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Startup and First Years in Operation (1953–1963)

INTRODUCTION

Savannah River grew out of a web of national and international events in science, politics, and business development, as well as relationships developing among these toward common goals of national defense and an increased understanding and development of nuclear physics. Interaction with the local community and local residents' responses to the plant helped to shape its emerging identity. Although the primary goal of the site was to produce tritium and plutonium for the national nuclear weapons complex, the tenor of the times during the early years of operation pushed production at Savannah River into diverse missions. These first simply used the available versatility of the reactors, but by the 1960s began to make that versatility a key factor in the image projected of the plant by both Du Pont and the Atomic Energy Commission.

Operations, Construction, and AEC personnel pose in photograph taken in 221-F on December 28, 1954, commemorating the first shipment of plutonium from Savannah River. The photograph was first published in 1972 in the *Savannah River Plant News*. Its caption identifies the individuals as well as their 1972 job titles. "From left, Julian D. Ellett, general superintendent of Production and now manager of Du Pont Atomic Energy Division; Henry Greene, assistant plant manager; Sam Smiley, Separations; Don Miller, first plant manager; James J. Urban, Separations; Curtis A. Nelson, manager of AEC Savannah River Operations Office; Lowry Danser, Separations; Robert K. Mason, Construction field project manager; James K. Lower, Separations, now assistant plant manager; and Ralph Rosette, Julius Rubin, Goff Giboney and Dave Low, all of SROO." Source: *Savannah River Plant News*, Vol. XX, No. 1, February 18, 1972. Courtesy of SRS Archives, negative 1511007.

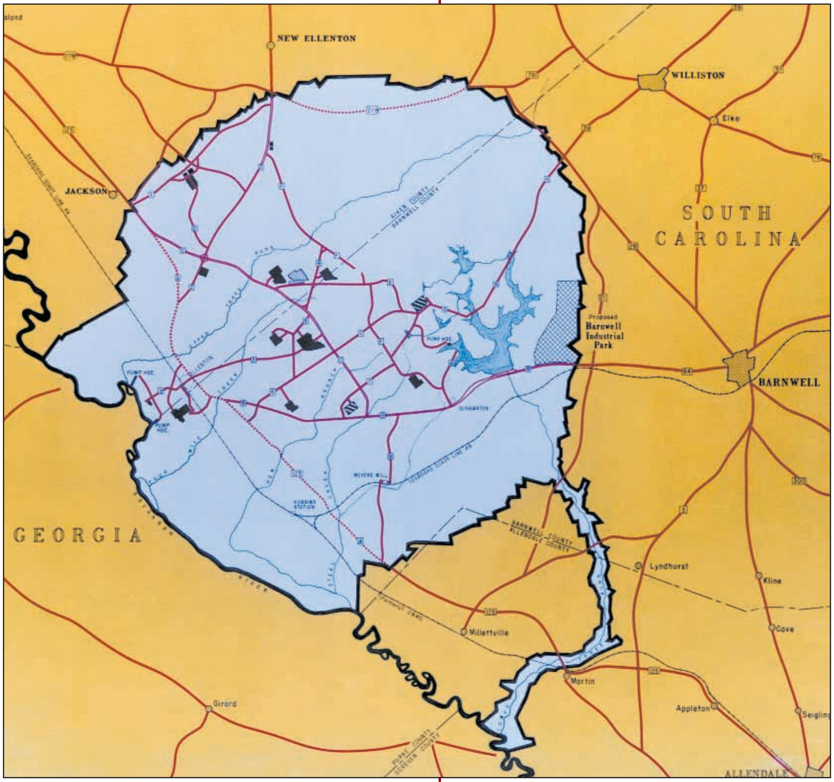
The approach to the administration of the operations at Savannah River developed in the political environment of the years that followed World War II. This was combined with the expertise Du Pont had gained during World War II and since the beginning of the twentieth century. The combination of business and government experience created a system of operations that governed in the individual areas and at the site as a whole, and that reached out to integrate Savannah River into the Atomic Energy Commission's national nuclear complex. Overarching and intertwined with site administration were concerns for security and safety. At Savannah River, as elsewhere, the former was necessary due to the military missions, and the latter due to the nature of the work at the site and the commitment of the Du Pont company.

The common threads that wove the site and its major processes into a system of operations are the focus of this chapter.

THE SAVANNAH RIVER SYSTEM

Du Pont organized its management of Savannah River in a way that allowed for input from a variety of administrative and functional divisions and departments to be considered in determining the means to achieve missions. Savannah River was part of an atomic energy infrastructure whose overall mission was production of weapons and non-weapons material to meet a variety of goals, and which also aimed to establish the groundwork for new atomic energy-related industries in the United States. Savannah River was not a single factory guided by a single administrative organization, but was nine factories under an administration that was, at times, a collaboration and at times a duel between government and contractor management.

In the broad view, the Atomic Energy Commission held the responsibility to establish the goals for the burgeoning nuclear industry in the nation, and to orchestrate the overtures played out across the continent in efforts to achieve its goals. Hand in hand with that responsibility was the necessity of relinquishing the authority and providing the support for the contractors of individual facilities to make their contributions. Du Pont was adamant in contract negotiations that it have the liberty to operate Savannah River in the way it saw best fit within the legal framework of the Atomic Energy Act, and that the Atomic Energy Commission help coordinate Du Pont's efforts with the other components within the national system. Without this coordination and attention to defined—even if evolving—goals, the effort would be shoddy if not ineffective. And Du Pont had little reason in the postwar era to deviate from its commercial endeavors and become involved in an effort that did not shine.

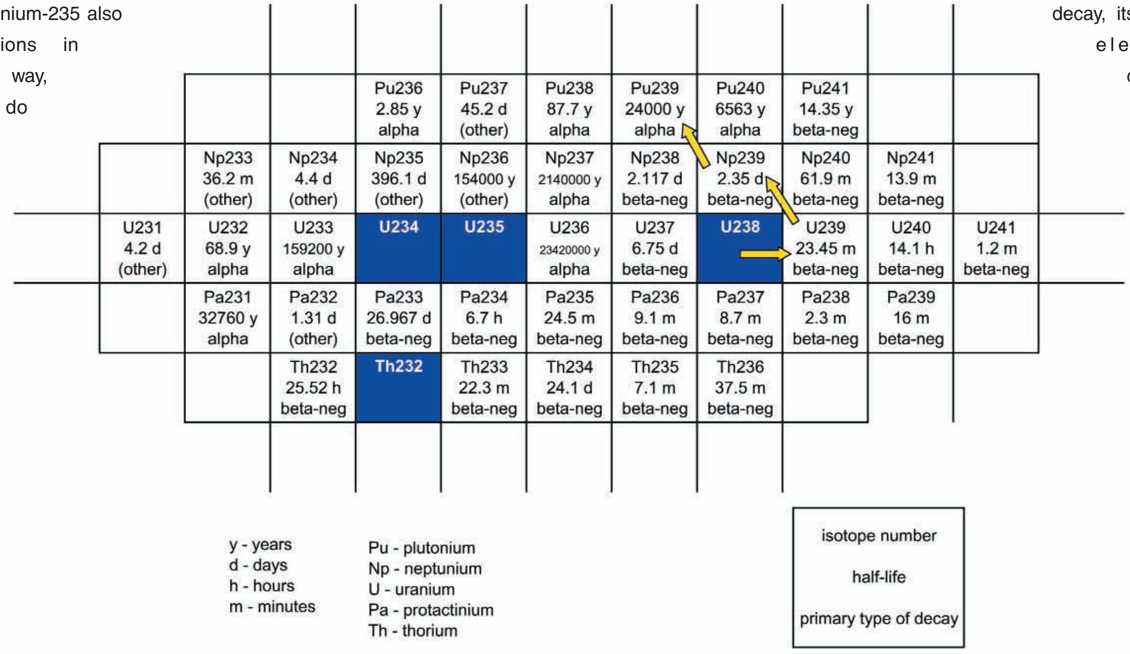


Savannah River Plant Site Map showing process areas in operation and site layout, circa 1970. Par Pond (center right) is shown. Hatching in Building Areas indicate that that process area is shut down. Source: SRS History Project.

Plutonium is a chemical element that does not exist on earth, although it would be present in some exotic environments in space. Scientists at the University of California first produced the element in 1940. The first isotope produced was plutonium-238; the same group produced plutonium-239 the following year.

Plutonium has the atomic number 94, which means it has 94 protons in its nucleus. Add a proton or take away a proton, and the element will no longer be plutonium—it will become americium if a proton is added, neptunium if one is taken away. To put it another way, the chemical element with 94 protons is called plutonium. This 94-proton element can, however, exist in several different forms, called isotopes. Just as the element changes with a change in the number of protons, the isotope changes with the addition or loss of neutrons. Plutonium that has 100 neutrons would be the isotope plutonium-194, the isotopic number being arrived at by adding the number of protons and neutrons in the nucleus. Weapons-grade plutonium is the isotope plutonium-239, meaning it is an atom with 94 protons and 145 neutrons in its nucleus. The special characteristic that makes plutonium-239 important for weapons applications is that it fissions easily when it absorbs a highly energetic neutron. When a plutonium atom fissions, it breaks apart into smaller atoms and releases neutrons and energy. These neutrons cause other plutonium atoms to fission, releasing more neutrons and energy in an explosive chain reaction. Uranium-235 also fissions in this way, as do some other isotopes, but supplies of these are limited, and plutonium-239 is relatively easy to manufacture.

Since natural plutonium is not available to us on earth, it must be created from elements that are readily available. The element that comes closest to having the 94 protons of a plutonium atom and does exist with relative abundance in nature is uranium, with 92 protons, so naturally it would seem easiest to use that as the building block for plutonium. Which in fact is what is done. Plutonium-239 is created from uranium-238, which has 92 protons and 146 neutrons. The uranium-238 is bombarded with free neutrons in a reactor, some of which are captured by the uranium nuclei. When a uranium-238 atom captures a neutron, it is then the isotope uranium-239. The nucleus of a uranium-239 atom is unstable, so it cannot remain in this form for long before undergoing some sort of alteration. The change that usually occurs in the nucleus of uranium-239 to increase stability is the loss of one unit of negative charge, and this change is called beta negative decay. One way of describing this would be that a neutron (neutrons have a neutral electrical charge; protons have a positive electrical charge, and electrons have a negative charge) gives off—or radiates—the equivalent of an electron. The particle emitted in this way is called a beta negative particle, and this type of radioactive decay is called beta negative decay, or sometimes just beta decay (beta positive decay rarely occurs). When a neutron undergoes beta negative decay, its neutral electrical charge



			Pu236 2.85 y alpha	Pu237 45.2 d (other)	Pu238 87.7 y alpha	Pu239 24000 y alpha	Pu240 6563 y alpha	Pu241 14.35 y beta-neg		
	Np233 36.2 m (other)	Np234 4.4 d (other)	Np235 396.1 d (other)	Np236 154000 y (other)	Np237 2140000 y alpha	Np238 2.117 d beta-neg	Np239 2.35 d beta-neg	Np240 61.9 m beta-neg	Np241 13.9 m beta-neg	
U231 4.2 d (other)	U232 68.9 y alpha	U233 159200 y alpha	U234	U235	U236 23420000 y alpha	U237 6.75 d beta-neg	U238	U239 23.45 m beta-neg	U240 14.1 h beta-neg	U241 1.2 m beta-neg
	Pa231 32760 y alpha	Pa232 1.31 d (other)	Pa233 26.967 d beta-neg	Pa234 6.7 h beta-neg	Pa235 24.5 m beta-neg	Pa236 9.1 m beta-neg	Pa237 8.7 m beta-neg	Pa238 2.3 m beta-neg	Pa239 16 m beta-neg	
		Th232 25.52 h beta-neg	Th232	Th233 22.3 m beta-neg	Th234 24.1 d beta-neg	Th235 7.1 m beta-neg	Th236 37.5 m beta-neg			

y - years
d - days
h - hours
m - minutes

Pu - plutonium
Np - neptunium
U - uranium
Pa - protactinium
Th - thorium

isotope number

half-life

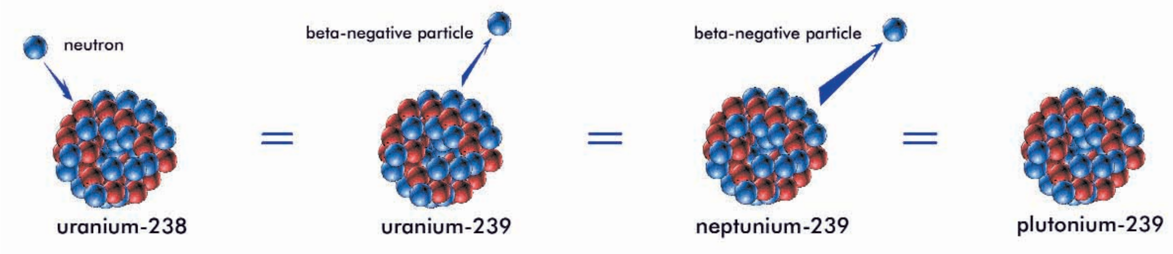
primary type of decay

becomes positive by the loss of the negatively charge particle, thus the neutron becomes a proton. The same atom now has 93 protons, which means it is no longer uranium but has transmuted into neptunium, or more precisely neptunium-239, the total number of neutrons and protons being still the same. Uranium-239 has a very short half-life of about 23 minutes, so one out of every two uranium-239 atoms will become neptunium-239 every 23 minutes. The neptunium-239, also unstable, has a slightly longer half-life of about 56 hours. This element goes through the same process of change to further increase its stability, beta negative decay, to become the relatively stable plutonium-239, which has a half-life of over 24,000 years.

The Place of Plutonium Among the Isotopes, and How it is Produced

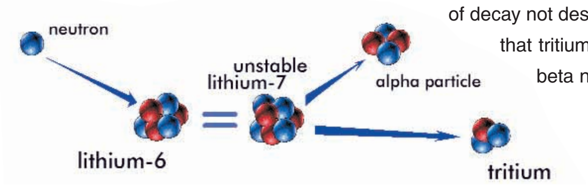
The numerous protons and neutrons in the nucleus of a plutonium atom make it a heavy material, slightly heavier than lead, which is usually found in nature with between 206 and 208 protons and neutrons. Tritium is at the opposite extreme, among the lightest elements. Tritium is also known as hydrogen-3. Most hydrogen is found in nature as hydrogen-1, having only a single proton in its nucleus, but a small amount of hydrogen-2, also known as deuterium, occurs in nature. Tritium has one proton and two neutrons, and does not generally occur in nature.

The type of reaction that is used to produce tritium is slightly different than what is used to produce plutonium-239. Tritium production begins with lithium-6, one of the two naturally occurring isotopes of lithium, this one containing three protons and three neutrons. As in plutonium production, the lithium is bombarded with neutrons, and when one is absorbed the nucleus becomes unstable. Instead of emitting a beta particle, this unstable lithium-7 atom emits an alpha particle. Alpha particles are comprised of two neutrons and two protons (in other words, they are helium atoms without any electrons), so subtracting the two neutrons and two protons from the lithium atom leaves two neutrons and one proton—tritium.



The Place of Hydrogen Among the Isotopes, and How Tritium is Produced

As we can see from the chart of isotopes, for the uranium-239 to neptunium-239 to plutonium-239 decay chain, beta negative decay caused each isotope to become the isotope identified in the square one row above and one column to the left of the isotope that underwent decay. Alpha decay, on the other hand, can be followed by moving two rows down (the loss of two protons) and two rows to the left (the loss of two neutrons). The decay of any isotope for which the type of decay is known can be traced in this manner (there are other types of decay not described here, which can also be traced on isotope charts). Thus it can be seen that tritium, which has a half-life of slightly more than 12 years, will decay by emitting a beta negative particle to become helium-3.

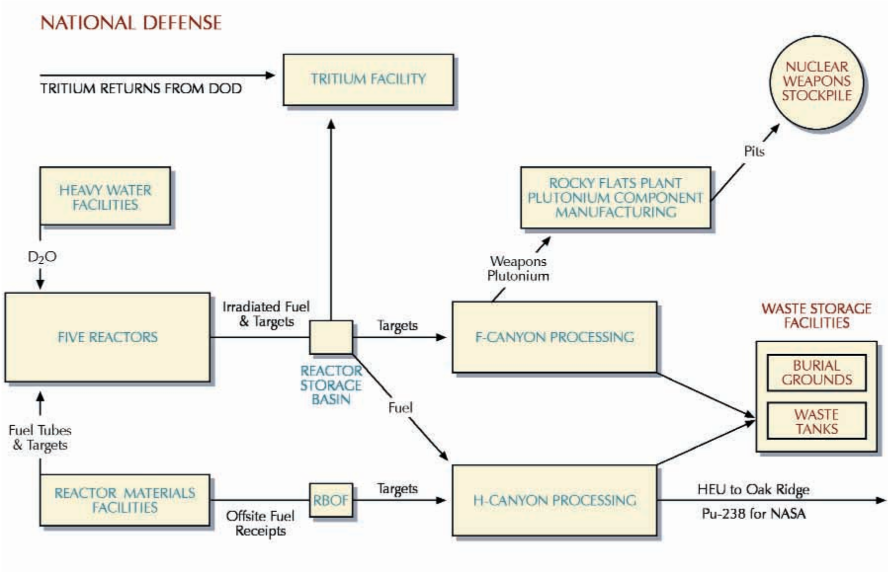


Source: Adapted from charts developed by Richard B. Firestone, Lawrence Berkeley National Laboratory, used with permission. Charts available at http://ie.lbl.gov/decay.html and http://ie.lbl.gov/astro/astronuclear.html.

