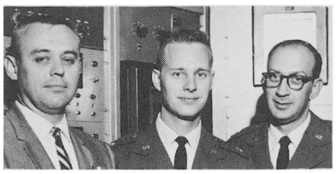
AUTHORS AND PAPERS

The highly condensed summaries of papers and technical notes (below) are intended to assist the busy reader in determining the order in which to read the technical material. Biographical comments are for human interest.

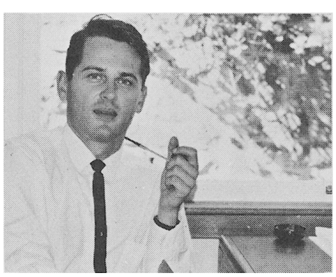
KINETIC BEHAVIOR OF A REACTOR



The kinetic response of a circulating water-cooled and -moderated reactor to large changes in reactivity can be predicted by this method. Time histories of power, peak fuel plate temperature, energy, reactivity, and period display the responses. The validity of the method is verified by the agreement of calculated and experimental data applied to the SPERT-IV reactor. General applicability and usefulness of the method are illustrated by an analysis of the Air Force Nuclear Engineering Test Reactor.

Charles J. Bridgman (shown at left in the photograph) is an Associate Professor of Nuclear Engineering, Physics Department, Air Force Institute of Technology (AFIT), where he is also faculty advisor of the American Nuclear Society Student Branch. His PhD degree is in nuclear engineering from North Carolina State. His present research interests are centered about reactor and weapon physics calculations. Capt. John A. Palmer (center) entered AFIT in 1963 as a graduate student. He received his MS in nuclear engineering from there in August 1965. Capt. David M. Verrelli (right) is presently the Chief, Reactor Operations and Maintenance Division of the Air Force Nuclear Engineering Test Facility (AF NETF). He received his MS in nuclear engineering from AFIT in 1961 and has had five years experience in the operation of TRIGA pusle-type reactors as well as the AF NETF.

OPTIMIZING REACTOR SHUTDOWNS



An analysis method embodied in the digital computer code SHUTDOWN makes possible the determination of near-optimum shutdown modes for most reactors. This paper presents determined functions which compare favorably with available data for the Canadian NRU reactor and solutions for the minimization of peak xenon problem found using Pontryagin's Maximum Principle.

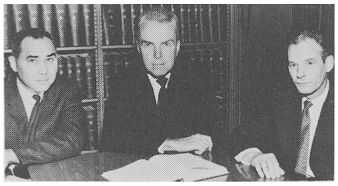
J. R. Fredsall has been with the Australian Atomic Energy Commission for the past two years and is engaged on the assessment of possible suitable reactor systems for Australia. His interest is reactor optimization, developed during the three years he worked as an operational physicist on the Hanford production reactors. He received BS and MS degrees in engineering from the University of Washington.

SAFETY OF NUCLEAR ROCKET TESTING

This work applies present effluent prediction techniques to ground tests of advanced nuclear rocket engines forthcoming in several years. If we assume that future fuel performance will be substantially the same as at present, effluent decontamination will be required to maintain the present safety record with longer running times and higher reactor power levels.

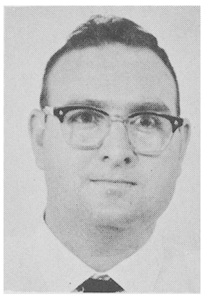
Morton I. Goldman is Vice President—Environmental Safeguards Division at NUS Corporation in Washington, D.C. Prior to joining NUS in 1961, he was Nuclear Installations Consultant with the US Public Health Service. He received MS degrees in Sanitary and Nuclear Engineering and his ScD from MIT. Dr. Goldman is responsible for NUS activities in siting and safeguards analysis and also serves as a member of the Safety Advisory Panel at the Nuclear Rocket Development Station, Nevada.

^{60}CO HEAT SOURCES

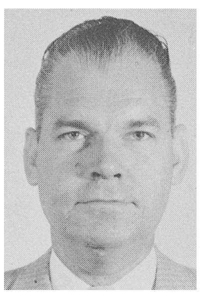


Large-scale applications of radioisotopes require concomitant availability. This paper shows that for current AEC projections of terrestrial applications ^{60}Co is unique in meeting the needs of potential users, while remaining economically competitive with other isotopes.

W. R. Cornman (PhD, University of Illinois, 1954), E. J. Hennelly (PhD, Princeton, 1949), and A. H. Dexter (MS, Rensselaer Polytechnic Institute, 1951), are all members of the Theoretical Physics Division of the Savannah River Laboratory. They have participated for several years in studies of the large-scale isotope production potential of existing reactors and of the development of new areas for large-scale applications of a variety of radioisotopes.



