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History of Hanford Site Defense Production (Brief)

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
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HISTORY OF HANFORD SITE DEFENSE PRODUCTION

Michele S. Gerber, Ph.D.

ABSTRACT

This paper acquaints the audience with the history of the Hanford Site, America's first full-scale defense plutonium production site. The paper includes the founding and basic operating history of the Hanford Site, including World War II construction and operations, three major postwar expansions (1947-55), the peak years of production (1956-63), production phase downs (1964-the present), a brief production spurt from 1984-86, the end of the Cold War, and the beginning of the waste cleanup mission. The paper also delineates historical waste practices and policies as they changed over the years at the Hanford Site, past efforts to chemically treat, "fractionate," and/or immobilize Hanford's wastes, and resulting major waste legacies that remain today.

This paper presents original, primary-source research into the waste history of the Hanford Site. Finally, the paper places the current Hanford Site waste remediation endeavors in the broad context of American and world history.

IMPORTANCE OF HANFORD SITE HISTORY

On August 6, 1945, an atomic bomb was dropped on Hiroshima, Japan, and U.S. President Harry S. Truman released the story of the special wartime weapons project that had produced it. Although the material in the Hiroshima bomb came from the Clinton Engineer Works (now the Oak Ridge Site) in Tennessee, the President told the world about the entire Manhattan Engineer District (MED), the landlord of the Hanford Engineer Works (HEW - predecessor to the current Hanford Site). Three days later, an atomic bomb consisting of material manufactured at HEW exploded over Nagasaki, Japan, and produced an Allied victory in World War II (WWII) just five days later. Then as now, the public was hungry for information about HEW. Then as now, it is important that we understand the history and the workings of these vast plants, their genesis, their operating history, and the wastes they produced.

The HEW mission, as defined at its founding, was to produce defense plutonium (Pu) production to help win WWII. The huge complex that was quickly developed in the Columbia Basin of eastern Washington succeeded completely. The site produced the core material for the world's first and third atomic explosions (the Trinity and Nagasaki weapons) less than two than two and one/half years after ground was broken. Yet the history of the Hanford Site is not simple and straightforward. It is still sought after and debated around the world, because in Hanford's history we can illuminate the Cold War and some of the most significant events of the twentieth century.

FOUNDING AND GENESIS OF THE HANFORD SITE

In December 1942, MED officer Col. Franklin T. Matthias and two officials of government contractor E.I. DuPont de Nemours Corporation (DuPont) arrived in the Columbia Basin of eastern Washington to scout potential locations for America's first industrial scale plutonium production complex.[1] They found the Columbia Basin to be a region not highly developed nor populated. About 19,000 people lived in Benton and Franklin counties, nearly a fourth of them in the railroad town of Pasco. Kennewick held 1,800 people, and White Bluffs, Richland and Hanford combined had 1,500. The rest lived on regional farms.

However, the stark and lovely Basin met the criteria defined by General Leslie R. Groves, head of the Manhattan Project, and by leading DuPont and MED scientists. It provided a large and remote tract of land, served by abundant power and rail lines and by the huge, clean water supply of the Columbia River. Its soil could bear heavy loads and yield a virtually endless supply of aggregate for making concrete. Matthias and the two DuPont scouts quickly realized that here they could establish a "hazardous manufacturing area" of at least 12 by 16 miles, far removed from main highways or populous towns.[2] They reported to General Groves that the place was "far more favorable in virtually all respects than any other."[3] Groves agreed, and land acquisition proceedings began.

WORLD WAR II CONSTRUCTION AND OPERATIONS

Once the land was procured, construction proceeded at a nearly unbelievable pace. Between groundbreaking in March 1943, and the end of the war in August 1945, the MED built over 1,000 permanent structures in addition to those for living requirements. The Hanford Project also constructed the new "government city" of Richland, capable of housing 17,500 people. It accomplished all of its construction at a cost of $230 million.[4]

Among the key facilities built at WWII Hanford were B, D and F reactors, the first three full-size nuclear reactors of any kind in the world. B Reactor, the first, has been placed on the National Register of Historic Places, and a private B Reactor Museum Association exists to preserve it. At HEW, the T, B, and U radiochemical separations buildings also were constructed. T-Plant was the first full-size processing plant of its kind in the world. A Plutonium Isolation Facility (231-Z Building) also was built to concentrate HEW's plutonium product to a thick paste for shipment to the Los Alamos Site in New Mexico for assembly into weapons. An irradiated materials storage complex also was constructed at the 200-North Area of HEW, and 64 underground, high-level waste storage tanks were built in the 200-West and 200-East Areas. Many unique buildings (now historic) were constructed for nuclear fuel fabrication in the Site's 300 Area.[5]

Tight secrecy at WWII HEW bred rumors among workers that the facilities were producing high-powered aircraft fuel, or chemical or germ warfare agents. Another prevalent rumor was that HEW was the site of a valuable minefield. Other rumors were joking and facetious. The vast majority of the approximately 300,000 workers who cycled through wartime Hanford had no idea that anything atomic or radioactive was being produced. Indeed, most people in WWII America had never heard of these terms.

