SECTION D-2

MANAGEMENT OF WASTE IN TANKS

Revision No.
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SECTION D-2

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SECTION D-2

MANAGEMENT OF WASTE IN TANKS

D-2-1 Introduction

This section describes the management of wastes in tank systems as required by 40 CFR 270.16 and ADEM Administrative Code Rule 335-14-8-.02(7). There are seven (7) units at the Facility in which hazardous wastes are managed in tank systems:

- Container & Tank Management Unit 520
- Container & Tank Management Unit 600
- Laboratory Tank Storage Unit 708
- Wheel Wash and Tank Storage Unit 900
- Containment Building/Container & Tank Management Unit 1200A
- Tank Management Unit 1400
- Leachate Tank Storage Units 1700A, B & C

The primary objective of these units is to safely manage segregated types of wastes in order to either accumulate a sufficient quantity to enable efficient batch treatment; equalize variable waste receipts and facilitate continuous, steady-state treatment; accumulate waste receipts during short periods when other storage or treatment units are out of service for repair or maintenance; or to accumulate wastes for subsequent off-site transfer.

The quantities and types of wastes received and managed at the Facility vary, and the Facility maintains tank management systems that can be used in a flexible manner to accommodate these variations. For example, a tank may be used interchangeably for the storage of two or more different types of waste, with intervening cleaning of the tank. Consequently, few of the tank systems described in this Application will necessarily be used only for the management of a single type of waste. Tables C-1-1 and C-1-2 in Section C of this Application list the EPA waste codes that are managed in tank systems at the Facility. All waste codes are listed in this table due to the fact that the EPA has determined that treatment residuals, wastewaters, dilute concentrations of hazardous waste constituents and mixtures of hazardous constituents in non-hazardous waste maintain, by virtue of the derived-from rule and mixture rule, their listed code(s) regardless of the concentration of hazardous constituents in the waste.

A summary of the management activities conducted in each tank management system at the Facility is provided in Section D as an introduction to the more specific designs, practices and procedures described in this section. Drawing No. 0100-010-001, Operations Flow Sheet, in Appendix D-1 to Section D, provides additional specifics which illustrate, by general waste type, the major waste management procedures and processes utilized at the Facility. Drawing No. 0100-020-001, Facility Layout, in Appendix D-1 to Section D, illustrates the locations of the tank management units within the active portion of the Facility. Design drawings for each unit at the Facility in which hazardous wastes are managed in tank systems are also provided in Appendix D-1 to Section D.

Descriptions of the general design features and management practices which are common to each of the units in which hazardous wastes are managed in tank systems at the Facility are provided in Subsections D-2-2 and D-2-3, respectively. Subsection D-2-4 provides information regarding the general types of waste treatment which are performed in all tank systems at the Facility. Unit-specific information regarding the design, the storage and treatment equipment in each unit, the types and quantities of waste managed in each unit, and any specific management practices utilized in each unit is provided in Subsection D-2-5.

D-2-2 General Design Features

Each of the units at the Facility in which hazardous wastes are stored and/or treated in tanks is designed to enable the management of these wastes in accordance with 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10. While the design of each tank management unit is unique, certain features are common to all of the tank management units at the Facility. These common design features are described in the following subsections. Many of the tank design features described in the following subsections, including tank dimensions, capacity, materials of construction, and design codes are summarized in Appendix D-2-1 of this Application. Calculations of secondary containment capacity for each tank system at the Facility are provided in Appendix D-2-2 of this Application. A summary of tank design shell thicknesses is provided in Appendix D-2-3 of this Application. Tank system design assessments and certifications as required by 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a) are provided in Appendix D-2-4 of this Application. Tank system installation assessments and certifications as required by 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g) are maintained within the Facility Operating Record. Other tank system design features such as operational controls and secondary containment system information are depicted in the Engineering Drawings for each unit, which are located in Appendix D-1 to Section D of this Application.

D-2-2a Tanks and Foundations

The shell walls, seams, connections, supports, anchorages and other structural components of each of the tanks at the Facility are designed in accordance with the appropriate recognized national standard(s) such as those as published by the American Petroleum Institute (API), the

American National Standards Institute (ANSI), the American Society of Testing Materials (ASTM), Underwriters Laboratories (UL), the Steel Tank Institute (STI), the American Society of Mechanical Engineers (ASME), the American Society of Civil Engineers (ASCE), the American Institute of Steel Construction (AISC), the American Concrete Institute (ACI) and/or the Standard Building Code (SBC). Many factors are considered in the design of tank structural components, including, but not limited to, the following:

- maximum specific gravity of the waste managed;
- minimum and maximum operating pressures;
- minimum and maximum operating temperatures;
- wind loads (outdoor aboveground tanks only);
- roof dead and live loads;
- Zone 1 seismic considerations (aboveground tanks only);
- configuration of the tank; and
- types of materials used for tank construction.

Each of the tanks is constructed of materials and/or provided with internal coatings which have been demonstrated to be compatible with the wastes managed in the tanks. Many factors are considered in the selection of tank materials of construction and internal coatings, including, but not limited to, the following:

- minimum corrosion allowance within the tank design;
- anticipated acidity of the wastes managed;
- anticipated alkalinity of the wastes managed;
- anticipated water content of the wastes managed;
- anticipated concentration of organic solvents in the wastes managed;
- anticipated type of organic solvents in the wastes managed (i.e., chlorinated hydrocarbons, etc.);
- temperature of wastes managed; and
- functionality of tank (i.e., types of treatment performed, agitation, etc.).

Each of the tanks is constructed of materials, provided with external coatings, and/or equipped with an external corrosion protection system which has been demonstrated to provide adequate corrosion protection from the ambient surroundings and materials in contact with the external surface of the tank. Many factors are considered in the selection of tank materials of construction, external coatings, or the type and degree of other external corrosion protection that is required to ensure that the integrity of the tank system is maintained during its useful life including, but not limited to, the following:

- location of the tank (i.e., indoors/outdoors or aboveground/underground);
- minimum degradation or abrasion allowance within the tank design;
- moisture content of the material in contact with the tank external shell;
- pH of the material in contact with the tank external shell;
- sulfide content of the material in contact with the tank external shell;
- resistivity of the material in contact with the tank external shell;
- structure of the electrical potential of the material in contact with the tank external shell;
- influence of nearby underground structures; and
- existence of stray electric currents.

All tanks at the Facility are designed to be supported by reinforced concrete foundations overlying a native or recompacted chalk base. The reinforced concrete foundations are designed in accordance with appropriate recognized national standard(s) such as those published by the ACI, the AISC and/or the SBC. Many factors are considered in the design of tank foundations, including, but not limited to, the following:

- the full load of the tank(s) and contents considering the design maximum specific gravity;
- the weight of tank ancillary equipment (e.g., agitators);
- wind, seismic and other loads imparted on the tank system;
- the effects of frost heave;
- the compressive strength of concrete foundations; and
- the load bearing capacity of underlying soils.

The backfill material for tank systems or components that are placed underground is specified to be a noncorrosive, porous and homogeneous material that is appropriate for its intended use. The design for the placement of the backfill material addresses the requirement for the tank and ancillary equipment to be fully and uniformly supported.

Conformance with the requirements of the material selection criteria and the design standards for tank structural components and foundations as described in this subsection ensures that tanks are designed to have sufficient structural integrity and compatibility with the wastes managed so as to not collapse, rupture, or fail in a catastrophic manner.

D-2-2b Tank System Operational Controls

The design for each of the tanks in which hazardous wastes are managed at the Facility includes engineering controls to prevent the accidental over-pressure or over-fill of a tank.

Tank designs include open vents, pressure/vacuum relief valves and/or emergency vents to prevent the accidental over-pressure of each tank. The venting capacity required for each of the tanks at the Facility is determined in accordance with applicable portions of American Petroleum Institute Standard 2000 (API-2000), "Venting Atmospheric and Low-Pressure Storage Tanks". Several factors are considered in the design and sizing of tank vent openings and venting devices, including, but not limited to, the following:

- maximum tank fill and withdrawal rates;
- minimum and maximum tank design pressures;
- capacity and dimensions of each tank; and
- anticipated flash point of wastes managed.

A design assessment and certification that attests to the structural integrity of each tank design and the suitability for managing hazardous waste in each of the tanks at the Facility in accordance with the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a) is included in Appendix D-2-4 of Section D-2 of this Application. These tank design assessments also include the supporting documentation and calculations to verify the adequacy of the designed size of each tank vent opening based on the required venting capacity calculated for each of the tanks.

Tank designs also include level sensing devices and automatic fill cut-offs to prevent the accidental over-filling of each tank. Many of the tanks at the Facility include a continuous level monitoring device to facilitate waste management within the tank. In addition, all tanks are equipped with a high (or high-high) level sensing device which is interlocked to all fill devices associated with the tank through a high-level switch. These high-level switches provide a mechanism to automatically stop the flow of material into a tank, and normally activate an audible and/or visible alarm to ensure that the potential over-fill is recognized and addressed through the appropriate management procedures. The set point for each tank at the Facility that is equipped with a high or high-high level waste fill cut-off is normally at or below the tank vapor space allowance as indicated in the Tank Data Sheets in the design assessments and certifications included in Appendix D-2-4 of Section D-2 of this Application. Piping systems are designed to include check valves at appropriate locations such as tank fill and discharge lines and centrifugal pump discharge lines to prevent accidental tank over-fill or spills due to backflow or siphoning.

A number of tanks or tank systems at the Facility are equipped with temperature sensing devices which are designed to cut off the flow of wastes and other materials into a tank upon the detection of high temperatures. The existence of this condition is normally only a concern in tank systems in which corrosive or reactive wastes are managed, especially in tanks constructed of fiberglass reinforced plastic (FRP), which normally have a maximum design temperature of approximately 180° F. The Piping and Instrumentation Diagrams (P&ID's) for tanks at the Facility, which are included in Appendix D-1 to Section D of this Application, indicate which tanks at the Facility are equipped with a temperature sensor to cut off the flow of waste into the tank at a high temperature. Unless otherwise specified in the unit-specific information provided in Subsection D-2-5, the high temperature set point for the cut off of waste feed is 150° F, or approximately 85% of the tank design temperature for these FRP tanks.

A number of tanks or tank systems at the Facility are equipped with continuous pH sensing devices which are designed to monitor treatment in a tank. The Piping and Instrumentation Diagrams (P&ID's) for tanks at the Facility, which are included in Appendix D-1 to Section D of this Application, indicate which tanks at the Facility are equipped with continuous pH sensing devices. Unless otherwise specified in the unit-specific information provided in Subsection D-2-5, the pH ranges or targets are established on a case-by-case basis in accordance with the results of a treatability evaluation performed in accordance with the requirements provided in Section C of this Application.

The pressure control, level sensing devices, pH sensing devices, temperature sensing devices and major pipeline control elements described in this subsection are depicted on the tank system P&ID's which are included in the Engineering Drawings in Appendix D-1 to Section D of this Application.

Any exceptions to the design or requirements for tank pressure, pH sensing devices, temperature, or over-fill control devices (i.e., for some open top tanks) are described in the unit-specific tank system descriptions in Subsection D-2-5.

D-2-2c Ancillary Equipment

Tank system ancillary equipment includes all components of the tank system that contact wastes or serve to control the storage and treatment of wastes within the tank system.

However, ancillary equipment does not include the tank itself, items fabricated as an integral part of the tank, tank structural supports and foundations, or the secondary containment system. Tank system ancillary equipment generally includes items such as the following:

- tank level sensing and control devices;
- tank pressure control devices;
- tank agitators and mixers;
- tank leak detection devices.
- pumps;
- strainers;
- piping systems;
- flow meters;
- operated valves, hand valves and check valves; and
- miscellaneous pipeline elements such as pressure gauges, backflow preventors and flame arresters.

The primary types of tank system ancillary equipment are piping and piping systems. Piping and piping systems that are ancillary to tank systems in which hazardous wastes are managed are designed in accordance with appropriate recognized national standard(s) such as ASME B31.3, "Chemical Plant and Petroleum Refinery Piping". Many factors are considered in the design of piping systems, including, but not limited to, the following:

- compatibility of piping materials with the wastes managed;
- design flow rates and pumping pressure requirements;
- temperature of waste transported in the piping;
- prevention of backflow or siphoning;
- prevention of physical damage from transport vehicles;
- prevention of excessive stress due to settlement, vibration, expansion, contraction or shock;
- prevention of spills at piping system connections; and
- secondary containment requirements for piping located outside of the limits of the secondary containment for the tank system.

Other tank system ancillary equipment is designed in accordance with good engineering principles and practices and to serve its intended purpose. Ancillary equipment that is integral to the tank is designed and rated to meet the same requirements for pressure, corrosion resistance and waste compatibility as the tank. Ancillary equipment that is integral to the piping system is designed and rated to meet the same requirements for pressure, corrosion resistance and waste compatibility as the piping.

The tank system ancillary equipment described in this subsection, including pumps, major pipeline elements, agitators, leak detection devices, and pressure and level controls, are depicted on the tank system P&ID's which are included in the Engineering Drawings in Appendix D-1 to Section D of this Application.

D-2-2d Secondary Containment Systems

Each secondary containment system for units at the Facility in which hazardous wastes are managed in tank systems is designed to comply with the requirements of 40 CFR 264.193 and ADEM Administrative Code Rule 335-14-5-.10(4). Secondary containment system design features such as overall containment dimensions, heights of containment walls and locations of waterstops are depicted in the Engineering Drawings for each unit, which are located in Appendix D-1 to Section D of this Application. The secondary containment system features described in this subsection are designed to provide a system which will prevent the migration of wastes or accumulated liquids out of the system to the surrounding soils, surface water or groundwater and will enable the detection and collection of releases and accumulated liquids.

D-2-2d(1) Capacity of Secondary Containment System

All aboveground tank management unit secondary containment systems are designed to contain 100% of the capacity of the largest tank within the limits of the system, plus the volume generated from a 7½" precipitation event (i.e., 25-year, 24-hour rainfall event) entering the portions of the secondary containment system which are exposed to precipitation. In order to minimize the amount of precipitation that enters aboveground secondary containments at the Facility, some of the tank management units have secondary containment systems that are equipped with full or partial roofs. Some of the roofs are equipped with overhangs to minimize the blow-in of precipitation. All roofs are sloped and/or guttered to route collected precipitation to the outside of the limits of the secondary containment system. In addition, some tanks are equipped with a roof gutter system to collect the precipitation that contacts the tank roof and to route the collected precipitation to outside the limits of the aboveground secondary containment system. The capacities required of the aboveground secondary containment systems account for the rainfall entering the system and for capacity deductions for tank foundations, pump pedestals, etc. Rainwater that falls within or is blown into the secondary containment system of a unit in which hazardous waste is managed in tanks will be collected and managed as described in Subsection D-2-3i of this section. Surface water run-on into aboveground secondary containment systems is prevented by the measures described in the Subsection D-2-2d(2) and, therefore, not considered in the required secondary containment capacity.

Calculations of the capacity of the secondary containment system for each aboveground tank management unit or system at the Facility are provided in Appendix D-2-2 to Section D-2 of this Application. The assumptions used to calculate the secondary containment capacity for each unit are also included in this appendix.

Secondary containment for all underground and in-ground tanks at the Facility is provided through the utilization of double-walled tanks. In accordance with the requirements of 40 CFR 264.193(e)(3) and ADEM Administrative Code Rule 335-14-5-.10(4)(e)3., all underground and in-ground tanks at the Facility are designed as an integral structure such that the inner tank is completely enveloped within the outer shell. Adequate secondary containment capacity is inherent in the design of these double-walled tanks due to the fact that any release from the inner tank is completely contained by the outer shell.

D-2-2d(2) Prevention of Run-On or Infiltration

Each aboveground or in-ground tank management unit at the Facility is surrounded by a perimeter containment wall or curb of sufficient height to prevent the run-on of surface waters. Each unit is situated above the elevation of the surrounding land surface, and the surrounding land surfaces are sloped away from the unit to promote drainage of run-off. In addition, each of the tank management units at the Facility is located above the elevation of the 100-year floodplain as documented in Subsection B-3b of Section B of this Application.

D-2-2d(3) Containment Foundations, Floors and Walls

The majority of the tanks or tank systems at the Facility are designed to have reinforced concrete foundations, floors and walls which surround the tank(s) or tank system completely and cover all surrounding earth that could come in contact with a release of waste from a tank. The components of the secondary containment system and the tank foundations are designed in accordance with appropriate recognized national standard(s) such as ASTM, AISC and ACI. Many factors are considered in the design of the secondary containment foundations, floors and walls to ensure that these components have sufficient structural strength and thickness to prevent failure. These factors include, but are not limited to, the following:

- resistance to pressure gradients from static head and external hydrological forces;
- resistance to stresses due to climatic conditions such as the effects of frost heave;
- resistance to daily operational stresses;
- resistance to stresses from nearby vehicular traffic; and

- resistance to excessive settlement, compression, or uplift.

In some cases, the secondary containment system floor also serves as the foundation for the tank(s) within the system. In these cases, the design of the foundation floor is in accordance with the general requirements described in Subsection D-2-2a of this Application.

