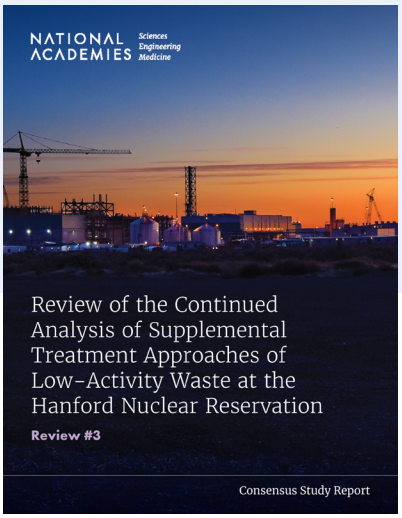
Review of the Continued Analysis of Supplemental Treatment Approaches of Low-Activity Waste at the Hanford Nuclear Reservation



The Hanford Nuclear Reservation, located in the state of Washington, produced about two-thirds of the nation's plutonium stockpile for nuclear weapons from 1944 until the last reactor was shut down in 1987. As a result, substantial amounts of radioactive and other hazardous wastes accumulated at Hanford; presently, about 56 million gallons of waste are stored in 177 underground tanks. Treating and disposing of that waste is expected to take 40-50 years at a cost of more than $50 billion.

The U.S. Department of Energy's Office of Environmental Management (DOE-EM), which is responsible for the cleanup, plans to use vitrification, or immobilization in glass waste forms, for all of the "high-level waste" at Hanford (about 10 percent of the volume and up to 99 percent of the radioactivity). The remainder—about 90 percent of the volume—is designated "low-activity waste," some of which also will be vitrified. However, because of capacity limits at the new vitrification plant that DOE is building, DOE must find alternatives for treating the remaining low-activity waste—referred to as "supplemental low-activity waste" or SLAW—for safe disposal in a near-surface disposal site.

The National Defense Authorization Act of 2021 (Section 3125) required DOE-EM to create a framework for decision-making that enables direct comparison, to the greatest extent possible, of proposed approaches for treating SLAW (see Box 1). DOE contracted with key Federally Funded Research and Development Centers (FFRDC), led by Savannah River National Laboratory, to carry out the analysis. Congress also specified that the National Academies provide ongoing review and advice to the FFRDC. This trilogy of reports from the National Academies reviews the FFRDC's third report released in January 2023.

BOX 1. FOUR SLAW TREATMENT TECHNOLOGIES ASSESSED BY THE FFRDC

The FFRDC reviewed four approaches that are most likely to succeed that have been demonstrated at other DOE sites including Savannah River Site and Idaho National Laboratory. Vitrification is considered to be the baseline alternative for comparison to the other technologies. Only vitrification has approval for on-site disposal.

1. **Vitrification**—This high temperature technology blends the SLAW into a glass waste form—with disposal at the Integrated Disposal Facility (IDF) at Hanford.

2. **Grouting:** Grouting technology operates at room temperature (about 25C) and blends the liquid SLAW with dry inorganic materials to produce a cementitious waste form.

3. **Steam Reforming:** This high temperature technology blends the liquid SLAW with dry inorganic materials at 750°C, forming dry granular mineral particles with a chemical structure that retains the radionuclides and metals.

4. **Phased approach:** This begins with off-site grouting and disposal then transitions to on-site operations.

ADEQUACY OF THE DECISION FRAMEWORK

The report finds that the FFRDC team has produced a useful framework that is helpful in understanding the issues and trade-offs and ultimately determining how and where the SLAW will be managed. The FFRDC considered and gathered information concerning all of the statutorily required factors, which include:

1. Long-term environmental and safety effectiveness
2. Implementation schedule and risk
3. Likelihood of successful mission completion
4. Lifecycle costs
5. Securing regulatory permissions
6. Public acceptance

While two important criteria – regulatory approval and public acceptance – were treated as uncertainties and not included in the team's comparative analysis, their potential importance as obstacles to implementation of any given alternative or option was acknowledged.

The final FFRDC report contains several new and revised ways of comparing the alternatives and subset of options for each alternative according to relevant criteria (i.e., tables that highlight different factors and make different pairwise comparisons), which will be helpful to decision makers. The FFRDC did an excellent job of disaggregating the technical statutory criteria into specific factual considerations that can be analyzed, often quantified, and compared with each other.

ADDITIONAL ANALYSIS OF GROUT

As specified in the National Defense Authorization Act of 2021 (Sec. 3125), the FFRDC report considered grout in greater detail than the prior FFRDC report by: (a) analyzing 15 grout options; (b) analyzing various off-site scenarios for grout treatment and disposal; and (c) considering in detail the SRS experience with grout treatment. The main criteria used to defend consideration of off-site vendors was the cost effectiveness of off-site grouting and the ability to start LAW treatment earlier using an

already operational grouting facility off-site. The FFRDC recommended that DOE expeditiously begin to develop multiple off-site, out-of-state pathways for either grouted SLAW or off-site pre-treatment of liquid SLAW and off-site disposal.

