U.S. DEPARTMENT OF ENERGY | OFFICE OF ENVIRONMENTAL MANAGEMENT

Vitrification of High-Level Waste (HLW) at the Defense Waste Processing Facility (DWPF) Operating History and Plan

Jonathan Bricker
Savannah River Remediation

October 2014

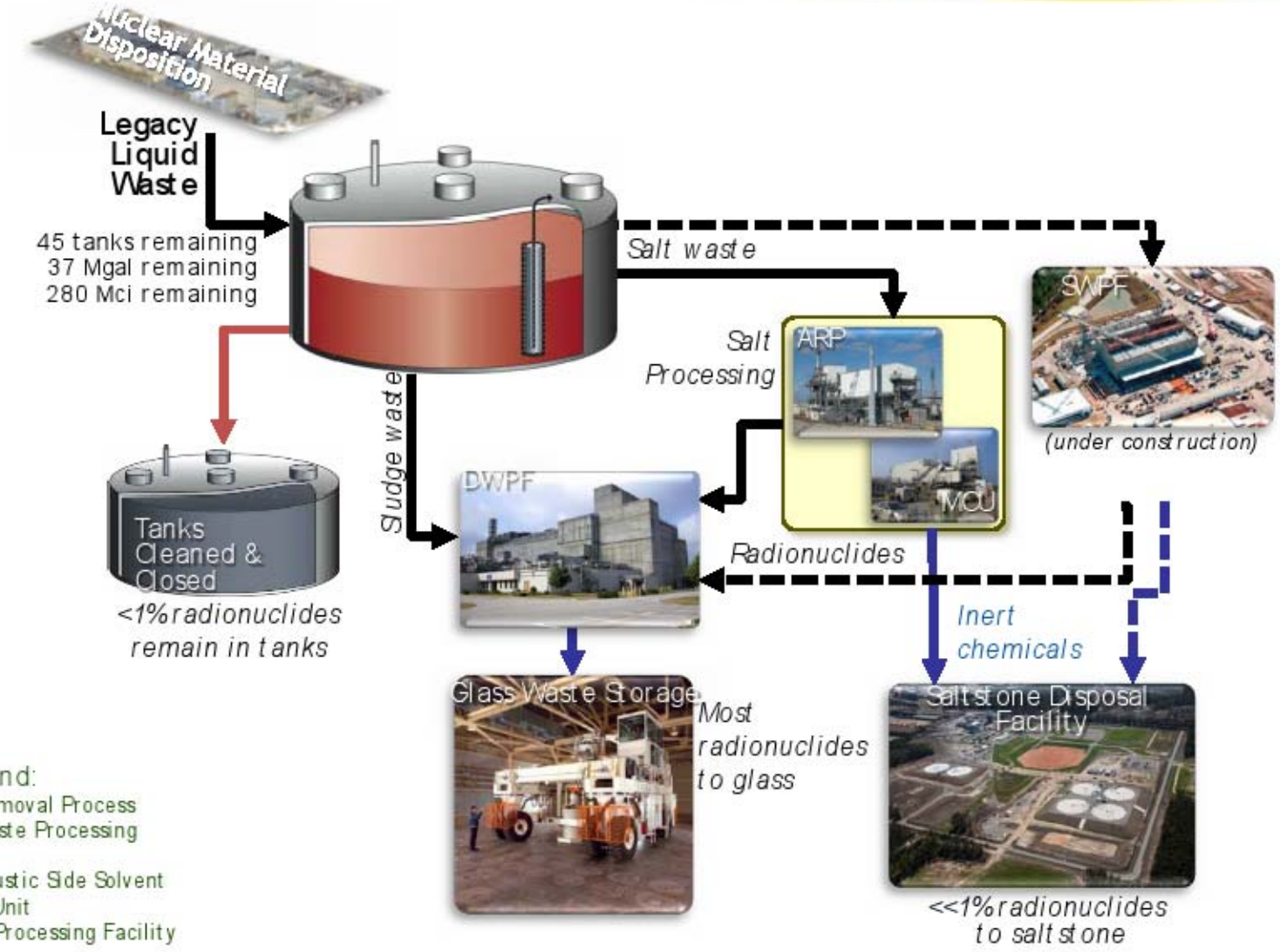
Savannah River Remediation
A URS COMPANY TEAMED WITH BECHTEL | CH2M HILL | B&W | AREVA

