and laboratory samples. The general subject has also been treated in two volumes, entitled *Nuclear Techniques and Mineral Resources,* published by the International Atomic Energy Agency (1969, 1971), but the present book is more comprehensive and more current.

Written for an interdisciplinary readership, the book contains fairly rigorous and detailed explanations of the aspects in nuclear theory involved with each technique. For geologists and engineers who may lack a strong background in nuclear science, an appendix on the fundamentals of atomic and nuclear physics is provided.

Major sections of the book deal with the measurement of gamma radioactivity from natural radioelements, with the use of x-ray analysis in mineral exploration, and with radioactivation methods of logging drill holes for solid minerals and petroleum. One chapter, on a topic not represented in the book title, describes the use of x-ray fluorescence geochemical analysis in investigations on the surface of Mars. Another chapter, also containing information outside the main thrust of the book, deals with the use of nuclear explosions in creating reservoir and canal excavations as well as in stimulating the recovery of oil and gas from impermeable formations.

The editor is deputy director of the Colorado Energy Research Institute and an adjunct professor of physics at the Colorado School of Mines. Authorship of individual chapters has been drawn from scientists and engineers associated with North American universities and geophysical firms and associated with the U.S. Geological Survey. As in most books involving multiple contributors, there is some repetition among chapters and among lists of references. On the whole, however, the book is well organized and well written. The information is supported by ample charts and tables, and there is a general index that permits the entire book to be of use as a reference work.

William C. Peters (PhD, geology, University of Colorado) is professor of mining and geologic engineering at the University of Arizona, where he teaches mining geology and mineral exploration. Prior to his academic appointment, he was chief geologist at the Bingham Canyon Copper Mine, Utah, and exploration geologist for FMC Corporation. He has engaged in uranium exploration throughout the western U.S., in North Africa, and West Africa. He has lectured on exploration geology at several European universities and is the author of more than 30 technical publications.

The Thermal-Hydraulics of a Boiling Water Nuclear Reactor

Authors R. T. Lahey and F. J. Moody

Publisher American Nuclear Society (1978)

Pages 433

Price $41.95

Reviewer F. G. Hammitt

This American Nuclear Society monograph will make a most excellent and useful addition to the bookshelves of both practicing nuclear engineers and nuclear engineering students interested in the power reactor field. As the title implies, it is pertinent particularly to the boiling water reactor (BWR) field, and well summarizes the technical information applicable thereto. It is well written by two highly experienced practitioners in that field and provides a thoroughly authoritative treatment of the existing technology.

The coverage is very broad, but particularly emphasizes such thermal-hydraulic aspects as two-phase flow, rather than the nucleonics parameters, and hence it should be of most value to engineers engaged in that field. The treatment of these aspects is sufficiently basic so that useful application can be made to fields other than BWRs. The treatment of boiling and other two-phase flow phenomena is especially strong. While no new data are presented, the drawing together of comprehensive information from numerous already published papers will be highly useful to those working in these fields, as will be the copious reference lists with each chapter. Hence, the book is most strongly recommended to the nuclear engineers and students active in, or wishing to learn about, these fields.

F. G. Hammitt is heavily engaged in multiphase flow research as professor-in-charge of the Cavitation and Multiphase Flow Laboratory, Mechanical Engineering Department, University of Michigan, Ann Arbor, and is the author of over 200 papers and articles, mostly in that field. For several years in the past, he served as a professor in the Nuclear Engineering Department at the same university, and now teaches a graduate course covering large nuclear power plants. Prior to serving at the University of Michigan, he accrued approximately ten years of industrial experience, mostly in fluid flow and heat transfer. He is a member of the American Nuclear Society, a fellow of the American Society of Mechanical Engineers and of the Institute of Mechanical Engineers (Great Britain), as well as a co-author of Cavitation *(McGraw-Hill Book Company, 1970).*

Radiation Exposure from Consumer Products and Miscellaneous Sources

Publisher National Council on Radiation Protection and Measurements (1977)

Pages 80

Price $4.00

Reviewer Gordon Dunning

The ever-expanding use of consumer products that emit radiation has focused attention on the need for better information and possibly additional regulatory action. National Council on Radiation Protection and Measurements (NCRP) Report No. 56, *Radiation Exposure from Consumer Products and Miscellaneous Sources,* compiled by the NCRP Scientific Committee 28 on Radiation Exposure from Consumer Products, addresses itself to the first of these needs and should be of significant assistance to those concerned with regulations.

