PREFACE

It is always an interesting exercise, after a book is written, to justify the need for the just-completed manuscript. The situation with this text is no different. The genesis for this book began well over a decade ago when one of us (AKH) began thinking about a book on spacecraft electrical power, with a focus on electrical power systems. The immediate need for such a book was made clear when, as a principal in an emerging academically-based research institute focusing on space power, I searched for a generic reference text for use by undergraduate and graduate students entering this interdisciplinary research arena. It was apparent then that the information was available, but dispersed among a large number of industrial technical memoranda, NASA and ESA technical reports, and proceedings of conferences. Although there were texts (liberally referenced in this work) that included space power systems as a topic, there was no comprehensive text treating the subject in a global sense.

The need for such a book, beyond its use in an academic setting, was evident for a number of other reasons: the uniqueness of space as an operating medium, the increasing demand for electrical power aboard newer spacecraft, the emergence of new power technologies that made higher power systems more feasible, the realization that power system design was a pacing factor in future space operations, and, as mentioned earlier, the absence of such a reference text on the subject.

In the Fall of 1997, Imperial College Press presented an opportunity to further develop my thoughts on just how such a text might be organized. The first step was to seek the advice of several colleagues more knowledgeable than I in the subject of space power– colleagues who appear as coauthors of this book. In the initial attempt to outline the book, the title chosen was *Spacecraft Power Systems*. That title was short-lived, however. After struggling for quite some time, it finally appeared to us that, while such a text could prove to be a useful addition to the technical literature on spacecraft design, any approach based on a *systems* concept would necessarily exclude a full discussion of the breadth and richness of the technologies upon which those systems are built.

The distinction between 'systems' and 'technologies' is not unique to spacecraft electrical power. It does, however, present an interesting challenge in the context of this particular subject of power.

Spacecraft electrical power systems are designed to address specific mission needs. The mission requirements would, for example, dictate a variety of design parameters such as operating lifetime, constraints imposed by launch vehicle and orbit choices,

average and peak power levels required by the payloads, the degree of reliability and redundancy appropriate for the mission, the operating temperature limits, the total project cost, *etc.* And since there is an almost limitless number of missions that can be performed in space, the number of spacecraft systems that are possible can quickly grow to a very large number also. A book based on power systems would necessarily lead to redundancies or gaps in the presentation.

Consider, for example, a photovoltaic system coupled to a battery reserve to serve as the power source during eclipse, the most commonly found power system in space. Even within this relatively simple system, the options for various photovoltaic cell materials, concentrator designs, and battery couples are numerous. Similarly, the description of a nuclear reactor power system would include a full discussion of a specific conversion process but could overlook the fact that the source of heat could equally well be a chemical or solar source, or that the conversion process could be one of several other static or dynamic conversion options.

We were thus drawn to the present organization of the book, with, as the title reflects, an emphasis on the technologies enabling the power systems rather than systems themselves. While we recognize that this, too, falls short of optimum in that it does not allow a full discussion of the integration of the various technologies into operating systems, it does provide a comprehensive basis on which that integration can proceed.

Under the premise that the three energy sources possible for space application are solar, chemical, and nuclear, the book attempts to explore each from several aspects. The two larger chapters are devoted to solar conversion and chemical storage/conversion, appropriately since those, by far, constitute the most mature space electrical power systems. Accomplishments in the Russian and U.S. nuclear power programs are presented in a series of chapters devoted to nuclear reactors and radioisotopes as heat sources interfaced to either static or dynamic conversion methods. A detailed discussion is also offered on the techniques and technologies of power management and distribution aboard spacecraft. Finally, two other chapters discuss topics which, while not directly related to power technologies, are critical in the design of spacecraft electrical power systems: the space environment within which the spacecraft operates and the thermal environment within the spacecraft.

We do hope that, in spite of all of its shortcomings, the present effort may prove to be of some value to those designers, engineers, scientists, and students for whom space is not just a place, but a profession.

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