Yet, there seems to be more mileage for the publisher in this concept. On the next round, perhaps the monographs could be brought out in looseleaf form in a handsome buckram binder available at a graduated price scale according to the number selected. Of course, a new title is in order, *Selected Topics in Nuclear Engineering.*

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Protection Against Radiation. By JOHN D. ABBATT, J. R. A. LAKEY, AND D. J. MATHIAS. Cassell, London, 1961. 235 pp., $6.50.

This is a useful text and to the layman, the physician, or the engineer it could be a prized first introduction to the subject of radiation protection. It covers a wide range of subjects including elementary physics of radiation, sources of radiation, medical care of radiation workers, dosimetry, instrumentation, maximum permissible exposure, personnel protection, shielding, and treatment of radiation effects. Because of this wide assortment of topics, all discussions are cursory and at a rather elementary level. Thus, the physicist or engineer might profit considerably from reading the chapters on radiation dosimetry, instrumentation, and personnel protection and should not waste his time reading the elementary discussions on physics of radiation or shielding. Although the health physics technician would benefit by a careful study of the entire text, the senior health physicist would not find in it much—if any—new information. For the college administrator who needs a better understanding of the problems of health physics or for the medical man who wishes to develop a greater insight into this field and better prepare himself to assist in radiation emergencies, this is a very valuable book.

A few examples of statements in the text that should be qualified are: "Radioactive elements observed in nature have a very long half-life" or "Gamma rays are a penetrating electromagnetic radiation similar to X-rays but very much more powerful." There are several statements with which the senior health physicist would take issue; for example, "Radiation dosimetry is the measurement of the intensity of radiation" or "gamma curies are curies of gamma activity." The text contains a very good assortment of tables and graphs that are useful in the rapid estimation of shielding factors, counting errors, unit conversions, etc. Some of the tables, although of value as a principal source of information for the layman or as a quick reference for the scientist, are a poor substitute for the more detailed discussions provided in the NCRP and ICRP handbooks. For example, the health physicist or engineer could refer more profitably to ICRP publication numbers 1, 2, and 3 for the authoritative and detailed discussions on maximum permissible exposure, internal dose, x-ray protection, etc. Likewise, the NCRP-NBS Handbooks provide a wealth of detailed information that can only be touched upon in this book. For example, NCRP-NBS handbooks numbers 63, 72, and 75 provide some of the best available information on the measurement of neutron flux, neutron dose and the protection against neutron radiation.

The discussion of health physics instruments not only furnishes the layman with a good, quick review of the types of instruments in use but also provides the health physicist from other countries with the opportunity to make comparisons with those instruments in common use in England. The table of levels of maximum permissible surface contamination for radioactive materials lists values that are higher than corresponding values used in the U. S., e.g., 70 times higher than those used at Oak Ridge National Laboratory. The general philosophy expressed by these authors is very good. For example, they state that since any unnecessary exposure is undesirable, we must always balance risk against acceptable potential benefit to the individual and to the community. They point out that, "In radiation work the doctor has a new colleague in the health physicist, and it is of the utmost importance that the health physicist and medical practitioner should work together as equal professional colleagues" and to the medical practitioner they caution, "It must be constantly remembered that the primary purpose of examining patients prior to or during radiation work is to protect the patient and it must never be regarded as an instrument of management."

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(About the Reviewer: Karl Z. Morgan is editor of the journal Health Physics, *and a member of the International Commission on Radiological Protection and the National Committee on Radiation Protection. He is chairman of the National and International Committees on Maximum Permissible Dose of Radiosotopes. As director of the Health Physics Division of the Oak Ridge National Laboratory, he supervises a large program of research in basic and applied problems of health physics. He is one of the original health physicists, having joined the metallurgical laboratory at the University of Chicago in 1943. He is a fellow of the American Physical Society and of the American Nuclear Society.)*

Reactor Heat Transfer. By W. B. HALL. Temple Press, London, 1958. 68 pp., 15 figs.

Reactor Heat Transfer is a monograph written for engineers and physicists working in nuclear reactor engineering by W. B. Hall, research manager at the Windscale Research and Development Laboratory. The monograph is divided into three chapters.

Chapter 1 presents a review of some of the elements of convective heat transfer. The heat transfer coefficient or conductance and the mixed mean fluid temperature are defined. The classical differential equations for the transient transport of heat and momentum in flowing fluids are also derived. The empirical convective heat transfer and friction relationships are summarized and the analogy between heat and momentum transfer is referenced. Discussions of entrance region convection and high gas velocity heat transfer are also presented.

Chapter 2 deals with fission heat source distributions in idealized solid fuel element reactor cores. The common fuel element and coolant temperature distributions in the axial and radial directions are derived. The ratio of pumping power to reactor heat extraction in terms of given axial and radial coolant temperature rises are developed. The principles discussed in this chapter are then utilized in two typical reactor heat transfer design problems.

