Tank 12H Grout Strategy

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Table of Contents

List of Tables and Figures

1.0 Summary

Waste has been removed from Tank 12 to the extent practical. The majority of the residuals are located in the tank primary. Residuals have been sampled and characterized, and Tank 12 is being isolated from the H-Tank Farm (HTF) facility.

Upon agreement from the Department of Energy (DOE), South Carolina Department of Health and Environmental Control (SCDHEC), and Environmental Protection Agency (EPA) that all HTF General Closure Plan (8.1) requirements have been met, the project will proceed with stabilizing the tank with grout. This strategy will outline the Tank 12 grouting process.

2.0 Grout Functions, Requirements, and Formulation

Liquid waste tanks undergoing closure are required to be filled with grout for the purpose of stabilizing residual material, filling the tank void space, and discouraging future inadvertent intrusion. Filling a waste tank with grout also protects the walls and ceiling from possible collapse thereby providing long-term stability.

The supplier selected to provide grout for Tank 12 will be required to demonstrate the ability to batch and deliver the flowable, structural fill material to HTF. Samples of material batched at full-scale will be tested to qualify the ability of the grout subcontractor to produce and deliver the mix. Previous grout mix test results from Tanks 5, 6, and 16 may be deemed acceptable. The Tank 12 bulk fill, cooling coil fill, and equipment fill grout will align with the specifications approved for furnishing and delivering tank closure grout (8.10, 8.14, and 8.30).

3.0 Design Criteria

Requirements for Tank 12 Grout Systems

Designs of Systems, Structures & Components (SSCs) must comply with the requirements of applicable National Codes and Standards, SRS Engineering Standards, and applicable state regulations. The applicable requirements for the grout systems to be used on Tank 12 are specified below:

Slickline System

- Performance Criteria: Provide a grout slickline system used to transport grout to Tank 12. Slickline must maintain piping integrity during normal operations and be sized to accommodate a minimum of fifty grout trucks (eight cubic yards each) during a ten hour time period.
- Technical Criteria: Design and build the grout slickline to the ACI 304.2R and ASME B30.7 requirements.
- Performance Category: PC-1 Wind, Wind Velocity = 100 mph
- Seismic Requirement: SDC-1 Seismic, Limit State A

Slickline Support System

- Performance Criteria: Provide support of the grout slickline used to transport grout to Tank 12
- Performance Category: PC-1 Wind, Wind Velocity = 100 mph
- Seismic Requirement: SDC-1 Seismic, Limit State A

Grout Ventilation System

- Performance Criteria: Provide a grout ventilation system which consists of a portable ventilation system required for contamination and flammability control. The exhaust system consists of ductwork, a demister, HEPA filter, instrumentation, and an exhaust stack. The inlet system consists of a HEPA filter, ductwork, and instrumentation. Use a Radiation Protection System (RPS) MAC-21 (500 CFM) exhaust fan. The grout ventilation system must maintain piping integrity during normal operations and be sized to accommodate two simultaneous riser openings while maintaining the tank pressure negative relative to atmosphere.
- Performance Category: PC-1 Wind, Wind Velocity = 100 mph
- Seismic Requirement: SDC-1 Seismic, Limit State A

Grout Ventilation Support System

- Performance Criteria: Provide the support structure to support the grout ventilation system
- Performance Category: PC-1 Wind, Wind Velocity = 100 mph
- Seismic Requirement: SDC-1 Seismic, Limit State A

4.0 Pour Methodology

The grout will be delivered to HTF using cement mixer trucks. A supplier will deliver bulk fill grout to a grout distribution and placement station which will be installed and operated by Savannah River Remediation LLC (SRR). The cement mixer trucks will empty grout into grout pumps located on the road east and approximately 23 feet above the Tank 12 tank top. The grout will be pumped downhill from the grout pump through slicklines to multiple Tank 12 primary tank and annulus risers. Only one riser will be used as a fill point at one time. Riser use sequencing will be controlled as needed to ensure even tank and annulus filling and to maintain tank structural integrity. The grout delivery contract does not have a required delivery frequency specified; however, early communications with the grout supplier during these critical placements ensures that SRR has the correct number of vehicles in the rotation to be successful. While the optimal number of vehicles for these select placements will vary from tank to tank (due to route length and personnel interaction) SRR has identified an ideal frequency to be approximately 8-10 trucks per hour.

