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Feed Qualification for New Streams to DWPF

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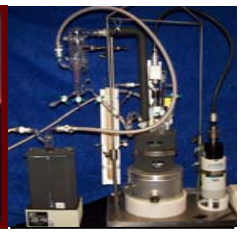

EM Waste Processing Technical Exchange

EM Office of Environmental Management
safety ❖ performance ❖ cleanup ❖ closure

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Presentation Outline

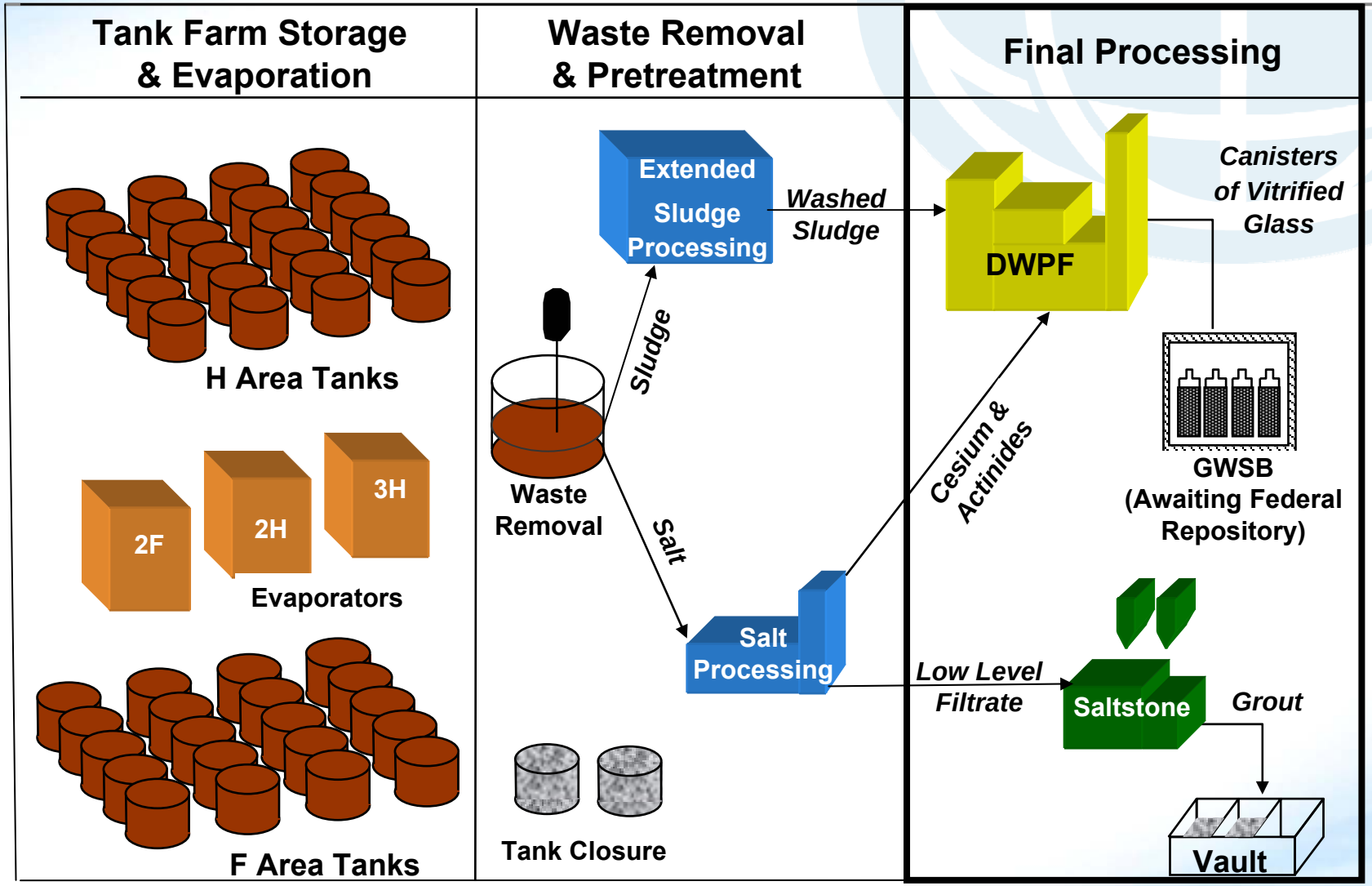
Overview of High Level Waste System

Considerations for Qualification

Qualification Process

- **Flowsheet Testing**
- **Glass Formulation and Processing Impacts**
- **Radioactive Sample Characterization & Verification**

