

**Bell Aerospace Company** DIVISION OF **Textron**

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BA Report No. 6176-950002

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DESIGN AND DEVELOPMENT OF A  
3-AXIS ACCELEROMETER (MESA)

by

William G. Lange, Murray A. Meldrum, Donald W. Honkala

BELL AEROSPACE COMPANY  
Post Office Box One  
Buffalo, New York 14240

Contract No. F19628-67-C-0097  
Project No. 6690, 8666, ILIR  
Task No. 669002, 866602, ILIR57  
Work Unit No. 66900201, 86660201, ILIR5701

FINAL REPORT

Period Covered: 1 December 1965 to 18 December 1970

18 January 1971

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This research was partially supported by the Air Force  
In-House Laboratory Independent Research Fund

Contract Monitor: Frank A. Marcos  
Aeronomy Laboratory

Prepared for

Air Force Cambridge Research Laboratories  
Air Force Systems Command  
United States Air Force  
Bedford, Massachusetts 01730

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## ABSTRACT

This final report summarizes the work performed on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097. The accelerometers were developed for determination of atmospheric density at low satellite altitudes by sensing the satellite deceleration due to aerodynamic drag. Systems #1 and #2 were successfully flown on the Air Force low altitude density research satellites CANNON BALL I and SPADES respectively. Three triaxial accelerometer systems were delivered to AFCRL. The funded contract activity, which began on 1 December 1966, was completed on 18 December 1970 with the delivery of Three Axis System #3.

## I. INTRODUCTION

This final report summarizes the work performed on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097. The accelerometers were developed for determination of atmospheric density at low satellite altitudes by sensing the satellite deceleration due to aerodynamic drag. Systems #1 and #2 were successfully flown on the Air Force low altitude density research satellites Cannon Ball I and SPADES respectively. Three triaxial accelerometer systems were delivered to AFCRL. The funded contract activity, which began on 1 December 1966, was completed on 18 December 1970 with the delivery of Three Axis System #3 (Cannonball II).

## II. DESCRIPTION

Detailed description of the Design and Development effort on this contract is contained in the following reports which were generated during the lifetime of the contract.

The enclosed Quarterly Progress Reports #1 to #16 (Appendix A) provide a detailed history of the activity on the Three Axis Accelerometer Development contract.

<u>Title</u>	<u>BAC Report No.</u>	<u>Date</u>
R&D Design Evaluation Report (LOADS and SPADES)	6087-927001	15 Sept. 1967
Equipment Information Report (LOADS and SPADES)	6098-954001	15 Dec. 1967
Acceptance Test Procedure (LOADS)	6098-928001	15 Dec. 1967
Acceptance Test Procedure (SPADES)	6098-928012	15 Feb. 1968
R&D Design Evaluation Report (Cannonball II)	6176-927001	1 Nov. 1969

### III. SUMMARY

The Three Axis Accelerometer Development contract resulted in delivery of three (3) triaxial system to AFCRL as follows:

System #1 (Cannonball/LOADS)	1 December 1967
System #2 (SPADES)	20 January 1968
System #3 (Cannonball II)	18 December 1970

Work was stopped in 1970 on one additional three axis system (System #4 - DENPER).

Systems #1 and #2 were launched into orbit aboard a single booster vehicle in July 1968. Operation of both systems in orbit was successful. The Cannonball I satellite, with an initial perigee of 150 km, remained in orbit for 39 days. Near the end of its life, measurements were made at a record low altitude of 120 km. Accelerometer measurements were obtained throughout the 118 day lifetime of the SPADES satellite which had an initial perigee of 160 km. System #3 is a reduced volume configuration and launch is anticipated in July of 1971. The Cannonball II satellite will have an initial 140 km perigee and a six-month lifetime.



APPENDIX A

QUARTERLY PROGRESS REPORTS

(#1 through #16)

This report summarizes the work carried out for the period December 1, 1966 through March 1, 1967 on the development on a Three Axis Accelerometer in accordance with a statement of work on contract No. F19628-67-C-0097.

## I. OBJECTIVES

The primary objective of this program is to develop a Three-Axis Accelerometer System capable of measuring drag in the  $10^{-5}g$  to  $10^{-10}g$  range on an orbiting satellite. From these measurements, the value of atmospheric density at varying orbital altitudes is expected to be obtained.

## II. PROGRESS

The major efforts in this reporting period have been concerned with:

1. Analysis of vehicle dynamics and their effect on instrument performance.
2. Definition of data handling and data analysis requirements and specifications.
3. Definition of mechanical, electrical, and thermal interface requirements.

Analysis has been conducted for two experiments (SPADES and CANNONBALL) which will be launched on an ATLAS OV-1 vehicle. A summary of the results of the analysis is given below:

A. VEHICLE DYNAMICS - The location of the accelerometer center of gravity, with respect to the vehicle center of gravity, is expected to be known within 0.005 inches. The angular alignment of the instrument sensitive axis to the vehicle reference axis is still to be defined. The spin rate for the CANNONBALL satellite is expected to be 1 rpm about a spin axis not determined at this time. The SPADES vehicle is expected to rotate at 10 rpm about an axis which will lie within a  $5^\circ$  cone angle. The sensitive and cross axis accelerations which the accelerometer triad will see, will be determined by analysis of the above information.

B. DATA HANDLING AND ANALYSIS - The specifications for two interface units which will convert the accelerometer digital output signals to a format suitable for telemetry transmission have been completed. Sampling rates of 1 second will be used in the IFU. Additional monitor signals will be conditioned for telemetry conversion.

C. MECHANICAL, ELECTRICAL, AND THERMAL INTERFACE - Power input voltage level and signal interface have been defined. The estimated weight of the electronics for each instrument is 4.3 lbs and the three axis mount with accelerometers is expected to weigh 5 lbs. The interface unit weight is 5 lbs.

### C. Mechanical, Electrical, and Thermal Interface (continued)

The electronics package configuration has been frozen and will be in accordance with BAC Drawing 6087-300100. The interface unit size is tentatively fixed at 2" x 4" x 6". The three accelerometers will be orthogonally mounted on a reference block which is 12" x 4" x 4".

A 70°F ±10°F operating temperature range is expected for both satellites.

The system thermal requirements at 4 psi pressure are as follows:

#### Accelerometer

Operating Temperature	+10°F above max ambient
Heater Power	.17 watts/°F
Min. Warm-up Power	.11°F/watt

#### Electronics

Operating Temperature	+40°F above max ambient
Heater Power	.11 watts/°F
Min. Warm-up Power	.2°F/watt

The above figures are for one accelerometer. The required heater power and warm-up time will be determined when the operating environment temperatures have been defined.

### III. PLANS FOR NEXT REPORTING PERIOD

Scaling and thermal design of the system is expected to be completed and hardware fabrication initiated for accelerometer electronics and interface units. Work on the R&D design evaluation report will be initiated.

