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FINAL REPORT

ADVANCED EARTH-TO-ORBIT PROPULSION TECHNOLOGY INFORMATION, DISSEMINATION AND RESEARCH
NAS8-38609, D.O. 91

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ABSTRACT

In this period of performance, July 28, 1993 - March 28, 1995, a conference (The 1994 Conference on Advanced Earth-to- Orbit Propulsion Technology) was organized and implemented by The University of Alabama in Huntsville and held May 15 - 17 to assemble and disseminate the current information on the Advanced Earth-to-Orbit Propulsion Technology. The results were assembled for publication as NASA CP 3282, Volume 1 and 2 and NASA CP-3287.

BACKGROUND

In the development of the Space Shuttle Main Engine (SSME) and the Space Transportation Main Engine (STME) it was felt by NASA that upgrading the capabilities of this engine concept was necessary in order to meet the challenge of the space transportation system needs for the future. The Marshall Space Fight Center (MSFC) was given the lead role to identify technology opportunities, develop multi-year plans and to oversee the implementation of these plans with the assistance and involvement of the Lewis Research Center. The overall objective of this program is the establishment of basic discipline technology necessary for an orderly evolution of high pressure oxygen-hydrogen stage combustion rocket engines to meet the needs of the earth-to-orbit space transportation for the next twenty-thirty years. It is expected that the accomplishments of these objectives have contributed to the nation's space program through providing a sound technological foundation for improvement in the technical specialties of rotor dynamics, structural dynamics, fluid and gasdynamics, fatigue/fracture mechanics/life, turbomachinery fluid mechanics, ignition/combustion processes, NDT/NDE inspection method, manufacturing/producibility, materials development/evaluation, cryogenic bearings, and instrumentation.

Since 1984 a series of conferences describing the research achievements on the NASA-wide research and technology programs dealing with advanced oxygen/hydrogen and oxygen/hydrocarbon earth-to-orbit propulsion has been held at Marshall Space Flight Center. The purpose of these conferences was to provide a forum for the timely dissemination to the propulsion community of the results emerging from this program with particular emphasis on the transfer of information from the scientific/research to the designer.

The first conference on the oxygen/hydrogen program was held at MSFC, on June 27-29, 1984. Proceedings of that conference entitled "Advanced High Pressure O_2/H_2 Technology" were published as NASA Conference Publication 2372. A copy of the Table of Contents and participants list of this proceedings is included in Appendix I. Subsequently, NASA's separate research and technology programs dealing with oxygen/hydrogen and oxygen/hydrocarbon propulsion were combined into one program entitled "Advanced Earth-to-Orbit Propulsion Technology". The second conference proceedings entitled "Advanced Earth-to- Orbit Propulsion Technology, Volumes I and II" were published as NASA Conference Publications 2436 and 2437. A copy of the table of contents and participants list of this proceedings is included in Appendix II. That conference was held on May 13-15, 1986. The third conference

on these subjects was held on May 10-12, 1988. The third conference proceedings entitled "Advanced Earth-to-Orbit Propulsion Technology" were published in two volumes as NASA Conference Publication 3012. A copy of the table of contents and participants list is included in Appendix III. The fourth conference on these subjects was held on May 12 - 15, 1990. The fourth conference proceedings entitled "Advanced Earth-to-Orbit Propulsion Technology - 1990" were published in three volumes as NASA Conference Publication 3092. A copy of the table of contents and participants list is included in Appendix IV. The fifth conference on these subjects was held on May 19-21, 1992. The fifth conference proceedings entitled "Advanced Earth-to-Orbit Propulsion Technology 1992" were published as in two volumes as NASA Conference Publication 3174. A copy of the table of contents and participants list is included in Appendix V. In addition a proceedings entitled Hydrogen Effects on Materials in Propulsion Systems was assembled and submitted to NASA/MSFC in July 1992 for publication. A copy of the table of contents and participants list is included in Appendix VI. The sixth conference proceedings entitled "Advanced Earth-to-Orbit Propulsion Technology" were published in two volumes as NASA Conference Publication 3282. A copy of the table of contents and participants list is included in Appendix VII.

