Massachusetts Institute of Technology
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MEMO

To: Russ Larson
From: Don Eyles
Date: 8 June 1971
Subject: Landing Pulse-Out

Apollo 15 landing test 6.4.2.2 experienced a throttle pulse-out near the end of the braking phase. See plot 1. The initial conditions in this test which account for the pulse-out are:

(1) N69 of 20000 feet downrange (and 20000 feet to the right) at TIG +30 which displaces the a priori LGC terrain model downrange by that distance, and

(2) State vector error which is about 3600 feet uprange. I.e. at a given time the LGC thinks it is farther from the site than the environment, or, at a given range, the LGC is passing over terrain which is nearer the site than it thinks.

Together these two conditions cause a terrain-terrain model mismatch of about 23600 feet in range. This causes the LGC terrain model to lie above the real terrain through the steep slope into Hadley Rille. (See Klumpp's Luminary Memo #208 for another case where terrain model above terrain causes trouble.) This causes the radar to read a greater altitude than expected and this causes the spacecraft to dive. The maximum descent-rate is 210.3 f/s at time 376665. At the bottom of the slope the terrain and terrain model suddenly come closer together in altitude. At this time a pulse-out occurs because the descent-rate is realized to be too great. Plot 2 shows the altitude difference in terrain model and terrain between about times 376600 and 376650, and shows that the pulse-out, tagged THRUP, comes where terrain and terrain model cross, at the bottom of the "cliff".

That the terrain-terrain model mismatch causes the pulse-out is confirmed by run 6.4.2.3 B which is the same as 6.4.2.2 except that the state vector error is input with the opposite sign, so that it diminishes the terrain mismatch due to the N69. Here the mismatch in range is about 15000 feet. In this run there is a rise in thrust near the end of P63 but as the desired thrust never exceeds HIGHCRIT no pulse-out occurs.

The effect of a long steep slope is to exaggerate terrain model altitude mismatch due to range mismatch, but since in the Apollo 15 case a pulse-out is not provoked until the mismatch exceeds 15000 feet downrange there is no reason to expect one in flight.

Distribution:

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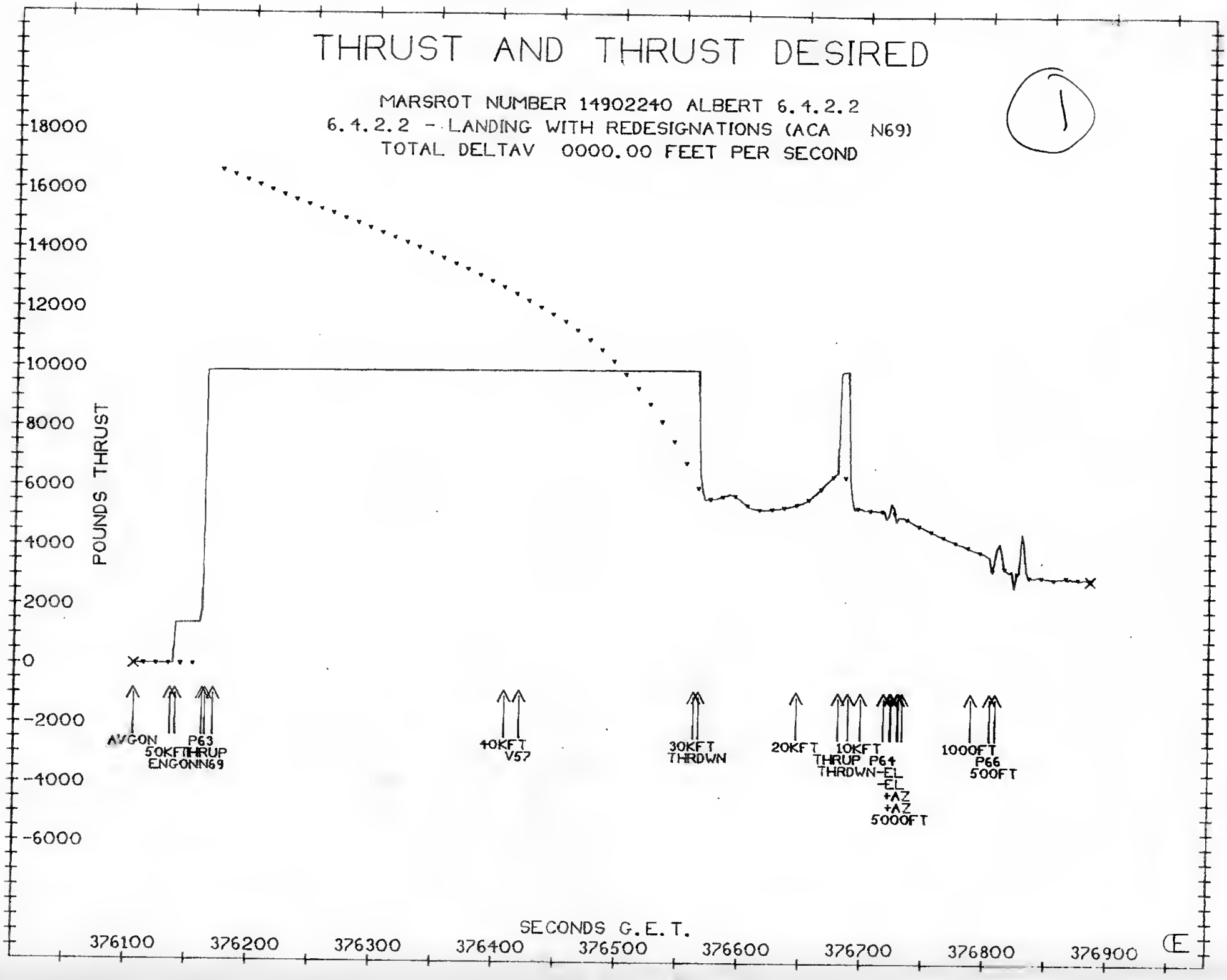
Allan Klumpp
Sharon Albert
Peter Volante
Don Millard
Dave Moore

