

## Book Reviews

**Iterative Solution of Elliptic Systems and Application to the Neutron Diffusion Equations of Reactor Physics.** By Eugene L. Wachspress. Prentice-Hall, Inc., Englewood Cliffs, N. J. 299 pp. \$12.95.

For quite some time, concern has been expressed about the gap that exists, and seems to be widening, between the physicist or engineer who has a problem to be solved and the techniques to be used for the problem solution. With the development of more sophisticated numerical methods, a chasm could develop were it not for books such as this one by E. L. Wachspress. An expert may also profit from his book.

Contents of the nine chapters may be briefly summarized as follows:

Chapter 1 is devoted to an exposition of subsequently used matrix concepts and facts. Possible methods of solution of linear systems of equations are also discussed.

Boundary value problems for second-order partial differential equations are examined and classified in Chap. 2. Several methods of discretization of the equations are exhibited, among them a discretization based on variational techniques. The stability and convergence of numerical procedures used to solve the discretized problem are examined.

Chapter 3 is a discussion of the group diffusion equations of reactor physics. The mathematical properties of these equations as consequences of physical laws are established. This leads to proof of existence of a greatest real eigenvalue and unique positive eigenvector (solution) for both the continuous and discretized equations. Further, the concepts of inner and outer iteration to obtain the neutron flux by iterative methods are introduced.

The successive over-relaxation (SOR) iteration schemes for solving linear systems of equations are the subject of Chap. 4. Questions of rate of convergence as affected by the form and eigenvalues of the coefficient matrix, relaxation parameter, point, line and block relaxation methods, and the selection of a relaxation parameter are studied.

Chapter 5 is concerned with the use of residual polynomials in extrapolation procedures. The Lanczos and Chebyshev methods are described. The remainder contains the use of Chebyshev extrapolation with SOR, and the construction of eigenvectors from residual polynomials.

Alternating-direction-implicit iteration (ADI) techniques constitute Chap. 6. These ADI techniques are shown to be quite efficient when combined with Lanczos-type iteration or Chebyshev extrapolation to form a "compound" iteration. Computation strategy for ADI and for compound type, and optimum parameters for this latter type are determined.

Chapter 7 examines the problem of finding a positive eigenvector corresponding to the largest eigenvalue of a given matrix. This problem reflects upon the relationship between the number of inner iterations per outer iteration for neutron diffusion problems.

In Chapter 8 the methods of Chaps. 4 through 6 are compared by actual computation of various problem solutions.

Chapter 9 explores a method for accelerating convergence based on variational techniques. By proper partitioning, the problem may be reduced to the direct solution of a series of smaller problems.

This clearly written and well-organized book is certainly worthwhile for anyone using computers for large problems such as reactor physics computations. If something bad has to be said, it would have been preferable if the fission source term in the diffusion equation had been written as

$$\frac{\chi_g}{\lambda_0} \sum_g (\nu \Sigma_f)_{g'}(r) \phi_{g'}(r)$$

instead of

$$\frac{\nu \chi_g}{\lambda_0} \sum_{g'} \Sigma_{f,g}(r) \phi_g(r),$$

and the few misprints had been avoided.

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*About the Reviewer: Harold Greenspan is an Associate Mathematician in the Applied Mathematics Division of Argonne National Laboratory. At Argonne since 1949, he has been active in reactor mathematics and reactor code development. In his connection with the Reactor Physics Constants Center he served as coauthor of the Chapter on Nuclear Codes in ANL-5800 (rev).*

**The Safe Transport of Radioactive Materials.** Edited by R. Gibson, Pergamon Press, New York (1966). 279 pp. \$12.50.

It is a challenge to briefly review this book about a book (*IAEA Regulations for the Safe Transport of Radioactive Materials, 1964 Revised Edition*) that succeeds a book (the Agency regulations of 1961). To the US reader who may not be familiar with the IAEA regulations, it should be mentioned that their principal features are similar to those of recently issued 10 CFR Part 71 and AEC Manual Chapter 0529. This is no accident, for two-way influence has led to the common aspects: the classification of radioisotopes; the three classes of packages for fissile material; the package criteria (performance and associated contents); and the control of certain shipments by "transport index." We must assume some familiarity with these features to avoid another book about. . . .

