Presentation before the National Academies' Committee regarding

Supplemental Treatment of Low-Activity Waste at the Hanford Nuclear Reservation

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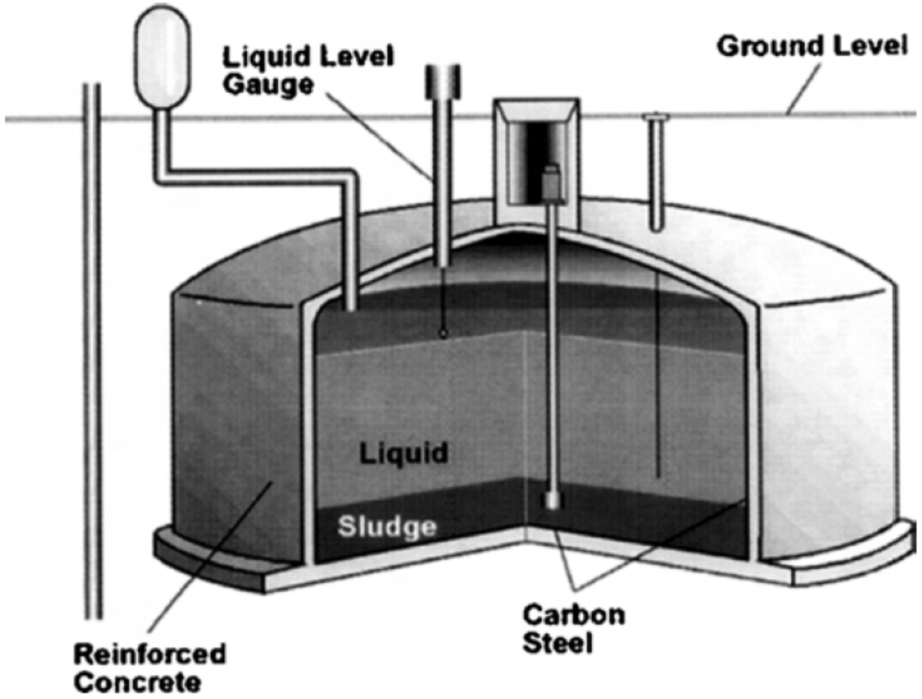
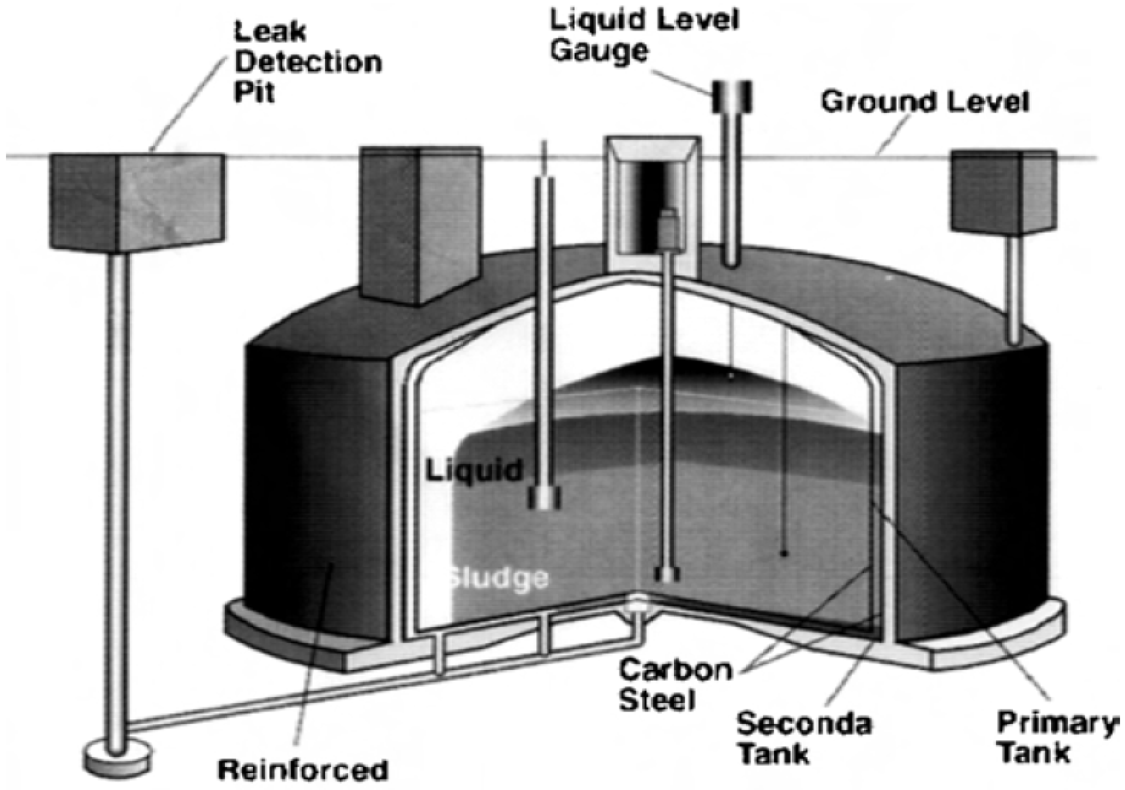
Single Shell Tanks (SST)—There are 149 SSTs with a single 1/4-inch carbon steel wall liner surrounded by concrete. They range in capacity from 55,000 to 1 million gallons, and were built between 1943 and 1964.