During the war, plutonium production was urgent and was accomplished quickly. Early understandings of the wastes and byproducts of production were incomplete, but precautions were taken insofar as possible to prevent the escape of radioactive byproducts. Two hundred-foot high stacks were erected in the reprocessing areas to vent the separations plants off-gases (particularly Iodine-131, or I-131) and to provide for safe dispersal through local air currents. Special fans and blowers added diluting air to the stack gases.[6] According to DuPont: "From the inception of the work under this program, it was realized...that the extraction of the plutonium from the uranium and fission products...would be accompanied by the removal and liberation of gases either highly toxic in nature or extremely radioactive." MED builders were determined to provide "for the safety of plant employees from the effects of these gases [and]...for the safety of all inhabitants and living creatures within a large radius of the project."[7]

MED leaders knew that HEW would need a team of on-Site experts in the new science of health physics. An umbrella organization known as the Health Instruments (HI) Section was established. (This section later expanded to become a division, and consumed four percent of Hanford's budget and personnel by 1950.) It defined and measured radiological hazards, established procedures to make jobs in plutonium production safe for workers, and developed and calibrated a number of new and unique environmental-monitoring instruments. In 1945, HI surveys of vegetation were expanded far afield of the Hanford Site, and routine monitoring of Columbia River water and aquatic life, and project groundwater, were established.[8] These efforts represent some of the earliest environmental monitoring endeavors in the world.

However, insufficient knowledge of the exponential generation of the off-gases and of the necessary "cooling" (decay) periods for irradiated metal, resulted in the release of 345,000 curies (Ci) of I-131 during 1945, and of 76,000 Ci during 1946.[9] Likewise, corrective measures in production processes were not always undertaken in time to prevent other types of radioactive and chemical wastes from reaching the environment.

POSTWAR PRODUCTION LULL

After the victory celebrations of WWII, President Truman offered a phased-in control of atomic energy and weapons to the United Nations. However, when the plan did not succeed, the U.S. in 1946 began to formulate legislation to place its atomic facilities under civilian control. Throughout late 1945 and most of 1946, the MED adopted essentially a caretaker position. In fact, it instituted cost-savings measures that, at HEW, resulted in the closure of B Reactor in December 1945, and in the decrease of power levels at D and F Reactors. The number of contractor personnel at the eastern Washington site fell by half, from 10,000 in September 1945 to 5,000 in December 1946.[10]

During the same period, many government officials and members of the public began to worry about the confused state of U.S. atomic policy and about slowed defense production. Finally, on January 1, 1947, the new civilian Atomic Energy Commission (AEC), formulated in the McMahon Atomic Energy Act of 1946, took control of the U.S. atomic complex, including Hanford Works (HW). (The word Engineer was dropped from HEW's name to symbolize the separation of the plants from wartime control by the Army Corps of Engineers).[11]

FIRST POSTWAR EXPANSION

Meeting early in the year, the AEC's General Advisory Committee assigned its highest priority to weapons research and production. Improvement and expansion of the plutonium-production units at Hanford topped the list. In a series of spring directives, the General Electric Company (prime site contractor since September 1946) was directed to build two new production reactors, a plutonium finishing facility, and to develop the new REDOX (reduction-oxidation) separations process as quickly as possible.

