The Columbia River at Risk

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Overview

The mighty Columbia River is a symbol of the power and beauty of nature, and of the Pacific Northwest region and its people. Its water is used to irrigate millions of acres of arid land and turn it into productive farmland that helps feed people all around the world. The river supports endangered salmon runs and is a popular recreation destination for boating, camping, windsurfing, fishing and swimming.

The Columbia River is also a river at severe risk.

For more than 40 years, the U.S. government produced plutonium for nuclear weapons at the Hanford Nuclear Site in southeastern Washington. This process generated enormous amounts of radioactive and chemically hazardous wastes. Beginning in 1944, Hanford workers began to store the most hazardous of these wastes in large underground tanks. Hanford's 177 waste storage tanks now hold more than 53 million gallons of highly radioactive waste. Sixty seven of these tanks have leaked an estimated one million gallons of waste into the soil. Some of this leaked waste has already reached the groundwater and will eventually reach the river, which flows through the Hanford Site.

The solution is to remove the waste from the tanks and immobilize it through a process called vitrification. Vitrification requires construction of large, expensive treatment facilities. The wastes will be treated to separate high-activity from low-activity waste (waste which contains smaller amounts of radioactivity in large volumes of materials, but which still pose a hazard). Most of the waste will be low-activity. The high-activity waste will be mixed with glass-making materials, heated, and then poured into steel containers to harden. These containers will be stored at Hanford until a national high-level waste repository is constructed. Some of the low-activity waste will be vitrified through a similar process and then permanently buried at Hanford. The U.S. Department of Energy (DOE), proposes to immobilize the remainder of the low-activity waste using some other technology. Although the material will still be radioactive, by changing the waste into a solid form it will no longer be mobile and able to enter the environment through the soil or groundwater.

DOE, which owns Hanford, has successfully operated vitrification facilities at two other DOE sites. Vitrification is also a proven technology in Britain and France. However, because of Hanford's large volumes of waste, Hanford's vitrification facilities need to be considerably larger and will be more complex than any previous vitrification facilities. Unfortunately, a variety of design, funding and construction problems is expected to delay the start-up of these facilities until 2019.

This issue paper explains the history of Hanford's tank waste, the leaks and their impact, other tank safety issues, and the consequences if the program is not successful.

Background

In early 1943, during the height of World War II, the U.S. government selected a remote area of southeastern Washington state as the location to manufacture plutonium for a nuclear bomb. Plutonium is produced when uranium fuel rods are irradiated in a nuclear reactor. The nuclear reactions produce heat and new elements, including plutonium. Eventually, nine nuclear production reactors were built along the banks of the Columbia River at Hanford. Hanford's first nuclear reactor began operation in September 1944.

Hanford Production Reactor

A series of chemical processes were used to separate the plutonium from the other elements. This process began at Hanford in late December 1944. The uranium fuel was put into large tanks where nitric acid and other chemicals dissolved the fuel. Other chemical processes separated the plutonium from the other radioactive materials.

Much of the waste created in the chemical separation process had low levels of radioactivity. This waste was discharged directly to the soil. Other portions of the waste were highly radioactive and were mostly placed into underground storage tanks.

The chemical separation activities occurred in Hanford's 200 East and 200 West areas, located near the middle of the site, eight to 12 miles from the Columbia River. The underground storage tanks are also in the 200 areas – clustered in groups of two to 16 tanks and referred to as tank farms. Underground pipes connect the tanks to other tanks, to other tank farms, and link the 200 East and West areas.

Sixty four waste storage tanks were built during World War II to support the chemical separation operations. Forty eight of the tanks were 530,000 gallons in size. The remaining sixteen were much smaller, and hold up to 55,000 gallons of waste.

Hanford went through several expansions during the Cold War. Each expansion resulted in the construction of additional underground storage tanks. By 1964, Hanford had 149 underground storage tanks in 12 tank farms. The newer tanks were 758,000 and 1,000,000 gallons in size.
By the late 1950s, Hanford officials realized that some of the tanks, which were designed to be used only 10 to 20 years, had leaked. Eventually, to try and prevent future leaks, tanks with a double-shell containment were designed and built, beginning in the late 1960s. A total of 28 double shell tanks – all at least one million gallons in size – were built. The newest of these tanks have 50 year design lives.

