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HUNTSVILLE, ALABAMA

Memorandum

TO : See Addressees

DATE: December 9, 1965

FROM : Chief, Guidance and Control Systems
Analysis Branch, R-ASTR-NG

In reply refer to:
R-ASTR-NG-130-65
WChubb/lw/876-1357

SUBJECT: Conflicting attitude constraints in the parking orbit phase of the AS-501 mission and the inability of performing J-2 engine restart in the first orbit.

1. Please reference the following:

a. Spacecraft System and Attitude Constraints for Mission AS-501, MSC, PS8/M-177/65, October 4, 1965.

b. Definition of Maximum Time Requirement Between J-2 Engine Starts in Flight, R-P&VE-PPF-64-M-220, September 23, 1964.

2. R-ASTR-NGD has recently been orally made aware of an attitude constraint by P&VE on the AS-501 orbital flight phase resulting from the J-2 engine restart bottle heating and cooling consideration. The bottle is charged with restart gas during initial flight phase of the S-IVB stage. The charge pressure is not sufficient, however, to initiate J-2 restart. It is therefore necessary to position the vehicle with Fin I down and the vehicle roll axis perpendicular to local vertical for 80% of the first orbit in order that the gas in the start bottle can absorb enough heat energy to be capable of J-2 restart. Conversely, if the bottle absorbs too much heat energy, the overpressure vent on the start bottle will expel mass (vent) and the bottle will have an insufficient gas mass to initiate restart. This attitude constraint is in direct conflict with the attitude constraints imposed on the orbital flight phase by MSC in Reference a. Attitude requirements from MSC for the corresponding flight phase state that the S-IVB stage should roll 90° when in orbit (Fin IV down) so that the thick portion of the heat shield will see neither the earth albedo or sunshine.

3. This conflict in attitude requirements was discussed in an informal meeting with Messrs. Long, Coates, and Thompson of P&VE, Winch and Ledford of AERO, Jones and Chubb of ASTR, and McDaris of IO. It was decided at this meeting that:

a. Mr. Winch would investigate the possibility of operating the S-IVB stage at a high propellant mixture ratio during the first 50-60 seconds of the S-IVB stage first burn, thus charging up the start bottle to a higher pressure and eliminating the need for the Fin I down position during 80% of the first orbit.

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b. Mr. Ledford would check with MSC to see how realistic the 90° roll requirement is for the two 501 orbits.

4. It should also be noted that as presently designed the J-2 start bottle heat input requirement prevents any possibility of J-2 engine restart during the first orbit (90 minutes). Reference b. discusses P&VE's position concerning the maximum time requirements between J-2 engine starts in flight and confirms the 90 minute coast requirement before J-2 restart is possible. It would be very desirable from R-ASTR-NG's point of view to have the capability of leaving during the first orbit for translunar and other second burn J-2 engine flight phases. This is desirable because:

a. System reliability decreases as a function of time.

b. Navigation errors, especially those resulting from low level LH₂ vents, increase significantly in the second and third orbits resulting in the need for an increased ΔV budget for midcourse correction. Figure 1 illustrates how navigation errors propagated through the first, second and third orbits result in increased ΔV requirements at the two hour translunar midcourse correction point. (The numerical values shown in Figure 1 have been extrapolated from previous navigation studies and illustrate trends and approximate numerical data. Studies are presently underway with updated platform information which will give more accurate results.) The fuel allotment for the translunar ΔV budget is equivalent to a ΔV of 47.2 m/s.

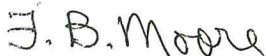
5. Resolution of the conflicting attitude requirements for the 501 mission is needed in the immediate future. Barring requests or direction to the contrary, it is hereby assumed that the conflict is resolved in the following manner. The 501 Mission Defining Document (MDD) which contains the S-IVB orbital attitude constraints was supplied to IBM on October 21, 1965. These orbital attitude constraints reflect only MSC requirements.



S. M. Seltzer

1 Enc:
Figure 1

Approval:



F. B. Moore
Chief, Guidance and
Control Division



Figure 1

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