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FFRDC Overview – Final Report on Analysis of Supplemental Treatment Approaches for Low Activity Waste at the Hanford Nuclear Reservation

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Richland, WA
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Summary of FFRDC Scope from NDAA17 Section 3134

- **Analysis of approaches for treating Supplemental LAW (SLAW)**
  - Treatment: Vitrification, grout, steam reforming, and any other approaches identified by DOE
  - Pre-Treatment: Further processing to remove long-lived constituents, esp. Tc-99 and I-129
- **Approaches are to be analyzed for:**
  - Risks related to treatment and disposal
  - Benefits and costs
  - Schedule
  - Compliance with CERCLA, RCRA, CWA, and CAA
  - Any obstacles inhibiting DOE's ability to pursue the approach
- **Areas Not Analyzed Based on Section 3134**
  - Integrated HLW/LAW/SLAW Alternatives
  - Other "Feed Vector" Scenarios

Cases Analyzed

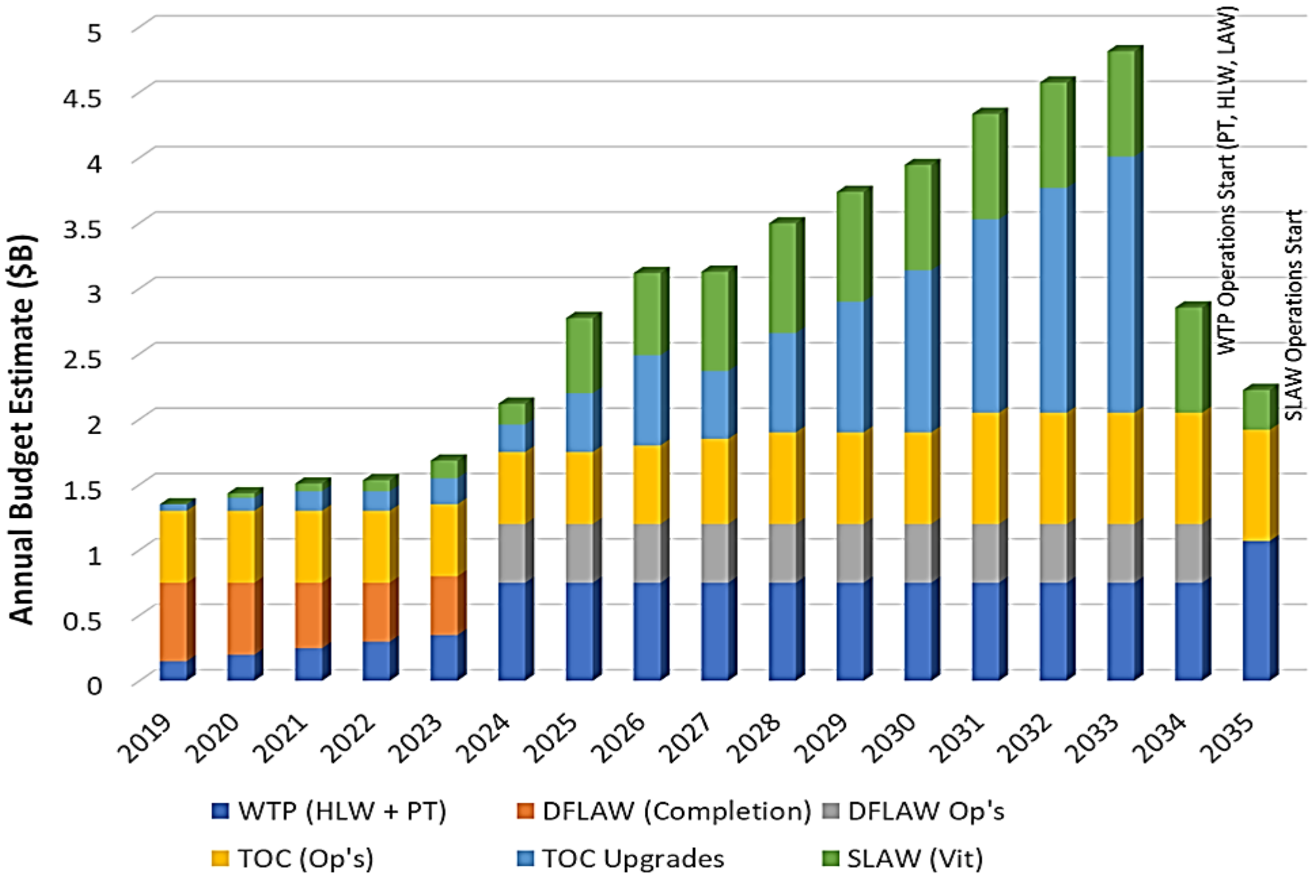
- **22 Initial Cases Reduced to 5:**

Five Cases Analyzed	Primary Waste Disposal Facility	Secondary Waste Disposal Facility	Additional Pretreatment
Vitrification	Onsite	Onsite	None
Grouting Case 1	Onsite	Onsite	LDR organics
Grouting Case 2	Offsite (out-of-state)	Onsite	LDR organics
Steam Reforming Case 1	Onsite	Onsite	None
Steam Reforming Case 2	Offsite (out-of-state)	Offsite (out-of-state)	None

- **Cases Considered Onsite & Offsite Disposal**
  – Onsite: Hanford Integrated Disposal Facility (IDF)
  – Offsite: Waste Control Specialist (WCS), Andrews, Texas
- **Wasteform Performance Criteria**
  – Performance Evaluation for IDF
  – Existing Waste Acceptance Criteria (WAC) for WCS
- **Key Information Developed by the FFRDC Team:**
  – Performance Evaluation (PE)
  – Conclusions
  – Areas for Further Evaluation