Experience with the development of products like nylon and Duco had taught Du Pont that progress could come from unexpected sources, and that broad-based communications between departments could benefit research and manufacturing efforts. The company's involvement would be likely to be more valuable if it were fully integrated into the government's atomic energy infrastructure through effective communications channels. Also, broad access to information was more likely to generate ideas for commercial atomic energy endeavors. Du Pont sought assurance of expanded communications in its Atomic Energy Commission project along two paths. From its headquarters, it reached out to other installations that had research and operations experience of value to the Savannah River Project by requesting that the Atomic Energy Commission establish initial links with the other contractors.[1] Requiring this to be done through the commission lent greater authority to the relations with the other contractors than such efforts would have if initiated by Du Pont. The company then extended those links down through its own Atomic Energy Division by setting up a network of cross-communication and avenues of cooperation within the various division sections at Wilmington and Savannah River. Although the organization charts for the division and its plant and laboratory sections appear to be a simple and straightforward hierarchy, the links between the various departments were complex and helped ensure a broad experience base that would better encourage input from diverse sources.

For instance, Technical Standards—the basic documents that determined the limits on plant operations—were developed by the Wilmington Technical Division and incorporated operations experience as documented by the appropriate Works Technical departments at Savannah River. Liaison between the Technical Division and the Atomic Energy Commission helped bring outside experience to the creation of Technical Standards when needed. Technical Standards had to be approved by representatives in Works Technical, the Savannah River Laboratory, the Process Section Manager in the Wilmington Manufacturing Division, and the director of the Manufacturing Division, thus ensuring that all four of the main Atomic Energy Division administrative units had an opportunity to comment on the development of the standards. Operating Procedures—generally step-by-step guides to production-related work—were developed by the Savannah River Plant production departments. These required more limited approval, but review by the section and general superintendents of the Works Technical Department, which maintained liaison relations with the Wilmington Technical Division, helped to incorporate the expertise of that division and by extension of the laboratories and other facilities associated with the Atomic Energy Commission. Test Authorizations were the means of deviating from operations procedures and operating outside limits established by technical and mechanical standards. These were a necessary step in process improvement, and were one means by which operations procedures were altered. Test Authorizations required a similar approval process, as did Technical Standards, again giving all major divisions opportunity for input.[2]

As part of its company philosophy, Du Pont wanted to keep its employees satisfied with their work, which meant the company provided them with opportunities to contribute to operations—to stand out and make themselves known so they could advance through the company hierarchy. Part of employee contentment is attributable to the general workplace environment Du Pont established, but the management structure was also a factor. Production improvement is one of the most obvious ways an individual or group can have an obvious impact on operations of a production facility—when production improves, management notices. Du Pont made attention to continual improvement a philosophy of site management. In contract negotiations, Du Pont insisted that there be a laboratory established specifically to support Savannah River, and this was a key to the company's intention of giving employees opportunities to show how they could be of value to the company. Shortly after assuming the directorship of the Atomic Energy Division, Milton Wahl stated that one of the basic responsibilities of the division in directing the work at Savannah River was to improve products and processes.[3]



(Left) This simplified view of materials flow through Savannah River covers only the major lines of movement. More detailed descriptions of material flow are given in later chapters.

Savannah River has been a cooperative organization of nine fairly autonomous production areas coordinated under a central administration led by the contractor to meet broad mission criteria established by the government. The physical products of those broad goals have been introduced in the preceding section. The following is an introduction to the processes that created those products and the site management under which initial operations took place.

INTRODUCTION TO THE PROCESSES

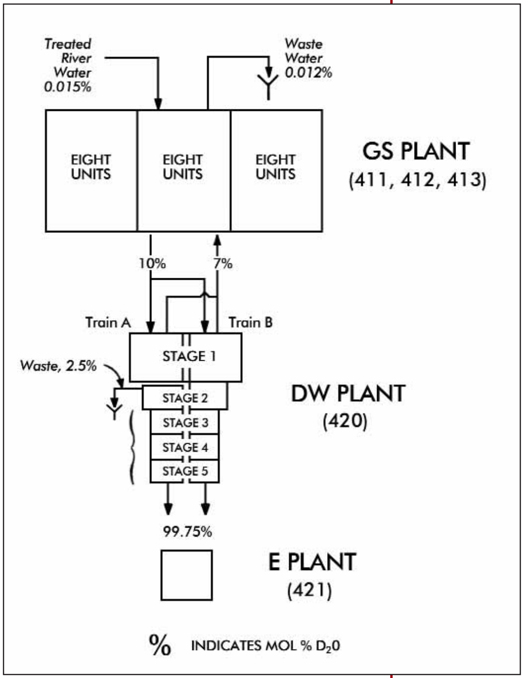
Heavy Water Moderator

Most hydrogen in nature has one proton and no neutrons, an isotope of hydrogen called protium, but about 0.015 percent of naturally occurring hydrogen exists as the iso-

(Opposite Page) Each area had a committee that represented the various departments that staffed the area. This committee allowed for input from all area workers into operations and the creation of a safe work environment. Each department contributed to the area's successful operation by maintaining machinery, supplying power, providing health protection, calibrating instruments, and other support functions.

L Area Committee, 1956. G. E. McMillan, Production; F. R. Bucko, Maintenance; D. D. Stubbs, M & S; O.A. Kraehenbuehl, Works Technical; C. F. Baxley, Service; W. A. Carrick, Traffic & Transportation; J. M. Tufft, Power; G. R. Reese, Patrol; D. G. Price, H.P.; V. O. Beam, Instrument; E. H. Hamilton, Project; A. D. Williams, Security; M. C. Milkerit, Electrical; D. E. Arnold, Safety; Dr. D. Clark, Jr., Medical. Source: *Savannah River Plant News*, October 12, 1956.

H Area Committee, 1957. Ray Larson, Wendell Beane, Walt Egan and Carl Wagner, Production; Don Laffoday, Safety; Gene Blakely, Security; Pat Patterson, Power; Tom Ridge, Traffic and Transportation; John Roop, Electrical; Bob Caldwell, Health Physics; John Elliott, Separations Technology; Milt Kirkpatrick, Project; Bob Girdler, Separations Technology; Al Rothwell, Instrument; Zane Kofford, Patrol; Perc Hennessey, Methods and Standards; and Dr. Charles Whitaker, Medical. Source: *Savannah River Plant News*, January 18, 1957.



Materials flow through Savannah River's 400-D Area. The hydrogen-sulfide water exchange process occurred in the GS Plant. Fractional distillation took place in the DW Plant and electrolysis occurred in the E Plant. The buildings associated with each step are shown in parenthesis. Adapted from flow chart in W. P. Bebbington, J. F. Proctor, W. C. Scotten, and V. R. Thayer, "Production of Heavy Water in the United States" in *Proc. Third International Conference on the Peaceful Uses of Atomic Energy, Vol. 12 Nuclear Fuels–III Raw Materials* (New York: United Nations, 1965).

tope deuterium, which has one proton and one neutron. Water, a chemical compound of oxygen and hydrogen, can be comprised of any isotope of these chemical elements; water molecules that contain the heavier deuterium isotope of hydrogen are called heavy water. Because of its special properties, the reactors at Savannah River were designed to use heavy water as the moderator (a moderator in a reactor slows neutrons so they are more likely to be captured by other atoms). Heavy water is also a source of deuterium, which is used in thermonuclear weapons.[4]

Several methods have been used to increase the percentage of heavy water in natural water, among them fractional distillation, electrolysis, hydrogen sulfide–water exchange processes and various combinations thereof. To fill the immediate need for massive amounts of heavy-water as moderator for the Savannah River reactors, a heavy water production facility was built by Du Pont at Dana, Indiana. Additional and more permanent production capacity was provided in the 400 Area at Savannah River itself, and the Dana facility was closed in 1957. At the Savannah River heavy water plant, all three methods mentioned above were used to produce heavy water. In the columns that defined much of the appearance of the 400 Area, the hydrogen sulfide–water exchange process was used to provide a first stage enrichment of the heavy-water content of water from the nearby Savannah River. Fractional distillation, then electrolysis, were used to further enrich the water.[5]

The type of hydrogen sulfide–water exchange process incorporated in the heavy-water plant at Savannah River is called the Girdler Sulfide process. The process uses different concentrations of the heavier isotope in hydrogen sulfide and water at different temperatures to concentrate the heavy water. By repeatedly passing hydrogen sulfide gas through water in alternately heated and cooled columns, the amount of deuterium can be concentrated in the water.[6]

Fractional distillation involves boiling the water to remove the lighter isotope. Since molecules of heavy water vaporize at a higher temperature than those of water containing the more common protium isotope (also called light water), boiling water and removing the vapors will leave water with a slightly higher concentration of the heavier deuterium

Heavy water was produced at D Area at Savannah River. After enough moderator was produced to supply the reactors, D Area was used to produce heavy water for offsite sales and leases, to purify moderator used in the reactors, and to produce deuterium for use in weapons components. The tall process columns used to produce heavy water, known by some as the Iron Forest, defined D Area. Courtesy of SRS Archives, negative 3391-3.

isotope. Water enriched by this method must go through many stages of controlled boiling. Final purification at Savannah River was provided by electrolysis, a process whereby electric current is used to separate the hydrogen and oxygen atoms in water—light water molecules more readily disassociate into their component gaseous elements than do those of heavy water, thus the light water tends to turn to a gas more quickly, leaving behind water slightly enriched in deuterium.[7]

INTO THE CORE

Two basic forms of materials for irradiation in reactors were fabricated during the Cold War era— solid slugs (usually rods, but a few plates were also used), and tubes. These were combined into assemblies for insertion into the reactors; slugs were situated side by side, and tubes nested inside each other. The assemblies included an outer aluminum housing that contained the slugs or tubes, and that outer housing is what is seen being inserted into reactor cores in photographs. The slugs and tubes were produced by foundry and machine shop procedures that converted uranium and other elements and alloys to metal then produced the shape desired for the assemblies. The production processes involved first casting the raw material into ingots, then shaping the ingots by extrusion, drawing, swaging, and straightening to produce rods or plates. These were often heated so they would release any gases trapped within the metal (called "outgassing"), then they were machined, cleaned, coated, and assembled into finished components. One of the last steps in the fabrication process was called "canning." The slugs and tubes had to be canned, or encased, in aluminum to prevent chemical interaction of the core material with heavy water used to cool the assemblies and moderate the nuclear reaction. Canning also hindered the leakage of radioactive material that could contaminate the moderator. When needed, the uranium would be bonded to the aluminum to optimize heat transfer by minimizing irregularities along the contact surfaces. Irregularities could cause "hot spots" and lead to the failure of the assembly components.[8]

The earliest natural uranium slugs contained both uranium-235 and -238; the former used to supply neutrons for the chain reaction and the latter used to absorb neutrons for the production of plutonium. The rods were produced in pieces five to six feet long and about one and one-half inches in diameter, then machined to units about eight inches long by 1.36 inches in diameter. As the understanding of reactor physics progressed and greater amounts of enriched uranium became available during the early years of the Cold War, reactor operators began placing the two isotopes of uranium in separate positions within the reactor tank. The manufacture of tubes provided even greater flexibility in arrangements of the uranium and other isotopes. Further advances included making

Attention to Improved Production Procedures was Evident from the Beginning of Operations

Even during the first years of operation, the slug canning process was improved and quickly made much more efficient. In June 1953, 10,000 slugs were produced at a cost of $13.04 each; by the following month, production had been increased to 39,000 slugs, which was 110 percent of the rated capacity for the 300 Area canning facilities. The cost of the procedure had also been cut nearly in half, to $7.13 per slug. These improvements were made possible by coordinated efforts that involved Du Pont technical groups (the Technical Division in Wilmington and Works Technical at Savannah River) and collaboration with the National Lead Company of Ohio through the Wilmington Manufacturing Division. National Lead was at that time operating the Feed Materials Production Center at Fernald, Ohio.

Source: William P. Bebbington, *History of Du Pont at the Savannah River Plant* (Wilmington, Delaware: E. I. du Pont de Nemours and Company, 1990), 46–47.

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assembly components from uranium containing a higher than normal percentage of uranium-235 for use as the reactor fuel, and making components containing less than the normal percentage of uranium-235 for use as targets for the production of plutonium.[9] Assembly components with slightly more than the normal amount of uranium-235 could be manufactured using the same techniques as were used with natural uranium, but highly enriched uranium had to be worked with special techniques that safeguarded against accidental criticality. Components made of natural, depleted, and low enriched uranium were produced at other facilities in the nuclear complex, then shipped to the Savannah River 300 Area for canning. Highly enriched uranium components were manufactured at the Savannah River 300 Area facilities. The lithium components, used in the production of tritium, were also manufactured in the 300 Area.[10]

Other materials have also been manufactured in the 300 Area for use in reactor assemblies to meet the various missions handed to Savannah River during its operation. Targets of thorium-232 were used to produce uranium-233; neptunium-237 components were used to produce plutonium-238; and bismuth-209 components were fabricated for irradiation into polonium-210. Small amounts of a number of other target materials have been irradiated to produce special isotopes such as thulium-170, iridium-192, plutonium-242, and various isotopes of lanthanum, americium, curium, and californium.[11]

Although the physics of nuclear reactions can be highly complex, as can be the design of reactor assemblies, their constituent parts, and the design of reactor loadings (the organization of the different assemblies in the reactor vessel to achieve specific goals), the actual operation of a reactor is not terribly complicated. The reactor assemblies are built up from the components manufactured or otherwise machined in the 300 Area, then placed in storage. The assemblies are taken from storage to be inserted into the reactor by a charge and discharge machine, control and safety rods are removed from the reactor vessel by overhead cables, and the materials are allowed to react (sometimes informally described as "to cook") while being monitored for problems. Some reactor campaigns went on for years, the process being stopped periodically to replace assemblies and deal with problems.

Once the reaction was complete, the assemblies would be removed from the reactor vessel and placed in a holding tank and allowed to cool for typically no less than 90 days (later 180 days). This allowed some of the more dangerous fission byproducts to decay into less harmful or more controllable isotopes; too short cooling times resulted in some releases from the separations areas during early operations. After spending time in storage, the assemblies were disassembled and placed in casks for movement by rail to the separations areas.[12]

The five production reactors operating at Savannah River during the Cold War were identified as C, K, L, P, and R reactors. The first Savannah River reactor to go online was the R reactor, which was tested for integrity and operability during the fall of 1953 and brought to criticality in December. P reactor was the second to go critical, the event occurring on February 20, 1954. The first irradiated fuel was discharged from R reactor the following June, and all five reactors were operating by the end of March 1955. Changes were soon made to both how the reactors operated, and to the reactors themselves. Improvements to instrumentation and signal systems mitigated the emergency shutdowns, or "scrams," that plagued the first months of operation. And increased tritium requirements from the Atomic Energy Commission required that the reactors be loaded in configurations specifically meant to produce tritium—during the first two years of operation tritium had been produced as essentially a byproduct of plutonium production, in spite of the initial intent of the construction of Savannah River as a tritium production facility. As operators found they could increase the power levels at which the reactors operated, they began adding heat exchangers so that the greater heat generated at the higher power levels could be carried away. C reactor was constructed with 12 heat exchangers, but the other four reactors initially only had six, a necessary shortcoming due to limited supplies of heavy water and vender production capabilities during the construction period. The number of heat exchangers was increased to 12 on all reactors in 1956, and the original power output of 378 megawatts was increased to 2250 megawatts.[13]

Startup of R Reactor

SRS retiree, Dexter C. (Skeet) Lee, remembers that December day in 1953 very well. He was reactor console operator on duty when startup occurred. In a newspaper interview on the 25th anniversary of startup, Lee, a man of average height, confesses that he felt, “I was 27 feet tall" that night.

He was one of three operators on the 4-12 am shift. The others were Earl Williams, who later transferred to Seaford, and Jim Huskey, who eventually became Lee’s Sunday School teacher at Millbrook Baptist Church in Aiken.

Lee remembers that he came in to work at 4 and found chairs set up in the control room. Senior Supervisor Hank Kiser approached him and said, "Skeet, we want you to take this thing up."

"Taking it up" involved raising the safety rods and then performing the tedious job of pulling the control rods. A pistol-like grip was used to apply pressure slowly and at intervals, while others kept their eyes glued to instruments.

Gradually, the instruments started to record the flow of neutrons as the pile became critical. There was a sigh of relief, some hand-shaking and a sort of "whoopee," Lee recalls, on the part of those who had been working day and night to bring about startup.

Still, Lee states the overall mood was somber and "there was no horsing around." The control room decorum established in the earliest days and continued through 35 years of reactor operation by Du Pont was preserved.

Source: SRS History Project.

