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# Deficiencies in the Proposed Waste Incidental to Reprocessing Phase II Test Bed Initiative

## Background

These comments are in response to the U.S. Department of Energy's 90-day public comment period on its Draft Waste Incidental to Reprocessing (WIR) Evaluation for the Test Bed Initiative (TBI).

The Department of Energy (DOE) may determine that certain waste is incidental to the reprocessing of spent nuclear fuel (SNF), is not high-level waste (HLW), and may be managed as low-level waste (LLW) so long as the criteria in DOE M 435.1-1 (Radioactive Waste Management Manual) are met.

The Draft WIR TBI Evaluation analyzes whether 2000 gallons of pretreated liquid waste from Hanford waste storage tank SY-101 meets the criteria in DOE M 435.1-1, is incidental to the reprocessing of spent nuclear fuel, and may be managed as mixed low-level radioactive waste and disposed of in an offsite licensed disposal facility (reference: Concept for Proposed [TBI] Demonstration at Tank SY-101, 11/4/2021).

## Introduction

DOE/Hanford is currently required to remove millions of gallons of liquid tank waste from Hanford HLW tanks and filter that waste through the use of ion exchange columns to remove cesium and other radionuclides. This process would occur on an outdoor pad in the tank farms at Hanford. DOE has estimated that 10 mega-curies of cesium-137 would end up in the columns, for which there is presently no declared disposition pathway.

As currently required, pretreated liquids would then be sent to the Waste Treatment Plant, where the Low Activity Waste (LAW) melter facility would vitrify the waste. The canisters containing the vitrified waste (VLAW) would be disposed of in an onsite facility, which has already been built, called the Integrated Disposal Facility (IDF). Approximately 23.5 million gallons (based on volume before pretreatment and solidification) of Hanford's liquid tank waste would end up being disposed at the IDF in this proposal.

There are three criteria to be met before any VLAW can be separated from the existing high level wastes in Hanford's tank farms, pretreated to remove key radionuclides, vitrified, then disposed of onsite in the IDF. These are:

*(1) As fully as possible, key radionuclides must first be removed from tank wastes.*

*(2) All applicable (10 CFR 61C) safety requirements must be met.*

*(3) Wastes must be in a solid form with radionuclide concentration limits not exceeding Class-C low-level waste (10 CFR 61.55).*

The Draft WIR TBI proposes replacing onsite vitrification with offsite grouting. Instead of operating on Hanford's greater than 550 square mile DOE-controlled site, the TBI calls for offsite waste grouting in a commercial/agricultural/residential area of Richland, WA. The TBI must meet the same three criteria described above for vitrified liquid wastes.

In addition to these requirements, DOE/Hanford must also meet the requirements of DOE M I.2.F(4), which details the additional requirements for treating DOE wastes at offsite non-DOE locations. DOE's manual states that, "DOE waste shall be treated, stored, and in the case of low-level waste, disposed of at the site where the waste was generated, if practical, or at another DOE facility."

The proposed TBI is a 2000-gallon pilot test of an alternative to the current requirements for the 23.5 million gallons of liquid waste at Hanford. The TBI also proposes grouting this DOE waste at an offsite non-DOE location, namely Perma-Fix NW in Richland, WA, (PFNW). Grouted waste would then be transported and disposed of in Texas, Utah or another location.

To summarize, rather than vitrify separated liquid wastes from the high-level waste tanks, DOE/Hanford would instead mix 2000 gallons of pretreated liquid wastes with grout at an offsite location in Richland, WA. The grouted waste will be disposed of at another offsite location. The proposed pilot test would use a pretreatment process that operates inside HLW tank SY-101.

## Concerns with the WIR TBI

### Organics and ammonia in liquid wastes

Liquid nuclear wastes in Hanford's storage tanks are a mix of radioisotopes and various chemicals used to process spent fuels. State of Washington Ecology officials have determined that classifying some of the tank waste as low-level radioactive waste does not necessarily remove the RCRA vitrification treatment standard from the waste. The US GAO acknowledges that there is currently no acceptable disposal facility for grouted wastes. Grouted wastes also have a shorter stable lifetime than vitrified wastes, sometimes significantly shorter because grout monoliths may not set properly upon formation.

