Packaging Development Needs To Support Environmental Restoration*

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INTRODUCTION

The U.S. Department of Energy (DOE) is in the process of bringing all of its facilities into compliance with present environmental protection regulations. At the Hanford Site, this includes cleaning up Hanford's radioactive and hazardous waste. This is the largest waste cleanup ever undertaken.

Westinghouse Hanford is the DOE's Management and Operations contractor at the Hanford Site responsible for this cleanup effort. Westinghouse Hanford's Transportation and Packaging Function has overall responsibility for implementation of, and compliance with, onsite and offsite radioactive and hazardous waste shipping requirements.

HANFORD SITE BACKGROUND

The Hanford Site was built by the Federal Government in 1943 as part of the Manhattan Project to produce plutonium for weapons. The Site covers about 1,450 square kilometers of desert in southeastern Washington State. This particular site was chosen because there were no major cities nearby thus enhancing security; the adjacent Columbia River could supply a large amount of water to cool the reactors; and electricity for power was available from Grand Coulee Dam. It took less than 16 months to build and start the Hanford Site's first-of-a-kind plutonium production reactor.

Plutonium production at the Hanford Site took place in three steps which were performed in three separate areas of the Site. Natural uranium, was made into fuel slugs in the 300 Area close to the City of Richland. The fuel slugs were inserted into nuclear reactors in the 100 Area along the Columbia River at the north end of the Site. Inside the reactors, uranium fuel was converted into plutonium. The irradiated fuel slugs

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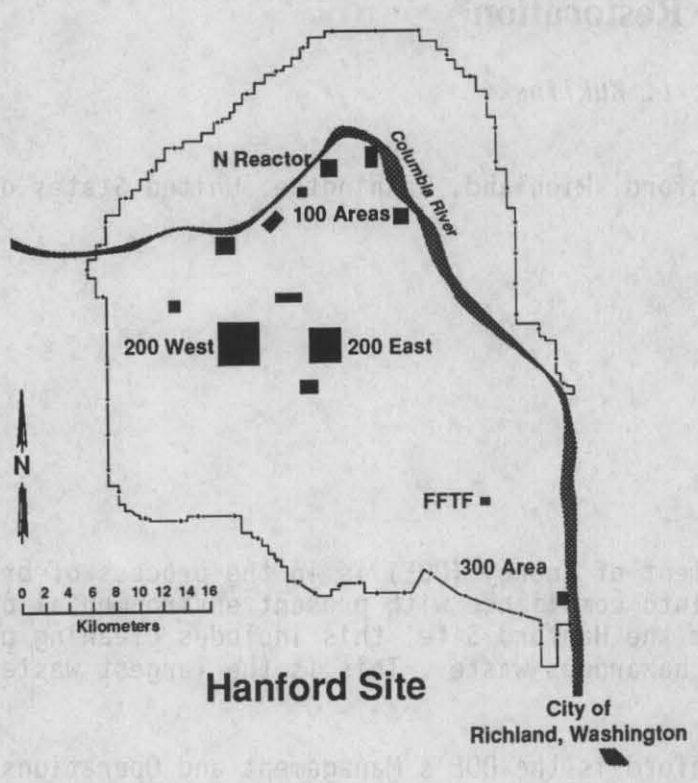


were sent through plutonium extraction facilities in the 200 Area near the center of the Site. Leftover waste was discharged to the ground or stored in the 200 Area.

Hanford Site activities grew to include nine production reactors, seven chemical processing plants, five coal-fired steam plants, nuclear fuel fabrication, and other support facilities including underground waste storage tanks, and numerous waste processing plants.

Underground storage tanks were used to store waste from processing of reactor fuel. There are two kinds of underground storage tanks used to store waste at the Hanford Site: single-shell tanks and double-shell tanks. They are found in the 200 Area near the center of the Site.

In the late 1960s and early 1970s, eight of the nine reactors at Hanford were closed. In 1987, plutonium production was stopped when the N Reactor was shut down.

CLEANING UP HANFORD

Today, top priorities at the Hanford Site are safety, restoration of land, and demonstration and application of cleaning technologies.

Cleanup will involve extensive collecting, consolidating, and processing of Hanford's vast radioactive and other hazardous wastes.

Since 1944, about 1.7 trillion liters of water and radioactive and hazardous wastes have been discharged to the soil. This waste contained 678,000 curies of radioactivity. Also, 630,000 cubic meters of solid waste were buried in numerous places across the Site.

Wastes ranging from high-level radioactive and hazardous waste stored in underground storage tanks to chemical wastes left from routine vehicle maintenance have been accumulating since 1943. The Hanford Site has over half of the nation's defense-related waste, and much of it is radioactive material that has a long half-life.

