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Defense Waste Processing Facility Process Enhancements

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November 16, 2010 (Session 2)

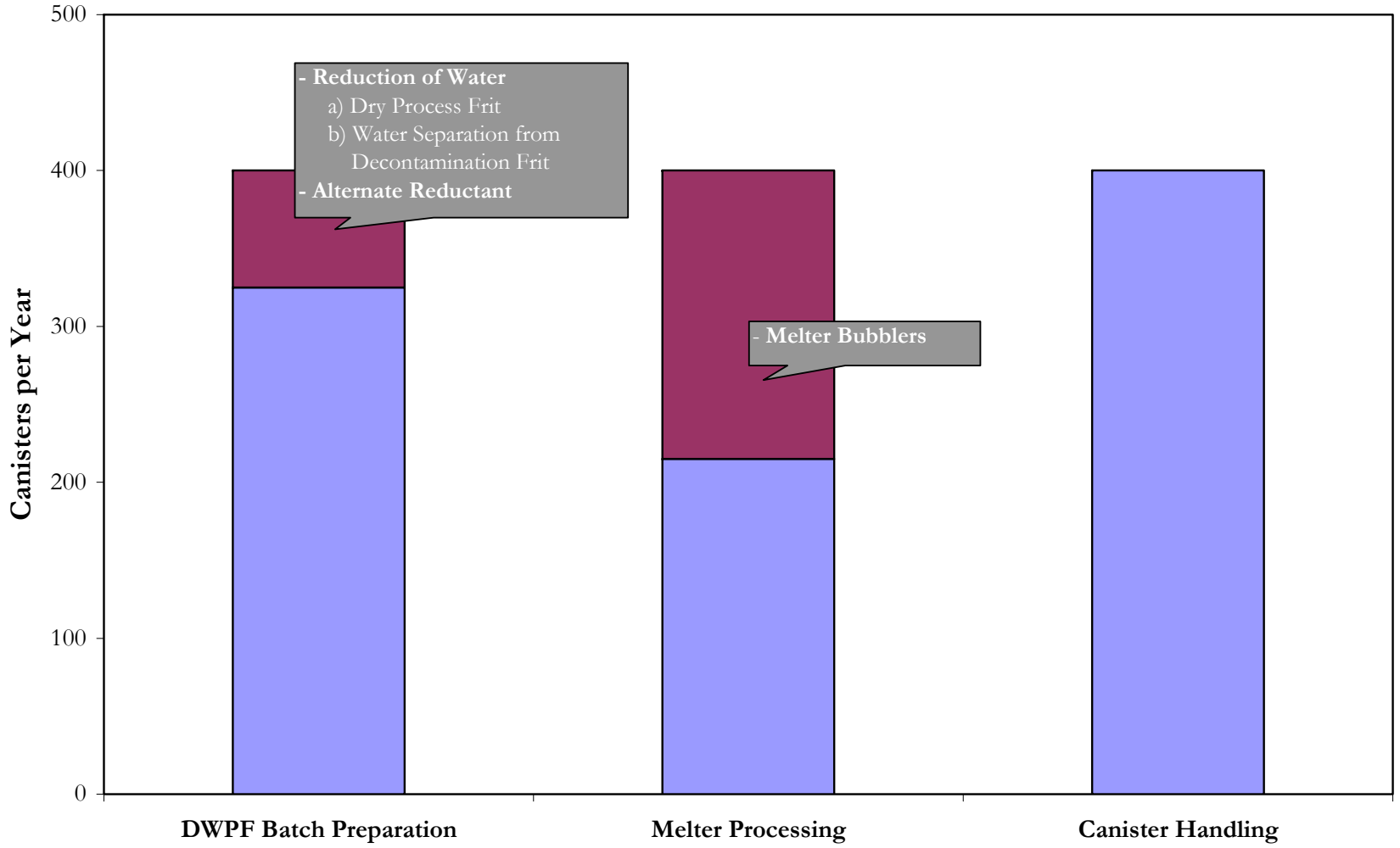
SRR-STI-2010-00704

EM Waste Processing Technical Exchange
Atlanta, GA

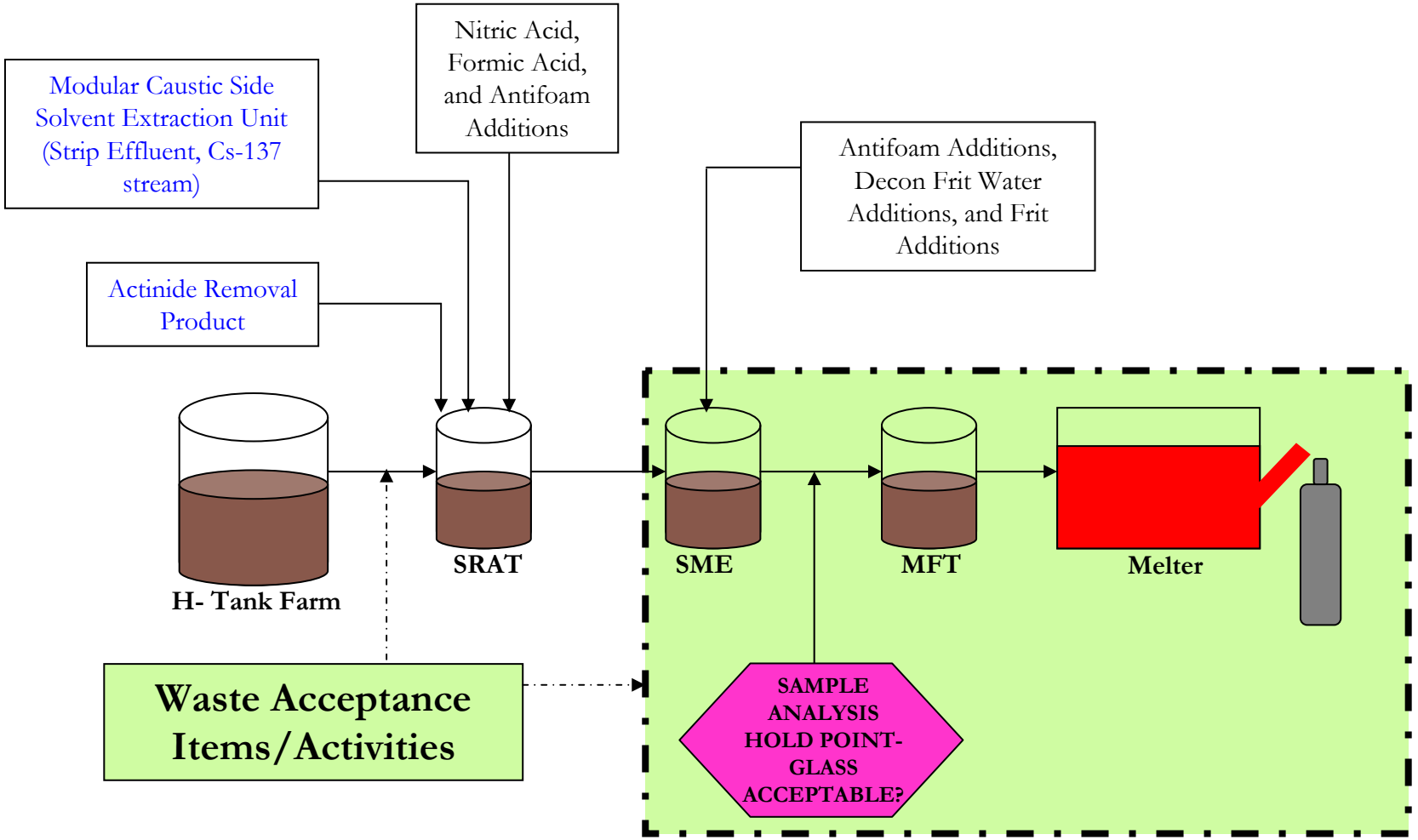
Agenda

- Introduction
  - Role of Process Enhancements
  - Current Flowsheet
- DWPF Process Enhancements
  - Melter Bubblers
  - Reduction in Water
  - Alternate Reductant
- Conclusions
- Discussion

