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APPLICATIONS TECHNOLOGY SATELLITE

GRAVITY GRADIENT STABILIZATION SYSTEM

Eighteenth Quarterly Progress Report

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EIGHTEENTH QUARTERLY PROGRESS REPORT
FOR THE
APPLICATIONS TECHNOLOGY SATELLITE
GRAVITY GRADIENT
STABILIZATION SYSTEM

1 November 1968 through 28 February 1969

CONTRACT NO. NWS 5-9042
FOR THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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SECTION I

INTRODUCTION

The Space Systems Organization of the General Electric Company has contracted to provide the NASA/Goddard Space Flight Center with gravity-gradient stabilization systems for three Application Technology Satellites and to provide flight analysis and data reduction support when each system is flown. One system was designed for an orbit at 6000 nautical miles and the other two were designed for synchronous orbit. Each gravity gradient system includes a set of primary booms, a combination passive damper/damper boom, a TV-camera system, a solar aspect sensor, and a power control unit. Two sets of ground test equipment were furnished for checking the gravity-gradient stabilization systems.

This report documents the status of the design, test, and flight analysis of these ATS gravity-gradient stabilization systems for the period from 1 November 1968 through 28 February 1969. Due to the fact that an estimated 97% of the program has been completed as of the date of this report, the documentation format has been simplified to the presentation of an event summary for each system.

During the reporting period, there was no activity on ATS-2, the ATS-4 final flight report was published and distributed, GE interlocked damper boom elements were developed, tested and incorporated into the ATS-E CPD/damper boom system, a final report on the investigations of the ATS-E hardware audit team

was published, the ATS-E TV flight cable was lengthened to accommodate relocation of components on the spacecraft, GE participated in a series of design reviews at Westinghouse and conducted a parts selection review on the Westinghouse primary boom system and GE thermal flutter investigations were concluded.

SECTION 2
SUMMARY OF EVENTS

2.1 ATS-2

(no activity)

2.2 ATS-4

17 October	AST-4 reentered at 28.5 degrees South Latitude, 12.8 degrees West Longitude.
25 October	An ATS-4 flight events summary was prepared and delivered at the request of GSFC.
28 October	The RTDT containing data on initial primary boom deployment (26 September) was received from GSFC.
8 November	Additional SAS data was provided by ATSOCC, via teletype to GE, for reduction and analysis. Data was handled on a rapid turnaround basis using same techniques as for operational data.
11 November	More SAS data was provided by ATSOCC and reduced by GE using same procedure as on 8 November. Data for 8-11 November covered days 228-231.
2 December	With the concurrence of the GSFC Technical Officer, a decision was made to restrict the final ATS-4 flight report to data received to date. The report has been delayed due to lack of receipt of RTDT data and ephemeris data for days 223-237 and 275-291.

Verbal discussions with ATSOCC will form the basis for discussion of events during the missing data periods.

- 18 December The ATS-4 Final Flight Report was submitted to Technical Publications for publication and distribution.
- 6 January Twenty-five copies of the ATS-4 Final Flight Report were delivered to GSFC. Activities in support of ATS-4 were terminated.

2.3 ATS-E

- 8 November GE test representation at Hughes was suspended for the duration of spacecraft rework; rework is to include the addition of an L-band communication system, a magnetometer and a magnetic torquing coil system. All gravity gradient equipment, at this time, has completed EPC checkout and is aboard the spacecraft preparatory to initiation of system tests. System test has been scheduled to resume in early February 1969.
- 11 November Requirements for modification of the ATS-E flight TV cable were obtained from Hughes Aircraft; connectors for the new cable will be reclaimed connectors from the previously supplied cable.

14 November The final report of the ATS-E hardware audit team was published and delivered; the report was delayed to include results of a final inspection of the damper boom at Hughes Aircraft Company.

27 November GE was represented at a design review of the Westinghouse primary boom system at Westinghouse.

3-5 December GE was represented at a Symposium on Gravity Gradient Attitude Stabilization, sponsored by the Air Force Systems Command, in Los Angeles, California. Several papers on thermal flutter have stimulated renewed concern over potential effects on ATS-E.

10 December A summary letter of recommendations and action items resulting from the 11/27/68 design review at Westinghouse was forwarded to GSFC.

10-11 December GE was represented during qual vibration tests at Westinghouse.