High Level Waste System



DWPF Feed Streams

HLW Sludge

- Bulk waste removal and tank closure
- Extended sludge processing

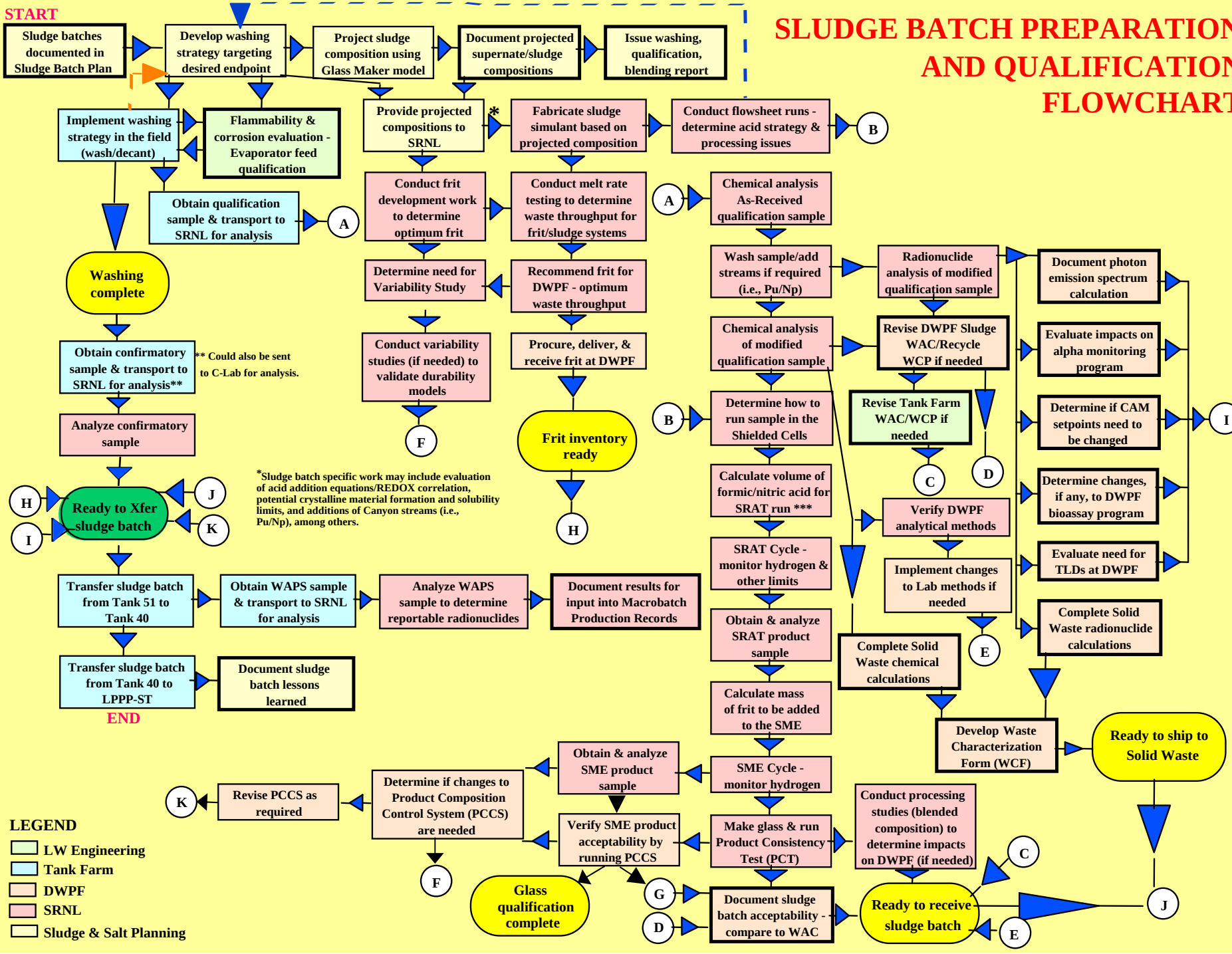
Salt Streams

- Cs and actinides
- Modular Caustic Side Solvent Extraction (MCU) and Actinide Removal Process (ARP) currently
- Salt Waste Processing Facility (SWPF) in the future
- Small Column Ion Exchange (SCIX) for enhanced salt throughput

