Materials and Fuels for High-Temperature Nuclear Energy Applications. Eds. M. T. Simnad and L. R. Zumwalt. MIT Press, Cambridge, Mass. 413 pages. $12.00.

A national topical meeting of the American Nuclear Society was held in San Diego, California on April 11 to 13, 1962. The subject of this meeting was recent developments in materials and fuels for high-temperature nuclear energy applications.

The subject book is an excellent documentation of the subject matter of this meeting and a valuable reference for scientists and engineers in the nuclear energy field. The contents are divided into two sections. Part 1, entitled "Nuclear Energy Systems," deals with the design and engineering data relating to the selection of materials and fuels for specific reactor systems. Part 2, entitled "Fuels and Materials," provides properties information on fuels and materials of interest for high-temperature reactor applications.

Part 1 contains nine chapters which provide excellent descriptions of five major atomic energy reactor projects, their materials requirements and materials work completed in support of Project objectives.

The first chapter on the Nuclear Rocket is a concise report of the development of the Rover and NERVA Projects, reactor design considerations, materials requirements and considerations which led to the selection of a hydrogen-cooled graphite system, and a description of the reactor-test site facilities and results of early Kiwi test reactor experiments. This chapter is of current interest considering the reported successful operation of the latest nuclear rocket experiment.

The two chapters devoted to the Pluto Project present a coverage of this project similar to that reported for the NERVA Project; however, the coverage is desirably more detailed. The chapter devoted to the fabrication, properties and evaluation contains valuable data on air-cooled beryllium oxide fuel elements. It is to be noted that the Tory II-C reactor, which is discussed in this chapter, recently became operable and has shown excellent operating performance.

The three chapters devoted to the SNAP Projects provide first an over all description of the various diverse SNAP systems, and then in more detail requirements and materials for specific systems. In general, equal coverage is given to isotopic and reactor heat sources and to mechanical, thermoelectric and thermionic conversion systems. The chapter on Thermionic Conversion provides excellent information regarding uranium carbide base fuel-element materials. Unfortunately, no reference is made to the applicability of other fuel forms (UO_2, UN) for this purpose.

The chapter on Molten Salt Reactors presents a timely reporting of the Oak Ridge Molten Salt Reactor (MSRE) in that this reactor is soon to become operational. But of more importance is the excellent documentation of physical, chemical and metallurgical data relative to molten salt systems.

The General Atomics' High-Temperature Gas-Cooled Reactor is described in the last chapter of Part 1. The properties and in-pile evaluation of fuel elements containing pyrolytic carbon-coated, spherical uranium-thorium carbide-fueled graphite are discussed with special emphasis on fission product retention.

Part two, entitled "Fuels and Materials," contains seven chapters. Three of these, Uranium Dioxide Future, Fueled Beryllium Oxide and Corrosion in Liquid Metal Reactors, are general state-of-the-art type reports. However, the remaining four reports contain a wealth of pertinent materials information.

The chapter on Physicochemical Properties of Carbides for Nuclear Applications is particularly outstanding. The importance of refractory carbides to nuclear energy is concisely presented along with detailed physical property data, phase diagram information and references.

The chapter on High-Temperature Control Materials also provides comprehensive properties data relative to refractory borides, borates and rare-earth oxide neutron absorbers. The important effects of irradiation and compatibility with heat-resistant alloys and the refractory metals are well-documented.

The very important subject of radiation effects to materials is covered in two excellent articles. One chapter deals with Neutron Embrittlement of Reactor Pressure Vessels and the second with Radiation Effects in Graphite. The contents of these chapters should be understood by all designers and materials people interested in high-temperature reactor technology.

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About the Reviewer: J. A. McGurty is Manager of Metallurgy Research at the Nuclear Materials and Propulsion Operation of the General Electric Company, Cincinnati, Ohio. His association with the AEC's programs began in 1949 when he joined the NEPA Project at Oak Ridge, Tennessee. He joined the General Electric Company in 1951 when the GE-ANP Program was formed to continue the work started under NEPA. He is presently responsible for metallurgical research and development being conducted under the AEC's High Temperature Materials Program at Cincinnati.