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Charleston, SC

Deadly legacy: Savannah River site near Aiken one of the most contaminated places on Earth

By Doug Pardue

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May 21, 2017

Editor's Note

The United States won the Cold War, not on a battlefield in some far off place, but in the Savannah River valley of South Carolina, the isolated deserts of New Mexico and along the Columbia River in Washington state. Those are among the dozen places scattered across the continent where

America created and built its nuclear arsenal. Today, the nation continues to cope with the legacy of that creation in sick, dying and dead nuclear workers. And the government still can't agree on where to permanently bury the deadly radioactive remains that will last for a quarter million years and cost untold billions of dollars to safely contain. The collapse earlier this month of a tunnel containing radioactive waste at a former nuclear weapons production site in Washington illustrates the continuing dangers.

Chapter One: Two worlds collide

In early September 1949, an Air Force B-29 bomber flew a routine but secret mission along the Soviet Union's Pacific coast. The high-flying warplane carried special filters to detect the radiological debris from an atomic bomb.

About the same time, 13-year-old Dorothy Dandridge trudged along rows of cotton plants to ready the crop for the upcoming harvest. She hated the work, the heat, the bugs, but that was all she knew growing up in the flat, swampy Savannah River valley.

Dandridge had no way to know it, but that B-29's flight would forever change her life and the lives of thousands in the South Carolina counties of Aiken, Barnwell and Allendale. It also would leave a swath of South Carolina larger than New York City among the most contaminated places on Earth, a storehouse of the deadliest radioactive materials known, enough to obliterate humanity. The government can't get rid of it and still doesn't know what to do with it. Just keeping it contained has cost billions of dollars, stands to cost untold billions more and has no end in sight.

The B-29 had made the same flight many times, but the filters had never trapped what set off instruments this time. More flights went out to collect additional samples, and scientists across the country pored over the results. Intelligence experts concluded the filters had detected the radioactive signature of an atomic bomb blast.

The U.S. had been monitoring for such an explosion to avoid being caught by surprise in an atomic Pearl Harbor, but intelligence experts had not expected the Soviets to pull it off until 1953.

America no longer owned an atomic monopoly, a stunning turnabout that President Harry Truman revealed to the nation less than a month after the Soviet bomb test. The Cold War suddenly got far more dangerous.

To counter the new Soviet threat and keep America's nuclear arsenal the most advanced, Truman embarked on a crash drive to build a "super bomb" theorized to be a thousand times stronger than the atomic bombs that ended World War II with the destruction of Hiroshima and Nagasaki.

At noon on Nov. 28, 1950, the government released the news: It planned to seize about 300 square miles in Aiken and Barnwell counties to make the ingredients for hydrogen bombs. The government allocated $260 million to start construction, compensate property owners, demolish almost every structure, destroy four towns, transplant graves and kick out 6,000 people.

Dorothy Dandridge was one of those people.

The last residents left the Savannah River Plant area by early 1952. Some tried to recreate their beloved hometown as New Ellenton just outside the gates of the plant near Aiken. EllentonSC.com/Provided

Gone forever

Most people in Ellenton and a handful of smaller, nearby farm towns huddled around radios as clocks struck noon to hear what all expected to be a major announcement. They'd known for weeks something big was in store. Rumors swirled about all sorts of industries planning to set up shop in the sleepy farmland along the middle range of the Savannah River, bringing high-paying jobs to an area where barter remained common.

The day before the announcement, Louise Cassels, daughter of one of Ellenton's civic and business leaders, expressed concern to her brother and sister: "I've an uncanny feeling it's something that'll change our entire way of life."

The next day, the Ellenton elementary school teacher heard another rumor: an H-bomb plant was coming. She did not like the thought of her peaceful hometown taking part in destroying people and places.

Dorothy Dandridge in her house in New Ellenton on Wednesday, Jan. 25, 2017.

Dandridge was forced to leave her home near the old town of Ellenton when the government seized about 300 square miles of land to build the Savannah River Plant. Unlike most kicked off the land, she was happy to leave. She hated working cotton fields and to this day avoids, when possible, cotton clothing. Michael Pronzato/Staff

Dandridge sat in her Aunt Annie Bell's 1946 Chevrolet when the announcement came over the car's radio. The Atomic Energy Commission planned to seize about 200,000 acres in Aiken, Barnwell and Allendale counties. About 1,500 families would have little more than a year to leave their farms, homes and shops. Fair compensation was promised to all — a promise many later felt went unfulfilled.

For many of the black residents, talk of fair compensation didn't mean much. Whites owned almost everything and black farmers often rented land to farm or sharecropped.

The announcement didn't specify exactly what the coming plant would produce, saying only that it would be material that could be used "for weapons or for fuels potentially useful for power purposes." The announcement emphasized that "operations at the Savannah River plants will not involve the manufacture of atomic weapons."

The Savannah River Plant, simply called "the bomb plant" by locals, would not actually assemble the hydrogen bomb. It would make the two key radioactive ingredients necessary to build such a devastating weapon — tritium and plutonium. Few understood that their cotton fields and pastures soon would yield the world's deadliest crop.

