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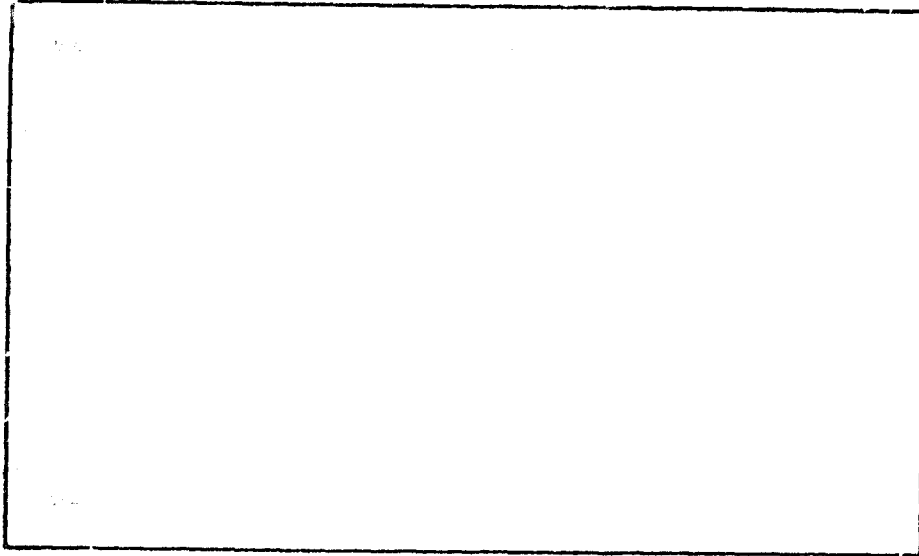
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**BELL AEROSYSTEMS COMPANY**

DIVISION OF BELL AEROSPACE CORPORATION - A **textron** COMPANY

**BELL AEROSYSTEMS COMPANY**  
DIVISION OF BELL AEROSPACE CORPORATION

**Report No. 2084-933002**  
**15 April 1963**

**COMPILATION OF UNPUBLISHED  
MATERIALS INFORMATION**

**FINAL SEMI-ANNUAL REPORT**

**Phase II**

**Current Materials Research and  
Development Programs in Effect**

**Contract AF33(657)-8555**  
**BPS No. 2(8-7381)-73812**

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## FOREWORD

This progress report was prepared by the Bell Aerosystems Company, Buffalo 5, New York under USAF Contract AF33(657)-8555 Engineering Services to Compile Unpublished Materials Information. The BPS Number assigned by the USAF is 2(8-7381)-73812. The work was administered under the direction of the Directorate of Materials and Processes, ASRC, AFSC Aeronautical Systems Division with Mr. George C. Young acting as project engineer.

This is the second and final semi-annual progress report to be prepared under Phase II of this contract summarizing Bell's activities on current materials programs which are not classified or are not proprietary. The materials programs reported in this compilation are the results of the efforts of many people within the Aerospace/Rockets Division including but not limited to the Rocket Engineering Department, the Engineering Laboratories, the Research Department and the Technical Publications Section.

This program is being coordinated at Bell Aerosystems under the direction of John M. Nowak of the Engineering Laboratories.

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### ABSTRACT

Summaries are presented of some of the materials research and development programs being conducted at the Bell Aerosystems Company, Aerospace/Rockets Division during 1963. The programs described in this report are company sponsored. The summaries consist of an abstracted and identifying version of materials research and development efforts presently scheduled and in effect. The purpose is to identify sources of potential information.

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## INTRODUCTION

The company sponsored materials research and development programs currently being conducted by the Bell Aerosystems Company, Aerospace/Rockets Division, are abstracted in this report. This is the second and final semi-annual report prepared under Phase II of Contract AF33(657)-8555. The first semi-annual report (Bell Aerosystems Company Report No. 2084-933001) prepared under Phase II of this contract listed the materials research and development programs that were being conducted in 1962. The objective of these reports is to identify sources of potential information. Detailed test data are not included in these abstracts. Programs which may result in classified or proprietary information are not included in these compilations.

