

Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

Apollo Project Memo # 7-69

TO: Distribution
FROM: George W. Cherry
DATE: January 23, 1969
SUBJECT: What is LUMINARY 1A?
Some Results of the 28th Apollo Software Configuration
Control Board Meeting

The release date for LUMINARY 1A, the Mission "G" program is scheduled for 19 March 1969 as the result of SCB approval of PCR's on the baseline program which was scheduled for release on 15 March 1969. This memo describes, by technological area, the presently approved contents of LUMINARY 1A. It also alludes to LUMINARY 1A items which were disapproved. We must now prepare a detailed development plan and test plan for LUMINARY 1A.

In this memo I have given action items for the implementation of the changes. My assignments must be confirmed by Dan Lickly or Jim Kernan. In some cases I have also given additional information about implementing the PCR which cannot be found in the PCR itself. For some PCR's we will have to hold a design review.

I would like to have the development plan handle the initial programming changes by PCR status; - PCR Design Review complete date, PCR item test plan complete, PCR GSOP change pages complete, PCR coding complete, PCR testing complete, etc. By doing this we should prevent the changes and improvements from introducing new problems.

The items which changed the delivery date of LUMINARY 1A are:

- PCR 270 Placement of Desired Insertion Radial Velocity component into Erasable for P70/P71/P12 - One Day.
- PCR 722 Improve Performance of RR Designate Routine on the Lunar Surface - Two Days.
- PCR 268.2 Reduction of P34/P35 Run Time - One Day for detailed change evaluation.

Abort and Ascent Changes (Approved)

1. Reduce program execution time in P70, P71, and P12.
Action: Craig Schulenberg and Larry Berman.
2. PCR 697. Limit LM Abort Orbit Insertion to One-half Degree Plane Change.
Action: Larry Berman.
3. PCR 708. Provide Continually Variable Abort Insertion Targetting.
Action: Larry Berman, John Vella and Craig Schulenberg.

There will be two polynomials of the form

$$V_{hf} = a + b(TFI) + c(TFI)^2 + d(TFI)^3$$

one for DPS abort and one for APS abort (a, b, c and d in erasable). After V_{hf} is determined N76 registers should be loaded so that the crew can see what V_{hf} is. N76 is redefined by this PCR and PCR 270.

N76	R1	VHF
	R2	HDOT F
	R3	CROSS RANGE

A design review will be required to determine whether N76 should normally come up in P70/71 or merely be an on-call display. Also, should we let this noun be loadable in P70/P71? Probably not.

4. PCR 717. DAP Bias Acceleration Initialization in P12.
Action: Bill Widnall and Craig Schulenberg.
 Question: Should we do this in P71 also?
5. PCR 260. We already had a design review on this subject and we are doing it the way Craig Schulenberg proposed.
GSOP Action: Walker Kupfer and Bill Marscher.
Action: Craig Schulenberg.
6. PCR 270. Allow Non-Zero Radial Rate Insertion Targets in P70, P71 and P12.

The purpose of this change is to get to the apolune of the abort orbit and hence the CSI burn about 14 degrees of central angle travel sooner. Since CDH is done one half rev after CSI this will add about 4.5 minutes between CDH and TPI. Also, positive flight path angles will put apolune before perilune - which seems safer to me.

The details of the change are:

- a. One pad load of HDOT F for P70/P71 and
- b. A different pad load of HDOT F for P12. (If we haven't this unshared erasable for P12 we can use fixed storage since the crew can load N76 in P12 if the value loaded from fixed is wrong.)
- c. Change N76 definition as noted above.

One question then, should we make N76 loadable in P70/P71 as well as P12?

DAP Changes (Approved)

Action: Bill Widnall

1. PCR 715 Increase Docked DAP Bending Stability.
2. PCR 716 Improve Ascent Powered Flight RCS Control.
3. PCR 717 DAP Bias Acceleration Initialization in P12.

DAP Changes (Approved) (Cont.)

