

20 Savannah River Site at Fifty: Stewardship and Legacy

Savannah River reached a turning point between 1987 and 1989. Within this three-year period, Du Pont announced its withdrawal from the plant, the last of the Savannah River reactors were shut down, and a new contractor, Westinghouse Electric, was selected to operate the plant. The next decade would begin on untried ground as

Westinghouse began to establish an identity on site and in the larger community. The ending of the Cold War mandated changes in old missions and new directions for the forty-year-old production site with the primary emphasis on environmental management rather than production. The Department of Energy and Westinghouse Savannah River Company, unfamiliar partners, would be joined in pursuit of these new directions that stemmed from the legacy of the past missions and would begin, in concert, to define the site's livelihood for the future.

By the close of the century, SRS's mission would be defined as the safe and secure stewardship of the nation's nuclear weapons stockpile, nuclear materials, and the environment. Expanded, this means that SRS will meet the needs of the enduring U.S. nuclear weapons stockpile; will store, treat, and dispose of excess nuclear materials safely and securely; and finally will treat and dispose of legacy wastes from the Cold War and clean up environmental contamination.¹ The site mission of 2000, compelled by the social, political, and economic context in which it was formed, is vastly different from the production mission that characterized the site's first four decades. In 2000, waste management, environmental cleanup, nuclear weapon stabilization, nonproliferation, and the

development and application of related technologies via technology transfer have joined production as pathways to the Site's future.



Glass melter crew and equipment at TNX, 1991. Courtesy of SRS Archives, negative 91-1602-3.

WESTINGHOUSE SAVANNAH RIVER COMPANY BECOMES PRIME CONTRACTOR

Previously, Savannah River had been operated for a one-dollar profit and the reimbursement of allowable costs over the course of several contract extensions by Du Pont. This changed dramatically at contract change. The new contractor would operate the plant

for profit, with annual profits expected to be somewhere between \$25 and \$40 million. The two corporations that placed competitive bids for running Savannah River were Westinghouse Electric and Martin Marietta. Westinghouse was joined by Bechtel National, Inc., while Martin Marietta teamed up with EG & G, Stearns Catalytic Division, and United Engineers and Construction.² On September 8, 1988, the Department of Energy awarded the contract to Westinghouse Savannah River Company, a subsidiary of Westinghouse Electric created for the purpose of running the plant.³

Both Westinghouse and Bechtel had a history of nuclear work with DOE. Westinghouse's nuclear roots are over a half-century deep. Westinghouse Electric Corporation entered the nuclear field in 1948, when the firm signed a contract to construct a thermal submarine reactor propulsion plant based on an Argonne design. Between 1948 and 1989, the firm became a major leader in the field, constructing over 170 commercial reactors, in addition to their government contracts under which they operated other sites within the DOE complex. Westinghouse assumed authority for operating Hanford in partnership with Kaiser in 1987 and DOE's Fernald Feed Materials Production Center in Ohio in 1985. Westinghouse's primacy at Hanford was more the result of a consolidation than a transition—the firm was already on site at Richland as one of eight DOE contractors. When six of the eight contractors left Richland in 1987, Westinghouse became operating and management contractor and Kaiser became prime engineering contractor.⁴

With their nuclear experience and as a presence already known to DOE, Westinghouse in 1989 could be likened to the Du Pont of 1950 in its qualifications to run Savannah River. It had demonstrated success with the Department of Energy and maturity within the nuclear field. Bechtel was also a veteran firm with extensive experience in nuclear power. Under the Westinghouse–Bechtel agreement, Bechtel's role was to act as prime construction and engineering subcontractor. At contract signing, Westinghouse Savannah River Company became the operators of South Carolina's largest manufacturing site and the state's largest industrial employer. Fortuitously, the question of contractor liability for the new contractor was settled even before the contract was awarded. It became clear that a renewed version of the Price–Anderson Act would pass Congress, guaranteeing liability protection for the new Savannah River contractor–operator.⁵

When Westinghouse officially took over the plant on April 1, 1989, it moved quickly to establish a new identity for the production plant by changing the name from “Savannah River Plant” to “Savannah River Site.” While the name change reflected the presence of several “plants” within the site, it also suggested that the era of production, if not over, would have to make way for other missions—especially the cleanup effort that was required after almost four decades of nuclear materials production. Around 36 metric tons, or 40 percent of the plutonium in U.S. stockpiles, were made at Savannah River between 1953 and 1988, and the waste materials generated by this production were still on hand.⁶ Although the Defense Waste Processing Facility was nearing completion, there were still

Barbara Kish and Julie McLeod Kirby with the SRS Sign Shop signs with new name and logo, 1991. Courtesy of SRS Archives, negative 91-1448-4.



Savannah River and the Community

The Savannah River Operations Office encouraged community interaction from its inception. As noted in earlier chapters, the United Way, begun locally by Senator Strom Thurmond and known initially as the Community Chest, has been a major focus from 1952 onward for the site. Savannah River's contributions to the community-based organization since 1952 total \$32,865,723, and in 2000, Savannah River represented about 40 percent of the donations to the regional campaign.

Education and educational outreach has been a priority for DOE, Du Pont, and Westinghouse and its contract partners. Under Du Pont, field trips to the plant by local secondary school students took place on the birthday of Thomas Edison to encourage the teaching of science in high schools. Other early outreach programs included the Savannah River Laboratory's agreement to help Clemson College initiate a program in nuclear engineering. In the late 1950s, professors from the college spent time in training at the Laboratory; later, graduate students worked at the Laboratory as part of their course requirements. Similar arrangements with other schools were established to allow graduate and later undergraduate students to work in plant operations. The first student to complete a cooperative program at the plant was Lynwood Croom, a University of Florida electrical engineering student who completed the work-study portion of the program in 1958. At that time, 11 students in various physics and engineering programs were involved in work study programs at the plant. In addition to the University of Florida, the students came from Georgia Tech, Auburn, and Georgia State.

When peaceful uses for atomic energy received greater emphasis under Glenn Seaborg's direction of the Atomic Energy Commission, an expanded educational role for Savannah River was begun. The program initially targeted the University of South Carolina, Clemson, the University of Georgia, Emory University, and Georgia Tech. Professors were able to work in the Laboratory, graduate students were presented scholarships from the Atomic Energy Commission and some also worked in the Laboratory. Du Pont personnel in the Laboratory contributed to and conducted lecture programs and seminars at local institutions of higher learning. In the summer of 1967, more than two dozen graduate and 100 undergraduate students participated in summer work programs at the Plant and Laboratory. Most were from South Carolina and Georgia, but others came from as far away as New York, Wisconsin, Michigan, and Texas. An effort to broaden still further the cooperative programs began in 1970, when specific invitations to universities with predominantly African-American enrollment were extended. Colleges joining the program at that time included the Tuskegee Institute of Alabama, the Tuskegee and North Carolina Agriculture and Technical

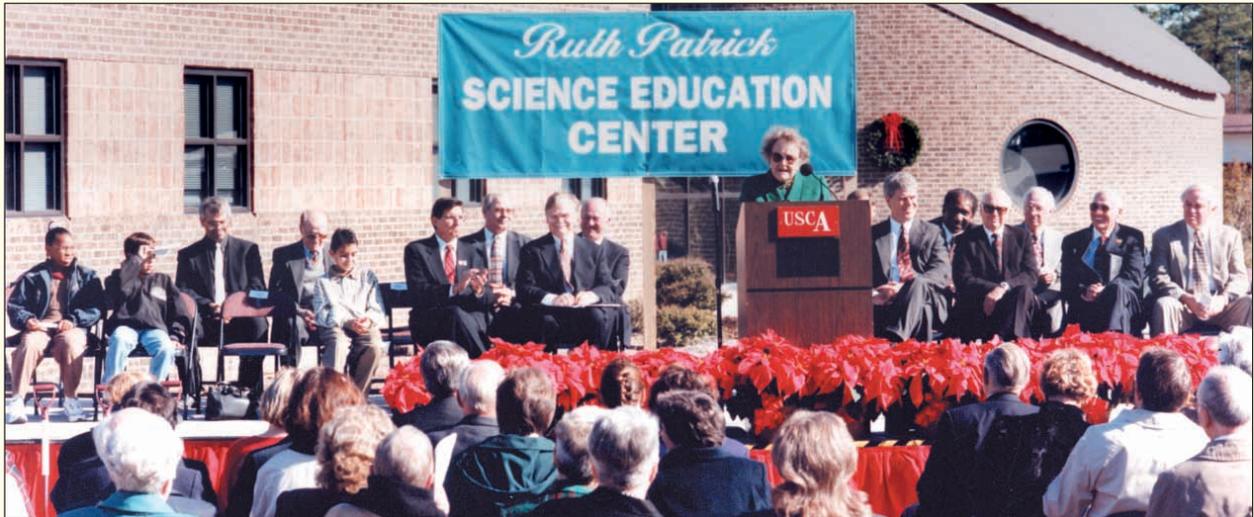


Students with the AEC Summer Employment Program pose with SROO Manager Nat Stetson, 1974. Courtesy of SRS Archives, negative 18219-1.

State University, the South Carolina State College at Orangeburg, and Voorhees College.

Beginning in the 1970s, outreach and cooperative programs shifted to include greater focus on environmental studies. The Savannah River Ecology Laboratory was an important component of environmental research cooperative programs, and when Savannah River became the nation's first National Environmental Research Park, selected areas were designated for research and efforts taken, to encourage local and visiting environmental scientists to use these areas to conduct research aimed at developing a better understanding of ecological principles. SREL continues this tradition today, as does Savannah River Forest Station through its Savannah River Field Station and other programs that offer educational advancement in ecological and environmental studies. Savannah River Archaeological Research Program is also dedicated to public outreach, specifically in the area's cultural history.

Education became a focus offsite under Du Pont, and this program was reinforced by Westinghouse's commitment to become a corporate partner with its community. The Ruth Patrick Science Education Center (RPSEC) at the University of South Carolina-Aiken was conceived over a dinner attended by the USC-Aiken chancellor Dr. Robert E. Alexander and Du Pont staff members. A partnership between the university and Du Pont was brokered to further science and math education in the CSRA. Du Pont contributed \$250,000 towards the center that includes the Du Pont Planetarium. The center offers science courses and workshops that teach about the environment, chemistry, and nuclear science for teachers. It is also the home base for the Traveling Science Demonstration Program that allows materials to be checked out for use in area schools. Westinghouse was on hand to help with the costs of



Groundbreaking for addition to Ruth Patrick Science Education Center at USC–Aiken, 1997. Dr. Patrick addressing Secretary of Energy, Federico Peña; current WSRC Manager, Joe Buggy; WSRC President, Ambrose Schwallie; and others. Courtesy of SRS Archives, negative 97-1558-3.

enlarging the center with a donation of \$250,000, and DOE provided \$1.4 million to finance the addition that was named Westinghouse Hall. Dr. Jeffrey M. Priest, director of the RPSEC, noted that tens of thousands of students benefit each year by visiting Westinghouse Hall, or by having access to the center's scientists, or from the loans of scientific materials that allow science teachers to improve scientific education in their home schools.

In addition to its support of the RPSEC, Westinghouse has provided in excess of \$2 million to scholarships, student internships and research, specific department support, and the arts and cultural programs to USC-Aiken. Funding in the neighborhood of \$1.5 million was also provided to the school for scientific and environmental research. Aiken Technical College has benefited from Westinghouse's commitment to its community in the areas of technical training, grants toward construction of the Dale Phelon

Information Technology Center, and in financially supporting academic and continuing education programs and student scholarships.

At the elementary and high school level, the Site is responsible for a plethora of educational programs in Aiken, Allendale, Barnwell, and

Bamberg counties in South Carolina and Richmond County, Georgia. The CSRA Science and Engineering Fair held annually, grants given for science supplies, the CSRA College Night attended by about 4,000 students, and the DOE Savannah River Regional Science Bowl are all examples of ongoing programs that show Savannah River's commitment to its community.



Student Tour, SRTC, 1992, in Robotics Laboratory, 1992. Courtesy of SRS Archives, negative 92-1711-20.

Source: "First Co-Op Finishes Stint Here, Heads Back for Final Classroom Work," *Savannah River Plant News*, September 26, 1958. "Education Research Program Planned for S.C., Georgia," *Savannah River Plant News*, April 19, 1963. 108 "Undergrad in Summer Work," *Savannah River Plant News*, June 30, 1967. "Negro Colleges Add to SRP Co-Op Program," *Savannah River Plant News*, June 12, 1970. Loren Schneider, "Contributions - The Positive Impact on the Community," *Aiken Standard*, November 27, 2000.