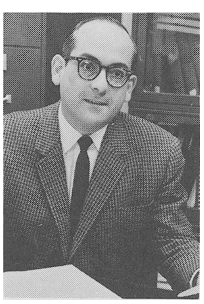
PRODUCTION OF ^{33}P



The $^{33}S(n,p)^{33}P$ and $^{36}Cl(n,\alpha)^{33}P$ reactions were used for the production of ^{33}P in millicurie amounts at Oak Ridge. Enriched ^{33}S was prepared by electromagnetic separation, and ^{36}Cl was prepared by reactor irradiation of natural chlorine. Postirradiation aging depleted the ^{32}P content of the end product. This paper also describes chemical procedures for separation of carrier-free phosphorus activities from elemental sulfur and sodium chloride.

R. E. Lewis (left) and T. A. Butler are members of the Development Department of the Isotopes Division at Oak Ridge National Laboratory. Lewis (BS, Oklahoma State University, 1959), was the principle investigator with the direction of Bulter (MS, Iowa State University, 1951). Their work in neutron and cyclotron products is concerned with technology of preparation and the characterization of now unavailable radioactive isotopes to assist medical, biological, and other research workers in obtaining radionuclides applicable to their needs.

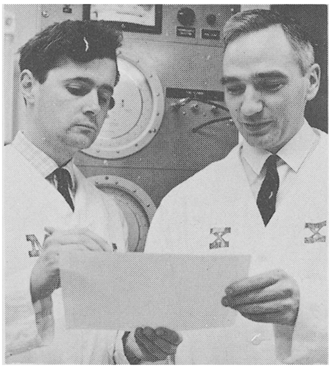
EMBRITTLEMENT OF REACTOR PRESSURE VESSELS



This work presents a radiation damage model, which accounts for neutron spectral differences between irradiation locations, and applies the model to pertinent data on the change in ductile-to-brittle transition temperature for A302B pressure vessel steel. The resulting correlation supports the author's contention that such a damage model provides a more meaningful measure of exposure than the usually cited neutron flux above 1 MeV.

K. Shure is an Advisory Scientist at Bettis Atomic Power Laboratory, where he is currently responsible for the development of improved calculational procedures for use in reactor shield design. He jointed Bettis in 1951, where his work has included shield design, measurement of radiation levels on operating plants, and measurement of parameters pertinent to shield design. He received his AB degree (1945) from Brooklyn College and his PhD degree (1951) in nuclear physics from the Massachusetts Institute of Technology.

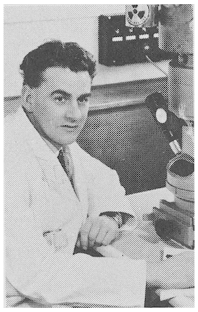
EFFECT OF UO_2 DENSITY



Increasing the density of UO_2 fuel can decrease the fission product gas release but also increase the sheath strain of the fuel element. Inconsistencies between the gas releases measured in different fuel element irradiations are shown to be related to the structural changes in the fuel; however, the cause of the differences has not been established.

M. J. F. Notley (left in the photograph) works in the Reactor Materials Branch at Atomic Energy of Canada Limited, where he has been concerned with the design and analysis of in-reactor experiments on fuel element performance. J. R. MacEwan, a Group Leader in the Branch, is best known for his work on grain growth and diffusional gas release from nuclear ceramics.

FISSION–GAS BUBBLE DISTRIBUTION IN UO_2



The author of this paper concludes that, in a fuel element in which a high temperature gradient exists, the gas release below 1800°C is controlled by the migration of bubbles to grain boundaries and by the degree of linking up between the gas-filled voids produced at grain boundaries. At temperatures above 1800°C, large gas-filled voids produced at grain boundaries are expected to migrate up the temperature gradient by the vapor transfer mechanism, continuing the process of sweeping up most of the gas started by the initial grown-in porosity.

Since 1956, A. D. Whapham has been working at Atomic Energy Research Establishment, Harwell, England, studying fundamental radiation damage problems. He first became concerned with the observation of radiation effects in uranium dioxide by transmission electron microscopy in 1961. He obtained his BSc (physics) and PhD degrees from London University in 1953 and 1956, respectively.

DIFFUSION IN DOPED UO_2

Uranium dioxide, labeled with rare gas by means of ion bombardment and reactor irradiation, was used in this study of fission-gas release. At low gas concentrations, the gas release occurred by a mechanism independent of self-diffusion of either oxygen or uranium. At high gas concentrations, retarded release of gas occurred, as shown by transmission electron microscopy to coincide with formation and annealing of radiation-induced bubbles and dislocation loops.

Hj. Matzke received his MS degree in physics from the University of Kiel and his PhD from the Technical University of Braunschweig, Germany. Following post graduate study at the Technical University of Gothenburg, Sweden, he worked at the Euratom plant in Ispra, Italy. Since 1964 he has been on a leave of absence from the Technical University of Braunschweig, while attached to the Chalk River Nuclear Laboratories as a Post Doctoral Fellow of the Canadian National Research Council. His general field of interest is atomic transport processes in ionic crystals or more specifically, the behavior of rare gases in solids.

