the upper limit of controllable fission; a fundamental concern is the diffusion leakage of hydrogen through the engine piping; and the number of control drums must be some multiple of four.

The book simply seems to miss the point in many discussions. Trivial effects are accorded the same treatment as basic design considerations. In some cases, a correct result or conclusion is stated but is then supported by an irrelevant or inconsequential rationale. One could almost conclude that the book deliberately avoids the obvious (but basic) points, which have already appeared in other published works, in a search for something different. This might be a provocative approach to intrigue the advanced reader, but it presents a very confusing picture to a person wishing to understand the why and how of nuclear propulsion.

The book includes a considerable amount of basic information based on the extensive bibliography cited in an appendix. It is unfortunate that the references are not cited in the body of the text, since the reader is dependent on his own prior knowledge to sort out the information and the speculation. The book itself has an attractive format and is liberally illustrated with tables, graphs, and line drawings. Mathematical expressions are used profusely, but it is not obvious that they always serve a useful purpose, since the discussion is basically descriptive and qualitative. Many of the equations represent the result of complex and detailed considerations, such as neutron diffusion theory, and it can be wondered what they convey to the reader who has just been introduced a few pages ago to a very elementary discussion of the concepts of fission, nuclear cross sections, and reactor criticality. At the same time, the lack of a rigorous mathematical development makes the stated final equations of little value to the technically qualified reader unless he recognizes them as familiar friends.

Aside from a brief mention of the successful 1964 ROVER reactor tests early in the book, the existence and accomplishments of the national effort in the development of nuclear rocket engines are ignored. A rationale for this omission can be made if the book is intended (as stated in the preface) to have a slow rate of obsolescence in a fast-moving technology. However, this same rationale also properly limits the contents to those basic principles and concepts that are unlikely to change rapidly. Unfortunately this limitation was not recognized, and a great deal of the book is devoted to specific design proposals, some of which solve problems already proved to be trivial or nonexistent or else problems which result from situations or applications invented by the author. The result is somewhat less than informative to the reader who wishes to know what is really going on.

In summary, it can be said that the book discusses in some form almost all of the aspects of nuclear propulsion ranging from the discovery of uranium to the layout of the nuclear-astronauts' consoles. It is essentially devoid of any information on what is actually being done in this program and contains much speculation about the way in which reactors, engines, and spacecraft *might* be designed. As a guide to the nonexpert, it is of dubious value unless read in conjunction with the more factual reports that are appearing in increasing numbers. It is of essentially no value as a reference document to the engineer or scientist seeking exact and complete information, although it might be a challenge for such people to match wits with the author.

R. E. Schreiber is the Technical Associate Director of Los Alamos Scientific Laboratory. He was Division Leader for the nuclear rocket propulsion work at LASL from the time that program was started in 1955 until assuming his present position three years ago. He has been the author of a number of papers and articles on nuclear propulsion and has served on advisory committees of NASA and USAF dealing with this subject. Earlier work at Los Alamos included reactor research and nuclear weapon engineering. He received a PhD degree from Purdue University in 1941 and an honorary DS degree from Purdue in 1964. He is a Fellow of the ANS, AIAA, and APS.

THERE HAS BEEN A SLIP

Title Radioisotopes and Their Industrial Applications

Author H. Piraux

Publisher Charles C. Thomas, 1964

Pages *xiv* + 266

Price $14.50

Reviewer Jerome Kohl

As is cited in the bibliography to *Radioisotopes and Their Industrial Applications,* there have been a number of British, American, and other texts on properties of radioisotopes and on industrial applications of radioisotopes. *This* book was prepared by a scientist from the Phillips Laboratories. Originally written in French, it has been translated by Phillips into German, Spanish, and English. It is stated in the preface that the book is intended for the general public, or "layman," and it may be useful to such readers. I do not recommend this book for radiochemists, or for any scientist familiar with radioisotopes and their application; and, unfortunately, I cannot recommend it for industrial scientists who are seeking possible radioisotope applications, because its value to such people is severely limited by the lack of references to most of the applications of radioisotopes cited in the book.

The author states "we have thought it useful to include in the bibliography the titles of works on every subject discussed in the present book." Unfortunately, between this intention and the actual production of the book there has been a slip. There are only 34 references cited in the book for material described in the text. Of these 34, 5 are on detectors and 4 references have no titles, so there are 25 references to applications; and yet, in the text, 261 applications are described. Thus, a serious worker who becomes interested in a particular application has a very low probability of finding a reference to the original work, or to

work that would let him examine the technique, its cost, limitations, and the other factors needed to determine whether or not a potential application is really feasible.