To ensure that the foundations, floors and walls of the tank management units are free of leakable cracks or gaps (i.e., cracks or openings that compromise the containment system as opposed to: 1) minor surface striations; 2) surface fractures covered and sealed by coatings; 3) cracks sealed with an appropriate sealant system; or 4) other such partial penetrations that do not compromise the containment system), well-proven construction techniques and quality construction materials are used, and the containments for tank systems are inspected in accordance with Subsection D-2-3h of this section. The floor, curbs, walls and sumps comprising each tank secondary containment system are formed of structurally reinforced concrete designed to support the loads imparted by the tanks and/or ancillary equipment and to resist the stresses described above. All floors, sumps, curbs, and walls are designed as monolithic units or as separate units with all concrete joints sealed with a chemical-resistant waterstop. All construction, expansion, contraction, crack control and other joints within secondary containment areas are keyed as necessary and equipped with a chemical-resistant waterstop and sealed. Details of the construction of the concrete containments and foundations for each of the tank management units are provided in the Engineering Drawings in Appendix D-1 to Section D of this Application.

Any exceptions to the general design features of secondary containment system foundations, floors and walls are described in the unit-specific tank system descriptions in Subsection D-2-5 of this Application.

D-2-2d(4) Containment System Interior Surface Coatings

To ensure that all surfaces within the secondary containment systems for tank management units are impermeable to physical contact with the wastes managed, all floor surfaces, the interior surfaces of containment curbs and walls, and the bottoms and sides of all sumps are coated with a chemical-resistant concrete coating system. In addition to exhibiting chemical resistance to the waste managed, the concrete coating systems that are applied to wear surfaces are also abrasion resistant to withstand excessive physical degradation and damage from forklifts, vehicular traffic and maintenance equipment, and to minimize the amount of coating repairs and replacements that must be performed.

Four (4) types of concrete coating systems may be utilized within secondary containment systems for tanks. Within a given unit, any single system or a combination of two or more concrete coating systems may be utilized to ensure that adequate physical and chemical resistance is achieved. Each type of coating system is selected to provide the appropriate level of protection against chemical and abrasive degradation to all concrete secondary containment surfaces within the Facility. The four (4) types of concrete coating systems are differentiated by the configuration of the surface to which they are applied. The four (4) types of concrete coating systems are designated as Types A, B, C and D. Appendix D-1-3 to Section D-1 of this Application provides a description of the surface configuration upon which each type of concrete coating system is used, the general functional properties required of each concrete coating system, and concrete coating system descriptions and specifications which establish the minimum standards for each type of coating system.

<u>D-2-2d(5) Secondary Containment for Ancillary Equipment</u>

Ancillary equipment located outside of the secondary containment system for the tanks is limited to piping and piping systems. In accordance with the of 40 CFR 264.193(f) and ADEM Administrative Code Rule 335-14-5-.10(4)(f), piping located outside of the secondary containment system for the tanks is designed either to be void of flanges, valves, joints or other connections, or is equipped with an outer containment pipe that completely surrounds and contains the inner carrier pipe. Aboveground piping that is ancillary to tank systems and is not equipped with an outer containment system is inspected daily in accordance with Subsection D-2-3h of this section. Piping system components such as valves, meters, flanges and other joints located outside of the secondary containment system for the tanks are placed within a vault or other device that serves the same purpose as an outer containment pipe. The outer containment pipes are sloped to drain back into the secondary containment system for the tanks or into a containment vault. Waste and catchment water carrier pipes within these systems are equipped with check valves at appropriate intervals and locations to limit the volume of material that could drain or flow back into a secondary containment device to below the volume of the secondary containment device. This design prevents the accidental over-fill of a secondary containment device in the event of a leak or failure in a segment of the carrier pipe. The secondary containment devices or systems that are subject to this type of accidental over-filling and that cannot be inspected on a daily basis are equipped with automatic leak detection devices to indicate the presence of liquids within the containment.

Since vent piping does not contain liquids, it is not required to meet the criteria for tank system ancillary equipment that must be located within a secondary containment system.

D-2-2e Leak Detection Systems

In accordance with the 40 CFR 264.193(c)(3) and ADEM Administrative Code Rule 335-14-5-.10(4)(c)3., the secondary containment system for each tank management system at the Facility is designed with provisions to enable the detection of leaks resulting from failure of the primary containment provided by the tank or ancillary equipment, or other accumulated liquid within 24 hours. The majority of the tank systems including ancillary equipment are located aboveground, and the management of wastes in underground or in-ground tanks and ancillary equipment systems is limited to only a few units or systems such as in Unit 708, Unit 900, Unit 1200A, and the Underground Site Pipe Chase which is considered to be ancillary to Unit 1400.

All aboveground tanks and ancillary equipment systems are designed such that leaks and accumulated liquids are detected by visual inspection. With the exception of the portion of some tanks that rest directly on slotted bases or the base of the secondary containment system, all portions of aboveground tanks and ancillary equipment systems are designed to allow direct visual inspection. Slotted bases on which tanks rest directly are designed to slope towards the perimeter of the tank. This sloped base design promotes the drainage of liquids from beneath the bottom of the tank and allows leaks from the tank to be detected by indirect visual inspection. In addition, all aboveground secondary containment system bases are sloped to promote the drainage of liquids resulting from leaks, spills or precipitation to collection trenches, sumps or low points within the containment. These sumps facilitate the detection and timely removal of accumulated liquids from within secondary containment systems.

All underground or in-ground tanks and ancillary equipment systems are designed such that leaks are detected by automatic engineering controls. These leak detection systems are designed as built-in systems that operate continuously. These leak detection systems are also designed to provide a visual and/or audible alarm to ensure that the potential leak is recognized in a timely manner so that it can be addressed through the appropriate management procedures. The leak detection systems for underground or in-ground tanks and ancillary equipment systems may consist of one or more of the following types:

- a loss of vacuum sensor on the interstitial space of a double-walled tank;
- a liquid detection cable or probe within the interstitial space of a double-walled tank;
- a liquid detection probe or cable within an in-ground ancillary equipment secondary containment device or outer containment pipe; or
- an equivalent device or method capable of providing continuous leak detection monitoring and timely annunciation, alarm or automatic shutdown.

Plans, sections and details which depict the leak detection features of the secondary containment systems for each of the tank management units at the Facility are provided in the Engineering Drawings in Appendix D-1 to Section D of this Application.

Any exceptions to the general design features of leak detection systems are described in the unit-specific tank system descriptions in Subsection D-2-5 of this Application.

D-2-2f Design Considerations for Ignitable, Reactive or Incompatible Wastes

Each of the units at the Facility in which ignitable or reactive hazardous wastes are stored and/or treated in tanks is designed to enable the management of these wastes in accordance with the applicable requirements of 40 CFR 264.17, 264.198 and ADEM Administrative Code Rules 335-14-5-.02(8) and 335-14-5.10(9).

All tanks at the Facility in which ignitable or reactive hazardous wastes are stored and/or treated are located to comply with the requirements for the maintenance of protective distances between the tank(s) and any public ways, streets, alleys, or adjoining property that can be built upon as defined by the NFPA-30, Flammable and Combustible Liquids Code. The locations of all tank management units at the Facility are indicated in Drawing No. 0100-020-001, Facility Layout, which is located in the Engineering Drawings in Appendix D-1 to Section D of this Application.

Other features utilized in the design of tanks in which ignitable or reactive hazardous wastes are stored and/or treated consider and address the necessity to take precautions to prevent the accidental ignition or reaction of ignitable or reactive wastes. The design of these tank systems include, but are not limited to, the following special features:

- located to maintain adequate protective distances from fixed sources of ignition such as open flames, hot surfaces or excessive radiant heat in accordance with the applicable portions of NFPA-30;
- protection from ignition due to static discharges in accordance with NFPA-30, including tank grounding and the use of anti-static inlets (i.e., dip tubes);
- protection from ignition due to electrical sparks or discharges through the use of appropriately rated electrical equipment in accordance with NFPA-70;
- minimization of the risk of ignition of vapors in tanks and vent lines through the use of inert gas blanketing on proposed tank systems in which ignitable hazardous wastes are managed;
- minimization of the potential for the advancement of a flame front through the use of strategically located flame arresters on tank systems in which ignitable hazardous wastes are managed in accordance with the applicable requirements of NFPA and API;
- minimization of the spread of and damage caused by fires involving tanks in which ignitable hazardous wastes are managed through the use of tank shell and/or leg

fire sprinkler system(s) and through the ability to provide protection of exposures, in accordance with the applicable requirements of NFPA and FM Data Sheet 7-88; and

- protection from the accumulation of ignitable vapors within the area by venting of the tanks and tanker loading stations through a closed vent system to an air pollution control device or system.

Each of the units at the Facility in which incompatible hazardous wastes are stored and/or treated in tanks is designed to enable the management of these wastes in accordance with 40 CFR 264.17, 264.199 and ADEM Administrative Code Rules 335-14-5-.02(8) and 335-14-5.10(10). Tank management units in which chemically incompatible hazardous wastes are managed are designed with segregated secondary containments which physically separate management areas by sloping floors or containment walls.

Any additions or exceptions to the general design features for managing ignitable, reactive or incompatible hazardous wastes are described in the unit-specific tank system descriptions in Subsection D-2-5 of this Application.

D-2-2g Assessment of Tank System Designs

In accordance with the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), the Facility obtains an assessment of the design of each new tank system (i.e., tank system for which construction commenced after July 14, 1986) at the Facility in which hazardous wastes are managed. These assessments are reviewed by an independent, qualified registered Alabama Professional Engineer and certified in accordance with 40 CFR 270.16(a) and ADEM Administrative Code Rule 335-14-8-.02(2)(d). The certifications attest that the assessment of the design of the tank system demonstrates that the tank system foundation, structural supports, seams, connections, and pressure controls are adequate, and that the tanks have sufficient structural strength, compatibility with the wastes to be managed, and/or protection from corrosion so that they will not collapse, rupture or fail when properly installed, operated within the design limits, and properly inspected and maintained. In accordance with the requirements of 40 CFR 264.192(g) and 40 CFR 270.16(a), and ADEM Administrative Code Rules 335-14-5-.10(3)(g) and 335-14-8-.02(7)(a), these design assessments and certifications for each current and proposed tank system at the Facility are included within the attachments to Appendix D-2-4 of Section D-2 of this Application.

In accordance with the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), the Facility also obtains an assessment and certification for the design of new tank systems in which hazardous waste are managed in accordance with 40 CFR 262.34(a)(1)(ii) and ADEM Administrative Code Rule 335-14-3-.03(5)(a)1.(ii). In accordance with the requirements of 40 CFR 264.192(g) and 40 CFR 270.16(a), and ADEM Administrative Code Rules 335-14-5-.10(3)(g) and 335-14-8-.02(7)(a), a design assessment and certification for the 90-day generator accumulation tank system in Laboratory Tank Storage Unit 708 (Tank T-726), which is currently in service at the Facility, is maintained within the Facility Operating Record.

D-2-2h Minor Deviations from the Permit Design

During final design and construction of proposed tank management units or alterations or expansions to existing tank management units, minor deviations may be required from the permit designs included within this Application. Such deviations may be required to facilitate the final design and construction of the unit through adherence to standard design and construction practices and requirements so that the unit can serve its intended purpose. The necessity for minor deviations from the permit designs of tank management units may stem from requirements within one or more of several categories such as the following:

- to enable compliance with applicable codes, standards or regulations such as Building Codes, OSHA, or NFPA;
- to aid in the constructability of the unit;
- to allow for the substitution of equivalent or superior equipment; and/or
- to allow for the substitution of equivalent or superior materials of construction.

These deviations will not alter the intent of the permit design or functionality of the unit and will not compromise the ability to manage the unit as required by the regulations. In addition, these deviations will not decrease the capacity of the secondary containment system for the unit as described in this Application and will not increase the amount of waste to be managed within the unit as described in this Application. Any deviations from the designs contained within this Application that constitute a material or substantial alteration or addition to a permitted unit in accordance with 40 CFR 270.41(a)(1) and ADEM Administrative Code Rule 335-14-8-.04(2)(a)1 will be submitted to the Department as a request for modification in accordance with the applicable portions of ADEM Administrative Code Rule 335-14-8-.04.

D-2-3 General Management Practices

Each of the units at the Facility in which hazardous wastes are stored and/or treated in tanks is managed in accordance with the applicable requirements of 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10. While the management practices utilized within each tank storage and treatment unit are unique, certain management practices are common to all of the tank management units at the Facility. These common management practices are described in the following subsections. Additional unit-specific management practices are provided for each unit in the subsections in Subsection D-2-5.

D-2-3a Types of Waste Managed in Tank Systems

Wastes managed in tank systems at the Facility include virtually every type of hazardous waste listed or identified by 40 CFR Part 261 and ADEM Administrative Code Chapter 335-14-2, TSCA-regulated PCB wastes, and certain non-hazardous wastes. With the exception of TSCA-regulated PCB waste, Tables C-1-1 and C-1-2 in Section C of this Application list the EPA waste codes for the hazardous wastes managed in tank systems at the Facility. All EPA waste codes are listed in these tables due to the fact that EPA has determined that treatment residuals, wastewaters, dilute concentrations of hazardous waste constituents and mixtures of hazardous constituents in non-hazardous waste maintain, by virtue of the waste-derived from rule and mixture rule, their listed code(s) regardless of the concentration of hazardous constituents in the waste. Treatment residues from wastes bearing the waste codes listed in Tables C-1-1 and C-1-2 will also be managed in accordance with the Permit and particularly the Waste Analysis Plan provided in Section C of this Application. The physical characteristics of the types of waste managed in tanks at the Facility include free liquids, pumpable and non-pumpable semi-solids and sludge, solids, finely divided materials, shredded containers, and all varieties or combinations of these physical states.

D-2-3b Storage and Treatment Decisions

After waste sampling, analyses and acceptance procedures are complete; a determination is made as to the most appropriate methods of managing the waste within tank systems at the Facility. The procedures utilized in making this determination are outlined in the Waste Analysis Plan provided in Section C of this Application. The physical and chemical characteristics of wastes are the primary factors which dictate whether a waste is managed in tank systems at the Facility. Decisions regarding the treatment of wastes in tank systems also consider the compatibility of any treatment reagents and all by-products or residuals from the treatment process, as well as the compatibility of the waste with the materials of construction of the tank system. All decisions regarding the storage and/or treatment of wastes in tank systems at the Facility are made in accordance with the requirements of the Waste Analysis Plan provided in Section C of this Application.

D-2-3c General Operating Practices and Procedures

Tank systems at the Facility in which hazardous wastes are managed are operated in accordance with management practices and procedures necessary to comply with the applicable requirements of 40 CFR 264.194 and ADEM Administrative Code Rule 335-14-5- .10(5). These procedures and practices are taken as precautionary measures to prevent the accidental over-fill or over-pressure of the tanks or failure of the tank or secondary containment systems.

The management procedures and practices described in Subsections D-2-3b, d and e of the section prevent the placement of wastes or treatment reagents in a tank system which could cause the tank, ancillary equipment or secondary containment system to leak, rupture, experience an excessive rate of corrosion, or otherwise fail in a catastrophic manner.

The Facility also utilizes practices and procedures to prevent the over-fill of tanks, prevent the overflow of secondary containment systems, prevent accidental spills outside of the secondary containment system, and minimize spills within the secondary containment system. The procedures and practices include, but may not be limited to, the following:

- the use of spill prevention measures such as check valves, dry disconnect couplings, drip pans, carboys or other similar devices during the transfer of wastes;
- the monitoring of the engineering controls used to prevent tank over-filling such as the level sensing devices, high level alarms and automatic feed cutoff switches described in Subsection D-2-2b;
- the maintenance of the tank level sensing devices and interlocks in proper working order;
- the establishment of high level cut off set points such that the shut off of fill device(s) upon activation of the high (or high-high) level device occurs well before the tank is actually over-filled;
- the monitoring of the engineering controls and/or the use of visual inspections to ensure that sufficient freeboard is maintained within open top tanks to prevent accidental over-filling;
- the maintenance of a daily running record of the volume of wastes and reagents placed into and removed from each tank;
- the supervision by a Facility operator of all transfers of waste and reagents to and from all tanks and tanker trucks in which hazardous wastes are managed;
- the maintenance of the structural integrity of the secondary containment system to be free of cracks or gaps (i.e., cracks or openings that compromise the containment system as opposed to: 1) minor surface striations; 2) surface fractures covered and sealed by coatings; 3) cracks sealed with an appropriate sealant system; or 4) other such partial penetrations that do not compromise the

containment system), such that, in the unlikely event of a tank over-fill, the spilled material does not escape the secondary containment system;

- the monitoring and maintenance of the secondary containment leak detection systems to detect spills of hazardous waste or accumulated liquids and ensure proper working order; and
- the timely removal of accumulated liquids (e.g., precipitation) from secondary containment systems such that, in the unlikely event of a tank over-fill, adequate secondary containment capacity is available, and the spilled material does not escape the secondary containment system.

Any additions or exceptions to these general management practices for the prevention of tank over-fills or releases from secondary containment systems are described in the unit-specific tank system descriptions in Subsection D-2-5 of this Application.

D-2-3d Special Practices for the Management of Ignitable and Reactive Wastes

The Facility utilizes special management practices and procedures to comply with the applicable requirements of 40 CFR 264.17, 40 CFR 264.198 and ADEM Administrative Code Rules 335-14-5-.02(8) and 335-14-5-.10(9) relative to the management of ignitable and reactive wastes in tank systems. These procedures and practices are taken as precautionary measures to prevent the accidental ignition or reaction of ignitable or reactive wastes. The tank(s) or tank systems in which ignitable or reactive hazardous wastes are managed are indicated in Appendix D-2-1 of this Application.