### IV. VISIT REPORTS

January 25, 1967 (Held at BAC)

Attendees: Mr. F. Marcos - CRL  
Mr. M. Meldrum - BAC

February 10, 1967 (Held at BAC)

Attendees: Mr. F. Marcos - CRL  
Mr. J. Platt - CRL  
Mr. M. Meldrum - BAC  
Mr. W. Alabran

IV. Visit Reports (continued)February 27, 1967 (Held at BAC)

Attendees:	Mr. F. Marcos	-	CRL
	Mr. J. Platt		
	Mr. R. Smith	-	Adcole
	Mr. M. Meldrum	-	BAC
	Mr. W. Alabran		

This report summarizes the work performed during the period 1 March 1967 to 31 May 1967 on the development of a Three Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVES

During the reporting period, the scope of the contract was modified significantly. The contract now includes fabrication and testing of the following:

- 1 - Three Axis System (LOADS)
- 1 - Three Axis System (SPADES)
- 1 - Interface Unit (LOADS)
- 1 - Interface Unit (SPADES)
- 2 - Spare Single Axis Accelerometers
- 1 - Spare Three Axis Mount
- 2 - Ground Test Sets

## II. PROGRESS

Good progress was made in all areas of the program. The major effort during the reporting period was to attempt to firm up the design requirements for the System and to begin the design effort. The follow-on contract which was received during the reporting period added the requirement for a second three axis system and for Interface Units for both Satellites which would convert the output of the accelerometers to a format suitable for telemetry transmission. Progress in the individual areas is summarized below:

### 1. Parts Procurement

The majority of the electronics parts which were ordered for the contract were received during the reporting period. Late delivery was experienced on a few critical parts. These were the precision inductors for the MESA accelerometers and the solid tantalum capacitors for the Electronics Package.

### 2. Three Axis Mount

Layout and design of the three axis mount was begun. The design was discussed in detail at the technical meeting held at Bell on 10 May 1967. Some redesign was required to decrease the mount size and provide three mounting holes as required for installation into the vehicle.

### 3. MESA Accelerometer

Preliminary mechanical fabrication of MESA Accelerometers was begun; however, fabrication could not be completed due to the parts shortages noted above.

### 4. Interface Unit

A Bell Specification Control Drawing (6098-300100) was generated for the Interface Units. This S.C.D. incorporated the requirements formerly discussed at a technical meeting held at Bell in February. One additional bit was added to the LOADS IFU. The LOADS output was now to contain four 17 bit words instead of four 16 bit words. In addition, the size of the LOADS IFU was decreased to 2" x 4" x 4-1/2". The SPADES IFU size is 2" x 4" x 6".

### 5. Signal Conditioning Box

The firming up of the telemetry and command interface requirements for the experiments has disclosed a need for additional circuitry to make the MESA accelerometer compatible with the vehicle systems. To incorporate the additional circuits into the existing electronics package would require extensive redesign, thus a separate unit is envisioned. Detailed requirements for this unit will be generated during the next reporting period.

## III. PLANS FOR NEXT REPORTING PERIOD

During the next reporting period the design of the electronics package is to be completed and fabrication effort will be started. The sheet metal fabrication will be continued. The three axis mount design will be completed and fabrication will be started. The requirements for the Interface Units for both satellites will be firmed up and the units will be procured from Adcole Corporation in Waltham, Massachusetts. Wooden models of the LOADS and SPADES Systems will be fabricated and furnished to CRL.

## IV. VISIT REPORTS

Date:	10 May 1967
Place:	BAC
Purpose:	Design Review
Attendees:	F. Marcos - CRL
	J. Platt
	M. Meldrum
	W. Lange
	D. Honkala
	R. Hallet
	E. Trunzo
	- BAC

This report summarizes the work performed during the period 1 June 1967 to 31 August 1967 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVES

The main objectives of this reporting period were to complete the design and drafting activity, and to begin mechanical and electronic fabrication of the various subsystems.

## II. PROGRESS

### 1. Three Axis Mount

No design changes were made during this period. All purchased parts were placed on order and fabrication of the base started. The cg location was estimated and entered on the drawing.

### 2. Signal Conditioner

The design of this unit was completed and all purchased parts were ordered. Sheet metal and printed circuit board fabrication was started. The two configurations are identical except for the addition of the suspension command logic for the OV1-16 (LOADS).

### 3. Electronics Assembly

The complete design was released for fabrication with the exception of the pulse generator. Final scaling of the sensitive axis for both satellites will permit release of these during the next report period. The cg location was added to the outline drawing. It is planned to build one spare unit for the OV1-15, scaling and one for the OV1-16 scaling..

### 4. Interface Unit (Adcole Counter)

The purchase order for the two (2) Interface Units was placed with Adcole. The outline and connector pin functions were finalized. The cg location was added to the outline drawing. No design changes were made during this period. Delivery of the OV1-16 unit is now expected during the week of October 1, 1967.

### 5. Interconnecting Cables

The interconnecting wiring diagram was revised to reflect the changes resulting from the design meetings at GDC on June 28 and 29 and again on August 30 and 31. Cable drawings were released for fabrication of potting shells. It was agreed



that all cable material except wire would be furnished by BAC for both satellites. This material plus detail fabrication drawings of each cable will be shipped to CRL during the next period.

#### 6. Wooden Models

Wooden models of the OV1-16 (LOADS) System were shipped to CRL on 30 August 1967. The models were to be used to route the wiring in the satellite.

### III. PLANS FOR NEXT REPORTING PERIOD

During the next reporting period, the OV1-16 (LOADS) 3-axis system is scheduled to be delivered to CRL.

Module fabrication and module and channel tests are scheduled to be performed on both LOADS and SPADES Systems. 3-axis system test will occur on the LOADS System. The Signal Conditioning Box will be fabricated and tested.

The 3-Axis Mount and Adcole Interface Units will be received from suppliers.

Wooden models of the SPADES experiment will be shipped to CRL.

The R & D Design Report will be completed and submitted to CRL.

### IV. VISIT REPORTS

The following two visits were erroneously omitted from Quarterly Status Report No. 2.

Date: 28 March 1967  
 Place: BAC  
 Purpose: Technical Review  
 Attendees: F. Marcos - CRL  
             W. Lange  
             M. Meldrum - BAC

Date: 12 April 1967  
 Place: BAC  
 Purpose: Technical Meeting - Initial discussion of thermal interface, command sequence, and scaling.

Attendees: F. Marcos - CRL      M. Meldrum }  
             J. Platt      - CRL      W. Lange      - BAC  
    D. Gilkinson }



The following visits took place during this reporting period:

Date: 2 June 1967

Place: BAC

Purpose: Technical Meeting - Outline drawings submitted defining interface; discussion of possibility of no temperature controls to save power; scaling and telemetry signals discussed.