Budget for SLAW Vitrification in Conjunction with Key Hanford Mission Facilities and Operations

- **Estimate Basis**
  - Class 5: -20/+50% to -30/+100%
  - FFRDC used:
    - *Capital -10% to +100%*
    - *Operations -20% to +20%*
- **Point Estimates Based on Analog Facilities**
  - WTP LAW, Saltstone, IWTU
- **External Risks Can Inflate Further**
  - Appropriation less than Baseline Assumptions
  - Fixed Caps
- **Low Range Vit used in Graph**
  - $20B Lifecycle, $750M/yr. Project



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Evaluation of Supplemental Low Activity Waste Treatment Options: Performance Evaluation and Other Options

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NAS Public Meeting
October 31, 2019

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Summary of Key Updates to Report

- Disposal Appendix, including Performance Evaluation
- Other Options-Hybrids
- Risk Assessment
- Added a more concise Executive Summary and renamed the previous "Overview"
- Added a more detailed comparison section and table
- Added more discussion of technical maturity
- Added more information on specific chemical and radiological composition of the feed vector
- Added reference for risk of tank leaks
- Added information on impacts to HLW vitrification of potential addition of cesium, iodine, and strontium removed from LAW
- Miscellaneous clarifications to technology descriptions (not covered today)
- Updated conclusions
  - Modified conclusion on cost differences
  - Added conclusion statement on secondary wastes
  - Removed conclusion that no technology was best in all categories evaluated
  - Selected editorial changes
- Updated key areas for further study

Finding 3-2: Access to IDF PA or PE Data and Analysis; Waste Degradation Models and Mechanisms

- **2017 IDF PA made available August 2019**
- **PE data and analysis was included in Appendix F. Additional references to source data have been provided, including reference to specific sections of IDF PA**
- **Expanded discussion of degradation models and mechanisms and technical bases, with references in Appendix F, Section F.4.3.3**
  - Glass Dissolution and Release Mechanism
    - *Provides the technical basis for Hanford-based approach used in EIS, 2017 IDF PA, and NDAA PE.*
    - *Describes GRAAL approach relative to Hanford*
  - Grouted Wasteform Release Mechanism
    - *Provides the technical basis for use of intrinsic diffusion coefficient in combination with a distribution coefficient (Kd) based on experimentally derived effective diffusion coefficients,*
    - *Consistent with approach used in IDF PA.*
  - Steam Reforming Mineral Release Mechanism
    - *Provides the technical basis for use of diffusion coefficient in combination with a distribution coefficient (K_d) assuming a geopolymer-encapsulated granular mineral waste form*
    - *Insufficient data existed for parameterizing a dissolution release approach*
- **Also Addresses:**
  - Recommendation 2-1: How effective is each waste form in immobilizing the waste…and over what time periods?

Finding 3-3: Committee is unable to assess the potential significance of mobile, long-lived fission products

- **2017 IDF PA made available August 2019**
- **Added fig. F-5 – key radionuclides from 2017 IDF PA (Fig. 6-108)**
- **If Se-79 inventory was in a SLAW grout**
  - Time to peak (~78,000 yr) driven by vadose zone Kd
  - Peak groundwater concentration significantly below DWS