The expansion of the Hanford plants and the city of Richland that occurred from 1947-49 was the largest peacetime construction project in American history up to that point, and cost more than the original building of HEW ($350 million). During this expansion, H and DR reactors were constructed, going critical in October of 1949 and 1950, respectively. Z Plant, or the Plutonium Finishing Plant, also was built, making possible the conversion of Pu nitrate paste to hockey-puck-shaped plutonium metal, known as "buttons," and 42 additional high-level waste storage tanks were constructed. Work went forward on the development of the REDOX process, in order to save scarce uranium that was wasted in the first cycle of the wartime chemical separations process. In 1949, Hanford Works built C-Plant in 200-E Area as a "hot semi-works" (pilot plant) for the REDOX process.[12]

Also during the 1947-49, the AEC built new permanent housing on the west side of Richland, and the city grew to about 23,000. Richland was now larger than Pasco, and the Richland-Pasco-Kennewick region began to be known as the Tri-Cities. During this same two-year period North Richland was founded five miles north of the then-current border of Richland. Barracks and small trailers there housed construction workers and their families. By the summer of 1948, just one year after its establishment, North Richland housed about 12,000 construction workers and about 13,000 of their family members.

SECOND POSTWAR EXPANSION (KOREAN WAR EXPANSION)

In the late summer of 1949, the defense equation was altered by an astonishing new development. The Soviet Union (U.S.S.R.) detonated its first atomic bomb, and Hanford Works was plunged into another major growth surge. This expansion, lasting from 1950-52, received added impetus from the victory of Mao Tse-tung's Communist forces over Nationalist forces in China. Quickly, Mao signed a mutual assistance pact with the Soviet Union. On June 25, 1950, Communist North Korean forces crossed south of the 38th parallel and the Korean conflict became a "hot war". For this reason, Hanford's second postwar expansion is sometimes known as the "Korean War Expansion." During the same period, some of the most well-known spy cases in American history surfaced, including those of Klaus Fuchs, Julius and Ethel Rosenberg, David Greenglass and Alger Hiss.

These events initiated the greatest era of expansion in U.S. atomic/nuclear history. Between late 1949 and 1952, the Nevada Test Site was established and began trials with atomic weapons, and the Pacific Proving Ground (Bikini and Enewetak - formerly spelled Eniwetok - Atolls) was expanded and refurbished. The same period saw the founding of the Reactor Testing Station (now Idaho National Engineering and Environmental Laboratory), the Paducah Gaseous Diffusion Plant (KY), the Savannah River Plant (SC), the Rocky Flats Plant (CO), the Pantex Plant (TX), the Fernald Feed Materials Production Plant (OH), and the Sandia Laboratory (as a separate entity from Los Alamos). In January 1950, Truman approved development of the hydrogen (fusion) bomb, known at that time as the "Super."[13]

At Hanford, the REDOX plant was completed and began operations in January 1952. REDOX utilized a methyl isobutyl ketone (known as hexone) solvent extraction chemistry, with prolific use of aluminum nitrate, nitric acid, sodium dichromate, and solutions containing ferrous ions. All of these corrosive chemicals, contaminated with radionuclides, reached the environment through spills, overflows, and ground disposal practices. Additionally, significant particulate releases of ruthenium 103/106 from the REDOX stacks occurred during the first three years of operations.[14]

Other facilities built during the 1950-52 expansion at Hanford Works included C-Reactor, which went critical in November 1952, a large Experimental Animal Farm and Aquatic Biology Laboratory in 100-F Area, and 18 more single-shell storage tanks for high-level waste. The chronic shortage of tank space led to the decision to build two evaporators, 242-B and 242-T. Beginning in 1951, they functioned to boil off low-level wastes for cribbing, and to concentrate and reduce the volume of high-level wastes.

In the 300 Area, five large buildings, along with ancillary service structures, opened as the "Technical Center" to place Hanford on the leading edge of the developing sciences of radiochemistry, radiometallurgy, reactor (or "pile") technology, health physics, and other work. The 325 Radiochemistry Building, complete with eight "hot" cells, assumed many of the developmental missions of the WWII Technical (3706) Building. The 325 Building, along with three other new structures, was connected to a Radioactive Liquid Waste Sewer (RLWS) that led to the new 340 Retention and Neutralization Complex for holding radioactive wastes for transport and disposal in the 200 Areas. The 326 Physics and Metallurgy Building conducted approach-to-critical, lattice design experiments that led to safer, more efficient lattice configurations in the KE, KW, and N reactors. The 327 Radiometallurgy Building also opened in 1953, conducting both destructive and non-destructive examination (DE and NDE) of fuel rods and reactor process tubes. The 328 Building, a large machine and fabrication shop that replaced four WWII shops, also was completed. The 329 Biophysics Laboratory opened to develop and utilize state-of-the-art radiation detection instruments for the pioneering Hanford Works environmental monitoring and bioassay program.[15]