Of these, 67 tanks are estimated to have leaked over 1 million gallons. The single-shell tanks store about 132,500 cubic meters of saltcake, sludge, and liquid containing 110 million curies of radioactivity. About 90 percent of SST wastes are sodium nitrates and nitrites. About 75 percent of the radioactivity in these tanks comes from strontium-90 concentrated in sludge and 24 percent from cesium-137 in soluble liquids and saltcake.

Double-Shell Tanks—Between 1968 and 1986, 28 tanks with double steel liners were constructed with a capacity of 1 to 1.16 million gallons. They contain about 83,279 cubic meters or 23 million gallons of mostly liquids (~80 percent), as well as sludges and salts. The estimated amount of radioactivity in the DSTs is about 64 million curies (Cs-137 = 72 percent and Sr-90 = 27 percent). As in single-shell tanks, wastes are primarily composed of sodium salts, and also have additional metal hydroxides, phosphates, carbonates and sulfates.



Generally, Hanford tank wastes are in three basic forms.

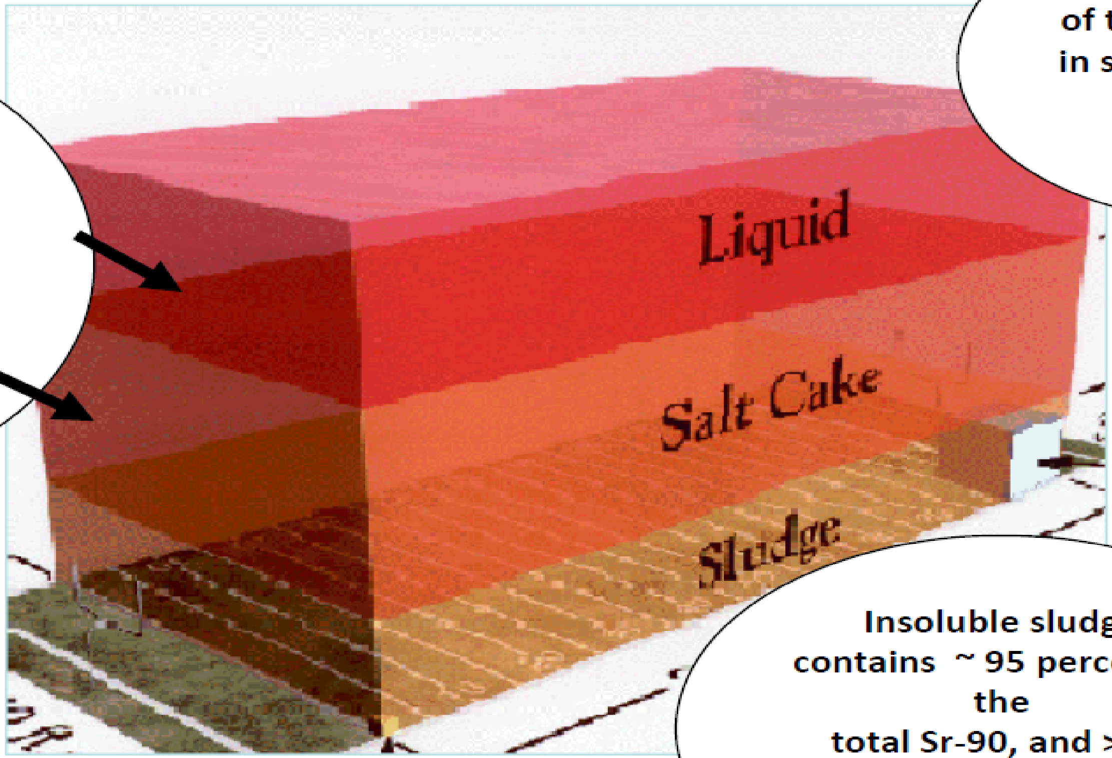
Sludge: A dense, water insoluble component that has settled to the bottom of the tank to form a thick layer of varying consistencies;