Fear was the fertilizer

Not since the attack on Pearl Harbor thrust America into World War II had events been so frightening and the future so uncertain: The Soviet Union had the atomic bomb. Their spies were said to have infiltrated the government. Communist forces had taken control of mainland China. Communist North Korea invaded South Korea, pushing America into another war. And Chinese forces streamed to North Korea's defense, threatening to ignite a so-called "police action" into World War III.

In Aiken and Barnwell counties, the federal government hurriedly took control of 310 square miles of land, started clearing and began construction in 1951. The last residents left by early 1952, and later that year, the bomb plant began production for the weapons of Armageddon.

Many of those kicked out scattered across the country, but most resettled in nearby communities, particularly the cities of Augusta and Aiken. Some tried to recreate their beloved hometown as New Ellenton just outside the gates of the plant near Aiken.

New Ellenton would be split by a four-lane highway instead of the old town's railway track. Local businesses would remain modest with a barbeque restaurant, a couple of fast food joints and a town hall along its main street. A few of the homes would be those that owners jacked up, placed on trailers and hauled from the old town.

Most of the residents left consoling themselves that they had done their patriotic duty to defend the country from the communist menace. Louise Cassels would later write in a memoir: "our little town of Ellenton is just a beautiful memory … The sacrifice was heartbreaking." Nevertheless,

she continued, “we small town folk are proud to have played a part in helping to preserve and protect our United States of America.”

Louise Cassels wrote in a memoir, “Our little town of Ellenton is just a beautiful memory … The sacrifice was heartbreaking.” EllentonSC.com/Provided

Clarence Bush worked a couple miles from old Ellenton at Leigh Banana Case Company in the days before the bomb plant. Leigh was the largest manufacturing business in the area, harvesting hardwoods, including cypress and sweet gum, from the swamps along the Savannah River to turn into crates and baskets for fruit and vegetables.

The forced removal was rough on many, but Bush snagged a job at the huge new bomb plant. The handyman started in the labor pool and rose to a supervisory position in the transportation department, eventually making $1 an hour, pretty good pay for a black worker then.

Bush, now 88 and owner of an auto repair shop in New Ellenton, recalls the forced move as feeling “like one of the awfulous things to me, but my opinion, as far as economically, it was one of the best things that could happen.”

As government bulldozers leveled virtually every structure in the area seized for the plant, American scientists half a world away built a three-story tower on the tiny Pacific island of Elugelab that U.S. troops liberated from the Japanese Empire eight years earlier during World War II.

The scientists placed an experiment called “Mike” on the tower to test the Teller-Ulam design, named after two of the Manhattan Project scientists who helped develop the atomic bombs dropped on Hiroshima and Nagasaki. The two physicists conceived a way to unlock the vastly greater explosive power released through fusion of atomic nuclei instead of the atom-splitting employed

in the atomic bombs. Fusion unleashes the same force that powers the sun. The concept for such a powerful bomb had been around for more than a decade, but scientists struggled to find a way to make it work.

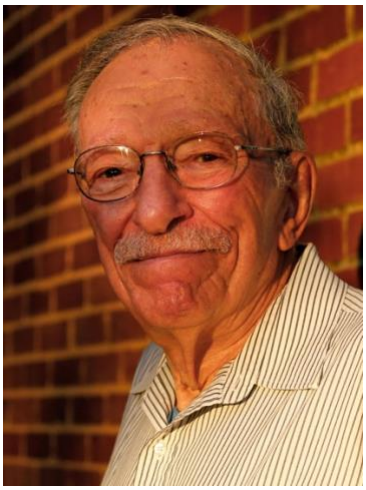
On Nov. 1, 1952, Mike erupted with an ear-splitting explosion and a blinding, three-mile-wide fireball. The blast vaporized Elugelab and plowed a hole in the ocean floor more than a mile wide — deep enough to hold a 16-story building. A giant mushroom cloud with a stem 20 miles wide shot into the atmosphere. The cap boiled higher than fighter jets could fly, bursting into a 100-mile-wide radioactive umbrella that cast a dark shadow above an area larger than the state of Connecticut.

Mike proved the Teller-Ulam design correct and unleashed the world's first thermonuclear explosion — the hydrogen bomb. It threw a destructive punch 700 times that of the atomic bomb that leveled Hiroshima, killing some 70,000 people and untold thousands more over the years as radiation took its toll.

Scientists bound for work at the bomb plant now knew they would no longer be working on just a theory. America had released the power of the sun and once again owned a monopoly on nuclear superiority.

The race for Armageddon

News of the H-bomb echoed across the rolling hills and gentle mountains around Pennsylvania State University as Walt Joseph pursued graduate studies in engineering. On an educational lark he also dabbled in the exciting new field of nuclear science, taking a couple of the classes on the subject the university offered at the time.



