could be determined, including the thickness and the integrity of the fueled cores. Alpha counting techniques were also employed to detect uranium contamination of the coatings.

Several papers discussed means of detecting the distribution and the homogeneity of fuels within a fuel element. A variety of techniques was described, depending somewhat on the type of fuels, geometry of the fuel element, and the desired accuracy. These techniques included microradiography, external-gamma and x-ray attenuation measurements, Archimedes principle, and gamma counting. More information with higher accuracy was obtained using gamma counting techniques; however, gamma counting is more time-consuming and more sensitive to geometrical considerations than most of the other techniques. In most cases, the gamma counting was done on the 184-keV peak for the determination of the concentration of ^{235}U. Bond testing of fuel elements was accomplished by either ultrasonic pulse echo or through transmission techniques, with emphasis on the automation of these techniques. Fuel-element closure welds were inspected both by radiographic and ultrasonic methods. Leaks in these welds were detected by helium leak-testing techniques.

Dimensional analysis, including the measurements of core width and thickness, cladding thickness, tube diameter, and fuel plate spacing were determined by x-ray, gamma attenuation, ultrasonics, eddy currents, air gauges, and various pneumatic and mechanical linkage devices.

Dimensional analysis, radiography, leak-testing, and visual examinations of irradiated fuel elements were carried out remotely. In two cases, betatrons were used to obtain radiographs. McKane and Honkonen reported that they performed dimensional analysis on samples under water to reduce dimensional changes that would occur in air, due to self-heating of the sample.

Gamma counting techniques were used to determine the burnup of irradiated fuels. The gamma peak from ^{144}Pr (half-life of 285 days) was used to determine the number of fissions attributed to ^{235}U. The gamma peak for ^{106}Rh (half-life of 370 days) was used to determine the number of fissions attributed to ^{39}Pu.

Several papers covered the determination of physical and mechanical properties of either fueled or unfueled components as a function of temperature or irradiation dose. These techniques included the measurement of the mechanical resonant frequencies of rods for computing the dynamic elastic constants. Internal friction was measured by resonant damping and by ultrasonic attenuation techniques, and the electrical conductivity was measured by eddy current techniques.

The use of radiographic and ultrasonic techniques to determine the integrity of welds in pressure vessels was discussed in several papers. Some discussion of the base materials was also presented. McGonnagle discussed the application of the ASTM Boiler Code for Nuclear Vessels in Sec. 3.

Eddy current and ultrasonic techniques were used to detect defects in heat exchanger tubing both before and after assembly in the heat exchanger.

Nearly every phase of nondestructive testing of nuclear materials and components was covered in this symposium. Many of the papers dealt with complete nondestructive quality-control programs used at different sites.

An enormous amount of technical data is contained in these papers and it is far beyond the scope of this review to give complete coverage of all these data.

It is worthy to note that, in general, the nondestructive testing techniques and standards used in nuclear technology are quite similar and almost uniform around the world.

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June 8, 1966

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From 1952 to 1956, Mr. Clark studied mechanical engineering at the University of Cincinnati. In 1956, he joined the General Electric Aircraft Nuclear Propulsion Department, where he worked in the field of nondestructive testing. In 1961, he was registered as a professional engineer in the state of Ohio, and, since that time, he has devoted his whole time to nondestructive testing at General Electric's Nuclear Materials and Propulsion Operation.

He is the author of several papers on specialized nondestructive testing techniques, and is familiar with most of the nondestructive tests and techniques in use in the nuclear industry in the United States.

He is past Chairman and Vice Chairman, and is presently a member of the Board of Directors of the Miami Valley Chapter of the Society for Nondestructive Testing.

Naval Reactors Physics Handbook, Vol. I, Selected Basic Techniques. A. Radkowsky, Editor, Naval Reactors, DRD, USAEC, (1964). 1545 pp. (Available from Superintendent of Documents, Washington, D. C., 20402). (Price unknown).

Although this volume is called a Handbook, it is in spirit more of a review and status report of the accomplishments of the Naval and Shippingport PWR reactor physics programs. As might be expected in so massive a tome (1545 pages, 76 authors), the work is of uneven quality and of varying vintage. However, it is clear that the Naval Reactors program has come a long way since the days when Radkowsky worked at Argonne on the neutron transport properties of water, Henry worked at Bettis on nodal methods in reactor kinetics, or Hellens worked on few-group calculations for water lattices. The accomplishments of the program are many and varied as is indicated by a mere listing of the names of some of the authors: Hurwitz, Selengut, Francis, Klein, Amster, Kaplan, Feiner, Goldman, Harris, Gelbard, Wachspress, etc., and others such as Krasik, Sampson, Stark, Weil, Ehrlich, Zweifel, Krieger, Nelkin, and Varga whose contributions were important at early stages of the work.

The reviewer's acquaintance with Rickover's domain dates back to 1952. In 1951, the USAEC asked BNL to investigate the feasibility of a proposed slightly enriched uranium-water reactor for power and plutonium production. The next year, this proposed reactor was scrapped, but the BNL uranium-water lattice experiments were continued in support of an aircraft carrier reactor proposed by Rickover. When this proposal also went down the drain, the Shippingport PWR reactor sprang up to take its place and to support a cooperative experimental program between BAPL and BNL on slightly enriched uranium fuel rods. On such vagaries of fortune were the future BNL and Bettis reactor physics programs built. It is to the Navy's credit that continuous support of a broad reactor physics effort at BAPL and KAPL has been maintained. Except for a period following the disbanding of Hurwitz's group at KAPL, this support has resulted in excellent reactor physics work at both laboratories. At a time when mechanized and directed research is being emphasized in our most basic scientific disciplines, it is encouraging to note the many triumphs of the free spirit of scientific inquiry within the confines of this *Naval Reactors Physics Handbook.*

The *Handbook* itself is divided into seven chapters. After a short Introductory Chapter by Radkowsky these are: The Neutron Slowing-Down Problem; The Neutron Thermalization Problem; Reactor Design Techniques; Reactor Kinetics; Comparisons of Integral Experiments with Theory; and Reactor Physics Computation.

One passes over as hopeless any detailed critique of the work. When one thinks of the Navy's contributions one thinks first of all of their sustained efforts in the application of high-speed digital computers to reactor physics calculations. Then one thinks of their advances in control-rod theory and experiments—core depletion and lifetime studies—fission-product poisoning studies—burnable poisons—seed-and-blanket reactors—water-gap flux peaking—uranium-oxide lattice experiments—cross-section calculations and integral measurements—consistent multigroup calculations—sourceless startup—space-dependent reactor kinetics. Much of this work, some fresh, some obsolete, some blind alleys, is reported in the volume. There is still some tendency for inbreeding; that is, to concentrate on Navy project literature rather than the open literature. This leads to several instances of inaccurate reporting of original work and a tendency to lag behind recent developments at other laboratories; for example, the recent work on neutron thermalization and resonance absorption.

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