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SUBJECT: Trajectory Analysis Aspects of Short Transearth Flight Times for the C' Mission Case 310

DATE: November 14, 1968

FROM: T. L. Yang

MEMORANDUM FOR FILE

The planned C' lunar orbit mission results in a substantial SPS fuel reserve compared to a typical Apollo lunar landing mission. Current plans are to use some of this fuel reserve in the TEI maneuver in order to decrease the transearth flight time to a value in the neighborhood of 56 hours (compared to 70 - 90 hours for a typical landing mission). Additional fuel reserve exists to provide an even shorter flight time should some time critical contingency require it. Accordingly, it is of interest to study TEI ΔV costs and Entry conditions for these short return times.

Using December 21, 1968 as the date of launch, patched conic trajectories were generated for Site II-P-2. Various transearth flight times ranging between 15 and 82 hrs were used to determine the TEI ΔV requirements, the costs in CSM fuel and the entry velocities. The earth-moon distance at the time of TEI for this launch opportunity is about 1250×10^6 ft (near the average) and increasing. The velocity requirements for other launch opportunities will differ slightly from these results because of the differences in earth-moon distance.

Figure 1 shows the TEI ΔV, the entry velocity and the excess CSM fuel weight as functions of the transearth flight time. The shortest flight time the CSM can achieve is about 32 hrs requiring a ΔV of 6750 fps at TEI and resulting in an entry velocity of 37100 fps. Figure 2 shows the limits on flight path angle at earth entry as functions of the entry velocity.* The acceptable flight path angle for the 32 hr flight is between 5.4° and 7.4°.

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*See "Preliminary High-Speed Entry Corridor" by P. E. Moseley, TRW Interoffice Correspondence 3353.1-13, Task A-191 File, August 23, 1968.

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The mission data used for these simulations are given in the Table following the figures.

Ta-lun Yang

2011-TLY-vh T. L. Yang

Attachments
Figures
Table

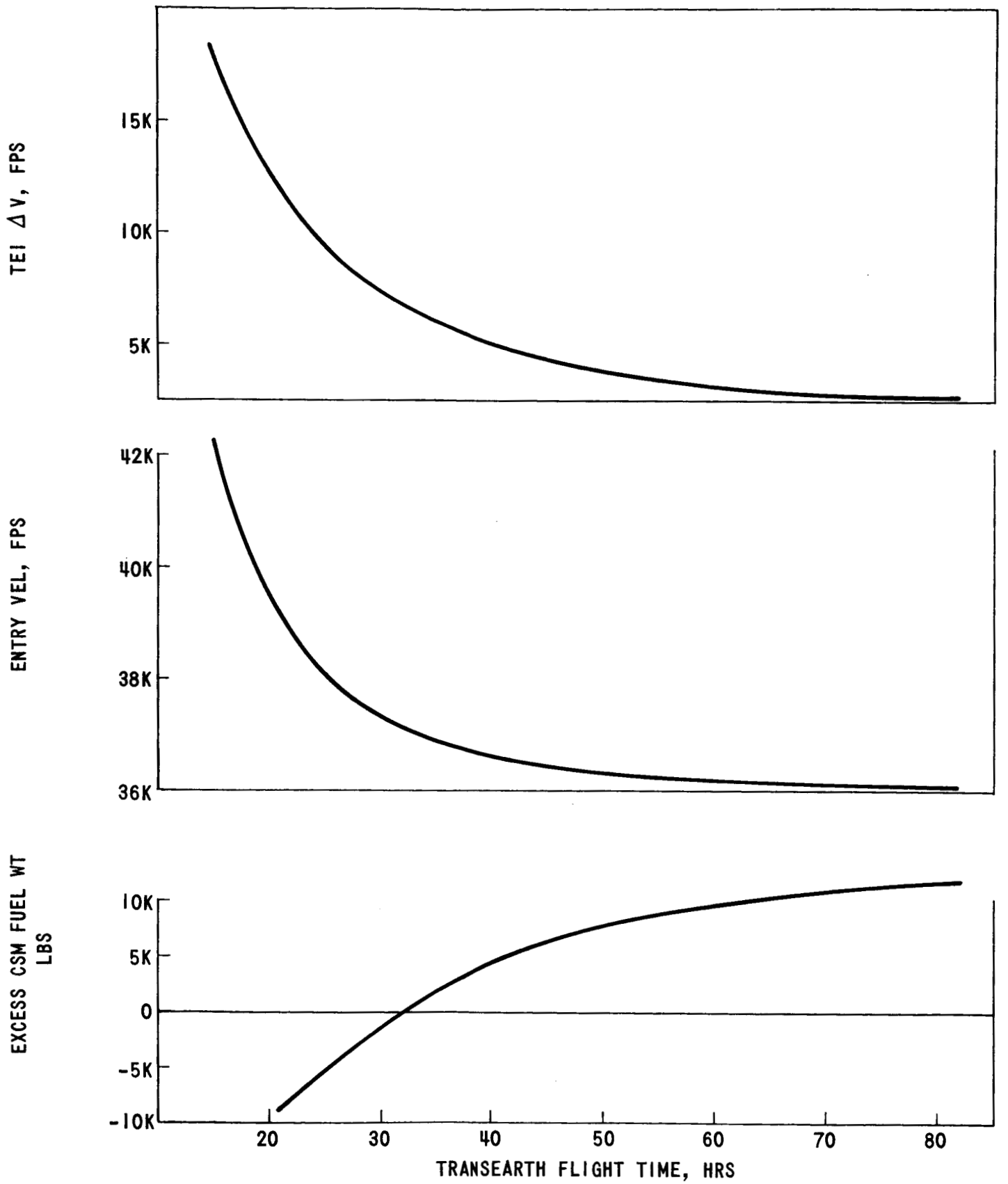

FIGURE 1 - TEI Δ V, ENTRY VELOCITY AND EXCESS CSM FUEL WEIGHT VS. TRANSEARTH FLIGHT TIME FOR MISSIONS TO 11-P-2 LAUNCHED ON DEC. 21, 1968