Ambrose Schwallie, WSRC President, 1991–1999. Courtesy of the SRS Archives.

“I was most impressed at the dedication to safety and safety culture. I was also impressed with the quality and caliber of the people at the site. The technical excellence out there is tremendous as well as the work ethic of the people at SRS. I also realized what a national asset SRS was and turned out to be. That ground out there served a tremendous role in the history of the country. It’s a great site and I’ve probably never become so emotionally attached to a job or a piece of property in my whole career.”

Source: Sandy NeSmith, “Westinghouse Era,” *Aiken Standard*, November 27, 2000.

problems associated with the various processes that would have to be resolved. In meeting this challenge and others, Westinghouse also agreed to conform to standards and rules set by DOE. At a basic level, this meant adhering to the general standards preferred by the Department, specifically those established by the International Organization for Standardization, or ISO.⁷ The company made it clear that it would run the facility in accordance with DOE’s preferences and in a cooperative fashion. In addition, Westinghouse promised to support and pursue areas of common interests with local universities: Clemson University, Medical University of South Carolina, and the University of South Carolina at Columbia and at Aiken. Technology transfer, a distinguished scientist program, graduate courses in disciplines linked to waste, health, and environmental issues were all targeted. They further pledged to use minority businesses, continue work on environmental problems, and to “continue our tradition of active and supportive involvement with local communities, universities and organizations to maintain and enhance the role of both the Savannah River Plant and Westinghouse as a ‘good neighbor.’”⁸

James S. Moore was named president of the new company and leader of the management and operation of the Site. Prior to this, Moore was vice president and general manager of the parent corporation’s Government Operations Business Unit that handled all of Westinghouse’s government operations. He served as manager of SRS for a two-year period. Ambrose Schwallie, who started out as executive vice-president at the Site, succeeded Moore in 1991. Schwallie began his career with Westinghouse in 1972, working as an engineering manager within Westinghouse Corporation’s Advanced Energy Systems. In 1979, he managed the core reactor design of the Clinch River Breeder Reactor at Oak Ridge. Notably, Schwallie had orchestrated the successful contact proposal that led to the designation of Westinghouse as the new prime contractor in 1988. His tenure as manager at SRS lasted a decade. In 1999, he was designated president and chief operating officer of the government operating unit of Washington Group International, of which WSRC is a wholly owned subsidiary.⁹

At the outset, all of Savannah River Plant’s employees were offered employment, and an additional 37 key positions were offered to members of Du Pont’s upper management. According to one report, Westinghouse would add twenty-two upper management positions to this while Bechtel National added six. For the first three years of the new contract, there were some difficulties as a largely “Du Pont” work force integrated themselves into Westinghouse’s corporate culture.¹⁰ A working relationship between Westinghouse and DOE also had to develop simultaneously. The complexity of these changes was only deepened by the context in which they were to occur. All of these growing pains were reported upon by the media; by the 1990s, Savannah River Operations was a media presence, and its missions and changes in them were open for public input.

The shift in the main mission at Savannah River from nuclear–materials production to site cleanup and remediation was partially a cause of some of the problems. The path from one to the other was not smooth, and for a number of years in the early 1990s, Westinghouse was required to do both simultaneously—and to more exacting safety standards. By 1991, the Savannah River work force had swelled to a peak of 25,800 persons, and the facility had an annual budget of \$2.2 billion, twice what it had been two years earlier.¹¹ And while work progressed on both fronts, criticism of the facility heightened,

especially as Savannah River prepared to restart K Reactor for tritium production. After the Soviet Union dissolved in 1991, the public outcry against the restart program became too great, and DOE decided to eliminate the program. It took a number of years before new missions would be sorted out.

FIRST HURDLE—K REACTOR RESTART

When Westinghouse took over the Savannah River Site, there was the intention of starting at least some of the original five reactors. Even though the reactors had been shut down in 1988 due to various safety concerns, it appears that the Department of Energy wanted the reactors shut down so that restart could be done with a new contractor–operator. Although the Cold War was winding down, DOE was still concerned about the nation’s nuclear arsenal. Plutonium, which has a half-life of some 24,000 years, was in no need of replenishment in an era of relaxing tensions. The same, however, could not be said for tritium. An essential ingredient for hydrogen bombs, tritium has a half-life of 12 years. Without renewal, virtually the entire U.S. supply of this gas could decay over a single lifetime. Counter-balanced against this need, however, was growing public and political pressure not to restart any of the original five SRS reactors, no matter how urgent the need for tritium. It was in this context that an attempt was made to restart K Reactor for tritium production in the early 1990s.

Westinghouse completed its first safety review in April 1989 noting that K, L, and P Reactors all had restart potential, although the main focus of study was K Reactor.¹² In 1990, a top official at Bechtel averred that the push to restart the three production reactors was the “Number 1 priority on the site.”¹³ In May of that year, James Watkins, the Secretary of Energy under President Bush, announced that K Reactor would be returned to service by December, and that P and L would follow in March and September of 1991, respectively.¹⁴ Despite this enlarged focus, work remained concentrated on K, which did not reopen in December. L Reactor was relegated to a back-up source for tritium in 1990, while P Reactor was shut down permanently in February 1991.¹⁵ In the meantime, K Reactor was upgraded to meet more stringent safety regulations, especially those related to loss of pumping accidents.¹⁶

One of the main reasons for the delay of the K Reactor restart was the demand for a facility to treat the effluent hot water. Just as L Reactor, 10 years earlier, had not been allowed to restart without the addition of L Lake, so K Reactor was not allowed to reopen without a cooling tower, similar to those required for commercial power reactors. It was announced in June 1990 that a cooling tower would be constructed to comply with South Carolina water quality standards pursuant to Consent Order No. 84-4-W with SCDHEC. This order mandated thermal mitigation for all the Savannah River reactors (C, K, and P Reactors) as well as other facilities. Like similar towers, it was designed to take the reactor effluent water at a temperature of 170° F and reduce the temperature to 90° F, as required by South Carolina law.¹⁷ With a projected construction period of two years, the K Reactor Cooling Tower was initially estimated to cost around \$79 million.¹⁸ By January 1992, with the tower still under construction and the facility scheduled for completion by the fall of that year, the cost had risen to \$90 million. By the time of completion, the K Reactor Cooling Tower was 447 feet high, with a base diameter of 345 feet.¹⁹

Even though it was to be connected to K Reactor in December 1992, the cooling tower was never actually used, since K Reactor itself never progressed beyond a test run.

By 1992, it was obvious that the K Reactor restart project faced an uphill public relations battle. In late December 1991, a leak in one of the K Reactor heat exchangers released 150 pounds of tritiated water into the Savannah River, a relatively minor contamination that was picked up by sensors on the Savannah River. Despite SRS denials of any imminent danger, public utilities downstream from the Site closed their intake valves until the contaminated water had passed.²⁰ This accident released a groundswell of political opposition to the reopening of K Reactor itself. Unlike previous protests, this not only included environmental interest groups, but also many local South Carolina and Georgia politicians who previously gave their unanimous support for Federal undertakings at SRS.²¹ To help defuse the situation, the Department of Energy announced in February that K Reactor would only act as a reserve, to be tested and then shut down until needed for future tritium production.²²

K Reactor was raised to criticality on June 8, 1992; however by then it was understood that the reactor would be operated only



K Area Cooling Tower under construction (Top). K Area after construction of cooling tower (Above). Note stacks of Georgia Power nuclear facility, Plant Vogtle, to the west across river in Georgia. Courtesy of SRS Archives, negatives 93-1340-17 and 91-2203-20.

for a test run.²³ Even though there were plans to restart the reactor in the spring of 1993, international and domestic political events worked to keep the reactor closed.²⁴

Although the nation needed tritium for hydrogen bombs, there was a decrease in the need for bombs, as the Cold War finally came to a close in the early 1990s. In August 1991, Communist hardliners led a push against increasingly reformist leaders in Moscow. Not only did the uprising fail, but it also backfired, leading to the final dissolution of the Soviet Union and the rise of Boris Yeltsin as President of Russia. In the United States, there was soon a “peace dividend” to be awarded at home. President Bush announced unilateral nuclear cuts in September 1991, and it was clear that DOE contractors were increasingly interested in facilitating the “nuclear clean-up” work.²⁵ In January 1992, during the controversy over the tritiated water released in the Savannah River, the Department of Energy announced a shift in focus from defense to environmental clean up. Plutonium-production activities at Rocky Flats were halted, and plans to restart K Reactor were reconsidered.²⁶

The next year would bring even greater changes. In November 1992, William J. Clinton defeated George Bush's bid for reelection, and the new administration, which took office in January 1993, was not sympathetic to the nuclear status quo. The Clinton administration almost immediately cut funding for atomic reactor research and in other areas.²⁷ At SRS, the workforce was pared from a high of around 25,800 in 1991, to 22,000 by 1994, with plans to reduce the number of employees systematically in the years to follow.²⁸

No one personified these changes more than the new Secretary of Energy, Hazel O'Leary. By the end of 1993, O'Leary was calling into question the veil of secrecy that had previously been the hallmark of the nuclear weapons complex. She called for a revision of the Atomic Energy Act of 1954 to permit a greater openness of information²⁹ and the declassification of many previously secret DOE documents.³⁰

All of these changes spelled the end of the SRS production reactors. In April 1993, the Department of Energy sent a letter to Westinghouse to shut down L Reactor without possibility for restart. K Reactor was to be placed on "cold stand-by," with no planned provision for restart.³¹ That same year, the R, P, L, and C Reactors were declared "excess" by DOE, with no further production mission.³² In November 1993, Secretary of Energy O'Leary announced that K Reactor would not be restarted.³³

CONTRACT RENEWAL

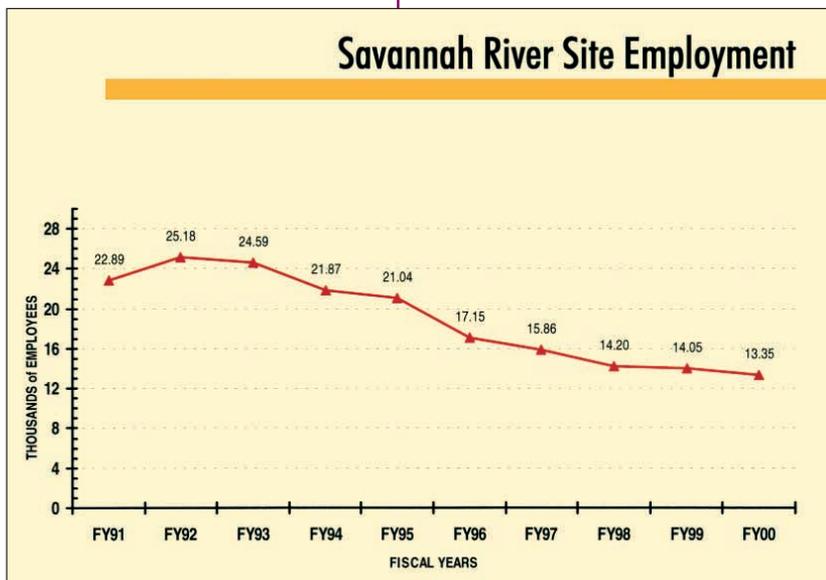
Difficulties during the transitional first years of the contract, intense public pressure on SRS not to resume reactor operations, and scrutiny from Washington compelled DOE to announce that it would seek an open selection process for the new Savannah River contract, with bids submitted in 1995 and the contract to be awarded the following year. Only one bid was made, and that bid was submitted by the existing contractor, Westinghouse Savannah River Company. The new Westinghouse proposal, based on experience at the Site, differed from the previous bid. An enlarged team of subcontractors had been assembled with each bringing specific expertise to help the main contractor meet the demands of what was turning out to be a new set of missions and a developing scope of work.³⁴ By the mid-1990s, there was less discussion on resuming reactor operations, and this change translated into less media attention for the site. Also stakeholders in the site's operation within the local community were now able to provide input into site operations through public meetings and public comment periods, easing the tension once felt between the site and its community. By 1995, given all these factors, the facility had largely made the transition from the old missions to the new, and it had a set of experienced subcontractors charged with specific responsibilities to carry out the work that was projected.