The 21 authors of *The Safe Transport of Radioactive Materials* are contributors to the IAEA regulations and to

corresponding national regulations or regulations of international transport organizations. But none belongs to the Agency staff (the foreword is by Servant of the IAEA). As individuals, the authors provide changes of pace ranging from the pedantic to touches of British humor and French wit. The cost of so many authors—some repetition—is worth it to the reader with specialized interests that are represented by a few of the 19 chapters. Collectively, the authors are a practical lot. Whether by design or chance, capability outweighs consideration of national origin. And here we point out to the suspicious American that a four-to-one ratio of UKAEA authors to those from the USAEC does not imply an overemphasis of UK practices. The international point of view is preserved fairly.

If the IAEA regulations were frozen, the commentary about them would be of limited value. But, as Gibson's crew points out, the regulations must be reviewed periodically and adapted to changing times and increased information. The authors anticipate further major revisions like the significant improvement of 1964, as well as amendments under the new 90-day procedure. Consistent with this view, all who have a stake in improved regulation require a commentary that goes far beyond simple interpretation.

*The Safe Transport of Radioactive Materials* provides this extended commentary. It explains why the international regulations are so hard to draft and why they turn out to be more complex than idealized regulations should be. For example, the following problems were encountered:

1) Both the USSR and US-UK systems of radiation control, including different exposure standards for transport workers, had to be accommodated regardless of complication.

2) Originally, the European railroads represented by RID had reservations about handling fissile material, and, to counter this reluctance, detail has been belabored and the Class I concept was pushed (some believe, oversold).

3) Nonuniform approval practices and insurance requirements lead to complex certification of fissile and "large-source" shipments (IAEA "specification packages" may offer an ultimate solution).

4) A current embarrassment is that US practices of radiation-unit measurement were adopted by the Agency, then repudiated by us in ICC Order 70. The life of an internationalist is not easy.

Difficulties of this sort are brought out incidentally to a primary intent, which is to explain the bases for the different portions of the regulations, not necessarily to justify them. Underlying models for the escape and uptake of radioisotopes, for the gamma-ray exposure of persons and film, for the evaluation of packaging, and for the behavior of packaged fissile material are described, and certain practical departures from these models are explained. In the course of this discussion, the somewhat complex administrative requirements, including the role of national "competent authorities," are clarified, and there emerge suggestions for further improvement or study of the Agency's regulations. Also emphasized are relationships with regulations of member nations and of international transport organizations.

In only a few statements do the authors depart from their typically practical viewpoint. In particular, a couple of the administrative specialists seem to show an unnatural queasiness about fissile material, which, fortunately, is not shared by their technical brothers.

Whether or not an unstated purpose of the book is to "sell" the IAEA regulations, the result is a soft sell that worked on this reviewer. The inherently useful parts of the regulations now loom larger than apparent faults. Regulators, national or international, and shippers of radioactive materials and packaging designers who are concerned with eventual economy will want *The Safe Transport of Radioactive Materials*.

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*About the Reviewer: Hugh Paxton has been at Los Alamos since 1948 with responsibilities for the group performing critical experiments. This activity complements, and stimulates, his intense interest in bettering regulations and standards. His pre-Los Alamos experience is wide and interesting, including graduate studies at Berkeley, cyclotrons in Paris, and membership on the small team in New York that first separated the uranium isotopes by gaseous diffusion. With a counterpart from the United Kingdom and one from France, Dr. Paxton served the IAEA as consultant to the panel that prepared the Regulations for the Safe Transport of Radioactive Materials.*