A Study on Hanford Nuclear Waste Site

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ABSTRACT

This article introduces the readers to the background of the Hanford Site, the nation's first operational plutonium production facility. The founding and fundamental operational history of the Hanford Site is covered in this essay, along with construction and operations during World War II, three significant postwar expansions (1947–1955), the production peaks (1956–1963), production phase-downs (1964–the present), a brief introduction spurt (1984–1986), the end of the cold war, and the start of the waste cleanup mission. This essay examines original primary source research regarding the Hanford site's waste history. The study concludes by putting the ongoing waste remediation efforts at the Hanford site in the broader context of American and global history.

Keywords: Hanford site, Cold war, World War-II, Plutonium production and remediation efforts.

I. INTRODUCTION

The Hanford Site is a federally run decommissioned nuclear production facility on the Columbia River in Benton County in the U.S. state of Washington. Site W and the Hanford Nuclear Reservation are two names that have been used to refer to the location. The Hanford Engineer Works and B Reactor, the first full-scale plutonium production reactor in the world, were located at the site, which was built in 1943 as a component of the Manhattan Project. The first atomic bomb, which was tested during the Trinity nuclear test, and the Fat Man bomb, which was used to attack Nagasaki, both contained plutonium produced at the facility.

The project grew during the Cold War to encompass nine nuclear reactors and five huge plutonium processing facilities, which produced plutonium for the majority of the more than 60,000 nuclear bombs constructed for the American arsenal. During this time, nuclear technology advanced quickly, and scientists at Hanford made significant scientific advances. As a result of numerous early safety safeguards and waste disposal techniques being insufficient, considerable volumes of radioactive elements were released into the air and the Columbia River.

With the end of the Cold War, the reactors used to produce bombs were deactivated, and the Hanford Site was the site of the biggest environmental clean-up ever undertaken in the country. In addition to the clean-up effort, Hanford was home to the Columbia Generating Station, a for-profit nuclear power plant, as well as several scientific research and development facilities, including the Pacific Northwest National Laboratory, the Fast Flux Test Facility, and the LIGO Hanford Observatory.

II. SITE DESCRIPTION

Fig-1: Hanford site

Southeast Washington State's Pasco Basin of the Columbia Plateau is where the Hanford Site is located. The site is a relatively undeveloped shrub-steppe habitat (a drought-resistant shrub and grassland environment) with a wide diversity of plant and animal species. It is situated north of the city of Richland and covers an area of around 586 square miles. The site's enormous land area serves as a buffer for the smaller portions on it that historically were used for the manufacturing of nuclear materials, waste storage, and waste disposal. Public access to much of the site is restricted.

The Columbia River forms a portion of the eastern site boundary as it passes through the northern portion of the Hanford Site from east to north.

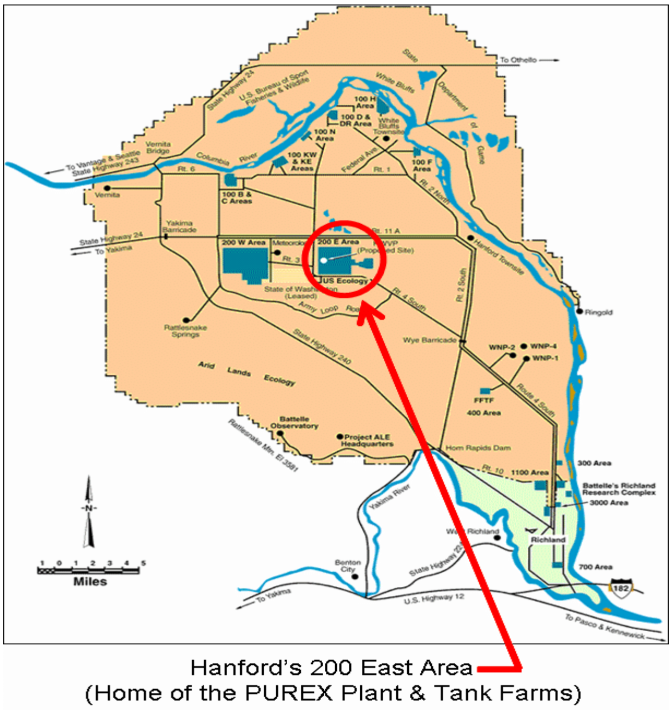

Figure-2

The following are some of the principal DOE operational, scientific, and administrative areas on and near the Hanford Site:

- **100 areas:**

Nine nuclear reactors were housed in the 100 Areas, which are in the northern part of the site along the Columbia River. These reactors have since been deactivated. The 100 Areas have a total area of about 4 square miles.