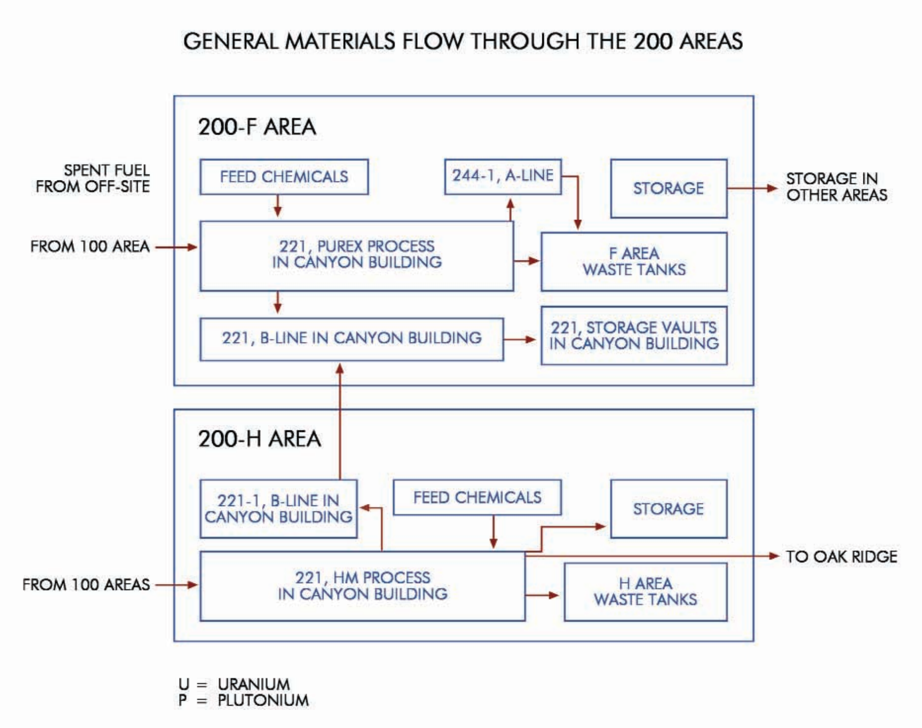
To further increase the capabilities of the cooling system, a large retention lake was created. Heavy water was used to remove heat from the reactors, and light water from the Savannah River was used to remove heat from the heavy water. The increase in the amount of heat being removed via the heavy water meant a concurrent increase needed to be made in the amount of heat being removed by the light water. But unlike the heavy water, the light water was returned to the river, so a means of dissipating its heat before returning the light water to the environment was necessary. The 2600-acre P and R Pond (generally known by its acronym as Par Pond) was constructed for this purpose, and was integrated into the cooling system in 1958. All the cooling water from R reactor then was routed to Par Pond, and a portion of P reactor water was sent out via Par Pond. The new reservoir not only served as a means of cooling water, it also created an additional source of cooling water for P and R reactors, which produced savings in pumping costs. Since they would then be drawing less water from the Savannah River, more would be available for the other three reactors. These and further improvements in the light water circulating system allowed C reactor to be brought to a power level of 2575 megawatts in 1960, and to eventually reach its all-time peak of 2915 in 1967.[14]

Aerial view of 105-P. Each reactor building is a concrete envelope covering the three major process areas: the reactor under the high hat and the two wings; the assembly area and disassembly area. Fuels arrived in the 100 Areas by truck and were placed in the Assembly Area where they were readied for irradiation. Once irradiated, they were cooled in the Disassembly Area from which they were transported to the 200 Areas by railroad. Courtesy of SRS Archives, negative 30141-10.

PURIFYING THE PRODUCTS

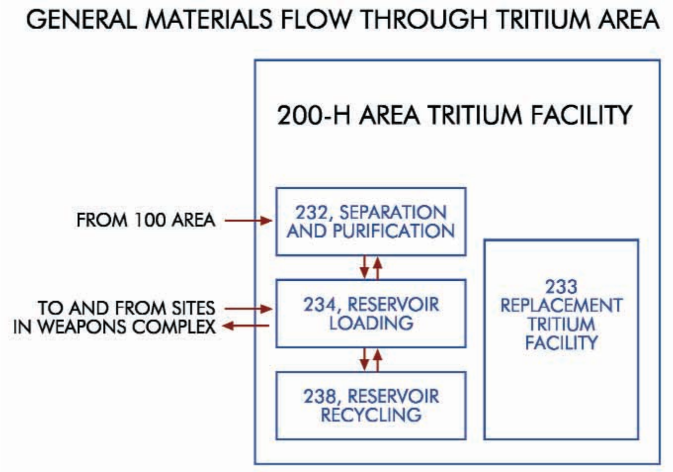
What is generally called “separations” at Savannah River, the purification steps that follow irradiation in the reactors, involves some of the most complex operations at the site. As the name implies, these operations involve the separation of chemical elements from each other, in this case desired products from contaminants, waste, and other reactor byproducts. After material has been irradiated in a reactor, the products must be separated from waste so that they can be used.[15] By chemically dissolving or melting the irradiated fuel and target elements, then reacting the irradiated atoms in liquid or gas form to various chemical elements, the desired products can be separated from the fission wastes and byproducts. The term separations as used here also includes not only the separation of the desired product from the undesirable fission byproducts, but also the dissolution or melting of reactor assembly components prior to actual separation, and the conversion of liquid product streams into solid metal or other stable form. In the case of tritium, the process includes the packaging of the gas into containers for storage or use in weapons.[16]

Savannah River has primarily employed two types of separations—wet processes and gaseous processes. Wet processes involve dissolving reactor assemblies, then treating the resulting solution with chemicals and actions that separate unwanted material from wanted material. Gaseous separation has been used primarily for tritium extraction. The separations steps take place in the 200-F and 200-H Areas at Savannah River, and much of the wet chemistry process equipment is installed in the enormous canyon buildings in the F and H Areas. The two canyons were originally designed to be run by remote operation and maintenance—which meant that the process areas were not designed to be entered by personnel on a routine basis. A chemical process was developed for use at Savannah River as the facilities were being constructed, and that process, called Purex, has become the standard for plutonium and uranium separation around the world.[17] Scientists at the Knolls Atomic Power Laboratory and at Oak Ridge developed Purex during the late 1940s and early 1950s. The Savannah River F Area was the first full-scale Purex separations plant to go into operation in the world. That process has always been used in F Area to purify plutonium, and H Area employed a variation called the HM process to recover enriched uranium during most of its history. Other variations on the Purex process have been used to extract additional products in both areas.[18]



The movement of materials through the F and H areas is complex because of the number of products being separated and the variety of locations and special facilities for dealing with the different products. To further generalize from the figure, all wet chemical separations were accomplished in the canyon portion of the canyon building. Final products were solidified for shipment elsewhere in the B-Lines, and uranium was solidified for reuse or storage in the A-Lines.

The initial gas separations process for the purification of tritium took place in F Area, but the plant there was more of a pilot plant than full-scale production facility. F Area tritium separations began in 1955, where the first irradiated lithium–aluminum reactor assemblies were melted in furnaces, then separated by various means that relied on heat to make lighter elements rise and the ability of certain hydrides to absorb and release specific gases. A tritium facility originally planned for H Area was left unfinished during the original construction project due to diminished need for tritium in the weapons program at that time. Evolving requirements soon reactivated construction of the H Area tritium facility, where many improvements were developed and installed based on the experience gained in F Area. In 1958, all tritium production was shifted to H Area.



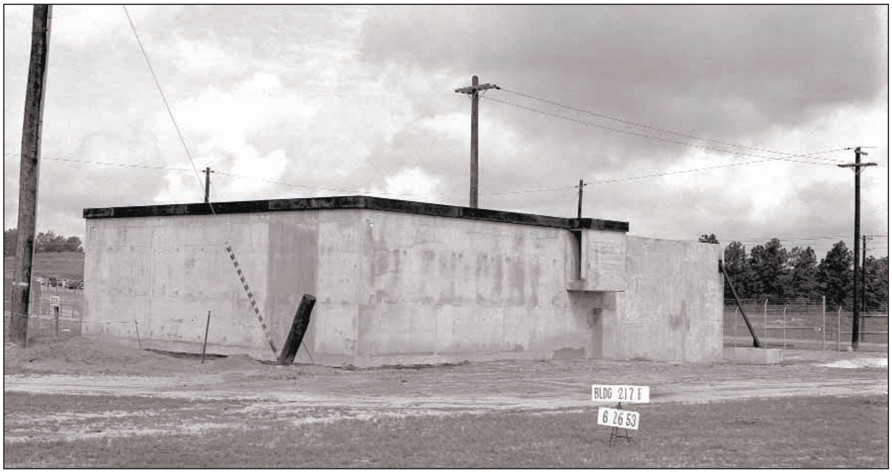
Shown in this diagram is the material movement through the H Area tritium facility during the majority of its operational history. Most tritium separation and purification now takes place in the Replacement Tritium Facility.

The F Area canyon went into operation in November 1954, and the H Area canyon was online the following July. In these two buildings, the assemblies that came from the reactors were dissolved in acid to separate the uranium and plutonium from waste fission products by chemical extraction in solution.[19] The major steps of the separations process involved dissolving the reactor assemblies in nitric acid, then adding chemicals to cause select molecules in the solution to rise or fall, enabling the desired products to be separated from contaminants. Once separated, plutonium or other elements in solution could be concentrated and further treated by conversion to metal or other forms suitable to shipment or storage. The conversion generally took place in the A-Line or B-Line. The heart of the Purex process is the chemical compound tributyl phosphate (commonly known as TBP), which has the ability to carry or release various metallic elements in the actinide series of elements (uranium, plutonium, and neptunium are all actinides). Making only minor chemical adjustments to the solution in which they are dissolved can alter TBP's affinity for these various elements.

During the first year of operation, the F Area canyon attained its designed throughput level of three metric tons of uranium per day. Modifications to the H Area canyon by applying lessons from early operations in F Area allowed H Area operations to see a throughput of seven tons per day. In early 1957, the F Area canyon was closed down so that substantially larger equipment could be installed to increase throughput, and so that a new, enlarged facility to convert the plutonium to metal (the B-Line) could be built on the canyon roof. This would more than double the capacity of the canyon. The modifications took two years to complete, and the F Area canyon went back into operations in March 1959, with a capacity to process 14 tons of uranium each day. As soon as F Area was back in operation, H Area was shut down for conversion to a modified Purex process designed to safely recover enriched uranium from target elements then beginning to be used in the Savannah River reactors, a change that took only three months. The H Area canyon was back in operation by June. After the Savannah River reactors began using highly enriched uranium in 1968, the H Area canyon B-line facilities recovered this uranium from spent fuel rods and some offsite research reactor fuels. The enriched uranium recovered in H Area was sent to the Oak Ridge Site Y-12 plant for conversion to metal and reuse.[20] Many more minor modifications of the canyons followed over the years to allow products other than uranium and plutonium to be recovered, but the fundamental processes for extracting plutonium and uranium remained essentially the same throughout the operational history of the 200 Areas.

Plutonium-239 button. As plutonium-239 only emits alpha radiation, the plastic covering and gloves offer the holder sufficient protection from exposure. Courtesy of SRS Archives.

Tritium separations took place in two much smaller portions of the F and H Areas. Slugs irradiated to produce tritium were initially sent to Building 232-F, which started operating in October 1955. There, the slugs were melted, instead of dissolved, to release the gaseous tritium. After melting, the tritium was purified by a process known as thermal diffusion. The H Area tritium building was outfitted for production in 1956, and by the end of the year two lines were operating. The process was similar to that employed in the F Area tritium facility, but the equipment and process steps were much improved, greatly increasing throughput. The tritium-containing assemblies were melted in furnaces, then purified by thermal diffusion and other methods developed and improved during the ensuing years. These additional processes have included low-temperature distillation and thermally cycled sorption and desorption in hydride beds. In 1958, all tritium separation and purification was moved to the H Area, and Building 232-F was closed. Tritium was originally shipped elsewhere for placement in reservoirs—the canisters that hold the tritium in thermonuclear weapons—but by 1957 this was being done at Savannah River in Building 234-H. In August of the following year, tritium began being removed from reservoirs, purified, and placed again in reservoirs in this facility as well.



Vault, 217-F, on completion in 1953. 217-F was the only facility on the site that was solely controlled by the AEC. Once the product entered its separately gated area, the AEC officials accepted responsibility for its storage and shipment. Visual barrier walls extended from the nondescript but important building that had an integrated loading dock providing access to two vault areas. Courtesy of SRS Archives, negative 2-481-11.

DEALING WITH THE REMAINS

The process of chemically separating uranium and plutonium from byproducts produces great amounts of highly radioactive waste, called high-level waste. Less radioactive wastes are divided into low-level waste and mixed low-level waste. Another category of waste is called transuranic waste. This latter category of waste has relatively low levels of radioactivity, is composed of materials contaminated with uranium-233 and heavier-than-uranium (transuranium) elements, and has been segregated to make future handling of the transuranium elements easier.[21]

High-level waste is stored at Savannah River in 51 underground carbon steel tanks set in concrete vaults; most of this waste comes from wet separations processes. Of these tanks, 24 are single-wall tanks with catch pans to contain leaks; the remainder is composed of double-wall units. The waste facilities at Savannah River were modeled on those

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at Hanford, modified somewhat since the radioactivity of the high-level wastes would be greater than those at Hanford. The original tanks each had a capacity of 750,000 gallons, were supported by internal columns, set on top of a steel pan to catch any leaks, and encased in concrete. Separate tanks were provided for high- and low-level wastes, and the high-level units were provided with cooling coils to remove heat generated during the decay of the wastes (cooling coils were added to all these tanks in 1955). Waste evaporation facilities were also provided as a means of reducing waste volume.[22]

The separation of uranium, plutonium, and other materials from contaminants and unwanted fission byproducts was carried out in the F and H Areas. The largest building was known as the "canyon" building because of its unusual shape and interior—within are two, long, and open process corridors running the length of the building, each called a canyon. The buildings and structures surrounding the canyon all provide support or supplementary functions. Waste tanks both in use and under construction are shown.

(Top) F Area, 1978. Courtesy of SRS Archives, negative 28317-1.

Eight such tanks were originally built in the F Area, and four in the H Area (with space for four additional tanks set aside), each buried under at least 9 feet of soil. Four more tanks were approved for H Area in 1954, due to expected increases in the throughput of H Canyon. These four tanks were larger, each having a capacity of 1.07 million gallons, but other details of design were essentially the same as those of the original 12 tanks. They were constructed in 1955 and 1956. By June 1955, the first high-level waste tank was already full, prompting efforts to reduce the volume of waste sent to storage.[23]

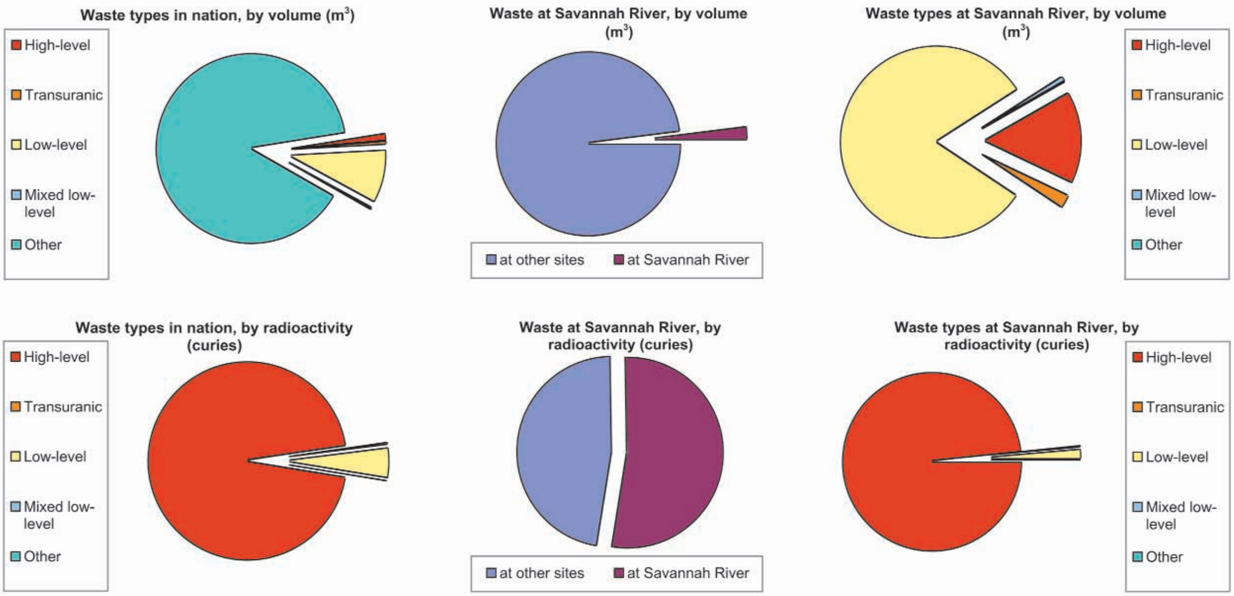
Four single-wall tanks for low-heat, high-level wastes were constructed in the F Area in 1958 and four in the H Area in 1962. These tanks have caused numerous problems due to leakage through fine cracks caused by the reactions of the solutions stored there with the materials in the tank walls. However, only one of the original 12 tanks has leaked substantially. Four others have deposits on the outside of the tank walls that may indicate leakage, but no leaks have been found. An additional 27 tanks, each with a capacity of 1.3 million gallons, have been constructed since 1962. These are all similar in design to the initial tanks, except the catch pans extend the full height of the tanks, rather than only five feet, as with the initial design.[24]

(Right) H Area, 1978. Courtesy of SRS Archives, negative 28320-1.

