

articles in *Review of Modern Physics* in 1936-37 and Blatt and Weisskopf's *Theoretical Nuclear Physics* in 1952. Now after another 17 years we have in "Bohr and Mottelson" a worthy follower of these predecessors. A comparison will show how much nuclear physics has progressed in the intervening years and how powerful are the new methods now available. This is not a book for the novice or the nuclear engineer who want a quick survey of the field. However, it will be indispensable for every serious student of nuclear physics, theorists and experimenters alike.

Lothar W. Nordheim

Gulf General Atomic Incorporated
San Diego, California 92112

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About the Reviewer: Lothar Nordheim, a frequent and generous contributor to these columns, was educated in Europe and has held professorships at Purdue and Duke and has been prominently associated with the laboratories at Oak Ridge, Los Alamos, and, most recently, at General Atomic. Presently a consultant for Gulf General Atomic, Dr. Nordheim has been an observer of and participant in the nuclear scene for about forty years. He is a Fellow of the American Nuclear and Physical Societies and a member of the Editorial Advisory Committee of Nuclear Science and Engineering.

Fundamentals of Radiation Protection. By Hugh F. Henry. Published by Wiley-Interscience, New York (1969). 473 pp. \$17.50.

The author sets himself an unusual task which he describes in the preface as follows: "If this book in any way helps to place the overall subject of radiation, its hazards and control, into an appropriate perspective for the casual reader while at the same time helping to clarify its basic concepts for those with a more serious interest in the subject, my purpose in preparing it will have been at least partly fulfilled."

The book, in fact, seems to be aimed primarily at the general interest student level. It is rather difficult for the reviewer to assess fairly what its penetration might be either for the casual reader or as a clarifier of basic concepts for those who expect to advance in the subject. On the whole, we would find it rather difficult to discover appropriate merits for this last class.

Dr. Henry writes in an easy style and manages to compress a good number of facts into a short exposition, a feature which seems to be increasingly rare in writing about radiation protection. Thus, the first three chapters on the basic physics of atomic structure and nuclear transformations are highly readable and appropriate. Chapters 4 through 9, which take the reader into the areas of biological effects and establishment of physical and biological dose relationships, are adequate. Whatever selection is made from this vast body of material can easily be criticized by the next potential author. With a few exceptions, Dr. Henry's choice seems to be appropriate if one is willing to overlook a number of minor faults. Some are not readily excusable, as when he says on page 3 that the erythema dose is now estimated to be about 1800 rads, whereas by page 116 the sensitivity of the skin has increased to the point that 700 rads (or reportedly as low as 300 rads) has resulted in erythema while at 1500 rads

blisters appear. It is equally surprising to find that "the tragic and well publicized cases of the radium dial painters" involved only *several* girls.

Those who have spent their careers in association with radiation therapy will be dismayed to discover that "certain diseases and disabilities have *apparently* been relieved by such exposures." The underlined word could surely have been omitted.

The middle section of the book, which is concerned with permissible exposure limits, internal exposure evaluations, radiation detection and measurement, and the basic principles of monitoring, generally seems to meet the standards that the author set for himself. We are less happy with the final section beginning with Chap. 16, which offers "Guides to Practical Protection Measures." We would have found this much more helpful if the reader had been given a clue as to the principal hazards likely to apply in normal operation of typical facilities. For example, if one is concerned with radiation protection for a reactor installation, are the principal issues the emission of high-intensity neutron beams, the radiation from activated fuel or fuel casing pieces removed from the reactor, or radioactive gases that leak into the atmosphere, or some other cause? The text, as it were, tends to offer solutions to these problems without first indicating what the problems are and how they may arise. Of all the people who take any part in a radiation protection program, it is doubtful if as many as 1% ever have any contact with a radiation accident. Yet the text on accidents and emergencies seems to be more vigorous than that on mundane affairs of day to day operation. This section, and especially the chapter on administration, bears too heavily on the circumstances in the typical major U.S. Atomic Energy Commission programs. There is only about one sentence that refers to other circumstances, and this sentence is totally unsatisfactory. One simply cannot accept that a radiologist is a normal and appropriate health physicist for a hospital. Either a more balanced presentation between the needs of U.S. Atomic Energy Commission programs, current commercial operations, university and other laboratories, and medical programs should have been given, or this section omitted. Similarly, we feel that space could have been occupied better than with a discussion of nuclear weapons and the fallout problem. Finally, we find the most inappropriate assignment of space to be Appendix II, Part 2, which consists of 71 pages of the standard tables on maximum permissible concentrations that the specialist would have on his desk from normal NCRP and ICRP sources, and which others will find completely useless.

In summary, applying the standard subjective appraisal methods currently so popular in radiation protection we must say that the benefits of exposure to this text clearly outweigh the risks. In fact, if Dr. Henry had not tried quite so hard to make a little irradiation sound tolerable, if not actually desirable, we might have recommended that one of the philanthropic foundations could have found many less satisfactory ways of using its funds than in some way giving a free copy of this text to everyone who purchases a copy of any one of the current "Perils of Pauline"-type accounts of radiation hazards.

