R. Larson (MSC)

Mission Techniques Memo #28C

TO: Distribution
FROM: Malcolm W. Johnston
DATE: June 23, 1969
SUBJECT: "G" Descent

1. Enclosed anomaly report LNY #72 describes a program alarm that will recur if the LR fails to reposition at high gate. The Dsky displays will not be affected. (See MTM #28B, item #2).

2. Enclosed Luminary Memos #80 and #84 by D. Eyles describe the effects of incorrect initial conditions on the ignition algorithm. (Also see MTM #28B- item #4).

3. AGS initialization (R47) may be exercised during operation of the descent programs.

4. During descent, the most limiting of the +X or -X impingement constraints should be honored as balanced couples are utilized by the DAP.

5. Enclosed anomaly report LNY #64 and Luminary Memo #88 describe the effects of a restart occurring between PDI and FTP in P63. It should be noted that the manual throttling "work-a-round" is best done early. Also, the Dsky procedure needn't be exercised for up to a minute after the restart occurs.

6. Can a pre-PDI LR test utililizing R04/R77 be exercised while in P63?

Ans. Yes, as long as it is terminated prior to PDI Tig-30 secs. If not, a program alarm will terminate it when R12 is activated. (See MTM #23, item #7).

Malcolm W. Johnston

Malcolm W. Johnston

MIT/IL SOFTWARE ANOMALY REPORT

MIT REPORT NO.: LNY 72

1.1 ORIGINATOR:	1.2 ORGANIZATION:	1.3 DATE:	1.4 ORIGINATOR CONTROL NO.	PROGRAM:	PROGRAM REVISION:
G.W. CHERRY	MIT/IL	5/20/69		LUMINARY	97, 99

1.5 DESCRIPTION OF ANOMALY:

If the LGC does not receive indication of the antenna's reaching position 2 in the antenna re-positioning routine, this routine displays priority alarm 523. It is intended that the crew be able to terminate R12 and any alarms associated with the LR by keying in V32E to the priority display. Unfortunately, there is another check of the antenna position discretes in coding which is not terminated by the V32E response to the priority display of 523, This check turns on the program alarm light and stores alarm code 511. 511 is not a prio alarm; but it does turn on the program alarm light every 2 seconds.

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1.6 DESCRIPTION OF RUN:

Landing run on Cape LMS. Reported by Bob Pearson.

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- MIT ANALYSIS -

2.1 CAUSE:

Implementation error.

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2.2 RECOGNITION:

Program alarm light every two seconds after V32E to 523 alarm.

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2.3 MISSION EFFECT:

523 is written over any other alarm code and crew cannot tell what is causing the program alarm light.

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2.4 AVOIDANCE PROCEDURE:

Don't try to land without LR in position 2.

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2.5 RECOVERY PROCEDURE:

Set FLAGWORD 11 to 40000 by V21N01, ECADR = 00107. This sets LRBYPASS flag and stops all use of LR.

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2.6 PROGRAM CORRECTION:

Set LRBYPASS flag when V32E in response to FLV05N09, R1 = 523.

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

Fix in LUMINARY 1B.
Program note in LUMINARY 1A.

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2.8 RECOMMENDED RE-TESTING:

Level 6 run with landing and Level 3 with particular coding checked.

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2.9 MIT/IL SIGNATURE:	2.10 DATE:

3.1 NASA DIRECTION:	4.1 CLOSING ACTION TAKEN:
CONTINUED ON PAGE	CONTINUED ON PAGE

3.2 NASA/MSC SIGNATURE:	3.3 ORGANIZATION	3.4 DATE:	4.2 SIGNATURE:	4.3 ORGANIZATION:	4.4 DATE:

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Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

LUMINARY Memo #80

To: Distribution
From: D. Eyles
Date: 24 April 1969
Subject: Abnormal Exit from Landing Ignition Algorithm

Grossly bad initial conditions can cause the landing igntion algorithm to terminate abnormally. Recognition of this innocuous phenomenon is simple: if the flashing V06N61 which should appear after the ignition algorithm (the first P63 display) does not appear, and instead V06N63 is seen, it has happened. The display is non-flashing and unchanging, and in fact P63 is dead, although 63 remains in the mode lights.