The organics and ammonia in liquid wastes are potentially reactive, toxic and combustible. Hanford's HLW tanks contain 54 million gallons of mixed nuclear and hazardous chemical wastes including ammonia, mercury compounds and hazardous organic chemical constituents. In particular, the presence in the liquid wastes of potentially hazardous and flammable organic compounds, and reactive chemicals like ammonia, dramatically increases the accidental release potential during grouting. Performing this task offsite makes the repercussions of such an accident, unnecessarily severe. The mix of immiscible organic liquids, reactive ammonia, suspended solids, and volatile compounds may interfere with grout formation, leading to early grout monolith failure.

A 2014 report by Hanford Challenge noted that more than 1,800 chemicals have been documented in the vapors contained within Hanford's tank headspaces, which escape from the tanks through various pathways, even under routine circumstances. According to tank farm contractor documents, at least 120 Hanford workers in and around the tank farms were exposed to toxic vapors since January 2015. Seventy-three (73) workers experienced a vapor exposure at Hanford in April and May 2016 alone.

Workers exposed to toxic vapors have suffered serious long-term health effects including brain damage, lung diseases, nervous system disorders, and cancer. Short-term health effects have included nosebleeds, profuse sweating, persistent headaches, tearing eyes, burning skin and lungs, coughing, sore throats, eye problems, dizziness, nausea, memory loss, difficulty breathing, and increased heart rates.

Some workers are on long-term disability resulting from chemical vapor exposure at Hanford, with illnesses such as toxic encephalopathy, neurological damage, nerve damage, and lung disease. Others are still fighting for their claims to be recognized. A 1997 Pacific Northwest National Laboratory study found that cancer risks from exposure to tank farm vapors carried a fatal cancer risk as high as 1 in 10. These risk levels are unconscionable for workers, but equally so for residents and workers offsite who could be exposed to chemical vapors at the nonDOE offsite grouting contractor in Richland, WA.

**Perma-Fix NW is unsuited for this project**

Treating tank waste from Hanford by solidifying liquid wastes at Perma-Fix NW is an unacceptable proposal, and it is also one highly discouraged by DOE's own policies and procedures. More than 32,000 people live within 5 miles of Perma-Fix NW and a daycare center is located less than a mile away. Perma-Fix NW received a notice of significant noncompliance from the US Environmental Protection Agency as recently as 2019. In that same year the facility had two fires, one of which was deemed "a near-catastrophe" by a state inspector, as fire alarms were inoperative at the time.

Perma-Fix NW does not have a permit nor is there a publicly available permit application for the proposed WIR TBI operations that might take place there. This means that there is no way to evaluate the safety of this proposal, which has not undergone a public permitting process. Critical questions such as, "Does Perma-Fix have sufficient controls to participate in TBI?" and "Can Perma-Fix deal with ammonia and organics?" remain unanswered and unanswerable.

Hanford waste should be treated on the Hanford Site, not off-site at Perma-Fix NW. This would lower the risk to the community; eliminate transportation risks; and increase transparency, accountability, and safety.

**Liquid waste composition remains unknown**

It's understood that the actual composition of the WIR TBI waste is not currently known, and it's unclear what will actually be in the 2000 gallons of liquid wastes that will potentially be sent to Perma-Fix NW in Richland, WA. The wastes in the Hanford tanks are not uniform and not well characterized. Grouting radioactive liquids with varying compositions remains an untested skill, but it is known that grouting will require customized grout formulations for each tank, and possibly for each batch from each tank.

Liquid tank wastes will be withdrawn from a single tank in the proposed TBI, however consistency between the wastes in each individual tote is potentially problematic. The tank contents themselves are stratified, with different compositions at different elevations within the same tank. A grout recipe that successfully sets for the first tote of withdrawn waste may not set for the sixth tote. Civil engineers normally use equalization tanks prior to waste liquid treatment, but adding this extra operation would increase the risks of offsite grouting beyond the already unacceptable proposed level.

Prior studies (Ojovan, doi:10.1016/j.jhazmat.2011.01.00) have noted that, "although cementation technology is typically simple the actual development of an appropriate formulation might require extended research dependent on the chemical complexity of the waste streams." The study goes on to note that the long-term safety of the grouted waste form in near-surface burial is dependent on the engineered nature of the disposal facility. The actual underground conditions are also noted as, "of paramount importance". Finally, in addition to site design, the actual final chemistry of the grouted waste is very important to ensuring the overall safety of the disposal plan.

This means that each critical portion of the plan for safe long-term storage (chemical composition of waste, optimizing grout recipes and conditions for both radiochemicals and hazardous chemicals simultaneously, burial conditions, near-surface landfill design) remains unknown. Just to make the stakes even higher, prior research on cemented radioactive wastes has generally been performed only on low-level or intermediate-level radioactive wastes. There is little data available to support significant plans to cement wastes originally classified as high-level.

