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FINAL
ABOVEGROUND INJECTION SYSTEM CONSTRUCTION AND MECHANICAL INTEGRITY TEST PLAN

Contract No. 1806318

Prepared for:

Sandia National Laboratories, New Mexico

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SANDIA NATIONAL LABORATORIES, NEW MEXICO (SNL/NM)

ABOVEGROUND INJECTION SYSTEM CONSTRUCTION AND MECHANICAL INTEGRITY TEST PLAN APPROVAL

Contract No.: 1806318

Site Location: Sandia National Laboratories, New Mexico (SNL/NM)

The Aboveground Injection System Construction and Mechanical Integrity Test Plan presented in this document has been developed specifically for SNL/NM activities in Albuquerque, New Mexico. For this contract, Banda Group International LLC (Banda) is the prime subcontractor providing consulting services and Amec Foster Wheeler Environment & Infrastructure Inc. (Amec Foster Wheeler) is the secondary subcontractor providing consulting services. Project personnel referenced below have reviewed and approved this plan for implementation during the duration of this contract. Procedures to be followed for document submission, approval, integration and implementation of changes to this plan are discussed within the body of the plan.

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LIST OF ACRONYMS

®	Registered Trademark
ABC	Air-Bleed Cap
AIS	Aboveground Injection System
Amec Foster Wheeler	Amec Foster Wheeler Environment and Infrastructure Inc.
Banda	Banda Group International LLC
BGI Team	Banda Group International and Amec Foster Wheeler
COCs	Constituents of Concern
DOE	Department of Energy
e.g.	exempli gratia
GPM	Gallons per Minute
ISB	In-situ Bioremediation
KAFB	Kirtland Air Force Base
MIT	Mechanical Integrity Test
NM	New Mexico
NPT	National Pipe Thread
ORP	Oxidation/Reduction Potential
PCO	Pest Control Operator
PSID	Pounds per Square Inch Differential Pressure
SNL/NM	Sandia National Laboratories, New Mexico
TA-V	Technical Area-V
TCE	Trichloroethene

1.0 Introduction

An In-Situ Bioremediation (ISB) Pilot Test Treatability Study is planned at Sandia National Laboratories, New Mexico (SNL/NM) Technical Area-V (TA-V) Groundwater Area of Concern. The Treatability Study is designed to gravity inject an electron-donor substrate and bioaugmentation bacteria into groundwater using an injection well. The constituents of concern (COCs) are nitrate and trichloroethene (TCE). The Pilot Test Treatability Study will evaluate the effectiveness of bioremediation and COC treatment over a prescribed period of time. Results of the pilot test will provide data that will be used to evaluate the cost and effectiveness of a full-scale system.

2.0 Purpose

This Aboveground Injection System (AIS) Construction and Mechanical Integrity Test (MIT) Method Plan describes the activities and procedures to be used in the fabrication of the AIS and MIT. This Plan with its appendices and the AIS Engineered Drawings (BGI, 2017) provides the specific rationale, engineering analysis, materials/equipment, construction procedures, and specifications that will be used to build and test the AIS, including the MIT. The MIT will be conducted on the AIS components to insure they do not leak when operated; and, to ensure that the mechanical components of the AIS function as designed.

3.0 Aboveground Injection System Construction

Construction of the AIS includes procuring the materials and equipment; and, fabricating the components of the AIS, including the following:

- Deoxygenation Tanks and Tank Platforms;
- Deoxygenation Tank Connection Assemblies;
- Main Manifold;
- Wellhead Connection Manifold with Air-bleed Valve
- Deoxygenation Tank Filling and Emptying Manifolds; and
- Premix/Chase Water Tank with Sump Pump.

The piping assemblies and manifolds will be constructed in accordance with the specifications provided in Appendix A and the AIS Engineered Drawings. It will include the following: piping sections; connection fittings (tees, elbows, true unions, Camlok® fittings, etc.); injection hose (aboveground portion); valves, sample ports, and instrumentation (flow meters and pressure gauges). A hydrostatic pressure test in accordance with the project specifications will be conducted on the piping manifold prior to transport and installation at the site. Any leaks will be remedied prior to transport. The tanks will be carefully inspected for defects prior to installing at the project site. The aboveground injection line will be procured and readied for installation.

4.0 Deoxygenation Tanks and Tank Platforms

The pilot test requires two 5,000-gallon poly tanks to be used for deoxygenation, storage and mixing of the bioamendment solution, and their associated platform. Prior to transport to the site, the designated area will be prepared to receive the tanks and platform. Prior to mobilizing the tanks and platform, all work will be coordinated with SNL personnel.

4.1 Deoxygenation Tank Platforms

The 5,000 gallon tanks will be placed on portable steel platform with outriggers attached to footings/plates. The outriggers will facilitate safe distribution and stabilization of the weight of the tank and its contents as well as allow the raising and lowering of the tank for optimal performance. Ten adjustable outriggers will be used on each tank platform, five on each side. The platforms will be fabricated in accordance with the AIS Engineered Drawings (BGI, 2017) and Appendix B (Specifications). Prior to transport the platform will be inspected for proper function and construction. Strength and stability engineering calculations in support of the steel platform design are provided in Appendix A.

4.1.1 Steel Work

All steel work including welding and metal bending will be performed by qualified experienced personnel. Construction of the tank platform will be done in accordance will the AIS Engineered Drawings. Specifications Sections 055014 Structural Metal Fabrication and 0500523 Structural Welding contained in Appendix B provide detailed reference for the steel work associated with construction of the steel platforms.

4.1.2 Painting/Coating

Prior to transport to the site, the tank platforms will be painted. Painting will provide the tank platform a measure of protection against weather and continuous outdoor use. Specification Section 099000 Painting – Coating Metalwork contained in Appendix B provides detailed reference for the painting/coating of the steel platforms.

4.1.3 Concrete Footings

Concrete footings will be constructed for the two middle outriggers attached to the platforms, one on each side. Concrete footings will be constructed by removing landscape surfacing to establish contact with level, bare soil and placing a form constructed with sonotube beneath the designated outrigger. Concrete footings will be constructed in accordance with the project specifications and design drawings. Footings will be used to support a portion of the weight of the platform. Specification Section 033210 Cast-In-Place Concrete contained in Appendix B provides detailed reference for the concrete work.

The other eight outriggers on each steel platform will be placed on quarter-inch thick, two-foot square steel plates placed on bare soil.

4.2 Deoxygenation Tanks

Two 5,000-gallon poly tanks, will be installed on the constructed platforms. The tanks will be emptied by connecting piping and valves, to the bottom of the tanks allowing them to be fully drained.

4.2.1 Tank Description

The selected deoxygenation tanks are Norwesco® 5,025-gallon molded poly tank. These tanks will be used to store and mix substrate solution for deoxygenation and lowering of oxygen reduction potential (ORP) and are then gravity-drained to inject the solution into the injection well. As part of the pilot test the tanks will receive extracted groundwater from well TAV-INJ1.

Norwesco tanks are manufactured to strict quality guidelines to ensure years of high-performance use. Rugged, impact-resistant, one-piece, seamless, UV-resistant, black polyethylene construction make these tanks suitable for the storage and/or transport of the liquids and chemicals planned for the ISB treatability study. Black color for the tank was selected to limit the exposure to sunlight which would likely result in algae growth in the tanks. Norwesco tanks are manufactured using resins that meet United States Food and Drug Administration specifications to ensure safe storage of potable water.

The deoxygenation tanks are configured in a horizontal orientation and have built-in stabilizers. The tanks are 92 inches in diameter, 96 inches in height, and 190 inches long. Tanks will be fitted with 2-inch female National Pipe Thread (NPT) bulkhead outlet fittings. The tanks will also be fitted with transparent sighting tubes.

The catalog page and dimensioned drawing of the tank from the manufacturer are provided in Appendix C.

4.2.2 Connecting Tanks to Tank Platform

Tanks will be bolted to the platform via galvanized steel leg bands and supported with built-in legs. Steel tabs fabricated with angle iron will be welded to the platform so that the leg bands can be secured to the platform.

4.2.3 Tank Emptying/Filling/Equilibration and Amendment Addition Manifolds

Deoxygenation tanks will be plumbed together at each end so that the tanks can be filled and emptied as designed and so that tank contents can be exchanged, equilibrated, or even recirculated (e.g. through a filter), if needed. The manifolds will be constructed from fittings, Camlok® connectors, and braided/reinforced tubing and fitted with valves.

The emptying manifold will be connected to the injection line and main manifold used to inject tank contents into the injection casing.

The filling/amendment addition manifold will be connected to bulkhead fittings on the opposite end of the tank from the emptying manifold. The filling/amendment manifold will allow for the addition of amendment or water (or even washing solutions) into the tank.

The emptying and filling/amendment addition manifolds are shown in the AIS Engineered Drawings. Additionally, specification Section 400513 Pipe Erection and Testing contained in Appendix B provides detailed reference for the fabrication of these manifolds.

5.0 Gravity Feed Piping/Metering/Regulating Components

A series of gravity feed piping assemblies and manifolds will be constructed and installed to meter and regulate the injection of bioamendment into the test wells. The assemblies and manifolds will be positioned below the level of the deoxygenation tanks, and above the injection casing wellhead. The chief material used in the fabrication of the assemblies and manifolds will be stainless steel piping and fittings. The manifold will be constructed as shown in the AIS Engineered Drawings. Specification Section 400513 Pipe Erection and Testing contained in Appendix B provides a detailed reference for the fabrication of the gravity feed piping/metering/regulating components. The components will be assembled and tested at the Amec Foster Wheeler shop prior to installation at the site.

5.1 General Construction Description

The gravity feed piping manifold consists of valves, pressure gauges, and a totalizing flow meter. It connects the various injection sources to the injection wellhead. The main manifold will be used to control and monitor the injection stream before it reaches the injection wellhead.

5.2 Sampling Ports

Stainless steel lab cock sampling ports will be mounted in a tee fitting with reducer as shown in the AIS Engineered Drawings. Each sample port reduces from the 2-inch diameter main line piping runs down to ¼-inch diameter tubing connector. The sample ports will facilitate a point of connection for clean, new sample tubing to a barbed connection at select point along the AIS. The AIS contains five sample ports; one on each of the four deoxygenation tank connection assemblies and one on the main manifold.

5.3 Support and Racking

Weldless metal framing with integral channels (e.g., Unistrut®) to attach pipe clamps will be used to fabricate the supports and racking of the AIS components. The metal framing for the deoxygenation tank connection and filling-manifold assemblies will be integrated into the deck of the steel platforms so that the associated valves and sample ports will be supported, relieving stress on the deoxygenation tank bulkhead fittings. The main manifold and injection wellhead connection assembly will be racked on free-standing metal frames with legs and stabilizers so that they can be positioned as desired in the field. The main manifold racking frame will be field fitted so that the manifold sits level and as close to the ground surface as practical so that the gravity feed from the deoxygenation tanks is maximized. The injection wellhead connection assembly will be fitted with a steel frame that is adjustable so that assembly can be supported and sturdy while connecting to the injection well casing.

5.4 Deoxygenation Tank Connection Assemblies

Four deoxygenation tank connection assemblies, one for each of the tanks will be constructed as designed and shown in the AIS Engineered Drawings. These assemblies connect the 2-inch tank bulkhead fitting and the aboveground injection line that leads to the main manifold.

Two deoxygenation tank assemblies will be constructed prior to the pilot test. Two additional deoxygenation tank assemblies (four total) will be built for the full-scale implementation of the project.

5.5 Main Manifold

The main manifold is the principal plumbing section that connects injection streams from the deoxygenation tanks and the bioaugmentation assembly, into one central line leading to the injection wellhead. The main manifold includes means of controlling and measuring total flow and flow rates, sampling the combined injection flow stream, and monitoring injection line pressures.

The main manifold will be built as detailed in the AIS Engineered Drawings. The main manifold consists of couplings, check valves, tees, nipples, barbs, meters and gauges to control and monitor the AIS.

5.6 Injection Wellhead Assembly

The injection wellhead assembly is comprised of the aboveground injection line, which conveys injectate from the main manifold to the injection wellhead via connection to the injection casing wellhead. At the top of the injection well casing, a compression fitting collar with Camlok® connector is used to connect the aboveground injection line to the wellhead. It forms a seal at the top-of-casing.

The compression fitting allows for the fitting to be removed to allow the well vault lid to close properly when the injection line is not connected to the injection casing.

A one-hole well seal will facilitate a data logging field cable and the wire rope safety cable connected to the downhole multi-parameter sonde. An 18-inch x 18-inch traffic-rate steel manhole will house the well and allow access to the wellhead assembly. The wellhead assembly will be constructed as shown in the AIS Engineered Drawings.

An air-bleed assembly will be installed on the top of the Injection Wellhead Assembly. The air-bleed assembly will be used to collect and release air displaced by injection and flowing upwards from the injection casing. Without this assembly air displaced during the initialization of injection would flow through the main manifold, disrupting the totalizer, and end up in the deoxygenation tanks.

6.0 Premix/Chase-water Tank and Sump Pump

A premix/chase-water tank and sump pump will be incorporated as part of the AIS. The premix/ chase-water tank and sump pump will be used for mixing injectate solution with potable water prior to transferring the solution into the deoxygenation tanks via use of a sump pump; and, to flush the injection line and injection well following amendment addition. The design drawings show detail of the premix/chase-water tank and sump pump configuration. Brief descriptions of the system components are provided below.

6.1 Premix/Chase-water Tank Description

The premix/chase-water tank will be a Norwesco® 150 gallon White Ribbed Pest Control Operator (PCO) Tank. The tank will be translucent white is 48-inches in length, 37-inches wide, and 29-inches high. It is fabricated from rugged, impact-resistant, one-piece, seamless, UV-resistant polyethylene, which are compatible with the chemicals that will be used during the ISB treatability study.

The manway centered at the top of the tank is 16-inches in diameter which will facilitate placing and removing the sump pump. The premix/chase-water tank will have a low enough profile to allow easy access to top opening while standing on the ground.

The catalog page and dimensioned drawing of the tank from the manufacturer are provided in Appendix C.

6.2 Sump Pump

A Little Giant® ½ horsepower sump pump will be used to transfer injectate solution between the premix/chase-water tank and deoxygenation tanks or main manifold. The sump pump will also be used to consolidate and empty residual water from tanks.

The manufactures cut sheet for the sump pump is provided in Appendix C.

6.2.1 Pump Description

The Little Giant® ½-horsepower stainless steel sump pump operates using a 115 electric voltage connection and has a 20-foot long tree-pronged power cord. The pump is rated for a discharge capacity greater than 20 gallons per minute through a 2-inch NPT fitting.

The sump pump will be powered via a connection to a portable gasoline powered generator.

6.2.2 Pump Discharge Setup

The sump pump discharge setup will consist of a 2-inch female to male Camlok® fitting attached to a 2-inch diameter Camlok® connector and PVC hose. The PVC hose will be custom manufactured to the required length between the premix/chase-water tank and deoxygenation tanks.

6.2.3 Adapter/Connectors

2-inch female/male Camlok® fittings will be used to attach the sump pump the transfer hose and deoxygenation tank or main manifold.

6.2.4 Hose

2-inch diameter aluminum cam and PVC hose will be used to transfer injectate solution between tanks. The hose will be custom manufactured to the required length.

6.2.5 Electrical

The sump pump will be hardwired with a 120 volt electrical power cord and plug by the manufacturer. Electrical power will be supplied using a gasoline-powered generator.

7.0 Spill Containment Area

A spill control area will be installed in the mixing area to collect and contain incidental spills during the pilot- or full-scale operations.

7.1 Underlayment

Plastic sheeting will be placed under the premix-tank, main manifold, injection line, and tank emptying manifolds to protect the ground from potential spillage. The footprint of the plastic sheeting will be kept to a minimum to limit potential slip/fall hazards associated with walking/working on the plastic sheeting. The footprint of the underlayment directly under the main manifold and premix tank will be bermed using filled sand bags or equivalent placed under plastic sheeting to prevent run-off of spilled liquids.

7.2 Spill Containment Supplies

Two spill kits consisting of absorbent pads, bleach, water, and a clean five-gallon bucket will be kept on site for the duration of the fieldwork.

8.0 Mechanical Integrity Tests

Upon completion of the AIS piping construction, including the deoxygenation tank connection assemblies, the tank emptying and filling manifolds, the main manifold, and the wellhead connection assembly, the Department of Energy (DOE) and SNL personnel will be contacted to arrange for observation of the mechanical integrity tests at the offsite construction/fabrication shop.

During the MIT, a test-run to simulate the gravity-injection through the main manifold and the "side-stream" of another liquid flow until the system is stabilized will be performed. The MIT will demonstrate the following:

- Each piping manifold and assembly of the AIS pass a hydrostatic leak detection test pursuant to Specification Section 400513 Pipe Erection and Testing Specification contained in Appendix B.
- The side-stream process from the KB-1 ® dispenser to the main manifold. The volume of the side-stream for the test-run period shall be such that it can be extrapolated to complete the planned daily injection volume of the dechlorinator.
- The side-stream process from the chase water tank to the main manifold.

The hydrostatic pressure and side-stream tests are described in detail in the subsections below.