Walt Joseph spent his entire professional career as an engineer at the Savannah River Plant, starting out of graduate school in 1954 and helping perfect the manufacturing methods for the two key radioactive materials that make a hydrogen bomb so explosive, plutonium and tritium. He's now directing creation of the Savannah River Site Museum in downtown Aiken. He said the early days were exciting times when he and fellow scientists and engineers "had to figure out what was basically unknown." Michael Pronzato/Staff

However, the pressures from years of studies and stretched finances weighed on the young, married man as he found both his energy and cash flagging. About the same time, he spotted a job posting on a bulletin board. The Savannah River Plant was recruiting scientists and engineers. It

offered a respite and a hefty paycheck to boot, so he and his wife, Paula, drove down over Christmas 1954 to check it out.

The plant officials who interviewed him didn't reveal much about what he'd be doing, but he took the job. He and Paula figured they'd stay a couple of years, recover financially and return to Penn State to finish his doctorate.

They rented a house in nearby Aiken, no easy task as thousands of people converged on the small, horse-country resort town to work at the plant. Some 38,000 workers gathered to build and run the sprawling facility, the nation's single largest building project since construction of the Panama Canal.

Among those workers were two diminutive brothers, Eugene and Eulie David. The two skilled welders had been among the actors in the 1939 classic film "The Wizard of Oz" who played the part of Munchkins. The brothers stood under 4 feet, giving them an advantage over taller welders in the often tight constraints involved in building the plant. That attribute proved particularly useful welding inside the long, waist-high pipes needed to bring water from the Savannah River to cool the super-hot nuclear reactor cores.

Among the Savannah River Site construction workers were Eugene and Eulie David. The two skilled welders had been among the actors in the 1939 classic film "The Wizard of Oz" who played the part of Munchkins. Courtesy of SRS archive

The area seized for the plant was huge — 22 miles wide and about the same in length. Despite construction of more than 200 miles of paved roads, including the first cloverleaf intersection in South Carolina, traffic was horrendous as workers scrambled to get to the round-the-clock construction project. Joseph and his fellow engineers, like almost everyone else at the plant, were required to carpool.

Hours at work were long. Some workers simply slept any place they could find at the plant, including the women's restrooms. Most women worked daytime jobs at the time, so at night men commandeered the women's bathrooms because they were often the only places with couches.

Secrecy was absolute. You couldn't even tell your wife what you did. After Joseph and his wife started a family, their son was asked at a party how his father earned a living. He replied that his dad was a barber. The child got that impression because the only business he had ever seen his father leave after work was a barbershop after an occasional haircut.

Joseph and the other engineers, scientists and technicians were thrown into the nuclear fray, learning as they went to refine the ingredients for the world's deadliest weapon. He studied the limits of heat transfers in reactor assemblies and other means to improve efficiency and production. He and his fellow scientists and engineers designed unheard of weapons material, scribbling on blackboards in a huge leap of faith.

Computers weren't introduced to the plant until the early 1960s. Until then, the engineers used hand-held slide rules with three decimal point precision for critical calculations.

DuPont, the company that helped build the atomic bombs that ended WWII, also was entrusted by the government to build and run the bomb plant. The company had a reputation for strict safety. But the engineers and scientists also were reminded: "We need every bit of production we can get."

The need for speed created an atmosphere ripe for unanticipated consequences. Many at the bomb plant in those early days, especially the blue-collar workers, didn't see radiation as a real danger. Most didn't understand what it was. Besides, the high wages and benefits made it worth the risk.

Five construction workers would die and 180 would be injured in the massive building project. And over the next half-century thousands of workers would receive cancer-causing and sometimes deadly exposure to radiation and other hazardous materials.

Joseph understood the radiation danger, but he worked in the relative security of the lab, focused on winning the scientific battlefield to prevent World War III. And America was losing ground.

One morning in August 1953, the Soviets detonated their own H-bomb, just nine months after the Mike explosion introduced the world to thermonuclear destruction. American scientists consoled themselves that the Soviet version was not a true hydrogen bomb and its explosive power was difficult to enhance.

The Savannah bomb plant experts doubled down to refine the American weapon, knowing the Soviets would not rest until they matched its destructive potential. For Joseph, it was a frightening race with skilled opponents rushing to solve the same scientific puzzles.

"Nothing had been tested on the scale we were working. We had to figure out what was basically unknown. It was scary, but all of us realized we had a national mission."

Then, on Nov. 22, 1955, the sky over the Soviet test site at Semipalatinsk, in what is now Kazakhstan, ignited with a power 100 times that of the first Soviet atomic bomb.

Now the Soviets also had the world's deadliest weapon: the hydrogen bomb.

'Duck and cover'

In the 1950s, Bert the Turtle starred in cartoons shown in public schools across the country. He strolled along a tree-lined path accompanied by a breezy ditty: "Dum, dum, dittle-dum, there was a turtle by the name of Bert. When danger threatened he never got hurt. He knew just what to do. He'd duck and cover."

America's schoolchildren drilled to the warnings of Bert: "You must be ready all the time for the atomic bomb – duck and cover." Teachers taught students that when air raid sirens blared they could survive nuclear attack by simply crawling under their desks with hands wrapped behind their heads.

Surviving nuclear war became a national obsession, even as Americans tried to enjoy the newfound prosperity of the country's post-war economic boom.

