waves, light, x-rays or gamma rays—is absorbed, its energy appears as heat, leaving nothing behind."

Other misleading statements are:

"Helium would be a good moderator if pressurized, but has not yet been used."

"Relatively little has been published about the technology of fuel elements, but one design has been described in detail."

"Both [West Stands and Calder Hall] had to utilize natural uranium, which, as we have remarked, is basic to all nuclear energy programmes depending on fission."

"The neutrons and gamma rays which escape from the core carry quite a lot of heat with them which is wasted. . . ."

"We see that oxygen and carbon are the only two freely available elements that can be incorporated in a reactor core while keeping neutron wastage to a minimum."

"The latter [leakage] is very important because neutrons go through solid matter like water through a sieve."

"The dimensions of the array are so chosen that a (fast) fission neutron from ^{235}U has a good chance of escaping from the rod in which it is liberated before being captured by ^{238}U: the rods must not be too thick."

"The smallest unit of length used by the engineer is a microinch,"

With these quotations, I leave you to your own conclusions.

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(Editor's Note: Karl H. Puechl is Deputy Director of the Plutonium Program, Nuclear Materials and Equipment Corporation, Apollo, Pennsylvania. For the seven years prior to joining NUMEC in 1959, Mr. Puechl was Manager of the Theoretical Department at Walter Kidde Nuclear Laboratories and the successor corporation, Associated Nucleonics.)

Elementary Nuclear Physics. By W. K. Mansfield. Temple Press, London, 1959. 60 pp., 38 illustrations $1.75.

The book is one of a monograph series in Nuclear Engineering designed for undergraduate college students. Although limited to the aspects of nuclear physics of utility in the nuclear reactor field, the selection of material is good. The major sections deal with basic ideas of atoms and nuclei, radioactivity, neutron reactions, radiation attenuation, and particle detection. In order to compress a large amount of information in a few pages, the author restricted himself to factual statements, with little explanatory material. One often wonders how well a student having only one year of college physics, primarily classical in nature, is able to assimilate condensed versions of nuclear physics.

With its admitted goal of producing an inexpensive volume, the publisher has employed many rough or qualitative graphs. For example, the Maxwellian speed distribution curve does not identify the value of the most probable speed; no indication is given of voltages in the geiger counter characteristics. The lack of grid work prevents a student from picking off corresponding numbers with any accuracy. Also, some of the diagrams are hard to understand, even if the reader knows the subject matter, for example, neutron absorption Fig. 21, and the neutron chain reaction Fig. 24.

As for emphasis, the author would have done well to place the magnitude of the energy release from fission and fusion in context with energy from common fuels. Similarly, a fine opportunity to summarize the roles of hydrogen, lead, and boron in a reactor shield was missed.

For the reader who cannot or does not wish to invest enough to obtain a more thorough background in nuclear physics, the book is useful.

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(Editor's Note: Raymond L. Murray is Burlington Professor and Head of the Department of Physics at North Carolina State College. He was with the Manhattan Project in Berkeley and Oak Ridge from 1943 to 1946, with Oak Ridge National Laboratory from 1947 to 1950, and has been at North Carolina State since that time. He obtained the Ph.D. degree from the University of Tennessee. He is author of "Introduction to Nuclear Engineering" and "Nuclear Reactor Physics." He has been a member of the ANS Board of Directors from 1958 to the present and is currently the chairman of our Education Committee.)

Materials for Nuclear Engineers. Edited by A. B. McIntosh and T. J. Heal. Interscience, New York, 1960. 373 pp. $11.85.

This book is a collection of articles on some possible reactor materials, namely: uranium, plutonium, thorium, uranium dioxide, uranium mono-carbide, uranium silicides, thorium oxide, graphite, magnesium, beryllium, and zirconium.

Dr. McIntosh, Development Director of the United Kingdom Atomic Energy Authority Production Group, has understandably chosen all authors from the UKAEA and these authors have understandably stressed materials and information of particular interest to the British reactors. Thus, there are almost as many pages on magnesium as there are on uranium, while there are none at all on beryllium oxide, nor in fact any on ceramic fuels diluted with ceramics or metals.

Most sections contain information on occurrence, extraction, preparation, physical properties, mechanical properties, creep properties, nuclear properties, compatibility, fabrication, and effect of reactor conditions on the material in question. There are numerous tables and curves which collect information in a readily visible and useable form.

There are some tantalizing lacks of information. For example, the editor says "only properly planned irradiation experiments can provide reliable data", but there is no suggestion throughout the book on how to properly plan such experiments.

There are relatively few misprints. These include some careless ones. On page 81 it states that PuO_2 is obtained by heating Pu metal in ammonia. On page 177 there is a confusion between temperature and density in the text and caption of the figure. On page 216 the half-life of C^{14} is given as 10^3 yr while actually it is about six and one-half times this long. On page 273 ammonium fluoride is written instead of beryllium fluoride. On page 305 it is stated that there is no evidence for a beryllium hydride. Actually there are a number of articles in the literature on this material.[1]

[1] See for example: *J. Am. Chem. Soc.* **79,** 3687–89 (1957).

