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INSTRUMENTATION FOR ACCELEROMETER DENSITY MEASUREMENTS.(U)

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INSTRUMENTATION FOR ACCELEROMETER
DENSITY MEASUREMENTS

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Final Report
December 1974 - September 1978

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AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A major part of the work performed under this contract has been directed toward engineering development, fabrication, testing, calibration and field testing of improved AFGL rocketborne falling sphere systems used to determine accurately atmospheric density within the altitude range 35-150 km. In this report a summary is given of rocket launches carried out at various sites using hardware and instrumentation developed and fabricated under this contract. The effort included engineering and field support on both the		

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AFGL/Hi-Ball falling sphere system (7 inch diameter sphere instrumented with omnidirectional transit-time accelerometer) and the AFGL/PZL Densitometer (10 inch diameter sphere with piezoelectric drag sensors in triaxial configuration).

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FOREWORD

This document is the final report required under AFGL Contract No. F19628-75-C-0051 describing the contract effort to develop and fabricate improved falling sphere accelerometer density systems.

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INTRODUCTION

Contract No. F19628-75-C-0051 was initiated with the Aeronomy Laboratory, LK, of the Air Force Geophysics Laboratory (AFGL), formerly called the Air Force Cambridge Research Laboratories (AFCRL), Hanscom Air Force Base, Bedford, Massachusetts, on 1 December 1974, and was completed on 30 September, 1978. This project represents essentially a continuation of the work involved in Contract No. F19628-72-C-0283, which existed with the Aeronomy Laboratory of AFCRL from 15 May, 1972 to 30 November, 1974.

SCOPE

It was required that this contract supply the necessary personnel, facilities, services and materials to participate in research and development leading to the fabrication of falling sphere payloads for use in rocket borne experiments directed toward the determination of atmospheric density within the altitude range of 35-150 km. Included therein are (a) development of omnidirectional accelerometers used to detect atmospheric drag during the free flight of the sphere and the development of improved alignment and calibration procedures; (b) fabrication of the falling sphere payloads, with appropriate hardware, to interface with 9 inch O.D. rockets and release mechanisms required to deploy a 7 inch or 10 inch diameter sphere during flight; (c) performance of vibration, shock and other environmental tests to evaluate electro-mechanical integrity of the electronic subsystems; (d) performance of payload integration work during the launching of the density experiments at the sites designated by the Air Force Geophysics Laboratory; (e) participation in telemetry support phases during the rocket launching; and (f) the collection and processing of flight data when required.

DESCRIPTION OF WORK

The first production during the life of this contract came with the launching of a ten inch sphere at White Sands Missile Range, New Mexico, utilizing a University of Utah transit time accelerometer, through the medium of a Ute-Tomahawk Rocket, No. A09-407-1. The payload installations for this vehicle included: C-band radar transponder, timers, batteries and associated support gear; ejectable nose cone and Yo-Yo despin unit.

A second mission was carried out from the NASA Launch Facility at Wallops Island, Va. on 17 January, 1975 in support of the AFGL Post Aladdin Program. This sphere payload, which was No. 79, contained Accelerometer No. WI-25 and Sphere No. AF-1, and was shared with a chemical (TMA) payload. Excellent experimental results were acquired.

A second 7 inch sphere payload was completed and tested, making two payloads available for Exercise PARADISE AEOLUS (Auroral Excitation of Oscillation and Layering of the Underlying Species). One of these spheres was successfully launched on 10 April, 1975, at the Fort Churchill Research Range, Manitoba, Canada, by means of a Paiute Tomahawk Rocket, No. A10.303-3. The purpose of this mission was the investigation of the dynamical properties of the auroral zone atmosphere in a coordinated rocket and ground based program designed to characterize the differences between geomagnetic quiet and disturbed conditions correlated with aurorally active times.

The next major project undertaken during the life of this contract was the preparation and assembly of components for two Falling Sphere Project flights which took place on 14 August, 1975, at Vandenberg Air Force Base, California. Pyro power cables for the 10 inch sphere payload were assembled and installed in the nose cone. Test units were assembled and tested for the purpose of making pyro circuit, leakage, resistance and voltage/no voltage checks on system components.

In order to increase the reliability of sphere separation in flight, Hercules Corp. detonators No. D213AO were procured for use in the 7 inch sphere ejection circuits. Two one and one-half volt cells were added to the existing four cells, thereby increasing the squib voltage to 9 volts. Static balance tests of the 7 inch sphere, No. AF-5, were conducted.

In addition to the above, static balance tests were performed on the 10 inch spheres. Two push button switches, for the purpose of monitoring the nose cone separation of the 10 inch payload, were installed in place of potentiometers.

Telemetry and shake tests were performed on both 7 and 10 inch payloads, with the 10 inch payload being subjected to additional spin table tests to include dynamic separation of the nose cone and ejection of the sphere. Transit time measurements were made and recorded, and the units were stored in dry nitrogen for shipping. The aforementioned flight of the 10 inch sphere payload was deemed a success and satisfactory data were recorded. The flight of the 7 inch sphere was cancelled by AFGL pending further evaluation of test results.