In this Sept. 12, 1958, picture, Beverly Wysocki (top) and Marie Graskamp emerge from a new family-type bomb shelter on display in Milwaukee, Wis. File/AP

Magazines and construction companies advertised plans and kits for building fallout shelters. Across the nation, homeowners converted portions of basements into bomb shelters or dug backyard fortifications like those used for tornadoes. Others built elaborate, multi-room

underground homes to ride out a nuclear blast. One Iowa farmer reportedly built a bomb shelter for 200 of his cows.

Plant engineer Joseph watched as residents in Aiken and Augusta, the two largest cities near the plant, took similar steps to protect their families. Residents around the plant, many of whom worked there, seemed to be building more shelters than residents of other areas. Perhaps they understood the destructive potential better than most.

In Aiken, one family built an underground concrete structure that was sealed off with a steel entrance and had features designed to deflect radiation. The main living area contained a hand-cranked device for ventilation. Shelves and other compartments provided places to stockpile basics the family would need to survive for a couple of weeks. That's how long they thought it would take for the initial radiation from a nuclear bomb to subside enough to safely venture outside.

The bomb plant itself was one of the most protected places in America. It was built with the threat of a nuclear attack in mind, and jet fighters stood ready to intercept Soviet bombers. The reactors were randomly named by single letters of the alphabet as reactors R, P, K, L and C, and were built at least 2.5 miles apart to minimize the impact of a reactor explosion or H-bomb attack.

The reactors also were aligned along a long, sharply curved horseshoe shape to prevent a straight-line bomber run. The reactors, steel-reinforced concrete monsters, reached 200 feet in height and 40 feet below ground. The entire plant complex was designed to wholly, or partially, continue to operate after taking a nuclear hit.

As the '50s progressed, the reality of all-out nuclear war began to sink in for the American public.

The stakes grew higher still with the introduction of intercontinental ballistic missiles at the tail end of the decade. Now the world had a long-range missile race to go along with an H-bomb race.

On the silver screen, Hollywood further stoked fears with apocalyptic movies such as 1959's "On the Beach," a film about a journey undertaken by America's sole-surviving nuclear submarine in the aftermath of a nuclear war.

The threat of mutually assured destruction remained the main, if unnerving, safeguard against a nuclear attack. And bomb plant engineer Joseph remained certain the technological lead America's scientists and engineers had built made the Soviets afraid to launch a nuclear attack.

Joseph's confidence was tested in October 1962 after an American U-2 spy plane flying high over Cuba returned with photographs of Soviet nuclear missile sites under construction. That would put Soviet H-bombs just 90 miles away, capable of striking the nation's heartland in minutes.

A week later, President John F. Kennedy ordered a naval blockade of the island and drew a line in the sand: The United States would not tolerate Soviet nuclear missiles in Cuba. The military prepared for an invasion of Cuba, and America's intercontinental missiles were readied for launch.

Polaris submarines went to battle stations, and B-52 bombers prepared for attack. The Soviets ordered Warsaw Pact militaries to war status and the U.S. military moved to DEFCON 2, the highest state of nuclear war readiness ever reached. The next stage, DEFCON 1, signaled "Imminent nuclear war."

The world stood still as Soviet ships continued to steam toward the American blockade with Kennedy and Soviet Premier Nikita Khrushchev locked in a game of nuclear chicken.

Chapter Two: Mutually assured destruction

In 1964, engineer Walt Joseph neared his 10th anniversary at the Savannah River bomb plant helping to perfect the nation's nuclear weapons. But secrecy at the hush-hush facility remained so tight he could not breathe a word about what he did. That same year, Joseph and his wife went to see a popular new movie that dealt, in a way, with what he worked on at the plant.

"Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb" depicted a deranged American officer launching a nuclear-armed B-52 bomber attack on the Soviet Union as frantic Americans struggled to call back the jets or help the Soviets shoot them down. One bomber managed to make it through, triggering thermonuclear Armageddon.

Dr. Strangelove was all too real for Joseph, who worked to design ever more effective ways to manufacture the explosive power of thermonuclear weapons. To him and many Americans the movie captured the reality of the fear that permeated the nation and those making the weapons of mass destruction to protect it.

The movie underscored what Americans increasingly understood: That mutually assured destruction, the strategy shared by the U.S. and the Soviets, was exactly what its acronym said, "MAD." All it took for annihilation was one accident, a split-second miscalculation or a crazy decision as the two superpowers dueled for military superiority. Joseph saw the film as a frightening satire.

"It was funny, yet there was a lot of truth."

The mission for Joseph and his fellow engineers and scientists was to keep the nation's nuclear arsenal the most advanced in the world, a goal that became more urgent later that year as Communist China exploded an A-bomb and joined the nuclear club.

Sweat was still fresh from the Cuban Missile Crisis when both superpowers came to their senses and initiated a series of baby steps to curb what they had created. The missile crisis ended peacefully with a negotiated settlement and the immediate withdrawal of Soviet nuclear-armed missiles from Cuba. The first step came on Aug. 5, 1963, when the powers agreed to ban nuclear tests in outer space, under water or in the atmosphere.

Nevertheless, imminent danger from the superpowers' growing arsenals and their nuclear brinkmanship remained.