8.1 Hydrostatic Pressure Tests on AIS Components

Hydrostatic pressure tests on each AIS component will be accomplished using test adapters that will facilitate the following:

- Filling of the AIS component with water;
- Removing air from the AIS component as it is filled with water;
- Pressurizing and shutting in the pressured water within the AIS component; and

- Monitoring the shut-in pressure.

Two test adapters will be fabricated to accomplish the hydrostatic pressure tests: a filling and air-bleed cap (ABC) adapter. The filling test adapter will be fabricated to connect to the upstream end (per check valve orientation) Camlock® connection of the AIS component being tested; and, it will include a check-valve, pressure gauge, isolation valve, and tap-water connection (e.g., ¾-inch diameter threaded, swivel water hose connector). The air-bleed cap adapter will be fabricated to connect to the downstream end Camlock® connection of the AIS component being tested; and, it will include an isolation valve and an air-bleed valve assembly. The ABC adapter will need to be fitted with tubing above the air-bleed valve so that the relative elevation of the air-bleed line can be positioned at least 4 feet above the highest pipe or valve on the AIS component being tested. Prior to hydrostatic pressure testing the filling and ABC assemblies will be joined and tested to assure that they are functioning properly and do not leak.

Hydrostatic pressure tests will be accomplished by first fully opening any valves on the AIS component being tested and connecting the filling and ABC test adapters. Some of the AIS components may include additional open ports (e.g., chase-water connection on the Main Manifold). These ports will need to be capped or plugged prior to hydrostatic testing. Camlock® caps or plugs can be used to seal off these open ports that are not fitted with a test adapter. The valves on sample port stopcocks and the KB-1 connection point on the main manifold will be left open prior to hydrostatic testing. The valves at these ports/connection points will be closed during filling of the AIS component once air is displaced and water begins to flow from them.

Prior to filling the AIS component with water, the air-bleed valve on the ABC test adapter will be fully opened. Initially, water will be introduced by slowly filling the assembly through the filling test adapter to displace air through the air-bleed cap test adapter. The valves on sample port stopcocks and the KB-1 connection point on the main manifold will be left open prior to hydrostatic testing. The valves at these ports/connection points will be closed during filling of the AIS component once air is displaced and water begins to flow from them. Once air stops and water starts flowing from the air-bleed valve on the ABC test adapter the flow of water into the filling test adapter will be stopped. The AIS component being tested will be moved/agitated and the water flow will be turned back on and off quickly to liberate trapped air. Once satisfied that the AIS component being tested is filled with water and air is removed to extent practical, the air-bleed valve will be closed and the flow of water slowly turned on to increase hydrostatic pressure in the AIS component being tested.

During the pressurization phase of the hydrostatic pressure test, the pressure in the AIS component being tested will be raised to 8 pounds per square inch differential (PSID) pressure plus or minus 2 PSID (8 ± 2 PSID). The pressure will be monitored on the filling test adapter pressure gauge. Once raised to the desired pressure the isolation valve on the filling test adapter will be closed and the hydrostatic pressure monitoring will begin.

During the hydrostatic pressure monitoring phase, the pressure on the filling test adapter pressure gauge will be recorded from the beginning of the test at 5-minute intervals for 20 minutes. A successful test will be recorded if two conditions are met as follows:

1. the pressure during testing is maintained within 10% of the starting pressure; and,
2. no visible leaks are observed.

For instance, if the starting pressure during an AIS component's hydrostatic pressure test was 9.0 PSID and the four, 5-minute interval pressure readings were between 8.1 PSID and 9.9 PSID; and, no leaks were observed then the test would be deemed a success. If either of the conditions of a successful test are not met, the AIS component will be inspected and fittings will be tightened or replaced. The component will then be retested and the process repeated until a successful test is completed.

Once all AIS components pass the hydrostatic pressure testing, a simulation of field operations will be conducted. Field conditions will be simulated using the sump pump and premix/chase-water tank to reproduce gravity flow from the deoxygenation tanks through the deoxygenation tank connection assemblies, emptying manifold, main manifold, and injection wellhead connection assembly. The set up will be a closed circuit with water pumped from the premix/chase-water tank, through the AIS components, and back into the premix/chase-water tank at the discharge from the injection wellhead connection assembly.

All records of the hydrostatic pressure testing will be documented in a field notebook including but not limited to test time and date, AIS component name, pressure and flow readings, observations, repairs or adjustments, and retest results. Additionally, the hydrostatic test setup and operations will be photographed. Copies of the field notebook and photographs will be included in the results report for the AIS Construction and Testing.

8.2 Field Condition Simulation and Side-stream Tests

Prior to the start of the field-condition simulation test, the premix/chase-water tank will be filled approximately ¾ full of tap water, and the sump pump with discharge line attached will be lowered into the tank. The water flow from the sump pump will be throttled down using the inline ball valve on the pump discharge line to achieve a flow rate of 7.5 gallons per minute (GPM) plus or minus 2.5 GPM (7.5 ± 2.5 GPM). Three consecutive bucket flow-rate tests using a 5-gallon graduated bucket and stopwatch will be performed to establish this flow rate and ball-valve setting. This will be done so that the simulated flow rates are within the specified flow rates desired in the field from the gravity draining of the deoxygenation tanks. After setting the inline ball valve to achieve the flow desired for the test, the sump pump will be shut off and the discharge line will be attached to the test setup.

The field-condition simulation test setup will consist of attaching the sump pump discharge line to the Tank A deoxygenation tank connection assembly, connecting each of the four deoxygenation tank connection assemblies to the emptying manifold, connecting the emptying manifold to the main manifold, connecting the main manifold to the injection wellhead connection assembly and routing the discharge back to the premix/chase-water tank. The set up should be laid out on the ground surface with all AIS components on the ground and in the approximate pattern anticipated during field conditions. Since the simulated flow will be powered by the sump pump, the elevations of the components will not have to be imitated as anticipated in the field. As part of the setup, the isolation valves on deoxygenation tank connection assemblies for Tank B, C, and D, all sample ports, side-stream ports, and the air-bleed valve on the injection wellhead connection assembly should be fully closed. The remaining valves should be fully opened. The reading on the totalizer on the main manifold should be recorded at the completion of the field-condition simulation test setup.

Once the setup is completed, the sump pump should be turned on to start the recirculation of water from the premix/chase-water tank through the AIS components and back to the tank. Air trapped in sample ports and the air-bleed valve should be flushed, and a stopwatch should be used with the totalizer to measure the recirculated flow rate for the first 15 minutes of recirculation. After the first fifteen minutes, three consecutive bucket flow-rate tests should be conducted on the discharge side of the recirculation to check the accuracy of the totalizer. The globe valve on the main manifold should be used to lower the recirculated flow rate to approximately half that of the original flow and another 15-minute observation period of the recirculated flow followed by three consecutive flow-rate bucket tests should be conducted. During this testing the pressure gauges on the main manifold should be monitored, and if the pressures reach or exceed the range of the gauges the flow rate should be lowered using the ball valve on the sump-pump discharge line.

Following the second flow rate adjustment and totalizer/globe-valve check described above, the sump pump and globe valve should be adjusted so that the total flow rate recirculated is 17.5 ± 2.5 GPM. Similar to above, the flow rate should be adjusted and observed; however, bucket flow-rate tests at this juncture of the simulation are not required/reasonable.

Once the recirculation through the field-condition simulation test setup is established at 17.5 ± 2.5 GPM, the side-stream tests can be conducted. The side-stream tests will be used to simulate the KB-1 dispenser and chase-water injections into the main manifold during gravity drainage of the deoxygenation tank contents into the injection well.

The KB-1dispenser side-stream test will consist of injecting tap water dyed with food coloring (e.g., red Wilton® gel food coloring) into the 3/8-inch diameter KB-1 injection port on the main manifold during recirculation through the field-condition simulation test setup. The dyed tap-water side-stream injection will be accomplished using a proportioning injector (e.g., Add-It® Proportioning Fertilizer Injector [https://www.groworganic.com/add-it-fertilizer-injector-pint-size.html]) filled with stock solution consisting of water and food coloring (e.g., red Wilton® gel food coloring) connected to 3/4-inch hose.

The discharge side of the proportioning injector will be fitted with a totalizing flow meter (e.g., Assured Automation MW-PC-075 Series Water Meter [https://assuredautomation.com/WM-PC/]) and 3/4-inch x 3/8-inch reducer and 3/8-inch tubing with male quick connect. The 3/8-inch male quick connect on the proportioning injector discharge will be fastened to the female quick connect on the KB-1 side-stream on the main manifold, and flow from the tap will be turned on slowly to inject the dyed tap water into the recirculation flow. The flow meter totalizer and stopwatch will be used to increase the flow rate up to approximately 2 GPM. Approximately 30 gallons of dyed water will be injected during this KB-1 side-stream test. Success will be assessed visually by observing the dye entering the recirculated water line.

The chase-water side-stream test will be run similarly to the KB-1 dispenser side-stream test. The 3/4-inch x 3/8-inch reducer and hose will be removed from the discharge side of the proportioning injector and replaced with 3/4-inch hose. This hose will be connected to the filling test adapter (see hydrostatic test description in Section 8.1 above). The filling test adapter will then be connected to the chase-water injection port on the main manifold. The proportioning injector will be filled with stock solution containing water and a contrasting dye compared with the dye used in the KB-1 dispenser side-stream test. The flow meter totalizer and stopwatch will be used to increase the flow rate up to approximately 5 GPM. Approximately 50 gallons of dyed water will be injected during this chase-water side-stream test. Success will be assessed visually by observing the dye entering the recirculated water line.

NOTE: *During the operation of the side-stream tests it may be necessary to remove water from the premix/chase-water tank. This can be accomplished by diverting the discharge from the field-condition simulation test setup to the ground surface or drain.*

All records of the field condition simulation and side-stream tests will be documented in a field notebook including but not limited to test time and date, AIS component name, pressure and flow readings, observations, repairs or adjustments, and retest results. Additionally, the simulation and side-stream test setup and operations will be photographed. Copies of the field notebook will be included in the results report for the AIS Construction and Testing.

9.0 References

Banda Group International, LLC (BGI), 2017, Bioremediation Treatability Study - Aboveground Injection System Design, Technical Area-V, Sandia National Laboratories, New Mexico, October 2017.

APPENDIX A
STRENGTH AND STABILITY
ENGINEERING CALCULATIONS
FOR TANK PLATFORMS

Strength Checks:

The analysis for the structural HSS 8x4x1/4" tubes considered limit states for bending, shear, weld strength at connections, and base metal strength at the weld. The analysis for the Ram Jack Stands considered maximum allowable compressive force (10 kips), weld strength at connections, and base metal strength at the weld. **Table 1** provides the strength properties/limits of the steel members. Strength of the structural members was checked using Load and Resistance Factor Design (LRFD) methodology. Using LRFD methodology, resistance, or capacity, (R) of structural members is calculated and multiplied by a resistance factor ($\phi < 1$) for comparison with calculated loads (Q) applied to the structure amplified using load factors ($\Upsilon > 1$). **Table 2** summarizes the capacity checks and load calculations performed for this analysis. The interaction (actual/allowable) value is not permitted to exceed a value of 1.0.

Table 1: Trestle support members and considered material properties

Steel Member	Steel Grade	Yield Strength	Ultimate Strength
HSS 8x4x1/4"	ASTM A500 Gr. B	F_y = 46 ksi	F_u = 58 ksi
Ram Jack Support (Assumptions)	ASTM A36	F_y = 36 ksi	F_u = 58 ksi

Table 2: Steel Platform Structural Strength Summary

Steel Member	Limit State	Factored Strength (ϕR_n)		Factored Load (ΥQ_u)		Actual Over Allowable
HSS 8x4x1/4 (9' Ribs)	Bending	550.8	kip*in	195.0	kip*in	0.35
	Shear	84.7	kip	7.3	kip	0.09
	Weld	8.4	kip/in	3.4	kip/in	0.41
	Base Metal Yield (weld)	6.9	kip/in	3.4	kip/in	0.49
	Base Metal Rupture (weld)	5.8	kip/in	3.4	kip/in	0.59
HSS 8x4x1/4 (20' Span)	Bending	550.8	kip*in	139.0	kip*in	0.25
	Shear	84.7	kip	3.8	kip	0.04
Ram Jack Support (5 on each side)	Compression	10.0	kip	7.3	kip	0.73
	Weld	8.4	kip/in	5.1	kip/in	0.61
	Base Metal Yield (weld)	5.4	kip/in	5.1	kip/in	0.94
	Base Metal Rupture (weld)	6.9	kip/in	5.1	kip/in	0.74

Given: A cylindrical HDPE plastic tank with fluid volume capacity of 5,025 gallons is proposed to be supported using a steel platform. The tank dimensions are 190 inches long, 96 inches tall, and 92 inches wide. The tank will contain water. The weight of the empty tank is 1,509 lbs.

$V := 5025\ gal$ $L := 190\ in$ $\gamma := 62.4\ \frac{lbf}{ft^3}$ $W_{self\_weight} := 1509\ lbf$

Find: The weight of the full tank considering the self weight.

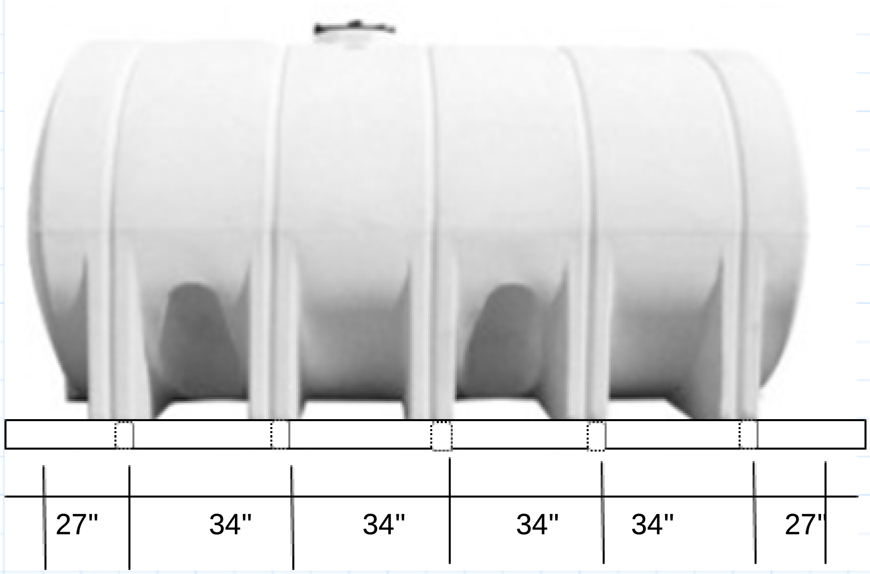
Calculate the dead load distribution on each of the platform ribs.

Solution:

Calculate The Full Weight of the Tank:

$W_{fluid} := \gamma \cdot V$ $W_{full} := W_{self\_weight} + W_{fluid}$

$W_{full} = 43425.9\ lbf$

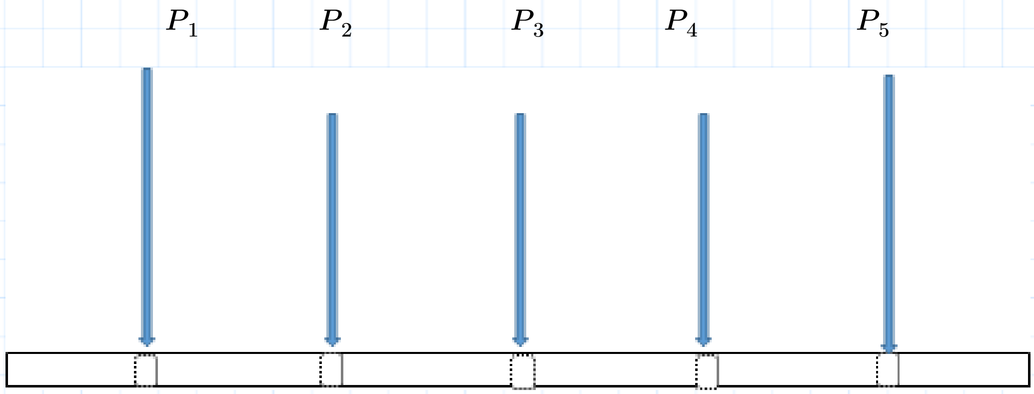


Load Distributon Percentages at the end supports and the middle supports:

$T_{ends} := 23\%$

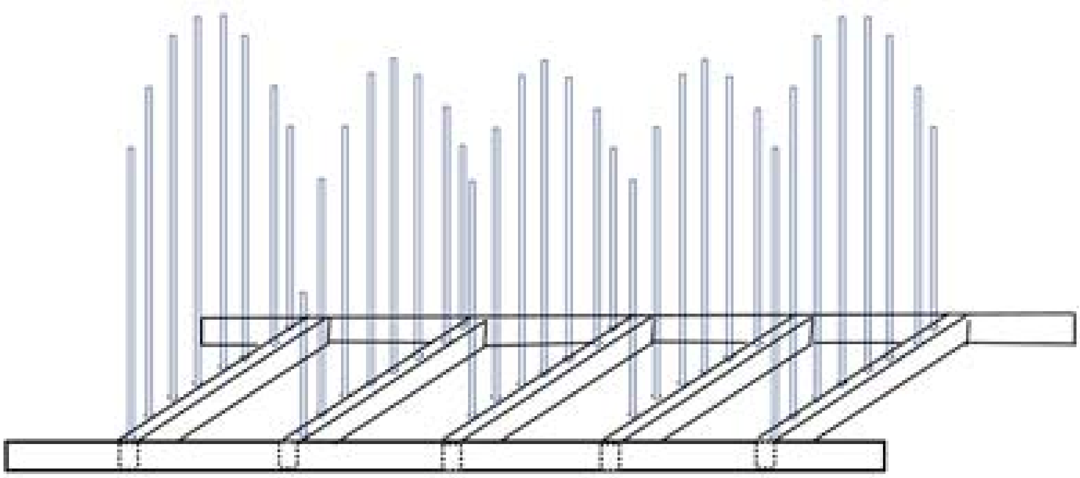
$T_{mid} := 18\%$

amec foster wheeler



$P_1 := (T_{ends}) \cdot W_{full}$ $\quad P_2 := (T_{mid}) \cdot W_{full}$ $\quad P_3 := P_2$ $\quad P_4 := P_2$ $\quad P_5 := P_1$

$P_1 = 9988\ lbf$ $\quad P_2 = 7817\ lbf$ $\quad P_3 = 7817\ lbf$ $\quad P_4 = 7817\ lbf$ $\quad P_5 = 9988\ lbf$



Calculate Idealized Uniform Load Distribution for Each platform rib using maximum resultant (P1):

$L_b := 108\ in$ Clear span of each rib

$w_{tank} := \frac{P_1}{L_b}$ Maximum Uniformly Distributed Load

$w_{tank} = 1110\ plf$

Calculate Uniform Distributed load for each platform rib from 1/8" steel decking:

$Deck\_Weight := 1044\ lbf$ 9' x 20' x 1/8" steel decking:

$$w_{deck} := \frac{\left(\frac{Deck\_Weight}{5}\right)}{L_b}$$

Deck Weight distributed evenly across each rib

$w_{deck} = 23.2\ plf$

Self Weight of the platform ribs (tubing):

$w_{rib} := 15\ plf$ Table 1 - AISC Steel Construction Manual 13th Ed.

