SRS Citizens Advisory Board

Liquid Waste System Plan Revision 21

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Department of Energy – Savannah River
Waste Disposition Programs Division
### Purpose

- Present Topic requested by the CAB
- Support other topics to be presented in 2019

<table>
<thead>
<tr>
<th>Topic</th>
<th>Work Plan Item:</th>
<th>Description:</th>
<th>Recommendation Deadline:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 1</td>
<td>Work Plan Item:</td>
<td>Demonstration of ion exchange technology to remove cesium out of salt waste will be executed with a Tank Closure Cesium Removal Unit in FY2019 followed by a feasibility study to determine technical viability and cost effectiveness. From a community perspective, provide recommended prioritization of implementing a second TCCR Unit vs. other perceived needs either within LW or elsewhere.</td>
<td>July 2019</td>
</tr>
<tr>
<td>Topic 2</td>
<td>Work Plan Item:</td>
<td>Liquid Waste Operations Update</td>
<td>January 2020</td>
</tr>
</tbody>
</table>

| | | Report status of Liquid Waste facilities and projects to provide information to the public. | |

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Acronyms

- ARP – Actinide Removal Process
- BWR – Bulk Waste Removal
- D&D – Decontamination and Decommissioning
- DWPF – Defense Waste Processing Facility
- ETP – Effluent Treatment Facility
- FTF – F Tank Farm
- HLW – High Level Waste
- HTF – H Tank Farm
- KCi – thousands of curies
- LLW – Low Level Waste
- LW – Liquid Waste
- MCU – Modular Caustic Side Solvent Extraction Unit
- Mgal – millions of gallons
- SDU – Saltstone Disposal Facility
- SRR – Savannah River Remediation (current Liquid Waste Contractor)
- SWPF – Salt Waste Processing Facility
- TCCR – Tank Closure Cesium Removal
Agenda

- Liquid Waste Overview
- System Planning process
- Inputs for Rev 21
- Results
Why Do We Need a Liquid Waste Program?

Volume
- 16.2 Mgal (46%)
- 32.2 Mgal (92%)
- 16.0 Mgal (46%)
- 2.8 Mgal (8%)

Salt Supernate

Saltcake

Sludge

Curies
- 120 MCI (48%)
- 132 MCI (53%)
- 12 MCI (5%)
- 116 MCI (47%)

35.0 Million Gallons (Mgal)

248 Million Curies (MCI)

Inventory values as of 2018-12-31
Waste Storage Tank Types

Type I
- 90" Earth Cover
- Primary Tank Jet
- Cooling Coils
- 24'-6" Height
- 750,000 gallons

Type II
- 27'-0" Height
- 1,030,000 gallons

Type III
- Cooled Waste Storage Tank, Type III (Stress Relieved Primary Liner, Original 1,500,000 gallons)

Type IV
- Construction Opening (90" diameter)
- Single Liner (no annulus)
- Waste Storage Tank, Type IV (Stress Relieved Liner, Original 1,300,000 gallons)
Waste Tank Under Construction

Tanks were built at grade and then backfilled with dirt to provide shielding

<table>
<thead>
<tr>
<th>Type</th>
<th>Const. Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1951–1953</td>
</tr>
<tr>
<td>II</td>
<td>1955–1956</td>
</tr>
<tr>
<td>IV</td>
<td>1958–1962</td>
</tr>
</tbody>
</table>
F – Tank Farm
Liquid Waste Operations Overview

170 acres
3 miles in length

Inter-Area Line (2.2 miles)

Saltstone Processing/Disposal Facilities

5WPF

DWPF

H-Tank Farm

Effluent Treatment Project

F Tank Farm
• 22 tanks
• 1 evaporator (2F)

Inter-Area Line (2.2 miles)
• Pump pits at each end
• Diversion boxes at each end and at high point in the middle

H Tank Farm
• 29 tanks
• 2 evaporators (2H & 3H)
• Volume reduction and pre-treatment occurs in H Area
SRS Liquid Waste Program

Legend:
- ARP: Actinide Removal Process
- BWRE: Bulk Waste Removal Efforts
- DWPF: Defense Waste Processing Facility
- ISS: Interim Safe Storage
- MCU: Modular Caustic Side Solvent Extraction Unit
- TCCR: Tank Closure Cesium Removal
- SWPF: Salt Waste Processing Facility

Operational Goals:
- Radionuclides to glass
- Chemicals to Saltstone
- Tanks cleaned and operationally closed

51 Tanks
- 8 grouted & operationally closed
- 1.2 million curies immobilized in grout
- 5 BWRE complete
- 66% empty or grouted (old style)
- 23% empty (new style)