Attendees: F. Marcos - CRL  
J. Platt  
W. Lange }  
D. Honkala } - BAC  
Z. Milburn }  
F. D. McCollum )

Date: 30 June 1967

Place: General Dynamics Corporation  
San Diego, California

Purpose: Interface Meeting, OV1-15 and OV1-16

Attendees: F. Marcos - CRL  
W. Lange - BAC  
H. M. Ikerd - GDC  
Others

Date: 7 July 1967

Place: BAC

Purpose: Technical Meeting - Discussion of command sequencing, output impedances, scaling, and spin rates.

Attendees: F. Marcos - CRL  
Z. Milburn )  
D. Honkala } - BAC  
D. Allen )

Date: 19 July 1967

Place: BAC

Purpose: Technical and Status Review - General Program Discussion.

Attendees: F. Marcos - CRL  
W. Lange - BAC

Date: 9 August 1967  
Place: BAC  
Purpose: Progress Review - Schedule Discussion  
Attendees: F. Marcos - CRL  
W. Lange  
D. Honkala - BAC

Date: 30 and 31 August 1967  
Place: General Dynamics Corporation  
San Diego, California  
Purpose: Experiment Design Freeze Meeting - Discussion  
of location of experiments in satellite; requested  
to add c.g. and weights to drawings; review of  
interface wiring; power surge reduction discussion.  
Attendees: F. Marcos - CRL  
H. Ikerd - GDC  
W. Lange - BAC  
Others

This report summarizes the work performed during the period 1 September 1967 to 30 November 1967 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVE

The main objective during this reporting period was to complete electronic fabrication and testing of the "LOADS" Three (3) Axis System with subsequent delivery to AFCRL.

## II. PROGRESS

### 1. "LOADS" Three (3) Axis System

Module fabrication and test were completed for the three Electronics Packages for the LOADS System. Single axis setup and test was then performed on the individual channels. This included the calibration of bias and scale factor with temperature over the range of +40 to +120 degrees F. The entire three (3) axis system was then assembled and system tests were performed.

The three axis system consisted of the Three Axis Mount (including three (3) orthogonally mounted MESA accelerometers) three (3) Electronic Packages, one (1) Signal Conditioner, and one (1) Adcole Interface Unit.

During vibration test a minor failure occurred in the Bridge Pre-Amplifier of the MESA accelerometer. An open was found in a solder joint due to the movement of the printed circuit board along its periphery. The failed accelerometer and all accelerometers on this contract were modified by adding epoxy spacers to strengthen the assembly. The failed accelerometer was then vibrated and re-checked to determine the adequacy of the corrective action.

System test was completed and the unit was ready for shipment as scheduled on 29 November 1967. It was agreed to hand carry the unit to CRL on 1 December 1967 since Bell personnel were to be at CRL for a meeting on that day.

### 2. Electronics Packages (SPADES)

Module fabrication was completed for the 3 Electronics Packages of the SPADES System. Single axis channel testing was scheduled to begin on 4 December 1967.

### 3. Three Axis Mount

The LOADS Mount was received and included in the LOADS System.

The two remaining Three Axis Mounts were received from the vendor for the SPADES and spare systems. Cabling for the SPADES Mount was in work.

### 3. Signal Conditioner

The LOADS/Cannonball Signal Conditioner fabrication and test was completed and the unit was System Tested with the LOADS System. The SPADES Signal Conditioner fabrication and module test was completed. The unit is in final sub-assembly test. The two configurations are identical except for the addition of the suspension command for the OV1-16 (LOADS).

### 4. Interface Unit

The LOADS and SPADES Interface Units were received from Adcole Corp., Waltham, Mass. The LOADS unit was Acceptance Tested and System Tested with the LOADS System. The SPADES unit is now in Acceptance Test.

Both units simultaneously accept the three digital pulse trains from each accelerometer channel. The LOADS unit samples the input at three-second intervals and provides the output in serial form. The SPADES unit samples the input at one-second intervals and provides the output in parallel form.

### 5. Interconnecting Cables

Connectors, potting shells, potting forms, and tubular braiding for the LOADS (CRL) and the SPADES (GDC) Systems were shipped to CRL during the report period. In addition, the complete cabling drawings were sent to CRL. Both CRL and GDC are to wire the cables for their respective satellites.

### 6. Wooden Models

Wooden models of the SPADES (OV1-15) System were sent to CRL during the report period. Models of the LOADS (OV1-16) System were previously provided.

### 7. Drill Templates

Drill templates for the SPADES (OV1-15) System were sent to GDC on 29 November 1967. The templates are to be used to drill the matching installation holes in the GDC satellite structure.

### 8. Test Set

Test Sets were fabricated for both the LOADS and SPADES Systems. The Test Sets will be used at Bell for 3 axis testing and will then be delivered to CRL with each System.

## 9. R & D Design Evaluation Report

The R & D Design Evaluation Report (BAC Report No. 6087-927001 dated 15 September 1967) was submitted to CRL during the report period. The report describes the design approach for the two (3) axis systems and includes a description of system operation and error analysis.

### III. PLANS FOR THE NEXT REPORTING PERIOD

During the next reporting period, the LOADS/Cannonball (OV1-16) Three (3) Axis System will be delivered (1 December 1967) and testing of the components and System Test of the SPADES (OV1-15) Three (3) Axis System will be completed. The SPADES System is scheduled to be delivered on 28 December 1967. Fabrication and testing of the spares will also be completed.

The R & D Test and Acceptance Plan and the R & D Equipment Information Reports will be completed and submitted to CRL.

### IV. VISIT REPORTS

The following visits took place during this reporting period:

Date: 26 September 1967

Place: AF CRL

Purpose: Contract Discussion Re:

Bell request for extension of the scheduled delivery dates under the "excusable delays" section of the contract.

Attendees: F. Marcos - CRL  
J. Levy

G. Gesel }  
W. Lange } - BAC  
D. Honkala }

Date: 5 October 1967

Place: BAC

Purpose: Technical Meeting Re:

Discussion of the cabling requirements and witnessing of testing on the LOADS System.

Attendees: F. Marcos - CRL  
J. Platt

W. Lange }  
L. Spina } - BAC  
D. Honkala }

Dates: 1 and 2 November 1967

Place: BAC

Purpose: Technical Meeting Re:  
Review of temperature calibration data on  
LOADS MESA accelerometers and electronics  
packages. Status review of LOADS system.

Attendees: F. Marcos  
G. Faucher - CRL  
W. Lange }  
L. Spina } - BAC  
D. Honkala }

Date: 8 November 1967

Place: BAC

Purpose: Discussion of follow-on procurement

Attendees: F. Marcos - CRL  
R. Smith - Adcole Corp.  
W. Lange }  
M. Meldrum } - BAC  
G. Gesel }  
D. Honkala }

Date: 17 November 1967

Place: BAC

Purpose: Technical Meeting Re:  
To witness vibration testing on the LOADS  
System. To discuss the BAC response to the  
CRL - RFQ for two additional three (3) axis  
systems.

Attendees: F. Marcos - CRL  
W. Lange }  
G. Gesel } - BAC  
M. Meldrum }  
D. Honkala }

This report summarizes the work performed during the period 1 December 1967 to 29 February 1968 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVES

The main objectives during this reporting period were the delivery to AFCRL of the LOADS Three (3) Axis System and the testing of the SPADES Three (3) Axis System with subsequent delivery to AFCRL.

