SPENCER H. BUSH

1920–2005

Elected in 1970

“For contributions in the physical and mechanical metallurgy of materials used in nuclear reactors.”

BY JUDITH GRAYBEAL
SUBMITTED BY THE NAE HOME SECRETARY

SPENCER BUSH, an international authority on nuclear metallurgy and a driving force in the development of nuclear power codes and standards, passed away on October 2, 2005, in Richland, Washington, at the age of 85. He was elected to NAE in 1970 “for contributions in the physical and mechanical metallurgy of materials used in nuclear reactors.”

On July 12, 1945, a U.S. Army corporal drove an inconspicuous sedan to an old adobe ranch house on what is now the White Sands Missile Range. His cargo was the plutonium core of the “gadget,” the world’s first nuclear device. When it was detonated four days later in the Trinity test, it not only changed the world, it also set the direction of the young man’s life. Spencer Harrison Bush devoted more than 50 years to advancing knowledge of the physical and mechanical metallurgy of nuclear materials and to ensuring the safety of nuclear reactors.
Spence Bush was born on Easter Sunday, April 4, 1920, in Flint, Michigan. After attending high school and junior college in Flint, he worked as an assistant chemist at Dow Chemical Company in nearby Midland, Michigan, until he left to serve in the Army from 1942 to 1946. He spent the last years of the war in the Special Engineering Detachment assigned to the Manhattan Project at Los Alamos, New Mexico.

After the war, Spence enrolled at the University of Michigan, where he earned bachelor’s degrees in metallurgical and chemical engineering in 1948, a master’s degree in 1950, and a doctorate in chemical engineering in 1953. During that time he also launched a publishing career that eventually included more than 100 journal articles, as well as book chapters, formal reports, and one book.

In 1953, he went to work at the Hanford Site near Richland, Washington. Reactors at Hanford produced the plutonium for the Trinity test, the Nagasaki bomb, and, later, for the nation’s Cold War arsenal. Bush transferred to Pacific Northwest National Laboratory (PNNL) in 1965, when the U.S. Department of Energy spun off the laboratory from Hanford and widened its research base. Although he retired in 1983 to establish his own firm, Review & Synthesis Associates, Spence said he “could not imagine not being involved in some way with the nuclear power industry.” He continued as a consultant to the laboratory and others in government and industry worldwide until his death.

Spence was a registered professional engineer whose areas of research included failure mechanisms in pressurized nuclear reactor systems, stress corrosion in piping and turbines, effects of radiation damage on material properties and component design, and seismic design of pressure-boundary components. His early work centered on the effects of radiation on materials used in reactor fuel and reactor fabrication, particularly metallic uranium, zirconium, austenitic stainless steels, and pressure-vessel steels. He directed fundamental studies on irradiation damage of fissile and non-fissile metals and supervised the development of fabrication processes for nuclear fuels and
structural components. Several of those processes were used for many years in the production of nuclear components.

“It was a whole new field back then,” said PNNL colleague Burt Johnson. “The impacts of radiation on corrosion environments were not well understood, and there was a fascination to see the effects and how they applied to the specification of materials.”

Spence soon broadened his interests to include the reliability and failures of piping for nuclear power plants, reactor pressure vessels, and related systems. His work on stress corrosion and failure mechanisms was acclaimed in the nuclear community. He pioneered the development of non-destructive inspection technologies and risk-based in-service inspection standards, as well as the development of rules for flaw evaluation that provide a basis for rational decisions about whether nuclear power plants can operate safely. Bush also was instrumental in the evaluation of flexibility analysis rules for piping systems to ensure reliability while reducing maintenance costs.

Highly regarded by his peers in the nuclear power community, Bush represented the United States in the International Atomic Energy Agency’s effort to develop international in-service inspection standards and was a key member of several European and Japanese programs for the inspection of steel components. He chaired or served on numerous U.S. Nuclear Regulatory Commission committees, including the Advisory Committee on Reactor Safeguards. He also chaired the Welding Research Council’s Pressure Vessel Research Council steering committee on the design of nuclear piping systems and the Pressure Vessel Study Group of the Electric Power Research Institute.

Spence was extremely active in the American Society of Mechanical Engineers (ASME). He played an essential role in the development of the ASME Boiler and Pressure Vessel Code Section XI: Rules for In-service Inspection of Nuclear Power Plant Components, which established criteria for the pre-service and in-service examination of nuclear power plants. Spence led the development of the analytical methods
in Section XI for evaluating flaws identified by in-service inspections. Section XI was then expanded to include methods of repairing unacceptable flaws.

