

gramming System," provides a summary of the essential components and characteristics of today's mathematical programming systems. It includes a discussion of desirable control language facilities, input-output processor capabilities, and algorithm library contents, as well as consideration of linear programming problem size, program maintenance and debugging requirements, and the effects of multiprogramming and multiprocessing using current computer systems. Chapter 13 deals with solution strategy and the use of auxiliary controls. Here, as in Appendix B, the material presented is a distillation of the author's extensive experience in the field.

In conclusion, this book should find its place in the library of the analyst or user of today's mathematical programming systems and the computer scientist engaged or interested in the construction and development of such systems. It is not recommended as a course text or introduction to the field.

Margaret Butler is a mathematician in the Applied Mathematics Division of Argonne National Laboratory, where she has been since 1948, except for two years as a statistician with the US Bureau of Labor Statistics. She is currently program chairman of the Mathematics and Computation Division of ANS and served as chairman of that Division in 1966-67.

MEDICAL ISOTOPES TABULATED

Title Radioatoms in Nuclear Medicine
Author P. H. Blichert-Toft
Publishers Rigmor Nilsson, 1968
Pages 78
Price Sw. Kr. 25:-
Reviewer Paul Fields

Radioatoms in Nuclear Medicine by P. H. Blichert-Toft is a 78-page paper-bound book describing the nuclear properties of 53 radioactive nuclides. One or more pages are devoted to each nuclide, depending on the amount of nuclear information

available. A decay scheme is given for each nuclide described in the book, but only the well-defined states with their spins, parities, and energies are included in the decay diagrams. The half-lives of excited state are indicated, and Q -values for the decay are given, and, if more than one mode of radioactive disintegration is known, then the corresponding Q -values are also listed. The absolute intensities of β^- , β^+ , and electron capture groups are given as percentages of the total parent disintegrations. The absolute intensities and energies of gamma transitions are listed below the decay schemes.

Of great value to medical users of this compilation is a class rating system that indicates the degree of accuracy to which dose calculations can be made, based on the given absolute intensities. Also listed are the half-life and the standard deviation adopted by the author, based on published values. The author made an attempt to evaluate the data, and, in cases where several accurate determinations were available, he averaged the results and listed the error in the average. Finally, the most probable method of producing the nuclide and the isotopic abundance of the suggested target is given. The literature sources for most of the nuclear properties are listed adjacent to the values quoted. One of the most important sections for each isotope is the general discussion, which includes a description of how the parent half-life, Q -values, and absolute intensities were obtained and also lists the references containing the most definitive work.

In my opinion, this tabulation is an excellent and concise summary of the radioactive properties of certain nuclides and should be quite useful to medical researchers and others interested in calculating dose rates from these substances. The information is presented in a very convenient manner so that pertinent information can be obtained at a glance. Unfortunately, the pamphlet probably will not find a broad application in nuclear chemistry and physics because of the limited number of isotopes reviewed.

Paul Fields, a senior chemist at Argonne National Laboratory, re-

ceived his BS in chemistry in 1941 from the University of Chicago. After three years with the Tennessee Valley Authority, he joined Seaborg's group at the Metallurgical Laboratory, University of Chicago. He left for one year, after the war, to work at Standard Oil Company (Indiana) and then returned. In 1946 he became a group leader in heavy element chemistry at the newly organized Argonne National Laboratory. His main research interests have been the nuclear and chemical properties of the transuranium elements, the electronic structure of lanthanide and actinide elements, nuclear reaction mechanisms, geochemistry, and applications of nuclear techniques to archaeology. He is a member of the AEC Transplutonium Element Advisory Commission and of the Editorial Advisory Board of Nuclear Applications.

THORIUM FUEL--A USEFUL REFERENCE

Title Fabrication of Thorium Fuel Elements
Authors L. R. Weissert and G. Schileo
Publisher American Nuclear Society, 1968
Pages ix + 208
Price \$10.00 ANS and ASM members; \$11.10 others
Reviewer Arthur A. Bauer

The book, *Fabrication of Thorium Fuel Elements*, will serve as a useful reference for persons interested in obtaining, under one cover, broad coverage of the various facets of the thorium fuel cycle along with detailed descriptions of thorium fuel-element fabrication experience. It is not intended as a source for new ideas and relies almost exclusively on published information for its content. Emphasis is placed on providing an account of fabrication methods which have been successfully applied in the manufacture of thorium-fueled cores or experimental fuel-element assemblies rather than on principles involved in their fabrication. As such,

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.

Arthur A. Bauer is a Fellow in the materials engineering department of Battelle Memorial Institute, Columbus Laboratories. He joined Battelle in 1952 after receiving his BS and MS degrees in Metallurgical Engineering (1950 and 1952) from Columbia University. At Battelle his experience has involved a broad spectrum of materials for nuclear applications. From 1964 to 1967, he served as US Representative-Metallurgical Specialist to the German Atomic Research Center at Karlsruhe, Germany, under terms of the USAEC-Euratom Fast Reactor Exchange Program. Since returning to Columbus he has again become involved in nuclear materials programs and related power plant technology.

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.

J. L. Meem (PhD, Indiana, 1949) is Chairman of the Nuclear Engi-