The grout distribution and placement system will be slicklines configured to support primary or annulus filling as required. The slickline routing to individual risers will be implemented using slickline fittings (e.g. tees, valves, couplings, and elbows). The

slicklines, routed to minimize their length, will be compliant with American Society of Mechanical Engineers (ASME) B30.27-2009, *Material Placement Systems*, (8.12) and American Concrete Institute (ACI) 304.2R-96, *Placing Concrete by Pumping Methods* (8.13 & 8.19). These standards have been evaluated for use and are acceptable for design, installation, and operation of grout slicklines (8.26).

Bulk fill reducing grout will be used to fill to the extent practical the volume of both the primary tank and annulus of Tank 12, including the annulus ventilation duct. The bulk fill reducing grout will flow and cover any residual material remaining in the tank and annulus. The grout used for Tank 12 meets the Performance Assessment (PA) requirements (i.e. segregation, compressive strength, and hydraulic conductivity). If additional pour locations are required to cover the remaining residual material, additional access points will be identified and slicklines installed to address the exact area requiring special effort. As shown in Attachment 9.1, Tank Risers 1, 3, 5, 8, and Annulus risers West, and East are the typical grout pour locations.

5.0 In-Tank Equipment

5.1 Overview

Various types of equipment from the bulk waste removal and heel removal campaigns remain in Tank 12. The goal of in-tank equipment grouting is to eliminate possible vertical fast flow paths through the grout that could allow infiltrating water to reach the residual material on the tank floor. A vertical fast flow path negates two of the primary purposes of the entire grouted tank:

1.) Slow water infiltration and
2.) Chemical interaction of the infiltrating water with the reducing grout to retard contaminant migration.

Any open vertical pathway (e.g. pump discharge lines, thermowells, etc.) in the tank will be filled with grout to the extent practical. The equipment fill grout mix (8.30) will be used for the filling of abandoned equipment. Tables 5.1-1 and 5.1-2 show the location and equipment remaining at the start of grouting in Tank 12. Equipment to be grouted in the tank is listed in sections 5.2-5.8. To ensure grouting will meet the PA assumptions in Ref 8.2, successful grouting of the internals of open ended equipment requires grouting activities to be performed in the correct order. Vertical pipes open at the bottom, such as dip tubes, must have the open bottom end of the pipe covered by bulk fill grout before they are grouted.

Due diligence will be used to add the equipment fill grout into the equipment to ensure that voids are filled to the extent practical. Visual or volume verification will be used to ensure equipment and risers are filled to the extent practical. Smaller items are generally considered negligible with respect to post-closure performance of the stabilized tank. (8.3) Specific smaller piping and equipment should be documented to demonstrate that efforts were made to grout equipment to the extent practical. The void

space associated with the equipment remaining in the tank will be accounted for in the "Tank 12 Internal Equipment Evaluation" document. (8.15) The internal equipment evaluation (8.15) may also be referenced for a more detailed description of the grouting process as it relates to equipment that will be grouted in-place inside of Tank 12. All efforts should be made to vent equipment being filled with grout to prevent air pockets from forming.

