fix
 - c. do (a) above with 10% TLOSS
 - d. do (b) above with 10% TLOSS
4. Test that ELEV (DP) is initialized to zero in P34-PCN 1048
 - a. pad load posmax into ELEV - trace coding to show proper load and note R2 of NOUN 55 equals zero.
 - b. use old level 4 test NEWROT (rollback) to show that Lambert computes good ELEV for TIG loaded.
5. Test P40 restart fix: L-1C-01
 - a. Trace S40.8 to show direct transfer back to UPDATEVG which had called it.
 - b. Cause a Restart during S40.8 and trace as in (a).
6. Test TOO FEW doesn't share, period: PCR 1013
 - a. show that TOO FEW does not change during an entire landing

Level IV Addendum
Test Plan for Luminary (rev 163+)

Prepared by: McCoy
Date: 5/28/70

Rerun previous Level IV with following additions:

- 4.1.1 Nominal Automatic Landing
 - a. call P20 in no-update mode (V95E)
 - b. call P30 to load any ΔV into NOUN 81 at TIG of PDI +1 minute
 - c. Trace loading of LRWH1 into LRWH
 - d. Rollback ANEWROT and load the proper value via V21N01E, XXXXXE in P64 prior to data good after antenna reposition
- 4.1.2 Nominal Landing w/ Redesignations
 - a. Trace 1st Pass through R12 to show proper re-initialization.
- 4.4.0 Surface Operations
 - a. call P22 when Range to CSM > 400 n. mi.
 - b. when V16N54 appears, call R47 via V47E
 - c. note any discrepancy

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

RECEIVED

SEP 15 1970

R. A. LARSON

LUMINARY Memo #167

To: Distribution
From: B. McCoy, P. Rye
Date: 17 August 1970
Subject: Luminary 1D: Which One, What Kind, How Many?

Luminary 1D will be released for the third time on 19 September 1970; its revision # is 178. The new changes incorporated are PCRs 322, 1056 and 1058. Herewith are the descriptions.

PCR 322: One of the major causes of the predatory "throttle castellations" was the response time of the DPS throttle (THROTLAG). The previous value was 0.2 seconds; the new value is 0.08 seconds.

PCR 1056: The required ullage time for a very light Ascent Stage burn using 2 jets is 14 seconds before ignition. The previous Luminary 1D had assumed 3.5 seconds of ullage before ignition causing 2-3 fps overburn. The Apollo 14 crew will be using 4 jet ullage and this would contribute another 2-3 fps to the overburn. Luminary 178 will turn on ullage at 6 seconds prior to ignition. For 4 jet ullage, the required ullage time is 30 seconds. Since, the LGC turns it on at TIG -6 seconds, the astronaut can release the ACA when V99 appears (at TIG -5 seconds). Specifically, "P42TABLE +6" was changed to 2390 (-29.9 +6 seconds) and S40.13 uses "FRCS4" instead of "FRCS2" to assume 4 jet ullage, and also it uses "6.5 SECS" to assume 6.5 seconds of ullage (ullage is turned off at TIG +0.5 seconds). The value of K1VAL (total APS impulse in one second) was 2800 lbf·sec which is based on a "dry" (not yet fired) APS engine. The TPI impulsive burn and most conceivable burns on the APS (except lunar ascent) will be done on a "wet" engine. The value of 2800 lb/sec caused an overburn of roughly 2 fps. This value was changed to 3150 lbf·sec (extrapolation of data from LM Data Book).

PCR 1058: When it was found that the Landing Analog Displays Routine (R10) gave results with errors up to 3.5 fps in the cross pointer display, a new R10 was suggested to effectively eliminate these errors. In the process the altitude-rate glitch was eliminated. The word saving was 119 words; the new R10 takes 1% longer. The main cause of the errors was the single precision dot products; these were changed to double precision. Also, some computational simplifications were made to the dot products, knowing that the IMU is aligned to the landing site. A PIPA bias correction term is added to increase accuracy; computation of VBIAS formerly done in P66 is now done in SERVICER. Altitude is based on a simpler extrapolation than before. R10 now computes altitude and Alt-Rate every pass (every 1/4 second) outputting Alt-Rate before a 12 cs pause, Altitude immediately after the pause. Flag bit SWANDISP is now set immediately after SERVICER computes the parameters necessary for R10 so that R10 may start near TIG -30 rather than at ignition. The DIDFLAG definition remains the same; just DID the initialization. IMODES33 bit 7 is no longer used. ACB L-11 and Anomaly L-1B-04 were not incorporated into the new R10 as originally conceived, but they are in Luminary 178: The forward velocity for NOUN 60 will be computed if the MODE SELECT switch is not in PGNCS (and incidentally accurate to 0.1 fps); R10 will be initialized if the RR CDU ENABLE bit is removed by e. g. moving the RR MODE switch into and out of LGC.

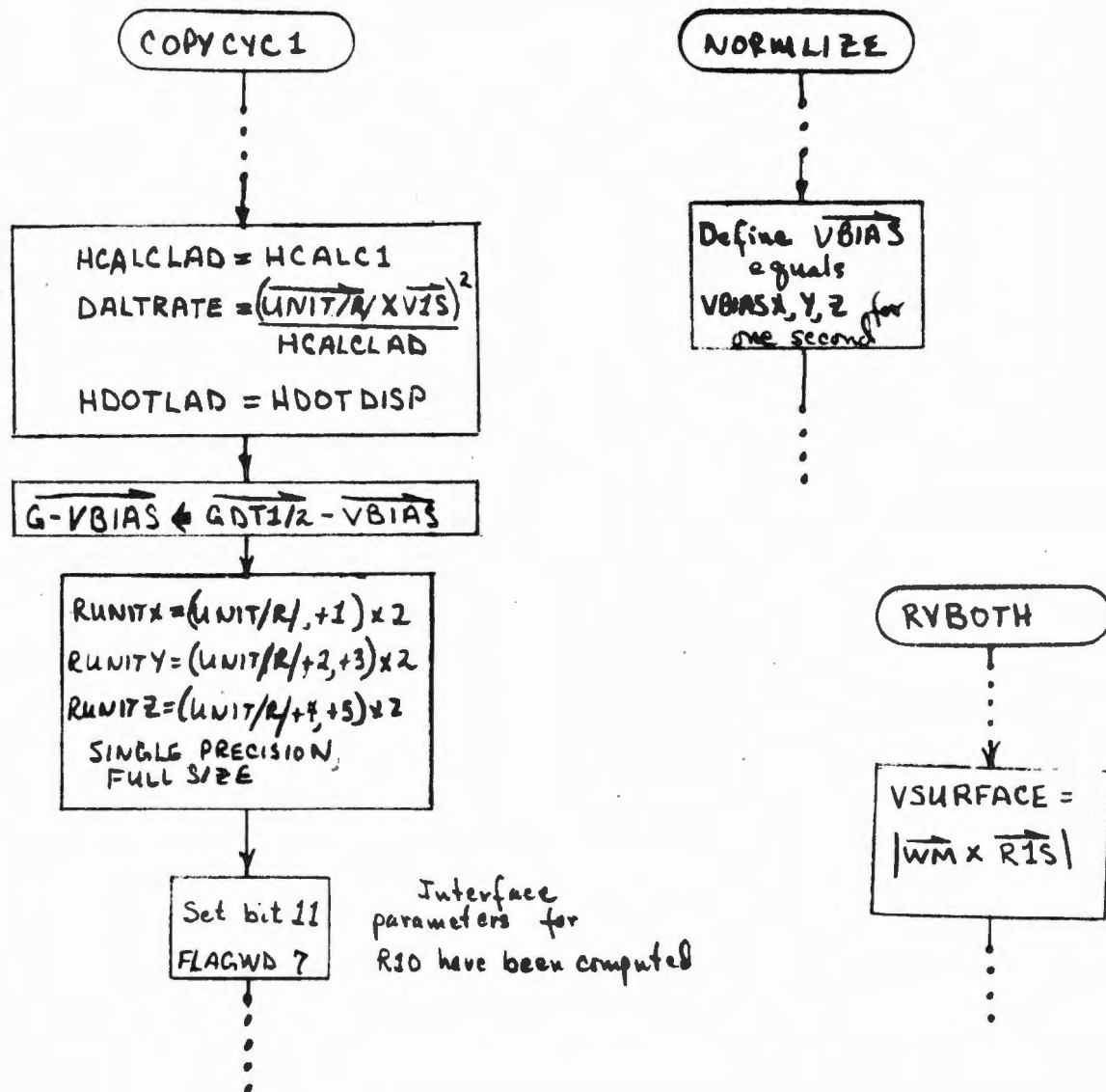
The R10FLAG has been redefined. When it's set by P12, P70, P71, the inertial Y velocity will be displayed on the lateral velocity cross pointer while the forward velocity crosspointer is set to be zero. The lateral velocity is ~~VVECT +2 minus VSURFACE +2; (inertial (Y) - SURFACE (Y) velocities).~~

Flow Charts for R10 and its interface parameter computation are attached. For more details see Luminary Memo #162 by Don Eyles. This memo superceeds Memo #162 where differences occur.

Changes to other areas due to R10 design:

1. downlist ~~new~~^{me} mnemonic changes
LATVEL to LATVMETR
FORVEL to FORVMETR
2. VBIAS calculation moved from STRTP66A into NORMLZE;
~~parameter GHZ removed~~
3. For erasable overlay purposes ZAXIS computation moved to Ascent Guidance from P12 initialization.

R10 COMPUTATIONS in SERVICER



LANADISP

$\text{PIPCTR2} \leftarrow \text{PIPCTR1}$
 $\text{TBASE2} \leftarrow -(\text{TIME1})$

Bit 11
 FLAG 7

CLEAR: SERVICER completed

SET: SERVICER not completed

$\text{DISPRSET} + 1$
 page 10

$\vec{VVECT} \leftarrow \vec{V} - \vec{VSURFACE}$

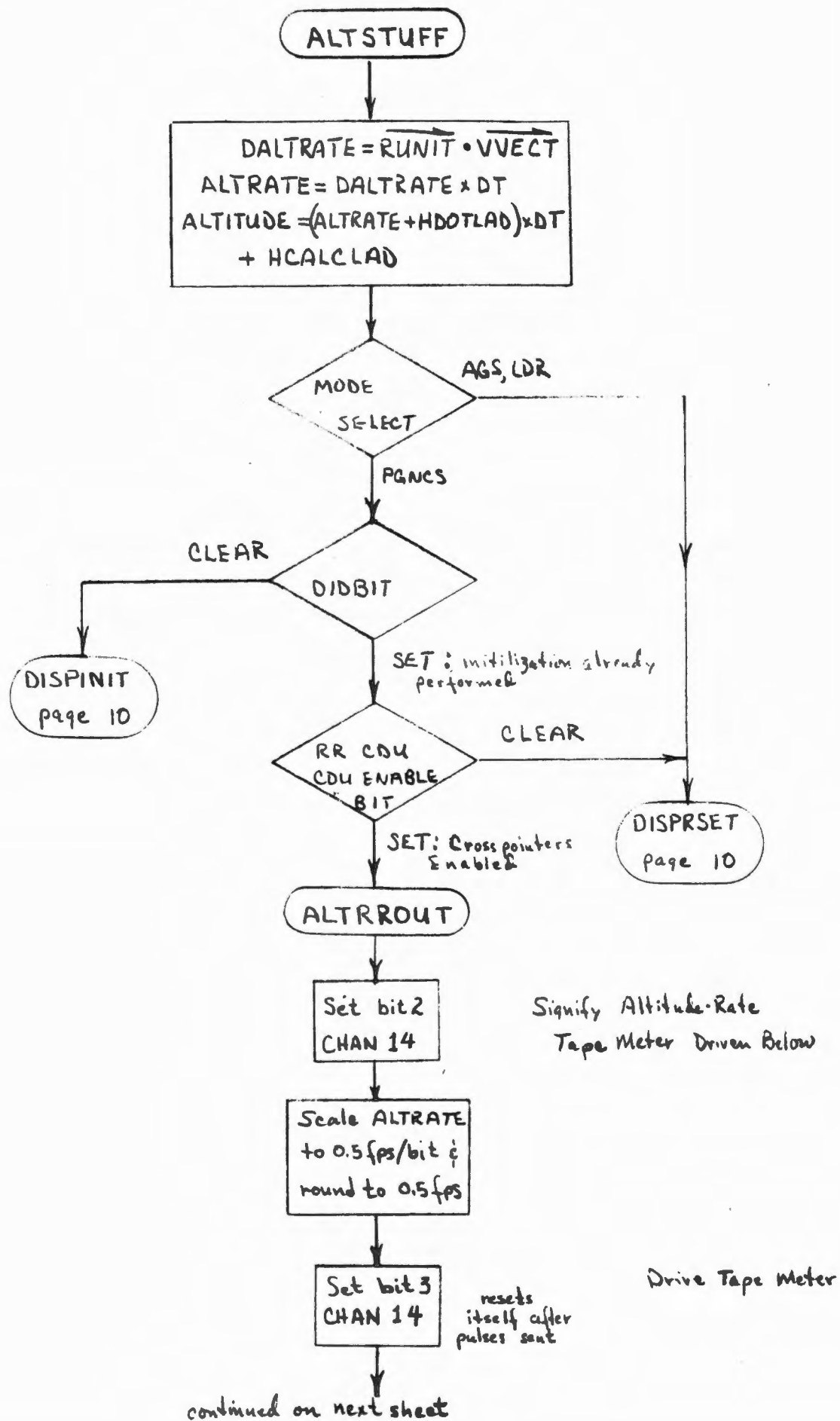
$\text{DT} \leftarrow \text{TIME1} - \text{PIPTIME} + 1$

$\vec{VVECT} \leftarrow \vec{VVECT} + (\vec{PIPA} + \vec{PIPATMP}) \times \text{LANAKPIP}$

$\vec{VVECT} \leftarrow \vec{VVECT} + (\vec{Q} - \vec{VBias}) \times \text{DT}$

ALTSTUFF

continued on next sheet



from preceeding sheet

PAUSE
12 CS.

ALTROUT

Reset bit 2
CHAN 14

Signify Altitude
Tape Meter

Scale ALTITUDE
to 2.345 ft/bit

Lower limit
+ ZERO

Set bit 3
CHAN 14

resets
itself after
pulses sent

Drive Tape Meter

CROSCOMP
Page 9

limit FORVTEMP command to
198 fps. Scale in units of
0.5571 fps and round to
nearest 0.5571 fps.

$CDUSCMD = FORVTEMP -$
 $FORVMETR + (-ZERO)$
 $FORVMETR = FORVMETR$
 $+ CDUSCMD$

continued on next sheet
7

from proceeding sheet

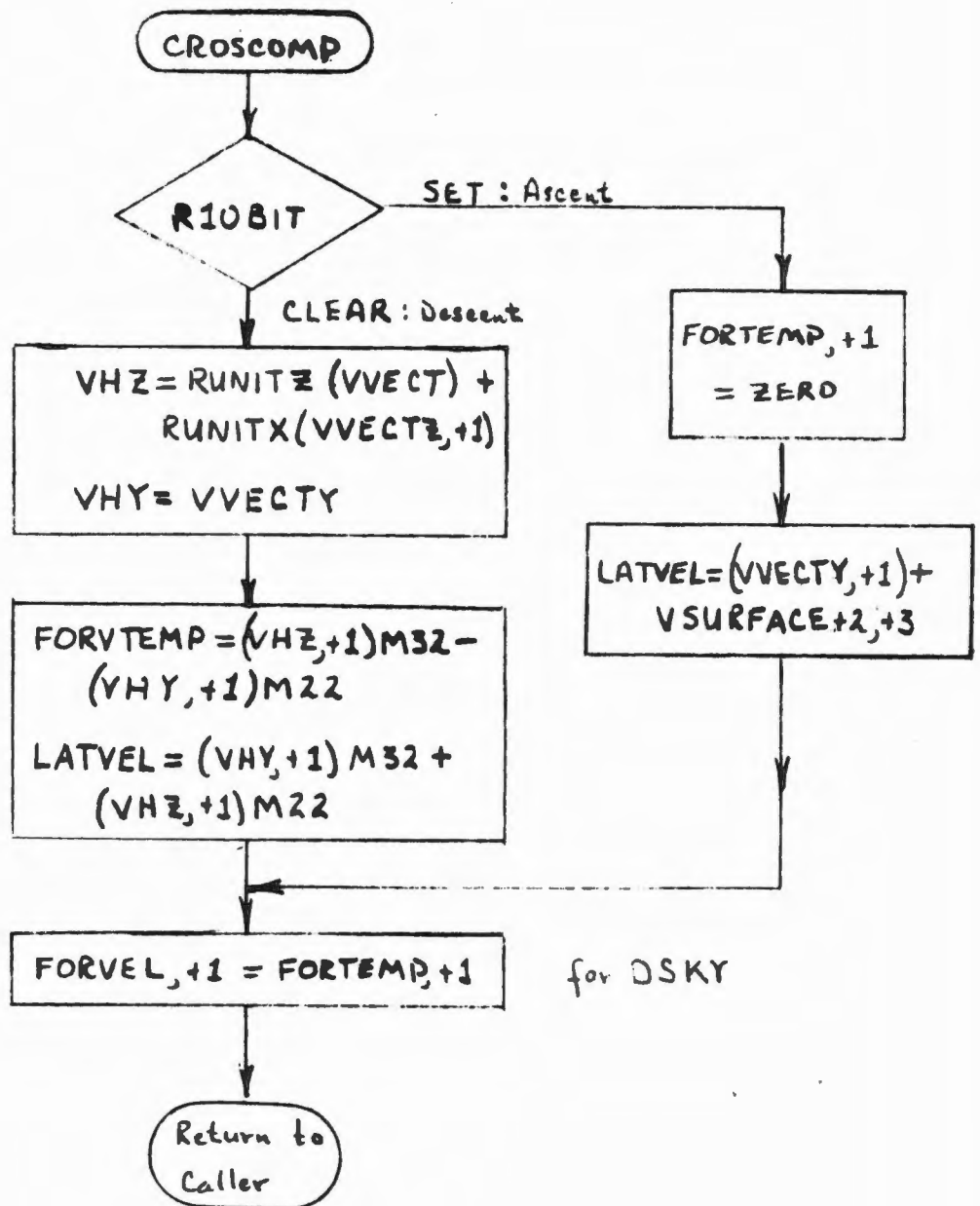
limit LATVEL command to
198 fps. Scale in units of
0.5571 fps and round to
nearest 0.5571 fps.

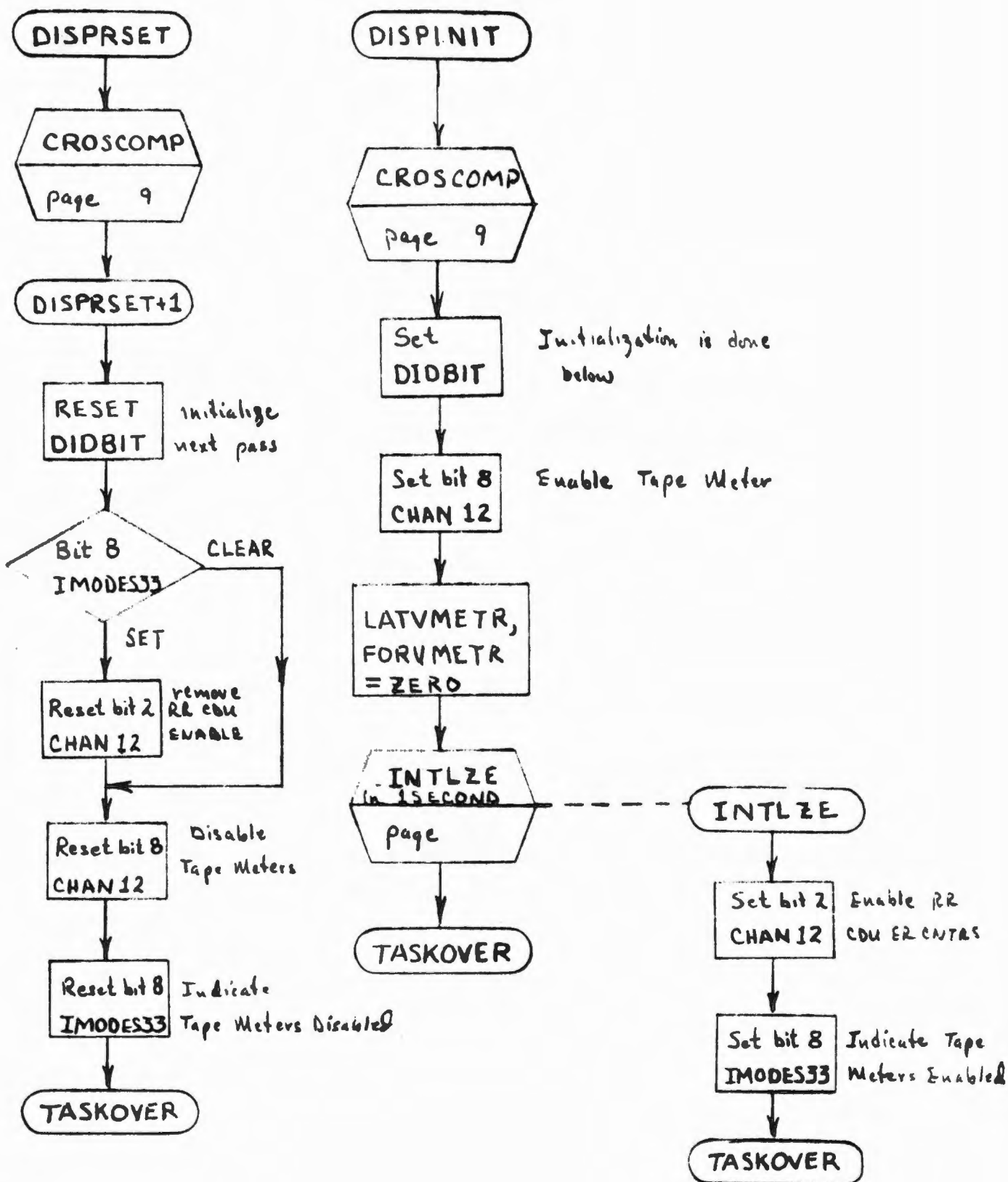
$CDUTCMD = LATVEL -$
 $LATVMETR + (-ZERO)$
 $LATVMETR = LATVMETR +$
 $CDUTCMD$

Set bits 11 & 12 of CHAN 14

Drive Cross Pointers

TASK OVER





02 LGYRO less than 10 words

LGYRO is location for location of which gyro axis is being targeted. It is zeroed on normal (good) exit of PULSE. If not good exit (cage or course align before normal exit) LGYRO is left nonzero; other jobs coming up to do pulse integrity see LGYRO is nonzero & go to sleep.

04 PLS 2 words

05 P20/22 EBANK

06 DUTOTAL 5 words + 2 ERASABLE

01 NEEDLER ~~0 words~~
~~CHECKBITS~~ in routine CHECKBITS
if MODE CONTROL OFF, ~~set bit 3 of PCSFLAG~~
TC to same place when IMODE33 bit 6 is
set, to set bit 3 of PCSFLAG to cause
NEEDLER to reinitialize itself when next called
(after DAP is turned on)

07 XAXIS OVRD 6 words
(fixed not verified by test yet)

10 1/ACC3 - 9 words

APOLLO 14

RECEIVED

SEP 15 1970

R. A. LARSON

EXISTING ANOMALIES IN LUMINARY ID AS OF 9/24/70

LN 31 Don't use V30 or V31 (a. load N26) during any of the programs or routines mentioned.

LN 51 When P20 is exited by means of V56, and no other program is running, the major mode display on the DSKY goes blank.

L-1D-01 NEEDLER initialization never takes place following DAP turn-on.

L-1D-02 Core set overflow (31202) Alarm from bad return from pulse to quing.

L-1D-04 P25 will not control spacecraft attitude if range to CSM is greater than 566 NM. coded

L-1D-05 Certain Verb routines should not be requested if P20 or P22 is running. READY TO GO

L-1D-06 DV TOTAL increments twice in one service cycle.

L-1D-07 Manual rate control mode improperly terminated.

L-10-08 Padload LRWH1 stores erasable location with RM
of P20.

L-10-10 There are a number of windows during which
a change in major mode would wipe out a waiting I/ACCS
job, leaving the DAP with improper data.

L-10-11 WB off by $\times 2$
12 VHI during remode

MIT/IL SOFTWARE ANOMALY REPORT

MIT REPORT NO.	LN Y31
PROGRAM	LUMINARY
PROGRAM REVISION	69

1.1 ORIGINATOR: J. KERNAN	1.2 ORGANIZATION: MIT/IL	1.3 DATE: 1/20/69	1.4 ORIGINATOR CONTROL NO.
1.5 DESCRIPTION OF ANOMALY: Request Executive (V30) and Request Waitlist (V31), which require loading Noun 26, should not be used with programs which share the N26 erasables, DSPTEM 1, +1, and +2. The other nouns which use there erasables are 4, 5, 25, 34, 41, and 97. CONTINUED ON PAGE 2			
1.6 DESCRIPTION OF RUN: Use V30 or V31 while running a program or routine which uses one of the above nouns; e.g., P21. CONTINUED ON PAGE			
- MIT ANALYSIS -			
2.1 CAUSE: Erasable conflict. CONTINUED ON PAGE			
2.2 RECOGNITION: Abnormal program behavior. CONTINUED ON PAGE			
2.3 MISSION EFFECT: Indeterminate. CONTINUED ON PAGE			
2.4 AVOIDANCE PROCEDURE: Don't use V30 or V31 (or load N26) during any of the programs or routines mentioned in 1.5. CONTINUED ON PAGE			
2.5 RECOVERY PROCEDURE: Terminate the program or routine and reselect it. CONTINUED ON PAGE			
2.6 PROGRAM CORRECTION: Use unshared erasables for Noun 26. CONTINUED ON PAGE			
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Program note. CONTINUED ON PAGE			
2.8 RECOMMENDED RE-TESTING: None. CONTINUED ON PAGE			
3.1 NASA DIRECTION:		2.9 MIT/IL SIGNATURE: <i>James S. Kernan</i>	2.10 DATE: <i>1-21-69</i>
CONTINUED ON PAGE		3.1 CLOSING ACTION TAKEN: Program note in LUMINARY 1A also <i>George W. Cherry</i> CONTINUED ON PAGE	
3.2 NASA/MSD SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:
			4.3 ORGANIZATION: 4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: J. KERNAN	1.2 ORGANIZATION: MIT/IL	1.3 DATE: 1/20/69	1.4 ORIGINATOR CONTROL NO.
			REPORT NO. PROGRAM LUMINARY PROGRAM REVISION 69

1.5 Description of Anomaly, cont'd.

The programs and routines which use the nouns in question are:

R04 (N25)	P06 (N25)
P07 (N41, N97) ground test	P12 (N25)
P20 (N05, N25)	P21 (N34)
P22 (N05, N25)	P38 (N34)
P40 (N25)	P42 (N25)
P51 (N05, N25)	P52 (N05, N25, N34)
P57 (N04, N05, N25, N34)	P63 (N25)
P70 (N25)	P71 (N25)
P78 (N34)	

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: D. A. Pettit		1.2 ORGANIZATION: GAEC		1.3 DATE: 3/26/69	1.4 ORIGINATOR CONTROL NO. LM-LUM-14	MIT REPORT NO. LNY-51 PROGRAM LUMINARY PROGRAM REVISION 69
1.5 DESCRIPTION OF ANOMALY: When P20 is exited by means of V56, and no other program is running concurrently, the major mode display on the DSKY goes blank. V37 flashes requesting a new program. The major mode on the DSKY remains blank until a new program is selected via the DSKY. The integration in P20 is completed before exiting P20, but while in program blank there is no integration performed, i.e., the downlink state vectors will remain static until a new major mode is selected.						
						CONTINUED ON PAGE
1.6 DESCRIPTION OF RUN: FMES/FCI						
						CONTINUED ON PAGE
- MIT ANALYSIS -						
2.1 CAUSE: The program is designed to operate as described.						
						CONTINUED ON PAGE
2.2 RECOGNITION: N/A						
						CONTINUED ON PAGE
2.3 MISSION EFFECT: None						
						CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: Answer the Flashing V37 as soon as practical.						
						CONTINUED ON PAGE
2.5 RECOVERY PROCEDURE: N/A						
						CONTINUED ON PAGE
2.6 PROGRAM CORRECTION: None. This is not an anomaly.						
						CONTINUED ON PAGE
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): None						
						CONTINUED ON PAGE
2.8 RECOMMENDED RE-TESTING: None						
						CONTINUED ON PAGE
3.1 NASA DIRECTION:				2.9 MIT/IL SIGNATURE: <i>Henry W Cherry</i>		2.10 DATE: 3/26/69
3.2 NASA/MSD SIGNATURE:				4.1 CLOSING ACTION TAKEN: N. IMPACT ON MISSION F.		
CONTINUED ON PAGE				CONTINUED ON PAGE		
3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION: 4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

MIT REPORT NO. L-1D-01
PROGRAM LUMINARY 1D
PROGRAM REVISION 163

1.1 ORIGINATOR: Garman, J. R.	1.2 ORGANIZATION: FSD/FS5	1.3 DATE: 5/12/70	1.4 ORIGINATOR CONTROL NO.		
1.5 DESCRIPTION OF ANOMALY: "NEEDLER" initialization never takes place following DAP turn-on if IMU error counters (CH 12 B 06) are enabled. This causes cells EDRIVE to be improperly loaded and cause a bias (constant except where changed due to DAC overflow) in the ATTITUDE ERROR NEEDLES. CONTINUED ON PAGE					
1.6 DESCRIPTION OF RUN: Apollo 13: Crew turned on LGC with DAP OFF. They did a P52 option 1 which included a coarse align. This left CH 12 B 06 set so that "NEEDLER" did not properly initialize when DAP was subsequently turned on. CONTINUED ON PAGE					
- MIT ANALYSIS -					
2.1 CAUSE: Proper initialization of the FDAI needle display only occurs when 1. The LGC is on, 2. The PGNCs mode select switch is not "Off", CONTINUED ON PAGE 2					
2.2 RECOGNITION: Constant bias in the needles; needles not nulled at the attitude reached by the DAP. CONTINUED ON PAGE					
2.3 MISSION EFFECT: Crew has an incorrect indication of the attitude error. CONTINUED ON PAGE					
2.4 AVOIDANCE PROCEDURE: 1. Do not coarse align with the PGNCs mode select switch "Off". 2. After LGC power up (or a verb 43) do coarse align or CDU zero with PGNCs not "Off". CONTINUED ON PAGE					
2.5 RECOVERY PROCEDURE: Do a CDU zero (V40N20) with the PGNCs attitude mode select switch not turned to "Off". CONTINUED ON PAGE					
2.6 PROGRAM CORRECTION: Set RCSFLAGS/bit3 to call for NEEDLER initialization whenever the mode select switch is found "Off" (in addition to the present logic). CONTINUED ON PAGE					
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Ensure that Apollo 14 checklists follow "avoidance procedure". Fix in LUMINARY 1E. CONTINUED ON PAGE					
2.8 RECOMMENDED RE-TESTING: Limited testing on hybrid to show that various sequences all give valid needles. CONTINUED ON PAGE 2.9 MIT/IL SIGNATURE: <i>K. A. Larson</i> 2.10 DATE: 7-8-70					
3.1 NASA DIRECTION:		4.1 CLOSING ACTION TAKEN:			
CONTINUED ON PAGE		CONTINUED ON PAGE			
3.2 NASA/MSD SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION:	4.4 DATE:

1.1 ORIGINATOR: Garman, J. R.	1.2 ORGANIZATION: FSD/FS5	1.3 DATE: 5/12/70	1.4 ORIGINATOR CONTROL NO.	1.5 REPORT NO. L-ID-01
PROGRAM LUMINARY 1D				PROGRAM REVISION 163

2.1 continued

3. Either IMODES 33/bit 6 is set (DAP disabled by IMU routines) or channel 12/bit 6 is reset (IMU error counters disabled).

This initialization should be done whenever the NEEDLER routine may not have proper knowledge of the voltages to the FDAI needles; thus, it should be done after any IMU coarse align (which uses those same voltages to drive the IMU), a V43 (test of the FDAI needles), or a power-down of the needles' digital-to-analog converter.

As noted in block 1.6, in Apollo 13, P52 was done while the DAP was still "Off". Consequently, the setting and resetting of the two bits mentioned above did not serve to trigger the needed initialization.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-1D-02

ADR # _____

☐ COLOSSUS 2E	☐ LUMINARY 1D
☐ COLOSSUS 3	☒ LUMINARY 1E
☐ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

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

ACTION: _____

Program Supervisor's Approval: Margaret Hamelton☐ 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 InstructionsProject Manager R.H. LarsonDate 7-8-70

MSC REPORT NO.
1-10-02

MSC Form 1409 (Rev May 68)

MIT/DE PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
 ANOMALY # L-10-04-
 ADR # _____

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☒ LUMINARY 1E |
| ☐ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☐ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☒ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

- ☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.
☐ Technical Committee Meeting(s) held on _____
 Attendees: _____

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: _____

Date: 7-8-70

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.
L-1D-04
PROGRAM
LUMINARY
PROGRAM REVISION
173

1.1 ORIGINATOR: P. Volante		1.2 ORGANIZATION: MIT/DL		1.3 DATE: 6/26/70		1.4 ORIGINATOR CONTROL NO.	
1.5 DESCRIPTION OF ANOMALY: P25 will not control spacecraft attitude if range to CSM is greater than 566 N. M.							
1.6 DESCRIPTION OF RUN: N/A JLN							
- MIT ANALYSIS -							
2.1 CAUSE: Coding error - P20/P22 logic is also being applied to P25.							
2.2 RECOGNITION: After selection of P25, no attitude changes occur; possible alarm light (code 526)							
2.3 MISSION EFFECT: — 11 —							
2.4 AVOIDANCE PROCEDURE: R63 can be used to position Z-axis along line-of-sight							
2.5 RECOVERY PROCEDURE: None							
2.6 PROGRAM CORRECTION: Restore RNDVZFLG check to LPS20.1 subroutine.							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for 1E; work-around for 1D							
2.8 RECOMMENDED RE-TESTING: P25 with range > 400 N. M.							
3.1 NASA DIRECTION:				2.9 MIT/IL SIGNATURE: R. H. Larson			
3.2 NASA/IL SIGNATURE:				4.1 CLOSING ACTION TAKEN:			
3.3 ORGANIZATION				4.2 SIGNATURE:			
3.4 DATE:				4.3 ORGANIZATION:			
				4.4 DATE:			

☐ COLOSSUS 2E	☐ LUMINARY 1D
☐ COLOSSUS 3	☒ LUMINARY 1E
☒ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☒ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special InstructionsProject Manager R. H. LarsonDate 7-8-70

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.
L-1D-05PROGRAM
LUMINARY
PROGRAM REVISION
173

1.1 ORIGINATOR:

P. Volante

1.2 ORGANIZATION:

MIT/DL

1.3 DATE:
6/22/701.4 ORIGINATOR
CONTROL NO.

1.5 DESCRIPTION OF ANOMALY:

The following extended verb routines should not be requested if P20 or P22 is running and the range to the CSM is greater than 400 N. M.

R04 (V63) LR/RR self-test
R05 (V64) S-band antenna
R30 (V82) Apogee/Perigee display
R31 (V83) Range/Range rate display
R47 (V47) AGS initialization

V67 W-matrix monitor
V85 Mode II RR position display

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN:

N/A

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE:

Erasable conflict

CONTINUED ON PAGE

2.2 RECOGNITION:

Incorrect computations by these routines, also noun 54 display in P20/P22 incorrect.

CONTINUED ON PAGE

2.3 MISSION EFFECT:

Bad AGS update if V47 requested.

CONTINUED ON PAGE

2.4 AVOIDANCE PROCEDURE:

Do not select extended verbs while in P20/P22 with range > 400 N. M.

CONTINUED ON PAGE

2.5 RECOVERY PROCEDURE:

Terminate extended verb

CONTINUED ON PAGE

2.6 PROGRAM CORRECTION:

Change erasable assignments to avoid conflict.

CONTINUED ON PAGE

2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):

Work-around for 1D fix in 1E

CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING:

Select above extended verbs in P22 while N54 is being displayed

CONTINUED ON PAGE

2.9 MIT/IL SIGNATURE:

2.10 DATE:

7-6-70

3.1 NASA DIRECTION:

4.1 CLOSING ACTION TAKEN:

CONTINUED ON PAGE

CONTINUED ON PAGE

3.2 NASA/MSC SIGNATURE:

3.3 ORGANIZATION

3.4 DATE:

4.2 SIGNATURE:

4.3 ORGANIZATION:

4.4 DATE:

PCR/PCN # _____
ANOMALY # L-10-06
ADR # _____

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☒ LUMINARY 1E |
| ☒ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

- | | | |
|---|--|---|
| ☐ MIT Approved PCN | ☐ NASA Approved PCR | ☐ NASA Approved Software Anomaly |
| ☐ MIT Approved ADR | ☐ NASA Approved PCN | ☒ MIT Approved Software Anomaly |

A. Coding

☒ Begin coding immediately

Peter Adler

ACTION: _____

Program Supervisor's Approval: Margaret Hamilton

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: R.H. Johnson
Date: 7-8-70

MSC REPORT NO.
L-1D-06

MSC Form 1409 (Rev May 68)

MIT PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-10-67

ADR # _____

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☒ LUMINARY 1E |
| ☒ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

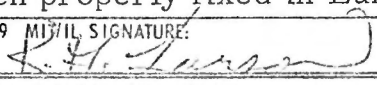
Special Instructions

Project Manager _____

Date _____

R. H. Larson
7-8-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: G. R. Kalan		1.2 ORGANIZATION: MIT/Draper Lab		1.3 DATE: 6/18/70		1.4 ORIGINATOR CONTROL NO.		PLC REPORT NO. L-1D-07	
1.5 DESCRIPTION OF ANOMALY: If the mode control switch is moved from the ATT. HOLD to the AUTO position before the manual rate command mode has been properly terminated and while X-axis override is inhibited: 1) A short RCS jet firing (.15 sec. maximum) may occur about the yaw axis if the mode control switch is later returned to the ATT. HOLD position or if the X-axis override inhibition is removed.								PROGRAM Luminary PROGRAM REVISION 173	
1.6 DESCRIPTION OF RUN: Examination of coding		CONTINUED ON PAGE 2							
- MIT ANALYSIS -									
2.1 CAUSE: 1) When the manual rate command mode is improperly terminated by switching to the AUTO mode control switch position while		CONTINUED ON PAGE 2							
2.2 RECOGNITION: 1) A short yaw RCS firing at switch to ATT. HOLD or automatic removal of X-axis override inhibition.		CONTINUED ON PAGE 2							
2.3 MISSION EFFECT: Possible unexpected RCS firing or yaw maneuver at switch to ATT. HOLD or automatic removal of X-axis override inhibition.									
2.4 AVOIDANCE PROCEDURE: Wait at least 5 sec before switching mode control switch to AUTO position after returning ACA to detent following manual rate command maneuvers.									
2.5 RECOVERY PROCEDURE: 1) No recovery procedure necessary 2) Move ACA rapidly out of detent and back in yaw axis (a natural reaction).									
2.6 PROGRAM CORRECTION: Reset OURRCBIT whenever mode control switch is in AUTO position while X-axis override is inhibited.		CONTINUED ON PAGE 2							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Work around in Luminary 1D Fix in Luminary 1E									
2.8 RECOMMENDED RE-TESTING: Verify that anomaly has been properly fixed in Luminary 1E before release.		CONTINUED ON PAGE		2.9 MIT/IL SIGNATURE: 				2.10 DATE: 7-7-70	
3.1 NASA DIRECTION:				4.1 CLOSING ACTION TAKEN: 					
CONTINUED ON PAGE				CONTINUED ON PAGE					
3.2 NASA/MSO SIGNATURE:		3.3 ORGANIZATION:		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION:	
								4.4 DATE:	

ORIGINATOR:
G. R. Kalan

1.2 ORGANIZATION:
MIT/Draper Lab

1.3 DATE:
6/18/70

1.4 ORIGINATOR
CONTROL NO.

1.5 Cont.

- 2) The LM may yaw to a different attitude (180° max) when the X-axis override inhibition is removed if the direct rate damping phase of the manual rate command mode is active for the Q or R axis at the time of the switch to AUTO. During P 64, for example, if:
 1. The Mode Control Switch is moved to the ATT. HOLD position.
 2. A 10° /sec pitch rate is commanded with the ACA.
 3. The ACA is snapped back into detent position.
 4. The Mode Control Switch is moved back to the AUTO position within 1 sec of the return to detent.
 5. The yaw attitude is changed due to lateral redesignations.

When P66 is subsequently entered, the X-axis override inhibition is automatically removed. The vehicle will then yaw to the yaw reference attitude that existed when the Mode Control Switch was in the ATT. HOLD position.

2.1 Cont.

X-axis override is inhibited, OURRCBIT remains set. Consequently if the X-axis override inhibition is removed or if the mode control switch is moved back to the ATT. HOLD position, the P-axis manual rate command mode coding is entered immediately without the proper initialization. Thus, the manual P-axis attitude error, DXERROR, remains equal to the change in P-axis attitude since the improper termination of the manual rate command mode. If DXERROR is greater than the deadband, RCS jets may fire for up to 0.150 sec to reduce DXERROR. On the next DAP pass the manual rate command mode will be terminated properly, and the attitude hold mode will be entered.

- 2) If the direct rate damping phase of the manual rate command mode is active for the Q or R axis at the time of the switch from the ATT. HOLD to the AUTO mode control switch position while X-axis override is inhibited, QRBIT as well as OURRCBIT remains set and JUSTIN bit remains reset. When the X-axis override inhibition is removed, the P-axis manual rate command coding is immediately entered without initializing DXERROR. As in case 1, the RCS jets will fire to reduce DXERROR. Because JUSTIN is reset and QRBIT is set, however, the manual rate command mode cannot be terminated unless the mode control switch is moved back to the ATT. HOLD position (so that the QR axis manual coding will be exercised and QRBIT will be reset). Consequently, the DAP will yaw the vehicle until DXERROR is reduced to zero, then hold the new yaw attitude in the pseudo auto manual rate command mode.

2.2 Cont.

- 2) Yaw to new attitude at automatic removal of X-axis override inhibition.

2.6 Cont.

Reset QRBIT during rate damping in X-axis override mode.