- **200 west and 200-east areas:**

The Central Plateau's 200-West and 200-East Areas are situated 5 and 7 miles south and west, respectively, of the Columbia River. The plateau's surface is 328 feet above the Columbia River's level and 280 feet above the water table underneath it. These locations hosted "separations plants" that separated plutonium from dissolved radioactive fuel as well as underground waste storage tanks. The area between the 200-East and 200-West Sections is around 6 square miles.

- **300 area:**

The 300 Area, which is around 0.6 square miles in size and is situated just north of Richland, is situated. The 300 Area at the Hanford Site was the location of nuclear fuel fabrication and research and development operations from the early 1940s until the start of the clean-up project.

- **400 area:**

The 400 Area, which is 0.23 square miles in size and is situated northwest of the 300 Area, is situated. The Rapid Flux Test Facility, which has been inactive since 1992 and was being deactivated and decommissioned in 2007, is situated there. This nuclear reactor was created and is currently being utilised to test various nuclear fuel types, create industrial and medical isotopes, and carry out collaborative worldwide research.

- **600 area:**

The entirety of the Hanford Site that is not occupied by the 100, 200, 300, and 400 Areas is included in the 600 Area.

- **700 area:**

The DOE administrative buildings are located in the 700 Area in Richland's downtown.

- **Former 1100 area:**

Between the 300 Area and the city of Richland is where the former 1100 Area used to be. As part of the DOE Richland Operations Office's efforts to diversify the local economy, this region was transferred to the Port of Benton in 1998 and is no longer a part of the Hanford Site. Contractors for the DOE are still renting out space here.

III. CONSTRCUTION

The nuclear facilities' construction moved along quickly. The HEW constructed 554 structures at Hanford before the war ended in August 1945, including three nuclear reactors (105B, 105D, and 105F) and three plutonium processing units (221T, 221B, and 221U). The project needed four electrical substations, 158 miles (254 km) of railway, and 386 miles (621 km) of roadways. Concrete volume utilised for the HEW was 780,000 cubic yards (600,000 m3), and structural steel weight was 40,000 short tonnes (36,000 t).

B Reactor's construction began in August 1943 and was finished on September 13, 1944. After overcoming neutron poisoning, the reactor reached criticality in late September and began producing plutonium on November 6, 1944. The reactors were water cooled and graphite moderated. They were made up of a graphite cylinder measuring 28 by 36 feet (8.5 by 11.0 metres), weighing 1,200 short tonnes (1,100 t), and 200 short tonnes (180 t) of uranium slugs. The cylinder was punctured horizontally along its entire length by 2,004 aluminium tubes. They were completely devoid of moving parts, and the only noises were the water pumps. Pumping through the tubes was done at a rate of 30,000 US gallons (1,900 L/s) of cooling water. This amount of water supplied a million residents in a city.

Production process:

Billets of uranium were delivered to the Hanford Engineer Works. They were fabricated into cylindrical "slugs" measuring 1.569 inches (3.99 cm) in diameter and 8 inches (20 cm) in length in the Metal Fabrication and Testing Department (500). More than 20,000 billets were needed for the three reactors' first charge, and an additional 2,000 were needed each month. Since uranium is very reactive with water, they were canned in aluminium in a molten bath of copper-tin alloy, with the cap being arc welded on to prevent corrosion from the cooling water. The canning procedure had to be meticulous because a flawed can may clog and burst inside the reactor, halt the flow of cooling water, and force a total shutdown of the reactor.

Irradiated fuel slugs were shipped by rail in a special remote-controlled train car to enormous chemical separation facilities that were roughly 10 miles (16 km) away. [66] The vast separation buildings had walls that were 3 to 5 feet (0.91 to 1.52 m) thick, were windowless, and measured 800 feet (240 m) long, 80 feet (24 m) high, and 65 feet (20 m) wide. A variety of chemical processing techniques were used to isolate the little

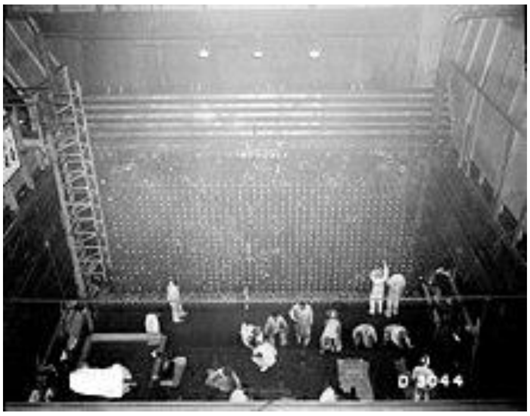

Fig-3: workers lay the graphite neutron moderator of B Reactor during construction.