## II. PROGRESS

### 1. LOADS Three (3) Axis System

The completed LOADS Three (3) Axis System was hand carried to AFCRL by Bell personnel for delivery on 1 December 1967.

### 2. SPADES Three (3) Axis System

The completed SPADES Three (3) Axis System was hand carried to GDC by L. Spina, Project Engineer - CRL, for delivery on 22 January 1968. The system was accepted at GDC by Mr. Frank Marcos of AFCRL.

During compatibility tests at GDC, it was determined that the Adcole Interface unit was responsible for an excessive amount of conducted and radiated EMI. After consultation with Roger Smith of Adcole, it was decided that both the SPADES and LOADS interface units would be returned to Adcole for repair. After repair, the LOADS unit was returned directly to AFCRL while the SPADES unit was hand carried to GDC and checked again with the entire system. The EMI levels at this time were acceptable.

### 3. Interconnecting Cables

Bell supplied the shielded wire necessary for GDC to complete the interconnecting cables for SPADES.

### 4. R & D Equipment Information Report

The R & D Equipment Information Report (BAC Report No. 6098-954001) was submitted to CRL during the report period. The report contains the theory of operation of the two (3) axis systems and includes a series of tests to determine that the systems are operating properly prior to and after installation in the satellite. It also describes the procedure to be followed if one of the channels requires replacement. Included with the report are a series of drawings pertinent to the procedures described in the report.



### 5. Electronics Packages (Spares)

Module fabrication was completed for the two spare Electronics Packages. Testing of these spare units is scheduled to begin in the near future.

### 6. System Connectors

After delivery to AFCRL, it was found that both LOADS and SPADES had been inadvertently built with cadmium plated connectors. The LOADS system was hand carried back to Bell by Mr. Frank Marcos. The connectors were changed and the entire system rechecked. (The connectors for SPADES were also replaced.) During this check, it was found that one channel of the Adcole counter was malfunctioning. The LOADS system was hand carried by a Bell employee to AFCRL where the counter was returned to an Adcole employee for repair. After repair, the counter was delivered to AFCRL.

### 7. Follow-on Three Axis System

During the report period a contract amendment was processed which added one additional three axis system to the program. The added system was to be a reduced volume version. The two spare MESA Accelerometers and spare three axis mounting frame from the basic contract are to be incorporated into the follow-on system.

## III. PLANS FOR NEXT REPORTING PERIOD

During the next reporting period the spare accelerometers and electronics packages for LOADS and SPADES will be tested and delivered to AFCRL. The design and drafting effort on the follow-on system will be started.

## IV. VISIT REPORTS

The following visits took place during this reporting period:

Date: 1 December 1967

Location: AFCRL

Purpose: Delivery of the LOADS Three (3) Axis Accelerometer System and negotiation of the follow-on procurement.

Attendees:	F. Marcos	}	- CRL
	J. Levy		
	Dr. Champion)		
	G. Gesel	}	- BAC
	W. Lange		
	D. Honkala		
	M. Meldrum)		



Date: 18 December 1967  
 Location: BAC  
 Purpose: Witness calibration of SPADES  
 accelerometers and electronics  
 packages.  
 Attendees: F. Marcos - CRL  
               W. Lange    }  
               D. Honkala } - BAC  
               L. Spina    }

Date: 10 January 1968  
 Location: BAC  
 Purpose: Witness SPADES System Test  
 Attendees: F. Marcos - CRL  
               W. Lange    }  
               D. Honkala } - BAC  
               L. Spina    }

Date: 22 January 1968  
 Location: General Dynamics Corp.  
 San Diego, Calif.  
 Purpose: Delivery of the SPADES Three (3) Axis  
 Accelerometer System and compatability  
 of the system with the GDC interface.  
 Attendees: F. Marcos - CRL  
               L. Spina - BAC

Date: 2 February 1968  
 Location: General Dynamics Corp.  
 San Diego, Calif.  
 Purpose: Return the SPADES counter to GDC to  
 reaffirm elimination of any EMI problem.  
 Attendees: L. Spina - BAC

Date: 15 February 1968  
 Location: BAC  
 Purpose: Return LOADS system to replace cadmium  
 plated connectors.  
 Attendees: F. Marcos - CRL  
               W. Lange    }  
               D. Honkala } - BAC  
               L. Spina    }

Date: 29 February 1968  
Location: AFCRL  
Purpose: Return LOADS System to AFCRL  
after replacing cadmium plated  
connectors and return Adcole  
counter for repair.  
Attendees: F. Marcos - CRL  
L. Spina - BAC  
R. Smith - ADCOLE

This report summarizes the work performed during the period 1 March 1968 to 31 May 1968 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVES

The main objectives of this reporting period were the testing and subsequent preparation for delivery to AFCRL of the spare systems and field support of both LOADS and SPADES during satellite integration tests. In addition, the design and drafting effort for the follow-on three axis system was to be started.

## II. PROGRESS

### 1. Spare Systems

Both spare units were tested, calibrated, and are scheduled to be delivered to AFCRL on 7 June 1968. The units are to be delivered as GFE in order to be available for Bell's field support activities.

### 2. SPADES Satellite Integration

Satellite integration tests were held at General Dynamics Corp., San Diego from 1 April through 4 April 1968 to determine if there were any interference problems among the nine (9) experiments and/or the satellite logic and telemetry. No problems were encountered with the Three (3) Axis Accelerometer System.

### 3. LOADS Electronics Packages

While performing tests with the LOADS system at CRL, it was noticed that two of the electronics package covers had developed cracks along the rear seams. The three electronics packages were returned to Bell where angle braces were added to the four corners of each cover. The electronics packages were returned to AFCRL the same day.

### 4. LOADS Thermal Vacuum Test

During thermal vacuum tests at AFCRL, a failure was experienced in the Z channel. A Bell employee hand carried the LOADS spare to AFCRL and replaced the failed unit. This unit was returned to Bell for repair.

A second failure was experienced in the Z channel during the next thermal vacuum test. It was also noted at this time that the signal conditioner failed to accept suspension range commands at high temperatures. The failure of the Z channel was analyzed as overheating of the output transistors in the suspension amplifier. A resistor in the output stage was increased in value to lower the current through the output stages, thus reducing the power dissipated. The transistor cases were also painted black to increase their radiation capabilities.

The second failed unit was replaced at AFCRL and a vacuum test was run on the Z channel only at Northeastern University. No failure was experienced.

The signal conditioner was hand carried back to Bell where a zener diode was added to the power supply of the command logic to keep this voltage constant over the temperature range. The unit was then hand carried back to AFCRL.

Another set of thermal vacuum tests were conducted at AFCRL and at Associated Testing Labs. This second test was identical to that in which the two units had failed previously. No failures were experienced and the signal conditioner accepted all range commands.