*Maximum Unfactored Dead Load at each platform tube:

$w_{dmax} := w_{tank} + w_{deck} + w_{rib}$

$w_{dmax} = 1148\ plf$

*Minimum Unfactored Dead Load at each platform tube:

$$w_{tank\_empty} := \frac{\left(\frac{W_{self\_weight}}{5}\right)}{L_b}$$

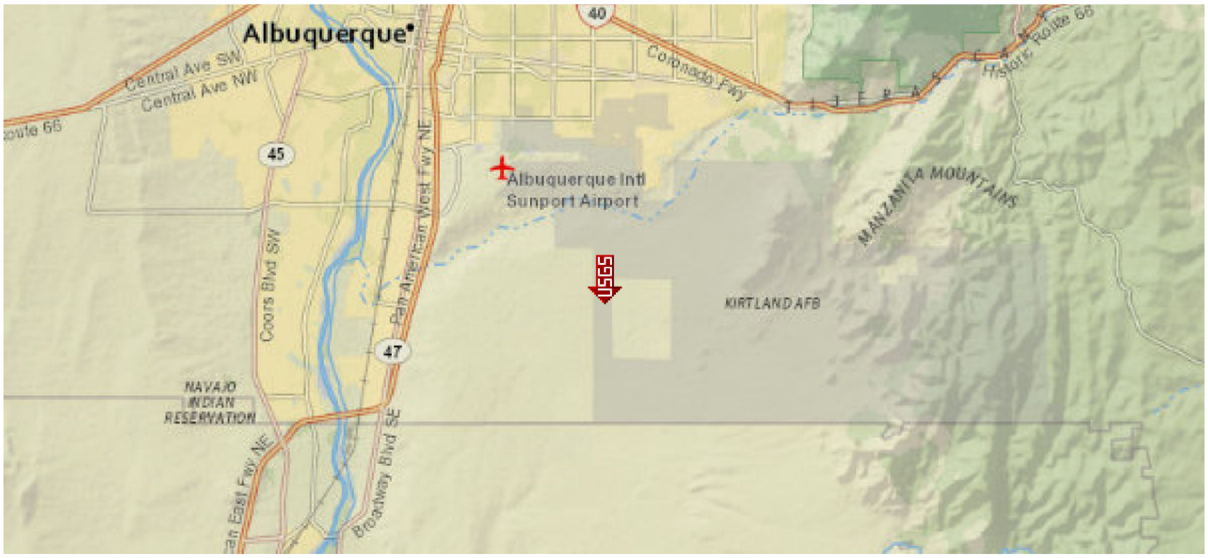
$w_{dmin} := w_{tank\_empty} + w_{deck} + w_{rib}$

$w_{dmin} = 72\ plf$

USGS Design Maps Summary Report

User–Specified Input

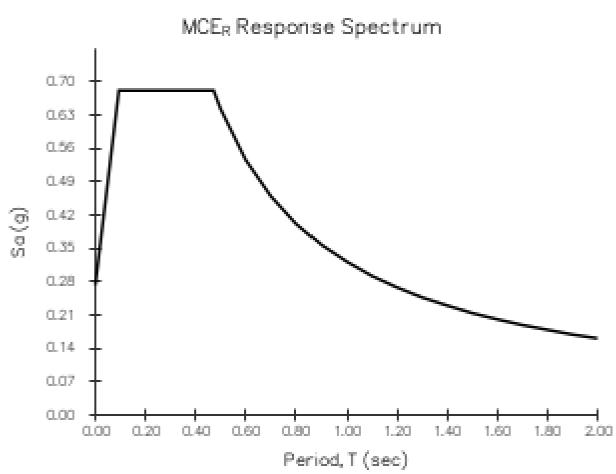
Building Code Reference Document	ASCE 7-10 Standard (which utilizes USGS hazard data available in 2008)
Site Coordinates	35°N, 106.564°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

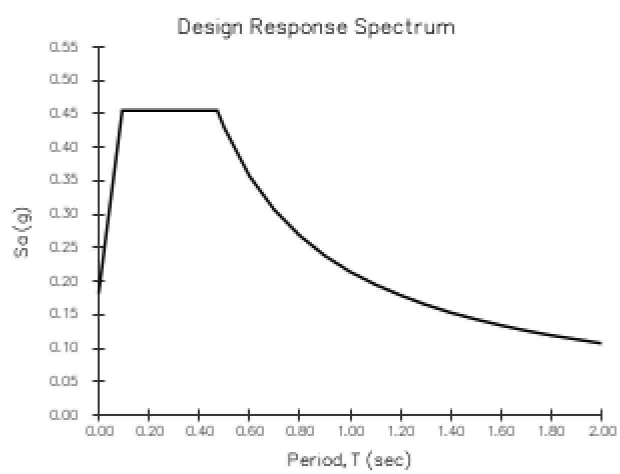


USGS–Provided Output

S_S = 0.482 g	S_{MS} = 0.682 g	S_{DS} = 0.455 g
S_1 = 0.145 g	S_{M1} = 0.322 g	S_{D1} = 0.214 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.

Given: The HDPE plastic tank supported using a steel platform, w = 43,425.9 lb

*Risk Category I (Table 1.5-1)

"Buildings and other structures that represent low risk to human life in the event of failure."

$I_e := 1.0$ Imprtance Factor

Find: The Horizontal and Vertical seismic design forces applied to the platform.

Solution: ASCE 7-10 - Chapter 13.6.8.1, ASME Pressure Piping Systems

$I_p := 1.0$ *Section 13.1.3

$S_{DS} := 0.455$ *USGS Design Maps Summary Support

$W_p := 43425.9 \cdot lbf$ *Calc. 1 Dead Load Component Operating Weight

Table 15.4-2 - Tanks Vessels, Bins, or Hoppers on symmetrically braced legs (not Similar to buildings $R := 3$

*Section 15.1.3 Structural Analysis Proceedure Selection. Nonbuilding structures that are not similar to buildings shall be designed using either the equivalent lateral force procedure in accordance with section 12.8

$$C_s := \frac{S_{DS}}{\left(\frac{R}{I_e}\right)}$$

12.8.1 - Equivalent Lateral Force Procedure Base Shear (V) $V := C_s \cdot W_p$

Horizontal seismic design force:

$V = 6586\ lbf$

Calculate the vertical seismic design force per Section 12

$F_V := 0.2 \cdot S_{DS} \cdot W_p$

$F_V = 3952\ lbf$ *Applied Upward or Downward

Hydrodynamic Effects:

$\gamma_{h20} := 62.4\ pcf$

*Section 15.7-2

$\Delta_\gamma := 0.2 \cdot S_{DS} \cdot \gamma_{h20}$

$\Delta_\gamma = 5.678\ pcf$

$\gamma_L := \gamma_{h20} + \Delta_\gamma$

$\gamma_L = 68.078\ pcf$

$V_{tank} := 5025 \cdot gal$

$W_{hdl} := \gamma_L \cdot V_{tank}$

$W_{hdl} = 45731\ lbf$

$Hydrodynamic\_Load\_Increase := W_{hdl} - W_p$

$Hydrodynamic\_Load\_Increase = \left(2.305 \cdot 10^3\right)\ lbf$

Total Lateral and Vertical Seismic Load:

$E_H := V + Hydrodynamic\_Load\_Increase$

$E_V := F_V + Hydrodynamic\_Load\_Increase$

$E_H = 8892\ lbf$

$E_V = 6257\ lbf$

Lateral seismic loading will be resisted by bracing. Vertical seismic load will transmit to the platform tubing evenly:

$$L_b := 108\ in$$

$$w_{EV} := \frac{\left(\frac{E_V}{5}\right)}{L_b}$$

$$w_{EV} = 139\ plf$$

Given: The HDPE plastic tank supported using a steel platform,

*Risk Category I (Table 1.5-1)

"Buildings and other structures that represent low risk to human life in the event of failure."

$I_w := 1.0$ Imprtance Factor

Find: The Horizontal and Vertical Wind design forces applied to the Platform.

Solution: Wind Loading on "Other Structures" - ASCE 7-10 - Chapter 29

$b := 15.8 \cdot ft$ *Length of Tank

$D_c := 7.7 \cdot ft$ *Diameter of tank

$V := 105$ Figure 26.5-1C Risk Category I Exposure C

$K_d := 0.95$ Section 26.7

$K_{zt} := 1.0$ Section 26.8

$G := 0.85$ Section 26.9

$K_z := 0.85$ Table 29.3-1

$$q_z := 0.00256\ K_z \cdot K_{zt} \cdot K_d \cdot V^2 \cdot \frac{lbf}{ft^2}$$ Equation 29.3-1

$q_z = 0.158\ psi$

$C_f := 0.5$ Force Coefficient 29.5-1

Calculate Force:

$$F := q_z \cdot G \cdot C_f \cdot b \cdot D_c$$

$$F = 1178\ lbf$$

Fluid Mechanics - Flow Over Immersed Bodies

$\rho := 2.38 \cdot 10^{-3} \cdot \frac{slug}{ft^3}$ *Density of air at 59 F and standard pressure

$\nu := 1.57 \cdot 10^{-4} \cdot \frac{ft^2}{s}$ *Kinematic Viscocity of air at standard pressure

$V := 105 \cdot \frac{mi}{hr}$ *3 second Gust per ASCE 7-10, Figure 26.5-1c (Risk Category I)

$V = 154 \frac{ft}{s}$

$b := 15.8 \cdot ft$ *Length of Tank

$D_c := 7.7 \cdot ft$ *Diameter of tank

$Re := \frac{(V \cdot D_c)}{\nu}$ *Reynolds Number

$Re = 7.553 \cdot 10^6$

$C_D := 0.8$ *Drag Coefficient as a function of Reynolds number (2.803E6) for a smooth Cylinder, Fig. 9.21 Fundamentals of fluid mechanics, Munson 5th Ed.

Drag Caculation for wind on pipeline on trestle support

$$D := \frac{1}{2} \cdot \rho \cdot V^2 \cdot b \cdot D_c \cdot C_D$$

$D = 2746.8 \ lbf$

Given: The steel tank platform rib load calculations:

$L_{rib} := 9 \cdot ft$ $\quad E := 29000 \cdot ksi$ $\quad I_{rib} := 20.9\ in^4$

$D := 1148 \cdot plf$ (Uniformly Distributed - Calculation 1)

$E_h := 8.892 \cdot kip$ (Calculation 2)

$E_v := 6.257 \cdot kip$ (Calculation 2)

$$E_{vrib} := \frac{\left(\frac{E_v}{5}\right)}{L_{rib}}$$

$W := 2.747 \cdot kip$ (Calculation 3)

$L := 3\ kip$ (Table 4.1 Minimum Concentrated Live Load for Heavy Manufacturing)

Find: Moments, Shears, and Deflections for the Tube Steel Ribs and Spanning Support Beams

Solution:

W6x4x1/4" Rib:

*ASCE 7-10 Section 2.3.2
Applicable Basic Load Combinations (Factored Loads)

$$Combo1 := 1.4 \cdot D$$

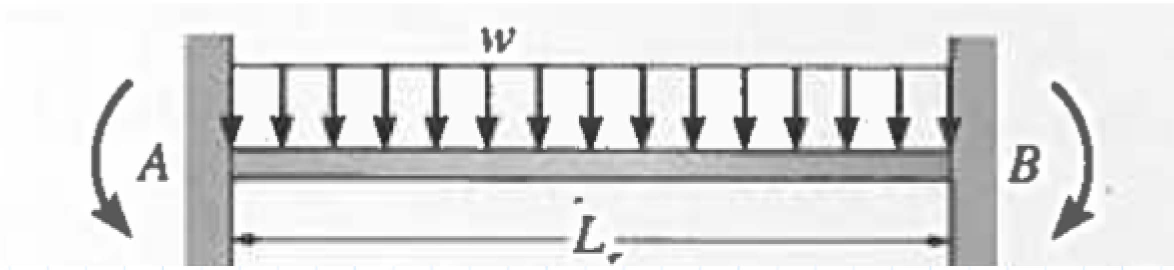
$$Combo5 := 1.2\ D + 1.0 \cdot E_{vrib}$$

$$Combo1 = \left(1.607 \cdot 10^3\right)\ plf$$

$$Combo5 = \left(1.517 \cdot 10^3\right)\ plf$$

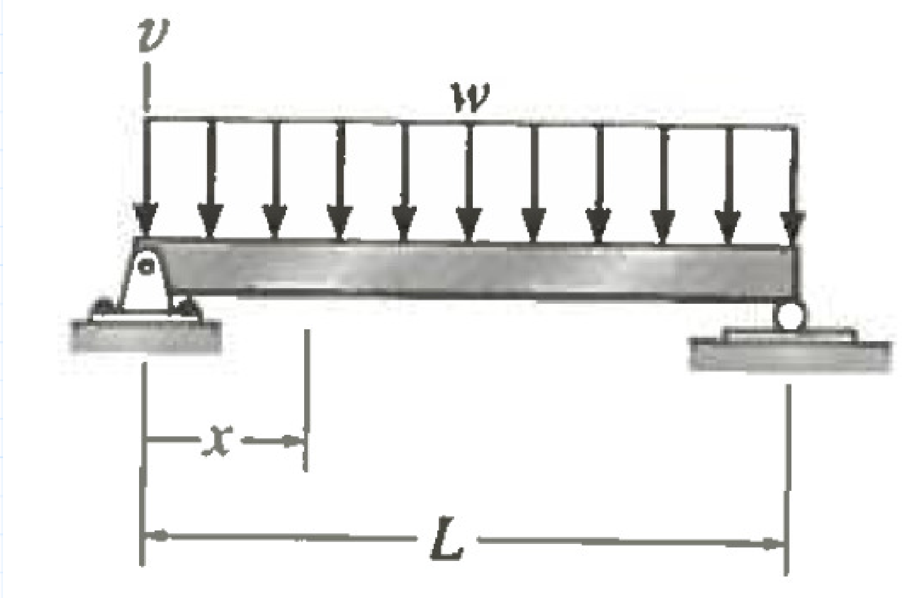
$w_u := 1607\ plf$ *Load Combination 1 Governs for downward applied loading for the ribs

*Idealized Rib



$R := \frac{w_u \cdot L_{rib}}{2}$ $V_u := R$ $M_{end} := \frac{-w_u \cdot L_{rib}^2}{12}$ $M_{mid} := \frac{w_u \cdot L_{rib}^2}{24}$

