experience with either sodium-cooled reactors or with fast reactors.

The book is divided into six chapters, of which the first five are the best, since the sixth chapter delves into the problems of liquid metal heat transfer in what the reviewer feels to be an inappropriate extent.

Chapter 1 discusses the long-range value of fast reactors due to the breeding abilities of the type, and the discussion is limited to this particular advantage with no indication of other technical advantages which fast reactors may have for propulsion and other applications. In this chapter the basic technological problems common to all fast reactors are indicated, and brief summaries of the characteristics of the Dounreay fast reactor, the EBR-II, and the Enrico Fermi reactor are given to illustrate the contemporary solutions to these problems.

Chapter 2 discusses the general problem of materials in a fast reactor, and points out that in general no common structural materials are excludable a priori from fast reactors simply on the basis of their nuclear characteristics. There is a discussion of the present fast reactor fuel materials with a brief discussion of possibilities for the future. The grounds on which sodium or NaK have been selected for use as coolant in present fast reactors are stated concisely, together with some comments on canning and structural materials.

Chapter 3, headed "Sodium Technology," is a good summary of the engineering problems that are involved in the use of sodium as a coolant, although not at all unique to such use in a fast reactor. The methods for detection and control of impurities are mentioned, and the problems involved in pumping sodium, and in designing heat exchangers in which heat removed from the reactor is ultimately transferred to water, are described with the use of excellent sketches. The problems involved in providing bearings for operation in a sodium environment are mentioned, although some of the solutions given probably would not be considered adequate today.

Chapters 4 and 5 cover "Fast Reactor Statics" and "Fast Reactor Dynamics," and would in themselves be a useful introduction for one who had previous experience in thermal reactor physics and was interested in some semi-quantitative aspects of fast reactor physics. In an attempt to reach the audience which is the objective of this monograph, some extremely elementary concepts are developed, perhaps more fully than could have been the case, but in general the presentation is accurate and flows well. The discussion on reactivity feedback and the EBR-I stability investigations might well be too detailed for most of the technicians that the reviewer knows. This area is also somewhat out of date. Somewhere in these two chapters it would have been appropriate to have included a section on the safety problems that are unique to fast reactors, as this subject is only mentioned in a cursory way in Chapter 1.

The sixth chapter has far too much detail about liquid metal heat transfer and is not appropriate in depth to the rest of the material in the book.

All in all, "Fast Reactors" is an interesting monograph which should be useful to the audience which it seeks to reach, and of background interest to one seriously involved in design, even though many of the most troublesome engineering problems which have arisen in the design of fast reactors are not covered explicitly.

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(About the Reviewer: Mr. McCarthy is Assistant to the General Manager of Power Reactor Development Company, the organization which has built and is to operate the Enrico Fermi Atomic Power Plant near Detroit. Mr. McCarthy was for a number of years Head of the Nuclear and Analytical Division of Atomic Power Development Associates, Inc., and has been active in the fast reactor field since 1952.)

Principles of Cyclic Particle Accelerators, JOHN J. LIVINGOOD. Van Nostrand, Princeton, New Jersey. 392 pp., $10.75.

The author, Doctor John J. Livingood, is a recognized elder statesman of accelerator physics. His work on accelerators began in the early 1930's as a collaborator with E. O. Lawrance at the University of California where he participated in the early "great thrust forward" of the cyclotron. Following World War II he was associated with the Collins Radio Company and headed the group which constructed 60-in. cyclotrons for several U.S. institutions. In 1952 Doctor Livingood joined the Argonne National Laboratory where he headed the Zero Gradient Synchrotron (ZGS) project during its formative years.

"Principles of Cyclic Particle Accelerators" is an introduction to fundamental principles and major fabricational features of cyclic accelerators, i.e., cyclotrons, synchrocyclotrons, synchrotrons, betatrons, linacs, etc. It is a distinct pleasure to find a full account of the principles of this wide class of machines in a single volume; for the introductory reader this should be especially advantageous. Emphasis in the book is on conveying to the reader an understanding of phenomena rather than on rigorous mathematical development, and as a result the author nicely avoids getting bogged down in mathematical detail. (A mathematical background is assumed roughly equivalent to that of a good undergraduate degree in Physics or Engineering.) The careful reader will obtain from the book an understanding of essentially all of the basic phenomena of cyclic accelerators.

In a critical vein, the origin of the book as a set of introductory notes for new ZGS personnel is, unfortunately, still substantially discernable; the discussion and choice of examples at several points tend to overemphasize edge focusing machines. Noteworthy for its absence is the elegant canonical coordinate description of synchrotron oscillations. The chapter on "Quadrupole Lenses" would be considerably less confusing if definitions had been employed in more direct accord with the long established and highly functional traditions of thick lens optics.

The format of the book is excellent—the print is easy to read and the large number of figures and plates are reproduced with excellent clarity. Typographical and other mistakes have been reduced to a minimal level which is in pleasant contrast to many of today's scientific works, especially first editions.

Over-all, the book is an excellent introduction to the accelerator field and is highly recommended for persons seeking an initial acquaintance with the principals of these machines; it is particularly recommended to engineers and graduate students joining an accelerator project without previous experience in the field. The book is not intended

for the accelerator sophisticate who would undoubtedly find the development greatly overdetailed. As a reference volume on accelerator technology the book has substantial value, particularly in its very complete bibliography.

