Sludge Batch Preparations within the Tank Farm

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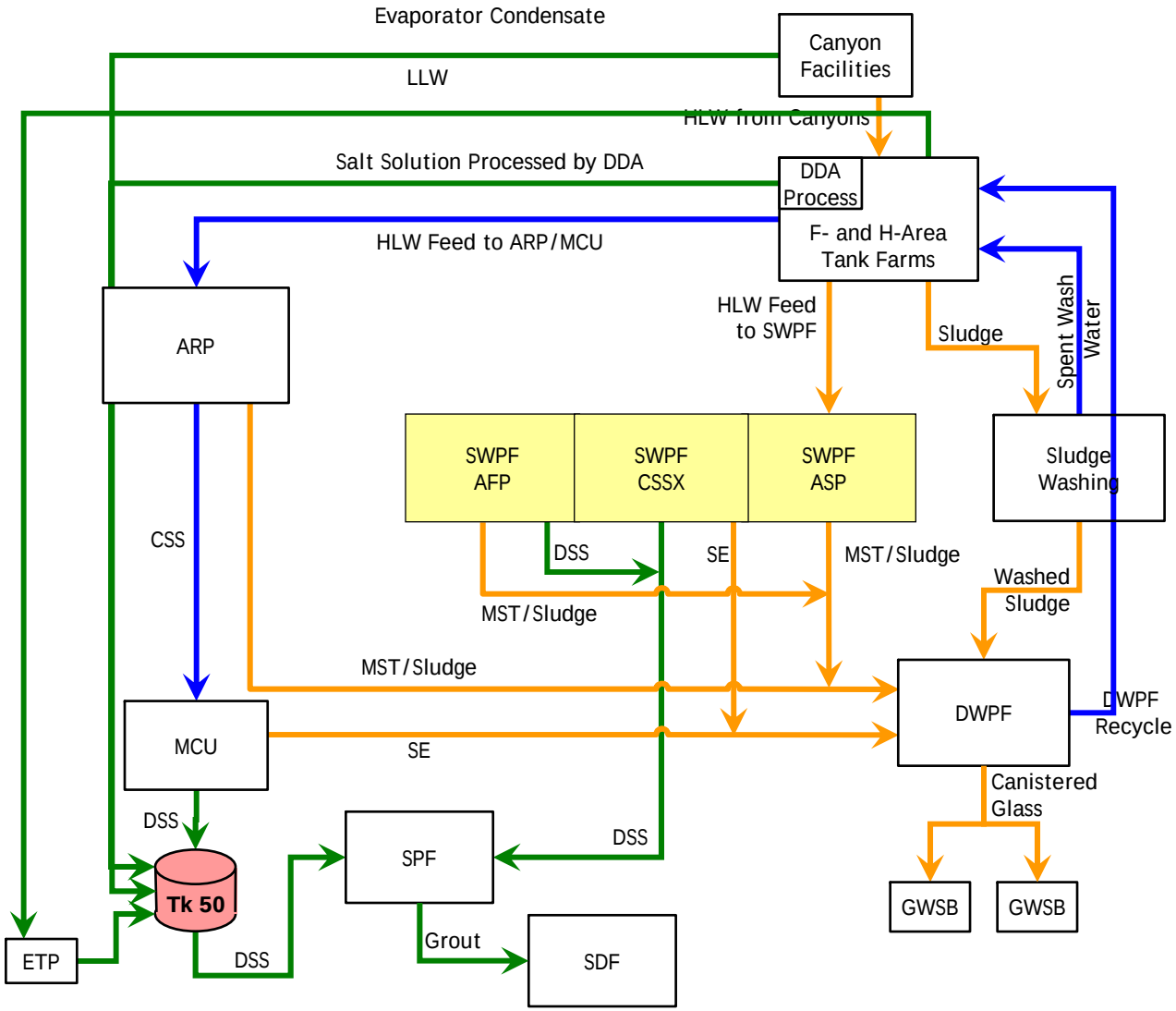
Agenda

- Liquid Waste System Overview
- Sludge Characteristics
- Sludge Batch Planning
- Sludge Batch Preparation Sequence
  - Aluminum Dissolution
  - Sludge Washing
  - Sludge Batch Qualification/Acceptance
- Questions

