# AIAA/SAE 7th Propulsion Joint Specialist Conference

THIS Survey Paper, the next three papers, and the first two Engineering Notes in this issue were presented at the AIAA/SAE Propulsion Joint Specialist Conference in Salt Lake City, Utah, June 14–18, 1971. Additional papers from this meeting will be published in a later issue of the *Journal of Spacecraft and Rockets.*

The Propulsion Conference has addressed some of the major technical propulsion problems and presented information for the high performance propulsion systems of the future. In reviewing the papers from the Conference, it is evident that a great deal of sophisticated knowledge exists in the propulsion industry today. Propulsion systems are now highly developed and are capable of delivering design performance over a wide range of operating conditions. In particular, the available knowledge regarding chemical rockets can be utilized for the design of a low cost, highly reliable space shuttle engine.

Future efforts will focus not only on performance improvements and cost reductions, but also on modifications to satisfy current environmental requirements. Several papers presented at the Conference were devoted to pollution generated by jet propulsion. Modeling and prediction techniques for gas turbine emissions were shown to be capable of yielding qualitatively accurate results. Sufficient understanding of combustor nonuniformities appears to be available so that the prediction techniques for exhaust gas composition can be applied to more realistic combustor systems. R and D efforts on reducing the noise of aircraft powerplants also continue to receive strong support, as substantial noise reduction is achieved with prototype configurations.

The Conference proceedings indicate that more effort is required in the development of advanced air-breathing propulsion systems. These advanced systems include not only devices such as higher Mach number turbojets and ducted afterburning rockets but also powerplants for hypersonic flight. Relevant information for this flight regime was discussed and should eventually lead to the design and development of a propulsion system for a hypersonic vehicle. Such a vehicle might well incorporate an advanced cryogenic rocket boost system and a supersonic combustion ramjet.

The 1971 Conference has given us a glimpse of future innovations, e.g., vortex film cooling for rocket chambers, an extendable nozzle skirt, a reliable performance prediction technique for tank injection pressurization, control devices for solid rocket motors, and a staged combustion rocket motor. In addition, the Conference provided us with further information in certain unresolved areas, e.g., combustion instability in rockets, gas turbines, and thrust augmenters. The research programs discussed may eventually provide us with sufficient information to predict motor stability behavior and to evolve design criteria for acoustic absorbers.

The wealth of information included in the Conference papers and exchanged during the discussions should prove useful in the design of advanced propulsion systems. As we progress into the decade of the 70's, we can hopefully look forward to further advances in propulsion in spite of the reductions that have occurred in aerospace funding.

Louis A. Povinelli
*Guest Editor*

---

MARCH 1972 J. SPACECRAFT VOL. 9, NO. 3

# Survey of Satellite Auxiliary Electric Propulsion Systems

LEE B. HOLCOMB
*Jet Propulsion Laboratory, Pasadena, Calif.*

**Lee B. Holcomb is an Engineer in the Liquid Propulsion Section's Systems Engineering Group at the Jet Propulsion Laboratory. He received a B.S. in Mechanical Engineering from U.C.L.A. in 1968 and an M.S. in Mechanical Engineering, Jet Propulsion Option, from the California Institute of Technology in 1969. He is engaged in the development and application of system selection techniques for auxiliary propulsion and has participated in auxiliary-propulsion system design and selection for JPL advanced spacecraft studies such as TOPS and SEMMS. He is a member of the AIAA.**

## Introduction

WITH the success of the experimental electric thrusters that are on board the Application Technology Satellite (ATS) IV, Lincoln Experimental Satellite (LES) 6, and Space Electric Rocket Test (SERT) II, along with the applications of state-of-the-art electric propulsion technology to LES 8 and ATS F and G, auxiliary electric propulsion is emerging from experimental to flight status. The satellite auxiliary propulsion designer is now faced with the evaluation of present state-of-the-art auxiliary electric thrusters for application to unmanned satellites, particularly long-life synchro-

Presented as Paper 71-685 at the AIAA/SAE 7th Propulsion Joint Specialist Conference; Salt Lake City, Utah, June 14–18, 1971; submitted June 11, 1971; revision received October 22, 1971. This paper presents the results of one phase of research carried out at the Jet Propulsion Laboratory, California Institute of Technology, under Contract NAS 7-100, sponsored by NASA/OSSA Applications Technology Satellites Program Office. The author acknowledges the cooperation of the many corporations, NASA, and other government agencies in granting permission to reproduce photographs and data, and in freely discussing various technical areas. During the preparation of the manuscript, the author had the benefit of critical reviews of various sections by C. Dulgeroff, J. Hyman, and H. J. King of Hughes Research Laboratories; R. M. Worlock of Electro-Optical Systems; S. Zafran of TRW Systems Group; G. Seikel and S. A. Burkhart of NASA Lewis Research Center; and W. J. Guman of Fairchild-Hiller. The author would further like to acknowledge the continuous assistance of J. H. Kelley, D. J. Kerrisk, T. D. Masek, and N. Nerheim, of Jet Propulsion Laboratory.

Index categories: Spacecraft Propulsion Systems Integration; Electric and Advanced Space Propulsion.