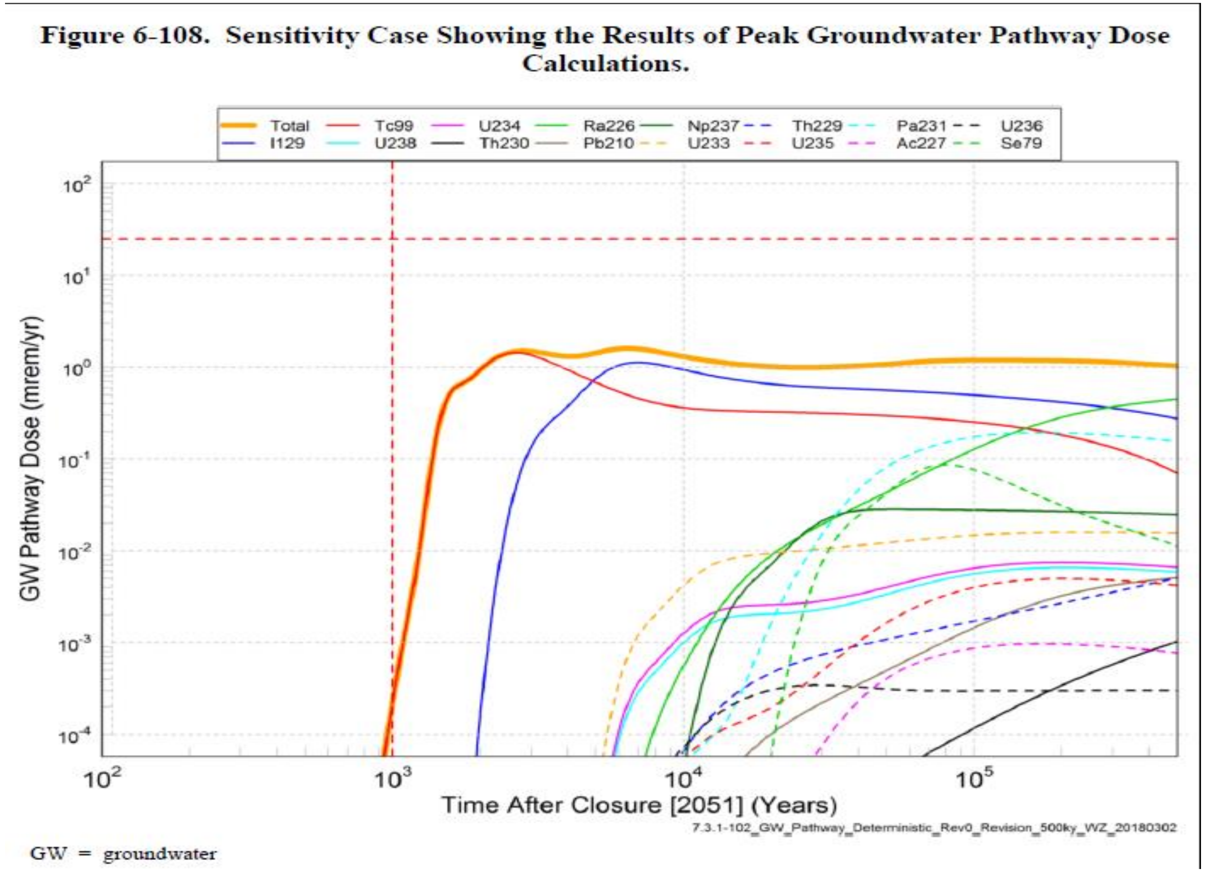

Figure F-5 Impacts to Groundwater of Key Radionuclides from the 2017 IDF PA

- **Also Addresses:**
  - Recommendation 2-1: Determining how much and what type of pre-treatment is needed….other long-lived radionuclides, such as selenium-79, may be relevant.

Recommendation 2-1: Determining how much and what type of pre-treatment is needed – Tc-99 and I-129

- **Analysis Results provided in Tables F-20, F-21, and F-22 show peak groundwater concentrations resulting from projected inventories of Tc-99 and I-129 in each waste form**
- **Treatment targets for are readily calculated from information in this table based on linear relationship between peak flux and peak groundwater concentration**

Radionuclide	Preliminary Treatment Requirement (% removal) [1]	Revised Treatment Requirement: PE Results (% removal)
Tc-99	92%	56% [2]
I-129	50%	91% to 96% [3]

[1] From Sect. 3.1.1.3 & 3.1.1.4, to meet DWS (maximum contaminant level) based on LSW grout from 2017 IDF PA

[2] Based on low performing SLAW grout results documented in App. F, performance evaluation

[3] Based on high and low performing SLAW grout results, respectively documented in App. F, performance evaluation

Recommendation 4-1: Other Options—Provide the springboard for serious consideration of adopting an approach of multiple, parallel, and smaller scale technologies

- Table 10, Section 3.5 included an option for "Modular Processing of Tank Waste – tailored to specific tanks, farms, or processing areas"
- Added new paragraph in Section 3.5 to highlight the potential benefits of a hybrid alternative approach
- The hybrid option does not address the entire SLAW feed vector, therefore it was not considered as a primary option consistent with the NDAA charge

Other Comments: Risk Assessment (pages 18-19)

- **Clarification added to risk assessment on the types of risks evaluated and the limitations of the risk assessment**
  - Improved explanatory narrative
  - Clarified risk types
    - *Estimating uncertainties*
    - *Programmatic Risks – Focus of Appendix E*
    - *System Risks*

Other Comments: Performance Evaluation

- **F 5-2: "Follow-on opportunity for DOE to engage with its regulators and stakeholders to identify performance standards based on existing regulatory requirements for waste form disposal…"**
  - Added discussion of LAWABP1 reference glass used in EIS and earlier SLAW Risk Assessment, including projected groundwater impact relative to glasses evaluated in this study (addressing WA State public comment)
  - Clarified potential for improvements in SSW form performance, and basis for parameter values used in this study (addressing questions regarding
- **Chapter 2, p. 31: "What other near-field geochemical or hydrologic processes (e.g., solubility limits or sorption) slow the release and/or decrease the mobility of radionuclides?"**
  - 2017 IDF PA documents near- and far-field processes and parameters. PE used PA-parameter set
- **Chapter 2, p. 31: "How do assumptions about future conditions, e.g., climate or the geologic medium, affect the PA results?"**
  - 2017 IDF PA, App. A addresses a broad set of features, events, and processes. PA base case basis was used for the PE

Other Comments (continued):

- **Chapter 2, p. 31: "How do the principal components in the IDF interact with one another?... Such as the effect of grout.. Interacting with the glass?"**
  - Section F.4.3.2 communicates that "Potential interactions from the adjacent emplacement of different wasteforms were not simulated in the PA or PE, but potential impacts of intermingled wasteforms have been acknowledged and will be evaluated in lysimeter studies at Hanford (Bacon, et al., 2018)." In addition, "it is assumed that operational vs. wasteform release tradeoffs will be assessed in future performance assessments and that the IDF can accommodate separation of dissimilar wasteforms."
- **Chapter 2, p. 30: ".. report does not provide an explanation or analysis of the materials (getters) that would be used."**
  - Getters used in prior studies that provided basis for best performing grouts were specified in section F.4.3.4 and Table F-16, with reference to source documentation.
- **Chapter 3, p. 39: "The possibility of moving these two radionuclides (Tc & I) into the high-level waste (HLW) stream was not evaluated by the FFRDC in the report."**
  - Tc & I removal was considered as a risk mitigation (App. E) and considered either offsite disposal of separated Tc & I or immobilization in the HLW stream. While not evaluated in detail, the team generally concluded that offsite disposal was more cost effective and lower technical risk option.

Other Comments (continued):

- **Chapter 3, p. 41: "Not clear how the FFRDC used the available literature in its analysis … waste form performance."**
  - Added more complete literature references and discussion in "Wasteform Performance" section of App. F.