Since 1960 in the F Area and 1963 in the H Area, evaporation has been used to reduce the volume of the Savannah River separations wastes. Solids in the high-level tanks are allowed to settle, then the liquid is concentrated by evaporation. Condensate from the evaporator, containing only low levels of radioactivity, has been discharged to surface level seepage basins and, since 1990, mixed with concrete and stored in aboveground vaults. High-level wastes began being encased in glass in 1996 in the Defense Waste Processing Facility. From the beginning of operations until 1988, some of the low-level wastes from canyon processes were discharged to seepage basins, then to streams after evaporation. After 1988, these wastes were processed through the Effluent Treatment Facility prior to discharge. Solid wastes were generally sent to the E Area Radioactive Waste Burial Ground and the Mixed Waste Management Facility burial ground.[25]

Two burial grounds serve as the disposal site for solid wastes. The original burial ground occupied about 76 acres and was used from 1953 until 1972. The second, larger burial ground has been used since 1972; it covers approximately 119 acres. Solid low-level waste from all plant areas has been buried there, with special areas set aside for items

	Volume in cubic meters		Radioactivity in curies	
	Other Sites	Savannah River	Other Sites	Savannah River
High-level	380,000.00	130,000.00	960,000,000.00	532,000,000.00
Transuranic	220,000.00	19,900.00	3,800,000.00	591,000.00
Low-level	3,300,000.00	681,600.00	50,000,000.00	9,409,000.00
Mixed low-level	146,000.00	7,300.00	0.00	0.00
Other	32,079,000.00	140.00	0.00	0.00
	35,286,060.00	838,940.00	471,800,000.00	542,000,000.00



One of Savannah River's most important missions has been and continues to be the safeguarding of radioactive waste in storage at the site. As can be seen by theses charts, the volume of waste is only a small portion of that created by the nation's nuclear weapons production complex, a little over two percent. However, the waste at Savannah River accounts for nearly 55 percent of the radioactivity contained in nuclear waste across the nation. Savannah River is taking care of about 34 percent of the nation's high-level radioactivity generated by the government weapons and atomic energy programs. Although that high-level waste accounts for only about 15 percent of the waste stored at Savannah River, it produces nearly 98 percent of the radioactivity that the site manages. Source: Department of Energy, *Linking Legacies: Connecting the Cold War Nuclear Weapons Production Processes to Their Environmental Consequences* (Washington, DC: U.S. Department of Energy, 1997) 7, 36, 42, 47, 55, 59, and 62.

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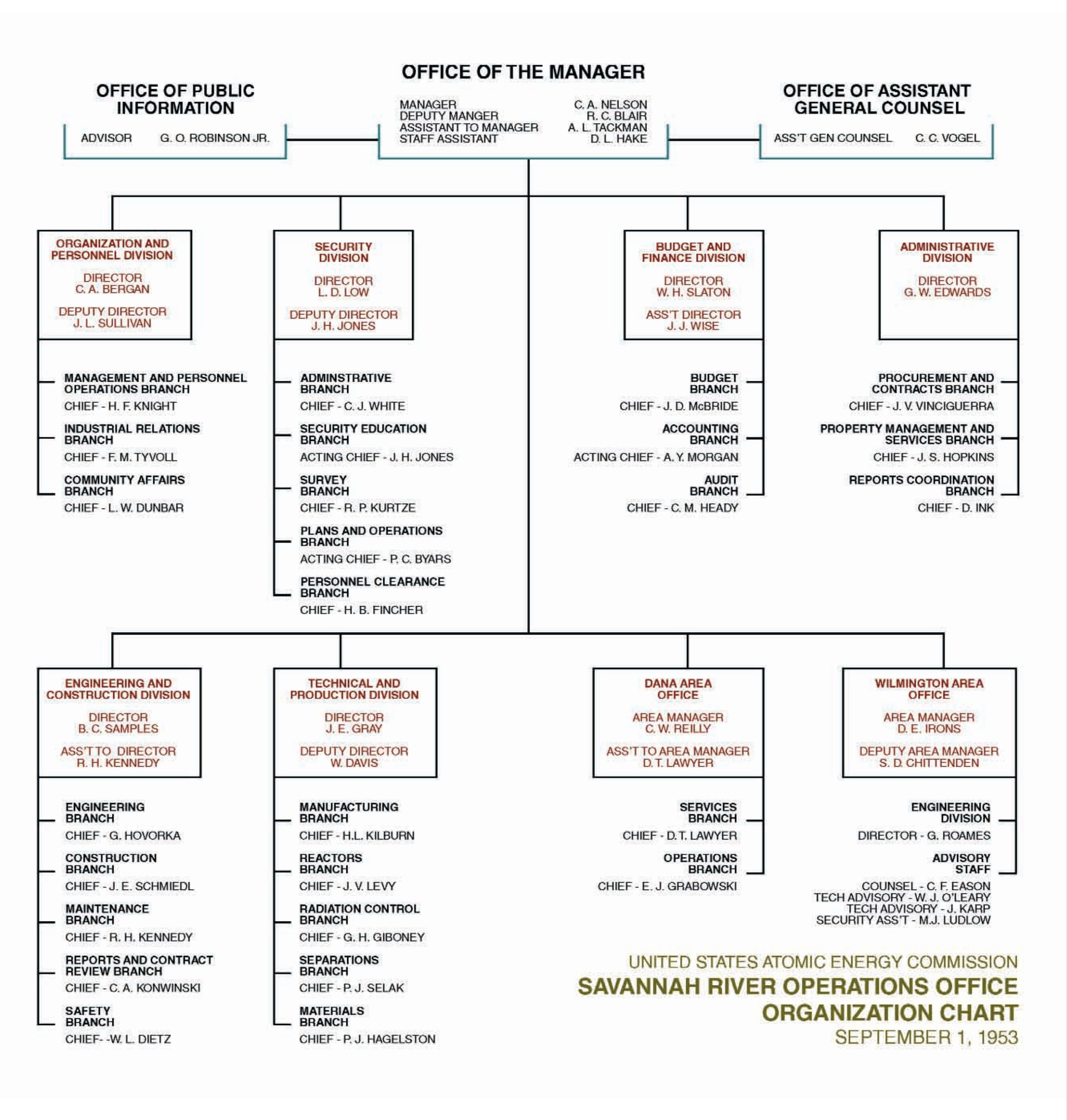
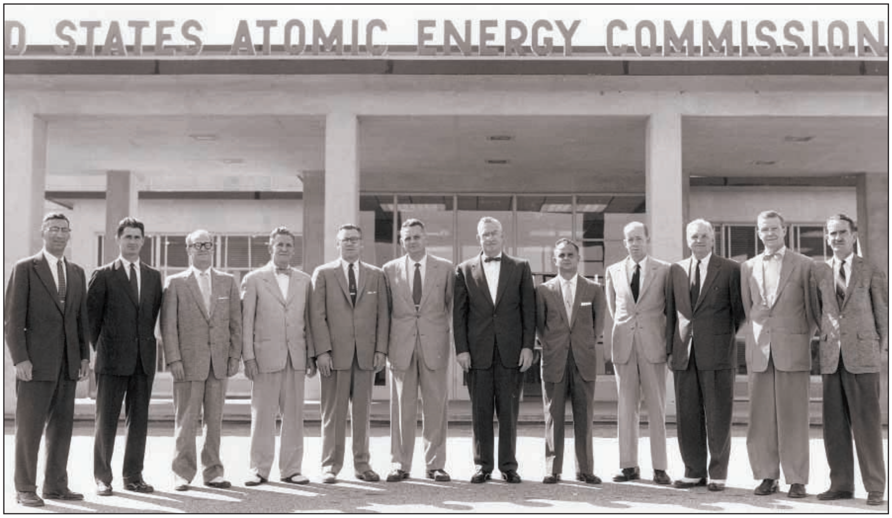
with higher levels of radiation or with plutonium fission products. The transuranium solid wastes have been in the past buried in designated sections of the burial ground, but by the early 1980s were being stored on concrete pads in containers that allowed for later retrieval.[26]



UNITED STATES ATOMIC ENERGY COMMISSION
SAVANNAH RIVER OPERATIONS OFFICE
ORGANIZATION CHART
SEPTEMBER 1, 1953



(Left) Savannah River Operations Office Photograph, 1957. Robert Blair succeeded Curtis Nelson as Manager and a cohort of Savannah River personnel was established. From left to right: Joel V. Levy, James J. Wise, John L. Sullivan, Bourke C. Samples, J. Howard Jones, Winston Davis, Robert C. Blair, John V. Vinciguerra, Howard L. Kilburn, C. A. Bergan, Allen M. Coker, and James S. Hopkins. Courtesy of SRS Archives, negative DPSPF 4601-3.

(Below) SROO, US AEC and Du Pont Staff, 1959. (**First Row**) Left to right: Dr. J. Elton Cole, Director of Manufacturing, Du Pont; Robert Blair, Manager, SROO; Admiral Paul F. Foster, Deputy Manager, USAEC; Julian D. Ellett, Manager, Savannah River Plant, Du Pont; and Hood Worthington, Director of Technical Division of the Atomic Energy Division, Du Pont. (**Second Row**) Left to right: John V. Vinciguerra, Assistant Manager, SROO; A. D. Day, Field Project Manager, Du Pont; Dr. Milton H. Wahl, SRL Director and Assistant Director of the Technical Division of the Atomic Energy Division, Du Pont; and Nat Stetson, Director, Technical and Production Division, SROO.

SITE MANAGEMENT

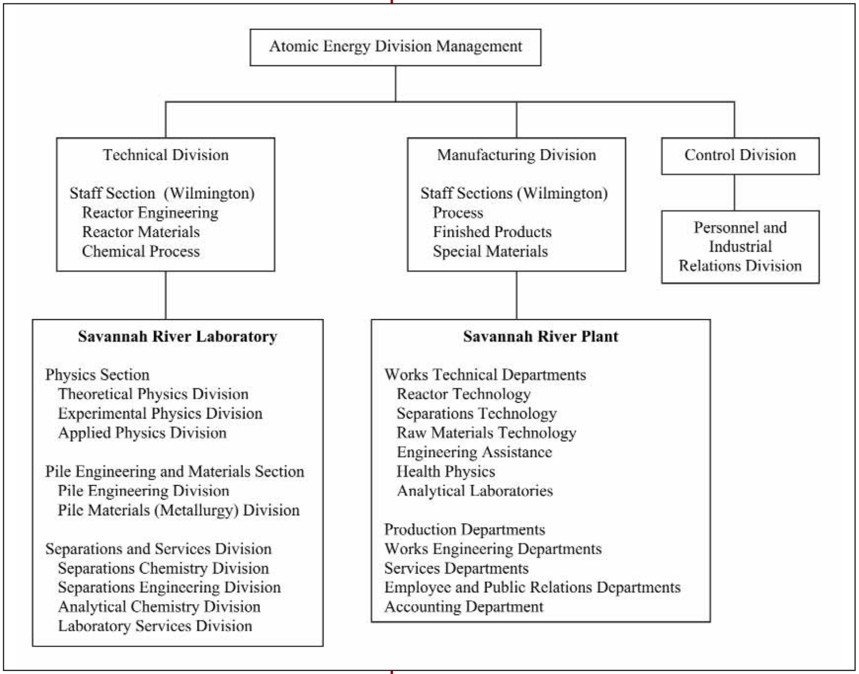
ATOMIC ENERGY COMMISSION

Savannah River grew out of the national organization that had as its primary purpose the development and production of nuclear and thermonuclear weapons, and as its secondary purpose the promotion of peaceful uses of atomic energy. The government arm of that effort was extended to Savannah River in the form of the Savannah River Operations Office, the Atomic Energy Commission operations office that had jurisdiction over Savannah River. Shortly after its creation, the commission determined that it would have a decentralized administration structure, which more broadly was to be “the touchstone of future Government practices.”[27]

The overall goals of the Atomic Energy Commission and the weapons and peaceful programs related to nuclear energy in the United States were established in Washington at the Atomic Energy Commission headquarters. The Atomic Energy Commission headquarters staff could be divided into two groups: program directors in charge of the various commission projects and management directors in charge of administration. The general manager, through assistant general managers and the commission division directors, carried out policies. The major divisions within the commission were Production, Research, Reactor Development, Contracts, Construction, Safety, Raw Materials, Isotope Development, Nuclear Education and Training, Biology and Medicine, Licensing and Regulation, and International Affairs. The policies, programs, and oversight functions of the headquarters were carried out through the major field offices, called “operations offices.” Each operations office was “a complete

organizational unit with almost entire responsibility for the business and technical aspects of the programs under its jurisdiction."[28] These operations offices—originally located at Los Alamos, Oak Ridge, New York, Chicago, and Hanford—were given authority to hire and fire their own personnel and to set their own means of meeting commission objectives.[29]

The Savannah River Operations Office was established in early 1951. The field office was ultimately under the authority of the Atomic Energy Commission director of production, the local focus of responsibility being the manager of operations. This operations manager was charged with seeing carried out the production of fissionable and special materials, as well as fabricated items (such as the plutonium warhead pits originally planned to be produced at Savannah River); oversight of engineering and construction program administration; supervision of the Dana Area Office; and the approval of purchases and contracts, with the further approval of the director of production for those valued over five million dollars. The operations office geographical area of responsibility included not only the Savannah River production facility, but also general assignments for Atomic Energy Commission programs in South Carolina, North Carolina, Georgia, Florida, Alabama, and in the Former Panama Canal Zone. These responsibilities primarily included monitoring and coordinating with off-plant persons and organizations in issues related to atomic energy and radiation control and research, and providing public information.[30]



Du Pont's Atomic Energy Division had two major operations-related subdivisions and an administrative subdivision. Wilmington's Technical Division headed research and development at Savannah River via its administration of the Savannah River Laboratory. The Manufacturing Division at Wilmington extended to South Carolina in the form of the Savannah River Plant, the production entity at Savannah River. Source: *Science and Engineering With Du Pont at Savannah River* (Aiken, South Carolina: Savannah River Plant, ca. 1960), 6.

DU PONT MANAGEMENT AND DEPARTMENTS

Initial Du Pont management of its operations at Savannah River was derived from its commercial operations and its recent wartime experiences. As stated in the contract covering Du Pont's involvement at Savannah River, the company had very nearly full control of site management. Du Pont took the stance that the functions of the Atomic Energy Commission, and its oversight arm of the Savannah River Operations Office, as far as the operation of the plant was concerned, were limited to setting production goals; coordinating efforts in the national complex; ensuring the quality, safety, and accountability of products and operations; and auditing expenditures.[31]

Du Pont management extended from the company headquarters in Wilmington, Delaware, through the Atomic Energy Division of the Explosives Department, established as soon as Du Pont agreed to take on the Savannah River project. Concurrent with this change, R. Monte Evans was made assistant general manager of the Explosives Department, and Bill H. Mackey became manager of the new division. H. F. Brown was at that time general manager of the Explosives Department.[32]

Construction was managed under two departments, the Explosives and the Engineering departments, with the assistance of auxiliary departments such as Legal and Purchasing. The Explosives Department had primary responsibility—it defined the scope of work and developed process specifications—and Engineering acted as the architect–engineer. The Design Division of the Engineering Department handled all in-house design work; all final designs had to be approved by the Explosives Department, whether those designs were developed in-house or subcontracted. Once plans were approved, Engineering's Construction Division took on the construction. Completed facilities were turned over to the Explosives Department for operation.

Savannah River Plant Staff, January 12, 1955. (**First Row**) Left to right: C. W. J. Wende, G. W. Coulson, A. J. Schwertfeger, W. A. Smith, M. H. Wahl, D. A. Miller, H. L. Greene, F. S. Adams, J. D. Ellett, W. P. Overbeck. (**Second Row**) Left to right: W. R. Tyson, J. W. Morris, C. M. Patterson, W. P. Bebbington, R. T. Cooke, H. J. Bowman, C. W. Setter, L. S. Danser, W. O. Christy, T. E. Dill, T. C. Evans, G. Dessauer, E. R. Riggin. (**Third Row**) Left to right: E. Symes, Jr., H. M. Fogel, C. R. Bradford, J. L. Gosnell, L. G. Ahrens, W. S. Church, K. W. Millet, R. B. Fenninger, F. H. Endorf, A. A. Johnson, J. W. Croah, Jr., H. A. Hansen, L. C. Peery. Source: William P. Bebbington, *History of Du Pont at the Savannah River Plant* (Wilmington, Delaware: E. I. du Pont de Nemours and Company, 1990).