Production activities:

The reactors could be turned off in two and a half seconds, but heat would still be produced by the fission products as they decayed. Hence, it was crucial that the water flow continue. In the event of a power outage, the steam pumps would immediately kick in and deliver water at full capacity for as long as necessary to permit a controlled shutdown. On March 10, 1945, a Japanese balloon bomb detonated between Grand Coulee and Bonneville, striking a high-tension line. In the wires leading to the reactors, this generated an electrical surge. The safety mechanisms automatically started a scram and turned off the reactors. The bomb did not detonate, and there was minimal damage to the transmission line. The only nuclear power plant in the United States to experience enemy attack was The Hanford Engineer Works.

IV. APPLICATIONS OF MANHATTAN PROJECT OR HANFORD

1. Contractor selection:

The federal Office of Scientific Research and Development's (OSRD) S-1 Section financed a plutonium research effort during World War II. Scientists at the University of Chicago Metallurgical Laboratory conducted the study. At the time, lab-made plutonium was a rare element that had just recently been created. The idea was that because plutonium is fissile, it might be utilised to make an atomic weapon. The development of a nuclear weapons programme in Germany alarmed the US government. The nuclear reactors (sometimes referred to as "piles") that could irradiate uranium and transform it into plutonium were being designed by scientists at the Metallurgical Laboratory. Chemists looked into techniques to extract plutonium from uranium in the meanwhile.

2. Site selection:

Carpenter expressed concerns about constructing the reactors near Oak Ridge, Tennessee; given that Knoxville is only 20 miles (32 km) away, a catastrophic accident may cause fatalities and serious health consequences. Even a less fatal incident could result in the evacuation of the isotope separation facilities used in the Manhattan Project and halt crucial war production, particularly of aluminium. Six reactors and four chemical separation plants were envisioned for planning purposes; however, expanding the facilities at Oak Ridge would necessitate the purchase of more property.

The site should be described in the following ways:

- A plentiful supply of pure water (at least 25,000 US gallons per minute, or 1,600 L/s)
- A huge electrical supply (about 100,000 KW)
- a minimum 12-by-16-mile "hazardous manufacturing area" (19 by 26 km)
- At least 8 miles (13 km) away from the closest reactor or separations plant, there is room for laboratory facilities.
- The settlement of workers is at least 10 miles (16 km) away from the factory.
- No communities with a population of more than a thousand should be located within 20 miles (32 km) of the danger rectangle.
- There are no major thoroughfares, railroads, or employee villages within 10 miles (16 km) of the dangerous rectangle.
- Ground capable of supporting large loads.

The availability of electricity was the most crucial of these factors. Many areas of the country were experiencing power shortages due to the demands of the war industries, and the Tennessee Valley Authority (TVA) was ruled out since it was anticipated that the Clinton Engineer Works would use up all of its excess energy.

3. Land acquisition:

One of the largest land acquisition operations in American history, it involved the purchase of 4,218 plots totalling 428,203.95 acres (173,287.99 ha). About 88 percent of the land was covered in sagebrush, where between 18,000 and 20,000 sheep grazed. Although not all of it was being farmed, about 11% of the land was used for farming. Farmers believed they should receive payment for both the value of the land itself and the crops they had planted. Groves made the decision to delay taking physical ownership of properties used for agriculture so farmers could harvest the crops they had previously sown because development plans had not yet been developed and work on the site could not begin immediately.

4. Construction workforce:

On the location of the village of Hanford, they built the construction camp, and on the site of Richland, they built the operating village. On June 21, 1944, there were 45,096 people employed in the construction industry. Women made up about 13% of the population, and non-whites made up 16.45%. African-Americans were underpaid compared to white labour, had separate messes and recreation areas, and lived in segregated housing. Hanford had three different types of lodging: barracks, hutments, and trailer parking. The initial group of workers lived in tents while building the first barracks. On April 6, 1943, work on the barracks began. 195 barracks were eventually built: 110 for white men, 21 for black men, 57 for white women, and seven for black women.

V. CONCLUSION

The federal government is now faced with a clean-up task more challenging than any other environmental remediation operation in history after nearly 50 years of waste management practises that endangered both human and environmental safety. In addition to waste that was deposited directly into the ground, nearly one-third of Hanford's storage tanks are leaky, which increases the flow of radioactive materials into the ground water. The risks of being exposed to these pollutants are significant; if the Columbia River were to become contaminated, not only would the local people suffer greatly, but so would everyone who lives downstream and depends on the Columbia for their livelihood.

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