Special Report:
Hanford's Waste Treatment Plant
The Science Behind the Setbacks

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Technical information adapted from a report by Allyn Boldt, a retired Hanford engineer.

Photo courtesy of Northwest Public Radio

The Waste Treatment Plant (WTP) is central to the cleanup of the Hanford site. Designed to stabilize radioactive liquid waste in a glass form, vitrification is the best available technology for dealing with Hanford's 53 million gallons of tank waste. Unfortunately, the implementation of this technology has proven extremely challenging and expensive. The dire need for this facility and the pressure to justify the billions already sunk into it could result in starting operations at the WTP without remedying major flaws or considering promising alternatives. If that occurs, the result may be a radioactive disaster greater than anything seen in the Western Hemisphere.

Though important seismic corrections have been made to the WTP design, many hurdles remain: chemistry issues unique to Hanford's waste, unproven pretreatment technology designed to prepare tank waste for vitrification, and major design flaws that could lead to the plant's premature closure. These chemical, equipment, and facility uncertainties result in a high risk that the WTP will fail to fulfill its mission and could be unsafe to operate. Solutions to these issues may lie in independent oversight and technologies from Russia's large-scale vitrification programs. Ultimately, it is time to start looking at backup plans to more safely store and treat the tank waste.

Waste Chemistry: No "Goldilocks" Solution

The Pretreatment Facility, the vital entry point for liquid waste into the WTP, divides the tank waste into two streams, High Level Waste (HLW) and Low Activity Waste (LAW), each with their own vitrification facilities. The goal of these facilities is to safely stabilize as much radioactive waste into as little molten glass as possible. This is especially true of HLW which must be handled and stored under strict federal regulations.

Hanford's tank waste is tricky stuff. It is riddled with aluminum and sulfate sludge that make it difficult to mix into glass at optimal concentrations. The Pretreatment Facility s designed to remove most of the aluminum and sulfate solids from the tank waste by "washing" it with caustic (sodium hydroxide). Investigations reveal that removing aluminum and sulfate solids is more difficult than originally estimated. The current work-around is dilution: stabilize less HLW in more glass. Vitrifying the same amount of waste in more glass will require replacing expensive melters more often and result in straining less replaceable components beyond their design limits, increasing the likelihood of an accident.

Adding more caustic to wash aluminum and sulfate from the sludge complicates LAW vitrification in similar ways. Caustic reduces the concentrations of LAW that can be mixed with glass - which means that more LAW glass must be produced. Low-concentration glass puts expensive and potentially dangerous strains on the LAW facility. It also takes longer to treat the same amount of waste and greatly increases the volume of waste that must be stored.

At this point, there is no "Goldilocks" solution, no "just right" balance between aluminum/sulfate concentrations and the addition of caustic that does not put unacceptable strains on the equipment, increase the risk of accidents, and exacerbate storage issues. To make properly concentrated HLW, the LAW must be diluted. Taking this reality into account, DOE concedes that perhaps as little as a quarter of the tank waste will be vitrified, 13.25 million gallons. This will leave 39.75 million gallons of untreated tank waste sitting in unstable tanks. No request has been made to Congress for the billions it will cost to deal with the remaining waste, and no secondary disposition plan exists to safely contain it.

Putting the Waste Treatment Cart Before the Radioactive Horse

To help work through some of the technical problems with Pretreatment, a pilot plant called the Pretreatment Engineering Platform (PEP) is being built to test the technology. The PEP is a scaled-down

version of the WTP's Pretreatment Facility. Despite the fact that PEP tests will not begin with simulated tank waste for several months, much of the important equipment that will be examined in these tests has already been ordered for the final Pretreatment Plant. A more conservative approach would test and ensure that equipment works *before* ordering it.

Pretreatment is an exceptionally complicated process that is difficult to test in a simulated and scaled-down environment. Filters selected for pretreatment that work in the PEP test on simulated sludge may clog on the real thing. The series of tanks and agitation system scaled-down in PEP may not give an accurate prediction of the performance of their scaled-up counterparts in the actual facility.

The PEP test with simulated tank waste will take place at the end of 2008 and run through spring 2009. Given the importance of this test, it is irresponsible to lack a backup plan in the event that testing reveals serious problems.

Betting on Risky Technology in a High Stakes Facility

The Pretreatment Facility uses a largely abandoned "black cells" design philosophy to house some of the equipment. Black cell equipment is designed to last the 40 year life of the facility but lacks any ability to be repaired or replaced once radioactive waste starts moving through the plant. If critical equipment in a black cell fails, the entire facility is inoperable. This would result in the termination of tank waste treatment until *an entirely new pretreatment facility is constructed*.

Confidence in the quality of materials in black cells must be total, yet much equipment installed in the WTP's black cells was found to be poorly designed and made of substandard materials. This crucial information was brought to light by whistleblowers working on the project. The regulatory regimes of Bechtel and DOE have been sharply criticized since 2001, when the Nuclear Regulatory Commission lost its oversight authority. DOE has acknowledged Bechtel's quality and safety issues in 2004 and 2005 and is working to track down and resolve those issues.

Russian Glass to the Rescue?

There is a potential solution for the aluminum and sulfate dilution problem. The WTP vitrification process is based on borosilicate glass formulations developed for commercial nuclear fuel reprocessing liquid HLW. The borosilicate glass has limitations in absorbing chemicals such as sulfate, sodium, aluminum, and chromium found in liquid HLW from nuclear weapons production.

The Russian program for treating waste from weapons production used a phosphate glass formulation that can incorporate higher concentrations of the chemicals that are complicating efforts at the WTP. Reformulation of the Russian phosphate glasses for Hanford HLW and LAW can eliminate the pretreatment sludge washing and potentially the entire Pretreatment Facility with significantly reduced glass production, mission duration, and costs. There is potential to reduce the Hanford tank waste treatment program by up to 15 years and $20 billion. The Pacific Northwest National Laboratory released a report in 2003 discussing the advantages of phosphate glass in LAW vitrification, yet no serious consideration has been given to this promising technology at WTP.

The WTP is Important, Let's Make Sure it's Done Right

The PEP test is worth watching. Performed at the Pacific Northwest National Laboratory, the PEP has the power to make or break the Waste Treatment Plant, according to DOE managers. With important milestones to be met, no backup plans on the table if the test fails and billions of dollars at stake, there is incredible external pressure that the PEP be a success. If Hanford's history is any indication, the only way to make sure that the PEP is held to the most rigorous scientific standards is to require independent oversight.

All across the WTP, more oversight is required to ensure safe future operations. Even though the clock is ticking on the waste in the tanks, a disaster at the WTP could produce a Chernobyl-scale event in an instant. DOE and Bechtel have taken measures to improve their regulatory cultures but have done so after years of poor self-oversight. The road to true quality assurance will be a long one.

The Nuclear Regulatory Commission (NRC) had a very active role at the WTP before DOE and Bechtel assumed control of the project in 2001. With a history at the site and a good track record of nuclear safety around the US, the NRC is the natural regulatory agency for the WTP. Proper oversight may delay the start of operations, but if it saves the Tri-Cities, the Columbia River, and the wider region from a preventable nuclear disaster, it will have been worth it. *Hanford Challenge* advocates that every precaution be taken before throwing the switch at the Waste Treatment Plant.