Soon after these buildings were completed, continuing defense production expansions brought major additions to many of them. Also, the projected coming of N Reactor led to construction of the 306 Metal Fabrication Development Laboratory in 1956, and the 333N Fuels Manufacturing Building in 1960.[16]

In 1952, U-Plant in 200 W Area, built during WWII but not needed as a processing canyon, was retrofitted as the Metal Recovery Plant. It's mission was to utilize a new tri-butyl phosphate/saturated kerosene (TBP-NPH) extraction technique, pioneered by Hanford chemists, to recover uranium from the waste stored in Hanford's tank farms. The scarcity of high-grade uranium supplies made this mission crucial. Unfortunately, this mission also generated unexpectedly large amounts of chemically complex waste. Ferrocyanide salts were added to the waste stream in order to precipitate the cesium-137 component, thereby making the remaining wastes available for evaporation and ground discharge. However, the ferrocyanide additions have added complex challenging ones to Hanford's tank waste cleanup program, and the ground discharges have added radionuclide and chemical burdens to subsurface soils and water.

Once the U Plant was operating in its metal recovery mission, a small facility nearby was refurbished as the Uranium Trioxide (UO3) Plant. This facility then received the uranium stream being recovered as uranyl nitrate hexahydrate (UNH) from tank wastes in U Plant. The UO3 plant calcined the UNH into uranium trioxide powder, and shipped it to AEC facilities in the eastern United States for use in other weapons plants and processes.[17]

THIRD POSTWAR EXPANSION

Just as the first Korean War expansion was reaching completion, the election of President Dwight D. Eisenhower initiated yet another huge augmentation at HW. The new President, alarmed that the defense budget had tripled in the past three years, believed that a spending slowdown could be achieved by concentrating resources on atomic weapons rather than conventional forces. He called this policy the "New Look" in armaments. His beliefs, in combination with the threat perceived by the explosion of the first Soviet hydrogen bomb in 1953, and with the need for plutonium for the embryonic American intercontinental ballistic missile (ICBM) development program, brought more rapid growth to Hanford.

This third postwar expansion, sometimes known as the Eisenhower expansion, saw the construction of KE and KW reactors, the PUREX (plutonium uranium extraction) plant, 21 more single-shell waste tanks, and the development of the RECUPLEX (plutonium recovery and recycle) process at the Plutonium Finishing Plant. The coming to power of the K reactors, known as the "jumbos," in 1955 brought the total number of defense plutonium production reactors operating at HW to eight. The cumulative effects of their effluent, released into the Columbia River after only a few hours in retention basins, attracted the attention of the AEC. Scientists and physicians from the Division of Biology and Medicine conferred repeatedly with Hanford officials regarding potential threats to river life and safety.[18]

The PUREX plant, like the U-Plant, used a basic TBP/NPH chemistry. The PUREX process offered many advantages such as built-in concentrators and the utilization of nitric acid that could be distilled and reused many times. However, it also produced copious volumes of liquid wastes, and increased groundwater mounds and radionuclide values in groundwater beneath 200-E Area. The RECUPLEX process produced relatively small, but highly concentrated, wastes. Carbon tetrachloride and many acidic wastes, all contaminated with Pu, were disposed to soils around the RECUPLEX plant from 1955-62.[19]

The 1950s also were a time of expansive plans and dreams for the future of the "peaceful atom." President Eisenhower's "Atoms for Peace" program, announced in December 1953, and the passage of the new U.S. Atomic Energy Act of 1954, designed to allow for more private, commercial atomic applications, brought innovative, non-defense programs to HW.[20]

PEAK PRODUCTION YEARS AT THE HANFORD SITE

The years 1956-64 witnessed the most intense defense production period at the Hanford Site. Tensions of the Cold War, by the coming to power of Nikita Khrushchev in the Soviet Union, drove the production of special nuclear materials. The Soviet Union launched Sputnik I, the world's first, man-made vehicle to orbit the earth, on October 4, 1957. Within seven months, it had launched Sputniks II and III. These achievements combined with a dazzling string of other Soviet "firsts" in space to create a sense of national urgency in the United States. Senator John F. Kennedy won election to the Presidency in 1960 by pledging that he would close the "missile gap" with the U.S.S.R., and "get America moving again." Policies that he initiated tripled the U.S. nuclear destructive capability by 1964. During the early 1960s, development of U.S. guided missile systems began, Polaris for the Navy, Jupiter for the Army, and Atlas and Minuteman for the Air Force.[21]

