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

Disposal Performance Evaluation

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Hanford Advisory Board Briefing

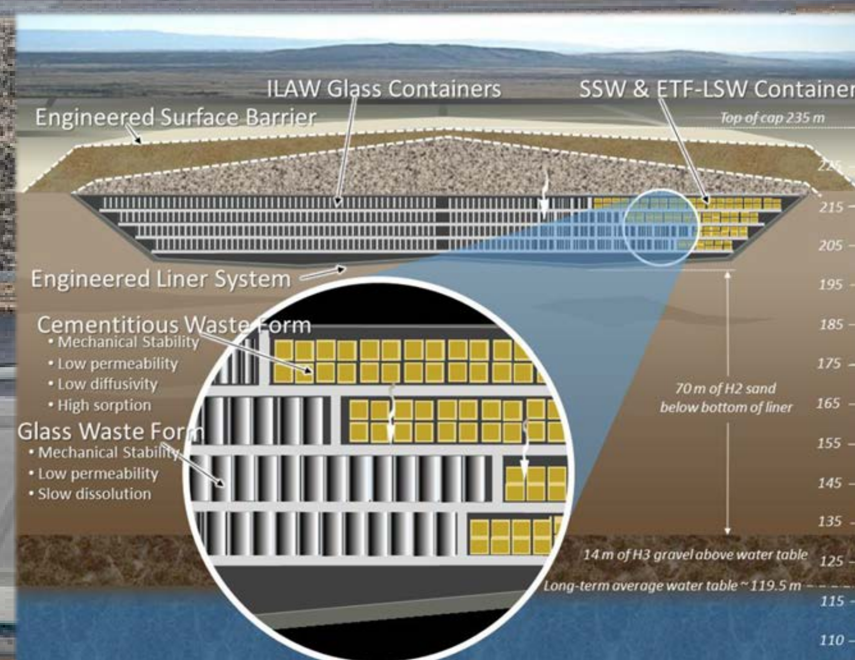
May 20, 2020

PNNL-SA-151239

PRE-DECISIONAL

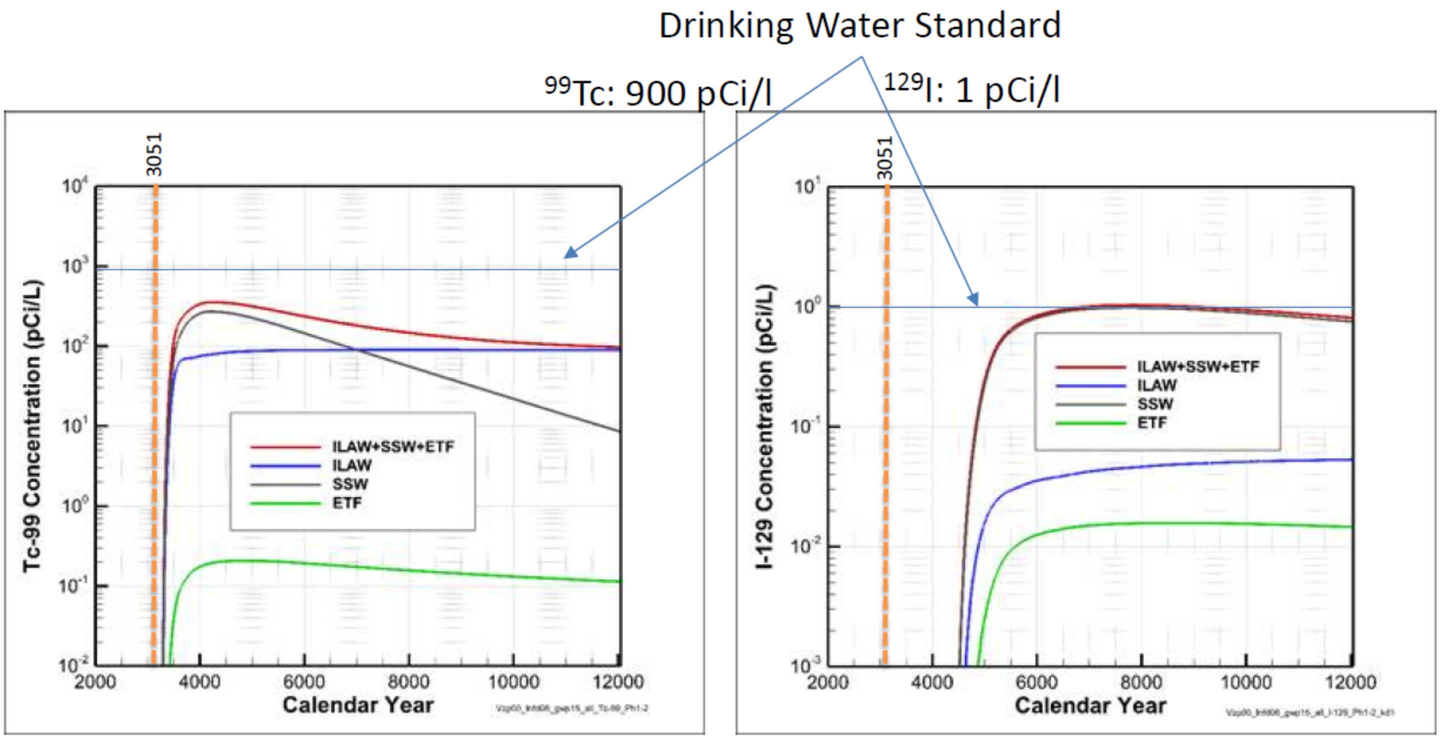
Waste Forms Performance Evaluation for On-Site Disposal (IDF)