H. G. Blosser
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(*About the Reviewer: Professor Blosser currently heads a group at Michigan State University engaged in the construction of a 50 Mev variable-energy sector focused cyclotron. Prior to going to Michigan State, he was group leader of the Cyclotron Analogue project at Oak Ridge National Laboratory.*)

(Newnes) Concise Encyclopaedia of Nuclear Energy. Advisory Editors: D. E. Barnes, O.B.E., G.M., B.Sc.; R. Batchelor, M.A.; A. G. Maddock, M.A., Ph.D., D.I.C.; J. A. Smedley, B.Sc.; Denis Taylor, M.Sc., Ph.D. Foreword by H. Kronberger, O.B.E., Ph.D., F. Inst.P. Newnes, London, 1962. £8. Wiley New York, 1962. 886 pp. $25.00.

The process of having books reviewed in this Journal is such as to frequently tempt its editor to submit to the task inasmuch as the reviewer keeps the book as token compensation. However, never before has he finally yielded to the temptation, and that he does so now is testimonial to the desirability of this encyclopaedia.

Perhaps the most obvious question is: Why an encyclopaedia? Why order the content alphabetically according to subject instead of adopting a logical unfolding of the material to be covered? The answer, of course, is that it caters to the nonspecialist who wants a correct but concise description of an item. He does not have to know that a hyperon is an elementary particle found in cosmic rays in order to read about it. If he can spell it he can find it. And in these times, with so very much science for us to keep up with, the ready-reference system is greatly to be desired.

Perhaps the next question is: How much alphabetizing? Does one alphabetize only the major headings, or is this to be extended to all discrete minutiae? The editors have used the latter approach, albeit with the crutch of cross-referencing which keeps the size within bounds. Thus one can find Xi-particles, Y-particles, and Sigma-particles, all defined succinctly with a cross reference to "Mesons and hyperons" which gives more detail.

Evidently the editors have given much thought to the needs of the user. It is easy to find the items one looks for in the bold-face capitals; the headings are well chosen. Even the contributors are displayed in Encyclopaedia Brittanica's useful, though unusual, way, which caters to the sequence that the reader encounters: he finds the contributer's initials at the end of an article and then seeks his name and affiliation; so the contributors are listed in the alphabetical order of his initials. (A. E. Souch probably never before stood second in an alphabetical list of 82.) But "Dame J. V." appears with the J's, not the D's.

The list of contributors covers most United Kingdom atomic energy establishments as well as quite a few universities. There is one from the USA—Tench from Brookhaven, and one from Malaya—Skyrme, who used to be at Harwell.

There is a comparatively strong coverage of the biological and health physics aspects of nuclear energy. Thus "isotopes, artificial," occupying 1.6 in. of column, is followed by "isotopes in animal physiology" with 87.5 in. of column covering labeling to mechanism of bone growth. Eighty-eight pages are devoted to the table of isotopes, which is nicely annotated with decay schemes at the foot of each page.

The thermonuclear reactor business is covered, presumably for completeness, and as a hedge against the miracle which might rescue it from the doldrums. The reader is led on a merry chase in finding it, though. One finds "Thermonuclear reaction" but is merely sent from there to "Fusion," which advice is practical but somehow offends the purist in us. From the short "Fusion" article one finds that there is a discussion of "Controlled Thermonuclear Research, q.v." Thus this path is sanitary in that it avoids the H-bomb (no entry found for this, but "Fusion" mentions it—presumably a violation). We note also that there are no thermonuclear reactors, but only "devices," "schemes," and "experiments." With such caution this encyclopaedia should live a long time.

We had a chance to check on whether our March, 1961, editorial recommending use of "fissile" for thermally fissionable was indeed consistent with British usage. Sure enough, contributor Clarke, of Reading, Berks, says *fissile materials* are "materials which are capable of undergoing fission by thermal neutrons." Our satisfaction, however, is dulled by the preceding entry of contributor Green of Aldermaston for *fissile*: "The term loosely applied to any nucleus which can be made to undergo fission. However, it is normally taken to mean fissionable by thermal neutrons." And it is devastated by Green's entry for *fissionable material*: "The term fissionable normally refers to material which is thermally fissile, U^{233}, U^{235}, and Pu^{239} being the most important examples." This seems to call for a malt-lubricated conference in some convenient pub between Reading and Aldermaston.

On the whole, the book is very satisfying. We thought of no pertinent subject which was not easily found. The illustrations are profuse and well done. The entries are well chosen. We are glad to have earned our copy and recommend that the reader get one too.

Everitt P. Blizard
Oak Ridge National Laboratory
Oak Ridge, Tennessee

(*About the Reviewer: Everitt P. Blizard is Director of the Neutron Physics Division at the Oak Ridge National Laboratory and moonlights the editing of this Journal.*)

International Directory of Radioisotopes, 2nd ed. International Atomic Energy Agency, Vienna, 1962. 697 pp. $9.00. Not on sale through bookstores; obtainable from International Publications, Inc., 801 Third Avenue, New York 22, New York.

This is a directory. It has about the same usefulness as a telephone book. The information operator always, and the ordinary subscriber sometimes, uses an up-to-date telephone book. A radioisotope pharmaceutical house or a well-equipped library probably should have this international