NUCLEAR SCIENCE AND ENGINEERING: 22, 395-399 (1965)

Book Reviews

Directory of Nuclear Reactors - Volume V, Research, Test and Experimental Reactors. Published by IAEA. 326 Pages. $7.00.

This volume supplements earlier volumes (II and III) published by the International Atomic Energy Agency using the previously adopted format for presentation of data. It contains information on 78 reactors in 16 countries that are in operation or under construction as of the date of publication. As is inevitably the case in any publication of this nature in book form, the time lapse between collection and publication or use leads to some inaccuracies. Most of the information presented is dated in 1962 and 1963; thus, for example, modifications in designs or status during 1964 are not reflected. This need to record changes has been recognized by the IAEA with a Reactor Card Index which is issued as an addition to the *Directory of Nuclear Reactors* and which is updated by periodic issuance of new and replacement cards. Its use is recommended for those who want to assure current validity of information.

The reactors summarized in Volume V are grouped in accordance with the following categories: light-water moderated pool-type; light-water moderated tank-type; Argonaut type; solid homogeneous; heavy-water moderated; graphite moderated, and fast. Fortunately, much repetition of data on very similar reactors is avoided by cross references and by concentration on differences after the first complete data sheets.

Those who are familiar with previous volumes will recognize that the emphasis in these presentations is on providing a broad range of comparative data along with drawings and flow charts sufficient for an understanding of the reactor concept but not sufficient to present a detailed description of the design. Thus, drawings have a sparsity of dimensions and detailed notations. Those interested in more details are provided a bibliography for guidance.

The summaries of research facilities for each reactor generally are rather well done, though concise, and should be of particular interest to those involved in planning broad research and development activities.

While the editorial job appears to have been very competent and the uniformity of format facilitates comparative studies, the brevity of the information provided warns that such comparisons should be done with caution. This probably is particularly true with respect to information on the cost of building and operating each facility, though an effort is made to identify supporting facilities and a summary of the operating staff is generally included.

Volume V, particularly when used in conjunction with other volumes in the *Directory of Nuclear Reactors*, is a useful source document for anyone interested in the world's nuclear reactors. This should include scientific or technical workers and management personnel both in industry and government.

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About the Reviewer: Mr. U. M. Staebler, since graduating from the University of Kansas with a B.S. degree in Physics in 1942, has devoted essentially his entire professional career to the field of nuclear energy, first with the duPont Company on loan to the Metallurgical Laboratory at the University of Chicago, then at the Hanford Works until 1949 when he joined the Atomic Energy Commission.

His assignments in connection with broad technical management positions in the reactor development program have led to extensive travel and to participation in many major meetings on nuclear energy in the United States and abroad.

Reactor Handbook. Second Edition, **Volume IV, Engineering.** Editors: Stuart McLain and John H. Martens, Interscience Publishers (New York, London, Sydney), (1964) 857 pages, $25.40. Prepared under the auspices of the Division of Technical Information, USAEC.

According to its Preface, the *Reactor Handbook* "first materialized as a set of classified volumes

in 1953. Then in 1955 three of the four volumes were declassified and reissued... Efforts to revise this volume began anew in late 1958 . . . some chapters represent developments circa 1958-59; others are as new as mid-1962... " I sympathize with the editors who, to judge from the above quotation, had some manuscripts on hand for three years while they waited for others. But I do not like to read in a book published mid-1964, "Detailed analyses . . . are available in current reports" and find the reports dated 1957 and 1958.

The book is essentially restricted to the work of the USAEC and its contractors. The first 15 chapters present the principles of reactor engineering and the remaining six chapters are on specific reactor systems. In many cases the style is that of survey articles rather than a handbook.

There is an obvious error in the first half-page that turned out to be the first material change from the 1955 text, consisting of the mistaken substitution of "density" for "hydrostatic head." Fortunately this is not characteristic of the book which, on the whole, is well written. However, the user may have to read several chapters to find all the material on a topic. His search will be prolonged by the inadequacy of the cross-referencing. Finding a section by number or finding the number of a section is time-consuming. Take, for example, section 4.4.5 (g); the g is on page 147, the 5 on page 142, and the 4.4 is on page 140.

Some brief notes are given below on individual chapters.

Chapter 1. "Fluid Flow"

The authors are experts in their fields and this chapter is up to date for 1962. Its contents are well set out in handbook form. There are many useful flow correlations that cover a wide variety of practical situations.

Chapter 2. "Heat Transfer"

Similar remarks apply to this chapter. It deals not only with the basic heat-transfer correlations but includes a section on heat exchangers for water, liquid metals, gas, and fused salts.

Chapter 3. "External Loop Components"

This is mainly concerned with specific examples of pumps, valves and pressure vessels.

Chapter 4. "Heat Generation and Thermal Analysis"

Although heavily biased towards a multipass reactor, this chapter contains a great deal of useful information. One feels that the detailed treatment of DNB should have been given in Chapter 2, or at least mentioned there, and suspects that Chapter 4 is more up to date. The very practical approach of §4.4 to heat generation in components should have been cross-referenced to the academic approach of §6.3 on thermal stresses and vice versa.

Chapter 5. "Fuel Element Design"

Many of the factors that enter into fuel element design are capably discussed. The authors of this chapter appear to be biased in favor of dispersion fuels. Concerning sintered UO_2 one reads on page 176, "High specific power levels, coupled with the poor thermal conductivity of UO_2, lead to large temperature gradients in practical elements that cause sintering, grain growth, and even gas-induced swelling" and finds no mitigation until page 204 where the sentence that should have followed occurs: "But many sintered and powder-loaded cylindrical fuel elements have been operated successfully with no significant axial fuel migration or sheath deformation . . ."