Other Streams

- Tank 48 Steam Reforming product
- Tank chemical cleaning products
- Excess materials from Nuclear Materials Processing

SLUDGE BATCH PREPARATION AND QUALIFICATION FLOWCHART



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Considerations for Qualification

Where/when will the stream be added?

- During sludge batch preparation
- To the DWPF feed tank
- In the DWPF

What is the volume of the stream?

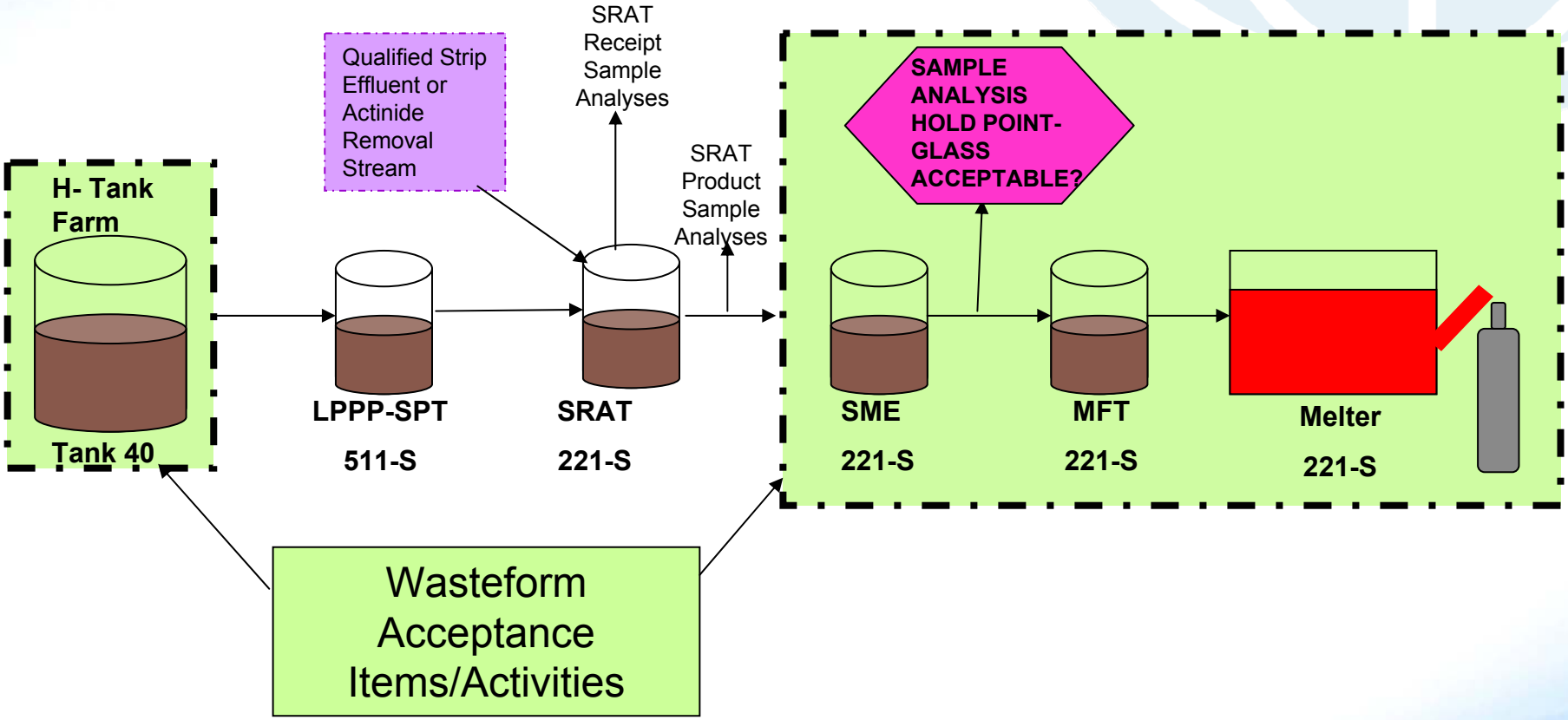
- Throughput and canister impact

What is the impact on the wasteform composition?

