Savannah River Remediation
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December 12, 2017

SAVANAH RIVER SITE TANK 12 GROUTING

Steve Thomas, SRS Waste Disposal Authority

Greg Arthur, SRS Tank Closure Engineering

SRR-CWDA-2017-00087, Revision 0

Savannah River Remediation
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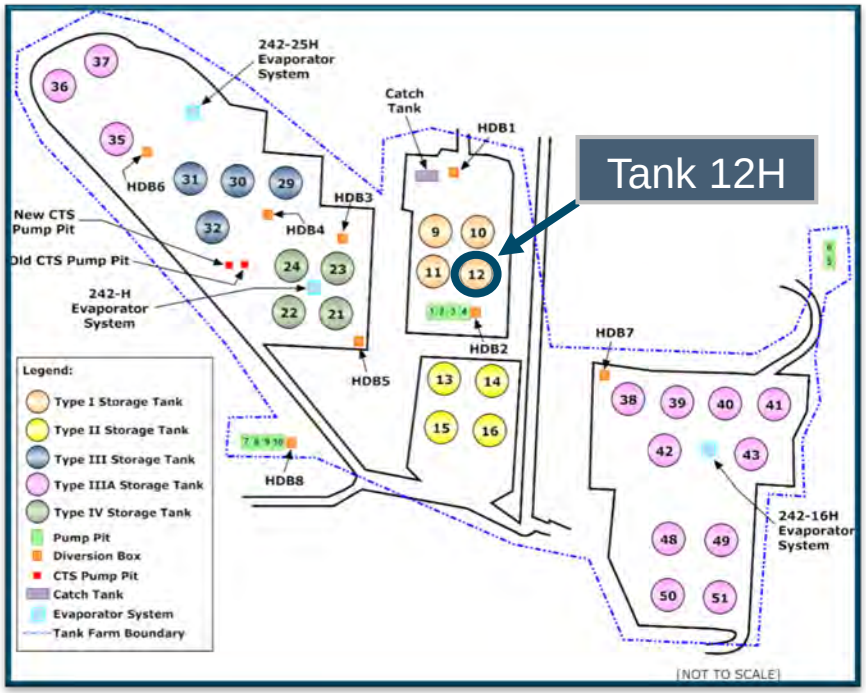
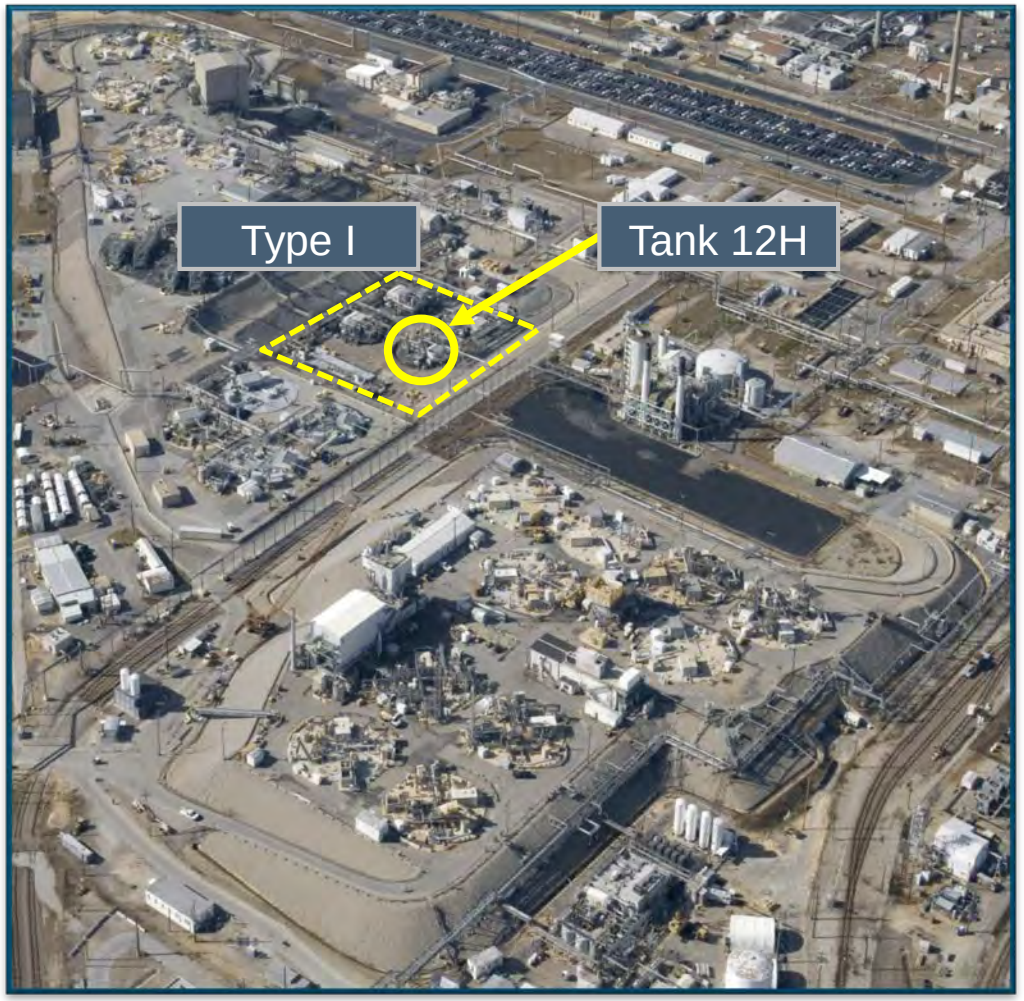
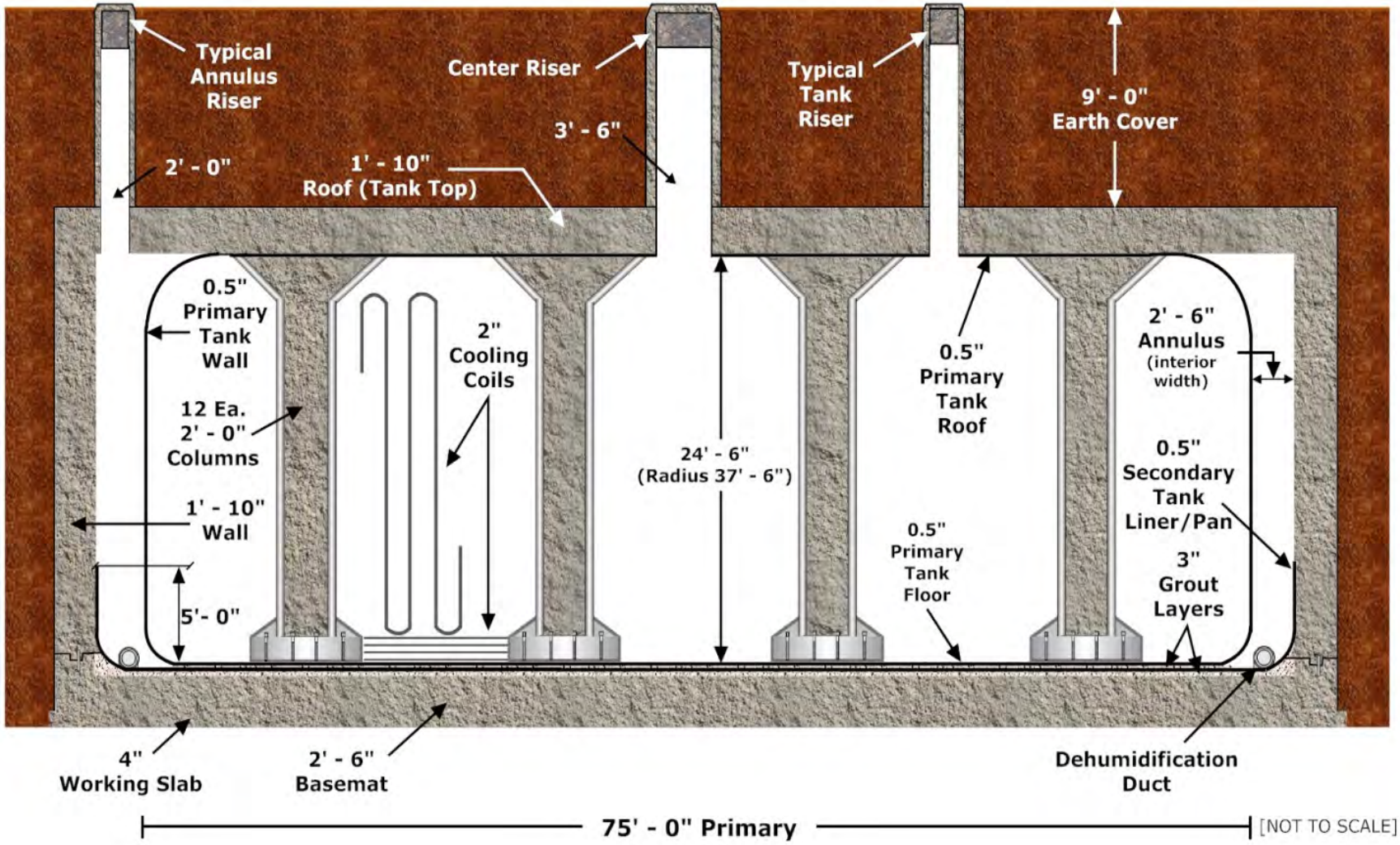
Liquid Waste Sysem