Saltcake: A crystallized saltwaste formed above the sludge, which is mostly water soluble; and

Liquid: Above or between the denser layers and sometimes embedded in saltcake are liquids of water, dissolved salts, and other chemicals called supernate.

The basis for high-level waste management at Hanford was established in World War II to meet production deadlines and limit waste storage costs. Because wastes coming out of the reprocessing plants were acidic, the U.S. government decided to neutralize them by adding sodium hydroxide (lye) and water so that cheaper carbon steel could be used to line the tanks, rather than more expensive high quality stainless steel. The decision to maintain a high pH, to reduce corrosion of the steel liners, substantially increased the volume of wastes.

Hanford High-Level Wastes



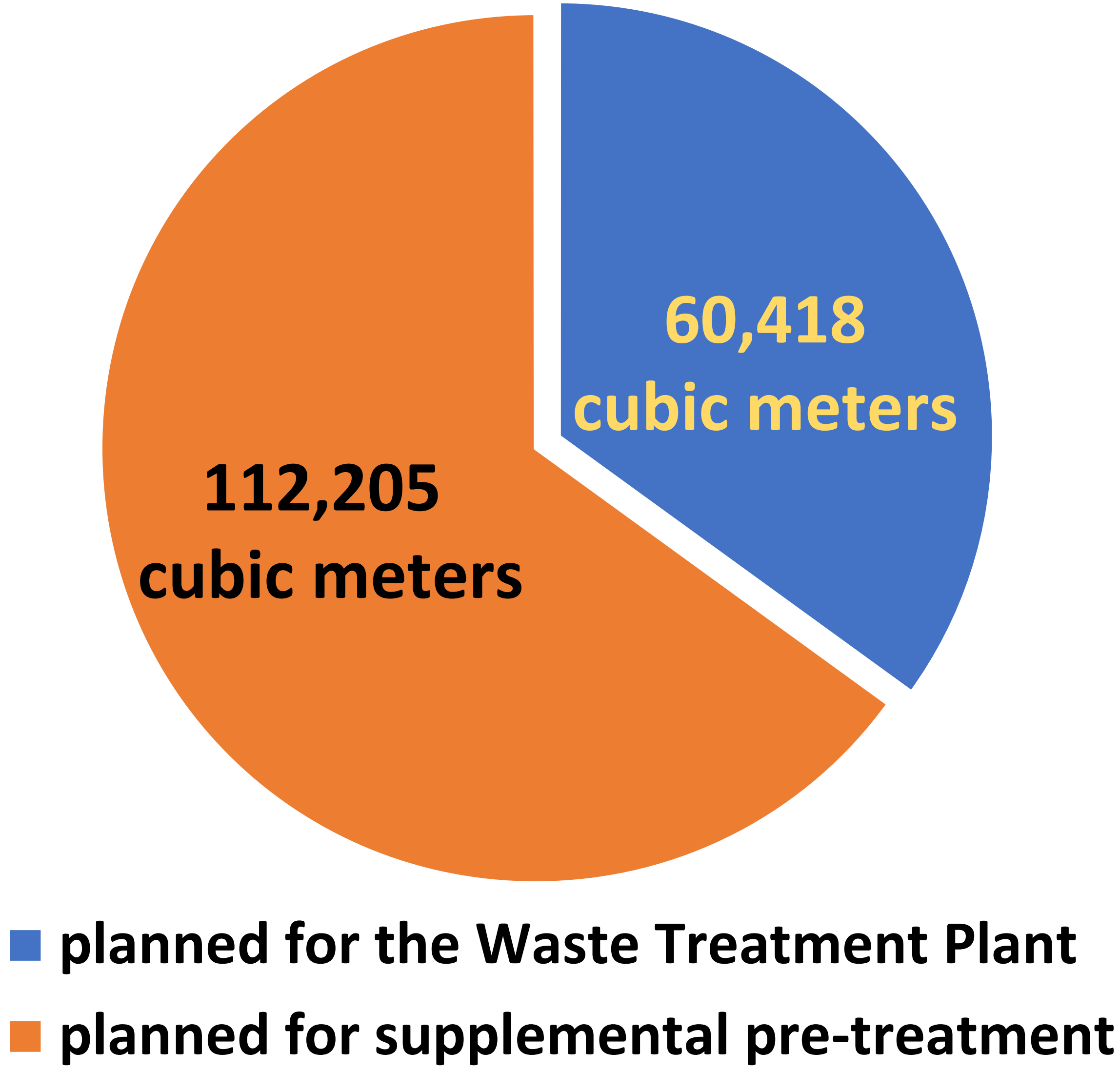
Soluble wastes are ~ 80 percent of volume and contain ~50 percent of the total radioactivity.

About 96 percent of the radioactivity in soluble wastes is cesium-137.

Insoluble sludge contains ~ 95 percent of the total Sr-90, and > 90 percent of the total transuranics.

Adapted from:
DOE/RL-98-34

Rough Estimate of Low Activity Tank Wastes at Hanford



Low Activity Wastes (LAW) is a term used by DOE to describe the predominantly liquid portion of tank waste. Untreated low activity waste (LAW) is similar to high level waste in terms of environment, safety and health effects and requires geologic disposal.

Treated LAW may be capable of meeting incidental waste criteria and, thus, it may be suitable for near surface disposal like low level waste.

