the development of the chemical high-explosive components for the World War II Manhattan Project atomic bomb program.

Lowrance has recognized the introduction of new risks from the introduction of new technologies, but he reminds the reader that the undesirable effects must be viewed as the expense of decreasing our vulnerability to the hazards of nature. The book acknowledges that mankind is in many ways safer today than ever before. This trend will probably continue in the safer direction, since new technologies generally tend to supplant devices and techniques of greater risk. Furthermore, existing technology is so frequently challenged, investigated, legislated, and improved upon that even techniques of long standing are required to get safer. Anesthesia, electrical appliances, communications (in a sense of warning), and labeling are examples of classical technologies improving in safer directions.

Lowrance shows his scientific detachment in analyzing risks and then mixes with these scientific viewpoints a personal response to hazards when he speaks of rural America in 1900. Among the rural hazards, he lists "tetanus-inducing rusty nails." In my early years I, too, was warned of "rusty nails" and "lockjaw." It took many years before I became aware of the germ theory of disease and learned that it really wasn't the rust or iron oxide to be afraid of, it was the pathogen.

The author pursues another social entrapment when he speaks of the known success of dramatic crusades in reducing abestosis and black lung and includes in the same paragraph "eye-saving standards for factory lighting." The extraordinary increase in lighting levels in the last generations probably was influenced at least as much by cheap power, improved technology, an affluent society, and artistic enhancement as by health and safety interests.

Lowrance understates the potential accomplishments of safety by direction when he avers that the goal of having workers "at no greater risk in carrying out their labor than they are off the job" is merely an admirable goal and has probably never been very closely approached in any country. Many, perhaps most, safety people feel that risk on the job can readily be made less than risk off the job and that indeed this has already been done in many industries. This can be attributed to enlightened and capable management determined to take the responsibility for reducing occupational accidents.

Of Acceptable Risk examines the broad issues of safety by analyzing social change, measuring risk, judging safety, and trying to come to grips with acceptable risk, public problems including legislation and the courts, the workplace, education, regulation by law and by consensus, costs, and examination of risk-benefit concepts.

The author is an able writer, and the tightly written prose permits the reader to enjoy the book despite the necessary discontinuity of the separate chapters and subchapters. The reader may open the book to any chapter or page and find some fruitful discussion. Lowrance issues challenge after challenge and with equal strength invites challenge again and again. It is the foundation of safety—challenge, not for its own sake, but for reexamination of existing methods and hardware and of changes proposed in the name of safety.

Lowrance states that scientists, engineers, designers, architects, physicians, and public health experts do have special responsibilities to the rest of society with respect to personal safety. My enthusiasm for this book suggests an extension of the author's view. I believe that at the senior or graduate level, students in those disciplines enumerated above should be subjected to a short course (five sessions, perhaps) with *Of Acceptable Risk* as a text.

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About the Reviewer: Roy Reider has been engaged in accident-prevention activities since 1936, serving as safety director of the Los Alamos Scientific Laboratory since 1948. Mr. Reider is an engineering graduate of the Rensselaer Polytechnic Institute and has authored more than 50 papers on a variety of safety subjects.

Environmental Aspects of Nuclear Power. By G. G. Eichholz. Ann Arbor Science (1976). 657 pp. $29.50.

This book pulls together a vast amount of information on a wide variety of topics related to nuclear power. It covers such subjects traditionally associated with its title as radiation effects, waste heat dissipation, in-plant treatment and environmental dispersion of radioactive effluents from power plants, radioactive releases in various parts of the fuel cycle and in transport accidents, and radioactive waste disposal. But its coverage also extends to such diverse subjects as energy sources and usage, power plant siting, and technological assessment. Most treatments are in considerable depth, including detailed descriptions of relevant equipment and processes. All in all, the book has 14 chapters with 123 figures and 183 tables containing an impressive wealth of information, plus about a thousand references.

As an example of the depth of coverage, the chapter on waste heat dissipation includes tables on cooling water requirements for various types of systems, cooling water requirements in various geographical areas versus time, heat rejection rates of common activities, representative natural and man-made power densities, properties of water, chemical wastes from a power plant, lethal temperatures for various fish, temperature ranges for successful fish egg hatching, water temperature standards for various states, costs and land requirements of cooling ponds, seasonal temperature variations of isotherms in ponds, toxicity of elements used in cooling tower operations, detailed breakdown of cooling device costs, comparative costs of alternative cooling systems, and business volume associated with various thermal pollution effects. It contains formulas with extensive symbol definitions for Stokes' law, evaporation rate (as a function of wind speed, etc.), heat conduction, equilibrium temperature with insolation, temperature profiles along heated water jets, the densimetric Froude number of a discharge, zone of equilibration on a river, concentration of radioisotopes versus time, duty coefficient of a natural draft cooling tower, and dimensions of the fog plume from a cooling tower. The chapter covers 52 pages and has 12 figures, 52 references cited in the text, and 16 additional references.

The book has some aspects of an encyclopedia. The amount of material covered is so large and varied that no single author could be intimately familiar with a large fraction of it, so one frequently recognizes quotes or paraphrases from documents; however, far from detracting from the value of the discussion, this introduces the reader to (or reminds him of) the pertinent documents. The number and variety of documents thus introduced is truly impressive; in fact, more of the references are to conference proceedings and reports than to journals, and there are almost none to books. This last point emphasizes the need for, and timeliness of, this book. To the best of my knowledge, there is no other book with a comparable breadth and depth of coverage.