Print to Digital

In the 1990s, site communications moved from print to digital media. The first local area network at the site was installed in 1982, serving only the main Savannah River Laboratory building. The first site-wide network was installed in 1986 and 1987, geographically one of the largest in the country at the time. At the end of Du Pont's tenure and under Westinghouse, every office was wired to have at least two computer data connections. The extensive site computer network, called SRSnet, now provides the means of direct, daily messaging to supervisors and all employees who have computers in their workspaces, and made offsite employees in Aiken, North Augusta, and Augusta an integrated part of site communications. Information distribution was further enhanced in 1996, with the implementation of the Savannah River Information Network Environment, or ShRINE, through which all employees have access to telephone directories, newsletters, forms, site manuals, and other information necessary to the workplace.

Although electronic mail and the site's computer network have given employees digital access to much of the information that once was provided by letters, booklets, and memoranda, not all of the earlier modes of communication have been set aside. The plant newspaper, renamed the *SRS News* when Westinghouse became the prime facility contractor in 1989, continues to be published on a monthly basis.

Savannah River Site Employment, 1991–2000. Source: Doug Carnahan and Rich Keenan, *Savannah River Site Overview*, Westinghouse Savannah River Company LLC. Prepared for WGI, Denver, August 9, 2000.



For the contract that began in 1996, Westinghouse Savannah River Company, in addition to Bechtel, brought on board Babcock & Wilcox Company (later known as BWX Technologies) and British Nuclear Fuels Ltd.³⁵ The division of labor is roughly as follows: Westinghouse operates the nuclear facilities, the Savannah River Technology Center (the Savannah River Laboratory), environment, safety, health, quality assurance, and all formerly administrative functions. Bechtel Savannah River, Inc., is in charge of the environmental restoration project management, engineering, and construction work. Babcock & Wilcox Savannah River Company was introduced to handle facility decontamination and decommissioning, and British Nuclear Fuels was brought in to run the solid waste program. All of these firms operate under the aegis of the Westinghouse Savannah River Company, identified as the main contractor.³⁶

Underneath the umbrella of Westinghouse, but independent of it, is the next tier of contractors. These consisted of Wackenhut, in charge of security; the Savannah River Ecology Laboratory, affiliated with the University of Georgia; and the Savannah River Natural Resource Management and Research Institute, which was effectively an arm of the U.S. Forest Service. By 2000, Westinghouse and its various contract partners had a total workforce of 12,300 people. Wackenhut has another 800, followed by 150 for the Savannah River Ecology Laboratory and another 80 with the Forest Service. With a supervisory force of around 500, the local office of the Department of Energy, DOE-Savannah River, rounds out the team. The complete work force at SRS now stands at 13,830.³⁷

FUTURE PATHS

The reactor closings and negative publicity led to positive action within the nuclear community in the early 1990s, especially in the Savannah River Site area. Long protected by secrecy and unfamiliar with the demands of public relations work, the local nuclear community saw negative reaction to their livelihood progress as fear of low-level radiation appeared to become a national concern. To present a more balanced view of nuclear energy, a local group of concerned scientists established the Citizens for Nuclear Technology Awareness (CNTA) in 1991. This group's activities expanded over time, as the threat to nuclear programs increased across the board.³⁸ As part of the CNTA program in support of nuclear energy, Edward Teller was invited to the area in 1992, and his comments were recorded. Teller noted that France produced 75 percent of its electricity in power reactors, while the United States was still mired in the 20 percent range—virtually unchanged since Three Mile Island. Teller expressed his fear that in rejecting nuclear energy, the U.S. might also be turning its back on technology in general.³⁹ While Teller's comment con-



Citizens for Nuclear Technology Awareness Pioneers with Edward Teller at inaugural Teller Lecture, 1992. Dr. Teller is seated in center. Courtesy of CNTA.

cerning technology may have been overstated, there was no denying that the nuclear industry was in decline.

Despite such publicity, there was still the question of tritium production, and for many that solution was a new reactor. Tritium had not been produced for the U.S. nuclear weapons stockpile since 1988. Stockpile requirements were met through the recovery of tritium from dismantled nuclear weapons and from routine tritium reservoir exchanges from the existing stockpile. Throughout the 1980s and into the 1990s, there was much discussion over the need and location for a “new production reactor” or NPR. Built to modern specifications and with up-to-date safety features, it would be easier to commission than an older reactor that required upgrades. With K Reactor out of the picture, the NPR remained a theoretical possibility. By the late 1980s, a heavy-water NPR had been planned for Savannah River Site, and at that time, it was assumed that it would take 10 years to build.⁴⁰ In November 1991, it was announced that any future planning work on the NPR would be delayed for two years as a result of the end of the Cold War.⁴¹ The following year, NPR plans were again postponed until at least 1995.⁴² In May 1994, there was discussion of a dual reactor that could burn excess plutonium for electricity and also produce tritium for national security, a concept that was strongly supported by the CNTA.⁴³ In the end, the NPR never left the drawing board, in large measure because the very concept of a reactor had negative connotations to the American public.

In 1995, the Secretary of Energy focused on two options: the purchase of an existing commercial reactor or the purchase of irradiation services from a commercial light water reactor (CLWR) or the design and construction of an accelerator system. The possibility of producing tritium without a reactor was discussed as early as 1989 when a scientific panel proposed construction of a “linear accelerator,” rather than an NPR, for the production of tritium.⁴⁴ Conceived as a tube, about a mile long, the linear accelerator remained under considera-

Artist's Conception of Accelerator. Courtesy of SRS Archives.



Shovels filled with red clay at ground-breaking of New Tritium Extraction Facility in July 2000. From left to right, Steve Sohinki (DOE-HQ Director, Office of Tritium Production); Dave Beck (Assistant Deputy Administrator for Military Application and Stockpile Operations); Carolyn Huntoon, Assistant Secretary for Environmental Management; Greg Rudy, DOE-SR Manager; Secretary of Energy Bill Richardson; John Gordon, Administrator, National Nuclear Security Administration; Madelyn Creedon, Deputy Administrator for Defense Programs; Joe Buggy, WSRC President; and Rich Viviano, SR Acting Deputy AM for National Security. Courtesy of SRS Archives, negative 00-1269-9.

tion.⁴⁵ The accelerator had a number of advantages over a reactor. It would not require fissile materials, there would be no fission process and no spent fuel, and there would be a safety bonus as well, since there would be no possibility of a criticality accident.⁴⁶ SRS was the proposed site, should one be built.

In December 1998, DOE ended the debate by choosing to use an existing reactor, the commercial light water reactor option, for future tritium production. The accelerator is now considered a backup option; as a consequence only design and development work will be completed.⁴⁷ Instead, a program has been initiated to produce tritium using the Tennessee Valley Authority's Watts Bar and Sequoyah reactors. Tritium Producing Burnable Absorber Rods (TPBARs), supplied by DOE, are to be irradiated in the TVA reactors, after which the irradiated material would be shipped to SRS for extraction and processing. The Tritium Extraction Facility (TEF), expected to cost \$400 million and scheduled for construction in H Area, will allow SRS to extract tritium-producing gases from the TPBARs. The gases will then be delivered to the Reservoir Loading Facility where they will be purified and readied for use to fulfill stockpile requirements.⁴⁸ The TEF, when completed, will consist of three structures: the Remote Handling Building (RHB), a Tritium Processing Building, and an administration building.



The RHB will be located inside the existing tritium area at SRS just west of the Reservoir Loading Facility. The RHB will include a truck receiving area, cask decontamination area, TPBAR and waste preparation area, furnaces, hot maintenance areas, and associated extraction pumps and tanks. It will also include an overhead crane and remote-handling equipment. The purpose of the Tritium Processing Building is to provide preliminary purification of the extracted gases prior to transfer to the Reservoir Loading Facility.⁴⁹

As noted, tritium stockpile requirements were met through the recovery of tritium from dismantled nuclear weapons and from tritium reservoir exchanges from the existing stockpile since 1988. Recycling the remaining tritium from existing weapons reservoirs allows reuse of the tritium, and SRS has the sole facility in the nation for recycling tritium from nuclear weapons reservoirs returned from service. Each reservoir, a stainless steel canister, contains three gases: the remaining tritium, non-radioactive deuterium, and helium-3. The latter is produced when tritium decays and it is this “poison” gas that needs to be separated from the useful isotopes, tritium and deuterium.⁵⁰

The Replacement Treatment Facility, a one-acre underground, totally confined building, was constructed in H Area for this purpose. The new facility became operational in 1994. Within it, tritium gases are unloaded from old reservoirs, useful hydrogen isotopes (tritium and deuterium) are separated out and purified, and then mixed to the correct specifications for loading into reservoirs. A 400-watt laser is used to remove the gases from the reservoirs by cutting a hole in it, allowing the gas to expand into a receiving tank. Once separated, the tritium/deuterium gas is placed in metal hydride beds, metal containers with metal particles that absorb hydrogen isotopes when the particles are cold but release gases when heated. The transferred gas safely awaits enrichment in these beds.

“Enrichment” used in this context actually means “separated” so they can be mixed in exact proportions. This is executed using the Thermal Cycling Absorption Process (TCAP) in which the gas is repeatedly placed into a cool TCAP column, where it is heated. The heavier isotope, tritium, gravitates to one end of the column, while the lighter deuterium remains at the other end; each is then drawn off and separately stored. Mixing of the gases occurs next, and several types of reservoirs result; mass spectrometry is used to test the exactness of the blend. A mechanical compressor system compels the gas mixture into a reservoir and the fill stem of the reservoir is then pinched, resistance-welded, and tested.⁵¹

The new facility provides a much safer work environment due to the facility design. Process rooms are operated as “clean” radiologically controlled areas; all tritium work is completed in gloveboxes filled with nitrogen gas (nitrogen atmosphere reduces the possibility of the production of tritiated water); stripper systems that remove residual tritium from gloveboxes are in place; metal hydride beds allow the safe storage of the isotopes in a solid form; a laser system is used for unloading reservoirs replacing a mechanical shear-

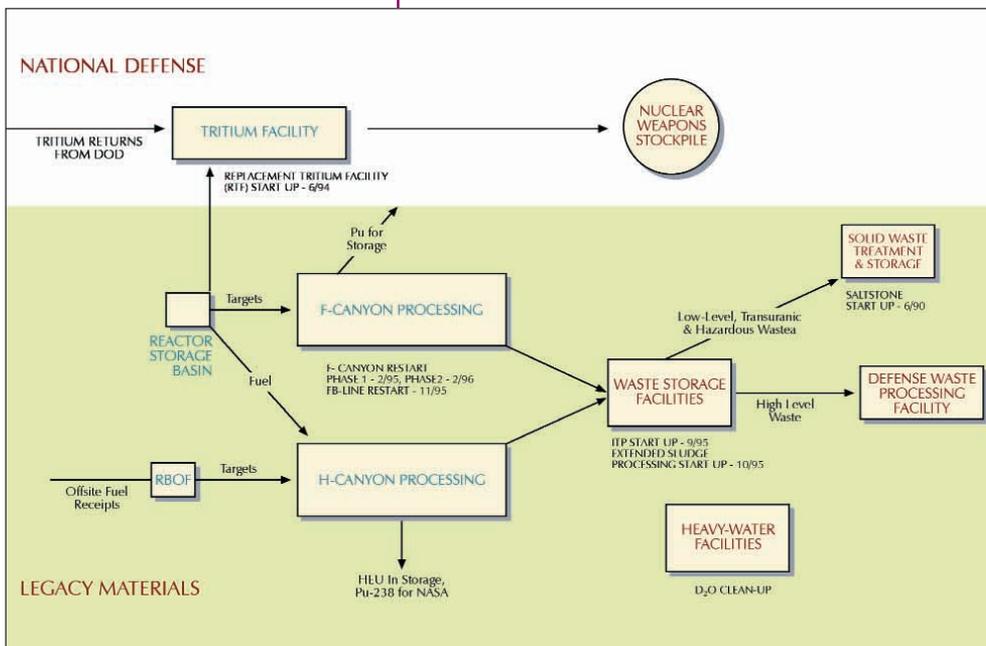


Replacement Tritium Facility Group, 1993. (Front Row from Left to Right) Glenn Gilbody, Maggie Hitt, Gary Thurnock, and Don Kinnsch. (Back Row from Left to Right) Tom Crouse, Brian Geyer, Joe Weatherly, and Roger Yancey. Courtesy of SRS Archives, negative 93-1189-1.

ing system that was formerly used; and a dry pump system now operates in the building. The Replacement Tritium Facility is now one of four main buildings that house tritium facilities at Savannah River Site.⁵²

NUCLEAR MATERIALS STEWARDSHIP

Spent nuclear fuels (SNF) is a generic term for fuel and isotope production targets that are taken from nuclear reactors after irradiation.⁵³ The sources of SNF are commercial power reactors, defense material production reactors, domestic and foreign research reactors, and naval reactors. SRS is one of two DOE sites that receive SNF and it does so in accordance with the May 1995 DOE Programmatic Spent Nuclear Fuel Environmental Impact Statement Record of Decision. Between 1964 and 1992, the Receiving Basin for Offsite Fuels (RBOF) was used as a holding facility for SNF. Under the Atoms for Peace Program, the U.S. provided nuclear technology to foreign countries to pursue peaceful



Savannah River Site Production Flow, 1995. Courtesy of WSRC.