Riser	Riser Equipment Status After Isolation	Work Required Before Grouting	Grout Plan
1	Grout Plate, Spraywash Chamber	M-DCF-H-12729 will drill a hole in the spray chamber plate to allow for grout access into the riser void spaces.	Utilize the hole in the spray chamber plate to grout the riser. Utilize the grout plate for bulk fill.
2	North Annulus Jet Discharge Pipe, 1" Capped Pipe, Tank 9-12 Gang Valve Vent, 4" Access Port, Splash Plate Design	M-DCF-H-12724 will D&R the riser cover, its associated equipment, and install a new grout plate. Fabricate ventilation equipment.	Ventilation Outlet
3	Grout Plate, Spraywash Chamber	M-DCF-H-12729 will drill a hole in the spray chamber plate to allow for grout access into the riser void spaces.	Utilize the hole in the spray chamber plate to grout the riser. Utilize the grout plate for bulk fill.
4	Purge Ventilation Inlet, Reel Tape, Blanked H&V Drain, HLLCP, Thermowell, 4" Access Port	Fabricate grouting ventilation equipment, D&R Reel Tape, cut and lower HLLCP and Thermowell, install grouting connections for remaining equipment.	Utilize 4" Access Port for Inlet Ventilation. Entomb HLLCP and grout fill thermowell and HLLCP housing.
5	Grout Plate, Spraywash Chamber	M-DCF-H-12729 will drill a hole in the spray chamber plate to allow for grout access into the riser void spaces.	Utilize the hole in the spray chamber plate to grout the riser. Utilize the grout plate for bulk fill.
6	Abandoned Transfer Jet	Remove the tape from the steam inlet line.	Grout fill the abandoned transfer jet.
7	Submersible Transfer Pump with Caisson and transfer line to HDB-2,Thermowell, 3" Access Ports	Lower pump to bottom of the tank and Install grout fill connections.	Grout fill the submersible transfer pump and thermowell. Entomb the caisson.
8	Grout Plate, Spraywash Chamber	M-DCF-H-12729 will drill a hole in the spray chamber plate to allow for grout access into the riser void spaces.	Utilize the hole in the spray chamber plate to grout the riser. Utilize the grout plate for bulk fill.
Center	Dewatering Pump, Two 6" Access Ports, Splash Plate Design	The dewatering pump will be lowered to the bottom of the tank. The center riser will be core drilled to allow for grout to access the riser void spaces. Fabricate ventilation equipment.	Entomb Pump Ventilation Outlet

Table 5.1-1: Remaining Equipment in the Tank 12 Primary at Start of Grouting

Riser	Riser Equipment Status After Isolation	Work Required Before Grouting	Grout Plan
North	Annulus Jet, Conductivity Probe, 7 3/4" Access Port	M-DCF-H-12724 isolates the annulus jet. Install grout connections on the annulus jet. Cut and lower the conductivity probe. Fabricate ventilation equipment.	Utilize the 7 3/4" Port for Outlet Ventilation. Grout fill the annulus jet and conductivity probe port.
South	Conductivity Probe, Two 4" Access Ports	Fabricate ventilation equipment. Cut and lower the conductivity probe.	Utilize one 4" Port for Inlet Ventilation. Grout fill conductivity probe port.
East	Steel Wall Temperature Element	M-DCF-H-12742 will cut and lower the steel wall temperature element and install a new grout plate.	Utilize the grout plate for bulk fill. Entomb steel wall temperate element.
West	Level Transmitter Downcomer	M-DCF-H-12725 will lower the level transmitter downcomer and install a new grout plate.	Utilize the grout plate for bulk fill. Entomb level transmitter downcomer.

Table 5.1-2: Remaining Equipment in the Tank 12 Annulus at Start of Grouting

5.2 Spray Chambers

The field implementation of M-DCF-H-12729 (8.27) drilled a hole into the spray chamber plate to allow for grout access into the internal void spaces. Spray chambers will be grouted internally to the top or covered with concrete or a metal plate to minimize potential water intrusion. Risers with spray chambers will be skirted/curbed with grout/concrete around the riser outside perimeter (8.3).

5.3 Robotic Crawlers

Two electrically powered robotic crawlers used in the sampling effort, will remain in the primary tank. The robotic crawlers will not require internal grouting due to their lack of internal void space. (8.3) Cabling attached to the sampling robots has been cut and dropped to the tank floor. The cabling is not required to be moved from its current location in the tank. The sampling crawlers will be entombed in place on the tank floor. The potential for galvanic corrosion of the carbon steel tank floor due to the presence of stainless steel equipment was evaluated (8.5) and found to be negligible.

