The Nuclear Safeguards Program

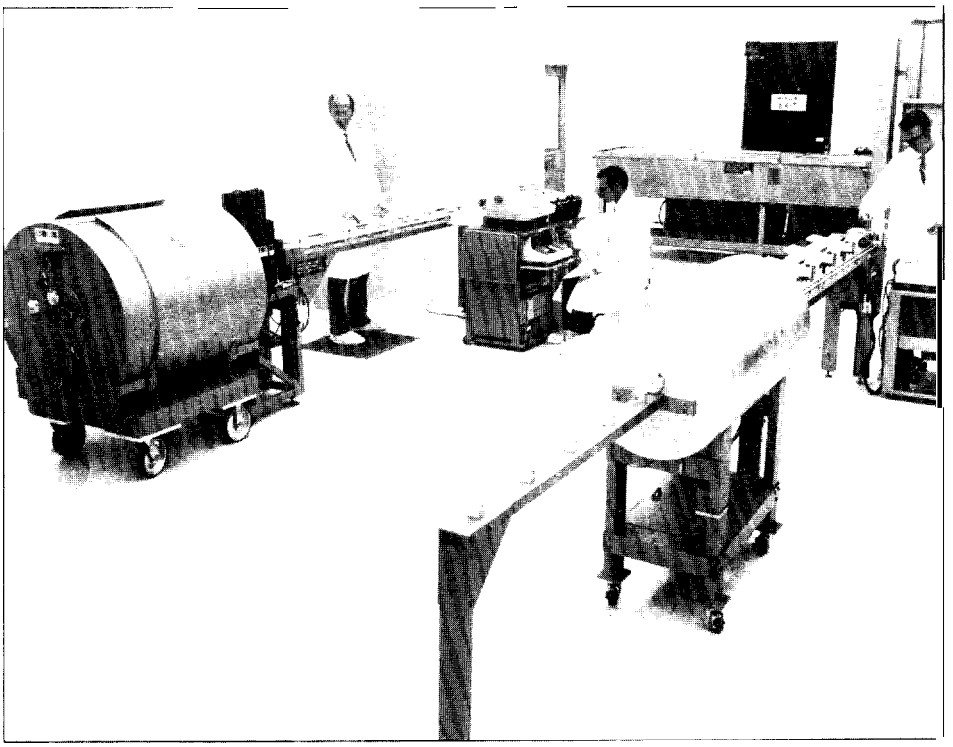
compiled by Darryl B. Smith

"Los Alamos's interest in safeguards . . should not really surprise you. Our pioneering work in nuclear weapons has left us. . . with the profound concern that these devices never get used in anger, never get used surreptitiously, never get made by surprise. by theft. or by diversion," Dr. Norris E. Bradbury used these words in his welcoming remarks to the more than three hundred and fifty participants in the Second AEC Symposium on Safeguards Research and Development held in Los Alamos in October 1969.

Immediately following the end of World War II there was a hope that the proliferation of nuclear weapons could at least be delayed by means of rigid controls over all nuclear activities (the Baruch Plan, 1946). Despite efforts by the United States to maintain strict secrecy, by 1952 three additional nuclear weapons states had emerged, and several nations were seeking the benefits of nuclear electric power. In 1953, President Eisenhower announced the "Atoms for Peace" program to promote vigorously the peaceful use of nuclear energy while discouraging or preventing any military use. In the course of implementing this policy, the International Atomic Energy Agency (IAEA) was created in 1957 and entrusted with the international promotion and control of peaceful uses of nuclear energy.

The Los Alamos Nuclear Safeguards program began in 1966 when worldwide interest in nuclear energy for the production of electrical power was rapidly expanding. Bob Keepin, a nuclear physicist in the Nuclear Propulsion Division, had just returned to Los Alamos after two years as head of the Physics Section, Division of Research and Laboratories of the IAEA in Vienna, Austria, and was firmly convinced of the coming importance—both political and technical—of the worldwide nuclear safeguards problem. He was equally convinced that Los Alamos should launch a vigorous program to develop new nondestructive assay techniques and instruments that would in time provide the technical basis for meeting the increasingly stringent safeguards requirements that were inevitable. Following a lengthy series of briefings, hearings, buttonholing, and budget reviews with the AEC and the Congressional Joint Committee on Atomic Energy, the nation's first research and development program in safeguards was funded and launched at Los Alamos in December of 1966. Six months later, the AEC established a new Office of Safeguards and Materials Management (OSMM) as well as a Division of Safeguards in its Regulatory Branch. The Regulatory Branch is now the Nuclear Regulatory Commission (NRC). The OSMM is now the Department of Energy's Office of Safeguards and Security and still provides the lion's share of the $12 million Safeguards research and development program at Los Alamos.