Savannah River National Laboratory™
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

Agenda

- Overview of Defense Waste Processing Facility
- Current Status of Operations
- Implemented Improvements
- Status of Ongoing Improvements
- Conclusions

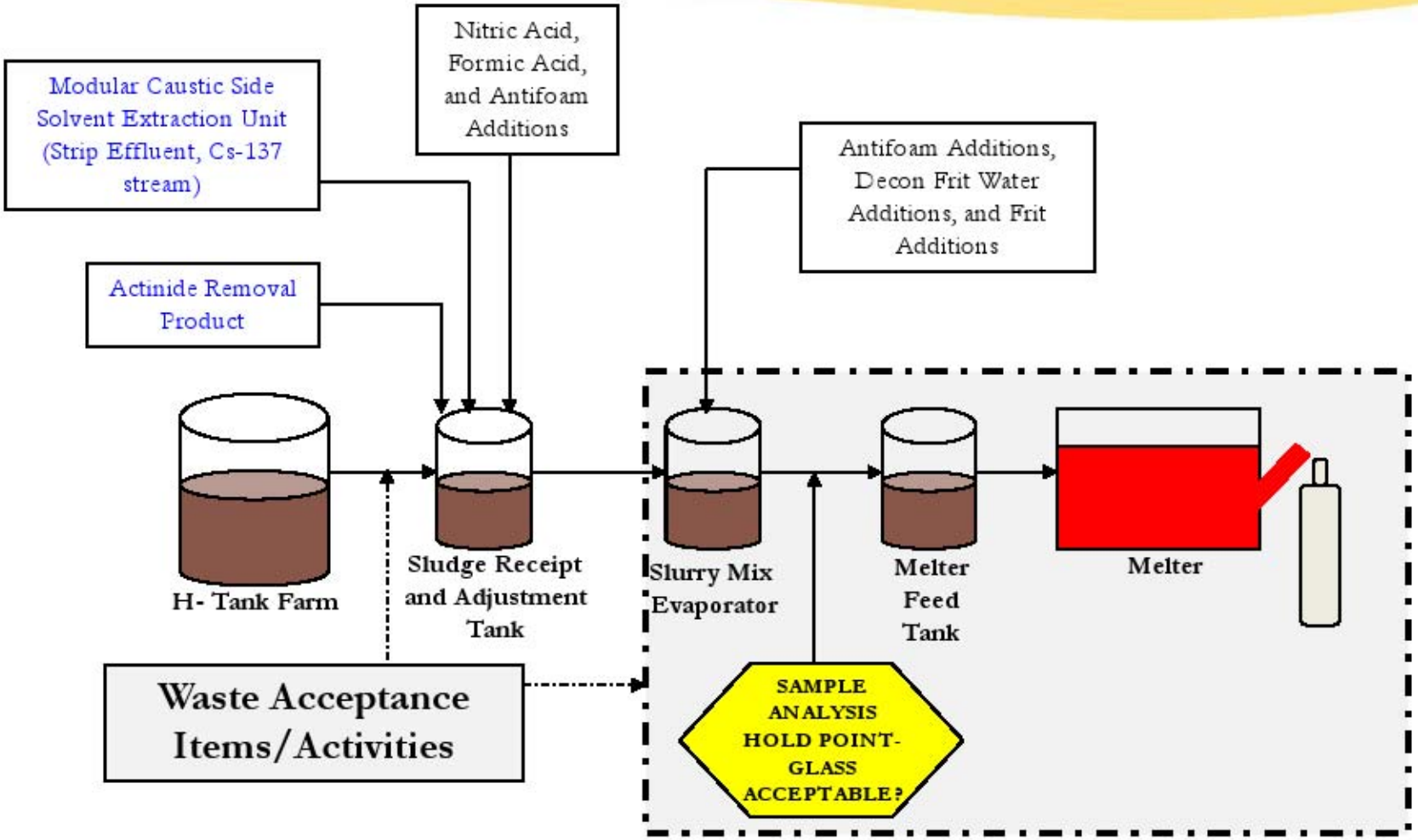
Integrated Liquid Waste System



Legend:

ARP	Actinide Removal Process
DWPF	Defense Waste Processing Facility
MCU	Modular Caustic Side Solvent Extraction Unit
SWPF	Salt Waste Processing Facility