The third chapter consists of a number of miscellaneous topics. The turbulent liquid metal solutions of Martinelli and Lyon at low Peclet moduli are shown to reduce to the slug flow solution. Remarks on heat conduction in clad fuel elements, effectiveness of finned surfaces, and some of the differences between the cooling characteristics of water and liquid metals are also presented.

One difficulty in writing a monograph on a subject like reactor heat transfer is that although some parts of the field are sufficiently elementary so that they can readily be described in limited space, the more difficult parts can only be referenced. It appears to the reviewer that Mr. Hall has capably presented some of the important elements of reactor heat transfer.

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Numerical Methods for Nuclear Reactor Calculations. By G. I. Marchuk. Translated from Russian by Consultants Bureau, New York, 1959. 295 pp., $22.50.

The author's objectives in writing this book seem, at first glance, to be clearly laid out in his opening comments. On page 2 he says "This monograph is a discussion of the fundamental problems arising when using numerical methods for nuclear reactor calculations." and, on page 3 "Problems relating to the general theory of nuclear reactors . . . are barely touched upon." One soon discovers, however, that these comments are misleading. Marchuk's book, in fact, contains more material on reactor theory than on numerical methods. Dr. Marchuk has set himself a very difficult task. Apparently he wants his book to be completely self-contained. He derives all the basic equations of reactor theory, develops the most important approximations, and then shows how the reactor equations (in their various approximate forms) can be solved numerically.

Many of the advantages and defects of Marchuk's book stem from this structure. The advantages are clear. Surely the numerical analyst who deals with reactors wants to know something about reactor theory. Probably he prefers a condensed presentation of reactor theory, a presentation which stresses its mathematical, rather than its physical, content. This book, one might think, would suit his needs quite well.

On the other hand it is difficult to condense reactor theory without the omission or distortion of key arguments. Marchuk has not always succeeded in avoiding this pitfall. On page 59, for example, we find a derivation of the Wigner thin resonance formula. This derivation involves a Taylor series expansion of the scalar flux, $\varphi(u')$, about a neighboring lethargy u. Only one term of the series is retained. Yet the flux varies rapidly near the resonance energy, and the reader may well ask why such a drastic truncation of the Taylor series is permissible.

The Taylor series approach is used, throughout this book, in the derivation of approximate expressions for slowing-down integrals. Often it is not used very carefully. In deriving age theory, for example, the author puts series expansions for $\Sigma_s\varphi$ and $\Sigma_S j$ into the P_0 and P_1 slowing-down integrals. It is asserted that, upon dropping terms whose coefficients are "of the first order of smallness" one is left with the age diffusion equation. But, if the coefficients are to be ordered in ascending powers of $1/A$ (where A is the mass of the scatterer), this statement is wrong.[1] Otherwise it is ambiguous.

In Marchuk's section on perturbation theory a different type of problem arises. This section is clear and useful, but the author never mentions the connection between perturbation theory and variational methods. He does not point out that the perturbation theory expression for the reactor eigenvalue is stationary with respect to variations in the flux. In fact variational principles are not discussed anywhere in this book.

Apparently Marchuk has chosen to pass over the more subtle features of reactor theory in order to get on to his main subject, namely, numerical methods. But he has also sacrificed much material on numerical methods in order to make room for reactor theory. One notices this first when Marchuk discusses the power method, the "outer" iterative procedure for solving reactor problems. He proves that the iterative procedure converges for bare reactors, but says nothing about its rate of convergence. He makes no mention, either, of the many devices which have been used to accelerate convergence of the outer cycle. In a later section in the iterative solution of two-dimensional difference equations there is, again, no discussion of convergence rates.

The *Sn* method is described briefly, but only in one of its early forms. At the end of his section on *Sn*, the author says: "This [S_4] approximation is even more accurate than the P_3 approximation. . . ." Upon what evidence is this conclusion based? It seems possible from the context that the author is referring to one specific problem, namely, the eigenvalue computation for a bare sphere. It seems safe to assume, also, that when Marchuk refers to the P_3 approximation, he means the P_3 approximation with Marshak boundary conditions. These are the only boundary conditions he discusses. But this reviewer is not familiar with any comparisons between the S_4 approximation and the P_3 approximation with Marshak boundary conditions.

Perhaps, at this point, the reader will conclude that Marchuk's book has little value. This is by no means true. The book has many fine features. It is convenient to have so much material on reactor theory covered in such a concise form. Despite occasional lapses, Marchuk's presentation is, for the most part, simple and clear. His section on resonance capture in lumps is particularly interesting. Here he compares the Russian and western resonance escape formulas, and he does this very well.

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[1] E. Greuling, F. Clark, and G. Goertzel, A multigroup approximation to the Boltzmann Equation for critical reactors. NDA 10–96 (September 1953).