

of the published work in England, the United States, and Canada in this field. As expected, English practice is considered in more detail.

The volume cannot be considered as a text book on waste disposal since certain aspects of waste disposal are not covered at all. Rather, it concentrates on the utilization of the liquid fission product waste as a source of ionizing radiations. Omitted from the text is any discussion of the problem of disposing of wastes from the beneficial application of small quantities of radioactive materials (the normal radioisotope user) because this subject ". . . would easily fill a separate volume, . . ."; there is little if any discussion of the disposal of radioactive wastes from hospitals (not a subject in the index); there is no discussion of the handling or disposal of solid wastes; except for the excellent chapter on "Dispersion of Activity from Chimney Stacks" by Chamberlain, there is no discussion of the handling, treatment, or disposal of gaseous wastes, aerosols, or airborne particulates generated during nuclear energy operations; and there is no discussion of the waste problems associated with fixed nuclear power production stations and mobile reactors associated with propulsion of vessels. There are omissions in waste handling, treatment, and disposal of interest to the reviewer and to other workers in the field. To these may be added some of the more recent approaches studied in the United States for the disposal of low and high activity wastes such as deep well disposal, disposal into soil formations, hydrofracturing, and the use of such natural materials as clinoptilolite. Discounting these omissions, the sections on waste handling, treatment, and disposal are well prepared and factual.

Several errors appear as a result of typographical errors, faulty proofreading, etc., but these do not detract much from the text. Several errors of fact should be called to the attention of the reader, namely: on page 227 reference is made to slow sand filtration, whereas trickling filters is meant; on page 251 monthly release to the Thames from Harwell should not exceed 20 curies—not 2 as indicated; on page 258 a second source of liquid effluent is given although this reviewer cannot find a first source; on page 259 the statement is made that the single pass water used to cool the Hanford reactor is demineralized—it is treated by normal coagulation but not demineralized; on page 275 the decay scheme for ^{106}Ru to ^{106}Rh to ^{106}Pd (stable) shows only beta emissions, whereas ^{106}Rh decays by both beta and gamma emission as does ^{103}Ru ; and the definition of rad given in the glossary should read: The rad is a unit of absorbed dose, which is 100 ergs per gram in any medium. It is a measure of the energy imparted to matter (i.e., retained by matter) by ionizing radiation per unit mass of irradiated material at the place of interest.

In summary, the volume is interesting and presents a tremendous amount of widely scattered information in a single document. The few deficiencies (generally minor) referred to earlier should not detract from the use of the volume by all levels of workers concerned with the utilization, handling, treatment, and disposal of radioactive materials.

CONRAD P. STRAUB
Robert A. Taft Sanitary Engineering
Center
Cincinnati, Ohio

(About the Reviewer: Conrad P. Straub is Chief of the Radiological Health Research Activities in the Division of Radiological Health at the Taft Sanitary Engineering Center in Cincinnati. He joined the Public Health Service in 1941 and completed his PhD with Cornell University in 1943. He is the Chairman of the Committee on Handling and Disposal of Radioactive Wastes of the International Commission of Radiological Protection, a member of the Expert Advisory Panel on Radiation of the World Health Organization, and a consultant to the Food and Agriculture Organization. He currently is preparing a book on Low Level Radioactive Wastes—Their Handling, Treatment, and Disposal.)

Reactor Handbook, Volume II, Fuel Reprocessing. Second Edition. Edited by S. M. STOLLER AND R. B. RICHARDS. Interscience, New York, London, 1961 665 pp., 410 tables, 645 illustrations, \$21.40.

The expressed objective of this volume is to present a condensed version of the data available on chemical reprocessing as of early 1960. To accomplish this the editors have recruited an impressive list of specialists in the various fields as authors. The authors have purposely emphasized engineering and operational concepts rather than basic science and have given a comprehensive list of references.

The text is written in six parts:

A: Introduction; including chapters on reactor system effects and reprocessing and reconversion economics.

B: Aqueous separations processes; including chapters on head-end processes for solid fuels, aqueous separation, reprocessing of aqueous fuel, and fluoride and other halide volatility processes.

C: Nonaqueous separations processes dealing with pyrometallurgical processes.

D: Reversions; including chapters on natural, slightly enriched or depleted uranium chemistry, highly enriched or fully enriched uranium chemistry, thorium chemical reversion, plutonium reversions, and isotopic enrichment.

E: Radioactive waste disposal; including chapters on gaseous waste, liquid waste treatment and disposal, solid wastes.

F: Engineering; including chapters on plant design, equipment design and plant management.

The chapter on reprocessing and reconversion economics gives a breakdown of capital and operating costs for a multipurpose processing facility which is of general interest. The comments relating to over-all power cycle costs use U. S. ground rules and are of value primarily to U. S. readers. The section on head-end processes for solid fuels deals with most proposed power reactor fuels in a most comprehensive manner. In the section on aqueous separation the currently significant aqueous separation processes are discussed in detail. Sufficient basic data is provided to allow calculation of optimum flowsheet conditions for a wide variety of fuels. The calculation methods are also provided and a useful record of operating experience is given. Reprocessing of the proposed homogeneous reactor fuels uranyl sulphate, uranyl phosphate, uranyl nitrate, and uranyl fluoride is discussed in the section on reprocessing of aqueous fuel. Slurries, D_2O recovery, and blanket reprocessing are also covered. The section on halide volatility processes gives a comprehensive tabulation of the pertinent physical and thermodynamic properties of the various

halides and detailed flowsheets of the halide processes. Details of equipment and operating experience and comparisons with conventional aqueous processing are also given. Separations by fractional distillation, zone melting, liquid metal extraction, and oxidation are covered in the section on pyrometallurgical processes. The sections on reconversion deal primarily with the conversion of the nitrates of uranium, thorium, and plutonium to the metals. Methods of handling gaseous liquid and solid wastes are described in the section on waste disposal and factors influencing plant layout and process equipment design are discussed in the section on engineering.