- No impact such as an organic
- Potential impact due to contribution >0.5 wt% to final composition such as titanium

Does the stream impact the DWPF feed preparation process or melter operation?

DWPF Process Overview



SRR Impacts Evaluation

Sludge & Salt Planning

- Projects impact on sludge batch composition, sludge washing strategy, and approximate batch mass

Tank Farm Engineering

- Evaluates impact on flammability/corrosion control program and evaporator feed qualification
- Revises Tank Farm Waste Acceptance Criteria (WAC)/ Waste Compliance Plan (WCP) as needed

DWPF Engineering

- Implements any necessary changes in flowsheet, analytical methods and in process control systems (PCCS)
- Revises WAC/WCP, Waste Qualification Report volumes, and Documented Safety Analysis (DSA) as needed

Steps Necessary to Qualify a New Stream

Feasibility assessment based on calculations/ assumptions

DWPF Flowsheet testing with simulants

- **Evaluate impact on acid addition/processing strategy using nominal process volumes or bounding quantities**

Glass formulation and processing impacts

- **Predict potential processing window and identify candidate frits**
- **Verify model acceptability/predictability and solubility limits**
- **Assess melter processing impact**

Radioactive sample characterization and verification

- **Characterize representative samples to meet requirements**
- **As necessary, demonstrate Tank Farm and DWPF processes**

DWPF Flowsheet Testing with Simulants

Develop simulant to match chemical & physical properties of particular batch of interest

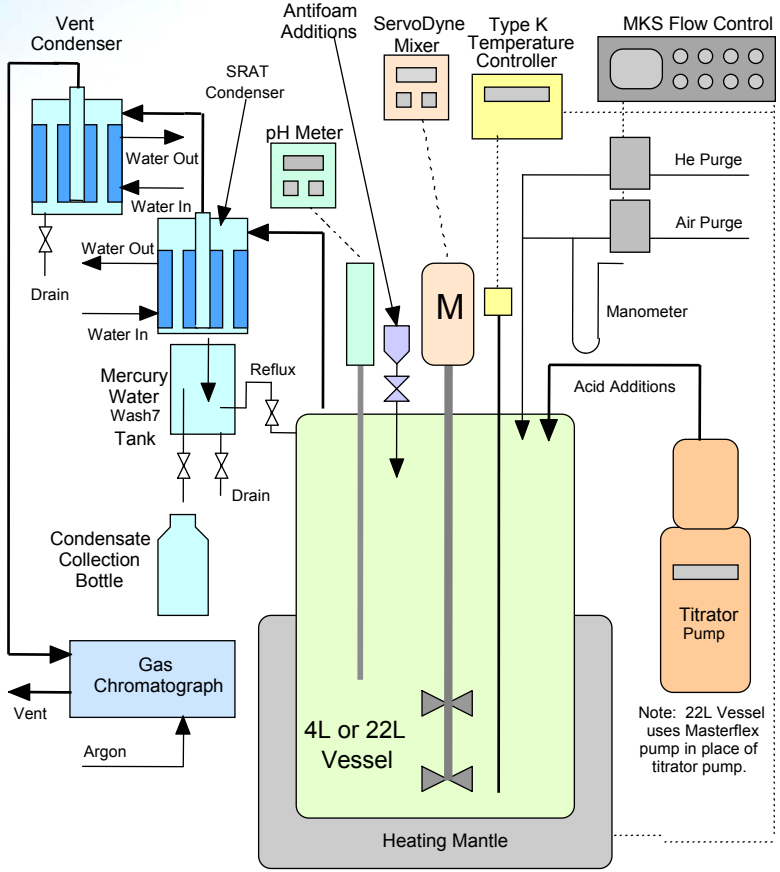
- If the new waste stream will be processed through the Tank Farm, add stream at the appropriate time in simulant production
- If added in DWPF, fabricate a separate simulant of the stream