The choice of AGR and Bradwell (designed by TNPG and not UKAEA as stated) for Table 5.8 keeps the Table free from any suggestion that gas-cooled power reactors had operated successfully. Calder Hall would have been a good addition to this almost unique mention of other countries' reactors.

The chapter includes an illustrated list of 84 fuel element configurations that is a tribute to designers' ingenuity.

Chapter 6. "Structural Analysis"

The industrial codes pertaining to nuclear pressure vessels and piping are reviewed. Methods and formulas are given for calculating stress, with appropriate emphasis on thermal stress, which has enhanced importance in nuclear work because of internal heat generation.

Chapter 7. "Maintenance of Coolants"

Chapter 7 contains a fairly thorough discussion of coolant preparation and of special problems arising from activity added to the coolant. The coolants considered are high- and low-pressure water, air, organics, Na, and NaK. Circulating fuel coolant systems are discussed briefly.

Chapter 8. "Control and Instrumentation"

The corresponding chapter in 1955 was well written and acceptable for that time. The control section of the present chapter is an "edited and expanded" version that should have been brought more into line with recent practice. "Discussions of what is loosely referred to as 'philosophy of reactor control' is avoided" may represent an acceptable policy for 1955, but has little justification nowadays. In §8.3 there is a peculiar use of *nv* as "unit neutron flux" that should not be copied.

In a book that is on the open market, reference to classified documents should be minimized. I suspect that with a little more care in the revision, many of the ten classified references in this chapter could have been eliminated. Other chapters have the same fault; a spot check brought out six consecutive classified references in Chapter 7.

Chapter 9. "Shielding"

The engineering aspects of shield design are well covered in this chapter. For data on attenuation, *Volume III Part B (Shielding)* should be consulted.

Chapter 10. "Reactor Operations"

This is a very short chapter (5 pages). Naturally reactor operations cannot be fully discussed in so few pages, and this chapter deals mainly with startup. The poor impression given by the statement, "It is based upon ... operation of ... reactors as reported in 1956" turns out to be unwarranted.

Chapter 11. "Reactor Safety"

The chapter contains a general discussion of safety regulations and associated studies that gives authoritative background information on this important topic.

Chapter 12. "Reactor Site and Plant Layout"

A short well-organized chapter on the safety and civil-engineering aspects of site selection and layout.

Chapter 13. "Plant Operation and Services"

This is a good essay on staffing, maintenance, radiation control, and procedures for the operation of reactors. It mentions various regulations and licensing procedures of the USA.

Chapter 14. "Remote Handling of Radioactive Materials"

The sixty pages give an excellent review of the many types of equipment from simple hoods to the large reactor-assembly Hot Shops. The design and choice of manipulators and viewing systems are discussed, as are many problems that arise in the field of remote handling.

Chapter 15. "Reactor Development Test Facilities"

Considering that a major expenditure on civilian nuclear energy (apart from power-reactor construction) is the provision of in-reactor loops for development tests, this chapter is completely inadequate, having only a page and a half of very elementary discussion devoted to in-reactor tests.

The remaining six chapters, on heterogeneous water-cooled reactors, liquid-metal cooled reactors, gas-cooled reactors, aqueous-fuel reactors, liquid-metal-fuel reactors and molten-salt reactors, are individually well handled and make interesting reading. The material might have been better coordinated with the rest of the book. This lack of coordination is perhaps most obvious in Chapter 21 because of the paucity of material that properly belongs in that chapter. Of its 40 pages, 16 discuss materials (12 of which describe the development of the alloy INOR-8) and 14 discuss pumps, leaving only 10 pages, or one-fourth of the chapter, for molten-salt reactors. (Volume I of the handbook is entitled *Material* and might be the proper repository for the 16 pages; the 14 pages on pumps belong in Chapter 3 of the present volume.) The editorial preface of the 1955 edition made a statement that still holds: "greater unity of presentation should be possible in future editions."

The price of the book may make the purchase an institutional and not a personal matter; most institutions concerned with atomic energy will find the purchase worthwhile. The copy of the 1955 edition that I consulted was falling apart and some sections were dog-earred through constant use. I expect that many copies of the edition under review will suffer the same fate.

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About the Reviewer: D. G. Hurst is Director of the Reactor Research Division at Chalk River where he has served Canada's nuclear-energy program since 1945. He received his academic training, through the Ph.D., at McGill and did his research at the Radiation Laboratory (Berkeley) and at the Cavendish Laboratory (Cambridge). He is a Fellow of the Royal Society of Canada and of the American Nuclear Society, and is a member of this Journal's Editorial Advisory Committee. He will be on leave for the next two years to the IAEA as head of its Reactor Division.

Biological Effects of Neutron and Proton Irradiations. International Atomic Energy Agency, Vienna, 1964. (Available from International Publications, Inc., 317 East 34 Street, New York, N. Y., 10016.) Vol. I, 433 pages, $9.00, Vol. II, 443 pages, $9.00.

This book, in two volumes, contains the proceedings of a symposium on biological effects of neutron irradiations held at the Brookhaven National Laboratory. The proceedings were edited by the staff of the International Atomic Energy Agency and were printed by composition typing and photo-offset lithography. Most of the fifty-four papers are in the English language, but six are in Russian and four are in French. Each paper is preceded by an abstract in English, Russian, French, and Spanish.

Dosimetry, including estimation of absorbed dose in biological material, is discussed in the first fourteen papers. The second series of papers deals with the biological effects of high-energy protons. The third series of papers is on cellular and genetic effects. The first thirteen papers of