The Construction Division, under the direction of the Du Pont Engineering Department, was formed during operations. This division, based in Central Shops, was responsible for changes and improvements to the facilities and for new construction. Their ranks included field project managers, engineers, and superintendents for most of the major crafts groups such as ironworkers, pipefitters, layout, electrical, sheet metal, and carpentry. Employee relation's superintendents, such as T. E. Ewing and I. B. Lawton, Jr., were part of the force, as was a physician, cost and evaluation personnel and individuals with expertise in instrumentation. Construction also had resident subcontractors who were specialists in piping, electrical work, insulation and testing and inspection of completed works.[33] B. F. Shaw is a good example of a resident subcontractor.

The head of the Atomic Energy Division was ultimately responsible for the company's management of Savannah River. Under the division head were three managers over functionally divided Technical (originally Research), Manufacturing (originally Production), and Control divisions. The Technical Division during the design and construction phase was responsible for development of the operations facilities and their equipment; initial engineers who served important functions in the Technical Division included V. R. Thayer (heavy water), J. C. Woodhouse (metallurgy), D. F. Babcock, and C. W. J. Wende (reactor physics and development). As Savannah River went into operation, the Manufacturing Division took on more responsibilities. William C. Kay was the original manager of that division.[34]

Savannah River Construction Staff (As of August 1, 1969) (**Front Row**) Left to Right: J. C. Spinks, Div. Eng.; W. F. Powell, Div. Eng.; J. W. Mercke, Control Supt.; G. A. H. Tice, Doctor; J. T. Chesser, Jr., Asst. Field Project Mgr.; R. K. Mason, Constr. Mgr.; A. M. Scherffius, Jr., Field Project Mgr.; R. L. Wootten, Field Supt.; I. B. Lawton, Jr., Asst. to Employee Relations Supt.; T. E. Ewing, Employee Relations Supt.; M. E. McDaniel, Sr., Mech. Supt. (transferred 7/13/69); P. J. Masciocchi, Eng. Office Supt. (**Second Row**) Left to Right: A. A Cornell, Area Eng.; G. A. Georgeson, Area Eng.; R. D. Cook, Gen. Supt.; A. S. Freeman, Asst. Control Supt.; D. A. Damewood, Div. Eng.; W. W. Whalen, Asst. Ironworker Supt.; H. J. Kennedy, Div. Eng.; T. H. Riner, Pipe Supt.; R. A. Sentelle, Layout Eng.; R. C. Brineman, PTL Supt.; J. C. Carter, Elec. Supt.; P. J. Codespoti, Sr., Sheet Metal Supt,; T. W. Carr, Area Eng. (**Third Row**) Left to Right: C. W. Barksdale, Area Eng.; P. J. Cotter, Insp. Leader; L. P. Lalonde, Sr., Div. Eng.; D. M. Butler, Sr., Area Eng.; A. D. Herndon, Instrumentation Supt.; A. W. Schoenfelder, Asst. Elec. Supt.; R. M. Garnto, Carp. Supt.; H. S. Mura, Jr., Div. Eng.; W. C. Welborn, Transportation Supt.; J. B. McPherson, Layout Eng.; J. C. Lovett, Jr. Mech. Supt.; J. E. Crawford, Cost and Evaluation Supvr.; W. G. Edmonds, Jr., Area Eng.; R. D. Brown, Area Eng. (**Supervision Absent at Time of Photograph**): N. R. Salley, Safety Supervisor; W. H. Spangler, Resident Design Eng.

Works Technical's Steve Markette and Joel Livingston inspect equipment for corrosion and to evaluate the need for replacement, 1956. Courtesy of SRS Archives, negative 3051-21.

Wilmington's Manufacturing Division was responsible for the operation, maintenance, and security of Savannah River overall; for assuring that design, construction, and modifications were carried out effectively and as necessary; and for safety and quality in general. The most important section of the Manufacturing Division was Process. The Process Section coordinated work with Du Pont's Engineering Department, analyzed Technical Division information and prepared it for use in production, worked closely with the Works Technical and Works Engineering at Savannah River to overcome problems and make improvements, and helped with the budgeting and coordination of major activities. The Process Section also acted as liaison between South Carolina operations and the Atomic Energy Commission and its other contractors concerning engineering and process matters.

Under the Savannah River Plant organization, the Works Technical Department served very important functions assuring continued safe and efficient operations. There was a department for each major manufacturing activity at Savannah River, and departments for overall concerns such as the Health Physics, Analytical, and Equipment Engineering Divisions of the Works Technical Department. Works Technical provided guidance for operations, initiated and followed facility improvement tests, evaluated results, and very importantly served as the channel through which production requested assistance from the laboratory and worked with the laboratory to translate research and development efforts there to plant operations. Works Technical also prepared Test Authorizations and Reactor Startup Authorizations, which were formal notifications granting permission to begin operations activities according to normal practices or deviating from normal practices. Of great importance to the site in all areas was the Health Physics Department, which was responsible for monitoring contamination and potential contamination both within the site boundaries and in the wider region.

"If It Can't Be Bought, EED Can Make It"

Equipment Engineering Department designed and made custom equipment, developed software, analyzed metals supplied by offsite vendors as raw materials, and furnished new techniques and technology where needed in support of the Plant's missions. Originally organized under Tom Evans in 1952 to provide process assistance to the plant's fuel and target fabrication program, the small team was located in Buildings 320-M and 8300-M. In 1954, their mission was expanded and nineteen individuals, within the new Engineering Assistance Section of Works Technical, participated in providing metallurgical, mechanical, and instrument assistance to the plant. The group was then housed in M and H areas. The M Area group split off, developing into the Raw Materials Technology Section, and would later become part of the Reactor and Raw Materials Technology Department in the 1980s. The remainder still worked as part of the Engineering Assistance Department, which was renamed the Equipment Engineering Department in 1975. Tom Evans stewarded the department through 1975. Bill Taylor, Ben New, John Stewart, Stan Goodman, and Bill Anderson followed in that capacity through 1982.

From a staff of 19 in 1954, the EED grew to 125 by 1962. This department employed 152 individuals in 1982 working with computer and instrument development, a mechanical group, a metallurgical assistance group, and a power technology group. The NIMs (nuclear incident monitors located on the plant), health protection badge readers, Automatic Incident Alarm (AIA), an emergency cooling back-up system for the reactors, and the plant perimeter gamma monitoring system were developed by the EED personnel. Also computer control applications first developed for 105-K were a "first of a kind."

Source: "If It Can't be Bought, EED Can Make It," *Savannah River Plant News*, April 29, 1982.

The Production Departments, as the name implies, were responsible for operations in the various plant areas in accordance with the technical standards developed by the Wilmington Technical Division. Production also wrote operations procedure manuals for normal and abnormal conditions. Each of these will be discussed at length in following chapters.

Works Engineering embraced five departments. The Power Department supplied water, steam, and electricity to the entire site. Its services could be likened to a public utility. The Power Department personnel were the first to occupy each building area as it was completed, allowing the power workforce time to check all power equipment and to inspect all domestic water and sanitary waste treatment facilities to assure they were ready for use. The first work force report showed 132 employees on the payroll and one source notes that over half had previous power-related work experience. Les Ahrens was power superintendent from start-up to 1955 after which he was transferred to the GS Department. He was followed by Art Kroll (1955–1961), E. P. Eckhardt (1961–1976), F. W. Kanne (1976–1977), Hal Smoland, and Joe Jiunnes in the 1980s.

The First Laboratory Managers, Milton H. Wahl and W. P. Overbeck

The Savannah River Laboratory's first director was Dr. Milton H. Wahl, an early pioneer in the field of nuclear physics. Wahl was born in Emden, Illinois, in 1908, and received his primary and secondary education in St. Louis public schools. Central Wesleyan College awarded Wahl a Bachelor of Arts degree with highest honors in 1928. Then two years later he earned his Master of Arts degree in chemistry from the University of Missouri. Wahl received his doctorate in physical chemistry from the University of Illinois in 1933. During the next two years, he worked with Nobel Prize winner Harold C. Urey in isotope separation research.

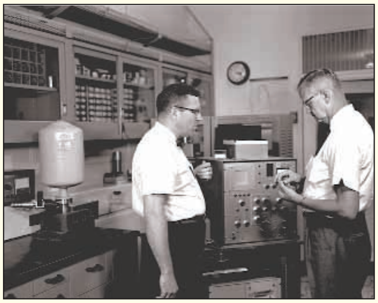
In 1935, Wahl joined the Du Pont Explosives Department, working at the Eastern Laboratory on new types of explosives and explosive hazards. In 1942, he was transferred to Wilmington to take up a position as an upper-level technical assistant in the Chemical Department. He was next transferred to the Technical Division of the TNX Department during the Hanford project, where he made significant contributions to equipment design. During his tenure with the TNX Department, he became the department's Process Manager.

Wahl returned to the Eastern Laboratory in July 1945 to head a development group, where he stayed until his 1950 appointment to Du Pont's new Atomic Energy Division. He first served as Liaison Office manager at Argonne National Laboratory, then became the director of the Savannah River Laboratory in August 1952. Wahl became the head of the entire Atomic Energy Division in 1961.

Physicist Milton H. Wahl served as the first director of the Savannah River Laboratory, holding the position from 1952 through 1960; Wahl became director of the Du Pont Atomic Energy Division in 1961. Dr. Wahl is seated to the left, C. W. J. Wende, laboratory assistant director, is seated to the right and J. W. Morris, director of Separations and Services Division, is standing.

When Milton Wahl became head of the Atomic Energy Division, W. P. Overbeck was appointed to take Wahl's place as laboratory manager. Overbeck was born in Glenwood Springs, Colorado, in 1911 and first attended college at the University of Denver. In 1934, he completed his Bachelor of Science degree in electrical engineering at Massachusetts Institute of Technology. He then worked for Raytheon for several years before becoming a research associate at the Massachusetts University and later at the University of Chicago, where Overbeck was one of the group of scientists that assisted with the first controlled nuclear chain reaction, in December 1942. Wahl was asked to supervise Du Pont instrument maintenance engineers working at Oak Ridge in 1943, then joined Du Pont in 1944 as an instrument superintendent at Hanford, staying on at that facility after General Electric became the operator. By this time, Wahl had authored or co-authored several patents related to early computer development and reactor operations.

In 1951, soon after Du Pont formed the Atomic Energy Division, Overbeck returned to Du Pont to help with the design and construction of the Savannah River facilities. He spent a year as director of Technical Division Instrument Development, then was transferred to Savannah River, where he served as general superintendent of the Works Technical Division until being named director of the laboratory in July 1961. He held the position until his retirement in October 1967.



The second director of the Savannah River Laboratory was W. P. Overbeck, a participant in the experiment at Chicago to initiate the first self-sustaining nuclear reaction. Overbeck served as laboratory director from 1961 through 1966. He is shown here (on the right) with LeConte Cathey (experimental physicist) discussing Cathey's home-made lithium-drifted germanium detector. This kind of detector was just being developed for high-resolution gamma ray spectrometry. Sources: “Introducing . . . Dr. Milton H. Wahl," 2; and "Savannah River 'A Vital Enterprise' In Organization of Du Pont Company," *Savannah River Plant News*, February 23, 1962. "Introducing . . . W. P. Overbeck," *Savannah River Plant News*, April 3, 1953, 2; "Overbeck Shares in Credit for Basic Reactor Patent," July 4, 1958, 2; "Major Reassignments & Promotions Announced," *Savannah River Plant News*, July 14, 1961; "Overbeck Retires, Kruesi to Head Laboratory," *Savannah River Plant News*, October 6, 1967, 1; and “Overbeck Attends Event Commemorating 'Landing in New World' of Atomic Energy," *Savannah River Plant News*, November 30, 1962, 1.

When designed, the power facilities at Savannah River were considered one of the largest industrial-types power facilities ever built. Nineteen coal-fired boilers were operated with a combined capacity of almost 2.5 million pounds of steam per hour at pressures ranging from 325 psig to 900 psig. About 450,000 tons of coal were burned annually to generate sufficient steam to operate the plant. The steam is used for process needs and for electrical generation. Steam driven turbogenerators in P, K, and D areas generated electricity and additional electricity was purchased from South Carolina Electric and Gas Company. In 1980, Savannah River was their largest customer. The electricity was distributed over 190 miles of transmission line; the load dispatcher's office in the control house (Building 751-A) coordinated the transmission of purchased power and the interchange of power between generating stations.

The Power Department also operated the Site's water systems. The department operated 52 water wells, 33 deep wells, and 19 shallow wells that were capable of providing almost 45 million gallons a day for domestic and process uses. The surface clarification water plant in D Area was under their administration as were the water-pumping stations that supplied approximately 510,000 gpm of cooling water to the 105 reactor buildings. That translated into pumping 533,000,000 gallons of water per day. The operation of seven large cooling towers and seventeen smaller towers was also part of their job, as was responsibility for the operation of the standby electrical generators. Finally, the department was responsible for the sanitary waste treatment facilities and the fulfillment of regulations later passed for meeting the discharge requirements of the site's NPDES permit.[35]

The Maintenance Department, under Works Engineering, played an equally important role. They were responsible for the care and maintenance of non-electrical stationary equipment in the areas. The canyon mockup facility in F Area was operated by Maintenance. Process equipment and interconnecting piping (known as jumpers) were readied for remote installation in the canyons in the mock-up building. The Electrical and Instrument Departments were tasked with the repair of motors, electrical distribution systems, process controls and instruments. Large repair shops were located in A Area, where difficult jobs were undertaken, while satellite repair shops were situated in the areas where smaller tasks could be completed. The two departments were joined in 1961 under the direction of Harold Bowman and Jack Gosnell.

The Project Department, the fifth department within Works Engineering, undertook smaller construction projects, providing specialized engineering assistance needed in maintaining specifications and standards, evaluating problem areas, and improving existing facilities through capital and cost projects. Initially, under first superintendent Bill Christy, vacated houses and the Ellenton School Building were renovated for use as temporary office space for Operations. By the 1970s, this department was responsible for the design, development and construction of equipment for processing high-level liquid waste, beginning with the sludge transfer process. Its staff included engineers, estimators, drafts persons, project assistants and clerical personnel. Other service departments performed the necessary support, administrative, and employee and public relations functions.

The Wilmington Technical Division was responsible for new products and processes, and for major improvement work, as well as for establishing technical standards. The division also maintained technical liaison with the Atomic Energy Commission and other sites under subcontract to the commission. The three technical sections in Wilmington worked with the Savannah River Laboratory by supporting and reviewing their efforts and

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coordinating the exchange of information between the laboratory, other Atomic Energy Commission sites, and the sections in the Manufacturing Division. The Technical Division also served as a channel for communications between field operations and Du Pont's Wilmington auxiliary departments and the Executive Committee.

At Savannah River, the laboratory organization was initially divided into three broad functional divisions associated with general physics, the reactors, and separations. In general, the laboratory was responsible for most development work, the testing of process modifications, maintaining the plant's technical standards, and approving test authorizations. The Physics Section dealt with broad theoretical, experimental, and criticality data, including the assessment of new reactor loadings. The Engineering and Materials Section developed and evaluated designs and fabrication techniques for reactor assemblies and their constituent components. Separations and Services operated the laboratory facilities and made improvements to chemical separations processes and equipment.[36]

By directive of the Atomic Energy Division, tight control on technical standards was a must, but the system that was developed also left room for improvements:

> A formalized system is employed by [the Atomic Energy Division] consisting of manuals, standards, specifications, and procedures. The control point in the system is a set of Technical Standards which prescribe fixed limits for the basic variables within which the process must be operated. The operating manuals and procedures of varying degrees of detail are designed to insure that these limits are maintained during operation and they are usually written to allow some factor of safety between the operating limits and the limits specified in the Technical Standards. The necessary flexibility of the system is obtained by means of Test Authorizations or Test Permits which are temporary technical standards intended to set the basic controls for tests of process changes or other operations of a nonrepetitive nature. The Technical Standards are based upon Technical Manuals which record the technical background of the equipment and process in sufficient detail to serve as a reference for the preparation and approval of Technical Standards.[37]

HUMAN ELEMENTS: SECURITY AND SAFETY

There are two aspects of work at Savannah River that have probably done more to define the work experience there than any other—security and safety. The extent to which these two items permeated the workplace did more than simply establish a framework within which the employees and managers would operate. They were two fundamental principles of operation that built a pervasive work environment which directed and even dictated many aspects of not only work life, but also of life at homes far beyond the plant fences. Security considerations could also be viewed as limiting the flow of information to the general populace that is necessary if the citizenry is to knowledgeably exercise its democratic rights of public governance. Safety had long been a hallmark of Du Pont operations. The company went to great lengths to establish safe working environments for employees, and to encourage the export of safe practices to the home. And security issues set limits to conversation both at work and at home.

STAYING WITHIN THE FENCE

As discussed in Chapter 9, entry into the site and information leaving the site had been an issue of control from the earliest days of design; measures to keep information within the fence were well in place by the time operations began.