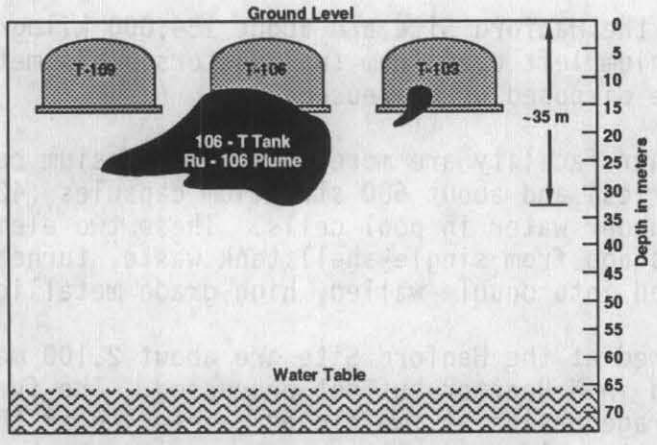
Many different chemicals were disposed of at the Hanford Site including cyanide, lead, chromium, mercury, and carbon tetrachloride. There are at least 1,391 waste sites: 134 contain chemically hazardous waste, 133 contain radioactive waste, 174 contain nonhazardous waste, and 950 contain radioactive and hazardous mixed wastes. As we sample and study the sites further, the number may change.

Most of the wastes at the Hanford Site are near the surface in the 200 Area near the center of the Site and about 16 kilometers from the Columbia River. This area is on a plateau about 60 to 90 meters above the groundwater.

Underground Tanks

There are 149 underground single-shell tanks. Their total capacity is about 356 million liters. Today, they hold about 139 million liters of waste, including low-level, high-level hazardous, or plutonium-contaminated "salt cake" sludge. Most of it is now solid though liquids and semisolids are also in the tanks. Probably as many as half of the tanks may have leaked 2.8 million liters or more of waste into the nearby soil. An even larger volume of cooling water pumped into some of the tanks may have reached the soil. An exact measure isn't available.

The waste that leaked or may have leaked from those single-shell tanks has for the most part remained trapped in the soil near them.



Many of the early single-shell tanks have leaked.

Over the years, most of the liquid originally stored in the tanks evaporated or was pumped out, leaving behind soil materials which have formed a "salt cake" on the bottoms of the tanks. Any remaining liquid is trapped within the solid waste.

To reduce the chance of future leaks, new double-shell tanks were built. There are 28 double-shell tanks that hold about 88 million liters of liquid radioactive waste. These tanks have a second shell containment wall. Double-shell tanks have been used since 1970 and none of them have leaked. If a double-shell tank should leak, its waste can be transferred to other tanks.

Double-shell tank waste will be processed in two parts. The larger portion will be low in radioactivity and toxicity. A smaller portion will be highly radioactive.

The low-level waste will be mixed with a cement-like material to form grout, which will be poured into underground vaults. Each vault will hold 5 million liters of grout, and at least 44 vaults will be filled.

High-level radioactive waste will be made into glass and poured into stainless-steel canisters at the Hanford Waste Vitrification Plant. The canisters will be stored onsite until they can be shipped to a national repository and buried deep underground.

Waste Stored On The Surface

There are many drums of solid waste stored on pads in special buildings awaiting treatment and disposal. Those with plutonium-contaminated waste will be shipped to the Waste Isolation Pilot Plant in New Mexico for deep underground disposal, if that site becomes a permanent disposal site. Drums containing mixed waste await the completion of our Waste Receiving and Processing Plant.

Cleaning solvents and other hazardous chemical wastes are housed in a storage building, then shipped to licensed companies for treatment and disposal.

Also stored at the Hanford Site are about 184,000 kilograms of metallic sodium and lithium left over from two reactors. This metallic sodium and lithium will be disposed of or reused.

Stored at another facility are more than 1,300 cesium capsules (65,000,000 curies) and about 600 strontium capsules (42,000,000 curies) stored safely under water in pool cells. These two elements were extracted years ago from single-shell tank waste, turned into a form of salt, and placed into double-walled, high-grade metallic capsules.

Also being stored at the Hanford Site are about 2,100 metric tons of fuel irradiated in N Reactor but not processed. The fuel is in underwater storage basins at two closed reactors near the Columbia River. The 40-year-old basins are monitored and checked for leaks.

The water is treated to remove contamination caused by the fuel's deterioration.

Waste In The Ground

Before 1970, solid wastes contaminated with hazardous chemical, plutonium, or low-level wastes were put into burial trenches. From 1970 to 1986, waste with hazardous chemicals were put into burial trenches. It is estimated that 109,000 cubic meters contain elements such as plutonium.

After 1970, most of the plutonium-contaminated waste produced at the Hanford Site was put in partially lined underground vaults or surface trenches. The estimated 10,000 cubic meters of waste will be retrieved and shipped to the Waste Isolation Pilot Plant for disposal.

There are also some sites where packaged, low-level radioactive and hazardous waste is buried. The packages include wooden boxes, cardboard boxes, bags, and drums. Some of the sites have large pieces of contaminated equipment.

There are 450 sites where contaminated liquid has been discharged to the ground. Some sites are still being used, but many have been taken out of service. There are 230 more sites where waste was spilled.