PCR/PCN # _____
ANOMALY # L-10-08
ADR # _____

☐ COLOSSUS 2E	☐ LUMINARY 1D
☐ COLOSSUS 3	☒ LUMINARY 1E
☒ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

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

ACTION: _____

Program Supervisor's Approval: _____

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

ACTION: _____

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

ACTION: _____

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

ACTION: _____

Special InstructionsProject Manager R.H. LarsoDate 7-8-70

INITIAL SOFTWARE ANOMALY REPORT				MSC REPORT NO. L-1D-08	
1.1 ORIGINATOR: B. McCoy		1.2 ORGANIZATION: MIT/DL		1.3 DATE: 6/24/70	
				1.4 ORIGINATOR CONTROL NO.	
1.5 DESCRIPTION OF ANOMALY:				PROGRAM Luminary 1D	
				PROGRAM REVISION 173	
Padload "LRWH1" shares erasable memory location with RM of P20.					
CONTINUED ON PAGE					
1.6 DESCRIPTION OF RUN:					
Eyeball					
CONTINUED ON PAGE					
- MIT ANALYSIS -					
2.1 CAUSE:					
see 1.5 above					
CONTINUED ON PAGE					
2.2 RECOGNITION:					
eyeball					
CONTINUED ON PAGE					
2.3 MISSION EFFECT:					
If P20 is selected before PDI to track CSM, the LR weighting function in P64 and P66 may affect navigation.					
CONTINUED ON PAGE					
2.4 AVOIDANCE PROCEDURE:					
Load LRWH1 prior to PDI: V21NOIE3756EXXXXXXE					
CONTINUED ON PAGE					
2.5. RECOVERY PROCEDURE:					
Load LRWH1: V21NOIE3756EXXXXXXE					
CONTINUED ON PAGE					
2.6 PROGRAM CORRECTION:					
Move LRWH1 to unshared memory.					
CONTINUED ON PAGE					
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):					
Program note for 1D; fix for 1E.					
CONTINUED ON PAGE					
2.8 RECOMMENDED RE-TESTING:					
Simulate landing sequence and show no change in LRWH1					
CONTINUED ON PAGE				2.9 MIT/DL SIGNATURE: <i>R. H. Larson</i>	
				2.10 DATE: 7-6-70	
3.1 NASA DIRECTION:				4.1 CLOSING ACTION TAKEN:	
CONTINUED ON PAGE				CONTINUED ON PAGE	
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:	
4.2 SIGNATURE:		4.3 ORGANIZATION:		4.4 DATE:	

MSC REPORT NO.
L-1D-10

MSC Form 1409 (Rev May 68)

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1D-10
PROGRAM Luminary
PROGRAM REVISION through 175

1.1 ORIGINATOR: P.S. Weissman	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 8/24/70	1.4 ORIGINATOR CONTROL NO.
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It also computes various quantities which effectively determine the placement and curvature of the switch curves in the RCS phase plane on the basis of jet control authorities, the current attitude deadband, the vehicle configuration, whether it is powered or coasting flight, and jet failures. 1/ACCS should be executed whenever any of its inputs change. Hence, it is done in SERVICER after the mass is decremented and a job to do it is set up by the routines which change the deadband and the various discrete inputs.

If one of these jobs is wiped out by a change in major mode, some change in data may not have been effectively assimilated into the autopilot. Specifically,

- 1) abnormal exits from a powered flight program (including a V34 response to a flashing V97 or V99) could leave an improper deadband and/or the powered flight configuration of the RCS control law;
- 2) termination of P20 or P25 could leave a 0.3 degree deadband if R23 or R60 were in progress;
- 3) termination of routine 03 at the second display (N47) by change in major mode would prevent any desired changes to the deadband or the vehicle configuration from being incorporated into the phase plane and the rate estimator;
- 4) a change in major mode immediately after an RCS isolation valve was opened or closed would prevent the proper modification to the RCS phase plane logic. (The window for this is extremely small.)

B. Another problem could arise if a restart occurred in a certain part of the Lunar Surface Navigation Program, P22, with the range greater than 400 nautical miles and a positive range rate. Immediately following such a restart, coding would be entered via the phase table which would terminate P22 and, in the process, wipe out waiting jobs. Since a restart calls for a 1/ACCS job and clears the ACCSOKAY bit (DAPBOOLS/bit 3,) the DAP will idle until the 1/ACCS is done. If the P22 exit comes in while that 1/ACCS is in the queue of waiting jobs, it will wipe it out (together with the rest of the queue). Thus, the DAP will be left idling, waiting for a job which has gotten "lost". It will idle until 1/ACCS is done by some other routine - e.g. RO3 or the initiation of AVERAGEG. Since P22 is only done on the lunar surface, when the DAP is not needed, it seems quite certain that the occurrence of this case would have no effect at all on the mission.

MIT/IL SOFTWARE ANOMALY REPORT

3

1.1 ORIGINATOR: P. S. Weissman	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 8/24/70	1.4 ORIGINATOR CONTROL NO.	MSC REPORT NO. L-10-10 PROGRAM Luminary PROGRAM REVISION through 175
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2.2 Recognition

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

A1) The crew or the ground might notice the discrepancy in the deadband because either the DAP was allowing the attitude error to grow larger than expected or the DAP was firing to correct attitude errors that were smaller than the expected deadband.

A2) Same as A1 except that the expected deadband would always be larger or equal to the deadband in effect.

A3) Same as A1 for deadband changes. Errors in configuration could result in extremely sloppy control or even instability.

A4) Some extra chattering of the RCS jets.

B) Console light(s) in the Mission Control Center would be lit. Also, if such a lock-out were accomplished and some activity which required the DAP were then carried out without first doing Routine 3 or in some other way causing 1/ACCS to be done, then it would be found that the DAP was not performing its function. One possible lunar surface activity that uses the DAP is an RCS test.

2.4 Avoidance Procedures

The crew can avoid the particular procedures that lead to the difficulties of case A. Specifically, the following should be avoided:

- 1) exits from powered flight programs after the pre-burn attitude is calculated that do not go through the final displays of that program;
- 2) termination of P20 or P25 during the execution of R23 or R60;
- 3) termination of R03 by a change in major mode;
- 4) change in major mode within a second of operating an RCS isolation valve.

There is no avoidance procedure for case B.

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1D-11
PROGRAM LUMINARY 1D
PROGRAM REVISION REV. 178

1.1 ORIGINATOR: R. Larson	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 9/11/70	1.4 ORIGINATOR CONTROL NO.
1.5 DESCRIPTION OF ANOMALY: The value of W_B is mis-scaled in Luminary 1D by a factor of 2 (See Luminary MEMO #169)			
1.6 DESCRIPTION OF RUN: Eyeball (Reported in comments to MIT from MSC)			
- MIT ANALYSIS -			
2.1 CAUSE: Error in preparation of PCR to change the LOSSEM Ephemeris Number.			
2.2 RECOGNITION: Error when an approximate position vector of the moon is computed in LSPOS			
2.3 MISSION EFFECT: Bad alignment if the sun and moon are used.			
2.4 AVOIDANCE PROCEDURE: See 2.5			
2.5 RECOVERY PROCEDURE: The ground can transmit a very accurate Moon position vector if that body should be desired for alignment.			
2.6 PROGRAM CORRECTION: Correct scaling of W_B			
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Luminary 1E. These numbers have to be changed for a new year for Apollo 15.			
2.8 RECOMMENDED RE-TESTING:			
3.1 NASA DIRECTION:		2.9 MIT/IL SIGNATURE: <i>R. Larson</i>	2.10 DATE: 9/11/70
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION	3.4 DATE:
3.5 SIGNATURE:		3.6 ORGANIZATION:	3.7 DATE:

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN #

ANOMALY # L-1D-12

ADR #

ONE FOR YOUR BOOK ID THAT IS

- | | |
|--|---|
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☒ COLOSSUS 3 | ☒ LUMINARY 1E |
| ☐ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS | ☐ LUMINARY |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☐ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☒ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

- ☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

9-13-70

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1D-12
PROGRAM LUMINARY 1D
PROGRAM REVISION 178

1.1 ORIGINATOR: P. VOLANTE	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 9/17/70	1.4 ORIGINATOR CONTROL NO.
1.5 DESCRIPTION OF ANOMALY: Selection of V41N72 (RR Coarse align) while an RR reposition or remode is in progress results in incorrect operation of V41N72. Also keying in V44 while a reposition is in progress will cause erroneous operation of a subsequent V41N72.			
1.6 DESCRIPTION OF RUN: N A. <i>LMS</i>			
- MIT ANALYSIS -			
2.1 CAUSE: V41N72 disables the RR error counter enable output, which stops the antenna drive, but the remode(or reposition) flags are not cleared.			
2.2 RECOGNITION: Following the loading of desired angles in N73, N72 will show actual angles not converging to desired angles.			
2.3 MISSION EFFECT: None.			
2.4 AVOIDANCE PROCEDURE: Do not key in V41N72 while a reposition or remode is in progress, or V44 while a reposition is in progress.			
2.5 RECOVERY PROCEDURE: Cycle RR MODE SELECT switch from LGC to SLEW and then back to LGC. (Wait at least one second before returning to LGC).			
2.6 PROGRAM CORRECTION: Add checks to V41 and V44.			
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Luminary 1E, workaround for Luminary 1D.			
2.8 RECOMMENDED RE-TESTING: V41N72 and V44 tested during RR repositioning			
3.1 NASA DIRECTION:		2.9 MIT/IL SIGNATURE: <i>R. H. Turner</i>	2.10 DATE: 9-18-70
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION:	3.4 DATE:
3.5 SIGNATURE:		3.6 ORGANIZATION:	3.7 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.

L-1D-13

1.1 ORIGINATOR: Larson	1.2 ORGANIZATION MIT/CSDL	1.3 DATE: 10/8/70	1.4 ORIGINATOR CONTROL NO.	PROGRAM Luminary 1D
1.5 DESCRIPTION OF ANOMALY: PCR 1028 provided a separate erasable load for LRWH in the programs following P63. P63 uses LRWH, post P63 uses LRWH ₁ . IF P66 is entered directly from P63, the P63 value of LRWH will be used.				PROGRAM REVISION 178
1.6 DESCRIPTION OF RUN: eye ball (TRW A-201 dated 23 May 1970)				
- MIT ANALYSIS -				
2.1 CAUSE: LRWH1 is initiated in the transition to P64 only.				
2.2 RECOGNITION: none				
2.3 MISSION EFFECT: For Apollo 14 LRWH1 = LRWH For subsequent missions - negligible effect				
2.4 AVOIDANCE PROCEDURE: none				
2.5 RECOVERY PROCEDURE: For Apollo 14, none; load LRWH with LRWH1 after P66				
2.6 PROGRAM CORRECTION: set LRWH = LRWH1 at manual entrance point to P66				
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): do not fix - ground note				
2.8 RECOMMENDED RE-TESTING: none				
2.9 MIT/IL SIGNATURE: <i>R. H. Larson</i>				
2.10 DATE: 10-8-70				
3.1 NASA DIRECTION:				
4.1 CLOSING ACTION TAKEN:				
3.2 NASA/MSC SIGNATURE:				
3.3 ORGANIZATION				
3.4 DATE:				
4.2 SIGNATURE:				
4.3 ORGANIZATION:				
4.4 DATE:				

R. LARSON

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: C. D. Sykes		1.2 ORGANIZATION: FS5		1.3 DATE: 10/8/70		1.4 ORIGINATOR CONTROL NO.		REC. REPORT NO. L-1D-14	
								PROGRAM LUMINARY 1D	
								PROGRAM REVISION 178	
1.5 DESCRIPTION OF ANOMALY: At TIG-5 in P40, TGO is computed. If TGO is computed to be less than 6 seconds, NO THROTTLE FLG (FW5 B12) should be set as shown on P. 398, line 680 of GSOP Section 4 (Lum Rev 131) to inhibit throttle command to max at TIG+ZOOMTIME. However, this bit is not set in LUMINARY Rev 178 causing the LGC to command max throttle at TIG+ZOOMTIME (although the engine would of course be off). CONTINUED ON PAGE									
1.6 DESCRIPTION OF RUN: Eyeball of FSB Programmed Guidance Equations Document. CONTINUED ON PAGE									
- MIT ANALYSIS -									
2.1 CAUSE: CONTINUED ON PAGE									
2.2 RECOGNITION: CONTINUED ON PAGE									
2.3 MISSION EFFECT: CONTINUED ON PAGE									
2.4 AVOIDANCE PROCEDURE: CONTINUED ON PAGE									
2.5 RECOVERY PROCEDURE: CONTINUED ON PAGE									
2.6 PROGRAM CORRECTION: CONTINUED ON PAGE									
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc) CONTINUED ON PAGE									
2.8 RECOMMENDED RE-TESTING: CONTINUED ON PAGE									
					2.9 MIT/IL SIGNATURE:			2.10 DATE:	
3.1 NASA DIRECTION: CONTINUED ON PAGE					4.1 CLOSING ACTION TAKEN:  CONTINUED ON PAGE				
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION:	
								4.4 DATE:	

MSC REPORT NO
L-1D-15

PAGE 1 OF

32/1/70 PROGRAM CHANGE INITIATING SLIP

PCR/PCN # _____

ANOMALY # L-1D-16

ADR # _____

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☒ LUMINARY 1E |
| ☐ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

- ☐ MIT Approved PCN
☐ MIT Approved ADR

- ☐ NASA Approved PCR
☐ NASA Approved PCN

- ☐ NASA Approved Software Anomaly
☒ MIT Approved Software Anomaly

A. Coding

- ☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

- ☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

- ☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

- ☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

- ☐ Review for corresponding changes in _____

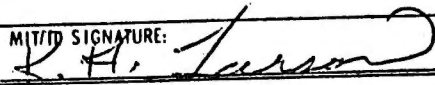
ACTION: _____

Special Instructions

Project Manager _____

Date 12-10-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Volante		1.2 ORGANIZATION: M. I. T.		1.3 DATE: 12-8-70		1.4 ORIGINATOR CONTROL NO.	
						MSC REPORT NO. L-ID-16 PROGRAM Luminary PROGRAM REVISION 178 & Subs	
1.5 DESCRIPTION OF ANOMALY: Fixed Memory constant VINJNOM (Nominal Injection Velocity) is 5509.3 fps instead of 5509.5 fps as specified in GSOP.							
CONTINUED ON PAGE							
1.6 DESCRIPTION OF RUN: None - found by examining listing.							
CONTINUED ON PAGE							
-MIT ANALYSIS-							
2.1 CAUSE: Loss of accuracy in converting from FPS to M./C.S.							
CONTINUED ON PAGE							
2.2 RECOGNITION: None							
CONTINUED ON PAGE							
2.3 MISSION EFFECT: None							
CONTINUED ON PAGE							
2.4 AVOIDANCE PROCEDURE: None							
CONTINUED ON PAGE							
2.5 RECOVERY PROCEDURE: None							
CONTINUED ON PAGE							
2.6 PROGRAM CORRECTION: Correct Constant							
CONTINUED ON PAGE							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Apollo 15 (LUM 1E) No action necessary for Apollo 14 (LUM 1D)							
CONTINUED ON PAGE							
2.8 RECOMMENDED RE-TESTING: Nominal 12 ascent run							
CONTINUED ON PAGE				2.9 MIT/ID SIGNATURE: 		2.10 DATE: 12-10-70	
3.1 NASA DIRECTION: 				4.1 CLOSING ACTION TAKEN: 			
3.2 NASA/MSR SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:	
						4.3 ORGANIZATION:	
						4.4 DATE:	

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-10-17

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☒ LUMINARY 1E |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

Peter Volante

ACTION: _____

Program Supervisor's Approval: Margaret Hamelton

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: R. H. Larson

Date: 12-10-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Volante		1.2 ORGANIZATION: MIT		1.3 DATE: 12/10/70		1.4 ORIGINATOR CONTROL NO.		MSC REPORT NO. L-1D-17	
1.5 DESCRIPTION OF ANOMALY:		The flashing verb 37 which terminates P22 when the range is greater than 400 n. m. and the range-rate is positive may not occur							
1.6 DESCRIPTION OF RUN:		Examination of coding.							
		CONTINUED ON PAGE							
- MIT ANALYSIS -									
2.1 CAUSE:		Flagword bit is shared between RR predesignate routing of R21 and V16 N54 display computations or P22.							
		CONTINUED ON PAGE							
2.2 RECOGNITION:		After RR tracks CSM into mode limits and no track light goes on, the V37 flash does not appear, but N54 is computed.							
		CONTINUED ON PAGE							
2.3 MISSION EFFECT:		None							
		CONTINUED ON PAGE							
2.4 AVOIDANCE PROCEDURE:		None							
		CONTINUED ON PAGE							
2.5 RECOVERY PROCEDURE:		Select desired program when 530 alarm appears in P22.							
		CONTINUED ON PAGE							
2.6 PROGRAM CORRECTION:		Unshare flagword bits in P22.							
		CONTINUED ON PAGE							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):		Fix for 1E.							
		CONTINUED ON PAGE							
2.8 RECOMMENDED RE-TESTING:		P22 nominal run							
		CONTINUED ON PAGE							
3.1 NASA DIRECTION:		2.9 MIT/IL SIGNATURE: <i>[Signature]</i>				2.10 DATE: 12-10-70			
		CONTINUED ON PAGE							
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION:		3.4 DATE:		4.1 CLOSING ACTION TAKEN:		CONTINUED ON PAGE	
4.2 SIGNATURE:		4.3 ORGANIZATION:		4.4 DATE:					

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-10-18

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☒ LUMINARY 1E |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager: _____

Date: _____

12-10-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Volante		1.2 ORGANIZATION: MIT.		1.3 DATE: 12/10/70		1.4 ORIGINATOR CONTROL NO. 178	
1.5 DESCRIPTION OF ANOMALY: In P22, if the R21 routine (RR designate) drives the antenna close to the RR Mode II limits as the CSM is moving away from the landing site, the RR antenna may oscillate between the mode limits and the mode center several times.						MSC REPORT NO. L-1D-18	
						PROGRAM LUMINARY	
CONTINUED ON PAGE							
1.6 DESCRIPTION OF RUN: System test lab run of P22 without allowing RR lockon.							
CONTINUED ON PAGE							
- MIT ANALYSIS -							
2.1 CAUSE: R21 and R24 do not clear designate flag when it finds the LOS outside Mode II limits in P22, so R25 calls for a designate after a reposition.							
CONTINUED ON PAGE							
2.2 RECOGNITION: Oscillation of antenna trunnion and shaft angles varying between mode limits and mode center.							
CONTINUED ON PAGE							
2.3 MISSION EFFECT: None- if this situation occurs, no tracking of the CSM could be obtained.							
CONTINUED ON PAGE							
2.4 AVOIDANCE PROCEDURE: Select P22 while CSM is approaching landing site and not yet within RR mode limits.							
CONTINUED ON PAGE							
2.5 RECOVERY PROCEDURE: None							
CONTINUED ON PAGE							
2.6 PROGRAM CORRECTION: Fix coding to clear designate flag.							
CONTINUED ON PAGE							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Apollo 15 (Lum 1E), work-around for Apollo 14 - (Lum 1D)							
CONTINUED ON PAGE							
2.8 RECOMMENDED RE-TESTING: P22 with designate (R21) attempted as CSM is leaving mode limits.							
CONTINUED ON PAGE				2.9 MIT/IL SIGNATURE: <i>R. H. Larson</i>		2.10 DATE: 12-10-70	
3.1 NASA DIRECTION:				4.1 CLOSING ACTION TAKEN:			
CONTINUED ON PAGE				CONTINUED ON PAGE			
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION:		3.4 DATE:		4.2 SIGNATURE:	
						4.3 ORGANIZATION:	
						4.4 DATE:	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-1D-19

ADR # _____

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☒ LUMINARY 1E |
| ☐ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

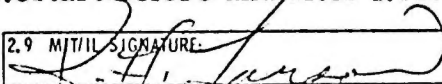
Special Instructions

Project Manager _____

Date _____

12-30-70

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: B. McCoy		1.2 ORGANIZATION: MIT/CSDL		1.3 DATE: 12/30/70		1.4 ORIGINATOR CONTROL NO.	
1.5 DESCRIPTION OF ANOMALY: Restarts in P20/25 may erroneously display V50N18 on DSKY.						MIT REPORT NO. L-1D-19	
						PROGRAM REVISION Rev 178	
CONTINUED ON PAGE							
1.6 DESCRIPTION OF RUN: Simulation at GAC - Restart testing for PCR324							
CONTINUED ON PAGE							
- MIT ANALYSIS -							
2.1 CAUSE: The Restart Point in R65 is after routine LPS20.1 call which computes RRTARGET. This shares erasable cells with radar read data. A Restart occurring after the radar read but before LPS20.1 restarts R65 with bad data in RRTARGET. The 15 degree check then fails and R60 is subsequently called.							
2.2 RECOGNITION: Restart followed by V50N18 display							
CONTINUED ON PAGE							
2.3 MISSION EFFECT: None							
CONTINUED ON PAGE							
2.4 AVOIDANCE PROCEDURE: None							
CONTINUED ON PAGE							
2.5 RECOVERY PROCEDURE: Depress ENTER pushbutton on DSKY; ignore request to perform maneuver.							
CONTINUED ON PAGE							
2.6 PROGRAM CORRECTION: Place Restart Point before LPS20.1							
CONTINUED ON PAGE							
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for 1E; prog note for 1D							
CONTINUED ON PAGE							
2.8 RECOMMENDED RE-TESTING: Digital Simulation with Restart before and after Restart Point.							
CONTINUED ON PAGE						2.9 MIT/IL SIGNATURE: 	
3.1 NASA DIRECTION:						2.10 DATE: 12-30-70	
						4.1 CLOSING ACTION TAKEN:	
CONTINUED ON PAGE						CONTINUED ON PAGE	
3.2 NASA/MSD SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:	
						4.3 ORGANIZATION: 4.4 DATE:	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-1D-20
ADR # _____

☐ COLOSSUS 2E	☐ LUMINARY 1D
☐ COLOSSUS 3	☒ LUMINARY 1E
☐ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☒ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date 1-6-70+1

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. Rye		1.2 ORGANIZATION: MIT/DL		1.3 DATE: 12/31/70		1.4 ORIGINATOR CONTROL NO.		MIT REPORT NO. L-ID-20						
								PROGRAM LUM 1D						
								PROGRAM REVISION 178						
1.5 DESCRIPTION OF ANOMALY: 1. If a BAILOUT occurs during permanent integration in P00, R22, or R21 and is followed by any other restart before another restart point has been established in the program, and if a second integration process has begun, it is possible that normal program flow will be interrupted or that state vector will be invalidated. 2. If a BAILOUT occurs during permanent integration in P00, followed by selection of V82, V89, or V90 before the integration is completed, the same effect as 1 can take place. CONTINUED ON PAGE														
1.6 DESCRIPTION OF RUN: Eyeball CONTINUED ON PAGE														
- MIT ANALYSIS -														
2.1 CAUSE: Erroneous clearing of REINTFLG by BAILOUT logic CONTINUED ON PAGE														
2.2 RECOGNITION: BAILOUT followed by another restart during times specified in 1.5 followed by anomalous program behavior. CONTINUED ON PAGE														
2.3 MISSION EFFECT: May need uplink of state vector and reselection of program. CONTINUED ON PAGE														
2.4 AVOIDANCE PROCEDURE: 1. Do not select V37 after BAILOUT in P20 until integration is completed. 2. Do not select V82, V89, or V90 until P00 integration is finished if a BAILOUT occurred. CONTINUED ON PAGE														
2.5 RECOVERY PROCEDURE: Correct state vector and reselect program if necessary. CONTINUED ON PAGE														
2.6 PROGRAM CORRECTION: Do not clear REINTFLG in BAILOUT CONTINUED ON PAGE														
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for LUM 1E CONTINUED ON PAGE														
2.8 RECOMMENDED RE-TESTING: Restart and BAILOUT tests P20 and P00 CONTINUED ON PAGE														
3.1 NASA DIRECTION:					2.9 MIT/IL SIGNATURE: <i>Russell H. Larson</i>					2.10 DATE: 1-6-70				
					4.1 CLOSING ACTION TAKEN:									
3.2 NASA/MSD SIGNATURE:					3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION:		4.4 DATE:	

MIT/ND PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-1D-21
ADR # _____

☐ COLOSSUS 2E	☐ LUMINARY 1D
☒ COLOSSUS 3	☒ LUMINARY 1E
☐ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

☐ MIT Approved PCN	☐ NASA Approved PCR	☐ NASA Approved Software Anomaly
☐ MIT Approved ADR	☐ NASA Approved PCN	☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date 1-25-71

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1D-21
PROGRAM LUMINARY
PROGRAM REVISION 178 + Subs.

1.1 ORIGINATOR: P. Volante	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 1/18/71	1.4 ORIGINATOR CONTROL NO.
1.5 DESCRIPTION OF ANOMALY: An RR antenna reposition initiated by R25 just after starting P20 or P22 can cause P20/P22 to loop and thus never get RR lock- on.			

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN: P22 with RR antenna reposition initiated just after P22 begins - program continued to run without locking on or issuing an alarm.

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE: P20/P22 initialization removes RR error counter enable (BIT 2 Chan 12).

CONTINUED ON PAGE

2.2 RECOGNITION: P20/P22 continues to run after selection without issuing alarm 503 or V50N72 display within approximately 1 minute of selection.

CONTINUED ON PAGE

2.3 MISSION EFFECT: Possible loss of marks in P20 and loss of entire P22 for that Rev.

CONTINUED ON PAGE

2.4 AVOIDANCE PROCEDURE:

None

CONTINUED ON PAGE

2.5 RECOVERY PROCEDURE: Select another program via verb 37, then reselect P20/22.

CONTINUED ON PAGE

2.6 PROGRAM CORRECTION: Do not remove RR error counter enable in P20/22 initialization.

CONTINUED ON PAGE

2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):

Fix for 1E

CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING:

System Test Lab

CONTINUED ON PAGE

2.9 MIT/IL SIGNATURE:

2.10 DATE:

3.1 NASA DIRECTION:

Fix 1-21-71 R2

CONTINUED ON PAGE

4.1 CLOSING ACTION TAKEN:

CONTINUED ON PAGE

3.2 NASA/MSC SIGNATURE:

3.3 ORGANIZATION:

3.4 DATE:

4.2 SIGNATURE:

4.3 ORGANIZATION:

4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-10-22
PROGRAM LUMINARY
PROGRAM REVISION 178 & Subs.

1.1 ORIGINATOR: P. Volante	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 1/18/71	1.4 ORIGINATOR CONTROL NO.
1.5 DESCRIPTION OF ANOMALY: A hardware or software restart during a RR TURNON sequence may result in an incorrect setting of the mode flag (ANTENFLG) in the RR status word, RADMODES (flagword 12).			

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN: P22 with RR turned on just prior to V37 selection of P22; software restart killed TURNON task and left RADMODES indicating Mode I, when antenna was really in Mode II.

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE: TURNON task killed by restart before setting mode flag (ANTENFLG) in RADMODES.	CONTINUED ON PAGE
2.2 RECOGNITION: RADMODES mode flag setting not agreeing with actual RR position; erratic behavior of RR since a reposition will be requested erroneously.	CONTINUED ON PAGE
2.3 MISSION EFFECT:	CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: Do not key in a V37 request within 10 seconds of RR TURNON; if a hardware restart or BAILOUT/P00D00 occurs during this time, repeat TURNON	CONTINUED ON PAGE
2.5 RECOVERY PROCEDURE: Cycle RR mode switch from LGC to SLEW and back, to force a TURNON sequence. (Hold in slew position for at least one second).	CONTINUED ON PAGE
2.6 PROGRAM CORRECTION: Have restarts set RR not-in-auto bit in RADMODES if RR TURNON bit is set; this will cause a new TURNON sequence to be initiated after restart.	CONTINUED ON PAGE
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Do not fix, write program note.	CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING: Level 3 with restart during RR TURNON-

CONTINUED ON PAGE			2.9 MIT/IL SIGNATURE: <i>R. H. L...</i>	2.10 DATE: 1-22-71	
3.1 NASA DIRECTION: Do not fix 1-21-71 RJ			4.1 CLOSING ACTION TAKEN:		
CONTINUED ON PAGE			CONTINUED ON PAGE		
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION	4.4 DATE:

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-10-23

ADR # _____

☐ COLOSSUS 2E

☐ LUMINARY 1D

☐ COLOSSUS 3

☒ LUMINARY 1E

☐ COLOSSUS 3A

☐ LUMINARY 1F

☐ COLOSSUS _____

☐ LUMINARY _____

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved
Software Anomaly

☐ MIT Approved ADR

☐ NASA Approved PCN

☒ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

1-25-71

MIT/IL SOFTWARE ANOMALY REPORT

ORIGINATOR: KLUMPP		L2 ORGANIZATION: MIT/DL		L3 DATE: 71 01 19		L4 ORIGINATOR CONTROL NO.		MSC REPORT NO. L-1D-23		
								PROGRAM Luminary		
								PROGRAM REVISION REV.178		
1.5 DESCRIPTION OF ANOMALY: In the erection of the guidance coordinate frame (CGCALC) 1. WCHPHASE instead of WCHPHOLD is used to select the index for selecting the criteria (TCGFBRAK or TCGFAPPR) for whether the frame is erected. On the final pass of P63 and P64, WCHPHASE is incremented before this use, therefore points to the succeeding phase. Consequently, CONTINUED ON PAGE 2										
1.6 DESCRIPTION OF RUN: Apollo 14 shakedown tests. (The problem also existed on Apollos 11 and 12) CONTINUED ON PAGE										
- MIT ANALYSIS -										
2.1 CAUSE: see 1.5 CONTINUED ON PAGE										
2.2 RECOGNITION: Tracked down a peculiarity in the orientation of the guidance coordinate frame. CONTINUED ON PAGE										
2.3 MISSION EFFECT: A yaw transient of about 5 degrees at the end of P64 can occur, particularly if JAPFG* +1 has a large magnitude and if azimuth redesignations have been made. CONTINUED ON PAGE										
2.4 AVOIDANCE PROCEDURE: Switch to P66 manually. Do not let P64 finish. In Apollo 14 JAPFG* +1 contains 07700, small enough so yaw transient is insufficient to require avoidance. CONTINUED ON PAGE										
2.5 RECOVERY PROCEDURE: Use X axis override in P66 to reorient the window CONTINUED ON PAGE										
2.6 PROGRAM CORRECTION: Use WCHPHOLD instead of WCHPHASE to select index registers in CGCALC. CONTINUED ON PAGE										
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix program (LUMINARY 1E) CONTINUED ON PAGE										
2.8 RECOMMENDED RE-TESTING: See sheet CONTINUED ON PAGE										
3.1 NASA DIRECTION: FIX - 1-21-71 RL CONTINUED ON PAGE					2.9 MIT/IL SIGNATURE: <i>[Signature]</i> CONTINUED ON PAGE					2.10 DATE: 1-22-71
					4.1 CLOSING ACTION TAKEN: CONTINUED ON PAGE					
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION		4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.	L-1D-23
PROGRAM	Luminary
PROGRAM REVISION	Rev. 178

1.1 ORIGINATOR: KLUMPP	1.2 ORGANIZATION: MIT/DL	1.3 DATE: 71 01 19	1.4 ORIGINATOR CONTROL NO.
---------------------------	-----------------------------	-----------------------	-------------------------------

1.5 continued.

on the final pass of the braking phase, the approach phase index is selected with the result that TCGIAPPR and TCGFAPPR are used as criteria instead of TCGIBRAK and TCGFBRAK. On the final pass of the approach phase an index is selected one location beyond the index table (the constant happens to be 77776, equivalent to -1) with the result that criteria are picked up one location before TCGFBRAK. This location happens to contain the lower half of GAINAPPR; consequently on the last pass of the approach phase the lower half of GAINAPPR is used for TCGFAPPR, and TCGFBRAK is used for TCGIAPPR.

2. Similarly, on the last pass of the braking phase INTPRETX loads -2 instead of 0 into the index register X1 causing CGCALC to use GAINAPPR instead of GAINBRAK, and on the last pass of the approach phase INTPRETX loads +1 instead of -2 into the index register X1 causing CGCALC to use the lower half of JAPFG* and the upper half of GAINBRAK instead of the upper and lower halves of GAINAPPR respectively.

- 2.8
1. Select criteria providing time windows for guidance frame erection in the braking and approach phases. Run a complete landing observing that the frame is erected only during the windows.
 2. Select criteria providing for guidance frame erection always. Observe that the correct index is always selected and that the frame is always correctly erected using the correct gain.
 3. Introduce restarts causing VAC areas to be switched after the indices have been selected and observe that correct indices are re-selected and the frame is correctly erected using the correct gain.

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: J. R. Garman		1.2 ORGANIZATION: Flight Software Br.		1.3 DATE: 1/14/71		1.4 ORIGINATOR CONTROL NO.		MSC REPORT NO. L-1D-24	
								PROGRAM LUMINARY	
								PROGRAM REVISION 178	
1.5 DESCRIPTION OF ANOMALY: P70 or P71 selection prior to P12 leaves P12 with at least 3 flags abnormally set: FW9B13 (P7071FLG) set 1, FW9B08 (FLAP) set 1, FW9B06 (ROT FLAG) set 1. The first causes abort-type variable targeting during P12. The second causes some abnormal logic paths during P12 initialization. The third seems to cause no problems. Total effect has not been investigated by author.									
CONTINUED ON PAGE									
1.6 DESCRIPTION OF RUN: LMS descent abort simulation, 1/14/71, Apollo 14 back-up crew, noted at MCC. An abort out of P66 was attempted (P71) without engine ignition. Subsequently P68, P00, and P12 were selected to do a T2 abort. Noted Flags are on AGC console event lites.									
CONTINUED ON PAGE									
- MIT ANALYSIS -									
2.1 CAUSE: See 1.5									
CONTINUED ON PAGE									
2.2 RECOGNITION: See 1.6									
CONTINUED ON PAGE									
2.3 MISSION EFFECT: The first would cause abort type targetting during P12; the second is set by P70 only so that P12 call would not occur afterwards; the third would cause no effect on mission.									
CONTINUED ON PAGE									
2.4 AVOIDANCE PROCEDURE: Set flags prior to P12									
CONTINUED ON PAGE									
2.5 RECOVERY PROCEDURE: None									
CONTINUED ON PAGE									
2.6 PROGRAM CORRECTION: Initialize flags at beginning of P12 to reset configuration.									
CONTINUED ON PAGE									
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Program note for 1D and 1E; fix for subsequent ropes.									
CONTINUED ON PAGE									
2.8 RECOMMENDED RE-TESTING: Preset these flags and call P12.									
CONTINUED ON PAGE					2.9 MIT/IL SIGNATURE: <i>J. R. Garman</i>			2.10 DATE: 1-21-71	
3.1 NASA DIRECTION: Do not fix for 1E 1-21-71					4.1 CLOSING ACTION TAKEN:				
CONTINUED ON PAGE									
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION	
								4.4 DATE:	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____
ANOMALY # L-1D-25
ADR # _____

☐ COLOSSUS 2E	☐ LUMINARY 1D
☐ COLOSSUS 3	☒ LUMINARY 1E
☐ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☐ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☒ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

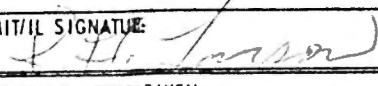
Special Instructions

Project Manager: _____

Date: _____

1-25-71

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: J. R. Garman		1.2 ORGANIZATION: Flight Software Br.		1.3 DATE: 1/14/71	1.4 ORIGINATOR CONTROL NO.	MSC REPORT NO. L-1D-25 PROGRAM Luminary PROGRAM REVISION 178
1.5 DESCRIPTION OF ANOMALY: Exiting P63, P40, or P42 with a V37 between average-G on and time of auto-ullage initiate may not kill the waitlist call to initiate ullage. The result is a continuous LGC ullage command with no way to terminate it except (1) V36, (2) AGS, (3) entering average-G and exiting. The problem is that V37 doesn't kill waitlist tasks until after AVETOMID integration (even though ullage is terminated at the start of V37).						
						CONTINUED ON PAGE
1.6 DESCRIPTION OF RUN: LMS descent abort simulation, 1/14/71, Apollo 14 back-up crew, noted at MCC. A wave-off of PDI occurred and the crew did not exit P63 until after AVG-G on. He selected P00 via V37, during MIDTOAVE ullage came on, P00 then appeared and ullage continued. He selected P47 to see if he was ullaging, saw he was, went back to P00 which killed the ullage.						
						CONTINUED ON PAGE
- MIT ANALYSIS -						
2.1 CAUSE: See 1.5						
						CONTINUED ON PAGE
2.2 RECOGNITION: See 1.6						
						CONTINUED ON PAGE
2.3 MISSION EFFECT: Orbit perturbed by ullage						
						CONTINUED ON PAGE
2.4 AVOIDANCE PROCEDURE: If V37 is desired to terminate P63, P40, or P42 prior to ullage, do it before TIG-25 seconds.						
						CONTINUED ON PAGE
2.5 RECOVERY PROCEDURE: See 1.5						
						CONTINUED ON PAGE
2.6 PROGRAM CORRECTION: Put a KILLTASK for ULLGTASK in V37 logic before AVETOMID integration.						
						CONTINUED ON PAGE
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for 1E; program note for 1D.						
						CONTINUED ON PAGE
2.8 RECOMMENDED RE-TESTING: P40: V37 at TIG-8 seconds						
					CONTINUED ON PAGE	
					2.9 MIT/IL SIGNATURE: 	2.10 DATE: 1-21-71
3.1 NASA DIRECTION: Fix 1-21-71.					4.1 CLOSING ACTION TAKEN:	
					CONTINUED ON PAGE	
3.2 NASA/MSC SIGNATURE:		3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:
						4.3 ORGANIZATION
						4.4 DATE:

Date 27 July 1970

MIT/IL SOFTWARE DEVELOPMENT PLAN

FOR

LUMINARY 1D LGC PROGRAM

Russell H. Larson
LUMINARY Project
Manager's Signature

7-28-70
Date

R. H. Larson
Director, Mission
Development Approval

7/28/70
Date

This plan consists of 34 pages.

PREFACE

The LUMINARY 1D LGC Program
is being prepared to support a
manned Lunar or Earth Orbital LM
Flight of a Block II G&N system.

TABLE OF CONTENTS

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SECTION I

PROGRAM DEVELOPMENT SUMMARY

PROGRAM DEVELOPMENT SUMMARY FOR LUMINARY 1D

Date 7/27/70

Item No.	DESCRIPTION		Required Date	Predicted Date	Actual Date	COMMENTS
1	Establishment of Luminary 1D Assy.		11/6/69	11/6/69	11/6/69	
2	Change Design and Coding					
		Start	11/6/69	11/6/69	11/6/69	
	Rev. 163	Completion	12/23/69	3/27/70	5/1/70	
	Rev. 173	Completion			6/2/70	
	Re-release	Completion	7/31/70	7/31/70		
3	Level 2/3 Test Plan		1/16/70		1/16/70	Prel. - updated for each new PCR.
4	Level 2/3 Testing					
		Start	12/11/69		12/22/69	
	Rev. 163	Completion	1/22/70	4/20/70	5/18/70	
		Start	6/4/70	6/4/70	6/4/70	
	Rev. 173	Completion	6/12/70	6/12/70	6/12/70	
		Start	7/27/70	7/27/70	7/27/70	
	Re-release	Completion	8/17/70	8/17/70		
5	Level 4/5 Test Plan					
			1/15/70	2/18/70	3/23/70	
	Rev. 163				6/2/70	
	Rev. 173					
	Re-release	Digital	7/31/70	7/31/70		Prel. to be available on 7/29/70
		Hybrid	7/31/70	7/31/70		
6	Level 4 Testing					
		Start	4/13/70	4/13/70	4/13/70	
	Rev. 163	Completion	4/24/70	5/24/70	5/24/70	Luminary Rev. 163 released 5/6/70 for Rope Manufacturing
		Start	6/9/70	6/6/70	6/6/70	
	Rev. 173	Completion	6/15/70	6/15/70	6/15/70	Luminary Rev. 173 released 6/16/70
		Start	8/18/70	8/18/70		
	Re-release	Completion	9/19/70	9/18/70		

PROGRAM DEVELOPMENT SUMMARY FOR LUMINARY 1D

Date 7/27/70

Item No.	DESCRIPTION	Required Date	Predicted Date	Actual Date	COMMENTS
7	Level 5 Testing Start Completion .	7/1/70 9/19/70	6/15/70 9/18/70	6/15/70	Level 5 testing of Rev. 163 and 173 was not completed due to the re-lease of Luminary See Note Below
8	GSOP Publication (All PCR/PCNs approved at SCB Meetings #32 and 33). Section 2 Section 3 Section 4 Section 5	1/5/70 1/5/70 1/5/70 1/5/70	1/14/70 1/14/70 1/14/70 1/14/70	1/13/70 1/13/70 1/13/70 1/13/70	
9	GSOP Publication (All PCR/PCNs approved up until program delivery). Section 2 Section 3 Section 4 Section 5 GSOP change pages for Re-release	4/5/70 4/5/70 4/5/70 4/5/70 9/18/70	6/25/70 7/20/70 7/30/70 9/18/70 9/18/70	7/9/70 7/17/70	
NOTE: No Level 5 Testing is presently planned, as Level 4 testing is to be conducted on the planned release revision.					