That danger was demonstrated on Jan. 17, 1966. A B-52 carrying four of America's H-bombs, each dozens of times more powerful than the bomb dropped on Hiroshima, returned toward its North Carolina base from a simulated bombing run on the Soviet Union.

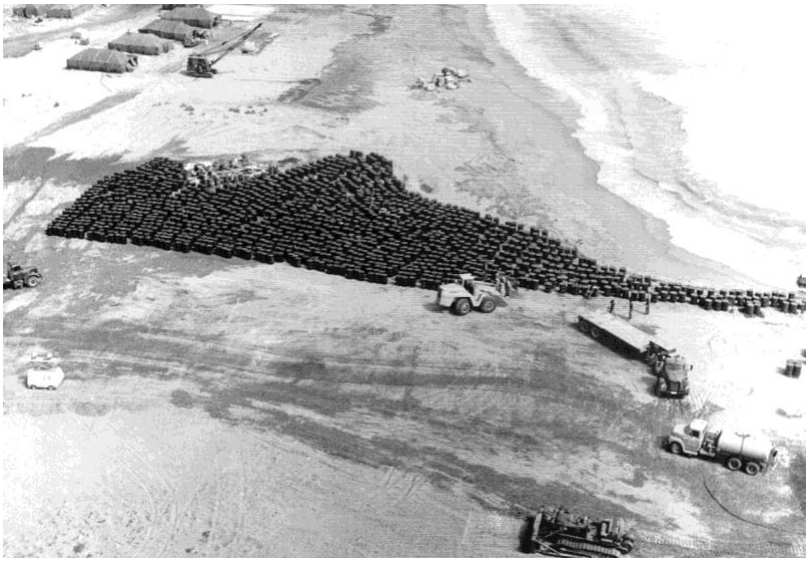
The country kept nuclear-armed B-52s constantly in the air to deter a Soviet nuclear attack. On that January morning, the bomber approached Spain and a 31,000-foot-high rendezvous with a mid-air refueling tanker. The routine maneuver went horribly wrong as the B-52 slammed into the tanker's fuel umbilical, ripping off the bomber's left wing. As the jet broke up, flames raced up the umbilical, igniting the tanker in a giant fireball, incinerating the four crew members. Three of the bomber's crew also died. Four others parachuted to safety.

As the bomber disintegrated in mid-air, four H-bombs slipped from the fuselage and screamed toward the Spanish Andalusian coast. One landed in the Mediterranean and three hit land near the tomato farming village of Palomares. The bomber crew had not armed the H-bombs, preventing a nuclear conflagration that would have killed tens of thousands of people in a flash and doomed an untold number to untimely death from radioactive fallout.

Armageddon slipped by, but conventional explosives designed to set off the nuclear cores exploded in two of the bombs, showering tomato fields and farmhouses with the fine dust from more than six pounds of plutonium.

The military rushed some 1,600 servicemen to find the bombs and clean up the contamination. They shoveled plutonium-contaminated dirt into metal containers. The U.S. then shipped 1,500 tons of tainted soil back to the states for disposal. The 55-gallon steel drums of radioactive dirt were buried at the Savannah River Plant in 20-foot-deep unlined trenches.

That burial ground is where the plant dumped much of its solid radioactive waste at the time, often in cardboard boxes. Radioactive contamination continues to leach from burial trenches into groundwater and periodically the Savannah River despite efforts to cap the trenches and stem the leakage. Plant engineers built a dam to block most of the flow and create a large pond.



More than 1,000 sealed barrels containing radioactive soil near Palomares in Spain on March 18, 1966, where American H-bombs fell and broke open. The soil was taken to the U.S., to the Atomic Energy Commission's "burial ground" near Aiken for disposal. File/AP

Officials built a dam to hold back water contaminated with radioactive and other waste that continued to leech from old solid radioactive and chemical waste burial grounds. The water is held in this pond and sprayed back into the forests where trees absorb it and the water evaporates harmlessly into the atmosphere, plant officials said. By Michael Pronzato mpronzato@postandcourier.com

The contaminated pond water is used as irrigation and regularly sprayed into the surrounding forest where it is absorbed by the trees and evaporates harmlessly into the atmosphere. The pond also is home to two radioactive alligators dubbed by workers as Tritagator and Dioxinator — after two of the wastes, radioactive tritium and toxic dioxin.

Solid radioactive waste continues to be dumped into unlined ditches and buried. But now it's limited to low-level radioactive material with short half-lives — the time it takes for the material to lose half of its radioactivity. Plant officials say the material loses virtually all of its radioactive punch before it can leach into groundwater and spread very far from the trenches.

'The China Syndrome'

In the 1970s, Hollywood continued to reflect America's evolving emotions toward nuclear power. One movie in particular raised unsettling questions.

The plot of "The China Syndrome" revolved around the possibility that lax safety could trigger the meltdown of a reactor core, unleashing a devastating radioactive explosion as the super-heated core melted through the containment floor and straight down to China.

Nuclear industry officials blasted the film as fantasy and an unfair attack on an uncommonly safe source of electric power.