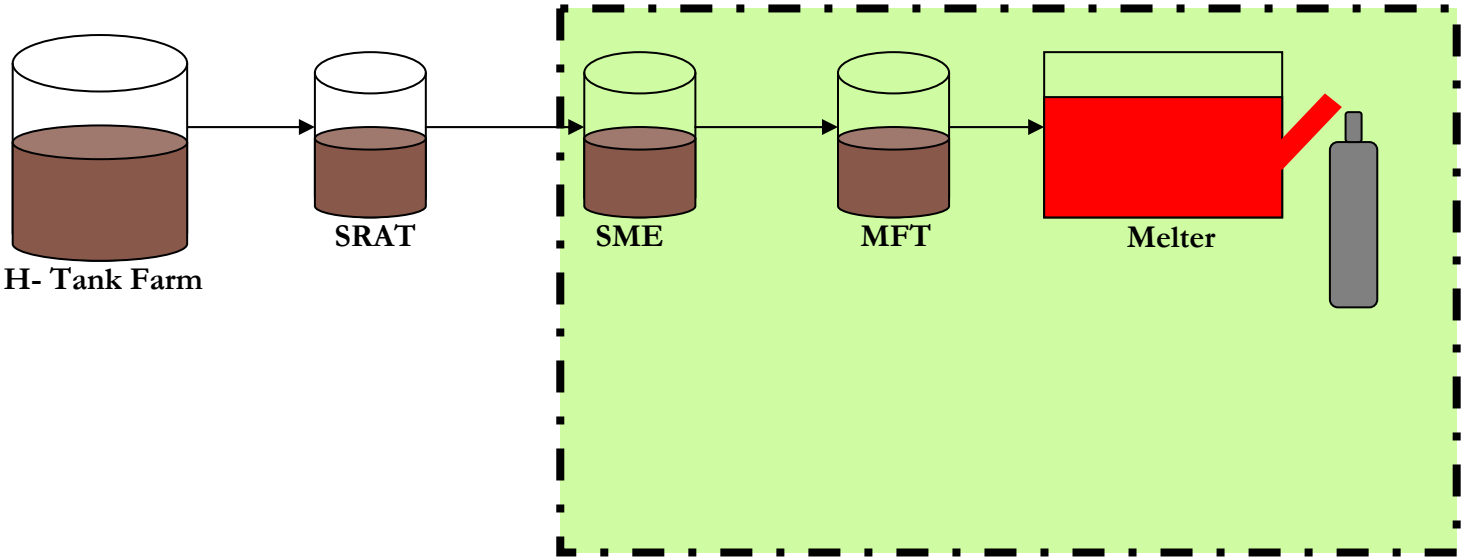
DWPF Process Enhancements



Current DWPF Flowsheet



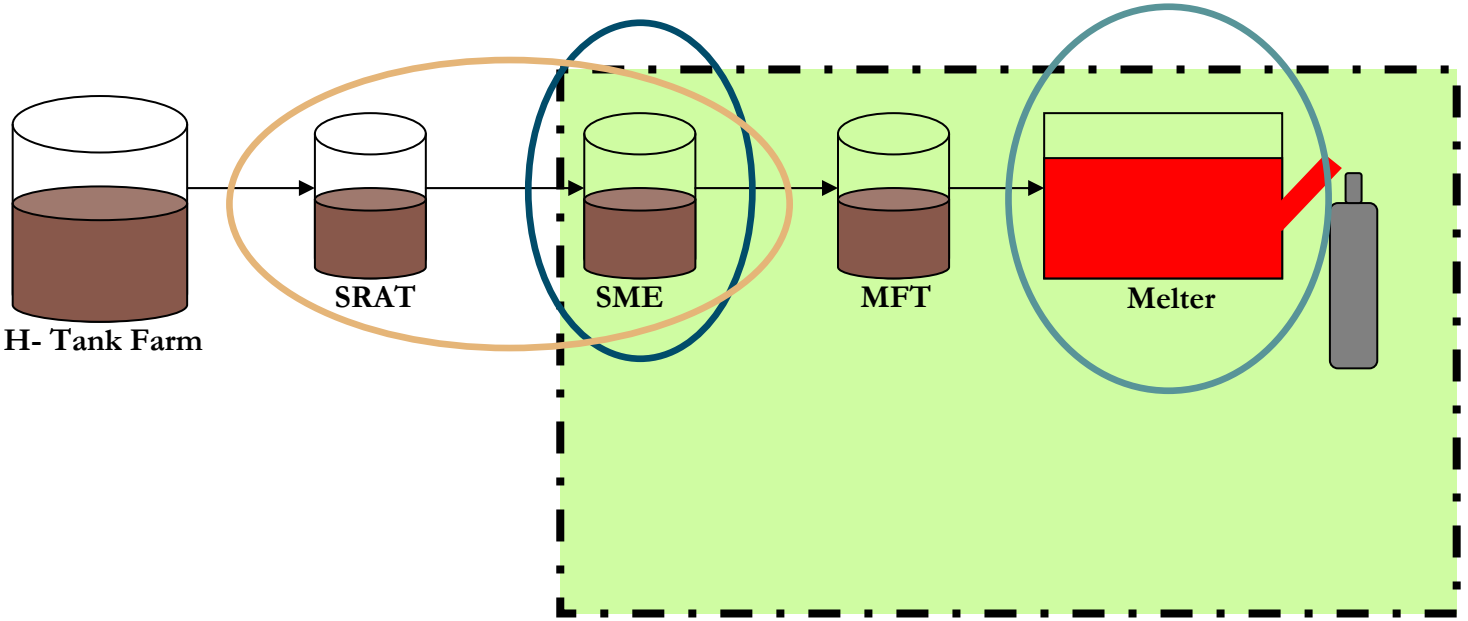
Current DWPF Flowsheet



Current DWPF Flowsheet

PROCESS ENHANCEMENTS

1. Melter Bubblers
2. Reduction in Water
3. Alternate Reductant



Melter Bubblers

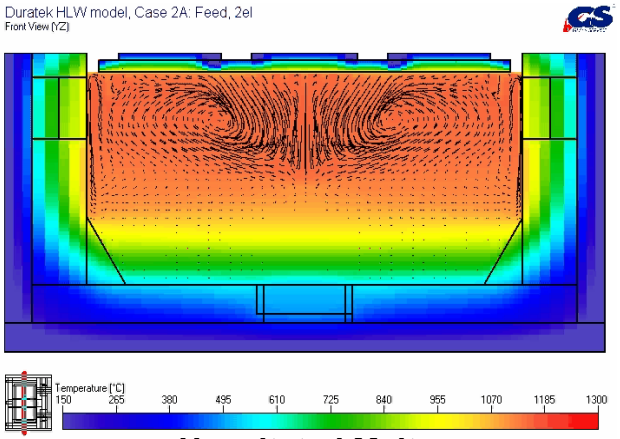
PURPOSE: Retrofit existing DWPF Melter design with bubblers to increase melt rate capacity and waste throughput.

BENEFITS: Potential improvements in canister production via forced convection of the melt pool.

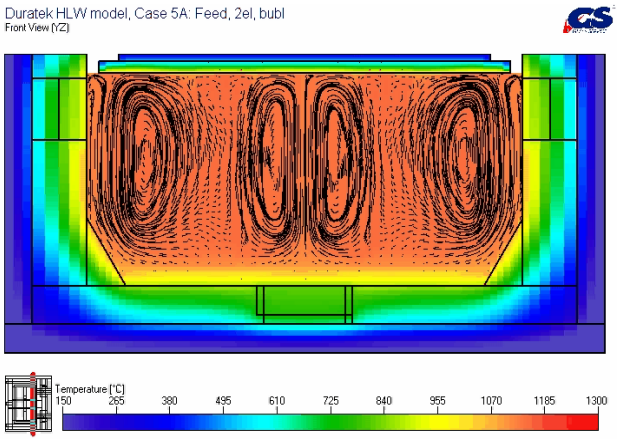
KEY TECHNICAL CONSIDERATIONS: Impact of bubbling on melter flammability, component volatility, impact of bubbling medium on glass oxidation state, bubbler design

KEY IMPLEMENTATION CONSIDERATIONS: Bubbler changeout, change in melter operations