When the latter agreement expired, the receipt of highly enriched uranium fuels was curtailed, and low-enriched uranium fuels were no longer received after 1992. This policy changed in 1996 at the behest of the U.S. Department of State and the International Atomic Energy Agency. Shipments of fuel from foreign research reactors (one shipment containing 4–8 casks) will arrive every four months until the end of the program in 2009. Fuels from domestic reactors (two shipments per month) will be received until 2035.

Built for this purpose, the RBOF is slightly larger than a baseball infield, encompassing an unloading basin, two storage basins, a repackaging basin, a disassembly basin, and an inspection basin. The walls are specially treated and the basin floor is covered with stainless steel plate; the total volume of all the basins and their linking transfer canals is 500,000 gallons of water. The fuels are shipped to the facility via railroad in heavily

applications in the fields of medicine, agriculture, or industry. The loaned technology was typically in the form of research reactor technology and the highly enriched uranium fuel needed to run the reactor. As the uranium used in these experimental venues could also be used to produce nuclear weapons, the U.S. stipulated that the used fuel elements or “spent fuels” would be returned to the U.S. for processing after use by foreign researchers. This was done in accordance with first bilateral agreements then under the Off-Site Fuels Policy in effect between 1964 and 1988.⁵⁴

shielded casks and are lifted into the unloading basin, which is 29 feet deep. Notably, spent fuels from SRS production reactors are about 14 feet long and 3–4 inches in diameter, while those from offsite are individually shorter but are packaged in containers that are 11 and 14 feet in length. The SNF created at SRS from its production mission is stored in L and K Reactors' disassembly basins. Also, as space is limited in the RBOF, L Reactor basin and water chemistry was modified to enable it to receive and provide short-term storage of research reactor fuel assemblies. It received the first shipment in January 1997.

The inventory of SNF at SRS includes about 1,400 production reactor assemblies; 3,400 assemblies of aluminum-clad research-reactor spent nuclear fuel; and 2,000 assemblies of zirconium/stainless-steel-clad research reactor spent nuclear fuel. Planned future disposition of these assemblies varies for each group. The SRS production reactor SNF will be processed onsite at the canyons through 2003 as directed by the 1997–1998 INMAN Environmental Impact Statement Record of Decision. The assemblies that are clad in aluminum will be processed through a new facility called the Treatment and Storage Facility and readied for disposal in a geologic repository. Finally, the third group of assemblies, uranium clad in zirconium or stainless steel, is scheduled to be sent to the Idaho National Engineering and Environmental Laboratory about 2010, where process modifications will be made to treat these assemblies. Aluminum-clad fuel stored at Idaho will be shipped to SRS for processing.

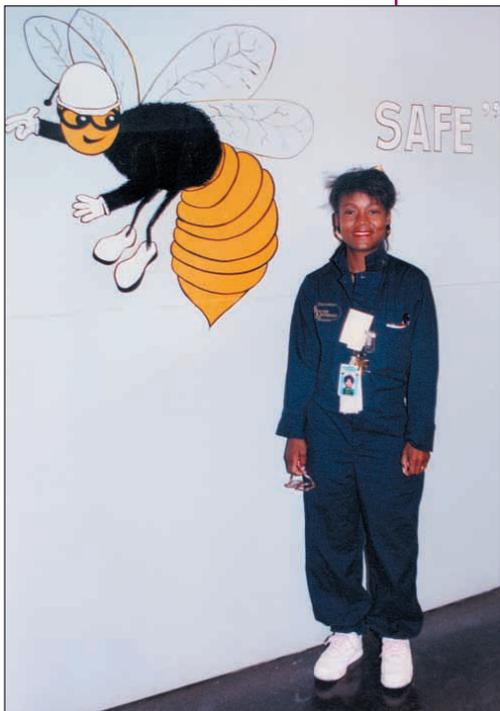
Despite its low volume within the SNF inventory, aluminum-based research reactor SNF offers particular technical problems for disposal that have to do with its diverse forms after manufacture, its corrosion rate, and level of enrichment. SRS researchers, after much analysis, have designated a demonstrated technology, the melt–dilute process, for a pilot study. This process, in which furnaces melt the SNF and dilute the uranium enrichment, is also the preferred technology for most of the research reactor SNF. L Reactor has been targeted for possible use after modifications for the Treatment and Storage Facility that would house the melt–dilute process.⁵⁵ The impetus for this work derives from a 1996 DOE commitment to implement a program for “identifying, developing and implementing a technology alternative to conventional chemical reprocessing for the stabilization and final disposition of aluminum-based research reactor spent nuclear fuel. The mission of the Alternate Technology Program is to develop a treatment and interim dry storage of the spent fuel in a manner that will be “road-ready” for disposal in DOE’s planned geologic repository.”⁵⁶

Even though neither tritium nor plutonium has been produced since 1988, plutonium-processing facilities at SRS have been newly constructed and older facilities upgraded and



Spent Fuel Shipping Cask, 1981.
Courtesy of SRS Archives, negative
DPSTF 1-15039.

modified during the 1980s and 1990s to handle existing and future plutonium processing needs. SRS has the only production-scale plutonium glovebox facilities within the complex that have been routinely operated in the 1990s. As a consequence it is the only site with accredited plutonium operators and has a radiological-worker-training program in place.⁵⁷



Rosetta Wiley poses in front of M Area safety mural “BEE SAFE.”
Courtesy of SRS Archives.

The New Special Recovery Facility (NSR) was constructed to reprocess plutonium from the Hanford N Reactor and scrap for weapons-grade material. Located on Building 221-F, near the B Line, the facility was constructed at a cost of around \$86 million. In 1992, when the facility was almost complete, it was suggested that it might not be opened, if only because there was simply no need for the plutonium that it would provide. To date, the NSR has not been used.⁵⁸

The HB Line (Phase I and Phase II) with its glovebox layouts on the roof of H Canyon discussed in the previous chapter, was built to produce plutonium-238 for the U.S. space programs. No new plutonium-238 has been produced since the closing of the last SRS reactors; however all of the plutonium-238 processed for the Space Program and for the nation’s defense was handled at SRS.⁵⁹ Shut down in 1987, the HB-Line, was restarted in the 1990s. The HB Line is now used to stabilize solutions stored in H Canyon. To date, plutonium-238 and plutonium-242 stabilization campaigns have been undertaken, and the Phase II process line within the HB Line is to be used to stabilize plutonium-239 and neptunium-237.⁶⁰ In addition, major modifications were made to the FB-Line that is located in F Area on the top of F Canyon. When built, this process line converted plutonium-239 nitrate solution produced in F Canyon to a solid form, called a button. In 1997, this process line was used for a new plutonium packaging process called “bagless transfer.” In this process, stabilized plutonium is put in strong, welded stainless steel cans rather than plastic; this technology, which allows for safer plutonium storage, was developed at SRS and it is the first use of this packaging within the DOE complex.⁶¹ A summary of plutonium-processing history at SRS notes that 40 percent of the total plutonium-239 in the DOE complex was processed at SRS, and that figure rose to 90 percent after 1970.⁶²

In accordance with a directive that resulted from the 1996 Moscow Summit between President Clinton and President Boris Yeltsin, excess weapons plutonium was slotted for conversion into materials that could not be reused in nuclear weapons. In 1997, a Record of Decision was made in which DOE agreed to pursue this disposition of surplus plutonium by converting it to a mixed-oxide fuel (MOX) and then using that fuel to generate electricity in commercial reactors.⁶³ This conversion entails the construction of three facilities. A pit-disassembly and conversion facility disassembles the cores of nuclear weapons and converts the plutonium inside to a powdered oxide. The MOX facility then takes the powdered oxide for use in the manufacture of nuclear fuel. The third component in the process is the immobilization facility that immobilizes the remaining plutonium oxide into ceramic material and readies it for long-term storage. At this writing, SRS is the preferred site for all three facilities.

Duke Cogema Stone & Webster was selected to design and construct the Mixed Oxide Fuel Fabrication Facility. This is a consortium of firms comprised of Duke Engineering and Services (DE & S); Cogema, a U.S. subsidiary of the French firm Cogema, which specializes in the design, construction, and operation of mixed-oxide fuel fabrication facil-

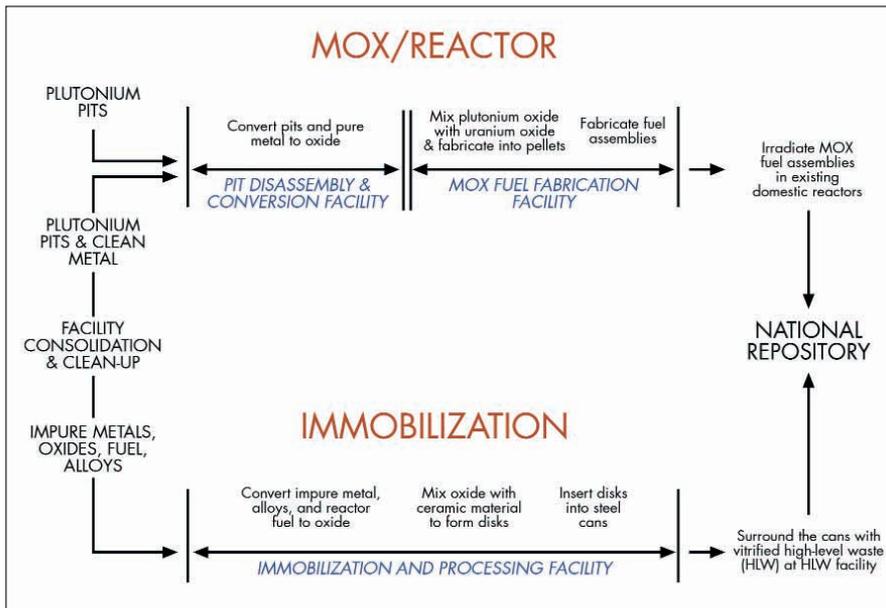


Diagram showing MOX process.
Courtesy of WSRC.

ities; and Stone and Webster, specializing in plutonium design work. The MOX fuel provided by this team will then be available to Duke Power for use in its commercial reactors.⁶⁴

This program has led to an adaptive re-use of K Reactor.⁶⁵ In the year 2000, K Reactor was established as the “K-Area Materials Storage Facility” (KAMS), to be used in the first phase of the MOX process. The many upgrades that SRS was required to make on 105-K for the restart program—from structural upgrades to security changes—made the selection of 105-K for the KAMS project an easy one. A Record of Decision made by Secretary of Energy Bill Richardson in January 2000 on the basis of the Surplus Plutonium Disposition Environmental Impact Statement designated SRS as a major player within the excess plutonium disposition program, of which KAMS is the initial step. In 2000, over 1,000 shipping containers of plutonium were received at K Reactor for storage from other sites within the DOE complex. Double that amount will be stored in K Reactor by the completion of KAMS Phase II. The plutonium, placed in welded canisters, and then nested in containers, will remain in its shipping containers until the processes for disposition outlined above are in operation.

ENVIRONMENTAL STEWARDSHIP

Environmental restoration, waste management, and facility disposition are key components within the site’s environmental stewardship policy developed under DOE’s 1989 Environmental Management Plan. While the pre-operational baseline studies are the foundation on which the current environmental programs are overlain, work in the early 1980s really set the site’s program in action. The site’s placement on the EPA’s CERCLA’s National Priority List in 1989 was followed a year later with a comprehensive site-restoration program.