$R = 7232\ lbf$ $M_{end} = -10847\ lbf \cdot ft$ $M_{mid} = 5424\ lbf \cdot ft$



$$M_{midss} := \frac{w_u \cdot L_{rib}^2}{8}$$

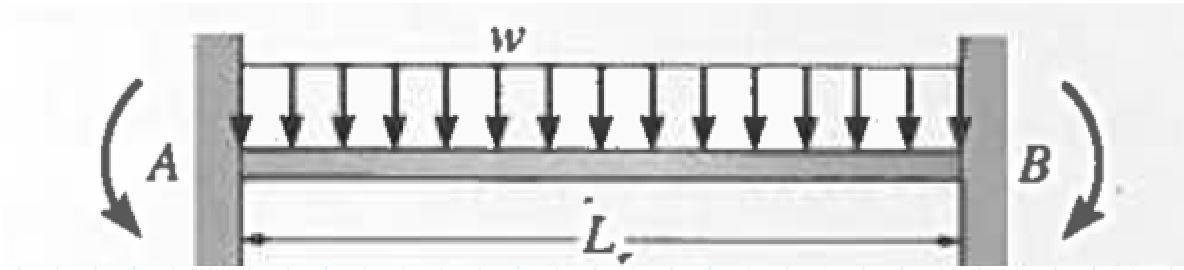
$$M_{midss} = 16271\ lbf \cdot ft$$

* $M_u := M_{midss}$

$M_u = 16271\ lbf \cdot ft$ $M_u = 195\ kip \cdot in$

$$V_u = 7232\ lbf$$

*Rib Deflection



$E := 29000 \cdot ksi$

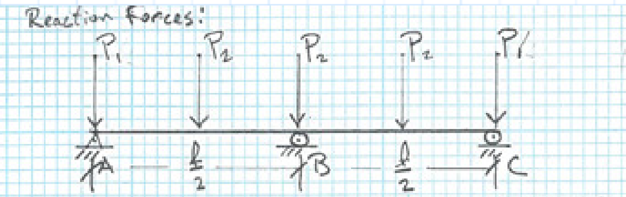
$I_{rib} := 20.9\ in^4$

$$\Delta_{max} := \left(\frac{D \cdot L_{rib}^{\ 4}}{384 \cdot E \cdot I_{rib}} \right)$$ at center span

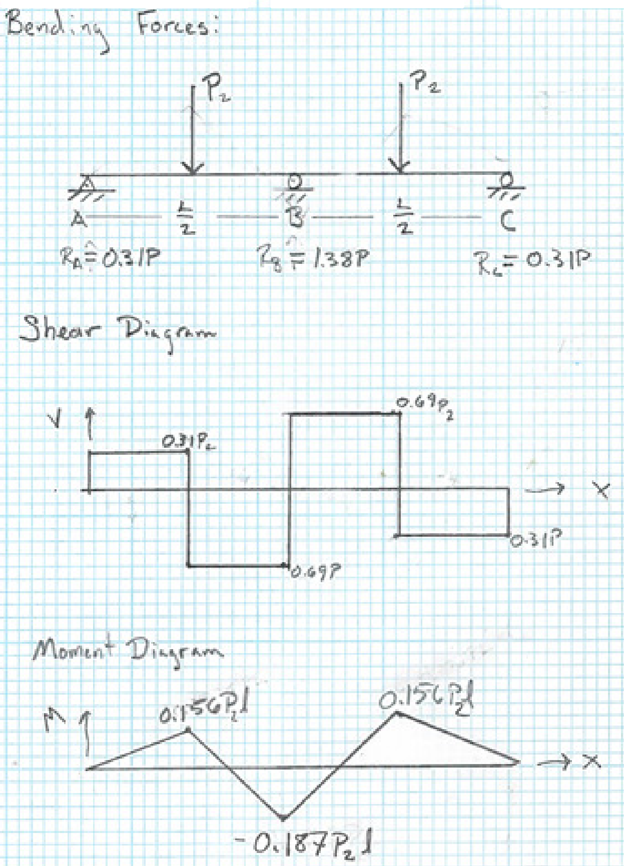
$\Delta_{max} = 0.056\ in$

W6x4x1/4" Spanning Support Beam : $l := 136 \cdot in$

$P_1 := 1.4 \cdot \frac{9988}{2} \cdot lbf$ $P_2 := 1.4 \cdot \frac{7817}{2} \cdot lbf$ *Calculation 1 (Factored)



$R_A := P_1 + 0.31\ P_2$ $R_B := 2.38 \cdot P_2$ $R_C := R_A$



$R_A = 8688\ lbf$ $V_u := 0.69 \cdot P_2$ $M_u := -0.187 \cdot P_2 \cdot l$

$R_B = 13023\ lbf$ $V_u = 3776\ lbf$ $M_u = -11597\ lbf \cdot ft$

R > 10kips, N.G. More than 3 outriggers needed

$M_u = -139\ kip \cdot in$

$R_C = 8688\ lbf$

Owner	BGI			**Computed By**	J. Hays
Plant		**Unit**		**Date**	9/9/2017
Project No.	17-517-00045	**File No.**			
Title	Platform Ribs (Tube to Tube Connection)				
	Weld Capacity for Rectangular Weld				

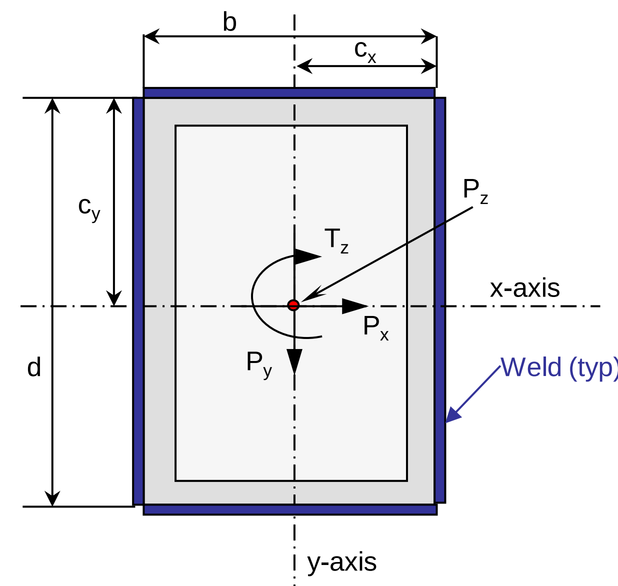
Weld Capacity for Rectangular Weld

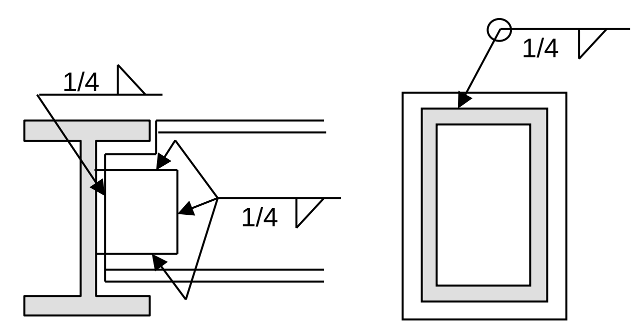
ENTER INFORMATION

Loads:			Section Properties:			Weld Strength Properties:		
P_x =	0	kips	d =	6.875	in	F_w =	1.395	kip/in / (1/16" weld)
P_y =	7.232	kips	b =	3.3	in		Fw = 0.60 Fexx	
P_z =	0	kips					Fexx = 70	
M_x =	130.2	kip-in					(ϕRn = 0.75*(0.707*w*Fw))	
M_y =	0	kip-in				SR_{allow} =	1	
T_z =	0	kip-in						

CALCULATIONS

Distance from y-axis to Edge of Weld, c_x =	1.65	in
Distance from x-axis to Edge of Weld, c_y =	3.44	in
Total Length of Weld in x-direction, L_x =	6.6	in
Total Length of Weld in y-direction, L_y =	13.75	in
Total Length of Weld, L_w =	20.35	in
Section Modulus of Weld About x-axis, S_x =	38.44	in^2
Section Modulus of Weld About y-axis, S_y =	26.32	in^2
Polar Moment of Inertia About z-axis, I_z =	175.6	in^3
Shear Stress on x-axis of Weld, f_{vx} =	0.000	kip/in
Shear Stress on y-axis of Weld, f_{vy} =	0.526	kip/in
Torsional Stress on x-axis of Weld, f_{tx} =	0.000	kip/in
Torsional Stress on y-axis of Weld, f_{ty} =	0.000	kip/in
Axial Stress on Weld, f_a =	0.000	kip/in
Bending Stress about x-axis of Weld, f_{bx} =	3.387	kip/in
Bending Stress about y-axis of Weld, f_{by} =	0.000	kip/in
Total Force Acting in x-direction, f_1 =	0.000	kip/in
Total Force Acting in y-direction, f_2 =	0.526	kip/in
Total Force Acting in z-direction, f_3 =	3.387	kip/in
Resultant Force on Weld, f_r =	3.427	kip/in





Typical Weld Callouts

Allowable Stress on Weld (per inch), F_{weld} =	**1.395**	kip/in/(1/16" weld)
Allowable Stress on Weld (per inch), F_{weld} =	**8.370**	6 /16 weld (3/8")
Minimum Required Weld Size, $\mathbf{t_{min}}$ =	**3/16**	**in**
Weld Stress Ratio, SR =	0.819	

Other Possible Weld Sizes

1/8	in. weld	SR =	1 8/35
1/4	in. weld	SR =	0.614
6.35	**mm weld**	**SR =**	**0.614**

Legend:

P_x = Major axis load (x-axis)	M_x = Moment about x-axis	d = Depth of rectangular weld
P_y = Minor axis load (y-axis)	M_y = Moment about y-axis	b = Flange width of rectangular weld
P_z = Axial load (z-axis)	T_z = Torque about z-axis	F_w = Weld strength [kip/(1/16")]
		ASIF = Allowable stress increase factor
		SR_{allow} = Allowable stress ratio

Equations:

$c_x = b/2$	$f_{vx} = P_x/L_z$	$f_1 = f_{vx} + f_{tx}$
$c_y = d/2$	$f_{vy} = P_y/L_z$	$f_2 = f_{vy} + f_{ty}$
$L_x = 2*b$	$f_{tx} = T_z*c_y/I_z$	$f_3 = f_a + f_{bx} + f_{by}$
$L_y = 2*d$	$f_{ty} = T_z*c_x/I_z$	$f_r = (f_1^2 + f_2^2 + f_3^2)^{1/2}$
$L_w = L_x + L_y$	$f_a = P_z/L_w$	$F_{weld} = F_w$ (if ASIF = "n"); $= ASIF*F_w$ (if ASIF = "y")
$S_x = d/3*(3*b + d)$	$f_{bx} = M_x/S_x$	$t_{min} = f_r/(SR_{allow}*F_{weld}*16)$
$S_y = b/3*(3*d + b)$	$f_{by} = M_y/S_y$	$SR = f_r/(F_{weld}*t_{min}*16)$
$I_z = (b + d)^3/6$		

Base Metal Check

Member Fy=	46	Support Fy=	46				
Member Fu=	58	Support Fu=	58				
Member Thick. (t_m)=	0.25	Support Thick.(t_s)=	0.25				
Member base metal capacity Yield		= 0.6 x (Fy) x (t_m)=	**6.9** kip/in	>	3.427 kip/in	OK	
Member base metal capacity Rupt.		= 0.4 x (Fu) x (t_m)=	**5.8** kip/in	>	3.427 kip/in	OK	
Support base metal capacity Yield		= 0.6 x (Fy) x (t_s)=	**6.9** kip/in	>	3.427 kip/in	OK	
Support base metal capacity Rupture		= 0.4 x (Fu) x (t_s)=	**5.8** kip/in	>	3.427 kip/in	OK	
SR=Max{Weld SR,(fr/Member base metal Capacity), (fr/Support base metal Capacity)}=						**SR=**	**0.614**

Owner	BGI		**Computed By**	J. Hays
Plant		**Unit**	**Date**	9/9/2017
Project No.	17-517-00045	**File No.**		
Title	Platform Ribs (Beam to RamJack Connection)			
	Weld Capacity for Double Weld			

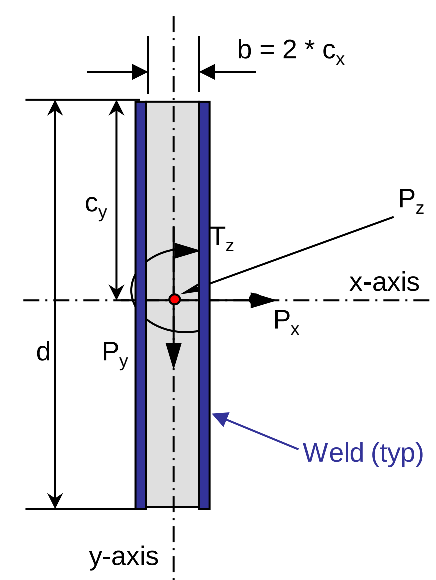
Weld Capacity for Double Weld

Weld @ Ram Jacks

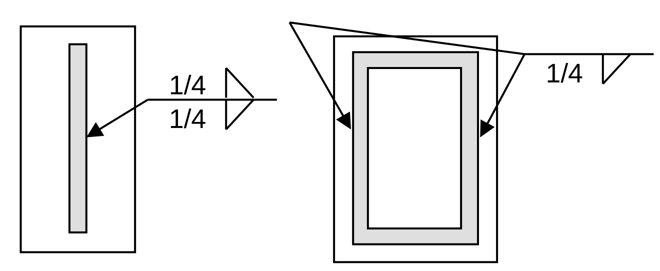
ENTER INFORMATION

Loads:			Section Properties:			Weld Strength Properties:		
P_x =	0	kips	d =	6.875	in	F_w =	1.395	kip/in / (1/16" weld)
P_y =	7.232	kips	b =	3.7	in		Fw = 0.60 Fexx	
P_z =	1.778	kips					Fexx = 70	
M_x =	64.8	kip-in					(ϕRn = 0.75*(0.707*w*Fw))	
M_y =	0	kip-in				SR_{allow} =	1	
T_z =	64.8	kip-in						

CALCULATIONS



Distance from y-axis to Edge of Weld, c_x =	1.85	in
Distance from x-axis to Edge of Weld, c_y =	3.44	in
Total Length of Weld in x-direction, L_x =	0	in
Total Length of Weld in y-direction, L_y =	13.75	in
Total Length of Weld, L_w =	13.75	in
Section Modulus of Weld About x-axis, S_x =	15.76	in^2
Section Modulus of Weld About y-axis, S_y =	25.44	in^2
Polar Moment of Inertia About z-axis, I_z =	101.2	in^3
Shear Stress on x-axis of Weld, f_{vx} =	0.000	kip/in
Shear Stress on y-axis of Weld, f_{vy} =	0.526	kip/in
Torsional Stress on x-axis of Weld, f_{tx} =	2.201	kip/in
Torsional Stress on y-axis of Weld, f_{ty} =	1.184	kip/in
Axial Stress on Weld, f_a =	0.129	kip/in
Bending Stress about x-axis of Weld, f_{bx} =	4.113	kip/in
Bending Stress about y-axis of Weld, f_{by} =	0.000	kip/in
Total Force Acting in x-direction, f_1 =	2.201	kip/in
Total Force Acting in y-direction, f_2 =	1.710	kip/in
Total Force Acting in z-direction, f_3 =	4.242	kip/in
Resultant Force on Weld, f_r =	5.076	kip/in



Typical Weld Callouts

Allowable Stress on Weld (per inch), F_{weld} =	1.395	kip/in/(1/16" weld)
Allowable Stress on Weld (per inch), F_{weld} =	**8.370**	6 /16 weld (3/8")
Minimum Required Weld Size, $\mathbf{t_{min}}$ =	**1/4**	**in**
Weld Stress Ratio, SR =	0.910	

Other Possible Weld Sizes

3/16	in. weld	SR =	1.213
3/8	in. weld	SR =	0.606
6.35	**mm weld**	**SR =**	**0.910**

Legend:

P_x = Major axis load (x-axis)	M_x = Moment about x-axis	d = Depth of C-shape weld
P_y = Minor axis load (y-axis)	M_y = Moment about y-axis	b = Flange width of C-shape weld
P_z = Axial load (z-axis)	T_z = Torque about z-axis	F_w = Weld strength [kip/(1/16")]
		ASIF = Allowable stress increase factor
		SR_{allow} = Allowable stress ratio

Equations:

$c_x = b/2$	$f_{vx} = P_x/L_z$	$f_1 = f_{vx} + f_{tx}$
$c_y = d/2$	$f_{vy} = P_y/L_z$	$f_2 = f_{vy} + f_{ty}$
$L_x = 0$	$f_{tx} = T_z*c_y/I_z$	$f_3 = f_a + f_{bx} + f_{by}$
$L_y = 2*d$	$f_{ty} = T_z*c_x/I_z$	$f_r = (f_1^2 + f_2^2 + f_3^2)^{1/2}$
$L_w = L_x + L_y$	$f_a = P_z/L_w$	$F_{weld} = F_w = 0.6Fexx$
$S_x = d^2/3$	$f_{bx} = M_x/S_x$	$t_{min} = f_r/(SR_{allow}*F_{weld}*16)$
$S_y = b*d$	$f_{by} = M_y/S_y$	$SR = f_r/(F_{weld}*t_{min}*16)$
$I_z = d/6*(3*b^2 + d^2)$		

Base Metal Check

Member Fy=	36	Support Fy=	46			
Member Fu=	58	Support Fu=	58			
Member Thick. (t_m)=	0.25	Support Thick.(t_s)=	0.25			
Member base metal capacity Yield	= 0.6 x (Fy) x (t_m)=	**5.4** kip/in	>	5.076 kip/in	OK	
Member base metal capacity Rupt.	= 0.4 x (Fu) x (t_m)=	**5.8** kip/in	>	5.076 kip/in	OK	
Support base metal capacity Yield	= 0.6 x (Fy) x (t_s)=	**6.9** kip/in	>	5.076 kip/in	OK	
Support base metal capacity Rupture	= 0.4 x (Fu) x (t_s)=	**5.8** kip/in	>	5.076 kip/in	OK	
SR=Max{Weld SR,(fr/Member base metal Capacity), (fr/Support base metal Capacity)}=				**SR=**		**0.940**

APPENDIX B
SPECIFICATIONS

DRAFT

ABOVEGROUND INJECTION SYSTEM CONSTRUCTION AND MECHANICAL INTEGRITY TEST PLAN

APPENDIX B - SPECIFICATIONS

Contract No. 1806318

Prepared for:

Sandia National Laboratories, New Mexico

Prepared by:

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Albuquerque, New Mexico 87113

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SECTION 01010 - SUMMARY OF WORK

PART 1 GENERAL

1.1 DESCRIPTION

The work to be performed consists of a Treatability Study at Technical Area-V (TA-V) at Sandia National Laboratories, New Mexico. The Treatability Study will consist of an initial small-scale proof of concept test (pilot test) at newly installed injection well TAV-INJ1. Results from this test will be evaluated to determine whether to implement a full-scale injection at well TAV-INJ1 and whether to refine procedures. Results from the full-scale test at well TAV-INJ1 will be evaluated to determine whether to install two additional injection wells, TAV-INJ2 and TAV-INJ3, and perform full-scale tests at these locations. A series of bioamendment injections will be performed at the site using onsite injection equipment and materials.

