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Apollo Project Memo #56

TO: Distribution
FROM: George W. Cherry
DATE: June 9, 1969
SUBJECT: What is LUMINARY 1B? Some Results of the 31st Apollo Software Configuration Control Board Meeting

LUMINARY 1B will be built to support a November launch readiness date for Apollo 12*. Raytheon can begin work on this program on 12 August 1969; accordingly, we will carry this date in our LUMINARY 1B development plan for the program release date.

LUMINARY 1B will consist of the PCR's approved at the 31st SCB meeting, anomaly repairs, the software repair of the LGC/LR/RR interface problem, a handfull of program improvements, and perhaps a few more worth-while PCR's not yet submitted and approved. It should be pointed out that P31 was deleted from LUMINARY 1B by oral direction from Tom Gibson. This direction was confirmed by the 31st SCB meeting; but no PCR has been generated. (Ken Greene, please send a PCR deleting P31 to MSC.)

Candidates for additional PCR's for LUMINARY 1B must be few and significantly helpful. I know of two worthwhile candidates. They are:

1. Permit the LGC to display DAP-derived vehicle rates on the attitude error needles. Selection of display-attitude

* LUMINARY 1A (Rev. 99) will support a September Apollo 12 launch readiness date.

errors in body axes or attitude rates in body axes - would be by extended verbs. Both the Apollo 9 crew and the Apollo 10 crew have complained that the analog autopilot's drive of the attitude rate needles resulted in an intolerably inaccurate display of vehicle rates. Tom Stafford lectured the folks gathered for the G&N debriefing that it is very important to be able to null the vehicle rates on a spacecraft in drifting flight. On Apollo 10 he said that the needles were off by about 0.25 degrees/second. He would orient the spacecraft to where he wanted it and then try to null the rates. With 0.25 degrees/second attitude rate error, the spacecraft would develop 5 degrees attitude error in 20 seconds, requiring constant crew attention and wasting fuel. Apparently Tom was using minimum impulse command mode. It is possible for the PGNCS rate command/attitude hold mode to achieve very small rates. But that mode is not necessarily the mode the crew wants to fly. It is important to be able to null LM rates during terminal rendezvous since the observed motion of the CSM appears the same whether the LM is drifting normal to the LOS or rotating about its axes. (Stars are hard to see.) Of course, with the light LM vehicle there is a torque to inertia problem ("sporty" vehicle) which no display can solve. However, the minimum impulse command change in the light LM angular rate is about the size or a little smaller than the kind of error the Apollo 10 crew saw in the rate needles. Therefore, an improvement in the display seems worthwhile. The crew also pointed out that the scaling on the rate needles was too coarse. (5 deg/sec or 25 deg/sec). We could drive the "attitude" needles with a 1 deg/sec scaling. If the rate gyro package fails, the crew will not have any display of vehicle rate.

2. Allan Klumpp has suggested that there are two uses of the spare DSKY lights which can indicate dangerous conditions during landing.

a. Light a DSKY light if the LM is on an impact trajectory during landing . Allan thinks this could be down for 3 to 10 milliseconds (about 0. 5% of the computer time execution time.)

b. Light another spare DSKY light if the guidance equations command downward thrust.

It appears to me that both these conditions merit warning the crew; but I believe that a priority alarm could also serve this function. Tom Price, are you interested in setting up a meeting between MSC and MIT components to pursue this?

PCR's Approved by the SCB for LUMINARY 1B

PCR 773. 2 Fix Constants for Planetary Inertial Orientation Subroutine.

The state of this PCR is really pending until MSC verifies our numbers. Tom Gibson, we're waiting to hear from you.

PCR 776. 2 Improved R-2 Model Timing.

This coding of the R-2 model saves about 25% integration time compared to the F or G programs.

PCR 779 Leave Track Enable Set When R29 is Terminated.

This keeps the RR tracking in the LGC mode at the end of P12, P70 or P71 so that the crew can call R04 and look at pure radar range and range rate.

PCR 780 Provide Pure RR Range, Range Rate, and Time Lag During P20, P22, and P25.

23B folks, please read the PCR carefully for I worded it to state that the implementation of this PCR would slip in one R61 reading of the RR before R22 to clear that shift register in the RR of all ones (the way it comes up after

turning on the RR.) By the way, if R29 could be arranged to set up the N78 erasables with pure range and range rate the crew could monitor these quantities during ascent. Would this help during G Manual Ascent, Bill Tindall?

PCR 781.2 PIPA Bias Compensation Scale Change.

This allows compensation for larger PIPA biases with some modification of crew procedures for manual PIPA bias compensation determination. Jim Nevins, do we have to modify the AOH? Ain Laats, whom do we tell about the K-start tape change? I hope that we get the world informed of this so that we don't make any scale factor mistake.

PCR791.2 Do Not Allow a PROCEED Response to V21, V22, or V23.