H-Tank Farm

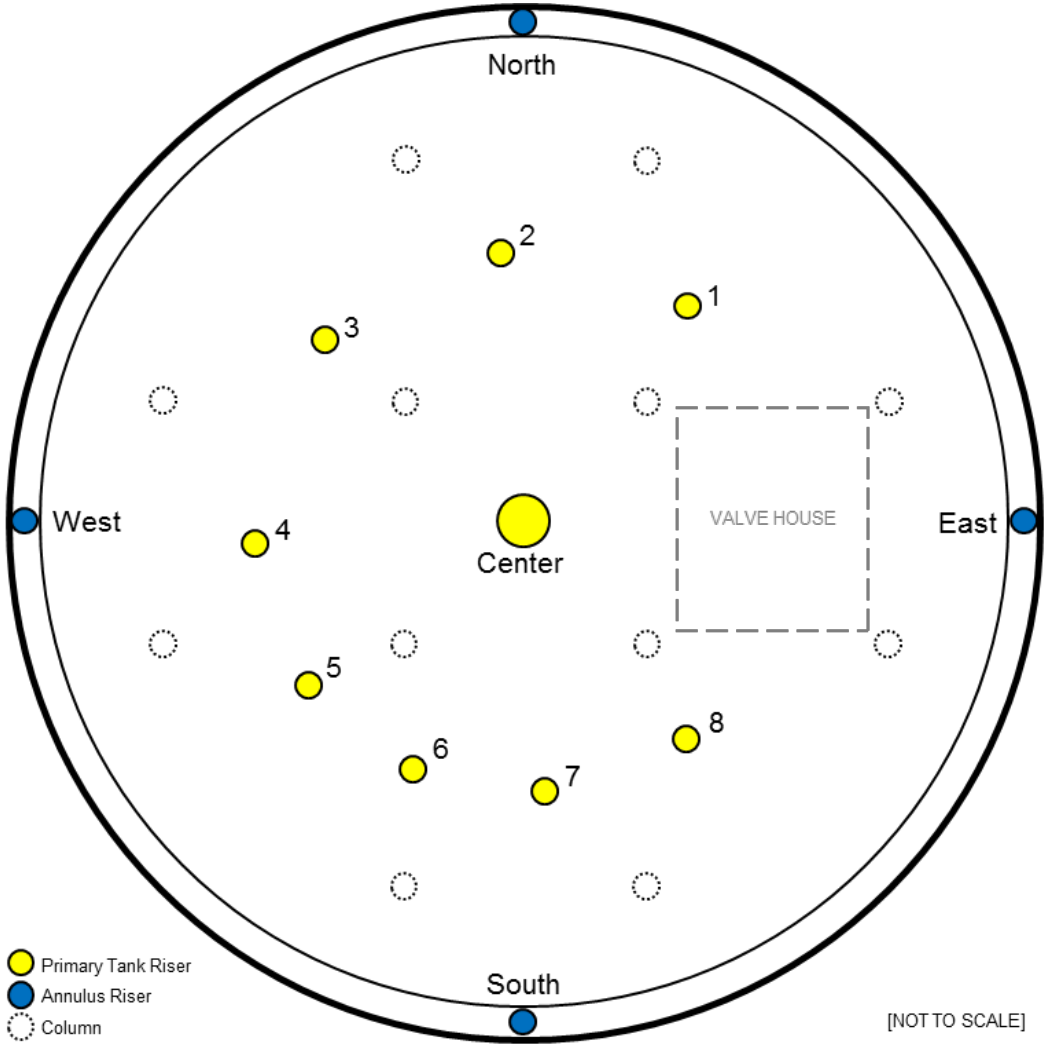

242-25H Evaporator System
Catch Tank
HDB1
Tank 12H
HDB6
HDB3
HDB4
New CTS Pump Pit
Old CTS Pump Pit
242-H Evaporator System
HDB2
HDB5
HDB7
HDB8
242-16H Evaporator System
Legend:
Type I Storage Tank
Type II Storage Tank
Type III Storage Tank
Type IIIA Storage Tank
Type IV Storage Tank
Pump Pit
Diversion Box
CTS Pump Pit
Catch Tank
Evaporator System
Tank Farm Boundary
[NOT TO SCALE]