This phenomenon has frequently been observed on NASA and Grumman simulators.

Since the guidance phase-switching logic is within the guidance loop called as a subroutine by the ignition algorithm, initial conditions which cause the time-to-go calculator to arrive at an answer which satisfies the switching criterion (TENDBRAK or TENDAPPR) - that is a positive or small negative value - result in phase indicating indices being advanced. This makes the guidance equations exit using a path appropriate to the powered part of the phase: the strange display is posted, then TCF ENDOFJOB. The throttle and FINDCDUW are not called because STEERSW has not been set.

Recoverly is the same as for the POODOO 1406 alarm: correct the initial conditions if you can and reselect the program.

Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

LUMINARY Memo #84

To: Distribution
From: D. Eyles
Date: 21 May 1969
Subject: Ignition Algorithm Convergence

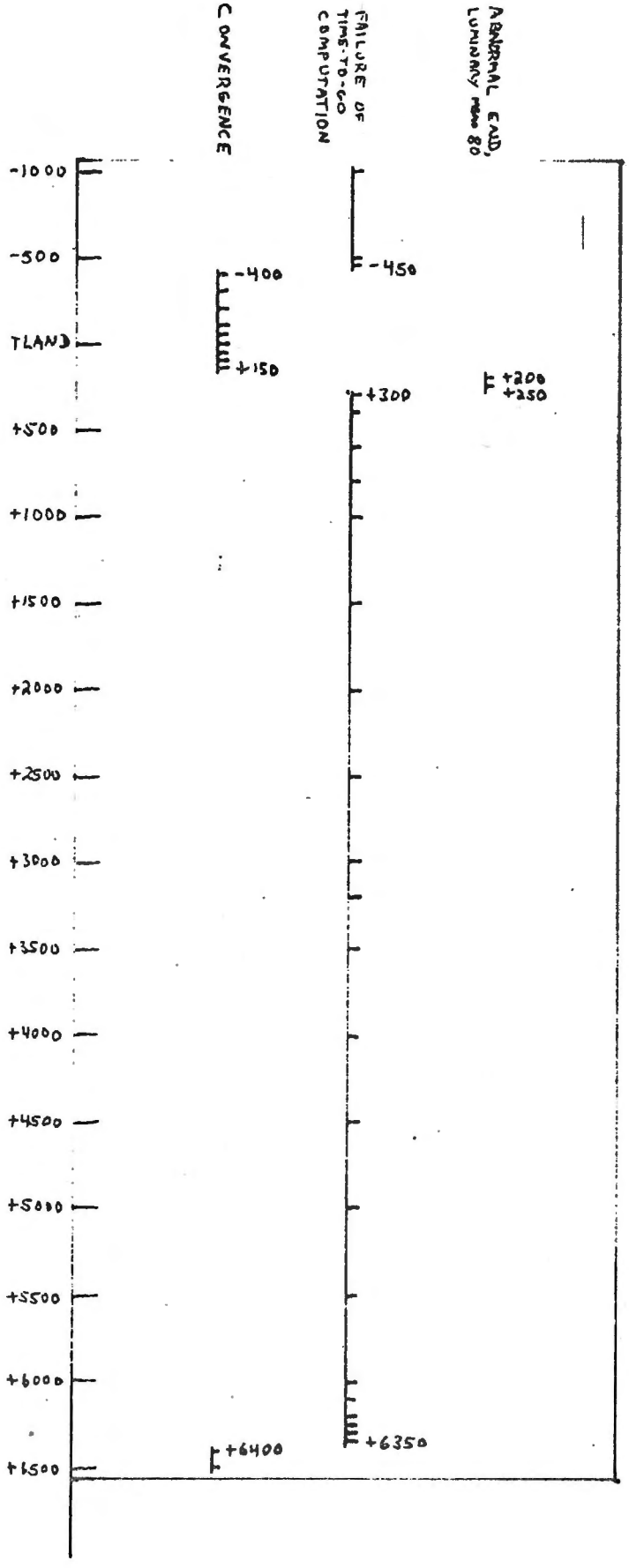
This memo presents the results of a fairly unexciting series of tests of the landing ignition algorithm of Luminary 1A. The parameter varied in these runs was TLAND, the number which determines the first guess of ignition time and place. The aim was to locate points on the descent orbit at which convergence on a wrong solution or other bad behavior can occur. None were found.