Defense Waste Processing Overview

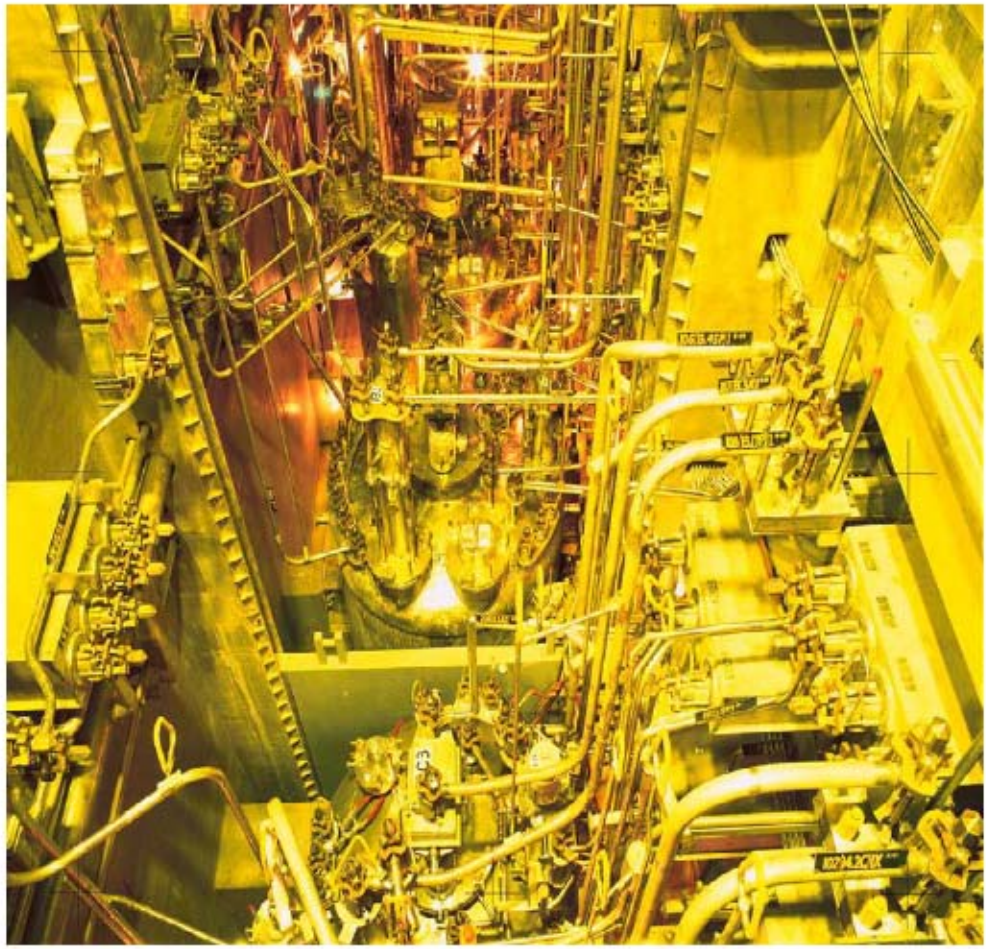


Process works to produce highly durable borosilicate wasteform.

Defense Waste Processing Facility Status

- **DWPF**
  - World's largest operating HLW vitrification plant
  - Radioactive operations started in 1996
  - Currently processing Sludge Batch 8