- Integrated Disposal Facility RCRA Permit and Waste Acceptance Criteria
  - Currently limits LAW waste form to glass canisters
  - Requires Performance Assessment (PA) analysis and assessment of impacts to groundwater of all wastes to be disposed
    - *Permit specifies process to propose additional wastes for disposal (including secondary wastes)*
    - *Requires mitigation if results >75% of any performance standard (e.g., drinking water standards)*
- 2017 IDF Performance Assessment
  - Only considered ILAW glass and secondary wastes from LAW processing
  - No consideration of SLAW alternatives or their secondary wastes
- FFRDC Team identified the need for a Performance Evaluation (PE)
  - Assess the ability of supplemental treatment alternatives to meet the waste acceptance criteria of IDF
  - Modelled after the 2017 IDF PA methods and approach, but a more limited effort



2017 IDF Performance Assessment – Key Results

- Groundwater concentrations of Tc and I are driven by releases from solid secondary waste (SSW)



Groundwater concentrations

Tc-99 driven by SSW initially, then ILAW glass when SSW inventory in IDF is depleted. ILAW source is about 10×below drinking water standard

I-129 driven by SSW at all times. ILAW source is about 18× below drinking water standard

Lee, K.P. et al, 2019. Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington. RPP-RPT-59958 Rev. 01A, Washington River Protection Solutions, Richland, Washington.

SLAW Waste Form “Systems” for IDF Performance Evaluation

Analysis Case	Supplemental LAW Waste Forms	
	SLAW	Secondary Wastes
1 – Glass (Vitrification)	Borosilicate Glass	LSW - ETF SSW - HEPA filters SSW – GAC absorber
2 - Grout	Cast Stone	SSW – HEPA filters SSW - GAC absorber
3 - Steam Reforming (FBSR)	FBSR Mineral – Macro-encapsulated	SSW – HEPA filters SSW - GAC absorber