During the peak production years of 1956-64, N-Reactor was built at HW, and power and fuel exposure levels at the Site's eight older reactors were raised repeatedly. The aggregate result was that, by 1964, power levels in megawatts approached ten times the WWII levels in the oldest reactors. During the same years, the last four single-shell, high-level waste storage tanks were constructed at Hanford, and a larger and more sophisticated plutonium recycling plant, known as Plutonium Reclamation Facility (PRF), opened in 1964.[22]

As part of non-defense work, HW pioneered experiments with alternate nuclear fuel mixtures and types. The 308 Plutonium Fuels Pilot Plant (PFPP) and the 309 Plutonium Recycle Test Reactor (PRTR), both were completed in 1960 in Hanford's 300 Area to support this work. Site chemists also led a number of "isotope campaigns," producing megacuries of cerium, strontium, cesium, promethium and other rare earths elements for special military and National Aeronautics and Space Administration (NASA) applications. During that period, Hanford was the world's only source for promethium, a rare earth element not found in nature, but used by Donald W. Douglas in the development of the artificial heart. From 1968-78, B-Plant, the WWII separations plant, operated to extract strontium (Sr-90) and cesium (Cs-137) from high-level waste.[23]

In Richland, the Federal Building was built in 1963, and regional growth in the Columbia Basin was rapid. The combined population of Benton and Franklin Counties totaled approximately 100,000 by 1962. In addition to Hanford Site work, regional growth was fueled by the construction of five new power generation dams along the Columbia and Snake Rivers within 65 miles of the Tri-Cities, and the construction of a large Boise-Cascade Company pulp and paper mill at Wallula (25 miles from the Tri-Cities) during 1958-59. Additionally, the U.S. Department of the Interior's Columbia Basin Irrigation Project expanded throughout Franklin and nearby Grant and Adams Counties throughout the 1950s and early 1960s.

PRODUCTION PHASE-DOWNS AT THE HANFORD SITE

In January 1964, President Lyndon Johnson announced a decreased need for special nuclear materials. "Hanford To Cut Back In 1965," proclaimed the local Tri-Cities newspaper the following day.[24] Thus, the era of peak nuclear production at the eastern Washington desert complex slowed. Between December 1964 and January 1971, all eight of Hanford's older reactors shut down. Production continued at N Reactor for another 17 years, driven by national programs to improve and expand guided missile systems, anti-ballistic missile systems, and other U.S. weapons programs. During these years, 28 double-shell tanks for the storage of high-level nuclear waste were constructed. The Site also engaged in new missions involving chemical extractions of special radioisotopes, and experiments with waste solidification methods. Development and construction of the Fast Flux Test Facility (FFTF), an experimental power reactor, brought new growth in many Hanford areas.

PRODUCTION RESURGENCE IN 1980s

For a brief time in the early and mid-1980s, nuclear defense production rose sharply at the Hanford Site. While production in the 1983-86 period never reached the heights of the early 1960s, N Reactor, the PUREX facility, and the Plutonium Finishing Plant were refurbished in the early 1980s and worked to produce materials required by defense initiatives of President Ronald Reagan.[25] The first agreement between the U.S. and the Soviet Union that actually reduced nuclear arms production was signed by Reagan and Soviet President Mikhail Gorbachev in 1988. At that time, Hanford production plummeted, and no defense plutonium has been produced at the Site since 1988.

WASTES GENERATED BY HANFORD SITE DEFENSE PRODUCTION

As discussed earlier, airborne releases from stacks of the chemical separations plants constituted the largest waste releases to the environment at early Hanford. As the years of peak production occurred at HW between 1955-64, volumes of wastes produced by the eight single-pass reactors, N-Reactor, the REDOX, PUREX, Z-Plant and B-Plant facilities, fuel fabrication plants, and multiple support facilities across the Site, increased sharply. The reactors, through their cooling water, contributed to thermal increases and chemical and radionuclide burdens to the Columbia River. The river was cooled by huge controlled spills of cold water from the bottom levels of Lake Roosevelt, behind Grand Coulee Dam, each summer from 1958-64.[26]

By 1954, AEC and contractor leaders and scientists at the Site recognized and discussed radioactive contamination in Columbia River whitefish near Hanford, and chemical and thermal hazards to salmon. By 1959, radionuclides from Hanford were discovered in shellfish in coastal waters near the Columbia River's mouth, about 300 miles from Hanford. In 1960 and 1963, Site studies tracked a uranium-bearing waste plume in the river from the 300 Area past Richland. Hanford chemists and operators sought new practices that would reduce radionuclide formation in reactor effluent, or would bind or transmute the isotopes in different disposal practices. Much time, effort and money was applied, but workable, large-scale solutions remained elusive. Columbia River contamination did not begin to decrease markedly until after Hanford's eight older reactors shut down. N Reactor's use of a recirculating coolant system in its primary loop considerably lessened its contamination burden to the Columbia River.