STATUS: Operational as of September 2010

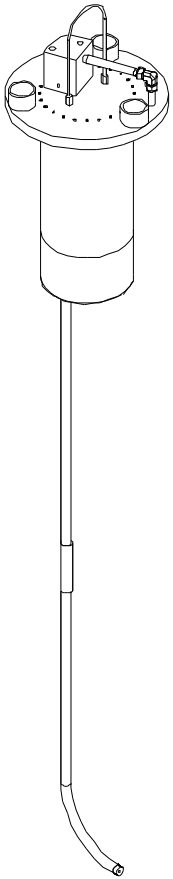


Unagitated Melter (natural convection)



Agitated Melter (forced convection)

Melter Bubblers



MODIFICATION OVERVIEW

- Install single feed tube in center nozzle E
- Install bubblers in Nozzles B1 & B2
- Install 3 function device in nozzle C2
  - Bubbler
  - Level probe
  - Melter plenum pressure sensing
- Install 2 function device in nozzle C4
  - Bubbler
  - Thermowell
- Bubbler design by Energy*Solutions*

Melter Bubblers

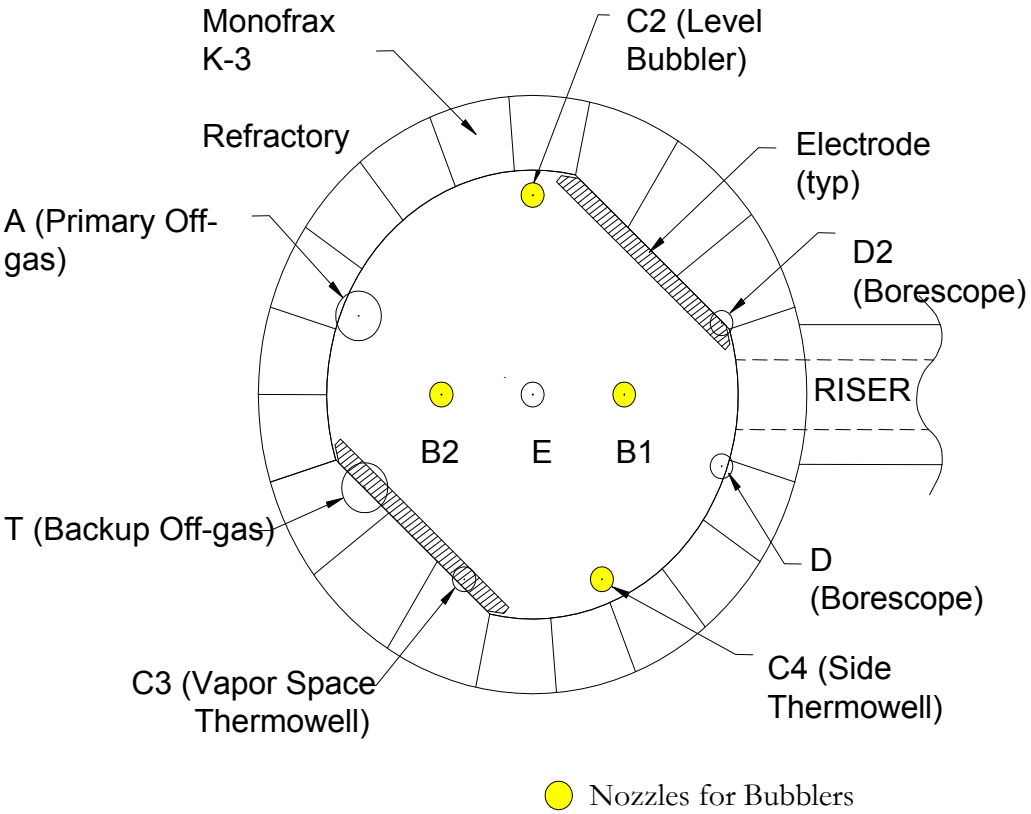


Image of DM1200 Melter courtesy of ES/VSL.

Melter Bubblers

PRELIMINARY PROCESSING NOTES

1. Approximate increase in melt rate is from 130 lb/hr (pre-bubbler installation) to 200 lb/hr (post bubbler installation).