In order to separate and protect ignitable and reactive wastes managed in tank systems from sources of ignition or reaction, no activities that may create a source of ignition will be permitted within or adjacent to tank management units in which ignitable or reactive wastes are stored or treated. These precluded activities include, but are not limited to, the following:

- smoking;
- cutting or welding;
- activities that may generate or cause open flames;
- activities that may generate frictional heat;
- activities that may generate static, electrical or mechanical sparks;
- activities that may generate excessive radiant heat;
- activities that may cause spontaneous ignition of the waste; and
- other activities that may pose a potential source of ignition.

Warning signs such as "No Smoking", "No Welding", etc. are conspicuously posted at entrances into all tank management units in which ignitable or reactive wastes are managed. When practical, maintenance activities which may require or generate sources of ignition are conducted a safe distance from all units in which ignitable or reactive hazardous wastes are managed in tank systems. When it is not possible or practical to perform such activities outside the affected unit, the activity may be conducted within the unit only with the expressed, written permission of the Facility's Environmental, Health and Safety Manager (or designee). All such activities performed within a unit in which ignitable or reactive wastes are managed in tanks are conducted in accordance with all applicable OSHA and NFPA standards.

The precautions outlined in this subsection, in conjunction with the procedures and practices described in Subsection D-2-3b, are designed to prevent reactions of ignitable or reactive hazardous wastes which may:

- generate heat or pressure in excess of the design rating of the tank system in which the wastes are managed;
- generate fires, explosions or uncontrolled violent reactions;
- generate uncontrolled toxic mists, fumes, dusts, or gases in excessive quantities or in quantities which pose an unreasonable risk of fire or explosion;
- generate uncontrolled flammable fumes or gases in excessive quantities or in quantities which pose an unreasonable risk of fire or explosion; or
- generate conditions which could damage the structural integrity of the tank system in which the wastes are managed.

Any additions or exceptions to these general management practices for managing ignitable or reactive waste are described in the unit-specific tank system descriptions in Subsection D-2-5 of this Application.

D-2-3e Special Practices for the Management of Incompatible Wastes

The Facility utilizes special management practices and procedures to comply with the applicable requirements of 40 CFR 264.17 and 40 CFR 264.199, and ADEM Administrative Code Rules 335-14-5-.02(8) and 335-14-5-.10(10) relative to the management of incompatible wastes in tank systems at the Facility. These procedures and practices are taken as precautionary measures to prevent the accidental ignition or reaction of incompatible wastes.

Prior to mixing wastes in tank systems, the compatibility of the wastes is assessed in accordance with the procedures outlined in the Waste Analysis Plan provided in Section C of this Application. This assessment will consider not only the compatibility of the waste with the current or previous contents of the tank(s), but also the compatibility of the waste with the materials of construction of the tank(s). Based on the results from sampling and analysis and after acceptance procedures are completed, chemically incompatible wastes are placed only in tank systems that have segregated secondary containment areas. In addition, wastes are placed only in tanks which previously held a compatible waste or in tanks which have been emptied and cleaned subsequent to the management of an incompatible waste. Tank systems will be cleaned, and incompatible residues will be removed by processing a mutually compatible transition waste or other appropriate material through the tank. All waste clean-out residues from the tanks and ancillary equipment will be collected and managed in accordance with the requirements for the waste codes associated with the waste removed. Tank management units in which chemically incompatible hazardous wastes are managed are designed with segregated secondary containments which physically separate management areas by sloping floors or containment walls. These segregated areas enable the storage and treatment of incompatible hazardous wastes within the same unit.

The precautions outlined in this subsection, in conjunction with the procedures and practices described in Subsection D-2-3b, are designed to prevent reactions resulting from the management of incompatible hazardous wastes which may:

- generate heat or pressure in excess of the design rating of the tank system in which the wastes are managed;
- generate fires, explosions or uncontrolled violent reactions;
- generate uncontrolled toxic mists, fumes, dusts, or gases in excessive quantities or in quantities which pose an unreasonable risk of fire or explosion;
- generate uncontrolled flammable fumes or gases in excessive quantities or in quantities which pose an unreasonable risk of fire or explosion; or
- generate conditions which could damage the structural integrity of the tank system in which the wastes are managed.

Any additions or exceptions to these general management practices for managing incompatible wastes are described in the unit-specific tank system descriptions in Subsection D-2-5 of this Application.

D-2-3f Response to Leaks or Spills

The management practices and procedures of this subsection are utilized to comply with the requirements of 40 CFR 264.196 and ADEM Administrative Code Rule 335-14-5-.10(7) for responding to leaks or spills of hazardous waste from tank systems at the Facility.

Upon the detection of a tank system or secondary containment system from which there has been a leak or spill, or which is determined to be unfit for its intended use, the Facility will implement the following management actions immediately (i.e., in as timely a manner as can reasonably and practicably be achieved regarding to the protection of human health and the environment):

- the affected tank system and/or secondary containment system will be removed from service;
- the flow of hazardous waste into the tank system and/or secondary containment system will be stopped;
- waste will be removed from the tank system and/or secondary containment system as necessary to prevent further release of hazardous waste to the environment and to allow inspection of the system;
- the tank system and/or secondary containment system will be inspected to determine the cause of the leak, spill, failure or release;
- if a release from a secondary containment system has occurred, a visual inspection of the environs affected by the release will be conducted, and actions will be taken as necessary to prevent further migration of the released material to soils or surface waters and to remove any visible contamination from the affected soils or surface waters, and to conduct any necessary sampling and analysis of the affected soils or surface waters to demonstrate effective cleanup;
- if the cause of the spill, leak, or release did not damage the integrity of the tank system or secondary containment system, the system will be returned to operation as soon as the release is removed and any necessary repairs are completed;
- the Facility will obtain a certification from an independent, qualified, registered Alabama Professional Engineer, in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), that tank systems or secondary containment systems that have undergone major repairs are capable of managing hazardous waste without release for the duration of the systems' intended life; and
- if the spill, leak or release was caused by damage or caused damage to the integrity of the tank system or secondary containment system, such that the system is not repairable in accordance with the requirements of 40 CFR 264.196(e) and ADEM Administrative Code Rule 335-14-5-.10(7)(e), the tank system will be closed in accordance with the applicable requirements described in Section I of this Application.

The certification of major repairs of tank systems as required by 40 CFR 264.196(f) and ADEM Administrative Code Rule 335-14-5-.10(7)(f) are maintained on file at the Facility.

Upon the detection of a tank system or secondary containment system from which there has been a leak or spill, or which is determined to be unfit for use, the Facility will issue the following notifications and/or reports:

- any release from a tank system or secondary containment system to the environment which is in excess of a quantity of one (1) pound or which has not been immediately contained and removed will be reported to the Department within 24 hours of its detection as required by 40 CFR 264.196(d)(1) and (2) and ADEM Administrative Code Rules 335-14-5-.10(7)(d)(1) and (2);
- within 30 days of detection of a release to the environment from a tank system or secondary containment system, a report will be submitted to the Department which contains the following information as required by 40 CFR 264.196(d)(3) and ADEM Administrative Code Rule 335-14-5-.10(7)(d)(3):
  - likely route(s) of migration of the release;
  - characteristics of the surrounding soils;
  - results of any monitoring or sampling conducted in connection with the release (within 30 days or as soon as the results become available);
  - proximity of release to down-gradient drinking water sources, surface waters, and populated areas; and
  - description of response actions taken or planned; and
- within seven (7) days of returning a tank or tank system to service after major repairs have been performed, the certification required by 40 CFR 264.196(f) and ADEM Administrative Code Rule 335-14-5-.10(7)(f) will be submitted to the Department.

D-2-3g Closure of Tank Systems

The Facility will close the units or systems in which hazardous wastes are managed in tanks in accordance with the requirements of 40 CFR 264.197 and ADEM Administrative Code Rule 335-14-5-.10(8). The general and specific procedures that will be used in the closure of each tank system at the Facility are included in Section I of this Application.

D-2-3h Inspection of Tank Management Units

The management practices and procedures of this subsection are utilized to comply with the requirements of 40 CFR 264.195 and ADEM Administrative Code Rule 335-14-5-.10(6) for inspection of units at the Facility in which hazardous wastes are managed in tank systems. All inspections of tank systems in which hazardous wastes are managed in tank systems will be performed in accordance with the Inspection Plan provided in Section F of this Application. If a tank system is found to be leaking or unfit for service, the actions required by ADEM Administrative Code Rule 335-14-5-.10(7) will be initiated.

The performance and results of these and other tank system inspections will be documented and maintained within the Facility's Operating Record in accordance with 40 CFR 264.195(d) and ADEM Administrative Code Rule 335-14-5-.10(6)(d).

Any additions or exceptions to these general management practices for inspection of tank systems are described in the unit-specific tank system descriptions in Subsection D-2-5 of this Application, and in Section F of this Application.

D-2-3i Removal and Management of Liquids from Containments

The design of the secondary containment for all aboveground and on-ground tank systems is such that any accumulation of liquids can be detected by visual inspection of the collection sumps or low points within the containment. This type of design facilitates the inspection of the integrity of the sump as well as the detection of accumulated or standing liquids. As described in Subsection D-2-2e of this Application, the detection of liquids in the secondary containments for underground and in-ground tanks is achieved via automatic engineered controls. The detection of liquids within the secondary containments for underground and in-ground tanks may result in the removal of the tank from service in accordance with the requirements of 40 CFR 264.196 and ADEM Administrative Code Rule 335-14-5-.10(7) for further inspection and repair of the tank or leak detection system.

Secondary containment system sumps will be inspected for accumulated liquids at least once each operating day, and, in accordance with the requirements of 40 CFR 264.193(c)(4) and ADEM Administrative Code Rule 335-14-5-.10(4)(c)4., any standing liquids detected in the sumps will be removed in a timely manner (i.e., within 24 hours after detection or as soon as practicable). The source of all accumulated liquids will be identified as either hazardous waste from a spill or leak, rainwater contaminated with hazardous waste, or uncontaminated rainwater.

If the accumulated liquids are determined to be hazardous waste from a spill or leak, or rainwater contaminated with hazardous waste, the liquids will either be pumped into an appropriate tank within the unit, a tanker, or a smaller container, or will be transferred to Unit 1400 via the site pipe chase. If quantities of accumulated liquids are relatively insignificant and cannot be removed with a pump, the accumulated liquids may be absorbed and containerized in accordance with the Waste Analysis Plan (Section C). These containerized liquids or solids removed from the secondary containment for a unit in which hazardous waste is managed in tanks will be properly managed (i.e., managed as a Facility generated waste, characterized based on knowledge of the waste that it contacted or characterized by other procedures as described in the Waste Analysis Plan).

Liquids accumulated within the secondary containment for a unit in which hazardous waste is managed in tanks may be determined to be rainwater uncontaminated with hazardous waste only if all of the following conditions are met:

- the liquids are known to be the result of precipitation;
- there has not been a spill or leak of hazardous waste within the containment since accumulated liquids were last removed from the containment;
- no sheen is present on the surface of the liquid; and
- there is no visual or other indication of contamination.

If the accumulated liquids are determined to be uncontaminated rainwater, they will be pumped to the outside of the secondary containment system in accordance with the provisions of the Facility's NPDES permit.

D-2-3j Installation of Tank Management Systems

The Facility ensures that proper procedures are used for handling tank system components and ancillary equipment to prevent damage during installation. Prior to placing any tank system or component in hazardous waste service, an independent, qualified installation inspector or an independent, qualified, registered Alabama Professional Engineer, in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), will inspect the tank system and ancillary equipment in regard to the following conditions:

- weld breaks in tanks, piping or other ancillary components;
- punctures in tanks, piping or other ancillary components;
- scrapes of internal and external protective coatings on tanks;
- cracks in tanks, piping or other ancillary components;
- corrosion of tanks, piping or other ancillary components;
- proper installation of piping and support for ancillary equipment to protect against physical damage or excessive stress due to settlement, vibration, expansion or contraction in accordance with an appropriate, recognized national standard such as ANSI B31.3 and the tank system design;
- proper installation of tank level controls in accordance with the tank system design;

- proper installation of tank pressure controls in accordance with the tank system design;
- proper installation and functionality of automatic feed cut offs in accordance with the tank system design;
- proper installation and functionality of leak detection systems in accordance with the tank system design;
- proper dimensions of secondary containment systems in accordance with the tank system design;
- proper installation of secondary containment concrete coating system(s) in accordance with Appendix D-1-3 of this Application;
- proper placement of waterstops in concrete joints within the secondary containment system;
- integrity of the concrete secondary containment concrete system regarding the presence of leakable cracks or gaps (i.e., cracks or openings that compromise the containment system as opposed to: 1) minor surface striations; 2) surface fractures covered and sealed by coatings; 3) cracks sealed with an appropriate sealant system; or 4) other such partial penetrations that do not compromise the containment system);
- proper installation of cathodic protection systems and test apparatus;
- proper installation of the backfill material for tank systems or components that are placed underground in accordance with the tank system design;
- other structural damage or inadequate construction/installation of tanks, piping or other ancillary components.

All discrepancies, damage, or other inadequacies discovered during the installation inspection of tank systems will be corrected, repaired, or replaced prior to placing the tank system in hazardous waste service.

In addition to the inspections outlined above, all tanks and ancillary equipment will be tested for tightness in accordance with an appropriate, recognized national standard such as API-650 or ANSI B31.1 prior to being placed in hazardous waste service. If a tank system or ancillary component fails to meet the requirements of the tightness testing, the system or component(s) will be repaired to correct the source of the breach of integrity prior to being placed in hazardous waste service.

In accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f), the Facility obtains an assessment and certification for the installation of tank systems for which construction commenced after July 14, 1986 in which hazardous wastes are managed. In accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), installation assessments and certifications for the following tank systems, which have been previously installed and are currently in service at the Facility, are maintained within the Facility Operating Record:

- Tank T-520 in Container & Tank Management Unit 520;
- Tank T-725 in Laboratory Tank Storage Unit 708;
- Tanks T-901 through T-904 in Wheel Wash & Tank Storage Unit 900;
- Tanks T-1201A and T-1202A in Containment Building/Container & Tank Management Unit 1200A;
- Tanks T-1405 through T-1420 in Tank Management Unit 1400; and
- Tank T-A and Tanks T-1701,T-1702, T-1703 and T-1704 in Leachate Tank Storage Units 1700A, B & C.

In accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f), the Facility also obtains an assessment and certification for the installation of new tank systems in which hazardous wastes are managed in accordance with 40 CFR 262.34(a)(1)(ii) and ADEM Administrative Code Rule 335-14-3-.03(5)(a)1.(ii). In accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an installation assessment and certification for the 90-day generator accumulation tank system in Laboratory Tank Storage Unit 708 (Tank T-726), which is currently in service at the Facility, is maintained within the Facility Operating Record.

D-2-3k Recordkeeping for Wastes Managed in Tank Systems

In accordance with the requirements of 40 CFR 264.73(b)(1) and ADEM Administrative Code Rule 335-14-5-.05(4)(b)1., the Facility maintains within the Facility Operating Record a description and quantity of each hazardous waste managed in tank systems, and the method(s) and date(s) of treatment, storage, or disposal. In accordance with the requirements of 40 CFR 264.73(b)(2) and ADEM Administrative Code Rule 335-14-5-.05(4)(b)2., the Facility also maintains within the Facility Operating Record a description and quantity of hazardous waste transferred into and out of each of the tank system management units at the Facility.

D-2-4 General Description of Treatment in Tank Systems

This subsection provides general information regarding the types of waste treatment that are conducted in tank systems at the Facility. Although the specifics of treatment in tank systems in each unit are unique, certain types of treatment are performed in the same general manner in many of the tank systems at the Facility. Supplemental information regarding the treatment of wastes in tank systems is provided as necessary in the unit-specific descriptions provided in Subsection D-2-5.

D-2-4a Types and Quantities of Waste Treated in Tank Systems

The types of waste that are treated in each tank system at the Facility are indicated by general hazard class in Appendix D-2-1 of this Application. As shown in this Appendix D-2-1, each tank or tank system is designed to accommodate the storage and/or treatment of a broad range of wastes within the various hazard classes. Tables C-1-1 and C-1-2 in Section C of this Application list the EPA waste codes that are treated in tank systems at the Facility. All waste codes are listed in these tables due to the fact that EPA has determined that treatment residuals, wastewaters, dilute concentrations of hazardous waste constituents, and mixtures of hazardous constituents in non-hazardous waste maintain, by virtue of the derived-from rule and mixture rule, their listed code(s) regardless of the concentration of hazardous constituents in the waste. Therefore, specific waste code groupings for each of the tank management systems cannot be assembled.

Within the unit-specific information on tank systems provided in Subsection D-2-5 of this Application, the estimated design capacities for treatment in the tank systems are provided. These rates are based on wastes received for treatment and may be expressed in time units of minutes, hours, days, weeks, months, or years. However, due to the wide variety of physical characteristics of wastes managed, instantaneous treatment capacities will vary and may exceed the stated capacities. Thus, all units of treatment capacity provided within this Application are implied to be average, annualized totals equated to the specific time units expressed within any description in this section. Units of measure normally associated with liquids, such as gallons, may also be used to express the equivalent volume of solids. Likewise, units of measure normally associated with solids, such as cubic feet or cubic yards, may also be used to express the equivalent volume of liquids.

