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MEMORANDUM

2 September 1968

From: Code 5614 NRL.

To: SAFASS Wm Boenning

Subj: Additional costing details relative to Enclosure #2 of NRL ltr of 20 August 68, BYE-51911-68.

I. Significance of the Gravity Gradient Stabilization Problem isolated in Mission 7105.

A. Mission 7105 flight experience presented evidence which had heretofore been unavailable to the community, concerning the instabilities of the attitude stabilization systems when they are subjected to the orbital sunlight/darkness conditions. Late in Fy-68 these effects were isolated and the stabilization systems being readied for Mission 7106 were judged to be inadequate to fulfill more rigorous demands for Mission 7106. These demands for in-flight satellite attitude stabilization are imposed by the collection antennas being used and more importantly by the requirments for station-keeping or controlled separation between the four satellites. In Mission 7106 (1) for the first time in this Program it will be possible with digital data capability at the ground based data collection sites, to monitor all four of the satellites at the same time. This capability will allow observation

B. Increased capability for the attitude stabilization is also demanded for Mission 7106 in order that the four satellites may be controlled in their flight separations by use of on-board thruster systems.

C. Improved real-time attitude monitoring of the satellites for Mission 7106 will be imposed by the requirement to maintain close

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orbital spaceings. Even though the on-board thrusters are very low-level devices the delay of several days after a thrusting maneuver xxxxxxxxx to discern the change in spaceing can result in a very long response time to the station keeping situation. xxxx Four satellites xxxxxxxxxxxxx required in a tight in-line cluster in orbit Mission 7106 has severely increased demands for fast response in the thruster action and also in the ground based data analysis capability which will support the flight systems in order for the full operational capability of these operational collection systems to be attained.

XXX O. It has thus been necessary to greatly enhance the flight system design for GGS and on-board thrusters for Mission 7106, at a time late in the development cycle. NRL thus was faced with a schedule pace-setting R & D effort late in FY-68 which causeda delay in the launch schedule for Mission 7106. In the 20 August 68 NRL Budget paper it was pointed out that two types of Costs were contained in Enclosure #2: (1) direct costs associated with the Gravity Gradient Stabilization technical difficulty and xxx (2) other costs which were delayed into FY-69 because of the schedule delay. Inx order to clairfy these Items from Enclosure #2 they will be treated sequentially as follows:

New type of GGS boom material utilizing an interlocking type construction was undertaken by two companies simultaneously to reduce the risk in further schedule delays and to assure the production of a usable boom material in the time available. The interlocking construction will greatly increase the axial rigidity under orbital thermal conditions, which are the limiting factors in the system as demonstrated in Mission 7105. The first company under NRL and NASA contract
Westinghouse has/a designxxx a boom material which appears satisfactory if it can be manufactured in the required lengths and this contract is given in Item #1 of the reference (a), Enclosure #2. In addition it has been pointed out that a second contract for $84K has been awarded to the Spar Company (an outgrowth from the DeHavialland Co of Canada) to design a material and mechnaism for deployment (Called BiStem) which now seems to have the required performance characteristics for Mission 7106A,C and D.

Item #2 is the cost of integrating this Bistem mechanism into the Philco 3-axis stabilization GGS/Flight system.

Item #3 is the SOW cost of commercially carrying out the Thermal Balance work which will result by incorporating the new boom material into a design which already been completed in the Satellite thermal balance.

Item #4. Was the cost of integrating into the G.E. design for their Rod-Wheel three-axis GGS semi-active system, the Bistem material for a flight in Mission 7106B.

Item #5 is a cost of the category which had been budgeted for in late Fy-68 but due to the delay in the flight schedule has now been necessary to be carried overinto FY-69. The Thermal/Vacuum test of the flight payloads are carried out in the NRL Vacuum chambers where it is necessary to subject them to the conditions of outer space including the solar simulation tests. These tests take about 30 days per payload at a cost of $2000.oo per day.

Item #6 is the investment costs which will be required to support the operational Flight systems of Mission 7106 in the face of the increased demands for timely information of in-flight payload attitude. These demands stem from (1) need to allow quick response for thrusting action for station keeping purposes on the payloads, (2) the demands imposed by more directional collection antennas to be used on the payloads. The Pulse Code Modulation(PCM) demodulators are required at the data collection sites so that the data-link systems may be monitored during the actual collection of data, a demand imposed by the new Delayed-Command interrogation system to be used in Mission 7106 for the first time. The payload is remotely interrogated and in order that the satellite (tasking) collection systems actually in use during collection of data be unambiguously known it is mandatory that the PCM data of the payload be monitored. This will be proof positive of the state of Data system command so that it will no longer be necessary to determine the particular collection system in use by the data content alone.

Improved computor system for reduction of GGS data will provide the quick reactionacapability needed to operationally support the orbital spacing requirements discussed above. This is an investment cost for the NRL Satellite Techniques Branch and maybe should have been entered in Category #III Facilities costs (Investment) instead of the Operational Services IV Category.

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Note* SUMMARY OF FLIGHT EFFECTS NOTED FROM MISSION 7105:

1. When the payload was subjedted to a cyclic solar illumination and then was shaded by the earth, the long booms tended to bend. On some occasions the individual boom motions canceld out and the payload remained relatively quiesent and stabilized. However on other occasions the individual boom flexures reinforced each other and the effect was rather violent...causing rapid Yaw rotation and on the most severe occasions causing the payload to actually trun upside down for a period of over one month. This inverted attitude rendered this particular payloadd max operationally usless since the collection antenna systems are oriented downward at an angle of about 40° from the horizon.

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