2. On-going optimization will further improve glass production rate.

3. Circulation promoted by installation of the bubblers verified by convergence of the upper and lower glass temperatures.

4. Cold cap coverage monitored by evaluating melter vapor space temperature, melt pool temperature, and dome heater power.

5. Three months following installation, remove and inspect bubblers to assess condition.

Dry Process Frit Addition

PURPOSE: Replace current slurry-fed (nominally ~40wt%) transfer design with a dense phase (dry) conveying system.

BENEFITS: The current flowsheet includes addition of 2000 gallons of water to each SME batch from bulk process frit addition. This **represents a portion (~5%) of the overall water returned to the Tank Farm**. Additionally, the reduction in water to the SME can result in a **cycle time reduction of up to 7%.**

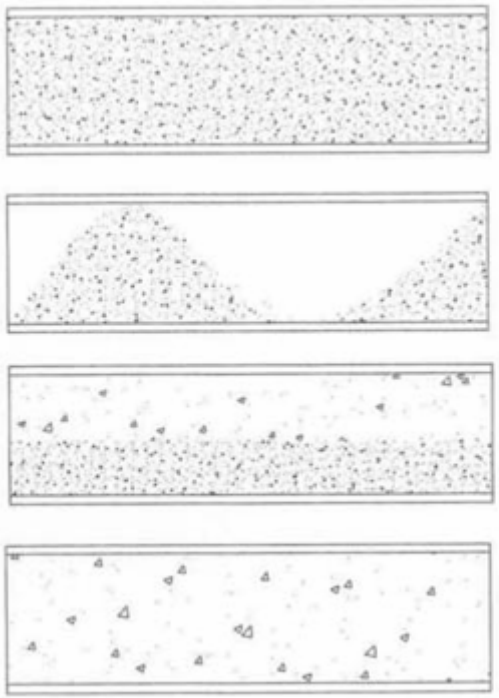
KEY TECHNICAL CONSIDERATIONS: Identification of dry transfer system, component erosion, dry additions to receipt tank

KEY IMPLEMENTATION CONSIDERATIONS: Minimizing canyon complexity, canyon penetration

STATUS: Design and Construction

Dry Process Frit Addition

TRANSPORT OPTIONS



- Solid Dense Phase
- Pipeline is continuously full of material

- Discontinuous Dense Phase
- Material is conveyed in a series of slugs

- Continuous Dense Phase
- Material is conveying in a moving bed

- Dilute Phase
- Material is Homogenously mixed with the conveying air and is fully suspended

- Discontinuous dense phase conveying identified as primary mode of granular transport based upon facility needs

Dry Process Frit Addition

Contracts awarded to three separate vendors to provide testing with "off-the-shelf" systems.

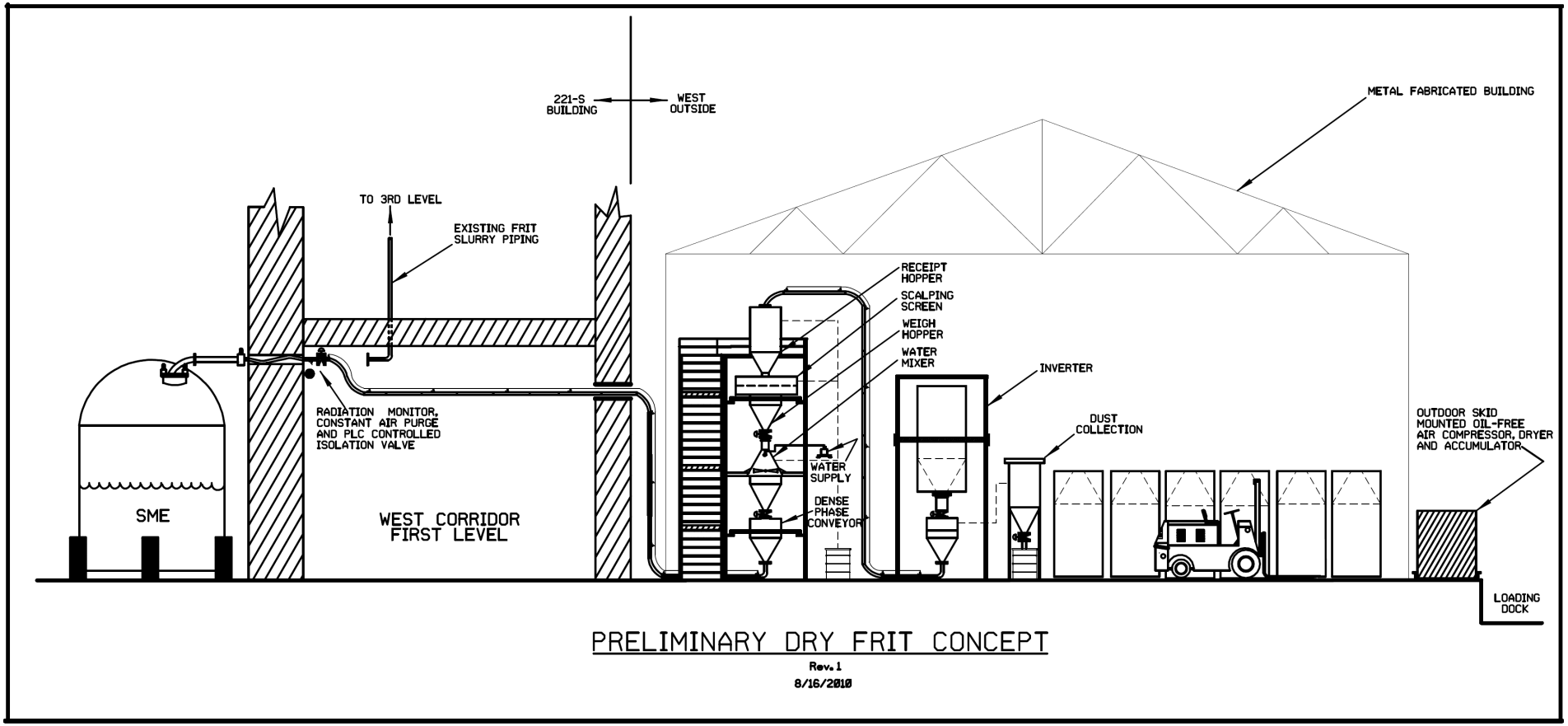
NOL-TEC SYSTEMS

DYNAMIC AIR® Conveying Systems

Macawber

Image of Mock-up courtesy of Nol-Tec.

