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TECHNOLOGY ASSESSMENT OF PORTABLE ENERGY RDT&P

PHASE I

Compiled by

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TRW SYSTEMS AND ENERGY

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA Ames Research Center

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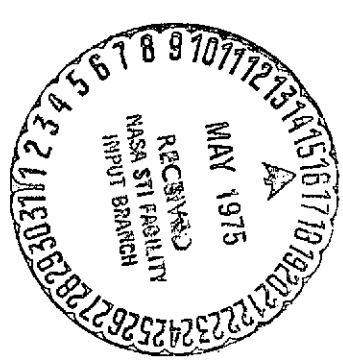

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EXECUTIVE SUMMARY REPORT

TECHNOLOGY ASSESSMENT OF PORTABLE ENERGY RDT&P

PHASE I

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CONTENTS

1. THE STUDY AT A GLANCE

The NASA in conjunction with the TRW Systems and University of Texas study teams have undertaken a technology assessment of transportation energy research, development, technology and production (RDT&P) to assess the technical, economic, environmental and sociopolitical issues associated with transportation energy options and to determine those courses of action impacting aviation and air transportation R&T. The term portable energy implies the need to carry fuel on-board the transportation vehicles.

The 80 general conclusions and recommendations produced by the Technology Assessment Workshop participants were analyzed and subjected to certain NASA criteria: (1) the area must be relevant to NASA aviation R&T, transportation R&T or energy; (2) the issue has not been adequately addressed elsewhere; and (3) NASA/industry/universities have the competence to address the issues. This evaluation eliminated many of the subject areas principally because they were well covered by other agencies, by industries or previous technical work, or because they obviously were outside NASA's interests or capabilities. This approach worked very well in eliminating certain subject areas for good and sufficient reason but at the same time, left 18 issues having strong justification for problem statement development.

Seven of these problem statements directly address NASA's aeronautical responsibilities. They are:

- Determine Availability of the Most Probable Aviation Fuels
- An Analysis of Institutional and Associational Barriers to the Implementation of New Portable Fuel Sources
- Develop an Approach to "Generating an Industry" to Manufacture, Market and Use New Synthetic Liquid Fuels
- Direct Conversion of Coal to Light Aviation Fuel
- Engine Test New Synthetic Liquid Fuels to Assure Their Reliable Operation in Aircraft
- A Systems Analysis of the Energy Costs Related to the Design, Manufacture and Use of Aircraft with the

Eventual Objective of Identifying Opportunities for the Conservation of Energy and Other Natural Resources

- Automation Systems for Drilling Rigs and Outer Continental Shelf Oil and Gas Exploitation

Two programs have been defined which would use NASA-developed technology in the general solutions of energy problems of the United States. These are:

- Thermoelectrics for Commercial Power/Process Plant Energy Augmentation
- Application of NASA Sensor and Teleoperator Technology to Improve Mining and Mineral Resource Operations

Transportation research and technology can be advanced by the following programs:

- Develop New Approaches to a Better Hydrogen Supply for Synthetic Liquid Fuel Development
- Develop Approaches and Identify Application Areas for Small-Scale Conversion of Wastes to Power or Synthetic Fuels
- Specification for the Production of Alternative Scenarios by Simulation
- Social-Demographic Influences on the Demand for Air Transportation

The TA Teams jointly can contribute to additional programs which have general energy importance but indirect impact on aviation research and technology, such as:

- Evaluate Hydraulic/Solvent Methods for Safely Increasing the Mining of Coal
- Relationship Between Energy Load Demand and Geothermal Resource Areas
- Design Study for a Solar Energy Concentrator
- Evaluate Mechanical, Physical and Chemical Methods for Energy Storage
- Delineate Potential Societal Dislocations Resulting from Efforts to Establish Energy Independence in the United States

The process used in this study was a new approach to defining important research and technology areas for future investigation. The subject areas covered in the problem statements are recommended for serious consideration by NASA.

