SAVANAH RIVER SITE
TANK 12 GROUTING

December 12, 2017

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SRR-CWDA-2017-00087, Revision 0
Liquid Waste System

- Saltstone Production/Disposal Facilities
- Salt Waste Processing Facility
- Defense Waste Processing Facility & Glass Waste Storage Buildings
- Effluent Treatment Facility
- H-Tank Farm
- Inter-Area Line (2.1 miles)
- F-Tank Farm
H-Tank Farm

Tank 12H

Type I
Typical HTF Type I Tank Cross Section

- Typical Annulus Riser
- Center Riser
- Typical Tank Riser
- 9’-0” Earth Cover
- 2’-0” Roof (Tank Top)
- 3’-6”
- 1’-10”
- 0.5” Primary Tank Wall
- 12 Ea. 2’-0” Columns
- 1’-10” Wall
- 5’-0”
- 0.5” Primary Tank Roof
- 24’-6” (Radius 37’-6”)
- 2” Cooling Coils
- 0.5” Secondary Tank Liner/Pan
- 3” Grout Layers
- 2’-6” Annulus (interior width)
- Dehumidification Duct
- 75’-0” Primary

[NOT TO SCALE]
H-Tank Farm Type I Tanks
Type I Tanks’ Elevation vs. Water Table Elevation

- Ground Elevation
- Water Table Elevations
- Tanks (9, 10, 11, 12)
- Tank Top Elevation (269.8 ft above MSL)
- Working Slab

<table>
<thead>
<tr>
<th>Time (year)</th>
<th>MSL Elevations (ft)</th>
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<tbody>
<tr>
<td>1975</td>
<td>235</td>
</tr>
<tr>
<td>1980</td>
<td>240</td>
</tr>
<tr>
<td>1985</td>
<td>245</td>
</tr>
<tr>
<td>1990</td>
<td>250</td>
</tr>
<tr>
<td>1995</td>
<td>255</td>
</tr>
<tr>
<td>2000</td>
<td>260</td>
</tr>
<tr>
<td>2005</td>
<td>265</td>
</tr>
<tr>
<td>2010</td>
<td>270</td>
</tr>
<tr>
<td>2015</td>
<td>275</td>
</tr>
</tbody>
</table>
The Performance Assessment (PA) simulates fate and transport of contaminants associated with residual material in the closed tanks. PA assumptions are supported by the grout properties/processes.

<table>
<thead>
<tr>
<th>PA Assumptions</th>
<th>Grout Properties/Processes Protection Assumptions</th>
</tr>
</thead>
</table>
| Waste Tank Stability/Physical Barrier to Intruders | • Minimize void space  
  • Maintain compressive strength  
  ▪ Avoid segregation (drop height) |
| Flow Modeling                        | • Avoid cracks/voids that increase flow through the grout monolith.  
  ▪ Grout fill remnant equipment  
  ▪ Grout fill cooling coils  
  ▪ Grout fill annulus and ductwork  
  • Maintain roof integrity - Grout fill risers |
| Reducing Capacity                    | • Grout formulation                                                                                                   |
Flow Modeling

Avoid conditions that increase flow through the grout monolith
The Isolation Plan included:

- Transfer Lines
- Drain Lines
- Water
- Air
- Steam
- Ventilation
- Power
- Instrumentation
Tank 12 Transfer Line Isolation

Before

After
Grout Preparation - Tank System Isolation

Tank 12 Chromate Cooling Water Supply and Return Lines in Valve House

Before

After
Tank 12 Valve House Alarm/Relay Panel Isolation

9 - Conductor #14AWG cable to be isolated. Cable is routed to terminal blocks in 1H Control Room

Cables cut and taped

Relays removed
Tank 12 Radiation Monitor Power Cable

**Before**

Located On Tank Top

**After**

OOC PER E-DCP-H-14011
ISOLATION POINT 15
Grout Preparation

Tank 12

Notes:
1. Tank is to scale. Surrounding road and grout pump/hoop are not to scale and are shown for illustration only.
2. The slickline shall be supported at least every 10 ft by either unistrut or scaffolding.
3. Slickline has maximum length of 291 ft. This distance is measured from the grout pump to Riser 8, then to Pigg ing Container 2. For conservatism, 300 ft will be the maximum length.
4. The structural steel is 8' above the tank top and helps support the slickline. The slickline rests on either Scaffolding or PS-200 Unistrut on top of the structural steel and tank top.
5. Slickline route may vary within ±10 ft from proposed Slickline route variations must be approved by engineering.
6. Slickline will conform to ACI 304.2R and ASME B30.27 standards.
7. Slickline full of grout weighs approximately 42lbs/ft.