D-2-4b Description of Treatment Processes Performed in Tank Systems

Hazardous wastes are treated in tank systems in five units at the Facility (i.e., all tank management units except for Laboratory Tank Storage Unit 708 and Leachate Tank Storage Units 1700A, B & C (which are used solely for storage)). The treatment of hazardous waste in tank systems at the Facility includes the following processes:

TANK TREATMENT PROCESSES (T01)	SPECIFIC HANDLING CODES
A. Chemical Treatment Processes	
1. Chemical fixation	T21
2. Chemical oxidation	T22
3. Chemical precipitation	T23
4. Chemical reduction	T24
5. Chlorination	T25
6. Cyanide destruction	T27
7. Degradation	T28
8. Detoxification	T29
9. Neutralization	T31
10. Other	
a. Extraction (Washing)	T34
b. Immobilization (Microencapsulation)	T34
B. Physical Treatment Processes	
1. Separation of components	
a. Centrifugation	T35
b. Clarification	T36
c. Coagulation	T37
d. Decanting	T38
e. Microencapsulation	T39
f. Filtration	T40
g. Flocculation	T41
h. Sedimentation	T44
i. Thickening	T45
j. Other	
(i) Extraction (Abrasive Blasting)	T47
(ii) Extraction (Scarification)	T47
(iii) Extraction (Spalling)	T47

(iv)	Extraction (Vibratory Finishing)	T47
(v)	Extraction (Pressure Washing)	T47
(vi)	Size Reduction (Shredding)	T47
(vii)	Encapsulation (Sealing)	T47
(viii)	Screening	T47

2. Removal of Specific Components

a.	Activated carbon	T49
b.	Blending	T50
c.	Leaching	T59

C. Biological Treatment

1.	Activated sludge	T67
2.	Aerobic tank	T69
3.	Other (Anaerobic tank)	T77

Treatment in tank systems may be accomplished through a number of processes applicable to a particular waste depending on the physical and chemical characteristics of the specific waste stream. Under most normal conditions, a particular waste requires only one type of treatment, with portions of the waste treatment residuals directed for further treatment as appropriate. However, in some cases it may be necessary to utilize one or more of the treatment processes identified above in order to provide the necessary and appropriate treatment of a particular waste. The necessary processes for treatment of wastes in tank systems, such as compatibility evaluations and treatability evaluations, are described in Subsection D-2-3 and in the Waste Analysis Plan in Section C of this Application. Within any of the tank management units, certain basic treatment functions such as decanting, bulking, blending, mixing, phase and component separation, etc. may be performed. Descriptions of these basic treatment functions are provided in the following subsections. Unit-specific treatment processes are provided within the descriptions of each tank system management unit in Subsection D-2-5.

<u>D-2-4b(1) Phase Separation, Component Separation and Decanting in Tank Systems</u>

D-2-4b(1)(a) Description of Process

Phase separation, component separation, and decanting describe any process by which a waste mixture is separated into components, layers, or phases by physical means. Certain wastes may stratify into fairly distinct layers of separate components or phases. The withdrawal and separation of these layers and phases is designed to provide components which are more amenable to subsequent treatment or recovery than is the composite mixture. Multi-layered wastes are particularly amenable to phase separation. Within tank systems this process is primarily achieved through the identification of separate layers or phases via sight glass inspection and/or sampling and the subsequent removal of the layer or phase through isolation and pumping.

Separated or decanted liquids, sludges, or semi-solid fractions are most often pumped into another tank of similar, compatible material but can also be pumped into a container for transfer to another unit on-site or to off-site reclamation or treatment facilities. The phase and component separation processes may be conducted in all organic and inorganic tank treatment systems, including the neutralization/detoxification systems.

Although the phase and component separation processes are most often applicable to liquids, sludges or semi-solid wastes, the separation process may also be applied to wastes that are solid. For example, large solids or debris may be removed from a tank of predominantly smaller solids and placed in a separate tank or container. The separation of solids may also be performed using screens or other mechanical devices.

D-2-4b(1)(b) Types of Waste Amenable to Phase and Component Separation

Practically all types of liquid, semi-solid, and solid wastes and mixtures thereof are amenable to phase and component separation. The actual types of waste considered for separation will depend on the type of subsequent treatment, recovery or disposal required. For example, organic wastes may be separated for solvent recovery, with the unrecoverable residuals destined for off-site incineration. Inorganic wastes may be separated for subsequent stabilization, treatment as debris, direct disposal or transfer off-site for subsequent management.

D-2-4b(2) Blending, Mixing and Bulking in Tank Systems

D-2-4b(2)(a) Description of Process

Blending, mixing, and bulking describe any process in which wastes are combined by physical means. The combining of wastes is designed to provide a final mixture which is more amenable to subsequent treatment or recovery than are the individual wastes. The process involves blending or mixing two or more wastes, or a waste and reagents, at prescribed ratios to obtain a final mixture that exhibits the desired physical and/or chemical characteristics. The process is accomplished in tank systems by pumping, pouring, conveying or otherwise adding one or more waste streams and/or reagents into a tank while mixing is provided by an agitator, backhoe, shredder or other physical means. Bulking of waste in tank systems primarily refers to the combining of waste streams to achieve a sufficient quantity of waste to enable efficient treatment via subsequent processes. Bulking may be performed with or without the aid of mechanical mixing devices, and pretreatment reagents may or may not be employed.

Although most wastes to be blended, mixed, or bulked will be liquids, semi-solids, or sludges, waste solids may also be subject to this type of processing in units in which the appropriate equipment is available. Blending, mixing, and bulking may be performed in all organic and inorganic tank treatment systems, including the neutralization/detoxification systems.

D-2-4b(2)(b) Types of Waste Amenable to Blending, Mixing and Bulking

Practically all types of liquid, semi-solid and solid waste and mixtures thereof may be blended, mixed or bulked provided they conform to the requirements of the Waste Analysis Plan (Section C). The actual types of waste considered for blending, mixing or bulking depend on the type of subsequent treatment, recovery or disposal required. For example, organic wastes may be blended for off-site incineration. Inorganic wastes may be mixed or bulked to accommodate subsequent stabilization, treatment as debris, direct disposal or transfer for off-site management.

D-2-5 Unit-Specific Information

The following subsections provide a description of the unique design features and the management practices utilized in each of the units in which hazardous wastes are managed in tank systems. The general design features and management practices described in Sections D-2-2 and D-2-3, respectively, apply to each of these units, except as noted. Specific information regarding the design and function of each tank and tank system at the Facility is summarized in Appendix D-2-1 of this Application. The information provided in Appendix D-2-1 shall be referenced throughout Subsection D-2-5. Appendix D-2-1 of this Application includes the following information:

- Tank Identification No. and Unit No.;
- regulatory function of tank (i.e., storage/treatment/generator);
- type of waste managed in tank (i.e., ignitable, corrosive, reactive, toxicity characteristic, acute hazardous, toxic);
- tank service date;
- type of leak detection (i.e., visual, slotted base, double-wall, etc.);
- Design Code(s) (i.e., API-620, API-650, ASTM-D3299, ASME RTP-1, etc.);
- tank materials of construction/internal coatings (i.e., carbon steel, fiberglass reinforced plastic (FRP), etc.);
- tank configuration (i.e., vertical, horizontal, cone bottom, etc.);
- tank diameter or tank length;

- tank shell length or tank height;
- tank bottom cone or dish depth or tank width;
- total permitted capacity of each tank;
- total permitted capacity of all tanks in each unit; and
- maximum design specific gravity of waste to be managed within each tank.

In addition, information regarding the shell thicknesses of each tank at the Facility is summarized in Appendix D-2-3 of this Application. The tank information contained in Appendix D-2-3 shall be referenced throughout Subsection D-2-5. Appendix D-2-3 of this Application includes the following information for each tank or group of tanks at the Facility:

- the design minimum corrosion allowance of each shell course, the roof, cone and bottom as specified by the user;
- the minimum thickness of each shell course, the roof, cone and bottom, not including the design minimum corrosion allowance, as calculated to meet structural requirements per the design code;
- the minimum thickness of each shell course, the roof, cone and bottom, not including the design minimum corrosion allowance, as specified in the design code;
- the minimum thickness of each shell course, the roof, cone and bottom, including the design minimum corrosion allowance, as specified by the user; and
- the allowable service life corrosion relative to the design code structural requirements.

Other tank system design features are included on the Piping and Instrumentation Diagrams, Tank Layouts, Tank System Sections and Tank System Details in the Engineering Drawings for each unit, which are located in Appendix D-1 to Section D of this Application.

A design assessment and certification attesting to the structural integrity and suitability for managing hazardous waste in each of the tanks at the Facility is included within the attachments in Appendix D-2-4 of this Application. These assessments include a Tank Design Data Sheet for each tank and the supporting documentation and calculations to demonstrate the adequacy of the tank materials, structural components and foundations.

D-2-5a Container & Tank Management Unit 520

Unit 520 is located just south of Unit 603 at the Facility. Unit 520 consists of one (1) tank and one (1) associated bulk container storage and loading/unloading station. The primary function of Unit 520 is to enable the blending, mixing, and/or bulking of organic waste liquids for loading and subsequent transfer off-site for solvent recovery, energy recovery, incineration, or other appropriate treatment.

The following Engineering Drawings for Unit 520 are located in Appendix D-1 to Section D of this Application:

- Drawing No. 0520-010-001 Container & Tank Management Unit 520 - P&ID;
- Drawing No. 0520-020-001 Container & Tank Management Unit 520 - Plan View;
- Drawing No. 0520-030-001 Container & Tank Management Unit 520 - Sections; and
- Drawing No. 0520-040-001 Container & Tank Management Unit 520 - Details.

Unit 520 consists of the bulk container storage and loading/unloading station (Containment Area 1) and the tank management area (Containment Area 2). The design and management of the bulk container storage and loading/unloading station is described in Section D-1 of this Application.

D-2-5a(1) Types and Quantities of Wastes Managed in the Tank in Unit 520

The types of wastes managed in Tank T-520 within Unit 520 will primarily be ignitable wastes. However, due to the derived-from and mixture rules, virtually all types of hazardous wastes listed and identified in 40 CFR Part 261 and ADEM Administrative Code Chapter 335-14-2, except for corrosive and reactive wastes, may be managed in the T-520 tank system as shown in Appendix D-2-1 of this Application. In addition, non-hazardous wastes and treatment residues from listed wastes may also be managed in Tank T-520.

The total capacity for storage in tanks (S02) in Unit 520 is indicated in Appendix D-2-1 of this Application. The design capacity for treatment in tanks (T01) in Unit 520 is 50,000 gallons per day of blending, mixing, bulking, etc., excluding transfers between tanks and containers.

D-2-5a(2) Design of Unit 520

The design of Tank T-520 within Unit 520 is in accordance with the general design features for aboveground tanks in which ignitable wastes are managed as described in Subsection D-2-2. The design of Tank T-520 also facilitates and enables adherence to the general management practices and procedures for aboveground tanks in which ignitable wastes are managed as described in Subsection D-2-3. Specific design features for Tank T-520 are provided in Appendices D-2-1 and D-2-3. The design assessment and certification for Tank T-520 is provided in Appendix D-2-4. The installation assessment and certification for Tank T-520 is maintained within the Facility Operating Record.

Tank T-520 is located within Containment Area 2 of Unit 520. As shown in Drawing Nos. 0520-020-001, 0520-030-001, and 0520-040-001, the design of the secondary containment system for Containment Area 2 of Unit 520 is in accordance with the general design features described in Subsection D-2-2. The secondary containment system for Containment Area 2 is equipped with a roof to minimize the volume of rainfall that will collect within the unit; however, the containment area does not have sidewalls and there is an open portion of the roof surrounding the outer perimeter of Tank T-520. Therefore, rainfall accumulation is accounted for through the roof opening and via blow-in from the sides of the structure in the secondary containment calculations. The calculations of secondary containment capacity for Containment Area 2 of Unit 520 are provided in Appendix D-2-2 of this Application.

<u>D-2-5a(3) Management of Unit 520</u>

The management practices and procedures utilized in Unit 520 are in accordance with the general management practices and procedures for aboveground tanks in which ignitable wastes are managed as described in Subsection D-2-3.

<u>D-2-5a(4) Treatment of Wastes in Unit 520</u>

The treatment of wastes in Unit 520 consists primarily of the blending, mixing, and bulking of ignitable and other organic liquids accumulated and transferred from other units on-site. As shown in the Drawing No. 0520-010-001, the design of Tank T-520 and associated ancillary equipment facilitates the safe and efficient storage and treatment of waste in Unit 520. Treatment of wastes in Tank T-520 via blending, mixing or bulking is facilitated by the agitator and side sample manifold provided. In addition, the arrangement of the pump and piping system enables the receipt of waste from the Unit 604 decant station, the recirculation of waste through T-520, and the transfer of wastes between T-520 and tankers located within the Bulk Container Storage and Loading/Unloading Station. Upon verification confirming that the desired treatment has been obtained, wastes are transferred to a tanker truck for shipment off-site.

D-2-5b Container & Tank Management Unit 600

Unit 600 is located adjacent to and within the same building as Unit 604 at the Facility. The tank system in this unit is located in Containment Area 3 of Unit 600 and consists of three storage tanks (T-634, T-635, and T-636) and ancillary equipment and an associated tanker loading/unloading station located inside the building. The primary function of the tank system in

Unit 600 is to provide adequate capacity to accumulate and store solvents used as PCB transformer flush agents, to receive liquids decanted from containers in Unit 604, and to provide a system for the transfer of these liquids to tanker trucks for shipment solvent recovery, energy recovery, incineration, or other appropriate treatment.

The following Engineering Drawings for Unit 600 are located in Appendix D-1 to Section D of this Application:

- Drawing No. 0600-010-001 Tank Management Unit 600 - P&ID;
- Drawing No. 0600-020-001 Tank Management Unit 600 - Plan View;
- Drawing No. 0600-030-001 Tank Management Unit 600 - Sections;
- Drawing No. 0600-030-002 Tank Management Unit 600 - Sections; and
- Drawing No. 0600-040-001 Tank Management Unit 600 - Details.

D-2-5b(1) Types and Quantities of Wastes Managed in Unit 600

Tanks T-634, T-635, and T-636 are primarily used to store combustible rinsates and flush materials in Unit 600. However, due to the derived-from and mixture rules, virtually all types of hazardous wastes listed and identified in 40 CFR Part 261 and ADEM Administrative Code Chapter 335-14-2, except for corrosive and reactive wastes, and including TSCA-regulated PCB wastes may be managed in Tanks T-634, T-635, and T-636 as shown in Appendix D-2-1 of this Application.

The total capacity for storage in tanks (S02) in Unit 600 is indicated in Appendix D-2-1 of this Application. The quantity of wastes processed in this tank storage unit varies depending on the quantity of containerized wastes received, the proportion of decantable free liquids contained in these wastes, and the quantity of PCB transformers processed within a given period of time. The design capacity for treatment in tanks (T01) in Unit 600 is 60,000 gallons per day of blending, mixing, bulking, phase separation, etc., excluding transfers between tanks and containers and transfers between tanks.

D-2-5b(2) Design of Unit 600

The design of the tank system in Unit 600 is in accordance with the general design features for aboveground tanks in which ignitable wastes are managed as described in Subsection D-2-2, with the exceptions noted below. The design of the tanks in Unit 600 also facilitates and enables adherence to the general management practices and procedures for aboveground tanks in which ignitable wastes are managed as described in Subsection D-2-3. Specific design features for Tanks T-634, T-635 and T-636 are provided in Appendices D-2-1 and D-2-3. The design assessment and certification for Tanks T-634, T-635, and T-636 is provided in Appendix D-2-4 of this Application.

Tanks T-634, T-635, and T-636 are located within Containment Area 3 of Unit 600. As shown in Drawing Nos. 0600-020-001, 0600-030-001, 0600-030-002 and 0600-040-001, the design of the secondary containment system for Containment Area 3 of Unit 600 is in accordance with the general design features described in Subsection D-2-2. Containment Area 3 is located within a building to facilitate the processing of PCB transformers. Although the piping between Unit 604 and the tanks in Unit 600 is located within a secondary containment system, double-walled piping is used to minimize the potential for mixing of incompatibles should the primary carrier pipe leak or fail. Since Containment Area 3 is enclosed within a building, rainfall allowance is neglected in the secondary containment calculations. The calculations of secondary containment capacity for Containment Area 3 of Unit 600 are provided in Appendix D-2-2 of this Application.

D-2-5b(3) Management of Unit 600

The management practices and procedures utilized in Unit 600 are in accordance with the general management practices and procedures for aboveground tanks in which ignitable wastes are managed as described in Subsection D-2-3. In addition, the management practices and procedures required to comply with the standards for storage of TSCA waste are utilized.