SECTION II

PROGRAM CHANGE REQUEST/NOTICE STATUS

PCRS/PCNS

PCR STATUS REPORT FOR LUMINARY 1D

Date 7/27/70

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
286	Format Change to Landing Site Update.	MSC 10/1/69	No Slip.	0	Implement & provide detailed evaluation.	2	
287	Removal of 526 Alarm in P22.	MSC 9/25/69	No Slip.	0	Implement & provide detailed evaluation.	4, 5	
291.2	Fourth Order Potential Model.	MSC 10/15/69	No Slip.	0	Disapproved.		
293.2	Update Fixed Constants for 1970-1971 Ephemeris Year.	MSC	No Slip.	0	Withdrawn.		
294	Update Fixed Memory Mass Properties.	MSC 11/12/69	No Slip.	0	Implement & provide detailed evaluation.	5	
296	Set "G" Vector Parallel to Landing Site for Radius Vector.	MSC 12/10/69	No Slip.	0	Implement & provide detailed evaluation.	4, 5	
297	P66 Change.	MSC	No Slip.	0	Withdrawn.		
298	Decrease Time to Call Alarm Code 523.	G&C 1/16/70	No Slip	0	Implement & provide detailed evaluation.	4	
299	Change Setting of NOLRREAD Flag.	G&C 1/16/70	No Slip	0	Withdrawn		
300	Check LR Position #1 Discrete before 523 Alarm in HIGATJOB (R12).	GAC 1/19/70	No Slip	0	Disapproved		
301	Eliminate Taking Marks in Pairs.	G&C 1/11/70	No Slip	0	Disapproved		Rewrite for Apollo 15

PCR STATUS REPORT FOR LUMINARY 1D

Date 7/27/70

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
302.2	Channel 77	FSB 1/21/70	No Slip	Less than 25 words.	Implement & provide detailed evaluation.	2,4	
303	DAP Change	EG7 1/28/70	No Slip	0	Disapproved		
304	Implement apriori Terrain Profile.	MPAD 2/12/70	No Slip	0	Disapproved	—	
306	Add ΔV_M to Descent/ Ascent Downlist.	FM2 1/30/70	No Slip	0	Implement & provide detailed evaluation.	2	
307	Lunar Surface Align Downlist Change.	MPB 2/25/70	No Slip	0	Implement & provide detailed evaluation.	2	
314	Downlist Changes for Powered Descent.	MSC 2/26/70	No Slip	0	Implement & provide detailed evaluation.	2	
315.2	Channel 77 Modifica- tion.	MSC 3/5/70	No Slip	0	Implement & provide detailed evaluation.	2	
309	PIP Time in P57.	G&CD 3/13/70	1 Week	+1 E	Disapproved		
310	Time to call 511 Alarms	G&CD 3/17/70	3 Days	+ 4 F + 1 E	Implement & provide detailed evaluation	4	
312	Disapprove PCR 308	FSB 4/9/70	No Slip	0	Implement & provide detailed evaluation	--	
313	Disapprove PCR 1012	FSB	No Slip	0	Implement & Provide detailed evaluation	--	

PCR STATUS REPORT FOR LUMINARY 1D

Date 7/27/70

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
821.2	Move AZO to Fixed Ephemeris Constants.	Stoppelman 6/5/69	No Slip.	+2 fixed -2 erasable	Implement & provide detailed evaluation.	5	
872.2	Initiate TFI in P40s.	Copps 8/8/69	No Slip.	0	Implement & provide detailed evaluation.	4	
874.2	Change Decimal Load Technique.	Copps 8/8/69	No Slip.	+20 words	Implement & provide detailed evaluation.	4	
892	Delete R29.	Garman 8/18/69	No Slip.	-30 words	Implement & provide detailed evaluation.	2, 4, 5	
894	Delete FLV50N25, R1 = 00500 from P63.	Cherry 8/20/69	No Slip.	0	Disapproved.		
896	LR Velocity Read Centered at PIPTIME.	Covelli 8/19/69	No Slip.	-50 words	Implement & provide detailed evaluation.	2, 4, 5	
897	Delete PCR 775.	Covelli 8/19/69	No Slip.	-15 words	Implement & provide detailed evaluation.	5	
898	LR Velocity Read.	Covelli 8/19/69	No Slip.	-10 words	Implement & provide detailed evaluation.	2, 4, 5	
899	N38 in C/A, LS, and R/P Lists.	Garman 8/18/69	No Slip.	0	Implement & provide detailed evaluation.	2	

PCR STATUS REPORT FOR LUMINARY 1D

Date 7/27/70

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
906.2	R00 Initialization.	Garman 8/18/69	No Slip.	+30 words	Disapproved.	—	Accomplished in Luminary 1C.
942	LR Update Cutoff.	Hackler 8/18/69	No Slip.	+6 words	Implement & provide detailed evaluation.	4, 5	
944	Read X-pointer Input from CDUs.	Hackler 8/21/69	No Slip.	0	Implement & provide detailed evaluation.	2	
945	Descent Downlist Change.	Hackler 8/18/69	No Slip.	0	Implement & provide detailed evaluation.	2	
970.2	Modify Gyro Torquing Routine.	Lones 10/14/69	No Slip.	+16	Implement & provide detailed evaluation.	1	
975.2	Modification of R36.	Crocker/ Goode 11/6/69	No Slip.	-11 words	Disapproved.	—	
976	Erasable Program for LM Deorbit.	McCoy 11/25/69	No Slip.	0	Implement & provide detailed evaluation.	—	
979	Delete 521 Alarm.	Covelli 12/1/69	No Slip.	-10 words fixed	Implement & provide detailed evaluation.	4, 5	
981.2	L1 Lunar Gravita- tional Potential Model.	Robertson 12/9/69	No Slip.	+34 fixed +1 eras.	Disapproved	—	
982	Extend Capability of Lunar Surface Star Acquisition Routine R59.	Millard 12/9/69	No Slip.	+10 words	Implement & provide detailed evaluation.	4, 5	
983	Unit Vector Capability for N88.	Millard 12/9/69	No Slip.	+5 words	Implement & provide detailed evaluation.	4	

TP 22587-3

PCR STATUS REPORT FOR LUMINARY 1D

Date 7/27/70

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
986.2	Update Fixed Constants for 1970-1971 Ephemeris Year.	Reber 12/12/69	No Slip.	0	Implement & provide detailed evaluation.	5	
990*	V44 RR Remode Check.	Volante 12/19/69	No Slip.	+6 fixed	Implement & provide detailed evaluation.	4, 5	
991.2	Sum Uplink Data.	Edmonds 12/17/69	No Slip.	+6 fixed	Implement & provide detailed evaluation.	2, 4	
996	Liftoff Check in P07.	Rye 1/26/70	No Slip.	+8 fixed memory.	Implement & provide detailed evaluation.	4	
998	Non-repeating 511 Alarm.	Covelli 1/23/70	No Slip.	+8 fixed +1 flagbit	Disapproved	—	
999	Reset POSTORK, NEGORK in P12 Initialization.	McCoy 1/28/70	No Slip.	+5 fixed	Disapproved	—	
1012	Multiple Servicers Avoidance.	Klumpp 1/30/70	No Slip.	0	Disapproved	—	
1014	V32E Check	Larson 2/2/70	No Slip.	+4	Disapproved	—	
1015	Check for AVEGON at Start of R 36.	Larson 2/2/70	No Slip.	+3 fixed	Implement & provide detailed evaluation.	4	

PCR STATUS REPORT FOR LUMINARY 1D

Date 7/27/70

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
1016	Prevent DAP from Maneuvering the Vehicle to Follow Platform during Gyro Torquing.	Larson 2/2/70	No Slip.	+4 fixed	Withdrawn.	—	
1017	To Preclude P3X Computations being Overwritten by P47.	Larson 2/2/70	No Slip.	+7 fixed	Withdrawn.	—	
1021	Fixed Memory Landing Radar Transformation Matrices.	Covelli 2/10/70	No Slip.	+10 fixed	Implement & provide Detailed evaluation.	5	
1022	Landing Radar Position Alarms.	Covelli 2/10/70	No Slip.	-25 words	Implement & provide detailed evaluation.	2, 4, 5	
1025	Remove Gravity Computation after Landing Radar Attitude Update.	Covelli 2/27/70	No Slip.	-1 Fixed	Implement & provide detailed evaluation.	5	
1027	A priori Terrain Models.	Kriegsman 3/3/70	No Slip.	+10 unshar. Eras. +2 shared Eras. +30 wds. fixed	Implement & provide detailed evaluation.	4, 5	
1028	Two-segment Altitude Weighting Functions for Landing Maneuver	Kriegsman 3/3/70	No Slip.	+1 unshared eras. +2 fixed words.	Implement & provide detailed evaluation.	5	
1029	Timing-indicators.	Larson 3/18/70	No Slip	0	Implement & provide detailed evaluation	2	

PCR STATUS REPORT FOR LUMINARY 1D

Date 7/27/70

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
1035*	V68 & P66 terminate the terrain model	McCoy 4/14/70	No Slip	+ 10 Fixed	Implement & provide detailed evaluation	4	
1036*	PCR 996 (Liftoff check in P07) Improvements	McCoy 4/21/70	No Slip		Implement & provide detailed evaluation	4	
1037*	P66 corrections	Klump 4/22/70	No Slip	+ 2 Fixed	Implement & provide detailed evaluation.	3, 4	
1038*	Keep 526 Alarm in P20 (PCR 287)	McCoy 4/27/70	No Slip		Implement & provide detailed evaluation	4, 5	
1039*	Terrain Model Improvements (PCR 1027)	Klump 4/28/70	No Slip		Implement & provide detailed evaluation	4, 5	
1040*	Only P40 has Early TFI Countdown (PCR 872.2)	McCoy 4/29/70	No Slip		Implement & provide detailed evaluation	4	
1042*	Sec. 3 Rev. 4 GSOP Fix for L-1C-08	Klawnsnik 5/8/70	No Slip	0	Implement & provide detailed evaluation	3	
1043	Remove Zeroing of Bit 4 of Channel 14 on restart or V37	McCoy 5/12/70	No Slip	0	Implement & provide detailed evaluation	2	
1007*	GSOP Sec. 2 Rev. 9 Editorial Changes	H. Maher 5/11/70	No Slip	0	Implement & provide detailed evaluation	2	
1008*	GSOP Sec. 3 Rev. 5 Editorial Changes	Klawnsnik 5/15/70	No Slip	0	Implement & provide detailed evaluation	3	
1048	Initialize Elev. angle in P34	McCoy 5/28/70	No Slip	+2 Fixed	Implement & provide detailed evaluation	4	
1052*	P66/IMU Offset Compensation	McCoy 5/28/70	No Slip	+11 Fixed	Implement & provide detailed evaluation	5	

PCR STATUS REPORT FOR LUMINARY 1D

Date 7/27/70

PCR No.	DESCRIPTION	Originator/ Date	MIT IMPACT		NASA/SCB DIRECTION	GSOP Section Affected	COMMENTS
			Schedule	Storage			
*1056	P42 Improvements for Impulse and Ullage Logic	MIT/DL 7/20/70		1 Fixed			To be accomplished in 9/18/70 re-release of Luminary 1D.
*1058	New Landing Analog Display (R10)	MIT/DL 7/6/70					To be accomplished in 9/18/70 re-lease of Luminary 1D.
*XXX	Throttle Constant						To be written by MSC and accomplished in 9/18/70 re-release of Luminary 1D.

SECTION III

PRE-LEVEL 4 TESTING
AND
LEVEL 3 SYSTEM TEST LAB TESTS

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
PCR 286	Format Change to Landing Site Update.	McCoy	12/22		12/22	4/16	/27	4/27	149
PCR 287	Removal of 526 Alarm in P22. (PCR 1038)	Dunbar/Volante	1/7	1/12	1/12	4/16	4/10	4/10	149
PCR 294	Update Fixed Memory Mass Properties.	Kirven	1/7	1/12	1/31	4/16	3/27	2/2	143
PCR 296	Set "G" Vector Parallel to Landing Site for Radius Vector.	Millard/Moore	2/23	3/27	3/27	3/2	4/20	5/4	149
PCR 298	Decrease Time to Call Alarm Code 523.	Moore	2/23	3/27	3/27	3/2	4/20	5/4	149
PCR 302.2	Channel 77.	Albert	2/23	3/27	3/27	3/2	4/20	5/8	149
PCR 303	DAP Change.	Kalan	3/27	3/27	3/27	4/20	5/5	5/8	149
PCR 306	Add ΔV_M to Descent/Ascent Downlist	Albert	3/27	3/27	3/27	4/20	5/5	5/4	160
PCR 307	Lunar Surface Align Downlist Change.	Millard	3/27	3/27	3/27	4/20	5/5	5/8	149
PCR 314	Downlist Changes for Powered Descent.	Albert	3/27	3/27	3/27	4/20	4/20	4/20	160
PCR 315.2	Channel 77 Modification.	Densmore	TESTED WITH PCR 302.2.						149
PCR 310	Time to call 511 alarms								

TP 22587-1

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
PCR 821.2	Move AZO to Fixed Memory Constants.	Millard	12/22		12/22	4/16	4/20	4/20	143
PCR 872.2	Initiate TFI in P40s. (PCN 1040)	Kirven	1/7	1/12	1/12	4/16	1/16	1/16	143
PCR 874.2	Change Decimal Load Technique.	Rosenberg	12/22		12/22	4/16	1/16	1/16	143
PCR 892	Delete R29.	Berman/ Volante	12/22		12/22	4/16	2/23	5/4	143
PCR 896	LR Velocity Read Centered at PIPTIME.	Covelli	1/7	3/27	3/12	4/16	4/20	4/20	149
PCR 897	Delete PCR 775.	Covelli	12/22	3/27	12/22	4/16	4/20	4/20	143
PCR 898	LR Velocity Read.	Covelli	1/7	3/27	3/12	4/16	4/20	4/20	149
PCR 899	N38 in C/A, LS, and R/P Lists.	Finkelstein	12/22	3/27	12/22	4/16	4/20	5/3	143
PCR 942	LR Update Cutoff.	Moore	12/22	3/27	12/22	4/16	4/20	4/20	143
PCR 944	Read X-pointer Input from CDUs.	Albert	12/22	3/27	12/22	4/16	4/20	5/4	143
PCR 945	Descent Downlist Change.	Albert	12/22	3/27	12/22	4/16	4/20	5/8	143
PCR 970.2	Modify Gyro Torquing Routine.	Megna	2/23	3/27	3/27	3/2	4/20	4/20	149
PCR 979	Delete 521 Alarm.	Covelli	1/7	3/27	3/27	4/22	4/20	4/24	143
PCR 982	Extend Capability of Lunar Surface Star Acquisition Routine R59.	Millard	1/7	3/27	3/27	4/22	4/20	5/8	149
PCR 983	Unit Vector Capability for N88.	Millard	1/7	3/27	3/27	4/22	4/20	5/8	143
PCR 986.2	Update Fixed Constants for 1970-1971 Ephemeris Year.	Dunbar	1/7	3/27	3/27	4/22	4/20	4/20	143
PCR 988	Auto P66. (PCN 1037)	Moore	3/27	3/27	3/27	4/20	4/20	5/2	149

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
PCN 990*	V44 RR Remode Check	Volante	1/7	3/27	3/27	4/22	2/23	4/20	143
PCR 991.2	Sum Uplink Data.	Rosenberg	1/7	3/27	2/16	4/22	2/23	2/23	149
PCR 996	Liftoff check in P07. (PCN 1036)	Rosenberg	2/23	3/1	3/1	3/2	4/20	4/20	154
PCR 1015	Check for AVEGON at Start of R36.	Volante	2/23	3/27	3/27	3/2	4/20	4/20	154
PCR 1021	Fixed Memory Landing Radar Transforma- tion Matrices.	Moore	3/27	3/27	3/27	4/20	4/20	4/20	154
PCR 1022	Landing Radar Position Alarms.	Moore	3/27	3/27	3/27	4/20	4/20	4/20	154
PCR 1025	Remove Gravity Computation after Landing Radar Attitude Update.	Moore	3/27	3/27	3/27	4/20	4/20	4/20	154
PCR 1027	Apriori Terrain Models. (PCNs 1035 & 1039)	Klumpp	3/27	3/27	3/27	4/20	4/20	4/20	154
PCR 1028	Two-segment Altitude Weighting Functions for Landing Maneuver.	Moore	3/27	3/27	3/27	4/20	4/20	4/20	154
PCR 1029	Timing Indicators	Albert	4/5	4/5	4/5	5/2	5/2	5/3	160
PCN 1035*	V68 & P66 terminate the terrain model	Klumpp	Tested with PCR 1027						
PCN 1036*	PCR 996 (Liftoff check in P07) Improvements	Rosenberg	Tested with PCR 996						
PCN 1037*	P66 corrections	Moore	Tested with PCR 988						
PCR 1038	Keep 526 Alarm in P20(PCR 287)	Volante	Tested with PCR 287						
PCN1039	Terrain model improvements (PCR 1027)	Klumpp	Tested with PCR 1027						
PCN 1040	Only P41 has Early TFI Countdown (PRC 872.2)	Kirren	Tested with PCR 872.2						

*PCN

TP 22587-1

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
PCR 1043	Remove Zeroing of Bit 4 of Channel 14 on restart or V37	Densmore	Fixed	by	ACB L-17				

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
L-1B-11	Terminal Mass Error in Descent and Ascent due to Inaccurate Mass Computation in SERVICER.	Kirven	Disposition Change: Program note & close out.						
L-1C-01	Delta-V Increment may be Subtracted from V _G Twice following a Restart.	Kirven	12/22	12/22	12/22	1/16	1/16	1/16	143
L-1C-03	Inspection of Coding V59 in P00.	Moore	12/22	3/27	12/22	1/16	4/16	4/20	143
L-1C-04	Two Remode Tasks Operating Simultaneously.	Volante	1/7	3/27	3/27	1/22	4/20	4/20	143
L-1C-05	Correct for Sign Agreement when HCALC is Calculated in RVBOTH.	Moore	1/12	3/27	3/27	1/16	4/27	4/27	154
L-1C-06	P40, P42 or P63 Commanding Ullage with Average-G off.	Albert	3/27	3/27	3/27	4/20	4/20	4/20	156
L-11	Change Coding in SPEEDRUN to Compute LATVEL and FORVEL.	Bernikowich	12/22	12/22	12/22	1/16	5/24	5/18	143
L-12	Change Exit from LONGCALL.	Densmore	12/22	12/22	12/22	1/16	2/23	2/25	143
L-13	Create Subroutine RLEASVAC to Release VAC Area and Change a FINDVAC to a NOVAC Job.	Moore/ Volante		3/27	3/27	1/22	4/20	5/4	143
L-14	Save 3 Words in Bank 1 to Add Restart Table Entry.	No Test	—	—	—	—	—	—	143
L-15	Set Bit by "TC CLRADMOD".	Volante	2/16	3/27	3/27	2/23	4/20	4/20	143

TP 22587-1

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
L-16	Present Coding can produce random branching if a restart in P64 leaves a job request for the restart point in the throttle routine unsatisfied at the time P66 is entered.	Moore	3/27	3/27	3/27	4/20	4/20	4/20	154
L-17	Remove the zeroing of bit 4 of channel 14 from STARTSUB2.	Albert	3/27	3/27	3/27	4/20	4/20	5/4	154
L-18	Change order of coding from STEERSW check then overflow check to overflow check then STEERSW check change from attitude-hold to Ratestop.	Moore	3/27	3/27	3/27	4/20	4/20	4/20	154
L-19	Save time in P66.	Moore	3/27	3/27	3/27	4/20	4/20	4/20	154
L-20	Correct downlist quantity.	Albert	3/27	3/27		4/20	4/20	5/8	154
L-21	Addition of ECADRs to listing.	Densmore	—	—	—	—	—	—	
L-22	Delete setting and resetting R04 flag.	Volante	3/27	3/27	3/27	4/20	4/20	4/20	154
L-1C-07	Erroneous state vector and W-matrix in P00		Not an Anomaly						
L-23	Delete definitions of W.IND1, VACX, VACY and VACZ from the erasable assignment log section	No Test	—	—	—	—	—	—	
L-24	Move ZERLINA, ELVIRA, AZIMCR1 and ELINCR1 from E7 1443-1446 to E7 1644-1647	Moore	4/12	4/12	4/12	4/20	4/20	4/20	158
L-1B-XX = Anomalies reported on Luminary 1B; Fixed in 1D. L-1C-XX = Anomalies reported on Luminary 1C; Fixed in 1D. L-XX = ACBs.									

TP 22587-1

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
L-1C-08	DAP performance after a restart in Manual Rate Control Mode.	Kalan	4/1	4/1	4/1	4/20	4/20	4/16	156
L-25	Modify BURNBABY BURN	White	4/20	4/20	4/20	5/4	5/4	5/7	160

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D RE-RELEASE (REV. 173)

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
L-20	Test Scaling of Noun 60 R1	Albert	6/4	6/4	6/4	6/12	6/12	6/9	167
PCR 988	Test Restart Point in P66	Moore	6/4	6/4	6/4	6/12	6/9	6/9	165
PCR 96	{ Test R12 Velocity Radar Readings Test R04 Rend. Radar Reading	Moore	6/4	6/4	6/4	6/12	6/9	6/9	165
L-1D-03		White	6/9	6/9	6/9	6/12	6/12	6/12	165
PCN 1048	Test that ELEV is Initialized to Zero in P34.	White	6/4	6/4	6/4	6/12	6/9	6/8	165
L-1C-01	Test P40 Restart Fix	Kirven	6/4	6/4	6/4	6/12	6/9	6/5	165
PCR 1013	Test TOCFEW Does Not Share Erasable	Moore	6/4	6/4	6/4	6/12	6/9	6/9	165
PCN 1052	Test IMU/CG Offset Acceleration Comp.	Klumpp	6/6	6/6	6/6	6/12	6/12	6/15	167
L27	Save 3 words in Bank 5 to make room for clearing of R12RDFLG in Fresh Start fix to PCR 896.	Densmore	6/6	6/9	6/9	6/15	6/13	6/13	165
NOTE: For a complete description of tests see Luminary Memo #155.									

PROGRAM DEVELOPMENT STATUS FOR LUMINARY 1D Re-release (Rev. _____) Date 7/27/70

Date 7/27/70

PCR/ ANOM/ ACB	DESCRIPTION	Responsible Engineer	PRE-LEVEL 4 TESTING						FIXED IN REV
			START			COMPLETED			
			Req	Pred	Act	Req	Pred	Act	
PCN 1056	P42 Improvements for Impulse and Ullage Logic	Adler/Albert		7/27	7/27	8/17	8/17		174
PCN 1058	New Landing Analog Display (R10)	Eyles		7/27	7/27	8/17	8/17		174
PCN XXX	Throttle Constant	Eyles				8/17	8/17		

*PCN

LEVEL III SYSTEM TEST LAB TESTS FOR LUMINARY 1D

Date 7/27/70

TEST	TITLE	Responsible Engineer	TEST COMPLETE			DOCUMENT APPROVED		
			Req	Pred	Act	Req	Pred	Act
RP	Radar Changes	Reedy	3/31	3/31	3/20		4/14	3/23
C77	Channel 77 Restart Monitor	Sheridan	3/31	3/31	3/25		4/30	5/7
PT	IRIG Torque	Sheridan	3/31	3/31	3/25		4/30	5/4
SU	Sum Uplink	Sheridan	3/31	3/31	3/25		4/30	5/7

SECTION IV

LEVEL 4 AND 5 TESTING

AND

LEVEL 5 SYSTEM TEST LAB TESTS

LEVEL 4 AND 5 TESTING FOR LUMINARY 1D

Date 7/27/70

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
4.1.0	LANDINGS Assumptions: (a) No Instrument/S.V. Errors (b) Latest Terrain Model (c) Restarts/extended Verbs/monitors (d) Apollo 13 Datafile	Albert/Moore
4.1.1	Nominal Automatic Landing. P63, P64, P66, P68 V57, V16N92).	
4.1.2	Redesignations. P63 (N69), P64 (ACA), P66 (ATT HOLD), P68, 10% T-LOSS.	
4.2.0	RENDEZVOUS Assumptions: (a) No Instrument/S.V. Errors (b) Restart (P20, P40), Extended Verbs (V90) (c) Apollo 13 Datafile	P. White
4.2.1	Nominal Rendezvous, P52 Planet Option (10% T-LOSS during Average-G).	
4.3.0	ABORTS Assumptions: Same as Landing Tests.	W. Bernikovich

LEVEL 4 AND 5 TESTING FOR LUMINARY 1D

Date 7/27/70

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
4.3.1	Abort/Abort-Stage w/J1K1 Targets, 10% T-LOSS; "MODE SELECT SW" - AGS, V16N85, N77, N76.	
4.3.2	Abort/Abort-Stage w/J2K2 Targets, 10% T-LOSS, V16N85, N77, N76.	
4.4.0	LUNAR SURFACE Assumptions: (a) No Instrument/S.V. Errors (b) Restarts/extended Verbs/monitor (c) Apollo 13 Datafile	D. Millard
4.4.1	P68, P00, P12-P57 (Star/planet), P06, P57 (Gravity/star), P57 (Gravity/REFSMMAT), -P22 (R > 500 mi.) P12, P20, P32.	

LEVEL 4 AND 5 TESTING FOR LUMINARY 1D

Date 7/27/70

TEST No.	REV No.	LEVEL 4 TESTING						LEVEL 5 TESTING					
		START			COMPLETE			START			COMPLETE		
		Req	Pred	Act	Req	Pred	Act	Req	Pred	Act	Req	Pred	Act
4.1.0		LANDINGS											
4.1.1		4/13	5/4	5/4	4/24	5/6	5/6	5/6	5/6	5/6	6/30	6/30	See note below
4.1.2		4/13	5/5	5/4	4/24	5/6	5/6	5/6	5/6	5/6	6/30	6/30	
4.2.0		RENDEZVOUS											
4.2.1		4/13	4/13	4/13	4/24	4/24	4/24	5/6	5/6	5/6	6/30	6/30	
4.3.0		ABORTS											
4.3.1		4/13	4/13	4/13	4/24	4/24	4/24	5/6	5/6	5/6	6/30	6/30	
4.3.2		4/13	4/13	4/13	4/24	5/4	5/6	5/6	5/6	5/6	6/30	6/30	
4.4.0		LUNAR SURFACE											
4.4.1		4/13	4/27	4/27	4/24	5/24	5/24	5/6	5/24		6/30	6/30	
NOTE: Level 5 testing of Rev. 163 was not conducted due to the re-release of Luminary.													

TP 22597-5

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
4.1.0	LANDINGS Assumptions: (a) No instrument/S. V. errors (b) Latest terrain model (c) Restarts/extended verbs/monitors (d) Apollo 13 datafile	ALBERT/MOORE
4.1.1	Nominal Automatic Landing. P63, P64, P66, P68, 10% T-loss (a) Call P20 in no-update mode (V95E) (b) Call P30 to load any ΔV into noun 81 at TIG of PDI + 1 minute. (c) Trace loading of LRWH1 into LRWH (d) Rollback ANEWROT and load the proper value via V21NO1E, XXXXXE in P64 prior to data good after antenna reposition.	
4.1.2	Redesignations. P63(N69), P64(ACA), P66(ATT. HOLD), P68, 10% T-loss (a) Trace 1st pass through R12 to show proper reinitialization.	

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
4.2.0	RENDEZVOUS Assumptions: (a) No instrument/S. V. errors (b) Restart (P20, P40), extended verbs (V90) (c) Apollo 13 datafile	P. WHITE
4.2.1	Nominal rendezvous, P52 planet option (10% T-loss during ave - G)	W. BERNIKOVICH
4.2.2	Do short rendezvous profile (P20, P34, P42, P35, P41, P35, P41)	
4.2.3	Do CSM - active rendezvous	
4.3.0	ABORTS Assumptions: same as landing tests	
4.3.1	Abort/abort - stage W/J1K1 targets, 10% T-loss; "MODE SELECT SW" - AGS, V16N85, N77, N76	
4.3.2	Abort/abort - stage W/J2K2 targets, 10% T-loss, V16N85, N77, N76	

TEST NO.	DESCRIPTION	RESPONSIBLE ENGINEER
4.4.0	LUNAR SURFACE Assumptions: (a) No instrument/S. V. errors (b) Restarts/extended verbs/monitors (c) Apollo 13 datafile	D. MILLARD
4.4.1	P68, P00, P12-P57 (star/planet), P06, P57 (gravity/star), P57 (gravity/REFSMMAT), - P22, P12, P20, P32 (a) Call P22 when range to CSM > 400 N. Mi. (b) When V16N54 appears, call R47 via V47E (c) Note any discrepancies	

LEVEL 4 AND 5 TESTING FOR LUMINARY 1D RE-RELEASE (REV. 173)

Date 7/27/70

TEST No.	REV No.	LEVEL 4 TESTING						LEVEL 5 TESTING					
		START			COMPLETE			START			COMPLETE		
		Req	Pred	Act	Req	Pred	Act	Req	Pred	Act	Req	Pred	Act
4.1.0	173	— LANDINGS —											
4.1.1		6/9	6/6	6/6	6/15	6/9	6/9	6/17	6/17	6/17	7/19	7/19	7/1
4.1.2		6/9	6/6	6/6	6/15	6/9	6/9	6/17	6/17	6/17	7/19	7/19	7/6
4.2.0		— RENDEZVOUS —											
4.2.1		6/9	6/6	6/6	6/15	6/11	6/10	6/17	6/17	6/17	7/19	7/19	7/1
4.2.2		6/9	6/9	6/9	6/15	6/15	6/13	6/17	6/17	6/17	7/19	7/19	
4.2.3		6/9	6/9	6/9	6/15	6/15	6/13	6/17	6/17	6/17	7/19	7/19	
4.3.0		— ABORTS —											
4.3.1		6/9	6/6	6/6	6/15	6/11	6/10	6/17	6/17	6/17	7/19	7/19	7/1
4.3.2		6/9	6/6	6/6	6/15	6/11	6/10	6/17	6/17	6/17	7/19	7/19	7/1
4.4.0		— LUNAR SURFACE —											
4.4.1		6/9	6/6	6/6	6/15	6/11	6/15	7/1	6/15	6/15	8/15	6/15	6/15

LEVEL V SYSTEM TEST LAB TESTS FOR LUMINARY 1D (Rev 173)

Date 7/27/70

TEST	TITLE	Responsible Engineer	TEST COMPLETE			DOCUMENT APPROVED		
			Req	Pred	Act	Req	Pred	Act
SEV	Extended Verbs	Grace		7/1	6/18		7/31	
IOP	IMU Operational Programs	Grace		7/1	6/22		7/31	
STP2	IMU Performance test	Grace		7/21	7/21		7/31	
STP3	IRIG Scale Factor	Grace		7/21	7/21		7/31	
AAR6	Test P57-PCR982 Change	St.Amand		7/11	7/10		7/31	
RP	Radar Changes	Goodwin		7/11	7/10		7/25	7/13
PT	IRIG Torque	Sheridan		7/8	6/17		7/31	
SU	Sum Uplink	Sheridan		7/8	6/18		7/31	
C77	Channel 77 Restart Monitor	Sheridan		7/8	6/18		7/31	
	Miscellaneous Changes - included in Radar Change	Sheridan						

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 287~~ANOMALY~~ # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN☒ NASA Approved PCR☐ NASA Approved Software Anomaly☐ NASA Approved PCN☐ MIT Approved Software AnomalyA. Coding☒ Begin coding immediatelyACTION: Virginia Lumbard
Peter VolanteProgram Supervisor's Approval: Margaret Hamels☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☒ Prepare GSOP revisions for MDRB considerationACTION: Section 4 - F. DeCain☐ Technical Committee Meeting not required.☐ Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

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

ACTION: _____

Special InstructionsProject Manager R. Larson RWSDate 11/17/69

This change should also
be made to P20

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
- PROGRAM CHANGE REQUEST -

No. 287
(Completed by FSB):

1.0 COMPLETED BY
ORIGINATOR

1.1 ORIGINATOR: CTH-EG7
DATE: 9-25-69

1.2 ORGANIZATION: EG/Guidance & Control
APPROVAL: WCC DATE: 9/25

1.3 EFFECTIVITY:

LUM 10

1.4 TITLE OF CHANGE:

Removal of 526 Alarm in P22 & P20

1.5 REASON(S) FOR CHANGE: Current P22^{& P20} calls priority alarm 526 if range to CSM > 400 nm.
This alarm only confirms what the crew already knows.

1.6 DESCRIPTION OF CHANGE:

Replace the alarm code with contents of N54 (R,R) until range < 400 nm and then
let program proceed normally.

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

2.1

☐ APPROVED

☐ DISAPPROVED

2.2 REMARKS:

2.3 SOFTWARE CONTROL BOARD OR FLIGHT
SOFTWARE BRANCH SIGN OFF: _____

DATE: _____

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT:

3.2 IMPACT OF PROVIDING DETAILED EVALUATION:

3.3 STORAGE IMPACT:

3.4 REMARKS:

3.5 MIT COORDINATOR: _____

DATE: _____

4.0 SOFTWARE CONTROL
BOARD ACTION

4.1 IMPLEMENT AND PROVIDE
☒ DETAILED CHANGE EVAL.

PROVIDE DETAILED
☐ CHANGE EVALUATION ☐ DISAPPROVED

4.2 REMARKS:

4.3 SOFTWARE CONTROL
BOARD SIGN OFF: SCB

DATE: 11/13/69

5.0 MIT DETAILED PROGRAM
CHANGE EVALUATION

5.1 MIT COORDINATOR: _____
DATE: _____

5.2 MIT EVALUATION:

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 START OR CONTINUE ☐ DISAPPROVED OR STOP
☐ IMPLEMENTATION ☐ IMPLEMENTATION

6.2 REMARKS:

6.3 SOFTWARE CONTROL
BOARD SIGN OFF: _____

DATE: _____

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 294
ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

F. Kirven

ACTION: _____

Program Supervisor's Approval: [Signature]

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

J. GLENDENNING

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager [Signature]

Date 12-29-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

294

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR J. W. Jurgensen	DATE 11/12/69	1.2 ORGANIZATION FSB	APPROVAL	DATE
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1.3 EFFECTIVITY Apollo 14 LUMINARY 1D	1.4 TITLE OF CHANGE Update Fixed Memory Mass Properties
--	--

1.5 REASON(S) FOR CHANGE
To reflect changes in LM weights, etc., for example, HI DESCENT, the maximum value in the reasonableness test for LEMMASS is almost 200 lbs. less than the actual weight of the Apollo 12 lunar module.

1.6 DESCRIPTION OF CHANGE
~~Update Fixed Memory Mass Properties~~ CHANGE HI DESCENT TO 16,700 KG.

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

2.1 ☒ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF <i>[Signature]</i>	
DATE 11-13-69	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>[Signature]</i>	
DATE 12-29-69	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF SCB on 12/18/69	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 296
ANOMALY # _____

☐ COLOSSUS 2C	☐ LUMINARY 1B
☒ COLOSSUS 2D	☐ LUMINARY 1C
☐ COLOSSUS 2E	☒ LUMINARY 1D
☐ COLOSSUS 2F	☐ LUMINARY 1E

REISSUE 2/26/70

☐ MIT Approved PCN☒ NASA Approved PCR☐ NASA Approved Software Anomaly☐ NASA Approved PCN☐ MIT Approved Software AnomalyA. Coding* ☒ Begin coding immediatelyD. MOORE

ACTION: _____

Program Supervisor's Approval: Margaret Hamelin☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation* ☒ Prepare GSOP revisions for MDRB considerationSection 4 & 5

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

*Don Melan - provide
detailed evaluation
before coding &
documentation*

Project Manager Russell H. LarsonDate 2-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
- PROGRAM CHANGE REQUEST -

No. 296
(Completed by FSB)

1.0 COMPLETED BY
ORIGINATOR

1.1 ORIGINATOR: C.B. Parker
DATE: Dec. 10, 1969

1.2 ORGANIZATION: Flight Control Div.
APPROVAL: [Signature] DATE: 12/11/69

1.3 EFFECTIVITY:
LUMINARY APOLLO 14

1.4 TITLE OF CHANGE: Set "G" vector
parallel to landing site radius vector

1.5 REASON(S) FOR CHANGE: P-68 sets the gravity vector parallel to the IM X body axis. Thus, the first gravity measurement in P-57 (options 1 or 3) gives a gravity error angle equal to the displacement of the IM X body axis from the local vertical. This information is of little interest, since the IM body attitude is (cont.)

1.6 DESCRIPTION OF CHANGE:

In P-68, set "G" vector parallel to the LGC landing site radius vector instead of parallel to the IM X body axis.

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

2.1 ☐ APPROVED ☐ DISAPPROVED

2.2 REMARKS:

2.3 SOFTWARE CONTROL BOARD OR FLIGHT
SOFTWARE BRANCH SIGN OFF: [Signature]
DATE: 12-15-69

MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT:

3.2 IMPACT OF PROVIDING DETAILED EVALUATION:

3.3 STORAGE IMPACT:

3.4 REMARKS:

3.5 MIT COORDINATOR: _____
DATE: _____

4.0 SOFTWARE CONTROL
BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE
DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED
CHANGE EVALUATION ☐ DISAPPROVED

4.2 REMARKS:

4.3 SOFTWARE CONTROL
BOARD SIGN OFF: SCB on 2/4/70
DATE: _____

5.0 MIT DETAILED PROGRAM
CHANGE EVALUATION

5.1 MIT COORDINATOR: _____
DATE: _____

5.2 MIT EVALUATION:

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE ☐ DISAPPROVED OR STOP
IMPLEMENTATION IMPLEMENTATION

6.2 REMARKS:

6.3 SOFTWARE CONTROL
BOARD SIGN OFF: _____
DATE: _____

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE
REQUEST NO.

296

PREPARED BY: C.B. Parker

DATE: Dec. 10, 1969

ORGANIZATION:

Flight Control Div.

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

1.5(cont.) well defined by attitudes at landing. A more pertinent quantity to display at this time would be the angle between the IGC navigated landing site radius vector and the measured gravity vector, since this is an immediate indication of how much the landing site coordinates may be expected to change if a subsequent P-57 option 2 is exercised.

Also, it is possible, although very unlikely, that a procedural error could result in destroying the IGC estimate of the landing site coordinates. (If a P-57 option 2 were performed prior to a gravity measurement, and the resultant landing site coordinates were accepted.)

REMARKS

- | | |
|---|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☒ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

REISSUED - 2/26/70
** G&CD has verified that there are no ICD's that will conflict with a landing radar repetition time of 11 seconds.*

- | | | |
|---|---|---|
| ☐ MIT Approved PCN | ☒ NASA Approved PCR | ☐ NASA Approved Software Anomaly |
| | ☐ NASA Approved PCN | ☐ MIT Approved Software Anomaly |

A. Coding

☒ Begin coding immediately

ACTION: Burns McCoy

Program Supervisor's Approval:

Mary Ann Hamel

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

F DeCuir

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

*Implementation subject to date
If it is approved
MHL*

Project Manager Burns McCoy
Date 2-5-78

** Info taken from SCB Minutes of 2/17/70. (HEMO# 70-FA-T-15)
P&I spec says 10 sec. MAX.
NASA Data Book says 10 sec.*

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
- PROGRAM CHANGE REQUEST -

No. 298
(Completed by FSB)

1.0 COMPLETED BY ORIGINATOR	1.1 ORIGINATOR <u>C. T. Hackler</u> DATE: <u>January 16, 1970</u>	1.2 ORGANIZATION: <u>Guidance & Control Div</u> APPROVAL: <u>[Signature]</u> DATE: <u>1/19/70</u>
1.3 EFFECTIVITY: <u>LUM 1D</u>		1.4 TITLE OF CHANGE: <u>Decrease time to call alarm code 523</u>
1.5 REASON(S) FOR CHANGE: <u>Landing radar antenna in Apollo 11 and 12 switched positions in less than 7 seconds. If the antenna has not changed in 10 seconds, there is no reason to believe it will change with additional time.</u>		
1.6 DESCRIPTION OF CHANGE: <u>Change constant C=14 in LR antenna reposition routine to C=4.</u>		
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT		2.1 ☐ APPROVED ☐ DISAPPROVED
2.2 REMARKS:		2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF: _____ DATE: _____
3.0 MIT VISIBILITY IMPACT EVALUATION:		3.1 SCHEDULE IMPACT:
3.2 IMPACT OF PROVIDING DETAILED EVALUATION:		3.3 STORAGE IMPACT:
3.4 REMARKS:		3.5 MIT COORDINATOR: _____ DATE: _____
4.0 SOFTWARE CONTROL BOARD ACTION	4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DISAPPROVED	
4.2 REMARKS: <u>Subject to confirmation of no ICID violation.</u>		4.3 SOFTWARE CONTROL BOARD SIGN OFF: <u>[Signature]</u> DATE: <u>Feb 4, 1970</u>
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION	5.1 MIT COORDINATOR: _____ DATE: _____	
5.2 MIT EVALUATION:		
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION	6.1 ☐ START OR CONTINUE ☐ DISAPPROVED OR STOP IMPLEMENTATION IMPLEMENTATION	
6.2 REMARKS:	6.3 SOFTWARE CONTROL BOARD SIGN OFF: _____ DATE: _____	

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 302.2
ANOMALY # _____

☐ COLOSSUS 2C	☐ LUMINARY 1B
☐ COLOSSUS 2D	☐ LUMINARY 1C
☐ COLOSSUS 2E	☒ LUMINARY 1D
☐ COLOSSUS 2F	☐ LUMINARY 1E

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved
Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

302.2

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR J. R. Garman	DATE 1/21/70	1.2 ORGANIZATION FSB	APPROVAL	DATE
--------------------------------	-----------------	-------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D (Apollo 14)	1.4 TITLE OF CHANGE Channel 77
--	-----------------------------------

1.5 REASON(S) FOR CHANGE
A hardware module is being added to both the CMC and LGC starting with Apollo 14 that enables the software, and hence crew or ground, to determine the exact cause of any hardware restart. (Continued)

1.6 DESCRIPTION OF CHANGE
The following software changes should be made to make channel 77 an effective device: (Continued)

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

2.1 ☒ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF <i>Thomas J. White</i>	

3.0 MIT VISIBILITY IMPACT EVALUATION:

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

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS a) Verify that if the hardware channel is not added, the implementation of this PCR will cause no problems. b) Item B of 1.6 shall not be implemented.
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE SCB on 2/4/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 3

PROGRAM CHANGE REQUEST NO. PREPARED BY

DATE

ORGANIZATION

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

1.5 Reasons for Change (Cont'd)

This is being done by the addition of another I/O channel (channel 77) that is read only with the exception of a WRITE with all zeroes which will clear the channel. Should a hardware restart occur, one of the bits in the channel would be set (to binary 1) indicating the source. The bit definitions are:

<u>BIT</u>	<u>RESTART (and/or AGC warning) CAUSE</u>
15-10	Spare
9	Scalar double freq.
8	Scalar fail
7	Counter fail
6	Voltage fail
5	Nightwatchman
4	Ruptlock
3	TC Trap
2	E-memory parity fail
1	E or F-memory parity fail

If multiple restarts occur, more than one bit could possibly be left set afterwards (i.e., if they were different types). Many restarts of the same type would leave just one bit set with the software REDOCNTR indicating the number.

1.6 Description of Change (Cont'd)

A. Fresh Start should initialize the channel to 0. This should be V36E ("SLAP1") only, not the 1107 alarm type of fresh start.

B. The channel should be added to a NOUN for ease in crew readout should restarts occur. R3 of NO8 is suggested.

C. The channel should be added to the telemetry in place of the parameter CADRFLASH+0 in all downlists. CADRFLASH+1 may become spare if necessary.

D. The final V33E on a P27 state vector uplink should zero the channel.

Note that the only place the channel will be zeroed is in case of V36E (done nominally prelaunch) or state vector uplink. The ground or crew could input a V21N10E77EE which will also zero the channel. It should be noted that NO7 will not work with channel 77 (although N10 will, as previously implied). The purpose of the state vector uplink zeroing the channel is to provide a simple means for initializing the channel after
(Continued)

REMARKS:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 3 OF 3

PROGRAM CHANGE REQUEST NO.	PREPARED BY	DATE	ORGANIZATION

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

1.6 Description of Change (Cont'd)

nominal restarts (e.g. power-up) at a point in time after which the ground has examined the channel. Since state vector uplinks are a part of all power-up (or serious recovery) procedures and since uplinking is always preceded by ground data acquisition, such a scheme should prove most satisfactory.

It should be noted that there is emphasis to zero the channel as little as possible under software control to preserve as much information as possible. That is, should multiple restarts of different types occur, it would be most desirable to not have the second type erase all record of the first having occurred. This is true no matter what type of scheme is considered (such as buffering or push-down into two or more erasable memory cells), given that enough restarts occur (e.g. a single parity fail followed by a TC trap restart loop).

In summary, simply putting the channel on the telemetry along with the already present counter gives the maximum information for all the most probable restart conditions (single or loop of one type, etc.); and only very specialized cases would not be covered as completely as with other more complex and expensive software changes.