The program grew significantly from 9 sessions, with 43 papers in the first conference to 22 sessions, and 1 workshop. A total of 131 papers was presented in the 22 regular sessions which were included in the proceedings. An additional 30 presentations were made in the workshop and are being published separately. The attendance has approximately doubled from just over 200 in 1984 to about 400 in 1994. The contents of the conference was originally organized into ten topics and has grew to eleven topics and the 1994 coference was organized into ten topics which include: Materials Development, Manufacturing and Inspection, Instrumentation, Turbomachinery, Fluid and Gas Dynamics, Ignition and Combustion, Fatigue/Fracture/Life, Bearings, Structural Dynamics, and Controls and Health Monitoring. Additionally, a Hydrdogen Environment Embrittlement in Advanced Propulsion Systems Workshop was conducted concurrently with the 1986 conference, during the 1988 conference a workshop on the Status Review of Hyrodcarbon-Fuels/Copper Materials Compatibility was held and during the 1990 conference two workshops (Hydrogen Standardization Workshop and Efficient Engine Workshop) were conducted. The presentations at the 1986 workshop were published in the conference proceedings, the 1988 workshop was composed of informal discussions and manuscripts were not prepared, and the 1990 workshop presentations were published in the conference proceedings. In 1992, three special sessions concentrating on Fluid/Struction Interaction, Robust Turbopump, Turbomachinery Seals and two workshops entitled Propulsion System Avionics and Hydrogen Effects on Materials in Propulsion Systems were conducted concurrently with the conference. A workshop entitled "Aluminum Lithium Alloys for Aerospace Applications" was held in conjunction with the conference and the proceedings are published separately as NASA CP-3287.

The Marshall Space Flight Center Advanced Earth-to-Orbit Propulsion Technology program is a long standing program. Proper interaction between industry/university and government communities are necessary. It has been demonstrated by each of these conferences that we

were able to fill this need to provide a forum for these agencies. Specific task are included in the next section.

SPECIFIC TASKS ACCOMPLISHED

Implementation of the program was accomplisehd by the following specific tasks:

1. Together with the designated MSFC personnel, the P.I. coordinated the activities involve in one Advanced Earth-to-Orbit Propulsion Technology Conference held May 17 - 19, 1994.

2. Preliminary preparation for the conference was accomplished by updating the mailing list used for the 1994 conference, scheduling anticipated dates with the approval of the MSFC personnel as well as drafting a preliminary announcement for MSFC personnel approval.

3. The P.I. with the approval of the designated MSFC personnel selected the members of the technical committee for the conference.

4. The P.I. with the approval of the designated MSFC personnel selected scientists and engineers to participate in the conference.

5. The P.I. together with the members of the technical committee selected papers for presentation in the conference.

6. The P.I.'s office provided all the necessary logistic and technical support for the preparation and duration of the 1994 conference.

7. The P.I. was responsible for assembling all the papers presented at the conference, compling a table of contents, pagation, author index, foreword, and delivering the assembled proceedings to MSFC for publication.

The preparation and distribution of the 1994 conference proceedings as NASA CP 3282, Volumes I and I and NASA CP-3287 constituted the final report for this effort.

APPENDIX I

"Advanced High Pressure O_2/H_2 Technology"
NASA Conference Publication 2372

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"Advanced Earth-to-Orbit Propulsion Technology 1986, Volumes I and II"
NASA Conference Publications 2436 and 2437

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APPENDIX IV

"Advanced Earth-to-Orbit Propuision Technoiogy 1990, Volumes I. II and III"
NASA Conference Publications 3092

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Advanced Earth-to-Orbit Propulsion Technology 1990

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National Aeronautics and
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APPENDIX V

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"Hydrogen Effects on Materials in Propulsion Systems"
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APPENDIX VII

"Advanced Earth-to-Orbit Propulsion Technology 1994 Volume I and II"
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APPENDIX VIII

"Aluminum Lithium Alloys for Aerospace Applications"
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