Herbert M. Parker

Consultant to the Director
Pacific Northwest Laboratory
Battelle Memorial Institute
Richland, Washington 99352

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About the Reviewer: We, and I am sure our readers, welcome Herbert Parker to these columns again as the reviewer of another book on radiation protection. Mr. Parker, trained as a physicist in England (MSc., F. Inst. Phys.), began his career in nuclear energy at the Metallurgical Laboratory, University of Chicago, in 1942 when the Health Physics profession was founded. He subsequently managed the Hanford Laboratories, Richland, Washington for nine years and is now a consultant to the Director of the Pacific Northwest Laboratories of the Battelle Memorial Institute.

Economic Strategy for Developing Breeder Reactors. By Paul MacAvoy, The MIT Press (1969). 199 pp. \$10.00.

This is an important book. Briefly summarized, the study relies on three major analytic tools. First, MacAvoy undertakes a probability analysis of R&D costs and performance goals for the Liquid Metal Fast Breeder Reactor (LMFBR), the Gas Cooled Fast Breeder Reactor (GCFBR), and a dual program. Second, he develops a nationwide econometric model using Edison Electric Institute nine-region data to project both total electricity consumption and the nuclear share of that consumption. Third, production functions as well as associated electricity production costs are estimated. Public benefits are expressed as the discounted increase in consumer's research resulting from the increased electricity consumption, and the public cost is taken as the discounted R&D costs.

In Chap. 4, the author makes a cogent argument for a two-pronged attack on breeder development. He concludes that (a) future economic benefits will probably exceed development costs for either a gas-cooled or liquid-metal-cooled program, (b) the net present value of benefits for GCFR development appear to be higher than those for an LMFBR program, and (c) developing both types is superior to developing either alone. One important point associated with this latter conclusion is the belief that a two part development program will result in greater industry competition and lower future power costs. This is a conclusion affecting billions of dollars of public funds, and merits substantial consideration.

The assumptions and economic data on which the above conclusions are based appear to be reasonable and consistent with those used in other independent studies of the U.S. Civilian Power Program; however, the total electrical capacity forecast to the end of the study period (2005 A.D.) may be overoptimistic. The author's derived figure of 2 370 000 MW(e) added during the period 1985 through 2004 corresponds to annual growth rates ranging from 7.5 to 8.3% which are considerably higher than the 5.5% growth rate projected by the Federal Power Commission and the USAEC for this same period. The author's forecast procedure, described in detail in Appendix C, does not allow for saturation of some of the future markets for electricity such as home heating, for example. With a lower capacity demand, the net present value of benefits would be less than shown; however, the overall conclusions would probably remain unchanged.

Three other types of criticism may also be levied against the book. First, it has some proofing errors. Second, certain Gordian knots in economic theory are cleaved by simplicity in a non-convincing fashion. Third, the discussions of the technical aspects of the fission reaction are inaccurate. In general, these criticisms will not interfere with the reader interested in the analytic

approach described and the resulting conclusions drawn. However, the serious student of methodology will find these deficiencies somewhat frustrating, if not misleading. Fortunately, the proofing errors are evident with some thought on the reader's part and the technical discussions are not relevant to the main theme of the book.

More seriously, the author can be faulted for his Cyclopean view of certain contentious issues in economics. Specifically, consumers' surplus and single-equation demand estimation are both highly controversial. MacAvoy does his readers an injustice by not noting the logical limitations of his techniques as well as part of the voluminous literature centered upon them.

The discussion of probability and its utilization in the analysis is, in general, quite impressive. It sets a standard for other resource economists for the next few years. A minor defect, however, exists in the equal probabilities assigned to low costs, design costs, and high costs in Chap. 2. The data reported in Appendix A are a strong argument for assigning high costs a greater probability than low costs. Net benefits would be somewhat lower, for example, if $P(L) = 0.2$ and $P(D) = P(H) = 0.4$.

An error of probably minor importance appears in the first chapter. The figures there (as well as elsewhere in the book) show marginal cost as rising or constant. It seems more likely that marginal cost decreases over a significant range, and that this is one of the complexities of public policy in determining the degree of competition to encourage.

Finally, the paragraph describing benefit-cost analysis on page 3 would be more relevant to the book if the phrase "general environmental benefits" were deleted. Heat discharge, transmission lines, radioactive emissions, and explosion possibility are omitted from any consideration in breeder development. Analogously, the effects of strip mining, combustion by-products, and oil leakage are environmental effects of other steam-electric processes which are not considered in estimating the nuclear share. While the study is most comprehensive as it stands, it should be realized that an important component of benefits and costs was omitted.

Despite the foregoing comments, these reviewers feel that the author has done an excellent job of showing how one applies a benefit-cost analysis to alternative fast breeder strategies. The book is well written and adequately documented. The points raised in this review do not substantially detract from the objectives of the book nor from the conclusions reached.

*James A. Lane
and*

L. Duane Chapman

Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

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About the Reviewers: Jim Lane and Duane Chapman are presently associated with the group at Oak Ridge National Laboratory that is making a study of the feasibility of agro-industrial complexes centered around nuclear reactors in the Middle East. The former is now the Director of the Group. He has held many responsible positions, at both ORNL and AEC Headquarters, concerned with future planning for nuclear energy, a career he began at the Metallurgical Laboratory, University of Chicago, in 1942 following graduate studies in chemical engineering at Worcester Polytechnic Institute.