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LUMINARY MEMO # 66

TO: Distribution
FROM: George W. Cherry
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SUBJECT: Aborts from the Lunar Landing and Nominal Lunar Ascent Targetting

Introduction

There have been quite a few significant changes lately in the DPS abort and APS abort programs, P70 and P71. First, the abort logic is the same for aborts prior to and following TFI = 50. (TFI = time-from-ignition (PDI ignition)) Secondly, the horizontal abort velocity is a polynomial function of TFI (in order to adjust the abort orbit period to improve the phasing of the LM relative to the CSM). Thirdly, the abort radial rate is positive (in order to reach apolune and the CSI burn sooner).

The purpose of this memo is to describe the new abort velocity targetting. Most of these targets are in erasable storage but we might as well test the program with the numbers which I have garnered from a recent data priority meeting.

Variable Abort Insertion Targetting (for P70 and P71)

The horizontal component of velocity used for abort orbit insertion is a cubic function of TFI.

$$VHF = k_0 + K_1 TFI + K_2 (TFI)^2 + K_3 (TFI)^3$$

where there is one set of k_i s for a DPS abort and another set of k_i s for an APS abort. All 8 coefficients are in erasable storage.

Coefficient	Dimensions	DPS Value	APS Value
k_0	ft/sec	5644.2	5646.6
k_1	ft/sec^2	0.96133×10^{-1}	0.51569×10^{-1}
k_2	ft/sec^3	-0.93448×10^{-3}	-0.761478×10^{-3}
k_3	ft/sec^4	0.68567×10^{-6}	0.48214×10^{-6}

After VHF is computed with the appropriate set of coefficients, its magnitude is compared with the velocity required for a thirty nautical mile apolune ($\approx$ 5510 ft/sec, I believe) and the higher of the two values chosen for the target.

The radical rate desired, RDOTD, during aborts is

$$\text{RDOTD} = +19.5 \text{ ft/sec}$$

RDOTD for aborts is also located in a pad-loaded erasable.

For very late aborts, VHF is limited to be no less than 5510 ft/sec and the phasing between LM and CSM will degenerate. MPAD is still studying this area of aborts to see whether some special maneuvers will be required to re-establish the desireable phasing.

Abort from the Lunar Surface

There is the possibility of an abort from the lunar surface. (The LGC would not know that the LM has landed.) The astronaut waits to select P68 until he has confirmed that he does not want to abort from the lunar surface. The events and times are

The P12 orbit insertion targets are exactly the same as the lunar surface abort and late abort targets.

VHF = 5510 ft/sec

RDOT = 19.5 ft/sec

This time two catch-up revolutions are made in the 30 nautical mile apolune orbit. A ground-targetted P30-P41 maneuver at perilune boosts the apolune to 45 nautical miles about two revolutions after the insertion. This "boost" maneuver establishes nominal phasing from that point forward.

Unfortunately, the first two components of N76 must be loaded from fixed storage (N76 = VHF, RDOTD, CROSS RANGE) because of erasable storage shortage. The targets for this special quick early use of P12 are different from the targets used in P12 for a nominal ascent. Since the astronaut is more hurried during the early lift-off use of P12, we will use the targets for this orbit in P12 always. In normal use of P12, the astronaut will therefore have to load N76 each time he calls P12.

Nominal Ascents With P12

The normal ascent orbit insertion targets are

VHF = velocity for a 45 nautical mile apolune orbit

RDOTD = 30.0 ft/sec

These values will have to be entered in N76 on each use of P12.

Event	TFI
Touchdown	690 -775 seconds
Go/No-Go for Lunar Surface Abort	810 -895 seconds
Preferred Lift-off Time	980 seconds

If the astronaut decides not to abort he selects P68; if he cannot wait until TFI = 980 seconds he aborts immediately. (If he can wait his phasing will be better.) The abort targets, VHF and RDOTD, are the same for a lunar surface abort as for a powered descent abort.

The big difference is that for a lunar surface abort at TFI = 980, the ground targets a P30-P41 "boost" maneuver at perilune (about one rev after insertion) to boost the apolune from 30 nautical miles to 45 nautical miles. The "boost" maneuver establishes phasing which makes the lunar surface abort nominally the same from that point forward as a normal ascent from the lunar surface.

The lunar surface abort requires the astronaut to push "Abort Stage" which selects our APS abort program P71.

Quick Early Take-off In P12

After the LM crew passes the abort stage lunar surface lift-off opportunity at TFI = 980 seconds, they continue to make LM systems checks (such as APS propellant leaks). If they cannot wait a full CSM revolution to launch, they have a P12 launch opportunity at TFI = 1380 seconds. The events and times are

Event	TFI
Touchdown	690 - 775 seconds
V37E 68E	980 seconds
V37E 12E	
Go/No-Go for P12 Launch	1290 - 1375 seconds
P12 launch	1380 seconds