12 December GSFC was notified of an apparent incompatibility between the Westinghouse boom system and the PCU field driver circuit.

18 December GE initiated the preparation of a second interlocked damper boom demonstration unit (on GE funds) with the objective of stimulating renewed interest in the proposal submitted on 4 October and denied on 24 October.

2 January A letter providing the status of a GE review of the Westinghouse parts list was forwarded to GSFC; 27 additional drawings were requested to complete the review.

3 January Technical discussions on the subject of thermal flutter were held at GSFC with H. Hoffman, H. Price and B. Zimmerman in an attempt to establish a control law for momentum simulation of boom thermal flutter. Due to the intractable number of variables and uncertainties associated with the phenomenon, no control law was established. General agreement was obtained, however, that a representative sampling of momentum impulses (correlatable to thermal flutter) and simulated by momentum wheel disturbances in the ATS Math Model could provide valuable insight into system performance consequences of thermal flutter.

10 January PIR 1450-001, "The Feasibility of Simulating the Possible Thermal Flutter Effects on ATS-E Attitude Performance," by R. Moyer, was published.

10 January The GE interlocked damper boom was demonstrated at GSFC and samples of the boom were left with GSFC for stress analysis.

16 January	The ATS-E TV cable was received from Lear-Siegler but the keyway locations were wrong; the cable is being returned to Lear-Siegler for corrective action.
17 January	The 27 additional Westinghouse drawings required to complete the parts review were received.
21 January	GE was given a verbal go-ahead by D. Fordyce of GSFC to proceed with the development and test of an ATS-E interlocked damper boom.
27 January	A "fact-finding" session on the GE interlocked damper boom was conducted at GSFC. A five-foot specimen of the interlocked boom was provided to C. Staugaitis for examination and analysis. A revised proposal was submitted.
8 February	The first attempt at deployment of prototype interlocked boom elements failed; a subsequent decision was made to add rollers to alleviate problems encountered. The tooth pattern will also be modified to further reduce the probability of tape cracking.
12 February	The incompatibility between the Westinghouse boom system and the PCU field driver circuit was resolved; Westinghouse will eliminate the cross-circuit redundancy that produced the potential overload.

12 February PIR 1450-004, "Report on Thermal Flutter Investigations," by R. Freelin, was published. This PIR summarizes the analysis which supports the GE contention that thermal flutter is more likely to occur in the damper booms than in the primary booms.

13 February The ATS-E TV cable was shipped to Hughes after correction of keyway locations be Lear-Siegler.

13 February The flight CPD/damper boom was ordered returned from Hughes to GE for incorporation of digitated flight tape elements.

14 February Specification SVS 7563 for the Gravity Gradient Digitated Damper Boom Assembly for Project ATS-E was published and accepted by GE and GSFC management representatives.

18 February A preliminary summary of the Westinghouse Boom System Parts Evaluation was published as PIR 1342-i46.

19 February A series of successful pre-vibration prototype deployment tests was completed on the GE interlocked damper boom; this unit incorporated the new roller design and modified tooth pattern.

19 February GE participated in a design review of the Westinghouse primary boom system.

21 February Qual vibration and post-vibration functional testing were completed on the GE interlocked damper boom.

Vibration tests were run with the damper boom mounted to the prototype CPD.

- 26 February Retrofit of the ATS-E flight damper booms with the edge-interlocking booms and pre-vibration deployment were successfully completed.
- 27 February Flight level vibration and post-vibration functional deployment tests were successfully completed. Vibration tests were run with the damper booms mounted to the prototype CPD.
- 27 February "Results of Simulated 'Thermal Flutter' on the ATS-E Spacecraft," by Q. Schaffer, was published.
- 28 February The GE interlocked damper boom assembly and CPD were assembled, packed and shipped (38 days after go-ahead from GSFC).
- 28 February PIR 1342-152, "Completed Evaluation of Westinghouse Boom System," by E. Emery, was published. This presents final results of parts evaluation by GE of parts selected for use in the Westinghouse Boom system.

SECTION 3

NEW TECHNOLOGIES

There are no new technologies to report for this quarter. Because the development phase of the program has been completed, there will be few opportunities to uncover new technologies. However, GE will continue to provide surveillance over the ATS efforts and will report any new technologies as defined by the general provisions of the contract.