Physical barriers at the plant included a perimeter fence around the entire installation and additional fences around areas with restricted access. At least one area, surrounding Building 217-F, was from the beginning provided with a double fence, a separate alarm system, continuous lighting, and housing for the patrol force. This important building was where what was simply called "product"—plutonium-239 and tritium—was stored prior to transfer to the next point of manufacture in the nuclear weapons production complex. Entry to areas of restricted access was gained by way of the guardhouses. Some allowed vehicular passage, but many were designed for foot traffic only. Some were also designed with special protective features for the safety of the guards in case of an emergency. Entry to the site by air was for a short time guarded against by extensive anti-aircraft emplacements, constructed at several locations around the installation and operated by Army troops. In 1955, the 11th Antiaircraft Group provided this defense, with 90 officers and 1023 enlisted personnel, but the antiaircraft emplacements they manned were abandoned by 1960.[38]

To manage security, Du Pont set up a Security Department with two divisions: Security and Patrol. The former was to establish the rules and administrative procedures needed to comply with federal regulations and to educate employees about those rules and procedures, while the latter was to enforce the rules.[39] The patrol force, originally operated by Du Pont, was described as large enough to maintain "a city the size of Boston, San Francisco, or Washington, DC."[40] It was established in October 1952, and grew rapidly as construction was completed and operations began. By the end of 1952, after the 400 and the 300/700 Areas had been turned over to operations, the division had a total force of 261 persons. Patrol reached its peak in early 1954, with 854 patrolmen and 109 other persons. The force began to decrease as construction drew to a close, patrolmen transferred to operations positions, and the use of personnel was made more efficient. The gradual decrease continued through the years, reaching a low of 227 persons in June 1975. The number of persons in the division grew thereafter because of increased security concerns. Then, between November 1983 and February 1984, the Du Pont security force was disbanded and security of the plant was gradually turned over to Wackenhut Services, Inc., which continues to provide security at the site. Throughout Du Pont's operation of the patrol force at Savannah River, over three million rounds of ammunition were expended without an injury resulting in a lost workday.[41]

The broad requirements for security were established by federal legislation, then interpreted and applied by first Du Pont, then Wackenhut. The high level of security was nec-

Employees line up to pass into and out of the M Area gate in 1953. Courtesy of SRS Archives, negative 2-282-4.

Like today, employees at Savannah River wore badges for identification and to indicate their level of clearance during the early years of operations. Here, Helen Yarborough of the Health Physics department shows off one of the newly designed badges issued in 1958. Courtesy of SRS Archives, negative DPSPF-5285-3.

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essary because the Cold War was not just a battle of armaments and international positioning, but also one of technology, where gains on research or production fronts could be lost quickly with the transfer of vital information—inadvertent or purposeful.

THE PRIORITY OF SAFETY

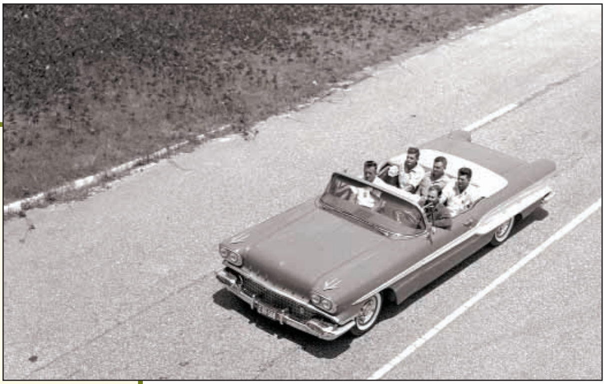
> "Whatever you do, on-plant or off, 'Fit Safety In First.'"[42]
> —Savannah River safety theme for 1962

The Du Pont company had made safety a prerequisite for plants long before operations began at Savannah River. After 40 employees were killed in an explosion in 1818, company founder Eleuthère Irénée du Pont established basic safety practices that have become principles of company operation. Du Pont had also, in company literature, relinquished the primacy of operations to safety by stating that the company would produce only materials that could be made, shipped, and used safely.[43] The text of one company safety publication states this clearly:

> The technology of a process or an operation is considered to be incomplete until every possible element of danger has been mastered or eliminated. And no such project gets the go-ahead signal until the safety factor is satisfactory. The rule is inexorable, and applies equally to a plant costing millions or a stairway costing a few dollars. Chance cannot be ruled out of any man's work, in industry or elsewhere. But predictable chance can be reduced to a minimum . . . [, and it] continually shrinks in Du Pont plants toward the visionary irreducible.[44]

The most formidable safety hazard at Savannah River was radiation. To create a safe work environment, buildings and work areas within buildings were designed to limit worker exposure. Items and materials that emitted penetrating gamma rays and neutrons were kept behind thick shielding. Protection from the less energetic radiation sources was provided by shielding, as appropriate. That protection in some areas including full protective clothing and external breathing air. Areas where workers could be exposed were clearly marked by barriers, and various personal monitors were worn to ensure shielding and barriers were operating as

The Carpool



For many plant employees, the workday began and ended with a ride in a car pool. In 1953, F Area clerk Deloris Fitts noted that her car pool companions would daily remind each other not to forget their badges. Evidently, the car pool buddies were commonly relied upon to be certain not to leave one's badge at home. During construction, information about forming car pools was made available to employees through the Personnel Division, and during operations through classified advertising in the plant newspaper. The Savannah River Plant News also ran a regular column called "Car Pool Comment," which as noted in its initial appearance took its text from the car pool conversations.

The car pool brought the plant to the employees' doors, but was not a complete extension of the plant boundaries. The prohibition against discussions of classified information at home was intended to include the car pool as well. Car-pooling was a family necessity, because many families had only one car, and a convenience because of limited parking space at plant lots. Some of the car pools were for-pay arrangements, where the driver would charge the riders a fee for the service, but most were offered on a shared basis. Typically employees carpooled with neighbor employees; companions were chosen on the basis of geography rather than common work departments or shared interests. Since employees did not always find rides with persons in their same departments or even in their management or labor grade, the ride to and from work sometimes offered cross-communication not otherwise available. Car-pooling was almost ubiquitous among plant employees, and as such was a defining element of Savannah River workers. Like a gatehouse that offered a defining point of entry to a controlled area, the car pool—with its reminders to not forget badges, its rules of timeliness ordained by the shift schedule, its attendant responsibility for the safety of other workers and for national defense—offered an extended, social point of entry to the work environment.

Photograph courtesy of SRS Archives, negative 5979-1.

they should be. Workers also had to monitor themselves for radiation exposure when leaving designated areas. Monthly and annual exposure limits were set, and if employees approached these limits they would be reassigned to areas where they would be less likely to be exposed to radiation.[45]

Another safety hazard at Savannah River was hydrogen sulfide. This highly toxic gas can be harmful or fatal even in very small quantities. Large quantities were used in the 400 Area, where the use of the gas was made even more dangerous by the pressures in the processing equipment—up to 300 pounds per square inch—and the high corrosiveness of the gas. From the beginning of 400 Area operations, the atmosphere in the area was continuously sampled, each worker carried paper that would indicate the presence of the gas in air at concentrations less than can be smelled (it has a strong rotten egg smell that can be detected at far below lethal levels), all personnel were issued gas masks, and workers in the units carried cylinders of breathing air. All work was also conducted on the buddy system, which required most work to be done by a minimum of two persons. If one was overcome by hydrogen sulfide, the other could get help.[46]

Du Pont also set up a safety monitoring and oversight department within the plant operations structure called the Health Physics Department; the name was later changed to Health Protection Department, and it is currently organized under the Safety and Health Department. Inspectors in this department monitor radiological safety conditions in the various operations areas. Although they were assigned to work in operations areas, and their work was determined by production demands and schedules, the Health Physics inspectors were not ultimately accountable to production management but to the independent Health Physics management. Thus radiological safety was placed on a level roughly equivalent to operations in the plant management hierarchy. The Health Physics department had the authority to alter or halt operations that were not being conducted according to Health Physics procedures, that were being conducted in areas that had become contaminated beyond allowable limits, or were for some other reason deemed unsafe.[47]

Health Physics had its beginning in the health group of the Manhattan project. The group conducted frequent physical examinations of employees, set exposure standards, developed instruments to measure exposure, measured radiation levels, and monitored contamination of clothing, laboratory desks, waste water, and the atmosphere. K. Z. Morgan, who did much to define the profession in the beginning, directed the Health Physics Division at Oak Ridge during the postwar years and helped form the Health Physics Society. There were few academic programs producing health physicists at that time, so Savannah River drew from personnel at Oak Ridge and Hanford. Early health physicists included H. A. McCleaeren, who had worked under K. Z. Morgan at Oak Ridge; C. M. Patterson, who worked at Hanford and headed the Savannah River Health Physics department from its establishment until 1978, and W. C. Reinig, also a Hanford health physics alumnus and manager of the department at Savannah River after 1979.[48] In September 1952, the section was moved under the Works Technical Department to better integrate it with other technical groups at the plant and give the section greater access to personnel. The move was made because it was then felt doing so would not undermine Health Physics' ability to control its own functions.[49]

Safety sign at the entrance of K Area in July 1958. The bottom flag had just been awarded to the area for operating 1000 days without a lost work case. Courtesy of SRS Archives, negative DPSPF-5265-1.

Safety

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Du Pont and other industries tallied workplace safety in terms of the number of hours worked without an injury serious enough that it required the employee to take off work. For instance, 100 employees, who worked an eight-hour day without an injury, would accumulate 800 injury-free person-hours. Figures like these were used to more dramatically illustrate the number of injury-free person-hours worked at Du Pont plants.

1. Courtesy of SRS Archives, negative M-307-5. 2. Courtesy of SRS Archives, negative M-2737. 3. Courtesy of SRS Archives, negative M-176. 4. Turtle Club members and their safety initiatives were noted in the Site newspaper. Courtesy of SRS Archives, negative 1941-12. 5. Courtesy of SRS Archives, negative PCD 0199-4. 6. Courtesy of SRS Archives, negative PCD 0199-5.

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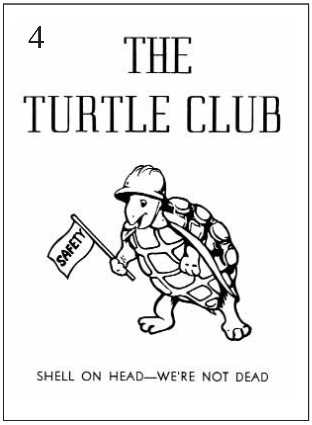

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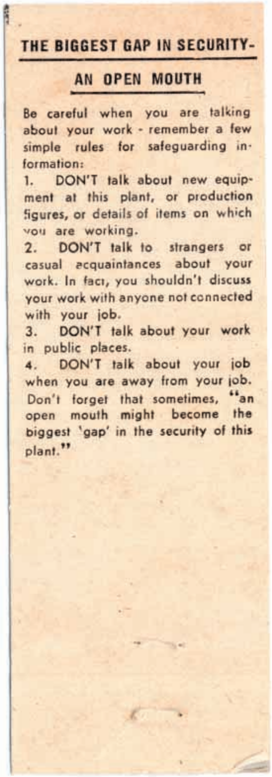
Security



THE BIGGEST GAP IN SECURITY-

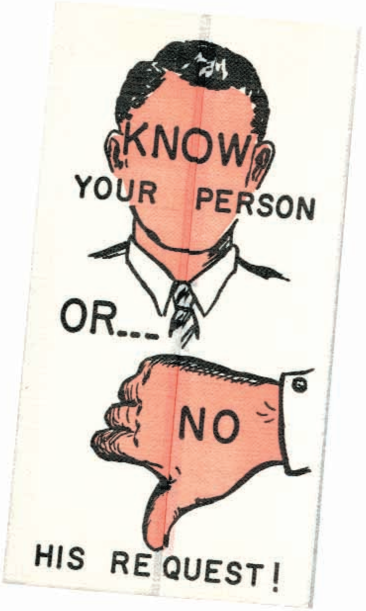
AN OPEN MOUTH

Be careful when you are talking about your work - remember a few simple rules for safeguarding information:

1. DON'T talk about new equipment at this plant, or production figures, or details of items on which you are working.
2. DON'T talk to strangers or casual acquaintances about your work. In fact, you shouldn't discuss your work with anyone not connected with your job.
3. DON'T talk about your work in public places.
4. DON'T talk about your job when you are away from your job. Don't forget that sometimes, "an open mouth might become the biggest 'gap' in the security of this plant."

Security signs and slogans were found painted onto billboards and placed along the plant's roads or over entry doors, made into posters, and in some cases, printed onto cafeteria napkins and matchbook covers.

The Savannah River's Security department archived a collection of sample signage printed on postcards that were used as models for SRP's Sign Department in the 1950s and 1960s. Shown are samples of security slogans from this collection. Source: SRS History Project.



The Health Physics group's three initial engineers began a training program in mid-1953 and started following the construction in the reactor and separations areas so they would have an intimate understanding of the designs and hazards, and so they could suggest improvements from a radiation safety perspective. The staff grew during the following year; training sessions were held for startup operators, and radiation zones and danger areas were established in all process buildings. The zones were designated, from less to more radioactive, as clean areas, regulated areas, and radiation zones. The latter two con-

Radiation and its Biological Impacts

Radiation is energy emitted in the form of particles or waves. The term includes microwaves, radiowaves, and even visible light, but in relation to atomic energy radiation refers to energy emitted from an unstable nucleus when it decays or when it is broken apart by means other than decay. This type of radiation is more specifically called ionizing radiation, which means it is energetic enough to strip electrons from other molecules.

There are four types of radiation: alpha and beta particles, gamma rays, and neutrons. Alpha particles are heavy, slow moving, and can be stopped by shielding as lightweight as a sheet of paper. They are composed of two neutrons and two protons, and thus are a form of helium. Although alpha particles do not travel far, an alpha emitter lodged in living tissue can do substantial damage. Beta particles are free electrons (and occasionally protons), and travel much farther and faster than alpha particles. A thick piece of wood is required to stop beta particles. Their higher energy levels mean they are much more penetrating and can cause greater damage to living tissue than alpha particles. Gamma rays are highly energetic and are similar to X-rays. They can pass through several inches of lead and several feet of concrete, and gamma rays can be extremely damaging to living tissue. Neutrons are emitted at a variety of energy levels and can also be very damaging.

Radiation is measured by two main yardsticks: curies and rems. A curie is a measure of the rate of decay of a radioactive source, and thus is a measure of its rate of emission of radiation. One curie is equivalent to 37 billion decays per second. A rem is a measure of the approximate effect of radiation on living tissue. The term "rem" is an acronym for roentgen-equivalent-man, a measure of effect based on the roentgen. A roentgen is a measure of radiation required to produce ions (that is, to strip electrons from molecules) in a specific quantity of air, and a rem is a measure of radiation exposure (expressed in rads) multiplied by various factors that take into account the damage caused by different types of radiation. Thus a rem expresses the amount of ionization in living tissue caused by exposure to various types of radiation. The ionization of molecules in living tissue can cause cell damage or death; if extensive enough, ionization can cause entire organs or organisms to die.

High doses of radiation can cause the burning of living tissue, while low doses can alter DNA and cause cancerous tumors and genetic mutations by the ionization of molecules. However, all of us are exposed to radiation every day. On average, about 82 percent of our daily radiation exposure comes from natural sources such as radon on earth, cosmic rays from space, and sources within our own bodies. External sources include medical X-rays and a small amount from fallout caused by nuclear explosions. On average, our exposure to radiation from manufactured non-medicinal sources is less than about five percent of our total exposure.

Sources: *Closing the Circle on the Splitting of the Atom*, Document Number DOE/EM-0266, (Washington, DC: Government Printing Office, January 1996), 39; and *The Nuclear Waste Primer* (1985; revised ed., Government Printing Office, 1993), 11 and 18.

(Opposite Page) 1. Many different types of radiation monitors have been used to assess exposure of personnel. An employee checks hands and feet for contamination by using an early style hand and foot counter. This type of monitor was used in the 1960s. Courtesy of SRS Archives, negative DPSTF-1 –8902. 2. Walkover monitors were used to ensure that contamination did not leave an area on the soles of employees' shoes. Courtesy of SRS Archives, negative DPSTF-1-10229-8. 3. Mary Canuette, Ruth Edenfield and Louise Montgomery working in mobile unit change film in film badges, 1956. Health Physics personnel performed this task weekly, working two shifts. Courtesy of SRS Archives, negative 3109-30. 4. More precise measurements of exposure could be determined by analysis of the components in the criticality Neutron Dosimeter, also called a "pencil," and sometimes "pen" for short. These pencils were about four and one-half inches long and a half-inch in diameter. Neutron Dosimeters were worn so they would fit tightly against the body for a more accurate count of exposure to neutrons. Courtesy of SRS Archives, negative DPSTF-1-11757-5. Views 5 and 6. Film badges and dosimeters were used to measure beta and gamma radiation exposure. Film badges were worn by all persons in areas where they could be exposed to radiation during a criticality accident or other event resulting in possible radiation exposure. These badges allowed health physics personnel to quickly determine if and to what extent a person had been exposed to radiation. In this photograph, the badge has been disassembled to show its component parts—the complete badge is on the left. Courtesy of SRS Archives, negatives DPSTF-1-10310-16, DPSTF-1-11945.

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Detecting Radiation

The instruments and equipment used by Health Physics personnel were important aspects of their jobs. World War II-era instrumentation included "Sneezy" and "Pluto" monitors, used to measure airborne radioactive dust and surface alpha contamination, respectively. An array of instruments and equipment had been developed by the mid-1950s. These had names like Juno, Fish Pole Probe (manufactured at Savannah River using Raychronix Cutie Pie monitors), Samson, A. C. Poppy Probe, Kanne Chamber, and the P. I. T. Source Monitor (manufactured by the Health Physics section).