D-2-5b(4) Treatment of Wastes in Unit 600

The treatment of wastes in Unit 600 consists primarily of the blending, mixing and bulking of ignitable and other organic liquids generated from the decanting of containers in Unit 604 or from the flushing of PCB transformers in Unit 600. As shown in Drawing No. 0600-010-001, the T-634, T-635, and T-636 tank system and associated ancillary equipment facilitate the safe and efficient storage and treatment of waste in Unit 600. The arrangement of the pumps and piping system within Unit 600 enables the decanting of waste into any of the three tanks and the transfer of wastes between any of the tanks and tankers located within Unit 600.

D-2-5c Organic Container & Tank Management Unit 703

Unit 703 is located adjacent to the northeast corner of Unit 700. All tanks and ancillary equipment have been removed, only the secondary containment area remains. This unit is inactive.

D-2-5d Laboratory Tank Storage Unit 708

Unit 708 tank systems are located just east of Unit 707/708 as shown on Drawing No. 0100-020-001 in Appendix D-1 to Section D of this Application. The Unit 708 tank system consists of one storage tank (T-725), one accumulation tank (T-726, which is a 90-day generator tank that does not require a permit), and the ancillary equipment for waste collection, transfer, and removal, and for leak detection. The primary function of Tank T-725 is to collect and store miscellaneous diluted organic and acidic washwater wastes generated during the operation of the laboratory. After storage in Tank T-725, these wastes are transferred to Tank T-726 or directly into tanker trucks for transfer to other units on-site. Tank T-726 is used to receive and accumulate wastes from Tank T-725, and is operated as a 90-day generator accumulation tank in accordance with the applicable requirements of 40 CFR 262.34(a)(1)(ii) and ADEM Administrative Code Rule 335-14-3-.03(5)(a)1.(ii). Wastes are transferred from Tank T-726 into tanker trucks for transfer to other units on-site.

The following Engineering Drawings for Unit 708 are located in Appendix D-1 to Section D of this Application:

- Drawing No. 0708-010-001 Laboratory Tank Storage Unit 708 - P&ID; and
- Drawing No. 0708-020-001 Laboratory Tank Storage Unit 708 - Piping Layout & Tank Details.

D-2-5d(1) Types and Quantities Of Wastes Managed in Unit 708

Due to the nature of the operations conducted in the laboratory, virtually all types of hazardous wastes listed and identified in 40 CFR Part 261 and ADEM Administrative Code Chapter 335-14-2, except for ignitable wastes, may be managed in the Unit 708 tank systems as indicated in Appendix D-2-1 of this Application.

The total capacity for storage in tanks (S02) in Unit 708 is indicated in Appendix D-2-1 of this Application. Treatment of waste does not occur within Tank T-725, excluding transfers between tanks and containers and transfers between tanks.

D-2-5d(2) Design of Unit 708

The design of Tank T-725 is in accordance with the general design features for underground, double-walled tanks in which reactive wastes are stored as described in Subsection D-2-2. The design of Tank T-725 also facilitates and enables adherence to the general management practices and procedures for underground, double-walled tanks in which reactive wastes are managed as described in Subsection D-2-3. Specific design features for Tank T-725 are provided in Appendices D-2-1 and D-2-3. The design assessment and certification for Tank T-725 is provided in Appendix D-2-4 of this Application. The installation assessment and certification for Tank T-725 is maintained within the Facility Operating Record. The design and installation assessment and certification for 90-day generator accumulation Tank T-726 is maintained within the Facility Operating Record.

Drawing No. 0708-020-001 depicts the gravity piping system leading from the laboratory to Tank T-725. This piping system is a double-walled, high density polyethylene piping system. Wastes from Tank T-725 are periodically transferred by pump to the generator Tank T-726 for accumulation of sufficient quantities to facilitate efficient treatment at other units at the Facility. The transfer piping system and controls for Tanks T-725 and T-726 are depicted on Drawing No. 0708-010-001.

Leak detection for Tank T-725 is accomplished by a pressure sensor which continuously monitors the interstitial space between the tank wall and the outer tank shell. If a loss of integrity of the primary tank shell occurs, the vacuum in the interstitial space will be lost, and an audible and visual alarm will be activated. Within the secondary containment system for the underground piping, there is a liquid sensor to detect a failure of the primary carrier piping and collection of liquid within the outer secondary containment pipe. This piping liquid sensor also provides an audible and visual alarm indicating a potential leak within the piping system.

The secondary containment for Tank T-725 is provided by the outer shell of the tank in accordance with the general design features for integral, double-walled tanks as described in Subsection D-2-2d of this section. The verification of adequate secondary containment capacity for Tank T-726 is provided in the design and installation assessment and certification for Tank T-726, which is maintained within the Facility Operating Record.

D-2-5d(3) Management of Unit 708

The management practices and procedures utilized for Tank T-725 in Unit 708 are in accordance with the general management practices and procedures for underground tanks in which reactive wastes are managed as described in Subsection D-2-3.

D-2-5e Wheel Wash and Tank Storage Unit 900

Unit 900 is located east of Unit 707/708 and south of Unit 1300, as shown on Drawing No. 0100-020-001 in Appendix D-1 to Section D of this Application. The management of hazardous waste in tanks in Unit 900 is performed in two (2) aboveground tanks (T-901 and T-902) and two (2) in-ground tanks (T-903 and T-904). Tanks T-901 and T-902 are used to store the recovered wash-waters collected in Tanks T-903 and T-904 located in the automatic wheel wash and manual equipment wash bays, respectively.

The following Engineering Drawings for Unit 900 are located in Appendix D-1 to Section D of this Application:

- Drawing No. 0900-010-001 Wheel Wash & Tank Storage Unit 900 - P&ID;
- Drawing No. 0900-020-001 Wheel Wash & Tank Storage Unit 900 - Plan View; and
- Drawing No. 0900-030-001 Wheel Wash & Tank Storage Unit 900 - Sections & Details.

D-2-5e(1) Types and Quantities of Wastes Managed in Unit 900

The types of wastes managed in Unit 900 will primarily be aqueous in nature and are non-hazardous. However, for permitting purposes, CWM assumes that virtually all types of hazardous wastes listed and identified in 40 CFR Part 261 and ADEM Administrative Code Chapter 335-14-2, except for ignitable, corrosive, and reactive wastes, may be managed in the Unit 900 as indicated in Appendix D-2-1 of this Application.

The total capacity for storage in tanks (S02) in Unit 900 is indicated in Appendix D-2-1 of this Application. The quantity of wastes processed in this tank storage unit varies depending on the quantity of truck wheels washed. The design capacity for treatment in tanks (T01) in Unit 900 is 15,000 gallons per day of phase separation, mixing, etc., excluding transfers between tanks and containers and transfers between tanks.

D-2-5e(2) Design of Unit 900

The design of the tank systems in Unit 900 is in accordance with the general design features for in-ground and aboveground tanks as described in Subsection D-2-2. The design of tank systems in Unit 900 also facilitates and enables adherence to the general management practices and procedures for in-ground and aboveground tanks as described in Subsection D-2-3. Specific design features for Tanks T-901 through T-904 are provided in Appendices D-2-1 and D-2-3. The design assessment and certification for Tanks T-901 through T-904 is provided in Appendix D-2-4 of this Application. The installation assessment and certification for Tanks T-901 through T-904 is maintained within the Facility Operating Record.

Tanks T-901 and T-902 are located within Containment Area 1, Tank T-903 is located within Containment Area 2, and Tank T-904 is located within Containment Area 3 of Unit 900. As shown in Drawing Nos. 0900-020-001 and 0900-030-001, the design of the secondary containment system for Tanks T-901 and T-902 (Containment Area 1) is in accordance with the general design features for aboveground tanks as described in Subsection D-2-2. The secondary containments for Tanks T-903 and T-904 are provided by the outer shells of the tanks in accordance with the general design features for integral, double-walled tanks as described in Subsection D-2-2d of this section. Tank leak detection for Tanks T-903 and T-904 is accomplished by a pressure sensor which continuously monitors the interstitial space between the tank walls. If a loss of integrity of the primary tank shell occurs, the vacuum in the interstitial space will be lost and an audible and visual alarm will be activated.

Since Containment Areas 1, 2, and 3 are enclosed within a building, rainfall allowance is neglected in the secondary containment calculations. The calculations of secondary containment capacity for Containment Areas 1, 2, and 3 of Unit 900 are provided in Appendix D-2-2 of this Application.

D-2-5e(3) Management of Unit 900

The management practices and procedures utilized in Unit 900 are in accordance with the general management practices and procedures for in-ground and aboveground tanks as described in Subsection D-2-3.

D-2-5e(4) Treatment of Wastes in Unit 900

Drawing No. 0900-010-001 in Appendix D-1 to Section D provides the P&ID for Unit 900. The tank system is operated by collecting, reclaiming, and recycling the wash-water. Collected wash-water is pumped from Tank T-903 through a solids separation system to Tank T-901. The water is then pumped through another solids separation system to Tank T-902. Water from the primary storage tank (T-902) is then pumped back into the washing system for reuse. Water from the secondary storage tank (T-901) is piped through the reclamation unit, then into the primary storage tank (T-902) for reuse. Both tanks have auxiliary ports from which water and accumulated solids can be removed and pumped, via the site pipe chase system, to Unit 1400. Liquids from Tank T-904 are directed to the pipe chase system for transfer to Unit 1400. Solids collected in the tanks, sumps, and in roll-off boxes in this unit will be removed at least every 90 days and taken to the stabilization unit for processing. Most wash-waters are recycled back through the washing system. Periodically the wash-water is transferred to a tank in Unit 1400 via the pipe chase system or a tanker truck.

D-2-5f Containment Building/Container & Tank Management Unit 1200A

Unit 1200A is located to the south of existing Unit 1400 and to the east of Unit 2000, as shown in Drawing No. 0100-020-001, in Appendix D-1 to Section D of this Application. Unit 1200A consists of the Containment Building/Container Management & Tank Management Area (Area 1 on Drawing No. 1200A-020-001).

The construction of Unit 1200A was planned to occur in three (3) phases. The first phase includes the Containment Building / Container Management & Tank Management Area, including the stabilization reagent storage silos. The first phase of Unit 1200A is existing. The second and third phases were proposed under the original facility permit, but are no longer proposed and are not included in this Permit Application.

This subsection provides unit-specific information relative to the design features of Unit 1200A, management practices and procedures utilized in the Tank Management Area of Unit 1200A, and the storage and treatment of wastes in Tanks T-1201A and T-1202A and the role and function of equipment and processes which support the management of waste in these tanks. Information regarding the management practices and procedures and treatment processes relative to management of wastes in containers and in containment buildings is included in Section D-1 and in Section D-9, respectively, of this Application.

The following Engineering Drawings for Unit 1200A are located in Appendix D-1 to Section D of this Application:

- Drawing No. 1200A-010-000 Building 1200A, Piping/Instrumentation Symbology;
- Drawing No. 1200A-010-002A Building 1200A, P&ID;
- Drawing No. 1200A-010-003 Building 1200A, P&ID;
- Drawing No. 1200A-010-004 Building 1200A, P&ID;
- Drawing No. 1200A-010-005 Building 1200A, P&ID;
- Drawing No. 1200A-010-006 Building 1200A, P&ID;
- Drawing No. 1200A-020-001 Building 1200A, General Arrangement;
- Drawing No. 1200A-020-002 Building 1200A, General Arrangement;
- Drawing No. 1200A-030-002 Building 1200A, Elevations;
- Drawing No. 1200A-030-003A Building 1200A, Sections;
- Drawing No. 1200A-030-004A Building 1200A, - Liner System Subgrade Plan;
- Drawing No. 1200A-030-005 Building 1200A, - Containment Details & Sections;
- Drawing No. 1200A-040-001 Building 1200A, Ground Floor and Foundation - Sections and Details;
- Drawing No. 1200A-040-002 Unit 1200A, Batch Stabilization Mixing Tanks - T-1201A & T-1202A; and

D-2-5f(1) Types and Quantities of Wastes Managed in Tanks in Unit 1200A

As shown in Appendix D-2-1 of this Application, virtually every type of hazardous waste listed and identified in 40 CFR Part 261 and ADEM Administrative Code Chapter 335-14-2 is managed in tank systems in Unit 1200A, except for ignitable wastes. In addition, TSCA-regulated PCB wastes, non-hazardous wastes, and treatment residues from listed wastes are also managed in tank systems in Unit 1200A. Hazardous wastes managed in this unit will not contain volatile organic compounds in excess of 500 ppmw, with the exception of Subpart CC regulated waste pursuant to 40 CFR Part 264.1082c(4). This exemption is noted in Appendix D-10-1 (note Tank T-1202A is identified as T-1200B in Appendix D-10-1) of this Application.

The total capacity for storage in tanks (S02) in Unit 1200A is indicated in Appendix D-2-1 of this Application. The quantity of wastes treated in tanks in this unit varies depending on the quantity of waste received at the Facility which is, or can be rendered to be, amenable to treatment via one or more of the processes conducted in Tanks T-1201A and T-1202A. The design capacity for treatment of debris and non-debris in Tanks T-1201A and T-1202A (T01) in Unit 1200A is 575,540 gallons per day.

D-2-5f(2) Design of Tank Systems in Unit 1200A

The design of the tank systems in Unit 1200A is in accordance with the general design features for in-ground tanks as described in Subsection D-2-2. The design of tank systems in Unit 1200A also facilitates and enables adherence to the general management practices and procedures for in-ground tanks as described in Subsection D-2-3. Specific tank design features for Tanks T-1201A and T-1202A are provided in Appendices D-2-1 and D-2-3. The design assessment and certification for Tanks T-1201A and T-1202A is provided in Appendix D-2-4 of this Application. The installation assessment and certification for Tanks T-1201A and T-1202A is maintained within the Facility Operating Record.

Secondary containment for Tanks T-1201A and T-1202A is provided by the outer shells of the tanks in accordance with the general design features for integral, double-walled tanks as described in Subsection D-2-2d of this Application. Tank leak detection for Tanks T-1201A and T-1202A is accomplished by liquid sensors which continuously monitor the interstitial space between the tank walls. If a loss of integrity of the primary tank shell occurs, the sensor will come in contact with liquids, and an audible and visual alarm will be activated to signal a potential leak in the primary tank. To minimize the accumulation of condensation in these interstitial spaces and to avoid false leak detections, each tank shall be equipped with a dry, compressed air supply and vent pipes located near the top and edge of each tank. This system will provide a sweep of dry air through the interstitial space to evaporate any small amounts of condensation that may occur, when necessary.

The Tank Management Area of Unit 1200A is designed to facilitate the processing and treatment of wastes with a diversity of physical and chemical characteristics. Several unique features have been incorporated into the design of this area so that sufficient flexibility and functionality is provided to enable the processing of waste in containers, tanks and on the floor of the unit (i.e., containment building) within one area. This flexible and multi-functional design will minimize the on-site transfer of wastes from unit to unit and will enable the safe, effective, and efficient management of a wide variety of waste types.

The Tank Management Area of Unit 1200A consists of the following general functional components, systems or areas:

- an enclosed and contained area for the unloading and cleaning of waste delivery vehicles or Facility vehicles, for the storage and processing of waste in containers, and for the management of waste in an area that complies with the requirements of a containment building;
- two in-ground batch stabilization/mixing tanks (T-1201A and T-1202A);
- an area for excavator(s) to mix wastes with the reagent in these tanks;
- reagent storage silos and feed systems;
- two (2) fugitive dust collection and management systems;
- areas for container unloading/loading, container storage and treatment in containers, storage and treatment of wastes on the floor of the unit, and for the operation of the excavators; and
- in addition to the tank management systems, this portion of Unit 1200A is equipped with an (8) eight-foot-high containment wall, a dual barrier containment system, and other features to comply with the requirements of 40 CFR 264 Subpart DD and ADEM Administrative Code Rule 335-14-5-.30 for Containment Buildings.

The Tank Management Area of Unit 1200A is fully enclosed in a steel frame metal building with an eave height of approximately 45 feet and a reinforced concrete floor system with a perimeter curb. The building eave height enables the waste delivery vehicles to off-load bulk containers, and to back up, tip, and unload waste loads directly over the edge of the mixing Tanks T-1201A and T-1202A, while being within the confines of the building structure. The entire building, in this area, is underlain by a dual liner system which complies with the requirements for Containment Buildings as described in Section D-9 of this Application.

The base wearing surface of the Tank Management Area of Unit 1200A is constructed of a sloping, reinforced concrete slab equipped with a perimeter containment curb and wall. The height of the curb/wall is a minimum of eight (8) inches at all doorways and eight (8) feet at all other locations. The wearing surface of the building slopes in the direction of Tanks T-1201A and T-1202A at a minimum rate of approximately 1/8" per foot. The perimeter curb/wall provides secondary containment, and the sloping floor of the building aids in the collection of solids, wash-waters generated during periodic cleaning, potential leaks from containers, etc. In addition, each of the interior of the metal wall panels in the Tank Management Area of Unit 1200A are fitted with a metal turn-out that intercepts and connects the wall panels with the perimeter curb/wall. The turn-out allows the wash-down of the interior wall surfaces and contains the wash-water within the area containment system.

To control particulate emissions from treatment conducted in the Tank Management Area of Unit 1200A, the bulk waste will be unloaded while the transport vehicle is entirely within the building with all exterior doors and other openings closed except as necessary to accommodate vehicular and personnel traffic. In addition, a particulate collection and control system consisting of an air intake plenum at each tank, ventilation duct work, dust collectors and exhaust fans will be utilized. This system will minimize particulate emissions from the operation.