Liquid Waste Processing at SRS



ARP – Actinide Removal Process
AFP – Actinide Finishing Process
ASP – Actinide Strike Process
CSS – Clarified Salt Solution
CSSX – Caustic-side Solvent Extraction
DDA - Deliquification, Dissolution, and Adjustment
DSS – Decontaminated Salt Solution
DWPF – Defense Waste Processing Facility
ETP – Effluent Treatment Project
GWSB - Glass Waste Storage Building
HLW – High-Level Waste
LLW - Low-Level Waste
MCU - Modular CSSX Unit
MST – Monosodium Titanate
SE - Strip Effluent
SDF – Saltstone Disposal Facility
SPF – Saltstone Processing Facility
SWPF – Salt Waste Processing Facility

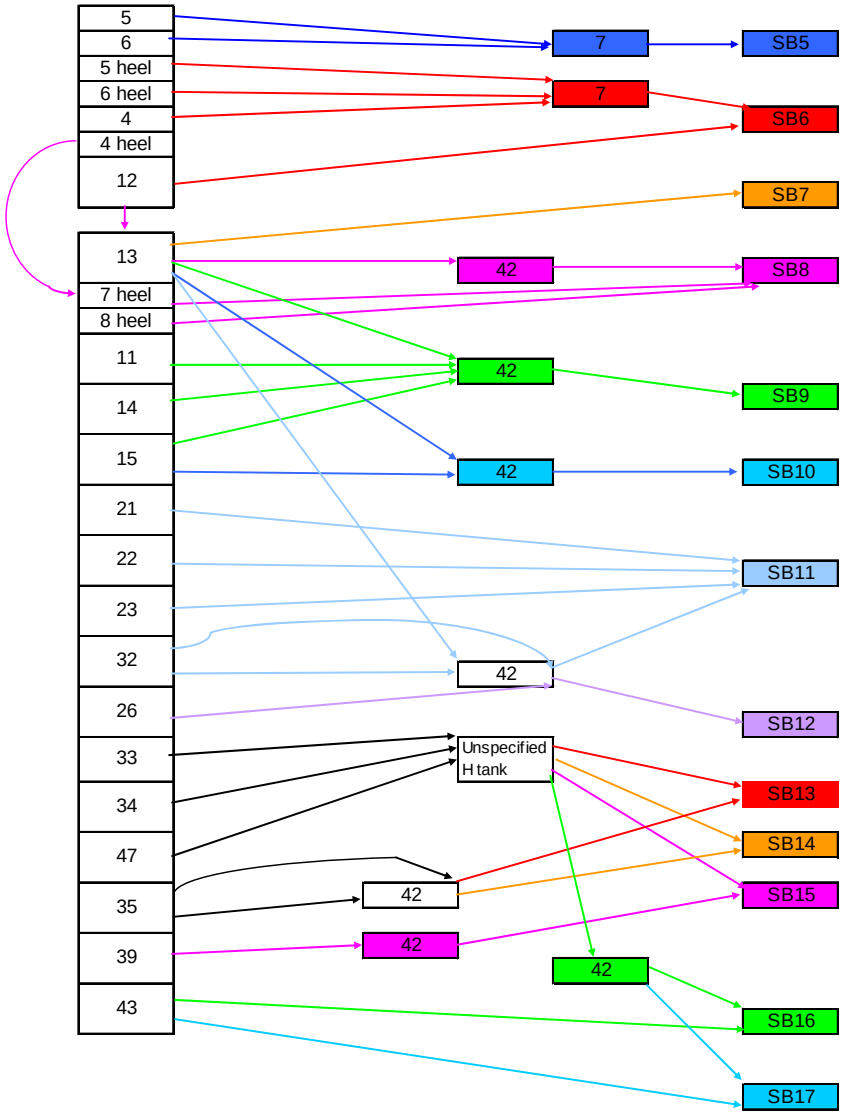
Sludge Characteristics

- Metal oxides and hydroxides from uranium and plutonium chemical separations
- Approximately 3 million gallons (~8% waste volume, ~48% waste activity)
  - Majority of sludge is contained in 12 tanks
- Two distinct process types geographically separated
  - PUREX sludge stored in F Tank Farm
  - HM sludge stored in H Tank Farm
- Specific gravity: solids 2-5, supernate 1 -1.4
- Sludge slurry solids concentration: 5-18 wt%
- Sludge slurry yield stress: typically < 10 Pa for transfers

