

the book will be of interest principally to those having design or managerial responsibilities involving fuel systems, cost evaluations, and fuel production.

As indicated above, all of the facets of the thorium fuel cycle are touched on in this publication. The first four chapters, representing about a fourth of the total pages, are concerned with sources of thorium, description of the water-cooled and gas-cooled power reactors for which thorium fuel elements have been fabricated, a summary of thorium fuel properties, and a description of the nature and sources of radioactivity in thorium fuel that will influence fabrication procedures. The next three chapters give detailed accounts of fabrication experience with alloy, oxide, and carbide fuels, starting in each case with the feed materials and generally proceeding through to the finished fuel element, with a brief summary of irradiation experience. The description of thorium alloy fabrication is restricted to coextrusion procedures, while that on oxide fabrication encompasses pelletizing and vibratory compaction with brief mention of pellet extrusion. The description of oxide fabrication experience is disappointing because fabrication details for the Indian Point and Elk River Reactor Cores, which represent major milestones in the commercial application of thorium fuel technology, cannot be presented for proprietary reasons. Instead, a generalized description of fabrication technique is offered. Coated-particle technology is emphasized for carbide fuels, used principally in gas-cooled reactors, although casting procedures for the monocarbide are also touched on. A chapter dealing with recycle technology, in fabricating thorium-uranium-233 fuel, contains a review of development work on direct, semi-remote, and remote fabrication procedures and pilot-plant fuel-element productions which includes previously unpublished information on the subject. The concluding chapters include a valuable description of the hazards and consequent control procedures which must be considered in design and operation of a fabrication plant and, finally, a summary of the important programs involving the thorium fuel cycle in progress throughout the world, the present commercial status of that cycle, and

the broad questions which must be answered before the commercial future of the thorium fuel cycle can be predicted with assurance.

The text is well illustrated by line drawings and curves; photographs are less numerous but adequate. Flow charts are presented for all of the major fuel manufacturing processes.

In summary, the book represents a good, practical, state-of-the-art type of review of thorium fuel technology.

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#### SPACE POTPOURRI

*Title* Space Systems Technology  
*Editor* Regis D. Heitchue, Jr.  
*Publisher* Reinhold Book Corporation, 1968  
*Pages* x + 300  
*Price* \$15.00  
*Reviewer* J. L. Meem

The nuclear engineer interested in space applications will find this book interesting and generally very readable. It does suffer from a malady that is common to nearly all books on space science and technology these days. That is, it is a collection of a number of papers by different authors on relatively unre-

lated subjects, which are edited and put under one cover. It is high time that the space industry acquired an individual like Samuel Glasstone who can weave all these subjects into a smooth continuous flow of knowledge in one book.

As pointed out by the Editor, those technical people involved in the very complex present day space systems need to have a broad understanding of all space system technologies. The book contributes to the achievement of this broad understanding. Each of the seven chapters is on a separate subject important to space technology. Again, quoting the Editor, each subject is essentially an overview for technical people and is to be treated so as to avoid a rigorous, theoretical, highly mathematical approach. The only chapter which does not meet this objective is the chapter on Flight Control. Controls Engineering is a highly mathematical field, and admittedly it is difficult to explain without mathematics. However, in this chapter, the reader is quickly led into transfer functions, Bode diagrams, Nyquist plots, and so on. Nuclear engineers working in reactor controls are familiar with these terms, but most of those not working in controls will soon lose interest and pass on to another chapter.

Knowing very little about the subject matter covered in the chapters on Structures and Materials, Life Sciences, and Life Support Systems, I found these chapters most interesting and readable. They do much to give the reader a broad understanding in these areas.

Most nuclear engineers interested in space technology will find familiar material in the chapter on Propulsion and the chapter on Secondary Power Conversion Systems. Nuclear rockets are included in the chapter on Propulsion, of course, and the nuclear engineer will find the discussion on nucleonics extremely elementary. On the other hand, the chapter should be very readable to the non-nuclear expert. I found the comparisons between nuclear and non-nuclear systems quite valuable in both the chapter on Propulsion and the chapter on Secondary Power Conversion systems.