D-2-5f(3) Management of Wastes in Tanks in Unit 1200A

The management practices and procedures utilized in Unit 1200A are in accordance with the general management practices and procedures for in-ground tanks as described in Subsection D-2-3. Additional practices and procedures are utilized to manage wastes within the Tank Management Area of Unit 1200A due to the multi-functional design of the area that enables the processing and treatment of wastes with a diversity of physical and chemical characteristics in containers, tanks and containment buildings.

Additional management practices employed within this area to enable flexible and multi-functional operations and management of a wide variety of waste types in a safe, effective and efficient manner are as follows:

- stabilization reagents that have buffering capacities to protect the carbon steel tanks from experiencing an excessive rate of corrosion are used in the stabilization process;
- the wear surface and containment walls are maintained to be free from significant cracks, gaps or other deterioration that could allow hazardous waste to be released from the primary barrier or containment walls into the secondary containment system or to the outside of the unit;
- within the containment building, waste may be stored or processed directly on the floor or within containers or tanks. While in storage, groups of containers are be positioned within the confines of secondary containment so that adequate space is allowed for inspection and for response to spills or emergencies, as described in Section D-1 of this Application;

- the dust collector(s) described in Section D-9 are operated, and all building openings (e.g., doors, windows, etc.) are managed to maintain a state of no visible emissions from any openings in the unit in accordance with 40 CFR 264.1101(c)(1)(iv) and ADEM Administrative Code Rule 335-14-5-.30 (2)(c)1.(iv). If necessary to maintain this state of no visible emissions from the containment building area of Unit 1200A, waste treatment and other activities are suspended during the periods required for personnel, vehicles or heavy equipment to enter or exit the building;
- in order to prevent the tracking of any significant quantities of hazardous waste out of the containment building when managing waste in mass on the floor, the tires of delivery vehicles, heavy equipment, portable treatment equipment such as mixers, compactors, washers, etc., or other items that come in contact with waste are observed and/or cleansed prior to removal from the containment area as described in Section D-9 of this Application. Any rinsate generated from this decontamination process is collected within the process container or the floor sumps in the unit, removed by portable pumps or other means, containerized, and properly managed (i.e., managed as a Facility generated waste, characterized based on knowledge of the waste that it contacted or characterized by other procedures as described in the Waste Analysis Plan);
- the unloading of wastes into the mix tanks, the addition of dry and liquid reagents, the mixing of wastes and the loading of roll-offs or trucks are supervised and/or controlled by the excavator operator. The operator has the ability to stop any of these transfers if spillage or over-filling is imminent;
- the batch stabilization mix tanks are operated to maintain two (2) feet of freeboard to minimize the potential for spillage from these units;
- the leak detection system for each mix tank is inspected daily. If any liquids that are not condensate (as determined by the lack of an immediate reoccurrence after evacuation and removal of accumulated liquids) are discovered in the leak detection system, the tank involved is removed from service, and cleaned, inspected, and repaired as necessary, and pressure tested prior to reuse;
- the collected particulate accumulation container is inspected daily to prevent over-filling and is emptied at least once every 90 days;
- wastes that contain volatile organic compounds in concentrations in excess of 10% by volume are not managed in tank systems in this unit; and
- in accordance with the procedures provided in the Facility's Waste Analysis Plan, incompatible wastes or reagents are not managed within the area in a manner to cause accelerated corrosion or deterioration of the containment components or undetectable failure of the primary barrier or secondary containment system.

D-2-5f(4) Batch Stabilization of Wastes in Tanks in Unit 1200A

The following P&ID's depict the general flow of wastes through Unit 1200A, and the equipment and engineering controls utilized in the treatment of wastes in tank systems in Unit 1200A. These drawings are located in Appendix D-1 to Section D of this Application:

- Drawing No. 1200A-010-002A Building 1200A, P&ID;
- Drawing No. 1200A-010-003 Building 1200A, P&ID;
- Drawing No. 1200A-010-004 Building 1200A, P&ID;
- Drawing No. 1200A-010-005 Building 1200A, P&ID; and
- Drawing No. 1200A-010-006 Building 1200A, P&ID.

As shown on these drawings, wastes can be introduced into Tanks T-1201A and T-1202A from the shredder or directly from bulk containers such as dump trailers or roll-off boxes. Each stabilization tank (i.e., T-1201A and T-1202A) is capable of accommodating batches of at least two (2) to three (3) loads (20 to 30 cubic yards of waste per typical load) of waste and reagents, depending upon the physical and chemical characteristics of the waste, the recipe for stabilization and/or the type of other treatment required. Dry pre-treatment reagents may be added as required by manual means or via mechanical bag unloaders. Dry reagents are added to the tanks from the storage silos via a system of screw conveyors. Process water will be supplied directly from a potable water line, will be pumped from the potable water storage tank located outside of the building into Tanks T-1201A and T-1202A, or will be supplied by non-contaminated surface water or leachate treated to F039 standards. Each of these stabilization components will be added in the quantities in accordance with the specified stabilization recipe. The mixture of waste and reagents is then thoroughly combined and blended by the excavator located adjacent to the tanks. Stabilized and treated wastes are subsequently out-loaded by the excavator into roll-off boxes or dump beds which are staged in the back-in truck loading aisle. Waste out-loaded will be transported to Unit 2200 or other bulk container storage units for storage while sampling and testing to verify the adequacy of treatment are performed or transported to landfill units for disposal.

D-2-5f(5) Treatment of Debris in Tanks in Unit 1200A

One or more of the chemical or physical treatment techniques described in this subsection may be performed in Tanks T-1201A or T-1202A to render a waste amenable to direct landfill disposal, subsequent treatment via stabilization, or subsequent management in containers or tanks.

Physical treatment technologies which may be employed to render contaminated debris available for landfill disposal include extraction techniques such as abrasive blasting scarification, spalling, vibratory finishing, high pressure washing, or immobilization techniques such as sealing. Other physical treatment techniques which may be employed to render wastes available for landfill disposal or more amenable to subsequent stabilization or management in containers or tanks include waste size reduction, waste blending and bulking, and leaching.

Chemical treatment technologies which may be employed to render contaminated debris available for landfill disposal include chemical extraction via washing with water or chemical reagents that enhance the removal of hazardous contaminants from the surface of debris and immobilization techniques such as microencapsulation.

Debris treatment residuals such as blast grit or rinse waters generated from the aforementioned treatment technologies and treated wastes which do not meet the land disposal restrictions will be collected, stored, and managed in accordance with 40 CFR 268.45 and ADEM Administrative Code Rule 335-14-9-.04(6). The process or storage areas of a unit may also be used to store wastes during curing, treatment verification, and as needed to schedule subsequent treatment or disposal.

Any of the aforementioned treatment techniques may be employed using specialized equipment to render contaminated debris suitable for landfill disposal or to provide treatment or pre-treatment of debris treatment residuals or wastes separated from the contaminated debris prior to landfill disposal.

D-2-5f(5)(a) Physical Treatment of Debris in Tanks In Unit 1200A

The primary physical treatments that will be performed include various physical extraction techniques that are designed to remove the surface contamination and/or surface layers from hazardous debris. The physical extraction techniques which may be performed in this area are as follows:

- abrasive blasting with water or air-propelled solid media such as sand, steel shot or glass beads;
- scarification with surface striking heads or grinding wheels;
- spalling by drilling or chipping holes into the surface of the debris;
- vibratory finishing utilizing scrubbing media or oscillatory mechanical devices;
- spraying with high pressure steam or water
- removal of debris components; or

- any other ADEM-approved technique.

The physical treatment techniques listed above may be performed utilizing portable equipment which may be temporarily stationed in the waste management unit. Solid treatment residuals will be collected within Tanks T-1201A or T-1202A. Liquid treatment residuals will be collected within Tanks T-1201A or T-1202A and may be removed with portable pumps. Within this area, the utilization of the ventilation system, dust collector and management practices, as previously described, will minimize the escape of airborne fugitive emissions from the unit during the use of these techniques. The removal of the debris components may be performed within Tanks T-1201A or T-1202A, which allows the separated debris to be further processed as debris and the non-debris component to be treated as necessary to meet the required restrictions.

Other physical treatments that may be performed in Tanks T-1201A or T-1202A to render contaminated debris available for landfill disposal include immobilization techniques such as sealing. These techniques involve the application of tightly adhering surface coating materials to substantially reduce the exposure of contaminated debris surfaces to media which may leach contaminants after disposal. The application of such coatings will require the use of specialized portable mixing and/or application equipment, which may be temporarily stationed in an area of each unit. Specific requirements for the control of applied coatings and of airborne fugitive emissions will be addressed on a case-by-case basis to comply with the requirements of 40 CFR 264.1101 and ADEM Administrative Code Rule 335-14-5-.30 and the Facility's air permit. These immobilization techniques will achieve complete encapsulation of the debris. All encapsulation materials used will be resistant to degradation by the debris, its contaminants and the materials with which it may come into contact after disposal (e.g., leachate). The determination as to the suitability of encapsulation materials will be based on the following factors:

- materials of construction of the land disposal unit (e.g., HDPE, etc.);
- industry standards and standards developed at other disposal facilities; or
- other materials as verified by testing (i.e., EPA Publication SW-846 third edition, Method 9090, etc.).

These standards will ensure that the likelihood of migration of contaminants is substantially reduced.

Some physical containment techniques may be employed in Tanks T-1201A or T-1202A to provide a waste that is subsequently more amenable to stabilization or other treatment. Waste size reduction, bulking and blending may be performed to achieve these goals. Contaminated debris will not be reduced to a particle size of less than 60 mm prior to treatment, unless waste-specific treatment techniques are to be subsequently employed. Debris which has been decontaminated by cleaning and separation of the debris from the waste via a physical or chemical extraction technique may be reduced in size to accommodate subsequent disposal. Contaminated debris will not be sized subsequent to treatment unless it is to be retreated. Other wastes may be reduced in size prior to treatment. Such wastes which are compatible and require the same treatment prior to disposal may be blended into bulk loads in Tanks T-1201A or T-1202A.

D-2-5f(5)(b) Chemical Treatment of Debris in Tanks in Unit 1200A

The chemical extraction of specific or non-specific contaminants from the surface of debris may be achieved by washing the debris surface with aqueous solutions of contaminant soluble chemicals. This process is similar to and may be performed in Tanks T-1201A or T-1202A with the same equipment as is used to physically extract surface contamination of debris by high pressure washing. However, the use of chemicals, surfactants, water baths and/or elevated temperatures or pressures will allow the removal of contaminants from the solids in a manner similar to leaching. Chemical extraction of contaminants via washing will be performed in Tanks T-1201A or T-1202A using specialized portable washing equipment which may be stationed in the processing areas during use. Reagents to be used in the chemical washing process will be selected and managed in a manner to prevent accelerated corrosion or deterioration of Tanks T-1201A or T-1202A. Wash solutions collected from Tanks T-1201A or T-1202A during such a process may be recirculated to the application unit during the treatment of compatible waste batches requiring the same washing procedures. All spent wash solutions will be managed in accordance with 40 CFR 268.45 and ADEM Administrative Code Rule 335-14-9-.04(6).

Another chemical treatment technique which may be performed in Tanks T-1201A or T-1202A is immobilization of contaminants through microencapsulation. Microencapsulation may be utilized to immobilize or reduce the leachability of contaminants on debris surfaces or in other types of wastes. Microencapsulation or stabilization of debris or other wastes will be achieved by bringing the contaminant into intimate contact with one of a number of materials. Other reagents may also be added to the mixture to enhance the curing and/or compressive strength of treated wastes. In addition, other types of immobilization agents may be used, provided a determination as to the suitability of these agents is performed based on industry standards and standards developed at other disposal facilities or verification by testing that the leachability of contaminants are immobilized or reduced. The microencapsulation to be performed in Tanks T-1201A or T-1202A may be the final treatment of contaminated debris prior to disposal or may be pre-treatment of wastes prior to final stabilization.

D-2-5f(5)(c) Combinations of Debris Treatment in Tanks in Unit 1200A

In some instances, the proper treatment of contaminated debris or other waste in Tanks T-1201A or T-1202A may only be achieved by utilizing combinations of the various physical and chemical treatment technologies discussed above. This section will provide a discussion of some of the potential treatment combinations which may be used; however, since there are a large number of potential combinations and since information on each individual treatment technique has been previously provided, a discussion of all treatment combinations is not warranted or required.

One of the most common combination treatments will involve the removal of surface contamination via a chemical or physical extraction technique followed by sealing or even immobilization via microencapsulation. A specific example of this combination is the removal of surface contaminants from debris to prepare the surface for application of sealants to still-contaminated debris, as certain surface contaminants may interfere with some immobilization techniques.

Another example of combination treatments involves the use of microencapsulated wastes as an agent in a mixture used for macroencapsulation of contaminated debris. Microencapsulated wastes are applied to contaminated debris to form a jacket of inert materials which substantially reduces the exposure of the surface of the debris to potential leaching media upon landfill disposal. Microencapsulated wastes are applied to achieve a full surface coating on contaminated debris, to form a jacket around the debris, and/or to fill void spaces within the debris (i.e., macroencapsulation) by submerging the debris within the microencapsulated waste, by pouring the microencapsulated waste into a container of debris such that the debris is completely surrounded, or by other similar methods that successfully achieve macroencapsulation. Microencapsulated waste used to encapsulate debris is subject to compatibility and land disposal restriction (LDR) testing requirements as described in the Waste Analysis Plan, Section C of this Application. The use of encapsulated waste to macroencapsulate debris minimizes the use of reagents or materials.

For debris with hard-to-remove surface contamination, a combination of physical extraction techniques, such as abrasive blasting and high pressure washing, may be required to achieve a clean debris surface.

Other combination treatment techniques may be required to achieve the alternate treatment standards for hazardous debris or the waste-specific treatment standards for other types of wastes. Combination and multiple treatment techniques may be employed within Tanks T-1201A or T-1202A as required to achieve appropriate disposal treatment standards. The design and management of Tanks T-1201A or T-1202A allows storage and treatment to be performed in a safe and efficient manner.

D-2-5f(5)(d) Debris Treatment Capacities in Tanks in Unit 1200A

As discussed in the previous sections, numerous hazardous waste treatment techniques will be performed in Tanks T-1201A or T-1202A. The actual treatment capacity that may be achieved for each of these techniques will vary depending on the physical and chemical characteristics of the debris, waste or contaminants. The treatment capacities for each technique represent the average capacity that may reasonably be achieved in Tanks T-1201A or T-1202A based on the physical and operational constraints of Tanks T-1201A or T-1202A. The combined, estimated design treatment capacity for specific debris treatment techniques to be conducted in tanks in Unit 1200A are indicated in the following list. These debris treatment techniques may be performed in either Tank T-1201A or in Tank T-1202A, and the following estimated design treatment capacities represents the combined capacity for both tanks:

TANK TREATMENT PROCESSES (T01)

	Treatment Technology	Treatment Technique	Treatment Code
Chemical	Extraction	Water Washing	T34
	Immobilization	Microencapsulation	T34
Physical	Extraction	Abrasive Blasting	T47
		Scarification	T47
		Spalling	T47
		Vibratory Finishing	T47
		High Pressure Washing	T47
	Removal of Specific Components	Blending	T50
		Phase Separation	T50
	Immobilization	Sealing	T47

D-2-5g Tank Management Unit 1400

Unit 1400 is centrally located within the active portion of the Facility to the south of PK-1000 and to the north of Unit 2000, as shown in Drawing No. 0100-020-001 in Appendix D-1 to Section D of this Application. Unit 1400 consists of sixteen (16) on-ground storage tanks (Tanks T-1405 through T-1420), all located within a single secondary containment system.

The general purpose of Unit 1400 is to store and treat all types of aqueous wastes including off-site receipts and Facility-generated wastes such as landfill leachate, landfill berm surface waters, secondary containment system catchment waters, and aqueous residues from treatment of other wastes. Additionally, Unit 1400 will house clean water storage tank(s) for the

Leachate Treatment Plant located in Unit 2001. The majority of the underground pipe chase is considered to be ancillary to Unit 1400. Only the portions of the underground pipe chase between the limits of the landfill trenches and the Unit 1700 tanks are considered to be ancillary to Unit 1700A, B & C. The underground pipe chase enables the collection of leachate from the landfill trenches, catchment waters from various tank secondary containment systems, blow-down from Unit 900, and wastewaters from Unit 708, and subsequent underground transfer of these wastewaters to Unit 1400. Schematic Diagrams for the underground pipe chase are provided in Drawing Nos. 0100-010-003 and 0100-010-004, which are located in Appendix D-1 to Section D of this Application. The underground pipe chase is constructed in phases as required to support the management of leachate generated from new landfill trenches and other wastewaters generated on-site.