Type I
Tank 12H

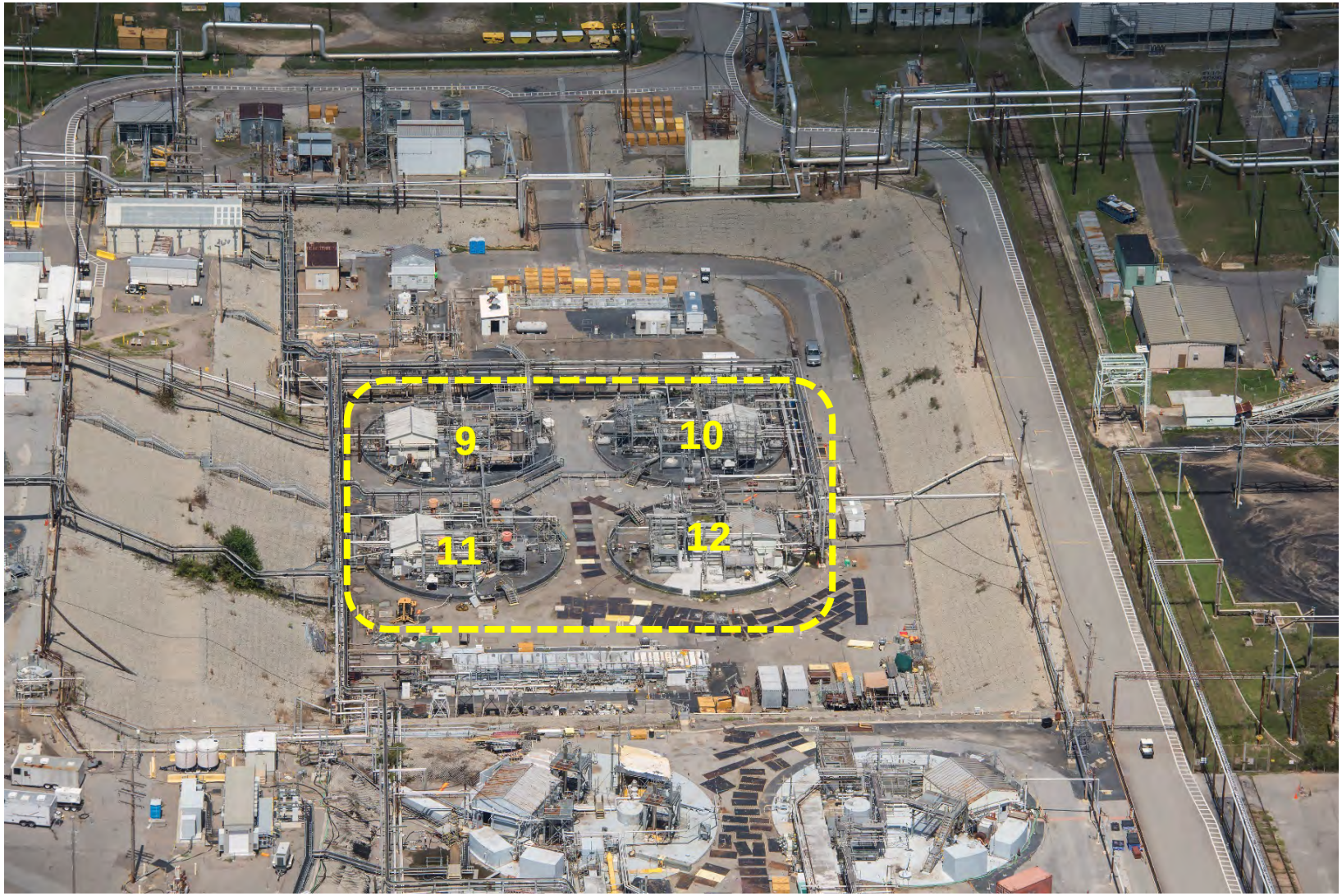
Typical HTF Type I Tank Cross Section



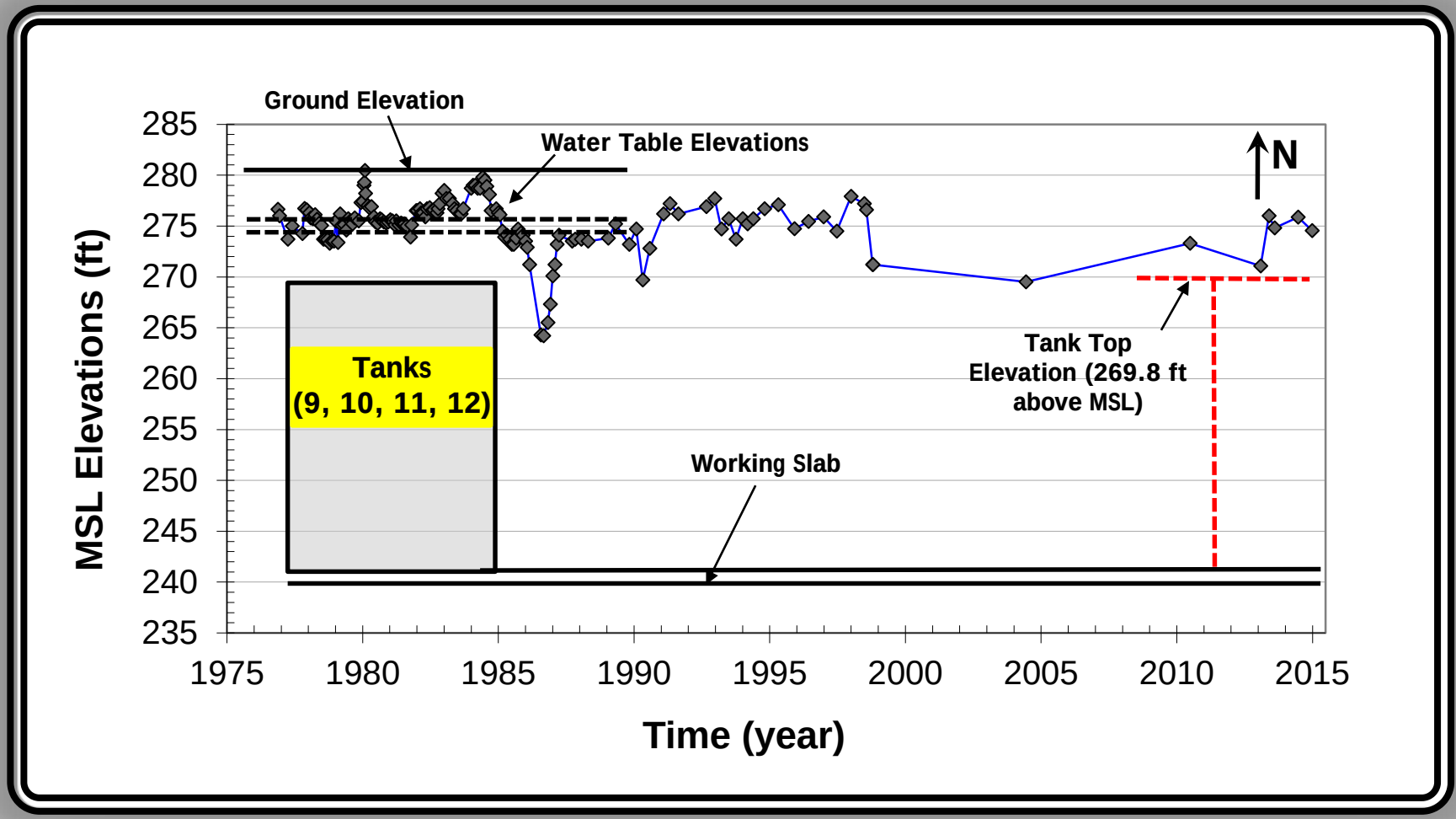
Typical HTF Type I Plan View



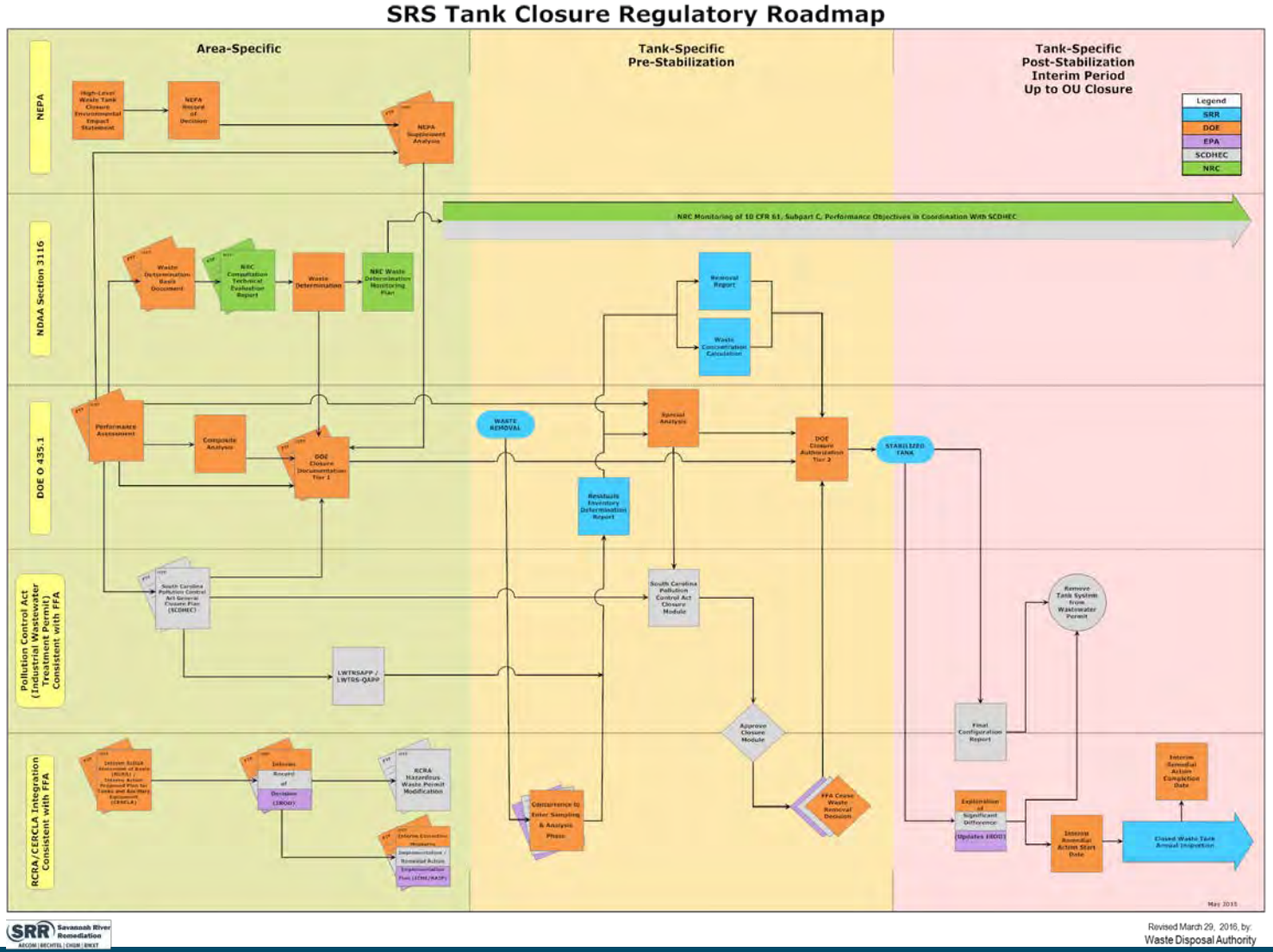
H-Tank Farm Type I Tanks



Type I Tanks' Elevation vs. Water Table Elevation



Tan Closure Regulatory Roadmap



Performance Assessment Assumptions for Grout

- 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

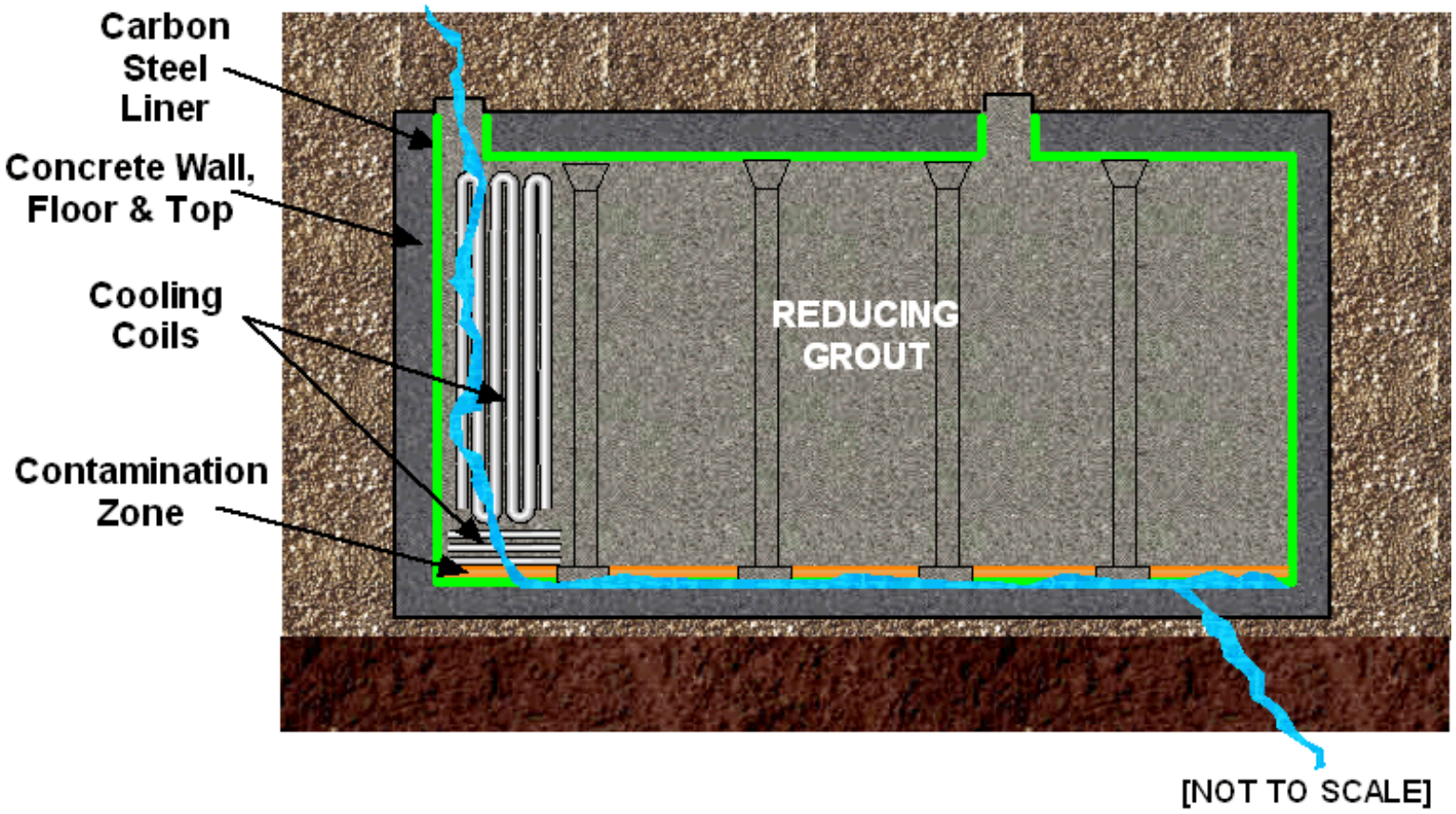
PA Assumptions	Grout Properties/Processes Protection Assumptions