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Key Updates, Conclusions, & Areas for Further Study

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New Executive Summary and High Level Table

NDAA CRITERIA	VITRIFICATION CASE: DISPOSAL ONSITE AT HANFORD	GROUTING CASE 1: DISPOSAL ONSITE AT HANFORD	GROUTING CASE 2: DISPOSAL OUT OF STATE AT WASTE CONTROL SPECIALISTS (WCS)	STEAM REFORMING CASE 1: SOLID MONOLITH PRODUCT DISPOSAL ONSITE AT HANFORD	STEAM REFORMING CASE 2: GRANULAR PRODUCT DISPOSAL OUT OF STATE AT WCS
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

New Comparison Section

Parameter	Primary Waste Form: Vitrification	Primary Waste Form: Grout	Primary Waste Form: Steam Reforming
Pretreatment Required[1]	No	Yes - LDR Organics	No
Expected pretreatment system	None needed	Oxidative treatment system	None needed
Feed System	Blends glass former chemicals and sugar with waste	Blends grout chemicals with waste	Blends clay with waste
Immobilization	Joule-Heater Slurry Fed melter	Grout mixer	Heated fluidized Bed
Auxiliary Systems for Immobilization	Air for bubblers and pressure control Cooling water for melter electrodes and melter components Temperature monitoring for melter components	NA	Pre-heated steam Coal addition system Nitrogen, air, and oxygen feeds
Offgas System	Film Cooler Submerged Bed Scrubber Steam Atomized Scrubber Heater HEPA Activated Carbon Bed Heat Exchanger Thermal Oxidizer Selective Catalytic Reducer Caustic Scrubber Blower Stack	Heater HEPA Activated Carbon Bed Blower Stack	Offgas Filter Thermal Oxidizer Cooler Activated Carbon Bed Wet Scrubber Heater HEPA Blower Stack
Liquid Effluent Recycle Process	Hold Tank Caustic Adjustment Tank Evaporator Concentrate Hold Tank Evaporator Condensate Hold Tank Bypass Line to Tank Farm with Inhibitor Addition Systems	Flush Hold Tank	Hold Tank
Product Packaging	Molten glass poured into stainless steel container Inert Fill System Capping Station Container Decon and swabbing Buffer Storage	Liquid Feed Slurry poured into PolyBag in a transport box Container Decon and swabbing Buffer storage	Granular solids fed into polybag in a transport box Container Decon and swabbing Buffer storage

New Comparison Section

Parameter	Primary Waste Form		
	Vitrification	Grout	Steam Reforming
Projected Primary Waste Volume	~0.4X feed volume	~1.8X feed volume	~1X feed volume
Immobilization unit operation vessel size (Length, Width, Height)	Outside Dimensions: 31'X22'X16' Melt Chamber: 16'X6.8'X2.5' 4 melters	18'X4'X4' 1 grout mixer	Outside Diameter: Up to 11' (estimated) Outside Height: Up to about 35'2 steam reformers 2 steam reformers
Single Pass Retention of Tc-99/I-129	40 / 10	100/100	83/88
Waste form Density (kg/m^3)	2800	1770	800