The following Engineering Drawings for Unit 1400 are located in Appendix D-1 to Section D of this Application:

- Drawing No. 1400-010-001 Tank Management Unit 1400, P&ID;
- Drawing No. 1400-010-002 Tank Management Unit 1400, P&ID;
- Drawing No. 1400-010-003 Tank Management Unit 1400, P&ID;
- Drawing No. 1400-010-004 Tank Management Unit 1400, P&ID;
- Drawing No. 1400-010-005 Tank Management Unit 1400, P&ID;
- Drawing No. 1400-010-006 Tank Management Unit 1400, P&ID;
- Drawing No. 1400-010-007 Tank Management Unit 1400, P&ID;
- Drawing No. 1400-020-001 Tank Management Unit 1400, Area Foundation Location Plan;
- Drawing No. 1400-020-003 Tank Management Unit 1400, Area Paving Plan;
- Drawing No. 1400-030-001 Tank Management Unit 1400, Sections;
- Drawing No. 1400-030-002 Tank Management Unit 1400, Sections;
- Drawing No. 1400-040-001 Tank Management Unit 1400, Details;
- Drawing No. 1400-040-002 Tank Management Unit 1400, Details; and
- Drawing No. 1400-040-003 Tank Management Unit 1400, Details.

D-2-5g(1) Types and Quantities of Wastes Managed in Unit 1400

As shown in Appendix D-2-1 of this Application, virtually every type of hazardous waste listed and identified in 40 CFR Part 261 and ADEM Administrative Code Chapter 335-14-2 is managed in tank systems in Unit 1400, except for ignitable and reactive wastes. In addition, non-hazardous wastes, as well as treatment residues from listed wastes are managed in tank systems in Unit 1400.

The total capacity for storage in tanks (S02) in Unit 1400 is indicated in Appendix D-2-1 of this Application. The quantity of wastes treated in tanks in this unit varies depending on the quantity of aqueous wastes received at the Facility from off-site and the quantity of aqueous wastes, leachate, wheel wash blow-down, and catchment waters which are generated on-site. The design capacity for treatment in tanks (T01) in Unit 1400 is 1,008,723 gallons per day of mixing, blending, phase separation, removal of specific components, biological treatment, etc., excluding transfers between tanks and containers and transfers between tanks.

D-2-5g(2) Design of Unit 1400

The design of the tank system in Unit 1400 is in accordance with the general design features for on-ground tanks in which corrosive hazardous wastes are managed as described in Subsection D-2-2. The design of the tanks in Unit 1400 also facilitates and enables adherence to the general management practices and procedures for on-ground tanks as described in Subsection D-2-3. Specific design features of Tanks T-1405 through T-1420 are provided in Appendices D-2-1 and D-2-3. The design assessment and certification for Tanks T-1405 through T-1420 is provided in Appendix D-2-4 of this Application. The installation assessment and certification for Tanks T-1405 through T-1420 is maintained within the Facility Operating Record.

Tanks T-1405 through T-1420 are located within Containment Area 1 of Unit 1400. As shown in Drawing Nos. 1400-020-001, 1400-020-003, 1400-030-001, 1400-030-002, 1400-040-001, 1400-040-002, and 1400-040-003, the design of the secondary containment system for Unit 1400 is in accordance with the general design features for on-ground tank systems as described in Subsection D-2-2. Portions of Containment Area 1 are covered, and the tanks are equipped with roof gutters to minimize the generation of catchment waters from rainfall within the containment area. Therefore, rainfall accumulation within the uncovered portions of the containment area is accounted for in the secondary containment calculations. The calculations of secondary containment capacity for Containment Area 1 of Unit 1400 are provided in Appendix D-2-2 of this Application.

D-2-5g(3) Management of Unit 1400

The management practices and procedures utilized in Unit 1400 are in accordance with the general management practices and procedures for on-ground tanks in which corrosive hazardous wastes are managed as described in Subsection D-2-3.

D-2-5g(4) Treatment of Wastes in Unit 1400

As shown in Drawing Nos. 1400-010-001 through 1400-010-007 which are located in Appendix D-1 to Section D of this Application, Unit 1400 consists of 16 storage and treatment tanks and associated ancillary equipment. The treatment of wastes in Unit 1400 consists primarily of the equalization, biological treatment, blending, mixing, bulking, separation of phases and separation of components within aqueous wastes accumulated and transferred from other units or systems on-site such as landfill leachate, landfill berm surface waters, secondary containment system catchment waters, wheel wash blow-down and aqueous residues from treatment of other wastes. Aqueous wastes generated on-site are generally transferred to Unit 1400 via the underground pipe chase depicted in Drawing Nos. 0100-010-003 through 0100-010-007, which are located in Appendix D-1 to Section D of this Application. In addition, aqueous wastes may be transferred to Unit 1400 from on-site or off-site sources via tanker truck.

The biological treatment of the aqueous waste may be initiated within the limits of Unit 1400 and be regulated under RCRA requirements. This treatment will be referred to as pretreatment where initial inoculation of the aqueous waste occurs. Once pre-treated, the liquid will be transferred to the Leachate Treatment Plant located in Unit 2001 for completion of treatment.

As shown in Drawing Nos. 1400-010-001 through 1400-010-007, which are located in Appendix D-1 to Section D of this Application, the design of Unit 1400 and associated ancillary equipment facilitates the blending, mixing or bulking of wastes. The side sample and withdrawal manifolds, pH meters, continuous level instrumentation on each tank, and the flow metering devices and general arrangement and flexibility of piping systems in Unit 1400 facilitates the blending, mixing, bulking and segregation of large quantities of aqueous wastes. The piping systems and ancillary equipment in Unit 1400 also enable the transfer of wastes between any of the tanks in the unit and tanker trucks located in the adjacent Loading/Unloading Station. The separation of phases in Unit 1400 consists primarily of the removal of solids and sludges that settle within the tanks. The separation of these materials is facilitated by the oversized withdrawal nozzles and the large clean-outs and access doors located at the bottom of each tank.

After the aqueous wastes have been treated to achieve the quantities and blends required or desired for effective subsequent treatment, the wastes are transferred to on-site units for further treatment or reuse via the site pipe chase or tanker trucks. Alternately, aqueous wastes from Unit 1400 may be transferred via tanker truck to off-site treatment and/or disposal facilities.

D-2-5h Leachate Tank Storage Units 1700A, B, & C

Units 1700A, B, & C consists of the collection systems, storage tanks, secondary containment systems, and ancillary equipment to enable the collection of leachate and berm surface waters generated in landfill Trenches 19, 21, and 22. Portions of the underground pipe chase between the limits of the landfill trenches and the Unit 1700 tanks are considered to be ancillary to Units 1700A, B, & C. The remaining portions of the underground pipe chase are considered to be ancillary to Unit 1400 as described in Subsection D-2-5g of this section. The underground pipe chase system enables the collection of leachate from the landfill trenches, catchment waters from various tank secondary containment systems, blow-down from Unit 900 and wastewaters from Unit 708, and subsequent underground transfer of these wastewaters to Unit 1400. The general layout of and location of the underground pipe chase and the components of Units 1700A, B, & C are shown in Drawing No. 1700-020-001, and Schematic Diagrams for the Underground Pipe Chase are provided in Drawing Nos. 0100-010-003 and 0100-010-004, which are all located in Appendix D-1 to Section D of this Application. Unit 1700 tank systems and the Underground Pipe Chase are constructed in phases as required to support the management of leachate generated from new landfill trenches and other wastewaters generated on-site. The following equipment and systems are considered to be ancillary components to the Unit 1700 tank systems:

- existing Tank T-A;
- existing portions of the underground pipe chase between Trench 19 and Tank T-A, as shown on Drawing No. 0100-010-003;
- existing Tanks T-1701 and T-1702;
- existing portions of the underground pipe chase between Trench 21 and Tanks T-1701 and T-1702, as shown on Drawing No. 0100-010-003; and
- existing portions of the underground pipe chase between Trench 22 and Tanks T-1703 and T-1704, as shown on Drawing No. 0100-010-004.

The following Engineering Drawings for Unit 1700 are located in Appendix D-1 to Section D of this Application:

- Drawing No. 1700-010-001 Leachate Tank Storage Units 1700B & C, Tanks T-1701 through T-1704, P&ID;
- Drawing No. 1700-010-003 Leachate Tank Storage Unit 1700A, Tank T-A, P&ID;

- Drawing No. 1700-020-001 Underground Pipe Chase Units 1700A, B, & C - Site Plan;
- Drawing No. 1700-020-002 Leachate Tank T-A, Unit 1700A, Plan & Sections;
- Drawing No. 1700-020-003 Leachate Tanks T-1701 & T-1702, Unit 1700B, Plan, Sections and Details;
- Drawing No. 1700-020-004 Leachate Tanks T-1703 & T-1704, Unit 1700C, Plan, Sections and Details; and
- Drawing No. 1700-040-001 Leachate Tank T-A, Unit 1700A, Details.

The following Engineering Drawings for the Underground Pipe Chase system are also located in Appendix D-1 to Section D of this Application:

- Drawing No. 0100-010-003 Underground Pipe Chase Layout, Schematic Diagram;
- Drawing No. 0100-010-004 Underground Pipe Chase Layout, Schematic Diagram;
- Drawing No. 0100-010-005 Underground Pipe Chase, Trench 19, Unit 703A, Unit 708, & Unit 900, P&ID;
- Drawing No. 0100-010-006 Underground Pipe Chase, Intermediate Locations, P&ID;
- Drawing No. 0100-010-007 Underground Pipe Chase, Trench 21 Cells 1 & 2, P&ID;
- Drawing No. 0100-010-008 Underground Pipe Chase, Trench 21 Cells 3 & 4, P&ID;
- Drawing No. 0100-010-009 Underground Pipe Chase, Trench 22 Cells 1 & 2, P&ID;
- Drawing No. 0100-010-010 Underground Pipe Chase, Trench 22 Cells 3 & 4, P&ID;
- Drawing No. 0100-020-002 Underground Pipe Chase, Site Plan; and
- Drawing No. 0100-040-001 Underground Pipe Chase Junction Vault Details.

D-2-5h(1) Types and Quantities of Wastes Managed in Units 1700A, B & C

The Unit 1700 tank systems are only used to accumulate and store leachate and berm surface waters resulting from the disposal in landfill Trenches 19, 21, and 22 of more than one of the restricted wastes classified as hazardous under Subpart D of 40 CFR Part 261 and ADEM Administrative Code Rule 335-14-2-.04 (e.g., EPA Hazardous Waste No. F039). The EPA Hazardous Waste No. F039 waste generated in the landfill trenches is a dilute, aqueous solution which is listed in 40 CFR 261.31(a) and ADEM Administrative Code Rule 335-14-2-.04(2)(a) based solely on a Toxic Waste (T) Hazard Code. However, as indicated in Appendix D-2-1 of this Application, the F039 wastes generated in landfill Trenches 19, 21, and at the Facility have been (or are expected to be) determined to be capable of also meeting the characteristics of corrosivity (C) and/or toxicity characteristic (E), but have not been (and are not expected to be) determined to be capable of meeting the characteristics of ignitability (I) or reactivity (R).

The total capacity for the storage of leachate and surface berm waters in Unit 1700 tank systems (S02) is indicated in Appendix D-2-1 of this Application. The quantities of leachate generated are dependent on numerous factors including the status of construction of landfill trench, the total amount of hazardous wastes disposed in a cell, and rainfall amounts and intensities. Leachate and surface berm waters are not treated within the Unit 1700 tank systems, excluding transfers between tanks and containers and transfers between tanks.

D-2-5h(2) Design of Units 1700A, B & C

The design of the Unit 1700 tank systems is in accordance with the general design features for aboveground tanks as described in Subsection D-2-2. The design of the Unit 1700 tank systems also facilitates and enables adherence to the general management practices and procedures for aboveground tanks as described in Subsection D-2-3. Specific design features for Tanks T-A and Tanks T-1701 through T-1704 are provided in Appendices D-2-1 and D-2-3. The design assessment and certification for Tank T-A and Tanks T-1701 through T-1704 is provided in Appendix D-2-4 of this Application. The installation assessments and certifications for Tank T-A and Tanks T-1701 and T-1702 are maintained within the Facility Operating Record.

Tank T-A is located within Unit 1700A (Containment Area 1), Tanks T-1701 and T-1702 are located within Unit 1700B (Containment Area 2), and Tanks T-1703 and T-1704 are located within Unit 1700C (Containment Area 3). As shown in Drawing Nos. 1700-020-001, 1700-020-002, 1700-020-003, and 1700-020-004, the design of the secondary containment systems for Tanks T-A and Tanks T-1701 through T-1704 is in accordance with the general design features for aboveground tank systems as described in Subsection D-2-2. Containment Areas 1, 2, and 3 are all separate, fully enclosed buildings; therefore, rainfall allowance is neglected in the secondary containment calculations. The calculations of secondary containment capacity for each of the Unit 1700 tank systems are provided in Appendix D-2-2 of this Application.

The underground site pipe chase system consists of the piping systems and associated equipment to enable the automatic transfer of landfill leachate and berm surface waters from the landfill trenches to the Unit 1700 storage tanks, and from these tanks to Unit 1400. The underground site pipe chase system is considered to be ancillary equipment to the Unit 1700 and Unit 1400 tank systems. Portions of the pipe chase system that are located outside of the secondary containment systems for tanks are designed to comply with the requirements for secondary containment and leak detection for ancillary equipment as described in Subsections D-2-2d(5) and D-2-2e of this section.

The underground site pipe chase system piping that is located outside of the secondary containment for a tank system is equipped with an outer containment pipe that completely surrounds and contains the inner carrier pipe. Underground site pipe chase piping system components such as valves, meters, flanges and other joints are located within secondary containment junction vaults. The outer containment pipes are sloped to drain back into the secondary containment system for the tanks or into a containment vault. Carrier pipes within these systems are equipped with check valves at appropriate intervals and locations to limit the volume of material that could drain or flow back into a secondary containment junction vault to less than the volume of the secondary containment junction vault. This design prevents the accidental over-fill of a secondary containment junction vault in the event of a leak or failure in a segment of the carrier pipe.

The secondary containment junction vaults within the underground site pipe chase system are equipped with automatic leak detection devices to indicate the presence of liquids within the containment. These leak detection systems operate continuously and provide a visual alarm to ensure that the potential leak is recognized in a timely manner so that it can be addressed through the appropriate management procedures. The leak detection systems within the underground site pipe chase system junction vaults are liquid detection probes located within the junction vaults. The location of these liquid detection probes and other relevant junction vault design and construction features are provided in Drawing No. 0100-040-001 which is located in Appendix D-1 to Section D of this Application.

D-2-5h(3) Management of Units 1700A, B & C

The management practices and procedures utilized in Unit 1700 tank systems are in accordance with the general management practices and procedures for aboveground tanks as described in Subsection D-2-3. However, because only leachate and berm surface waters generated from the landfill disposal trenches will be managed in Unit 1700 tanks, there is no concern for mixing of incompatible wastes in these tanks systems.

As shown in Drawing Nos. 1700-010-001 and 1700-010-003 and Drawing Nos. 0100-010-003 through 0100-010-010, the removal of leachate and berm surface waters from the landfill cells is accomplished through the use of pumps located within the landfill cell risers or on the surface of an active landfill cell. Each landfill cell riser is equipped with a leachate removal pump that operates automatically to limit the amount of leachate accumulated in a cell. The landfill berm surface water pumps are operated manually. The leachate and berm water is pumped through portions of the underground site pipe chase system to the nearest set of Unit 1700 leachate storage tanks. The quantities of all leachate and berm waters is metered and recorded within the system prior to discharge into one of the Unit 1700 storage tanks. When the quantity of liquids accumulated within any one of the Unit 1700 storage tanks reaches a certain preset level, the leachate and berm water mixtures are automatically pumped through the underground site pipe chase system to Unit 1400. If the level of leachate in any one of the Unit 1700 storage tanks reaches a high-high level, all pumping of leachate from the cells within the associated portion of the underground site pipe chase system is automatically discontinued.