REMARKS:

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 306

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Elena Denesmore
Margaret Hamill

Program Supervisor's Approval:

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Section 2

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Lawrence

Date 3-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by TSB)

306

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR J. H. Alphin	DATE 1/30/70	1.2 ORGANIZATION FM2	APPROVAL R. H. Lanson	DATE 2/20/70
--------------------------------	-----------------	-------------------------	--------------------------	-----------------

1.3 EFFECTIVITY Apollo 14	1.4 TITLE OF CHANGE Add ΔV_M to descent/ascent downlist
------------------------------	--

1.5 REASON(S) FOR CHANGE
Aid in postflight analysis for trajectory ΔV /propellant usage. This is not a mandatory change and should only be considered if (a) ΔV_M is presently computed onboard and (b) space is presently available on the downlink.

1.6 DESCRIPTION OF CHANGE
Add ΔV_M to descent/ascent downlist. word 78 should be used
log PCR # 214

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS: SCB WORK-ON
3.5 MIT COORDINATOR R. H. Lanson	
DATE 3-6-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF 3/4/70	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIPPCR/PEN # 307ANOMALY # :

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN☒ NASA Approved PCR☐ NASA Approved Software Anomaly☐ NASA Approved PCN☐ MIT Approved Software AnomalyA. Coding☒ Begin coding immediatelyACTION: Dana SenmoreProgram Supervisor's Approval: Margaret Hamill☐ Do not code until new GSOP material has been approved by the Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☒ Prepare GSOP revisions for MDRB considerationACTION: Section 2

Technical Committee Meeting not required

Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

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

ACTION: _____

Special InstructionsProject Manager: R.H. LarsonDate 3-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

307

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR T. J. Blucker	DATE 2/25/70	1.2 ORGANIZATION MPAD/MPB	APPROVAL	DATE
---------------------------------	-----------------	------------------------------	----------	------

1.3 EFFECTIVITY Apollo 14 and Subsequent	1.4 TITLE OF CHANGE Lunar Surface Align Downlist Change
---	--

1.5 REASON FOR CHANGE The AOT mark data in P-57 is needed for the AOT + G RTCC processor to determine the LM lunar position. This data will permit a more accurate estimate of the LM position by the processor than the measured star unit vectors which are currently on the downlist due to not having to rotate the sighting data through the gimbal angle (cont'd)

1.6 DESCRIPTION OF CHANGE Change word no. 90 which is currently POSTORK P and NEGTOCK P to the AOT detent code used for the star sighting. Place the AOT cursor and spiral angles in word no. 100 and place the AOT mark time in word no. 99.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS: SCB WORK-ON
3.5 MIT COORDINATOR R.H. Larson	
DATE 3-6-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

307

PREPARED BY

T. J. Blucker

DATE

2/25/70

ORGANIZATION

MPAD/MPB

1.5 Reason(s) for Change (cont'd)

matrix. The observations will be computed from the spiral and cursor angles in IM body coordinates and processed likewise.

REMARKS:

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 310

ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Peter Volante

Program Supervisor's Approval: M. Chamberlin

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: F. DECAIN

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. LARSON KWS

Date 4/10/70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

FORM 100 (Completed by 730)

310

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR

C. T. Hackler

DATE

3/17/70

1.2 ORGANIZATION

EG/Guidance & Control

APPROVAL

DeChatter

DATE

3/18/70

1.3 EFFECTIVITY

LUM 1D

1.4 TITLE OF CHANGE

Time to call 511 alarms

1.5 REASON(S) FOR CHANGE

Crew request.

1.6 DESCRIPTION OF CHANGE

Change time to call 511 alarms from two to ten seconds.

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

2.1

☐

APPROVED

☐

DISAPPROVED

2.2 REMARKS:

2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE
BRANCH SIGN OFF

DATE

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT

3 day + 4 filed + 1 evalable.

3.2 IMPACT OF PROVIDING DETAILED EVALUATION

3.3 STORAGE IMPACT

3.4 REMARKS:

3.5 MIT COORDINATOR

DATE

4.0 SOFTWARE CONTROL BOARD ACTION

4.1

☒ IMPLEMENT AND
PROVIDE DETAILED
CHANGE EVAL.

☐

PROVIDE
DETAILED
CHANGE
EVALUATION

☐

DIS-
APPROVED

4.2 REMARKS

4.3 SOFTWARE CONTROL BOARD SIGN OFF

4/9/70

DATE

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR

DATE

5.2 MIT EVALUATION

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1

☐

START OR CONTINUE
IMPLEMENTATION

☐

DISAPPROVED OR STOP
IMPLEMENTATION

6.2 REMARKS:

6.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 314

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly

☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Dana Denmore

Program Supervisor's Approval: Margaret Samuels

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Letter 2

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

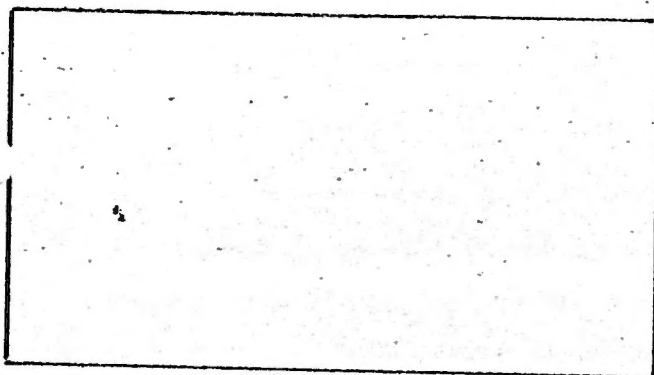
☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 3-6-70



OLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

314

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR S. G. Bales	DATE 2/26/70	1.2 ORGANIZATION Flight Control	APPROVAL <i>[Signature]</i>	DATE 3/2/70
-------------------------------	-----------------	------------------------------------	--------------------------------	----------------

1.3 EFFECTIVITY LUMINARY ID (Apollo 14)	1.4 TITLE OF CHANGE Downlist changes for powered descent
--	---

1.5 REASON(S) FOR CHANGE
The change will provide the ground with an accurately timetagged value of Guidance Thrust Command. This data is necessary if the ground becomes involved in a throttle modulation procedure.

1.6 DESCRIPTION OF CHANGE
Move Guidance Thrust Command (currently word 78a) to word 5a, place piptime into words 6a and 6b, and place a downlink "snapshot" buffer on words 5 through 12 and 6.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS: SCB walk-on
3.5 MIT COORDINATOR <i>R.H. Larson</i>	
DATE 3-6-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF 3/4/70	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/PL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 315.2

ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Sharon Albert

Program Supervisor's Approval: Margaret Hamilton

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Section 2

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

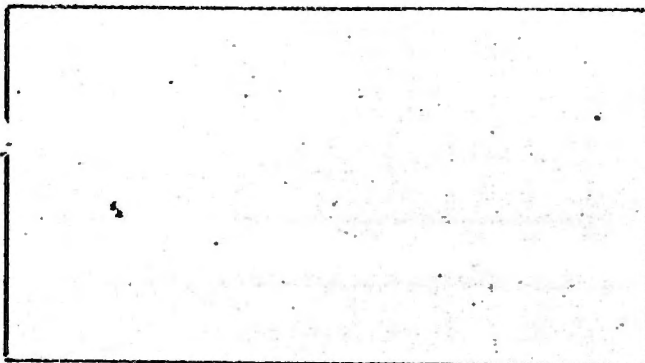
☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 3-6-70



315.2

Rev 1, 3/2/70

JLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSO)

302-2 (Rev-1)

315.2

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR P. RYE	DATE 3/2/70	1.2 ORGANIZATION MIT/CSD Lab.	APPROVAL	DATE
--------------------------	----------------	----------------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Channel 77.
--------------------------------	------------------------------------

1.5 REASON(S) FOR CHANGE

See initial issue of PCR 302.2.

1.6 DESCRIPTION OF CHANGE

Revised paragraph 1.6, item "C" on page 2 of the original PCR to read as follows:
C. The channel should be added to the telemetry in place of the parameter
CADRFLASH+1 in all downlists. CADRFLASH+0 will become a spare.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. Larson</i>	
DATE 3-2-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF 3/4/70	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 322
ANOMALY # _____
ADR # _____

☐ COLOSSUS 2E	☒ LUMINARY 1D
☐ COLOSSUS 3	☐ LUMINARY 1E
☐ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

☐ MIT Approved PCN
☐ MIT Approved ADR

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly
☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: Margaret Hamilton

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Laro

Date 8-18-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

322

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR J. H. Alphin	DATE 7/27/70	1.2 ORGANIZATION MPAD/LAB	APPROVAL R. Miller	DATE 8/3/70
--------------------------------	-----------------	------------------------------	-----------------------	----------------

1.3 EFFECTIVITY Apollo 14 LVM ID	1.4 TITLE OF CHANGE Change Fixed Constant "Throtlag" from 0.2 to 0.08
-------------------------------------	--

1.5 REASON(S) FOR CHANGE
The onboard computer uses a constant to simulate the DPS engine response. The actual response is smaller than predicted.

1.6 DESCRIPTION OF CHANGE
Change the fixed memory constant "Throtlag" from 0.2 to 0.08.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

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

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 8/13/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 821.2

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

Russell H. Larrison
10-31-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

821.2

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR J. STOPPELMAN	DATE 6/5/69	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
---------------------------------	----------------	----------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Move AZO to Fixed Memory.
--------------------------------	--

1.5 REASON(S) FOR CHANGE
AZO is for all effective purposes, constant for a given year and this change would yield two unshared erasables.

1.6 DESCRIPTION OF CHANGE
Delete AZO in erasable.
Define AZO in fixed.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT +2 FIXED -2 ERASABLE	3.4 REMARKS:
3.5 MIT COORDINATOR Russell H. Tanner DATE 10-7-69	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF APPROVED SCB DATE 10/9/69	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR DATE	5.2 MIT EVALUATION
-----------------------------	--------------------

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF DATE	

MIT MIL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 872.2
ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Peter Asker will act as consultant. Also, please coordinate with Don Eyles.

Project Manager _____

Date _____

Russell H. Larson
10-31-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 872.2	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR S. COPPS		DATE 8/8/69		1.2 ORGANIZATION MIT/IL	
1.3 EFFECTIVITY LUMINARY 10		1.4 TITLE OF CHANGE Initiate TFI in P30s.			
1.5 REASON(S) FOR CHANGE To provide astronaut with useful display.					
1.6 DESCRIPTION OF CHANGE Initiate TFI clockjob in P30s so that N35 and N40 are available anytime after N45.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 0			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED			4.2 REMARKS: Apollo 14/		
4.3 SOFTWARE CONTROL BOARD SIGN OFF JF [Signature]					
DATE 10-9-69					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 874.2
ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

Sumner Rosenberg
will have this coding
prepared for COLOSSUS

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 874.2	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR S. COPPS		DATE 8/8/69		1.2 ORGANIZATION MIT/IL	
1.3 EFFECTIVITY LUMINARY 10		1.4 TITLE OF CHANGE Change Decimal Load Technique.			
1.5 REASON(S) FOR CHANGE Saves keystrokes.					
1.6 DESCRIPTION OF CHANGE Change decimal load logic to not require 5 digits. For example, if all zeros are desired simply load sign and enter, or if +50 is desired, simply load +50 ENTR.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 20 Words.			3.4 REMARKS:		
3.5 MIT COORDINATOR					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED			4.2 REMARKS Apollo 14		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 10-9-69					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 892
ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly

☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

H. MAHER (2)
G. POPE (3) ?
F. DECAIN (4)
J. GLENDENING (5)

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

Russell H. Larson
10-31-69

Craig has some
of this done.

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 892	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR		DATE	1.2 ORGANIZATION	APPROVAL	DATE
J. R. Garman		8/18/69	FSB	<i>George Cherry</i>	8/20/69
1.3 EFFECTIVITY			1.4 TITLE OF CHANGE		
LUMINARY 10			Delete R29		
1.5 REASON(S) FOR CHANGE					
It is believed that the 390+ word cost is not worth the output of the routine.					
1.6 DESCRIPTION OF CHANGE					
Remove R29 from the LUMINARY program.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
LUMINARY 1C baseline					
3.3 STORAGE IMPACT			3.4 REMARKS:		
save 390 words					
3.5 MIT COORDINATOR					
<i>George W. Cherry</i>					
DATE					
8/20/69					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED			4.2 REMARKS: <i>Apollo 14</i>		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
<i>77 Rbf</i>					
10-9-69					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 896
ANOMALY # _____

☐ COLOSSUS 2C	☐ LUMINARY 1B
☐ COLOSSUS 2D	☐ LUMINARY 1C
☐ COLOSSUS 2E	☒ LUMINARY 1D
☐ COLOSSUS 2F	☐ LUMINARY 1E

☐ MIT Approved PCN☒ NASA Approved PCR☐ NASA Approved PCN☐ NASA Approved
Software Anomaly☐ MIT Approved
Software AnomalyA. Coding☒ Begin coding immediatelyACTION: Bob ConellProgram Supervisor's Approval: Margaret Hamell☐ 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: _____F. DECAIN
J. GLENDENNINGC. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

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

ACTION: _____

Special InstructionsProject Manager Russell H. TurnerDate 10-31-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 896
1.0 COMPLETED BY ORIGINATOR				
1.1 ORIGINATOR R. COVELLI	DATE 8/19/69	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
1.3 EFFECTIVITY LUMINARY ^{ID} 2.1C		1.4 TITLE OF CHANGE LR Velocity Read Centered at PIP TIME.		
1.5 REASON(S) FOR CHANGE By centering the LR Velocity Reads about PIPTIME, the velocity extrapolation in R12 can be removed. Saves about 150 ms execution time.				
1.6 DESCRIPTION OF CHANGE Center LR Velocity read about PIPTIME.				
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT				
2.1 ☐ APPROVED ☐ DISAPPROVED		2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF				
DATE				
3.0 MIT VISIBILITY IMPACT EVALUATION:				
3.1 SCHEDULE IMPACT		3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT -50 words.		3.4 REMARKS:		
3.5 MIT COORDINATOR <i>[Signature]</i>				
DATE				
4.0 SOFTWARE CONTROL BOARD ACTION				
4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED		4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF APPROVED SCB				
DATE 10/9/69				
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION				
5.1 MIT COORDINATOR		5.2 MIT EVALUATION		
DATE				
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION				
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION		6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF				
DATE				

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 897
ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

897

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR R. COVELLI	DATE 8/19/69	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
-------------------------------------	------------------------	-----------------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1C	1.4 TITLE OF CHANGE Delete PCR 775.
---------------------------------------	---

1.5 REASON(S) FOR CHANGE
PCR 775 (LGC Doppler compensation) is not used. It uses storage and execution times.

1.6 DESCRIPTION OF CHANGE
Delete coding.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT -15 words.	3.4 REMARKS:
3.5 MIT COORDINATOR <i>Bruce J. McCoy</i>	
DATE	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF APPROVED SCB	
DATE 10/9/69	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 898

ANOMALY # _____

☐ COLOSSUS 2C	☐ LUMINARY 1B
☐ COLOSSUS 2D	☐ LUMINARY 1C
☐ COLOSSUS 2E	☒ LUMINARY 1D
☐ COLOSSUS 2F	☐ LUMINARY 1E

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

ACTION: _____

Program Supervisor's Approval: _____

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

ACTION: _____

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

ACTION: _____

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

ACTION: _____

Special InstructionsProject Manager Russell H. LarsonDate 10-31-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSS) 898	
1.0. COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR R. COVELLI	DATE 8/19/69	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE	
1.3 EFFECTIVITY LUMINARY ^{ID} LC			1.4 TITLE OF CHANGE LR Velocity Read.		
1.5 REASON(S) FOR CHANGE Begin LR velocity reading at start of P63 SERVICER.					
1.6 DESCRIPTION OF CHANGE Remove IVI < VUP test.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT - 10			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>James J. McLaughlin</i>					
DATE					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF APPROVED SCB					
DATE 10/9/69					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 899
ANOMALY # _____

- | | |
|---|---|
| ☒ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

Russell H. Turner
10-31-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 899	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR	DATE	1.2 ORGANIZATION	APPROVAL	DATE	
J. Garman	8/18	FSB	<i>George W. Cherry</i>	8/20/69	
1.3 EFFECTIVITY			1.4 TITLE OF CHANGE		
LUMINARY 1D			N38 in C/A, LS, and R/P lists		
1.5 REASON(S) FOR CHANGE					
N38 would allow the ground to follow the progress of integration and detect integration loops.					
1.6 DESCRIPTION OF CHANGE					
Remove: LR VELZ and LR RANGE from word 76 in C/A; DELTA THETA from word 28 in LSA; OFFSET PT from word 95 in R/P; replace above with TET.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 0			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>G. W. Cherry</i>					
DATE 8/20/69					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED			4.2 REMARKS: <i>Apollo 14</i>		
4.3 SOFTWARE CONTROL BOARD SIGN OFF <i>J. Garman</i>					
DATE 10-9-69					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 970.2

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

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

ACTION: _____

Program Supervisor's Approval: _____

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

ACTION: _____

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

ACTION: _____

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

ACTION: _____

Special Instructions

Project Manager: _____

Date: 2-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSD)

970.2

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR R. LONES	DATE 10/14/69	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
1.3 EFFECTIVITY LUMINARY		1.4 TITLE OF CHANGE Modify Gyro Torquing Routine.		

1.5 REASON(S) FOR CHANGE

To minimize Gyro Bias Shifts as a result of pulse torquing .
See Data Amplification Sheet.

1.6 DESCRIPTION OF CHANGE

Modify Gyro Torquing Routine so that pulse torquing will always finish with the same polarity pulses.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
STORAGE IMPACT 16 25 words	3.4 REMARKS:
3.5 MIT COORDINATOR R. H. Lones	
DATE 12-11-69	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS oral approval received from T. Price 12/11/69
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE SCB on 2/4/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 2

PROGRAM CHANGE
REQUEST NO. 970.2

PREPARED BY: R. LONES

DATE: 10/14/69

ORGANIZATION:
MIT/IL

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

1.5 Reason for Change, cont'd.

Recently built gyros have a large bias shift that is dependent on the polarity of the last torquing done on the gyro. (The Apollo 11 cm x & y gyros had an in-flight NBD shift of -2.1 and -1.6 meru respectively when drift compensation was changed from minus to plus.) The proposed change will eliminate this type of shift due to any polarity pulse torquing.

REMARKS

MITIL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 979
ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

- | | | |
|---|---|---|
| ☐ MIT Approved PCN | ☒ NASA Approved PCR | ☐ NASA Approved Software Anomaly |
| | ☐ NASA Approved PCN | ☐ MIT Approved Software Anomaly |

A. Coding

☒ Begin coding immediately

R. Conelli

ACTION: _____

Program Supervisor's Approval: James J. McLaughlin

☐ 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

F. DECAIN

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson
Date 12-29-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

979

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR R. Covelli	DATE 12/1/69	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
------------------------------	-----------------	----------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Delete 521 Alarm
--------------------------------	---

1.5 REASON(S) FOR CHANGE Currently Program Alarm 521 is issued during a radar read whenever the data good signal is not present, provided that the radar read request was not made by R04, R12, R29 or R77. Cont. on page 2

1.6 DESCRIPTION OF CHANGE
Delete the coding that issues the 521 alarm.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT 0	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT -10 words fixed	3.4 REMARKS:
3.5 MIT COORDINATOR <i>James H. Taron</i>	
DATE 12-4-69	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF SCB on 12/13/69	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

979

PREPARED BY

R. Covelli

DATE

12/1/69

ORGANIZATION

MIT/IL

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

1.5

This means that the alarm can only occur during P20 or P22 radar reads. However, when the data good signal is not present in these cases, the software lights the tracker fail light on the DSKY, and the hardware lights the No Track light on LM panel 3. Because of those two indications, the program alarm is not necessary and is probably undesirable. Removing the alarm would also save 10 words of fixed memory.

REMARKS:

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 982

ANOMALY # _____

- | | |
|---|---|
| ☒ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☒ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date _____

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

982

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR D. MILLARD	DATE 12/9/69	1.2 ORGANIZATION MIT/IL	APPROVAL <i>R.H. Larson</i>	DATE 12-15-69
-------------------------------------	------------------------	-----------------------------------	--------------------------------	-------------------------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Extend capability of Lunar Surface Star Acquisition Routine R59.
---------------------------------------	--

1.5 REASON(S) FOR CHANGE
Provide R59 with the capability of locating, via cursor, spiral (N79) any celestial body specified by N88.

1.6 DESCRIPTION OF CHANGE
Provide N88 display any time non-catalog stars are selected by V01N70.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT + 10 WORDS	3.4 REMARKS:
3.5 MIT COORDINATOR <i>Russell H. Larson</i>	
DATE 12-15-69	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF SCB on 12/18/69	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 983
ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

D. Millard

ACTION: _____

Program Supervisor's Approval: D. Millard

☐ 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

F. DECAIN

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Larson

Date 12-29-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSU)

983

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR D. MILLARD	DATE 12/9/69	1.2 ORGANIZATION MIT/IL	APPROVAL <i>[Signature]</i>	DATE 12-15-69
------------------------------	-----------------	----------------------------	--------------------------------	------------------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Unit Vector Capability for N88.
--------------------------------	--

1.5 REASON(S) FOR CHANGE Compatibility with CSM N88.

1.6 DESCRIPTION OF CHANGE Change N88 to accept a unit vector.
--

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT +5 WORDS	3.4 REMARKS:
3.5 MIT COORDINATOR <i>[Signature]</i>	
DATE 12-15-69	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF SCB on 12/18/69	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 986.2

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

G. Dunbar

ACTION: _____

Program Supervisor's Approval: Dunbar 9/27/69

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

J. GLENDENNING

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Laro

Date 12-29-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSH) 986.2	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR J. M. REBER		DATE 12/12/69	1.2 ORGANIZATION MIT/IL		APPROVAL
1.3 EFFECTIVITY LUMINARY 1D		1.4 TITLE OF CHANGE Update Fixed Constants for 1970-1971 Ephemeris Year.			
1.5 REASON(S) FOR CHANGE This program will be used after July 1, 1970.					
1.6 DESCRIPTION OF CHANGE Update PIOS Ephemeris data, LOSSEM Ephemeris, and Star Table.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS: 		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE 					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS: 		
3.5 MIT COORDINATOR <i>Richard H. Landon</i>					
DATE 12-16-69					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED			4.2 REMARKS 		
4.3 SOFTWARE CONTROL BOARD SIGN OFF SCB on 12/18/69					
DATE 					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE 					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS: 		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE 					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 6

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

986.2

J. M. REBER

12/12/69

MIT/IL

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

PIOS EPHEMERIS CONSTANTS:

GSOP UNITS

AZ_0	4.86315127049 E+0	rad
ωE	7.29211514667 E-5	rad/U-sec.
B_0	4.09159633164 E-1	rad
$\dot{B}$	-7.19757979072 E-14	rad/U-sec.
$\ddot{a}_{10}$	5.85919688671 E+0	rad
$\ddot{a}_1$	-1.07047015062 E-8	rad/U-sec
F_0	+1.52167495975 E+0	rad
$\dot{F}$	+2.67240425515 E-6	rad/U-sec

Calculated using ΔT (1.0 July 1970) = 40.6 sec.

and ΔT (1971.0) = 41.1 sec.

Source: J. Marshall Reber: MIT

REMARKS:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 3 OF 6

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

986.2

J. M. REBER

12/12/69

MIT/IL

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

PIOS EPHEMERIS CONSTANTS:

AGC UNITS

AZO	7.739945637	E-1	B 0	revs.
WEARTH	1.160576171	E-7	B23	rev/cs.
BSUBO	6.511977813	E-2	B 0	rev
BDOT	-1.145530402	E-16	B28	rev/cs.
NODIO	9.325201471	E-1	B 0	rev
NODDOT	-1.703706159	E-11	B28	rev/cs.
FSUBO	2.421820916	E-1	B 0	rev
FDOT	4.253263471	E-9	B27	rev/cs.

Source: J. M. Reber: MIT

REMARKS:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 4 OF 6

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

986.2

J. M. REBER

11/21/69

MIT/IL

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

LOSSEM EPHEMERIS NUMBERS

KONMAT	+ 8	0.91746	B-1	K1 COS (OBL)
	+10	-0.035711	B-1	K2 SIN (OBL) SIN (IM)
	+14	0.39784	B-1	K3 SIN (OBL)
	+16	0.082354	B-1	K4 COS (OBL) SIN (IM)
RATESP	+ 0	0.03660099	B+4	LOMR
	+ 2	0.00273780	B+4	LOSR
	+ 4	-0.00014720	B+4	LONR
	+ 6	0.174685017		LOMO
	+ 8	0.274011893		LOSO
	+10	0.932520213		LONO
VAL67	+ 0	0.017531111	B+1	AMOD
	+ 2	-0.224249436		AARG
	+ 4	0.036291713	B+1	1/27
	+ 6	0.003484442	B+1	BMOD
	+ 8	0.058226609		BARG
	+10	0.031250000		1/32
	+12	0.005329930	B+1	CMOD
	+14	-0.010500980		CARG
	+16	0.002737925	B+1	1/365

Source: H. McQuat: MIT

SEE LUMINARY MEMO #119.

REMARKS:

LIST OF NAVIGATION STARS (1970 - 1971)

Catalogue No. (octal)	Star Name	Vis: Mag.	X Coordinate	Y Coordinate	Z Coordinate
1	α Andromedae (Alpheratz)	2.1	+ .8748133997	+ .0262841262	+ .4837464836
2	β Ceti (Diphda)	2.2	+ .9342553544	+ .1737172460	- .3114309732
3	γ Cassiopeiae (Navi)	2.2	+ .4774532337	+ .1167072881	+ .8708718726
4	α Eridani (Achernar)	0.6	+ .4918000631	+ .2205989850	- .8422997006
5	α Ursae Minoris (Polaris)	2.1	+ .0129982160	+ .0078080287	+ .9998850339
6	θ Eridani (Acamar)	3.4	+ .5449551668	+ .5316172328	- .6483879887
7	α Ceti (Menkar)	2.8	+ .7030586868	+ .7077417542	+ .0693548283
10	α Persei (Mirfak)	1.9	+ .4103778920	+ .4989028983	+ .7633386428
11	α Tauri (Aldebaran)	1.1	+ .3505042402	+ .8927120666	+ .2832171316
12	β Orionis (Rigel)	0.3	+ .2009372589	+ .9690787331	- .1432153163
13	α Aurigae (Capella)	0.2	+ .1369502971	+ .6814042795	+ .7189804058
14	α Carinae (Canopus)	-0.9	- .0615513667	+ .6031426337	- .7952549230
15	α Canis Majoris (Sirius)	-1.6	- .1822546265	+ .9404481198	- .2869504922
16	α_2 Canis Minoris (Procyon)	0.5	- .4120676148	+ .9064582964	+ .0923776901
17	γ Velorum (Regor)	1.9	- .3613079259	+ .5746463708	- .7343283537
20	ϵ Ursae Majoris (Dnoces)	3.1	- .4659729684	+ .4773764969	+ .7449703838
21	α Hydrae (Alphard)	2.2	- .7743822014	+ .6150774086	- .1483643740
22	α Leonis (Regulus)	1.3	- .8609439465	+ .4634300302	+ .2097811430
23	β Leonis (Denebola)	2.2	- .9656970164	+ .0523798707	+ .2543336816
24	γ Corvi (Gienah)	2.8	- .9524789319	- .0595555999	- .2987256513
25	α Crucis (Acrux)	1.0	- .4522463508	- .0494719393	- .8905199410
26	α Virginis (Spica)	1.2	- .9169129501	- .3504194263	- .1909891817
27	η Ursae Majoris (Alkaid)	1.9	- .5812126603	- .2910465457	+ .7599235169
30	θ Centauri (Menkent)	2.3	- .6896884364	- .4183842954	- .5910029120
31	α Bootis (Arcturus)	0.2	- .7860975319	- .5219727016	+ .3310516106
32	α Coronae Borealis (Alphecca)	2.3	- .5325711148	- .7161840263	+ .4510526000
33	α Scorpii (Antares)	1.2	- .3514226152	- .8241537737	- .4441539178
34	α Trianguli Austr. (Atria)	1.9	- .1144569328	- .3399947346	- .9334362275
35	α Ophiuchi (Rasalhague)	2.1	- .1122343912	- .9695188377	+ .2177995974
36	α Lyrae (Vega)	0.1	+ .1218415406	- .7702450672	+ .6260009387
37	σ Sagittarii (Nunki)	2.1	+ .2071906196	- .8719421540	- .4436089799
40	α Aquilae (Altair)	0.9	+ .4539032479	- .8778479991	+ .1528225504
41	β Capricorni (Dabih)	3.2	+ .5522208574	- .7931952248	- .2566972144
42	α Pavonis (Peacock)	2.1	+ .3203620343	- .4435303001	- .8370478121
43	α Cygni (Deneb)	1.3	+ .4541602263	- .5391353124	+ .7092754074
44	ϵ Pegasi (Enif)	2.5	+ .8140910890	- .5555422636	+ .1691995627
45	α Piscis Austr. (Fomalhaut)	1.3	+ .8343989109	- .2390600205	- .4966173214

LIST OF NAVIGATION STARS (1970 - 1971)

Catalogue No.
(octal)

Star Name

Vis. Mag.

RIGHT
ASCENSION

DECLI-
NATION

HR MIN SEC

DG MIN SEC

1	α Andromedae (Alpheratz)	2.1	0	6	53.0	+28	55	49
2	β Ceti (Diphda)	2.2	0	42	8.0	-18	8	44
3	γ Cassiopeiae (Navi)	2.2	0	54	56.5	+60	33	36
4	α Eridani (Achernar)	0.6	1	36	38.0	-57	23	2
5	α Ursae Minoris (Polaris)	2.1	2	3	58.3	+89	7	52
6	θ Eridani (Acamar)	3.4	2	57	9.5	-40	25	13
7	α Ceti (Menkar)	2.8	3	0	45.5	+3	58	37
10	α Persei (Mirfak)	1.9	3	22	14.5	+49	45	34
11	α Tauri (Aldebaran)	1.1	4	34	15.2	+16	27	8
12	β Orionis (Rigel)	0.3	5	13	8.5	-8	14	2
13	α Aurigae (Capella)	0.2	5	14	32.5	+45	58	13
14	α Carinae (Canopus)	-0.9	6	23	18.5	-52	40	46
15	α Canis Majoris (Sirius)	-1.6	6	43	52.2	-16	40	32
16	α_2 Canis Minoris (Procyon)	0.5	7	37	47.0	+5	18	1
17	γ Velorum (Regor)	1.9	8	8	38.2	-47	15	2
20	ϵ Ursae Majoris (Dnoces)	3.1	8	57	13.7	+48	9	24
21	α Hydrae (Alphard)	2.2	9	26	9.6	-8	31	56
22	α Leonis (Regulus)	1.3	10	6	49.6	+12	6	34
23	β Leonis (Denebola)	2.2	11	47	34.8	+14	44	3
24	γ Corvi (Gienah)	2.8	12	14	18.6	-17	22	52
25	α Crucis (Acrux)	1.0	12	24	58.2	-62	56	19
26	α Virginis (Spica)	1.2	13	23	39.6	-11	0	38
27	η Ursae Majoris (Alkaid)	1.9	13	46	23.8	+49	27	27
30	θ Centauri (Menkent)	2.3	14	4	58.0	-36	13	42
31	α Bootis (Arcturus)	0.2	14	14	20.1	+19	19	57
32	α Coronae Borealis (Alphecca)	2.3	15	33	27.5	+26	48	40
33	α Scorpii (Antares)	1.2	16	27	37.5	-26	22	9
34	α Trianguli Austr. (Atria)	1.9	16	45	34.6	-68	58	37
35	α Ophiuchi (Rasalhague)	2.1	17	33	35.1	+12	34	47
36	α Lyrae (Vega)	0.1	18	35	57.2	+38	45	20
37	σ Sagittarii (Nunki)	2.1	18	53	28.0	-26	20	4
40	α Aquilae (Altair)	0.9	19	49	22.0	+8	47	26
41	β Capricorni (Dabih)	3.2	20	19	22.8	-14	52	27
42	α Pavonis (Peacock)	2.1	20	23	21.6	-56	49	47
43	α Cygni (Deneb)	1.3	20	40	26.5	+45	10	34
44	ϵ Pegasi (Enif)	2.5	21	42	45.5	+9	44	29
45	α Piscis Austr. (Fomalhaut)	1.3	22	56	3.0	-29	46	35

MIT/IL PROGRAM CHANGE ROUTING SLIP

~~PCR~~/PCN # 990
ANOMALY # _____

MIT-PCN

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☒ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

Peter Volante

ACTION: _____

Program Supervisor's Approval: Margaret Hammer

☐ 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

F. DECAIN

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager Russell H. Larson

Date 12-22-69

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

990

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR P. VOLANTE	DATE 12/19/69	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
------------------------------	------------------	----------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE V44 RR Remode Check.
--------------------------------	---

1.5 REASON(S) FOR CHANGE Fix Anomaly L-1C-04. See Data Amplification Sheet.
--

1.6 DESCRIPTION OF CHANGE Have V44 check for RR antenna Remode in progress and not disable RR error counters until remode complete.
--

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT None	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 6 Fixed	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. Larson</i>	
DATE 12-22-69	

APPROVED FOR IMPLEMENTATION

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

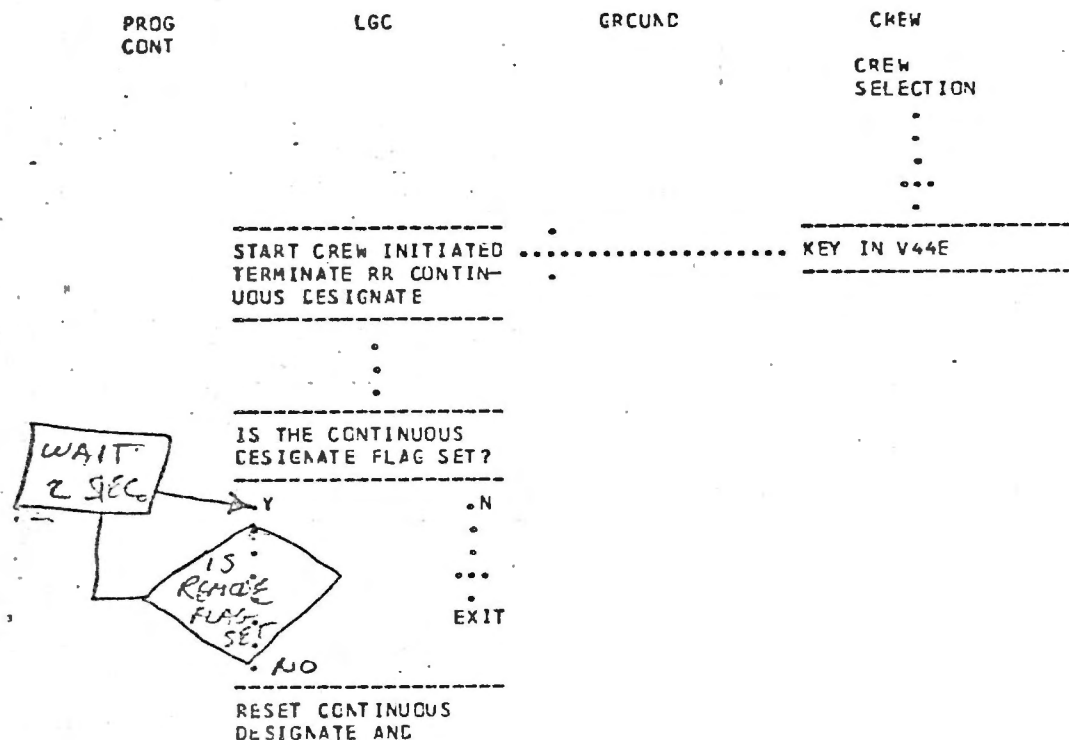
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT-PCN

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET			PAGE <u>2</u> OF <u>3</u>
PROGRAM CHANGE REQUEST NO. <u>990</u>	PREPARED BY P. VOLANTE	DATE 12/19/69	ORGANIZATION MIT/IL
CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)			
1.5 Reason(s) for Change, cont'd. If V44 (Terminate RR Continuous Designate) is keyed in while an antenna remode is in progress, the RR error counters are disabled which stops the antenna drive. However, the remode task keeps running and the remode flag (Bit 14 or RADMODES) remains set, until a hardware or software restart occurs. A RR coarse align request (V41N72) during this time can cause erratic antenna behavior because the presence of the remode flag causes the designate routine to start a second remode task, which conflicts with the one still in progress. Recovery from this situation is effected by any V37 request (to cause a software restart) <u>and</u> cycling the RR mode control switch.			
REMARKS:			

- PURPOSE:
- (1) TO TERMINATE THE CONTINUOUS DESIGNATE OPTION V41N72.
 - (2) TO DISABLE THE RR CDU ERROR COUNTERS.
 - (3) TO ENABLE R25.

- ASSUMPTIONS:
- (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.
 - (2) V44E IS EFFECTIVE ONLY IF RR CONTINUOUS DESIGNATION (V41N72, COARSE ALIGN RR CDUS, OPTION 2) IS IN PROGRESS.
 - (3) THE PROCESS MAY BE SELECTED AT ANY TIME.



V44/LUMINARY

MIT/IL PROGRAM CHANGE ROUTING SLIP

REISSUE

PCR/PCN # 991.2

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

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

ACTION: _____

Program Supervisor's Approval: _____

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

ACTION: _____

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

ACTION: _____

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

ACTION: _____

Special Instructions

Project Manager _____

Date 2-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by ISM)
991.2

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR G. EDMONDS	DATE 12/17/69	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
-------------------------------------	-------------------------	-----------------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Sum Uplink Data.
---------------------------------------	--

1.5 REASON(S) FOR CHANGE
Make UPRUPT Program the same as COLOSSUS and allow more efficient summing of K-start tape loads.

1.6 DESCRIPTION OF CHANGE
Modify UPRUPT so that during ground testing the number of uplink key codes is counted and each key code is summed and stored. See attached GSOP page.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 6 fixed.	3.4 REMARKS: <i>I vital approval by T. Price on 12-29-69</i>
3.5 MIT COORDINATOR <i>Russell H. Larson</i>	
DATE 12-29-69	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS: <i>If NODOPOT flag is set, disable the sum uplink data. Do not share erasables with any cells loaded by Pre-launch Erasable Load or any uplink loads.</i>
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE SCB on 2/4/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

2.1 Digital Uplink to LGC (P27)

By means of the LGC UPLINK, ground control can insert data or issue instructions to the LGC in the same manner that these functions are normally performed by the spacecraft crew in using the DSKY keyboard. The LGC is programmed to accept the following UPLINK inputs;

1. LIFTOFF TIME INCREMENT: Provides ground capability via VERB 70 to increment or decrement the LGC clock, LM and CSM state vector times, and TEPIEM time with a double precision octal time value, scaled centiseconds $/2^{28}$.
2. CONTIGUOUS BLOCK UPDATE: Provides ground capability via VERB 71 to update from 1 to 18 consecutive E memory registers in the same EBANK.
3. SCATTER UPDATE: Provides ground capability via VERB 72 to update from 1 to 9 nonconsecutive E memory registers in the same or different EBANK's.
4. OCTAL CLOCK INCREMENT: Provides ground capability via VERB 73 to increment or decrement the LGC clock with a double precision octal time value, scaled centiseconds $/2^{28}$.

All information received by the LGC from the uplink is in the form of keyboard characters. Each character is assigned an identifying code number called its character code. Each character code transmitted to the LGC is sent as a triply redundant uplink word preceded by a leading "1" bit. Thus, if C is the 5-bit character code, then the 16 bit uplink word has the form:

$$1 \ C \bar{C} \ C$$

where $\bar{C}$ denotes the bit-by-bit complement of C. (Table 2-1 defines all the legal input keycodes.) To these 16 bits of information the ground adds a 3-bit code specifying the system aboard the spacecraft which is to be the final recipient of the data and a 3-bit code indicating the spacecraft which should receive the information. The 22 total bits are sub-bit encoded (replacing each bit with a 5-bit code for transmission). If the message is received and successfully decoded, the on-board receiver will send back an 8-bit "message accepted pulse" to the ground and shift the original 16 bits of the uplink word to the LGC ($1 \ C \bar{C} \ C$). The leading "1" bit causes an interrupt within the LGC after all 16 bits have been shifted from the uplink receiver.

Any ground command sequence normally transmitted via the uplink may be duplicated by the astronaut via the keyboard. All reference to uplink words used in this section are in the form transmitted from the uplink receiver to the LGC. Therefore, they do not contain the vehicle or subsystem addresses added by the ground facilities.

During ground testing the count of UPRUPTS and the sum of the C.C.C. codes entering the LGC are accumulated in erasable registers, permitting a count and sum-check on data transmitted UPLINK to the LGC.

MIT/H PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 996
ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☒ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

- | | | |
|---|---|---|
| ☐ MIT Approved PCN | ☒ NASA Approved PCR | ☐ NASA Approved Software Anomaly |
| | ☐ NASA Approved PCN | ☐ MIT Approved Software Anomaly |

A. Coding

☒ Begin coding immediately

ACTION: Phyllis Byr
Program Supervisor's Approval: Margaret Hamel

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Fred De Cain

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager Russell H. Laro
Date 2-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

996

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR P. RYE	DATE 1/26/70	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
---------------------------------	------------------------	-----------------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Liftoff Check in P07.
---------------------------------------	---

1.5 REASON(S) FOR CHANGE
Prevent selection of P07 during flight in order to avoid overwriting shared erasable memory.

1.6 DESCRIPTION OF CHANGE
Set bit by uplink at liftoff called NODO P07 (this bit is not cleared in FRESH START). Check NODO P07 at beginning of P07. If this bit is set, send out 21521 ALARM (POODOO). Request for V37 will result from POODOO.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT None	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 8 Words of fixed memory.	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. Tamm</i>	
DATE 2-2-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE SCB on 2/4/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

Word Number

39-44
(Cont'd)

Contents

<u>Flagword</u>	<u>Bit</u>	<u>Meaning</u>
3	12	LUNAFLAG. Used in lat-long subroutine. A 1 means lunar lat-long. A 0 means earth lat-long. Set to 0 or 1 by routines that call lat-long subroutine.
3	11	NODO P07 BIT is set to 1 by ground uplink at liftoff. Tested by V92 which performs POODOO (alarm 21521) if the bit is set. Tested in UPRUPT which maintains erasable sum of key codes if the bit is 0. (NOTE: this bit is not cleared by FRESH START.)
3	10	VFLAG. Used in automatic star selection routine (R56) during IMU alignment program (P52). Set to 1 to indicate that a pair of stars are not in the AOT field-of-view. Set to 0 if pair of stars found. Initially set to 1 at beginning of R56 and is used temporarily for program control purposes.
3	9	Bit used for two distinct functions, hence assigned two separate mnemonics. R04FLAG. Set to 1 by Verb 63 entry to indicate R04 is running and set to 0 at the end of R04. Set to 0 by Verb 78 entry to indicate R77 is running, rather than R04, since the two routines use much of the same coding. Set to 0 in R00 (V37). Set to 0 in the beginning of P20/P22 in order that alarm 521 be sent if the radar cannot be read. Set to 1 by R65 before reading RR and set to 0 by R65 after reading RR. The bit is checked in the RADAREAD routine (which is used by R04 and P20/P22) if the radar cannot be read; if the bit is 1 (R04 is running), alarm 521 will not be sent. READRFLG. Bit is set to 1 by R29 when RR lock-on has been achieved and the RR read cycle is starting. A 1 indicates that R29 is reading RR data. Bit is reset to 0 by R29 when exiting the RR read cycle because of a bad reading or the RR not in LGC mode. Bit is reset to 0 by software restart (V37), FRESH START, and hardware restart. A 0 indicates that R29 is not reading RR data. Bit is tested by the RR read cycle of R29 to determine if radar read is allowed.