Perform flowsheet testing in lab-scale SRAT vessel under design basis conditions to assess the impact

- Replicate incorporation process if simulant does not already contain the new stream
- Evaluate process chemistry – Hg stripping, redox control, hydrogen generation
- Assess slurry physical properties – foaminess, rheology
- Use data to assess impact on melter flammability

Ultimate objective is an operating window that meets DWPF WAC and safety limits

Lab-Scale SRAT Vessel

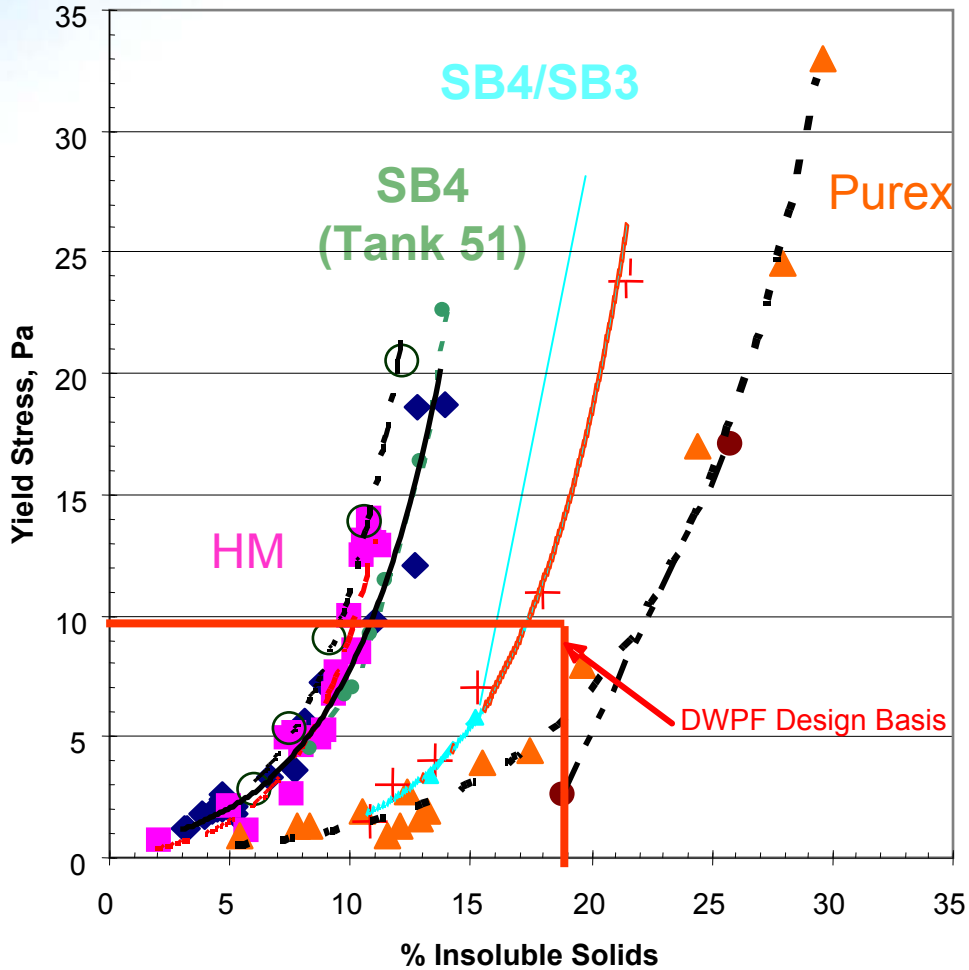


1L Shielded Cells Vessel

4L Simulant Testing Vessel

treams to DWPF

Sludge Rheology Variation



Sample	Yield Stress (Pa)	Total Solids (wt%)	Insol. Solids (wt%)
SB1a	1.4	18	N/A
SB1b	1.1	17	N/A
SB2	12	18.4	15.5
SB3 Qual	4.1	29.9	15.4
SB3 Blend	5.7	22.8	16.0
SB4 Qual	17	19.9	13.0
SB4 Blend	5.6	20.3	15.4
SB5 Qual	6.8	17.1	11.2
SB5 Blend	5.2	16.0	11.0