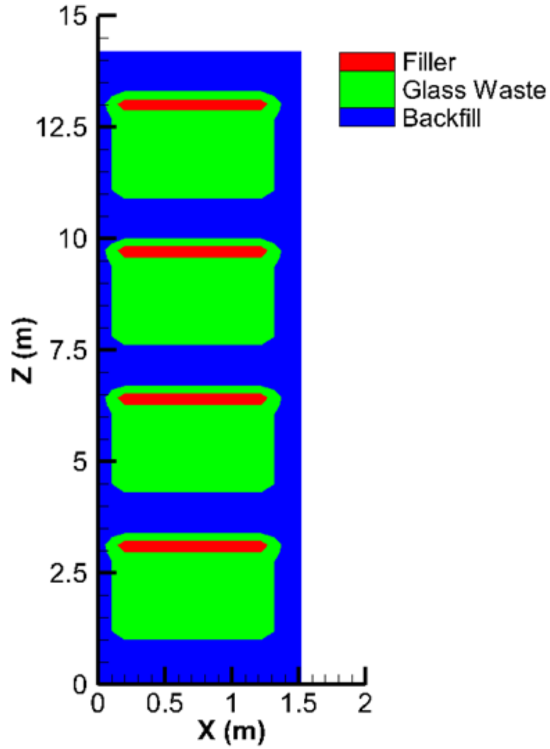
FBSR=fluidized bed steam reforming; LSW=liquid secondary waste; ETF=Effluent Treatment Facility; SSW=solid secondary waste; GAC=granular activated carbon; HEPA=high efficiency particulate air filter

Three sensitivity cases (sets of waste form release parameters) were selected for each waste form

- Low performing case – lower range of experimental data
- High performing case – upper range of experimental data
- Projected best case – recent enhancements to formulations and performance improvements that have been observed, but require additional studies to confirm

PE – Analysis Methodology

- Focused on groundwater pathway and impacts of key radionuclides—Tc-99 and I-129
  - o Groundwater impacts from Tc and I previously shown to be key area of concern for ILAW, SLAW, and secondary wastes from LAW processing
- STOMP modeling platform applied for consistency with 2017 IDF PA analysis
  - o eSTOMP (scalable version of STOMP) was used to enable more efficient modeling
  - o Benchmark simulations conducted for ILAW glass and secondary wastes to assure PE was producing equivalent results to the IDF PA for the same model inputs
- Simulated a full stack of waste packages within IDF with a unit inventory of Tc-99 and I-129 in each package
  - o Four stacked ILAW glass canisters, or eight stacked B-25 (secondary waste) boxes, or eight 8.3 m^3 (SLAW grout or steam reforming) boxes
  - o Model output provided fractional release rate (Ci released/Ci disposed/yr) from bottom of IDF as a function of time
- Translated eSTOMP-derived peak release rate to peak groundwater concentration using 2017 IDF PA algorithm based on full vadose zone and groundwater transport modeling



2D simulation domain for the LAW glass simulation with four stacked waste packages

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Performance Evaluation Results - Technetium

- All waste forms can meet Tc-99 regulatory objectives, except:
  - Low performing grout case exceeds the Tc-99 MCL of 900 pCi/L
  - Low performing FBSR case exceeds 75% of Tc-99 MCL (requiring mitigation)
- High performing and projected best cases for glass, grout, and FBSR waste form systems result in Tc-99 groundwater concentrations well below regulatory objectives