V36, REQUEST FRESH START

REV 03 12/03/69

PURPOSE: (1) TO INITIATE A COMPUTER FRESH START.

ASSUMPTION: (1) THIS PROCESS MAY BE SELECTED AT ANY TIME.

(2) FRESH START CAN BE INITIATED IN ANY OF THE FOLLOWING WAYS:

- (A) VIA PROGRAM IF PHASE TABLE DISAGREEMENT IS DETECTED FOLLOWING A RESTART (ALARM CODE 01107).
- (B) VIA PROGRAM IF SELF CHECK IS INTERRUPTED BY A RESTART DURING ITS ERASABLE MEMORY CHECK AND ERASABLE MEMORY IS SUSPECT.
- (C) BY SIMULTANEOUS DEPRESSING OF THE MARK REJECT AND ERROR RESET BUTTONS DURING A RESTART.
- (D) CSKY ENTRY OF V36E.

NOTE: A COMMANDED FRESH START (V36) WILL TURN OFF THE ENGINE, AS WILL PRESSING "MARK REJECT" AND "ERROR RESET" DURING A RESTART.
 THUS: "A" AND "B" DO NOT SHUT OFF THE DPS OR APS, "C" AND "D" WILL SHUT OFF THE DPS OR APS.

(3) IF FRESH START INTERRUPTS STATE VECTOR INTEGRATION, THE STATE VECTOR MAY BE INVALIDATED.

NOTE: LGC FRESH START INITIALIZES ALL FLAGWORDS (SEE EXCEPTIONS BELOW), CLEARS ALL JOB CORE SET AND VAC AREAS, SETS WAITLIST TASKS TO ENDTASK, INITIALIZES ALL OUTPUT CHANNELS, INITIALIZES OAP IDLING PROGRAM, INITIALIZES DOWNLINK TO COAST-ANC-ALIGN DOWNLIST, BLANKS THE DSKY, AND EXITS TO AN IDLING STATE (DUMMY JOB).

LGC FRESH START DOES NOT ALTER THE STATE OF THE FOLLOWING FLAG BITS:

- (1) APSFLAG, WHICH INDICATES IF THE DESCENT STAGE IS ATTACHED.
- (2) SURFACE FLAG, WHICH INDICATES IF THE LM STATE IS ON THE LUNAR SURFACE.
- (3) LHOONFLG, WHICH INDICATES IF THE LM STATE IS EARTH OR LUNAR CENTERED.
- (4) CHOONFLG, WHICH INDICATES IF THE CSM STATE IS EARTH OR LUNAR CENTERED.
- (5) REFSHMAT FLAG, WHICH INDICATES IF REFSHMAT IS VALID.

(6) NODOP07 FLAG, which indicates liftoff has occurred.

PROG
CONT

LGC

GROUND

CREW

CREW
SELECTION

•
•
•
•
•

 START CREW INITIATED
 FRESH START

 KEY IN V36E

010

V36/LUMINARY

 PAGE 3053
 PCR 996

MIT DL PROGRAM CHANGE ROUTING SLIP

MIT-PCN

PCR/PCN # 1007
ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

☒ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☐ Begin coding immediately

(GSOP ONLY)

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

J. KLAWSNIK (MAHER)

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R.H. [Signature]

Date 6-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1007	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR H. Maher		DATE 5/11/70	1.2 ORGANIZATION MIT		APPROVAL DATE
1.3 EFFECTIVITY LUMINARY ID			1.4 TITLE OF CHANGE GSOP Section 2 Rev 9 Editorial Changes		
1.5 REASON(S) FOR CHANGE To Improve Quality of Document					
1.6 DESCRIPTION OF CHANGE See Data Amplification Sheets					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT			3.4 REMARKS:		
3.5 MIT COORDINATOR <i>[Signature]</i>					
DATE 6-5-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

MIT-PCN

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 6

PROGRAM CHANGE REQUEST NO. 1007	PREPARED BY H. Maher	DATE 5/11/70	ORGANIZATION MIT
------------------------------------	-------------------------	-----------------	---------------------

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

1.6 Description of change (cont)

Note: PCR 818 was complied with in Revision 5 but was inadvertently not so indicated in the list above.

ADD

ix

NUMBER
CHANGED

2.1.6	Absolute Addresses for UPDATE Program	2-18a
2.2	LGC Digital Downlink	2-19

xvii

PLUS SIGN

2.1.1.2.1.1 Verb 70 Double Precision Time Verification

Program 27 verifies that the double precision octal time can be subtracted from the LGC clock without causing overflow. (For this operation two of the UPBUFF registers, UPBUFF + 18D and 19D, are used as temporary buffers for TIME2 and TIME1.) If the double precision input time can be subtracted from the LGC clock without causing overflow, P27 proceeds to increment TEPHEM and decrement the LGC clock, the CSM State Vector time, and the LM State Vector time. Program 27 will then turn the uplink activity light "OFF", replace the downlink list code in DNLSTCOD with the code for the Coast and Align downlist, release the State Vector data for other routines, and reinstate the previous program.

2-7

* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

NUMBER CHANGED

2-15

* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

46

2-16

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1007

PREPARED BY
H. Maher

DATE
5/11/70

ORGANIZATION
MIT

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

1.6 Description of change (cont) NUMBER CHANGED

* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

2-17

NEW NUMBER

2.1.6 Absolute Addresses for UPDATE Program

ASSEMBLY REVISION 205 OF AGC PROGRAM LUMINARY BY NASA 2-21112-13

ABSOLUTE ADDRESSES FOR UPDATE PROGRAM

INADVERTENTLY
OMITTED FROM
ASSEMBLY

ECADR

MNEMONIC

01501

=ECADR UPSVFLAG

03606

=ECADR XSRD

NEW
NUMBER

01731

=ECADR REFSMPT

03433

=ECADR DELVSLV

NEW
NUMBER

02020

=ECADR RLS

UPDATE ECADRS FOR LUMINARY REV 163

2-18a

D. The Descent and Ascent List is transmitted during:

P12 Powered Ascent Guidance

P63 Braking Phase Guidance

P64 Approach Phase Guidance

P66 Terminal Descent Phase Guidance

NEW PROGRAM
TITLE

2-22

MIT-PCN

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PROGRAM CHANGE REQUEST NO.
1007

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H. Maher

DATE
5/11/70

ORGANIZATION
MIT

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

1.6 Description of change (cont)

Word Number

Contents

39-44
(Cont'd)

Flagword Bit

Meaning

2

8

XDELVFLG. Set to 1 if an External Delta V burn is to be performed. Set to 0 if a Lambert burn is required. Set to 1 in P30 before N42 display. For P34, P35, P74, and P75 - set to 0 in subroutine S34/35.2. For P32/P72 and P33/P73 set to 1 in subroutine ADVANCE.

"SET 1 BY P72
AND P73"
DELETED

2-39

CORRECTED SPELLING

3

15

POOHFLAG. Set to 1 in STATINT 1 as P00 integration is started to bypass backwards integration and perform check for 4 time-step

2-40

3

9

R04FLAG. Set to 1 by Verb 63 entry to indicate R04 is running and set to 0 at the end of R04. Set to 0 by Verb 78 entry to indicate R77 is running, rather than R04, since the two routines use much of the same coding. Set to 0 in R00 (V37).

THERE WERE TWO FUNCTIONS FOR THIS FLAGWORD,
BIT 9 AND TWO MNEMONICS. NOW THERE IS
ONLY ONE

2-41

2-1 AUTRATE2
AUTRATE1

These bits are used together to indicate astronaut-chosen KALCMANU maneuver rates.

CORRECTED
SPELLING

2-69

91a

CHANNEL 11. Output channel. Bits are used to control engine on/off and for display parameter quantities. Set 20000 by a fresh start. A restart zeroes all output channels by hardware means.

2-77

WAS "SET 0"

MIT-PCN

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

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1007

H. Maher

DATE

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ORGANIZATION

MIT

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

1.6 Description of change (cont)

95

PIPTIME1. The time at which the accelerometers were read (associated with words 96-98, but since the group is not a snapshot quantity, their values as transmitted may not be valid simultaneously). When the PIPAs are read, the time is stored in PIPTIME1 (except during gravity determination in P57); when the state vector is updated, the contents of PIPTIME1 is stored in PIPTIME. Scaled centiseconds/ 2^{28} , referenced to computer clock.

ADDED

99

DEFINITION
ADDED

Spare. The first half of each spare contains 00000₈. The second half is ARUPT (the contents of the accumulator when the telemetry interrupt was recognized).

2-87

79

Repeat of word 29 on the Rendezvous/Prethrust List.

2-94

NEW REFERENCE

PAGE NO CHANGED

✓ 30-66

Same as words 30-66 on Orbital Maneuvers List.

NEW

67

Spare, See page 2-87 for definition.

REF.

68-75

Same as words 68-75 on Orbital Maneuvers List.

76

Same as word 13 on Orbital Maneuvers List.

77-94

Same as words 77-94 on Coast and Align List.

PAGE NO 95

Same as word 76 of Coast and Align List.

CHANGED

100

Spare. See page 2-87 for definition.

2-100

MIT-PCN

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1007

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5/11/70

ORGANIZATION
MIT

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

1.6 Description of change (cont)

18-20 ~~CORRECTED SPELLING~~ VG VEC (X, Y, Z). A stable member vector that indicates current velocity error. Scaled (meters/centisecond)/ 2^7 . Calculated every

67-72
~~DELETED
REFERENCE
TO SEC. 5~~

LM STATE VECTOR in GUIDANCE COORDINATES. Words 67-69 contain the position vector (X, Y, Z) scaled meters/ 2^{24} . Words 70-72 contain the velocity vector (X, Y, Z) scaled (meters/centisecond)/ 2^{10} . Calculated once every 2 sec. during P63 (after full throttle) and P64. Not good during ascent and aborts.

2-105

NEW REFERENCE

79

Same as word 29 on Rendezvous/Prethrust List.

99b

Garbage. Same erasable location as word 5b on this list.

2-106

PAGE NO
CHANGED

30-67

Same as words 30-67 on Orbital Maneuvers List.

PAGE NO

68

Spare. See page 2-87 for definition.

CHANGED

82

Spare. See page 2-87 for definition.

2-115

29 DELETED

27

Same as word 27 on Rendezvous and Prethrust List.

CHANGED

80-89

Same as words 80-89 on Orbital Maneuvers List.

CHANGED

91-98

Same as words 91-98 on Orbital Maneuvers List.

2-110

NEW MNEMONIC 8 HMEASDL

2-120

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1008

ANOMALY # _____

MIT-PCN

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

☒ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☐ Begin coding immediately

(GSOP ONLY)

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

J. KLAWNSNIK

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Linn

Date 6-5-70

MIT-PCN

Page 1 of 9

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1008

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR J. Klawsnik	DATE 5/15/70	1.2 ORGANIZATION MIT	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY ID	1.4 TITLE OF CHANGE GSOP Section 3 Rev 5 Editorial Changes
--------------------------------	--

1.5 REASON(S) FOR CHANGE To Improve Quality of Document
--

1.6 DESCRIPTION OF CHANGE See Data Amplification Sheet

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>[Signature]</i>	
DATE 1-5-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT-PCN

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

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PROGRAM CHANGE REQUEST NO.

1008

PREPARED BY

J. Klawnsnik

DATE

5/15/70

ORGANIZATION

MIT

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

1.6 Description of change cont.

In addition to changes of a purely editorial or format nature, perform the following: Refer to "Attitude mode control Switch" as "PGNCS Attitude mode control Switch"; combine tables 3.6-1 and 3.6-3; indicate on page 3.2-17 that SNUFFBIT affects both automatic and manual axis control; on page 3.3-13 FLR/I should read FL δ /I; clarify assumptions on page 3.3-17; mention R61 as one of the Preferred Axis Tracking Routines on page 3.7-10 and 3.7-16; speak specifically of the Attitude maneuver routine on page 3.2-5; on page 3.6-16 U', V' should replace U, V; in figure on page 3.7-2, θ should be $\underline{\theta}$. Also make the following changes on the pages indicated:

3.2.2.2 Automatic Maneuvers

Automatic attitude maneuvers are implemented with exactly the same logic as that used in attitude hold, except for the additional inputs shown in Fig. 3.2-2. One important difference is that the reference angles, θ_d , will, in general, be functions of time. These angles are generated by the steering routines, such as the attitude-maneuver routine, R60, shown schematically in Fig. 3.2-2*. The attitude-maneuver routine also generates the following quantities to provide smooth and efficient control:

1. $\Delta\theta_{do}$, $\Delta\theta_{di}$, $\Delta\theta_{dm}$ - reference CDU angle increments
2. ω_{dP} , ω_{dQ} , ω_{dR} - desired spacecraft rates
3. β_P , β_Q , β_R - attitude lag angles

*The preferred tracking attitude routines, R61 and R65 maneuver the vehicle by sending the final desired CDU angles directly to the DAP whenever the desired attitude is less than 15 degrees from the current attitude (for angles greater than 15 degrees they call R60).

3.2-3.

MIT-PCN

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

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PREPARED BY

DATE

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J. Klawnsnik

5/15/70

MIT

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

1.6 Description of change (cont)

β_Q would be of the order of 250 deg. This would produce unpredictable results; therefore, the high rate should not be selected for the CSM-docked configuration. (Even with a different algorithm, such a maneuver would be undesirable because of the exorbitant RCS fuel consumption.)

Note that when steering is completed, $\bar{\omega}_d$ and $\Delta\theta_d$, as well as $\bar{\beta}$, are reset to zero and, in effect, the LM DAP reverts to attitude hold about the desired gimbal angles.

3.2-6

modes of operation.

X-axis override is available only when the PGNCs attitude mode control switch is placed in the AUTO position. Its use is further restricted by an internal program discrete as described in Subsection 3.2.4.

3.2.2.5 Minimum Impulse Mode

Figure 3.2-4 shows the functional elements associated with the minimum impulse mode. In this mode, the LM DAP responds only to hand-controller commands. Each time the ACA is moved from the center (detent) position past the pulse/direct switches of the ACA, a single 14-millisecond firing of the RCS jets results about the axes commanded. The ACA must be returned to detent before another firing will be made. If no ACA commands are present, the spacecraft will drift freely.

In the CSM-docked configuration, the duration of the firings is 14 millisecond for commands about the P axis and is 60 millisecond for commands about the Q and R axes. In all other respects, the minimum impulse mode is identical for the CSM-docked and LM-alone configurations.

Although the DAP does not utilize the state estimate in this mode, the rate estimate is maintained, consequently the V60 rate display on the FDAI needles is valid.

3.2-8

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APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

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PROGRAM CHANGE REQUEST NO.	PREPARED BY	DATE	ORGANIZATION
1008	J. Klawnsnik	5/15/70	MIT

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

1.6 Description of change (cont)

3. XOVINHIB bit must not be set. XOVINHIB is set automatically in:

- a) The P12 powered ascent program between the time of ignition and 12 sec after the radial velocity equals +40 ft/sec.
- b) The P70 DPS abort program and the P71 APS abort program (if the LGC-estimated altitude at initiation is less than 25,000 ft) between the time of ignition and 12 sec after the radial velocity equals +40 ft/sec.
- c) The P63 braking phase program and P64 approach phase program when the LGC-estimated altitude is less than 30,000 ft.

3.2-15

in the PGNCS mode of operation is supplied by the resolvers mounted on the IMU gimbals. The attitude-rate meters are driven from signals generated by the rate-gyro assembly via the control electronics section of the stabilization and control system. The attitude-error meters, (which interface with the LGC via the digital-to analog converters of the IMU CDU's), display one of the following three DAP-computed parameters:

1. Mode 1 attitude errors (autopilot following errors) - selected via the DSKY by V61E.
2. Mode 2 attitude errors (total attitude errors with respect to the angles in Noun 22) - selected by V62E.
3. Estimated vehicle rates - selected by V60E.

3.2-19

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 5 OF 9

PROGRAM CHANGE REQUEST NO.

1008

PREPARED BY

J. Klawnsnik

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ORGANIZATION

MIT

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

1.6 Description of change (cont)

These quantities are displayed in the pilot axes. They are available in all operational modes of the autopilot and are updated every 200 milliseconds.

Mode 1 is provided as a monitor of the LM DAP and of its ability to track steering commands.

Mode 2 is provided to assist the crew in manually maneuvering the spacecraft to the attitude (gimbal angles) specified in N22 and in monitoring automatic maneuvers. These errors represent the difference between the N22 angles and the current CDU angles, resolved into pilot axes. The crew may preset an attitude reference (desired gimbal angles) into N22, but caution is advised since this may interfere with data generated under program control. It is therefore recommended that N22 be loaded for this purpose in P00 only. Note that N22 represents desired gimbal angles, not ball angles.

Since the conversion from gimbal angles to FDAI ball angles is somewhat complicated, routine 60 will automatically convert the desired gimbal angles in N22 to the required ball angles in N18 to assist the crew in monitoring and performing large spacecraft attitude maneuvers.

DAP-estimated vehicle rates may be selected by the crew with the DSKY by means of V60E. The rate-display mode provides a much finer scaling and better accuracy than that available on the attitude-rate needles driven by the rate-gyro assembly and can also be used as a backup to the rate-needle drive by the analog autopilot if the rate-gyro assembly fails.

Routine 60 automatically selects the Mode 2 attitude-error display (an equivalent of V62E). Consequently, DAP-estimated rates or Mode 1 errors will be displayed during and after automatic maneuvers only if selected by the crew after the initiation of R60.

In the PGNCS minimum impulse mode, the LM DAP will zero the Mode 1 error displays. If AGS control is selected the DAP will continue to generate the displays, provided that the PGNCS attitude mode control switch is left in either the AUTO position or the ATT HOLD position. However, the rate display is meaningless. If the PGNCS attitude mode control switch is in the OFF position, the needles are not maintained at all.

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

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PREPARED BY

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5/15/70

MIT

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

1.6 Description of change (cont)

where

 F = the computed descent-engine thrust L = the distance from the hinge pin of the descent-engine bell to the center of gravity of the LM I = the pitch or roll moment of inertia of the LM δ = the component about the pitch or roll axis of the angle between the descent-engine thrust vector and the vector $\bar{L}$ from the descent-engine hinge pin to the LM center of gravity

3.3-7

The proper choice for the rate gain constants N_{ω_L} and N_{ω_C} and the acceleration gain constants N_{α_L} and N_{α_C} is best understood by an analysis of the state estimator as a frequency-domain filter. To simplify the analysis, assume that the unexplained attitude θ will exceed the threshold $\theta_{\max}$ every control-sample period. The computed rate gain K_{ω} and acceleration gain K_{α} take on constant values.

3.3-26

ations in the autopilot gains would produce unpredictable performance. If, on the other hand, the acceleration-estimate time constant was too great, there would be a prolonged transient in powered flight characterized by inefficient jet firings while the bias-acceleration estimate reached steady-state.

The values of filter gains selected appear to satisfy the various requirements. Figure 3.3-10 shows that, for a sinusoidal disturbance of 1-deg amplitude, the error in the bias-acceleration estimate for the LM-alone case will not exceed 3.3 deg/sec², and for the CSM-docked case will not exceed 0.13 deg/sec². Propellant slosh modes, with frequencies usually of the order of 0.5 cycles per second, will induce errors well below these maxima. Testing of the ascent powered flight indicates an acceptable start transient with an offset center of gravity. Testing of descent powered flight with initial gimbal mistrim indicates that an insignificant amount of RCS fuel is consumed in opposing the torque due to the lagging trim gimbal.

3.3-29

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 7 OF 9

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

1008

J. Klawnsnik

5/15/70

MIT

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

1.6 Description of change (cont)

is executed every two seconds during powered flight, and at certain other times when one of its inputs is changed by another subprogram. The routine computes the functions of acceleration and deadband required by TJETLAW. Table 3.4-3 shows the quantities computed in the 1/ACCS routine. These quantities are computed for the P, U', and V' axes. For the P axis, all quantities that are

3.4-16

the LM-alone autopilot). Rather, jets are turned on or off only at the control-sample instants and are left on or off for the full sampling period.

* By George R. Kalan and Edgar M. Oshika.

** For the CSM-docked case, the U' and V' axes are set coincident with the U and V axes, respectively. This is a consequence of the assumption (see Subsection 3.3.1.3) that an average moment of inertia can be used for the Q and R axes. When the Q and R inertias are equal, the U'-V' system is equivalent to the U-V system.

3.4-21

rate has been reached, the DAP returns to the logical path that is followed when the jets are not firing, to re-evaluate the torquing policy.

In the re-evaluation of the torquing policy, a check is first made to determine if the error-rate magnitude, $|EDOT|$, exceeds the outer rate limit of 1.73 deg/sec. If the outer rate limit is exceeded, the jet firing time is set to a convenient large number (± 5.12), sec signed so as to reduce the error rate, and the jet-inhibition logic is entered. When the outer rate limit is not exceeded, the control policy represented by Fig. 3.4-12 is used to determine the jet firing time. If the state lies

3.4-27

MIT-PCN

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 8 OF 9

PROGRAM CHANGE REQUEST NO.

1008

PREPARED BY

J. Klawnsnik

DATE

5/15/70

ORGANIZATION

MIT

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

1.6 Description of change (cont)

further information, see Section 4 of this GSOP.

* By Richard D. Goss and Lowell Hull.

** The two-position selector on the controller must be in the JETS position to obtain control of translation by means of the RCS jets. With the selector in the THROTTLE position, up-and-down motion of the controller along the X axis results in varying the thrust magnitude of the descent engine, and the other motions of the hand controller are prevented mechanically.

3.4-41

pitch axis and one for the roll axis — are always set at 0.3 sec each time the GTS attitude control law is executed. Thus, if the use of the trim gimbals is disallowed, and execution of the GTS attitude control law is bypassed, the drives will stop within 0.3 sec.

3.5-4

attitude errors or DAP-estimated rates on the FDAI needles. This is done whenever the IMU CDU's are usable and the PGNC mode select switch is not in the OFF position. It should be noted, however, that the attitude error displays are meaningless if the last computed "desired attitude" or the outputs of the IMU CDU's are

3.6-5

The following points will aid in reading Figs. 3.6-2 through 3.6-4:

1. The trapezoidal blocks indicate the LM DAP outputs to the hardware.
2. The symbols θ , ω and α denote estimated attitude, angular rate, and bias angular acceleration, respectively.

* Most of these functions are described in Subsection 3.4.2.

3.6-9

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 9 OF 9

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

1008

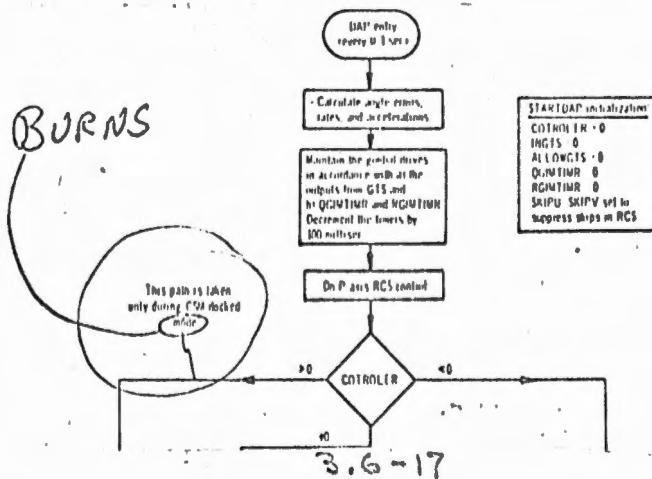
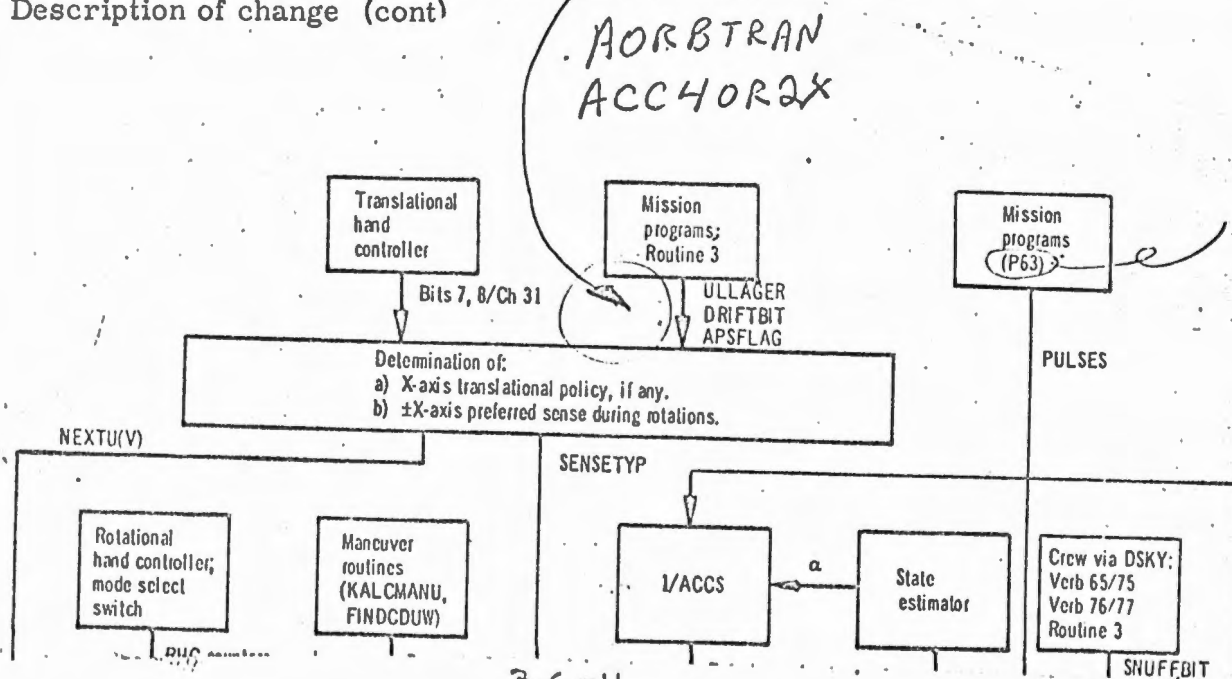
J. Klawnsnik

5/15/70

MIT

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

1.6 Description of change (cont)



each DAP pass, the timers are decremented by 0.1 sec. When one of the timers is zero, the appropriate gimbal drive is stopped. This mechanism also serves to guard against a run-away of the gimbals that could otherwise occur when trim-gimbal control is suddenly locked out by the USEQRJTS bit being restored to 1 (as part of the engine-off routine, for example). The timers are set up in each pass of the GTS attitude control law to a value such that they will not be counted down to zero before the next trim-gimbal-system pass; the drives therefore continue

3.6-20

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN# 1013

ANOMALY#

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☒ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☐ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Dave Moore

Program Supervisor's Approval: Margaret Hamilton

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Section 5

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R.H. Larrison

Date 3-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1013

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR A. KLUMPP	DATE 2/2/70	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
-----------------------------	----------------	----------------------------	----------	------

1.3 EFFECTIVITY LUMINARY IC only	1.4 TITLE OF CHANGE Multiple Servicers Avoidance in P66.
--	---

1.5 REASON(S) FOR CHANGE
If there is an unexpected amount of time loss, or an excessive computation load, several servicer jobs can run simultaneously with the possibility of producing out-of-order and erroneous guidance commands.

1.6 DESCRIPTION OF CHANGE
See Data Amplification Sheet.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

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

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS Decision as to whether or not to fly this change on Apollo 13 will be made by 3/17/70
4.3 SOFTWARE CONTROL BOARD SIGN OFF 3/4/70	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

1013

A. KLUMPP

2/2/70

MIT/IL

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

1.6 Description of Change:

- (1) At the beginning of P66, check the elapsed time since reading the PIPAs for the current state vector (TIME2 - PIPTIME). If the elapsed time is within the padloaded erasable margin 2LATE466, continue the P66 guidance. Otherwise, omit P66 and exit to the vertical displays.
- (2) If the number of throttlings between any omission is not greater than the padloaded erasable TOOFEW, issue the alarm 01466. This avoids locking out P66 completely without notice.
- (3) Raise the priority of the servicer job to 21 shortly after the preceding checks. This prevents a subsequent servicer job from starting until P66 finishes.
- (4) Request the independent ROD job at priority 22. This allows the independent ROD job to bump the servicer job at any point except in the ROD equations.
- (5) Raise the priority of the servicer job and the independent ROD job to 23 at the start of the ROD equations. This locks all subsequent jobs out of the ROD equations until the current job finishes.

This method of responding to computer overloads retains a fixed (as opposed to a variable) servicer period.

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1015
ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☒ NASA Approved PCR
☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly
☐ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

Fred Crocker

ACTION: _____

Program Supervisor's Approval: Margaret Kinneth

☐ 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

Fred De Cain

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 William M. Jones

Date 2-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1015

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR R. LARSON	DATE 2/2/70	1.2 ORGANIZATION MIT/IL	APPROVAL	DATE
-----------------------------	----------------	----------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Check for AVEGON at Start of R36.
--------------------------------	--

1.5 REASON(S) FOR CHANGE
R36 (rendezvous out of plane display, V90E) uses the permanent state (which during P12 would be the R and V on the lunar surface) and since that state was not an orbital state, an acceleration overflow in integration will occur, causing a 20430 POODOO alarm.

1.6 DESCRIPTION OF CHANGE
Check for "AVEGON" at start of R36. Turn on OPP ERR light if on.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 3 Fixed.	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. Larson</i>	
DATE 2-2-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE SCB on 2/4/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1021

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Dave Morris

Program Supervisor's Approval: Margaret Hamel

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Section 5

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

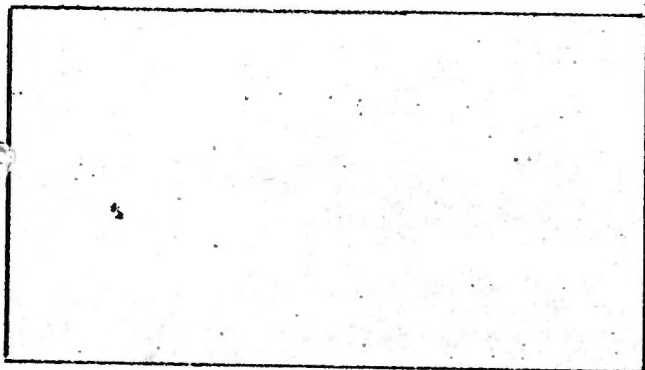
☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R.H. Larson

Date 3-6-70



1.0 SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by PCB)
1021

1.0 COMPLETED BY ORIGINATOR

R. COVELL

0/70

1.2 ORGANIZATION

MIT/Draper Lab

APPROVAL

DATE

1.3 EFFECTIVITY

LUMINARY 1D

1.4 TITLE OF CHANGE

Fixed Memory Landing Radar
Transformation Matrices.

1.5 REASON FOR CHANGE

To permit the program to use the transformation matrix for either landing radar position without additional computation.

1.6 DESCRIPTION OF CHANGE

Replace the routines SETPOS1 and SETPOS2 with the landing radar transformation matrices.

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

2.1 ☐ APPROVED ☐ DISAPPROVED

2.2 REMARKS:

2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE
BRANCH SIGN OFF

DATE

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT

3.2 IMPACT OF PROVIDING DETAILED EVALUATION

3.3 STORAGE IMPACT

3.4 REMARKS:

COORDINATOR

4.0 SOFTWARE CONTROL BOARD ACTION

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

4.2 REMARKS:

4.3 SOFTWARE CONTROL BOARD SIGN OFF

DATE

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR

5.2 MIT EVALUATION

DATE

5.3 ☐ START OR CONTINUE
IMPLEMENTATION ☐ DISAPPROVED OR STOP
IMPLEMENTATION

5.4 REMARKS:

5.5 SOFTWARE CONTROL BOARD SIGN OFF

DATE

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1022

ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Dave Morie

Program Supervisor's Approval: Margaret Hamilton

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Section 2
Section 4, 5

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. H. Lunn

Date 3-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

10221

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR R. COVELLI	DATE 2/10/70	1.2 ORGANIZATION MIT/Draper Lab	APPROVAL	DATE
------------------------------	-----------------	------------------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Landing Radar Position Alarms
--------------------------------	--

1.5 REASON(S) FOR CHANGE See Data Amplification Sheet.

1.6 DESCRIPTION OF CHANGE See Data Amplification Sheet.
--

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT -+10 FIXED -25 words	3.4 REMARKS:
3.5 MIT COORDINATOR <i>James H. Turner</i>	
DATE 2-23-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF 3/4/70	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 3

PROGRAM CHANGE REQUEST NO. 1022	PREPARED BY R. COVELLI	DATE 2/10/70	ORGANIZATION MIT/Draper Lab.
---	----------------------------------	------------------------	--

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

1.5 Reason(s) for Change:

Changing the landing radar position alarm logic will simplify the astronaut procedures if the landing radar fails to reposition when it should, or if it repositions when it should not. The change also permits landing radar data incorporation any time that the data good signal is present, regardless of antenna position.

1.6 Description of Change:

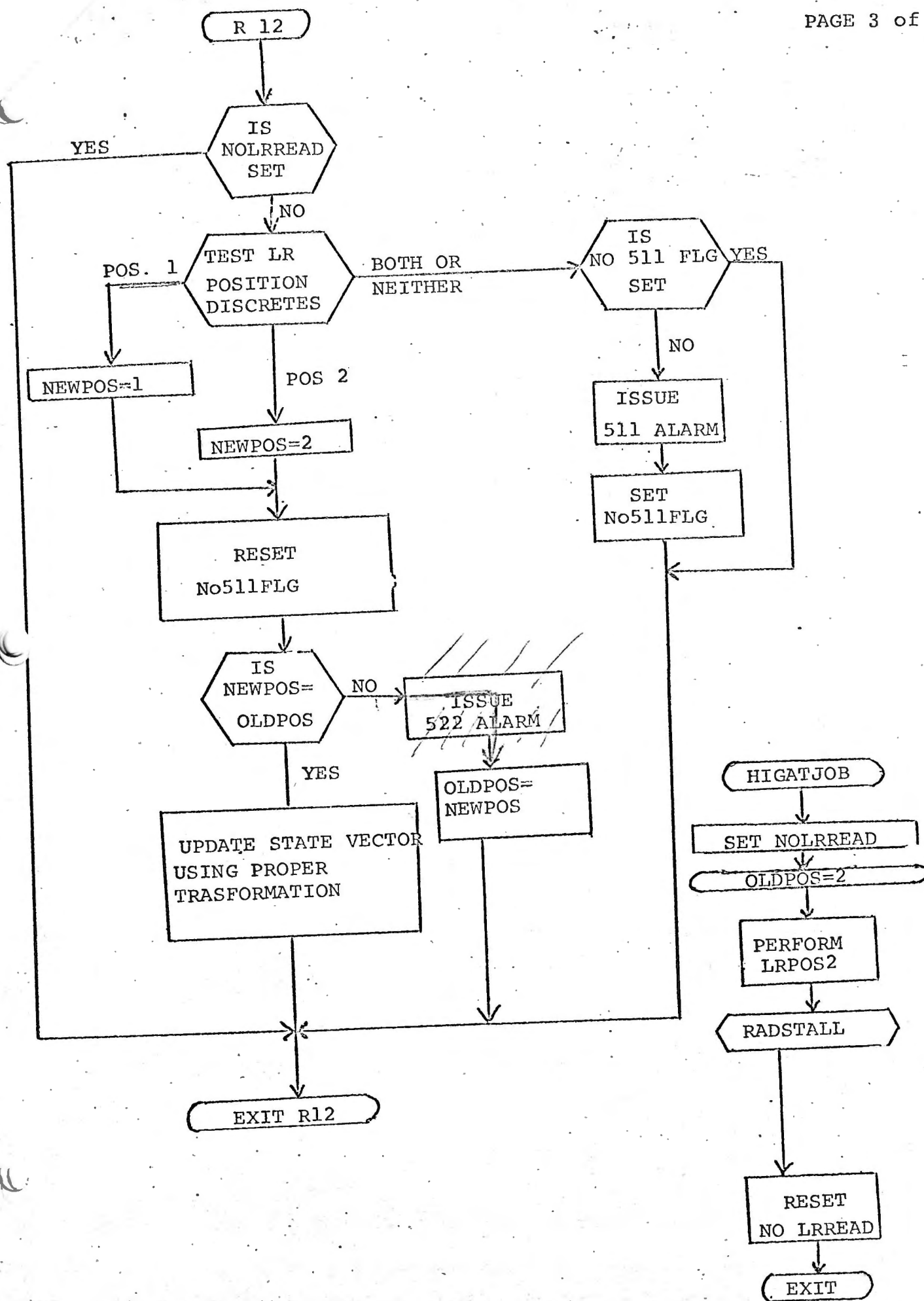
The key to this change is the removal of the concept of "desired landing radar position." The program will accept landing radar data in either position as long as the data good discrete is present. If neither position discrete is present, or if both are present, program alarm 511 is issued. The 511 alarm will not be repeated on subsequent cycles if the same conditions persist, so that the alarm system will not be locked out by the 511 alarm.

If the landing radar position changes unexpectedly, ~~program alarm 522 will be issued.~~ The data will not be used the first time because the antenna may have been moving during the data reading.

The 523 alarm will no longer be issued if the antenna fails to achieve Position #2. If the antenna remains in Position #1, ~~a 522 alarm will be issued and~~ on the following cycles the data will be used as long as the data good signal is present. If the antenna leaves Position #1 but fails to achieve Position #2, a 511 alarm will be issued.

REMARKS:

- (1) It is expected that PCR #1021, "Fixed Memory Landing Radar Transformation Matrices," will also be approved. This would reduce execution time for computing the matrix each time the position changes.
- (2) The crew can manually reposition the landing radar antenna at any time. Program alarms 511 and 522 will appear, but the data will then be used. *until the LR reaches the desired position (i.e. LGC receives the position discrete)*



MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1025

ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Dave Morin

Program Supervisor's Approval: Margaret Hornich

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Section 5

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. A. Lunn-King

Date 3-6-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1025

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR R. Covelli	DATE 2/27/70	1.2 ORGANIZATION MIT Draper Lab	APPROVAL	DATE
------------------------------	-----------------	------------------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Remove gravity computation after landing radar altitude update
--------------------------------	---

1.5 REASON(S) FOR CHANGE
Reduce execution time during R12. The gravity vector is now recomputed after the landing radar altitude update, although its change is insignificant.

1.6 DESCRIPTION OF CHANGE
Remove to call to MUNGRAV after LR altitude update

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT 0	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT - 1 Fixed	3.4 REMARKS: SCB walk-on
3.5 MIT COORDINATOR <i>R. H. L...</i>	
DATE 3-6-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF 3/4/70	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1027

ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Don Eyles

Program Supervisor's Approval: Margaret Hamilton

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Section 485

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R.H. Laro

Date 3-6-70

2.0 SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed)

1027

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR B. Kriegsman	DATE 3-3-70	1.2 ORGANIZATION MIT/Draper Lab	APPROVAL	DATE
--------------------------------	----------------	------------------------------------	----------	------

1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE A-PRIORI TERRAIN MODELS
--------------------------------	--

1.5 REASON(S) FOR CHANGE SEE DATA AMPLIFICATION SHEET
--

1.6 DESCRIPTION OF CHANGE SEE DATA AMPLIFICATION SHEET

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:	
3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION

3.3 STORAGE IMPACT 10 UNSHARED ERASABLE 2 SHARED ERASABLE + 30 WORDS	3.4 REMARKS: FIXED
3.5 MIT COORDINATOR R. A. L... ..	SCB WALK-ON
DATE 3/3/70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF 3/4/70	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

LO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

1027

B. Kriegsman

3-3-70

MIT

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

1.5 Reason for Change

The present powered landing-maneuver navigation system essentially assumes a smooth lunar terrain. As a result, significant errors can occur in the estimates of vehicle altitude w.r.t. the site when the approach terrain to the site is rough and contains large slopes, hills, or craters. These errors can adversely effect the required landing-maneuver ΔV , LPD operational characteristics, and the terminal-phase altitude vs. range-to-go characteristics. This has been observed in simulated landings to Censorinus-B, Censorinus-C, and Fra Mauro (Refs. 1 and 2) and also to Littrow-2 (Ref. 3).

1.6 Description of Change

A significant improvement in performance is obtained by storing in the LGC an a-priori model of the approach terrain to the site of interest. The basic idea is to store the deviations in terrain altitude w.r.t. the site altitude (TEREST) as a function of the computed range-to-go from the landing site (RZG). It is recommended that this be done by a series of linear segments or slopes, as shown in Fig. 1 for Littrow-2.

Important considerations in implementing the change are the following:

- (1.) Based on studies to date (Refs. 1 - 3) it is felt that a minimum of five segments are required to give satisfactory performance for the sites of interest.
- (2.) In order to obtain the desired flexibility over a wide range of terrain profiles (Censorinus, Littrow, and Copernicus), the two parameters defining each linear segment, e.g. the slope and starting range-to-go, should be in erasable memory.
- (3.) The range-to-go (RZG) used in the storing of the a-priori terrain should be computed as the difference between the down-range components of the estimated LM and landing site position vectors. SM coordinates, i.e.:

NO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 3 OF 3

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

1027

B. Kriegsman

3-3-70

MIT

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

1.6 Description of Change (cont.)

(3.)
$$RZG = r_{P,2} - r_{SP,2}$$

where r_P and r_{SP} are the computed LM and site position vectors. It should be noted that $r_{SP,2}$ will be changed by N69 updates and by landing-site redesignations.