ENVIRONMENTAL RESTORATION

Environmental restoration in this context encompasses the assessment and cleanup of inactive waste units and groundwater. This began onsite in 1981 with the identification of groundwater problems emanating from M Area settling basin. The cleanup involved and its ultimate closure under SCDHEC guidelines was chronicled earlier. The term “cleanup” refers to a number of strategies from complete removal of a substance or to its stabilization and containment. Simply put, the goal is to treat the substance so that it cannot impact human health or the environment.⁶⁶

The Site’s current restoration program was established in 1990. Under the program, 515 inactive waste and contaminated groundwater units were identified. These units range in size from a few cubic feet of soil to tens of acres, and the types of wastes include solid waste, radioactive waste, hazardous waste, and mixed waste (a mixture of hazardous and radioactive waste). On the basis of the inventory data, SRS, in conjunction with the

USEPA and SCDHEC, maintains a priority list of waste sites that need cleanup, and evaluations on the best approaches to their cleanup given the risks they impose to human health and the environment. If, after investigation, a site is found not to pose a significant health or environmental risk, and USEPA, SCDHEC, and the public are in agreement with the finding, then no further action is taken.

Several federal regulations stipulate how waste is managed at SRS. The Resource Conservation and Recovery Act (RCRA) provides a method for tracking and managing hazardous wastes from their point of origin to their disposal and requires corrective action for releases of hazardous waste from active or inactive waste units. The Comprehensive Environmental Response Compensation and Recovery Act (CERCLA) and the Superfund

Amendments and Reauthorization Act establish liability, compensation, cleanup, and emergency response for hazardous substances released to the environment. The Federal Facility Compliance Act calls for the creation of schedules for mixed waste treatment that are acceptable to both the state and to the Federal regulatory agencies involved. The National Environmental Policy is also a key regulation, requiring that the site evaluate the potential environmental impact of Federal activities and explore alternatives. The Clean Air Act and the National Pollutant Discharge Elimination System are also applicable.

Underneath these regulations, 33 of SRS’s waste sites have been completely remediated, and an additional 39 sites are in progress. Current fieldwork is focused on *in situ* soil stabilization and the placement of low-permeability soil covers over the old F Area Seepage Basin, L Area Oil and Chemical Basin, and F Area Retention Basin. Large-scale groundwater cleanup systems are in place and operating in A, F, H, and TNX areas and in C Area Reactor Seepage Basin, the Mixed Waste Management Facility, and the Nonradioactive Waste Disposal Facility.

SRS has used a number of innovative techniques to accelerate these programs and to perform them with greater efficiency. The groundwater cleanup in A/M Area was expedit-



In situ soil solidification remedial action began at the old F area seepage basin in 1999, and a media event was held at the site in August to commemorate the milestone. Here, the project manager explains the grouting process to a newspaper reporter. Source: Sandy DeWald (NFN).

ed by vacuum extraction technology used since 1995 that removed solvents from the soils above the groundwater, eliminating the possibility of further contamination. BaroBall™, designed by Savannah River Technology researchers, was also used in A/M Area to remove contaminated soil vapor from the subsurface and to eliminate further contamination. The Dynamic Underground Stripping (DUS), a product of Lawrence Livermore National Laboratory that uses steam-injection and soil-vapor/groundwater extraction, was placed into service in A/M Area. The DUS allowed SRS environmental personnel to take Dense Non-Aqueous Phase Liquid contamination from the subsurface, and bring it up to where it could be treated. C Area's Burning/Rubble Pit was the site of three remediation strategies: the placement of a low-permeability soil cover, sparging and soil vapor extraction. This was the first time air-sparging (forcing air into contaminated groundwater to evaporate the solvents) and soil-vapor-extraction equipment were combined at SRS to accelerate the contamination removal process.⁶⁷

The 55-acre Nonradioactive Waste Disposal facility was chosen for a major bioremediation program in 1999:

Naturally occurring bacteria in the soil are capable of breaking down chlorinated organic solvents if they are stimulated with oxygen and additional nutrients. Engineers therefore installed two horizontal wells to feed air, methane, and other nutrients to stimulate microbial activity to destroy the contaminants. These 1400-foot-long wells have the largest screen zones in the country being used to supply nutrients for a bioremediation cleanup. Computer modeling has shown that remediation will reduce groundwater cleanup time for volatile organics from 15 years to 6 when compared with conventional pump and treat alternatives.⁶⁸

This program and others such as the Monitored Natural Attenuation process that uses the indigenous microbe population in the subsurface to remediate groundwater are indicative of SRS attention to innovations that can accrue cost savings for the site as well as increase efficiency. By the close of 1999, 221 sites out of the 515 identified were either closed, in the course of being cleaned up, or found to need no further action. Since 1996, the SRS Environmental Restoration program has been credited with achieving a \$50 million cost savings due to its use of innovative cleanup strategies and a healthy exchange of expertise between the site and others in the DOE complex.

WASTE MANAGEMENT

After decades of production, SRS is responsible for the management of high-level waste, low-level waste, hazardous waste, mixed waste, transuranic waste and sanitary waste that was generated as a result of the manufacture of plutonium, tritium, and other nuclear materials.⁶⁹ The types of wastes and their storage have been discussed earlier, as well as their site locations. In 1999, waste management functions were carried out in five areas: E, F, H, S, and Z. E Area which is situated between the two separations areas, is the locus of most of the Site's disposal and storage facilities. Waste generated from site

operations is stored or treated at: the Solid Waste Management Facility (E Area), the Effluent Treatment Facility (H Area), the high-level waste storage tanks assembled into “farms” in F and H -Areas, the Extended Sludge Processing Facility, the Defense Waste Processing Facility in S Area; the Saltstone Facility (Z Area), and the Consolidated Incineration Facility (adjacent to H Area). The Solid Waste Management Facility, the Extended Sludge Processing Facility, the Defense Waste Processing Facility, the Saltstone Facility, and the Consolidated Incineration Facility all became operational in the 1990s, some after extensive planning that occurred in the previous decade. The management of these materials in the 1990s is largely divided between Solid Waste Management and High Level Waste Management.

E Area’s Solid Waste Management Facility is the repository for solid low-level wastes such as protective clothing, tools, and equipment that are contaminated. In 1994, concrete vaults were constructed for the permanent disposal of solid low-level waste. The composition of the concrete is specially formulated to discourage cracking. SRS is the first facility in the DOE complex to use such facilities, which represent a significant improvement over previous methodologies. Low-activity waste is separated from intermediate-activity waste and placed in separate vaults. Most wastes that are certified as low-level are stored or disposed of in the E Area vaults.



“0 Days Until Radioactive Operations,” DWPF Startup Sign 1996. Courtesy of SRS Archives, negative 96-1120-44.

Prior to this, solid low-level waste was placed in the 195-acre Low-level Radioactive Waste Disposal Facility, referred to earlier as the Burial Grounds. After characterization of the waste types and radioactivity, the waste was sorted and packaged for disposal. Low-activity beta–gamma waste was packaged in steel boxes and placed in engineered trenches approximately 22 feet deep, that featured sloped sides to prevent cave-ins and slightly sloped floors to provide rainwater runoff into sumps at one end of the trench. The higher-activity waste within the low-level waste category was placed in separate trenches or in fiberglass-lined cylindrical holes or concrete trenches to offer

better confinement. No new waste has been introduced into the Low-Level Radioactive Waste Disposal Facility. The groundwater in the area surrounding it will be monitored to identify radioactivity that may have migrated from the facility which will be closed under RCRA guidelines.

The Solid Waste Management Facility is also where transuranic waste is stored. Transuranic waste is defined as “radioactive waste contaminated with certain isotopes that have decay rates and activity levels exceeding defined standards. It contains manmade elements that are heavier than uranium, some of which decay slowly, thus requiring thousands of years of isolation.”⁷⁰ Since the early 1970s, 11,289 unvented transuranic waste drums have been stored in E Area. Of that number, 8,809 were covered by earth and

2,480 were put under weather cover. A 1996 decision to retrieve the buried drums and to vent and purge them was carried out between 1996 and 1999. All of the drums have been repackaged in 55-gallon lined, vented, and unvented drums; casks and boxes are used for bulky equipment. Drums containing waste with higher radioactive levels of transuranic nuclides are further protected within concrete culverts that are overlaid onto concrete pads. Sloping of the pad allows for environmental sampling of the rainwater from the sump prior to the water's discharge. The transuranic waste is stored safely in readiness for eventual shipment to the New Mexico Waste Isolation Pilot Plant (WIPP).⁷¹

The Consolidated Incineration Facility (CIF) was designed to burn specific hazardous, low-level radioactive, and mixed wastes. Approved for construction in H Area, with an estimated cost of around \$90 million, it was engineered to process four million pounds of waste per year.⁷² Construction on this facility began in January 1993. The first trial burn and the start of radioactive operations occurred in April 1997.⁷³ It successfully and safely burned 2,437,000 pounds of radioactive waste in 1999, triple the amount treated in 1997.

The Effluent Treatment Facility (ETF) also in H Area treats the low-level liquid waste that historically was sent to seepage basins. This facility, discussed in the previous chapter, began operation in 1988 and processes about 20 million gallons of wastewater annually. Treated water from the ETF is channeled to a National Pollutant Discharge Elimination permitted outfall which captures all chemical and radioactive contaminants except tritium.

The greatest challenge for the nuclear community today is the treatment of the millions of gallons of high-level radioactive waste generated from hundreds, if not thousands, of reactor cycles and their subsequent purification in the separations process. This high-level waste has been stored in growing numbers of huge metal tanks, both at Hanford and at Savannah River, with the expectation that a process would be identified that would lead to its permanent disposal. It was not until the first tanks began to leak in the 1970s that serious attempts were made to find a permanent solution to this problem.

After years of study, the Defense Waste Processing Facility was conceived as a way to process this high-level waste, using a method that had found favor in the French nuclear community. This method of disposal, the vitrification process, bonded radioactive material with silicon to form "glass logs" that would then be leak-proof. Onsite process development and research began in the 1970s at the CNX/TNX Area. Actual construction of the Defense Waste Processing Facility, or DWPF, began in 1983, and it was completed at a capital cost of \$1.276 billion and start-up operating costs that reached \$1.2 billion. Delays, mostly dealing with process problems and safety practices, occurred throughout the construction and startup period. All were given publicity in the late 1980s and early 1990s.⁷⁴ At the time of radioactive startup in 1996 there were other problems, most notably with the build-up of benzene gas.

In order to understand the problems associated with the DWPF, it is essential to know more details about the process. In the 1940s and 1950s, when the first high-level wastes were stored in large carbon steel tanks, concern over how the wastes were to be disposed of was limited. The major concern at that time was how they could be stored in carbon steel tanks without causing corrosion. Since the waste was acidic, caustics like sodium hydroxide were added to neutralize the matrix. Over time, the neutralized material precipitated out as a sludge that formed on the bottom of the tanks. The liquid matrix above the sludge, known as the supernate, held the lighter elements in a radioactive salt solution.⁷⁵



Simulated Savannah River Liquid Waste Samples, 1978. Courtesy of SRS Archives, negative DPSTF 1-14033-1.

Aerial view of DWPF Building, 1997.
Courtesy of SRS Archives, negative
97-1527-1.



By 1988, there were an estimated 35 million gallons of high-level radioactive waste at SRS, stored in 51 large, shielded, underground tanks clustered into two tank “farms.” The most radioactive elements within the tanks were found in the sludge, which comprised three million gallons of this total. The less-radioactive supernate, also known as salt waste because much of it is sodium nitrate and sodium nitrite, comprised 32 million gallons.

The sludge, because it contains the heavier, more radioactive, elements, was scheduled to go directly to the DWPF after pretreatment at the Extended Sludge Processing Facility. At this facility, the sludge is washed to curtail the concentration of sodium salt and then it is dissolved to remove aluminum for better glass quality at the DWPF. In 1999, the facility began to process the second of ten sludge batches that will need to be completed to vitrify all of the high-level waste sludge.