Dry Process Frit Addition



Water Separation

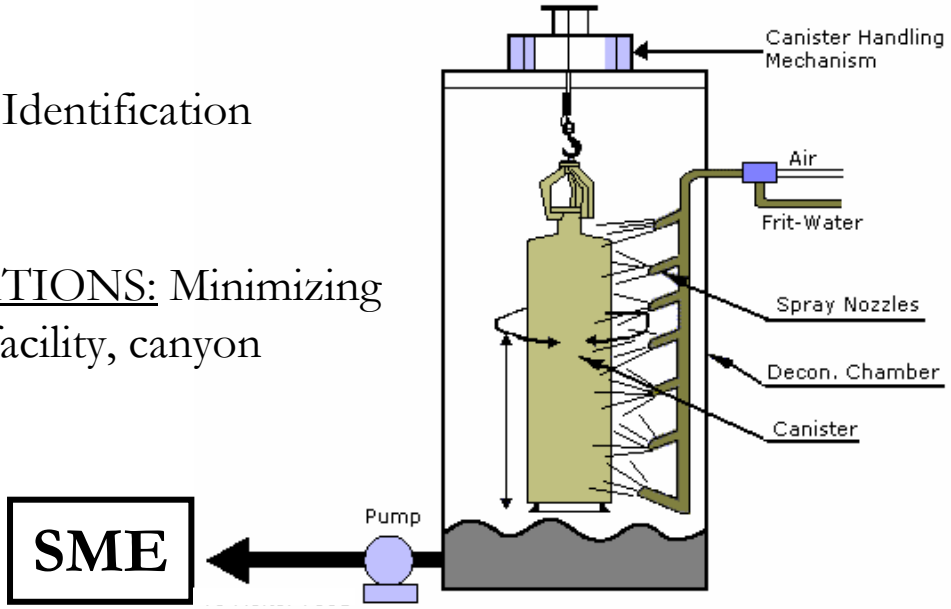
PURPOSE: Incorporate separation technology to remove water from decontamination frit slurry (nominally ~8wt%).

BENEFITS: The current flowsheet includes addition of 5500 gallons of water to each SME batch from canister decontamination activities. This **represents a significant portion (~15%) of the overall water returned to the Tank Farm**. Additionally, the reduction in water to the SME can result in a **cycle time reduction of up to 20%.**

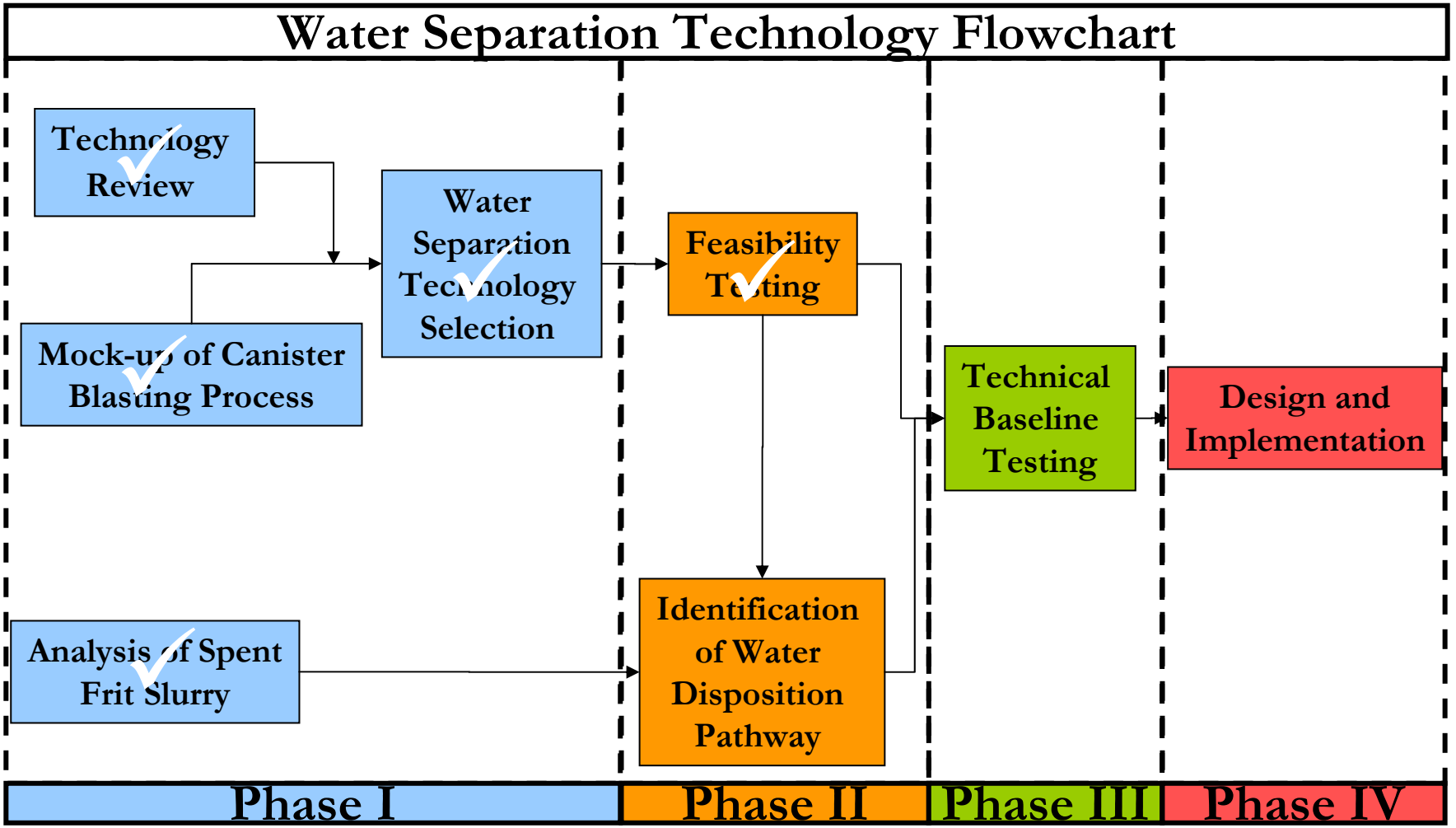
KEY TECHNICAL CONSIDERATIONS: Identification of technology, compliance of waste stream

KEY IMPLEMENTATION CONSIDERATIONS: Minimizing canyon complexity, identification of receipt facility, canyon real estate

STATUS: Applied Engineering Phase



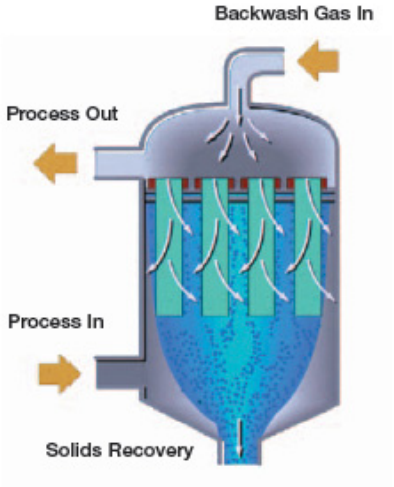
Water Separation



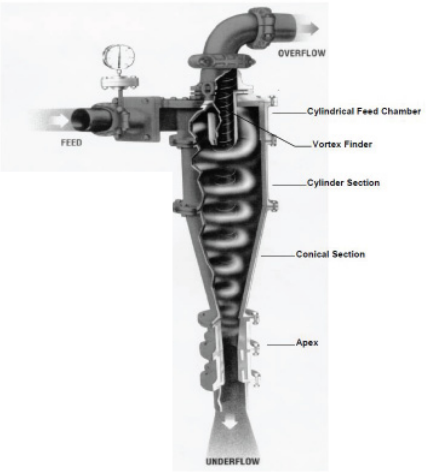
Water Separation

In conjunction with Energy*Solutions*, DWPF identified two technologies (based on technical maturity and ease of implementation) to be carried into feasibility testing.