B. The work will include the following items, to be constructed as shown on the detailed drawings.

1. Site Mobilization.
    a. Support facilities will be constructed prior to commencement of injection activities.
    b. Support facilities will include:
        i. Office Conex with storage
        ii. Tank platform and injection skid
        iii. Sanitation facilities
2. Installation of injection wells prior to mobilization of injection equipment.
3. Provision of a system to store, mix, and inject bioamendment material in an aqueous solution.
4. Connection to the public power supply to run the office trailer.

1.2 UNDERGROUND FACILITIES

No underground facilities are required for the injection system other than injection well TAV-INJ1, which will be completed prior to mobilization.

1.3 WORK QUALITY

A. Shop and field work shall be performed by workers skilled and experienced in the execution of the work involved. All work required shall be performed in accordance with the best practices and in accordance with the detailed drawings and specifications.

B. All finished work shall be free from defects and damage.

C. The DOE and SNL personnel reserve the right to reject any materials and work quality that are not considered to be up to the highest standards of the various trades involved. Such inferior material or work quality shall be repaired or replaced, as directed, at no additional cost.

1.4 FIELDWORK

Provide all labor and tools required to execute the Scope of Work. Provide field records as required.

END OF SECTION
033210 - CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of the unformed concrete placements as well as the formed vertical and horizontal concrete placements.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials, AASHTO M 182, Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.

B. American Concrete Institute:

1. ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
2. ACI 301, Specifications for Structural Concrete for Buildings.
3. ACI 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305R, Hot Weather Concreting.
5. ACI 306R, Cold Weather Concreting.
6. ACI 308, Standard Practice for Curing Concrete.
7. ACI 318, Building Code Requirements for Reinforced Concrete.

C. American Society for Testing and Materials:

1. ASTM C 31, Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C 33, Specification for Concrete Aggregates.
3. ASTM C 39, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C 42, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C 94, Specification for Ready-Mixed Concrete.
6. ASTM C 143, Test Method for Slump of Hydraulic Cement Concrete.
7. ASTM C 150, Specification for Portland Cement.

8. ASTM C 156, Test Method for Water Retention By Concrete Curing Materials.
9. ASTM C 171, Specifications for Sheet Materials for Curing Concrete.
10. ASTM C 172, Practice for Sampling Freshly Mixed Concrete.
11. ASTM C 173, Test Method for Test for Air Content of Freshly Mixed Concrete by the Volumetric Method.
12. ASTM C 231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
13. ASTM C 260, Specification for Air-Entraining Admixtures for Concrete.
14. ASTM C 309, Specification for Liquid Membrane - Forming Compounds for Curing Concrete.
15. ASTM C 494, Specification for Chemical Admixtures for Concrete.
16. ASTM C 881; Specification for Epoxy-Resin-Base Bonding System for Concrete.
17. ASTM C 882; Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
18. ASTM D 570; Test Method for Water Absorption of Plastics.
19. ASTM D 638; Test Method for Tensile Properties of Plastics.
20. ASTM D 695; Test Method for Compressive Properties of Rigid Plastics.
21. ASTM D 732; Test Method for Shear Strength of Plastics by Punch Tool.
22. ASTM D 790; Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 QUALITY ASSURANCE

Meet requirements of The American Society for Testing and Materials (ASTM) Recommended Practice for Inspection and Testing Agencies for Concrete and Steel in Construction ASTM E 329.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement: Portland Cement conforming to ASTM C 150, Type II, Moderate Sulfate Resistance.

B. Aggregates for Concrete: Normal weight aggregates conforming to ASTM C 33 and subject to the following limitations:

1. Maximum size of coarse aggregate shall not exceed 1 ½-inches.

C. Water: Clear and free from deleterious amounts of acids, alkalis, and organic substances.

D. Curing Materials: Use curing materials that will not stain or affect concrete finish or lessen the concrete strength.

2.02 CONCRETE QUALITY

A. Classes of Concrete/Compressive Strengths: In general, use Class A concrete for all concrete work except where otherwise indicated on Drawings or specified herein.

1. Class A: 3,000 psi. minimum compressive strength at 28 days.

B. Proportions of Concrete Ingredients: Establish proportions, including water-cement ratio, on the basis of field experience.

C. Slump: Proportion and produce concrete to have a slump not to exceed 5 inches if consolidated by rodding, spading or other manual methods.

PART 3 EXECUTION

3.01 EXAMINATION

A. Field Inspection: Inspect work to receive cast-in-place concrete for deficiencies which would prevent proper execution of the finished work. Do not proceed with placing until such deficiencies are corrected.

3.02 PREPARATION

A. Formwork Preparation: Prepare formwork in advance and remove snow, ice, water and debris from within forms.

1. Prepare subgrade sufficiently to eliminate water loss from concrete.
2. Do not place concrete on frozen ground.

B. Production of Concrete: Mixed and in accordance with manufacturer's instructions.

3.03 INSTALLATION

A. Placing Concrete: Conduct concrete placement work in accordance manufacturer's instructions.

B. Handle concrete from mixer to final deposit rapidly by methods which will prevent segregation or loss of ingredients to maintain required quality of concrete.

C. Placement concrete continuously to produce monolithic unit. Carry on placing at such a rate that concrete which is being integrated with fresh concrete is still plastic.

1. Do not allow concrete to drop vertically more than 4 feet.
2. Deposit in layers of 6 to 8 inches.
3. Do not deposit fresh concrete on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within sections.
5. Do not use concrete which has partially hardened or has been contaminated by foreign materials.
6. Do not subject concrete to procedures which will cause segregation.
7. Do not place concrete in forms containing standing water.

C. Consolidate concrete spading, rodding or other manual methods.

D. Cold Weather Concrete Work: In general, perform cold weather concrete work in temperatures above 32° F and in compliance with requirements as follows:

1. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 degrees F.
2. Provide materials and methods for protecting concrete from freezing during freezing or near-freezing weather. Do not use frozen materials or materials containing snow or ice.
3. Surfaces which the concrete is to come in contact with must be free of frost, snow and ice.
4. Concrete placed in forms shall have a temperature of 50 degrees F. or higher after placement.

E. In general, perform hot weather concrete work in accordance with requirements as follows:

1. Temperature of concrete shall not exceed 90 degrees F.
2. Cool ingredients before mixing to prevent temperature in excess of 90 degrees.
3. Make provisions for windbreaks, shading, fog spraying, sprinkling or wet cover when necessary.

3.04 FINISHING

A. General Requirements: Finish exposed concrete surfaces true and even, free from open or rough areas, depressions or projections. In vertical pours, place concrete to the required elevation, and strike-off with a straight edge and float surface to a level plane.

   1. Spade Finish: Obtained by forcing a flat spade or similar device down adjacent to the form and pulling the top of the spade away from the form to bring mortar to the surface next to the forms.

3.05 CURING AND PROTECTION

General Requirements: Immediately after placement, protect concrete from premature drying, excessive hot or cold temperatures and mechanical injury. Cure concrete until ready of load bearing capacity.

3.06 FIELD QUALITY CONTROL

A. In general, the concrete work will not require testing unless, in the Engineer's opinion, concrete materials and methods of operations are not in conformance with the specified requirements. If testing is ordered by the Engineer, perform testing as specified by the Engineer.

END OF SECTION

055014 - STRUCTURAL METAL FABRICATIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2012; Errata 2011) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX (2010) BPVC Section IX-Welding and Brazing Qualifications

1.2 SUBMITTALS

Not Used

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Welders and Welding Operators

Certify that the qualification of welders and welding operators and tack welders who will perform structural steel welding have been qualified for the particular type of work to be done in accordance with the requirements of AWS D1.1/D1.1M, Section 4, or ASME BPVC SEC IX, Section IX, prior to commencing fabrication.

a. List the qualified welders by name and specify the code and procedures under which qualified and the date of qualification.
b. Maintain an approved inspection system and perform weld inspections. Welding will be subjected to inspection to determine conformance with the requirements of AWS D1.1/D1.1M.

1.3.2 Detail Drawings

Submit detail drawings for metalwork prior to fabrication, include within the detail drawings fabrication and assembly details as appropriate.

PART 2 PRODUCTS

Materials shall be of appropriate grade as denoted on project drawings.

2.1 MATERIALS

2.1.1 Materials List

Materials used in the fabrication of structures shall be in accordance with detail drawings.

2.2 FABRICATION

2.2.1 Structural Fabrication

Material shall be straight before being worked. Perform straightening, if necessary, by methods that will not impair the metal. Sharp kinks or bends will be cause for rejection of the material. Material with welds will not be accepted except where welding is definitely specified, indicated or otherwise approved. Make bends using approved dies, press brakes or bending rolls. Where heating is required, take precautions to avoid overheating the metal and allow it to cool in a manner that will not impair the original properties of the metal. Proposed flame cutting of material, other than structural steel, will be subject to approval and shall be indicated on detail drawings. Shearing shall be accurate and all portions of the work neatly finished. Corners shall be square and true unless otherwise shown. Re-entrant cuts shall be filleted to a minimum radius of 3/4 inch unless otherwise approved. Provide finished members free of twists, bends and open joints. Bolts, nuts and screws shall be tight.

2.2.1.1 Dimensional Tolerances for Structural Work

The overall dimensions of an assembled structural unit shall be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work.

2.2.1.2 Structural Steel Fabrication

Structural steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Prepare surfaces and edges in accordance with AWS D1.1/D1.1M, Subsection 3.2. Where structural steel is not to be welded, chipping or grinding will not be required except as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Chip, grind or machine to sound metal hand-guided cuts which are to be exposed or visible.

2.2.1.3 Structural Aluminum Fabrication

Not used.

2.2.2 Welding

2.2.2.1 Welding of Structural Steel

a. Welding Procedures for Structural Steel – Conform to welding procedures for structural steel as described in AWS D1.1/D1.1M.
b. Welding Process - Perform welding of structural steel by an electric arc welding process using a method which excludes the atmosphere from the molten metal and conforms to the applicable provisions of AWS D1.1/D1.1M. Minimize residual stresses, distortion and shrinkage from welding.
c. Welding Technique
    (1) Filler Metal - The electrode, electrode-flux combination and grade of weld metal shall conform to the appropriate AWS specification for the base metal and welding process being used or be as shown where a specific choice of AWS specification allowables is required. Include the AWS designation of the electrodes to be used in the schedule of welding procedures. Use only low hydrogen electrodes for manual shielded metal-arc welding regardless of the thickness of the steel. Use a controlled temperature storage oven at the job site as prescribed by AWS D1.1/D1.1M, Subsection 3.5 to maintain low moisture of low hydrogen electrodes.
d. Workmanship - Perform welding workmanship in accordance with AWS D1.1/D1.1M, Section 3 and other applicable requirements of these specifications.
    (1) Preparation of Base Metal - Prior to welding inspect surfaces to be welded to ensure compliance with AWS D1.1/D1.1M, Subsection 3.2.
    (2) Temporary Welds - Make temporary welds, required for fabrication and erection, under the controlled conditions prescribed for permanent work. Make temporary welds using low-hydrogen welding electrodes and by welders qualified for permanent work as specified in these specifications. Conduct preheating for temporary welds as required by AWS D1.1/D1.1M for permanent welds except that the minimum temperature shall be 120 degrees F in any case. In making temporary welds, arcs shall not be struck in other than weld locations. Remove each temporary weld and grind flush with adjacent surfaces after serving its purpose.
    (3) Tack Welds - Subject tack welds that are to be incorporated into the permanent work to the same quality requirements as the permanent welds; clean and thoroughly fuse them with permanent welds. Perform preheating as specified above for temporary welds. Multiple-pass tack welds shall have cascaded ends. Remove defective tack welds before permanent welding.

2.2.2.2 Welding of Steel Castings

Not Used.

2.2.3 Machine Work

Not Used.

2.2.3.1 Finished Surfaces

Provide surface finishes as indicated or specified in detailed drawings.

2.2.3.2 Unfinished Surfaces

Not Used.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Project Engineer inspects fabricated structures for conformance with design. Any alternations identified as need by the Project Engineer will be made as required.

2.3.1 Nondestructive Testing

Not Used.

2.3.2 Inspection of Structural Steel Welding

Nondestructive examination of designated welds will be required. Supplemental examination of any joint or cut from any location in any joint may be required.

2.3.2.1 Visual Examination

For all visual examination of completed welds, clean and carefully examine for insufficient throat or leg sizes, cracks, undercutting, overlap, excessive convexity or reinforcement and other surface defects to ensure compliance with the requirements of AWS D1.1/D1.1M, Section 6, subsection 6.9, Part C.

2.3.2.2 Nondestructive Examination

Not Used.

2.3.2.3 Test Coupons

Not Used.

2.3.2.4 Supplemental Examination

When the soundness of any weld is suspected of being deficient due to faulty welding or stresses that might additional inspection may be performed as designated by the Project Engineer.

2.3.3 Structural Steel Welding Repairs

Repair defective welds in accordance with AWS D1.1/D1.1M, Subsection 3.7. Thoroughly clean surfaces before welding. Retest welds that have been repaired by the same methods used in the original inspection.

PART 3 EXECUTION

3.1 Workmanship

Workmanship must be of the highest grade and in accordance with the best modern practices to conform to the specifications and detailed drawings for the item of work being furnished.

END OF SECTION

050523 - STRUCTURAL WELDING

PART 1 GENERAL

Welding shall conform to AWS D1.1. All weld metal shall have chemistry similar to the base metal and shall have a minimum Charpy Impact test of 20 foot-pounds at 20 degrees F. Welders shall be qualified per AWS for the type of welding required.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360 (2010) Specification for Structural Steel Buildings
AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)
ASNT SNT-TC-1A (2011; Text Correction 2012) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 (2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0M/A3.0 (2010) Standard Welding Terms and Definitions
AWS D1.1/D1.1M (2012; Errata 2011) Structural Welding Code - Steel
AWS D1.3/D1.3M (2008; Errata 2008) Structural Welding Code - Sheet Steel
AWS D1.4/D1.4M (2011) Structural Welding Code - Reinforcing Steel
AWS D14.1/D14.1M (2005) Specification for Welding Industrial and Mill Cranes and Other Material Handling Equipment
AWS D14.4/D14.4M (2012) Specification for Welded Joints for Machinery and Equipment
AWS Z49.1 (2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM E165/E165M (2012) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709 (2008) Standard Guide for Magnetic Particle Examination

1.2 DEFINITIONS

Definitions of welding terms are in accordance with AWS A3.0M/A3.0.

1.3 SYSTEM DESCRIPTION

Conform the design of welded connections to AISC 360, unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Perform welding as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Do not commence welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Perform all testing at or near the work site. Each Contractor performing welding shall maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

1.4 SUBMITTALS

Not Used.

1.5 QUALITY ASSURANCE

All welds will be in accordance with AWS D1.1/D1.1M

1.5.1 Certificates

Ensure that each welder is certified and meets applicable qualifications. Keep certifications current and on file.

1.5.2 Symbols and Safety

Symbols shall be in accordance with AWS A2.4, unless otherwise indicated. Safe welding practices and safety precautions during welding shall conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 WELDING EQUIPMENT AND MATERIALS

Provide all welding equipment, electrodes, welding wire, and fluxes capable of producing satisfactory welds when used by a qualified welder or welding operator performing qualified welding procedures. All welding equipment and materials shall comply with the applicable requirements of AWS D1.1/D1.1M.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

3.1.1 Requirements

Conform workmanship and techniques for welded construction to the requirements of AWS D1.1/D1.1M and AISC 360. When AWS D1.1/D1.1M and the AISC 360 specification conflict, the requirements of AWS D1.1/D1.1M govern.