5.4 Riser 4 Equipment

The reel tape electronics will be removed and retained for future facility use. The reel tape itself will be cut and dropped, where it will remain on the tank floor. The High Liquid Level Conductivity Probe (HLLCP) and Thermowell electronics will be cut and lowered to the bottom of the tank and their connection points/housing in the riser will be filled with grout.

5.5 Riser 6 Abandoned Transfer Jet

P-DCP-H-04009 relocated the Tank 12 Riser 7 transfer jet to Tank 12 Riser 6. Riser 6 has two riser plates, an upper riser plate that rests atop the 36'' square riser opening, and a lower riser plate that rests on the lower 23'' riser opening. The upper riser plate has two access ports, one available for access and the other containing the remains of a conductivity probe. The lower riser plate supports the transfer jet and has one open (plug not installed) access port.

Due to ALARA and exposure concerns, the transfer jet will remain in the tank and be grout filled to the extent practical. The transfer jet has an open 3'' discharge line and a taped 1'' supply line. The tape on the 1'' supply line will be removed. Grout will be poured through the upper riser access ports to fill the entire riser and subsequently flow into the transfer jet lines to the extent practical.

5.6 Riser 7 Submersible Transfer Pump and Thermowell

The pump will be lowered to the tank floor. Connections will be installed on the submersible transfer pump and thermowell for grout filling the equipment. The caisson will be entombed during bulk filling.

5.7 Center Riser

The dewatering pump will be lowered to the tank floor. The riser will be core drilled to allow for grout to access internal void spaces. The dewatering pump will be entombed during bulk filling.

5.8 North Riser

M-DCF-H-12724 (8.28) will isolate the annulus jet. Connections will be installed on the inlet and outlet of the annulus jet for grout filling. The fill connections will include the pipe jacket. The conductivity probe will be electrically cut and lowered to the tank floor. The remaining housing will be grout filled.

6.0 Grout Strategy

6.1 Pre-Grout Activities

The preferred risers for Tank 12 grout additions are Tank Risers 1, 3, 5, 8, and annulus risers West, and East. The risers are adequately spaced to allow for grout to be spread throughout the four quadrants of the primary tank and annulus. These risers will be modified and any internal obstructions removed to permit grout to be placed into the tank. Tank 12 Risers 1, 3, 5, 8 currently have grout plates installed, while the East and West riser covers will be replaced with riser covers to support grouting.

A temporary ventilation system will be used in both the primary tank and the annulus for radiological control. These ventilation systems will easily provide enough flow to maintain a non-flammable vapor space per NFPA 69. For the Tank 12 primary tank, Riser 4 will be the ventilation inlet, while Riser 2 and Center will act as the ventilation outlets. In the annulus, the South Riser will be used as the ventilation inlet, while the North Riser will function as the outlet. The exhaust ventilation trains for the primary are redundant and in this way, no adverse impact to grouting operations will occur if the High Efficiency Particulate Air (HEPA) filters need replacing. The exhaust ventilation for the annulus is not redundant and has been determined to be an acceptable risk based upon no HEPA filter failures during previous tank groutings. In addition, the time required to fill the annulus is significantly less than the time to fill the primary tank thereby further reducing the risk of HEPA filter failure on a single annulus exhaust train. The exhaust system will have provisions (e.g., demister) for controlling moisture in the vapor.

The guidance provided in the Flammability Control Program Description Document (8.9) will be followed for NFPA 69 compliance (8.11) once grouting commences. To maintain desired conditions in the annulus, a reduced ventilation system operation between grout placements in the annulus is recommended. However, vapor space sampling for NFPA 69 compliance will still be followed and may require the ventilation to be operational.

Provisions will be made for grout delivery point(s) into the tank; camera and lighting access into the tank, management of air displacement, management of ventilation condensate, and handling of any overflow while filling equipment, tank/annulus, and void spaces or risers. Attachment 9.1 shows a typical slickline path and riser installation concept. Risers 1, 3, 5, 8, West, and East will be configured to support video recording operations.

