Final Report
Hybrid Heat Engine / Electric Systems Study
Volume I: Sections 1 through 13

71 JUN ∅1

Prepared for DIVISION OF ADVANCED AUTOMOTIVE
POWER SYSTEMS DEVELOPMENT
U. S. ENVIRONMENTAL PROTECTION AGENCY
Ann Arbor, Michigan

Contract No. F04701-70-C-0059

Office of Corporate Planning
THE AEROSPACE CORPORATION
El Segundo, California

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FOREWORD

Basic to analyzing the performance of the hybrid vehicle was the importance of understanding the characteristics of each major component since each would be operating in a nonstandard mode required by the hybrid arrangement. In addition, the potential for improvement had to be understood to predict the performance of advanced designs. This report, therefore, contains two types of information: (a) hybrid system analysis and results; and (b) major component state-of-the-art discussions, characteristics used in this study, and advanced technology assessments. Heat engine operating characteristics, mechanical parameters, and exhaust emissions are covered extensively because of both their primary importance and the difficulty involved in collecting a reliable comprehensive set of data; this should relieve future investigators making studies of nonconventional propulsion systems of the necessity of repeating the burdensome task of assembling a data bank.

It should be recognized that calculated results are based on data compiled in this study. The magnitude and trends were established on the basis of a comprehensive survey and evaluation of the best data from both the open literature and current available unpublished data sources. These data are considered suitable for use in the feasibility study conducted under this contract. However, for further detailed design a substantial refinement of the data base would be necessary.

he report is organized to give a logical build-up of information starting with study specification, analytical techniques, and component characteristics and concluding with system performance results and recommendations for development. However, selective reading of major systems performance results is possible and to assist those so interested, the following brief guide is presented:

Section 1	Summary of study results and recommentations
Sections 2, 3, 10, and 11	Presentation of study objectives, design specifications, and results
Sections 3 and 4	Description of computational techniques and performance requirements
Sections 6 through 9	Review of contemporary and projected technology of major components
Section 12	Cost estimates for high-volume production of hybrid cars
Section 13	Presentation of a technological plan for component and system development

This report is published in two volumes for convenience; however, separation of the material is made with due regard to organization. Volume I consists of Sections 1 through 13 and presents the essential study information, while Volume II consists of Appendices A through F and presents supplementary data.

The period of performance for this study was June 1970 through June 1971.

ACKNOWLEDGMENTS

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