BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Side Pointing vs. End Pointing for Workshop B - Case 620

DATE: March [illegible], 1968

FROM: J. Kranton

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(NASA-CR-95517) SIDE POINTING VS. END POINTING FOR WORKSHOP B (Bellcomm, Inc.) 3 p
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INTRODUCTION

The Advanced Studies Office of the Astrionics Laboratory at MSFC has completed a brief study of attitude control for Workshop B. As with the "Wet" Workshop, the salient problem is pointing an ATM to the sun. On Workshop B the ATM (not LM/ATM) is mounted at the base of the Workshop; that is, at the J-2 engine mount. The CMG being designed for the LM/ATM was chosen as the basic actuator for attitude control.

ATTITUDE ORIENTATIONS STUDIED

Two basic attitude orientations of Workshop B were examined. The first, called end pointing, has the long axis of the Workshop pointing to the sun with the ATM axially mounted (i.e., ATM optical axis parallel to long axis of the Workshop). The second, called side pointing, has the long axis of the Workshop lying in the orbit plane with the ATM radially mounted (i.e., ATM optical axis perpendicular to the long axis of the Workshop). In this configuration pointing the ATM to the sun is accomplished, as with the LM/ATM on the Wet Workshop, by first rotating about an axis perpendicular to the orbit plane until the sun line is perpendicular to the Workshop's long axis and then rolling the Workshop about this axis until the ATM acquires the sun.

ASSUMPTIONS

MSFC studied the attitude control requirements for these two attitude orientations for a 1 to 1 1/2 year mission at an altitude of 270 NM. A winter solstice launch was assumed with an orbit inclination of 50°. In such an orbit, the angle, beta, between the sun line and the orbit plane will vary ± 73 1/2 degrees over a one year period.

RESULTS

In assessing end pointing versus side pointing, MSFC investigated the effects of gravity gradient torque on the cyclic and bias momentum storage requirements of the CMG system. The effects of aerodynamic torque were estimated by assuming that its peak value was 10% of the peak gravity gradient torque. Determinations were made of the reaction thrust propellant needed for momentum dump.

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MSFC found that the end pointing orientation has the inherent disadvantage of producing large bias momentum which must be counteracted. The reaction thrust propellant required to cope with the bias momentum was found to be approximately 17,425 pounds per year. A second effect of the bias momentum is that for beta angles between 15 and 73 1/2 degrees, three 2000 ft.lb.sec. CMGs cannot stabilize the Workshop for a complete orbit without saturating. At a beta of 45°, the CMGs saturate in 1/2 an orbit. At least six CMGs would be required to accommodate the momentum storage requirements for a complete orbit for all values of beta.

With the side pointing orientation MSFC found that three 2000 ft.lb.sec. CMGs would be quite adequate for coping with the momentum storage requirements. If reaction thrust is used for bias momentum dump, approximately 1555 pounds of propellant per year would be required. Should the gravity gradient momentum dump schemes currently being developed by MSFC be successful, this propellant requirement would almost vanish.

ASSESSMENT AND COMMENT

1. For missions of one year duration, the full range of beta variation is experienced. The MSFC results based on the winter solstice launch can therefore be taken as representative of all launch dates.

2. MSFC's numerical results have been verified.

3. Disadvantages of end pointing include

   (a) Large fuel requirements for CMG momemtum dump.

   (b) Six CMGs are required as opposed to three for side pointing.

   (c) Frequent momentum dump operations; i.e., twice per orbit in worst case. This requirement imposes a heavy operational constraint.

   (d) Additional contamination risk. Fuel reaction products may jeopardize solar array and experiment performance.

4. MSFC's recommendation to employ the side pointing mode is correct based on control, experiment and operational considerations. Compelling reasons based on other considerations are required to alter the MSFC recommendation.

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