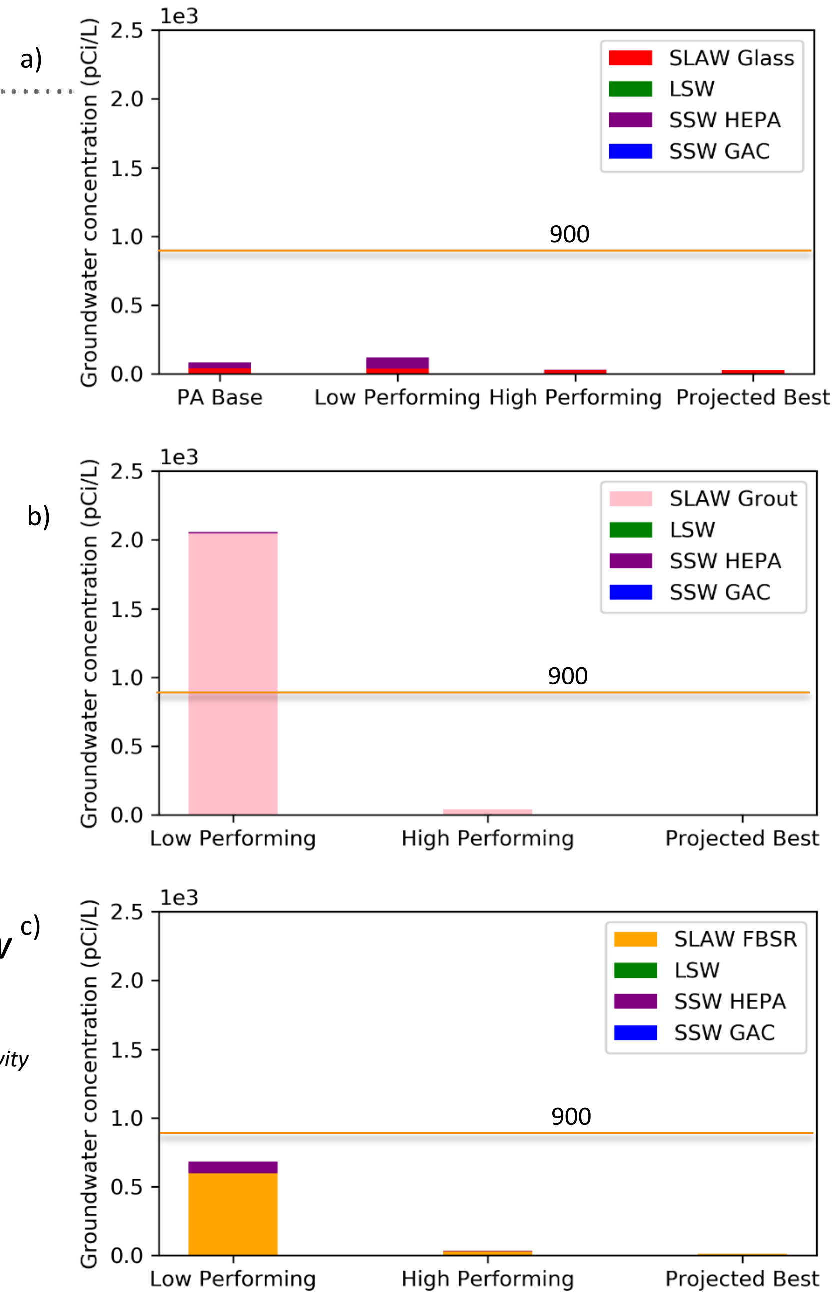


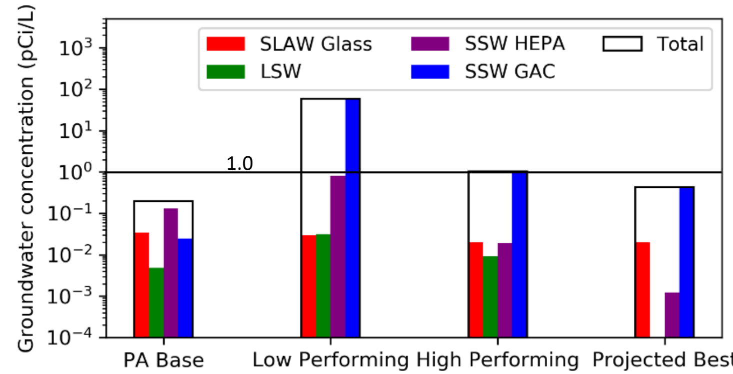
Figure F-15. Predicted technetium-99 groundwater concentrations for 100 m downgradient compliance well for **a) SLAW Glass**, **b) SLAW Grout**, and **c) SLAW Steam Reforming (FBSR) systems***

** SRNL-RP-2018-00687. 2019. Report of Analysis of Approaches to Supplemental Treatment of Low-Activity Waste at the Hanford Nuclear Reservation.*