New Comparison Section

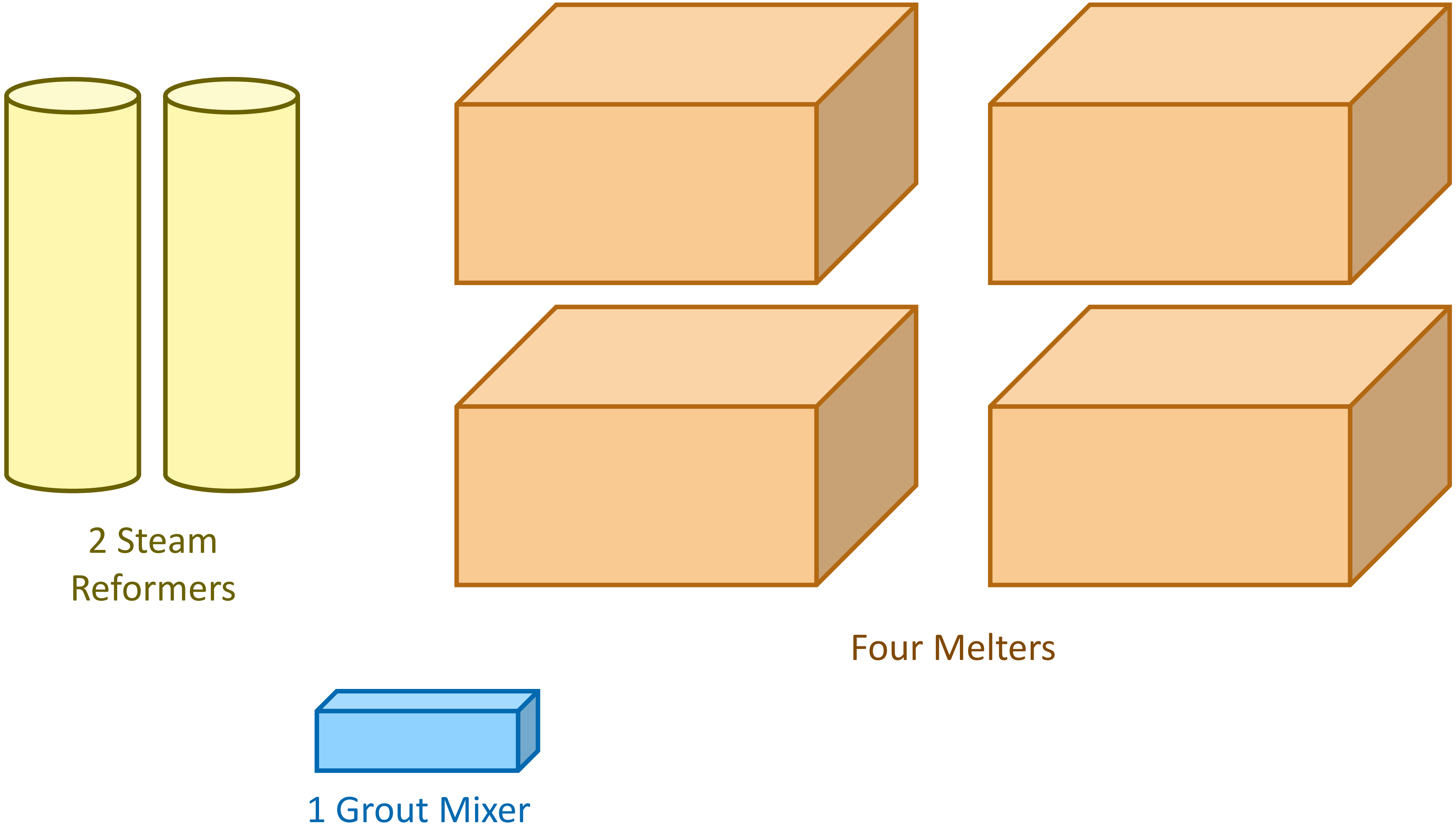
Parameter	Primary Waste Form		
	Vitrification	Grout	Steam Reforming
Immobilization	Joule-Heater Slurry Fed melter	Final waste container	Heated fluidized Bed
Immobilization Temperature	1150 Celsius	Ambient Temperature	~700 Celsius
Gases Emitted by Immobilization Process	Gas species that are volatized from the feed or produced during vitrification including steam, NO_x, N_2, CO, CO_2, H_2, and incompletely oxidized organic compounds such as acetonitrile), other acid gases (including chlorides, fluorides, and SO_x), and higher volatility elements including Hg, Tc-99 and Cs-137 that are not efficiently captured in a single pass in the melter. The melter offgas also contains entrained particulate matter.	Ammonia	Gas species that are volatized from the feed or produced during steam reforming including steam, NO_x, N_2, CO, CO_2, H_2, incompletely oxidized organic compounds, other acid gases (including chlorides, fluorides, and SO_x), and higher volatility elements including Hg, Tc-99 and Cs-137 that are not completely captured in a single pass in the steam reformer. The offgas also contains fluidizing steam, injected N_2 and O_2, and entrained particulate matter.
Secondary Liquid Waste	~3X feed volume	None	None
Secondary Solids Waste	Rad-con control waste Failed equipment Spent bubblers Spent melters Spent carbon absorbent Spent HEPA filters Solids from liquid secondary waste	Rad-con control waste Failed equipment Spent carbon absorbent Spent HEPA Filters	Rad-con control waste Failed equipment Spent carbon absorbent Spent HEPA Filters
Tc-99 assumed on HEPA filters	8 curies	0.8 curies	8 curies
I-129 assumed on Carbon Bed	3 curies	0.03 curies[12]	0.3 curies

New Comparison Section

Parameter	Primary Waste Form		
	Vitrification	Grout	Steam Reforming
Impact of cold shutdown	• Feed line flush required • Replace melter	• System flush required • Immediate restart is possible	• Cool-down requires 2-3 days • Restart requires gradual heat-up over 7 to 14 days
Impact of idling	• Semi-volatiles lost • Increased loading on HEPA filters • Lower waste loading achievable	• NA	• NA
Impact of feed turn down	• Increased loss of semi-volatiles if cold cap coverage not maintained • Increased loading on HEPA filters • Lower waste loading achievable	• NA	• NA
24 hr operation required to meet production rate or prevent adverse process impacts?	• Yes	• No	• Yes

New Comparison Section: Process Size

Each melter and SR will have its own feed and offgas system



The size of the primary containment structure is a major factor in nuclear facility costs.