Twelve days after the film's release, however, an equipment failure at Pennsylvania's Three Mile Island Nuclear Power Plant triggered a chain of mechanical and human errors: Cooling water stopped flowing to the nuclear fuel; heat soared and the core began to melt. If that fuel breached the containment dome, plant officials faced the possibility of an enormous explosive release of radioactive fallout, rendering some 1,000 square miles uninhabitable.

A photo of the Three Mile Island nuclear power station near Harrisburg, Pa., circa 1979. An accident caused a radiation leak at the plant in March 1979. File/AP Anonymous

The reactor dome held and a catastrophe was averted. But the episode generated a sea-change in public attitude about nuclear energy. It no longer was seen as clean, unlimited electricity. It had become a public danger.

The government responded with sweeping and expensive safety regulations that would bring a halt to new construction of nuclear power plants in the United States for the next quarter century.

The nation's nuclear weapons complex, however, continued to operate in its usual cloak of war secrecy.

Studies were conducted to show that safeguards at the Savannah River bomb plant's reactors wouldn't allow for a repeat of Three Mile Island. They pointed to automated systems that could shut down reactors when necessary and an advanced training simulator that helped technicians prepare for the worst.

A flare-up in the Cold War would soon shift attention back to production needs at the bomb plant.

In December 1979, the Soviet Union launched a massive air and ground invasion of Afghanistan. Ronald Reagan won the presidency the following year, pledging a military and weapons build-up to counter the Soviet Union, which he called "the evil empire."

That meant increased demand on the bomb plant for more fuel for more hydrogen bombs. To accomplish this task, Joseph took charge of a group of engineers to restart the plant's L Reactor, which had been on stand-by for a decade. Rust and 10 years of neglect made the job a challenge.

Joseph and his team also ran into a huge unexpected problem: They couldn't find an American company to manufacture the critical heat exchangers. The locomotive-sized machines essentially act as car motor radiators to help control the massive heat produced in reactors. Dejectedly, Joseph and his team turned to Japan to make those parts.

"And they worked great, but it grieved me that we were no longer capable of building that kind of equipment in this country."

Radiation, racism and reform

Until the Three Mile Island meltdown, Willar Hightower had not thought much about the risk posed by radiation or a nuclear reactor catastrophe. For him, work at the bomb plant provided more than what most black workers could expect in a job: an intellectual challenge, state-of-the-art equipment, and good pay and benefits.

That was a rare combination in 1967 when he was hired to program plant computers. At the time, whites in South Carolina and other parts of the South continued to resist public school desegregation and integration in general.

Most black workers at the bomb plant labored in blue-collar jobs, some involving exposure to radioactive and other hazardous wastes. Few black employees held professional positions when Hightower was recruited out of the Army, where he served as a lieutenant. As a college-educated mathematician and engineer, Hightower had skills the plant needed.

He began in a relatively isolated laboratory, where he worked mainly with similarly trained whites. On occasion, he found racist symbols near his work station, such as a hangman's noose. He also found racist words scribbled in places.

But for Hightower, now an Aiken County councilman, the worst discrimination came in the form of bias in promotions.

Willar Hightower

"It seemed like you couldn't move up in a job. Many of us hit a glass ceiling."

He and many other black workers ultimately filed a discrimination suit and received individual settlements.

Documents filed in that suit provided Hightower with his first thorough accounts of how racism played out for some blue-collar black workers. One case involved a black worker sent into a high-radiation area without proper protection. He also read accounts of black employees who were reportedly forced to take off their personal radiation monitors when they were sent into radioactive situations so it would not show up on official records.

Studies would later show that blacks experienced higher incidents than whites of some cancers and early deaths.

Plant officials continued to dismiss concerns despite growing evidence of sickness and death from radiation and other hazardous materials. They insisted the plant was safe.

Then, on the morning of April 26th, 1986, a technician at the Soviet nuclear power plant near the city of Chernobyl did what he had been taught to do when confronted with confusing reactor meter readings: He pushed the button to initiate an emergency shutdown. That unleashed the world's worst nuclear reactor accident.

The Unit 4 reactor core at the giant electricity plant melted down and exploded. Two workers died instantly and radiation poisoning killed 28 more within weeks. Untold others have since died from or contracted radiation-caused disease. The blast rendered an area the size of Rhode Island highly contaminated. Much of that area remains off limits.

American nuclear experts and those at Savannah River dismissed the Chernobyl explosion as the result of Soviet design and training flaws. They saw little to be learned from the episode. As happened after Three Mile Island, the bomb plant ran a number of studies to show how its superior training, equipment and procedures would head off a disaster like the one that occurred at Chernobyl.

A chimney over the destroyed reactor at the Chernobyl nuclear power plant (background left) and a gigantic steel-arch under construction to cover the remnants of the exploded reactor in the town of Prypyat close to Chernobyl, Ukraine. Houses in the foreground were abandoned by Chernobyl plant workers a few days after the explosion. Since then, Prypyat has become a ghost town. File/Efrem Lukatsky/AP

Nevertheless, for Congress and the American public, Chernobyl crystallized the potential for mass destruction from a nuclear accident and the need for improved safety and health protections. Increasingly, the cloak of secrecy that had shrouded the nuclear weapons industry for four decades lifted.

