shall undoubtedly witness improvement and even perfection . . . in waste treatment and disposal." The author does not concern himself with the possibility of plutonium diversion.

It has been alleged that U.S. reactor designs are unsafe because of competitive pressures. A comparison of performance parameters of Soviet and U.S. PWRs gives some evidence on the subject. The Soviet 1000-MW(e) PWR design point is 111 kW(th)/liter and 5.4 kW(th)/ft; U.S. commercial designs average about 100 and 5.3, respectively.

The book would have benefited from critical editing. The text is written in the repetitious didactic style much affected by Soviet officials. The translators show no inkling that word-by-word translation from Russian does not constitute Engligh. Despite these defects, which make reading a chore, the perspective obtainable from the book is well worth the effort. It may go far to reassure the nuclear engineer, beset by a paranoid opposition, that he is on the right track.

Karl Cohen

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August 14, 1975

About the Reviewer: Karl Cohen, after many years in charge of General Electric's Fast Breeder Reactor program, recently renewed his earlier interest in uranium enrichment and visited the Soviet Union in connection with this assignment in 1972 and 1973. Dr. Cohen's earlier contribution to the enrichment of uranium by gaseous diffusion was as Director of the Theoretical Division of the SAM Laboratories, Columbia University, in the early 1940's. Subsequently, he became extensively involved in nuclear reactor programs. Dr. Cohen's academic training was at Columbia.

Nuclear-Reactor Analysis. By Allan Henry. The MIT Press, Cambridge, Massachusetts (1975). 547 pp. $35.00.

It would be presumptuous of any reviewer of this book to introduce its author, Allan Henry, to the reactor physics community. He has contributed prolifically to the literature and culture of reactor physics for over 20 years. In writing this book, he has undertaken the enormous task of organizing his experience and expertise for the benefit of both students and reactor designers. At the risk of having this review read no further, I will state at the outset that this book is an excellent one which should be in the library of all concerned with the physics of reactor design.

As stated in the preface, it is the author's "thesis that a firm theoretical foundation [for reactor design] actually exists and that it can be made intelligible in a rigorous and systematic manner, starting with very simple physical concepts . . . ." In this reviewer's opinion, the author has succeeded admirably in transforming this simple premise into book form.

Chapters 1 and 2 are basically introductory in content, reviewing some of the underlying nuclear physics involved in fission technology, and acquainting the reader with the concepts of cross sections, scattering laws, kinematics of collisions, and the like. Chapter 3 concerns itself with the infinite, homogeneous critical reactor. After writing down the basic balance equation, the author proceeds to discuss multigroup formalism and the numerical solution of the resulting multigroup equations. This is followed with discussions of eigenvalues, approximate analytic solutions for the spectrum, resonance absorption, the Fermi age approximation, and the four-factor formula. In this chapter the tone of the book is set. The energy variable is introduced at the outset, and one-speed theory is not discussed here or elsewhere. Second, the formulation and numerical solution of the multigroup equations are considered before any simple or idealized analytic solutions are discussed. Finally, there is a balanced blend of the new (multigroup, computer, etc.) with the old (age theory, four-factor formula, etc.). This approach is characteristic of the entire book.

Chapter 4 treats the diffusion description of neutron migration, and deals with many aspects of this subject, such as one group, multigroup, boundary conditions, bare reactor solutions, reflected reactors, exponential experiments, etc. An interesting point here is that Fick's law of diffusion is postulated as being reasonable; the derivation of Fick's law from the transport equation is found much later in the book. Chapter 5 deals with the difficult problem of determining group constants in the presence of resonance absorbers. After a brief discussion of the Breit-Wigner formula and Doppler broadening, the author treats ultrafine group methods, analytic approximations such as the narrow and wide resonance formulations, and a host of other topics including multiregion cells, escape and collision probabilities, Dancoff factors, and reciprocity and equivalence relationships. Once again, the modern numerical approach (ultrafine groups) is discussed prior to the older analytic techniques.