3.1.2 Identification

Not Used

3.2 QUALITY CONTROL

Perform testing using a certified and experienced welder. Perform visual inspections to determine weld quality. Replace all unacceptable welds.

3.3 STANDARDS OF ACCEPTANCE

Conform dimensional tolerances for welded construction, details of welds, and quality of welds to the applicable requirements of AWS D1.1/D1.1M and project drawings.

3.3.1 Nondestructive Examination

The welding is subject to inspection and tests in the shop and field. Inspection of welds in the shop do not relieve the responsibility to furnish welds of satisfactory quality. When materials or workmanship do not conform to the specification requirements welds shall be replaced.

3.3.2 Destructive Tests

Make all repairs when metallographic specimens are removed from any part of a structure. Employ only qualified welders or welding operators, and use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, DOE and SNL personnel may perform their own inspections.

3.5 CORRECTIONS AND REPAIRS

If inspection or testing indicates defects in the weld joints, repair defective welds using a qualified welder or welding operator as applicable. Conduct corrections in accordance with the requirements of AWS D1.1/D1.1M and the specifications. Repair all defects in accordance with the approved procedures. Repair defects discovered between passes before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, blend the affected area into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before re-welding, examine the area by suitable methods to ensure that the defect has been eliminated. Repaired welds shall meet the inspection requirements for the original welds. Any indication of a defect is regarded as a defect, unless re-evaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

END OF SECTION

099000 - PAINTING – COATING METALWORK

1. Scope

The work consists of cleaning metal surfaces and applying paints and protective coatings.

2. Paint

For the purpose of this specification, paints and coatings shall be designated by types as defined below. Materials for systems requiring two or more coats shall be supplied by the same manufacturer.

Primer- Prime metal to be painted with a rust inhibitive primer. Color shall be gray or white. Apply primer at 2 to 3 mils dry-film thickness in one coat.

Top Coat- Apply a top coat of enamel (gloss) paint. Enamel Paint will be applied satisfactory at 2 to 3 mils dry-film thickness in one coat. Finish shall be gloss.

3. Surface preparation

Surfaces to be painted shall be thoroughly cleaned before the application of paint or coatings.

All surfaces to be coated shall be prepared by removing all grease and oil by appropriate means. The cleaned, finished surface shall be free of all visible foreign material or residue.

4. Paint-Coating Application

Painting and coating metalwork are designated as defined in this section.

Painting and Coating – Apply one primer coat as specified and one or more coats of enamel (gloss) to provide full coverage of all metal surfaces. No bare metal shall be exposed.

5. Application of paint

Surfaces shall be painted immediately after preparation or within the same day as prepared with a minimum of one coat of the primer type specified. Remaining surfaces not required to be painted shall be protected against contamination and damage during the cleaning and painting operation.

Paints shall be thoroughly mixed immediately before application.

After erection or installation of the metalwork, all damage to shop-applied coating shall be repaired and all bolts, nuts, welds, and field rivet heads shall be cleaned and painted with one coat of the specified paint.

Initial priming coats shall be applied by brush except on surfaces accessible only to spray equipment. All other coats may be applied by brush or spray. Each coat shall be applied in such a manner to produce a paint film of uniform thickness with a rate of coverage within the guidelines and limits recommended by the paint manufacturer. The drying time between coats shall be as prescribed by the paint manufacturer, but not less than that required for the paint film to thoroughly dry.

The finished surface of each coat shall be free from runs, drops, ridges, laps, or excessive brushmarks and shall present no variation in color, texture, and finish. The surface of each dried coat shall be cleaned as necessary before application of the next coat.

6. Atmospheric conditions

Paint application shall not be performed when the temperature of the item to be painted or the surrounding air is less than 50 degrees Fahrenheit. Painting shall be performed only when the humidity and temperature of the surrounding air and the temperature of the metal surfaces are such that evaporation rather than condensation results during the time required for application and drying. Surfaces shall be protected from adverse atmospheric conditions by special cover, heating, or ventilation shall remain so protected until the paint is thoroughly dry.

END OF SECTION

400513 - PIPE ERECTION AND TESTING

1.0 SCOPE

This specification covers the field erection, testing, inspection, and cleaning of fabricated metal piping.

2.0 REFERENCES

The latest edition of the following standards and publications were used in preparation of this specification.

- ASME Codes - B31.3- Process Piping
- ASME/ANSI Standards - B16.5 Pipe Flanges and Flanged Fittings

3.0 MATERIALS

Materials used in the erection of piping shall be in accordance with standard industry metal piping specifications and must be approved by the Project Engineer. Metal piping must be designated on drawings for the specific piping that is to be erected. The use of alternative piping requires approval of the Project Engineer.

4.0 PIPING ERECTION

Erection of piping shall comply with ASME 831.3 and ASME 831.1, as applicable. In case of conflict among these requirements, the most stringent requirements, as determined by the Project Engineer, shall govern. Follow piping layout shown on drawings. Piping shall not obstruct accessways, ladders, stairs, platforms, or walkways.

5.0 PIPING SYSTEMS

All components of piping systems (pipe, valves, etc.) shall be cleaned internally of dirt, debris, loose scale, etc., immediately before the components are erected. All threads, flange faces, gaskets, weld bevels, etc., shall be protected prior to and during erection to assure that they will be clean and free from defects in the final assembly.

6.0 THREADED JOINTS

Threaded piping joints will be used for all pipe connections. Threaded joints shall be made up with a lubricant (pipe dope) suited for the specific service. The lubricants shown in Table 1, or their equivalents, are recommended as indicated. Threads shall be clean and dry prior to and during the assembly. All cutting oil shall be removed prior to assembly of the joint. Threaded joints shall be tightened to assure full thread engagement.

1) For NPS 1 and less: five engaged threads.

2) For NPS 1-1/2 and NPS 2: six engaged threads.

Threaded joints that leak during a hydrostatic pressure test shall not be seal-welded without approval of the Project Engineer. Approval to seal weld a threaded joint shall not be given where the threaded joint has been provided for maintenance or operating reasons.

7.0 FLANGED JOINTS

Not Used

8.0 VALVES

Vales will installed where indicated on the drawings. Valve packing glands shall be checked for quantity of packing. Packing shall be added if required. Prior to installation, check valves and safety valves shall be tested for proper operation.

9.0 PRESSURE TESTING

Prior to initial operation, the piping system shall be tested, in the shop or field, in accordance with applicable standards used for design to ensure tightness. In addition, the requirements of local jurisdictions shall be satisfied. In the event of discrepancies between these requirements, the most stringent requirements shall apply.

ASME 831.3 – The test shall be a hydrostatic leak test unless alternative test procedures allowed are approved by the Project Engineer.

9.1 Preparation for Testing

All restrictions which would interfere with filling, venting, draining or flushing shall not be installed until after completion of the pressure test.

All piping joints, shall be visible and accessible for inspection during pressure testing.

Lines containing check valves shall have the source of pressure located in the piping system upstream of the check valve to insure that the pressure is applied underneath the check valve flapper. If this is not possible, the check valve flapper shall be removed through the bonnet cover, placed in a plastic bag and tied to the valve to assure its replacement after the satisfactory test of the line.

Before testing is begun, the physical layout and arrangement of the lines and equipment shall be checked to ensure that the entire system can be completely drained after testing. This is very important during freezing weather, and when the system being tested includes check valves.

10.0 TEST PROCEDURES

Test procedures shall be approved by the Project Engineer. Procedures shall include source of test fluid, disposition of test fluid, provisions to prevent the creation of significant negative pressure (vacuum) during draining of the test fluid, etc.

The hydrostatic pressure test shall be maintained long enough to permit a thorough inspection of all piping and piping components. The minimum time for the hydrostatic pressure test shall be thirty minutes.

Pressure gauges used for testing shall be installed as close as possible to the low point of the piping system.

After satisfactory completion of hydrostatic testing all lines shall be completely drained. The retesting of lines after the repair of leaks shall be done at pressures originally specified for test.

10.1 Hydrostatic Testing Fluids

Any piping system containing stainless steel shall be tested with water containing less than 50 ppm chloride. The piping shall be drained immediately after testing and line flushing, and dried by blowing with air. A strainer shall be installed in the fill line to minimize the possibility of foreign matter being introduced into the system during the hydrostatic pressure test and line flushing operation.

10.2 Test Pressures

A minimum test pressure of 100 psig shall be used, but not less than 1½ times the designed pressure of the piping.

10.3 Documentation

Each test of lines or systems shall be witnessed and approved by the Project Engineer. The test results shall be recorded and a copy shall be provided to the Project Engineer. The test results shall include the following:

1) Date of test.
2) Identification of Piping Assemblies Tested.

3) Test Medium Used.

4) Test pressure and holding time.

5) Signature of the Project Engineer.

END OF SECTION

APPENDIX C
MANUFACTURER DATA

DEOXYGENATION TANKS

PREMIX/CHASE-WATER TANK

TANK BULKHEAD FITTING SELECTION

SUMP PUMP

HORIZONTAL LEG TANKS

With the broadest leg tank line available, Norwesco manufactures a size that will fit your needs. Used primarily for transport and nursing applications, Norwesco's leg tanks feature molded-in legs that act as "baffles" to reduce sloshing. The 6025 gallon includes a baffle system to minimize fluid sloshing and increase safety aspects of transporting liquid. Support bands are shown below.

GALLON CAPACITY	DIAMETER	OVERALL HEIGHT	LENGTH	FILL OPENING	OUTLET/ DRAIN	NO. OF BANDS	PREMIUM WEIGHT PART NO. WHITE	HEAVY WEIGHT PART NO. BLUE
35 ¤	20"	23"	29"	5"	¾"	2 optional	45223	—
55 ¤	23"	26"	34"	5"	¾"	2 optional	41873	—
65 ¤	23"	26"	43"	5"	¾"	2 optional	45191	—
125	32"	35"	41"	8"	2"	2 optional	40298	—
225	38"	41"	49"	8"	2"	2 optional	40299	—
325	38"	43"	68"	16"	2"	2 optional	40217	—
425	49"	54"	60"	16"	2"	2 optional	42016	—
525 Δ	49"	54"	71"	16"	2"	2 optional	40181	40193
725 *	49"	54"	101"	16"	2"	3 required	40180	40194
925 *	62"	65"	80"	16"	2"	2 required	45209	—
925 * w/sump	62"	69"	80"	16"	2"	2 required	45210	—
1025 *	49"	54"	139"	16"	2"	4 required	40089	40131
1325 *	66"	70"	99"	16"	2"	3 required	41875	41877
1625 *	63"	68"	139"	16"	2"	4 required	40026	40133
1800 * 2CPT	62"	68"	146"	16"	2"	4 required	42990	—
1800 * w/sump, 2CPT	62"	72"	146"	16"	2"	4 required	42992	—
3725 *	92"	97"	145"	16"	3"/2"	4 required	44047	44049
5025 *	92"	96"	190"	16"**	3"/2"	5 required	41879	41881
6025 * w/baffle system	99"	103"	193"	22"***	3"/2"	5 required	44314	44316

¤May ship UPS *Requires full length support and bands ΔRequires full length support **16" hinged lid *** 22" hinged lid

NOTE: The 1800 gallon tank consists of two 900 gallon tanks, each with a fitting installed, and a cylindrical "donut" that with the referenced connecting bar at the bottom of this page, holds the two tanks together but does not plumb them together. Ships unassembled.

HORIZONTAL LEG TANK BANDS

Norwesco bands are custom fabricated to support the Norwesco tanks and are galvanized or powder coated for added corrosion protection. Whether using the tank in a stationary position or for transport, bands are necessary to ensure that the tank retains its shape and integrity. See diagram at right.

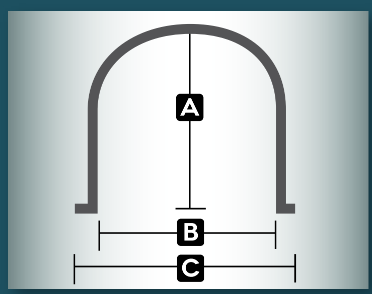
TANK SIZE	A	B	C	NO. OF BANDS	PART NO.
35 ¤	18½"	18½"	21⅜"	2 optional	60520
55 ¤	22"	22"	26½"	2 optional	61745
65 ¤	22"	22"	26½"	2 optional	61745
125 ¤	30¾"	30½"	35"	2 optional	61744
225 ¤	36½"	36"	42"	2 optional	60478
325 ¤	36½"	36"	42"	2 optional	60478
425	47¾"	46¼"	52¼"	2 optional	60057
525	47¾"	46¼"	52¼"	2 optional	60057
725	47¾"	46¼"	52¼"	3 required	60057
925	61"	60"	66"	2 required	62852
1025	47¾"	46¼"	52¼"	4 required	60057
1325	64"	64"	70"	3 required	63282
1625	61"	60¾"	67¼"	4 required	60079
1800 *	61"	60"	66"	4 required	62852
3725	89¾"	89½"	93⅞"	4 required	63284
5025	89¾"	89½"	93⅞"	5 required	63284
6025	96"	96¼"	101"	5 required	64085

¤May ship UPS *Tank requires one connecting bar, Part No. 63653

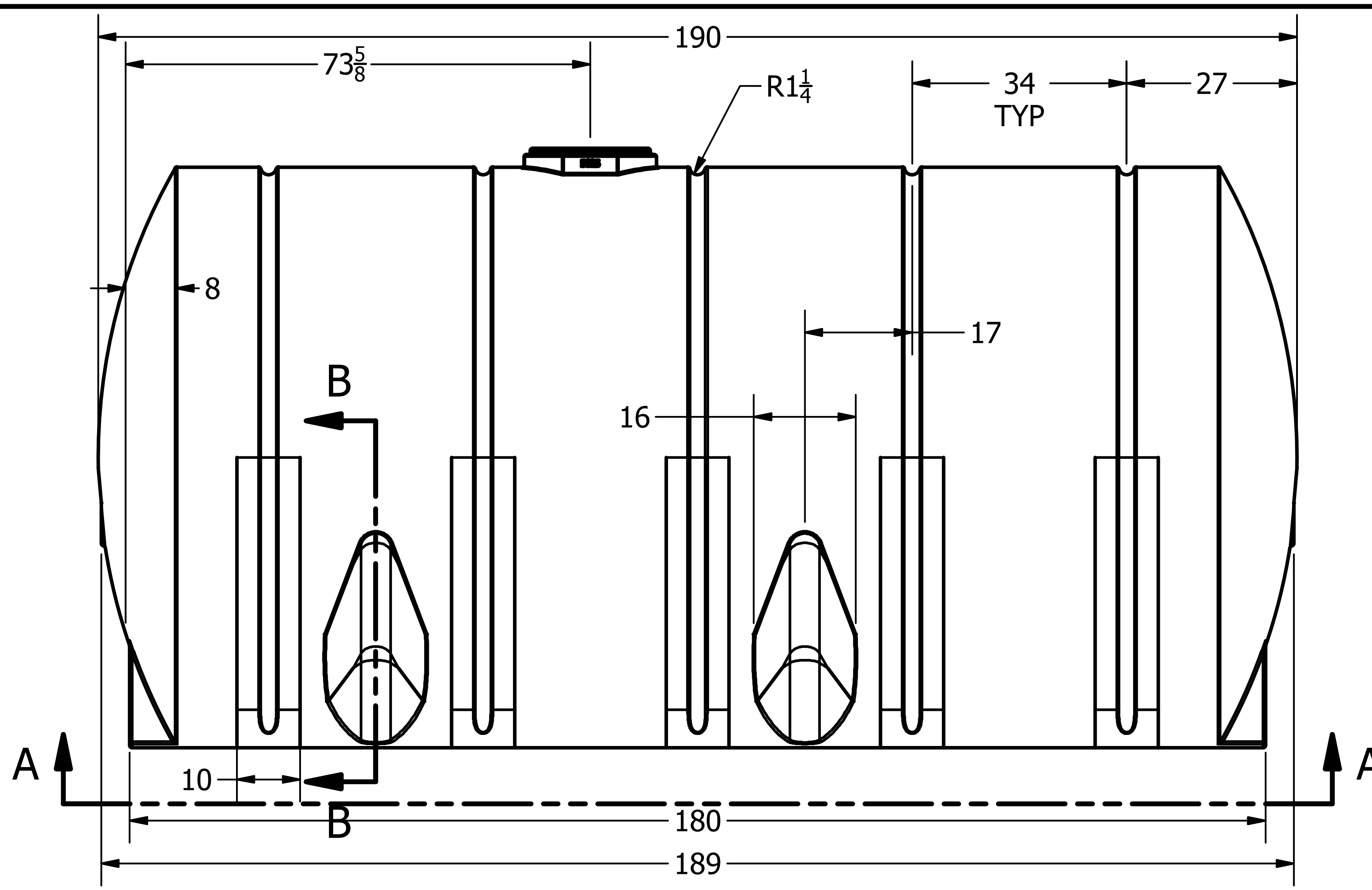
PLEASE NOTE:
Tank availability may vary according to manufacturing location. Please contact Norwesco Customer Service or your Norwesco distributor for specific details.
Tank dimensions and capacities may vary slightly and are subject to change without notice.