Hanford policy allowed untreated, low-level liquid waste discharges to the soil from 1943 to 1995. During these years, low-level wastes discharged to Site soils totaled about 440 billion gallons. During the peak years of production in the 1950s and 1960s, as a result of these discharges, large mounds developed in the water table beneath the 200-East and 200-West Areas, and activity levels grew in portions of the groundwater.[27]

Space in the Site's high level waste tanks was always scarce, and Hanford officials sought credible methods to allow soil discharge of some wastes originally intended for tanks. Over the course of Hanford's history, some tank wastes have been intentionally discharged to Site soils. Additionally, in the mid-1950s, suspected and sometimes confirmed leaks from single-shell, high-level waste storage tanks began. Site officials instituted several programs over the years to deal with tank wastes. Two large new evaporators were built in the 1970s to replace the aging and inadequate 242-B and 242-T facilities from the 1950s. An in-tank solidification pilot program in the 1960s attempted to heat and glassify some wastes in situ inside the tanks. Beginning in the 1980s, large saltwell screens (tall metal cylinders) were installed in single-shell tanks to allow interstitial liquids to drain away from solids and sludges in the center of the tanks. Then, pumps were inserted into the saltwells to pump out the liquids. Today, 67 of Hanford's 149 single shell tanks are assumed to have leaked, but no double shell tanks have leaked.[28] Most of the Site's single shell tanks have been emptied of their liquid contents, and an aggressive pumping program now is ongoing to remove the liquids from all of Hanford's single shell tanks by early 2004.[29] In 1997, the Department of Energy (DOE – a successor agency to the AEC), acknowledged that tank waste discharges have reached groundwater below the Hanford Site.[30]

MODERN WASTE CLEAN-UP ENDEAVORS AT THE HANFORD SITE

In the late 1980s, the DOE began the large-scale release of thousands of historical reports known as the Hanford Historical Documents. Through these, the public, officials of the U.S. Environmental Protection Agency (EPA), Washington State, and other agencies learned of the volume and extent of nuclear wastes at the Hanford Site. In consensus with the DOE, the decision was reached to pursue waste cleanup. The pioneering Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement, or TPA), signed at the Hanford Site in May 1989 now serves as a national model for remediation agreements.[31] Signed by the DOE, the EPA, and the Washington State Department of Ecology, the TPA is a living document that has changed many times in its 12-year lifespan. It is a roadmap for cleanup that contains specific tasks, milestones, and due dates for cleanup actions.

Learning from and about its past, the Hanford Site has embarked on a huge declassification effort, and has now made publicly available more information about itself than any other defense nuclear facility in the world. The DOE at Hanford has declassified approximately two million pages of documents since 1994, while keeping about another 20 percent classified because, according to strict guidelines, they contain information that could be used in restricted applications. An effort to declassify Site photos also was added to the Hanford declassification project.[32] The project will continue through FY 2003, and hopes next to review a large card file of document abstracts that, in some cases, are the only remaining parts of documents that no longer exist in whole.

The Hanford Site today is living with its history in the most constructive way possible. It is the only major U.S. Cold War site where all arms-related production has stopped completely. It does not have the lead for any future weapons development programs. It focuses on waste remediation, and participates in DOE initiatives in arms control and nuclear nonproliferation. It also reaches out, through tours, speeches, and education and information programs to open and teach about the Site history that has so many lessons for the world.

ENDNOTES:

[1] Leslie R. Groves, Now It Can be Told: The Story of the Manhattan Project (New York: Harper and Brothers, 1962, pp. 72-74; and Vincent Jones, Manhattan: The Army and the Atomic Bomb (Washington, DC: U.S. Army Center for Military History, 1985).

[2] Groves, Now It Can Be Told, pp. 70-71.

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[4] Michele S. Gerber, "Manhattan Project Buildings and Facilities at the Hanford Site: A Construction History," WHC-MR-0425 (Richland, WA: Westinghouse Hanford Co., 1993).

[5] DuPont Corp., "Construction of Hanford Engineer Works, History of the Project," HAN-10970 (Wilmington, DE: DuPont Corp., 1946), Vols. III and IV.

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