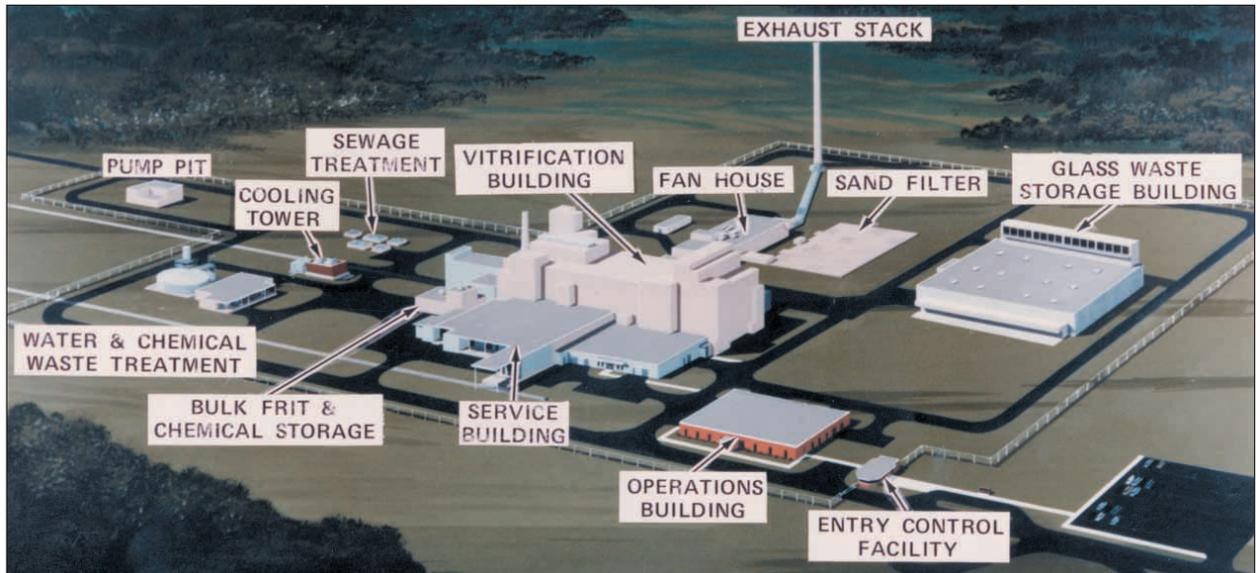
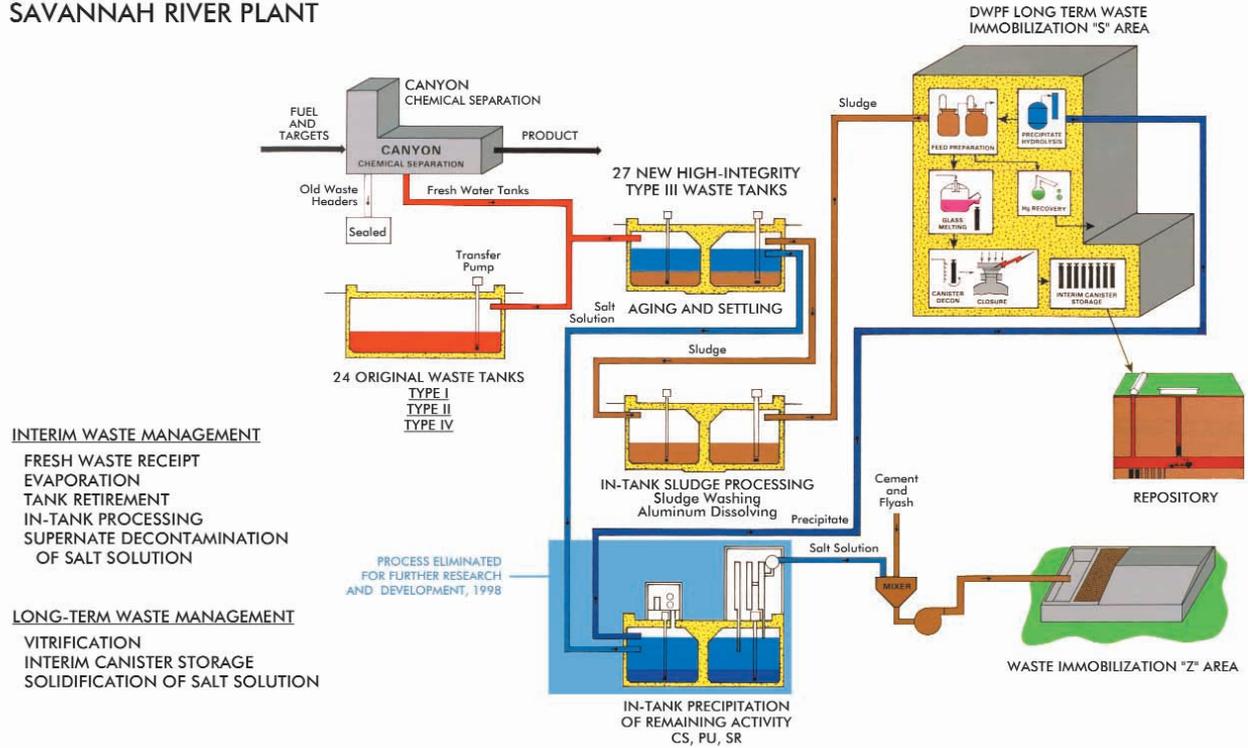
After processing at the Extended Sludge Processing Facility, the transformed sludge is transferred to DWPF for a “sludge only” vitrification. There, the waste, the sludge from the original waste and the highly radioactive material from the salt cake, is mixed with ground borosilicate (glass frit) and fed into a melter at 2100° F. The waste is poured into stainless steel canisters, ten feet high, two feet in diameter, and three-eighths of an inch thick, to cool. The glass-like solid that is produced envelopes the highly radioactive material and effectively seals it off from the environment. The canisters are then stored below ground in concrete vaults until a national repository is established.⁷⁶

With the liquid salt waste, the process was a little different. Any cesium-137 and strontium found in the supernate would be sent to the DWPF to be processed exactly like the sludge. The removal of those two elements reduced the salt waste from the category of high-level radioactive waste to that of a low-level waste. At this lower level, the salt waste does not need to go through the vitrification process. It can instead be sent to the Saltstone Facility, where it is put through a different process.⁷⁷ The SRS Saltstone Facility became operational in 1990.⁷⁸ In this process, the supernate is evaporated to a solid state identified as saltcake. After the cesium-137 and strontium are removed for shipment to the DWPF, the remainder of the saltcake is then mixed with cement, fly ash, and furnace slag,

(Opposite Page) 1. Flow Chart of High-Level Waste Management Processes. Courtesy of SRS Archives, negative 91-1358-1. 2. Layout of S Area showing buildings and their function as planned. Courtesy of SRS Archives, negative 47984-1.

Waste Management Processing

HIGH LEVEL LIQUID WASTE MANAGEMENT SAVANNAH RIVER PLANT



DWPF Interior Views



(Above) Interior of DWPF melt cell behind shielded glass, 1997. Courtesy of SRS Archives, negative 97-1273-9. (Right) Canister inspection within DWPF. Courtesy of SRS Archives, negative 97-1273-11.



to form a grout, that is pumped into one of these large concrete vaults, each of which is subdivided into cells or sections.⁷⁹ Within the cells the grout cures into a stable solid called “saltstone.” When each of the vaults is filled, it will be capped with protective grout, and ultimately final closure will entail covering each vault with a clay cap and a stratum of earth over the cap. Between 1990 and 1998, the Saltstone Facility processed about 2.5 million gallons of salt solutions, transforming them into more than 4 million gallons of “saltstone.”

The In-Tank Precipitation Facility (ITPF), a second pretreatment operation for DWPF, was designed to process the high-level waste salt to remove cesium and other radioactive materials. The facility went into operation in September 1995. It soon developed, however, that higher-than-expected benzene levels were encountered.⁸⁰ As a result, in August 1996, the Defense Nuclear Facility Safety Board recommended that the processing of the liquid salt waste be discontinued. In January 1998, it was determined that the ITP process could not cost-effectively meet safety and production requirements. A SRS engineering design team then studied approximately 140 alternatives to the ITP process and identified four promising alternatives: solvent extraction, ion-exchange using crystalline silicotinate (CST), small-tank precipitation, and direct disposal in grout.⁸¹ Extensive

research and development have been conducted on these alternatives, and the Department of Energy is expected to select a salt waste processing technology after research is completed.

The DWPF has successfully processed radioactive sludge since it began operation in 1996 and has produced over 1100 canisters. The facility will proceed with processing sludge until the “precipitate” from one of the salt processing alternative strategies is available.



Two of the site’s 51 high-level waste tanks, Tanks 20 and 17, both built in 1958 and first used in 1960, have been closed partially because of the successful operation of the DWPF. When the tanks were certified closed by SCDHEC in 1997, they marked a milestone in the site’s history and the DOE complex. They are the first high-level radioactive waste tank closures in the nation. The measures involved in their closure were the product of close collaboration between the DOE, SCDHEC, USEPA, and SRS personnel and the public:

Closure activities began years before the actual closing of the tanks. First, contaminated waste and sludge was removed from the tank to the extent practical (approximately 99.9 percent removed) while finalizing agreements and closure plans with state and federal regulators. Once these steps were completed, the closure activities began with workers pouring grout, a cement-type substance, into the 1.3 million-gallon tanks. The grout hardened, safely incorporating any residual radioactivity in the tank. Over the course of several weeks, the tanks were filled with grout to within a few feet of the top. Then the balance of the empty tanks was filled with very high cement.⁸²

Aerial of Z Area showing multisectional Saltstone Facility, 1989. Courtesy of SRS Archives, negative 89-2080-4.

Work towards alternate technologies and better techniques continues, so that the rest of the high-level waste tanks can be emptied and their contents processed. In this regard, the tank farm evaporators perform heroically in reducing the waste in these tanks to 10 to 33 percent of their original volume. Used since 1960, they have allowed SRS high-level waste managers to reclaim about 100 million gallons of tank space overall, and about 2 million gallons of tank space in 1999 alone. “Without these evaporator, systems, SRS would have required 85 additional waste storage tanks—at \$50 million apiece—to store waste over the site’s lifetime.”⁸³ To comply with Federal and state regulations, the program of waste-tank closures and high-level waste vitrification is to be completed by the year 2028. Even though the vitrified waste is currently stored at SRS, this is an interim arrangement. A permanent storage facility remains to be identified, although the most likely location appears to be Yucca Mountain in Nevada.⁸⁴

FACILITY DEACTIVATION AND DECOMMISSIONING

This component of SRS’s environmental management involves the deactivation of surplus facilities, placing them in safe storage, and readying them for final decommissioning. One hundred and thirty surplus facilities were identified in 1999; these range in type from historic facilities associated with the site’s production mission, such as the reactors and



(Left to right) R.V. Gann, Eric Plantz, Richard Newman, Mark Decosta, Charlie Varner, Teddy Crafton, Mary Fuller, James Wiederkerr and Nick Floyras pose for a staff photograph in 1992 prior to closing of Building 321-M. Courtesy of SRS Archives.

test reactors, to smaller support structures and buildings. The 1990s witnessed strong strides in the decontamination and decommissioning of the original Savannah River facilities associated with the original production mission. Seven of the original process areas, the five 100 Areas, 300 Area, 400 Area, and B Area (originally the TC or Temporary Construction Area) have already experienced change or will in the future in response to the site’s changing missions. The building stock in the Separations Areas has also been impacted.

The Heavy-Water Area (D Area) has been completely decommissioned. The last of the three heavy-water facilities in D Area, 412-D, shut down since 1982, was dismantled by D & D teams between 1993 and 1996.⁸⁵ D Area has now become an industrial archaeological site. During this same period and in the years that followed, the SRS reactors and manufacturing areas have been scenes of similar work. Much of the Fuel and Target Fabrication Area (M Area) has already been dismantled. HWCTR, the experimental heavy water

power reactor that operated in the early 1960s in the TC Area, began decontamination and decommissioning in 1994 and completed the process in 1997.⁸⁶

Building 232-F, which began extracting tritium from reactor materials back in 1955 and was shut down three years later, when new facilities were required, was dismantled in 1994–1997, with grass planted over the site.⁸⁷ The original product vault, 217-F, has also been demolished. And work on the Naval Fuels Facility was initiated in 1999.