DWPF WAC Limits and Targets – Flowsheet Testing

Limit/Target	*Test*	*Limit/Target*	*Test*
NO_x Emissions	Flowsheet Testing (Rad as Necessary)	Corrosive Species	Rad Sample Characterization
Canister Heat Generation	Rad Sample Characterization	Glass Solubility Limits	Rad Sample Characterization & Glass Formulation
Gamma Shielding	Rad Sample Characterization	Sludge Solids Content	Rad Sample Characterization
Neutron Shielding	Rad Sample Characterization	Glass Quality & Processability	Glass Formulation
Inhalation Dose Potential	Rad Sample Characterization	Nuclear Criticality Safety	Rad Sample Characterization
H_2 Generation & N_2O Concentration	Flowsheet Testing (Rad as Necessary)	Radiolytic Hydrogen Generation	Rad Sample Characterization

Glass Formulation & Processing Activities

Assessments of glass processing window based on projected waste stream compositions, potential frits, and target waste loading

- **Includes expected variation and analytical uncertainty**

Verification of individual solubility limits (e.g. sulfate)

Glass variability study to demonstrate glass processing region acceptability and verify the applicability of the durability models

- **Region covers the expected range of mixtures of frit, sludge and salt processing effluents over a WL interval of interest**
- **Considers existing glass data and generates new glass data as necessary**

As required, melt rate testing to down-select frit and project potential DWPF waste throughput

Glass/Wasteform Performance Criteria

Process Related Constraints

- **Liquidus temperature, <1050°C**
- **Viscosity, 20 to 110 Poise at 1150°C**

Product Performance Criteria

- **WAPS Spec 1.3 - "Producer shall demonstrate control of waste form production by comparing production samples to the EA glass"**
  - DWPF implements using variability study to establish applicability of the correlation between PCT results and chemical composition
- **Glass homogeneity, controlled by Al_2O_3 and Alkali concentration**
- **Mitigate nepheline formation, controlled by nepheline discriminator**

DWPF WAC Limits and Targets – Glass Related Testing

Limit/Target	*Test*	*Limit/Target*	*Test*
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Radioactive Sample Characterization

Characterization of radioactive sample to meet facility and wasteform performance requirements

- **WAPS Spec 1.1.2 - report the oxide composition of the waste form for all elements present at >0.5 wt%**
  - SRNL analyzes samples to identify elements ≥1 wt%
- **WAPS Spec 1.2.2 - provide estimate of the inventories of individual reportable radionuclides**
  - SRNL reports radionuclides that have half lives >10 years and that constitute at least 0.01% (on a curie basis) of the total radionuclide inventory at some time between production and 1100 years out
- **WAPS Spec 1.6 - report the total and fissile U and Pu**
- **WAPS Spec 3.8 - report the estimated heat generation rate for each canister**
- **WAPS Spec 3.14 - maintain concentration of ≤ 2500 g/m^3 Pu in each canister**
  - Current limit is 897 g/m^3

Radioactive Sample Verification Testing

Demonstration of planned Tank Farm sludge washing and concentration

- **Impact if new stream is added during sludge preparation process**
- **Assists in identification of potential Tank Farm control or DWPF processing problems**

Demonstration of the DWPF SRAT/SME cycle

- **May be performed with all radioactive material or just one stream radioactive depending on what flowsheet testing with simulants shows**
  - Depends on the necessary scenario to bound the new stream processing
- **Provides necessary data for DWPF compliance**
- **Provides opportunity to identify potential processing issues before facility processing**

Fabrication of glass for durability testing when required

- **Verify DWPF durability model predictability/acceptability**

DWPF WAC Limits and Targets – Radioactive Testing

Limit/Target	*Test*	*Limit/Target*	*Test*
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Summary

DWPF Qualification process is set-up to allow the introduction of new streams

Early involvement in the evaluation allows potential downstream impacts to be assessed and minimized

- **Helps determine where and how to incorporate**
- **Assessments can range from paper studies to full system evaluation depending on complexity or volume of the stream**

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