River water was used for cooling and processing reactor fuel to recover plutonium and other materials. Trenches, ponds, and ditches were commonly used to dispose of the water. Ditches carried water from processing plants to ponds. Some ponds were as large as 32 hectares.

Cribs (akin to a septic tank drain field) were used to receive low-level waste directly from processing plants. About 457 million liters of liquid were intentionally diverted to cribs from single-shell tanks. Cribs were the most common way of disposing of slightly radioactive liquid waste.

Some waste went directly into the ground through 11 deep wells known as reverse wells. One well was approximately 90 meters deep and reached the groundwater. These wells contain an estimated 250 cubic meters of contaminated soil.

There are 67 "French drains" at the Hanford Site. French drains are a shallower version of reverse wells and function like small cribs. They are usually about 3 meters deep and have coarse rock or gravel in the bottom. They usually received only low volumes of cooling water and condensed steam from processing plants, although some contamination was discharged to them.

Contamination at some underground locations has spread 16 or more kilometers beyond the original disposal site.

PACKAGING DEVELOPMENT NEEDS

Historical data on facilities and the amounts, types, locations, and times that wastes were discharged at the Hanford Site, help identify the packaging needed to support cleanup and environmental restoration.

Cleanup activities will require extensive transport of radioactive and other hazardous materials for waste processing, interim storage, and disposal. Specific areas of need include packaging for large components, bulk packaging for both solid and liquid waste, and sample packaging.

Packaging for Large Contaminated and Activated Components

The Hanford Site is home to several hundred facilities including nuclear reactors, fuel fabrication and processing facilities, waste storage and disposal facilities, and numerous support facilities. Decontamination and dismantling of these facilities will produce many large contaminated and activated components. These include structural components and equipment such as compressors, condensers, centrifuges, and reactor hardware.

Traditionally, large components have been transported and disposed of as complete units. In recent years, the Hanford Site has received components from reactor decommissioning that reach 14 meters in length, 10 meters in height, and over 1,000 metric tons in weight.

Packaging and regulatory development are needed to support transport of these items. Their reaction to accident conditions differ from small component packaging as a result of their great mass. Also, the sheer size of these types of components requires special transport routing and equipment. These conditions limit accident potential.

Bulk Packaging For Solids

Planned and accidental discharges of waste to the soil have contaminated millions of cubic meters of soil. Liquid waste disposal to cribs, ditches, ponds, wells, and underground storage tanks that have leaked, contaminate soil from the surface to as deep as the water table, 60 to 90 meters below the surface.

These wastes result from long-term disposal of slightly radioactive waste to high-level liquid waste from the underground storage tanks. Large volumes of waste will require packaging ranging from low specific activity to Type A and Type B as contaminated soil is excavated. Packaging systems compatible with an operation akin to heavy construction or mining will be needed.

New packaging technology will be required to provide the necessary shielding, containment, and levels of safety commensurate with the associated hazards.

Bulk Packaging For Liquids

Traditionally, liquid waste has been stored near its point of origin. Packaging systems are not available to handle bulk quantities of radioactive material beyond low specific activity.

With the Hanford Site restoration activities beginning, it will not be practical to construct treatment facilities for all waste streams onsite. The cost of designing, permitting, and constructing treatment facilities at all sites is prohibitive. The DOE is interested in developing high activity liquid packaging for transporting these materials to selected DOE sites. New packagings must be developed to handle Type A and Type B quantities of liquid waste. Facility effluents, decontamination chemicals, and stored liquid waste can then be transported between selected facilities or sites for treatment or disposal.

Sample Packaging

Cleanup activities begin with sampling to identify and characterize the type and quantity of hazardous materials involved. Environmental characterization samples are required to remain chilled to prevent evaporation of volatile components. These samples may be radioactive or nonradioactive hazardous materials and must usually be maintained at a temperature below 4°C during shipment.

Incidents have occurred when ice is used. The ice has melted and leaked from the packaging. Packaging systems need to be developed using advanced technologies to achieve the best possible results. New packaging designs will eliminate the melting of ice and leaking of water from packages.

Special packaging is required to support environmental sampling.

Summary

Radioactive and chemically hazardous waste has been accumulating at the Hanford Site since 1943. These wastes include high-level radioactive and hazardous waste stored in underground storage tanks, stored waste including plutonium-contaminated waste, waste in the soil, and contaminated facilities. The wastes are found in over 1,390 locations across the Site.

Packaging development needs to support the cleanup and environmental restoration of the Hanford Site are extensive. Extremely large contaminated and activated components will be generated from facility decommissioning. Bulk packaging will be needed for both solid and liquid waste including high activity liquids. Special packaging for samples is needed--chilled packaging for environmental samples, packaging for high-level waste samples from underground storage tanks, and process control samples from waste treatment and disposal operations.

Environmental restoration planning needs to integrate transportation and packaging requirements to ensure these needs are met. Packaging and transportation services are required for virtually all programs associated with waste-stream management. Transportation is the integration point between operations--water processing, interim storage, treatment, and disposal. Packaging and transportation needs logically drive the requirements for a basic operation.