There is some subtle humor, such as the explanation of the discrepancies between the British and USSR phase diagrams of Pu alloys being caused by the presence of "foreign" atoms. Wartime secrecy on the plutonium work has left some amusing scar tissue, such as the statement that for refractories for melting plutonium "compounds based on calcium, e.g., the fluoride or oxide, or cerium, e.g., the sulfide, may well meet (the) requirements." Also some understatements, such as the one concerning the criticality hazards of handling plutonium: "Beyond this point (criticality) the radiation hazard due to γ-rays and neutrons is vastly increased and the risk of explosion may be introduced."

The only reactor specifically referred to in the book is the Dragon, in the section on thorium. Perhaps this indicates, subliminally, enthusiasm for this concept.

Other evidence of provincialism is in the section on ceramic fuels in the statement, "To avoid the need for excessive enrichment a large number of uranium atoms per unit volume of fuel is desirable." It is not stated what is "excessive," nor are the possible advantages of diluted fuel discussed at all. In the same section the statement is made that "when minor additions are made, these are usually intended to ease fabrication." Some reference to the increase of thermal conductivity, the decrease of fission product damage, and the effect on temperature coefficient of diluted fuels would have been pertinent here.

In the section on graphite some unusual language is used. The flow of gas through the pores which is not dependent on the pressure is called slip flow, although this is usually called slip flow plus Knudsen flow. Also molecular weight is referred to as molecular complexity.

Nothing is said about the remarkable success both in England and in this country in decreasing permeability of graphite by impregnation and baking. This is somewhat surprising since the success of the Dragon reactor depends on this technique.

The conclusion that the corrosion rate by CO_2 on beryllium is negligible at 500°C in both wet and dry gas, given on page 305, does not seem to be in agreement with information in this country.

The book is easily readable, useful, and suitable for reference. It is more a prayer book than a Bible, but will give the nuclear engineer some general everyday guidance on what to expect and what not to expect from certain materials. Naturally to design a successful reactor, more religion is needed.

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(Editor's Note: Our reviewer, Edward C. Creutz, is Vice President — Research and Development — of the General Atomic Division of General Dynamics Corp. He is also the Director of the Division's John Jay Hopkins Laboratory for Pure and Applied Science. Previously he was head of the Department of Physics and Director of the Nuclear Research Center at Carnegie Institute of Technology. He received the Ph.D. degree from the University of Wisconsin and for two years thereafter was an instructor at Princeton. During the war he headed the first group to undertake metallurgical studies of uranium, beryllium, and aluminium for the Manhattan Project. He also worked with Professor E. P. Wigner at Princeton on measurements of resonance absorption of neutrons in uranium.)

Radioisotope Laboratory Techniques. By R. A. Faires and B. H. Parks. Pitman, London, 1960. xii + 244 pp. $5.75.

The authors' preface states that this book is intended as a practical guide to the use of radioisotopes, stressing the practical rather than the theoretical. They have attempted, using their experience at the Isotope School at Harwell, to provide in this compact volume information that will enable a scientist to use radioisotopes safely and effectively. In severely limiting the size of the book, the authors have chosen to omit the more unusual applications, and to present a broad, rather than detailed, picture of the subject.

The book is divided into four main sections—nuclear and radiation physics, safety, detection and measurement, and examples of radioisotope application. Approximately half of the total space is devoted to methods of radiation detection and measurement. The first three chapters cover briefly but adequately the elementary nuclear physics of radioactive isotopes, the properties of alpha, beta, gamma, and neutron radiation, and the methods by which radioisotopes can be produced. The discussions of accelerator-produced and carrier-free radioisotopes are particularly clear and meaty. Oddly enough the production of radioisotopes in fission is not mentioned, although a few fission products are listed in an appendix.

An excellent chapter on the absorption of radiation energy in tissue serves as a bridge between the sections on physics and safety. The treatment of radiological safety is always a problem in books of this sort, since the hazards are so strongly dependent on the types and quantities of radioactive nuclides used, and also on the nature of the experimental work. The problems involved in the use of tracer quantities of carbon-14 or sulfur-35 are so trivial in comparison with those which arise when large quantities of powdery materials, or of isotopes like radium and strontium-90, are handled that they really cannot be discussed together. As a result, laboratory facilities and procedures appropriate for a moderate-to-high radiation level are often prescribed as general requirements. Even though the authors recognize this problem and refer to various levels of hazard on several occasions, this reviewer cannot help but feel that the general *tone* of these sections is such as to discourage the use of radioisotopes as requiring too expensive facilities and too burdensome restrictions. To avoid a charge of over-general criticism, two specific areas will be cited. First, excellent tracer level work is being done safely in many very conventional laboratories with the addition of only an isotope storage area, an area for making initial dilutions, and simple monitoring equipment. Secondly, at least under the regulations in effect in the United States, the vast majority of isotope users can (and do) discard their radioactive tracer wastes directly into the sewer system, with only the most elementary precautions.

The treatment of the theoretical aspects of radiation measuring instrumentation is surprisingly clear and adequate for such a compressed presentation. I was particu-