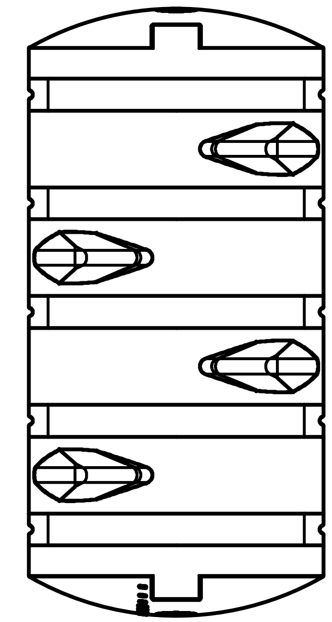
325 HORIZONTAL LEG / BANDS

1025 HORIZONTAL LEG / BANDS

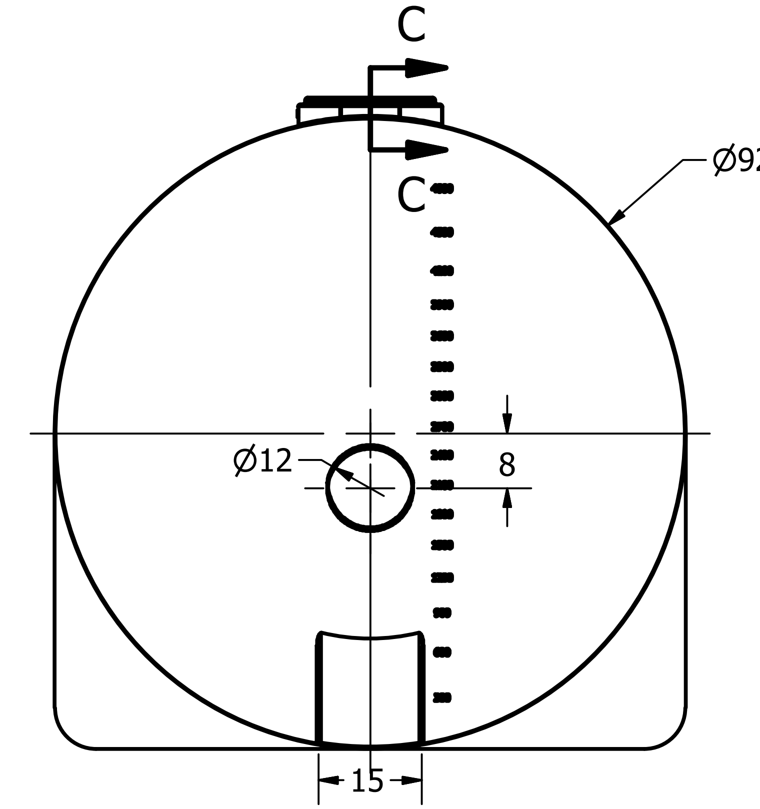


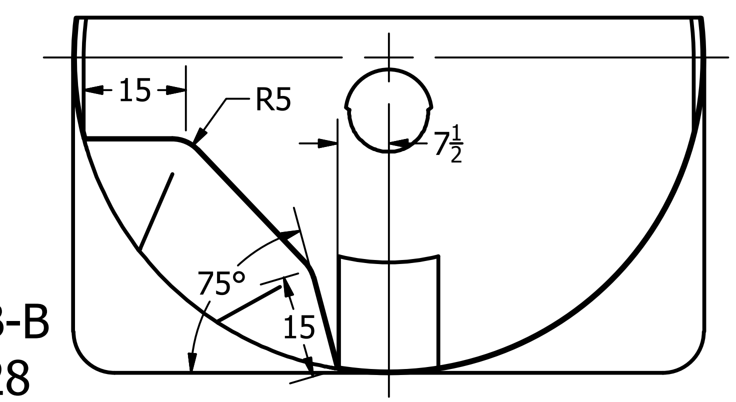
HORIZONTAL LEG TANK BANDS



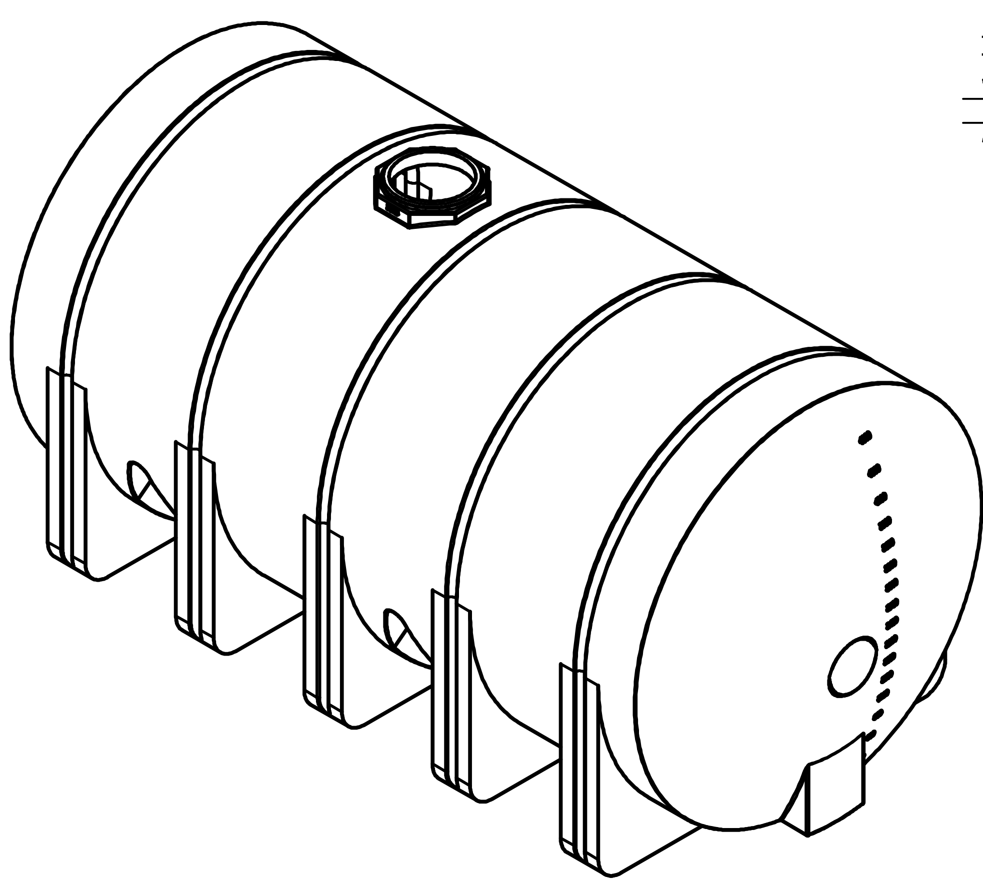


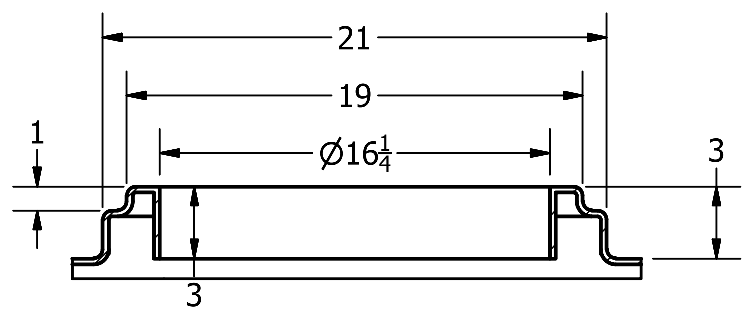
VIEW A-A
SCALE 1:60





SECTION B-B
SCALE 1:28

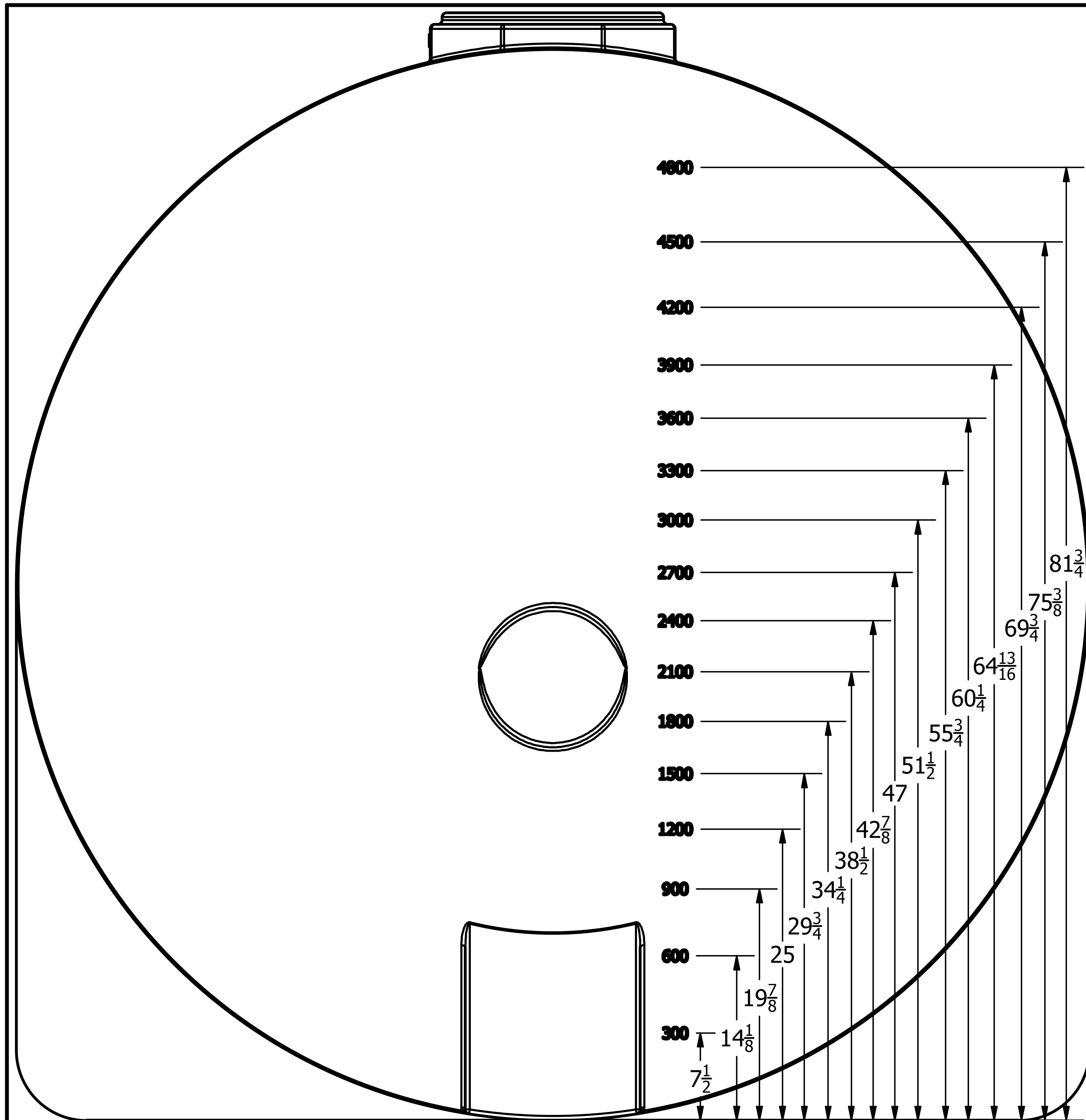




SECTION C-C
SCALE 1:8

REVISION HISTORY			
REV	DESCRIPTION	DATE	AUTHOR
A	REDRAWN	7/17/2013	Michael Holden

DRAWN Jerry Paulson	8/4/2003	NORWESCO NORWESCO, INC. SAINT BONIFACIUS, MN
CHECKED		TITLE 5025 GALLON HORIZONTAL LEG TANK
QA		
MFG		
APPROVED		SIZE B DWG NO REV A
		SCALE: 1/16 SHEET 1 OF 2



DRAWN Jerry Paulson	8/4/2003	NORWESCO NORWESCO, INC. SAINT BONIFACIUS, MN
CHECKED		TITLE 5025 GALLON HORIZONTAL LEG TANK
QA		
MFG		
APPROVED		SIZE B · DWG NO · REV A
		SCALE: 1/16 · SHEET 2 OF 2

DEOXYGENATION TANKS

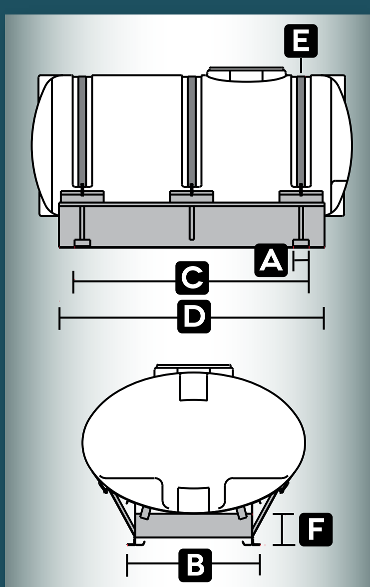
ELLIPTICAL TANK

Designed for larger volume applicator needs, the Norwesco elliptical tanks feature a low profile design and a low center of gravity for excellent visibility in the field and increased stability when towed. A deep sump permits complete drainage and the tanks feature an 8"or 16" fill-opening. Please refer to information below for steel supports.

GALLON CAPACITY	WIDTH	OVERALL HEIGHT INCLUDING SUMP	LENGTH	SUMP DEPTH	FILL OPENING	OUTLET/ DRAIN	PREMIUM WEIGHT PART NO. WHITE
200	40"	30"	66"	¾"	8"	1¼" & 1¼"	41252
300	48"	36"	70"	3"	16"	1¼" & 1¼"	40327
500	57"	44"	82"	5"	16"	1¼" & 1¼"	40328
500	57"	44"	82"	2"	16"	1¼" & 1¼"	40328
750	69"	48"	88"	3"	16"	2"	40329
1000	78"	55"	90"	3"	16"	2"	40330
1600 *	78"	54"	138"	2½"	16"	2"	47111

*Includes 1 stainless steel baffle
NOTE: Skid not included with tank. See below for skids.

750 ELLIPTICAL TANK / SKID



ELLIPTICAL TANK SKIDS

50 SMOOTH SIDE WALL PCO

ELLIPTICAL TANK SKIDS

Skids come with bands and bolts. See dimensional drawings at left.

TANK SIZE	TANK PART NO.	A	B	C	D	E	F	PART NO.
200	41252	4"	24"	52"	57"	2" x 68"	8"	63015
300	40327	4"	34"	46¼"	54¼"	2" x 76"	8"	63016
500	40328	4"	34"	60"	68"	2" x 96"	8"	63018
750	40329	4"	38"	69½"	78"	2" x 112"	8"	60371
1000	40330	4"	46"	60"	72"	2" x 130"	8"	60372

200 and 300 are galvanized; 500 and larger are black painted steel.
Replacement bands and hardware are available. Please contact Norwesco Customer Service for details.