Nominal TLAND is 357659.87 but this is rounded and TLAND +100, for instance, is 357760. Where there was an effort to determine closely at what TLAND ignition algorithm behavior changes, a granularity of 50 seconds was considered sufficient: thus for example the time at which the algorithm starts converging, on the minus side, is somewhere between -450 and -400.

First there is a chart showing behavior around one descent orbit. Second, a table summarizes the runs. "First computed TGO" is included because these values indicate that on the minus side the limiting factor is the scaling of that variable in the AGC: units of 2^{17} centiseconds for a maximum of 1310.64 seconds.

The results given here assume the targetting selected for Mission G.

IGNITION ALGORITHM CONVERGENCE AROUND ONE DESCENT ORBIT



ation LAND	Computed TIG	First Computed TGO	What Happens
-1000			Time-To-Go computation fails to converge
-500			"
-450			"
-400	356969.49	-1230.27	Converges in 3 passes
-300	356969.50	-1064.69	"
-200	356969.49	-904.67	"
-100	356969.47	-744.02	"
-50	356969.48	-661.60	"
0			Converges on first pass
+50	356969.47	-487.35	Converges in 3 passes
+100	356969.47	-392.18	"
+150	356969.46	-287.62	"
+200		-166.75	Abnormal end, see LUMINARY Memo 80
+250		-9.21	"
+300			Time-To-Go computation fails to converge
+400			"
+600			"
+800			"
+1000			"
+1500			"
+2000			"
+2500			"
+3000			"
+3200			"
+3500			"
+4000			"
+4500			"
+5000			"
+5500			"
+6000			"
+6100			"
+6200			"
+6250			"
+6300			"
+6350			"
+6400	363796.76	-1277.00	Converges on TIG for next orbit
+6500	363796.74	-1108.83	"

MIT/IL SOFTWARE ANOMALY REPORT

MIT REPORT NO. LHY64

1.1 ORIGINATOR:	1.2 ORGANIZATION:	1.3 DATE:	1.4 ORIGINATOR CONTROL NO.	PROGRAM: LUMINARY
C. SCHULENBERG	MIT/IL	4/28/69		PROGRAM REVISION: 97

1.5 DESCRIPTION OF ANOMALY:

If a restart occurs in P63 between the nominal ignition time and the time of FTP, the LGC will fail to throttle the DPS to maximum thrust and the landing guidance equations will not be put into operation.

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1.6 DESCRIPTION OF RUN:

Anomaly pointed out in TRW memo, entitled, Questional Items in LUMINARY 97 Listing (A-201, 4/23/69).

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- MIT ANALYSIS -

2.1 CAUSE:

Programmer Error.

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2.2 RECOGNITION:

See Section 1.5.

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2.3 MISSION EFFECT:

If the recovery procedure is not taken in a timely manner, the landing would have to be aborted via selection of P70 or P71.

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2.4 AVOIDANCE PROCEDURE:

None

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2.5 RECOVERY PROCEDURE:

Force DPS to maximum thrust via manual throttle at FTP time. Then key in V24N01E01252E02462E52067E. Then wait a few seconds and reduce manual throttle to 10 percent.