Chapter 6 concerns itself with fuel depletion. It is unusual in a reactor physics text to see a chapter devoted to this subject, and its presence here indicates the practical bent of the book. Topics covered include mathematical descriptions of the depletion process, fission product poisoning, conversion and breeding, power shaping, control, and xenon oscillations. Chapter 7, on kinetics, is quite short but probably one of the best parts of the book, reflecting the author's personal interest and contributions in this area. The content of the chapter is quite conventional, covering the basic equations, point kinetics, kinetics parameters, interpretation of reactivity, delayed neutrons, simple analytic solutions, and the inhour formula. The author's pertinent side comments on such things as the kinetics parameters add much to the conventional treatment. This chapter ends with a discussion of the perturbation formalism for reactivity, introducing the adjoint flux in a natural way.

Chapter 8 deals with the transport equation and is standard in its treatment. After deriving the transport equation and introducing its adjoint, the author discusses the eigenfunctions and eigenvalues associated with both equations. This is followed with brief sections on the P-N, B-N, S-N, and Monte Carlo methods of solution. The chapter ends with a derivation of a reciprocity relationship between the flux and its adjoint.

Chapter 9 deals primarily with the derivation of group diffusion theory from the transport equation. It is here that Fick's law of diffusion, postulated in Chap. 4, is obtained via the P-1 approximation to the transport equation. Topics discussed include diffusion coefficients, interface conditions, multigroup methods, few-group parameters, slowing down models, and spectrum calculations. Chapter 10 carries on the discussion of diffusion theory methods and concentrates on the subject of equivalent diffusion theory parameters to account for the heterogeneities encountered in the reactor design. Specific topics treated

are the concept of equivalence, both pointwise and integral, and blackness theory in a multidimensional and multigroup setting.

The book ends with Chap. 11 on advanced methods for reactor analysis. Methods touched upon are synthesis in general, overlapping groups, Galerkin, variational, finite element, higher order difference, nodal, and response matrix techniques. No discussion is given of convergence and stability questions associated with these numerical techniques.

As the reader of this review has undoubtedly gathered by now, I am very favorably impressed with this book. It is not perfect, and I occasionally ran across an ambiguous or incomplete statement. I could also take issue with the choice of topics covered. All in all, however, this is a fine book, written in an easy-to-read manner by an author obviously clear as to his purpose in writing another reactor physics text. The printing is pleasing to the eye, and the typographical errors are almost nonexistent. Each chapter is followed by a set of problems and general reading references. The book is not meant to bring the reader to the forefront of reactor physics research in that it contains no specific literature citations. It is rather meant as a source book of well-tried methods in use today for practical reactor design. As with most things these days, the price is too high ($35.00!). The book has been successfully used for a sequence of three one-term graduate courses in reactor theory at the Massachusetts Institute of Technology. I would venture the guess that in the near future it will be successfully used at many other schools as well.

I would like to end this review by quoting from the preface of the book:

> It is ironic that many of those who claim that our state of knowledge is such that efforts to develop more accurate methods of analysis can be reduced and that clean, unambiguous experiments are no longer necessary really don't believe the predictions of the theoretical models in present use. If it can possibly be managed financially, they always seem to want a full mock-up of any proposed design before making a decision to accept it. My conviction is that it is both uneconomical and unnecessary to allow this situation to persist.

This quote has no particular relevance to the review of this book, but it should give some hope to the creative reactor physicist that Allan Henry typifies so well.

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About the Reviewer: Gerald Pomraning is Vice-President of Science Applications, Inc., and active in its Theoretical Physics Group. Dr. Pomraning completed his graduate studies in nuclear engineering at the Massachusetts Institute of Technology in 1962 and has continued to contribute to the nuclear physics-nuclear reactor community at the General Electric Company and at Gulf General Atomic before joining Science Applications in 1969. His current research activities are in neutron and radiation transfer.

NUCLEAR SCIENCE AND ENGINEERING: **59**, 74-77 (1976)

Announcement of Current Topical Reports

The comments that appear with each announcement are those of the Editors and are intended solely to give the reader some idea of the scope of the document. The reports are marked as purchasable from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151, at the stated cost. We cannot, of course, guarantee availability or price.