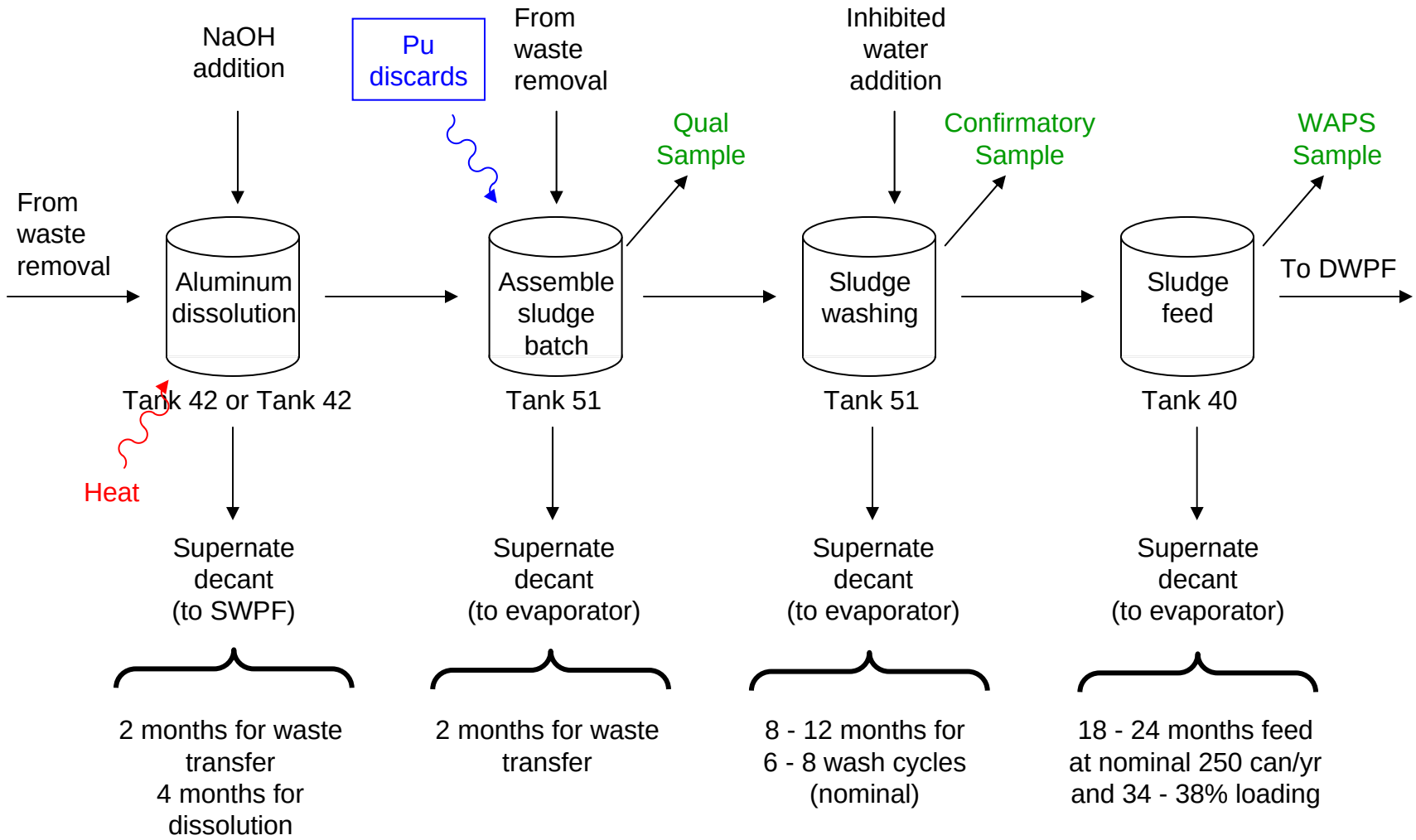
Sludge Batch Planning

- Tailored to achieve the following objectives:
  - Acceptable resultant glass quality as projected with the Glassmaker model
  - Amounts and combinations of sludge that result in reasonably efficient washing of the sludge
  - Combinations of sludge that provide efficiency and maximize waste loading and vitrification throughput
  - Produce sufficient batch size to support sustained vitrification operation while preparing next sludge batch
  - Supports meeting waste removal and waste tank closure commitments