Backpulse Filter



Hydrocyclone



	Backpulse Filter	Hydrocyclone
Advantages	*Optimal Separation Efficiency* *Reliable Separation Efficiency*	*Simple Operation and Maintenance*
Concerns	*Mechanically Complex* *Remote Operations* *Flushing Requirements*	*Reliable Separation Efficiency* *Failure Diagnosis*

Alternate Reductant

PURPOSE: Replace/minimize formic acid with an alternative reductant to reduce catalytic hydrogen generation during processing.

BENEFITS: Complete or partial replacement of formic acid with an alternative reductant reduces hydrogen generation, allowing for a **potential increase in steam rate capacity** (~20%) via reduction of purge flow, and **relaxation of gas chromatograph safety classification**.

KEY TECHNICAL CONSIDERATIONS: Identification of alternate reductant (based on chemical processing needs and facility constraints), conceptual development

KEY IMPLEMENTATION CONSIDERATIONS: Minimizing facility modification

STATUS: Development Phase

Alternate Reductant

"WHAT DO WE NEED AN ALTERNATE REDUCTANT TO DO?"

1. Eliminate/minimize storage and handling hazards of formic acid

2. Eliminate/minimize hydrogen generation (i.e. eliminate gas chromatograph requirements)

3. Maintain control of foaming in melter

4. Maintain feed processability
   a. Acceptable/improved rheology
   b. No species harmful to melter additions
   c. No/minimal additional degradation products in condensates
   d. No residue buildup in vessels/lines
   e. No foaming from additives

5. Continue to remove mercury from melter feed (Optional)

6. Maximize ability to process nitrate from other SRS stream

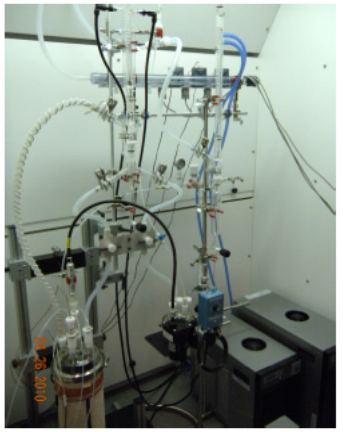
Alternate Reductant

BACKGROUND

- SRNL Identified 12 acidic reductants and 7 non-acidic reductants. Acknowledged that not all of the reductants would reduce Hg during SRAT cycle.
- Only acrylic acid was successful in both mercury reduction and REDOX control, but it has significant cold chemical handling safety issues.
- SRNL performed experimental scoping tests minimizing formic acid with nitric and glycolic acids. Only a blend of nitric/formic/glycolic provided REDOX balance as well as Hg reduction.
- SRNL recommended the use of sugar only if the processing constraint of "Hg removal in the SRAT" was eliminated. SRNL also recommended that the "fate of mercury" in the melter off gas system be studied.
- SRNL modeled the down stream impact of mercury in the melter/melter off-gas system. Modeling of a vapor space temperature of 650°C indicated that ~ 6% of the Hg is oxidized as HgCl, 90% is elemental Hg and ~4% is HgO. These findings indicate significant redesign to the melter off gas system may be required if mercury reduction was eliminated from the CPC process.
- ES/VSL recommended a third option be investigated; nitric/sugar/formic flowsheet minimizing the formic acid as in the nitric/formic/glycolic option.

Alternate Reductant

1. Nitric/Formic/Glycolic Flow Sheet - SRNL
2. Nitric/Formic/Sugar Flow Sheet - ES/VSL
3. Nitric/Sugar Flow Sheet - ES/VSL



SRNL™ SAVANNAH RIVER NATIONAL LABORATORY Operated by Savannah River Nuclear Solutions, LLC
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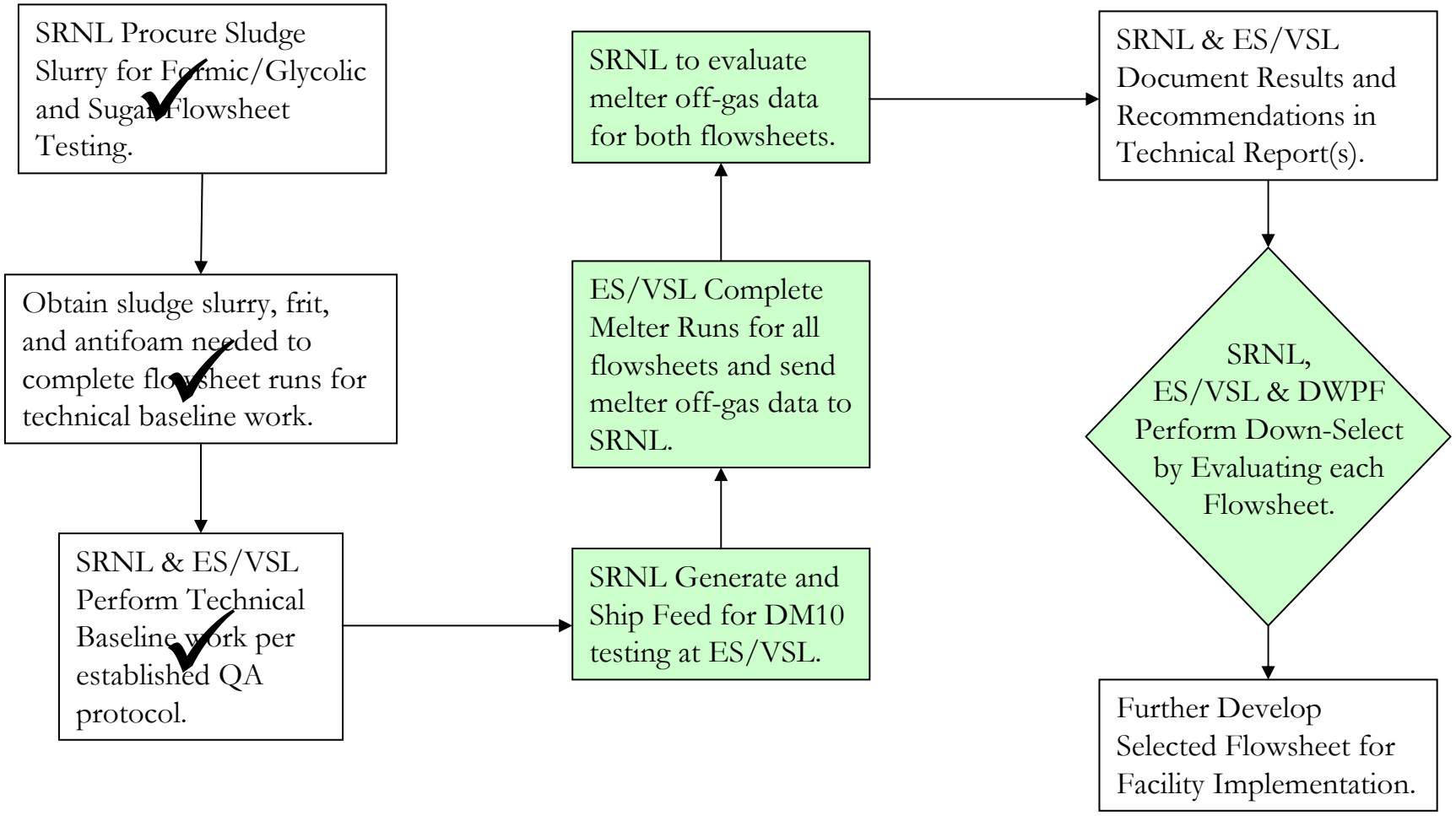
Laboratory consistency provided by utilizing same sludge simulant with bounding quantities of mercury and noble metals. Each laboratory to evaluate baseline flowsheet.