43 tanks
- 35 Mgal
- 248 MCI

8 Tanks
- Cleaned and Closed
- <1% radionuclides remain in tanks

Salt Processing

Salt waste
- 9.9 Mgal treated

Recycle

Sludge waste
- 4.3 Mgal treated

ARP

Most radionuclides
- to glass

Pour 4,179 cans of projected 8,170
- 61.2 million curies immobilized in glass

DWPF

Salstone Disposal Facility

<1% radionuclides to saltstone

17.2 Mgal LLW dispositioned
- containing 734 kCi
- (>35 Mgal grout)

ISS

(SRF) in Testing & Commissioning

2018-12-31

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Safe storage, treatment, and disposition of SRS liquid waste requires synchronization of several highly interdependent nuclear facilities and chemical operations.
Waste Retrieval

- Processing 1.0 gallon of settled sludge increases new style tank inventory by 1.3 gallons.
- One tank full of saltcake (1.3 million gallons) dissolves into more than 3 tanks full of dissolved salt.

Storing Waste

16 Older Style
27 New Style

8 Closed Tanks (Older Style)
51 Total

Removing Waste from Tanks

Water and Liquid Waste

Is focused on the Old Style Tanks first as space in new style tanks allows.
## SWPF and DWPF Feed Preparation

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="#" alt="Salt Batch Preparation" /></td>
<td><img src="#" alt="Sludge Batch Preparation" /></td>
<td><img src="#" alt="Tank Preparation" /></td>
<td><img src="#" alt="Install" /></td>
<td><img src="#" alt="Ready to Feed to SWPF" /></td>
</tr>
</tbody>
</table>

- **Salt Batch Preparation – Req’d for SWPF Feed**
  - Tank Preparation for Waste Removal
  - Design & Procure Dissolution Equipment
  - Dissolve & Salt
  - Ready to Feed to SWPF

- **Sludge Batch Preparation – Req’d for DWPF Feed**
  - Tank Preparation for Waste Removal
  - Design & Procure Sludge Removal Equipment
  - Install Sludge Removal Equipment
  - Assemble & Batch
  - Sludge Washing & Batch Qualification
  - Ready to Feed to DWPF
# Sludge Processing

## Immobilize Waste for Disposal

### Removing Sludge Waste from Tanks

- Water and Liquid Waste

### Defense Waste Processing Facility

- World's largest vitrification plant
- Entire 35 million gallons of waste awaiting disposition has about 248 million Curies of radioactivity
- Almost all radioactivity from waste dispositioned via DWPF
  - Over 61 million Curies to date
- Over 4,180 canisters filled since 1996

### Interim Storage of Canisters

- DWPF Glass Waste Storage Buildings (GWSB)
  - Seismically qualified underground concrete vaults
  - Designed for safe interim storage
- Existing storage capacity increased by 2,262 positions with Canister Double Stacking in GWSB#1
  - Total Storage Capacity: 6864
  - Total Positions Double Stacked to date: 553
  - Total Positions available: 2706
- Modular storage concept being considered for remaining cans ~2029
Salt Waste Processing

The vast majority of radioactivity from salt waste is sent to the DWPF.

Saltstone Facility

Over 99% of the volume is sent to Saltstone for disposal in concrete cells.

Removing Salt Waste from Tanks

Salt Waste Processing
- ARP/MCU (Interim)
- SWPF (Future)
- TCCR (Tech Demo)

Water and Liquid Waste
# Interim Salt Processing Facilities

## Modular Caustic Side Solvent Extraction Unit (MCU)

- Centrifugal Contactor Bank

## Actinide Removal Process (ARP)

- Actinide Removal Process/Modular Caustic Side Solvent Extraction Unit operational since April 2008
- Remove actinides, Strontium and Cesium (Cs-137) from salt waste
- Nominal operating capacity 1.5 Mgal/yr
- 6.9 million gallons treated to date
- Decontamination and throughput exceed initial expectations
- Completed service life extension program
- Completed installation of Next Generation Cesium Solvent in late 2014
- Providing operating experience for SWPF startup and initial operations
Future Salt Waste Treatment Capability

Salt Waste Processing Facility

This critical facility will:

- Reduce radioactive waste volume requiring vitrification
- Utilize the same actinide and cesium removal unit processes as Interim Salt Processing Facilities
- Ultimately process over 90% of Tank Farm liquid radioactive waste
- Commissioning and Startup testing in progress
**Saltstone**