Secrets exposed

By 1987, Congress realized that the Savannah bomb plant and other parts of the nation's far-flung nuclear weapons industry were dangerous places — leaking, radioactive dumps.

Testimony at Congressional hearings peeled back decades of government secrecy revealing a harrowing record of accidents and mistakes that could have triggered nuclear disasters rivaling Three Mile Island and Chernobyl.

At the Savannah River plant alone, the records detailed 30 serious incidents and elevated levels of cancer and other ailments among workers. Most had occurred in earlier years when the technology was new and speed was of the essence.

Two of the incidents occurred in 1970. One initiated a near Three Mile Island episode when fuel rods melted in the C Reactor as cooling water dropped too low because technicians ignored an automatic reactor shutdown and attempted to restart it three times. The other incident involved the release of large amounts of radiation in a room at the K Reactor while technicians ignored a radiation alarm for two hours. The cleanup took three months, exposing 900 workers to high levels of radiation.

In 1965, technicians at C Reactor ignored a warning alarm for 15 minutes before workers noticed that 2,000 gallons of cooling water had poured onto the floor. The spill caused the cooling water inside the fully-powered reactor to fall dangerously low, threatening a meltdown.

And in 1960, a nuclear chain reaction in the L Reactor nearly went out of control. Power in the reactor surged 10 times faster than considered safe. Technicians caused the near catastrophe when they ignored procedures and pulled safety and control rods to restart the reactor after it shut itself off automatically.

Plant officials acknowledged that technicians occasionally ignored warning alarms and instruments because of numerous false alarms. They didn't want to risk the costly loss of time to shut down reactors, conduct safety checks and restart.

Outrage over the previously cloaked failings, along with other concerns, led Congress to establish an independent board in 1988 to oversee safety, health and environmental matters at the nuclear facilities and to keep the public informed.

For thousands of current and former workers at the bomb plant it came too late. Many had been exposed to excessive, sometimes deadly, doses of radiation during the first three decades of the plant's operation. The congressional hearings revealed that safety took a back seat to production.

Still, these workers would not get compensation until the 20th century became the 21st and Congress approved a compensation program that provides for payments of up to $400,000 for illness or death related to the radiation, chemicals and other hazardous material at the weapons plants.

Nevertheless, for many of those workers, threading the bureaucratic quagmire to show a relationship between radiation exposure and an illness or death remains a nightmare given the secrecy that prevailed.

Chapter Three: Living with the fallout

The massive concrete building appears from the distance like an ancient Mayan tomb. It's not ancient or Mayan, but it is a tomb. Vultures circling overhead attest to its deadly contents. Tall chain-link fences and coils of razor-sharp wire encircle the gray monolith. Outside the fence, a 50-

foot-wide barrier of jagged, granite rocks, each thigh-high, blocks any rapid approach by foot or vehicle.

This is the tomb of 13 tons of the most deadly substance known — plutonium, the highly radioactive fuel that gives hydrogen bombs their destructive power. The tomb lies inside the old K Reactor, one of the Savannah River bomb plant's five nuclear reactors that produced much of the ingredients for the nation's H-bomb arsenal during the Cold War. At one point during that arms race, each superpower possessed about 30,000 nuclear bombs, now down to about 7,000 each.

The C Reactor is one of the five nuclear reactors at the Savannah River Site, all of which no longer function as reactors. The C Reactor is similar to the K Reactor, where some 13 tons of deadly radioactive plutonium is in so called temporary storage at the plant. Officials won't allow photographs of the highly-protected K Reactor, which like the C Reactor often has vultures roosting on top of it or flying overhead. Michael Pronzato/Staff

The need for that nuclear material ended with the collapse of the Soviet Union in 1991. Walt Joseph and his fellow bomb plant engineers and scientists credit that collapse to the technology America created that the Soviets went broke trying, and failing, to match.

The K Reactor was the last one working at the bomb plant. It shut down the same year the Cold War ended and was converted to store a large part of the deadly remains of America's nuclear arsenal.

It's supposed to be a temporary grave until a permanent tomb can be opened out west in either Nevada or New Mexico, but political agreement to make that happen has failed.

Inside the K Reactor the plutonium sits encased in 500-pound cylinders. Rows of these cylinders, stacked three high, fill reinforced-steel concrete bunkers with walls 7-feet thick. Each container can safely store the plutonium for about 50 years before the deadly contents likely would have to be repacked. That's about the same time it took for the U.S. to win the Cold War.

That sounds fairly safe until the properties of plutonium are considered.

In the life of plutonium, 50 years is nothing. Radioactive power can be measured in what scientists call half-lives, the amount of time it takes for the radiation to diminish by half. And scientists say it takes about 10 half-lives before the radiation is essentially gone.

The half-life of the plutonium-239 in the K Reactor containment cylinders is 24,000 years — four times longer than civilization has been around. The time it would take for it to be rendered harmless is 240,000 years — longer than modern humans have existed.