FISSION-GAS RELEASE UP TO 2000°C

Below 600°C, recoil and knock-out are the mechanisms of fission-gas release from UO_2 samples, according to this French work. Between 800 and 2000°C, excluding the evaporational escape above 1800°C, the fractional release follows an Arrhenius law where activation energy decreases with increasing density. The fractional release was found to be independent of neutron flux.

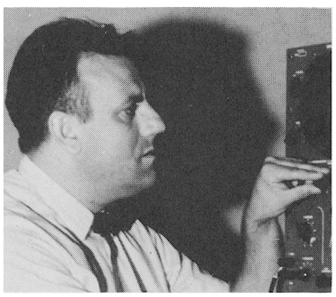
René Soulhier has been with the Commissariat à l'Energie Atomique since October 1962. He obtained the degree of docteur-ingénieur at the Universite de Toulouse (France) with a thesis on the naturally radioactive gases of the atmosphere. In the framework of the French project EL4, he is in charge of the studies of fission-gas release from UO_2 fuel.

DEFECT–TRAP MODEL

This work describes a defect-trap theory to explain fission-gas release from UO_2 specimens at temperatures below the grain growth region. The authors believe that a knock-out mechanism accounts for the majority of fission-gas release at UO_2 temperatures below 600°C. An experimental technique developed to evaluate the defect-trap theory is described, and initial results are interpreted in terms of the theory.

Oscar Sisman, shown at left, has been doing research in radiation effects for over 20 years. He is presently Chief of the Reactor Materials Section in the Reactor Chemistry Division at the Oak Ridge National Laboratory. He received the BS degree in chemical engineering in 1937 from Case Institute of Technology and later did graduate work at the University of Michigan and the University of Minnesota. R. M. Carroll is group leader for fission product behavior studies, Reactor Chemistry Division, Oak Ridge National Laboratory. He has studied the effect of irradiation on reactor materials for nearly 15 years and has conducted fission-gas release experiments on ceramic fuel materials for the past seven years. He began work at Oak Ridge in 1948 after receiving a BS in physics at Birmingham Southern College. Later, he did graduate work at the University of Tennessee and attended the Oak Ridge School of Reactor Technology.

DYNAMIC ANALYSIS OF GAS RELEASE MODELS

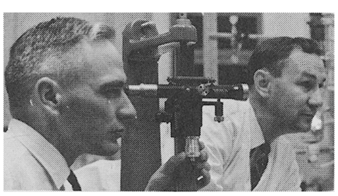


A dynamic method to study the release of fission gases from fuel specimens during irradiation can discriminate between diffusion and diffusion-trapping processes. This paper describes the technique of observing the different behavior of the release rate transfer function, with respect to neutron flux oscillations, for the two models.

Rafael Perez has visited the United States often from his native Spain: once to obtain his MS in nuclear engineering from the Massachusetts Institute of Technology in 1958. He returned to Spain to obtain his PhD in physics from the University of Madrid. Since 1961, he has been an Assistant Professor at the University of Florida. He has specialized in the study of neutron oscillations for reactor studies and has applied this technique to fission-gas release studies.

MIGRATION OF XENON

An earlier interpretation for xenon diffusion in a UO_2 matrix containing pre-existing and irradiation-induced trapping sites is extended in this work. Recent developments, concerning the mechanism for volume diffusion of xenon and the defects observed in irradiated UO_2 by electron microscopy, are reviewed with detailed reference to recent results obtained at Chalk River Nuclear Laboratory.



J. R. MacEwan, shown at left, and P. A. Morel have collaborated on experiments concerned with the migration of fission gases in UO_2 for the past six years. MacEwan received his final degree in chemistry from McGill University in 1957 and has worked at Atomic Energy of Canada Limited for the past eight years. He is presently a group leader in the Reactor Materials Branch. Morel has been employed by AECL for 19 years. After 12 years with the Analytical Control Group in the Operations Division, he transferred to the Chemistry and Metallurgy Division to work on fission-gas experiments.

FISSION GAS IN UO_2 FUEL

Fission-gas behavior varies widely with the UO_2 starting material and with its irradiation history of time and temperature, in a manner analogous to the baking of bread. Fuel rods are commonly designed with a plenum to collect gas, but the high density of pores and plasticity of the oxide delays or prevents much of the gas from reaching the plenum. Satisfactory designs have been achieved without a plenum. The process of fission-gas escape is not well established and requires consideration in each case by the design engineer.

W. Bennett Lewis graduated in physics at Cambridge in 1930 and studied with Lord Rutherford the fine structure and energies of α-rays. During World War II, he was connected with radar research in England, becoming Chief Superintendent of the Telecommunications Research Establishment. He came to Chalk River in 1946 to direct atomic energy research and has pioneered heavy-water-moderated power reactors. A past president of American Nuclear Society, he is a well-known and highly respected citizen of the nuclear community.