Alternate Reductant

Down-Select for Alternate Reductant Flowsheet for DWPF



Supplemental Information

"Alternative Reductants for DWPF Chemical Process Cell"

Tuesday, November 16, 2010: 1:30 PM

Session 2

Michael E. Stone, Process Technology Programs, Savannah River National Laboratory, Aiken, SC

"Sugar-Based Alternate Reductant Flow-Sheet for DWPF"

Wednesday, November 17, 2010: 6:30 PM

Session 11

Wing K. Kot, Vitreous State Laboratory, Catholic University of America, Washington, DC
Ian L. Pegg, Vitreous State Laboratory, Catholic University of America, Washington, DC

Conclusions

- DWPF Enhancements include:

  Installation of Melter Bubblers
  Dry Process Frit Additions
  Water Separation from Decontamination Frit
  Alternate Reductant

- Major enhancements require coordination with DWPF support organizations (Design, Engineering, Construction, Operations), as well as external resources (multiple research organizations)

Contact Information

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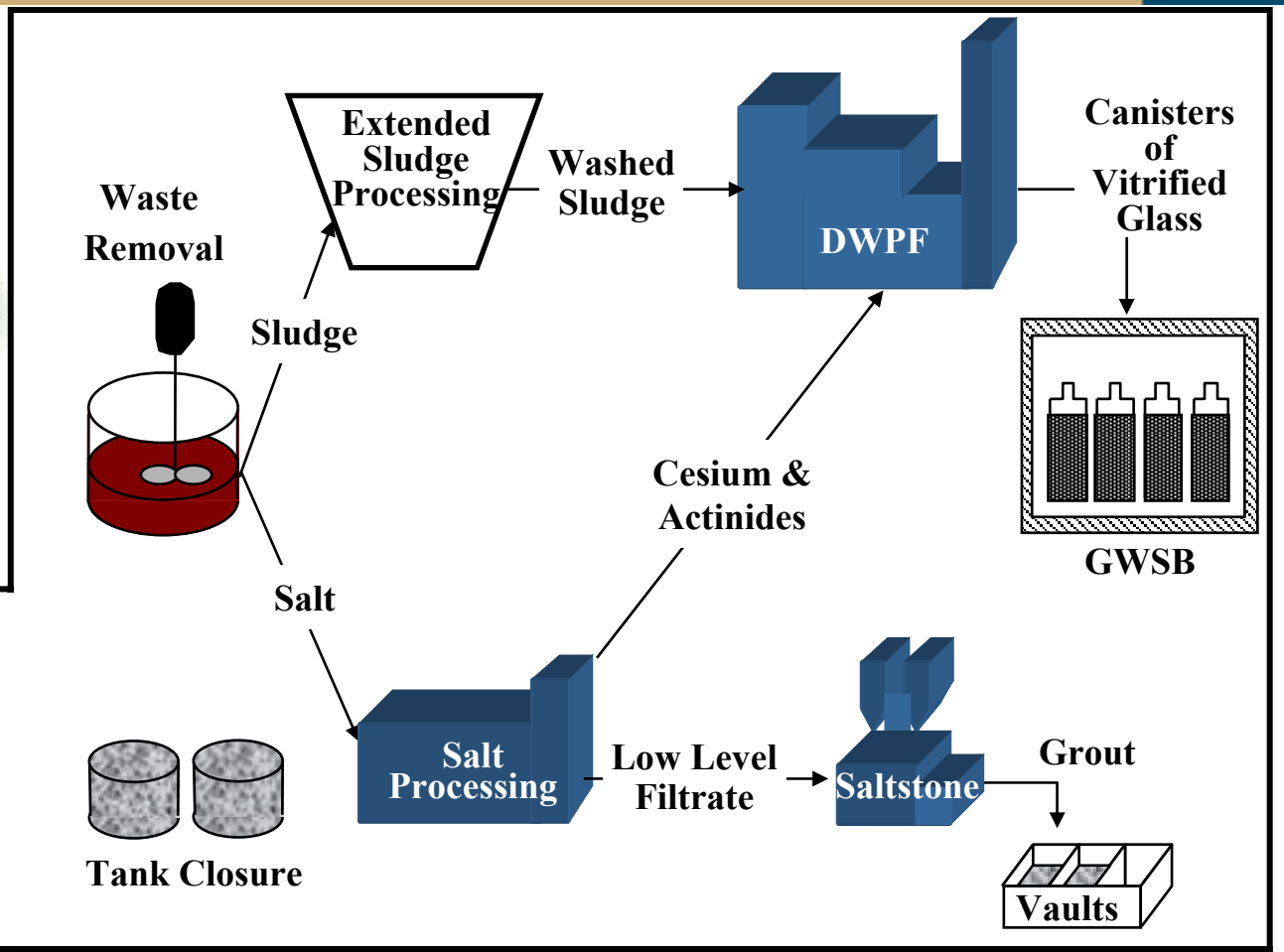
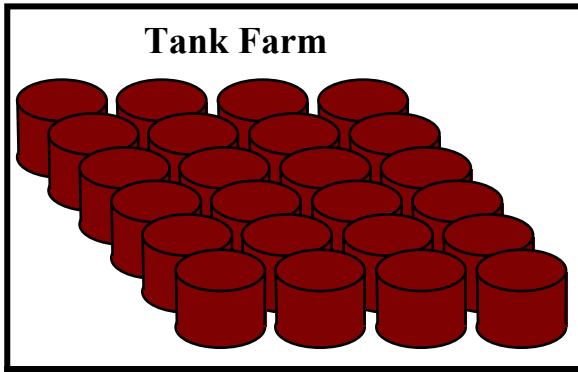
Supplemental