Waste Tank Stability/ Physical Barrier to Intruders	• Minimize void space • Maintain compressive strength ▪ Avoid segregation (drop height)

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



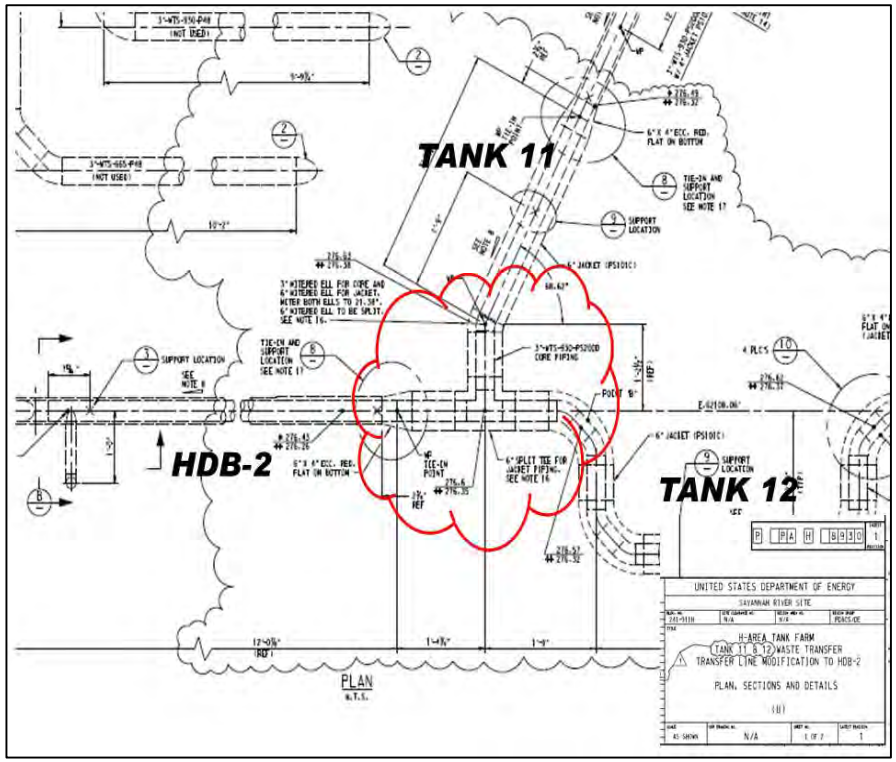
Grout Preparation – Tank System Isolation

The Isolation Plan included:

- Transfer Lines
- Drain Lines
- Water
- Air
- Steam
- Ventilation
- Power
- Instrumentation

Tank 12 Transfer Line Isolation

Before



After

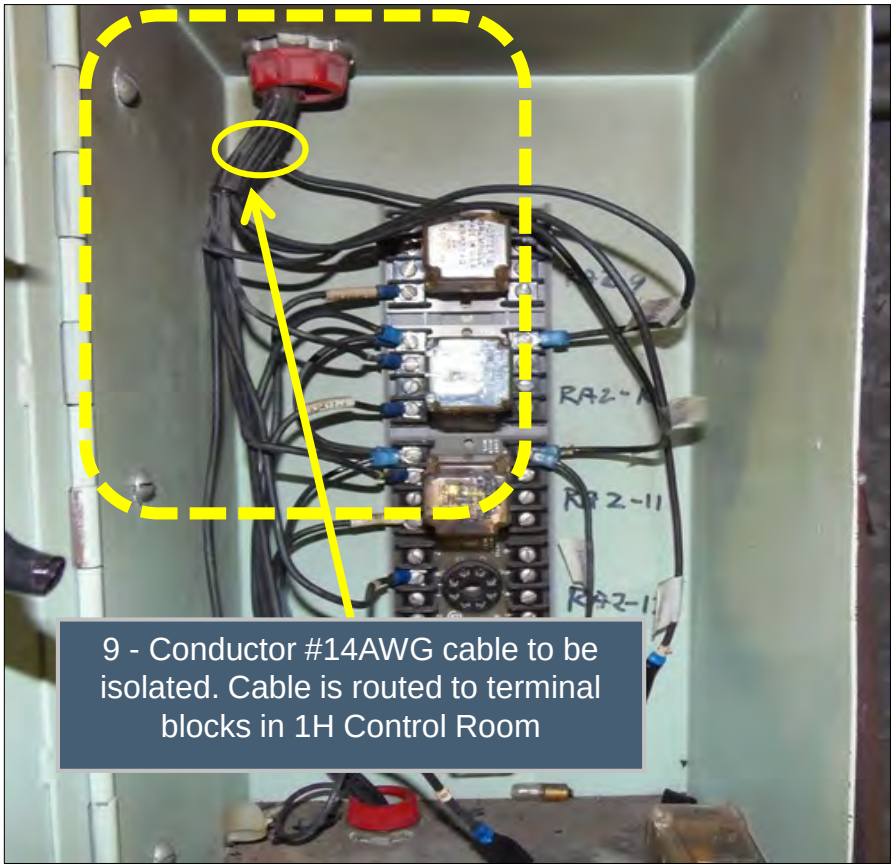
Tank 12 Chromate Cooling Water Supply and Return Lines in Valve House

