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STUDY OF BASIC PHYSICAL PROCESSES IN LIQUID AND SOLID ROCKET PROPULSION (5-33125)

Final Technical Report for the Period
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(May 14, 1993)

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PREFACE

This technical report was prepared by the staff of the Research Institute, The University of Alabama in Huntsville. It summarizes the research performed under contract NAS8-38609, Delivery Order 62. Joseph W. Monroe was Principal Investigator. We would like to recognize the contributions of Mr. Preston S. Craig whose technical maturity and insight provided the basis for this activity. Mr. Craig's contributions prior to his untimely death were inspirational to all associated with him.

Technical coordination was provided by Mr. Robert W. Hughes of the Research and Technology Office, Science and Engineering Directorate at MSFC.

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official National Aeronautics and Space Administration, Marshall Space Flight Center position, policy, or decision unless so designated by other official documentation.

I have reviewed this report, dated 5/14/93 and the report contains no classified information.

Joseph W. Monroe
Principal Investigator

Approval:

William Wolfenbarger
Research Institute

FINAL REPORT FOR

STUDY OF BASIC PHYSICAL PROCESSES IN LIQUID AND SOLID ROCKET PROPULSION SYSTEMS

ABSTRACT/SUMMARY

A process (model) has been developed to assess the suitability of new/modified technologies and subsystems for application to commercial launch vehicles.

Suitability is measured in terms of cost, safety and environmental impact.

Cost relates to recurring production and operational cost per flight, amortization of non-recurring development costs, "effective" cost of difference in payload capability and the cost of unreliability.

The process is also applicable for assessing technologies and subsystems for application to other launch vehicles.

The process will enable a comprehensive systems engineering approach 1) to assess the potential of technologies and subsystems for launch vehicle applications and 2) provide documentation of the results for application to technology planning for the future.

INTRODUCTION

The Science and Engineering Directorate of MSFC is planning to support the development of technologies and subsystems for the commercial launch vehicle industry.

A part of this effort is the assessment of the suitability of new and modified technologies and subsystems for reducing the cost of commercial payload delivery.

OBJECTIVE

The primary objective of this effort was to develop a model to provide visibility into the relative effectiveness of various technologies and subsystems in reducing the operational costs of commercial launch vehicles. A second objective was to identify and investigate those technologies/subsystems that had the potential for

technology leverage and technology transfer and could, therefore, provide a bigger return from the costs of their development.

RESULTS

Activities to date have resulted in the following:

1) Identification of technologies/subsystems of potential interest,
2) Identification of the required input data for comprehensive assessment,
3) Identification of the "yardsticks" to measure potential cost effectiveness and technical feasibility, and
4) The development of an assessment process ("model") to be applied individually to each technology/subsystem to support the decision making process.
5) A standardized format for the reporting the results of each assessment.

A significant part of the process is the determination of the impact on payload capability of the application of various technology and subsystem alternatives and the procedure for readily equating the change in payload capability to the "effective" cost per launch. This involves a set of Cost Equivalency Charts for each vehicle of interest. Each set of charts addresses each stage of the vehicle for each of the vehicles more prevalent missions. Such curves, which require many individual flight trajectory simulations, have been prepared for the Delta II launch vehicle. The remainder of the curves will not be completed by the completion of this contract.

Application of the overall process will require the support of technology specialists, cost specialists, reliability engineers and launch vehicle systems engineers to 1) verify certain assumptions that must be made, 2) assess technical feasibility, 3) provide estimates of relative cost and reliability, and 4) adapt the process to certain particular technologies/subsystems.

All of the data and documentation referred to above has been provided to Mr. Robert W. Hughes, the NASA/MSFC COTR.

CONCLUSIONS AND RECOMMENDATIONS

In the author's opinion, the process will enable a comprehensive systems engineering approach 1) to assess the potential of technologies and subsystems for launch vehicle applications and 2)

provide documentation of the results for application to technology planning for the future.

If the process is to be successfully applied, the following actions are recommended:

a. Assessment of several hypothetical cases to test the process and the applicability of the format for documenting the results.

b. Updating the process and format in accordance with the results of a) above.

c. Completion of the required technical supplements for the process, e.g., completion of the Cost Equivalence Charts for existing and potential launch vehicles.

d. Adaptation of the process by the S&E Directorate for overall technology planning and monitoring.

e. The provision for and coordination of special technical and systems engineering support to a continuing assessment process.

f. Determination of the potential for technology leverage and for technology transfer to commercial entities outside of the commercial launch vehicle industry.

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16. ABSTRACT

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