Technical Maturity Comparison

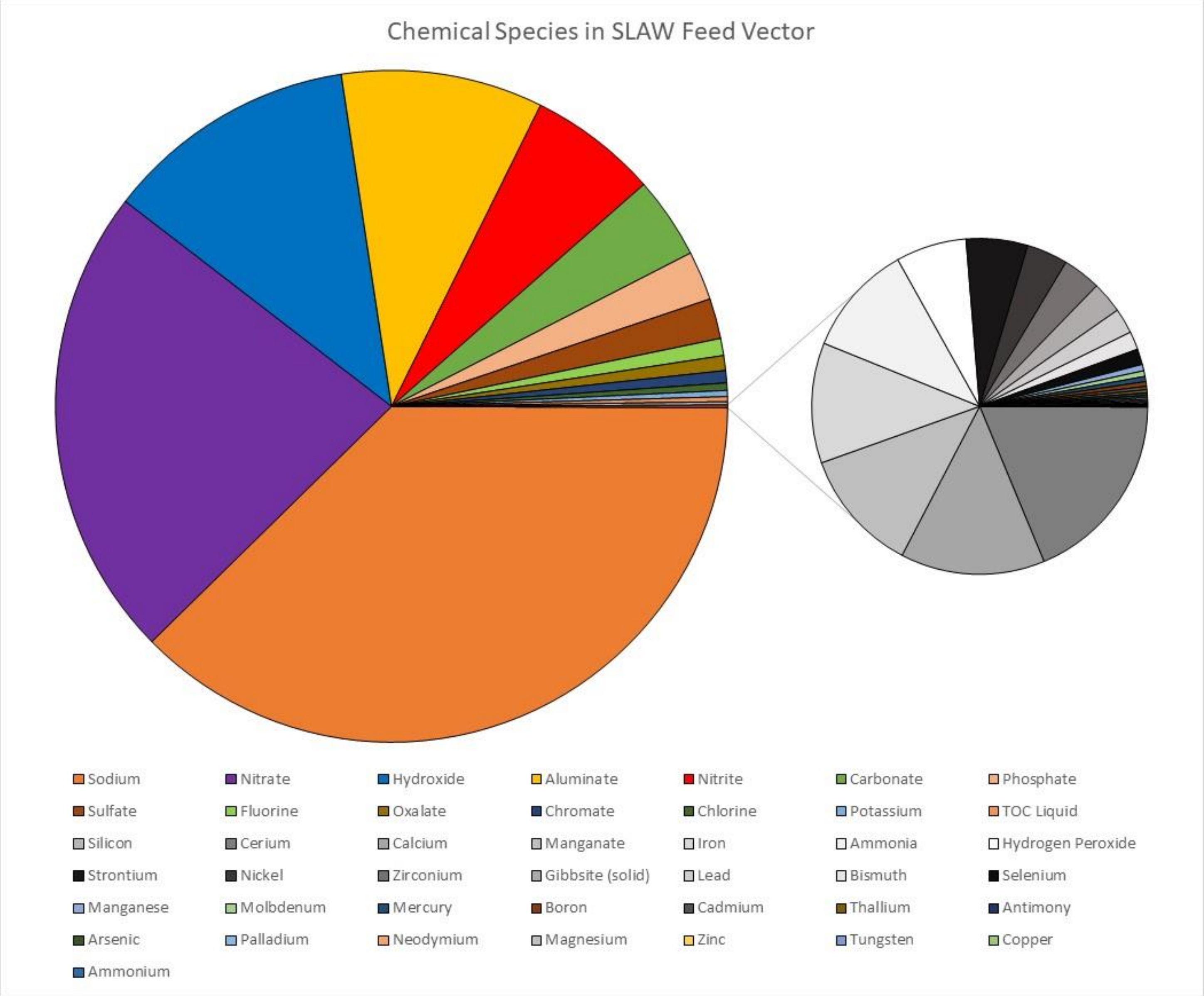
- **While the guidelines in the U.S. Department of Energy Office of Environmental Management Technical Readiness Assessment (TRA) /Technical Maturation Plan (TMP) Process Implementation Guide was utilized to aid the comparison, numerical values were not assigned.**

Vitrification	Grout	Steam Reforming
It is assumed that testing for the WTP LAW vitrification process would be directly applicable to the SLAW vitrification process. Laboratory scale testing has been performed with simulants and samples of the tank waste for all unit operations in the WTP process to vitrify the LAW. Extensive pilot scale testing has been performed for the WTP LAW melter and melter offgas systems at VSL. Vitrification has been utilized for HLW at SRS and West Valley.	Laboratory scale testing has been performed using simulants and tank waste. Limited pilot scale studies have been performed with simulants. Vitrification has been utilized for LAW at SRS and West Valley. Treatment of LDR organics has been performed on other types of wastes, but is not tested on Hanford wastes or simulants.	Laboratory scale testing has been performed using simulants and tank waste. Limited pilot scale studies have been performed with simulants. A steam reforming facility (the IWTU) has been constructed and tested with simulants during startup operations for immobilization of sodium bearing waste at INL – but with some different waste characteristics and treatment and performance requirements than for Hanford SLAW. Steam reforming is used to treat commercial radioactive wastes at the ResinSolutions Facility – but with some different waste characteristics and treatment and performance requirements than for Hanford SLAW.

Feed Vector Composition Details: Chemical Species

Species (mg/L)	AVERAGE	Maximum	Minimum
Sodium	1.80E+05	2.08E+05	1.29E+05
Nitrate	1.09E+05	1.75E+05	2.95E+04
Hydroxide	5.83E+04	1.20E+05	1.56E+04
Aluminate	4.66E+04	1.06E+05	1.03E+04
Nitrite	2.97E+04	5.82E+04	5.17E+03
Carbonate	1.89E+04	4.48E+04	3.66E+03
Phosphate	1.13E+04	4.01E+04	2.73E+03
Sulfate	9.27E+03	3.19E+04	1.46E+03
Fluorine	3.96E+03	1.85E+04	5.44E+02
Oxalate	3.44E+03	1.41E+04	9.71E+02
Chromate	2.82E+03	1.08E+04	6.32E+02
Chlorine	1.73E+03	3.50E+03	4.22E+02
Potassium	1.41E+03	7.18E+03	2.96E+02
Total Organic Carbon	1.16E+03	1.46E+04	1.97E+02
Silicon	7.40E+02	2.56E+03	1.93E+02

