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Electric Propulsion Space Experiment (ESEX)

OVER 120 spacecraft are currently using electric propulsion for functions including orbit raising, orbit maintenance, attitude control, and interplanetary travel. The technologies being used include resistojets, arcjets, ion thrusters, Hall thrusters, and pulsed plasma thrusters, with thruster power levels generally ranging from 100 W to 2.5 kW. The one major exception to this power range is the Air Force ARGOS spacecraft with its Electric Propulsion Space Experiment (ESEX) payload, which used a 26 kW arcjet propulsion system onboard to study the impact of high power electric propulsion on other spacecraft functions. This order-of-magnitude increase in electric power made ESEX not only the highest power electric propulsion system in orbit, but also one of the highest power spacecraft of any type.

Following over a decade of preparation, ESEX was launched on 23 February 1999 into an 846-km near-polar orbit. The experiment, which primarily consisted of eight ~six-minute firings (the longest was 9 min long) of the 26 kW ammonia arcjet, successfully demonstrated that high power electric propulsion can be operated on a spacecraft with no impacts on other subsystems.

This issue of the *Journal of Propulsion and Power* contains nine papers focused on the ESEX program and flight results. The paper selection was made to provide the reader with a sample of all aspects of this major project. The papers are generally divided into two sections; with the first three covering the program organization and history, spacecraft integration and system engineering, and a detailed description of the arcjet propulsion system; and with the last six papers describing specific results from the quite extensive flight measurements. Within the first three papers an effort was made to not only provide detailed technical information, but also to share some of the difficulties of managing a large, long-duration program involving several disparate organizations. Specific "lessons-learned" are also discussed in the hope that others can benefit from the ESEX experience. The first of the six papers on the flight results presents a detailed comparison between ground-test and inspace performance measurements used to verify the 786 s ammonia arcjet specific impulse and thrust level and the operation of the power processor and feed system. The rest of the flight papers present measurements of the communications impacts of the partially-ionized arcjet plume, ground-based telescopic observations of the plume for comparison with measurements made in ground-based facilities, solar cell degradation during thruster firing, mass deposition measurements, and heat transfer measurements. All of these spacecraft impacts measurements were done with instruments in the immediate vicinity of the arcjet, so they likely represent a worst-case condition for impacts assessments. The conclusion from all of these measurements is that integration of a 26 kW arcjet system onto operational spacecraft presents no major difficulties to other spacecraft subsystems.

As spacecraft payloads grow and the missions become more demanding, electric propulsion technology continues to evolve toward higher specific impulse and higher power operation. The ESEX program has helped pave the way.

In closing, the authors and I would like to thank Dr. Woody Waesche for originally conceiving of this special issue and for pushing the authors to get it organized. We would also like to thank Dr. Vigor Yang, our Editor-in-Chief, and Jen Samuels, our Managing Editor, for their help and support throughout the process of getting the nine papers submitted, reviewed, and properly formatted. I would personally like to thank Daron Bromaghim, who helped me immeasurably by serving as a focal point for the authors and ensuring that they all got their revisions done on time.

Roger M. Myers
Associate Editor