PCO TANKS

A multi-purpose tank, the PCO is well suited for nursery, agricultural and lawn care applications. These tanks feature self-supporting legs and do not require any saddles or steel supports. Flat spots are molded into both ends to provide mounting areas for agitation equipment

SMOOTH SIDE WALL PCO TANKS

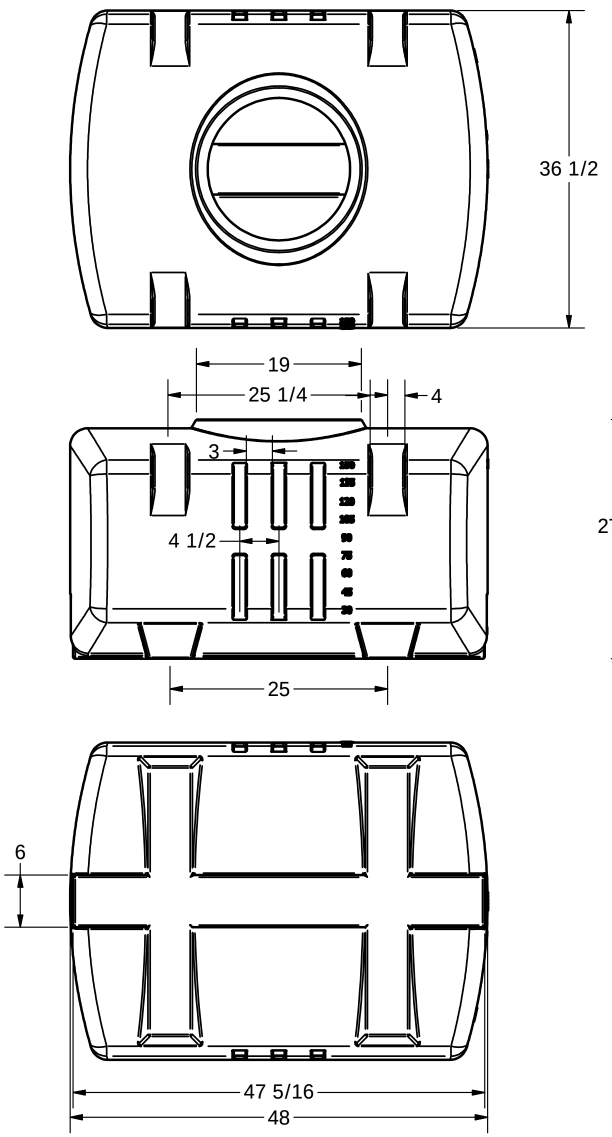
GALLON CAPACITY	WIDTH	OVERALL HEIGHT	LENGTH	FILL OPENING	PREMIUM WEIGHT PART NO. WHITE
30 ¤	19"	23"	25"	5"	41254
50 ¤	19"	22"	38"	8"	40664
100 ¤	30"	28"	38"	8"	40668
150	36"	28"	48"	8"	40669
200	36"	37"	48"	8"	41413
300	36"	37"	69"	16"	41381

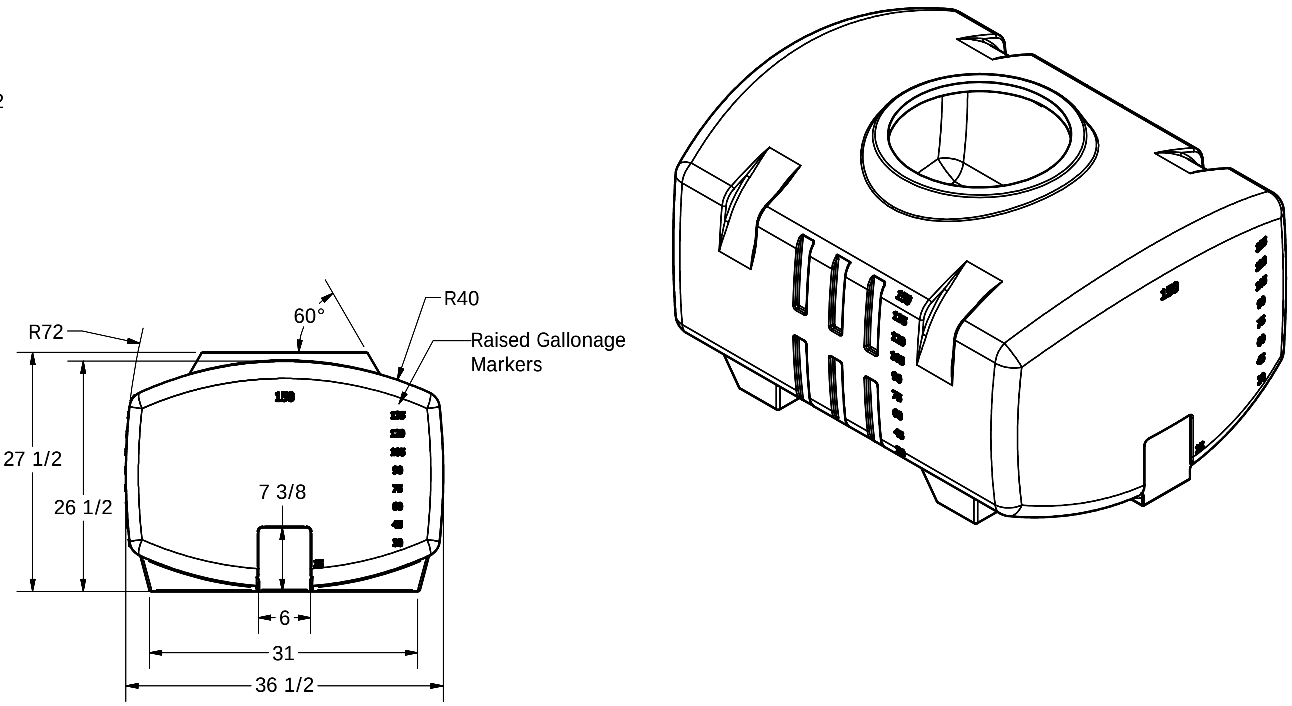
RIBBED SIDE WALL PCO TANKS

GALLON CAPACITY	WIDTH	OVERALL HEIGHT	LENGTH	FILL OPENING	PREMIUM WEIGHT PART NO. WHITE
50 ¤	19"	23"	38"	8"	42834
100	30"	30"	38"	8"	42835
150	37"	29"	48"	16"	42836
200	37"	37"	48"	16"	42837

¤ May ship UPS

PLEASE NOTE:
Tank availability may vary according to manufacturing location. Please contact Norwesco Customer Service or your Norwesco distributor for specific details.
Tank dimensions and capacities may vary slightly and are subject to change without notice.





DRAWN Jerry Paulson	6/28/2006	NORWESCO, INC., ST. BONIFACIUS, MN
CHECKED		TITLE
QA		150 GALLON PCO TANK
MFG		
APPROVED		
		SIZE B | DWG NO | REV
		SCALE: 1/16 | SHEET 1 OF 1

PREMIX / CHASE-WATER TANK

POLYPROPYLENE BULKHEAD FITTINGS / EPDM OR VITON GASKETS

Norwesco's polypropylene fittings come standard with an EPDM gasket. Viton gaskets are available as an option when EPDM may not be suitable for your application. The 2" stainless steel bulkhead fitting comes standard without a gasket.

DESCRIPTION	HOLE SIZE REQUIRED IN TANK FOR INSTALLATION	ITEM CODE	PART NO.
½" Heavy duty double threaded polypropylene fitting	1 7/16"	A	62834
¾" Double threaded polypropylene fitting	1 7/16"	A	60401
EPDM gasket for ½" and ¾" (62834 and 60401)			60402
Type A Viton gasket for ½" and ¾" (62834 and 60401)			60360
¾" Heavy duty double threaded polypropylene fitting	1⅝"	A	62798
EPDM gasket ¾" (62798)			62799
Type A Viton gasket for ¾" (62798)			62800
1" Double threaded polypropylene fitting	2¼"	A	60427
1¼" Double threaded polypropylene fitting	2¼"	A	60403
1¼" Anti-vortex polypropylene fitting	2¼"	D	63065
EPDM gasket for 1" and 1¼" (60427, 60403 and 63065)			60404
Type A Viton gasket for 1" and 1¼" (60427, 60403 and 63065)			60361
Anti-vortex adapter for 1¼" (60403)			62398
1½" Standard duty double threaded polypropylene fitting	2⅜"	A	63931
EPDM gasket for 1½" (63931)			63938
Type A Viton gasket for 1½" (63931)			63939
1½" Double threaded polypropylene fitting	3"	A	60124
Siphon tube, 1½" x 4 15/16" long			63682
Siphon tube, 1½" x 12" long			63279
2" Double threaded polypropylene fitting	3"	A	60405
2" Double threaded 316 stainless steel fitting, less gasket	3"		61767
EPDM gasket for 1½" and 2" (60124, 60405, 63481 and 61767)			60406
Type A Viton gasket for 1½" and 2" (60124, 60405, 63481 and 61767)			60523
2" Standard duty double threaded polypropylene fitting (maximum tank wall thickness = ⅜")	3"	E	63481
2" Heavy duty double threaded polypropylene fitting	3¼"	B	63683
EPDM gasket for 2" (63683)			60336
Type A Viton gasket for 2" (63683)			60008
Siphon tube, 2" short			60335
Siphon tube, 2" x 12" long			63262
Anti-vortex adapter for 2" bulkhead fitting			62399
2" Polypropylene dust plug			60021
2" Self-aligning double threaded polypropylene fitting			
(designed to install in dome of vertical tank above the liquid level)	4½"		63668
EPDM gasket for 2" self-aligning (63668)			60331
Type A Viton gasket for 2" self-aligning (63668)			60351
3" Double threaded polypropylene fitting (hex nut as shown in photo C)	4½"	C	62299
EPDM gasket for 3" (62299)			60331
Type A Viton gasket for 3" (62299)			60351
2" Polypropylene reducer for 3"			60330
Siphon tube, 3" short			60327
Siphon tube, 3" x 12" long			63263
Siphon tube extension, 3" x 19-1/2" long			64102
4" Double threaded polypropylene fitting (hex nut as shown in photo C)	5¾"		62171
EPDM gasket for 4" (62171)			62785
Type A Viton gasket for 4" (62171)			62786
Siphon tube for 4"			62714


A


B


C


D


E


F


G


H

POLYPROPYLENE DOUBLE THREADED BOLTED FITTINGS

Equipped with 316 stainless steel bolts and come standard with EPDM gaskets. Viton gaskets are available as an option for the fittings.

DESCRIPTION	ITEM CODE	PART NO.
¾" Polypropylene bolted fitting with SS bolts and EPDM gaskets	F	60502
1" Polypropylene bolted fitting with SS bolts and EPDM gaskets	F	60505
EPDM gasket for ¾" and 1" Part No. 60498 / Type A Viton gasket for ¾" and 1" Part No. 60355		
1½" Polypropylene bolted fitting with SS bolts and EPDM gaskets	F	60513
2" Polypropylene bolted fitting with SS bolts and EPDM gaskets	F	60516
EPDM gasket for 1½" and 2" Part No. 60497 / Type A Viton gasket for 1½" and 2" Part No. 60356		
3" Polypropylene bolted fitting with SS bolts and EPDM gaskets		62471
EPDM gasket for 3" Part No. 62048 / Type A Viton gasket for 3" Part No. 60602		

2 gaskets required per fitting

CON-TECH STAINLESS STEEL DOUBLE THREADED BOLTED FITTINGS

These fittings are designed to install in heavy wall tanks. Please contact Norwesco Customer Service for additional information.

DESCRIPTION	ITEM CODE	PART NO.
1" 316 SS double threaded bolted fitting with SS long bolts and EPDM gaskets		63972
EPDM gasket for 1" Part No. 64154 / Type A Viton gasket for 1" Part No. 63978		
1½" 316 SS double threaded bolted fitting with SS long bolts and EPDM gaskets		63973
EPDM gasket for 1½" Part No. 64155 / Type A Viton gasket for 1½" Part No. 63979		
2" 316 SS double threaded bolted fitting with SS long bolts and EPDM gaskets		63974
EPDM gasket for 2" Part No. 64156 / Type A Viton gasket for 2" Part No. 63980		
3" 316 SS double threaded bolted fitting with SS long bolts and EPDM gaskets		63975
EPDM gasket for 3" Part No. 64152 / Type A Viton gasket for 3" Part No. 63981		

2 gaskets required per fitting

STAINLESS STEEL BOLTED HALF NIPPLE FITTINGS

DESCRIPTION	ITEM CODE	PART NO.
¾" 316 SS half nipple fitting, MPT, and cross linked polyethylene gasket		64093

STAINLESS STEEL DOUBLE THREADED BOLTED FITTINGS

Bolts are threaded into back plate – no welds or bolt holes that can be potential points of leakage. Fittings come standard without a gasket and require a single gasket installed on the inside of the tank. Available gaskets are cross-linked polyethylene, EPDM or Viton.

DESCRIPTION	ITEM CODE	PART NO.
½" 316 SS double threaded bolted fitting less gasket	G	63216
¾" 316 SS double threaded bolted fitting less gasket	G	63035
1" 316 SS double threaded bolted fitting less gasket	G	62948
EPDM gasket for ½", ¾", 1" Part No. 63205 / Type A Viton gasket for ½", ¾", 1" Part No. 63224		
Cross-linked polyethylene gasket for ½", ¾", 1" Part No. 62950		
1¼" 316 SS double threaded bolted fitting less gasket	G	63036
Cross-linked polyethylene gasket for 1¼" Part No. 63041		
1½" 316 SS double threaded bolted fitting less gasket	G	63037
EPDM gasket for 1¼", 1½" Part No. 63426 / Cross-linked polyethylene gasket for 1½" Part No. 63042		
2" 316 SS double threaded bolted fitting less gasket	G	63038
EPDM gasket for 2" Part No. 63206 / Type A Viton gasket for 2" Part No. 63225		
Cross-linked polyethylene gasket for 2" Part No. 62848		
3" 316 SS double threaded bolted fitting less gasket	H	63038
EPDM gasket for 3" Part No. 63223 / Type A Viton gasket for 3" Part No. 63226		
Cross-linked polyethylene gasket for 3" Part No. 63043		
4" 316 SS 8-bolt double threaded bolted fitting with gasket		63688
EPDM gasket for 4" Part No. 63690 / Type A Viton gasket for 4" Part No. 63691		
Cross-linked polyethylene gasket for 4" Part No. 63689		

1 gasket required per fitting

STAINLESS STEEL SINGLE THREADED BOLTED FITTINGS

DESCRIPTION	ITEM CODE	PART NO.
3" 316 SS single threaded bolted fitting, anti-vortex, less gasket		63233
EPDM gasket for 3" Part No. 63223 / Type A Viton gasket for 3" Part No. 63226		
Cross-linked polyethylene gasket for 3" Part No. 63043 (1 required)		

1 gasket required per fitting

BULKHEAD FITTING SELECTIONS

SUMP PUMP

UTILITY PUMPS

Little GIANT®

FLS/FS SERIES - 1/2 HP, 1 HP

APPLICATIONS

Water transfer or recirculation and general construction dewatering

FEATURES

- 1/2 hp or 1 hp permanent split capacitor (PSC) motor with overload protection
- Designed for continuous duty
- 2" MNPT discharge
- 120 °F (49 °C) liquid temperature rating
- cCSAus listed

FLS-400

FS-750

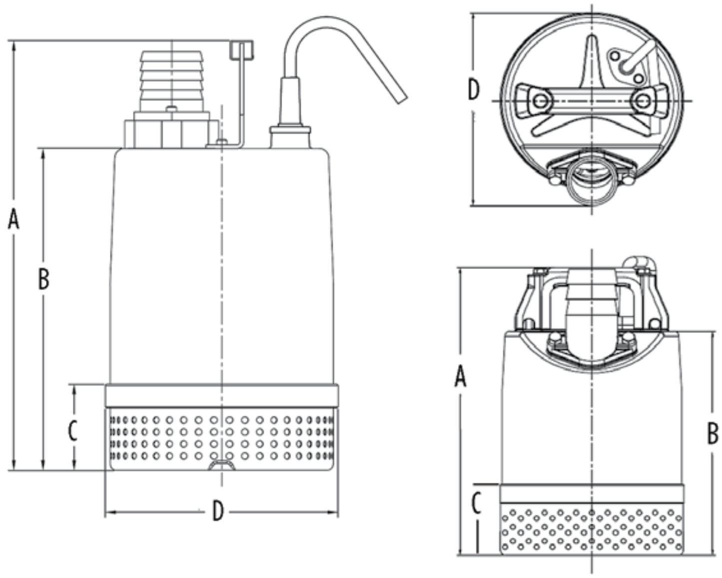
SERIES SPECIFICATIONS

HP	Volts	Hz	Amps		Watts	Performance (GPM @ Height in Feet)						Shut-Off (ft)	PSI
			FLA	Start		5′	10′	15′	20′	30′	40′		
1/2	115	60	5	24	488	60	54	42	20	–	–	37	16
1	115	60	10	47.6	950	80	76	73	68	54	38	52	22.5

Item No.	Model	HP	Volts	Switch Type/ Operation	Cord	Weight
620240	FLS-400	1/2	115	Manual	20′ 6.1 m	24 lbs 10.89 Kg
620241	FS-750	1	115	Manual	20′ 6.1 m	35 lbs 15.88 Kg

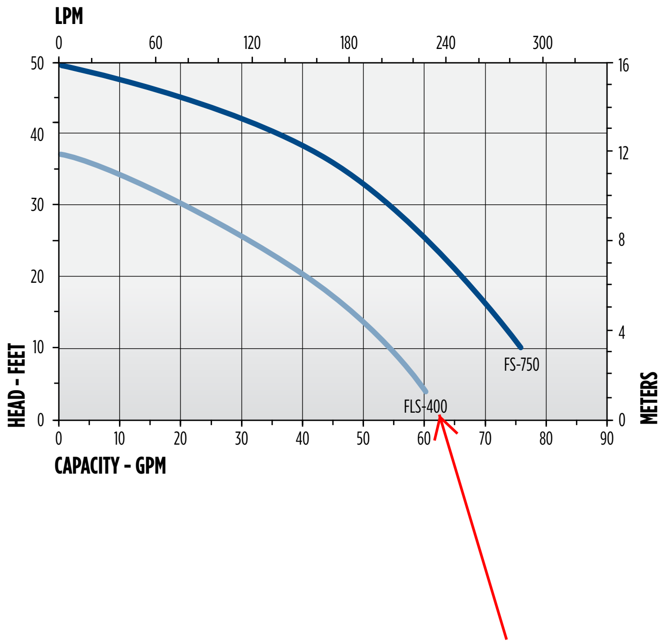
FLS/FS SERIES - 1/2 HP, 1 HP

ENGINEERING DATA



Model	A	B	C	D
FLS-400	11.93" 30.30 cm	9.3" 23.62 cm	2" 5.08 cm	7.99" 20.29 cm
FL-750	13.94" 35.41 cm	10.79" 27.41 cm	2.84" 7.21 cm	7.24" 18.39 cm

PERFORMANCE DATA



CONSTRUCTION

Motor Housing	Stainless steel
Impeller Material	Urethane rubber (620240) Balanced ductile iron (620241)
Impeller Type	Semi-open
Volute	Cast iron
Motor Shaft	Stainless steel
Seals	Double mechanical seals (lower - silicon carbide on silicon carbide, upper - carbon on ceramic)
Fasteners	Plated steel
Bearings	Upper and lower ball bearings
Power Cord	SJTW 14/3