The cancellation of the flight of the 7 inch sphere left intact the prime and back up 7 inch spheres for the next operation. The launch of Rocket No A09-406-2 at the Western Test Range, Vandenberg Air Force Base, on 11 December, 1975, carried sphere No. AF-4 as a continuation of the ESCAPE Project.

A 10 inch payload system was assembled and tested for launch on board a Paiute-Tomahawk Rocket, No. A10-507-1. This experiment, which took place at the Poker Flat Rocket Range, Alaska, on 3 March, 1976, was conducted for the purpose of determining atmospheric density and temperature in the altitude range of 40 to 140 km. under disturbed atmospheric conditions induced by active aurorae.

Two ten inch PZL sphere encoders, SE-1 and SE-2, in addition to two sphere squib and power distribution control units, P-1 and P-2, were assembled and tested. Nos. SE-2 and P-2 were launched on board Rocket No. All.605-1, at the Kwajalein Missile Range, on 20 August, 1976. Due to a second stage ignition problem, the rocket and payload failed to reach the required altitude. As a result, no usable density data were recorded. However, despin, tip-off, sphere ejection and accelerometer sensors uncage functioned properly and on time. Vehicle No. All.408-1, the back-up rocket containing SE-1 and P-1, was launched from the same site on 30 August, 1976. This flight was successful and obtained useful data. It should be noted that these flights were in support of Project Pretest ABRES (Advanced Ballistic Reentry System).

Rocket No. All.712-1 containing a 10 inch sphere was launched on 18 May, 1977, again at the Kwajalein Missile Range. This flight, using a Nike-Hvdc Rocket, was a success.

Following this launching, the remainder of 1977 and the beginning of 1978 were devoted to the preparation, modification, and testing of components to be incorporated in payloads for flights in 1978. The first two payloads were installed on rocket vehicles All.712-3 and All.712-4, which were launched at the Kwajalein Missile Range on 2 April, 1978. The former of these was especially notable in that the payload was originally rejected because of an intolerable amount of play in the nose cone's split ring and retention ring joint. Upon return to Wentworth, the payload was dimensionally inspected and found to be oversized by 0.012 inch on the inside diameter of the nose cone. This discrepancy was corrected by incorporation of a 0.006 inch thick copper shim in the split nose cone and split ring interface. Subsequent to the modification, prime vehicle No. All.712-3

encountered second stage malfunctions, causing a low altitude flight. Both spheres had accelerometer uncaging problems which resulted in no density data for either payload.

An identical problem appeared on Rockets A08.706-1 and A04.606-1 and an identical solution was attempted. On 15 May, 1978, the latter of these two was launched, but resulted in failure of the prime payload. It was decided at this time not to launch the former until the reasons for the flight failure could be ascertained. In this regard the former payload was disassembled and returned to AFGL for re-evaluation. An in-depth analysis of the problem pointed to a squib initiation circuit in the sphere release assembly as the source of the trouble. This was corrected and no further difficulty was experienced in subsequent flights.

PERSONNEL

The following is a summary of travel and field trips made during the life of the contract:

<u>Dates</u>	<u>Personnel</u>	<u>Destination and/or Reason</u>
12/3/74 - 12/14/74	G.B. Stromberg	White Sands Missile Range, N.M.
1/8/75 - 1/19/75	G.B. Stromberg P.L. Mundis	Wallops Island, Virginia
3/25/75 - 4/12/75	G.B. Stromberg P.L. Mundis	Fort Churchill Rocket Range, Canada
7/28/75 - 8/16/75	G.B. Stromberg P.L. Mundis	Vandenberg A.F. Base, California
12/2/75 - 12/14/75	G.B. Stromberg P.L. Mundis	Vandenberg A.F. Base, California
2/10/76 - 3/6/76	P.L. Mundis M. Baratz	Poker Flat Rocket Range, Alaska
7/26/76 - 7/28/76	G.B. Stromberg	Space Data Corp., Phoenix, Arizona Electrical and mechanical interface checks
8/7/76 - 9/3/76	G.B. Stromberg	Kwajalein Island
2/21/77 - 2/28/77	P.L. Mundis	Space Data Corp., Phoenix, Arizona
2/28/77 - 3/4/77	P.L. Mundis	Kwajalein Island; launch postponed
5/8/77 - 5/22/77	P.L. Mundis	Kwajalein Island
3/23/78 - 4/6/78	G.B. Stromberg	Kwajalein Island
5/8/78 - 5/16/78	G.B. Stromberg	White Sands Missile Range, N.M.

CONCLUSION

This report represents a brief overall summary, in chronological order and quasi-historical format, of the major activities and accomplishments of this contract. No attempt has been made to report a detailed description of the technical aspects of the many and varied processes followed in the Design Section, the Missile Laboratory and the Electronics Section. The definitive data and pertinent information obtained from the various experiments were evaluated and utilized by the Air Force Geophysics Laboratory at the time of its generation.

Similarly, no attempt has been made to cite, in detail, the many small supporting, yet essential and germane tasks in both the electrical and mechanical phases of the work, especially the type which represented modifications of units at various stages of fabrication and assembly. These are considered "standard procedure" in any endeavor encompassing new experimental units and prototypes, as well as in the processes involved in the modification of existing components in an effort to eliminate any possibility of malfunction and to increase their operational capabilities. All tasks under this contract were successfully completed.

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