XI.02

AERO-ASTRODYNAMICS LABORATORY
BIMONTHLY PROGRESS REPORT

August and September 1967

INDEX (Continued)

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I. TECHNICAL AND SCIENTIFIC STAFF

1. The four earth orbital aeronomy experiments, including the passive sphere ensemble, the paddlewheel/diffuse sphere/smooth sphere combination, the densitometer and a mass spectrometer, have been investigated to determine their capabilities and limitations compared with similar concepts that have been proposed or performed. The results indicate that the Odyssey package constitutes a relatively ambitious program that can provide much useful atmospheric data in the poorly charted altitude range from about 140 km to 240 km. Thermal analyses have continued to investigate different surface finishes and materials and to include spin rate effects.

Informal discussions with Dr. Fellows and some members of the OSSA Planetary Atmospheres Committee were held in August 1967. This first contact and subsequent critical analysis by some members of the committee established the recommendation that we complete our analysis and prepare for a formal presentation to the Planetary Atmospheres Committee. (Few)

2. Early Extravehicular Engineering Activities (EVEA)

The mid-term presentation on Contract NAS8-18128 "Extravehicular Engineering Activities (EVEA) Program Requirements with Emphasis on Early Experiments" was given by North American Aviation, Inc., at MSFC on August 9, 1967. During the afternoon the MSFC-MSC contract management panel in a meeting chaired by the Contracting Officer's Representative, Chester May, R-AS-VO, gave a critique of NAA's efforts to date. Again NAA was made aware of study deficiencies which had previously been called to their attention. NAA promised to comply with NASA contract directives. The difference between experimental EVEA and EVEA experiments was mutually defined.

Twenty technical/scientific experiments (requiring EVEA) proposed by North American Aviation, Inc., under Contract NAS8-18128 "Extravehicular Engineering Activities (EVEA) Program Requirements with Emphasis on Early Experiments," were reviewed the first of September. NAA intended to detail these proposed experiments to be performed in the 1971-1974 time frame for Phase II of the contract. Only six of the twenty experiments could be recommended to the COR as being feasible, timely, and furthering EVEA technology.

In a subsequent meeting with NAA at Downey, California, the COR determined -- based on the experiment recommendations of his MSFC-MSC management panel -- that the contractor has still not fulfilled Phase I contract requirements even after earlier discussions with him on this deficiency. Resulting was a change in NAA technical key personnel and a five-month extension of the study contract at no further cost to the government. Phase II will begin about November 1967. (Nathan)

3. The Newtonian flow formalism developed in earlier work was applied to compute pressure distribution and polars for several surfaces. A paper was prepared for presentation at the forthcoming Fifth Technical Meeting of the Society of Engineering Science.

The current computer program for piecewise evaluation of covariance functions was studied in detail as part of the involvement in the crossed-beam undertaking.

A note is being written on the wind component measurable by crossed-beam experimentation.

II. PROJECTS OFFICE

1. Engine-Out and EDS Analyses

A number of MSFC-MSC Meetings have been held to resolve the Apollo/Saturn engine-out and vehicle breakup problems. Work has been concentrated on AS-503 and AS-504. The following is a summary of our present status:

The differences in the spacecraft loads on AS-503 and AS-504 are not as great as presented earlier. An error, a sign convention of a yaw acceleration term, in the spacecraft structural equations used in MSFC/TBC simulations, was uncovered. In correcting this error, the spacecraft structural loads were reduced approximately 10 percent. With the corrected data, based on the limited cases examined, the AS-504 spacecraft has a 1.05 factor of safety during the maximum "q" region for one-engine-out. The spacecraft criterion is to maintain a 1.1 safety factor to assure the capability of always being able to abort from a malfunctioning vehicle. Since all indications are that the spacecraft is somewhat marginal for one-engine-out condition, MSC is planning spacecraft component testing. Test of the complete stacked spacecraft configuration may also be conducted. To support these tests and MSC/NAA detail stress analyses, MSFC is generating additional data based on the latest spacecraft weights.

The results of the launch vehicle tension structural tests of critical joints are showing that a greater launch vehicle capability exists than earlier calculated. This should also help resolve the problem of vehicle breakup at abort.