Ray Mulkin, "Characterization of Transuranic Solid Wastes from a Plutonium Processing Facility," LA-5993-MS, Los Alamos Scientific Laboratory (June 1975). $4.00

This report deals with residues related to glove-box operations in plutonium process areas. Several recommendations are made, among which are a call for studies of the balance between economic and ecological concerns and of possible hazards from nitric acid-exposed cellulosic materials.

M. J. Kupfer and W. J. Van Slyke, Eds., "Atlantic Richfield Hanford Company Quarterly Report, Waste Management and Transportation Technology Development, January 1975 through March 1975," ARH-ST-110 C, Atlantic Richfield Hanford Company (May 1975). $5.75.

Covers work on salt cake retrieval, tank integrity, storage system improvements, waste immobilization, and preparation of failed contaminated equipment for disposition.

K. J. Schneider and A. M. Platt, Eds., "High-Level Radioactive Waste Management Alternatives," BNWL-1900, Vol. 4, Battelle-Pacific Northwest Laboratories (May 1974). $10.60.

The fourth volume of a multidisciplinary study. Both present-day and anticipated technology are considered. This volume covers waste partitioning, extraterrestrial disposal, and transmutation processing.

J. M. Selby et al., "Considerations in the Assessment of the Consequences of Effluents from Mixed Oxide Fuel Fabrication Plants," BNWL-1697, Rev. 1, Battelle-Pacific Northwest Laboratories (June 1975). $7.60.

An expansion of BNWL-1697. The basis is a 1 MT/day plutonium fuel fabrication plant that manufactures 2 to 4 wt% PuO_2 mixed oxide fuel. The facilities are described, and the pathways and environmental factors that affect the consequences of an accident are discussed. Dose calculational methods, source terms, and probabilities of risks from internal and external events are given.

B. D. Epstein, "A Review of the Literature Pertinent to Fission-Product Migration and Interaction in Fuel Rods," GA-A13423, General Atomic Company (June 1975). $4.00.

An initial effort in the investigation of plateout and potential plugging in the gas-cooled fast breeder reactor fuel pressure equalization system.

M. T. Morgan, "Review of HTGR Coated Fuel Particle Stability," ORNL-TM-4882, Oak Ridge National Laboratory (Aug. 1975). $4.00.

An independent critical evaluation of diagrams of coating failure during abnormal excursions versus previous irradiation time that have been used to compute fission-product release from HTGRs.

David deLesdernier, "Pneumatic Classification of Fort St. Vrain Fuel Particles," GA-A13135, General Atomic Company (June 1975). $7.60.

A discussion of a method for separation of fertile and fissile fuel particles in reprocessing. A predictive model is proposed for TRISO/TRISO crossover.

J. M. Taub, "A Review of Fuel Element Development for Nuclear Rocket Engines," LA-5931, Los Alamos Scientific Laboratory (June 1975). $5.45.

A discussion of the materials problems of uranium-loaded graphite fuels and of the various approaches used for their solution over the history of the nuclear rocket program.

F. J. Tokarz et al., "Evaluation of Methods for Seismic Analysis of Nuclear Fuel Reprocessing Plants, Part 1," UCRL-51802, Pt. 1, Lawrence Livermore Laboratory (Feb. 1975). $2.25 (Microfiche).

The Barnwell Nuclear Fuel Plant is taken as representative of future commercial reprocessing plants. The object of the work is to prepare guidelines for structural analysis methods for seismic analysis.

G. L. Richardson, "Plutonium Partitioning in the Purex Process with Hydrazine-Stabilized Hydroxylamine Nitrate," HEDL-TME-75-31, Hanford Engineering Development Laboratory (June 1975). $5.45.

A study of HAN as an alternative to ferrous sulfamate in the Purex process. A 12-stage miniature contactor was used in the experiments on simulated LMFBR fuel (Pu/U ratio ≃ 0.12).

