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.

Bernard L. Cohen

University of Pittsburgh
Department of Physics and Astronomy
Pittsburgh, Pennsylvania 15260

December 20, 1976

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).

book's Fig. 1.1, which naively shows a single horizontal line illustrating the concept of steady-state power. On the whole, however, this book's real messages are in its equations and their lucid discussions.

To sum up, this monograph would be recommended for the serious researcher in random processes, especially if he is more theoretically than experimentally oriented. Thus, *Random Processes in Nuclear Reactors* might be explicitly titled *A Comprehensive Review of Historically Accepted Theoretical Methods in Both Zero Power and Power Reactor Noise*. In the laboratory or in the power plant where interests are more concrete than this book intends, it would probably accumulate dust. But well written in the style of the university academician, it will appropriately find a place on the bookshelves of many scholars, even those who are more interested in stochastic methods *per se* than in reactors.

Joseph A. Thie

P.O. Box 517
Barrington, Illinois 60010

November 29, 1976

About the Reviewer: Joseph A. Thie is an independent consultant to the reactor industry. He is presently engaged primarily in areas of safety, design, instrumentation/control, and testing. Among Dr. Thie's publications are many papers treating random fluctuations, including those presented at several international conferences, and his book, Reactor Noise. *Other books that he has authored or coauthored are* Heavy Water Exponential Experiments Using ThO_2 and UO_2, Nuclear Reactor Instrumentation Systems, *and* The Technology of Nuclear Reactor Safety.

A Rational Finite Element Basis. By E. L. Wachspress. Academic Press, New York (1975).

Gene Wachspress is well known in the nuclear engineering community, and his book *Iterative Solution of Elliptic Systems and Applications to the Neutron Diffusion Equations of Reactor Physics* will remain a basic reference for anyone working in the field of numerical reactor calculations. The scope of *A Rational Finite Element Basis* is quite different: As the author states in his concluding remarks, it is a research monograph, and no attempt is made to support the theory by extensive numerical calculations. In this reviewer's opinion, it is indeed a very fine piece of research, at least through its first eight chapters, which are not applications oriented. In brief, the author develops a finite element basis that applies to elements of arbitrary geometry in real coordinates, thus providing an alternative to the current isoparametric approach. The basis functions described are in general ratios of polynomials, but reduce to well-known and widely used polynomial functions when, for example, in two dimensions, triangles and parallelograms are considered. These rational basis functions are constructed in a logical manner with an increasing degree of sophistication and carefully selected examples, which support the progression and make it appear quite natural.

In Chap. 1, some notation and several definitions are introduced: "polypols" (closed planar figures bounded by algebraic curves) and, in particular, "polycons" (bounded by segments of lines and conics) are presented as generalizations of polygons (bounded by segments of lines, following the author, who is somewhat disrespectful for etymology). To each element node is associated a "wedge" basis function, and a set of properties are required of these wedges to achieve a C^0 continuous, first-degree, patchwork approximation over a collection of polypols. Except in Chap. 8, only "well-set" polypols are considered, i.e., polypols in which the boundary curves intersect transversally at the vertices and in which their extensions do not intersect the polypol (a generalization of convex quadrilaterals). In Chap. 2, the inadequacy of polynomials as quadrilateral wedges is demonstrated, and rational functions that satisfy the requirements of Chap. 1 are built up. In Chap. 3, similar concepts are applied to selected polycons: The analysis developed for quadrilaterals is extended to curved sides, and a qualitative description of the basis functions is given, while the precise construction recipe is deferred to Chap. 5. Chapter 4 is concerned with the algebraic geometry foundations necessary to generalize the previous analysis to more complex situations (polypols, higher-degree approximation, or higher-dimensional elements). Some new terms are introduced, and several key theorems are stated without proof, the reader being referred for the details to pertinent texts. The construction of rational wedges for polycons and polypols is then revised in Chap. 5 in a much more precise algebraic geometric setting. The generalization to polypols turns out to be more difficult; in particular, a general proof of regularity of the wedges functions is not given, but the construction appears to be reasonably well founded and fairly general. The next two chapters are devoted to generalizations to higher-degree approximations, and in three dimensions, while Chap. 8 treats the case of "ill-set" polypols, that is, polypols that, like nonconvex quadrilaterals, are not well set. The reader who leaves the book after these eight chapters would almost certainly remain quite impressed by the broad area of research covered in such a logical and progressive way. To go through some of the details, he will need paper and a sharp pencil, but fortunately quite a lot of well-chosen figures are provided that back up the text admirably and help very much in the understanding of what the author means.

The last two chapters of the book are applications oriented and, in this reviewer's opinion, are somewhat weaker than the rest of the book. In Chap. 9, the author, who clearly wants to "sell" his basis functions, faces in earnest the problem of achieving an actual discretization and, in particular, of evaluating various integrals over the elements, integrals of products of the basis functions and of their first derivatives. With rational functions, this turns out to be a nontrivial problem that is solved here by looking back at more familiar elements. Indeed, polypols are partitioned into triangles and segments, and the integrals are estimated by combining the contributions of the various components. For triangles, well-known quadrature formulas are available. For segments, such formulas are not as easily obtained, and the approach followed here consists in introducing isoparametric segments and using the corresponding quadrature formulas. In other words, one goes back partly to classical elements, and one could wonder whether it would not have been easier to achieve such a partition into triangles and isoparametric segments right from the beginning and to use the corresponding familiar polynomial or isoparametric functions, for which the approximation properties and the effect of numerical quadrature errors are theoretically well founded. Instead, several finite element discretizations are proposed by the author to approximate rational wedge integrals. In sharp contrast with the first part of the book, the approach here