Before

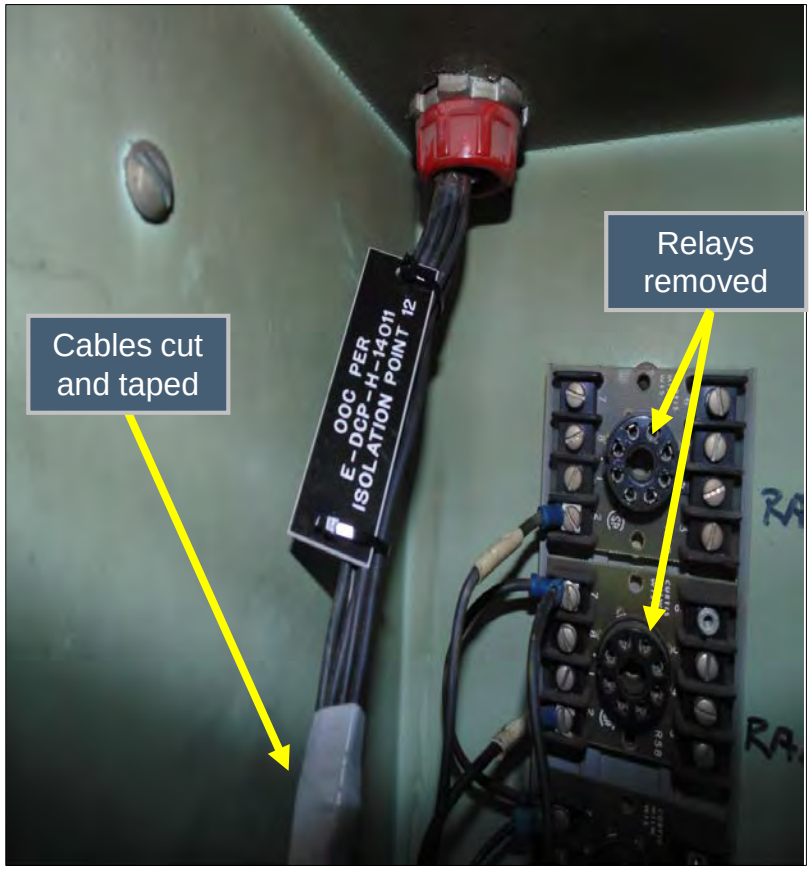
After

Tank 12 Valve House Alarm/Relay Panel Isolation

Before



After

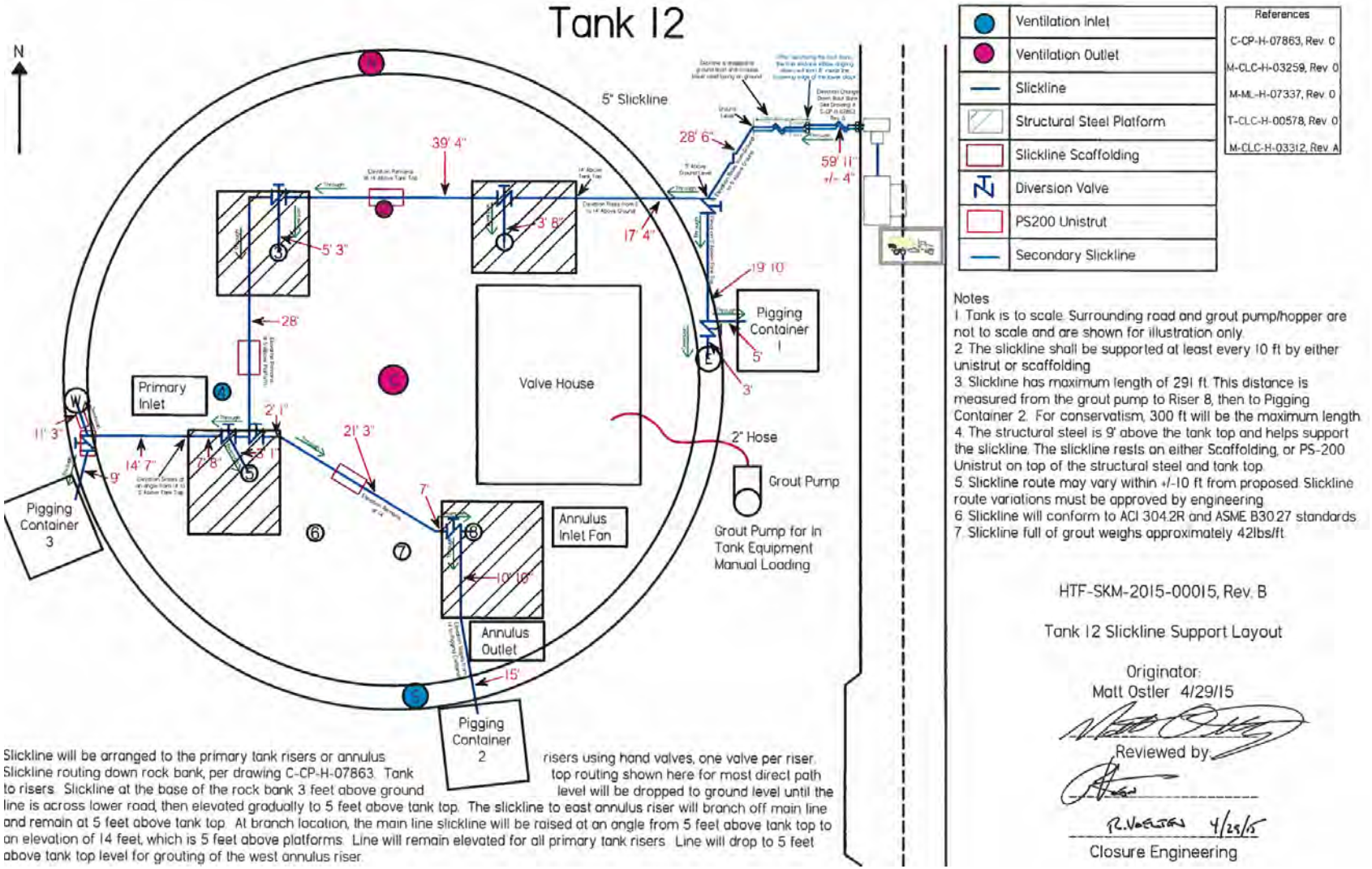


Tank 12 Radiation Monitor Power Cable

Before

After

Grout Preparation



Notes
1. Tank is to scale. Surrounding road and grout pump/hopper 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 Pigging Container 2. For conservatism, 300 ft will be the maximum length.
4. The structural steel is 9' 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:
R. Voelker 4/29/15
Closure Engineering

Slickline will be arranged to the primary tank risers or annulus risers using hand valves, one valve per riser. Slickline routing down rock bank, per drawing C-CP-H-07863. Tank top routing shown here for most direct path to risers. Slickline at the base of the rock bank 3 feet above ground level will be dropped to ground level until the 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

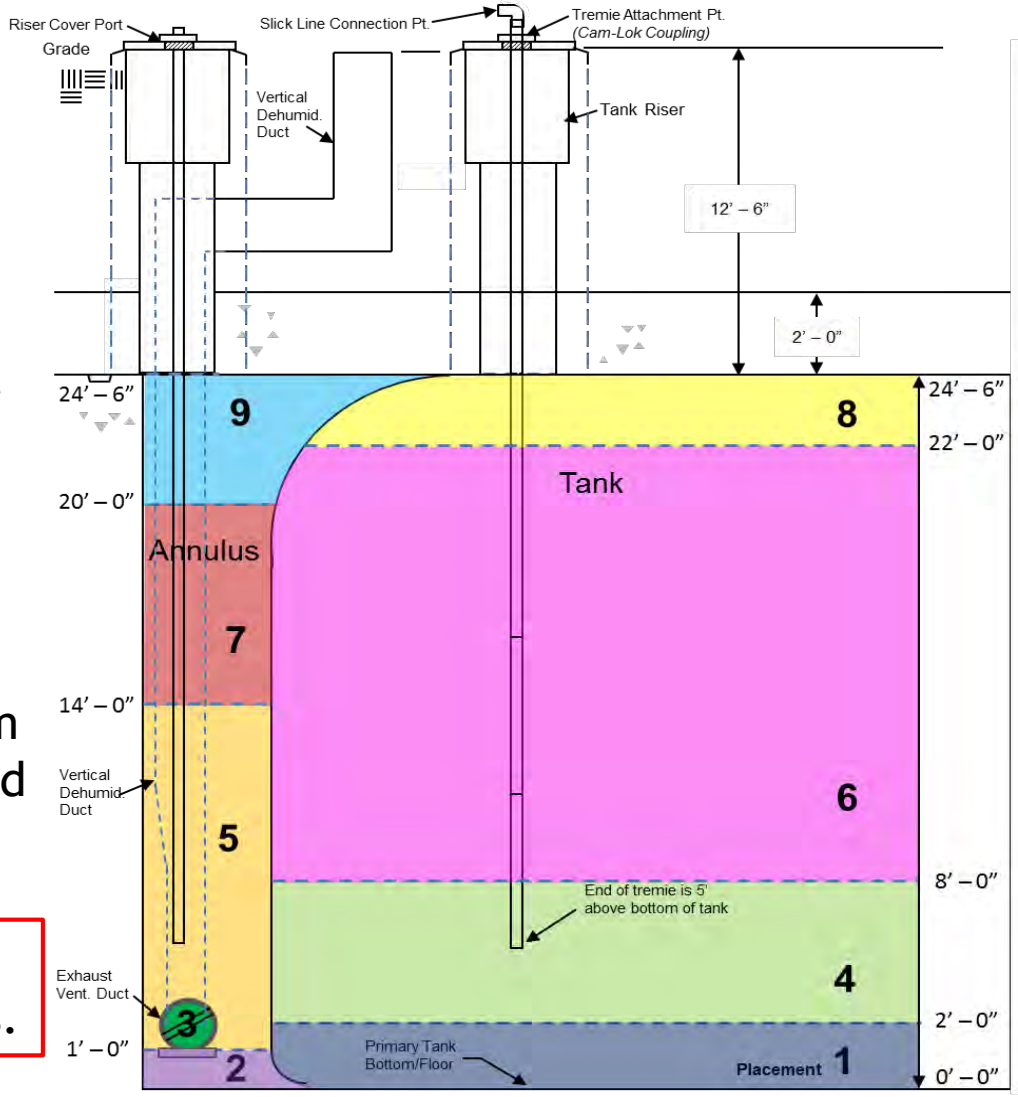
- Tank 12 Slick Line Support Beam Installation at Rock Bank East of Tank 12