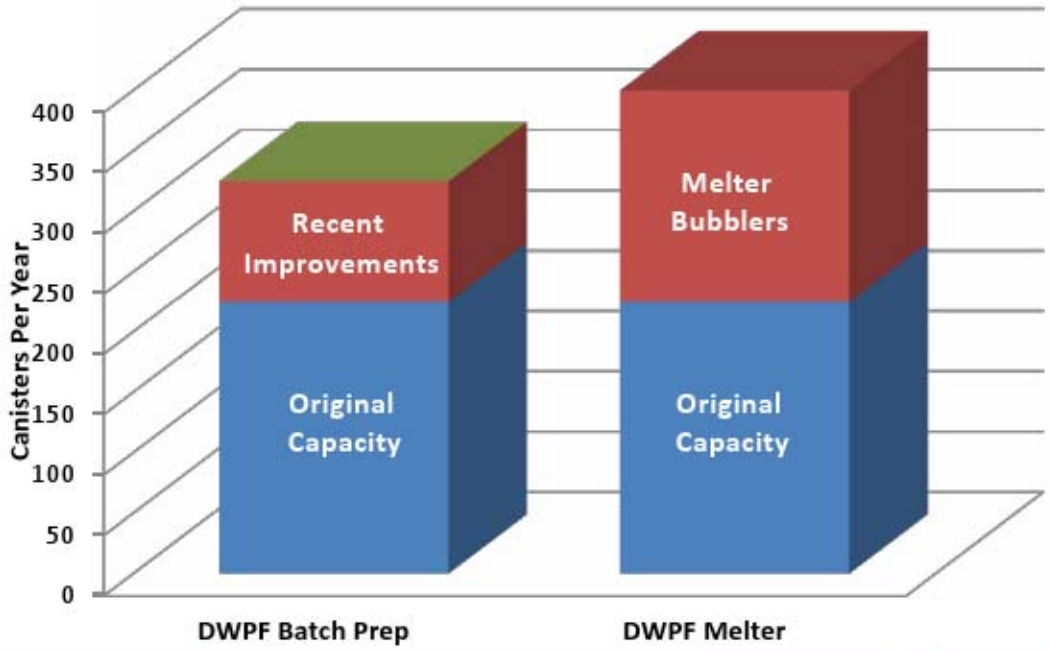
- **Operations to Date**
  - 4.3 million gallons HLW treated
  - 3800+ canisters filled (of 8500+ planned)
  - 15 million pounds of glass (55.6 million curies)



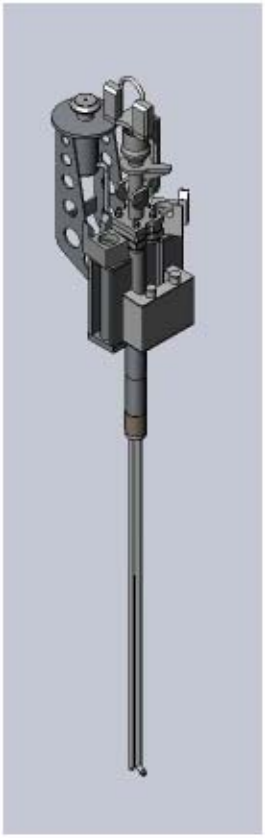
DWPF Short-term Improvements

- Increase in DWPF throughput (and flexibility) required to accommodate salt processing
- Extensive improvements made to increase waste throughput
  - Melter bubbler installation to increase melt rate
  - Reduction in cycle time of melter feed preparation cycle (e.g. analytical improvements)
  - Increase in waste loadings due to "tailoring" frit (i.e. more waste in each can)

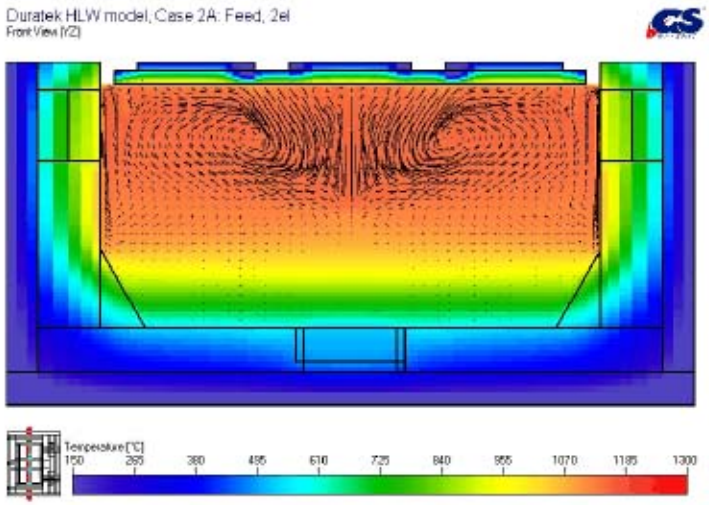
Goal is to maximize waste throughput to reduce environmental risk.



