Supplemental Treatment Technologies

Hanford Advisory Board
Tank Waste Committee

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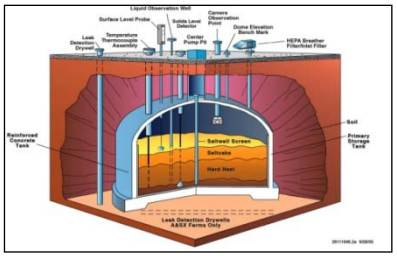
WP 1 - Waste Retrieval and Closure Technologies

Hanford	$2.4
Savannah River	$1.8
CRESP/ Vanderbilt	$1.0

$5.2 M



Challenge

- Increase capability to remove tank waste material
- Reduce waste volumes
- Increase storage capacity in existing tanks
- Ability to assess environmental safety of grouted waste residuals in tanks

Possible Solutions

- Develop alternative chemical cleaning methods to control tank heel chemistry
- Develop improved methods for tank waste handling and tank space usage
- Develop in-tank settling technologies to separate radionuclides
- Evaluate cementitious materials for in tank closure

Benefits

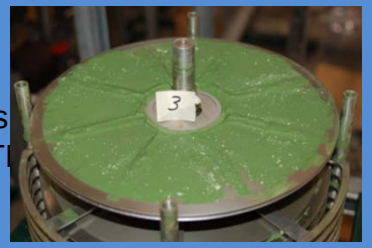
- Reduces retrieval time and improves efficiencies
- Reduces further environmental impact when retrieving from unsound tanks
- Reduces waste volume to maximize available tank space
- Provides backup evaporative capability to single large evaporator
- Provides predictive modeling and materials for tank closure decisions

WP 2 – Alternative Waste Pretreatment
$20.8M

Hanford	$8.8
Savannah River	$7.0
Idaho	$0.2
Oak Ridge	$1.4
Vitreous State Lab	$0.5
Other	$2.9

Challenges

- Accelerate tank waste treatment by using small, at-tank systems
- Increase incorporation of long-lived radionuclides in immobilized waste forms
- Remove glass-limiting, non-hazardous chemicals from waste to increase WTP efficiency
- Obtain reliable data without physical sampling

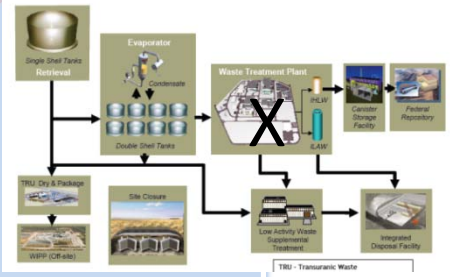


Possible Solutions

- Develop At-Tank/Near-Tank processing to provide supplemental waste treatment capability
- Develop approaches for managing Technetium during processing
- Develop in-situ tank characterization technologies
- Develop advanced separation technologies to address key waste constituents (aluminum, sodium and sulfate removal; Lithium Hydrotalcite process for sodium removal, beginning with bench-scale testing)

Benefits

- Decrease WTP mission duration
- Reduce or eliminate second LAW facility
- Increase WTP efficiency
- Reduce amount of glass produced, thus reducing disposal costs
- Minimize releases to Hanford soils and groundwater
- Reduces worker exposure and gives real-time data for process control



WP 3 - Advanced Unit Operations and Scaling
$3.6M

Hanford	$2.1
Savannah River	$0.8
Other	$0.7

Challenges

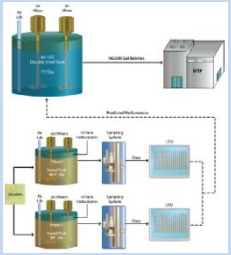
- To predict waste transport and mixing properties
- Validated waste simulants that mimic the actual waste for large-scale testing

Possible Solutions

- Develop advanced multi-phase mixing methods
- Develop simulants to enable design verification

Benefits

- Optimizes WTP flowsheet by reducing over-conservatism
- Increases WTP flowsheet flexibility
- Allows for validated testing on large-scale equipment

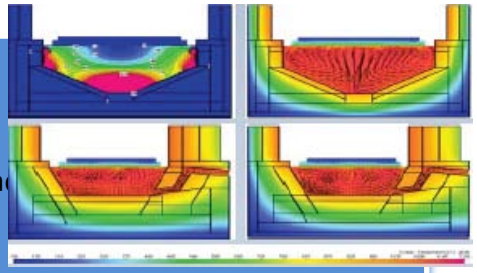


WP 4 - Improved Vitrification Capacity
$8.5 M

Hanford	$4.5
Savannah River	$1.3
Idaho	$1.1
Vitreous State Lab	$1.4
Other	$0.2

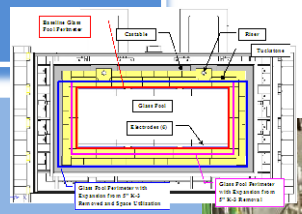
Challenges

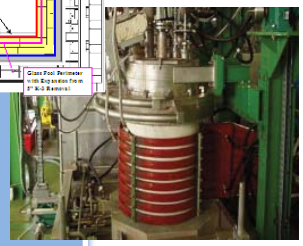
- Next generation melters are needed to increase WTP throughput
- Develop understanding a process tools for maintaining cold cap on melt surfa



