(NASA-CR-154795) INVESTIGATION OF PAYLOAD EFFECT OF CANTING THE S-IC ENGINES (Bellcomm, Inc.) 6 p

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SUBJECT: Investigation of Payload Effect Of Canting The S-IC Engines - Case 310

DATE: May 25, 1967

FROM: W. R. Thomson

MEMORANDUM FOR FILE

Attention has been focused recently on the finding that the Saturn V Emergency Detection System is incapable under certain malfunction conditions of giving the crew sufficient warning to abort, before vehicle loss. Reference 1 contains a brief review of the problem and additional relevant bibliography.

A malfunction condition of concern here is the case of loss of thrust of one of the outboard F-1 engines during a period of flight from 50-80 seconds after launch, under certain wind conditions. This case of vehicle loss during these flight times and wind conditions could be alleviated if it were possible to fly the vehicle with the F-1 engines canted through the vehicle's center of gravity.

Accordingly computer runs were made to determine the payload loss into lunar orbit of canting the engines through a series of angles. The results are seen in Figure 1. Unfortunately the S-IC engines can only be gimballed through a square pattern of 5°9', which implies a maximum gimbal angle at the corner of the pattern of approximately 7.3°. At liftoff the center of gravity of the launch vehicle subtends an angle of 9.4 between the vehicle's center line, and a line to the point about which the engine gimbals. At the critical period from 50 to 80 seconds into the burn the center of gravity has moved to subtend an angle of 9°, and at the end of S-I burn the angle is 5.3. Canting the engines through 9° for the duration of the S-IC burn would cost 2500 lbs. into lunar orbit.

Figure 2 shows the reduction of moment about the vehicle's center of gravity effected by canting through the angles shown, in the absence of wind forces.

Some additional runs were made to determine the effect on payload of canting the engines for a specified period (usually 20 seconds) occurring at different times during the S-IC burn. The results can be seen in Table

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FACILITY FORM 602

## REFERENCES

1. Loeffler, T. F., Saturn V E.D.S. Effectiveness Study, Bellcomm Memorandum for File, March 22, 1967.

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| TIME OF CANTING (SECS) | PAYLOAD LOSS (LBS) | PAYLOAD LOSS/SEC OF CANTING |
|---|---|---|
| 0 - 20 | 266 | 13.3 |
| 20 - 40 | 228 | 11.4 |
| 40 - 60 | 202 | 10.1 |
| 50 - 80 | 302 | 10.0 |
| 60 - 80 | 203 | 10.1 |
| 80 - 100 | 215 | 10.7 |
| 100 - 120 | 236 | 11.8 |
| 120 - 140 | 275 | 13.7 |
| 140 - 157 | 186 | 10.9 |

TABLE 1 PAYLOAD LOSS DUE TO CANTING ENGINE THROUGH 8° IN PERIODS SHOWN

$\left( \frac{\text{[illegible]}\ \beta}{\text{[illegible]}\ 0^\circ\ \text{[illegible]}} \right)$ vs. $\beta$

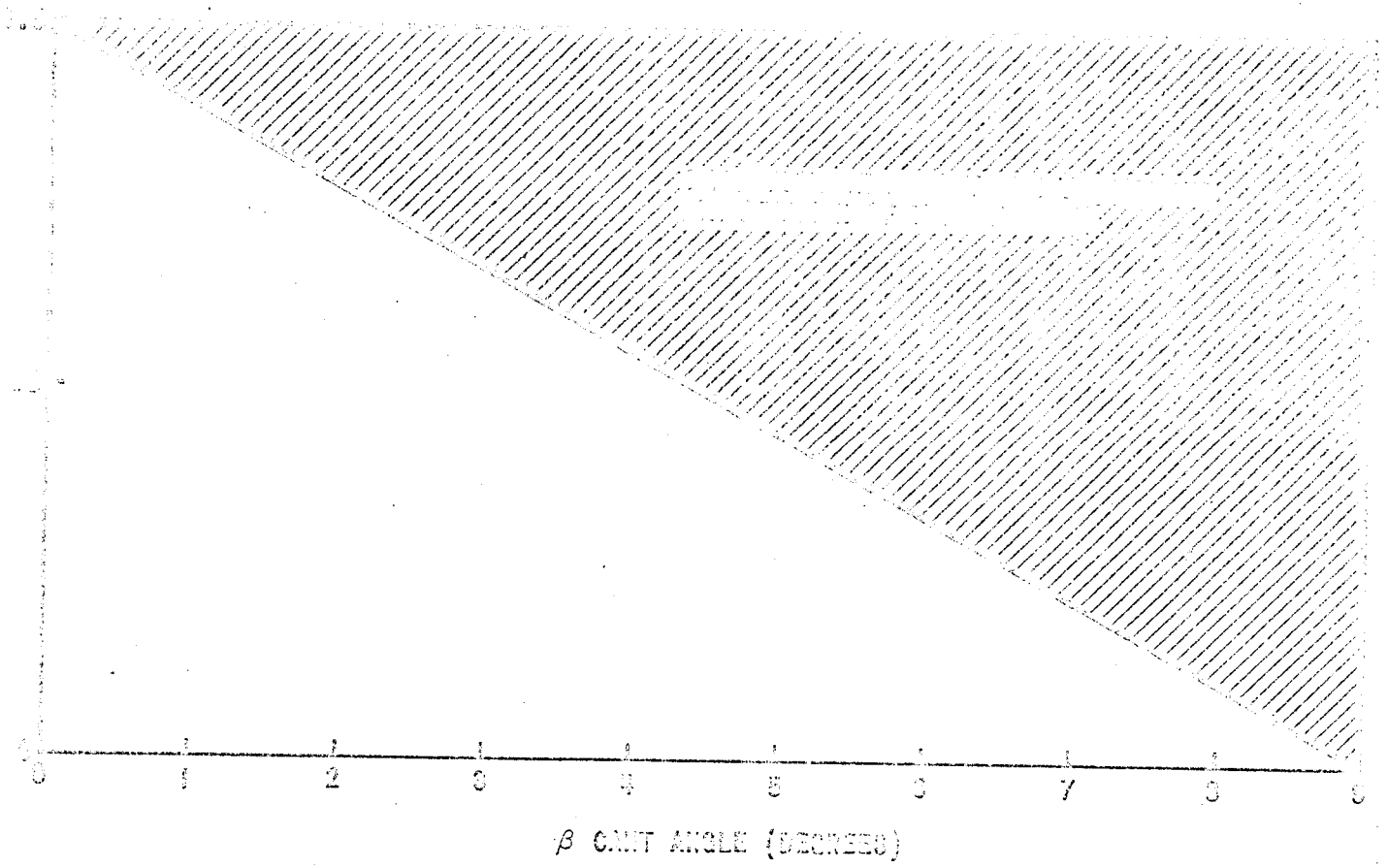


FIGURE 2

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Subject: Investigation of Payload Impact Of Canting The S-IC Engines

From: W. R. Thomson

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