The wastes placed in Hanford's underground tanks contain organic chemicals and solvents, radioactive materials (mostly cesium and strontium, along with uranium, plutonium, technetium and other elements) and miscellaneous wastes. Before the waste was pumped into the tanks, sodium hydroxide was added to neutralize acidic liquids. Otherwise, the acid would have quickly corroded the tanks.

Hanford's single shell tanks are cylindrical reinforced concrete structures with inner carbon steel liners just one-quarter to three-eighths of an inch thick. The domes of the tanks are made of concrete and do not include a steel liner. The smallest tanks are about 26 feet deep and 20 feet in diameter. The largest tanks are about 45 feet deep and 75 feet across.

The double shell tanks have two steel liners (with a single liner in the dome) and are reinforced by a concrete shell. All the tanks are covered with about 10 feet of soil and gravel.

Tank Space Issues

Throughout its history, Hanford has been plagued by a lack of waste storage space. By late 1946, half of the 64 tanks built during World War II were full and the others were nearly half full.

Even the addition of more than one hundred new tanks over the next four decades did not resolve – for long – the shortage of waste storage space. At times the tank space needs were so critical that high-level waste was disposed directly to the soil. The initial belief was that the radioactive materials would attach to the soil particles and move very slowly, if at all. That did not always prove to be the case. Direct releases were recommended at Hanford only in emergency situations. Hanford workers also reduced the amount of liquid waste through the use of evaporators.

Now, Hanford may once again be running out of available tank space.

Inside a Hanford Waste Tank

Hanford's tanks currently contain more than 53 million gallons of waste. Since the single-shell tanks are all well beyond their design life, and at least 67 are believed to have leaked, Hanford regulators want as much waste as possible – especially the free liquids – moved from the single-shell tanks to the double-shell tanks. The process to pump free liquids from the tanks is called interim stabilization. A tank is considered interim stabilized when it contains less than 50,000 gallons of drainable liquid and less than 5,000 gallons of liquid floating on top of the waste. All 149 single-shell tanks have been interim stabilized.

Hanford regulators also want the sludges removed from Hanford's single shell tanks. The Hanford Federal Facility Agreement and Consent Order, often called the Tri-Party Agreement, contains cleanup schedules called milestones. The Tri-Party Agreement contains several milestones – which are legal obligations – related to removal of sludges from the single shell tanks. However, there are about 30 million gallons of waste remaining in the 149 single shell tanks, and only a few million gallons of available tank space in the double shell tanks. Efforts to remove sludges from the single shell tanks can only continue for so long before available double shell tank space will be filled.

Hanford Tank Under Construction

Because the space crunch will not be resolved until the vitrification facilities are operating – at least 10-13 years from now – Hanford may yet need additional storage tanks at an estimated cost of more than $100 million per tank. The cost of new tanks would strain an already tight cleanup budget and may impact other cleanup work.

Tank Leaks

Hanford's first tanks were built in 1944. They were expected to last from 10-20 years. Within that time period – in 1956 – the first leak was suspected. By the late 1950s to early 1960s, several tanks were confirmed leakers. The largest known Hanford tank leak was 115,000 gallons in 1973. Despite other confirmed tank leaks in the following years, and the fact that leak detection methods have not always proven reliable, it was not until November 1980 that a ban on adding new waste to the single shell tanks was put in place.

In all, 67 single shell tanks have been declared or suspected of leaking. Some tanks have leaked more than once. The total amount of waste leaked is estimated at 750,000 to 1,050,000 gallons of high-level waste. No new leaks have been identified since 1993.

As long as waste remains in the tanks, leaks to the ground will continue to occur.

> "Risk assessments have shown that both a catastrophic tank failure and continued leaking pose unacceptably grave risks to the Northwest's citizens, the environment, and agricultural economy. Delays only increase these risks." Statement of the Hanford Advisory Board, February 19, 1998.

Tank Safety Issues

Beginning in 1989 and into the early 1990s, a series of concerns were raised about the potential for wastes in some of Hanford's tanks to ignite or explode. It was feared that an explosion or fire inside a tank could cause the dome to collapse and provide an outlet for radioactive materials to reach the environment.

By mid-1990, concern about these and other safety issues prompted a number of expert studies to assess the immediate threat. Most of the assessments indicated that the chance of a fire or explosion in a tank was possible, but not imminent.

