Then, what is the book? The main chapter headings are as follows: Safety Evaluation Methods, System Disturbances, Safety Criteria, Special Fast Reactor Characteristics, Containment, and Licensing.

The first chapter gives introductory material in fairly abbreviated form on point kinetics, thermal effects, reactivity feedback for fast reactors, some aspects of system effects, and fault-tree analysis. Here, as in later chapters, thermal reactors are frequently used as a point of departure to introduce fast reactor concepts. The discussion is mostly qualitative and is sometimes imprecise or incomplete in the physical explanation of the phenomena. Except for the fault-tree section, the topics are little more than identified. For example, the effect of sodium loss on the Doppler effect is not mentioned, and only a page is devoted to the modeling of sodium voiding, while there is a bit more discussion of stability in BWRs and of two phase flow in water reactors. A more detailed examination of reactivity effects would have been helpful, in my opinion.

The second chapter discusses in introductory fashion differences in systems and system disturbances between the low pressure sodium-cooled and the high pressure gas- or steam-cooled fast reactor concepts. Several examples of reactivity perturbation effects are illustrated. There then follows a relatively more extensive, elementary discussion of techniques for assessing system stability (e.g., description of Nyquist criterion, Bode plot, etc.). The Fermi I reactor stability analysis is quoted at some length.

The third chapter introduces the idea of failure criteria for fuel elements and the phenomena that may induce failure and influence the future course of a transient. A possible accident classification system is then mentioned. The AEC General Design Criteria for light water reactors (LWRs) are discussed in terms of their applicability to LMFBRs. The text appears to assume a reader who knows LWRs and the AEC criteria.

The third chapter begins to evince a considerable amount of subjective statement by the author; his opinions come out on various safety matters even more strongly in Chaps. 4 and 5. Here and in later sections, Fermi I, EBR-II, and Dounreay, all 1950s vintage reactors, are used to illustrate systems. The examples may not be illustrative of the larger, oxide-fueled LMFBRs of today and tomorrow.

Chapter 3 closes with a brief, but well-done summary of the relation between safety features and specific postulated accidents.

What I would consider the heart of fast reactor safety, namely a discussion of fast reactor accident analysis, has only 60 pages devoted to it in Chap. 4. The topics treated include voiding effects, criticality in super-prompt accidents, local failure effects, and sodium fires, With so limited a space, the treatment is mostly qualitative, with little examination of analytical methods. The greatest emphasis has been placed on fuel failure propagation, where the treatment is relatively more thorough. This chapter includes a brief discussion of experience with Dounreay, Rapsodie, Fermi I, EBR I, EBR II, etc. Here, as at various places in the book, minor errors have crept in such as: p. 232, Rapsodie: "The Doppler coefficient reduces to zero after 150 days at power due to fuel expansion within the central fuel void."

Chapter 5 on Containment begins with 25 pages on matters of general interest to reactor siting, such as radiological limits and effects, meteorology, and other site considerations. A series of potential design basis accident initiators for the LMFBR is identified by the author, and then each is discussed qualitatively and subjectively, with fairly strong, unqualified opinions presented. In particular the author states several accidents are incredible but gives the reader no quantitative definition of the term. This chapter concludes with a brief discussion of potential effects of an explosive energy release on various aspects of the primary containment, and the matter of post-accident heat removal from a destroyed core.

The last chapter presents a short description of the regulatory process in the USA; it is followed by a short appendix which very briefly describes many computer codes applicable to fast reactor safety analysis.

I find that my impression of the book, coming from a vantage point of considerable background in the regulatory process, agrees generally with that of a younger colleague at UCLA. The book does provide a readable introduction to much of fast reactor safety, and, as such, would be helpful for seniors or first-year graduate students having a first exposure to reactor safety. It is not a "reference book." And, for serious examination or an analytical presentation of almost any subject discussed, reference to other sources is required.