Plans are to have another joint MSFC/MSC Meeting when the state of the current activities (i.e., S/C structural testing, detail analyses by MSFC/TBC and MSC/NAA, etc.) have progressed sufficiently to aid in formulating a firm course of action.

2. S-IB Aerodynamic Data

The Saturn IB, CSM configuration aerodynamic data have been revised to be compatible with the current configuration and recent wind tunnel stability tests. The basic effects are a forward shift in center of pressure (CP/D) and a reduction in normal force coefficient, C_{N_α}. These data have been impacted within MSFC, and should not disturb the Saturn IB program. These data will be used to verify design and to determine possible flight restrictions.

3. Saturn IB Minuteman

CCSD has completed a three-month preliminary design effort of the Saturn IB Minuteman Configuration. Using the latest weights and design concept, i.e., M/M mounted parallel with the nozzles canted 7.5 degrees, the performance increase due to the Minuteman strap-on is $\sim$ 6,000 to 6,500 pounds. Aero-Astrodynamics Laboratory areas requiring further study include vehicle control, Minuteman plume and shock impingement, Minuteman flutter, aerodynamic heating, S-IB/S-IVB separation and EDS crew safety. Plans are to conduct wind tunnel tests within the next six months. These include pylon flutter, base heating and launch deflector, detail loads, acoustics, and refined static stability and aerodynamic heating.

4. Flight Limits Subpanel (FLSP)

The Tenth Flight Limits Subpanel meeting was held at MSC on July 26, 1967. The minutes are documented in memorandum 67-FM-13-319, dated August 29, 1967.

5. AAP Cluster

Work continued on the analyses of the first cluster mission in payload performance, orbital lifetime analysis, and tradeoff studies of orbital operations involving power, thermal, and attitude control conditions. The revisit mission AAP-3A between Mission A (AAP-1/2) and Mission B (AAP-3/4) was eliminated.

Payload improvement studies completed for AAP-2 and AAP-4 include investigation of jettisoning the SLA/NC during ascent as an integral unit by use of the LET jettison motor. Results show adequate clearance and a payload improvement of 2900 pounds. Payload improvement considerations for the AAP-1 and AAP-3 include the use of the CSM as a third stage to orbit and/or the use of a lightweight short SLA. Another approach is to reduce the required CSM weight by the elimination of the SPS system. Various meetings have been held with MSC on performance improvements mainly through the Mission Requirements Panel and its Guidance, Performance and Dynamics Subpanel. Work is in progress for a meeting with Mr. Mathews on the AAP cluster in mid-October. Present lifetime studies show that the insertion altitude for the AAP-2 (OWS) can be reduced from the present baseline of 260 n.mi. This result stems from the improved prediction of the solar activity at launch that can be made as we get further into the solar cycle, the reduction of the solar activity as the launch schedule is adjusted to later flights, and the reorientation of the OWS solar array during storage to a position normal to the OWS centerline. The decision to reorient the OWS solar array during storage was based upon the desire to store the OWS vehicle in a local vertical (gravity gradient) orientation to save propellant of the OWS Auxiliary Attitude Control System (AACS).

III. ADVANCED STUDIES OFFICE

A. Systems Analysis Section

The final review of the DAC study, Contract NAS8-21051 "Use of Large Solid Motors in Booster Applications," was conducted at MSFC on August 30, 1967. One major task, a detailed comparison of TVC systems for application to the 260" SRM/S-IVB launch vehicle studied previously, resulted in recommendation of a movable nozzle TVC over a liquid injection system. The results of the other major task in the study, the preliminary design and evaluation of a 156" SRM/S-IVB launch vehicle, indicated that a cluster of four 156" SRM's with approximately 1.12 million lbs of propellant each was the most desirable configuration for a boost stage. This design seems feasible, is cost effective, and yields a payload of 108,300 into a 105 n.mi. orbit. No major design problems were encountered. DAC performance on this study was quite satisfactory, and sufficient technical depth was achieved to make the results meaningful. The final report has been reviewed, and comments have been transmitted to DAC through the COR.