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2.6 PROGRAM CORRECTION:

Correct restart protection for P63 throttle-up task.

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

Fix program or be prepared to use recovery procedure depending on the likelihood of a restart in this time interval.

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2.8 RECOMMENDED RE-TESTING:

Restart test of P63.

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2.9 MIT/IL SIGNATURE:	2.10 DATE:
James E. Lawrence	5-1-69

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:

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Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

LUMINARY Memo #88

TO: Distribution
FROM: D. Eyles
DATE: June 11, 1969
SUBJECT: LUMINARY Anomaly #64

Due to some stupid coding in the "master ignition routine" if a hardware or software restart occurs between P63 commanded ignition and throttle-up (26 seconds, or Z00MTIME, later) the LGC will fail to take two important actions:

1) Throttle up
2) The placing of the 2CADR of LUNLAND into AUGEXIT to bring the landing guidance equations into the SERVICER loop.

The work-around procedure must take care of these items and clean up after itself:

1) 26 seconds (i.e. ZOOMTIME) after ignition the engine must be throttled-up manually to maximum. Do not put the THR CONT switch into manual as this is unnecessary (since the engine sums the manual and auto throttle signals) and would cause switching into P67 after step (2) is performed. This manual throttle-up must be done closely on time, better slightly early than late. Each second of delay in throttle-up means 12-16 seconds delay in throttle-down. Since nominal throttle-down may be as close as 60 seconds to the end of P63 no more than a 3 second delay is safe - if the hi-gate target conditions are to be met and visibility achieved at the beginning of P64. Time this action using the event timer. If the restart occurs near the end of the trim period quick reaction is required.

2) Next the ADRES half of AVGEXIT must be loaded through the DSKY. (The BBCON half is always already right.) This requires the following 16 keystrokes:

V21 N 1 E 1252 E 2462 E

The slightest mistake makes havoc. This step is not as urgent as (1); it should be done within one minute of throttle-up. The guidance equations normally call for no throttle change and only 8^{o} attitude change in their first 60 seconds. Once this step is performed the burn is guided. This should be verified by observing an immediate pitch change on the FDAI (12^{o} if step (2) comes 60 seconds after step (1)) and time-to-go change in noun 68. There is no harm, though I think little advantage, in one of the crew manually flying the nominal pitch profile while AVGEXIT is being loaded by the other.

3) Finally, after a further wait of at least 4 seconds the manual throttle must be returned to minimum to give throttle-control to the auto-throttle. If this resetting is not done by throttle-down time the throttle is in effect stuck at the top and the consequence of that as everyone knows by now is that about 40 seconds later the guidance equations will command the LM to thrust downwards.

This work-around must be executed with extreme care and no omissions.

The next page is a matrix of test data, including the nominal case and runs with throttle down 3 seconds early and late. These runs are acceptable. Unacceptable is the fourth run, with throttle-up 4.79 seconds late. High gate is missed and the site becomes visible 30 seconds later in the approach phase than nominally.

	Nom	Early	Late	Later
Commanded Ignition	356969.47s	356969.48s	356969.48s	356969.48s
Restart	none	356970.09s	356970.09s	356970.09s
Throttle-up	356995.47s	356992.51s early 2.96s	356998.51s late 3.04s	357000.26s late 4.79s
First Guidance Pass	357995.57s	357057.58s	357063.58s	357063.58s
Throttle-down Pass	357391.57s	357371.58s	357413.58s	357429.58s*
End of P63 — speed	522.8 f/s	520.2 f/s	531.3 f/s	700.5 f/s
End of P63 — altitude rate	-144.4 f/s	-142.1 f/s	-139.8 f/s	-174.5 f/s
End of P63 — altitude	7798 F	7704 F	8080 F	8936 F
Touchdown	357647.17s	357656.27s	357631.26s	357607.37s
DPS Fuel Left	991 lbs	978 lbs	1075 lbs	1239 lbs

* 9th pass of P64

Figure 1