#### 5. LOADS & SPADES Capture Circuits

During the testing of both spare units, the capture mode failed to operate properly intermittently. Even though this problem had not been experienced on any of the previous systems, it was decided to retrofit them with the solution to this problem as a preventive measure.

A Bell employee traveled to AFCRL to pick up the modules of the LOADS system to be retrofitted. Meanwhile, an AFCRL employee returning from GDC carried the SPADES system back to CRL. When the LOADS modules were returned to CRL, the SPADES system was brought back to Bell to be retrofitted and to bring the suspension modules up to the present configuration and to add the zener diode to the signal conditioner. The SPADE's system was then hand carried back to GDC by a Bell employee.

At this same time a failure was experienced in the X channel of the LOADS system at AFCRL. A Bell employee went to AFCRL to pick up the malfunctioning X channel and returned it to Bell. The problem was found to be the D.C. amplifier in the Pick Off module. The amplifier was replaced and the unit returned to AFCRL.

#### 6. Follow-on Three (3) Axis System

The design and drafting effort for this reduced volume follow-on version is almost completed pending receipt of the desired measuring ranges and the counter sampling time. This information is required in order to complete the Electronics Package design and to enable placement of the sub-contract for the Interface Unit with Adcole Corp.

### III. PLANS FOR NEXT REPORTING PERIOD

During the next reporting period Bell will be responsible for supporting satellite integration tests at GDC and Vandenberg AFB for both LOADS and SPADES. In addition, the design of the follow-on three axis system is scheduled to be completed provided the remaining necessary design information is provided by CRL. If the required design information is not provided in a timely manner, contractual delivery schedule relief will be required.

### IV. VISIT REPORTS:

The following visits took place during this reporting period:

Date: 27 March 1968  
 Location: BAC  
 Purpose: Return LOADS electronics packages for corner braces.  
 Attendees: Capt. Bloemker - CRL  
               L. Spina        }  
               D. Honkala     } - BAC

Date: 1 April 1968 - 4 April 1968  
 Location: General Dynamics Corp.  
            San Diego, Calif.  
 Purpose: Satellite integration tests - SPADES  
 Attendees: F. Marcos - CRL  
               L. Spina - BAC

Date: 17 April 1968  
 Location: BAC  
 Purpose: Technical discussion of follow-on contract.  
 Attendees: F. Marcos - CRL  
               W. Lange        }  
               D. Honkala     }- BAC  
               L. Spina        }

Date: 22 April 1968 - 23 April 1968  
Location: AFCRL  
Purpose: Replace Z channel in LOADS system  
after thermal vacuum failure.  
Attendees: F. Marcos - CRL  
Capt. Brown  
E. Hiscock  
L. Spina - BAC

Date: 30 April 1968 - 3 May 1968  
Location: AFCRL  
Purpose: Replace Z channel in LOADS system  
after second thermal vacuum failure.  
Run vacuum test at Northeastern  
University.  
Attendees: F. Marcos - CRL  
Capt. Brown  
E. Hiscock  
L. Spina - BAC

Date: 8 May 1968  
Location: AFCRL  
Purpose: Return LOADS signal conditioner to AFCRL  
Attendees: F. Marcos - CRL  
L. Spina - BAC

Date: 15 May 1968 - 17 May 1968  
Location: AFCRL  
Purpose: Assist in thermal vacuum test at CRL  
and Associated Labs.  
Attendees: F. Marcos - CRL  
Capt. Brown  
E. Hiscock  
L. Spina - BAC

Date: 21 May 1968  
Location: AFCRL  
Purpose: Pick up LOADS suspension modules and return them to Bell for retrofit.  
Attendees: Capt. Brown - CRL  
B. Pritchard - BAC

Date: 24 May 1968  
Location: AFCRL  
Purpose: Return LOADS suspension modules to AFCRL and bring back the SPADES system to Bell for retrofit.  
Attendees: F. Marcos - CRL  
L. Spina - BAC

Date: 27 May 1968 - 28 May 1968  
Location: General Dynamics Corp.  
San Diego, Calif.  
Purpose: Return SPADES system to GDC.  
Attendees: L. Spina - BAC

Date: 28 May 1968 - 29 May 1968  
Location: AFCRL  
Purpose: Pick up LOADS X Channel Pick Off Module and return it to Bell for repair.  
Attendees: F. Marcos - CRL  
L. Spina - BAC

Date: 31 May 1968  
Location: AFCRL  
Purpose: Return LOADS X Channel Pick Off Module to CRL after repair.  
Attendees: F. Marcos - CRL  
L. Spina - BAC

This report summarizes the work performed during the period 1 June 1968 to 31 August 1968 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVES

The main objectives of this reporting period were:

- A. Pre-launch field support for both LOADS and SPADES at launch site.
- B. Field support at time of launch.
- C. Completion of design and drafting effort on the reduced volume follow-on system.

## II. PROGRESS

### A. Spare Systems

The spare LOADS and SPADES single axis systems were hand carried to General Dynamics Corporation, San Diego on 7 June 1968. The equipment was delivered as GFP in order to be available to support vehicle testing at GDC and at Vandenberg Air Force Base, California.

### B. OV-1 Satellite Tests - GDC

Final OV-1 Satellite tests were held at GDC, San Diego on 7 June 1968. The tests were successful and the OV-1 Satellite was now ready for shipment to Vandenberg Air Force Base for installation atop the launch vehicle.

### C. Pre-Launch Tests - VAFB

Pre-launch testing took place at the Vandenberg AFB launch site between 14 June 1968 and 25 June 1968. Initial tests were performed on the individual experiments. The SPADES (OV1-15) vehicle tests and system integration tests were performed during the week of 17 June to 21 June 1968. The LOADS (OV1-16) vehicle tests and system integration tests were performed during the week of 24 June to 28 June 1968. All test results were satisfactory and the OV1-15 and OV1-16 experiments were ready for launch.

### D. Launch

The OV1 satellite was successfully launched into orbit atop an Atlas booster vehicle on Thursday, July 11, 1968. Good data on atmospheric air density was obtained. The LOADS (OV1-16) experiment re-entered the earth's atmosphere after 40 days and 640 orbits of successful operation. The SPADES (OV1-15) experiment re-entered in November 1968 after four (4) months. One channel of the SPADES did not send back data, however, the remaining two channels did



send back good data which allowed the experiment to be successful. It was not possible to determine the cause of the difficulty.

#### E. Field Support

A Bell engineer supported all tests at GDC and Vendenberg, and also aided the telemetry data resolution effort at Cape Kennedy.

#### F. Follow-On Three Axis System

The design of the reduced volume three axis system was completed pending receipt of the desired measuring ranges and the counter sampling time. This design information is needed in order to complete the Electronics Package design and to enable placement of the subcontract for the Interface Unit with Adcole Corporation.

Effort on the follow-on system is stopped until the required design information is received.

### III. PLANS FOR NEXT REPORTING PERIOD

No effort is contemplated on the contract until the information required to complete the design of the 3rd three axis system is received. Contractual schedule relief will also be required.