One consequence of grouting waste liquids of unknown composition is that the true percent removal of key radionuclides via pretreatment is unknowable. Table 4-6 in the 2021 *Draft WIR Evaluation for the TBI Demonstration* makes the claim that key radionuclide percent removal before grouting will be 99.999%. The same document nevertheless admits that this figure is based on estimates rather than actual analyses, and that the varying composition of these radionuclides in tank sludges has not been accounted for by the estimates. Even if radionuclide partitioning to sludges is ignored, percent removals are difficult to calculate when the initial compositions are estimated, best-basis inventories using only the most recent tests of a heterogenous waste that changes composition via decay and chemical/physical reaction on a daily basis.

Of course many of the liquid wastes at Hanford are the result of the necessary disposal of the corrosive and highly reactive chemicals used to convert spent nuclear fuel into dissolved forms of plutonium suitable for weapons. These powerful chemicals could not be recycled, and thus these remain in the liquid portion of these wastes. What little cementing data is actually available for high-level wastes is unlikely to also include this same degree of hazardous and reactive chemical constituents. The grouting process itself is a highly alkaline and chemically active environment. There is a significant and perhaps unavoidable risk in performing this level of extreme chemistry at an offsite, nonDOE facility that is located within an active mixed-use neighborhood.

**Prior data point is only three gallons**

Pretreated liquid Hanford tank waste has never been successfully grouted. Conjecture about this possible multi-billion dollar project depends on a prior experiment done with adding cement to three gallons of simulated liquid wastes. The proposed 2000-gallon TBI will be the first data point on whether this approach can be successful, regardless of whether it can also be scaled. This lack of safety and treatability data is a major impediment to allowing any part of this TBI to be performed offsite.

The liquid portion of mixed high-level nuclear and hazardous chemicals wastes in each of the 160 waste tanks at Hanford is distinct; no two tanks have the same constituent profile, and thus each of the grout recipes must be tailor-made. These grout recipes are not known because the actual constituents of each tank are currently unknown. This uncertainty applies to both the radiochemical and the hazardous/reactive but nonradiological portions of the waste.

The three gallons of the prior pilot grouting test were not compositionally related to the composition of the SY-101 waste in the proposed TBI. In fact, the 3-gallons of material pilot tested were actually a waste simulant.

**Liquid removal from waste tanks impacts heat balancing; added capacity may be negated by the need to add water for evaporative cooling.**

Liquid removal from the waste tanks will be done with narrow pipes and devices that must withstand the high heat and caustic environment of the tank interiors (Hanford/DOE 2022, https://www.hanford.gov/page.cfm/tankfarms). Historically waste tanks have used evaporative cooling (adding water that is allowed to boil off) to keep tanks from overheating. Some individual tanks have required more than

60,000 gallons of cooling water annually (DOE WHC-EP-0182-92 Waste Tank Report, 1995). Any tank capacity gained by liquid removal and grouting may be lost to introduced evaporative cooling water in many of the tanks.

**Will grout become a one-size-fits all solution?**

Grouted wasteforms are unproven and untried with actual SY-101 liquid wastes, but nevertheless have less stability upon disposal than vitrified waste forms. Long-lived isotopes such as plutonium and technetium will remain in the grouted wastes, and will have a high potential for release to the environment.

**Onsite vs. offsite treatment**

DOE guidance states that, "DOE waste shall be treated, stored, and in the case of low-level waste, disposed of at the site where the waste was generated, if practical, or at another DOE facility." Offsite treatment, and particularly, offsite treatment at Perma-Fix NW should be a last resort, not a first.

As noted in the introduction, in addition to these requirements of 10 CFR 61.55, DOE/Hanford must also meet the requirements of DOE M I.2.F(4), which details the compulsory prerequisites for treating DOE wastes at offsite nonDOE locations. DOE's manual states that, "DOE waste shall be treated, stored, and in the case of low-level waste, disposed of at the site where the waste was generated, if practical, or at another DOE facility."

**New double shell tanks are the fastest and most reliable way to create more HLW capacity**

In addition to the monetary analysis, Hanford/DOE believes that there is little capacity remaining in the double-shelled Hanford waste tanks. As wastes from failed tanks are redistributed, and as wastes are processed, DOE may run out of available tank space. Some Government stakeholders suggest that grouting rather than vitrifying liquids would free up tank space sooner, though we think this is based on assumptions with a great deal of uncertainty.