Section XI requires that all operating nuclear plants meet standards that ensure safe and reliable operation, requirements that were formally accepted by the Nuclear Regulatory Commission. Owen Hedden, a colleague, noted that, with Bush’s guidance and encouragement, nuclear power plant operators worldwide accepted or adapted the Section XI rules.

ASME recognized Bush’s achievements in a memorial symposium during a conference in July 2007. In describing Spence’s contributions to risk-informed in-service inspection technology, Kenneth Balkey of Westinghouse Electric and Fredric Simonen of PNNL wrote that Bush “spent two decades guiding ASME research efforts for this technology and then supporting the writing of Code requirements to implement programs in the United States and throughout the world.”

In another presentation, Martin Prager of the Pressure Vessel Research Council remembered Bush as an energetic and creative synthesizer of technology into effective practices. “Spence was a consensus builder by virtue of his knowledge, judgment, personality and professionalism. We called on him for many challenges, and he never said no to an assignment,” Prager said. “If there was a steering committee to be established, his name was always first on the list. Subjects as diverse as failure modes, NDE [non-destructive examination], piping design, seismic effects, corrosion fatigue, risk-based inspection, and other aspects of risk analysis were all in his sphere of expertise. His counsel was wise and his judgment practical, unbiased, objective and defensible.”

For these and many other achievements, Spencer Bush was elected to the National Academy of Engineering in 1970. Other honors included fellow of the American Nuclear Society (ANS), the American Society for Metals (now ASM International), and the American Society of Mechanical Engineers (now ASME International); ASME Gillette Lecturer and Mehl Lecturer for the American Society for Nondestructive Testing; senior
member of American Institute of Mining, Metallurgical and Petroleum Engineers; recipient of the ANS T.J. Thompson Award and the ASME Bernard Langer Nuclear Codes and Standards Award and Melvin R. Green Codes and Standards Medal; and member of Sigma Xi, Tau Beta Pi, and Phi Kappa Phi.

Colleagues called Bush a walking database who could instantly read—and remember—vast amounts of information and could "synthesize a recommendation out of apparent chaos." His vast library filled several rooms in the basement below his office. When attending conferences, he came "loaded with so much documentation that his briefcase caused him to walk with a list."

Despite traveling as many as 200 days a year, Spence always made time to assist and encourage junior staff. He instilled the importance of publishing in his young colleagues and chaired or served on numerous professional society honors and awards committees. He was an affiliate or adjunct professor of metallurgical engineering at the Joint Center for Graduate Study of the University of Washington, Washington State University, and the University of Oregon, as well as a Regents Professor at the University of California, Berkeley.

On the personal side, Spencer Bush and Roberta (Bert) L. Warren, whom he married in 1948, had two sons, David Spencer, born in 1949, and Carl Edward, born in 1957. Bert was a librarian at the Hanford Site for many years and frequently assisted Spence in obtaining the masses of documents on which he thrived.

A favorite memory of son Carl is his dad’s speed reading and photographic memory. Spence would consume several science fiction novels in a day. He devoured James Michener’s *Hawaii* in an afternoon and later amazed his carpool by quoting entire passages, complete with page numbers.

Spence was a gourmet cook, a wine connoisseur, and an early aficionado of Eastern Washington vintages. He loved salmon-fishing weekends at Fuzzy Joe’s Campground on the Pacific coast and hunting doves in the Horse Heaven Hills with his Weimaraner, Bonnie. Spence was president of the
Blue Mountain Council of the Boy Scouts of America, which covered southeastern Washington and all of eastern Oregon. He received the Scouts’ Silver Beaver Award for that service, an honor of which he was particularly proud.

His daughter-in-law remembers that:

When Spence was not working, he would take his young family fishing and sailing, and as the boys grew older he often took them bird hunting. He enjoyed being outdoors, and weather permitting, could often be found in the garden tending to the many fruit trees, raspberry bushes, vegetables, and perennials in the yard.

Spence enjoyed fine foods and wines, and his wealth of knowledge on the subjects was impressive. On one particular occasion he unknowingly educated a bystander at a cheese counter as he and his wife Bert discussed the merits of a particular cheese and where in Europe they had first encountered it. He was content in the kitchen working alongside Bert, trying out new recipes to go with that perfect bottle of wine. Over the years, when he visited family, he would show up with a grocery list of items to be obtained at gourmet food and wine shops, and always had a list of restaurants in the area he wanted to try.

“Spence was more than a genius,” said friend and collaborator Larry Chockie. “There are a lot of geniuses. But when an individual exceeds the definition of genius, that person is called a phenomenon, and a phenomenon comes along only once in a lifetime. That was Spence—he was a phenomenon.”

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