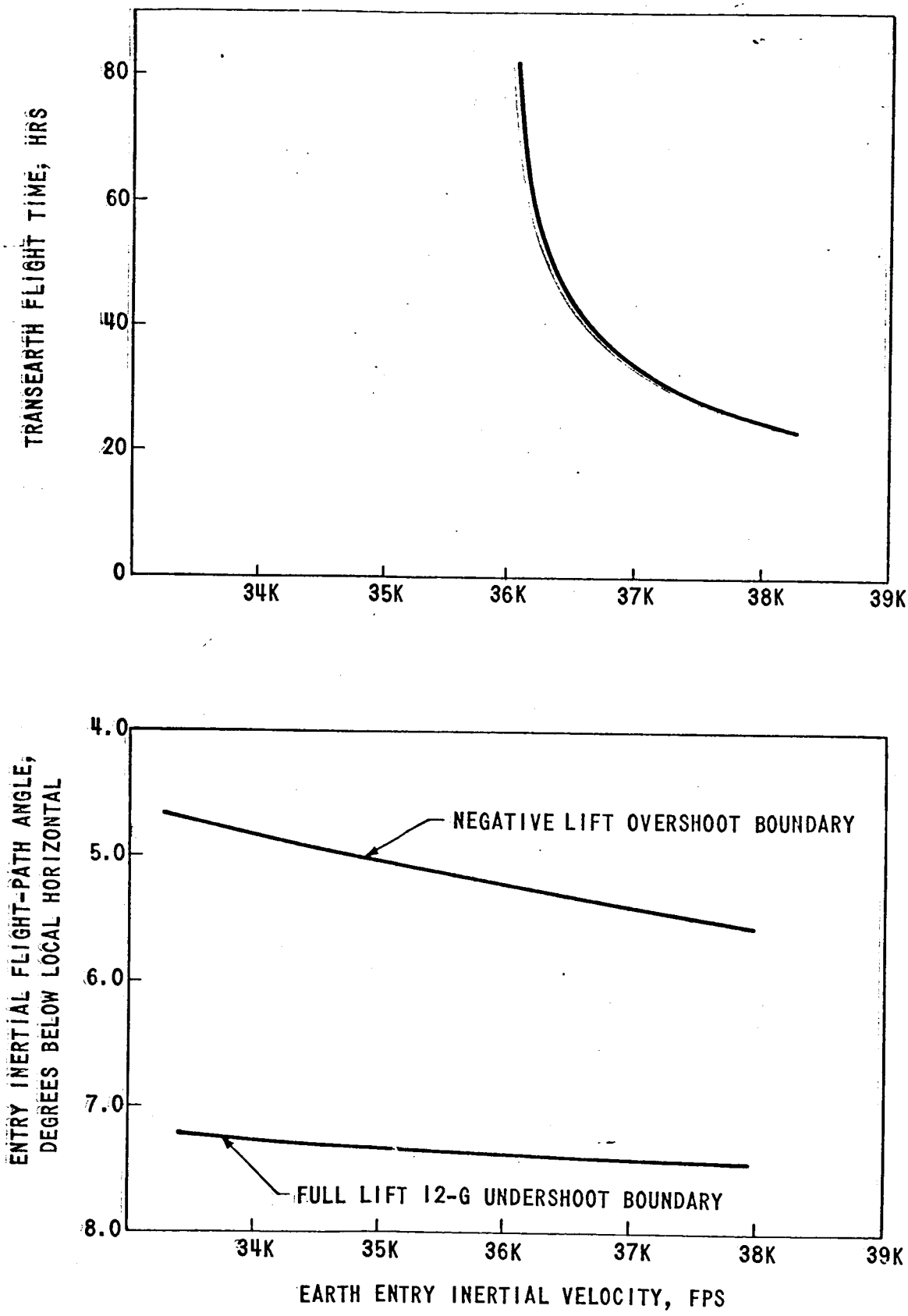

FIGURE 2 - ENTRY CORRIDOR

MISSION DATA

SITE: II-P-2 (LON = 2.725 LAT = 34.4)

TIME OF EARTH LAUNCH: December 21, 1968 12:30

VEHICLE WEIGHTS:

Total injected weight	68440 lbs
SLA	3900 lbs
CSM (with crew)	23500 lbs
SM SPS fuel (full tank)	39740 lbs
SM RCS fuel	1300 lbs

TRAJECTORY DATA:

Earth launch azimuth	+72°
Revolutions in EPØ before TLI	1.
LPØ azimuth over landing site	-78°
Revolutions in LPØ before TEI	10.

MIDCOURSE CORRECTION ΔV BUDGET:

Translunar phase	130 fps
Transearth phase	62 fps

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