<table>
<thead>
<tr>
<th>Saltstone Production Facility</th>
<th>Saltstone Disposal Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Vast majority of waste volume from tanks – but little radioactivity – left in SC</td>
<td>• Engineered low level waste disposal facility</td>
</tr>
<tr>
<td>• Curies left in SC are treated for disposal at the Saltstone Production Facility</td>
<td>• Grout is non-leaching and has low water permeability</td>
</tr>
<tr>
<td>- Salt solution stabilized by mixing with cement, flyash and slag</td>
<td>• Initial 12-cell rectangular vault (Vault 4) filled</td>
</tr>
<tr>
<td>- Resulting grout mixture mechanically pumped into concrete Saltstone Disposal Units (SDUs)</td>
<td>• Saltstone Disposal Unit (SDU) - 2 – modern watertight design – now full</td>
</tr>
<tr>
<td>• Safely processed over 12.3 Mgal of low-level radioactive liquid salt wastes into grout (21.8 Mgal) containing approximately 470 KCi of radioactivity</td>
<td>• SDU 3 and 5 completed and being filled</td>
</tr>
<tr>
<td></td>
<td>• Completed construction 3rd generation SDU-6</td>
</tr>
</tbody>
</table>

![Saltstone Production Facility](image1)

![Saltstone Disposal Facility](image2)
Completion of SDU 6 construction, which cost $120 million, comes in 18 months ahead of the target schedule and more than $20 million under the target cost.
Tank Closure Progression

Tanks 1, 2, 14, 21, 22, 23, 24

BWR (saltcake) development

Tanks 3, 9, 10, 13

Sludge Hub Tank

Hub Tank

Tanks 4, 7, 8, 11 & 15

8 tanks operationally closed
5 more active

Legend:

- **a** May not be required if no appreciable material remains in tank after BWRE
- **b, c** Not applicable for Type IV tanks. May be performed as part of heel removal step
- **c** May not be required if no appreciable material exists

**Note:** Figure also applies to ancillary equipment/structures, as appropriate.

Tanks 5, 6, 12, 16, 17, 18, 19 & 20 complete
Saltstone Disposal Permit Special Conditions

1. Implement objectives of LW Strategy
2. Only Tank 41 can be treated solely with DDA
3. Tank 48 cannot be aggregated w/o DHEC approval
4. Continue operation of DWPF
Liquid Waste System Planning

Supporting documents provide detailed bases for modeling inputs such as:
1. Sludge retrieval sequence
2. Sludge Batch recipes
3. Schedule durations
   - Heel removal
   - Chemical cleaning
   - Salt dissolution
   - Batch qualification
   - Tank grouting
4. ARP/MCU processing capacity
5. Recycle Management
6. Evaporator capacity

Key Assumptions
Technology Roadmap

Long Range

DOE & Site Strategic Plans
Project Execution Plan
Tank Closure Sequencing Plan
Sludge Batch Plan
DWPF Recycle Management Plan
Salt Sequencing Plan
Effluent Treatment Project Plan

Short Range

Emergent Opportunities
Update Frequency: 1 Week

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System Planning

Changes to System Plans are driven by:

• Advances in Technology
  – Increased utilization of Tank Closure Cesium Removal (TCCR) – slide 13
• Change in Sequencing
  – SWPF Startup date - slide 12
• Acceleration Opportunities
  – SWPF processing rate - slide 12
• Funding Adjustments – slide 10
• Changes to Regulatory Agreements
  – e.g., Dispute Resolution Agreement
• Realization of Risks/Equipment Failures
  – The 3H evaporator pot failed requiring repair
  – Melter #2 reached its end of life
  – Improved understanding of flammable gas generation has resulted in additional (more restrictive) controls in DWPF, the Tank Farms, and for Saltstone Disposal Units (SDUs)
Key Inputs

1. Priorities
2. Funding Profile
3. SWPF Startup date
4. SWPF processing rate
5. TCCR Assumptions
6. H-Canyon processing plan
Priorities for Rev 21

- Continual safe storage of liquid waste in tanks and vitrified canisters in storage.
- Complete LW System operational closure
- Complete operational closure of F Tank Farm
- Process liquid salt waste (e.g., dissolved salt solution, supernate) in FY16 through FY22 in accordance with the SCDHEC “Agreement”
- Remove the bulk of the waste in the Older Style H-Tank Farm tanks in the water table (i.e., Tanks 9, 10, 13, 14).
- Complete operational closure of the 1F Evaporator by the end of FY23.
Funding Assumptions for Rev 21

• FY19 funding is per the approved budget appropriation
• FY20 and beyond are determined by modeling
SWPF Assumptions (Revision 21)

- Hot Commissioning in March 2020
- First year (twelve months) of operations begins May 2020
- SWPF processes 6 Mgal during first 12 months of operations
- Next Generation Solvent is deployed after the first year of operations
- SWPF processes at a rate of 9 Mgal/year beginning in the second year of operations

Note: ARP/MCU will operate until 5 months prior to the SWPF Hot Commissioning date
## SWPF Assumptions (Revision 20 vs. Revision 21)

