Book Review

Engineering Compendium on Radiation Shielding: Vol. III, Shield Design and Engineering. By R. G. Jaeger (Ed.) Springer Verlag New York, Inc., New York, Heidelberg, Berlin (1970). 537 pp. $60.

Volume III of the massive *Engineering Compendium on Radiation Shielding* is the second volume to appear. When Vol. I, covering fundamentals and methods, was published a few years ago, a Vol. II was described as "in preparation." It was to cover shielding materials and design. For various reasons the articles on materials were delayed. Since the sections already written for Chap. 10 on shield design had grown in sum to book-size proportions, it was decided to issue this chapter first as a volume in its own right. Presumably Vol. II on shielding materials will be along in due course.

In a brief preface the editor underscores in pointed fashion the objectives of this volume. "There is a marked difference between the task of the shielding physicist, who deals primarily with idealized systems, and that of the shield designer . . . . the mathematical-physical models and calculational techniques . . . . have received an emphasis which tends to distort the overall character of the complex task of shield design and engineering." The editor clearly intends to restore the balance of emphasis. One can almost see the chip on his shoulder: "The design of radiation shields for nuclear facilities is an interdependent multi-region multi-phase process . . . . The present [volume] . . . . seeks to introduce design engineers to the overall considerations in the design of a variety of shield systems . . . ." As a "fundamentalist" shielding physicist, I am left feeling properly chastened by the complexities of the engineering-design task. My amour-propre is somewhat salved, however, by the frequency with which the design case histories, described in the articles, cite the results of basic calculations on idealized systems, or look to sophisticated computer techniques as the court of last appeal.

The present volume of the *Shielding Compendium* should serve especially as an eye-opener to those who automatically associate shielding problems only with nuclear reactors. Some 200 pages are covered before there is any serious mention of reactors; by that point about 35 different radiation situations have been discussed. They range from shipping casks for laboratory wastes to greenhouses equipped with gamma ray sources, and from hot cells and pyrometallurgical fuel processing plants to huge proton synchrotons. The variety of details that need consideration is incredibly far flung—from methods of fastening lead sheets on the walls of medical radiation rooms to the design of ventilation ducts for hot cells to the investigation of the physical properties of rock salt in which radioactive wastes may be stored. The shielding problems of reactors are not neglected either. Four types of research reactors, six kinds of stationary power reactors, and four nuclear powered ship designs are treated.

The nearly all-inclusive scope of design situations treated has clearly involved the editors in a number of problems and forced them in some instances to make troublesome decisions. With so many cases to describe, it is obviously impossible to discuss them all in complete or even in adequate detail. This is most obvious in the 30-odd page section which is devoted, in a somewhat patchy way, to the shielding of high energy accelerators. It was clearly impossible to treat so vast a subject in so constrained a space, especially as the underlying properties of the radiations involved had been given only a passing mention in Vol. I. The editors therefore felt called upon to prefix to the section some comments in effect excusing the spotty treatment: the field hasn't yet jelled to the stage of engineering handbook procedures, it is claimed, so it is still primarily in the hands of the physicists. Besides, high-energy accelerators are rare creatures (and likely to get rarer) and the customers for this type of information are not many. Perhaps so, but then it might have been better to leave out the section completely and use the space to expand the treatment of other, more legitimate, problems.

The diversity of subjects treated is also possibly responsible for considerable unevenness in the manner and depth with which many of the situations are handled. (One suspects though that the unevenness reflects also differences in authors' styles which the editors could not standardize to any great degree.) Thus Section 10.4.1 on irradiation facilities for research contains, among other items, specific treatment of design methods, replete with formulas and curves, along with detailed analyses of existing installations. In contrast, the short section on chemical fuel processing plants contains no formulae at all and is devoted to a rather generalized description of the nature of the facilities and of the shielding problems that might arise. Again, the brief article on cells for spontaneous fission sources details the design procedures and the specific numerical information needed to come up with design figures. On the other hand, the group of sections on cells for gamma ray sources (33 pages) is entirely qualitative although construction features and typical installations are discussed in all their minutiae.

The sections on power reactor shielding problems exhibit some peculiarities. One might almost be tempted to conclude that the more unsuccessful, or at least the more unpopular, the reactor type the more detailed the description of the associated shield design. This is undoubtedly an uncharitable construction to put on the circumstances, but the unequal distribution of space does strike even the casual peruser. Over one quarter of the portion devoted to power reactors is given over to a marvellously detailed and minutely descriptive presenta-

tion of the shielding problems for the Enrico Fermi fast reactor. This section is in many ways a model of what a shield description should be, and, of course, the pioneer status of the Enrico Fermi reactor is acknowledged by all. Still, the reactor has been plagued by crippling problems throughout its existence, and the technology of fast reactors has moved on a considerable distance and in a different direction since the original design. The next largest block of space is devoted to another sodium-cooled reactor—the Hallam plant, shut down in 1964! Considerable attention is also paid to the Canadian heavy-water reactor NPD and the ORNL molten-salt experiment, neither of which can be described as outstandingly successful or seminal. In contrast, light-water cooled reactors, which make up the bulk of the U.S. group of operating power reactors, receive only 10% of the space, and the Dresden plant is disposed of in less than four pages. The European favorite—the gas-cooled reactor—gets somewhat better treatment from British and French contributors, but still occupies a relatively small proportion of the whole.