Non-radioactive buildings have been decommissioned. Foremost among these are the original powerhouses in the C and P areas. Other areas of work include the R Area water-



Original Tritium Building, demolished 1997. Courtesy of SRS Archives.

treatment plant, the L Area “hot shop,” the R and C area helium-storage facilities, and the heavy-water distillation facilities in Areas P, L and C. Deactivation, and decommissioning teams, however, are not limited to work on structures; smaller items are also subject to cleaning. The Decontamination Facility in C Area is used to clean low-level radioactive contamination from small objects and portable items. This reduces the amount of material with low-level contamination that would otherwise have to be disposed of or stored.⁸⁸

ENVIRONMENTAL MONITORING, PARTNERS AND PRESERVES

Monitoring of the site environment is carried out both on and off the site by members of EPD’s Environmental Section in concert with the Division of Environmental Research of the Academy of Natural Sciences of Philadelphia.⁸⁹ The history of this collaboration was presented in Chapter 17. The monitoring program hinges on effluent monitoring and environmental surveillance, both radiological and nonradiological, and groundwater monitoring. Effluent monitoring is defined as the collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying contaminants, assessing radiation exposure to members of the public, and demonstrating compliance with applicable standards.

Monitoring takes place at the point of discharge, for example at an air stack or at the end of a pipe. In 1999, EMS personnel took approximately 4,200 radiological samples from 71 points of discharge upon which they performed the majority of the radiological analyses required. They focus on the detection of radioactive materials that could be released during site operations in the handling of plutonium, tritium, and other nuclear materials. The data are compiled within a monthly radioactive releases report and then summarized annually and published. The non-radiological airborne emissions of concern include sulfur dioxide, oxides of nitrogen, particulate matter, and toxic air pollu-

Environmental sampling, 1991. Courtesy of SRS Archives, negative 91-1712-20.



tants such as trichloroethylene, perchloroethylene, benzene, and hydrochloric acid. Data gathered from points of discharge are tabulated and then compared to assure that SRS is in compliance with permits issued by SCDHEC. An additional layer of monitoring is performed by the states of Georgia and South Carolina at offsite monitoring stations. This monitoring of ambient air is conducted to evaluate whether each state is in compliance with Federal ambient air quality standards. National Pollutant Discharge Elimination System outfalls provide sampling venues for nonradioactive liquid effluents.

Environmental surveillance is “the collection and analysis of air, water, soil, food-stuffs, biota and other media from DOE sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing the effects, if any, on the local environment.” Unlike monitoring, surveillance pursues the identification of contaminants in the environment. Ten thousand radiological analyses were undertaken on 5,000 samples; 26,958 radiological samples were completed on groundwater samples taken from 1,224 monitoring wells. Mathematical modeling is used to estimate concentrations based on the data collected from sampling; measurement at the point of discharge, which should represent the highest amount, is used to calculate the amounts that will be dispersed in water, soil, or vegetation. Nonradiological surveillance takes place in the site’s streams and in the Savannah River. Notably, the data from the outer areas are compared with outfall data to better detect the presence of materials that might harm the environment. The Environmental Report for 1999 states that approximately 6,300 nonradiological analyses for specific chemicals and metals were completed on about 1,200 samples; 134,123 nonradiological analyses were completed on groundwater samples.

The environmental monitoring efforts listed above for 1999 are a continuation of a program that began in the early 1950s. The records of the monitoring over time have been released for independent study by the Federal Centers for Disease Control and Prevention in Atlanta, Georgia, as part of the SRS Dose Reconstruction Study. The goal of the program is to determine the effects of the release of radioactive materials and chemicals since the site began operations. This program began as a result of the suit against the Department of Energy by the “Three Mile Island Public Health Fund,” an environmental group interested in the effects of long-term exposure to low levels of radiation. As a result of this suit, in May 1990, DOE released the health records of some 200,000 people and employees within the nuclear industry.⁹⁰ That same year, at SRS, Westinghouse made public the first reports that detailed the radioactive releases known to have occurred at the site from 1954 through 1988. These were divided into atmospheric releases, liquid-to-stream releases, and liquid-to-seepage-basin releases.⁹¹

In 1990, DOE contracted with the CDC to measure and evaluate the radiation doses received by people within and around the Savannah River Site. Two years later, the CDC launched its SRS Dose Reconstruction project by awarding a \$1.7 million contract for the first phase of work to Radiological Assessments Corporation of Neeses, South Carolina. Radiological Assessments Corporation (RAC) was commissioned to examine plant records to obtain relevant information, without any restraints from either DOE or the prime contractor.⁹² RAC began examining the SRS records in January 1993, marking the first time that a DOE facility had opened its documentation to outside researchers.⁹³ By September 1994, the first phase of this project was well underway, with more than 133,000 records entered into a master data base.⁹⁴ The record search was completed in 1996. Phase II



Dose Reconstruction Group gets started at SRS Archives, 1993. WSRC-SRTC's Brian Looney (second from left in background) reviews methods with visiting researchers. The Center for Disease Control launched the SRS Dose Reconstruction Project in 1992 when it awarded a \$1.7 million contract for the first phase of work to Radiological Assessments Corporation, of Neeses, South Carolina. The South Carolina firm was commissioned to examine plant records to determine the effects of the release of radioactive materials and chemicals since the site began operations. Courtesy of SRS Archives, negative 93-1780-10.

involved the reconstruction of the historical releases of radioactive materials and chemicals with the purpose of calculating the total amounts and types that were released. The final draft of the Phase II work is currently under review.

SAVANNAH RIVER ECOLOGY LABORATORY

The Savannah River Ecology Laboratory (SREL), a research unit of the University of Georgia, has grown to include a staff of around 165 individuals, including 20 faculty members. Its annual budget has grown from the initial grant of \$10,000 to over \$10 million. It is currently headquartered in A Area adjacent to SRTC within a large laboratory building completed in 1979 that is surrounded by waterfowl pens, greenhouses, and other laboratory structures. To help the SREL better conduct its educational outreach programs, it was announced in 1993 that a new Ecology Laboratory Conference Center would be constructed. This facility, which opened around 1997, is located near the extreme northern edge of SRS, in proximity to New Ellenton.⁹⁵

The SREL works in partnership with DOE to clean up the local environment at SRS and to provide environmental public outreach programming. It has been instrumental in identifying the various waste sites previously used at SRS, and has helped SRTC in formulating treatment plans for the site's waste units. After contaminated sites have been identified, SREL begins a study of these locations, classifying them as one of three types of contaminated areas: a source zone of contamination, a primary contaminant plume, or a dilute plume or fringe area. Once the cleanup commences, it is always done with caution, since overreaction can be worse than the contamination itself.⁹⁶ SREL was instrumental

in cleaning up and revegetating Lost Lake, a Carolina bay that had been heavily impacted by adjacent industrial contamination from M Area's seepage basin.⁹⁷ Their efforts at Lost Lake are considered one of the landmark environmental projects at the Site. SREL is credited with developing procedures for microbial ecology, which employs microorganisms in subsurface cleanup.⁹⁸ In this endeavor, the SREL worked closely with scientists in the Savannah River Laboratory, now known as the Savannah River Technology Center. Among its many current programs are four major areas of interest: ecological stewardship, ecotoxicology, radioecology, and the operation of an Advanced Analytical Center.⁹⁹

SREL's Environmental Outreach and Education Program is an important part of the laboratory's partnership with DOE. The major thrusts of the program are to communicate the importance of environmental awareness in decision-making that bears upon ecological problems and to introduce the site and instruct the American public about natural history and ecology. It has accomplished these goals through a variety of paths that include exhibits, public outreach brochures, laboratory tours, lectures, and eco-tours. The 1999 Environmental Report notes that SREL reached about 70,000 individuals in this manner, presenting a myriad of topics from plants and wetlands to careers in ecology. Also, in 1999, 33 graduate students and 12 undergraduate students participated in a SREL program that encouraged professional development. Their work contributed to the advancement of the Site's environmental stewardship mission.¹⁰⁰



The red-cockaded woodpecker population at SRS has grown from 4 in 1985 to 120 today due to the efforts of the Savannah River Forest Station. Source: Savannah River Forest Station

SAVANNAH RIVER FOREST STATION—USDA FOREST SERVICE

The Savannah River Forest Station has assumed a more central role on the site in the 1990s with an expansion of responsibilities that involve secondary road and boundary maintenance, endangered species recovery and management, engineering support for environmental restoration, soil erosion and watershed management, wildland forest control, wetland restoration, land-use planning, and community outreach.¹⁰¹ The role of the SRS forester in 1955 is far different than the role played by the foresters on site today. SRS is composed of approximately 198,000 acres, of which 12 percent is built out for industrial purposes, 9 percent is contained within ecological set-aside areas, and 7 percent is left undisturbed along Lower Three Runs and the Savannah River Swamps to limit the movement of trace radioactive contaminants.¹⁰² The remaining 72 percent of the site, characterized as mixed forest with 31 percent hardwood and 69 percent pine, is managed by the Forest Service. This area supports 54 mammal, 103 reptile and amphibian, 81 fish, and 259 bird species.

The Forest Station's forest product program has accrued over \$50 million in revenue since its inception in 1956 from the sale of forest products (mostly sawlogs for lumber), pulpwood for paper, and pine straw for mulch. In 1999, the estimated value of SRS standing timber was approaching \$500 million.

Annually, 25 million board feet are harvested, which is roughly equivalent to about 20 percent of the wood supply in the CSRA. The amount harvested is dictated by DOE's sustainable-resource-management objectives that encourage not only the sale of forest products but the protection of habitats for endangered species and the maintenance of a wide variety of forest conditions.

In addition to forest products and silviculture, the Forest Station maintains a wildlife and botany program.¹⁰³ This includes the red-cockaded woodpecker recovery program, which began in earnest in the early 1990s. Red-cockaded woodpeckers, commonly found in mature pine forests, have been in decline in recent decades, and were put on the endangered species list in 1970. As a result of efforts by the Forest Service, these woodpeckers have grown from 4 on site in 1985 to 120 today.¹⁰⁴ Other species under monitoring and protection are the bald eagle, woodstork, American alligator, short-nose sturgeon, and the smooth purple coneflower.

Fire management is practiced as an ecological process; prescribed burning is carried out on 15,000 to 18,000 acres on a yearly basis. In addition to assistance with site planning, road maintenance, and research related to management problems, the forest station is committed to public outreach and education. The Forest Service is an active partner with the Ruth Patrick Science Center at the University of South Carolina–Aiken, managing classroom facilities and outdoor study areas. It also operates the Savannah River



Savannah River Forest Station staff stage fire-safety demonstration for DOE-SR Annual Kids Day Event, 1998. Courtesy of SRS Archives, negative 98-1260-212.

Environmental Sciences Field Station that began in 1996. This is the only field station in the nation dedicated to providing field education opportunities in environmental sciences for undergraduates from minority institutions. The Field Station is composed of 21 historically black colleges and universities, as well as 5 institutions from four states.

CRACKERNECK WILDLIFE AREA AND ECOLOGICAL PRESERVE

Other areas have been subject to even greater protection. The Crackerneck Wildlife Management Area and Ecological Preserve consists of 10,000 acres under the protection of the South Carolina Department of Natural Resources as a biological and wildlife refuge. This action will preserve the unique plant and wildlife habitat that is located on the Site's western boundary along the Savannah River, which has been recognized as a special habi-

tat for certain species including a variety of threatened and endangered animals. This preserve is located on the northwest side of SRS, west of Highway 125 and north of Upper Three Runs Creek. In 1972, this land was turned over to the Forest Service, which returned the area to the care of DOE around the time that Westinghouse became the prime contractor. The preserve was turned over to the care of South Carolina Department of Natural Resources in June 1999.¹⁰⁵



First Citizen's Advisory Board. **First Row:** (From left to right) P. K. Smith, Walt Joseph (Facilitator), Bill Donaldson, Tom Heenan (DOE), Camilla Warren (EPA), Pat Tousignant, Tom Costikyan, Kathryn May, Mildred McClain, Alice Holingsworth, Vernon Zimmerman, Jo Ann Nestor, Ann Clark (SCHDEC). **Second Row:** Kevin Reed, Charlie Anderson (DOE), Lane Parker, Beaurine Wilkins, Ann Loadholt, Bob Slay, Kamalakar Raut, Andrew Rea, Bill Lawless, Myra Reece (SCDHEC), Ernie Chaput (DOE). Courtesy of the Citizen's Advisory Board.