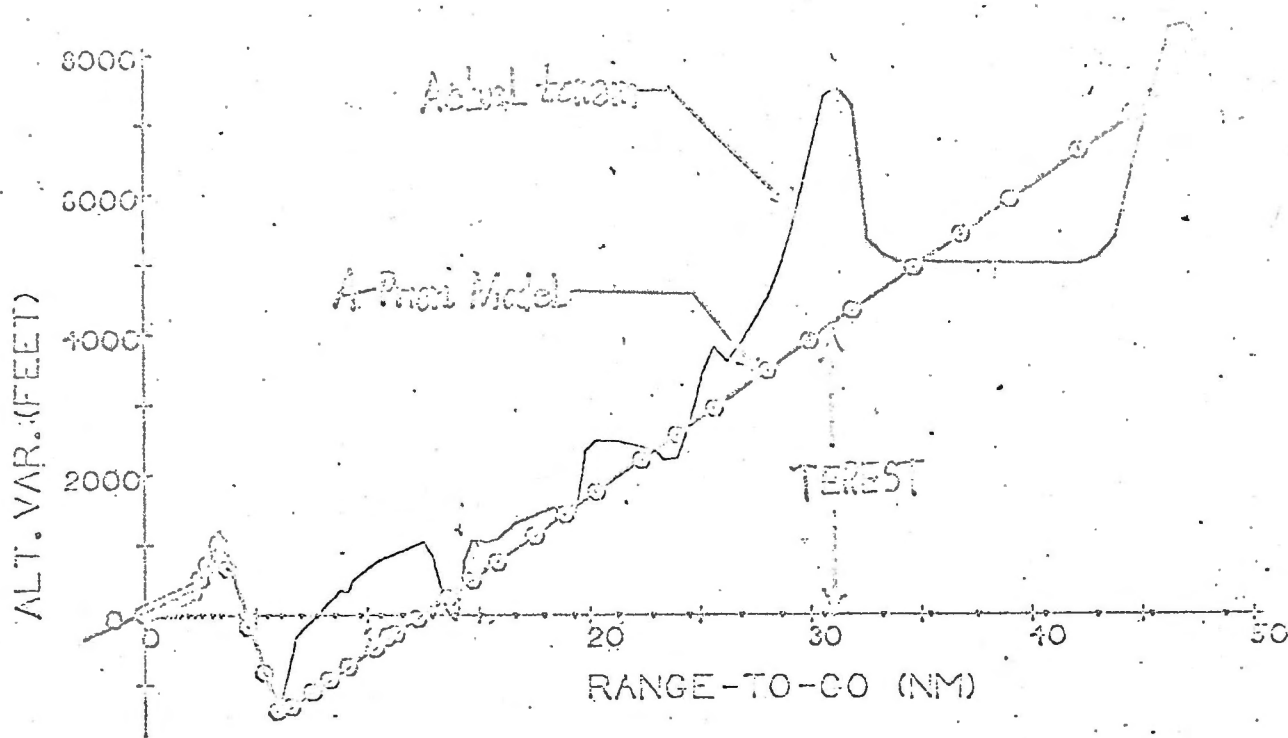
(4.) The terrain profile to be stored will be the one seen by the range beam on a nominal trajectory. It is felt that this is a better choice than the local terrain below the vehicle.

(5.) The a-priori terrain (TEREST) will be used to modify the altitude measurement ($\tilde{h}$) as indicated in the navigation relations below:

$$\begin{aligned} h' &= r_P - r_{SP} \\ \delta h &= \tilde{h} - h' + \text{TEREST} \\ r_P &= r_P + w_H \delta h u_{HP} \end{aligned}$$

The quantity h' is the a-priori altitude estimate, w_H is the LR altitude weighting function, and u_{HP} is a unit vector along the local vertical. It is assumed in the δh relation that the sign of TEREST is positive when a terrain point higher than the site is being modeled.

Fig. 1: Initial A-Prior Terrain Model for LAZAR



Relations Used to Simulate a-priori Model

$$\text{IF } RZG \text{ NEG, TEREST} = \frac{-333 \text{ } RZG}{14300}$$

$$\text{IF } RZG + 14300 \text{ NEG, TEREST} = 333 + \frac{700 (RZG + 14300)}{(11000)}$$

$$\text{IF } RZG + 21200 \text{ NEG, TEREST} = 1033 + \frac{2470 (RZG + 21200)}{(11000)}$$

$$\text{IF } RZG + 39300 \text{ NEG, TEREST} = -1446 + \frac{6000 (RZG + 39300)}{(11000)}$$

$$\text{IF } RZG + 300000 \text{ NEG, TEREST} = 8000$$

LLC SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 5 OF 5

PROGRAM CHANGE REQUEST NO. 1027	PREPARED BY B. Kriegsman	DATE 3-3-70	ORGANIZATION MIT
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CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request Form.)

REFERENCES

- (1.) Kriegsman, B. and Gustafson, D., "Powered Landing-Maneuver Navigation Over Rough Terrain", MIT Instrumentation Lab, Mission Simulation Memo #2-70, February 18, 1970.
- (2.) Kriegsman, B. and Gustafson, D., "Additional Landing-Maneuver Simulation Results Relating to Navigation Systems for Landing in Rough Terrain", MIT Instrumentation Lab, Mission Simulation Memo #4-70, February 23, 1970.
- (3.) Kriegsman, B. and Berberian, H., "Preliminary Simulation Results for Powered-Landing Maneuver to Littrow-2 with A-Priori Terrain Model in LGC", MIT Instrumentation Lab, Mission Simulation Memo #3-70, February 23, 1970.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN# 1028

ANOMALY#

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Dave Moore

Program Supervisor's Approval: Margaret Hamer

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: Section 5

Technical Committee Meeting not required

Technical Committee Meeting(s) held on
Attendees:

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION:

D. Other Programs Affected

☐ Review for corresponding changes in

ACTION:

Special Instructions

Project Manager R.H. Larson

Date 3-6-70

OLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1028

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR B. KRIEGSMAN	DATE 3/3/70	1.2 ORGANIZATION MIT/CSD Lab.	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Two-segment Altitude Weighting Functions for Landing Maneuver.
--------------------------------	--

1.5 REASON(S) FOR CHANGE See Data Amplification Sheet.

1.6 DESCRIPTION OF CHANGE See Data Amplification Sheet.
--

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 1 - schedule 2 - flight control	3.4 REMARKS: SCB walk-on
3.5 MIT COORDINATOR D. H. F. - all	
DATE 3-3-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

OLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. PREPARED BY

DATE

ORGANIZATION

1028

B. KRIEGSMAN

3/3/70

MIT/CSD Lab.

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

1.5 Reason(s) for Change:

Landing maneuvers over rough terrains with large hills and craters require relatively low weighting functions in the braking phase. This is desirable to avoid following the local terrain variations at long ranges, and introducing excessive pitch-angle oscillations (Refs. 1-3). In the approach phase, on the other hand, higher weighting functions are desired in order to keep the altitude estimation errors small close to the site. The present weighting-function scheme has limited flexibility.

1.6 Description of Change:

The present LR weighting function is given by:

$$W_H = LRWH (1 - h'/LRHMAX)$$

where h' is the estimated vehicle altitude, and $LRWH$ and $LRHMAX$ are erasable quantities used to set the slope of the weighting function. To provide flexibility in the choice of W_H , it is desired that a separate erasable load be provided for $LRWH$ in the programs following P63.

REMARKS:

REFERENCES:

1. Kriegsmann, B. and Gustafson, D. "Powered Landing-Maneuver Navigation over Rough Terrain," MIT/CSD Laboratory Mission Simulation Memo #2-70, Feb. 18, 1970.
2. Kriegsmann, B. and Gustafson, D. "Additional Landing-Maneuver Simulation Results Relating to Navigation Systems for Landing in Rough Lunar Terrain," MIT/CSD Laboratory Mission Simulation Memo #4-70, Feb. 23, 1970.
3. Kriegsmann, B. and Berberian, H. "Preliminary Simulation Results for Powered-Landing Maneuver to Lettrow-2 with A-priori Terrain Model in LGC," MIT/CSD Laboratory Mission Simulation Memo #3-80, Feb. 23, 1970.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/~~PCN~~ # 1029

ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☒ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: Don Eiler

Program Supervisor's Approval: M. Hamilton

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: H. MAHER

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. LARSON

Date 4/10/70

what about Colossus?
nhh

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSU)

1029

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR R. LARSON	DATE 3/18/70	1.2 ORGANIZATION MIT/CSD Lab	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Timing Indicators.
--------------------------------	---

1.5 REASON(S) FOR CHANGE To assess computer Duty Cycle and TLOSS.
--

1.6 DESCRIPTION OF CHANGE See Data Amplification Sheet.
--

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. Larson</i>	
DATE 4-7-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF 4/9/70	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. 1029	PREPARED BY R. LARSON	DATE 3/18/70	ORGANIZATION MIT/CSDL
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CONTINUATION SECTION: (Refer to Block Number and Title on Program Change Request form.)

1.6 Description of Change

Put on downlink the following indicators:

- (1) DUMMY JOB CNTR (DUM LOOPS).
- (2) DURATION OF SERVICER

$$\text{SURVDURN} = \text{TIME 1} - (\text{PIP TIME} + 1)$$

These indicators are to be put on the following downlist in the format:

FIRST REG	SECOND REG
SURVDURN	DUMLOOPS

<u>LIST</u>	<u>WORD</u>
COAST and ALIGN	75
RENDEZVOUS and PRETHRUST	25
DESCENT and ASCENT	13
AGS INITIALIZATION and UPDATE	67
ORBITAL MANEUVERS	67

REMARKS:

MIT-PCN

pg 1 of 2

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1035

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR McCoy	DATE 4/14/70	1.2 ORGANIZATION MIT	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY ID	1.4 TITLE OF CHANGE V68 and P66 terminate the terrain model
--------------------------------	--

1.5 REASON(S) FOR CHANGE See amplification sheet

1.6 DESCRIPTION OF CHANGE see amplification sheet
--

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 10 Fixed Words	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. L...</i>	
DATE 4-22-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT-PCN

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

1035

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

- 1.5 (a) An extended verb shall allow the astronaut to by pass the terrain model computations if the model causes adverse effects.
- (b) P66 need not use the terrain model because the program is not guiding toward a specific altitude. Also, the astronaut should have on his displays the true present altitude, rather than that relative to the landing site.
- 1.6 V68 and entrance to P66 set a flag to by pass the terrain model computations.

REMARKS:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by PSD)

1036

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR McCoy	DATE 4/21/70	1.2 ORGANIZATION MIT	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE PCR 996 (Liftoff check in P07) Improvements
--------------------------------	--

1.5 REASON(S) FOR CHANGE 1. To keep astronaut from having to set bit in flight. 2. Astronaut will not get a P00D00 for keystroke error.
--

1.6 DESCRIPTION OF CHANGE 1. Set N0D0P07FG in V37 logic 2. If V92E w/wh flag set, display operator error, not alarm 21521.
--

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. L...</i>	
DATE 4-22-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DISAPPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by TSB)

1037

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR Klump	DATE 4/22/70	1.2 ORGANIZATION MIT	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE P66 corrections
--------------------------------	--

1.5 REASON(S) FOR CHANGE See Data Amplification Sheet
--

1.6 DESCRIPTION OF CHANGE See Data Amplification Sheet

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 2 words	3.4 REMARKS: Verbal approved from T Price on 4-23-70
3.5 MIT COORDINATOR <i>D. H. Lunn</i>	
DATE 4-23-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

- MIT PCN -
- DRAFT -

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO. PREPARED BY

1037

DATE

ORGANIZATION

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

- 1.56 a. remove "stoprate" from P66 initialization
b. remove the resetting of REDFLAG from P66 initialization
c. provide a "stoprate" when a 01466 alarm occurs
- 1.6 a. it interrupts any attitude control of spacecraft when ROD's are skipped;
b. not necessary to reset it since redesignation monitor is terminated when P66 begins;
c. attitude rates should be terminated when the PGNS is having difficulty controlling the spacecraft as with the 01466 alarm situation.

REMARKS:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)
1038

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR McCoy	DATE 4/27/70	1.2 ORGANIZATION MIT	APPROVAL	DATE
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1.3 EFFECTIVITY Luminary 1D	1.4 TITLE OF CHANGE Keep 526 Alarm in P20 (PCR 287)
--------------------------------	--

1.5 REASON(S) FOR CHANGE
Due to the difficulty in providing a display in P20 while it is running in background of another program. (Also see Luminary Memo # 133)

1.6 DESCRIPTION OF CHANGE
See 1.4

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS: Verbal approval by T. Price on 27 April 1970
3.5 MIT COORDINATOR <i>T. Price</i>	
DATE 4-27-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/19/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSH)

1039

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR Klumpp	1.2 ORGANIZATION MIT	1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE TERRAIN Model improvements (PCR1027)
--------------------------	-------------------------	--------------------------------	---

1.5 REASON(S) FOR CHANGE: The terrain Model should correspond to the path followed by the intersection of the altitude radar beam with the Lunar Surface. PCR 1027 did not account for the downrange displacement introduced by the non-vertical orientation of the altitude beam.

1.6 DESCRIPTION OF CHANGE
See Data Amplification Sheet

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 MIT COORDINATOR N/A	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 SOFTWARE IMPACT N/A	3.4 REMARKS: Agreed to by MPAD's LaBrague
3.5 MIT COORDINATOR B. McCloy	
DATE 4/29/70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS: Re-evaluate to make sure that this is really a good thing to do. i.e.: Accuracy gain, T-loss etc.
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

1039

PREPARED BY

Klumpp

DATE

4/28/70

ORGANIZATION

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

$$1.6 \quad RZG = r_{P,2} + r_{LRP,2} - r_{SP,2}$$

where $r_{P,2}$ is the downrange position vector of the LM

$r_{LRP,2}$ is the altitude beam vector Z component,
and

$r_{SP,2}$ is the Landing Site position vector Z component,
all in platform coordinates.

REMARKS:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1040

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR McCoy	DATE 4/28/70	1.2 ORGANIZATION MIT	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Only P41 has Early TFI Countdown (PCR 872.2)
--------------------------------	--

1.5 REASON(S) FOR CHANGE Due to Complexity in changing the very neat Master Ignition Routine and the fact that P40 and P42 already have a TFI countdown and P41 has none.
--

1.6 DESCRIPTION OF CHANGE Do not incorporate PCR 872.2 into P3X, P40 or P42. TFI will begin counting down immediately after calling P41 and terminates at TIG -35.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 EFFECT OF IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>[Signature]</i>	
DATE 5-4-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1042

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

MIT-PCN

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☐ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: J. KLAWSNIK

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager [Signature]

Date 5-11-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1042

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR J. Klawnsnik	DATE 5/8/70	1.2 ORGANIZATION MIT	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Sect. 3 Rev. 4 GSOP Fix for L-1 C-08.
--------------------------------	---

1.5 REASON(S) FOR CHANGE To make coding consistent with GSOP.
--

1.6 DESCRIPTION OF CHANGE Change Sect. 3 GSOP to conform with Data Amplification Sheet.
--

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. Larson</i>	
DATE 5-7-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS- APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 2 OF 3

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

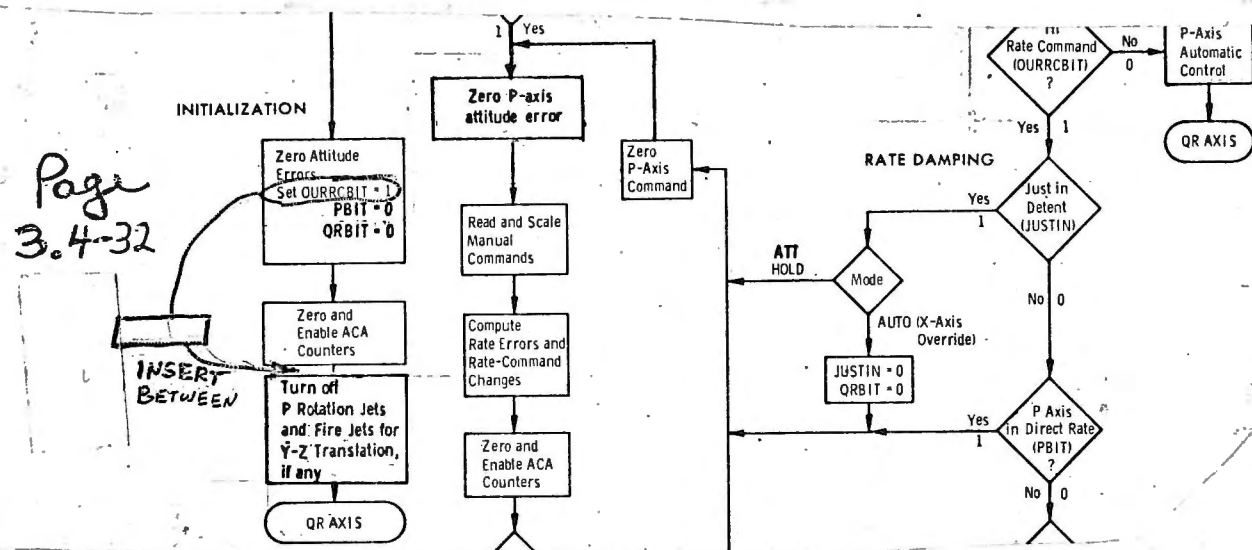
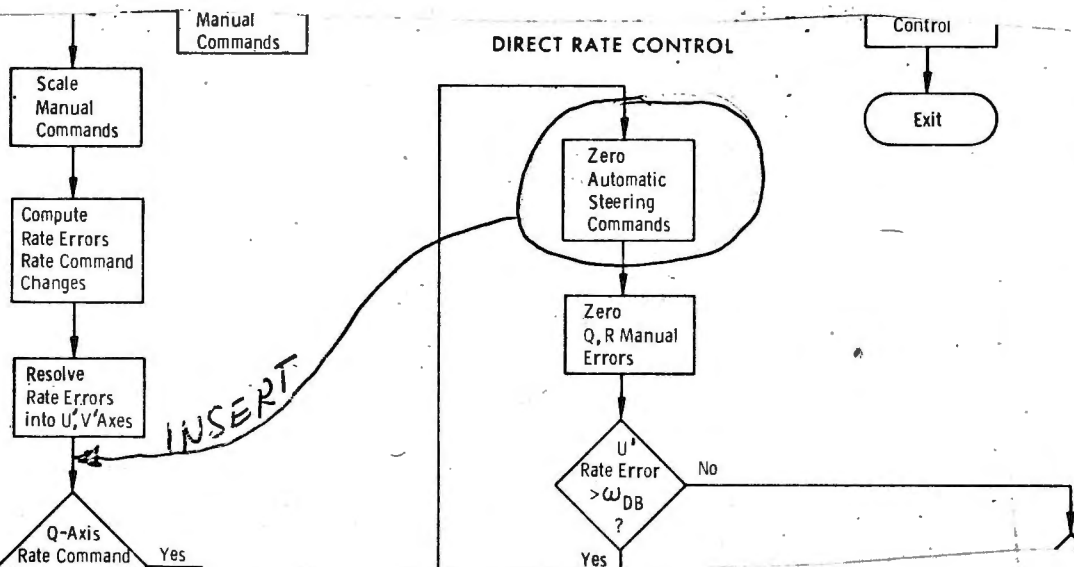
10.42

J. K. Klawsnik

5/8/70

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

1.6 Continued

PAGE
3.4-33

REMARKS:

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD DATA AMPLIFICATION SHEET

PAGE 3 OF 3

PROGRAM CHANGE REQUEST NO.

PREPARED BY

DATE

ORGANIZATION

1042

J. Klawnsnik

5/8/70

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

1.6 Continued

Change Pg. 3.4 - 38 as shown

U', V' axes, these rate errors are then resolved into U', V' components ($\omega_{eU'}$, $\omega_{eV'}$).

At this point, the automatic steering inputs are zeroed; that is,

$$\omega_{dP} = 0 \quad \Delta\theta_{do} = 0 \quad \beta_P = 0$$

$$\omega_{dQ} = 0 \quad \Delta\theta_{di} = 0 \quad \beta_Q = 0$$

$$\omega_{dR} = 0 \quad \Delta\theta_{dm} = 0 \quad \beta_R = 0$$

The desired CDU's are also set equal to the current CDU's; that is,

$$CDUXD = CDUX \quad \theta_{do} = \theta_o$$

$$CDUYD = CDUY \quad \text{or} \quad \theta_{di} = \theta_i$$

$$CDUZD = CDUZ \quad \theta_{dm} = \theta_m$$

A check is then made to determine if either $|\Delta\omega_{cQ}| > \omega_{BL}$ or $|\Delta\omega_{cR}| > \omega_{BL}$. If so, the Q, R-axes direct rate control law is selected. Before entering the direct rate control law, however, the Q, R-axes time counter, T_{cQR} , is set to 4 seconds. This counter has the same function as T_{cP} .

At the beginning of the direct rate control law, the Q, R manual errors, θ_{emQ} and θ_{emR} , are zeroed.

REMARKS:

MIT/DL PROGRAM CHANGE ROUTING SLIP

~~PCR~~/PCN # 1043

ANOMALY # _____

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☒ NASA Approved PCN

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

FIXED BY ACB L-17

ACTION: Dana Denness

Program Supervisor's Approval: Margaret Hamblin

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: H. MAHER

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager [Signature]

Date 5-19-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1043

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR McCoy	DATE 5/12/70	1.2 ORGANIZATION MIT	APPROVAL	DATE
-------------------------	-----------------	-------------------------	----------	------

1.3 EFFECTIVITY LUM 1D	1.4 TITLE OF CHANGE Remove zeroing of bit 4 of channel 14 on restart or V37.
---------------------------	---

1.5 REASON(S) FOR CHANGE If a software restart occurs during the throttle down of the DPS engine, the pulses to the DECA are terminated.

1.6 DESCRIPTION OF CHANGE Remove zeroing of bit 4 of channel 14 from STARTSB2.

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS:
3.5 MIT COORDINATOR <i>[Signature]</i>	
DATE 5-13-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 5/14/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1048

ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

☐ MIT Approved PCN

☒ NASA Approved PCN

☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☐ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: Margaret A. Hamel

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

B. GSOP Preparation

☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ 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 D. H. [Signature]

Date 6-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSB) 1048	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR McCoy		DATE 5/28/70		1.2 ORGANIZATION MIT/DL	
1.3 EFFECTIVITY LUMINARY 1D		1.4 TITLE OF CHANGE Initialize Elevation Angle in P34			
1.5 REASON(S) FOR CHANGE					
1. The option to compute Elevation Angle from TPI-TIG is used more often (astronaut loads zero)					
2. Eliminates possibility of 611 alarm: the erasable sharing with Elev. (cont'd)					
1.6 DESCRIPTION OF CHANGE Load zero into Elev_{dp} prior to first NOUN 55 display in P34.					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS:		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT None			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 2 words			3.4 REMARKS: <i>Verbal approval by T. Price on 6-3-70</i>		
3.5 MIT COORDINATOR <i>[Signature]</i>					
DATE 6-3-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED			4.2 REMARKS:		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS:		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

1048

PREPARED BY

McCoy

DATE

5/28/70

ORGANIZATION

MIT/DL

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

1.5 Cont'd

is so small that pinball scaling causes display to appear to Astronaut as zero. The astronaut wanting this option would not reload zero, however, the Lambert targetting would see a non-zero Elevation Angle (unreasonably small) and attempt, unsuccessfully, to find a solution, hence a 611 alarm.

REMARKS:

MIT/DL PROGRAM CHANGE ROUTING SLIP

MIT-PCN

PCR/PCN # 1052

ANOMALY # _____

- | | |
|---|---|
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS 3A | ☐ LUMINARY 1F |
| ☐ COLOSSUS _____ | ☐ LUMINARY _____ |

☐ MIT Approved PCN☐ NASA Approved PCR☐ NASA Approved Software Anomaly☒ NASA Approved PCN☐ MIT Approved Software Anomaly

VERBAL

A. Coding☒ Begin coding immediatelyACTION: Allen KlumpProgram Supervisor's Approval: Don Cyler☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☒ Prepare GSOP revisions for MDRB considerationACTION: J. KLAWSNIK☐ Technical Committee Meeting not required.☐ Technical Committee Meeting(s) held on _____
Attendees: _____C. KSC Testing and Checkout☐ Review for possible impact on KSC testing and checkout

ACTION: _____

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

ACTION: _____

Special InstructionsProject Manager [Signature]Date 6-5-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST				NUMBER (Completed by FSD)	
1.0 COMPLETED BY ORIGINATOR					
1.1 ORIGINATOR McCoy		DATE 6/3/70	1.2 ORGANIZATION MIT/SDL		APPROVAL DATE
1.3 EFFECTIVITY LUMINARY 1D			1.4 TITLE OF CHANGE P66 IMU/C.G. Offset compensation		
1.5 REASON(S) FOR CHANGE Due to the IMU being located approximately 1 1/2 meters from the center of gravity, Xtranslational acceleration is induced by any attitude vehicular rates by a factor of W/R, where W is the rate and R is the moment arm. (cont. page 2)					
1.6 DESCRIPTION OF CHANGE When computing present acceleration due to thrust (reading the PIPAS) remove effects of this offset acceleration					
2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT					
2.1 ☐ APPROVED ☐ DISAPPROVED			2.2 REMARKS		
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF					
DATE					
3.0 MIT VISIBILITY IMPACT EVALUATION:					
3.1 SCHEDULE IMPACT			3.2 IMPACT OF PROVIDING DETAILED EVALUATION		
3.3 STORAGE IMPACT 11 words (fixed)			3.4 REMARKS: <i>Verbal approval by T. Price on 6-3-70</i>		
3.5 MIT COORDINATOR <i>Russell H. Larson</i>					
DATE 6-3-70					
4.0 SOFTWARE CONTROL BOARD ACTION					
4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED			4.2 REMARKS		
4.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION					
5.1 MIT COORDINATOR			5.2 MIT EVALUATION		
DATE					
6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION					
6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION			6.2 REMARKS		
6.3 SOFTWARE CONTROL BOARD SIGN OFF					
DATE					

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
DATA AMPLIFICATION SHEET

PAGE 2 OF 2

PROGRAM CHANGE REQUEST NO.

1052

PREPARED BY

McCoy

DATE

6/3/70

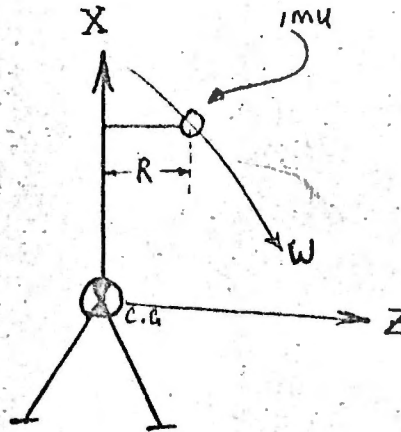
ORGANIZATION

MIT/SDL

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

1.5 Reason for change (cont.)

This acceleration sensed by the X PIPA affects the P66 vertical throttle control if the PIPA's are read while the vehicle rates are in progress.



REMARKS:

IT/DL PROGRAM CHANGE ROUTING SLIPPCR/PCN # 1056 Rev 1

ANOMALY # _____

ADR # _____

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

☒ LUMINARY 1D
☐ LUMINARY 1E
☐ LUMINARY 1F
☐ LUMINARY _____
☐ MIT Approved PCN☐ NASA Approved PCR☐ NASA Approved Software Anomaly☐ MIT Approved ADR☐ NASA Approved PCN☐ MIT Approved Software AnomalyA. Coding☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: Margaret Hamilton☐ Do not code until new GSOP material has been approved by the MIT Mission Design Review Board (MDRB) and distributed.B. GSOP Preparation☒ Prepare GSOP revisions for MDRB consideration

ACTION: _____

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

ACTION: _____

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

ACTION: _____

Special InstructionsProject Manager R. H. LoranDate 9-16-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1056 Rev. 1

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR B. McCoy	DATE 7/20/70	1.2 ORGANIZATION MIT/DL	APPROVAL	DATE
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1.3 EFFECTIVITY LUMINARY 1D	1.4 TITLE OF CHANGE Improvements for Impulse and Ullage Logic
---------------------------------------	---

1.5 REASON(S) FOR CHANGE
1. Remove overburn possibilities when ullage time is required to be greater than 3.5 seconds in P42. 2. Correct APS Impulse Constant for "Wet" Engine (cont.)

1.6 DESCRIPTION OF CHANGE
1. Turn on ullage at TIG-6 sec. in P42; assume 6.5 sec. in Routine S40.13. 2. Change K1VAL from 2800 to 3150 lb. sec. in Routine S40.13 3. Change Thrust Ullage (F_L) from 200 to 400 lbs. in Routine S40.13

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

2.1	☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF		
DATE		

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT 2 Words	3.4 REMARKS:
3.5 MIT COORDINATOR <i>R. H. Larson</i>	
DATE 9-16-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1	☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF		
DATE		

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1	☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF		
DATE		

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE ____ OF ____

PROGRAM CHANGE

REQUEST NO. 1056PREPARED BY: B. McCoyDATE: 7/20/70

ORGANIZATION:

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

1.5 Cont.

3. Prime Flight Crew will be using 4 jet x-translation for ullage in case (1) APS doesn't shutdown or (2) APS doesn't ignite at all, the ΔV will be easier to null than with 2 jets.

REMARKS

IN ASSUMPTION (6) ABOVE, DISPLAY SELECTION IS ALWAYS BASED UPON THE LAST ENTRY MADE IN THE DSKY.
FOR A MORE DETAILED DESCRIPTION OF THESE DISPLAYS REFER TO SECTION 3 OF R567, PARA. 3-2.6

(8) THE X-AXIS OVERRIDE OPTION PROVIDES THE CREW WITH THE ABILITY TO EXERCISE MANUAL CONTROL ABOUT THE LM X AXIS WITH THE ATTITUDE CONTROLLER EVEN THOUGH THE PGNC'S ATTITUDE CONTROL MODE IS AUTO. WHEN THE CONTROLLER IS RETURNED TO DETENT THE PGNC'S DAMPS THE YAW RATE, STORES THE YAW ATTITUDE WHEN THE YAW RATE IS DAMPED, AND THEN MAINTAINS THAT ATTITUDE. THE X-AXIS OVERRIDE OPTION IS ALWAYS AVAILABLE TO THE CREW, HOWEVER IT SHOULD NOT BE EXERCISED WHEN THE LGC IS SPECIFYING A DESIRED YAW ATTITUDE, I.E.: DURING THE ATTITUDE MANEUVER TO THE THRUSTING ATTITUDE (SEE R50).

(9) WHEN THE THRUST/TRANSLATION CONTROLLER IS SET TO MINIMUM THRUST POSITION AND THE LGC THROTTLE COMMAND IS ZERO THE DPS WILL START AT 10 PER CENT THRUST.

(10) THE LOAD DAP DATA ROUTINE (R03) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM AND THE DPS ENGINE GIMBAL HAS BEEN PREVIOUSLY DRIVEN TO THE CORRECT TRIM POSITION. IF THIS BURN IS OF SUFFICIENT DURATION THAT VEHICLE TRANSIENTS AT IGNITION DUE TO CG/THRUST DOES NOT AFFECT ACCOMPLISHMENT OF MANEUVER AIM CONDITIONS, THEN GIMBAL DRIVE TO TRIM POSITION NEED NOT BE DONE BEFORE TIG. GIMBAL DRIVE TO TRIM POSITION IN WORST CASE COULD REQUIRE 2 MINUTES. 4 JET X-TRANSLATION FOR ULLAGE OF 6.5 SECONDS IS ASSUMED.

(11) DURING DPS BURNS ONLY, THE PITCH-ROLL RCS JET AUTOPILOT (U AND V JETS) MAY BE DISABLED (V65) OR ENABLED (V75) BY EXTENDED VERO AS SHOWN. THIS CAPABILITY IS INTENDED TO BE USED TO PREVENT LM AND DESCENT STAGE THERMAL CONSTRAINT VIOLATIONS DURING CSM-DOCKED DPS BURNS (P40). THE CAPABILITY EXISTS DURING P63 AND P70 ALSO. PERFORMANCE OF FRESH START (V36E) WILL ALWAYS ENABLE THE PITCH-ROLL JETS.

(12) 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 RESTARTS ARE INVOLVED, THE ACCOUNTING OF THIS TOTAL TIME DELAY IS UP TO THE CREW.

(13) LGC AND CREW PROCEDURES IN CASES OF LGC-ASSUMED THRUST FAILURE ARE DEFINED BY THE DPS/APS THRUST FAIL ROUTINE (R4C). THIS ROUTINE IS CALLED AT DPS IGNITION BY THIS PROGRAM.

(14) THE LGC WILL NEITHER DESIGNATE NOR READ THE RENDEZVOUS RADAR (RR) DURING THIS PROGRAM.

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

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

PROG
CNT

LGC

GROUND

CREW

CREW
PROGRAM
SELECTION

START CFS
PROGRAM (P40)
DISPLAY P40

KEY IN DPS
PROGRAM (P40)
V37E 40E

1056
Pg 3 of 14

MODE 11 ATTITUDE ERROR DISPLAYS ARE AUTOMATICALLY SELECTED AT THE BEGINNING OF R60. WITH THE EXCEPTIONS INDICATED IN ASSUMPTION (6) ABOVE, DISPLAY SELECTION IS ALWAYS BASED UPON THE LAST ENTRY MADE IN THE DSKY. FOR A MORE DETAILED DESCRIPTION OF THESE DISPLAYS REFER TO SECTION 3 OF R567, PARA. 3.2.6.

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

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

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

(10) THE LOAD DAP DATA ROUTINE (R03) MAY HAVE BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM. 4 JET X-TRANSLATION
FOR 6.5 SECONDS VLLAGE IS ASSUMED.

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

(12) THE LGC WILL NEITHER DESIGNATE NOR READ THE RENDEZVOUS RADAR (RR) DURING THIS PROGRAM.

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

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

PROG
CCNT

LGC

GROUND

CREW

.CREW
.PROGRAM
.SELECTION

START APS PROGRAM
(P42) DISPLAY
P42

KEY IN APS
PROGRAM (P42)
V37E 42E

#10

1056
Pg 4 of 14

INSERT AT
ABOUT LINE 585

WILL ACTIVE STEERING
BE ATTEMPTED DURING
THIS MANEUVER?
(REFER PARA. 5.3.3.-
3.3 OF SECTION 5 OF
R567)

.Y N.

SET IMPULSE FLAG

CALL VERB 59 DIS-
PLAYS (SEE "A"
BELCH)

CALL SET OF ULLAGE
FLAG AT TIG 3.5 SEC

-6

WAIT UNTIL TIG -0

SET IGNITION FLAG

#640

#650

#660

#670

#680

1056
Pg 5 of 14

WAIT FOR KEYBOARD
ENTRY

6
AT TFI --00803 MONI-
TOR START OF +X4JET
TRANSLATION.

8740

MONITOR DSKY:
WAIT FOR INCREASE OF
DELTA VM INDICATING
SUFFICIENT ULLAGE-
REQUIRED ULLAGE
DELTA V IS A
FUNCTION OF VEHICLE
WEIGHT.

8750

SHALL I ATTEMPT
TO COMPLETE THE
THRUSTING MANEU-
VER WITH THE RCS?

8760

8770

Y N
KEY IN ENTER

8780

GO TO

1056
Pg 6 of 14

TERMINATE
CALL FOR
SET CF
ULLAGE
FLAG AT
TIG-3.5
SEC 1P
CALL NOT
YET DONE

-6

GO TO
"C"
BELOW

DO FINAL AUTO-
MATIC REQUEST
TERMINATE
ROUTINE (R00)

DO FINAL AUTO-
MATIC REQUEST
TERMINATE
ROUTINE (R00)

EXIT P42

EXIT P42

SET ASTRONAUT FLAG

IS IGNITION FLAG
SET?

.Y .N

RESUME STATIC DI-

MONITOR DSKY:
IS R1 DISPLAY CF TFI
NEGATIVE AND
NON-ZERO?

.Y .N

MONITOR DSKY

8840

8850

8860

8870

8880

FLAG

#1290

TERMINATE
CALL FOR
SET CF
LLAGE
FLAG AT
TIG-3.5
SEC IF
CALL NOT
YET DCNE

#1300

"A"
FROM
ABOVE

#1310

HOLD

MON

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

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

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

#1320

RECORD THESE VALUES
AS DESIRED.

#1330

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT CF PROCEED,

KEY IN PROCEED

If either the DPS or APS were selected for the maneuver, the Time-to-Go Prediction Subroutine of Fig. 3.3-11 is then processed. With reference to Fig. 3.3-11:

- S_{TH} DPS throttle inhibit switch
 - $S_{TH} \left\{ \begin{array}{l} 0 \text{ Allow DPS throttle up} \\ 1 \text{ Inhibit DPS throttle up} \end{array} \right.$
- S_I Impulse Switch
 - $S_I \left\{ \begin{array}{l} 0 \text{ Allow steering at the proper time via } \Delta V \text{ Monitor Routine (Section 5.3.3.6)} \\ 1 \text{ Indicates short maneuver and no steering is required} \end{array} \right.$
- F_L Ullage thrust (~~X~~⁴ jet thrust)
- K_1 APS impulse velocity acquired in a one second maneuver for a unit mass vehicle
- K_2 APS minimum impulse constant
- K_3 APS minimum impulse constant equal to the slope of minimum impulse curve.
- K_4 10% DPS engine thrust
- F_{APS} APS Thrust

The initial computation in Fig. 3.3-11 estimates the velocity-to-be-gained after ^{6.5} seconds of ullage. If the DPS were selected (P-40), the maneuver time, t_{go} , is then computed on the basis of 10% thrust. If this time is less than 6 seconds no active guidance steering is attempted ($S_I = 1$) and the vehicle attitude is maintained at the pre-thrust alignment throughout the maneuver. If the DPS t_{go} is greater than 95 seconds normal steering will

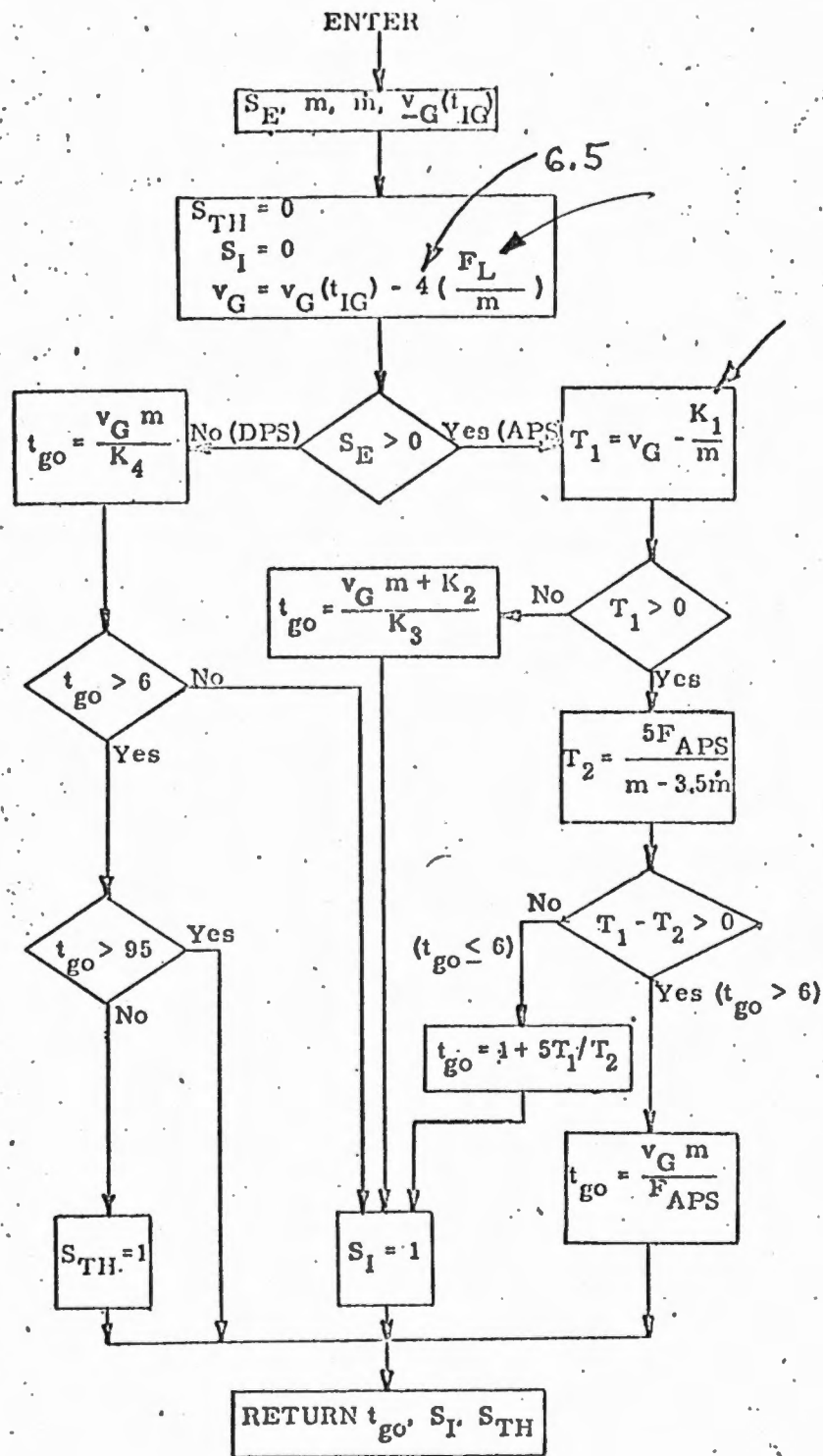


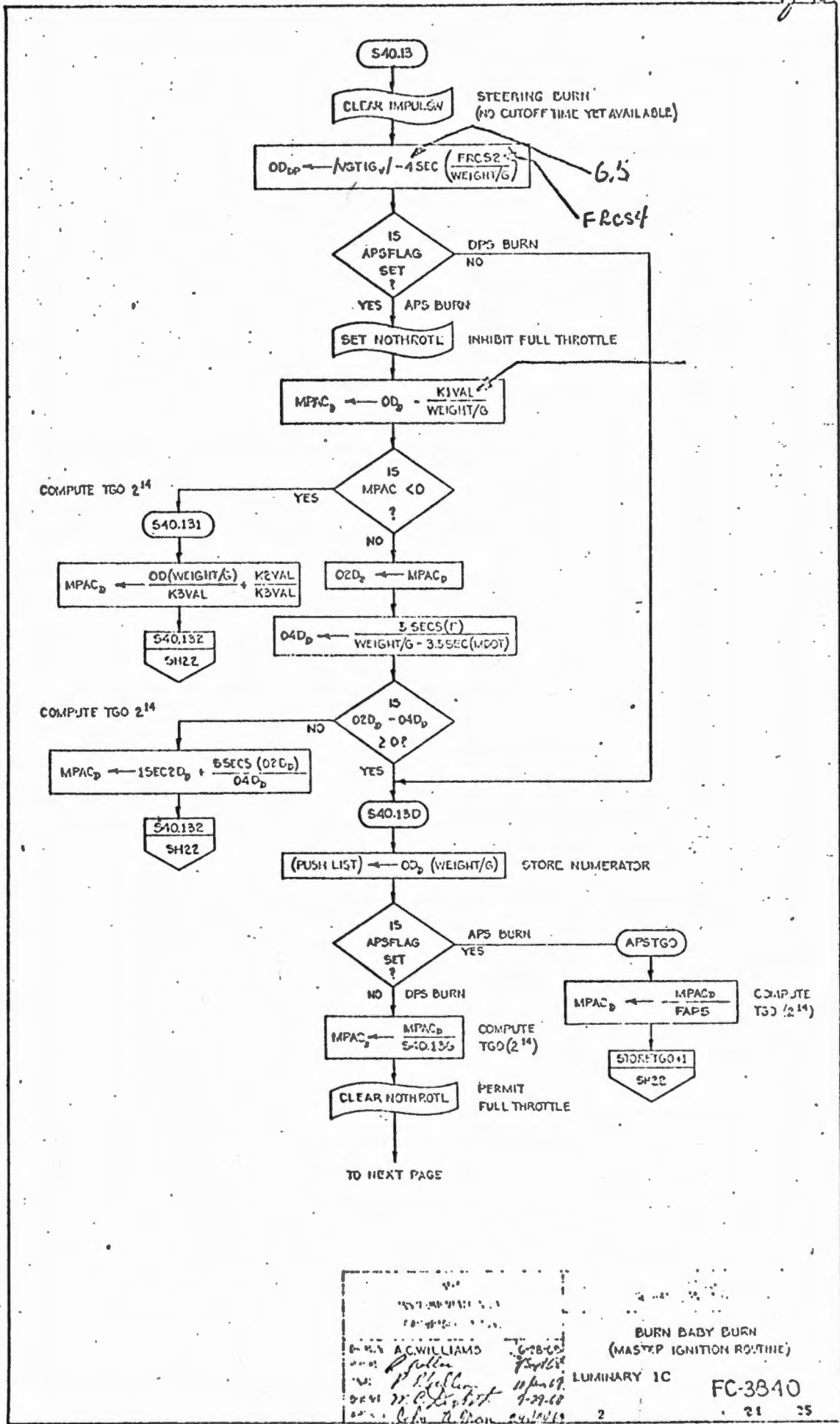
Figure 3.3-11 Time-to-go Predictor Routine