Much the same criticism might be made of the final section on the shielding of ship propulsion reactors. The pioneering "Savannah" and "Lenin" occupy the center of the stage, though neither represent efficient designs. It should be noted, however, that the longest article here (and probably the most up-to-date in the book) is on the Japanese experimental ship, which has not yet been built. There is the further problem in this section that naval reactors could not be discussed in a handbook devoted to peaceful applications (nor would the material have been available even if the editors had wished to include it). There is the anomalous consequence, though, that the reader is given no hint of the existence of considerable fleets of vessels with nuclear propulsion possessing highly optimized reactor shielding.

The peculiarities of emphasis in the sections on reactor shielding are reflections, most probably, of the main criticism that can be aimed at this volume of the *Shielding Compendium*—obsolescence of much of the material presented. Not the least of the pitfalls confronting the makers of handbooks and encyclopedias is the danger that the contents may be out of date by publication time. It cannot be said that the editors have been as successful in avoiding this pitfall as they might have been. The chronology of Vol. III is nowhere stated explicitly, but can easily be reconstructed from some dates given in the articles. Working backward, publication of the volume occurred sometime in the late spring of 1971 (the unfortunate delay in bringing out the present review is almost entirely the fault of this reviewer). The manuscript was probably sent to the printer early in 1970. The addenda, final notes, and corrections to articles mostly bear dates in 1968 and 1969, though at least two articles have footnotes or postscripts indicating 1970 references. But the main body of the articles was for the most part composed in 1964-66, as numerous dates in the articles and references testify. On the whole, therefore, this volume of the *Compendium* portrays the practice of shield design as it stood in 1963, give or take a year or two.

In a field which has attained a relatively stable maturity, such an interval between initial manuscript and published handbook might be acceptable. But radiation shielding is still, somewhat to the surprise of its practitioners (and funding agencies), a vigorously evolving subject. Computation capabilities scarcely dreamt of a decade ago, masses of new cross section information, considerable improvement in detectors—all have opened up new vistas in the understanding and the design of radiation shields, just as they have posed unanticipated problems. The state-of-the-art seven or even five years ago is not an acceptable standard by which to measure what can be accomplished now. Signs of such comparative antiquity are visible to the experienced eye throughout the volume. There are a number of references to RENUPAK and NIOBE—codes which have been obsolete and dead for five years. The authors of the well-written article on radiations from research reactors felt impelled to add a comment on the last page of the volume to the effect that the calculational and experimental methods described in the article are obsolete and have been replaced by far superior techniques. In discussing the design of shipping casks for spent fuel rods only the gamma radiation is considered. But in these days of high burnups the spontaneous fission source of neutrons from curium isotopes cannot be neglected, and the designs described would not now be considered safe. And these instances could be multiplied manyfold.

It may be questioned whether these criticisms are unduly harsh. This volume of the *Shielding Compendium* contains a vast amount of valuable information, much of it unpublished otherwise and the rest scattered over a wide range of references, most of which are difficult to obtain. It duplicates no other single source of information, and all who are deeply engaged in radiation shielding will have many occasions to refer to it with benefit. While acknowledging these virtues of the *Compendium*, it may still be claimed that the *Compendium* has fallen short of its own goal, certainly of what it could have been. Perhaps the argument is best given in terms of the accountant's jargon whose sting so many of us have felt—"cost-benefit analysis." The present volume of the *Shielding Compendium* provides many benefits for the expert in the field, fewer for the tyro who cannot distinguish the useful from the outmoded. And these benefits are presented at too great a cost. The cost is too great to the author, whose work would have been much more useful and to the point if it appeared in 1966 rather than 1970. And above all the cost of the volume is literally too great for the benefits the individual reader may obtain. The prospective purchasers have again been ill-served by the publisher. They have presented us with a beautifully printed and bound book—a questionable luxury in view of the short half-life of the material contained in it—and have charged what is even in these inflationary days an outrageous price.

One may still hope that some organization would be moved to try other editing and production techniques to achieve the optimum level of "cost benefit" for the shielding fraternity. Perhaps a series of shield design case histories could be issued, with typewriter composition and paper covers. And if an ink could be found that would fade to illegibility in five years—so much the better!

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About the Reviewer: As a contributor to these columns and as a member of the nuclear-energy community with many accomplishments in many topics, Professor Goldstein needs no introduction to our readers. His review of Volume I of Engineering Compendium on Radiation Shielding *appeared in the January 1970 issue of* Nuclear Science and Engineering.