### IV. VISIT REPORTS

The following visits took place during this reporting period:

Date: 6 June 1968

Location: General Dynamics Corporation

Purpose: OV-1 Vehicle Integration Tests

Attendees: F. Marcos - CRL

L. Spina - BAC

Date: 4 June 1968

Location: Bell Aerosystems

Purpose: Return Electronics Packages for replacement of output transistors

Attendees: F. Marcos - CRL

L. Spina - BAC

Date: 14 June 1968 to 25 June 1968  
Location: Vandenberg Air Force Base, California  
Purpose: Field Support and vehicle integration tests  
at launch site  
Attendees: F. Marcos - CRL  
L. Spina - BAC

Date: 11 July 1968 to 18 July 1968  
Location: Cape Kennedy, Florida  
Purpose: Field support during launch and post-launch  
activities at Cape Kennedy  
Attendees: F. Marcos - CRL  
L. Spina - BAC

Date: 20 August 1968  
Location: Bell Aerosystems  
Purpose: To review LOADS flight data with Bell  
Attendees: F. Marcos - CRL  
W. Lange - BAC  
D. Allen - BAC  
D. Honkala - BAC

Date: 26 August 1968  
Location: AFRL  
Purpose: Analysis of flight data  
Attendees: F. Marcos - CRL  
M. Meldrum - BAC  
Dr. D. Allen - BAC  
L. Spina - BAC

This report summarizes the work performed during the period 1 September 1968 to 30 November 1968 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

#### I. PROGRESS

Work on the contract continues stopped due to lack of final design parameters from AFCRL. This information is required in order to complete the Electronics Package design and to enable placement of the subcontract for the Interface Unit with Adcole Corporation.

This report summarizes the work performed during the period 1 December 1968 to 28 February 1969 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. PROGRESS

Work on the contract continues stopped due to lack of final design parameters from AFCRL.

### A. Technical Meeting

The only activity relating to the contract during the reporting period was a meeting which was held at AFCRL on 17 December 1968 to discuss the RFQ for a fourth three axis system. As a result of the meeting, Bell furnished a quote for Three Axis System #4 on 14 February 1969. Bell's proposal assumed a Cannonball low volume configuration, however, final design direction would be required from AFCRL to determine the actual configuration to be furnished.

## II. VISIT REPORTS

The following visit took place during this reporting period:

Date:	17 December 1968
Location:	AFCRL
Purpose:	Technical discussion of proposal for Three Axis System #4
Attendees:	F. Marcos - CRL
	M. Meldrum - BAC
	D. Allen - BAC
	L. Spina - BAC

This report summarizes the work performed during the period 1 March 1969 to 31 May 1969 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work on Contract No. F19628-67-C-0097.

## I. PROGRESS

Work on the contract continues stopped due to lack of final design parameters from AFCRL.

### A. Technical Meeting

The only activity relating to the contract during the reporting period was a meeting which was held at AFCRL on 26 March 1968 to discuss Bell's proposal for System #4. The meeting resulted in defining System #4 as a SPADES configuration similar to Systems #1 and #2 (i.e., not "low volume").

This allowed the two spare Electronics Packages, which were furnished on the basic contract, to be used for this system thereby reducing the cost.

Bell revised its proposal and will provide a new cost estimate early in the next reporting period.

It was also agreed that Systems #3 and #4 should be fabricated concurrently in as much as possible and the revised delivery schedule for System #3 would be furnished with the contract amendment for System #4.

## II. VISIT REPORTS

The following visit took place during this reporting period:

Date:	26 March 1969
Location:	AFCRL
Purpose:	Technical discussion and fact finding for negotiation of 3 Axis System #4
Attendees:	Dr. Champion - CRL
	F. Marcos - CRL
	J. Levy - CRL
	M. Meldrum - BAC
	N. Blossat - BAC
	D. Honkala - BAC

This report summarizes the work performed during the period 1 June 1969 to 31 August 1969 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. PROGRESS

### A. General

At the start of the reporting period, progress on the contract continued stopped due to lack of the final design parameters for Three Axis System #3. A plant shutdown due to a labor strike occurred between 9 June 1969 and 27 July 1969.

A technical meeting was held at AFCRL on 25 July 1969 to discuss the design parameters for System #3 and the Bell proposal for System #4. At the meeting the design parameters were verified for System #3 and it was determined that effort would be reinitiated on System #3 as soon as the strike was over. The requirements for System #4 were discussed and it was determined that Bell would provide additional material back-up for the System #4 quote which would allow definitization of the add-on contract amendment for System #4.

### B. Electronics Packages

The remaining design and drafting effort for the reduced volume Electronics Packages for Three Axis System #3 was reinitiated upon settlement of the labor strike on 27 July 1969.

### C. Interface Unit

The design Control Specification for the Adcole Interface Unit was generated and sent to AFCRL and Adcole Corporation for their comments prior to release for procurement. Comments were received back and incorporated. It is anticipated that the Interface Unit will be placed on order early during the next reporting period.

## II. PLANS FOR THE NEXT REPORTING PERIOD

During the next reporting period, the design effort for System #3 will be completed and the fabrication effort will take place. Upon receipt of the definitized contract for Three Axis System #4, the design effort for that system will be initiated.

### III. VISIT REPORTS

The following visits took place during the reporting period:

Date: 25 July 1969  
Location: AFCRL  
Purpose: Technical discussion of 3 Axis System #3 and proposal for System #4.  
Attendees: Dr. Champion - AFCRL  
F. Marcos - AFCRL  
J. Levy - AFCRL  
M. Meldrum - BAC  
W. Lange - BAC  
N. Blossat - BAC  
Roger Smith - Adcole

This report summarizes the work performed during the period 1 September 1969 to 30 November 1969 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVES

The main objectives of the reporting period were:

A. To complete the design and development of the reduced volume Electronics Package.

B. To start fabrication and assembly of the Cannonball II (System #3) tri axial system.

C. To purchase the Interface Unit from Adcole Corporation.

D. To complete the R&D Design Evaluation Report.

## II. PROGRESS

### A. Tri Axial System #3 (Cannonball II)

#### 1. General

The effort on this system had previously been reinitiated after approximately a one year delay as noted in Quarterly Progress Report #11.

The tri axial system is a reduced volume version (approximately 20% reduction) which consists of a three axis mounting frame with 3 MESA accelerometers, three (3) Electronics Packages, and an Interface Unit (Counter). The Signal Conditioning Box has been eliminated for this design. The functions formerly performed within the Signal Conditioning Box are now incorporated into the Electronics Pkgs. and the Interface Unit.

The design and development was completed during the reporting period. This allowed preparation and submittal of the R&D Design Evaluation Report to AFCRL (Ref. Contract Sub line item 1AL, first system). The R&D Report describes the design in detail.

#### 2. Electronics Packages

The design and drafting effort was completed for the Electronics Packages. The Electronics Packages volume reduction was achieved by repackaging the unit and eliminating the space formerly devoted to the temperature control modules and the oven.