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**TITLE:** Development and Improvement of Analytical Methods for Analysis of Propellants and Metals

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** R&D Lab No. 4

**DURATION:** Nine months

**LEVEL OF EFFORT:** One man/nine months

**PROGRAM:** • Application of latest techniques such as: gas chromatographic, infrared, emission spectrographic and calorimetric methods for the analyses of propellants and metals.

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**TITLE:** Synthesis and Evaluation of Hydrazine Based Solid Propellants

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** R&D Lab No. 3

**DURATION:** Nine months

**LEVEL OF EFFORT:** Four men/nine months

**PROGRAM;**

1. Synthesis and evaluation of hydrazine based solid propellants, especially polyethylene hydrazine perchlorate, as high burning rate materials adaptable to high acceleration rate missions such as anti-ICBM's and microrockets.
2. Synthesis and characterization of BN systems, seen as the step beyond perchlorates.
3. Proof-of-principle synthesis of NF systems.

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**TITLE: Studies of High Temperature Materials**

**SPONSOR: Bell Aerosystems Company**

**CONTRACT: Company R&D**

**PROJECT: Research 6**

**DURATION: Continued program from 1962**

**LEVEL OF EFFORT: Two man years**

**WORK PLANNED 1963**

The objective of this research program will be to investigate both qualitatively and quantitatively the ablative performance of a number of composites that could be used in the hyperthermal environments of advanced rocket engines. (For example, engines employing fluorine or fluorine-base oxidizers with fuels such as diborane, hydrogen or hydrazine.)

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**TITLE:** Investigation of Effects of Space Environment on Materials

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** Research 5

**DURATION:** Continued program from 1962

**LEVEL OF EFFORT:** One man year

**WORK PLANNED 1963**

Plastic and elastomeric materials developed for use in space vehicles will be subjected to the following simulated single and combined elements of extraterrestrial environment for periods up to 500 hours.

1. High vacuum —  $10^{-8}$  mm Hg.
2. Temperature extremes —  $-77^{\circ}$  to  $500^{\circ}$  K
3. Particulate radiation — Total integrated doses of gamma up to  $10^8$  rads.
4. Solar radiation — Ultraviolet .20 to .38 microns, infrared .78 to 1.5 microns.

The extent of changes in weight, dimensions, hardness, loss of lubricity, and mechanical properties, as well as their relative amount of outgassing, will be investigated and methods of reducing the degradation of these engineering materials will be recommended.

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**TITLE:** Electrochemical and Chemical Processes for Plating, Surface Finishing, and Metal Forming

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** R&D Lab No. 5

**DURATION:** Six months

**LEVEL OF EFFORT:** One man/six months

**PROGRAM:**

1. Development of dalic, electroless and electrolytic plating of nickel, copper and chromium. Evaluation will be based on results using a variety of test specimens including electroforming, corrosion studies and tensile tests.

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|                           |                                                                           |                           |
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**TITLE:** Develop Fundamental Relationship Between Ceramic Composite Materials and Design Engineering Data in Light of Brittle Fracture Theory

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** R&D Lab No. 9

**DURATION:** Two-thirds year

**LEVEL OF EFFORT:** One man/year

**PROGRAM:** The intermediate objective is to generate fundamental engineering property data on ceramic composite materials developed by Bell for high temperature ( $> 3000^{\circ}\text{F}$ ) applications in aerospace hardware. The engineering data will be studied in light of brittle fracture theory. The ultimate objective is to understand the failure mechanisms of selected ceramic material composites so that new ceramic material composites can be designed for application to aerospace hardware with a reasonable chance of success without extensive empirical testing.