Cold War warriors

Willar Hightower retired from the bomb plant in 2000 after 33 years. He remained for his entire career despite lingering concern about possible radiation-induced health problems for himself and his first wife, Josephine.

He lost a kidney from what he suspects was radiation or chemical exposure at the plant. Josephine lost her life.

Josephine worked at the plant for 31 years, mainly in computer programming and as an office worker. In 1996, she was diagnosed with breast cancer. The couple suspected the culprit was radiation, but plant officials continued to insist all was safe, especially for employees who worked in operations away from the reactors and radioactive materials.

She died from breast cancer on May 14, 2001. Hightower would later receive death compensation for his companion of 31 years through the government program begun in 2000.

"I'd rather have my wife," but at least the money serves as an acknowledgement of the bomb plant's years of lies, he said.

Warren Johnson is one of two lawyers handling efforts by bomb plant employees who started work there after 1972 to qualify for the same compensation as those who worked in the early nuclear bomb production years. He's hopeful but believes many of the workers will go to their deaths before their cases are resolved.

Virginia Anderson thinks she might become one of those.

Virginia Anderson at her house in Augusta, Ga. on Tuesday, Jan. 24, 2017. When Virginia Anderson, 60, went to work at the Savannah River Plant she was told it was one of the safest places anywhere. But after working there for a few years she was diagnosed with breast cancer that would return two additional times. Now she is trying to win compensation but was told she can't prove her cancer was caused by anything at the plant. Michael Pronzato/Staff

The Augusta resident started at the plant in 1978 while in her 20s. She worked as an administrative assistant in an office building a good distance from any of the reactors, laboratories or radioactive waste disposal areas. She vividly recalls her first day when she was assured at orientation that "this is the safest place you can work on Earth."

Eleven years later she was diagnosed with breast cancer and thought it unusual since she was the only woman in her family to get the disease. It seemed even more unusual when two other women in her office got the same diagnosis.

After surgery and painful chemotherapy, doctors told her the cancer was gone. She suppressed her concerns about radiation exposure and returned to work. Officials again assured her she was safe and something else had caused her illness

Anderson's cancer came back two more times.

Still, she continued working at the plant until retiring in 2006, returning for a brief period after that. Now, at 60, she can no longer work. Too many aches she also attributes to her cancers and exposure to hazardous materials at the bomb plant.

She filed for compensation but was rejected. She is appealing. They say she can't demonstrate a connection between her job at the plant and her cancer.

Signs are posted throughout the Savannah River Site with warnings for radioactive material and contamination on Wednesday, Jan. 25, 2017. Michael Pronzato/Staff

But Anderson recalls an incident in 2000 when a man in her office building went to get some food at the canteen. A radiation monitor alerted on one of his shoes when he tried to enter the food area. Safety officials retraced his steps and discovered a roach he had kicked aside in a hallway. The roach was hot from cesium-244, a radioactive isotope formerly used in a highly contaminated area of a secured lab.

Plant officials cautioned workers to avoid encounters with roaches and told them to alert the radiation-control division if they saw one. Officials characterized the incident as an isolated case involving a roach that managed to creep out of the radioactive lab through some tiny crevice. The plant also studied ways to beef up pest control.

Anderson believes the roach offers a sign that the entire bomb plant is radioactive and no place there is safe.

Just how many casualties arose from radiation exposure at the bomb plant and the nation's other similar facilities may never be known.

What is certain is that Anderson, Josephine Hightower and thousands of sick, dying and dead workers from the Savannah bomb plant and the nation's other nuclear weapons facilities manned the front lines in America's fight to win the Cold War — and they are among its only casualties.

How we did it

This story was compiled from dozens of interviews with some of those forced to give up their homes in the early 1959s when the Savannah River Site was built, present and former workers at the bomb plant, scientists, environmentalists, lawyers and government officials. Information also was gleaned from government documents, Congressional testimony, newspaper articles, and scientific and medical studies. Additional detail came from histories written about the plant and recordings of recollections of workers, engineers and scientists. The newspaper also relied on Louise Cassels' book "The Unexpected Exodus," detailing her memory of what it was like for her

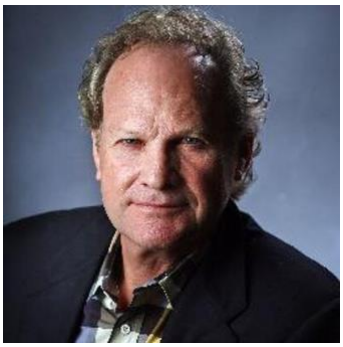
and some other residents in the South Carolina town of Ellenton who were forced by the government to abandon their homes to make room for construction of the Savannah River Plant.

The casualties

Nationwide, more than 114,000 workers from the government's nuclear weapons facilities have filed claims and more than $13.5 billion in compensation and medical bills have been paid out under Labor Department's Energy Employees Occupational Illness Compensation Program adopted in 2000.

At the Savannah River Site more than 10,000 workers have filed claims under the program and more than $1 billion has been paid out.

About half of all the cases are denied because demonstrating a link between illness or death and exposure to hazards at the nuclear weapons facilities remains a daunting task in what was a secret environment where workers couldn't even tell their spouses what they did.



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