FFRDC REPORT STRENGTHS

The FFRDC has made a strong technical case that (1) off-site disposal of grout is for the most part a preferred option, and may be a technically valid option with on-site disposal, depending on the results of a performance assessment for the on-site disposal facility; (2) that a clear and persistent difference exists between grout and the other two alternatives (vitrification and FBSR) on virtually all technical criteria that the FFRDC evaluated; and (3) that grout dominates the other two alternatives on the basis of lower cost and shorter time to operational start-up.

The FFRDC has made a technical case that grout treatment and disposal of SLAW could occur at locations other than the Hanford site—and in various combinations of function, location, and time—and thus articulated a clear rationale for disposing off-site if that is the choice of the relevant decision makers. The addition to the analysis of off-site treatment and/or disposal has created a new set of SLAW options for decision makers, noting the off-site locations do not reside near potable water or above aquifers.

FFRDC REPORT LIMITATIONS

The FFRDC report has been completed during—but separately from—ongoing "holistic review" of the Hanford facility construction, waste recovery, and disposition schedule, which is related to a review of the Tri-Party Agreement (TPA)[1] and revision of the federal district court's consent decree regarding Hanford clean-up. While these proceedings are almost entirely opaque given their confidential nature, the FFRDC had access to some of the technical underpinnings, such as the Analysis of Alternatives (AoA) that DOE released publicly just a few days before the committee's last meeting. Going forward, decision makers should integrate the AoA and conclusions from the private negotiations between DOE, the state of Washington, and the EPA that affect the TPA before they reach a final decision on how to manage SLAW. It is noteworthy that after three years of discussions the negotiating team announced conceptual agreement on May 2, 2023; however, further details will not be released until approved by the state and federal officials.

As stated above, FFRDC chose to exclude Criterion 5 (regulatory approval) and Criterion 6 (public acceptance) from its analysis of the four options it identified, limiting its analysis to purely technical considerations (Criteria 1-4). While this exclusion is preferable to having the FFRDC speculate on the probability of regulatory and public responses, these criteria will inevitably have to be considered in the future by decision makers to achieve in order to implement any option chosen. Moreover, the conditions and likelihood of regulatory approval and public acceptance are likely to vary considerably among options, e.g., off-site disposal of grouted SLAW versus disposal of grouted SLAW in IDF. Going forward, decision makers should immediately begin a thorough assessment of these two criteria to provide input to their consideration of how to manage SLAW.

Due to a number of limitations, the FFRDC's cost estimates are usable as indicators of relative costs but are not suitable for predicting actual costs and or establishing budgets. The cost estimates also can be useful as a constraint on the timing of various alternatives and a relative basis for comparison among alternatives. The cost estimates are sufficiently robust to demonstrate that there is a very significant gap between the costs of vitrification and FBSR on the one hand, and the various grout options on the other. The costs of the former and the latter, even after accounting for

1 The Tri-Party Agreement is a legally binding agreement between the U. S. Department of Energy, the U. S. Environmental Protection Agency, and the State of Washington Department of Ecology for achieving compliance with the statutory requirements for the cleanup at the Hanford Site.

the wide ranges of cost estimation uncertainty also identified in the FFRDC report, do not come close to overlapping.

CALL FOR ADDITIONAL ANALYSIS

Before reaching a decision on specific alternatives from the FFRDC recommendation, detailed analysis will still be needed for of a wider variety of grout options than what has been carried out to date, including but not limited to:

- the location of the grouting plant(s): on-site vs off-site, tank-side versus tank farm;
- the possibility of commercial SLAW facilities on the Hanford site and then the possibility of operating them;
- detailed assessment of the waste acceptance criteria, cost, and other aspects of off-site treatment or disposal, including regulatory and public acceptance.

LOOKING FORWARD

The DOE faces many uncertainties inherent in decisions with long-term completion horizons, challenging materials, complex technology, evolving technology, and an unpredictable regulatory and stakeholder environment. Under these circumstances, DOE should emphasize flexibility in its overall approach, allowing for multiple, redundant options and pathways, as well as the ability to change over time.

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This Consensus Study Report Highlights was prepared by the Nuclear and Radiation Studies Board based on the Consensus Study Report *Review of the Continued Analysis of Supplemental Treatment Approaches of Low-Activity Waste at the Hanford Nuclear Reservation (2023)*.

The study was sponsored by the U.S. Department of Energy. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project.

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