Example Sludge Batch Plan

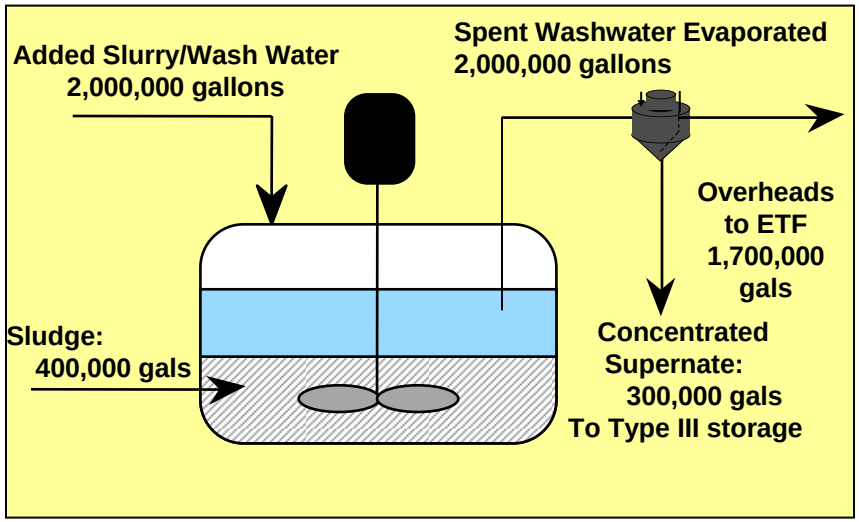


Sludge Prep Sequence

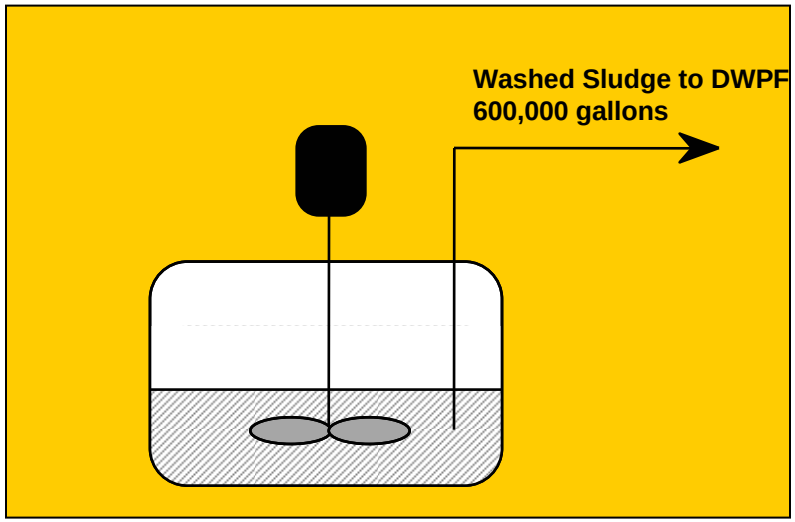


Sludge Prep Process Equipment

Tank 51 - Sludge Wash Tank



Tank 40 - Sludge Feed Tank

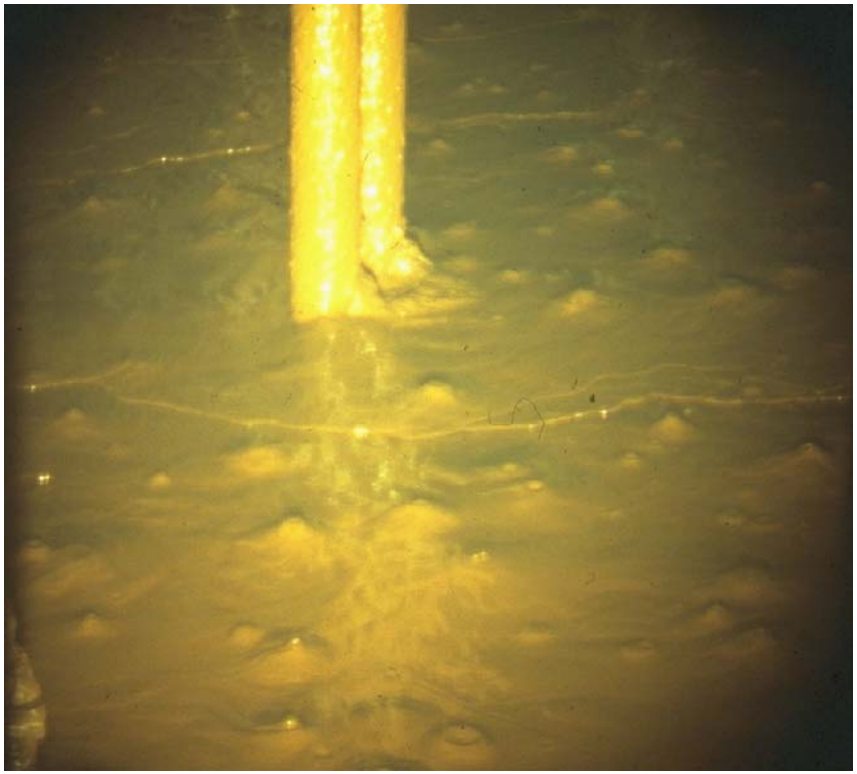


- Type IIIA waste tanks
  - Tank 51 or Tank 42 (sludge washing/aluminum dissolution)
  - Tank 40 (sludge feed)
- Four quad volute slurry mixer pumps (per tank)
- Inhibited water addition system
- Means for tank heating (aluminum dissolution)
- Caustic addition system (aluminum dissolution)
- Telescoping transfer jet for supernate transfers
- Telescoping transfer pump for sludge transfers

Aluminum Dissolution

- Volume Reduce Sludge Processed in DWPF.
- Reduce Total Number Glass Canisters Produced at DWPF
- Enable Present Sludge Loading in glass (Al impacts Glass Melt Liquidus Temperature, Melt Viscosity, etc.)
- Purex HAW and LAW, HM Low Activity waste --4 to 8 wt % Al
- HM HAW (Process Spent Fuel Assembly) -- 20 to 25 wt% Al
  - Current Batch (Tank 12) ~70 wt% Al
- Six tanks targeted for processing (Tanks 12, 13, 15, 32, 35 and 39)