During the Manhattan project, pocket detectors were developed to be worn by individuals as a means of roughly determining levels of exposure--the first dosimeters. These unreliable first models (employees wore two of the first pencil-style monitors for greater accuracy) were soon replaced by better film badges initially developed at Oak Ridge and improved there and at other locations; film badges were used at Savannah River to monitor beta, gamma, and neutron exposures. Special Neutron Dosimeters were also used to measure neutron exposures.

Improved personal monitors called Thermoluminescent Dosimeters (or TLDs; TLNDs in the case of the dosimeters for neutron measurement) replaced the older style film badges in 1970. The new monitors more accurately reflected the actual effect of radiation on biological tissue. This type of dosimeter was used for beta and gamma radiation exposure estimates until replaced by the current model in 1982. The neutron dosimeter was replaced by a new design in 1995.

Sources: C. N. Wright, J. E. Hoy, and W. F. Splichal, Jr., *Savannah River Plant Criticality Dosimetry System* (Aiken, South Carolina: Savannah River Laboratory, November 1965),5; Smyth, *Atomic Energy for Military Purposes*, 149--151; Dante W. Wells, "Advances in External Dosimetry at the Savannah River Site," in *50 Years of Excellence in Science and Engineering at the Savannah River Site*, Document Number WSRC-MS-2000-00061, draft (Aiken, South Carolina: Savannah River Site, 2000), 219-222; and W. L. Marter to S. D. Smiley, "Health Physics Instrument Specifications, 200 Area Increased Productivity Program," with attached equipment and manufacturer list, February 16, 1956, 1-5, Acc. 1957, Series III, Box 8, Folder 3, Hagley.

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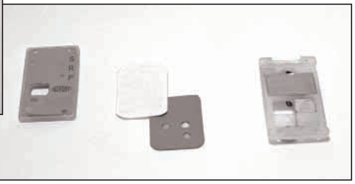

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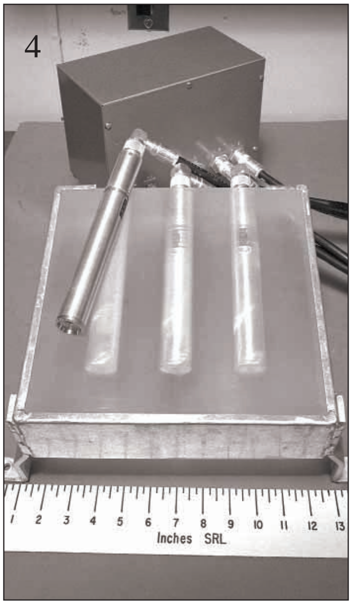

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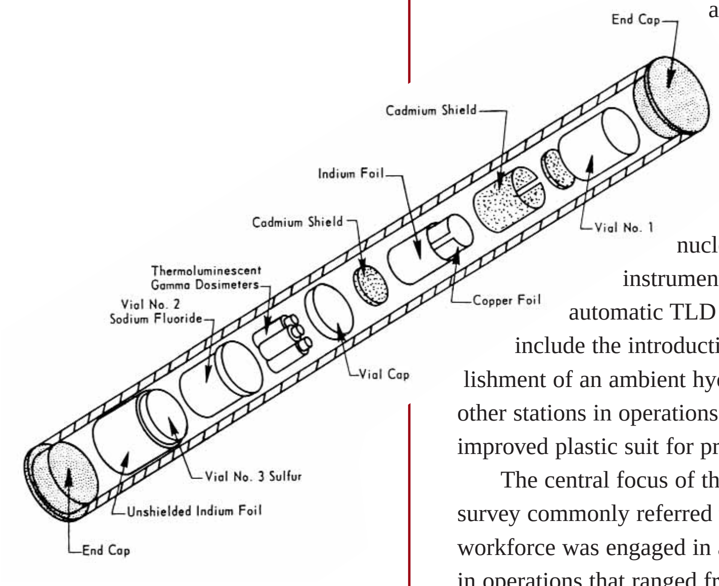
trolled zones, known as RAs and RZs, had guidelines for personal protective clothing and monitoring.[50] Health Physics also issued work permits for construction, maintenance, and service work in these areas after operations were underway. The work permits, which specified the type of protection and dosimeters required for the employees conducting the work, were means of incorporating Health Physics assessments into all modifications of the physical plant where radiation was a potential concern. Now generally known as Radiological Work Permits, similar permitting systems are the standard in the nation's nuclear industry.[51]

During the 1960s, health protection research and development expanded. An automated film badge system was introduced that allowed badges to be loaded and film numbered automatically. The whole body counter was completed in 1960 and calibrated for Savannah River radionuclides, and the process for counting employees was in place in 1961. The international limits for tritium protection were structured by data presented by Savannah River's Health Physics department. Also a new method for monitoring radiostrontium from fallout was devised by analyzing baby's teeth donated by employees and local dentists. In dosimetry, an advance was made with the introduction of a personnel dosimeter for measuring employee's exposure in the event of a criticality incident. This device was adopted for use at other nuclear plants. 1970 marked the replacement of film with thermoluminescent crystals in the personnel monitoring badges, and in 1971, the thermoluminescent neutron dosimeter (TLD) replaced the nuclear track film badge to determine neutron exposures. With instrument assistance provided by Engineering Assistance, now EED, an automatic TLD reader was created to read the new badges. Other advances include the introduction of a carcinogen handling policy and procedures, the establishment of an ambient hydrogen sulfide gas monitoring system in D Area that led to other stations in operations areas for other non-radioactive pollutants, and the design of an improved plastic suit for protective clothing.[52]



More precise measurements of exposure could be determined by analysis of the components in the criticality Neutron Dosimeter, also called a "pencil," and sometimes "pen" for short. These pencils were about four and one-half inches long and a half-inch in diameter. Neutron Dosimeters were worn so they would fit tightly against the body for a more accurate count of exposure to neutrons.

The central focus of the program, however, was the radiation and industrial hygiene survey commonly referred to as the "area survey." The majority of the Health Physics workforce was engaged in area survey, providing 24 hour assistance to all the departments in operations that ranged from surveillance of ongoing radiological and industrial hygiene conditions as well as providing input on preplanning work and job plans. Their objectives were the minimization of personnel exposure to radiation, toxic materials and other potentially damaging agents, such as noise; to minimize contamination of the site's facilities and environment; and to train its personnel to handle routine work and emergency situations safely. The Area survey personnel were also directly involved with the site's emergency response plan, providing training for all shift crews for the Emergency Operating Center.

The Health Physics Department was also responsible for monitoring the effects of radiation from Savannah River outside the plant boundaries. Its work supplemented that of another important organization from offsite. In May 1951, the Department of Limnology at the Academy of Natural Sciences in Philadelphia began a year long study of the plant and animal life in the region to ascertain normal biological conditions, to be used as a base from which to measure the impact of future industrial operations. Subsequent studies have been conducted every three to five years since the initial study.

The health of employees on the job was the domain of the Medical Department, which was responsible for pre-employment physicals, annual physicals, and emergency treatment. During construction, four first aid stations, one each in 3/700, D, R, and P areas, provided emergency care until a diagnosis could be made and a treatment plan defined. The first pre-employment physical occurred on February 1952. Du Pont experienced difficulties in hiring physicians the first two years of the project. The first Medical Superintendent was Dr. Cecil Bradford who transferred from Du Pont's Chattanooga Plant to Savannah River in 1952.

Dr. Bradford and Mary Hannah, the plant's first nurse, worked out of 704-D initially. With the completion of the main Medical Building (719-A), A Area became the central focus of the Medical Department with smaller medical stations established in each of the building areas. In June of 1955, the department employed 10 doctors, 38 nurses, 10 medical technicians, and 9 clerical employees. Training programs were undertaken to provide the medical staff with information about Du Pont Company medical health plans and policies and to train these individuals in the treatment of patients involved in hazards particular to Savannah River. Dr. Bradford retired in 1964; Dr. Donald Eckles was superintendent for the next two years. The plant's third medical superintendent, Dr. George A. Poda, promoted to the position in 1966 and active in that role for over two decades, became synonymous with health and wellness at Savannah River. Dr. Poda also strengthened community ties. He was appointed assistant clinical professor at the Medical College of Georgia where he taught industrial medicine in addition to his position at SRP. Also, a mutual assistance pact, hammered out by AEC's Karl E. Herde, was agreed upon between Fort Gordon and the Plant during his tenure.

As Operations got underway, physicians were assigned to each area where annual examinations and disability wage follow-ups were given. A nurse would rotate from area to area on a schedule, providing twenty-four hour coverage to all the outlying stations in the operating areas. Under Dr. Poda, health services were expanded to include audiometric testing, pulmonary function studies, and expanded laboratory tests that included blood chemistry and a blood count and hematology. All Savannah River nurses were trained as Emergency Medical Technicians, audiometric technicians, and pulmonary function technicians in order to carry out their expanded mission.

Overall, the department's responsibilities evolved into seven tasks: pre-employment physical examinations; continuing education about wellness; periodical physical examinations; the provision of emergency treatment for on/off jobs or injuries; practicing and educating employees about preventative medicine; providing some immunizations; referrals to private physicians; and providing physical examinations for retirees. The latter included the completion of a questionnaire, height, weight, and blood pressure checks, urinalysis, blood chemistry (13 parameters), complete blood count and hematology, eye examination, audiogram, chest x-ray and pulmonary function, and physician's examination.[53] Focus on health education programs increased over time.

Safety concerns extended to much broader areas beyond industrial medicine and radiological health onsite and off. Over $1.5 billion was budgeted for safety during the first 15 years of Savannah River operations. The first efforts to address broad operations safety issues were taken by the Central Safety Committee, established July 30, 1951, and comprised of upper management personnel. The committee held meetings twice a month and dealt with issues from operations safety to traffic accident prevention campaigns. The first

I just completed a residency in Philadelphia where I averaged two hours of sleep a night and decided that I wanted some place that I could work, and get eight hours of sleep a night. So, I answered an ad that led potentially to New York City. He [the interviewer] referred me to Du Pont for an interview and [I] was hired. Well, I went to Wilmington, Delaware…and they sent me to the Yerkes plant in Buffalo New York, where I started working as a facility physician. Arrived here [at Dana] January 31, 1951, with my administrative degree. Two years there, then I went to the Navy for two years, then to the Savannah River Site. When I was in the Navy, I got two phone calls, one - asking me to go back to the Dana plant, which I declined, and the next phone call offered me the Savannah River Site, which I gladly accepted.

[At Savannah River] I had a staff to coordinate, and I always felt that we were there for the employee… We wanted a prototype thing. I did not want them to say I'm medical, you're not. Therefore do what I tell you or else. I saw enough of that in the Navy. And I was bound and determined we were going to have an easy flow-family type thing. You come to me like a child, "Hey I'm hurt. What do I do?" That was the kind of attitude I tried to sell to my staff, and was able to do it. We had a good staff. We didn't have the employee-employer attitude. We were just one family. Medical and the Plant. And we ran it that way. Consequently people were not afraid to come to us. They came to us with all sorts of problems, and we were able to help them.

That was one of the things. The newness of the game, [we had] to look at the working conditions, which I did all the time. I made a lot of surveys while I was working there. For instance, in a hot gang valve corridor people were working at 140 degree temperatures. All right, I looked around and saw elbows in steam pipes that were not covered. I asked how come. They couldn't find any good insulating material that would take a bend like that. So I called Du Pont and wanted to know if their modular form could be casted, and they told me yes. So, our area supervision sent a foreman down to a plant in Georgia. I don't remember the name now. But he learned how to fabricate those things. We were able to manufacture all elbows and everything else to insulate these things and drop the temperature down to about 120 degrees. But it was still too high. So then I ran across a little tube sitting in the Health Physics office known as the vortex tube. Asked about it and was told that at one end you get red hot stuff that you can fry an egg [on] and at the other [end] it's about 45 degrees. I said that's exactly what we need in the hot gang valve corridor. So I went to Paul Moore who was then superintendent of F Area, and he assigned an engineer to get this adapted to Savannah River Plant, which we did. That…has been pretty much copied industry-wide for hot environments.

We had tritium. [As] a gas it's easier to maintain. If it's in water form, it'll go right through our polyvinyl suits. So Jim Corley of Industrial Hygiene and I worked together, and we found two key items that would keep it out: saran and silicone. I finally got two plant engineers to figure out a way of needling a saran to their tiegran and we were able to get somebody in Texas to manufacture plastic suits for tritium, and we were able to absolutely keep the tritium level down. These are some of the problems that we have. The big ones. And of course, how do you get rid of any radioactivity or radioactive materials that gets into the body? At that time very little was known about it. Very few people had any experience with it. So again, we kind of had to take the bull by the horns, and we developed two techniques down here of treating that, which was adapted throughout the whole world on the treatment of radioactive nuclides.

One, we had to develop a punch mechanism for cutting a finger and small puncture wounds. Just take a little punch and pull it out and instead of using surgery which made a lot nastier incision. This healed up over very quickly, and we were able to get it all out. We also developed a new technique we called chelation, which is the material that was given intravenously at one time to help the body get rid of everything. Well most of our uptakes were respiratory. Going back to basic high school chemistry if you want the quickest reaction you put two chemicals in one bottle. You don't put them in two bottles and put some permeable membrane between them. So if that was so, we could put the medicine in a bottle [to be inhaled], and I devised that, using what we use for asthma. Then we got more sophisticated. It was finally proven in England that that was a much more efficient technique than [was given] intravenously. It gave less drug more effectively, and that's been used world wide [since]. We also developed an ambulance service. We always had an ambulance service, but later on we developed EMTs specific for the ambulances.

All my doctors were required at least once a month to go out into the work place. Preferably some area that they hadn't been to before. So we all know somewhat [about] what a person [is] involved with. I mean it's awfully easy to sit back in an office and say hey. But you don't know what's going on. For instance in 400 Area, heavy-water area, we had the biggest power plant. Well when they shut down to clean it up. They went down into a great big type of thing which was 44 feet deep, but had only a 36-inch opening. If somebody got hurt down there how were we going to pull them out? Well, until I went down there and actually crawled through the 36-inch opening and went down to 44 feet and looked up and saw finally what was the problem, I didn't know what to do. But after going down there, yes. I was able to get what we call a restretcher which we could wrap around a person, and haul them up and get them through…And that same technique worked at the bottom of the storage tanks, and the separations divisions because they were deep and [we had] limited space to get them out. These are all the things that you have to work at in order to have a safe, helpful environment for people. Du Pont [supported us] very much that way. They tried awfully hard not to be the boss. Everyone worked together. Most of the foremen there were previously mechanics or operators. So you can't work with people for five or ten or more years and then all of a sudden be a supervisor and sit up on the throne. You're still one of them, and that's the way the whole plant was run. Management applauded [doctors going out into the areas]. They wanted all of us doctors to know what was going on. Prevent stuff. We were on all safety committees, and they listened very closely to what we had to say about hazards that might be apparent out there. So we had no problem there, [we] had a lot of help from management.

Before I was promoted to Superintendent of the department [1966], we had minimal medical offerings to the employees. I did not like what we were doing. I didn't think it was enough. I went to management and told them that, and they said, "Hey, it's your baby go ahead." [As a consequence] …we went to the multi-blood tests, like you would get on the outside. It's the only way I could see of finding early changes that might possibly be job related. X-ray program was improved. I worked with Du Pont, and I worked with Kodak, and I worked with others to lower the dose of radiation to the point where we had absolutely the lowest amount of radiation to get darn good x-rays. And as a matter of fact, some of the hospitals around here followed suit, and we cut radiation because of that. We got electro cardiograms, soft reading electro cardiograms, so that if in the areas if somebody went in with chest pains there was just a nurse there at the time, she could run a cardiogram. It would say right there or something like that. And she knew enough back then to either get the person by ambulance into a hospital, or call one of the physicians to come down and evaluate. We did all of those things. We developed a hearing program. Pulmonary program, checking eye pressures, so that they got a real complete physical, and we were able to perceive any subtle changes. Then if we solve them, we evaluated them against their job and referred them to private physicians for followup if it was not job-related, and that way had what's called a healthy worker problem out there. Most of our people had less problems than the general populace because we picked up [symptoms] early. I don't know how many cancers we found early dealing with the lung. We referred on them. They were able to remove a portion of the lung. The person got a cure. Things like that.

Health Physics personnel were in the field. They monitored everybody. They did all the monitoring of chemicals, radiation, environment. All that sort of stuff. And without them, I would not have known what's going on. We had a wonderful HP department, probably the best in the country, and whenever anything cropped up they would come to me with it. My area at first, and then when I was superintendent, any area would come to me with it. We'd go over it and try to come up with a solution. People that had a problem health, I treated with health physics monitoring. If they didn't monitor, I wouldn't know if my treatment was good or not. And we were able to in all of the years out there. There was not a single person that had a deleterious body burden from anything they picked up on the plant. For instance, for a while we were working with californium out there. Nobody in the world ever worked with californium. Health Physics people picked up on the stuff, and actually we found two people that ingested some californium. Okay. They were able to monitor. Nobody knew how to treat it. I went to several sources. They all said they'd never heard of it. So I went ahead and treated them. Lo, and behold, we cleaned them both up 100 percent. Health Physics monitored us to the point where we knew it was all out. That was the relationship we had. One without the other was lost.