<u>Section No.</u>	<u>GSOP Name</u>	<u>LGC Name</u>	<u>Units</u>	<u>Value</u>	<u>Reference (Sec. 5. 8. 2)</u>	<u>Comments (Sec. 5. 8. 3)</u>
5. 2. 4. 2. 2	var _{IMU}		(mr) ²	1. 0	6	
5. 2. 5. 3	ω_M		rad/sec	2. 661699 $\pm$ 8 x 10 ⁻⁶	2, 3, 4	
5. 3. 3. 3. 1	F _{DPS}		pounds	9817. 5	29, 30	24
	F _{APS}		pounds	3500	5, 17	
	F _{RCS}		pounds	400 or 200	5, 17	
5. 3. 3. 3. 3	ΔV_K (DPS) { LM only		cm/sec	36	19	2
	CSM		cm/sec	12	19	2
	docked		cm/sec	308	19	2
	ΔV_K (APS)		cm/sec	308	19	2
	$\dot{m}$ (APS)		lb/sec	11. 32	30	
	K ₁		kg-m/cs	121. 53 140.12	18	NEW REFERENCE TO THIS PCR IS TO BE ADDED.
	K ₂		kg-m/cs	31. 138	18	
	K ₃		kg-m/cs ²	1. 5569	18	
	K ₄		pounds	1050	5, 17	
	V _e (DPS)	DPSVEX	m/sec	2955. 889	29, 30	24
	V _e (APS)	APSVEX	fps	9942	30	25
	F _L		pounds	200 400	17	

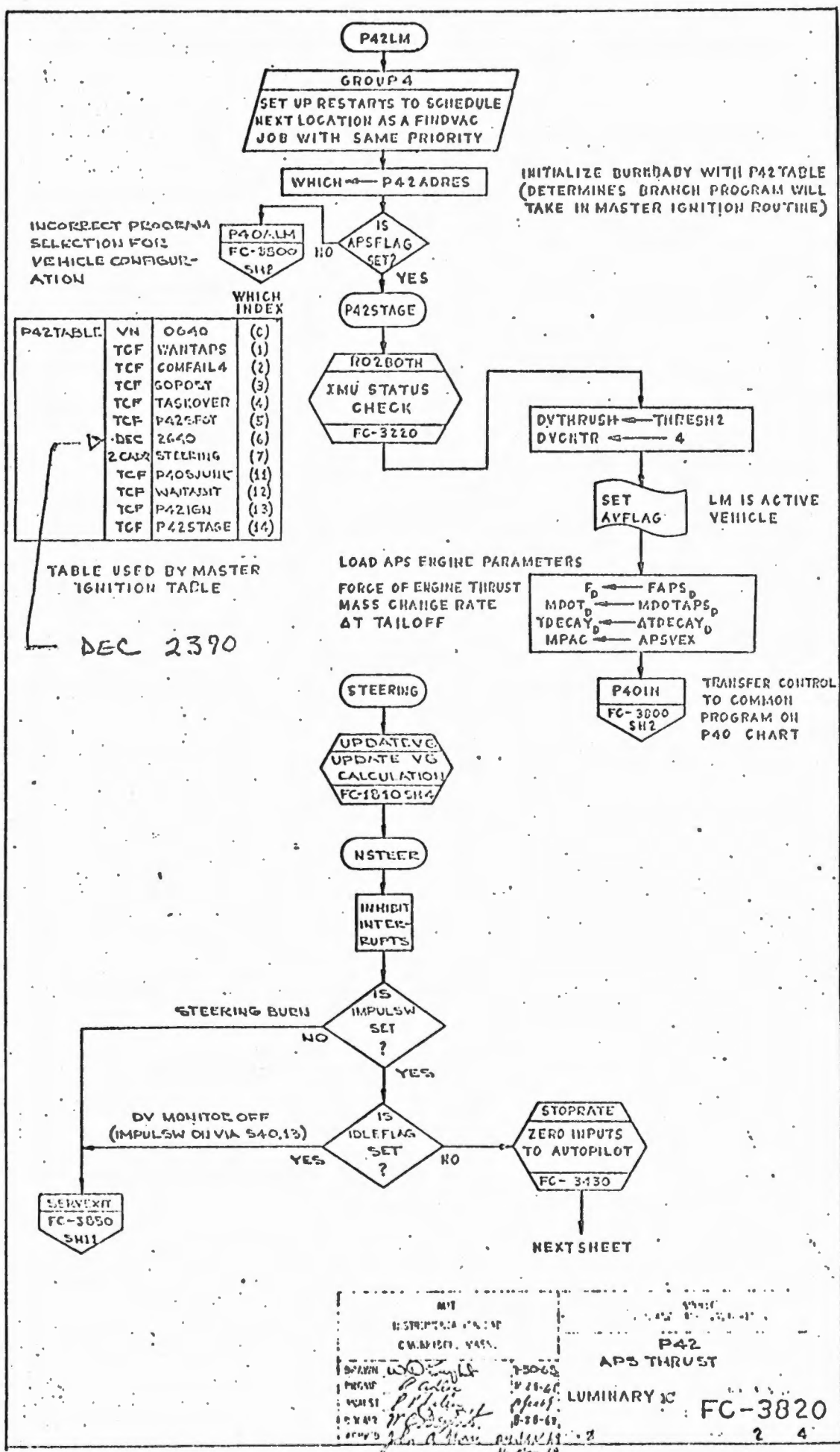
5. 8. 3

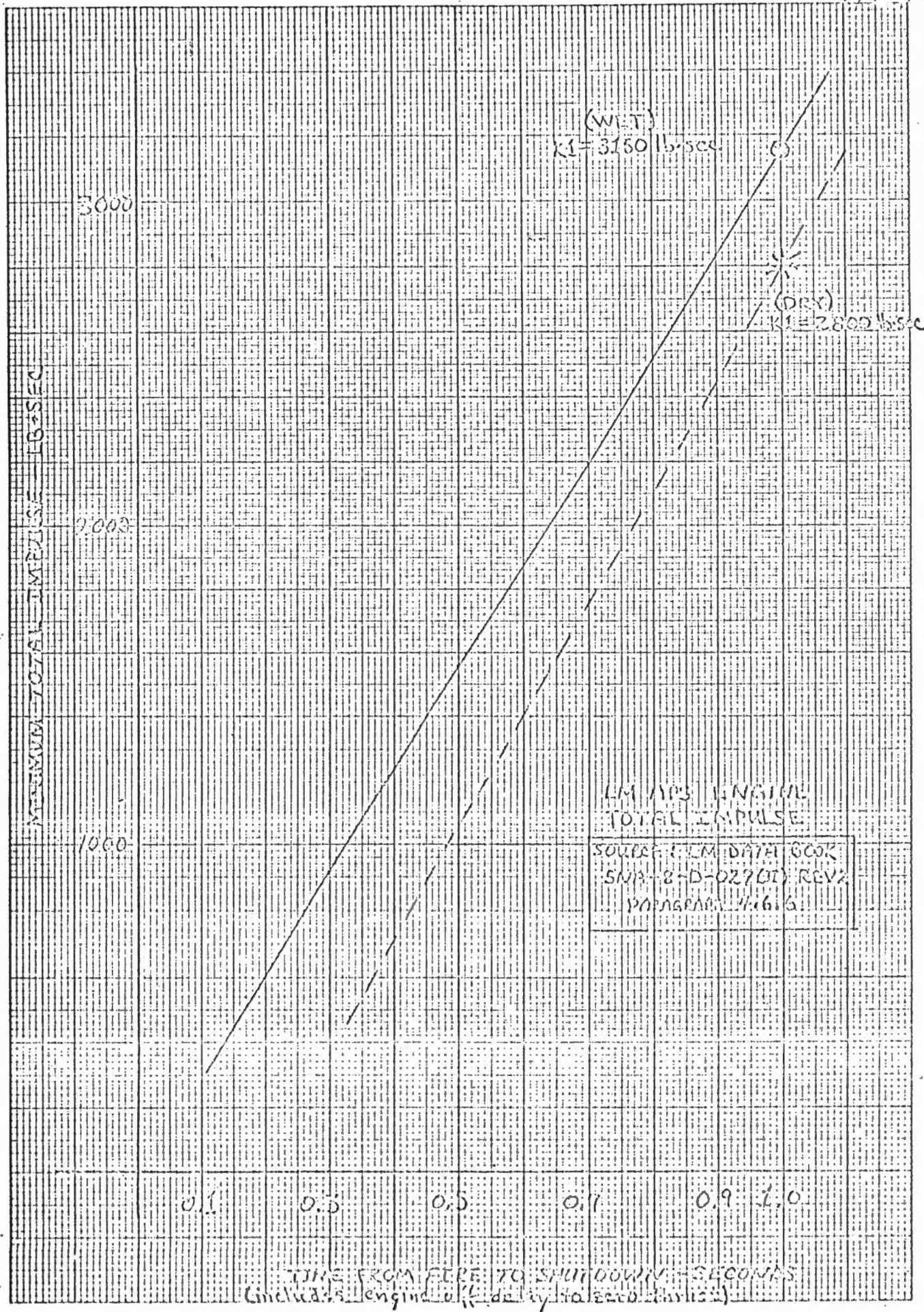
1056
29 11 of 14

1056
12/14



BURN BABY BURN
 (MASTER IGNITION ROUTINE)
 LUMINARY 1C
 FC-3840
 21 25





MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # 1058

ANOMALY # _____

ADR # _____

☐ COLOSSUS 2E	☒ LUMINARY 1D
☐ COLOSSUS 3	☐ LUMINARY 1E
☐ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

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

ACTION: _____

Program Supervisor's Approval: _____

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

ACTION: _____

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

ACTION: _____

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

ACTION: _____

Special InstructionsProject Manager R. H. LarsonDate 8-18-70

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD PROGRAM CHANGE REQUEST

NUMBER (Completed by FSB)

1058

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR EYLES	DATE 7/6/70	1.2 ORGANIZATION MIT	APPROVAL <i>[Signature]</i>	DATE 8-11-70
-------------------------	----------------	-------------------------	--------------------------------	-----------------

1.3 EFFECTIVITY LUMINARY 1D (Apollo 14)	1.4 TITLE OF CHANGE New Landing Analog Displays (R10)
--	--

1.5 REASON(S) FOR CHANGE See attached sheet
--

1.6 DESCRIPTION OF CHANGE See attached sheet

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

2.1 ☐ APPROVED ☐ DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT - 7.5 words	3.4 REMARKS: Will require < 1% additional comp time
3.5 MIT COORDINATOR <i>[Signature]</i>	
DATE 8-11-70	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☒ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DIS-APPROVED	4.2 REMARKS:
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE 8/13/70	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 20

PROGRAM CHANGE
REQUEST NO. 1058

PREPARED BY: EYLES
DATE: July 6, 1970

ORGANIZATION:

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

1.5 Reasons for Change:

- (1) Minimize errors in forward and lateral velocity displayed on the cross-pointers.
- (2) Eliminate the periodic "lurch" in the altitude-rate displayed on the tape meter.
- (3) Correct error and excessive granularity of the forward velocity displayed in R1 of noun 60 (during P66).
- (4) Speed up display of altitude and altitude-rate (display each every 1/4 second instead of every 1/2 second as at present).
- (5) Begin displaying analog data when average-G is turned on instead of waiting for ignition.
- (6) During ascent and aborts, display stable-member Y-axis velocity as "lateral velocity" and zero forward velocity.

1.6 Description of Change:

Incorporate in LUMINARY a new Landing Analog Displays (LAD). New features are (1) the addition of a PIPA bias correction term to the velocity computation which is the starting point of the LAD computations, and (2) a simpler altitude extrapolation:

$$\text{ALTITUDE} = \left(\frac{\text{HDOTLAD} + \text{ALTRATE}}{2} \right) \text{DT} + \text{HCALCLAD}$$

where HDOTLAD and HCALCLAD are altitude-rate and altitude at PIPTIME, DT is time since PIPTIME, and ALTRATE is the current altitude-rate computed by LAD. GSOP change pages for this PCR are attached.

REMARKS

P#21812

PCR 1058
Pg 3 of 20

Word Number

Contents

39-44
(Cont'd)

Flagword Bit
0 3

Meaning

FREEFLAG. Used as a temporary flag to control the internal logic of the following subroutines:

R54 - Used as a counter to control two passes through CHKSB which computes the star data check error. Set to 1 for first pass, set to 0 for second pass. Also used to indicate the response of the astronaut to the star data check display V06N05. Set to 1 if the astronaut performed PROCEED, V33E. Set to 0 if the astronaut performed RECYCLE, V32E.

R51 - Bit interrogated after R54 in P52. If bit is 1, gyro torquing (R55) is accomplished. If bit is 0, gyro torquing is bypassed and V50N25 R1 = 00014 is displayed.

P57 - GRAVITY VECTOR DETERMINATION routine is used to indicate astronaut response to error display. Bit is set to 0 if the astronaut performed PROCEED, and set to 1 if the astronaut performed RECYCLE.

P51 - Bit interrogated after R54. If bit is 1, the new REFSMMAT is computed and stored and the REFSMMAT flag is set. If bit is 0, P51 is started again and V50N25 R1 = 00015 is displayed.

LSPOS - Used as a counter to control two passes through POSITB. Bit is 0 for first pass, 1 for second pass.

0 2 R10FLAG. Bit set to 1 during ascent (in P12, P70, and P71) to indicate that R10 ~~only~~ ^{LATERAL VELOCITY AS INERTIAL CROSS AXIS VELOCITY} outputs data to altitude and altitude rate ~~meters~~ ^{AND ZEROES THE FORWARD VELOCITY.} Bit reset to 0 (initially and during descent) to indicate that R10 outputs data to the Forward and Lateral velocity cross-pointers, in addition to the altitude and altitude rate meters. Bit is checked in R10 (Landing Analog Displays) in order to determine the type of output to display ^{ON CROSS POINTERS.}

0 1 P66PROFL. Set to 1 when P66 is entered for the first time (in R13) as a directive to continue P66 horizontal nulling. It is reset to 0 when the astronaut proceeds on a flashing V06 N60 after touchdown, the 0 specifying a stop to P66 horizontal nulling. It is tested in P66 after horizontal commands have been calculated, but before commands are issued.

1 15 NJETSFLG. Used for thrust determination in P41. Set in R03 (entered via V48) as follows: set to 1 if bit 11 of DAPDATR1 is 0, indicating that 2-jet X translation is specified; set to 0 if bit 11 of DAPDATR1 is 1, indicating 4-jet X translation.

IV DESCENT/ASCENT LIST

PCR 1058
Pg 4 of 20.

Word Number	Contents
1a	I. D. word for this list. Will contain 77773 ₈ .
1b	Sync bits. Will contain 77340 ₈ .
2-4	SPARES. See page 2-70 for definition.
5a	GUIDANCE THRUST COMMAND (FC). The magnitude of the desired DPS thrust computed by the Lunar Landing Guidance Equations. It does not apply to Ascents or Aborts. Calculated once every 2 seconds during landing. Scaled lbs/(2.817 x 2 ¹⁴).
5b	Garbage. This erasable location contains RDOTV and ITCTR, neither of which is calculated during Descent/Ascent.
6	GTCTIME. The LM state vector time (PIPTIME) associated with guidance thrust command. Scaled centiseconds/2 ²⁸ , referenced to the computer clock.
7	MARKTIME. Time of CDUs for LR Velocity Reading when R12 running. Scaled centiseconds/2 ²⁸ , referenced to computer clock.
8	LR RANGE (d.p.). Landing radar slant range. Scaled ft/(1.079 x 2 ²⁸). Always low scale. Calculated every 2 seconds during altitude updates.
9	LR VELOCITY. Velocity along one of the antenna axes (as indicated by VSELECT). Each downlinked sample is the sum of five readings of one component. A different component is read every 2 seconds during LR velocity updates. Scaled (ft/sec)/[(K/5) x 2 ²⁸] where K = -0.6440 for X, K = 1.212 for Y, and K = 0.8668 for Z. This is the scaling for the average of the five readings, i.e., if the telemetered double precision octal fraction is converted to a decimal fraction and multiplied by (K/5) x 2 ²⁸ , the result is one component of the radar measured LM velocity relative to the surface, along the appropriate axis of the antenna coordinate frame as defined in the Lunar Landing Coordinate Systems section of Section 5 of the LUMINARY GSOP.
10, 11a	CDUY, CDUZ, CDUX. The Y, Z and X CDU for LR Range Reading for R12 at LR Range Time. 15-bit fractions scaled degrees/360.
11b	VSELECT. Indicates LR velocity (X, Y, or Z) which has been read. Changes after a different velocity component has been read. An integer. 2 indicates X, 1 indicates Y, 0 indicates Z. DURING DESCENT
12	LATVEL(12a)FORVEL(12b). Lateral and forward velocity. ^{the} orthogonal components of the horizontal velocity of the vehicle with respect to the moon, which are essentially parallel and perpendicular to the X-Z plane of the vehicle (for small pitch and roll angle displacements). ^{It is} scaled, (ft/sec)/(0.5571 x 2 ¹⁴) and is computed and displayed four times per second. DURING ASCENT AND ABORTS, LATERAL VELOCITY IS THE INERTIAL CROSS AXIS VELOCITY AND FORWARD VELOCITY WILL BE SET EQUAL TO ZERO.
13	Same as word 67 on Orbital Maneuvers List.
14	Same as word 14 on Orbital Maneuvers List.

++
+02
+EDIT
+
+02
++

(7) IF A THRUSTING MANEUVER IS PERFORMED WITH THE GUIDANCE CONTROL SWITCH IN PGNS AND THE MODE CONTROL SWITCH IN AUTO THE PGNS WILL CONTROL THE TOTAL VEHICLE ATTITUDE AND GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS AND VEHICLE ATTITUDE RATES (SEE ASSUMPTION (9)) FOR DISPLAY ON THE FCAI. 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.

++
+02
+
+EDIT
+02
++

IF A THRUSTING MANEUVER IS PERFORMED WITH THE GUIDANCE CONTROL SWITCH IN PGNS AND THE MODE CONTROL SWITCH IN ATTITUDE HOLD THE PGNS WILL HOLD THE VEHICLE ATTITUDE AND WILL GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS FOR DISPLAY ON THE FCAI. 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 P12, P40, P41, P42, P63, P70, P71, AND R40 AT MAIN ENGINE IGNITION; WITH THE EXCEPTION OF THESE CASES, MODE SELECTION IS ALWAYS BASED UPON THE LAST ENTRY MADE IN THE DSKY. DURING A THRUSTING MANEUVER IN THE PGNS/ATTITUDE HOLD MODE THE PGNS WILL NOT BE RESPONSIBLE IF REGISTER OVERFLOWS OCCUR WITHIN THE LGC.

(8) CONTROL OF THE LM RCS AND APS IS TRANSFERRED FROM THE PGNS TO THE APURT GUIDANCE SYSTEM (AGS) BY PLACING THE GUID CONT SWITCH FROM PGNS TO AGS.

THE AGS WILL BE CAPABLE OF TAKING OVER CONTROL OF THE LM DURING ANY PORTION OF THE LUNAR ASCENT, THE AGS WILL GUIDE THE LM TO A SAFE CREIT.

THE AGS MAY BE INITIALIZED BY THE LGC AT ANY TIME BY MANUAL SELECTION OF THE AGS INITIALIZATION ROUTINE (R47), AND SHOULD HAVE BEEN PERFORMED PRIOR TO SELECTION OF P12.

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

++
+02
+EDIT
+
+
+
+02
++

(9) THE PGNS CAN GENERATE TWO TYPES OF ATTITUDE ERRORS FOR DISPLAY ON THE FCAI:

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

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

PGNS-DERIVED VEHICLE ATTITUDE RATES MAY ALSO BE DISPLAYED VIA SELECTION BY EXTENDED VERB 60.

MODE II ATTITUDE ERROR DISPLAYS ARE AUTOMATICALLY SELECTED AT THE BEGINNING OF R60. WITH THE EXCEPTIONS INDICATED IN ASSUMPTION (7) ABOVE, DISPLAY SELECTION IS ALWAYS BASED UPON THE LAST ENTRY MADE IN THE DSKY. FOR A MORE DETAILED DESCRIPTION OF THESE DISPLAYS REFER TO SECTION 3 OF R567, PARA. 3.2.6.

(10) THE RENDEZVOUS RADAR (RR) WAS ENERGIZED AND CHECKED OUT PRIOR TO SELECTION OF THIS PROGRAM.

(11) THE LANDING ANALOG DISPLAYS ROUTINE (R10) IS ENABLED AT TIG, HOWEVER THE USE OF THE PR CDUS IS INHIBITED BY THIS PROGRAM. ~~THE POWERED FLIGHT DESIGNATE ROUTINE (R29) IS ENABLED AFTER P12 IS SELECTED. R10 AND R29 ARE TERMINATED UPON TERMINATION OF AVERAGE G. DURING THIS MODE ALTITUDE-RATE AND ALTITUDE ARE DISPLAYED ON THE TAPE METERS AND INERTIAL CROSSRANGE VELOCITY ON THE CROSS POINTERS.~~

(12) EITHER THE LCAO DAP DATA ROUTINE (R03) OR THE LANDING CONFIRMATION PROGRAM (P68) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM.

(13) 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 RESTARTS ARE INVOLVED, THE ACCOUNTING OF THIS TOTAL TIME DELAY IS UP TO THE CREW.

(14) THE ASTRONAUT MAY MONITOR THE FOLLOWING ADDITIONAL PARAMETERS DURING THIS PROGRAM BY KEYING IN V16N77E:

V16N77
K1-TG
K2-V(Y)
K3-ELANK

WHERE:

PCR 1058
Pg 5 of 20

THE PGNC'S COMMANDED SETTING.

THIS PROGRAM ASSUMES THE THROTTLE CONTROL TO BE IN "AUTO" (THE DPS RECEIVES THE SUM OF THE MANUAL AND PGNC'S COMMANDED SETTINGS) AND THE MANUAL THROTTLE TO BE SET AT MINIMUM FOR "ZOOMTIME" SECONDS OF THRUSTING, AND THEREAFTER AT A LEVEL LESS THAN THAT REQUIRED BY THE LGC. THE VALUE "ZOOMTIME" IS IN ERASABLE STORAGE, HAVING BEEN LOADED PRIOR TO LAUNCH OR BY P27.

++
+03
+EDIT
++
DUE TO THE REGION OF FORBIDDEN THROTTLING, THRUST COMMAND LOGIC IN CONJUNCTION WITH THE INTERIM TERMINAL CONDITIONS (SEE ASSUMPTION (8)) ASSURE THAT THE COMMANDED THROTTLE REMAINS AT MAXIMUM UNTIL THE GUIDANCE EQUATIONS FIRST REQUIRE IT TO BE WITHIN THE ALLOWABLE THROTTLE RANGE. THEREAFTER IT SHOULD REMAIN WITHIN THE ALLOWABLE THROTTLE RANGE. THIS PRINCIPLE IS DESCRIBED IN MORE DETAIL IN SECTION 5.3.4 OF R567. THE RESULT IS A SMOOTH AND EFFICIENT THRUST ATTITUDE PROFILE THROUGHOUT THE BRAKING PHASE.

FURTHERMORE THE DPS MUST BE STARTED IN THE FOLLOWING SEQUENCE: +X AXIS 2 JET ULLAGE FOR 7.5 SEC; IGNITION AT MINIMUM THROTTLE; ULLAGE OFF 0.5 SECONDS AFTER IGNITION; MINIMUM THRUST UNTIL TIG (AS DEFINED BY R41) + "ZOOMTIME"; AND THEN MAXIMUM THROTTLE. THE THROTTLE SETTING THEN BECOMES CONTROLLED BY THE GUIDANCE EQUATIONS.

++
+03
+285
+03
++
(11) DURING THE POWERED LANDING MANEUVER, THE LGC WILL MONITOR THE PRESENCE OR ABSENCE OF THE "NON-ATTITUDE HOLD" DISCRETE. THIS DISCRETE IS ISSUED TO THE LGC WHEN THE ATTITUDE MODE CONTROL SWITCH IS IN THE AUTO POSITION.

SHOULD THIS DISCRETE APPEAR DURING THE POWERED LANDING MANEUVER, THE LGC ASSUMES THAT IT NO LONGER HAS COMPLETE AUTOMATIC CONTROL OF THE MANEUVER.

THE MONITOR AND THE ASSOCIATED LGC LOGIC IS INCLUDED IN THE LANDING AUTO MODES MONITOR ROUTINE (R13) WHICH WILL BE CALLED BY THIS PROGRAM.

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

THE X-AXIS OVERRIDE OPTION IS AVAILABLE TO THE CREW (UNTIL THE ESTIMATED ALTITUDE IS BELOW 30,000 FEET), HOWEVER IT SHOULD NOT BE EXERCISED WHEN THE LGC IS SPECIFYING A DESIRED YAW ATTITUDE, I.E.: DURING THE ATTITUDE MANEUVER TO THE THRUSTING ATTITUDE (SEE R60). THE OPTION IS INHIBITED BY THIS PROGRAM FROM MIDWAY IN THE PROGRAM (SEE ASSUMPTION (13) BELOW) TO THE END.

(13) THE LGC SPECIFIES LM ATTITUDE DURING THE POWERED LANDING MANEUVER BASED UPON THE REQUIREMENTS OF THRUST VECTOR CONTROL, LANDING SITE VISIBILITY, AND LR ORIENTATION. AFTER DPS IGNITION, THRUST VECTOR CONTROL IS REQUIRED THROUGH THE REMAINDER OF THIS PROGRAM. THE LANDING SITE BECOMES VISIBLE AT THE BEGINNING OF THE APPROACH PHASE.

THRUST VECTOR CONTROL DOES NOT CONSTRAIN THE LM ORIENTATION ABOUT THE THRUST AXIS (YAW ATTITUDE). ROTATION ABOUT THE LM Y AND LM Z AXES IS USED TO POINT THE MEASURED THRUST VECTOR ALONG THE DESIRED THRUST VECTOR.

++
+03
+EDIT
++
THE FIRST RESTRAINT UPON THE LM YAW ATTITUDE TO OCCUR IS THAT OF LR ORIENTATION. THE LGC WILL NOT ATTEMPT TO USE LR DATA UNTIL THE LGC ESTIMATION OF ALTITUDE IS 30,000 FT.. AUTOMATIC X-AXIS OVERRIDE LOCKOUT (DONE BY R12) AND YAW ATTITUDE SPECIFICATION BY THE LGC WILL NOT OCCUR UNTIL THE LGC ESTIMATED ALTITUDE IS 30,000 FT.. BEFORE THIS TIME, THE ASTRONAUT MUST MANEUVER TO A ROUGHLY-WIND-UP YAW ORIENTATION TO PREVENT SUBSEQUENT LOSS OF S-BAND LOCK-ON. THE LGC WILL THEN COMMAND THE VEHICLE TO THE LGC-SPECIFIED YAW ATTITUDE.

SUBSEQUENT TO X-AXIS OVERRIDE LOCKOUT, CONTROL OF THE VEHICLE ABOUT THE LM X AXIS IS GOVERNED BY LR ORIENTATION REQUIREMENTS DURING THIS PROGRAM. THE LANDING SITE BECOMES VISIBLE TO THE COMMAND PILOT IF THE LOOK ANGLE (THE ANGLE BETWEEN THE LM -X AXIS AND THE LOS TO THE LANDING SITE) IS GREATER THAN 25 DEGREES AND THE LOS IS IN OR NEAR THE LM X/Z PLANE.

AT ANY TIME DURING P63, P64 OR P65, THE MAGNITUDE OF THE LOOK ANGLE AND THE ORIENTATION OF THE LOOK ANGLE PLANE (THAT PLANE CONTAINING THE LOS AND THE LM X AXIS) ARE DEFINED BY THE INERTIAL ORIENTATION OF THE LM X AXIS AND THE POSITION OF THE LM WITH RESPECT TO THE LANDING SITE.

(14) THE CREW HAS THE CAPABILITY TO DISPLAY LGC CALCULATED VALUES OF FORWARD VELOCITY, LATERAL VELOCITY, ALTITUDE AND ALTITUDE RATE ON CERTAIN LM METERS DURING THIS PROGRAM. THE CALCULATION OF THESE PARAMETERS IS UNDER THE CONTROL OF THE LANDING ANALOG DISPLAYS ROUTINE (R10) WHICH IS ENABLED ~~AT 0.5 SECONDS~~ WHEN AVERAGE G IS TURNED ON.

(15) THE RATE OF DESCENT (ROD) MODE IS NOT ENABLED DURING THIS PROGRAM (SEE LANDING (ROD) PROGRAM (P65), ASSUMPTION 12 FOR DEFINITION OF ROD MODE).

(16) AN ABORT FROM THE LUNAR DESCENT MAY BE REQUIRED AT ANY TIME DURING THE DESCENT ORBIT INJECTION, THE DESCENT CCAST, OR THE POWERED DESCENT (P63), (P64), (P65), OR (P66).

Pg 6 of 20

WAIT UNTIL TIG -30
SEC.

RETURN V06N62
DISPLAYS

MONITOR CSKY:
AT TFI = -00329
OBSERVE RETURN OF
V06N62 DISPLAYS TO
INDICATE THAT
AVERAGE G INTEGRA-
TION HAS STARTED.

START AVERAGE G
INTEGRATION (NOTE:
THE R10/R11/R12
SERVICE ROUTINE
(R09) AND THE DE-
SCENT STATE VECTOR
UPDATE ROUTINE (R12)
WILL BE CALLED ONCE
EVERY 2 SECONDS BY
AVERAGE G DURING
P63, P64, P65 AND
P66. ~~WHENEVER~~ THE
OPERATION OF ~~R09~~
AND R11 IS NOT
ENABLED UNTIL
IGNITION.

R10 ALSO BEGINS
IMMEDIATELY.

++
+03
+285
++

#840

#850

#860

#870

#880

PCR 1058
Ry 7920

569
P63/LUMINARY

47
SET, ABORT ENABLE
FLAG

#1190

SET LANDING ANALOG
DISPLAYS FLAG

#1200

++
+03
+EDIT
++

RESET IDLE FLAG

#1210

IS IMPLUSE FLAG SET?
(NOTE: ANSWER WILL
ALWAYS BE NO FOR
P63)

#1220

RESET IGNITION FLAG

#1230

RESET ASTRONAUT FLAG

CALL FOR RESET OF
ULLAGE FLAG

#1240

P63/LUMINARY

PCR 1058
Pg 8 of 20

523

DPS ABORT PROGRAM (P7C)

REV 02 12/03/69

++
 PURPOSE: (1) TO CONTROL A PGNC'S CONTROLLED DPS ABORT FROM THE POWERED LANDING MANEUVER (P63, 64, 65, OR 66) WHEN REQUIRED.
 +02 (SEE ASSUMPTION (1)).
 +285
 ++

++
 ASSUMPTIONS: (1) THIS PROGRAM WILL CONTROL A DPS ABORT IN ONE OF TWO WAYS:

(A) IF THE ALTITUDE IS GREATER THAN 25,000 FT, THIS PROGRAM WILL COMMAND MAXIMUM DPS THROTTLE, CONTINUE DPS THRUSTING, PERFORM AN ATTITUDE MANEUVER (USING THE RCS) TO THE CORRECT ATTITUDE TO CONTINUE THE ABORT ASCENT, AND COMPLETE THE ABORT ASCENT TO INSERT THE LM ON AN ABORT ORBIT.

(B) IF THE ALTITUDE IS LESS THAN 25,000 FT, THIS PROGRAM WILL COMMAND MAXIMUM DPS THROTTLE AND ENTER A VERTICAL RISE PHASE WHICH WILL TERMINATE EITHER WHEN THE LM ALTITUDE EXCEEDS 25,000 FT. OR WHEN THE LM VERTICAL VELOCITY IS GREATER THAN 40 FT/SEC.

DURING THE VERTICAL RISE PHASE, THE VEHICLE IS MANEUVERED TO ALIGN THE LM +X AXIS WITH THE LOCAL VERTICAL (USING THE RCS), AND THE LM +Y AXIS NORMAL TO THE ANTICIPATED PITCH MANEUVER PLANE. THE PROGRAM WILL THEN PITCH THE LM TO THE CORRECT ATTITUDE FOR ASCENT, AND COMPLETE THE ABORT ASCENT TO INSERT THE LM ON AN ABORT ORBIT.

++
 +02 (2) THE ABORT ORBIT IS DEFINED IN SECTION 5.4.3 OF R567.
 +285
 +EDIT
 +02
 ++

(3) THE LM IS ON THE POWERED LANDING DESCENT SOMEWHERE BETWEEN DPS IGNITION FOR THE MANEUVER (P63) AND DPS SHUTDOWN ON THE LUNAR SURFACE (P65 OR P66).

(4) THE CSM IS IN A NEAR CIRCULAR ORBIT AROUND THE MOON AT A NOMINAL ALTITUDE OF 60 NAUTICAL MILES. THE CSM IS MAINTAINING A PREFERRED TRACKING ATTITUDE FOR OPTICAL TRACKING OF AND RR TRACKING BY THE LM.

(5) THE INL IS ON AND ACCURATELY ALIGNED TO THE LANDING ORIENTATION. THE MOST RECENT IMU ALIGNMENT (FINE) TOOK PLACE DURING THE BRAKING PHASE PROGRAM (P63) PRIOR TO DPS IGNITION.

(6) THE LANDING RADAR (LR) IS ON AND WAS CHECKED OUT WHEN IN POSITION #1. THE LGC/LR OPERATION IS UNDER THE CONTROL OF THE DESCENT STATE VECTOR UPDATE ROUTINE (R12).

(7) THE RENDEZVOUS RADAR (RR) WAS ENERGIZED AND CHECKED OUT PRIOR TO SELECTION OF THIS PROGRAM.

(8) THE LANDING ANALOG DISPLAYS ROUTINE (R10) IS ENABLED UPON ENTRY TO THIS PROGRAM, HAVING BEEN ENABLED BY P63. ~~R10 USE OF RR GDS IS INHIBITED BY THIS PROGRAM. R10 IS TERMINATED UPON TERMINATION OF AVERAGE G. DURING THIS MODE ALTITUDE-RATE AND ALTITUDE ARE DISPLAYED ON THE TAPE METERS AND INERTIAL CROSS RANGE VELOCITY ON THE CROSS POINTERS.~~

(9) THE DPS IS NOT THROTTLEABLE OVER THE WHOLE RANGE FROM ZERO TO MAXIMUM. IT MUST BE OPERATED EITHER AT MAXIMUM THROTTLE OR OVER A SPECIFIC THROTTLE RANGE OF LOWER SETTINGS. THESE THROTTLE SETTINGS ARE SPECIFIED IN SECTION 5 OF R567 AND ARE TOTAL THROTTLE SETTINGS, I.E.: THE SUM OF THE MANUAL SETTING (WHOSE MINIMUM IS 10 PERCENT) AND THE PGNC'S COMMANDED SETTING.

THIS PROGRAM ASSUMES THE THROTTLE CONTROL TO BE IN AUTO (THE DPS RECEIVES THE SUM OF THE MANUAL AND PGNC'S COMMANDED SETTINGS) AND THE MANUAL THROTTLE TO BE SET AT A LEVEL LESS THAN THAT REQUIRED BY THE LGC. THE LGC WILL COMMAND MAXIMUM THROTTLE FOR ALL DPS THRUSTING CONTROLLED BY THIS PROGRAM.

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

THE X-AXIS OVERRIDE OPTION IS ALWAYS AVAILABLE TO THE CREW EXCEPT WHEN THE LGC IS SPECIFYING A DESIRED YAW

P70/LUMINARY

PCR 1058
 89920

APS ABORT PROGRAM (P71)

REV 02 12/03/69

PURPOSE:

(1) TO CONTROL A PGNS CONTROLLED APS ABORT FROM THE POWERED LANDING MANEUVER (P63, 64, 65, OR 66) OR A DPS ABORT (P70) WHEN REQUIRED (SEE ASSUMPTION (1)).

++
+C2

+285

ASSUMPTIONS:

(1) THE PROGRAM WILL CONTROL AN APS ABORT IN ONE OF TWO WAYS:

++

(A) IF THE ALTITUDE IS GREATER THAN 25,000 FT, THIS PROGRAM WILL IGNITE THE APS, CONTINUE APS THRUSTING, PERFORM AN ATTITUDE MANEUVER (USING THE RCS) TO THE CORRECT ATTITUDE TO CONTINUE THE ABORT ASCENT, AND COMPLETE THE ABORT ASCENT TO INSERT THE LM ON AN ABORT ORBIT.

(B) IF THE ALTITUDE IS LESS THAN 25,000 FT, THIS PROGRAM WILL IGNITE THE APS, CONTINUE APS THRUSTING, ENTER A VERTICAL RISE PHASE WHICH WILL TERMINATE EITHER WHEN THE LM ALTITUDE EXCEEDS 25,000 FT. OR WHEN THE LM VERTICAL VELOCITY IS GREATER THAN 40 FT/SEC. DURING THE VERTICAL RISE PHASE THE VEHICLE IS MANEUVERED IN ORDER TO ALIGN THE LM +X AXIS WITH THE LOCAL VERTICAL (USING THE RCS) AND THE LM +Y AXIS NORMAL TO THE ANTICIPATED PITCH MANEUVER PLANE. THE PROGRAM WILL THEN PITCH THE LM TO THE CORRECT ATTITUDE FOR ASCENT, AND THEN COMPLETE THE ABORT ASCENT TO INSERT THE LM ON AN ABORT ORBIT.

++

+02

+EDIT

++

(2) THIS PROGRAM DOES NOT CHECK TO SEE IF THE DPS HAS BEEN STAGED. THIS IF P71 IS SELECTED VIA V37 AND THE DESCENT STAGE HAS NOT BEEN MANUALLY STAGED THIS PROGRAM MAY COMMAND ENGINE ON (ASSUMPTION 1A OR 1B ABOVE). IN SUCH CASES THE COMMAND WILL GO TO THE DPS.

++

+02

+EDIT

++

(3) THE ABORT CREDIT IS DEFINED IN SECTION 5.4.3 OF R567.

(4) THE CSM IS IN A NEAR CIRCULAR ORBIT AROUND THE MOON AT A NOMINAL ALTITUDE OF 60 NAUTICAL MILES. THE CSM IS MAINTAINING A PREFERRED TRACKING ATTITUDE FOR OPTICAL TRACKING OF AND RR TRACKING BY THE LM.

(5) THE IMU IS ON AND ACCURATELY ALIGNED TO THE LANDING SITE ORIENTATION. THE MOST RECENT IMU ALIGNMENT (FINE) TOOK PLACE DURING THE BRAKING PHASE PROGRAM (P63) PRIOR TO DPS IGNITION.

(6) THE LANDING RADAR (LR) IS ON AND WAS CHECKED OUT WHEN IN POSITION #1. THE LGC/LR OPERATION IS UNDER THE CONTROL OF THE DESCENT STATE VECTOR UPDATE ROUTINE (R12).

(7) THE RENDEZVOUS RADAR (RR) WAS ENERGIZED AND CHECKED OUT PRIOR TO SELECTION OF THIS PROGRAM.

(8) THE LANDING ANALOG DISPLAYS ROUTINE (R10) IS ENABLED UPON ENTRY TO THIS PROGRAM, HAVING BEEN ENABLED BY P63. ~~R10 USE OF THE RR CUS IS INHIBITED BY THIS PROGRAM. R10 IS TERMINATED UPON TERMINATION OF AVERAGE G. DURING THIS MODE ALTITUDE-RATE AND ALTITUDE ARE DISPLAYED ON THE TFE METERS AND INERTIAL CROSSRANGE VELOCITY ON THE CROSS POINTERS.~~

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

THE X-AXIS OVERRIDE OPTION IS ALWAYS AVAILABLE TO THE CREW EXCEPT WHEN THE LGC IS SPECIFYING A DESIRED YAW ATTITUDE. THIS THE OPTION IS INHIBITED BY THIS PROGRAM ONLY IN THE CASE OF ASSUMPTION (1) (B) ABOVE, UNTIL THE COMPLETION OF THE PITCH MANEUVER TO THE ATTITUDE FOR THE ASCENT MANEUVER.

(10) IF A THRUSTING MANEUVER IS PERFORMED WITH THE GUIDANCE CONTROL SWITCH IN PGNS AND THE MODE CONTROL SWITCH IN AUTO, THE PGNS WILL CONTROL THE TOTAL VEHICLE ATTITUDE AND GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS

P71/LUMINARY

PCP 1038
P 10 of 20

LANDING ANALOG DISPLAYS ROUTINE (R10)

REV 03 12/03/69

PURPOSE:

(1) TO MONITOR THE "DISPLAY INERTIAL DATA" DISCRETE THE ABSENCE OF WHICH INDICATES THE CREW HAS SELECTED FOR DISPLAY ON THE LM METERS ONE OR MORE OF THE LGC-CALCULATED DISPLAY PARAMETERS. THESE PARAMETERS ARE:

(A) FORWARD VELOCITY - SEE SECTION 5 OF R567 FOR DEFINITION.

(B) LATERAL VELOCITY - SEE SECTION 5 OF R567 FOR DEFINITION.

(C) ALTITUDE - THE PRESENT ALTITUDE OF THE LM ABOVE THE LUNAR SURFACE AT THE DESIGNATED LANDING SITE, AS MODIFIED BY THE TERRAIN MODEL.

(D) ALTITUDE RATE - THE PRESENT RATE OF CHANGE OF ALTITUDE ((C) ABOVE).

(2) TO CALCULATE THESE DISPLAY PARAMETERS AND TRANSMIT THEM TO THE LM METERS WHEN THE "DISPLAY INERTIAL DATA" DISCRETE IS NOT PRESENT.