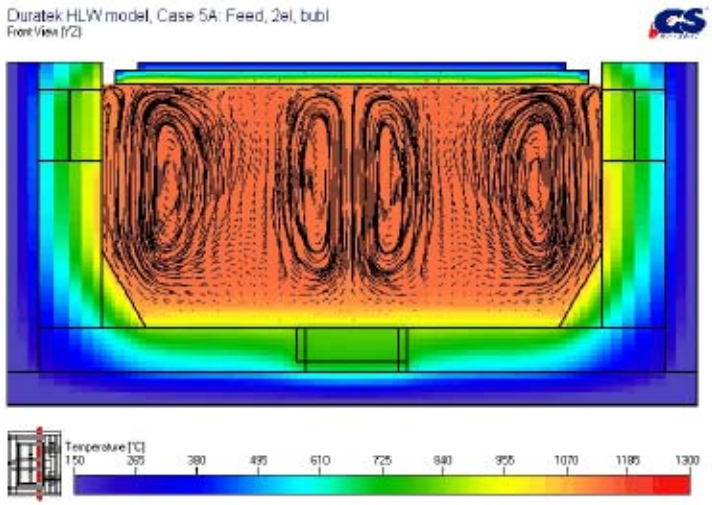
DWPF Short-term Improvements



Bubbler



Unagitated Melter (natural convection)



Agitated Melter (forced convection)

- Bubble gas into bottom of melt pool; rising/expanding bubbles increase melt pool convection
- Bubblers retrofit into existing (Melter #2) design
- Installation in 2010
- 50% increase in melt rate observed

DWPF Short-term Improvements

- **Sludge Receipt and Adjustment**

Tank Processing Steps	**Percentage of Overall Cycle Time**
- Sludge Receipt and Initial Concentration	36%
- Vessel Sampling for Input	9%
- Sludge Adjustment and Concentration	35%
- Vessel Sampling for Confirmation	20%

- **Slurry Mix Evaporator**

Processing Steps	**Percentage of Overall Cycle Time**
- Frit Additions and Concentration	64%
- Vessel Sampling for Confirmation	36%

Goal is to increase production capacity of the facility through innovative yet simple alterations to the Batch Preparation process.

DWPF Short-term Improvements

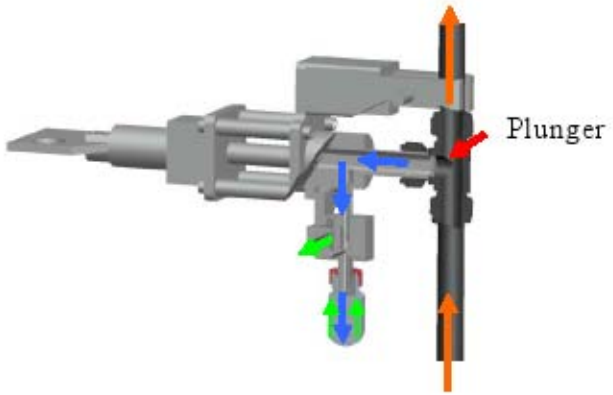
Utilize a systematic approach to simplify and optimize process flowsheet for maximum efficiency, all while minimizing risk.

- **Additional sludge transfer from Tank Farm** - leverages process changes associated with coupled operations to increase mass of sludge processed each batch (*10% throughput improvement per batch*)
- **Simplified blend strategy** - re-assess processing risks and utilize process control (versus process validation) to ensure processing goals are met (*savings of 24 hours per batch*)
- **Streamlined facility interface** - use of existing tools (e.g. procedures) as well as newer technology (e.g. web-based applications) to streamline process (*savings of 6-10 hours per batch*)