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**TITLE:** Development of Burst Pressure Test Data From Subscale Pressure Vessels

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** R&D Lab No. 2

**DURATION:** Three-fourths year

**LEVEL OF EFFORT:** One man/year

**PROGRAM:** Burst tests on subscale pressure vessels fabricated from 6061, 2014 and 2219 aluminum alloys will be conducted at temperatures down to -320° F.

|                           |                                                                           |                           |
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**TITLE:** Development of Data on Selected Alloys

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** R&D Lab No. 1

**DURATION:** One year

**LEVEL OF EFFORT:** Three-fourths man/year

**PROGRAM:** • Short-time tensile properties and creep properties of vanadium alloys, titanium alloys and columbium alloy FS85 will be determined at elevated temperatures up to 3400° F.

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**TITLE: Determine Effects of Structures on Deformation and Failure Behavior of Maraging Steels**

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** R&D Lab No. 7

**DURATION:** One year

**LEVEL OF EFFORT:** One-half man/year

**PROGRAM:** This program is designed to investigate optimum welding and heat treating procedures, to establish the correct sequence of operations, and to investigate resulting mechanical properties and related structures.

|                           |                                                                           |                           |
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**TITLE:** High Temperature Creep Properties of Nonmetallic Materials

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** -

**DURATION:** One year

**LEVEL OF EFFORT:** One-half man/year

**PROGRAM:** Provide high temperature creep data on nonmetallic materials by review of current literature and by test to designers of aerospace structures. Study mechanism involved.

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**TITLE:** Investigate Mechanical Properties and Structures of Refractory Metal and Stainless Steel Brazed Joints Designed for Elevated Temperature Service

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** R&D Lab No. 8

**DURATION:** 11 months

**LEVEL OF EFFORT:** One man/year

**PROGRAM:** Under this program optimum joint gaps, brazing alloys, and diffusion cycles will be investigated. Their relationship to elevation of remelt temperature, strength, ductility, and elevated temperature mechanical properties will be determined.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                          |                                             |
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| <p><b>TITLE:</b> Evaluation of Coatings for Metals and Nonmetals for Application to Aerospace Hardware</p> <p><b>SPONSOR:</b> Bell Aerosystems Company</p> <p><b>CONTRACT:</b> Company R&amp;D</p> <p><b>PROJECT:</b> -</p> <p><b>DURATION:</b> One-half year</p> <p><b>LEVEL OF EFFORT:</b> One-half man/year</p> <p><b>PROGRAM:</b> Evaluate available coatings for application to aerospace hardware being designed and/or developed by the Bell Aerosystems Company. Coatings for specific emittance properties and/or to provide oxidation resistance to materials are to be evaluated and tested.</p> |                                                                          |                                             |

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**TITLE:** Evaluate New Nonmetallic Materials and Processes Related Thereto

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company R&D

**PROJECT:** -

**DURATION:** Three-fourths year

**LEVEL OF EFFORT:** One-half man/year

**PROGRAM:** Study and evaluate new nonmetallic materials and processes that may be applied to aerospace hardware being designed and/or developed by the Bell Aerosystems Company.

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**TITLE:** High Energy Rate Metalworking Techniques

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company sponsored

**PROJECT:** -

**DURATION:** Ten months

**LEVEL OF EFFORT:** Three-fourths man/year

**PROGRAM:** This program is designed to survey the various techniques in use (magnetic field, spark discharge, exploding wire, explosive forming, etc.) to define the advantages and limitations of each, to determine the high energy rate forming characteristics of various materials, and to investigate low-cost tooling methods.

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**TITLE:** Tungsten Forming and Joining

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company-Sponsored

**PROJECT:** -

**DURATION:** Six months

**LEVEL OF EFFORT:** One-third man/year

**PROGRAM:** Convenient and economical heating methods for tungsten forming and welding pre- and post-heat will be studied. Also, methods of tungsten riveting will be investigated.

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**TITLE:** Fusion Welding of 7075 and 7178 Aluminum Alloys

**SPONSOR:** Bell Aerosystems Company

**CONTRACT:** Company sponsored

**PROJECT:** -

**DURATION:** Eight months

**LEVEL OF EFFORT:** One-fourth man/year

**PROGRAM:** This program is designed to develop optimum welding techniques for the difficult-to-weld 7075 and 7178 aluminum alloys.