Bob was named to head the new program, which began in a small laboratory at Pajarito Site replete with chipmunks in the offices and a rattlesnake on the doorstep. As the program grew, this space was augmented a year later by the addition of a second, larger laboratory at another site. With the encouragement and cooperation of Dick



Nondestructive assay of fast breeder reactor fuel. Two fuel-rod scanners developed by Los Alamos are being used here in 1974 at the Hanford Engineering Development Laboratory as part of their safeguards and quality control. The device on the l@ uses a computerized californium-252 system to measure both plutonium content with an accuracy of better than 0.5 percent and pellet-to-pellet uniformity of fissile material loaded into the rod. The system on the right uses a passive neutron-coincidence technique to measure plutonium-240 content, thus providing a cross-check with the first instrument.

In-line monitoring of uranium hexafluroide (UF_6) enrichment. This system, shown installed in 1975 at Goodyear's Atomic Gaseous Diffusion Plant in Piketon, Ohio, also uses two independent sensors developed at Los Alamos. The gamma enrichment meter measures the percentage of uranium-235; the neutron detector measures the percentage of uranium-234. This in-line instrument allows instantaneous isotopic analysis (to better than 0.5% accuracy), providing assurance of criticality safety during withdrawal into large cylinders as well as verification that the product selection meets the enrichment specifications. Because uranium-234 is also enriched in the diffusion process, its isotopic abundance in the product UF_6 provides useful diagnostic information for plant operation. The alpha-particle activity of uranium-234 is the principal source of neutrons emitted by enriched UF_6, and this neutron yield is an important signature for safeguards verification.

Baker, Chemistry-Materials Science Division Leader at the time, and the tolerance of Bill Maraman and his Plutonium Chemistry and Metallurgy Group, a special technical liaison committee was set up in 1967 to encourage cooperation among safeguards researchers and those staff whose group or division responsibilities were directly concerned with nuclear materials and equipment, This committee helped to identify needed, practical applications for testing and applying newly developed safeguards techniques to materials measurement, accountability, and safeguards problems. Such problems were not uncommon in the materials processing, fabrication, and recovery operations carried out routinely at the Laboratory's plutonium facility. The close liaison between safeguards researchers and the Laboratory's plutonium chemists and metallurgists significantly helped the Los Alamos Safeguards program get off to a head start in the safeguards field with a commanding lead that has been retained ever since.

The Agnew years saw the Los Alamos Safeguards research and development program grow by more than an order of magnitude. At the beginning of the '70s, most of the nuclear industry was unaware of the importance and economic impact the nondestructive assay techniques could have on their operations, so in the spring of 1970 Los Alamos fielded the Mobile Nondestructive Assay Laboratory (MONAL) to serve as a demonstration unit and assay laboratory and as a staging area for conducting in-plant assay using portable instrumentation. During the next few years, MONAL traveled to nuclear facilities nationwide, addressing special measurement problems. The first Los Alamos instrument installed in a nuclear facility for routine production use went to the General Electric fuel fabrication plant in Wilmington, North Carolina, in the spring of 1971 to assay reactor fuel rods. By the end of the decade, instruments and techniques developed by Los Alamos were in use throughout the world. In November 1973, the Safeguards staff conducted its first formal course in nondestructive assay techniques. By 1980 nearly seven hundred people had received training in safeguards techniques at Los Alamos, and currently about two hundred students participate each year in the eight to ten courses offered, including all new IAEA inspectors, who come to Los Alamos for their initial training.

Today, the Los Alamos Safeguards program is recognized worldwide as the fundamental source for state-of-the-art safeguards technology and has been designated as the DOE's lead laboratory in nuclear materials control and accountability research and development. It encompasses all aspects of the design, development, testing, and in-plant evaluation of new techniques, instruments, and integrated systems for safeguarding fissionable materials in all types of civilian and national defense nuclear facilities. ■