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neering Department and Director of the Reactor Facility at the University of Virginia. He was in the Aircraft Nuclear Propulsion program at Oak Ridge in the 1950's which led to his interest in nuclear space applications. He attended the Advanced Institute on Nuclear Rockets in Gainesville, Florida in the summer of 1962, and was a Visiting Staff Member at the Nuclear Rocket Development Station in Nevada in the summer of 1965. He teaches a graduate course in nuclear rockets at the University of Virginia and has served as a consultant with NASA, Lockheed, Westinghouse, and the Air Force.

### RE RADAPPERTIZATION, RADICIDATION, AND RADURIZATION

*Title* Microbiological Problems in Food Preservation by Irradiation

*Publishers* International Atomic Energy Agency, 1967

*Pages* 148

*Price* \$3.00

*Reviewer* Durwood B. Rowley

The papers incorporated in this volume are of high scientific quality and of great interest to readers concerned with radappertization, radication, and radurization. Good judgment was used in selecting papers concerned with a variety of microorganisms of public health concern. I was especially impressed with the recommendations as to further research areas of importance. Such emphasis will help direct interested scientists toward the pertinent problem areas and thus lead to concentrated research effort and more hope of success.

One major criticism of the book was that it included a few papers that consisted largely of data previously published in other scientific journals. It would have been preferable to have the authors publish a summary of such work with reference to the original data.

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### TOO MANY COMPROMISES

*Title* Introduction to Nuclear Theory

*Author* I. E. McCarthy

*Publishers* John Wiley & Sons, Inc., 1968

*Pages* xv + 555

*Price* \$13.95

*Reviewer* Leonard S. Kisslinger

It is very difficult to write a textbook on nuclear theory at the present time, since the subject itself is complex and is changing rapidly as are graduate courses in nuclear theory. Therefore, one can try either to write monographs which treat fairly completely important new aspects of the field, such as A. Lane's book on *Nuclear Theory*, or else devote an extraordinary amount of time and talent to try to cover most of the material out of which all possible courses in nuclear theory can be taught, such as the forthcoming volumes by A. Bohr and B. Motelson.

As is stated in the Preface, the book by I. E. McCarthy is a compromise, in fact a collection of compromises such as a professor might make in preparing notes for a course to be taught during one particular year. In order of increasing thoroughness, the main topics treated are nuclear structure, nuclear matter and the two-nucleon interaction, and nuclear reactions.

The treatment of nuclear structure is so incomplete that one can question the value of including in the book the three chapters (3, 5, and 7) in which this material is discussed. Most single-particle aspects of nuclear structure not contained in many other texts are repeated in Chap. 11 in the treatment of optical

potentials. The main chapter which deals with nuclear structure (7) leaves out essentially all of the topics which have made nuclear structure physics truly exciting during the past decade. I believe that it would have been better to have referred to other books which are now available to the students and to have omitted at least Chap. 7.

There are five chapters in which the two-body problem and two-nucleon interaction and nuclear matter are treated. There is a brief heuristic treatment of the two-nucleon force in which the range is related to the mass of the pion. Since a considerable effort is expended on the many-body methods (often known as Brueckner Theory) which were developed to get around the difficulty of the hard core in the nucleon-nucleon force, further treatment of the origin of two-body force in terms of meson exchanges would have been most appropriate.

The reader can find a discussion of some of the early work on nuclear matter that is not contained in other texts in nuclear theory. The author includes some work on Hartree-Fock calculations and the relation to the results obtained by Brueckner Theory. Unfortunately, since there is little discussion of symmetries in the book, and no treatment of the symmetries associated with the Hartree-Fock fields, the main purpose of the recent Hartree-Fock calculations in nuclear physics could not be treated very well. For example, the connection of the results of a Hartree-Fock value of the quadrupole moment to what might be interpreted as an intrinsic quadrupole moment of the nucleus is, at best, oversimplified in the text.

The last seven chapters of the book treat nuclear reactions. Chapters 8 and 9 review various theories and discuss their applications. This could be especially useful for experimentalists who wish to learn something about the treatment of their data. The author gives a fairly thorough description of the optical model and the properties of the wave functions which result from the optical model.

There is a useful chapter collecting the results of  $(p, 2p)$  reactions. The pickup and stripping reactions are discussed in some detail; however, the application of these reactions for studies of nuclear structure