Writing a textbook on fast reactor safety is a most difficult chore. The field encompasses many disciplines and various facets of engineering, and the potential reader ranges widely in his degree of sophistication. Mr. Graham is to be applauded for providing a working tool and a basis on which to build.

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About the Reviewer: David Okrent is now professor of engineering and applied science at the University of California at Los Angeles following a 20-yr association with Argonne National Laboratory. He served the U.S. Atomic Energy Commission as a member of its Advisory Committee on Reactor Safeguards since 1963, and was its chairman during 1966. In 1963 he was a visiting professor at Washington University and, more recently, occupied a professorship at the University of Arizona in the Argonne Universities Association Distinguished Appointment Program. Dr. Okrent received his undergraduate training at Stevens and completed his graduate studies at Harvard.

The Elements of Neutron Interaction Theory. By Anthony Foderaro. MIT Press (1971). 585 pp. $19.95.

This book is a clearly written exposition of neutron interaction theory for a specific audience, namely, first-year graduate students in nuclear engineering. However, it would appear to be useful also for anyone planning to do cross-section analysis, in particular, experimental physicists and those engaged in the evaluation or calculation of neutron cross sections for technological applications. Physics graduate students would find it helpful as an overview of the same area. It covers a set of topics that makes it essentially unique, although the individual topics are covered in separate text-books and review articles. Another feature that makes it useful for its intended purpose is the level of exposition. It is generally below the level of a graduate text in physics, yet gives the reader a comprehensive introduction to the main theoretical tools employed in cross-section analysis. The author has largely succeeded in sifting out what the practical user of neutron cross sections needs to know and has dispensed with the window dressing found in most texts. In each chapter he also gives down-to-earth suggestions for further reading. These are particularly valuable for the beginning student who must feel inundated by the publication flood.

The book starts out with a careful discussion of the basic concept of a cross section, something which is treated cavalierly in most textbooks. After a discussion of conservation laws and coordinate systems, it proceeds to a rather long exposition of elementary quantum mechanics. Again, the choice of topics in this section is fundamental, and I must believe Professor Foderaro's assertion that this is something the student has not yet encountered, but this particular subject is well-covered in dozens of standard textbooks and the present effort seems redundant.

The next chapters cover reaction analysis and various reaction types—elastic, inelastic, capture, charged particle, and fission. This enables the author to cover such fundamental topics as R-matrix theory, the optical model, Hauser-Feshbach theory, cascade reactions, statistical level theory, and the Bohr-Wheeler-Bohr concepts of the fission process.

The last chapter is a nicely written introduction to chemical binding effects in which the author covers most of the essential topics—Doppler, Fermi pseudopotential, bound- vs free-atom cross sections, sources of incoherence, and even a brief excursion into thermal inelastic scattering theory. This chapter partially fills a gap which exists between such descriptive and non-mathematical texts as Hughes' *Neutron Optics*, and the rather formidable mathematical treatments in the various advanced texts which have appeared in recent years. As far as I know, such a treatment is not available in any other book or review article.

The few misprints I noticed were all minor and not likely to trouble the reader. I was surprised, however, that no editor had caught the misspelling of Gordan. Also, the mass in the spin-orbit potential (p. 371) is conventionally taken as the pion mass, not the neutron mass, pursuant to an affectation of many years standing.

The accuracy of the discussion is throughout adequate to the presumed level of sophistication of the intended readers. My only criticism would be that the length of time spent in various discussions did not always seem commensurate with their importance. For example, the $1/v$ behavior of low energy cross sections is treated in the logarithmic-derivative formalism (p. 294), the Breit-Wigner formalism (pp. 445 and 480) and again in the Hauser-Feshbach formalism (p. 481). The reader may get the erroneous impression that there is more to these exercises than the demonstration that a slowly varying reaction rate leads to a $1/v$ cross section by definition.

I enjoyed reading the book and can recommend it to anyone wishing an introduction to the field of neutron cross-section analysis.

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