2. THE FOCAL POINT - TECHNOLOGY ASSESSMENT WORKSHOP

This study used the technique of a technology assessment workshop for the purpose of assessing portable energy futures. The workshop was held in Monterey, California, during the week beginning August 25, 1974. Thirty-eight people were present as active workshop participants, and they were supported by personnel from NASA, TRW, and The University of Texas at Austin. These participants represented diverse backgrounds and experience, including political science, law, sociology, banking, economics, as well as technology. Government, industry and university people were present. This diverse mixture of participants was arranged intentionally in order that important nontechnical elements of portable energy futures would not be overlooked.

Principles of group dynamics were used in operating the workshop. The participants were divided into six working groups throughout the week. The working groups operated on an informal basis both from the standpoint of the meeting arrangements as well as the approach and agenda.

The technique of differentiation/integration was employed in the workshop operation. For the first part of the week the working groups were generally structured homogeneously. Participants of similar backgrounds and experience were placed in the same working groups. This permitted most participants to initially develop portable energy futures according to the view of the world of their segments of society. During the last part of the week the groups were intermixed and heterogeneous so that each participant had to contribute to solutions according to a mix of requirements.

Before arriving in Monterey, each participant had been given a future energy scenario for his first working group and a description of about 24 possible potential actions (alternative energy processes). It was found that this information was prepared in too detailed a format. A better approach would have been to simplify the scenarios and potential actions and to initiate the meeting with a briefing session. Nevertheless, all working groups became actively involved in preparing reports answering the requirements for selecting the most promising technical options to satisfy their given energy demand scenarios. In the latter part of the

week, when the heterogeneous groups were operating, they were given an opportunity to develop their own scenarios of the future. Again, written reports were prepared. Real time support was given to the working groups in the form of a secretarial staff and a Xerox machine.

The results of the work were two-fold. First, the 12 working groups of participants produced written reports which contained over 80 conclusions, recommendations and items of interest. Minority reports were encouraged and received. The general directions proposed by the workshop can be classified in three areas, plus a miscellaneous category. The three principal directions were related to energy conservation, exploitation of known domestic energy resources and the development of new fuels. A further measure of the workshop success was that the participants were actively and spontaneously involved in producing their contributions throughout each day and well into the night. Considerable appreciation of the viewpoints of other disciplines developed. Finally, the workshop group reports were in fact a valuable tool in defining programs of importance in connection with assuring future supply of portable energy.

3. WORKSHOP RECOMMENDATIONS TO PROBLEM STATEMENTS

A workshop Proceedings Report was prepared and sent to NASA and each of the participants at the end of September 1974. This report contained the information sent to the participants before the workshop, including all six scenarios and the 24 potential actions. It also included a summary of the workshop as well as critiques from NASA, The University of Texas and TRW personnel. The compilation of the data base bibliographic index up to the time of the workshop also was included in this Proceedings Report. A vital part of this working document was the reports of the 12 working groups, which were prepared during the workshop sessions at Monterey. From these reports a compilation of conclusions, recommendations and items of interest were made. There were over 80 elements in this compilation.

After publication of the Workshop Proceedings Report, there was a more detailed examination of the conclusions, recommendations and items of interest mentioned above. There were, of course, duplications and considerable overlap of workshop recommendations. From this exercise, 47 candidate problem statement titles were prepared along with a brief description of each subject area. Each subject area was then explored in four different ways. First, there were NASA criteria which included: (1) the area must be relevant to NASA aviation R&T, transportation R&T or energy, (2) the issue has not been adequately addressed elsewhere, and (3) NASA/industry/universities have the competence to address the issue. If the subject area passed these NASA criteria, it then was examined in light of information available in the data base. Further, the subject area was discussed in telephone conversations with some of the participants and with knowledgeable people at NASA, TRW and The University of Texas. This exploration process eliminated 29 of these subject areas principally because they were well covered by other agencies, industries or previous technical work, or because they obviously were outside NASA's interests or capabilities. This approach worked very well in eliminating certain subject areas for good and sufficient reason, but at the same time, left 18 areas having strong justification for problem statement development.

A format was selected for use in writing the problem statements. The first portion was an introduction which covered background information, logic, need and justification. This was followed by a project objective and then a suggested approach. The final two elements included the task description and an estimate of time and costs. Again, during the problem statement preparation, continued use was made of the data base, suggestions from participants and knowledgeable people from the three organizations involved with this program.