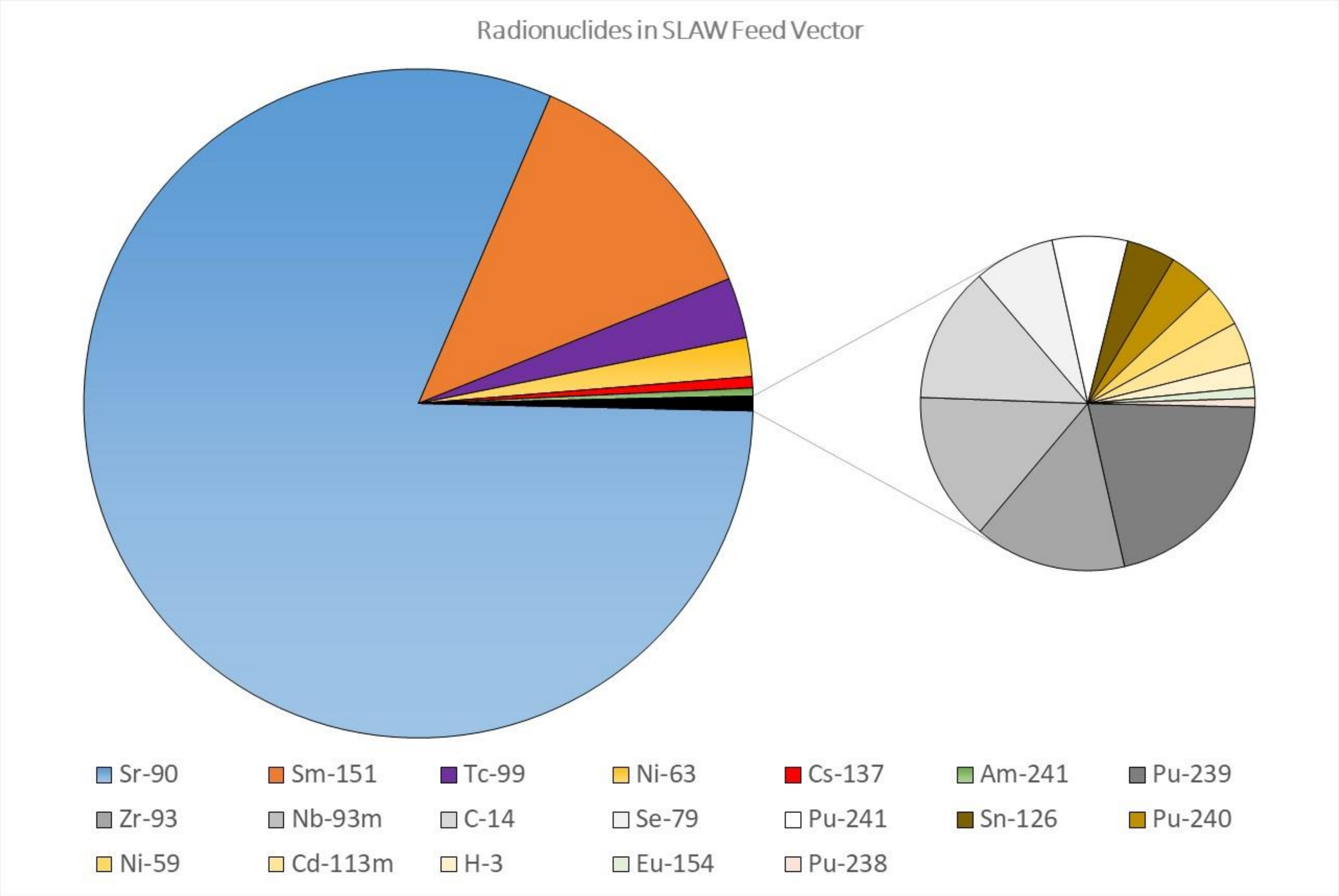
Feed Vector Composition Details



Feed Vector Composition Details: Radionuclides

Radionuclide (mCi/L)	AVERAGE	Maximum	Minimum
90-Sr	1.5E+00	2.2E+01	6.0E-01
151-Sm	2.3E-01	2.4E+00	2.7E-03
99-Tc	5.4E-02	6.0E-01	1.7E-02
63-Ni	3.5E-02	4.8E-01	3.1E-03
137-Cs	1.0E-02	1.2E-01	1.4E-03
241-Am	7.2E-03	1.0E-01	4.9E-04
239-Pu	2.8E-03	1.4E-02	6.2E-04
93-Zr	1.9E-03	2.5E-02	1.8E-04
93m-Nb	1.9E-03	2.4E-02	1.9E-04
14-C	1.7E-03	5.9E-03	4.9E-04
79-Se	1.0E-03	3.5E-03	2.0E-04
129-I	5.4E-05	2.0E-04	1.2E-05

Feed Vector Composition Details



Feed Vector Composition Details: SLAW Comparison to SRS Saltstone

Parameter	SLAW	Saltstone	Units
Sodium	1.80E+05	1.32E+05	mg/L
Nitrate	1.09E+05	1.19E+05	mg/L
Hydroxide	5.83E+04	3.38E+04	mg/L
Aluminate	4.66E+04	1.71E+04	mg/L
Nitrite	2.97E+04	2.60E+04	mg/L
Carbonate	1.89E+04	1.63E+04	mg/L
Phosphate	1.13E+04	3.74E+02	mg/L
Sulfate	9.27E+03	4.49E+03	mg/L
Fluorine	3.96E+03	<1.0E+02	mg/L
Oxalate	3.44E+03	5.04E+02	mg/L
Chromate	2.82E+03	1.14E+02[3]	mg/L
Chlorine	1.73E+03	5.04E+02	mg/L
Potassium	1.41E+03	4.59E+02	mg/L
Total Organic Carbon	1.16E+03	2.1E+02	mg/L
Silicon	7.40E+02	1.86E+01	mg/L
Mercury	3.0E+02	6.7E+01[1]	mg/L
90-Sr	1.5E+00	5.71E-02	mCi/L
151-Sm	2.3E-01	<4.11E-05	mCi/L
99-Tc	5.4E-02	4.61E-02	mCi/L
63-Ni	3.5E-02	<7.52E-08	mCi/L
137-Cs	1.0E-02	7.91E-01	mCi/L
129-I	5.4E-05	3.33E-05	mCi/L