Grout distribution piping, slickline, and tremie (i.e., long hose used to reduce the drop height of grout into the tank) details will be included in the installation work packages. Slickline supports from the pump point down the hill to the tank will be per MT-HTF-2014-00034 (8.22). All equipment modifications inside the tank isolation boundary will be detailed accordingly via field sketches that will be utilized during pre-grout and grouting activities (8.6 and 8.8). Modifications to the grout distribution piping, slickline, or tremie that deviate from the field sketch shall be approved by Engineering to ensure code compliance. The distribution piping will be inserted through one or more riser access port(s) to allow introduction of the bulk fill grout into the tank. The distribution pipe outlet may have the ability to allow limited directional control of the grout leaving the distribution piping. The distribution piping may be able to move within the riser opening or to another riser when needed. This additional movement can alleviate the possibility of grout forming a mound under the pour location. A 2014 study concluded that grout can be added to a tank by freefall from heights less than 42 feet without using a tremie and without adversely affecting the grout properties (8.23). If it becomes necessary for continuous grouting to continue, and the maximum freefall height is less than 42 feet, use of a tremie will not be required. (8.23)

The project team will develop detailed grout modification work packages for each riser. Bulk fill grout will be introduced into the tank annulus space using two of the four annulus risers. The two annulus risers used to place grout will be on approximately opposite sides of the tank. Two annulus risers shall be configured to support simultaneous camera operation. Two annulus risers shall be configured to support a portable ventilation system similarly configured to the portable tank primary ventilation.

6.2 Grout Sequencing Activities

The sequence of primary tank and annulus filling is subject to the restrictions imposed by Structural Integrity requirements (8.18).

On each day of grout placement in the primary tank or the annulus, a camera inspection shall be performed prior to start of pouring grout. These inspections will look for voids or anomalies in the grout placed the previous day and will be per the video inspection plan (8.25). The initial daily inspection, and any others performed, will be noted in the Person-In-Charge's (PIC's) notebook. Grout addition will not proceed until the initial daily inspection is performed. In the event of camera failure, grouting can continue with project personnel monitoring the material being added for anomalies, and for other problems with the addition. The grout level will be calculated based on the volume of grout added and verified using visual reference markings, as possible.

6.2.1 Annulus Bulk Fill Grouting

Grout will be introduced into the annulus between the outside radius of the annulus ventilation duct and the annulus steel pan. Initially, an approximately 6 to 12-inch deep grout layer will be placed on the annulus pan floor to support the horizontal ductwork sections during grouting. The horizontal ductwork will then be filled via the vertical section of ductwork to the extent practicable or until grout is observed exiting through the vent openings on top of the horizontal ductwork. As the annulus grout level is raised, grout will flow through any remaining openings and into any unfilled portions of the horizontal ductwork. The vertical duct work will be filled after the completion of annulus bulk fill.

In parallel with bulk filling of the annulus, the vertical section of annulus ventilation inlet duct will be filled all the way to grade level with grout. This will mitigate the potential for duct collapse because of increased lateral pressure outside the duct. The field implementation work package will require monitoring of the ductwork condition during grouting.

The annulus exhaust riser will be grouted to grade level after the grout level reaches the bottom of the riser, i.e., top of the annulus.

Figure 6.2.1.1: View of Tank 12H Annulus and Horizontal Ventilation Duct (West Riser, September 2012)

6.2.1.1 Mitigating Impact of Potential Rain Water Intrusion

The isolation of Tank 12 from the steam treated annulus ventilation air flow has reduced the facility's ability to prevent the gradual buildup of intruding water[1]. This is because the conditioned air, provided by the previously installed system, was able to evaporate intruding water at greater rates than the temporary ventilation system(s) used to support grouting and interim operations. As a result, a temporary water removal system has been installed should levels increase significantly. (8.31)

Prior to introducing grout to the annulus, the water removal system will be used (if necessary) to move water from the annulus of Tank 12 and into Tank 10. After the water level in the annulus has been reduced as much as practical (i.e. to approximately

[1] The originally installed annulus ventilation system was equipped with a pre-heater to heat incoming air in order to prevent moisture in the air from condensing within the annulus space. The heated air also removed condensation in the annulus space by evaporation.