Efforts to keep waste storage expenses down during the period of nuclear weapons production, created significant problems.

- Wastes were transferred extensively, between tanks, without adequate documentation, and with little regard for chemical compatibility, heat loads or radioactive concentrations.
- Nearly 300 chemicals and chemical products were added during the course of waste processing, including at least 5,000 tons of organics.
- Wastes were evaporated, and permitted to boil. Corrosion combined with the settling of high-heat sludges at the bottom of tanks resulted in the failure of steel liners.

These practices now pose major unresolved questions about waste characterization, safety and disposal, subsequently made worse by decades of neglect.

More than a third of Hanford's tanks, that is 67 SSTs, leaked ~ 1 million gallons of high-level wastes, some that reached groundwater which eventually enters the Columbia River.

One double shell tank has leaked.

Hanford wastes are unique and not well defined. It shouldn't be assumed that successful practices at other sites will work at Hanford.

- **At Hanford, five chemical separations processes were utilized, compared to the Savannah River Site, which used only one.**

- **Hanford's waste tanks contain complex mixtures that fit into 89 separate chemical profiles. Chemical concentrations in each of the tanks widely vary by as much as 100 percent.**

- **As the largest, first-of-a-kind process handling large volumes of ultrahazardous materials, safety risks are compounded by inadequate waste characterization data and a lack of processing experience with actual wastes.**

Diatomaceous earth in Hanford Tank 104-U (capacity, 530,000 gallons).