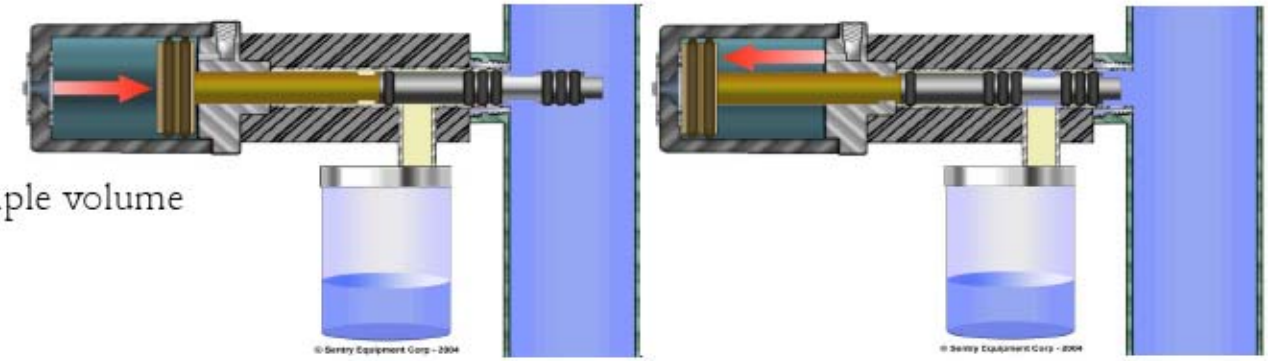
DWPF Short-term Improvements

Hydragard Sampler

- Turn handle extending plunger into stream (manipulator intensive)
- Flow enters cavity and fills vial
- Flow enters outer needle and is routed to recycle stream

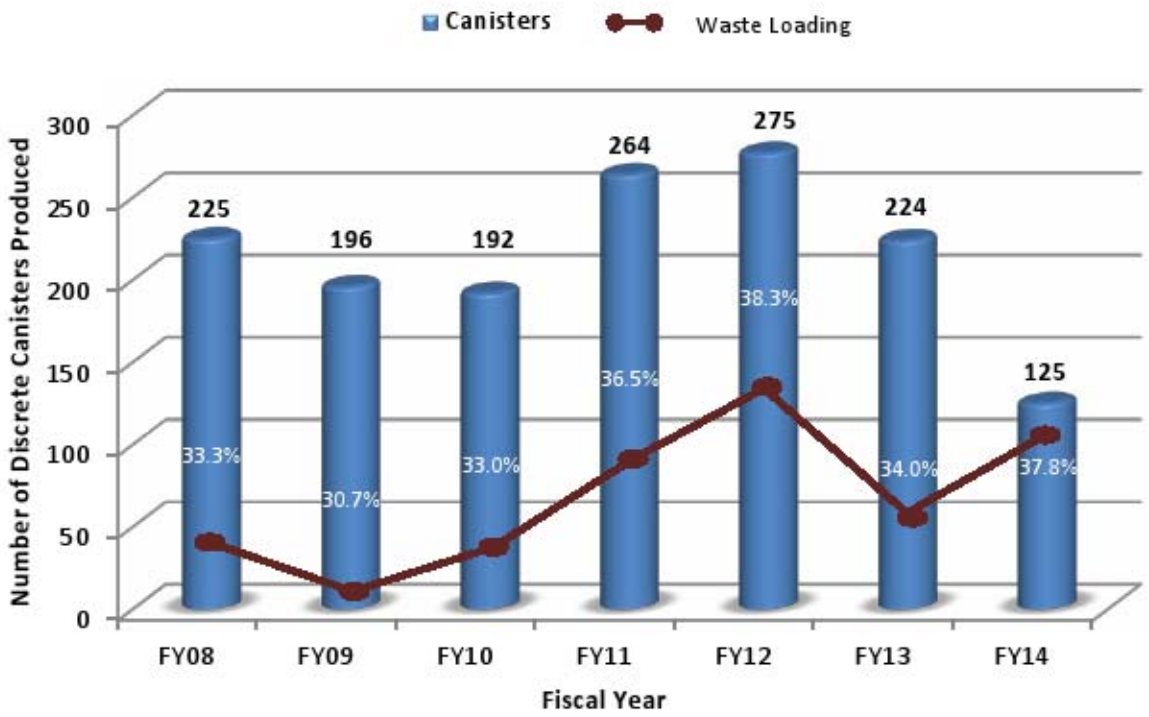


Isolok Sampler



- Flexibility in the size of sample volume
- Eliminates recycle waste
- Commercially manufactured and tested components.
- Reduce equipment wear and fatigue

DWPF Short-term Improvements



- Record production in FY11 and FY12
  - Significant production gains via process improvement (minimal cost)
- Reduced production in FY13 due to reliability issues
- Reduced production in FY14 to align with system objectives

DWPF Continuous Improvement

- Independent Review Team (DWPF Reliability Team) contracted to review practices and provide recommendations for improvement
  - Scope included all organizations (Maintenance, Operations, Engineering) and multiple facilities (DWPF and 512-S)