When the astronaut gets FL V06 NXY, he can put the right data in the displays by merely keying:

R1 XXXXX ENTER to the FLV 21
R2 XXXXX ENTER to the FLV22
R3 XXXXX to the FLV 23

and seeing all data right in R1, R2 and R3. If he keys PROCEED to the still flashing V23 he gets none of his data transferred. The only final response to the FLV 23 that will accept the data is ENTER. On almost every flight we've been bitten by this kind of mistake by the crew. No more will this happen. When the astronaut keys V25E he must ENTER data in R1, R2, and R3 and key the ENTER on his R3 entry. Operator error if he keys PRO rather than ENTER. Of course, if he is loading a two component noun or two components of a three component noun, he starts by keying V24E and then must key

R1 XXXXX ENTER
R2 XXXXX ENTER

and similarly for one component.

PCR797.2 Cause Key Release to Blank DSKY if No Display Waiting.

"In effect, if the DSKY has nothing to say, Key Release shuts it up." W. B. Goeckler

PCR798.2 Reset GLOKFAIL in R00.

Change was to keep uninitiated ground observers from being confused by a flag bit setting that has no meaning in flight.

PCR801.2 Make BAILOUT Alarms Start with 3XXXX and POODOO Alarms Start with 2XXXX.

This gives crew instant recognition of type of alarm. The GSOP uses one or two asterisks, but the DSKY can't.

PCR802.2 Save Alarm Data After "Error Reset."

R3 of N09 with always contain the alarm code of the last alarm. Error reset will not touch R3.

PCR805 Don't Allow V66 on the Surface.

V66 sets the CSM state vector equal to the LM state vector. Since in LOR we don't land the CSM we won't want V66 on the lunar surface.

PCR806.2 Allow N07 to Address Output Channels.

V25 N07E is an extended verb which permits the operator to set bits in flagwords. This modification permits the extended verb to set output channel bits also. (Mostly for ground checkout.)

PCR807.2 Add Present Time Option to P21.

Normally, when zero is entered into a GET time noun, the loaded value is a cue to the LGC to pick up current GET and use that for the noun. This is a convenience to the crew. This PCR adds this convenience to P21, the LAT-LONG Display Program.

PCR812.2 Resetting and Setting of the EXTERNAL DELTA-V Flag.

The referenced flag controls whether the burn programs, P40, P41, P42 do an external delta-V burn or an aimpoint (Lambert) burn. We presently set and reset these flags only after the final computation is completed which prevents the crew from doing the burn with the right setting after a first solution (re-cycle to N45). This change will put the flag in the right state earlier.

The PCR was modified to delay the resetting of the flag until the first computation had begun in P34 or P35 and delay the setting until just before N45 in P30 or after the first computations had begun in P32 or P33. This was to prevent the crew from selecting the wrong program between the right targetting program and the burn program and putting the flag in the wrong state. For the actual wording of the modified PCR see Steve Copps.

PCR814 Reduce Keystrokes Required to Check and Approve LR Data.

It formerly took 19 keystrokes to display the difference between LR derived altitude and LGC inertial altitude, approve the incorporation of LR data, and then check the effect of incorporating the LR data. We have cut this down to 6. The PCR was slightly modified to give a definite LGC display indication to note the approval of LR data incorporation. The change is shown in figure 1.

Incidentally, I hope that we can mechanize this so that we save computer time over the old way of doing this (by a monitor verb). I have discussed a technique with Don Eyles.

Margaret Hamilton, please note the new scheme in figure 1 and try to so mechanize this to save computer time.

PCR 816 Modify R03 to Permit Astronaut Setting of 1^{o} Deadband.

Presently R03 allows the astronaut to set a 0.3^{o} or 5.0^{o} deadband. In Apollo 10 when the crew called R03 after R60 in P42, the deadband was set to 0.3^{o}. Now the astronaut can set a 1.0 degree deadband. Pete Conrad liked this because 0.3 degree deadband hoses away too much RCS propellant in fine Z-axis track and 5.0 degree deadband may be too sloppy.

PCR 817 Eliminate Undesirable LR Position Alarms from R12.

The alarms with respect to LR position are straightened out by this PCR.

522 - will occur only in R04 if the LR is not in the astronaut-chosen position.

511 - will occur in the landing programs (R12) if the landing radar is not in position 1 before hi-gate or not in position 2 after hi-gate. (However, note description of 523 alarm.)

523 - will occur if the LR does not achieve position 2 within a certain time after hi-gate. 523 occurs as a priority alarm

FL V05 N09
R1 523

If the astronaut keys in re-cycle to this display, R12 and all its alarms (for example, 511) will be terminated.

PCR 818 Permit Rejection of Individual Measurement Incorporations in P20.

When a range, range rate, shaft or trunnion measurement would cause an "excessive" state vector update, the program displays FL V06 N49 with the magnitude of the position correction and velocity correction in R1 and R2. The astronaut can key in V32E to reject incorporation of the measurement which causes the alarm - but the re-cycle also rejects all the other measurements that have not yet been incorporated. PCR 818 allows the

astronaut to key in V32E to reject incorporation of the specific measurement which causes the alarm (R3 = 1 for range, 2 for range rate, 3 for shaft, 4 for trunnion in N49) but permits checking and incorporating the next measurement.