HTF-SKM-2015-00015, Rev B
Tank 12 Slickline Support Layout

Originator:
Matt Ostler 4/29/15

Reviewed by:

Closure Engineering

Slickline will be arranged to the primary tank risers or annulus.
Slickline routing down rock bank, per drawing C-CP-H-07863. Tank to risers. Slickline at the base of the rock bank 3 feet above ground line is across lower road, then elevated gradually to 5 feet above tank top. The slickline to east annulus riser will branch off main line and remain at 5 feet above tank top. At branch location, the main line slickline will be raised at an angle from 5 feet above tank top to an elevation of 14 feet, which is 5 feet above platforms. Line will remain elevated for all primary tank risers. Line will drop to 5 feet above tank top level for grouting of the west annulus riser.
Grout Preparation

- Tank 12 Slick Line Support Beam Installation at Rock Bank East of Tank 12
- Tank 12 Valve House Cooling Coils Prepared for Grouting
A Structural Analysis identified lift height limits to prevent tank wall failure:

1. Height of annulus grout above primary grout limited to ≤ 6 feet

2. Height of primary grout above annulus grout limited to ≤ 8 feet

Within these limits, lift heights were at the discretion of the grouting team and often influenced by resources and schedule.

Lesson Learned from previous tanks:
Provided more flexibility for lift heights.
• Grouting activities began on January 19, 2016.

• DOE documented completion of closure activities on April 28, 2016
Grout Delivery Route

Concrete Truck Ingress/Egress Route

Cleanout Station

Unloading Station

Testing and Accountability Entrance Station
Grout Testing Protocol

Grout Truck Arrival and Check-in:
- Every Truck
  - Batch Tickets (Multiple Verifications)
    - Grout mix
    - Timing < 90 minutes
    - Revolutions < 300
    - Point of delivery water additions
- Daily
  - First Batch & at least one truck after first 100 cubic yards
    - Molding Cylinders (7)
    - Compressive Strength (7 and 28-days)
    - Slump flow
    - Temperature
    - Unit weight/yield
    - Bleeding of grout
    - Air Content
- Additional testing frequency as determined by Construction Discipline Engineer (CDE)

Lesson Learned from previous tanks: Increased slump flow from 24-28 inches to 26-30 inches to provided better flow around obstructions.

Video of Grout Placement:
- Continuous during grout placement
Staged grout delivery trucks minimized delays in batch grout pours into the tank between trucks.

Lesson Learned from previous tanks: Minimal delays between batch pours reduced mounding.
Direct observation of grout delivery into the pump hopper provides visual indication that grout properties meet requirements.
The video screen console in the command center provides real time simultaneous observation of:

- Tank interior
- Grout pump hopper
- Tank top
- Delivery truck staging area
Bulk Fill Grout

Grout Flowing into Tank
Bulk Fill Grout

Camera

Grout Flowing into Tank
Daily Inspections

- Camera inspections of the grout surface were performed each morning prior to grouting.
- Localized surface cracks were identified on one occasion.
- The condition was evaluated and determined to not appreciably impact grout performance credited in the performance assessment:
  - Stability
  - Flow through tank
  - Reducing capacity
The relatively level surface of the grout as it approached the flat tank roof was important to minimize void space.

<table>
<thead>
<tr>
<th>Tank 12 Bulk Fill Grout Volume</th>
<th></th>
<th></th>
<th>+/-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated (yds$^3$)</td>
<td>3,927</td>
<td>3,887</td>
<td>-1%</td>
</tr>
<tr>
<td>Actual (yds$^3$)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annulus Grouting

- Bulk fill grout used to fill annulus
- Grout introduced into annulus through the East and West Risers
- Initial filling of horizontal ductwork through vertical section of ductwork
- In parallel with bulk filling of the annulus, the vertical sections of annulus ventilation inlet duct filled all the way to grade level with grout.

Tank 12H Annulus and Horizontal Ventilation Duct (West Riser)
## Annulus Grouting

Grout Flowing into Tank 12 Annulus

### Tank 12 Annulus Grout Volume

<table>
<thead>
<tr>
<th>Estimated (yds³)</th>
<th>Actual (yds³)</th>
<th>+/-</th>
</tr>
</thead>
<tbody>
<tr>
<td>583</td>
<td>613</td>
<td>+5%</td>
</tr>
</tbody>
</table>