Diatomaceous earth was dumped in to Tank 104-U, (1971) BX-102 (1971), SX-113 (1972), TX-116 (1970), TX-117 (1970), and TY-106 (1972). They contain ~2.51 MCi.

Hundreds of tons of Portland cement were dumped in 241-BY-105. The cement did not set in the high-caustic, high-salt liquid and no further additions of cement were made to this or any other tank. This tank contains ~575,000 Ci.

Table 1: Summary Information on LAW Radionuclide Composition

Radionuclide	Maximum Ratio, Bq/mole Sodium			Curies/Liter at 10 Molar Sodium		
	Envelope A	Envelope B	Envelope C	Envelope A	Envelope B	Envelope C
TRU	4.8E5	4.8E5	3.0E6	1.3E-04	1.3E-04	8.11E-04
Co-60	6.1E4	6.1E4	3.7E5	1.65E-05	1.65E-05	1.0E-04
Sr-90	4.4E7	4.4E7	8.0E8	1.19E-02	1.19E-02	2.16E-01
Tc-99	7.1E6	7.1E6	7.1E6	1.92E-03	1.92E-03	1.92E-03
Cs-137	4.3E9	2.0E10	4.3E9	1.16E+00	6.00E+00 (contract max.)	1.16E+00
Eu-154 + Eu-155	1.2E6	1.2E6	4.3E6	3.24E-04	3.24E-04	1.16E-03

No contribution from the suspended and entrained solids is included in this table. LAW envelopes may contain up to 2 percent solids, which are assumed to be HLW solids. The solids contribution to radiotoxicity is significant and amounts to approximately 90 percent of the unit liter dose.

Source: NUREG-1747

These waste envelopes lack detailed speciation of waste constituents to be processed at the Waste Treatment Plant (WTP).

The entire tank farm inventory should evaluated for process compatibility in the WTP. Other than broad generalizations about the WTP volumetric capacity, it's not clear what can be accurately quantified for supplemental treatment.

What and how much will be disposed on site using supplemental Treatment?

In 1997, after performing its first, and only, mass balance assessment of Hanford high Level radioactive Wastes DOE, indicated that at least 98 percent of the total radioactivity was to be removed Hanford, under a 1997 agreement with the Nuclear Regulatory Commission prior to on-site disposal, as incidental wastes.

By 2003, DOE planned to dispose of 35 MCi, more than double that agreed to with the NRC. DOE also planned to dispose of tank wastes on site with six times more transuranics than agreed with the NRC.

Although, the U.S. Congress enacted legislation authorizing the DOE to self-regulate onsite disposal of "wastes Incidental to reprocessing" in the FY 2005 Defense Authorization Act, Hanford was specifically excluded, and thus does not have this explicit legal authority.

Any review of supplemental treatment should be subject to a mass balance estimate of the amounts and types of radionuclides left onsite for permanent disposal.

DOE should cease its "design-build" approach and follow numerous expert recommendations to build and operate "pilot" operations using actual Hanford high –level wastes. Use of surrogate wastes may prove inadequate because actual Hanford wastes may be more reactive

The "design build" approach at the Savannah River Site for low activity waste pretreatment, for onsite disposal resulted in a 20-year failure costing $500 million with $1.8 billion estimated for a technological replacement, which, after more then 15 years, has yet attained full operational status.

"Off the shelf" technologies from other sites may not be applicable to Hanford's complex waste mixtures.

A major lesson is knowing when to stop, if it is not working.

"**Construction costs, although important, are not major determinants in life-cycle cost. . . . ,**
High-level waste operating cost savings from increased waste loading or throughput may not be attainable without corresponding throughput improvements (or additional facilities)."

John Ahearne et al., U.S. Department of Energy, Office of Environmental, Management, Tanks Focus Area Report, July 2001

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