4. PCR 718 Improve Light Ascent Control with Jet Failures.
5. PCR 701 Eliminate Trim Gimbal Control Underflow From CSM-Docked LM DAP.
6. PCR 710 Provide a Larger RCS Pulse Width During Minimum Impulse Control Modes with CSM Attached.

Bill, what pulse width do you propose?

Navigation Changes (Approved)

1. PCR 267 Synchronize the RR Data for the Downlink.
Action: Jim Kernan
2. PCR 646 Give astronaut the option to confirm main-lobe lock-on after R21 acquisition.
Action: Programming - Peter Volante
GSOP - Walker Kupfer
Harry McQuat
3. PCR 722 Improve performance of RR designate routine on the Lunar surface.
Action: Programming - Peter Volante
GSOP - Bob White (5)
Harry McQuat (4)
4. PCR 642 Provide wings-level, head-up, fine Z-axis tracking. Not heads up, but merely memory, so to speak, of what the astronaut specified. Don Keene knows how to do this. Modify VECPOINT so that there is an entry point which uses CDUXD, CDUYD, CDUZD rather than the actual CDUs. Thus R65 will call VECPOINT at this new entry point and the limit cycling of the DAP etc. will not be rectified.
Action: Bill Widnall, Don Keene and Pete Volante

5. Landing Changes (Approved)

1. Eliminate Attitude Oscillations from Terminus of P64

No PCR has been written yet - but Bill Widnall and Allan Klumpp have simultaneously hit on a solution I think, and a PCR (or PCN) should be forthcoming from them. The problem, apparently, is that the guidance equations are computing commands on the basis of a state vector which is about a second old and then the DAP lags and throttle response are implementing the commands on the order of a couple of seconds late. (The DAP deadband, apparently, is okay at one degree.) These lags cause oscillations. It is easy to adjust for this problem by extrapolating the guidance equations commands forward from the time, PIPTIME, at which the state was computed. The lead in the equations compensates for the computation lags and the DAP and throttle lags. Allen has tried 3 seconds forward extrapolation and this really smoothes out the attitude profile.

Action: Allen Klumpp and Bill Widnall to verify their hypothesis and submit a PCR to me.

2. PCR 700 Improve the RODMode (P66) Performance.

I had several conferences on the P66 problem while I was at MSC and we are going to do at least the following things outlined below. The G crew, Warren North, Don Cheatham, Ken Cox and many others agreed with the following changes. By the way, our contact with MSC on this and the above problem was officially defined for me by C. Kraft. Our contact is the Guidance and Control Division (Don Cheatham) and Thomas Price. Here are the changes we should implement. (In our conference, having P66 define an HDOTD other than HDOT, on initial entry, was completely shot down.)

- a. Put the scale factor for x ft/second per click into erasable.
- b. Perform the rate of descent equations and commands once per second.

Programming action for all the foregoing powered flight items: Peter Adler.

GSOP action: Ray Morth or Pete Philliou, Walker Kupfer (4).

Design reviews have either been held or none are necessary.

Powered Flight (Disapproved)

PCR 650 Variable Guidance Period

This held out the advantage of improving the crew trims because of the higher frequency display of VGs. Is there any easier way of doing this much, a la P66? Action: Peter Adler.

Miscellaneous (Approved)

PCR 719 Speed up P21.

PCR 720 Abort Coasting Integration when in Infinite Acceleration Overflow Loop.

PCR 721 Time-Theta and Time-Radius Alarm Abort.

PCR 659.2 Suppression of Kepler X-Moduling.

PCR 654 Reduce Delays in R31.

Program Action: Jim Kernan or Craig Schulenberg.

GSOP Action: Bill Robinson and Bill Marscher (5), Walker Kupfer (4).

Miscellaneous (Disapproved)

Alternate Angular Reference inputs to the crew defined maneuver routine, R62 (2 days).

Test Plans for Changes

Anyone who has the programming and coding change action must prepare a test plan to prove that his changes are working properly. These will be collated, added to, and made into a LUMINARY 1A Test Plan through Level 3. In some cases, Levels 1 and 2 of testing will be necessary - for example, in the T (APOAPSIS) change.

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