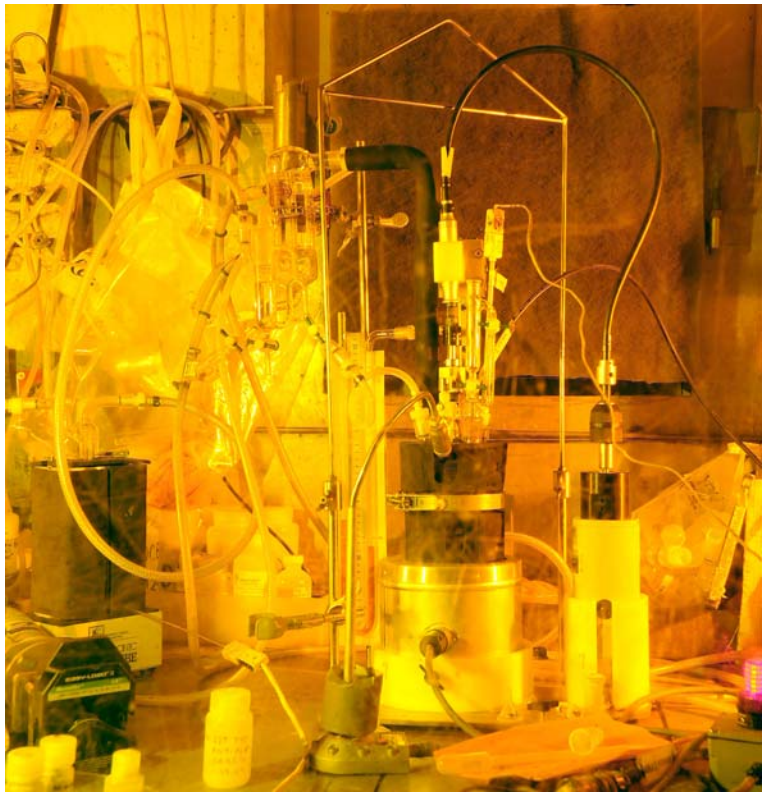
Sludge Washing



Hydrogen bubbles at surface of sludge

- Reduces soluble sodium salts in waste feed
  - Reduces number of glass canisters produced
  - Improves glass quality
- Decant Sludge Transfer fluid
- Add Inhibited Water
- Suspended Sludge using slurry pumps
- Settle Solids
  - Gravity settling
  - Limited by flammability controls, which require operating slurry pumps
- Decant Washwater
- Repeat Process 6-8 Wash Cycles.

Qualification and Processing Studies



- Performed in parallel with feed prep activities
- Qualification activities with radioactive sample
  - Sludge characterization
  - Sludge washing or concentration, as necessary
  - Demonstration of the Sludge Receipt and Adjustment Tank (SRAT) cycle
    - Adjusts feed rheology and removes components problematic to melting
  - Demonstration of the Slurry Mix Evaporator (SME) cycle
    - Adds frit and concentrates the slurry to the target solids
  - Fabrication of glass for Product Consistency Test (PCT) durability testing
- Qualification activities with simulants
  - Flowsheet testing to define DWPF SRAT/SME parameters
  - Glass variability study to verify the acceptability of the durability models
- Processing activities to support attainment
  - Frit development including melt rate and waste throughput testing
  - Flowsheet testing with the composition to be processed in DWPF

DWPF Feed Acceptance

- Safety
  - Safety basis source term
  - Biological shielding
  - Criticality
  - H_2 generation in Feed Preparation
    - HCOOH decomp by noble metals $\Rightarrow$ flammable H_2 mixture
  - Flammable gases in melter
  - N_2O generation in Feed Preparation
  - NO_2^- reaction with HCOOH $\Rightarrow$ reduces LFL of H_2
  - Glass insolubles
    - floating salt layer $\Rightarrow$ steam explosion

- Process Design & Operability
  - NOx emissions
  - Corrosive species
  - Canister heat generation
  - Glass viscosity & liquidus
  - Crystalline glass phase
  - Sludge solids

- Waste Acceptance Product Specification (WAPS)
  - Durability of waste form compared to Environmental Assessment glass
  - Elements & radionuclides to be reported

Sludge Batch Feed to DWPF

- After Sludge Batch is accepted, it is transferred from Tank 51H to Tank 40H and mixed
- Sludge transferred from Tank 40H to DWPF approximately weekly
  - Dependent on DWPF processing time
- Transfers support DWPF need
  - Tank Farm adjusts to DWPF schedule
- Initiated DWPF operations in 1996
  - Produced > 2700 HLW canisters to date
  - Over 10 million pounds of glass poured

Issues/Areas of Opportunity

- Improve understanding rheology, particle size, hydrogen retention relationships
- Hydrogen retention issues impact sludge batch size and wash volumes
- Gravity settling limits rate of sludge batch preparation and overall system throughput
  - Development of Rotary Microfilter
  - Additives to increase settling rate
- Glass formulation changes that eliminate/minimize the need for washing sludge
- Installed instrumentation to improve efficiency
  - Safety Class liquid level
  - Sludge level interface detection
  - Installed monitoring (i.e., Raman probe) for Na, Al, OH, etc. to reduce sampling dependence
- Facility upgrades to support aluminum dissolution
- Availability of salt waste processing capability
  - Limits system operating flexibility
  - Evaporator performance impacts wash decants

Sludge Batch Preparations

Questions?