CITIZEN'S ADVISORY BOARD

The voice of the public has input into operations and environmental issues engendered by the Site in the form of the Citizens Advisory Board (CAB), an independent organization chartered by DOE. This group, created in 1994, provides SRS “with ongoing counsel to help guide decisions consistent with stakeholder values and opinions.”¹⁰⁶ Comprised of 25 people from all walks of life, the board is drawn from around 250 applicants from both South Carolina and Georgia, reflecting the local diversity of the central Savannah River area. Board members serve terms of two to three years, and are empowered to provide advice and recommendations concerning environmental conditions and waste management to the Department of Energy, the U.S. Environmental Protection Agency, and the South Carolina Department of Health and Environmental Control. The Citizens Advisory Board that serves SRS is similar to those that serve other DOE nuclear facilities, such as Fernald, Hanford, Oak Ridge, Idaho National Engineering Laboratory, the Nevada Test Site community, Pantex, Sandia, and Rocky Flats.¹⁰⁷ Savannah River's board, which is nationally recognized as one of the most productive site-specific advisory boards in the DOE complex, authored 35 recommendations to the Federal agencies in 1999 that addressed issues in the Solid Waste program, the Environmental Restoration Program, Material and Facility Stabilization, and the High-Level Waste Program.

STEWARDSHIP OF THE SRS TECHNICAL LEGACY

The foregoing sections have been dedicated to the concept of stewardship and its development as a mission at SRS. Embedded in each discussion of the site's areas of responsibility was a wealth of technical and scientific data accumulated by the many men and women who form the Savannah River Technology Center, and its predecessor, the Savannah River Laboratory. The technical and scientific legacy that stems from their endeavors is large and as varied as the Site itself.

In 1992, the Savannah River Laboratory was renamed the Savannah River Technology Center (SRTC).¹⁰⁸ With the new name came a broader scope of work and a new mandate that SRTC begin to engage in technology transfer, sharing its knowledge and expertise. Previously, the Laboratory's function was to support the plant's main missions, whether that was defense production or the transplutonium programs. While researchers and scientists were encouraged to attend conferences and present professional papers, the nature of the work during the first four decades made most research unreportable. Gathered in secrecy for 40 years, this knowledge was to be made available to public and private enterprise throughout the region and the nation.¹⁰⁹

The SRTC offered 40 years of concentrated research and experimentation that ranged over the wide canopy of American science. In the course of providing assistance to areas like manufacturing, reactors, or separations, a considerable body of knowledge had been accumulated, and it was this accumulation that the SRTC proposed to share. One of the first examples of what came to be called "technology sharing" was the use of microbes to clean up organic solvent contamination with a minimum of surface and subsurface disturbance.¹¹⁰ By 1995, this technology included methods for pumping methane into the ground to assist local microbes in the cleanup of toxic chlorinated solvents.¹¹¹

By 1994, the SRTC's mission of "technology transfer" had spawned an Industrial Assistance Program whose sole-purpose was to provide technical assistance to private industry. At that time, it was noted that before 1990, only one technology transfer of this kind had ever been made, while in the years that followed, 58 licenses had been effected. Foremost among these were devices used to avoid exposure to radiation, as well as a wide array of robotics and remote sensors. SRTC also provided information on digital x-ray technology and specialized computer systems, among other technical offerings. One of the first local firms to benefit from the new technology transfer was the Graniteville Company, which acquired considerable expertise in remote sensor work.¹¹²

By 1995, the Hydrogen Technology Laboratory (HyTech) had been set up to disseminate SRTC's years of experience in hydrogen and tritium work.¹¹³ The Technology Business Development Department, which encouraged participation in advanced technology programs throughout the DOE complex, was established at this time as a stimulus to private enterprise.



Aerial view of Technical Area in 1989. SRTC is the multi-wing building in the center of view. Courtesy of SRS Archives, negative 89-2070.

SRTC defines itself today as an applied research and development laboratory that provides the technical leadership for the site to meet the challenges in its three areas of responsibility: Stockpile Stewardship, Nuclear Materials Stewardship, and Environmental Stewardship. Its 770 employees work within five divisions: the Waste Treatment Technology Department, the Environmental Sciences and Technology Department, the Strategic Materials Technology Department, the Engineered Equipment & Systems Department, and the Measurements Technology Department.

Each of these departments works in the service of the site. The many processes developed for the DWPF were honed and brought to the production line by the Waste Treatment Technology Department. SRTC's personnel are sharing their know-how of vitrification and associated processes with Hanford staff, who are also in the process of stabilizing their high-level waste. The contributions of the Environmental Sciences and Technology Department in problem-solving for environmental issues and the development of new technologies have been noted above. In addition to new development, they keep abreast of new technologies with SRS applicability, adopt them, and demonstrate their usefulness.

The Strategic Materials Technology Department is the focus of support, in terms of materials, chemistry, and process development, for the site's ongoing missions. It is considered the SRS authority in all materials issues. This Department is also a springboard for technology development in pursuit of new site missions. They have pioneered the Melt Dilute technology for the disposal of aluminum research-reactor spent fuels, and the Laboratory's work with tritium has yielded knowledge and expertise in hydrogen that will fuel work in associated industries:

SRTC is working with several partners to design, develop, demonstrate and ultimately commercialize a zero-emission light duty electric vehicle—suitable for transport and delivery in factories, airports and warehouses—that runs on renewable hydrogen energy. This vehicle uses a hydrogen storage system that is based on the hydride technology SRTC developed for use in the site's tritium mission.¹¹⁴

Engineering Equipment and Systems Department, group photograph in front of 723-A, 1992. Courtesy of SRS Archives, negative 92-1181-1.



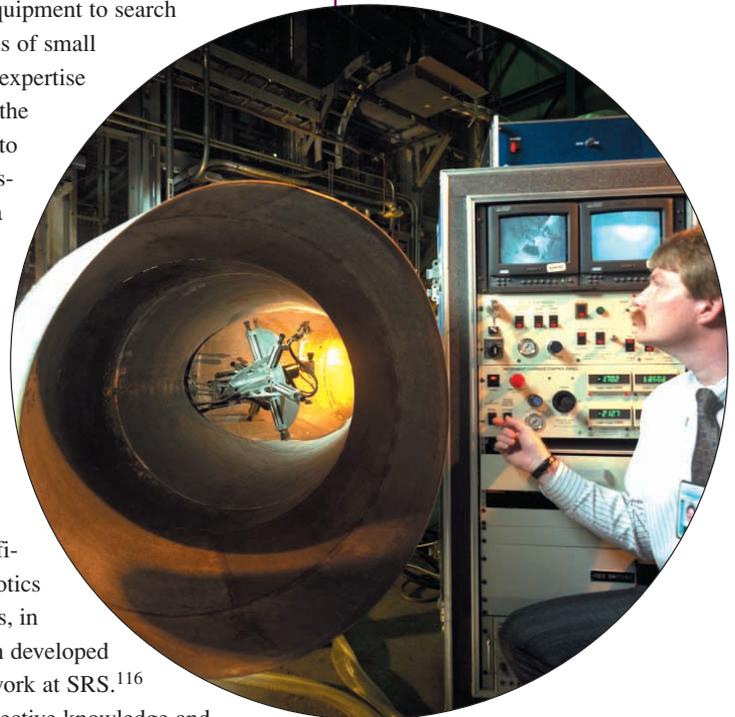
The Engineered Equipment & Systems Department does a wide variety of jobs within their main mission of providing engineering and technical support to SRS within all three of the site's stewardship areas. Instrumentation, data acquisition, remote handling, robotics, engineering modeling, thermal-fluids analysis, and radioactive material packaging and transportation are some of their fields of expertise. The removeable pour-spout insert created to increase productivity with the DWPF operations by allowing greater pour rates is a recent innovation that will yield an estimated savings of more than \$200 million by the end of DWPF operations. The Plutonium Bagless Transfer System, which involves the packaging of plutonium without plastic, is another coup for this Department that will increase savings within site operation.

The detection and measurement of radioactive, nonradioactive, and thermal emissions from SRS is the provenance of the Measurements Technology Department. This group's responsibilities extend beyond the region; they are also responsible for developing technologies for safeguarding special nuclear materials nationally and internationally. The department has played a significant role in developing technologies for use in non-proliferation, national security, and law enforcement agency applications. An example is a pilot program sponsored by DOE which involves a partnership that began with SRTC and local law enforcement agencies and has since spread.

Under a pilot program sponsored by DOE, SRTC explored opportunities to assist law enforcement agencies in the two-state area adjoining SRS by developing new technologies for evidence-gathering, by deploying SRTC personnel and equipment to search for and recover evidence, by conducting analysis of small fragments of evidence, and by applying unique expertise to crime-fighting challenges. Working through the National Institute of Justice, SRTC is now able to provide similar types of unique technology assistance to help law enforcement agencies across a 15-state region. SRTC is also working with the FBI as its nuclear forensics support laboratory, supplying unique technical expertise for the investigation and prosecution of nuclear terrorist acts occurring or directed at the United States.¹¹⁵

This example of technology transfer well illustrates this new drive within the Laboratory. SRS technology transfer encompasses areas as diverse as hydrogen technologies, vitrification procedures, environmental restoration procedures, robotics and remote-engineered systems, and advanced sensor systems, in addition to the various technological programs that have been developed in recent years to support the remaining nuclear processing work at SRS.¹¹⁶ It is a fitting tribute to all who labored at the site that the collective knowledge and intellectual capital that has accumulated over a half-century at SRS can find new life in service to its community.

Demonstration of robotic pipe crawler in action within pipe, 1992. Courtesy of SRS Archives, negative 92-2013-2.



ARSENAL FOR THE FUTURE

History, by definition, assumes a separation between the past and present. In reality, history is ongoing, the past separated from the present by moments. We are not used to thinking of the past in this manner, or of thinking of the very recent past as historic. Most histories are compiled for people, places, and events that are not only in the more distant past, but that have also reached conclusion. The story is thus complete, the results known,

although they may be open to interpretation.

The history of the Savannah River Site is not such a history. Written to celebrate the site's 50th anniversary, our story has no end. Indeed, this may be only the first installment in a series of histories, written at 50-year increments, tracking the course of a technology, an installation, a program, its missions, its people, and its region. As we look back on the first 50 years, we recognize that the site and the world surrounding it have changed dramatically. The Cold War, the threat of nuclear battle between the U.S. and the Soviet Union, has itself become historic, coming to an end. The promise of the atom was diminished as a result of shifts in America's perception of nuclear technology and



50th Anniversary commemoration of granite memorial at Ellenton town site on November 28, 2000. Former inhabitants of Dunbarton, Ellenton, and the general site area are saluted by the Department of Energy's Savannah River manager Greg Rudy. The stone is engraved with the following: "Fifty years ago today, November 28, 1950, President Harry S. Truman announced that the Savannah River Plant would be built. This marker is dedicated to the families who originally lived on this property and to the patriotic men and women who have made possible the safe operations and successful missions of the Savannah River Site." Courtesy of SRS Archives, negative no. 2000-1445-17.

the environment. The nuclear frontier, which once tantalized the American public, has been less vigorously explored as a consequence. Neither the site nor its mission is the same as a result, nor will they return to the way they were. It is important that a record is compiled that charts past actions, explains the site's technologies and their development, and provides younger generations with a sense of the spirit of the Savannah River Site community over the first 50 years of operations. Knowledge of the site's past and how it has faced numerous challenges—technological, economic, and social—between 1950 and 2000 provides an important arsenal of lessons learned and inspiration for the productive years ahead.

The Savannah River Site, although comprised of land, buildings, equipment and the people who manage and operate these things, has created an identity which is purely its own and which is greater than the sum of all these parts. Its legacy of technological research and innovation in engineering is among the finest in the country. Its contribution to the nation's defense and its role in the end of the Cold War have yet to be fully explored, a task best left to the next set of historians. While our country's need for nuclear weapons-grade fuel has decreased, Savannah River has a continuing defense mission with

the production of plutonium and tritium. Its diversified technological past, its high-caliber research laboratory, and its well-trained work force has opened many avenues for future missions within a location and community that embraces Savannah River Site and its continued well-being. The development of the MOX mission, continuing national defense production of plutonium and tritium, technology transfer, and the potential of establishing a nuclear research park within the Aiken area, and innovative documentation and treatment of environmental issues are all fitting endeavors and uses for the Savannah River Site which build on its legacy and carry it into the future. We can't forecast with certainty what the Savannah River Site will accomplish in the next 50 years, but, in light of the accomplishments of the first five decades, we expect no less in the future.