

Massachusetts Institute of Technology  
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DANCE Memo #56

TO: Distribution  
FROM: George W. Cherry  
DATE: April 1, 1968  
SUBJECT: Change to SUNDANCE Program and SUNDANCE FACI

I spoke too soon, One more FACI-impacting approved PCR has dropped through the chute. It's a very well-conceived modification and represents a significant program improvement. The program changes are fairly simple and they greatly alleviate certain problems and enhance the probability of mission success. The only written record I have of the approved new change is a rather illegible data-fax of the PCR, and therefore I am writing and circulating this memo to inform everyone concerned at MIT what we have to implement.

First of all, I will give you some background so that you see the reasons for the changes. There are three problems associated with turning off the ullage +X translation when the DELTAV monitor detects main engine thrust; (this is the way SUNDANCE presently terminates ullaging.) They are:

1. The +X translation jets may stay on as long as 6-8 seconds beyond the time that the engine-on signal is sent resulting in unnecessary RCS propellant consumption (about 5 to 10 lbs per burn).
2. The +X jets may damage the descent stage if the translation jets stay on for more than 15 seconds without subsequently staying off for a much longer time (to allow cooling). This time could be exceeded by the ullage +X translation if the engine does not ignite within the time the DELTA V monitor expects thrust. The reason: 7.5 seconds of ullage before TIG, about 6-8 seconds after TIG before engine fail is detected, and then 5 seconds more until the next possible TIG.

3. Finally, because the ullage jets are on until the DELTAV monitor detects thrust, the possibility of an engine fail false alarm is increased. Let me explain this. First, because more than 15 seconds of +X translation may damage the descent stage, the DELTAV monitor can only allow about 6-8 seconds after the nominal TIG before it gives the astronaut the engine fail indication and allows him to terminate ullage. Second, because the ullage jets are on while the DELTAV monitor looks for main engine thrust, the DELTAV threshold must be set between the maximum possible ullage thrust acceleration and the minimum anticipated main engine thrust acceleration, i.e., between the DELTAV from 400 lbs thrust and 1000 lbs thrust. If the ullaging jets are off, the discrimination problem is easier because the DELTAV threshold can be set equal to or even lower than the DELTAV provided by 4 jet translation.

The repairs to the above problems are fairly simple. They are

- (1) Terminate +X translation 0.5 seconds after DPS or APS engine on signal.
- (2) Increase the number which is used to initialize DVCNTR to four so that a minimum of eight seconds will be allowed for the DELTAV monitor to detect engine thrusting.
- (3) Decrease the threshold value of DELTAV for determining engine thrusting to
  - (a) For CSM-docked burns

$$0.256 \text{ ft/sec} = \frac{400 \text{ lbs}}{100,000 \text{ lbs}} \times 32 \text{ ft/sec}^2 \times 2 \text{ seconds}$$

- (b) For DPS burns

$$0.753 \text{ ft/sec} = \frac{400 \text{ lbs}}{34,000 \text{ lbs}} \times 32 \text{ ft/sec}^2 \times 2 \text{ seconds}$$

(c) For APS burns

$$5.818 \text{ ft/sec} = \frac{1000 \text{ lbs}}{11,000 \text{ lbs}} \times 32 \text{ ft/sec}^2 \times 2 \text{ seconds}$$

Change (1) above allows change (2) to be incorporated without "burning the IM's pants", and change (1) allows changes (3)a and (3)b to be made without 4 jets ullage fooling the DELTAV monitor into thinking ullage +X translation is main thrust. Changes (2) and (3) make the probability of the DELTAV monitor's ringing a engine fail false alarm very low. Finally, change (1) saves RCS propellant and the IM's pants.

I predicted the following schedule impacts because of the new changes.

SUNDANCE FACI - - - 3 day impact

(However, NASA wants to wait until April 16 or April 17, 1968.)

SUNDANCE CARR - - - 5 day impact

LUMINARY FACI - - - 3 day impact

The change outlined in this memo was negotiated by me with Chris Kraft and Tom Gibson after a discussion with Dr. Battin. The change has been approved by Kraft. It should be implemented as soon as possible

Ed Copps, Jim Kernan, Dan Lickly, Alex Kosmala, Peter Adler, Bill Marscher and I must assemble to determine what special tests of the change should be made before the FACI.

*George W. Cherry*