2”), the pre-planned grout lift sequence will ensure the annulus is filled with grout as quickly as possible. The grout lift sequence is intended to significantly reduce the likelihood of gradual water intrusion and buildup during annulus grouting activities.

While the need is highly unlikely, the team is prepared to remove accumulated water after the inception of annulus grouting. To accomplish this task, the water removal system will be used to transfer water from the annulus of Tank 12 and into decant totes for waste disposal.

6.2.2 Primary Tank Bulk Fill Grouting

Grouting of the primary tank will begin prior to the grouting of vertical cooling coils. Primary tank filling is subject to the restrictions imposed by Structural Integrity requirements (8.18).

Multiple risers may be used to place grout into the primary tank. Field experience and engineering judgment shall dictate which riser is used for grout addition and the frequency of switching risers. Grout will be strategically introduced into risers to avoid placing grout directly into wet spots and allow even distribution.

The in-tank equipment may be filled with grout when the open bottom sections of the individual pieces are visually determined to be covered by bulk tank fill grout. During the bulk fill grouting activities of the tank, the tank will be ventilated utilizing a portable ventilation system.

6.2.3 Cooling Coil Grouting

The bulk grout fill level in the tank shall be high enough to physically support the coils during grout filling. The bed of grout will support the vertical cooling coils and help prevent vertical coil failure during grouting. Engineering judgment shall be used in determining when the required grout depth has been reached. Limiting the grout level will provide the greatest opportunity for guillotined cooling coils to vent during grouting, while providing adequate structural support.

Tank 12 has a total of 36 cooling coils. Twenty-eight of these coils are considered to be failed and were previously flushed during the heel removal phase (8.29). The remaining eight are considered operational and will require flushing. A leak check of the existing operational coils will be performed to determine if their status has changed. Cooling coil flushing will be performed using an approved work package to ensure that any chromate-laden water is properly handled and dispositioned.

The status of each cooling coil will be determined by pressure testing and flushing prior to the start of grouting. Cooling coils will have their status checked during grouting by pressurizing each coil with flush water. If the coil holds pressure, the coil is considered operational and will be grouted to the extent practical. If the coil does not hold pressure, it is considered failed or guillotined. Guillotine failed coils shall be grouted from each

end until indicated to be full. It will not be possible to collect any residual water from these types of coils during the grouting. There may be sections of coils with guillotined breaks not connected to the coil inlets and/or outlets. These intermediate sections of coils with guillotined breaks may not be filled with grout internally due to their configuration. It is also possible for portions of guillotined coils connected to the coil inlet or outlet not to be completely filled with grout due to their configuration.

6.2.4 Tank Riser Grouting

The nine primary tank and six annulus risers for Tank 12 grouting are listed in Tables 5.1-1, 5.1-2 and Attachment 9.2. All risers have a cube-shaped upper portion that reduces down to a smaller diameter cylinder, capped by a riser cover. Risers will be properly ventilated during the riser filling process. Individual risers may be capped with bulk fill grout, 5000 psi concrete, or other suitable material. The grout level in risers or penetrations will be brought to the level of the riser opening. Degraded risers will be skirted/curbed with grout/concrete around the riser outside perimeter (8.3). This level of grout combined with the riser cover will minimize potential water intrusion. Riser capping activities will be performed per the requirements of NFPA 69 as described in Ref 8.11 or another engineering approved strategy. Any exceptions to this section will be evaluated in a similar manner as in references 8.4 and 8.17.

7.0 Conclusion

The current approach to closing Tank 12 is to fill the tank with a chemically reducing cementitious grout that is capable of protecting against inadvertent intrusion after area closure. The Tank 12 project team has designed the Tank 12 grouting strategy for planning purposes. This strategy may be revised as detailed planning of the specific grouting implementation activities progresses.