I'm the guy that fought for that [drug and alcohol treatment and rehabilitation program out at the site]. It took them seven years, number one to convince management, and number two [to] work up a protocol. But we worked hard at that, and I attended simple seminars on drug abuse and all of that. I think Kodak and Du Pont were the two originators of an alcohol rehabilitation program in [American] industry. Prior to that people just got fired if they were alcoholic. So that [alcoholism] we had worked with, but the drug program hit us when we had absolutely no way of checking. So as I said, I attended several seminars and got a lot of data on this and then worked with our personnel people in putting all of the data down into a format, which we did. That was reviewed and critiqued by I don't know how many people. Because you just can't go out there, and say, hey we have drugs, we're going to do this and that. Why are you going to do this? How are you going to do it? What effect does this have on the privacy of the individual? What effect does this have on this, that, and the other? When would it be called punitive rather than corrective? When can it be done honestly? That sort of thing. All of that had to be ironed out so that the thing's absolutely foolproof so that nobody would be discriminated against or picked on. In fact we even got it to the point where a computer picked the people to come [for testing]. That program turned out to be probably one of the best in the country for that period of time. Wilmington eventually pretty much adapted that program for general Du Pont use. The Atomic Energy Commission, later the Department of Energy, worked for years and years trying to come up with a program. Eventually I was a member of a committee to set a program up for the Department of Energy. All we did is take our program from Savannah River Plant, went down the list of everything, modified a few things that did not fit the government, and that was their program. So, it has been a huge success.

Source: Oral Interview with Dr. George Poda, June 21, 1999. SRS History Project.

(Opposite Page) Dr. George Poda, 1955. Courtesy of SRS Archives, negative M-1790-5. (Above) Nurse Norma Hedrick with ambulance, 1974. Courtesy of SRS Archives, negative 18520-7.

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formal employee safety meetings were organized the September after the Central Safety Committee was formed. Safety slogans were common, as were other means of instilling safety consciousness in the workers. Joe Kirkpatrick, a labor superintendent during the original construction phase, presented a “Dog House” and hardhat each week to the labor department with the highest safety violation frequency rate.[54] In a 1954 plant newspaper article, safety was directly related to the Cold War defense effort: “‘Without safety we cannot be productive, and only by being productive can we be strong and preserve the freedom of America,’ [construction field project manager Robert K. Mason] declared.”[55] Safety themes such as “fit safety in first,” the 1962 plant theme, were chosen in employee contests. Personnel who had safety suggestions adopted in operations were publicly commended in the newspaper. Safety flags were given to operations areas that achieved safety milestones.[56] And a poem appealing to the extension of the safe work ethic to offsite practices appeared in one early plant newspaper:

> There was a young worker named Mose,
> Unable to see past his nose.
> Safety shoes were too dear,
> He’d rather buy beer,
> Now he’s learning to walk without toes.[57]

Safety shoes were provided at no cost to employees for use at work (shoes for offsite use were sold at discount rates), as were safety glasses, gloves, and hard hats.[58] Offsite safety was rigorously promoted, especially traffic safety. A tally of the number of traffic accidents, warnings, and arrests was printed on the front page of most issues of the construction employees’ newspaper, the *Savannah River Plant News and Views.*

These efforts have been quite successful throughout the history of the site. Only one employee has received an exposure exceeding five rem per year, and that occurred in 1956.[59] Forty-eight employees received exposures exceeding three rem annually during the period of 1951 to 1988, quite low compared to the nuclear weapons complex as a whole—35 employees at Department of Energy sites received exposures surpassing three rem just in 1986, and the commercial nuclear industry had 728 employee exposures of more than

Plant Communications

The operations newspaper—The *Savannah River Plant News*—began in February 1953 and was published every other Wednesday. The coverage was similar to that of the *SRP News and Views*, with like attention paid to safety, general interest stories, and management introductions, but additional efforts were made to bring employees’ opinions to the forefront. Columns presented employees’ views on issues from the World Series to products they would like to see developed. Employee contributions and suggestions for stories were accepted. Stories also ran showing readers how various aspects of the site operated through full-page spreads with numerous photographs, covering activities such as payroll, the benefits plan, and the variety of jobs that were part of production at a site so large that some employees may never even see all of it. A lot of ink was allotted to promotions, including articles that featured photographs and biographies of people upgraded to Wilmington Salary positions.

Suggestion programs provided employees an avenue for communicating their ideas to managers for both construction and operations employees. Employees were encouraged by recognition and monetary rewards for suggestions that saved the company money and promotions like an occasional "Idea Day" that gave further incentive.

Later another means of communication was provided via the counselor program, begun in 1961. Managers designated as counselors were relieved of all other duties so they could devote their full attention to employee ideas, suggestions, and criticisms. Much of their time was spent walking through the areas they were assigned, talking to employees. The counselor program gave employees the opportunity to air grievances, and served a similar function as a shop steward in a union organization. Having this avenue of communication in place likely helped convince Savannah River employees and those at other Du Pont plants where the program was in place, from voting to unionize.

(Above) Mail Room workers stuffing *SRP News and Views* in manila envelopes for distribution, 1954. Courtesy of SRS Archives, negative 1729.

five rem during 1980. Savannah River had one of the best safety records and lowest radiation exposure rates of the entire nuclear weapons complex, and it has also been noted to be one of the safest industrial plants in South Carolina.[60]

Awards recognizing safety achievements have come from Du Pont headquarters during its Cold War-era operation of the site, as well as from governmental organizations. The first award came from the Du Pont Wilmington office and was called the General Manager's Safety award, posted in October 1952, noting the accumulation of 1.3 million hours of safe operations. Two months later, the President's Safety Award commemorated the accumulation of nearly 2.4 million safe hours. However, the top Du Pont safety award, the Board of Directors Award, which required 200 days of operations without any injury that caused an employee to miss a day of work, would elude the plant for more than a decade. Finally during 1966, all 12 contractor and employee groups working at Savannah River worked an entire year without a disabling injury, earning the award; by the first month of 1967 the plant was eligible for its third Board of Directors Award. The plant went on to win 35 more of these awards through the remainder of the Cold War. It also won the Atomic Energy Commission's "Best Ever" award 1970 for accumulating the largest number of injury-free person-hours of any AEC contractor.[61]

SUPPORTING SERVICES

A number of support services were developed to make the plant self-sufficient. Traffic and Transportation was integral to all operations across the site, from breaking down beaver dams that imperiled site roads to moving mammoth heat exchangers into the reactors. Originally, it consisted of five divisions: Traffic, Labor and Heavy Equipment, Automotive and Equipment Maintenance, and the Railroad Division. A large multi-bay automotive shop (Building 751-A) was constructed in A Area to handle automotive maintenance. A 1955 SRP news article noted that the cumulative mileage for one month for all the site's vehicles add up to a total of 835,000 miles, "a distance also equal to 33 trips around the earth or over three trips to the moon." To run the fleet of trucks, tractors, and light equipment alone required nearly 800,000 gallons of gasoline monthly along with 50,000 quarts of oil. Heavy equipment (riggers, cranes, bulldozers, etc) needed to handle a miscellany of site operations was garaged in Central Shops. Traffic and Transportation was responsible for road construction and maintenance, as well as all onsite shipping by truck or by rail.

Traffic and Transportation Maintenance, Central Shops, 1956. Courtesy of SRS Archives, negative 3109-6.

Savannah River's railroad operations were stretched over 60 miles of standard gauge track; the Classification Yard near the Dunbarton town site was the hub of activity. This division was responsible for the operation of the rolling stock and maintenance of the site's tracks. The site's tracks connected with the Charleston & Western Railroad at the site of Ellenton and the Atlantic Coast Line tracks at the site of Dunbarton. Four crews were assembled to handle the workload in 1955 in which the site's eight diesel engines

“Your Job is Just as Big as the Man Pushing the Buttons in the Reactor”

When I first come in, why I got hired so fast, the first thing, when they opened up a plant, they need what? Janitors. So I applied for a janitor. I wanted to get in there. So they applied me for a janitor. I worked as a janitor eleven months, then I went to T and T, transportation. I was in the old schoolhouse in Ellenton. That was my first job, down in the schoolhouse down there. I was a janitor down there. They had an office down there, in Ellenton, South Carolina. So that was my first job.

What happened, you cannot force no one to do the right thing. You've got to let them do it on their own. You've got to carry yourself in the way they will give it to you, and not you go try to take it. See, I could ask you for something, you will give it to me, but I try to take it, you're going to rebel. You're going to take longer giving it to me. So we decided we wouldn't do that. Most of them came up through the segregation world, and we know how, and we were trying to make it better for our kids by going along whatever they do.

We knew we couldn't go in the cafeteria and eat like other people; we had to go in the corner. We'd bring our lunch. We sat in a group and eat. We know we didn't have bathrooms to go to, wash our hands. When we'd go in the field to do jobs, we would carry fifty-five gallon drums with water on it to wash our hands. So we didn't rebel.

As it come, and when it did come—they integrated all the bathrooms—we didn't just run in there, and say, "I'm going to take this locker, I'm going to take that locker." We eased into what locker was available, easing in. So, trying to make it better for the next generation to come. So that is how we worked it.

Now these things here, the supervision didn't know nothing about. We talked that among ourselves, and we tried to be a part of the plant. Just like I'd tell them, said, "Now we may not run the reactors, we might not run the powerhouse, we might not run the administration building, but we repair the roads for them to get there. We're making a big contribution toward the plant. We repair the roads to get here, we repair the waterlines, we do that. We're making a great part of it for these people who are running the reactor, because they couldn't run the reactor if they couldn't get to it. They couldn't run the reactor if they didn't have water. So we're doing the greater part. Your job ain't low. Your job is just as big as the man pushing the buttons in the reactors.

I associated a lot with the minority of black. Their lives changed tremendous from poor to middle class. They got a better life out of that, by this plant coming, because just like I was trying to tell some of the guys that were working. I said, "You ought to be thankful the plant come here, because this land you was farming was just something to keep the earth together, the land was so poor." I said, but now most of them own homes, nice homes and all, so they benefit.

So I learned a lot from out there, and I hope that we continues to keep the plant. I worked the whole plant. I worked the whole plant. If somebody wanted something did, after I came to be a supervisor, I was over all the heavy equipment in roads and grounds. If they wanted something did, I'd try to get it did. Regardless of how it was, I tried to get it done. And then nine times out of ten, I got it did, because I had good peoples, and the onliest way to work with good peoples is to be good to them, and let them be a part of what's going on, make them feel a part of what you do. So we'd get in the line-up meeting in the morning. "We done got this job and we've got this going on there, so we're going to do so and so today. How do you want to do it?" And they've got some good ideas. So we get together, we go do it, and we can do it the easiest way and the safest way.

We had some of the dangerous work out there. We didn't have no accidents. We turned one motor-grader over since I was there, one of the motor-graders turned over, but nobody didn't get hurt. But we relied on each other. And something they're doing right now in T and T that I started when I was there, I did not work two blacks together, I did not work two whites together; I mixed them. You get a better line of work safety-wise and production when you do that. The two men, they compete. They didn't have nothing in common last night. Their wives didn't go out to eat together last night. They ain't got nothing to hide from

handled about 2,700 cars (including coal deliveries) a month.[62] The Railroad Division was also responsible for the delivery of materials within the site, particularly irradiated fuels from the 100 Areas to the 200 Areas. Fuel elements and targets were delivered to the 100 Areas by truck.

The 700 Area was the Site's main support center and its public face. Within its boundaries lie the main administration building, an imposing two-story building with four wings, and a host of other service buildings that housed the site's security headquarters, telephone exchange, medical facilities, stores, fire station, and automobile maintenance. The Savannah River Laboratory, discussed later, was also part of the 700 Area but was set

Shepherd Archie, Traffic and Transportation Department

each other, to share with each other. The only thing they got in common is their safety and their job, and they did a tremendous job together by working like that. I left that—they are still doing it now. In the CSWE [Central Services Works Engineering], it's working like that, and that's working out fine.

Most everybody benefit by this plant coming here, and by that Savannah River Plant coming here, it not only helped that people that moved out of the area, the people that worked out there, but the industries inside Augusta and in the surrounding area. [They] had to go up and match the salary, or come close to matching the salary at the Savannah River Plant, the people at Babcock and Wilcox, Miriam Brothers and everybody, they had to go up and match the salary, or come close to matching the salary at the Savannah River Plant to keep their employees.

So that being that Savannah River Plant over there, it helped the whole area. Helped everybody. It didn't just help the people that worked out at the Savannah River Plant. The people at Babcock and Wilcox, Miriam Brothers and everybody, they had to bring their salaries up to keep their employees, because they were leaving here and going out there. Even the police department. They were going, leaving the police department, going to work for Du Pont security department and different places.

[The area has] changed. Some of the peoples left and some—the guy next door there, he worked over there, but he died in '81. But it's been the same. Kind of changes everywhere—you don't have no hard feelings about the plant out there. Everybody really cared for the Savannah River Plant, because why, they felt like they were kind of safe with the Savannah up there, but they don't trust these chemical companies here now. But Savannah River Plant, they trusted Savannah River Plant. Savannah River Plant tried to practice what they preached.

And another thing that made Savannah River Plant great, they hired inside the families. See, I have a son working out there now. My wife and I raised her sister's boy, a nephew. He's out there. And I have a niece out there. See, a big part of the safety record was to—see, I brought safety home with me. I'd tell my kids about house safety and what to do, what to don't do, how to drive a car, what they don't do, and Savannah River Plant helped a lot of families. You hardly ever hear kids, that their family was employed at the Savannah River Plant, get in trouble, because of the family, the peoples, the family that took care of them.

That man out there, he have five kids. He have two sons, three daughters, and they're always doing well. And nine times out of ten, everybody that had families worked at the Savannah River Plant, they did good. I sent all three of my kids to college, from working at the Savannah River Plant. My son, he's out there now, in the fire department. The one on the end out there, she's a doctor in Morehouse College, Atlanta. And this one right there in the middle (points to photograph), she went to Paine College.

So the Savannah River Plant really upgraded this section of the Southeast, not only here, all around Beaufort and all of those places down there. I worked with a lot of peoples from down there. So I think that it did us a good thing by moving in here. That's why I hope they keep it there.

Source: Oral Interview with Mr. Shepherd Archie, April 20, 1999. SRS History Project. Photograph: Courtesy of Shepherd Archie.

to the east of the administration complex. The Main Administration Building contained offices for both the AEC and Du Pont management teams and administrative staff. Communications, Purchasing, Records, Mail, Reproduction, Payroll and Stores were all based in the 700 Area, as well as the main cafeteria and Employees' Credit Union.

All of these support groups allowed the site to be an independent industrial entity that, in size and complexity, could best be likened to a city. The use of satellite support facilities in the process areas and the distribution of key personnel within each building or process area enabled each area to act independently of one another. The next chapters provide more detailed discussions of the main process areas: heavy water, reactors, and separations.

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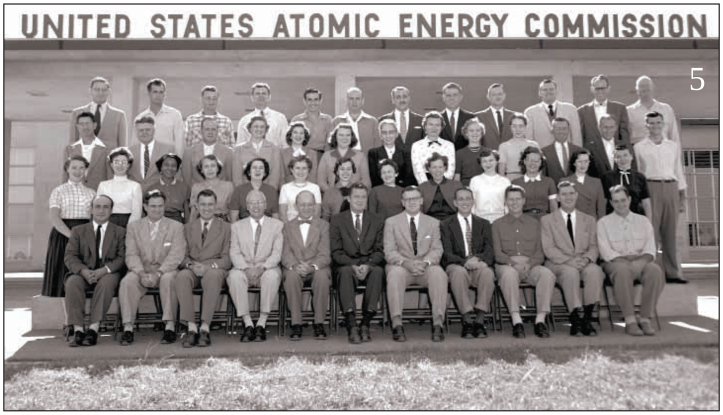

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1. 700 Area Fire Department, 1957. Courtesy of SRS Archives, negative 4279-18. 2. Credit Union Committee. Signing of charter application of Savannah River's proposal for a New Employee Credit Union, 1960. Courtesy of SRS Archives, negative 6500-4. 3. Document Control. Courtesy of SRS Archives, negative 3360-4. 4. Personnel Orientation in 719-A, 1978. Courtesy of SRS Archives, negative 27210-2 5. Atomic Energy Commission Extended Staff. Courtesy of SRS Archives, negative M-400-4. 6. Group of newly hired engineers, 1962. Courtesy of SRS Archives, negative 8031-1. 7. Summer Youth Program, 1956. Courtesy of SRS Archives, negative 3434. 8. Clerical Pool's Bea Talbert gives Liz Smith an assignment, 1957. Courtesy of SRS Archives, negative 27204-2. 9. Cafeteria view in A Area. Source: *Savannah River Twenty-Five Year Dinner*. Courtesy of SRS Archives. 10. S.W. O'Rear and Jim Hill pose in awe over increased technical report production, 1960. Courtesy of SRS Archives, negative 6673-12.


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