This was possible since temperature control is not utilized during flight in order to conserve heater power.

Fabrication of the printed circuit boards for the Electronics Package modules was completed. Assembly (installation of components) of the modules was begun. Module testing of the modules for channel no. 1 was started.

### 3. Interface Unit

The interface unit performs the major function of mating the MESA accelerometers to the satellite. The IFU is manufactured by Adcole Corporation.

The IFU for this system (CB II) is similar to the IFU for the original Cannonball. However, this unit incorporates the telemetry interface functions which were formerly included in the Signal Conditioning Box. In addition, the IFU incorporates an over-range function which automatically switches the constraintment and suspension ranges to a higher range when the full scale limits of a given range are exceeded.

The subcontract was placed with Adcole Corporation for the Interface Unit.

### 4. Three Axis Mount

The three axis mounting frame for CB II has the same outline dimensions as that for CB I and SPADES. The three MESA accelerometers, which are mounted orthogonally are the MESA Model IE, Electron beam welded accelerometers. The original CB and SPADES utilized MESA Model ID, "O" ring sealed units. The mounting frame will be the spare unit from the original contract.

## B. Tri-Axial System #4 (DENPER)

### 1. General

On 27 October 1969 an amendment to the contract was received which added one (1) additional Three Axis System. This system was to be similar to the original SPADES. It would utilize the two spare Electronic Package channels from the original contract.

The initial program planning and parts procurement effort was initiated during the reporting period.

A Preliminary Interface meeting was held at General Dynamics, Dan Diego, California on 8 October 1969 in order to attempt to firm up the Experiment Interface requirements.

### III. PLANS FOR THE NEXT REPORTING PERIOD

During the next reporting period, completion of module assembly, module test, and set up and calibration of the three channels of the Cannonball II System will take place. Fabrication and modification of the Electronics Packages for the DENPER Three Axis System will take place.

### IV. VISIT REPORTS

The following visits took place during the reporting period:

Date:	8 October 1969
Location:	G.D.C., San Diego, California
Purpose:	OV1-20 (DENPER) Preliminary Interface Meeting
Attendees:	F. Marcos - CRL Various Individuals - GDC W. Lange - BAC
Date:	21 October 1969
Location:	Bell Aerospace Company, Buffalo
Purpose:	Technical Visit and status review of System #3 (CB II) and Bell contract sign off for System #4 (DENPER)
Attendees:	F. Marcos - AFCRL W. Lange - BAC N. Blossat - BAC D. Honkala - BAC
Date:	13 November 1969
Location:	Bell Aerospace Company, Buffalo
Purpose:	Discussion of flight data (OV1-15 and OV1-16)
Attendees:	F. Marcos - AFCRL W. Lange - BAC Dr. D. Allen - BAC D. Honkala - BAC

This report summarizes the work performed during the period 1 December 1969 to 28 February 1970 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. 19628-67-C-0097.

## I. OBJECTIVES

The main objectives of the reporting period were:

- A. To complete module assembly, module test, and setup and calibration of the three channels of the Cannonball II System.
- B. To complete the MESA accelerometers for CB II.
- C. To modify and/or fabricate the hardware required for the DENPER Three Axis System.

## II. PROGRESS

### A. Tri Axial System #3 (Cannonball II)

#### 1. General

Early in the reporting period a redirection was received from AFCRL due to a change in the Satellite tracking network from Air Force to NASA (STADAN). Effort on the Adcole Interface Unit was held up until the design details could be worked out. This resulted in a delay in the scheduled delivery date to AFCRL until 26 June 1970.

#### 2. Interface Unit

The design details required to reinitiate the effort on the Interface Unit were received from AFCRL. These were incorporated into the Interface Unit specification and a new quote and delivery schedule was obtained from Adcole. The changes which were rather extensive resulted in a new delivery of 30 April 1970 from Adcole.

#### 3. Three Axis Mount

The three MESA Model IE accelerometers completed acceptance testing during the reporting period.

#### 4. Electronics Packages

Module testing was completed for Channel No. 1. Initial setup of the Electronics Package and the MESA Accelerometer was completed. The unit was awaiting temperature calibration at the close of the reporting period.

Module assembly was completed for channels #2 and #3. Module test was 90% complete for channels #2 and #3.

B. Tri Axial System #4 (DENPER)

1. General

The effort on this system was also affected as a result of the change to the NASA (STADAN) tracking network. Due to the fact that the design parameters for System 4 could not be defined at the time, effort was essentially stopped on the Signal Conditioning Box and the Adcole Interface Unit.

The remaining minor re-design effort required for this system was completed.

2. Three Axis Mount

The MESA accelerometer (Model ID) which was required for channel #3 was completed and tested. The two "spare" MESA accelerometers from the original OV1 flight will be utilized in channels #1 and #2.

Due to the existing funding limitation on the contract purchase of the three axis mounting frame and cover has been delayed.

3. Electronics Packages

The re-design effort required to incorporate the overrange circuitry was completed.

Fabrication of the printed circuit boards for channel #3 was begun. The Electronics Packages for channels #1 and #2 will be the "spares" from the original OV1 flight. The original Cannonball spare will have to be modified to the DENPER configuration. The SPADES "spare" will be usable as is, except for incorporation of the overrange module.

III. PLANS FOR THE NEXT REPORTING PERIOD

Temperature calibration and acceptance test of three channels for System #3 (CB II) is scheduled.

Modification and/or fabrication of the three channels for System #4 (DENPER) is scheduled. Providing that the design details for the vehicle interface are received, the Signal Conditioning Box and Interface Unit design can be completed.

IV. VISIT REPORTS

period: The following visit took place during the reporting

Date: 27 and 28 February 1970

Location: AFCRL

Purpose: General discussion of program status and application of MESA accelerometers to future satellites

Attendees: Dr. Champion - AFCRL  
F. Marcos - AFCRL  
D. Grimes - NASA/Goddard  
D. Studenick - NASA/Goddard  
W. Lange - BAC  
D. Honkala - BAC

This report summarizes the work performed during the period 1 March 1970 and 31 May 1970 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. 19628-67-C-0097.

## I. OBJECTIVES

The main objectives of the reporting period were:

A. To complete temperature calibration and acceptance test of three channels for System #3 (CB II).

B. To receive the Adcole Interface Unit (counter) after fabrication and test by Adcole.

C. To modify and/or fabricate the three electronics package channels for the System #4 (DENPER).

## II. PROGRESS

### A. Tri Axial System #3 (Cannonball II)

#### 1. General

Due to a delay in the receipt of the Interface Unit from Adcole Corp (see IIA2), the total program effort has been rescheduled. Delivery of the Three Axis System to AFCRL is now scheduled for 28 August 1970.

#### 2. Interface Unit (Counter)

The Interface Unit fabrication was not completed as previously scheduled. The reason cited was that the design changes which were required were even more extensive than previously anticipated. The unit is in fabrication and a delivery to BAC of 26 June 1970 is scheduled.