The first part of the book, covering 7 chapters and 127 pages, provides some basic material on radioisotopes, their physiological effect, etc. There is nothing particularly unique in this section, as compared to similar sections in many other books already available. Part II of the book describes 261 applications. Since only 133 pages are used to describe these 261 applications, it is clear that most of the descriptions are very brief. The book has a number of illustrations of some interest to American readers, since they show European devices. Almost all of the instruments shown are, of course, from Phillips.

For some reason not understandable to this reviewer, the author has included 12 color illustrations of an individual who suffered a fatal radiation exposure at Los Alamos during a criticality accident. The pictures are under the heading, "Physiological Effects of Ionizing Radiation." As the author mentions, the pictures don't portray the effect of an accident from misuse of radioisotopes in an industrial application, and as far as I know there have been no fatal exposures from radioisotope applications. It seems to me that the pictures are frightening and completely inappropriate.

Jerome Kohl is Manager of Marketing for Oak Ridge Technical Enterprises Corporation, Oak Ridge, Tennessee. Prior to this position, he was Coordinator of Special Products at the General Atomic Division of General Dynamics Corporation, and for 11 years was Manager of Engineering and Development for the Western Division of Tracerlab. He is the senior author of the book, Radioisotope Applications Engineering, *by Kohl, Zentner, and Lukens, and is the contributor of the Section on Radioisotope Applications to the "Handbook of Applied Instrumentation." His BS is in chemical engineering from the California Institute of Technology.*

A FAST-MOVING TARGET IS MISSED

Title The Economics of Nuclear Power

Author J. A. Hasson

Publisher Longmans, Green and Co. Ltd., 1965

Pages *viii* + 160

Price $7.00

Reviewer Charles H. Keenan

We will try to be impartial in our review, even though Dr. Hasson lists Yankee as a BWR.

The Economics of Nuclear Power by J. A. Hasson is an intellectual approach to the development of methods for the analysis of the economics of nuclear power costs. The author presents a number of computer techniques for the analysis of nuclear power costs that could be useful in governmental planning. However, from the standpoint of an American reactor operator, the book appears to have little practical value.

The rapid progress of nuclear power techniques has bypassed most of the author's assumptions and unknown factors. For example, the author states "that future nuclear power costs can not be assessed with any degree of measurable probability," and then the author uses the Shippingport Plant figures of 56 mill/kWh as the basis of his calculations. This is rather unfair, since Shippingport was built to prove pressurized-water techniques and to train personnel. It never was intended to be an economic guide post. Today, January 1966 (rather than the author's information of 1962-1964), it is known that in the United States a 500 MW(e) station can be constructed that will generate power at a cost of 5 to 6 mill/kWh. It is also clear that the trend of nuclear power cost in the United States is definitely downward with the only unknown factor being the rate of the trend.

The author spends a great deal of time on the evaluation of government subsidies of nuclear power. Currently, with the amendmant of the Atomic Energy Act permitting private ownership in the United States and the apparent end of the AEC Light-Water Reactor Development Program, the United States nuclear power industry is more on its own. Decisions on the construction of nuclear plants are now based on economic factors only, and the individual utility analyzes these factors through the use of standard time-proven procedures.

As an indication of demonstrated reliability and generation, the Dresden Reactor had produced more than 5 BkWh by November 1965, the largest amount from any reactor in the world. The Yankee plant has generated over 5 BkWh at average costs of just under 10 mill/kWh and monthly costs as low as 6.97 mill/kWh.

Nuclear power is certainly a fast-moving target in the 1960's.

Charles H. Keenan is Vice President of the Yankee Atomic Electric Company. He has been associated with the New England Power Service Company in purchasing, loaned to MIT Radiation Laboratory for administration in Project Cadillac, and later was Assistant Executive Officer for the Committee on Project Research and Inventions at Princeton University. In 1949, he joined the Brookhaven National Laboratory Staff as Administrative Officer for the Cosmotron Project and later served as Purchasing Agent. In 1958, he returned to the utility business as Assistant Vice President of Yankee. He received an AB degree (1937) from the College of the Holy Cross.

PRESTIGE, PROFIT, OR PROFESSORIAL PREDILECTION?

Title A Textbook of Nuclear Physics

Author C. M. H. Smith

Publisher Pergamon Press, 1965

Pages *xiv* + 822

Price $15.00

Reviewer *David D. Clark*