4. THE NEXT STEPS - NASA AND PORTABLE ENERGY

The Phase I study that this report summarizes was in fact a focusing and concentrating process. Starting with the assembly of a large data base, the definition of alternative actions and significant issues, and a consideration of present policies, the first focusing action involved the scenarios of possible futures prepared by The University of Texas at Austin. Using the foundation just described, the technology assessment workshop participants looked at portable energy futures from the viewpoints of their diverse backgrounds and, in effect, looked at the total energy future with some concentration on portable energy as a subset.

This Executive Summary Report and the full Final Report of this Phase I study describe the processes used to focus the more than 80 conclusions and recommendations of the workshop into 18 problem statements, which have been categorized and briefly described in Section 1. These 18 problem statements cover programs that would make valuable contributions to assuring energy futures in the United States. Obviously, the implementation of even a portion of these 18 statements would require significant governmental action, including interagency discussions and the allocation of the important resources of capable people and funds. Immediate steps can be taken to combine some elements of certain of these statements into a program of value to NASA's aviation research and technology responsibilities. This near-term activity is entitled, "Study to Determine Availability of the Most Probable Aviation Fuels". This study will describe the most probable aviation fuels and their resource base in the 1980's and 1990's. The study output will provide guidance for structuring a compatible aviation propulsion R T program.

Coal and shale are prime energy resources, but offer no direct possible use as aviation fuels. Many active or planned government and industry projects are designed to convert these domestic resources into other prime energy forms such as synthetic gas and crude oil. The primary rationale for this study rests on NASA's responsibilitytto undertake relevant aviation propulsion R&T which will provide the aviation and air transportation industry with propulsion systems that are compatible with the most probable aviation fuels in the 1980's and 1990's. Although both coal

and oil shale are our most plentiful domestic energy resources, there are many questions concerning their successful extraction and conversion into useful fuels that remain unresolved. These questions involve not only technical and economic considerations, but also important related issues such as environmental impacts, labor supply and training, extraction and conversion safety, and the broad question of the respective roles of government and industry. The proposed study would attempt to assess the potential impact of these issues and to resolve the questions relating to future aviation fuels availability.

The principal objective of this study is to describe the most probable aviation fuels in the 1980's and 1990's, and to determine the feasibility of providing an adequate supply of hardware-compatible aviation fuels derived from domestic coal or shale at stable competitive prices within this time-frame.

The study tasks required to define these objectives are:

- Study Task 1: Describe the present aeronautical fuel infrastructure and near-term trends (~5 years). This task would describe, and thus initiate, an understanding of the present raw material, manufacturing, transportation, marketing and use patterns for aviation fuels. It would be the reference point for several subsequent tasks described below.

- Study Task 2: Identify barriers, problems and influences in present aircraft fuel supply. It is most likely that the introduction of a new synthetic aviation fuel would be more easily accomplished if the present commercial channels could be used as much as possible. Thus, an identification and understanding of the type and character of present channels is required.

- Study Task 3: Identify present and potential processes and resource base. Processes for the preparation of aviation fuels would be identified and described in general technical terms, and the resource base necessary to implement all of the processes would be defined. This base would include resource extraction, transportation system and distribution channels among others.

- Study Task 4: Analysis of coal and shale-derived synthetic aircraft fuels technical options. This analysis would include commercial experience, technical uncertainties, development programs and time required,

- Study Task 5: Investigate barriers, problems and influences regarding the implementation of each technical option analyzed in Task 4. This investigation is similar to Task 2 above except that in this task the approach considers the questions in light of synthetic aviation fuel products.

- Study Task 6: Determine the availability of the most probable aviation fuels in the 1980's and 1990's. Using the results and information developed in Task 3, 4 and 5 above, an assessment and determination of the most probable aviation fuels option(s) would be prepared. Resources and time required to introduce the product(s) would be defined.

- Study Task 7: Identify the implication to NASA aviation propulsion research and technology. The introduction of any synthetic aviation fuels could have an impact on NASA's planned research and technology programs. This task will identify and describe these future impacts.

The production of synthetic aviation fuels from coal or shale would influence significantly NASA's aviation R&T program. The above study program is designed to define the R&T requirements in response to a determination of the most probable aviation fuels in the 1980's and 1990's.