#### 3. Electronics Packages

Module testing was completed for all three electronic packages. Electrical set up and mating with the MESA accelerometer was completed for Channels #1 and #2. Temperature calibration and acceptance testing was completed for Channel #1. Channel #2 was in temperature calibration at the close of the reporting period.

#### 4. Three Axis Mount

The MESA accelerometer for Channel #1 was EB welded and successfully leak tested. It was awaiting installation into the three axis mount after completion of Channels #2 and #3.

### 5. Mock-Ups

Mock-ups for the 5 units which comprise the CBII system are in work. Delivery to AFCRL is scheduled for 19 June 1970.

### 6. System Interconnecting Cable

Material was purchased and received for the System Interconnecting Cable. AFCRL is furnishing an installation drawing to enable a formed cable to be fabricated.

### B. Tri-Axial System #4 (DENPER)

#### 1. General

Early in the reporting period, Bell responded to an informal request by AFCRL and stopped work on the Three Axis System #4 (DENPER). Subsequently, written direction was received from AFCRL.

No further effort is to be expended on this system. The residual equipment is to be boxed up and held for AFCRL disposition.

### III. PLANS FOR THE NEXT REPORTING PERIOD

A. Temperature calibration and acceptance test of Channels #2 and #3 (CB II) will be completed.

B. The Interface Unit (counter) will be completed, tested, and received from Adcole Corp.

C. The three (3) MESA accelerometers will be installed and the three axis mount completed.

D. Three Axis System Test will be performed and the CB II System will be delivered to AFCRL.

### IV. VISIT REPORTS

The following visit took place during the reporting period:

Date:	10 April 1970
Location:	AFCRL
Purpose:	General discussion of program status
Attendees:	Dr. Champion - AFCRL
	F. Marcos - AFCRL
	W. Lange - BAC
	D. Honkala - BAC

This report summarizes the work performed during the period 1 June 1970 and 31 August 1970 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVES

The main objectives of the reporting period were:

A. To complete temperature calibration and acceptance test of Channels #2 and #3 (CB II).

B. To receive the Adcole Interface Unit (CB II) and perform acceptance test at Bell.

C. To install the (3) MESA accelerometers and complete the three axis mount.

D. To perform Three Axis System Test and deliver System #3 (CB II) to AFCRL.

## II. PROGRESS

### A. Tri-Axial System #3 (Cannonball II)

#### 1. General

Due to a delay in completion of MESA accelerometer S/N 3 (see IIA4), delivery of Three Axis System (CB II) is tentatively re-scheduled for 18 December 1970.

#### 2. Interface Unit (Counter)

The Interface Unit (Counter) was received from Adcole Corp. during the reporting period. Acceptance tests were successfully performed and the unit is available for Three Axis System Test.

#### 3. Electronics Packages

Temperature calibration and acceptance test was completed on Channel S/N 2. A portion of the temperature calibration testing was witnessed by the AFCRL Contract Monitor.

Electrical setup was completed on Channel S/N 3. The unit is awaiting mating with the MESA accelerometer.

#### 4. Thre Axis Mount

The MESA accelerometer for Channel #2 was EB welded and successfully leak tested. MESA S/N 1 and S/N 2 are awaiting installation into the three axis mount.



Difficulty was experienced during testing of MESA S/N 3. It required the disassembly of the unit. The difficulty appeared to be due to improper cleaning of the precision MESA parts. A change was made in the cleaning process to preclude re-occurrence. The accelerometer was in rebuild at the close of the reporting period.

#### 5. Mock-Ups

Fabrication of the mock-ups for the five units which comprise the CB II System were completed during the reporting period. They were shipped to AFCRL on 19 June 1970.

#### 6. System Interconnecting Cable

An Experiment Wiring Layout drawing was received from AFCRL during the reporting period. This drawing was used to form and fabricate the six (6) System Interconnecting Cables.

#### B. Tri-Axial System #4 (DENPER)

##### 1. General

Work continued stopped on this unit per AFCRL direction.

#### III. PLANS FOR THE NEXT REPORTING PERIOD

A. Temperature calibration and acceptance test of Channel #3 (CB II) will be completed.

B. The three (3) MESA accelerometers will be installed and the three axis mount completed.

C. Three Axis System Test will be performed and the CB II System will be delivered to AFCRL.

#### IV. VISIT REPORTS

The following visit took place during the reporting period:

Date:	28 July 1970
Location:	BAC
Purpose:	Witness of temperature calibration testing on Channel S/N 2.
Attendees:	F. Marcos, AFCRL
	W. Lange, BAC
	H. Schugardt, BAC
	D. Honkala, BAC

This report summarizes the work performed during the period 1 September 1970 to 31 December 1970 on the development of a Three (3) Axis Accelerometer in accordance with the statement of work of Contract No. F19628-67-C-0097.

## I. OBJECTIVES

The main objectives of the reporting period were:

A. To complete temperature calibration and acceptance test of Channel #3.

B. To install three (3) MESA accelerometers and complete the three axis mount.

C. To perform three axis system test.

D. To deliver the Cannonball II System to AFCRL.

## II. PROGRESS

### A. Tri Axial System #3 (Cannonball II)

#### 1. General

The Cannonball II Tri-Axial System was hand carried and delivered to AFCRL on 18 December 1970. Turn on tests were performed and the System was accepted by the Contract Monitor.

#### 2. Electronics Packages

Temperature calibration and acceptance testing was completed on Channel #3.

#### 3. Three Axis Mount

The MESA accelerometer for Channel #3 completed acceptance testing and was Electron Beam welded and successfully filled and leak checked.

Assembly of the three axis mount was completed and the three MESA accelerometers were installed.

#### 4. Three Axis System (CB II)

Mating of the elements of the Three Axis System was completed. The Three Axis System consists of three (3) Electronics Packages, one (1) Adcole Interface Unit (counter), six (6) Inter-connecting cables, and one (1) Three Axis Mount containing three (3) MESA accelerometers.

Environmental tests were performed consisting of thermal vacuum and sinusoidal vibration. Final three axis acceptance tests, including mounting orthogonality tests, were then performed.

B. Tri-Axial System #4 (DENPER)

1. General

Work continued stopped on this system per AFCRL direction.

III. VISIT REPORTS

The following visits took place during the reporting period.

Date: 28 and 29 October 1970

Location: AFCRL

Purpose: General Discussion of Program Status

Attendees: Dr. Champion, AFCRL  
F. Marcos, AFCRL  
W. Lange, BAC  
D. Honkala, BAC

Date: 2 December 1970

Location: BAC

Purpose: To witness Cannonball II Three Axis System Test

Attendees: Dr. Champion, AFCRL  
F. Marcos, AFCRL  
W. Lange, BAC  
D. Honkala, BAC

Date: 18 December 1970

Location: AFCRL

Purpose: Delivery of CB II System to AFCRL

Attendees: Dr. Champion, AFCRL  
F. Marcos, AFCRL  
W. Lange, BAC