The most obvious deficiency is the almost total neglect of power plant accidents. This is surely an important environmental aspect of nuclear power. There is little or no mention of ^{14}C emissions from power plants and reprocessing plants, and only a brief passing discussion of radon emissions from mill tailings, two subjects that many now consider to be of utmost importance from the environmental standpoint. Low-level waste burial, another recent "headline grabber," is covered very lightly. There is no discussion *per se* of plutonium toxicity problems that have been receiving so much publicity, and questions related to diversion of plutonium for use in bombs are not considered. Other discussions are more shallow than one might prefer, and few are deep enough for research-level consideration.

But the importance of this book is not in what it lacks, but in what it contains: namely, an excellent introduction and entré into hundreds of subjects pertinent to environmental aspects of nuclear power. As such, it would be a most valuable addition to the library of anyone interested in that subject.

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About the Reviewer: After nearly a decade in cyclotron research at Oak Ridge National Laboratory, Bernard Cohen returned to the academic field in 1958 and is now Professor of Physics and Director of the Scaife Nuclear Laboratories at the University of Pittsburgh. Dr. Cohen's graduate studies, in physics, were at the University of Pittsburgh and Carnegie-Mellon University. He has enjoyed a long and productive career in nuclear physics and, in the recent past, has investigated and reported on the potential risks associated with the nuclear fuel cycle.

Random Processes in Nuclear Reactors. By M. M. R. Williams. Pergamon Press, New York (1974). 236 pp. $22.50.

It is reasonable that a book on random phenomena in reactors would be written at this time. This is because reactor noise techniques are not only continuing in established areas but are also showing a growth by entry into new areas. Two previous books[1,2] have been practical-application-oriented and have been somewhat introductory in nature. As indicated in its preface, Williams' book indeed complements these books from the standpoint of giving theoretical backgrounds of many phenomena to the more advanced student and researcher.

This work, based on 1973 lectures at the Instituto Energia Atomica, Sao Paulo, Brazil, is now a few years old. If the book is intended to be a presentation of experimental data in power reactors, its age could be detrimental. However, this is not the case; rather, the book is a collection of historically established theoretical developments. Therefore, like today's physics texts still treating the ideas of Archimedes, Galileo, and Newton, there is more timelessness in the realm of underlying theory than in data. About 90% of the extensive reference listings at the end of the chapters consists of works of the 1960's and before.

If one attempts to categorize broadly the contents of the individual chapters, an approximate distribution would be one-third zero power noise, one-third power reactor in-core noise, one-sixth mathematical physics, and one-sixth miscellaneous related topics. Within all these categories, the primary emphasis is on the underlying mathematical concepts. Quite numerous are derivations of analytical formulas that are the consequences of models of various random phenomena. It is good to see this scholarly approach in the present age of "brute force" numerical solutions by computer, for example, seeing hypergeometric functions representing randomly excited fatigue damage rather than computer-drawn plots.

The absence in most cases of concrete implementations of the expressions obtained in a particular discussion could bother some readers who might like to see experimental examples or verifications of the theory. Also, in a few cases not even a concrete solution is given to the general stochastic model of the process discussed. But in fairness to the author, the mathematical physicist's point of view is uppermost here. Moreover, the original works he reviews frequently contain only quite general results developed for purposes of insight. For example, Williams introduces his own theory for the criticality equation of a spatially random array of fuel, but it was not within the scope of the book to compare it with data referenced.

Regarding the specific topics treated in this book, the variety is impressive. After a historical survey, three chapters are devoted to developments of a number of methods used in analysis of zero power reactors. However, a more organized and comprehensive survey of these methods can be found in an excellent review by Pacilio.[3] Next, an exposition of the Langevin technique and the Fokker-Planck formalism appropriately leads one to chapters on point reactor noise phenomena in power reactors and spatially varying noise in zero power reactors.

Missing, because of developments since the book was written, are the newer treatments of spatially varying noise in power reactors (e.g., the so-called global and local components of noise sources). This is the essence of understanding in-core neutron phenomena in today's large power reactors. Moreover, the now widely used cross-power spectral density is scarcely mentioned. However, these omissions are compensated by the variety in types of stochastic phenomena treated in the two final chapters, such as randomness in voids, fuel and absorbers, temperature, and hydrodynamically excited vibrations; point reactor noise for boiling water reactors; vibrating neutron absorbers; metal fatigue; and random bubble population theory.

Regarding clarity of presentation, the reader having the proper background will have no difficulty. However, the visually oriented might welcome more pictorial representations, such as of Markoff chains or phase-space representations. Such figures would be more useful than the

[1] J. A. THIE, *Reactor Noise,* Roman and Littlefield, New York (1963).

[2] R. E. UHRIG, *Random Noise Techniques in Nuclear Reactor Systems,* Ronald Press, New York (1970).

[3] N. PACILIO, "Reactor-Noise Analysis in the Time Domain," TID-24512, U.S. Atomic Energy Commission (1969).