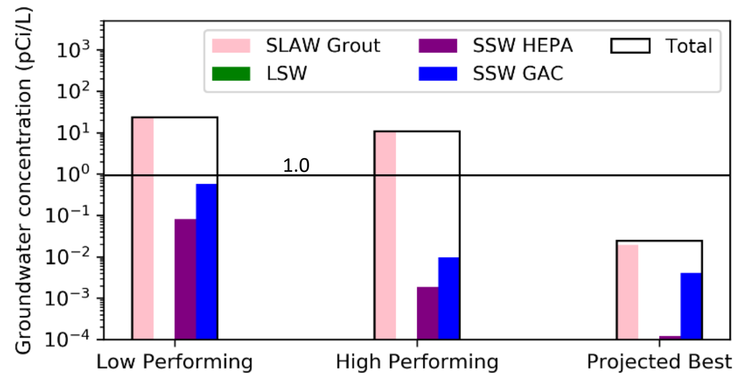
Performance Evaluation Results - Iodine

- Only high performing and best cases for FBSR, and projected best cases for grout and glass met the I-129 MCL of 1 pCi/L
  - Low and high performing cases for glass and grout, and low performing case for FBSR exceeded I-129 MCL of 1 pCi/L
  - SSW GAC performance was the primary driver for the glass and FBSR cases that exceeded MCL

a)



b)



c)

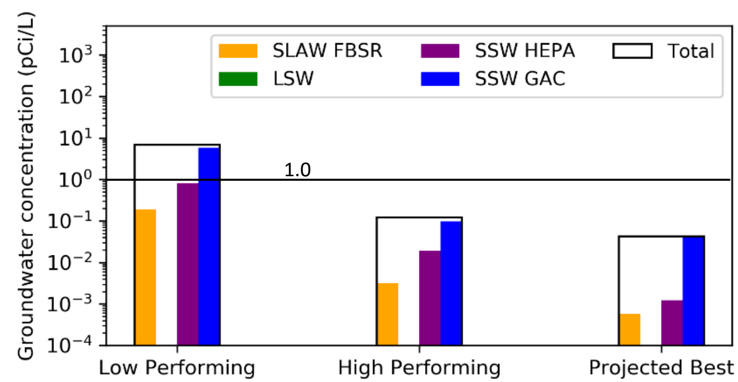


Figure F-17. Predicted iodine-129 groundwater concentrations for 100 m downgradient compliance well for **a) SLAW Glass**; **b) SLAW Grout**; and **c) SLAW Steam Reforming (FBSR) systems**.*

Outer box represents total sum of contributions of SLAW, SSW, and LSW waste forms

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Executive Summary and High Level Table

NDAA CRITERIA	VITRIFICATION CASE: DISPOSAL ONSITE AT HANFORD	GROUTING CASE 1: DISPOSAL ONSITE AT HANFORD	GROUTING CASE 2: OFFSITE DISPOSAL	STEAM REFORMING CASE 1: SOLID MONOLITH PRODUCT DISPOSAL ONSITE AT HANFORD	STEAM REFORMING CASE 2: GRANULAR PRODUCT OFFSITE DISPOSAL
RISKS/ OBSTACLES	• Difficult to build and operate because highly complex process	• Requires pretreatment of organics • Requires wasteform validation	• Requires pretreatment of organics	• Requires most technology maturation • Requires wasteform validation	• Requires most technology maturation
BENEFITS	• Similar to technology being built for first LAW	• Low integrated complexity • No liquid secondary waste	• Low integrated complexity • No liquid secondary waste	• No liquid secondary waste	• No liquid secondary waste
COST	~$20B to ~36B	~$2B to ~$3B	~$5B to ~$8B	~$6B to ~$12B	~$9B to ~$17B
YEARS NEEDED BEFORE STARTUP	10-15 years	8-13 years	8-13 years	10-15 years	10-15 years
REGULATORY COMPLIANCE	• Primary waste is compliant • Secondary waste may require Iodine mitigation	• Likely meets requirements after organics pretreatment • May require iodine mitigation	• Compliant following organics pretreatment	• Likely meets technical requirements	• Compliant

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