02/11/2016 PM 12:13:26
## Tank Closure Grout Comparisons

### Estimated vs. Actual Grout Volumes

<table>
<thead>
<tr>
<th>Tank</th>
<th>PRIMARY</th>
<th>ANNULUS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimated (yds³)</td>
<td>Actual (yds³)</td>
</tr>
<tr>
<td>18</td>
<td>8,343</td>
<td>8,094</td>
</tr>
<tr>
<td>19</td>
<td>8,343</td>
<td>8,090</td>
</tr>
<tr>
<td>5</td>
<td>3,927</td>
<td>3,871</td>
</tr>
<tr>
<td>6</td>
<td>3,922</td>
<td>3,849</td>
</tr>
<tr>
<td>16</td>
<td>5,552</td>
<td>5,425</td>
</tr>
<tr>
<td>12</td>
<td>3,927</td>
<td>3,887</td>
</tr>
</tbody>
</table>
Grouting the Dehumidification Duct

Grout Flowing into the Annulus Dehumidification Ductwork Inlet
Grouting the Dehumidification Duct

Grout flowing out of duct registers indicates that section of duct is filled.
Water in Annulus Ductwork Inlet Being Removed Prior to Filling with Grout

- Liquid was observed in the vertical section of the inlet duct near the end of grouting.
- Liquid determined to be primarily groundwater inleakage.
- Liquid was removed to:
  - ensure grout properties were maintained and
  - prevent spill of contaminated liquid as grout addition pushed liquid to the surface.

Temporary Transfer Hose Used to Remove Water

Water in Annulus Ductwork Inlet
Cooling Coil Grouting

- Cooling coil grout is prepared using a commercial grout skid.
- Dry ingredients are premixed at vendor facility and delivered in a Super Sack®.
- SRR personnel batch a fixed amount of water with the contents of the Super Sack® (i.e., dry materials) and mix the contents.
- Pump is used to meter grout into cooling coils.
- Totalizer at flow meter provided real time quantity of grout added.
- Intact cooling coils grouted from the coil inlet. When grout was visually detected at cooling coil outlet, additional grout continued to be introduced for a prescribed volume.
- Grout/flush water interface volume from intact coils collected and disposed of separately.
- Coils having guillotine failure were previously flushed, coils grouted from each end (inlet and outlet) into the waste tank.
Equipment Grouting

- Equipment fill grout was prepared in small batches
- SRR personnel pre-mix dry ingredients by weight
- Water was combined with the dry materials as required, mixture is allowed to hydrate with low shear mixer
- High shear mixer engaged to finish grout mixing and thin the grout
- Grout was metered into equipment by gravity via hose and funnel
- Equipment has high point vent that collects overflow indicating filling complete
## Tank 12 In-Tank Equipment Grout Volumes

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Location</th>
<th>Calculated Fill Volume (Gallons)</th>
<th>Actual Grout Volume (Gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reel Tape Riser Plug Penetration</td>
<td>Riser 4</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td>High Liquid Level Conductivity Probe (HLLCP) and Housing</td>
<td>Riser 4</td>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Thermowell and Housing on Tank Floor</td>
<td>Riser 4</td>
<td>1.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Spray Lance</td>
<td>Riser 4</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>H&amp;V Riser Drain</td>
<td>Riser 4</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Submersible Transfer Pump (STP)</td>
<td>Riser 7</td>
<td>22</td>
<td>39</td>
</tr>
<tr>
<td>Thermowell</td>
<td>Riser 7</td>
<td>2.0</td>
<td>1</td>
</tr>
<tr>
<td>STP Caisson Lance</td>
<td>Riser 7</td>
<td>4.75</td>
<td>4</td>
</tr>
<tr>
<td>Conductivity Probe #1</td>
<td>North Annulus Riser</td>
<td>0.3</td>
<td>0.25</td>
</tr>
<tr>
<td>Conductivity Probe #2</td>
<td>North Annulus Riser</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Steam Jet (Core and Discharge Line)</td>
<td>North Annulus Riser</td>
<td>22.0</td>
<td>26.0</td>
</tr>
<tr>
<td>Steam Jet (Jacket)</td>
<td>North Annulus Riser</td>
<td>8.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Conductivity Probe #1</td>
<td>South Annulus Riser</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>Conductivity Probe #2</td>
<td>South Annulus Riser</td>
<td>0.2</td>
<td>0.25</td>
</tr>
</tbody>
</table>
Lessons Learned

• Increase capability to view grout elevation and liquid within the risers by removing obstructions (such as spray chambers) and installing grout plates for better camera positioning.

• Evaluate the use of dry grout to assimilate free liquid.

• Allow more time for liquid to assimilate into grout between lifts

• Prepare and stage work packages, procedures, and equipment to remove liquid from tank

• Evaluate alternate methods to prepare the grout line/tremmies to minimize liquid addition into tank

• Evaluate use of alternate instrumentation (conductivity probes) to detect grout/liquid level in tank