Roland B. Knapp, "Thermal Stress Initiated Fracture as a Fragmentation Mechanism in the UO_2-Sodium Fuel-Coolant Interaction," TID-26827, Massachusetts Institute of Technology (May 1975). $7.60.

Theoretical studies show that thermal stress fragmentation is a feasible mode in the UO_2-sodium system. Aluminum oxide is believed to be a good substitute for UO_2 in experimental simulations.

G. M. Bjorkquist, "Experimental Investigation of the Fragmentation of Molten Metals in Water," TID-26826, Massachusetts Institute of Technology (June 1975). $5.45.

Small amounts of tin and bismuth were dropped into water. Metal temperatures as high as 700°C were used. High-speed motion pictures taken.

Alan E. Waltar et al., "Melt-III—A Neutronics, Thermal-Hydraulics Computer Program for Fast Reactor Safety Analysis," HEDL-TME-74-47, Hanford Engineering Development Laboratory (Dec. 1974). $13.60 (Two volumes).

Three-dimensional neutronics data can be directly utilized in this code. Time estimates on the UNIVAC-1108 are 20 sec per channel for steady-state calculations and 2 sec per time step per channel after cladding failure. Runs about 10 times faster on the CDC 7600.

K. Antonsen, G. L. Cauble, and E. T. Steeger, "Evaluation of Alternative Shutdown-Systems Concepts for the Gas-Cooled Fast Breeder Reactor," GA-A13300, General Atomic Company (May 1975). $4.00.

Fifteen potential shutdown system design variations are evaluated in the hope of obtaining greater diversity from present reference designs.

R. J. Price, "Property Changes in Near-Isotropic Graphites Irradiated at 300° to 600°C: A Literature Survey," GA-A13478, General Atomic Company (June 1975). $4.00.

A study as part of an assessment of the useful lifetime of HTGR top reflector elements. Design values are recommended to be used for stress and distortion calculations.

H. Ninokata and N. E. Todreas, "Turbulent Momentum Exchange Coefficients for Reactor Fuel Bundle Analysis," COO-2245-22TR, Massachusetts Institute of Technology (June 1975). $5.45.

A method is described for calculation of coefficients if the velocity distribution within a fuel rod array is available. Energy exchange coefficients for input data to COBRA can be calculated also.

John R. Travis, Francis H. Harlow, and Anthony A. Amsden, "Numerical Calculation of Two-Phase Flows," LA-5942-MS, Los Alamos Scientific Laboratory (June 1975). $4.00.

Describes a method applicable to such matters as reactor safety analysis (hypothetical LMFBR disassembly), fluidized dust bed dynamics, and aerosol transport.

Brian Cheng-jean Chen and Neil E. Todreas, "Prediction of Coolant Temperature Field in a Breeder Reactor Including Interassembly Heat Transfer," COO-2245-20TR, Massachusetts Institute of Technology (May 1975). $5.45.

A description of a computer code and computational methods for simplifying this calculation to reduce the large storage and running time required for codes such as COBRA, THI-3D, THINC, and HAMBO. Applications made to the CRBR.

S. A. Wilson, "Estimating the Relative Probability of Piping Severance by Fault Cause," GEAP-20615, General Electric Company (Sep. 1974). $5.45.

One basic premise of this study is that all piping damage results from oversights in design, fabrication, or operation and that relating faults with causes will suggest improvement in practice.

L. L. Wheat et al., "CONTEMPT-LT—A Computer Program for Predicting Containment Pressure-Temperature Response to a Loss-of-Coolant Accident," ANCR-1219, Aerojet Nuclear Company (June 1975). $7.60.

This is primarily a user's manual for this code. Information on the analytical models is given with derivations.

C. E. Knight, Jr., "Analysis of Stresses in Filament-Wound Spherical Pressure Vessels Produced by the Delta-Axisymmetric Pattern," Y-1972, Oak Ridge Y-12 Plant (Aug. 1975). $4.00.

A description of the application of the finite element method to the problem of achieving a pressure vessel of this type with the best possible strength-to-weight ratio.