Congressman (now Senator) Ron Wyden of Oregon successfully proposed legislation that created a "Watch List" of tanks. Tanks on the Watch List required special safety precautions because of the potential for release of high level radioactive waste through a fire or explosion. The Watch List was created in January 1991.

In all, 52 tanks (47 single shell and five double shell) were on the initial Watch List. Some tanks were on more than one list. A few additional tanks were added to the Watch List during the next several years. No tanks were added to the Watch List after May 1994.

Each of the four tank safety issues have since been resolved and the Watch List was closed in August 2001.

The Potential Consequences of Inaction

Absent action to remove waste from the tanks, more tanks will leak. The single-shell tanks are all well beyond their design life and evidence of corrosion in several of Hanford's double-shell tanks is proof that even the double-shell tanks have a finite life.

One of the biggest concerns and unknowns is the fate of the wastes once they have leaked from the tanks. What we do know is this – in November 1997, DOE found that waste from leaks in five tank farms had reached groundwater. Two months later, it was determined that waste from three other tank farms had also reached the groundwater.

With more tank leaks, more waste will get into the groundwater. And that means more waste will eventually reach the Columbia River.

We don't know when this will occur, or how much waste will leak or in what concentrations it will reach the river.

Right now, the concentrations of radioactive and chemically hazardous materials that are reaching the river from Hanford are not believed to pose a public health threat. Whether that will continue to be the case is uncertain. The potential for ecological damage to the river is also not fully understood.

Past tank leaks, although significant on their own, represent only a small percentage of the waste still remaining in the tanks. The greatest opportunity to reduce this risk is now, while the waste is still somewhat contained. It will be much more difficult – perhaps impossible – and certainly much more expensive, to remove waste leaked into the soil and groundwater.

In addition, the risk of a dome collapse increases with time, as the tanks get older and continue to deteriorate. This could result in a release of radioactive materials to the air.

Previous plans to treat Hanford's tank wastes have failed. The citizens of the Northwest cannot afford another failure. There is simply too much at stake.

Treatment Plans

The original Tri-Party Agreement, signed in May 1989, contained a schedule for construction and operation of a vitrification plant to immobilize Hanford's tank waste. This facility was scheduled to be operational in 1999, but after continual delays and lack of funding, was cancelled in 1993.

In 1994, DOE began to pursue a strategy of privatization for the tank waste treatment program, where a private company would pay all up-front design, construction and operating costs. The company would then get paid after they turned waste into glass. This venture into privatization – which saw estimated costs to treat just the first ten per cent of Hanford's waste escalate from $6.9 billion to $15.2 billion – was a failure and resulted in further delays to the program.

After an accelerated re-bid process, in December 2000, DOE awarded a ten year, $4 billion contract to a consortium led by Bechtel National and Washington Group International to design, construct and commission facilities to immobilize Hanford's tank waste.

Construction of the facilities began in July 2002. The contract called for facilities to be constructed and tested by 2007, with full operations by 2011. However, those dates will not be met.

Construction on major portions of the vitrification plant complex was slowed in late 2004, when it was determined that seismic requirements for the design had been underestimated by about 40 percent. That forced a delay to evaluate the construction work that had already been completed, and to review and revise engineering designs for the remainder of the construction.

In addition, it was determined in 2006 that the original baseline both for cost and schedule were not accurate, and a variety of studies completed in early to mid 2006 now project the vitrification facilities will not be completed until 2019 at a cost of about $11 billion.

It is hoped that the low-activity vitrification facility and the supplemental treatment process could be operating earlier to begin immobilizing the low-activity waste. But there is no certainty that will be the case.

This long time frame – more than 30 years from now to complete waste immobilization – emphasizes the need that this venture be successful. During this period, additional tanks will most certainly begin to leak. However, as soon as vitrification can begin, some additional tank space will be gained, allowing for the transfer of waste from the failing tanks.

It will be a challenge to maintain the tank waste in a safe manner for the next 25 years. The condition of the tanks and the waste inside must be carefully monitored so that we're aware of problems and perhaps can move waste or take other actions to mitigate the effects of these problems. Emergency response plans must be maintained in the event a tank does suffer a catastrophic event.

> "The chances of a catastrophic event (at Hanford) are real. Time is not on our side." Washington Governor Chris Gregoire (From a report on 60 Minutes, April 30, 2006).