ASSUMPTIONS:

(1) THIS ROUTINE IS AUTOMATICALLY CALLED EVERY .25 SECONDS BY THE ABORT DISCRETES MONITOR ROUTINE (R11), BUT ONLY DURING P12, P13, P14, P15, P16, P17, OR P18. HOWEVER, THE ROUTINE WILL BE INHIBITED FROM USING THE RANGES (FORWARD AND LATERAL VELOCITY CROSSPOINTER) DURING P12, P17, OR P18. THUS ONLY ALTITUDE AND ALTITUDE RATE (LAPE METERS) WILL BE DISPLAYED DURING P12, P17, OR P18. DURING P12, P17 AND P18 FORWARD VELOCITY IS ~~SET TO~~ ZERO AND LATERAL VELOCITY IS INERTIAL VELOCITY IN THE CROSSRANGE AXIS SET TO

PROG
CCNT

LGC

GROUND

CREW

• LGC
• ROUTINE
• SELECTION

START LANDING ANALOG
DISPLAYS ROUTINE
(R10)

•
•
•
•
•
•
•

IS THE LANDING
ANALOG DISPLAYS FLAG.

#10

#20

R10/LUMINARY.

PCR 1058
Pg 11 of 20

SET?

.N

.Y

UPDATE VELOCITY
VECTOR TO CURRENT TIME

CALCULATE ALTITUDE
AND
ALTITUDE - RATE

IS THE "DISPLAY
INERTIAL DATA"
DISCRETE PRESENT?

.Y

.N

IS DID FLAG SET?

.N

.Y

SET DID FLAG.

DO I WISH THE LGC TO
COMPUTE THE LANDING
ANALOG DISPLAYS?

.Y

.N

SET THE "MODE
SEL" SWITCH TO
"PGNS"

SET THE "MODE
SEL" SWITCH TO
"AGS" OR "LDG
RADAR"

EXIT
R10

#30

#40

#50

#60

#70

PCR 1058
Pg 12 of 20

871
RIO/LUMINARY

SET PARAMETER
PCINTER TO
ALTRATE.

IS REC FLAG
SET

SEND DISPLAY
INERTIAL DATA
DISCRETE TO
THE RR COUS

PERFORM INIT-
IALIZATION FOR
FIRST DISPLAY
OF DATA.

ENABLE RR ERROR
COUNTER

SET INERTIAL
DATA DISCRETE

#80

#90

#100

#110

#120

RIO/LUMINARY

PCR 1058
Pg 13 of 20

FLAG.

TRANSMIT
ALTITUDE RATE

EXIT
R10

PAUSE .120 SEC.

TRANSMIT ALTITUDE

UPDATE VELOCITY
VELOCITY TO CURRENT
TIME 0

IS THE RIC FLAG
SET?

Y N.
FORWARD
VELOCITY = 0

CALCULATE FOR-
WARD VELOCITY
AND LATERAL
VELOCITY.

CALCULATE
ASCENT
CROSS POINTER
DISPLAY

TRANSMIT FOR-
WARD VELOCITY
AND LATERAL
VELOCITY TO

IS THE LM ON THE
DESCENT TRAJECTORY?

Y N.

OBSERVE FORWARD
VELOCITY AND LAT-
ERAL VELOCITY
CROSS POINTERS

#130

#140

#150

#160

#170

PCR 1058
Pg 14 of 20

CCUS.

WHICH WILL BE
UPDATED 4 TIMES
PER SECCND.

CHECK PARAMETER
PUNTER.

ALT. RATE

SET PARAMETER
PUNTER TO ALT.

CALCULATE
ALTITUDE RATE.

SET PARAMETER
PUNTER TO ALT
RATE

CALCULATE
ALTITUDE

TRANSMIT ALTITUDE
OR ALTITUDE RATE
PARAMETER DATA
MESSAGE

OBSERVE ALTITUDE AND
ALTITUDE RATE ON
TAPE METERS WHICH
WILL BE UPDATED

#180

#190

#200

#210

PCR 1058
Pg 15 of 20

CALCULATED
DIRECTLY TO LM
METERS.

TIMES PER SECOND.

#220

EXIT
R10

#230

IS PID FLAG SET?

#240

IS INERTIAL DATA
DISCRETE FLAG SET?

.N Y.

DISABLE RR
ERRCK COUNTER

#250

REMOVE DISPLAY
INERTIAL DATA
DISCRETE FROM THE
RR COLS.

#260

RESET INERTIAL
DATA DISCRETE FLAG.

721

SET PARAMETER
TER C ALTCATE

RESET DID FLAG

EXIT
R10

CHANGE CCTRCL NGTES

LOGIC REV 01 PCR 475, 499, 617
REV 02 EDITORIAL
REV 03 (LUM IC) PCR 285

875
R10/LUMINARY

#270

#280

R10/LUMINARY

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Analog Display Parameters

The LGC is required to drive four analog displays in all landing-maneuver phases, if selected to do so by the astronaut. The various analog-display quantities are the following:

- 1.) h : Altitude
 The estimated local altitude of the vehicle as derived from the difference between the current position vector ($\underline{r}_P$) and the landing-site radius magnitude (r_{LS}). The LGC drives a digital tape meter with altitude scaled at 2,345 feet/bit over a range of 0-60,000 feet.
 AS MODIFIED BY THE A-PRIORI TERRAIN MODEL.
- 2.) v_V : Altitude Rate
 The component of the vehicle's velocity that lies along the local-vertical direction ($\underline{u}_{hP}$). The LGC drives a digital tape meter with this parameter scaled at 0.5 ft/sec per bit over a range of ± 500 ft/sec.
- 3.) v_{HF} , v_{HL} : Forward and Lateral Velocity
 Orthogonal components of the horizontal velocity of the vehicle with respect to the moon, which are essentially parallel and perpendicular to the X - Z plane of the vehicle (for small pitch and roll angle displacements). The coordinates and display requirements for these velocity components are defined in ICD LIS-540-10001. The scaling of these components is for a range of ± 200 ft/sec.

The altitude (h) and altitude rate (v_V) are computed and displayed two times/second, alternating them every 0.25-second, and forward and lateral velocity (v_{HF} and v_{HL}) are computed and displayed four times/second.

The displays are kept up-to-date by reading the PIPA-output data at certain special intermediate times (t_i). The vehicle's velocity with respect to the moon at these intermediate times ($\underline{v}_{MP_i}$) is computed from the relations:

$$\underline{v}_{MP_i} = \underline{v}_{MP_{n-1}} + \left(\underline{g}_{P_{n-1}} (t_i - t_{n-1}) + (\Delta \tilde{\underline{v}}_{P_i} + \Delta \tilde{\underline{v}}_{P_{n-1}}) - \underline{V}_{SURF} \right) \quad (t_n \leq t_i < t_j)$$

$$\underline{v}_{MP_i} = \underline{v}_{MP_n} + \left(\underline{g}_{P_n} (t_i - t_n) + (\Delta \tilde{\underline{v}}_{P_i}) - \underline{V}_{SURF} \right) \quad (t_j \leq t_i < t_{n+1})$$

(3.4.8.1)

where the subscript i refers to the display-computation time, the subscript n refers to the normal PIPA-output processing time, and the subscript j refers to the actual time that the cycle through the State-Vector-Update Routine is completed. $\underline{V}_{SURF}$ IS THE VELOCITY OF THE LUNAR SURFACE COMPUTED IN THE STATE VECTOR-UPDATE ROUTINE

Two different relations are required because the computations of velocity ($\underline{v}_{MP}$) and gravitational acceleration ($\underline{g}_P$) for time t_n are not completed until a later time t_j (greater than t_n). The PIPA-output registers, however, are read and then set to zero at the normal PIPA-output processing time (t_n). For this reason, it is necessary to save and use the preceding-cycle PIPA-output data $\Delta \tilde{\underline{v}}_{P_{n-1}}$ until the cycle through the State-Vector-Update Routine is completed (t_j), as shown in the first of the preceding two relations.

The vertical velocity displayed at the intermediate time (t_i), i.e., v_{V_i} is given by the relations*:

$$v_{V_i} = \underline{v}_{MP_i} \cdot \underline{u}_{hP_{n-1}} + v_{HOR_{n-1}} (t_i - t_{n-1}) \quad (t_n < t_i < t_j)$$

$$v_{V_i} = \underline{v}_{MP_i} \cdot \underline{u}_{hP_n} + v_{HOR_n} (t_i - t_n) \quad (t_j \leq t_i < t_{n+1})$$

(3.4.8.2)

where the subscripts i, j, and n refer to the times mentioned earlier in this section. It should be noted here that the local-vertical unit vectors ($\underline{u}_{hP_n}$ and $\underline{u}_{hP_{n-1}}$) correspond to the normal PIPA-processing times (t_n and t_{n-1}). For this reason, a correction term shown above is required to account for vehicle motion (and

* v_{HOR} is computed in the State-Vector-Update Routine

rotation of $\underline{u}_{HP}$ during the interval from the PIPA-processing time (t_n or t_{n-1}) to the display time (t_i).

The vehicle altitude displayed at intermediate times is given by the relations:

$$h_i = h_{n-1} + \frac{v_{V_i} + v_{V_{n-1}}}{2} (t_i - t_{n-1}) \quad (t_n \leq t_i < t_j)$$

$$h_i = h_n + \frac{v_{V_i} + v_{V_n}}{2} (t_i - t_n) \quad (t_j \leq t_i < t_{n+1})$$

(3.4.8.3)

where the altitude (h_n or h_{n-1}) and vertical velocity (v_{V_n} or $v_{V_{n-1}}$) are from the State-Vector-Update-Routine.

The forward and lateral velocity components (v_{HF} and v_{HL}) are computed from the same equations shown in the State-Vector-Update Routine, except that the intermediate time horizontal velocity ($\underline{v}_{MP_i}$) is used in place of that for the normal PIPA-output processing time ($\underline{v}_{MP}$ or $\underline{v}_{MP_n}$). For convenience, these relations are repeated below.

$$\underline{v}_{HZ_i} = \underline{v}_{MP_i} \cdot \underline{u}_{HZP}$$

$$\underline{v}_{HY_i} = \underline{v}_{MP_i} \cdot \underline{u}_{HYP}$$

$$\underline{v}_{HF_i} = \underline{v}_{HZ_i} \cos AOG_i - \underline{v}_{HY_i} \sin AOG_i$$

$$\underline{v}_{HL_i} = \underline{v}_{HZ_i} \sin AOG_i + \underline{v}_{HY_i} \cos AOG_i$$

where the subscript i is used to indicate quantities determined for the display times (t_i). The unit vector $\underline{u}_{HZP}$ is for the PIPA-processing time. The angle AOG is the stable member outer gimbal angle.

ANALOG DISPLAYS ARE POSTED DURING ASCENT (PI2, P70, P71) AS WELL. IN THIS CASE FORWARD VELOCITY IS ALWAYS DISPLAYED AS ZERO AND LATERAL VELOCITY IS V_{MPL} - IN OTHER WORDS INERTIAL CROSS RANGE VELOCITY.

MIT/IL PROGRAM CHANGE ROUTING SLIP

PCR/PCN #

ANOMALY # 1-10-01

☒ COLOSSUS 2C
☐ COLOSSUS 2D
☐ COLOSSUS 2E
☐ COLOSSUS 2F

☐ LUMINARY 1B
☒ LUMINARY 1C
☐ LUMINARY 1D
☐ LUMINARY 1E

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved
Software Anomaly

☒ MIT Approved
Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: P. Ryan
F. Kuenen

Program Supervisor's Approval: Margaret H. Hamel

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ 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

Consult with
Peter Adler

Project Manager Russ Larson

Date 11-7-69

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. ADLER	1.2 ORGANIZATION: MIT/IL	1.3 DATE: 11/5/69	1.4 ORIGINATOR CONTROL NO.	MSC REPORT NO. L-1C-01
1.5 DESCRIPTION OF ANOMALY:				PROGRAM LUMINARY
				PROGRAM REVISION ALL

Delta-V increment may be subtracted from V_G twice following a restart.

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN:

DOI Simulation at GAEC.

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE:

Due to faulty restart protection, the code that subtracts DELVREF from V_G may be executed twice.

CONTINUED ON PAGE

2.2 RECOGNITION: Following a restart, V_G (R2 of N40) may drop by twice the amount of ΔV accumulated in the past 2 seconds. This is not accompanied by a similar gain in DV total (R3, N40). At end of burn, DV total not equal to targeted V_G (71.1 / 63.5).

CONTINUED ON PAGE

3 MISSION EFFECT:

Causes LGC to command underburn. State vector unaffected; DOI results in 15 nmi perilune instead of 9 nmi.

CONTINUED ON PAGE

2.4 AVOIDANCE PROCEDURE:

None

CONTINUED ON PAGE

2.5 RECOVERY PROCEDURE:

Add appropriate ΔV manually at end of burn, normally 8.7 fps at 40% throttle.

CONTINUED ON PAGE

2.6 PROGRAM CORRECTION:

Insert phase change in S40.8.

CONTINUED ON PAGE

2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):

Fix for 1D. Program note for 1B, 1C.

CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING:

Digital DOI with restarts.

CONTINUED ON PAGE

2.9 MIT/IL SIGNATURE:

Russell H. Larson

2.10 DATE:

10-7

3.1 NASA DIRECTION:

CONTINUED ON PAGE

4.1 CLOSING ACTION TAKEN:

CONTINUED ON PAGE

3.2 NASA/IL SIGNATURE:

3.3 ORGANIZATION:

3.4 DATE:

4.2 SIGNATURE:

4.3 ORGANIZATION:

4.4 DATE:

Problem in Service - created a new restart-point in Spandance → 1C

MIT/IL PROGRAM CHANGE ROUTING SLIP

~~PCR/PCN #~~

ANOMALY # L-1c-03

- | | |
|--------------------------------------|---|
| ☐ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved PCN

☐ NASA Approved Software Anomaly

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

12-4-69

MSC REPORT NO.
L-1C-03

Amplification of PCR

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. VOLANTE		1.2 ORGANIZATION: MIT/IL		1.3 DATE: 12/19/69		1.4 ORIGINATOR CONTROL NO.		MSC REPORT NO. L-1C-04				
1.5 DESCRIPTION OF ANOMALY: See Attached Sheet.								PROGRAM LUMINARY				
								PROGRAM REVISION 1C & Subsequent.				
CONTINUED ON PAGE												
1.6 DESCRIPTION OF RUN: System test lab run - V41N72 with V44 during remode - followed by V41N72.												
CONTINUED ON PAGE												
- MIT ANALYSIS -												
2.1 CAUSE: Two remode tasks operating simultaneously.												
CONTINUED ON PAGE												
2.2 RECOGNITION: Antenna won't designate properly in V41N72.												
CONTINUED ON PAGE												
2.3 MISSION EFFECT:												
CONTINUED ON PAGE												
2.4 AVOIDANCE PROCEDURE: Do not key in V44E if RR is known to be remoding.												
CONTINUED ON PAGE												
2.5 RECOVERY PROCEDURE: V37 select of any program, followed by cycling RR mode switch.												
CONTINUED ON PAGE												
2.6 PROGRAM CORRECTION: Insert check for remode in progress in V44 coding.												
CONTINUED ON PAGE												
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for Luminary 1D (PCR 990) work-around for LUMINARY 1C.												
CONTINUED ON PAGE												
2.8 RECOMMENDED RE-TESTING: V41-V44-V41 Sequence as above.												
CONTINUED ON PAGE												
3.1 NASA DIRECTION:					2.9 MIT/IL SIGNATURE: <i>[Signature]</i>				2.10 DATE: 12-20			
					4.1 CLOSING ACTION TAKEN:						CONTINUED ON PAGE	
CONTINUED ON PAGE											CONTINUED ON PAGE	
3.2 NAS/MSC SIGNATURE:			3.3 ORGANIZATION		3.4 DATE:		4.2 SIGNATURE:		4.3 ORGANIZATION		4.4 DATE:	

Based on premise that was in Surveillance

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: P. VOLANTE	1.2 ORGANIZATION: MIT/IL	1.3 DATE: 12/19/69	1.4 ORIGINATOR CONTROL NO. REPORT NO. L-1C-04 PROGRAM LUMINARY PROGRAM REVISION 1C & subsequent
--------------------------------------	------------------------------------	------------------------------	---

1.5 Description of Anomaly:

If V44 (terminate RR continuous designate) is keyed in while an antenna remode is in progress, the RR error counters are disabled which stops the antenna drive. However, the remode task keeps running and the remode flag (Bit 14 or RADMODES) remains set, until a hardware or software restart occurs. A RR coarse align request (V41N72) during this time can cause erratic antenna behavior because the presence of the remode flag causes the designate routine to start a second remode task, which conflicts with the one still in progress. Recovery from this situation is effected by any V37 request (to cause a software restart) and cycling the RR mode control switch.

MITIL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-1C-05

- | | |
|---|---|
| ☒ COLOSSUS 2C | ☐ LUMINARY 1B |
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☐ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 2F | ☐ LUMINARY 1E |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

1-7-70

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO. L-1C-05
PROGRAM LUMINARY
PROGRAM REVISION 116 & sub.

1.1 ORIGINATOR: B. McCoy	1.2 ORGANIZATION: MIT/IL	1.3 DATE: 1/7/70	1.4 ORIGINATOR CONTROL NO.
-----------------------------	-----------------------------	---------------------	-------------------------------

1.5 DESCRIPTION OF ANOMALY:

HCALC, the altitude estimate during a Descent or an Ascent, does not have sign agreement; it is a Double Precision word. When it is added to "1-30 kft" overflow could occur from the low order half into the high order half. The test on this sum can be incorrect at the 30 thousand foot check to inhibit X-axis override.

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN:

A Descent at GAEC; also occurred during Apollo 12.

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE:

See 1.5.

CONTINUED ON PAGE

2.2 RECOGNITION:

See 1.6.

CONTINUED ON PAGE

2.3 MISSION EFFECT:

The windows may be brought up at an altitude of 26 kft rather than 30 kft.

CONTINUED ON PAGE

2.4 AVOIDANCE PROCEDURE:

None

CONTINUED ON PAGE

2.5 RECOVERY PROCEDURE:

None needed.

CONTINUED ON PAGE

2.6 PROGRAM CORRECTION:

Correct for sign agreement when HCALC is calculated in RVBOTH.

CONTINUED ON PAGE

2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):

Fix for LUMINARY 1D and program note for 1C.

CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING:

Trace HCALC at 30 kftchk to insure no overflow.

CONTINUED ON PAGE

2.9 MIT/IL SIGNATURE:

R.H. Larson

2.10 DATE:

1-7-70

3.1 NASA DIRECTION:

SEE 2.7

CONTINUED ON PAGE

4.1 CLOSING ACTION TAKEN:

CONTINUED ON PAGE

3.2 NASA/IL SIGNATURE:

Thomas H. Price

3.3 ORGANIZATION:

FSD

3.4 DATE:

1/3/70

4.2 SIGNATURE:

4.3 ORGANIZATION:

4.4 DATE:

Problem old

MIT/IL SOFTWARE ANOMALY REPORT

MIT REPORT NO.
L-1C-06

PROGRAM
LUMINARY

PROGRAM REVISION
LUM131 rev1

1.1 ORIGINATOR:
J. R. Garman

1.2 ORGANIZATION:
FS55

1.3 DATE:
1/19/70

1.4 ORIGINATOR
CONTROL NO.

1.5 DESCRIPTION OF ANOMALY:

P42
P40 or P63 commanding ullage, with average-g off.

This can occur if a V37EXXE is done after ullage initiation and prior to ignition (the point of ullage termination). For example, this can occur if, in response to a flashing V99, one goes to P00 via V37 rather than doing a PRO.

CONTINUED ON PAGE

1.6 DESCRIPTION OF RUN:

LMS descent aborts on February 5, 1970.

CONTINUED ON PAGE

- MIT ANALYSIS -

2.1 CAUSE:

See 1.5 and Amplification Sheet.

CONTINUED ON PAGE

2.2 RECOGNITION:

See 1.5.

CONTINUED ON PAGE

2.3 MISSION EFFECT: If in the unlikely event a burn would be terminated at this time, in this manner, the navigated state vector would not be correct to within 2 - 5 fps. depending on which program was used.

CONTINUED ON PAGE

2.4 AVOIDANCE PROCEDURE: In order to terminate a burn program use V34E in response to flashing V99; if engine is on, press Engine STOP pushbutton, then V37EXXE.

CONTINUED ON PAGE

2.5 RECOVERY PROCEDURE:

Correct state vector.

CONTINUED ON PAGE

2.6 PROGRAM CORRECTION:

Move engine off call from SEUDOP00 to a point after determining average G is on, but before resetting V37 flag.

CONTINUED ON PAGE

2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc):

Fix for LUMINARY 1D.

CONTINUED ON PAGE

2.8 RECOMMENDED RE-TESTING:

Trace V37 logic with engine on; ullage on.

CONTINUED ON PAGE

2.9 MIT/IL SIGNATURE:

R. Larson

2.10 DATE:

2-26

3.1 NASA DIRECTION:

SEE 2.7

CONTINUED ON PAGE

4.1 CLOSING ACTION TAKEN:

Write program note for Luminary 1C

CONTINUED ON PAGE

3.2 NASA/MS SIGNATURE:

Thomas R. ...

3.3 ORGANIZATION:

FSB

3.4 DATE:

3/18/70

4.2 SIGNATURE:

4.3 ORGANIZATION:

4.4 DATE:

SINCE SUNDANCE

MILIL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: J. R. Garman	1.2 ORGANIZATION: FS55	1.3 DATE: 2/19/70	1.4 ORIGINATOR CONTROL NO.	REPORT NO. L-1C-66 PROGRAM LUMINARY PROGRAM REVISION LUM131 rev 1
---------------------------------	---------------------------	----------------------	-------------------------------	--

1.5 Description of Anomaly

The V37 logic stops average-g immediately but does not terminate ullage until "AVETOM10" integration is complete.

A V34E followed by a V37 is a workaround for this problem.

2.1 Cause:

A similar situation exists with the APS/DPS engine on during a burn. If a V37EXXE is attempted while one of these engines is on, they will remain on until AVGTOMID integration is completed. Any ΔV accumulated is not incorporated into the navigated state vector because Average G is immediately terminated by the V37.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # L-1C-07

REISSUE - 3/18/70
(SEE NOTE BELOW)

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: W. O. Starnik

Program Supervisor's Approval: Margaret Hamilton

☐ Do not code until new GSOP material has been approved by the 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

NOTE:
FURTHER ANALYSIS HAS
SHOWN THAT THIS IS NOT
AN ANOMALY IN LUMINARY

R.L.

Project Manager R. H. Larson

Date 3-12-70

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.

L-1C-07

1.1 ORIGINATOR: W. OSTANEK	1.2 ORGANIZATION: MIT/CSD Lab.	1.3 DATE: 3/11/70	1.4 ORIGINATOR CONTROL NO.	PROGRAM LUM 1, 1A, 1B, 1C PROGRAM REVISION LUM 131; LM 131-1
1.5 DESCRIPTION OF ANOMALY: The result of extended verb precision integration while in P00 may be stored into permanent state vector storage, possibly resulting in erroneous state vectors and W-matrix. Extended verbs are: V82, V89, V90. CONTINUED ON PAGE				
1.6 DESCRIPTION OF RUN: CONTINUED ON PAGE				
- MIT ANALYSIS -				
2.1 CAUSE: STATEFLG is not cleared in P00 integration following determination that the CSM state vector need not be integrated. If a precision integration is waiting to be done at this time, the integration will be done and either SV may be updated. CONTINUED ON PAGE				
2.2 RECOGNITION: Difficult on board. Ground may detect using state vector times. P00 integration of CSM is done in full time steps which are truncated to 128 centi-seconds. (cont'd.) CONTINUED ON PAGE 2				
2.3 MISSION EFFECT: May result in loss of LM state vector and W-matrix correlation. (cont'd.) CONTINUED ON PAGE 2				
2.4 AVOIDANCE PROCEDURE: In P00, do V96 before V82, V89, V90. CONTINUED ON PAGE				
2.5 RECOVERY PROCEDURE: Uplink new state vectors. CONTINUED ON PAGE				
2.6 PROGRAM CORRECTION: Cause STATEFLG to be cleared when CSM is not integrated in P00. CONTINUED ON PAGE				
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Note for 1C. Fix for 1D. CONTINUED ON PAGE				
2.8 RECOMMENDED RE-TESTING: CONTINUED ON PAGE				
3.1 NASA DIRECTION: CONTINUED ON PAGE		2.9 MIT/IL SIGNATURE: <i>R. H. Larson</i> 2.10 DATE: 3-12-70		
		4.1 CLOSING ACTION TAKEN: FURTHER ANALYSIS AT MIT/IL HAS SHOWN THAT THIS IS <u>NOT</u> AN ANOMALY IN LUMINARY RL CONTINUED ON PAGE		
3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION: 4.4 DATE:

MIT/IL SOFTWARE ANOMALY REPORT

1.1 ORIGINATOR: W. OSTANEK	1.2 ORGANIZATION: MIT/CSD Lab.	1.3 DATE: 3/11/70	1.4 ORIGINATOR CONTROL NO.	REPORT NO. L-1C-07
PROGRAM LUM I, IA, IB, C				PROGRAM REVISION LUM 131; LM 131-1

2.2 Recognition, cont'd.

Thus legitimate permanent state vector updates in P00 will result in the same number of centi-seconds in the CSM time as before the P00 integration and the LM will always be integrated to CSM time.

If extended verb integration caused erroneous update, the state vector time will probably not show this relation.

2.3 Mission Effect, cont'd.

<u>SURFFLAG</u>	<u>Verb</u>	<u>State to be Integrated in Verb</u>	<u>Result</u>
OFF, ON	V82	CM	Precision CM to CM.
ON	V82	LM	RLS to LM.
OFF	V82	LM	Precision LM to LM.
OFF	V89	LM, CM	No Update.
ON	V89	LM	RLS to LM.
ON	V89	CM	No Update.
OFF	V90	LM	Precision to LM.
ON	V90	LM	RLS to LM.
OFF, ON	V90	CM	Precision CM to CM.

If RENDWFLG is set, an update of LM state vector results in W-matrix non-synchronization.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN # _____

ANOMALY # 1-12-68

- | | |
|---|---|
| ☐ COLOSSUS 2D | ☐ LUMINARY 1C |
| ☒ COLOSSUS 2E | ☒ LUMINARY 1D |
| ☐ COLOSSUS 3 | ☐ LUMINARY 1E |
| ☐ COLOSSUS | ☐ LUMINARY |

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☐ Begin coding immediately

ACTION: George Kalan

Program Supervisor's Approval: Margaret Hamilton

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

Technical Committee Meeting not required

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager R. L. ...

Date 4/14/73

MSC REPORT NO.	
L-1C-08	
PROGRAM	
Luminary	
PROGRAM REVISION	
LM 131 Rev 001	

MSC Form 1409 (Rev May 68)

DATE AMPLIFICATION SHEET

2.1 Cause:

- 1) After attaining a manually commanded rate, the DAP enters the pseudo-auto phase of the manual rate command mode. In the pseudo-auto phase, attitude is controlled using a set of special manual attitude errors, "DXERROR", "DYERROR", and "DZERROR", which are computed by integrating the rate errors. "DYERROR" and "DZERROR" use the same erasable locations as "QERROR" and "RERROR", the attitude errors computed in the non-manual modes from the difference between the actual CDU angles "CDUY" and "CDUZ", and the desired CDU angles "CDUYD" and "CDUZD". After a restart, the DAP idles for one or two passes, during which "QERROR" and "RERROR" are computed for the Mode 1 attitude error displays and overwrite "DYERROR" and "DZERROR". Since the DAP does not maintain "CDUYD" and "CDYZD" in the pseudo-auto phase, these quantities remain equal to the "CDUY" and "CDUZ" values at the entry of the pseudo-auto phase. Consequently the psuedo-auto control is resumed after the restart with a large attitude error bias which opposes the manually commanded rate. This causes jet firings which reduce or null the commanded rate. After several seconds (during which the state drifts across the RCS control law phase plane coast zone), the vehicle is again accelerated to the commanded rate.
- 2) During the initialization pass of the manual rate command mode, "OURRCFLG" is set to indicate that the manual rate command mode is active before zeroing "DXERROR", "DYERROR" and "DZERROR". If a restart occurs between the setting of "OURRCFLG" and the initialization, the DAP will enter the manual rate command mode after idling without any initialization.

Since they use the same erasable locations as "QERROR" and "RERROR" (which have not significantly exceeded the deadband size during the preceding attitude hold period), "DYERROR" and "DZERROR" will be nearly zero and should cause no problem. "DXERROR", however, is an unshared erasable which is initialized only in the manual rate command coding, but integrates the yaw changes whenever the DAP is not idling. Consequently, the vehicle could maneuver to any yaw attitude in this situation.

2.2 Recognition:

- 1) Vehicle rotation rate temporarily decreased or nulled to zero after restart during Q or R axis manual rate command maneuver.
- 2) Vehicle moves to a new yaw attitude after restart at beginning of Q, R or P axis manual rate command maneuver.

2.5 Recovery Procedure:

- 1) Move rotational hand controller to detent position for approximately 1 sec., then return to original position.
- 2) Move rotational hand controller quickly about P axis, then back to original position.

2.6 Program Correction:

- 1) Do "ZATTEROR" to set desired CDUs to actual CDUs on each Q and R axis pass in either phase of the manual rate command mode ("ZATTEROR" is currently done on each Q and R axis pass in the direct rate phase of the manual rate command mode).
- 2) Set "OURRCFLG" after completing initialization of manual rate command mode.

MIT/DL PROGRAM CHANGE ROUTING SLIP

PCR/PCN #

ANOMALY # 6-1D-03

☐ COLOSSUS 2E	☒ LUMINARY 1D
☐ COLOSSUS 3	☐ LUMINARY 1E
☐ COLOSSUS 3A	☐ LUMINARY 1F
☐ COLOSSUS _____	☐ LUMINARY _____

☐ MIT Approved PCN

☐ NASA Approved PCR

☐ NASA Approved Software Anomaly

☐ NASA Approved PCN

☒ MIT Approved Software Anomaly

A. Coding

☒ Begin coding immediately

ACTION: _____

Program Supervisor's Approval: _____

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

B. GSOP Preparation

☐ Prepare GSOP revisions for MDRB consideration

ACTION: _____

☐ Technical Committee Meeting not required.

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

C. KSC Testing and Checkout

☐ Review for possible impact on KSC testing and checkout

ACTION: _____

D. Other Programs Affected

☐ Review for corresponding changes in _____

ACTION: _____

Special Instructions

Project Manager _____

Date _____

6-5-70

MIT/IL SOFTWARE ANOMALY REPORT

MSC REPORT NO.
L-1D-03

1.1 ORIGINATOR: R. L. Pearson	1.2 ORGANIZATION: FCOB	1.3 DATE: 5/22/70	1.4 ORIGINATOR CONTROL NO.	PROGRAM LUMINARY PROGRAM REVISION 163
1.5 DESCRIPTION OF ANOMALY: The velocity updates during descents (P-63 and P-64) fail the reasonableness test shortly after LR lock-on and continue to fail intermittently throughout the descent. CONTINUED ON PAGE				
1.6 DESCRIPTION OF RUN: Descent runs and crew training on LMS-2. CONTINUED ON PAGE				
- MIT ANALYSIS -				
2.1 CAUSE: Velocity updates to state vector are done before all of the 5 radar reads have been taken. CONTINUED ON PAGE				
2.2 RECOGNITION: Simulation at MIT showed that a Radarread was occurring after VELUPDAT CONTINUED ON PAGE				
2.3 MISSION EFFECT: Loss of valid landing RadarData - Possibly cause for abort CONTINUED ON PAGE				
2.4 AVOIDANCE PROCEDURE: Possible increase computer duty cycle by calling extended verb, e.g. V82 and then monitor normal display with V16N63, V16N64, V16N60 CONTINUED ON PAGE				
2.5 RECOVERY PROCEDURE: None CONTINUED ON PAGE				
2.6 PROGRAM CORRECTION: Set flag in R12READ and reset it when exiting; check flag in VMEASCK and do CCS NEWJOB if flag is set and recycle, otherwise continue. CONTINUED ON PAGE				
2.7 RECOMMENDED DISPOSITION (Fix, Work-around, etc): Fix for re-release of 1D CONTINUED ON PAGE				
2.8 RECOMMENDED RE-TESTING: Digital Simulation to show logic paths CONTINUED ON PAGE				
3.1 NASA DIRECTION:		2.9 MIT/IL SIGNATURE: <i>R. L. Pearson</i>		2.10 DATE: 6-3-70
3.2 NASA/MSC SIGNATURE:		4.1 CLOSING ACTION TAKEN: CONTINUED ON PAGE		
		3.3 ORGANIZATION		
3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION:	4.4 DATE:	

Name of Program(s): Luminary 10Originator: McCombsOrganization: W117/SLDate: 11/25/69

Description of Change:

change the coding in SPEEDRUN (during SERVICE) to compute LATVEL and FORVEL regardless of position of MODE selector switch. - addition of six words

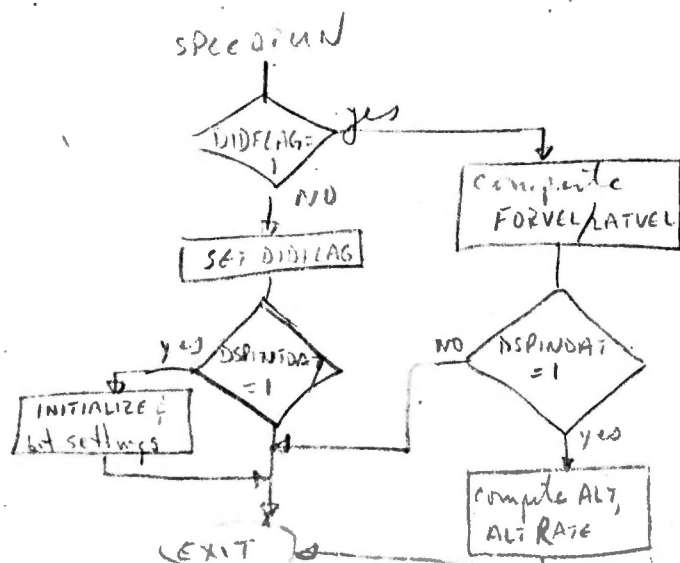
Reason:

The FORWARD VELOCITY (FORVEL) is not computed for display on X pointer or for update of the MODE selector, (which controls which gyros will display on the X pointer or tape reader) in any position but ~~ABS~~ **PGNCS**

Assigned to:

W. Berinkovich

Comments:

Approved by: M. HamiltonDate: 12/3/69

Assembly Control Board Request

No. LIV

Name of Program(s): LUMINARY

Originator: P. Rye

Organization: MIT

Date: 12-10-69

Description of Change:

Change exit from
LONGCALL

Reason: Presently it is not possible to
call a high superlattice via
LONGCALL. Change from DTCC -10
TC SUPERLATT allow this.

Assigned to:

DENSMORE

Comments:

Approved by: M. Hamilton

Date: 12-11-69

Name of Program(s): LUMINARY

Originator: P. Rye

Organization: MIT/IL

Date: 12/30/69

Description of Change:

Create subroutine RLEASVAC to release VAC area and change a FINDVAC to a NOVAC job. Perform this before putting up cyclic displays at end of guidance.

Reason:

To keep displays in landing and ascent from tying up a VAC area if DSKY is busy because of astronaut or extended verb.

Assigned to:

P. Rye

Comments:

For LUMINARY 1D

Approved by:

Burne McCoy
for
M. Hamilton

Date: 12/30/69

Assembly Control Board Request

No. L-0014

Name of Program(s): LUMINARY ID

Originator: Adler

Organization: MIT

Date: 9 JAN 70

Description of Change:

Save 3 words in bank 1 by
equating GENADR lags to fixed fixed
equivalents in order to add restart
table entry (PCR 872-2).

Reason:

PCR 872.2

Assigned to:

D. Demme

Comments:

Approved by:

M. Hamilton

Date:

11/13/70

Name of Program(s): Lumary IDOriginator: McBogOrganization: MIT/CSDLDate: 1/16/70

Description of Change:

Instead of setting bits via "CS, INH, MASK, TS,"
a "TC CLRADMOD" which does the same thing (reset
bits 14 & 10 of RADMODES) + resetting RR/CDU ERROR
COUNTER ENABLE.

Reason:

Saves 2 words in Bank 43

Assigned to:

P. Volante

Comments:

Approved by:

Bruce McBog
for
M. Hamilton

Date:

1/16/70

Assembly Control Board Request

No. ~~III~~ L16

Name of Program(s): LUMINARY

Originator: DON EYLES AND ALLAN KLUMPP

Organization: MIT

Date: 70 02 06

Description of Change:

P66 SHOULD CALL THE THROTTLE AS FOLLOWS:

TC POSTJUMP

FCADR THROT66

IN BANK 31 THE FOLLOWING SHOULD BE ADDED:

THROT66 TC THROTTLE +3

INCR CNTTHROT

COUNT ONE THROTTLE COMPLETION

TCF DISPEX66

IN BANK 32, DELETE INCR CNTTHROT AND THE TRANSFER TO DISPEX66
Reason:

THE PRESENT CODING CAN PRODUCE RANDOM BRANLHING
IF A RESTART IN P64 LEAVES A JOB

REQUEST FOR THE RESTART POINT IN THE THROTTLE ROUTINE
~~WHICH IS~~ UNSATISFIED AT THE TIME P66 IS ENTERED.

SEE PROGRAM NOTE 53 OF THIS DATE BY ALLAN KLUMPP.

Assigned to:

D. Eyles

Comments:

Approved by:

Margaret Hamill

Date:

2-9-70

Assembly Control Board Request

No. ~~42~~ L-17

Name of Program(s): Luminary 1D

Originator: B. McCay

Organization: MIT/CSD

Date: 2/18/70

Description of Change:

Remove the zeroing of bit 4 of channel 14 from
STARTSUB2.

Reason: If a software restart occurs during the
throttle down of the DPS engine, the pulses to the
DECA are terminated. On the next guidance pass they
are resumed, however.

Assigned to:

D. Demmore

Comments:

Approved by: M. Hamilton

Date:

Feb. 23, 1970

Name of Program(s): Luminary DOriginator: Dave MooreOrganization: MIT/ILDate: Feb 25/1970Description of Change: 1) Change order of coding from steersu check and then check for overflow to overflow check and then steersu check.

2) omit att-hold check and put instead: a ratestop (even though it duplicates the ratestop action in FINDOWN if in att-hold)

Reason: 1) Order changed so that if overflow occurs, commands will be skipped for one guidance cycle (in matter of ~~the~~ the SCs mode switch was changed to 4 THOLD from AUTO or vice-versa). Then commands will be issued on basis of steersu after any guidance of overflow has been cleared up.Reason: 2) omit att-hold check & place a ratestop instead; ~~the~~ the present coding may lock out performance of a ratestop by FINDOWN if: Between FINDOWN and next access of "steer?", steersu changed to 4 THOLD from AUTO (i.e. ends exist) and steersu ~~is~~ ^{used}; FINDOWN not accessed (coding goes to DISPEX; even if the ends exist — no ratestop performed)

Note: Done in Luminary already

Assigned to:

D. Denmore

Comments:

Approved by:

Margaret Hamel

Date:

3 - 2 - 70

Assembly Control Board Request

No. L 19

Name of Program(s): Luminary

Originator: EYLES

Organization: MIT

Date: 19 March, '70

Description of Change:

Use QUICKTRIG^{and *NBSM*} in P66R00
instead of CDUXNBSM to save some time.

Reason:

To save some time.

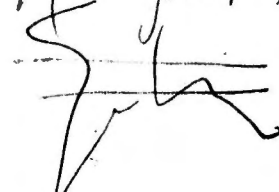
Assigned to: EYLES

Comments:

none

Approved by:

Date:

Margaret Hamilton


Assembly Control Board Request

No. L20

Name of Program(s): Luminary 10

Originator: McCoy

Organization: MIT

Date: 18 MAR 70

Description of Change:

1) change "NEG TOTKP" to "NEG TORKP"

2) change NORM table 5.517 to 5.571

Reason:

1) incorrect spelling for download quantity;
unreferenced

2) correct card punch error; insignificant

Assigned to:

McCoy

Comments:

Approved by:

M. Hamilton

Date:

3-20-70

Name of Program(s): LUMINARYOriginator: HamiltonOrganization: MITDate: 3 March 70

Description of Change: Put in a list of ECADRS at the beginning of the listing for uplinked parameters to be put in to Section 2 of the GSOP. This will be done with =ECADR op code and will be assembled with each revision but won't take up any room.

Reason:

Avoid obsolete ECADRS in the GSOP.Assigned to: Densmore

Comments: check to see if cocossus has same change

Approved by: Margaret HamiltonDate: 3-25-70

Name of Program(s): LUMINARY ID

Originator: ~~DANZON~~ Volante

Organization: MIT

Date: 23 march 70

Description of Change: Delete settings ^{and resetting} of
R04 FLAG. It formerly prevented
the issuing of a 521 alarm which
no longer exists.Reason: ~~make~~ ^{make} room to implement
PCR 979

Assigned to: Denismore

Comments:

Approved by: M. Hamilton

Date: 3-26-70

Name of Program(s): Luminary IDOriginator: DensmoreOrganization: MITDate: 8 April 70

Description of Change: Delete definitions of
4 unused shared erasables from
the erasable assignments log section.
W.IND1, VACX, VACY, and VACZ
are deleted. No response. Formerly
Reason: in E2 (unswitched).

Assigned to:

Densmore

Comments:

Approved by: Margaret Hameltr

Date:

4-15-70

Assembly Control Board Request

No. L24

Name of Program(s): Luminary ID

Originator: Eyles

Organization: MIT

Date: 7 April 70

Description of Change: MOVE ZERLINA, ELVIRA, AZINCR1 and ELINCR1 from E7 1443-1446 (sharing with ATARG) to E7, 1644-1647 where they belong, replacing the definitions of dummies for them there. Other variables (VDGUCRT (d.p.), NIGNLOOP, and NGUIDSOR, formerly equated to the
Reason: dummies were equated to the actual locations!

Assigned to:

Densmore

Comments:

Done in REV 158

Approved by: Margaret Hamel

Date:

4/15/70

Assembly Control Board Request

No. L-25

Name of Program(s): LUMINARY ~~TD 11~~

Originator: MCCOY

Organization: MIT

Date: 4/21/70

Description of Change:

modify 13 instructions in BURN BABY, BURN
so that enabler programs can utilize logic
in the master ignition routine. Also, add 1
word to bank 36

Reason:

specifically for the LM DEORBIT burn, but also
perhaps for contingency procedures, real time
programming during a mission.

Assigned to:

Comments:

Approved by: *Ry*

Date:

Name of Program(s): Luminary 1D

Originator: Densmore

Organization:

Date: 28 May 70

Description of Change: (1) unused constant OCT 7777 was deleted. (2) RESTARTS routine was called directly rather than by picking up a CADR for it. (3) A single constant 802 masking during FLAGWRD8 SWINIT initialization replaced adding in bits individually.

Reason: Save 3 words in Bank 5 to make room for clearing of R12 RDFLG in Fresh Start, Fix to ACR 896.

Assigned to:

Eana Densmore

Comments:

Approved by: Margaret H. Hamilton

Date: 6/10/70