- Tank 12 Valve House Cooling Coils Prepared for Grouting

Grout Sequence

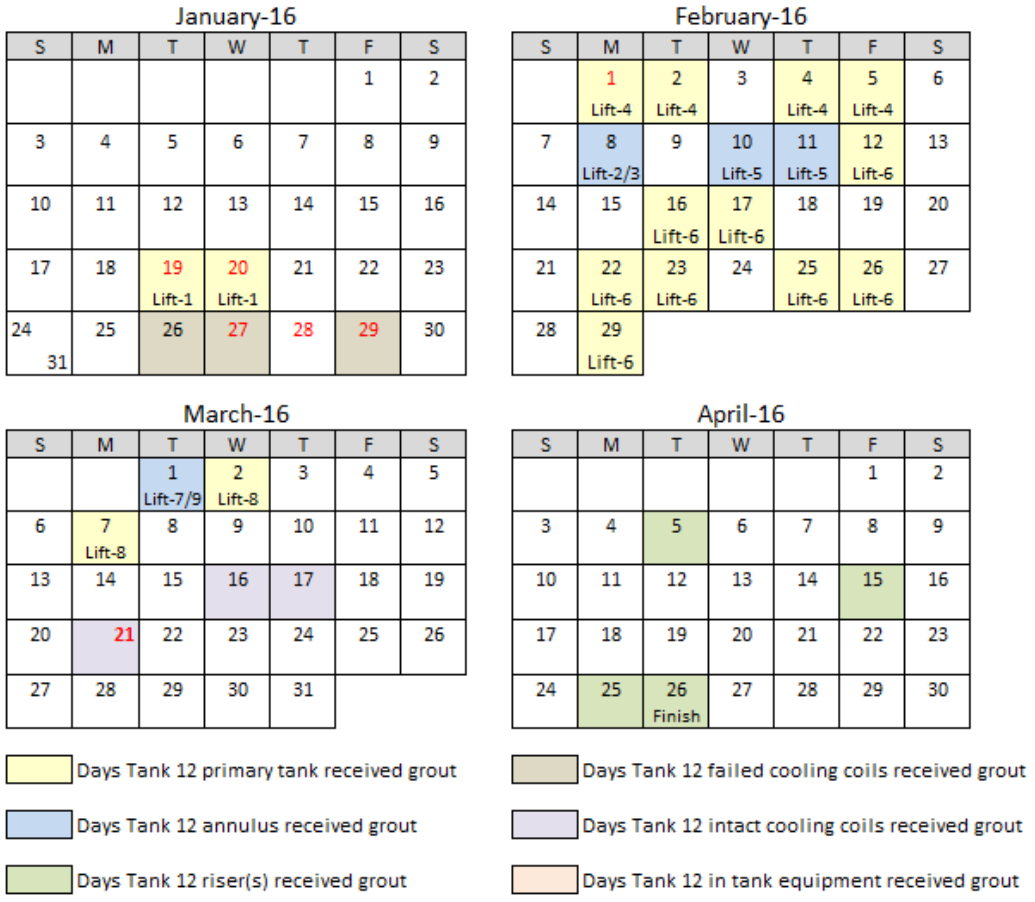
- A Structural Analysis identified lift height limits to prevent tank wall failure:
  1. Height of annulus grout above primary grout limited to ≤ 6 feet
  2. Height of primary grout above annulus grout limited to ≤ 8 feet
- Within these limits, lift heights were at the discretion of the grouting team and often influenced by resources and schedule.

Lesson Learned from previous tanks:
Provided more flexibility for lift heights.



Grouting Calendar

- Grouting activities began on January 19, 2016.
- DOE documented completion of closure activities on April 28, 2016



Tank 12H Closure Schedule

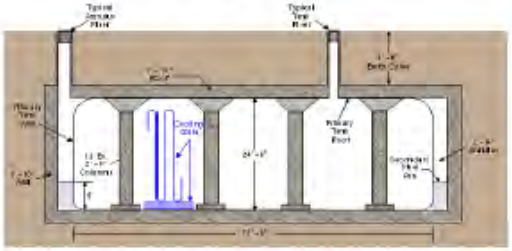
October 22, 2015

Environmental Management

September | October | November | December | January | February | March | April | May | June

Data Date

TYPE I TANK



Acronyms
CA – Corrective Actions
CM – Closure Module
CWR – Cease Waste Removal
FC – Forecast
FSA – Facility Self Assessment
MEP – Max Extent Practical
QT – Quiet Time
yd³ – Cubic Yards

START POUR

Grouting

Fill Failed Coils

Flush and Fill Intact Coils

Annulus and Primary Grouting

Lift 1

Vent Sys Rem, Riser Fill
Equipment Fill

Inspection

TANK CLOSED

FFA MILESTONE 5/31/2016

SRR DOCUMENTATION*
GROUT PREPS
TIER 2 DOE-SR REVIEW
TIER 2 COM. INC.
FSA
CA
MOB & FINAL SETUP
TIER 2 APR
CM Add Review
CM Add Comment Res
CM Add Notice & Public Comment
CM Add Comm Inc.
CM Add Approval
15 DAY HOLD

*SRR DOCUMENTATION
- ✓ Grout Strategy
- ✓ Communication Plan
- ✓ Closure Assurance Plan
- ✓ Management Control Plan
- ✓ FSA Plan

Risk Allocated Contingency

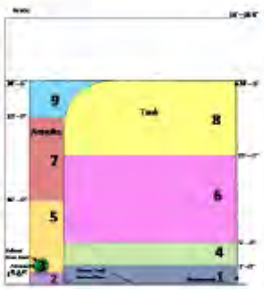
- Weather Delays
- Grout Delivery Issues
- Readiness Rework
- Annulus / Coil Fill Issues
- Equipment Issues
- Resource Limitations
- In-process Inspections Delays

PROGRESS

Documentation
- Closure Module (CM) - Revision 0 is conditionally approved by SCDHEC and EPA. Approval is contingent upon approval of the CM Addendum.
- The MEP document has been developed, reviewed, and approved.
- The SA and Class C calculation have been developed reviewed, and approved.
- A CM Addendum (Rev. A) based on the actual residual inventory has been developed, reviewed by SCDHEC & EPA, comments incorporated and Rev. 0 has been transmitted to SCDHEC & EPA. The Public Review and Comment period began October 19 and will continue through November 17 with a Public Meeting scheduled for November 4.
- Tier 2 – SRR has developed the Tier 2 Closure Plan, DOE has completed a review, and comments are incorporated.

Field Work
- Initial grout preparation activities at the tank have been completed and grout placement field activities are scheduled to begin Monday, January 25.