As stated in the introduction to this report, ". . . The

primary goal of the Committee was to identify consumer products that could be sources of ionizing radiation and to provide quantitative data on the range of typical dose equivalents to members of the population from each such source. To the extent possible, the Committee was also asked to provide information to assist in making decisions on whether a given application involving radiation exposure might better be replaced by some other method of accomplishing the same task without involving irradiation of the population."

The first goals to identify consumer products and to provide quantitative data on dose equivalents have been admirably met. This report is an excellent, albeit brief, compilation of the principal sources. The estimates of dose equivalents are necessarily imprecise owing to the difficulty of quantifying the available data on the amounts and uses of the consumer products and other radiation sources. The estimates are based, however, on the best available information as indicated by the authoritative list of 114 references.

The report reviews 6 categories of electronic products, 13 of radioactive materials, and 4 "miscellaneous exposure sources." In each case, there is a brief review of the product or source, its use, and the potential radiation exposure to a given population group. These data are summarized in an excellent three-page table at the end of the report.

Although it is not possible to review here each of the consumer products and sources, some summary statements will indicate their diversity and their contribution to human exposure:

1. The average annual whole-body dose of the U.S. population from consumer products and miscellaneous sources is <5 mrem, with ~70% of this arising from naturally occurring radionuclides in building materials.

2. The source contributing the second highest average population whole-body dose, perhaps surprisingly, is luminous clocks (up to 0.5 mrem/yr from ^{226}Ra).

3. In addition to the whole-body doses, ubiquitous TV sets add a 0.5-mrem dose per year to the gonads.

4. The annual population dose to the bronchial epithelial from natural radioactive materials in tobacco products is 2 rem, and the annual dose to the actual users of tobacco products is 8 rem.

5. The average annual population dose to the basal mucosa of the gum from uranium in dental porcelain is 10 to 15 rem, and the annual dose to wearers of dentures and crowns is up to 60 rem.

6. Although some 10 million persons are intentionally exposed to x rays at airport inspection stations, the average annual population dose is small (one microrem), since the exposed population receives only ~22 microrem annually.

The response of the Committee to its second goal—"To the extent possible, the Committee was also asked to provide information to assist in making decisions on whether a given application involving radiation exposure might better be replaced by some other method of accomplishing the same task without involving irradiation of the population."—is contained in a single page of the report. Most of the comments are in the categories of obvious recommendations to keep radiation doses "as low as is reasonably achievable" or to eliminate sources that serve "little or no useful purpose" or to use "other techniques" to reduce radiation exposures. Although a few examples are given, a reader would hope for a more extensive and definitive discussion. The rather comprehensive list of references does provide a source for further information, and now that NCRP Report No. 56 is at hand, perhaps others will proceed with the task of further evaluations and recommendations.

The ~5-mrem average annual whole-body dose from consumer products is small compared to the 130-mrem dose from naturally occurring radioactive sources, but as the types and quantities of consumer products grow, it is to be anticipated that the radiation exposures also can increase. Whether or not one should be concerned depends largely on one's point of view. Basically, the problem with the use of radioactive consumer products is the same as with all activities involving potential radiation exposures, i.e., the necessity of balancing benefits against risks. In a democracy, this probably will never be resolved to everyone's satisfaction, but NCRP Report No. 56 will help to provide needed information upon which to arrive at value judgments.

Gordon M. Dunning is a commissioner on the Arizona Atomic Energy Commission. He was with the U.S. Atomic Energy Commission for 20 years before retiring in 1972. He has a doctorate degree in science education from Syracuse University, majoring in physics and chemistry. He is a certified health physicist and has published about 30 papers in the field of health and safety.