8.0 References

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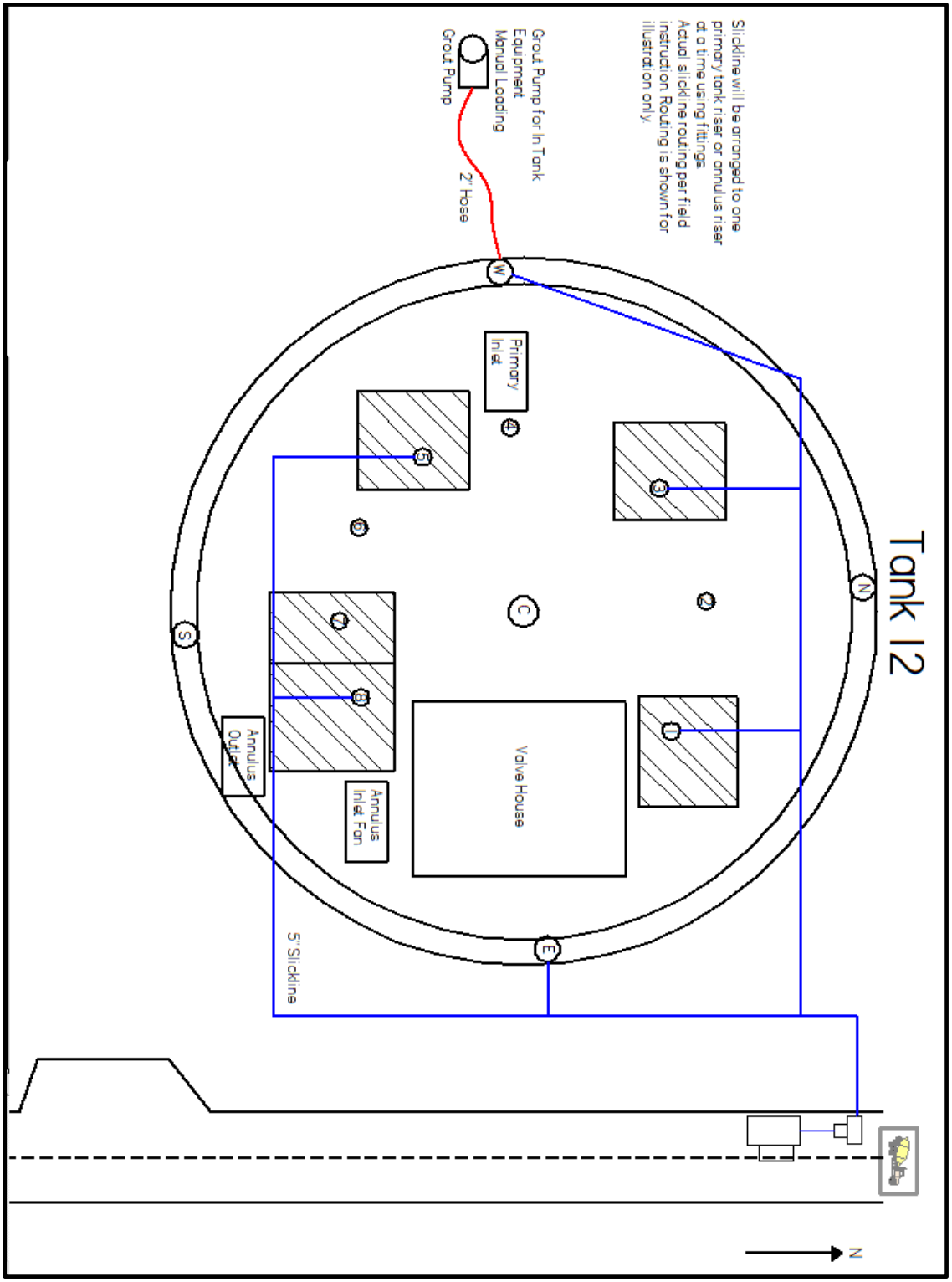
9.0 Attachments

9.1 Typical Grout Pour Locations



9.2 Tank 12 Pipe Penetrations