The editors state that reprocessing has undergone a constant and most rapid obsolescence primarily due to the shift in emphasis from production fuels for military purposes to power reactor fuels. This shift in emphasis is evident in the section on aqueous processing where power reactor fuels are dealt with in detail, but is missing in the section on reconversions which deals almost entirely with conversion from nitrates through fluorides to metals. The section on plant management also tends to favor a production plant for military purposes rather than a multipurpose plant, processing relatively small batches of fuel from different reactors.

The book is the most comprehensive volume issued to date on fuel processing. It is geared primarily to the specialist in the field but gives sufficient basic theory to be of value to the university graduate entering the field. It is written in surprising detail considering its scope and its detailed list of references will be of great value to those wishing to examine the original work in even greater detail. Because of the detail given it is rather heavy reading.

ROBERT G. HART
Atomic Energy of Canada, Ltd.
Chalk River, Ontario, Canada

(About the Reviewer: Robert G. Hart has been concerned with fuel reprocessing at Atomic Energy of Canada, Ltd. since 1948. From 1948 to 1955 he was actively engaged in development work in this field and was one of the original developers of the anion exchange separation process for plutonium. Since 1955, when fuel reprocessing was divorced from the immediate program at AECL, Mr. Hart has had the responsibility of keeping abreast of this field for his company. He is presently on the staff of the Whiteshell Nuclear Research Division where he will be in charge of fuel development.)

Fuel Element Fabrication with Special Emphasis on Cladding Materials, Vols. 1 and 2. Academic Press, New York, 1961. 538 pp., \$14.00 (Vol. 1). 384 pp., \$10.00 (Vol. 2).

This two-volume publication consists of the proceedings of a symposium on this subject held in Vienna on May 10-13, 1960, under the sponsorship of the International Atomic Energy Agency. The stated reason for publishing the proceedings is "that they will be an important source of information to a much wider community of scientists and representatives of industrial groups of Member States (of the I.A.E.A.) just starting their own programs of work in this field." Volume I consists of two sections, "Characteristics of Cladding Materials" and "Fuel Element Fabrication," made up of 28 papers. Volume II contains 22

papers distributed among three sections entitled "Quality Control and Inspection," "Corrosion and Radiation Damage," and "Economic and General Trends in Development." The books are printed in easy-to-read type and the many photomicrographs are, pleasantly, very clearly reproduced.

Generally complete, if not always reliable, abstracts of each of the papers are presented in English, French, Spanish, and Russian. Inexplicably, eight of the papers are printed in French; the others are in English whatever the original language. Discussions of the papers are included, but, as recorded, contribute little to the publication.

The subject of the conference was the fabrication of fuel elements for the production of low-cost nuclear power. In toto, the papers cover the work in this field rather well, even though some subjects, such as canned and unbonded oxide-pellet fuel elements seem, in retrospect, at least, to have received an excess of attention. Also, we hardly need to be reminded that, in such a rapidly developing field, information which was generally up to date at the time of the conference has become old-hat during the time required for publication of papers. No one should expect to find much information on the advanced materials and systems currently getting R & D money. Nonetheless, the books do contain much useful reference data on cladding and fuel materials, such as zircalloys, stainless steels, aluminum and its alloys, graphites, and UO₂, and basic information on fabrication techniques of continual interest, such as vibratory compaction, swaging, gas-pressure bonding, and ultrasonic welding. It should also be pointed out that, as with any collection of this kind, some papers are better than others. There are the usual pot boilers with little or no significant information. Some otherwise good papers are marred because they do not make use of all the data available at the time.

In summary, the publication is completely successful in its stated purpose of providing information for those just starting work in the field of fuel-element fabrication for low-cost power reactors. In addition, as a result of the unusually wide range of the papers included, there is considerable material of general use for reference. There is very little coverage of advanced materials and fuel element configurations. Therefore, the books would be valuable additions to libraries for reference use by fuel-element materials and fabrication groups, but will probably not find their way to many personal 5-foot shelves.

DONALD C. CARMICHAEL
Battelle Memorial Institute
Columbus, Ohio

(About the Reviewer: Donald C. Carmichael has specialized in the field of fuel-element fabrication with the Advanced Materials Development Division of Battelle Memorial Institute. He has been associated with numerous materials and cladding studies and was the principal metallurgical engineer in the development of the gas-pressure-bonding process now being used to produce PWR Core 2 fuel elements. His special interests are currently in the areas of the structure and properties of diffusion bonds, the mechanism of pressure bonding, and the compatibility of materials, including diffusion and reaction kinetics. In addition to papers published on fuel-element fabrication and diffusion, he has authored reviews on diffusion-bonding techniques and on diffusion studies which appear regularly in Reactor Core Materials.)