Focus Areas

Processability
Melter Off-Gas Flammability
Mercury
Recycle
System Integration

Secondary Areas

Alternate Reductant
Dry Frit
Metered Antifoam
Flowsheet Group
PVV Clean-up Plan
System Health Report Improvement

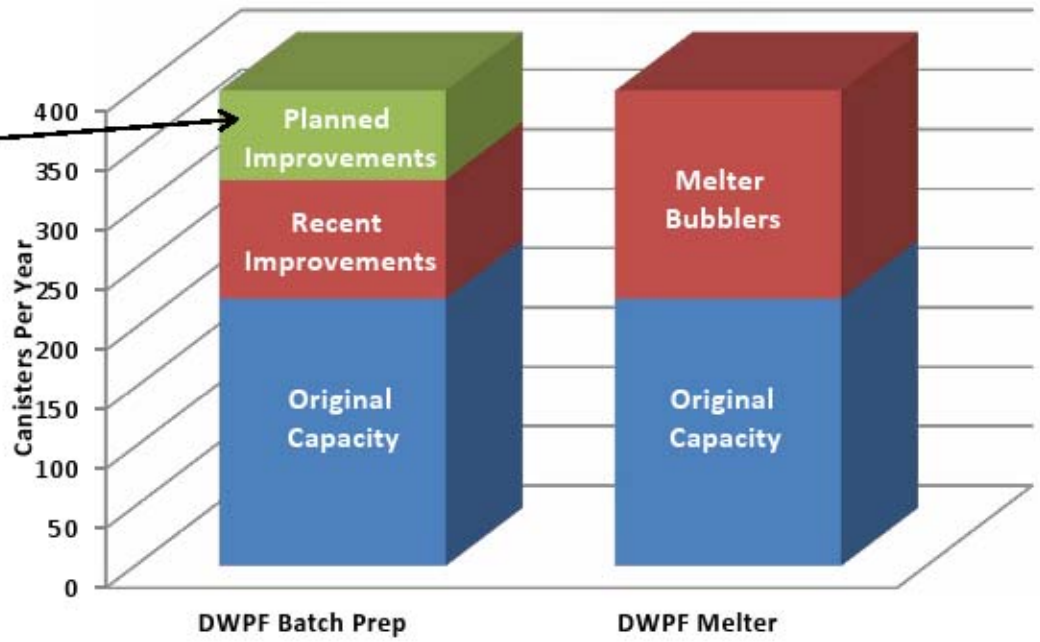
- Improvement Plan developed to address focus areas; all areas currently being worked

DWPF Long-term Improvements

- Growing need to provide flexibility to accommodate variability in SRR System Plan (e.g. waste feed compositions, input streams)
  - Addressing demand for higher process/equipment reliability due to closely coupled operations and increased activity in Tank Closure efforts and salt waste processing
  - Understand and expand operating windows (simplify process to improve throughput)
  - Optimize processing windows for future waste compositions (higher waste loadings)

- System Reliability
- Alternate Reductant
- Dry Frit
- SEFT to SME

Goal is to position facility for continuous success.



DWPF Long-term Improvements

Alternate Reductant

Replace formic acid with an alternative reductant to reduce catalytic hydrogen generation during processing and to improve operability and flexibility during Batch Preparation.

Operational benefits:

- Eliminates the formic acid hazard and the associated response actions
- Adjustment of rheological properties allows for higher solids content per given volume of sludge slurry
- Reduced CPC off gas production (increase steam rate, decrease flammability hazard)
- Reduced air purge requirements

DWPF Long-term Improvements

Dry 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 Slurry Mix Evaporator 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 Slurry Mix Evaporator can result in a **cycle time reduction of up to 7%.**

Cs-Rich Stream to Slurry Mix Evaporator

PURPOSE: Expand operational flexibility to allow disposition of salt waste by-products to either processing vessel in the Chemical Process Cell.

BENEFITS: Leverage reduction in water to the Slurry Mix Evaporator via the Dry Frit Addition project to allow (if required) the addition of salt processing by-products to an alternate vessel.

Conclusions

- Improvements to Defense Waste Processing Facility needed to support SWPF

- Optimization of melter feed preparation system performed through innovative, yet simple process alterations
  - Record facility production in 2011 and 2012
  - Reliability and system alignment focus in 2013 and 2014

- Longer-term projects aimed at bridging remaining gap between melter and melter feed preparation