<table>
<thead>
<tr>
<th></th>
<th>Revision 20</th>
<th>Revision 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARP/MCU Shutdown Date</td>
<td>September 2018</td>
<td>November 2019*</td>
</tr>
<tr>
<td>Start of First Year of Operations</td>
<td>December 2018</td>
<td>March 2020</td>
</tr>
<tr>
<td>Processing Rate (1st Year)</td>
<td>4.6 Mgal/yr</td>
<td>6 Mgal/yr</td>
</tr>
<tr>
<td>Processing Rate (2nd Year)</td>
<td>7.2 Mgal/yr</td>
<td>9 Mgal/yr</td>
</tr>
<tr>
<td>Processing Rate (3rd Year)</td>
<td>7.2 Mgal/yr</td>
<td>9 Mgal/yr</td>
</tr>
<tr>
<td>Processing Rate (4th Year)</td>
<td>9 Mgal/yr</td>
<td>9 Mgal/yr</td>
</tr>
<tr>
<td>NGS Operations Starting</td>
<td>January 2022</td>
<td>May 2021</td>
</tr>
<tr>
<td>NGS Transition Outage</td>
<td>3 months</td>
<td>Not required</td>
</tr>
</tbody>
</table>

* Last 2 months of ARP/MCU operations at reduced capacity for flushing
**TCCR Assumptions**

- A second TCCR (Unit #2) will be purchased and deployed in F-Tank Farm (FTF) and will begin processing dissolved salt on 10/1/21 at a rate of 1 Mgal/year.
- Once processing of FTF salt is completed, TCCR Unit #2 will be relocated to Tank 21 H-Tank Farm in FY26 and will continue processing dissolved salt at a rate of 1 Mgal/year.
- The TCCR demonstration processing Tank 10 dissolved salt will be successful.
- The current TCCR Unit #1 will be used to process dissolved salt from Tank 9 beginning 10/1/20.
- After processing Tank 9 dissolved salt, TCCR Unit #1 will be relocated to Tank 21 in FY23 and will continue processing dissolved salt at a rate of 1 Mgal/year.
Evaporators and DWPF Recycle

- 3H Evaporator continues to operate as-is performing general purpose evaporation
- DWPF recycle is diverted from the Tank Farm to ETP in April 2023
- 3H is shutdown in FY26

- 2H is converted to general purpose evaporation in FY24
- After salt processing is completed (FY30), one of the TCCRs is moved to HTF East Hill to process wash water from Tank 51 to Tank 50 enabling shutdown of 2H evaporator
Other Inputs

H-Canyon
- Continues to send waste to H- Tank Farm through FY30

Tank 48
- Technology Development (FY21 - FY22)
- Technology Deployment (FY23 - FY25)
- Treatment of Waste (FY26 - FY28)
- Heel Treatment and Closure (FY29 - FY31)

DWPF
- Canister production rate synchronized to salt processing rate
Results

• F-Tank Farm waste removal complete and inter-area line cut in December 2030
• SWPF Operations complete December 2030
• F-Tank Farm operationally closed June 2033
• H-Tank Farm waste removal complete September 2034
• DWPF waste processing complete September 2034
• 44 of 51 tanks operationally closed by September 2035
• Last tank operationally closed/Program complete March 2037
## Results – Comparison to Revision 20

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rev 20, Case 1</th>
<th>Rev 21,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date SWPF begins hot commissioning</td>
<td>Dec 2018</td>
<td>March 2020</td>
</tr>
<tr>
<td>Date last LW facility turned over to D&amp;D</td>
<td>2041</td>
<td>2037</td>
</tr>
<tr>
<td>Final Type I and II tanks complete operational closure</td>
<td>2033</td>
<td>2030</td>
</tr>
<tr>
<td>Complete bulk sludge treatment</td>
<td>2031</td>
<td>2031</td>
</tr>
<tr>
<td>Complete bulk salt treatment</td>
<td>2032</td>
<td>2031</td>
</tr>
<tr>
<td>Complete heel treatment</td>
<td>2036</td>
<td>2034</td>
</tr>
<tr>
<td>TCCR for supplemental salt waste treatment</td>
<td>1 unit Jan 2022</td>
<td>2 units May 2021</td>
</tr>
<tr>
<td>Next generation solvent for increased SWPF throughput</td>
<td>8,170</td>
<td>8,121</td>
</tr>
<tr>
<td>Year supplemental canister storage required to be ready</td>
<td>2029</td>
<td>2030</td>
</tr>
<tr>
<td>Radionuclides (curies) dispositioned in SDF within the amended SRS LW Strategy</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Total number of SDUs</td>
<td>14</td>
<td>13</td>
</tr>
</tbody>
</table>
Questions