THRUST AND THRUST DESIRED

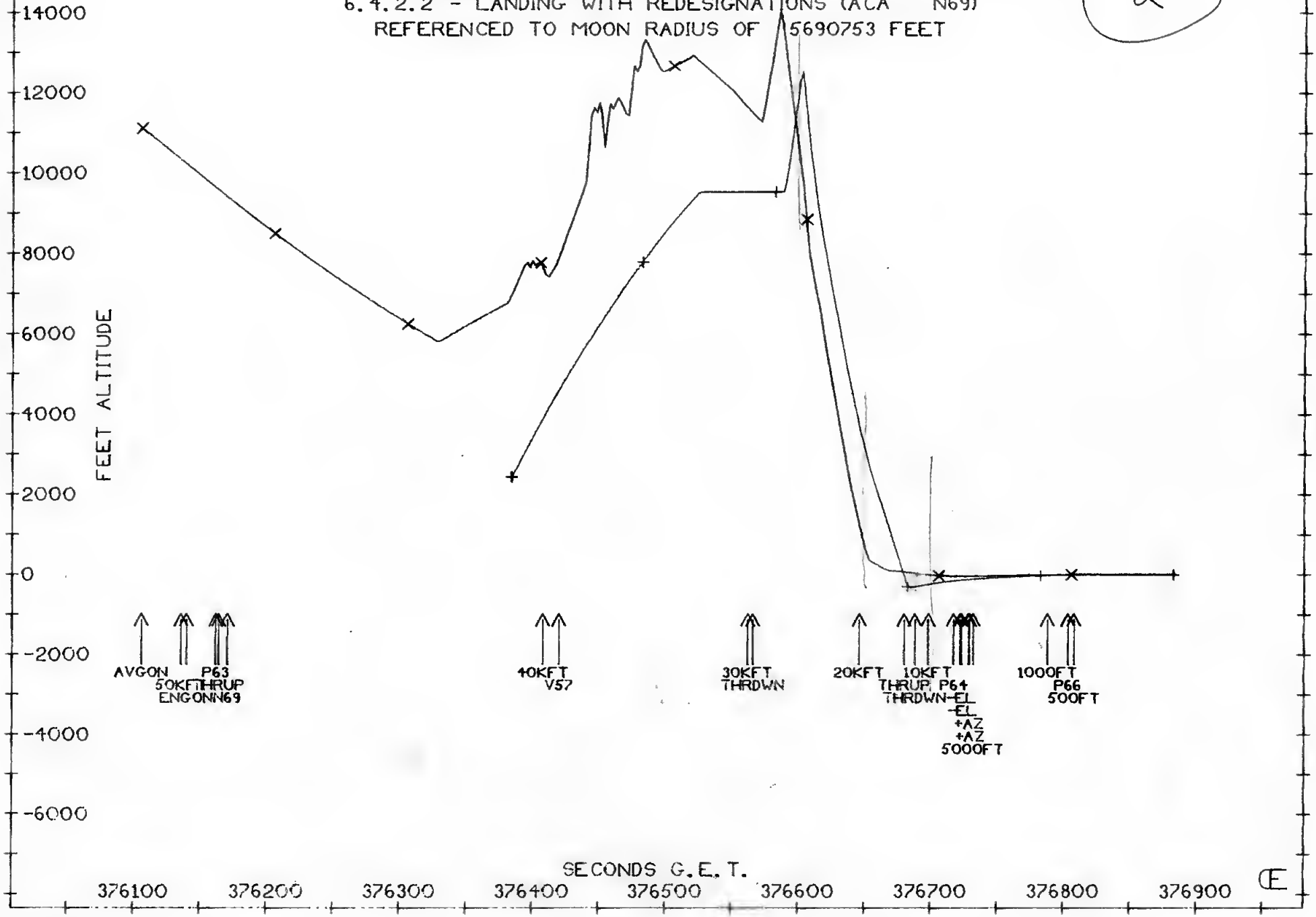
MARSROT NUMBER 14902240 ALBERT 6.4.2.2
6.4.2.2 - LANDING WITH REDESIGNATIONS (ACA N69)
TOTAL DELTAV 0000.00 FEET PER SECOND



REAL AND MODELED TERRAIN

MARSROT NUMBER 14902240 ALBERT 6.4.2.2
6.4.2.2 - LANDING WITH REDESIGNATIONS (ACA N69)
REFERENCED TO MOON RADIUS OF 5690753 FEET

2



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