Tank Space Issue Better Solved with New Tanks: USDOE's Savannah River National Laboratory estimates that vitrification of supplemental waste would take 10 to 15 years, while grouting would take 8 to 13 years. This is not a significant difference in terms of providing added double-shell tank capacity. Constructing new double-shell tanks however, would be faster than both grouting and vitrification in terms of providing added capacity.

**One final technical consideration**

The NRC has simple definitions for HLW and LLW. These are, "High-level radioactive wastes are the highly radioactive materials produced as a byproduct of the reactions that occur inside nuclear reactors. High-level wastes take one of two forms, spent (*used*) reactor fuel when it is accepted for disposal, and waste materials remaining after spent fuel is reprocessed"

"Low-level waste includes items that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation. This waste typically consists of contaminated protective shoe covers and clothing, wiping rags, mops, filters . . .."

While grouting reclassified HLW sounds like a valid option to some, HLW simply is not LLW. Grouted waste in a landfill will not have time to approach background levels of radioactivity before escaping into the environment. As currently understood by scientific staff at Hanford, all of the waste tanks will eventually leak into the vadose zone beneath the tank farms, resulting in potentially catastrophic releases of radioisotopes into the environment. After a short time, grouted wastes have and likely will release radionuclides to the environment in the same way. Sixty-nine Hanford tanks have already leaked. To prevent further releases, the HLW must be removed, stabilized by making it into a glass-like material, and then stored in an inaccessible underground geologic repository. Once in the repository, the HLW will have the best chance to be isolated from human activities for hundreds of thousands of years.

**Summary of concerns with the WIR TBI**

ORGANICS AND AMMONIA - Hanford's HLW tanks contain 54 million gallons of mixed nuclear and hazardous chemical wastes including ammonia, mercury compounds and hazardous organic chemical constituents. In particular, the presence in the liquid wastes of potentially hazardous and flammable organic compounds, and reactive chemicals like ammonia, dramatically increases the accidental release potential during grouting. Performing this task offsite makes the repercussions of such an accident, unnecessarily severe.

PERMA-FIX NW IS AN UNSUITABLE GROUTING SITE - The pretreated liquids would then be mixed with grout at an offsite location in Richland, WA, prior to disposal at a commercial facility in Utah or Texas. Perma-Fix NW in Richland, WA is the proposed grouting site for these liquid wastes, however the facility has had significant operating deficiencies. The deficiencies, and Perma-Fix's populated location, make it impossible to demonstrate that grouting pretreated liquid wastes at Perma-Fix would meet the requirements of DOE M I.2.F(4).

LIQUID WASTE COMPOSITION REMAINS UNKNOWN – The wastes in the Hanford tanks are not uniform and not well characterized. Grouting liquids with varying compositions remains an untested skill, and will require customized grout formulations for each tank, and possibly for each batch from each tank.

PRIOR DATA POINT IS ONLY THREE GALLONS - Pretreated liquid Hanford tank waste has never been successfully grouted. The needed grout recipes are not known because the actual constituents of each tank are currently not fully known. This high uncertainty in composition increases the risk level of any offsite operations.

THE IMPACT OF LIQUID REMOVAL ON HLW HEAT CONTROLS – Liquid waste removal from HLW tanks does not necessarily translate into added storage capacity, since evaporative cooling water has historically been added regularly to Hanford's tanks.

WILL GROUT BECOME A ONE-SIZE-FITS ALL SOLUTION? – Grouted wasteforms are unproven and untried with actual SY-101 liquid wastes, but nevertheless have less stability upon disposal than vitrified waste forms. Long-lived isotopes such as plutonium and technetium will remain in the grouted wastes, and will have a high potential for release to the environment.

ONSITE VS. OFFSITE TREATMENT - DOE guidance states that, "DOE waste shall be treated, stored, and in the case of low-level waste, disposed of at the site where the waste was generated, if practical, or at another DOE facility." Offsite treatment at Perma-Fix NW should be a last resort, not a first.

NEW DOUBLE SHELL TANKS ARE THE ONLY FAST AND RELIABLE WAY TO CREATE MORE HLW CAPACITY - The vitrification project would take 10 to 15 years, while grouting would take 8 to 13 years. Constructing new double-shell tanks would be faster than both in terms of providing added tank capacity.

ONE FINAL TECHNICAL CONSIDERATION - The US GAO acknowledges that there is currently no acceptable disposal facility for grouted wastes, and that grouted wastes in shallow burial have a shorter stable lifetime than vitrified wastes in a geologic repository.