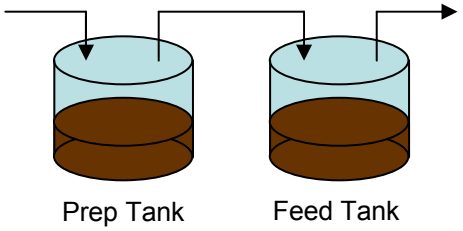




STORAGE	REMOVAL/ PRETREATMENT	FINAL PROCESSING

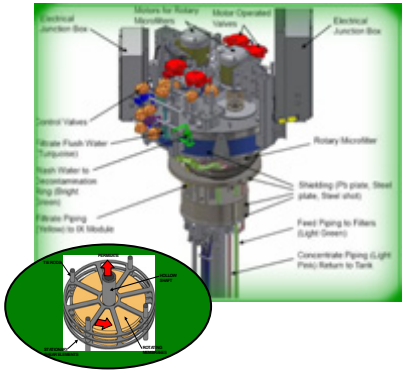
Supplemental

Tank Farm

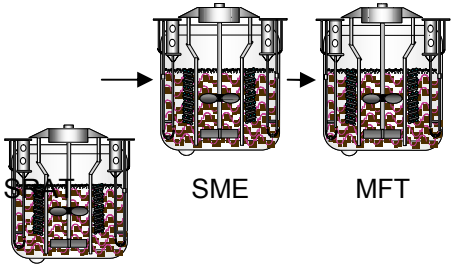


Sludge Feed Prep

- Dedicate additional sludge prep tank
- Deploy rotary microfilters



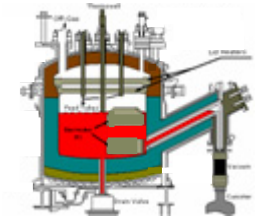
DWPF Chemical Process Cell



Melter Feed Prep

- **Alternate reductant**
- **Dry process frit addition**
- **Water separation from decon frit**
- Provide flexibility for strip effluent addition
- Analytical Cycle Time Reduction

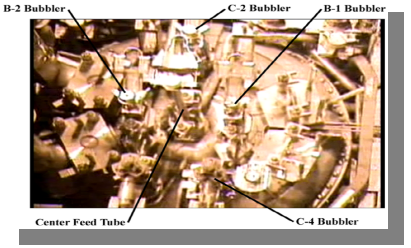
DWPF Melt Cell



Joule Heated Melter

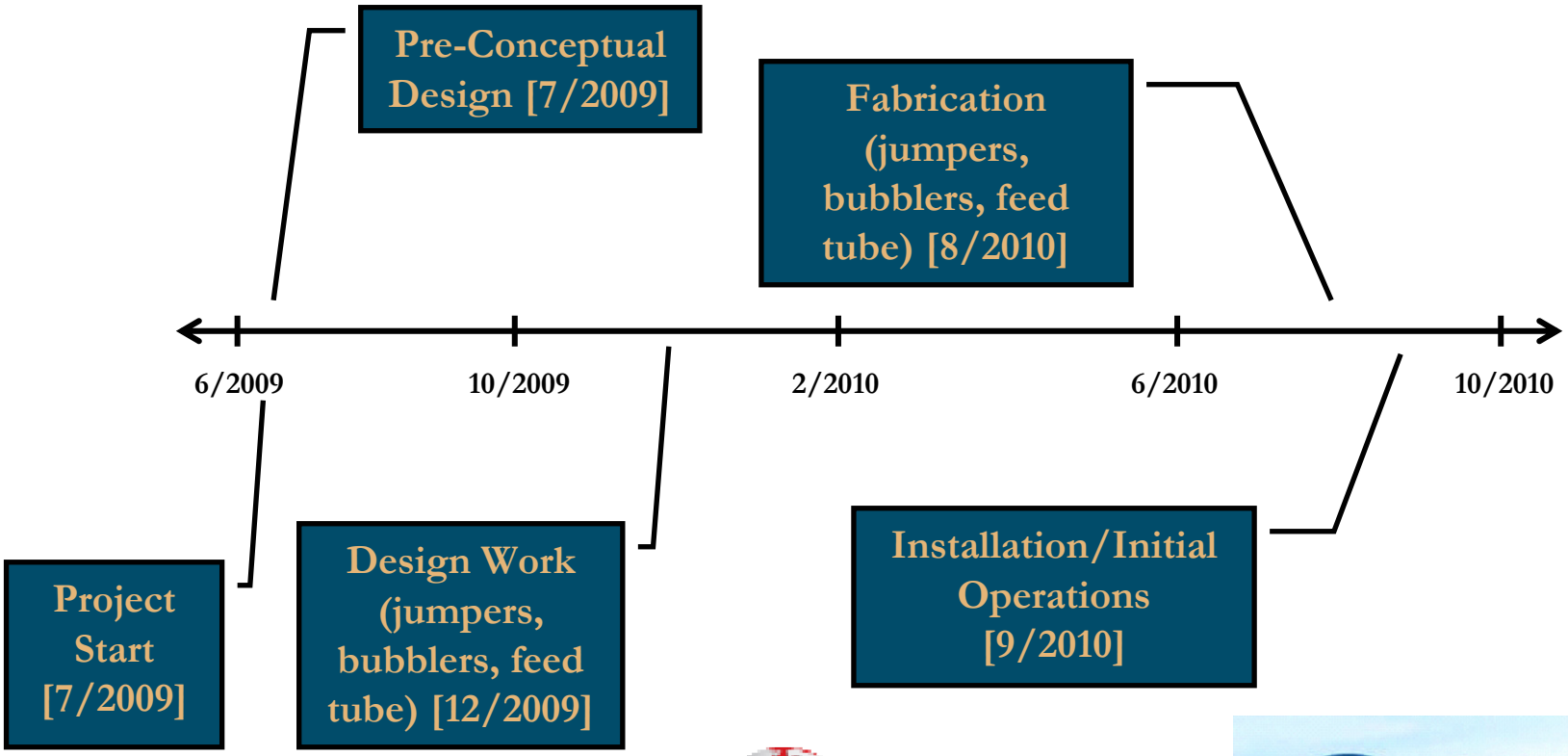
Vitrification

- **Deploy Melter Bubblers**
- Increase Waste Loading
- Decrease HLW canister wall thickness
- Continue frit optimization



Melter Bubblers

MELTER BUBBLER TIMELINE



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