Possible Solutions

- Develop next-generation melters such as advanced joule-heated melter and cold crucible induction melter
- Develop advance process understanding of cold-cap chemistry





Benefits

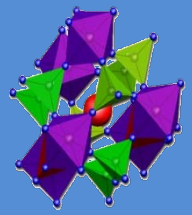
- Increase WTP efficiency by increasing melter throughput and increasing waste loading
- Increase flexibility in alternative waste forms
- Increase steady state operations by reducing process upsets

WP 5 - Increased Waste Loadings
$7.7 M

Hanford	$2.2
Savannah River	$2.3
Idaho	$0.1
Vitreous State Lab	$1.7
Other	$1.4

Challenges

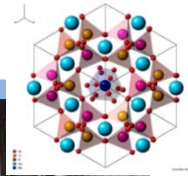
- Reduce total amount of glass by increasing waste loaded into the glass
- Develop treatment options for broader range of wastes including selected LAW's



iron phosphate local structure

Possible Solutions

- Increase waste loading to reduce the total amount of glass produced
- Develop Alternative Treatment and Disposal Processes



Benefits

- Increases WTP efficiency by increasing waste loading into glass without effecting melt rates.
- Reduces the amount of additional LAW capacity needed
- Provides another waste form for immobilizing waste from entering the environment

Develop Advanced Glass Formulations to Increase Waste Loading and Melt Rate

- ***Phosphate Glass Development and Demonstration:*** The initial focus will be on application of these glasses for Hanford LAW immobilization with some effort on immobilizing Hanford or Savannah River HLW.
    1. Develop phosphate glass formulations that can simultaneously meet processing and product quality requirements for Hanford LAW and HLW immobilization
    2. Develop and demonstrate a process for implementing these glasses in melters similar to those currently employed at Hanford [or determine if the next generation melters will be needed to produce these glasses]
    3. Determine the potential benefits and costs for implementing iron phosphate glasses
    4. Begin the effort to qualify phosphate glasses for disposal on site at Hanford.

- ***Advanced Silicate Glass Development and Demonstration*:** Recent developments in advanced silicate glasses suggest that step function improvements in HLW and LAW loading in glass are possible.
    1. Develop crystal tolerant glasses for HLW where sparingly insoluble components such as Cr are allowed to crystallize in the melter but are passed out of the melter before accumulating in a sludge layer
    2. Develop and demonstrate glasses with significantly higher Al content than what would be allowed by the current nepheline precipitation constraints as well as a corresponding revision to those constraints.
    3. Develop and test very-low silica glasses for ultra-high waste loadings..

Rotary Microfiltration

At-tank processing will require solid/liquid separation technology. The rotary microfilter (RMF) is a very promising technology for concentrating slurries as an improvement to the baseline technology of crossflow filtration. This project will complete design and construction of rotary microfiltration system for full scale pilot platform for simulants.

1. Complete Savannah River-based sludge simulant washing demonstration and complete long-duration (1000 h) run. Deliver full scale unit drawings.

2. Prepare and conduct additional 100-h tests on the full scale unit using a range of Savannah River sludge simulants.

3. Prepare and conduct additional 100-h tests on the full scale unit using simulants based on Hanford composition and physical properties.

4. Perform actual waste with Hanford Actual Waste using single-disk unit at 222-S.

Technetium Work

Improved Retention of Tc in LAW

The percent of Tc that is retained in the LAW glass in a single pass through the melter varies from 0 to 80% with an average value near 35%. As roughly 95% of the Tc in the Hanford tanks ultimately partitions to the LAW stream, this retention factor controls to a large extent the partitioning of Tc throughout the Hanford flowsheet. The fraction of Tc retained in LAW glass is determined by cold-cap reactions and is dependent on feed chemistry, redox conditions, and melter operating parameters. If methods to maintain a high fraction of Tc were to be developed, the rest of the process would have less Tc to manage opening many possible Tc management solutions.

- The scope of this task is to develop a better understanding of those reactions that lead to the volatility of Tc in the LAW melter and develop predictive models to control Tc partitioning.
  - FY10: Evaluate existing LAW glass partitioning information
  - FY11: Issue plan for to improve Tc retention in WTP LAW glass
    Complete Tc and Re tests in small scale melters
  - FY12: Complete scale-up cold-cap model confirmation tests

Tc Removal using Goehtite Precipitation

The loading of LAW in glass is reduced by recycle of LAW vitrification off-gas scrub solution. This recycle cannot currently be diverted to secondary waste because of the ^{99}Tc impacts on the durability performance of the waste form in the integrated disposal facility. If the Tc were precipitated as Goethite – (Tc,Fe)OOH – it could be diverted to the HLW stream .

- Testing will focus on developing a process to efficiently remove the Tc from various liquid streams and feed the goethite to the WTP as a HLW solid. .
  - FY10: Complete melter test with Re simulant goethite ppt product
  - FY11: Evaluate process options and complete systems analysis report
  - FY12: Complete pilot scale process test with Re simulant

Improve Retention in Secondary Wastes

Develop and test methods to incorporate Tc^{IV} (or other reduced state) into minerals that resist pore water corrosion and oxidation in low-temperature waste forms. This activity will work with the team currently testing secondary waste forms