RISKS
- Inclement Weather
- Resource Availability
- Additional modeling required



GROUT LIFTS

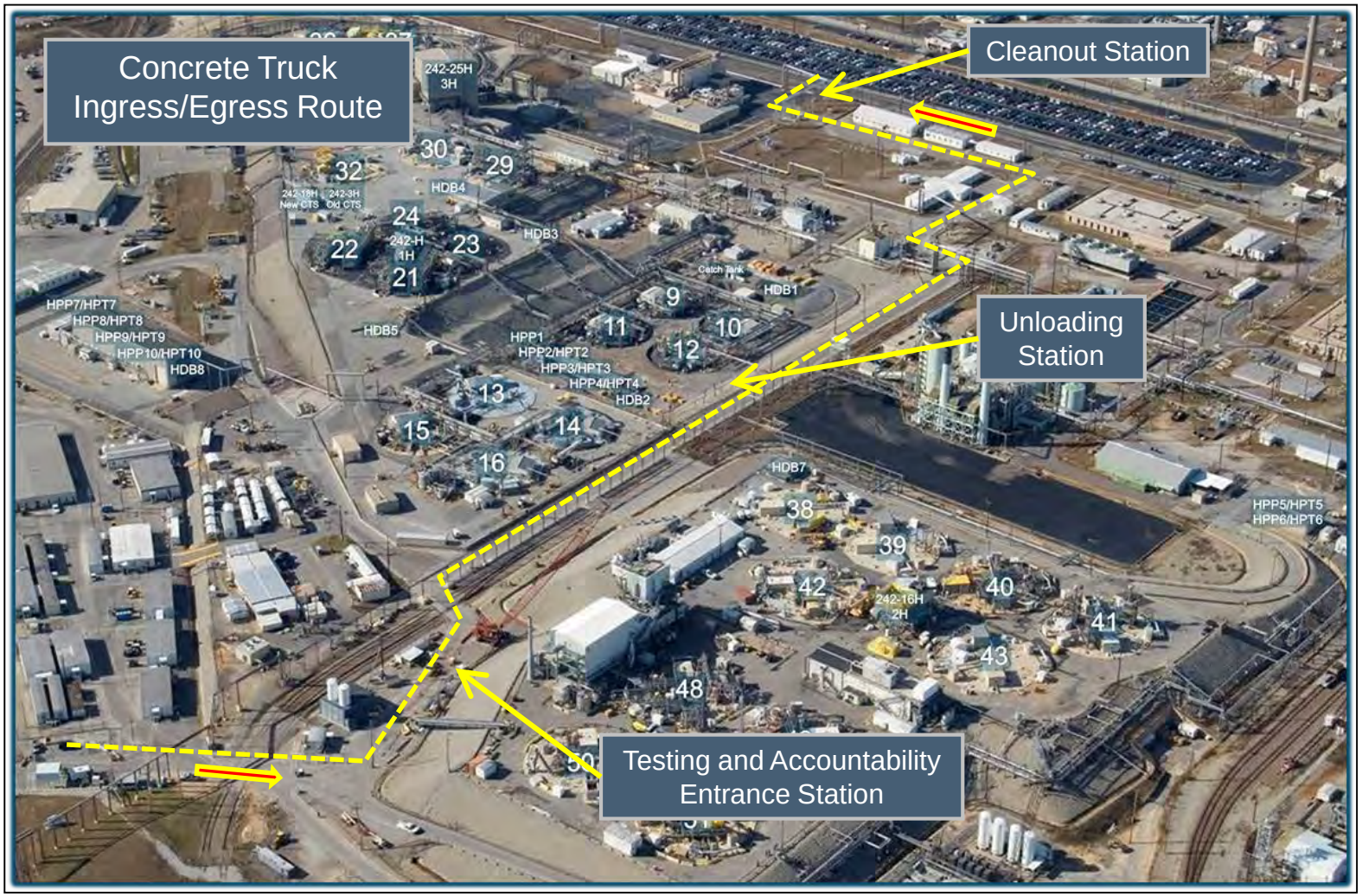
Approximate Values per Tank

LIFT	yd³	Trucks	Gallons
1	322	40	65,000
2	23	3	4,500
3	32	4	6,500
4	483	60	97,500
5	203	25	41,000
6	1,610	201	325,000
7	225	28	45,500
8	1,530	191	309,000
9	101	13	20,500
Total:	4,529	565	914,500

GROUT DELIVERY NUMBERS

Total Volume ≈ 4,529 yd³
8 yd³ per Truck
6 Trucks per Hour (max)
Pour 8 Hrs each 10 Hr Day
≈ 400 yd³ per Day (max)
4 Days per Week

Grout Delivery Route



Grout Testing Protocol

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

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)

Video of Grout Placement:

- Continuous during grout placement

Grout Delivery

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

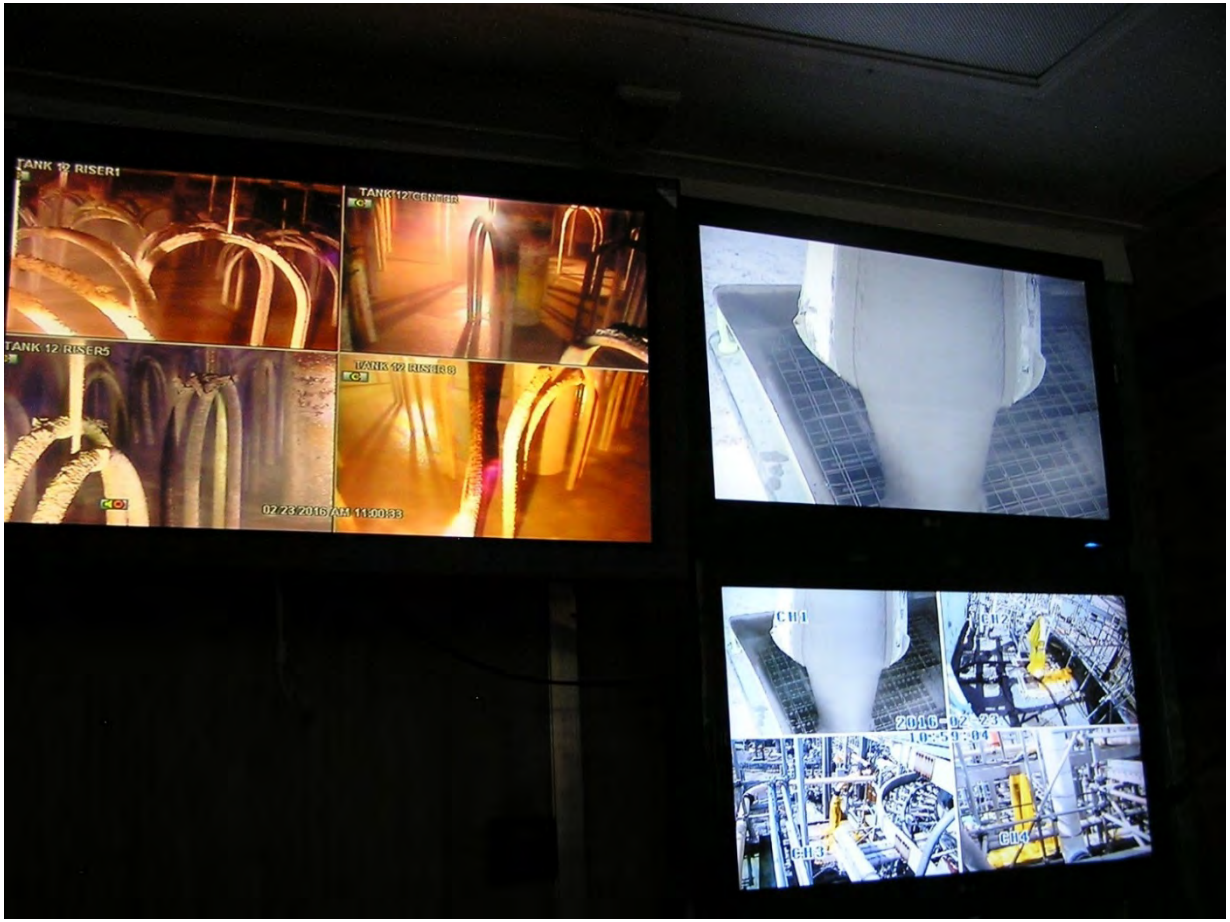
Grout Delivery to Grout Pump

Direct observation of grout delivery into the pump hopper provides visual indication that grout properties meet requirements.

Video Screen Console in the Command Center

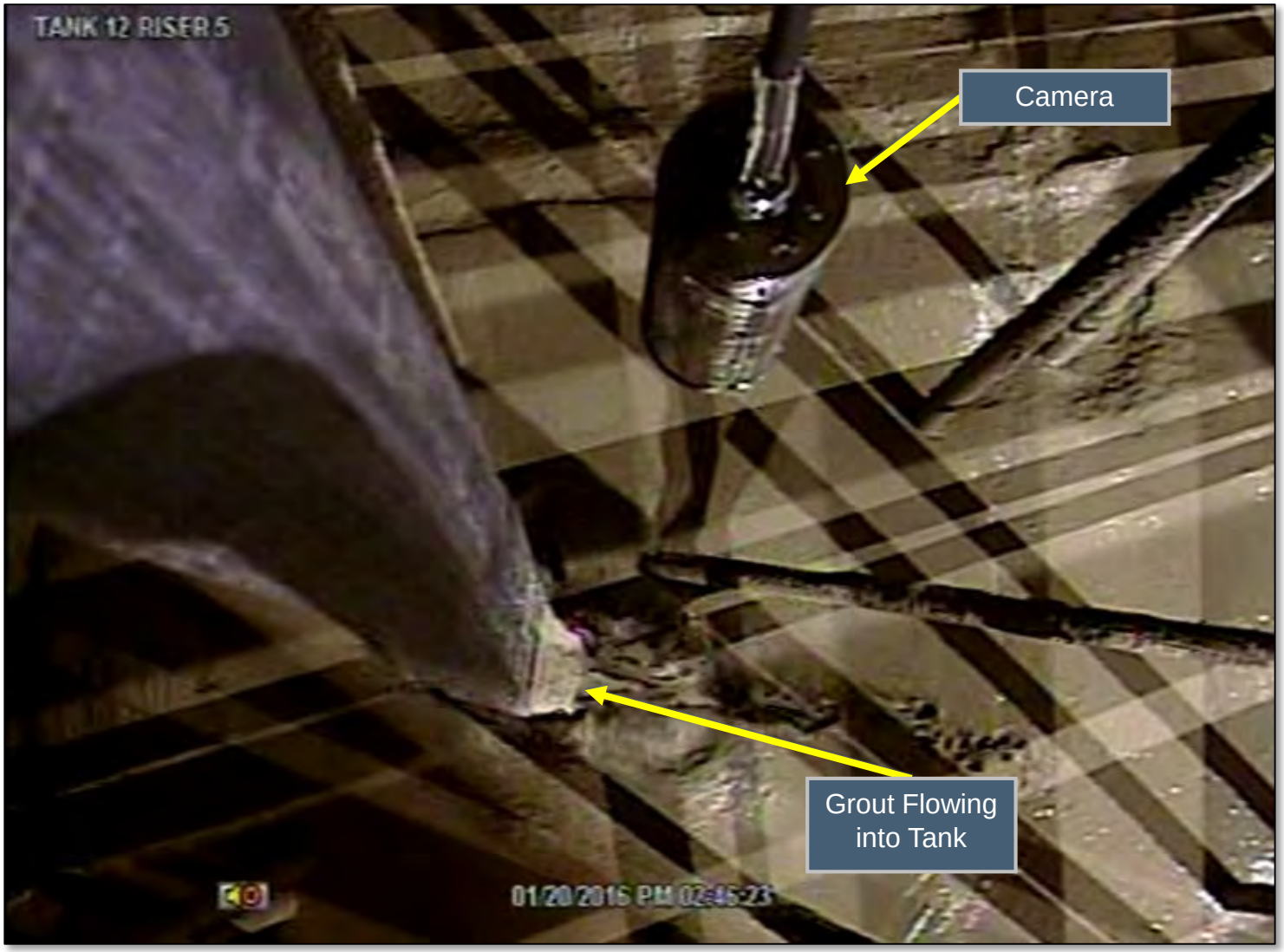
The video screen console in the command center provides real time simultaneous observation of:

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



Bulk Fill Grout

Bulk Fill Grout



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

Grout Level Approaches Tank Roof

The relatively level surface of the grout as it approached the flat tank roof was important to minimize void space.

Tank 12 Bulk Fill Grout Volume		
Estimated (yds^3)	Actual (yds^3)	+/-
3,927	3,887	-1%

Annulus Grouting

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

- 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.

Annulus Grouting

Tank 12 Annulus Grout Volume		
Estimated (yds^3)	Actual (yds^3)	+/-
583	613	+5%

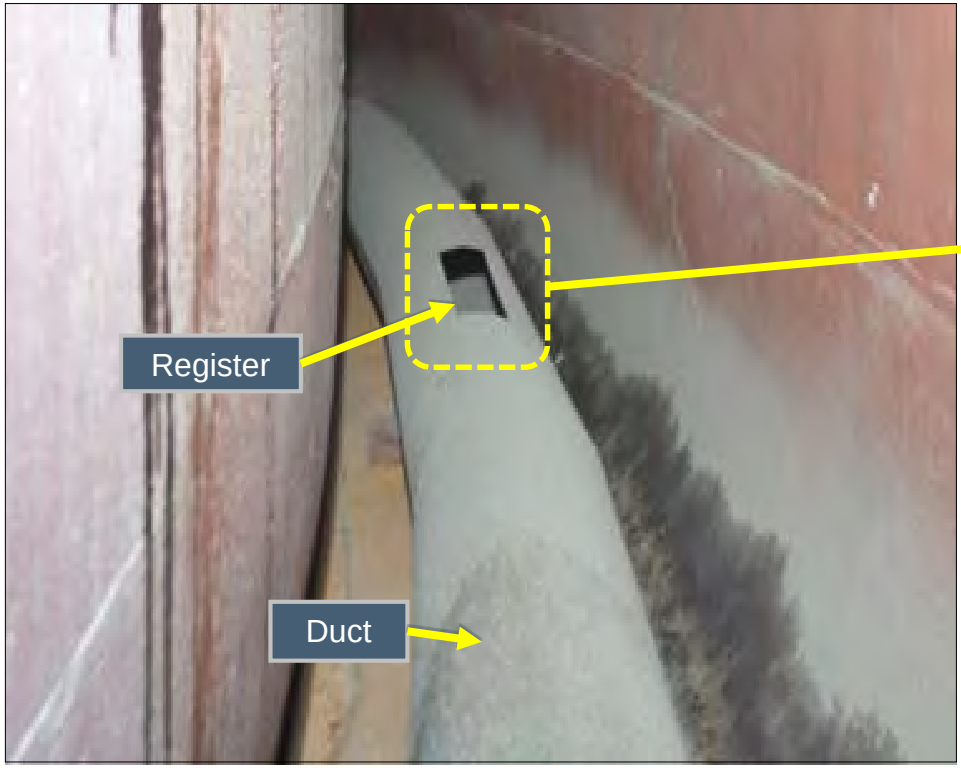
Tank Closure Grout Comparisons
Estimated vs. Actual Grout Volumes

Tank	PRIMARY			ANNULUS		
	Estimated (yds^3)	Actual (yds^3)	+/-	Estimated (yds^3)	Actual (yds^3)	+/-
18	8,343	8,094	-3%	NA	NA	-
19	8,343	8,090	-3%	NA	NA	-
5	3,927	3,871	-1%	583	612	+5%
6	3,922	3,849	-2%	583	601	+3%
16	5,552	5,425	-2%	687	697	+1%
12	3,927	3,887	-1%	583	613	+5%

Grouting the Dehumidification Duct

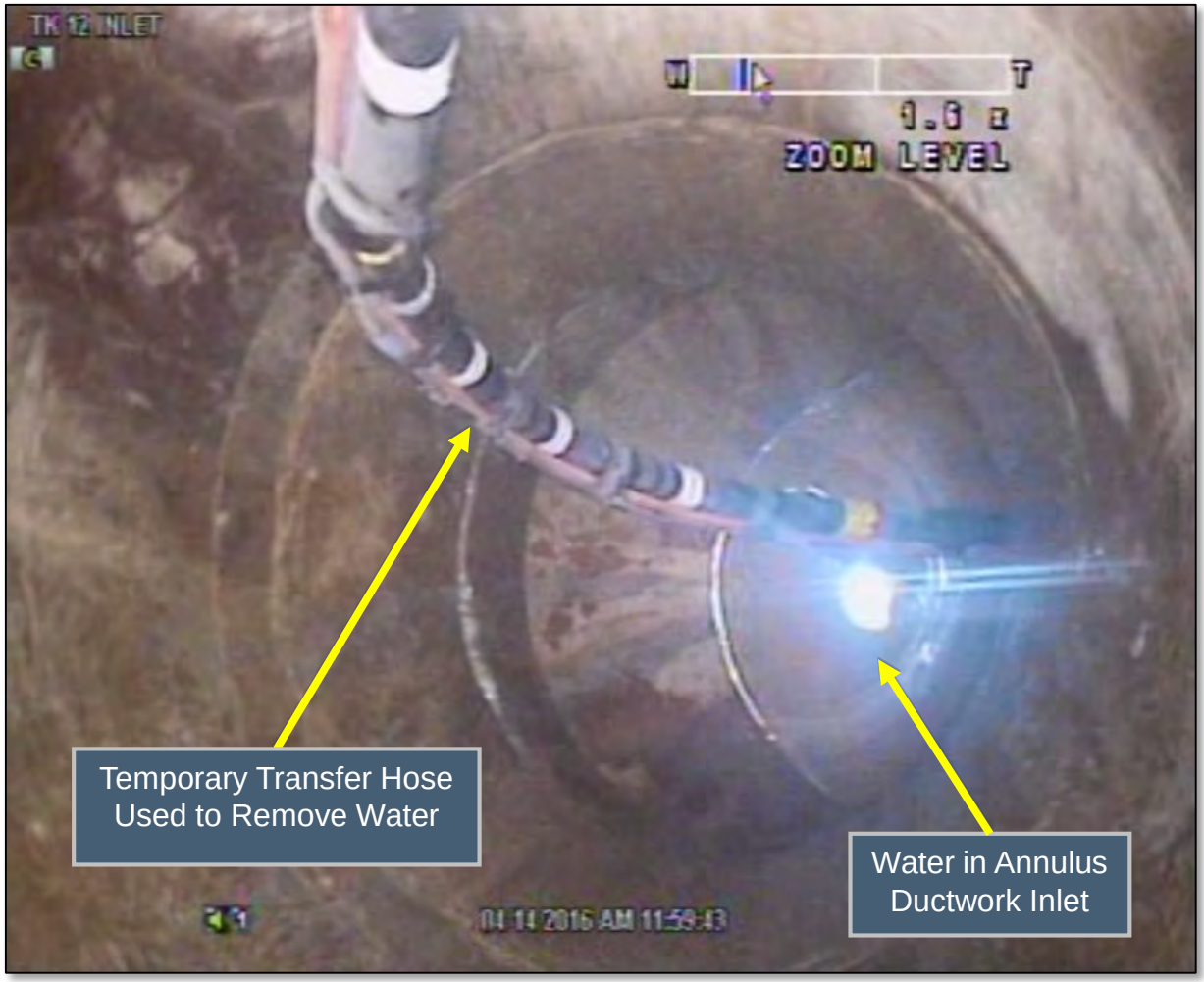
Grouting the Dehumidification Duct

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



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

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

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