A change to the PCR is that a V34E response rejects all the measurements made at the current mark. Thus V34E will do what V32E used to do.

Peter Volante, please notice the change when implementing the PCR.

PCR820 Eliminate Lighting of ALT Light When Low Scale Discrete is Absent.

Currently, when the LR altitude is below 2481 feet and the low scale discrete is absent the ALT light is turned on and R12 continues blithely incorporating the data! The change is to stop comparing the presence or absence of the low scale discrete to 2481 feet and to omit all alarms and indications concerning this discrete. See the PCR for the reasons.

POST SCRIPT on a Desired PCR, MSC still ardently desires explicit abort targetting is LUMINARY 1B. This is very very desirable operationally and we will at least give it a try. I asked Bill Tindall to PCR R29 out of P70 and P71 to save us some execution time and to PCR something like P38 and P39 out of LUMINARY to give us some storage space. Bill is working on this. We still have a schedule problem and perhaps an execution time problem; but if Bill does his part we will try to do ours.

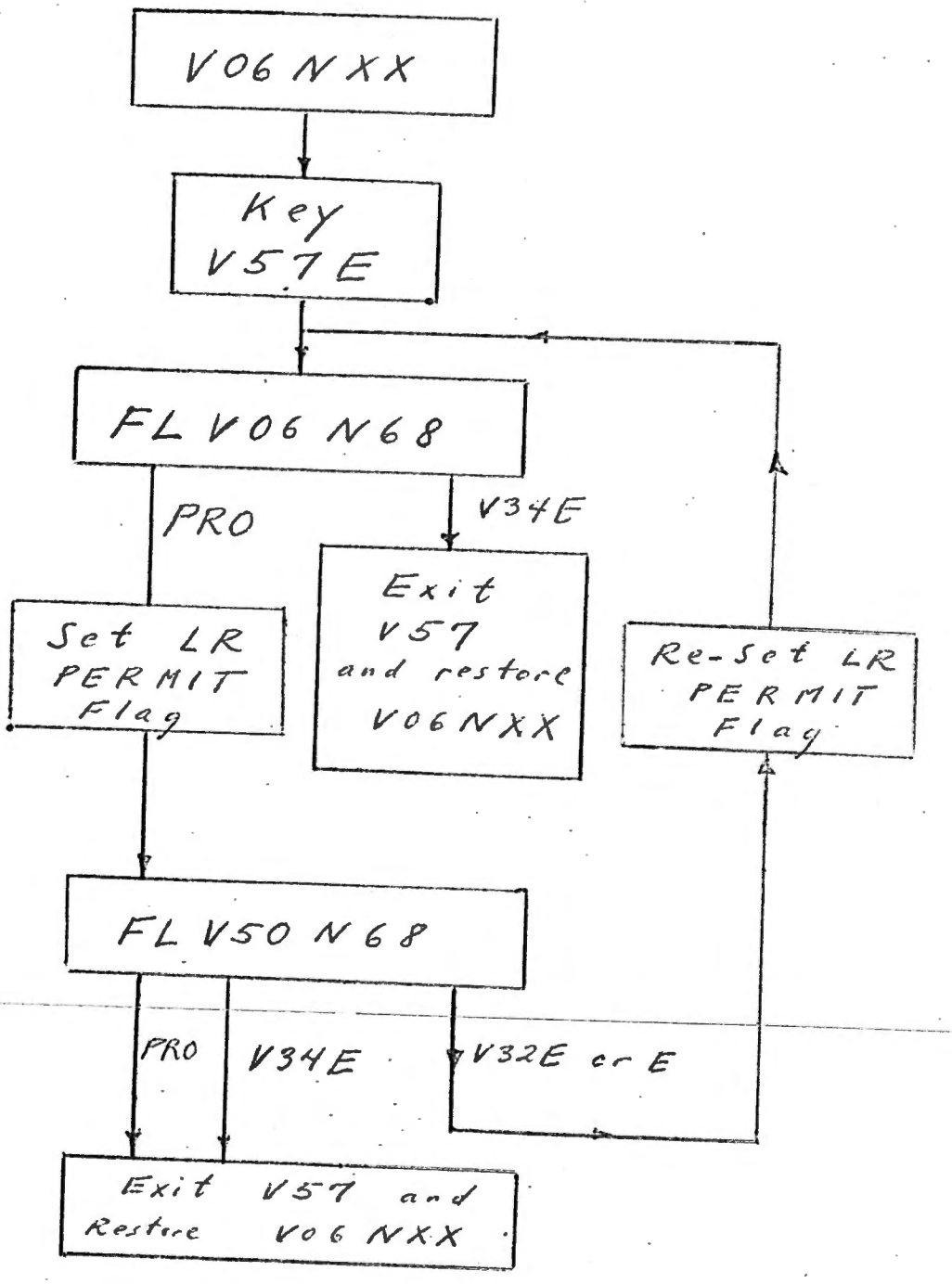

Figure 1. Keystroke Saving Extended Verb

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