Kenneth S. Kaminsky, Nancy R. Mann, and Paul I. Nelson, "Linear Invariant Prediction of Order Statistics in Location and Scale Families," ARL 75-0151, Aerospace Research Laboratories (June 1975). No price given.

A theoretical analysis of the failure of n items simultaneously subjected to stress and operated independently until failure. The times of the early failures are used to predict later failure times.

Karl G. Guderley, "A Quasi One-Dimensional Approach to Elastic-Plastic Problems of Solid Mechanics," ARL 75-0136, Aerospace Research Laboratories (June 1975). Price not given.

A discussion of a way in which two-dimensional problems can be reduced to one dimension. Advantages may be possible over difference equation methods, but programming may be more complex.

Bengt G. Carlson, "A Method of Characteristics for the Transport Equation Solution," LA-5952, Los Alamos Scientific Laboratory (July 1975). $4.00.

A revised method that helps to enforce positivity of solutions and reduce oscillations and ray effects.

T. R. Hill, "ONETRAN: A Discrete Ordinates Finite Element Code for the Solution of the One-Dimensional Multigroup Transport Equation," LA-5990-MS, Los Alamos Scientific Laboratory (June 1975). $5.45.

The advance claimed over existing one-dimensional finite element codes lies in the use of coarse-mesh rebalancing and in the accuracy and stability resulting from the finite element scheme.

C. K. Briggs et al., "Estimated Viscosity, Surface Tension, and Density of Liquid DT from the Triple Point to 25 K," UCRL-51827, Lawrence Livermore Laboratory (May 1975). $2.25 (Microfiche).

Starting with literature data for liquid hydrogen properties, corresponding data are deduced for DT and T_2. The effect of these properties on aspects of laser fusion is discussed.

M. N. Dixon, C. F. Holoway, B. L. Houser, and D. G. Jacobs, "Indexed Bibliography on Tritium—Its Sources and Projections, Behavior, Measurement and Monitoring Techniques, Health Physics Aspects, and Waste Management," ORNL-5057, Oak Ridge National Laboratory (Aug. 1975). $13.60.

The documents referenced in this bibliography were retrieved from the files of the Nuclear Safety Information Center of ORNL.

D. G. Doran et al., "Controlled Thermonuclear Research Quarterly Report, January, February, and March 1975," HEDL-TME 75-76, Hanford Engineering Development Laboratory (May 1975). $5.45.

Among the subjects discussed is a study of the effectiveness of available and proposed neutron spectra for determining damage functions for CTR applications. Reports a new displacement damage cross section for W calculated from ENDF/B-IV data up to 20 MeV.

William R. Ellis, "LTPF: A Linear Theta-Pinch Neutron Source," LA-6032-MS, Los Alamos Scientific Laboratory (July 1975). $4.00.

A discussion of this device as a basis for a fusion engineering research facility (FERF). A crude estimate of the cost is $20 to $30M with the largest expense associated with the power supply.

W. E. Sande et al., "Decontamination and Decommissioning of Nuclear Facilities," BNWL-1917, Battelle Pacific Northwest Laboratories (May 1975). $5.45.

Abstracts of more pertinent references assembled at the information center on this subject are arranged in chronological order, 1944 to 1974.

H. H. Rossi and E. J. Hall, "Annual Report on Research Project," COO-3243-4, Columbia University (Oct. 1, 1974 - Sep. 30, 1975). $7.60.

Covers basic and applied research on radiological physics (including dosimetry and microdosimetry), biophysics, and radiobiology, with the ultimate aim of identifying the basic mechanisms in radiation-tissue interaction.

"Nuclear Medicine—Bibliography from Nuclear Science Abstracts Volumes 28-30," TID-3319-S6, U.S. Energy Research and Development Administration (July 1975). $10.60.

Robert C. Kelly, "Plowshare—A Selected, Annotated Bibliography of the Civil, Industrial, and Scientific Uses for Nuclear Explosions," TID-3522-R9-S3, U.S. Energy Research and Development Administration (July 1975). $5.45.