Risks from Prolonged Storage of Hanford Tank Waste

- **Risks related to continued storage of waste in the Hanford tank farms is addressed in System Plan 8, Section 7.0**
  - References to this risk section in the System Plan have been added
- **This risk is not substantially addressed by the FFRDC report**
  - HLW and LAW process are linked and the SLAW study does not address the length of the HLW mission.
  - Expediting cleanup would need to evaluate the ability of the tank farms to support the needed retrieval rates.
  - The NDAA explicitly directed to evaluate the SLAW feed as defined at the time of the NDAA enactment
    - *(a) IN GENERAL.—Not later than 60 days after the date of the enactment of this Act, the Secretary of Energy shall enter into an arrangement with a federally funded research and development center to conduct an analysis of approaches for treating the portion of low-activity waste at the Hanford Nuclear Reservation, Richland, Washington, that, as of such date of enactment, is intended for supplemental treatment.*

HLW Impacts of Radionuclides Removed from LAW

- I-129 would be difficult to incorporate into the HLW glass and much of the I-129 sent to HLW could end up captured on the silver mordenite column, potentially impacting the sizing of that column and leading to the I-129 being in the HLW secondary waste.
- Tc-99 would have little impacts on HLW processing, but the low single pass retention would lead to a flywheel around the HLW and technetium removal process.
- Sr-90 would be readily incorporated in the HLW glass, but impacts on waste loading are possible depending on the amount of titania added.

It is not certain that radionuclides removed from LAW would be sent to HLW.

Updates to Conclusions

- **Modified conclusion on cost differences**
  – Grouting and steam reforming offer significant cost benefits over vitrification. Grout is the least expensive option, with FBSR and vitrification options ranging 2.5 to 5X and 4 to 10X higher, respectively, which is comparable to recent Government Accounting Office reporting.
- **Added conclusion statement on secondary wastes from vitrification**
  – Secondary waste generated from vitrification will require additional wasteform development and treatment capabilities.
- **Removed conclusion that no technology was best in all categories evaluated**
  ~~– No technology was evaluated highest in all NDAA17 study criteria.~~
- **Updated grout and SR onsite disposal pretreatment conclusions to be more precise**
  – Technetium removal is not needed for onsite disposal of grouted or steam reformed wasteforms, assuming high performing grouted and steam reformed wasteforms.
  – Iodine removal is not needed for onsite disposal of grouted or steam reformed wasteforms, assuming best performing grouted and high performing steam reformed wasteforms.

Final Conclusions

- A viable SLAW treatment and disposal option can be developed for each of the three technologies evaluated (vitrification, grouting, and steam reforming).
- For grouting, both onsite and out-of-state disposal will likely require treatment of select LDR organics if found in the waste, and additional flowsheet studies will be needed to define that LDR treatment.
- Removal of technetium and iodine is not needed for out-of-state disposal of grouted or steam reformed wasteforms.
- Technetium removal is not needed for onsite disposal of grouted or steam reformed wasteforms, assuming high performing grouted and steam reformed wasteforms.
- Iodine removal is not needed for onsite disposal of grouted or steam reformed wasteforms, assuming best performing grouted and high performing steam reformed wasteforms.
- Grouting and steam reforming offer significant cost benefits over vitrification. Grout is the least expensive option, with FBSR and vitrification options ranging 2.5 to 5X and 4 to 10X higher, respectively, which is comparable to recent Government Accounting Office reporting.
- A near-term decision on SLAW treatment technology is needed to meet DOE mission completion goals.
- Implementing any of the SLAW treatment technologies will exceed current funding levels when combined with required spending for all WTP and tank projects concurrent with SLAW treatment.
- Secondary waste generated from vitrification will require additional wasteform development and treatment capabilities.

Key Areas for Further Study

- Treatment of organics restricted from land disposal (onsite and offsite grout cases)
- Treatment of technetium and iodine (onsite grout case)
- Treatment of secondary wastes (vitrification case)
- Performance of grouted waste forms (onsite grout case)
- Performance of steam reformed waste forms (onsite SR case)

Key Areas for Further Study: Pretreatment

- **Treatment of organics restricted from land disposal (onsite and offsite grout cases)**
  - Verification of organics in tank waste
  - Applicable treatment for the organics in tank waste
  - Some of the organics noted in the vapor space studies are resistant to low temperature treatment methods
- **Treatment of technetium and iodine (onsite grout case)**
  - Technetium treatment has been extensively evaluated for Hanford tank wastes
    - *Technology selection*
  - Iodine treatment
    - *Process development required*

Key Areas for Further Study: Secondary Wastes

- **Treatment of secondary wastes (vitrification case)**
  - Composition of liquid secondary wastes exceeds some waste acceptance criteria for the LERF-ETF facility
  - Disposal of encapsulated solid waste is a main source of releases from IDF
    - *Iodine releases may require mitigation*
  - These issues apply to 1st LAW as well as SLAW vitrification
    - *Resolution of these issues is ongoing for 1st LAW*

Key Areas for Further Study: Primary Wasteforms

- **Performance of grouted waste forms (onsite grout case)**
  – Verification of performance from laboratory scale tests, including scale-up of process
- **Performance of steam reformed waste forms (onsite SR case)**
  – Verification of performance from laboratory scale tests, including scale-up of process

Backup Slides

Miscellaneous Updates

- **More detail on wasteform volume estimates**
- **Numerous clarifications and minor updates to address NAS comments**
  - Clarification of risks and schedule/costs uncertainties
- **More information on risks due to funding levels**
- **Acknowledgement of hybrid approaches**