[End of Section D-2 Text]

APPENDIX D-2-1

SECTION D-2

SUMMARY OF TANK DESIGN INFORMATION

<u>Revision No.</u>
5.0

TABLE D-2-1.1
SUMMARY OF TANK DESIGN INFORMATION
CHEMICAL WASTE MANAGEMENT, INC. EMELLE, ALABAMA

Tank No.	Regulatory Function [1]	Waste Types [2]	Service Date	Type of Leak Detection	Design Code	Material of Construction/ Internal Coatings [3]	Configuration of Tank [4]	Diameter/ Length (ft)	Shell/ Height (ft)	Bottom/ Width (ft)	Total Capacity [5] (gal)	Design Max. Sp. Gr.
CONTAINER & TANK MANAGEMENT UNIT 520												
T-520	S & T	I/E/H/T	May-91	Visual	API-620	CS	V/FR/CB/A	16.00	14.00	8.00	25,066	1.50
							Unit Total Permitted Capacity				25,066	
CONTAINER & TANK MANAGEMENT UNIT 600												
T-634	S & T	I/E/H/T	Sep-83	Slotted Base	API-650	CS	V/FR/FB/A	12.00	12.00	0.00	10,152	1.50
T-635	S & T	I/E/H/T	Sep-83	Slotted Base	API-650	CS	V/FR/FB/A	12.00	12.00	0.00	10,152	1.50
T-636	S & T	I/E/H/T	Sep-83	Slotted Base	API-650	CS	V/FR/FB/A	12.00	12.00	0.00	10,152	1.50
							Unit Total Permitted Capacity				30,456	
LABORATORY TANK STORAGE UNIT 708												
T-725 [6]	S	C/R/E/H/T	Dec-90	Double Wall	UL-58	CS/C1	H/DW/A	4.00	10.67	0.00	1,003	1.80
T-726	G	C/R/E/H/T	Jun-91	Slotted Base	ASTM-D3299	FRP-2	V/DR/FB	8.00	12.58	0.00	4,731	1.30
							Unit Total Permitted Capacity [7]				5,734	
WHEEL WASH & TANK STORAGE UNIT 900												
T-901	S & T	E/H/T	Oct-89	Visual	API-620	CS/C2	V/FR/CB/A	6.00	8.00	3.00	1,903	1.10
T-902	S & T	E/H/T	Oct-89	Visual	API-620	CS/C2	V/FR/CB/A	6.00	8.00	3.00	1,903	1.10
T-903	S & T	E/H/T	Oct-89	Double Wall	ACI/AISC	CS/C2	R/DW/OT/A	3.00	40.00	3.46	3,104	1.10
T-904	S & T	E/H/T	Oct-89	Double Wall	ACI/AISC	CS/C2	R/DW/OT/A	3.00	40.00	3.46	3,104	1.10
							Unit Total Permitted Capacity				10,014	
CONTAINMENT BUILDING/CONTAINER & TANK MANAGEMENT UNIT 1200A												
T-1201A	S & T	C/R/E/H/T	Oct-94	Double Wall	ACI/AISC	CS	R/OT/A	20.67	12.00	12.00	20,802	2.40
T-1202A	S & T	C/R/E/H/T	Oct-94	Double Wall	ACI/AISC	CS	R/OT/A	20.67	12.00	12.00	20,398	2.40
							Unit Total Permitted Capacity				41,200	

TABLE D-2-1.1
SUMMARY OF TANK DESIGN INFORMATION
CHEMICAL WASTE MANAGEMENT, INC. EMELLE, ALABAMA

Tank No.	Regulatory Function [1]	Waste Types [2]	Service Date	Type of Leak Detection	Design Code	Material of Construction/ Internal Coatings [3]	Configuration of Tank [4]	Diameter/ Length (ft)	Shell/ Height (ft)	Bottom/ Width (ft)	Total Capacity [5] (gal)	Design Max. Sp. Gr.
TANK MANAGEMENT UNIT 1400												
T-1405	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	52.00	32.00	0.00	508,333	1.10
T-1406	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	52.00	32.00	0.00	508,333	1.10
T-1407	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	52.00	32.00	0.00	508,333	1.10
T-1408	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	52.00	32.00	0.00	508,333	1.10
T-1409	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1410	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1411	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1412	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1413	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1414	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1415	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1416	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1417	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1418	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1419	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
T-1420	S & T	C/E/H/T	Dec-88	Slotted Base	API-650	CS/C3	V/DR/FB/A	39.00	28.00	0.00	250,195	1.10
							Unit Total Permitted Capacity				5,035,672	
LEACHATE TANK STORAGE UNITS 1700												
T-A	Storage	C/E/H/T	Nov-93	Visual	ASTM 1998	XLHDPE	H/A	5.33	15.92	0.00	2,500	1.10
T-1701	Storage	C/E/H/T	Feb-89	Visual	UL-142	CS/C3	H/IL/A	12.00	30.00	0.00	25,379	1.10
T-1702	Storage	C/E/H/T	Feb-89	Visual	UL-142	CS/C3	H/IL/A	12.00	30.00	0.00	25,379	1.10
T-1703	Storage	C/E/H/T	Mar-96	Visual	UL-142	CS/C3	H/IL/A	12.00	30.00	0.00	25,379	1.10
T-1704	Storage	C/E/H/T	Mar-96	Visual	UL-142	CS/C3	H/IL/A	12.00	30.00	0.00	25,379	1.10
							Unit Total Permitted Capacity				104,016	

TABLE D-2-1.1
SUMMARY of TANK DESIGN INFORMATION
CHEMICAL WASTE MANAGEMENT, LLC, EMELLE, ALABAMA

NOTES:

[1] Abbreviations for Regulatory Designations:

S = Storage T = Treatment G = Generator

[2] Abbreviations for Waste Types:

I = Ignitable R = Reactive H = Acute Hazardous

C = Corrosive E = Toxicity Characteristic T = Toxic

[3] Abbreviations for Materials of Construction and Interior Coatings:

Materials of Construction

CS = Carbon Steel

XLHDPE = Cross-Linked High Density Polyethylene

FRP (Fiberglass Reinforced Plastic):

FRP-1 = Derakane 470 Epoxy Vinyl Ester Resin Throughout with 200 mil Inner Corrosion Barrier including Double Synthetic (Nexus ®) Surfacing Veil

FRP-2 = Derakane 411 Epoxy Vinyl Ester Resin Throughout with 100 mil Inner Corrosion Barrier including Synthetic (Nexus®) Surfacing Veil

FRP-3 = Isophthalic Polyester Structural Laminate with 100 mil Inner Corrosion Barrier of Derakane 411 Epoxy Vinyl Ester including 10 mil "C" Glass Surfacing Veil

Interior Coatings for Carbon Steel Tanks

C1 = Vinyl Ester C3 = Epoxy

C2 = Epoxy Polyamide

[4] Abbreviations for Tank Configuration:

V = Vertical Shell H = Horizontal Shell R = Rectangular Shape DW = Double Wall A = Atmospheric Vessel (< 5 psig)

FR = Flat Roof DR = Dished/Domed Roof SR = Sloped Roof OT = Open Top P = Pressure Vessel (> 5 psig)

CB = Coned Bottom DB = Dished Bottom FB = Flat Bottom

[5] Total tank capacity is based on the physical dimensions of the tank. This figure represents the maximum volume of waste that could be physically stored within the tank and establishes the permit capacity for the tank.

[6] T-725 is the only tank at the Facility that is in direct contact with the soil.

[7] Since T-726 is a 90-day generator accumulation tank its total capacity is not included in the permitted tank storage capacity (S02) for Unit 708 or the Facility.

APPENDIX D-2-2

SECTION D-2

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

<u>Revision No.</u>
5.0

APPENDIX D-2-2

SECTION D-2

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

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APPENDIX D-2-2

SECTION D-2

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

In accordance with the requirements of 40 CFR 270.16(g) and ADEM Administrative Code Rule 335-14-8-.02(7)(g), this appendix provides the calculations of secondary containment capacity for the storage of waste in tank systems. In conjunction with the information provided within Appendix D-2-1, Summary of Tank Design Information, this appendix demonstrates compliance with the requirements of 40 CFR 264.193(e)(2)(i) and (ii), or (3)(i), and ADEM Administrative Code Rule 335-14-5-.10(4)(e)2.(i) and (ii), or 3.(i) regarding the provision of adequate secondary containment capacity within the tank management units at the Facility.

D-2-2-1 Basis for Secondary Containment Calculations

a. The containment system must be designed and operated to contain 100 percent of the capacity of the largest tank, as required by 40 CFR 264.193(e)(2)(i) and ADEM Administrative Code 335-14-5-.10(4)(e)2.(i).

b. In addition, the containment system must be designed and operated to prevent run-on or infiltration of precipitation into the secondary containment system unless the collection system has sufficient excess capacity to contain run-on or infiltration. Such additional capacity must be sufficient to contain precipitation from a 25-year, 24-hour rainfall event, as required by 40 CFR Part 264.193(e)(2)(ii) and ADEM Administrative Code 335-14-5-.10(4)(e)2.(ii). The 25-year, 24-hour rainfall event for Emelle, Alabama is approximately 7½" as indicated in Figure D-2-2.1, which is an excerpt from Technical Paper No. 40, published by the U.S. Department of Commerce, Washington, DC, in May 1961.

c. Rainfall allowance is not required for containment areas which are enclosed within a building. Where applicable, blow-in rainfall allowance is taken into account for the units or areas which are partially enclosed (e.g. roof only or units with partial siding). It is assumed that the rainfall blow-in will occur at a 30° angle to the vertical as measured at the top of the opening. This assumption of blow-in for an entire 25-year, 24-hour storm event is a worst-case scenario and provides a conservative approach.

D-2-2-2 Explanation of Terminology Referred to in the Containment Calculations

a. "Capacity within Perimeter Containment Curb" - This term refers to the capacity created by the perimeter containment curb only (see Figure D-2-2.2, Zone 1). The additional capacities created from sloped floors and/or sumps are not taken into account in this category.

b. "Capacity of Sloped Floor" - This term refers to the capacity created by the slope of the floor only (see Figure D-2-2.2, Zone 4). In cases where a sump is part of the containment system, the area above the sump is considered as part of the sloped floor capacity (see Figure D-2-2.2, Zone 2). As a conservative approach, the sloped floor capacity is calculated only when additional secondary containment capacity is required or when no containment curb capacity is available.

c. "Capacity of Sumps" - This refers to the capacity within the collection sumps (see Figure D-2-2.2, Zone 3).

d. "Capacity Deductions" - This term refers to the capacity which is occupied by equipment, structures, or other appurtenances within the containment area, such as the capacity of flat bottom tank pedestals, columns, pump pads, tanks, etc. The capacity for each item is subtracted from the "Gross Secondary Containment Capacity" to obtain the "Net Secondary Containment Capacity."

e. "Required Secondary Containment Capacity" - This term refers to the amount of secondary containment capacity that must be provided within each containment area in order to comply with the regulations. The required capacity is the sum of:

- 100 percent of the capacity of the largest tank (see Section D-2-2-1a, above) and
- the rainfall allowance (see Section D-2-2-1b & c, above).

f. The abbreviation "NA" means "Not Applicable".

D-2-2-3 Certification of the Calculations of Secondary Containment for Tanks

The estimated secondary containment capacities for the tank management units at the Facility have been calculated based upon the overall containment area dimensions, the sump dimensions, the curb heights, the depths of containment due to floor slope, and other dimensional information depicted on the applicable RCRA Part B Permit Application Drawings provided in Appendix D-1 to Section D of this Application. These RCRA Part B Permit Application Drawings were prepared for the sole, specific purpose of providing the information required to obtain a RCRA Part B Permit for the Facility. This certification is intended to address the calculations of secondary containment capacities for the tank management units at the Facility as provided within the tables of Appendix D-2-2, and does not certify the accuracy or completeness of any of the other information provided within this Application.

With regards to the secondary containment capacity calculations prepared to demonstrate compliance with the requirements of 40 CFR 264.193(e)(2)(i) and (ii), or (3)(i), and ADEM Administrative Code Rule 335-14-5-.10(4)(e)2.(i) and (ii), or 3.(i) for the tank management units at the Facility, I certify under penalty of law that the modified calculations were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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[End of Appendix D-2-2 Text]

APPENDIX D-2-2

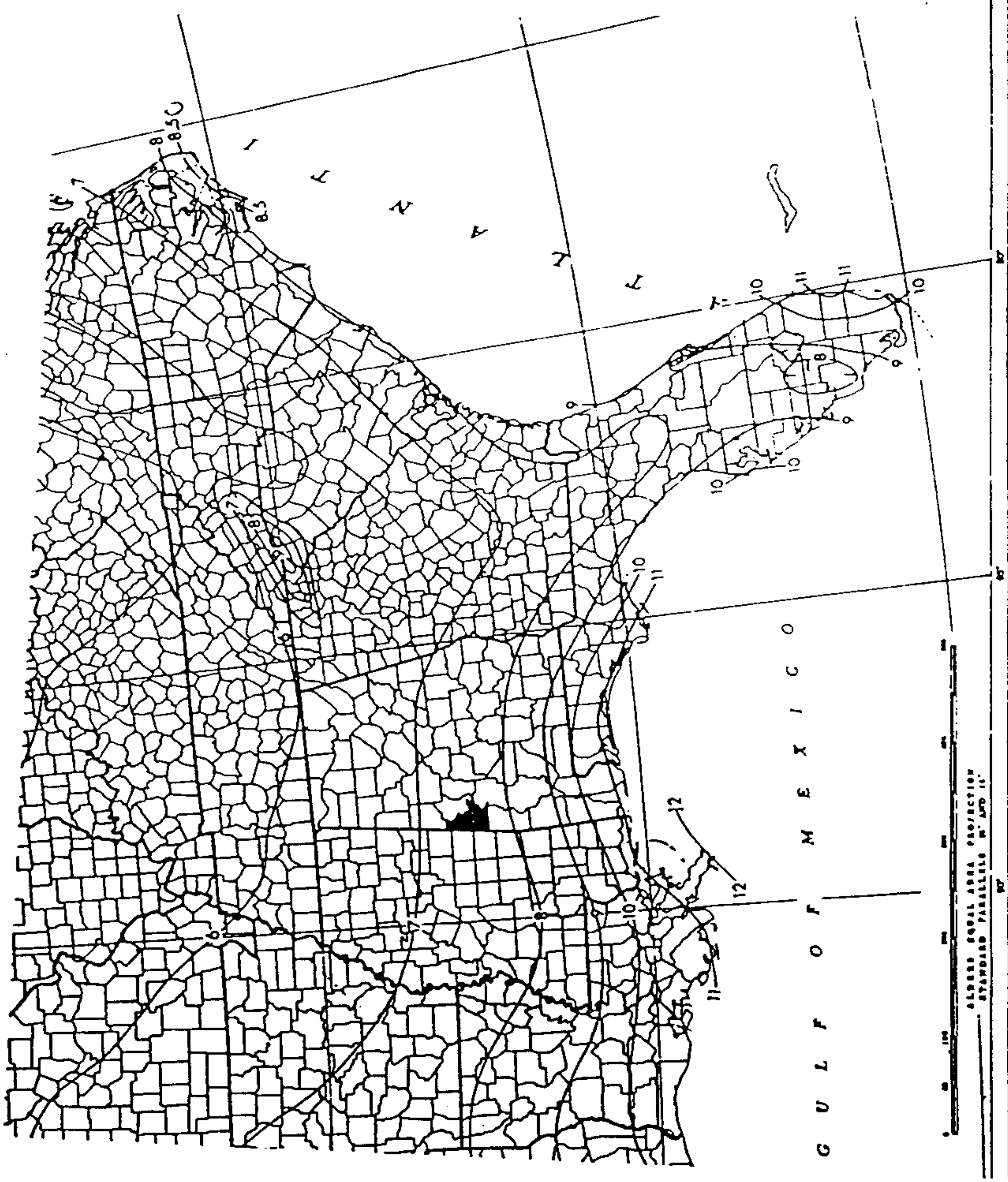
SECTION D-2

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

FIGURES

FIGURE D-1-2.1

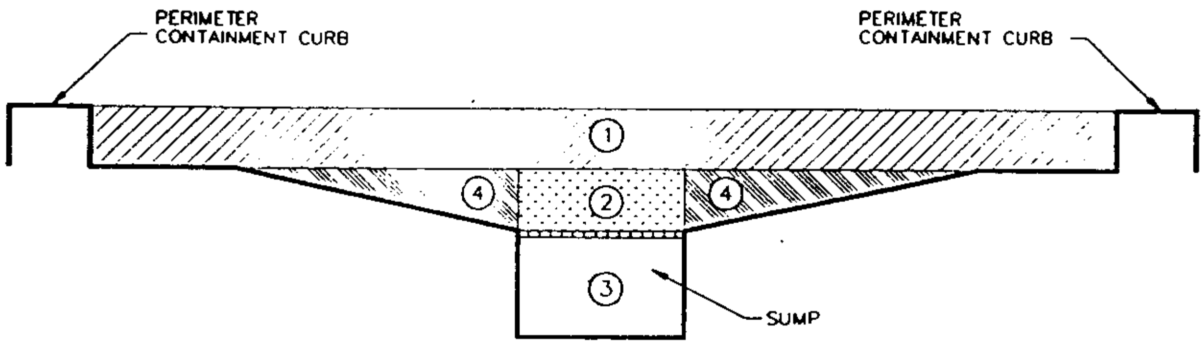
NOTE: This figure is an excerpt from "Technical Paper No. 40, Rainfall Frequency Atlas of the United States," published in May 1961 by the U.S. Department of Commerce and the Weather Bureau



25-YEAR 24-HOUR RAINFALL (INCHES)

FIGURE D-1-2.2

TYPICAL CONTAINMENT AREA CONFIGURATION



ILLUSTRATIVE SECTION VIEW
TYPICAL CONTAINMENT AREA

ZONE DESIGNATION

- (1) CONTAINMENT CAPACITY CREATED BY PERIMETER CONTAINMENT CURB
- (2) CONTAINMENT CAPACITY ABOVE SUMP
- (3) CONTAINMENT CAPACITY WITHIN SUMP
- (4) CONTAINMENT CAPACITY CREATED BY FLOOR SLOPE

APPENDIX D-2-2

SECTION D-2

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

TABLES

TABLE D-2-2.1
SUMMARY OF SECONDARY CONTAINMENT CAPACITIES
FOR TANK MANAGEMENT UNITS
CHEMICAL WASTE MANAGEMENT, INC. EMELLE, ALABAMA FACILITY

Unit Number	Containment Area Identifier	Tank(s)	Table	Largest Tank Volume (gallons)	Rainfall Allowance (gallons)	Secondary Containment Capacity	
						Required (gallons)	Provided (gallons)
520	2	T-520	D-2-2.2	25,066	1,900	26,966	32,542
600	3	T-634, 635, & 636	D-2-2.3	10,152	NA	10,152	51,750
708	NA[1]	T-725	NA[1]	5,734	NA[1]	NA[1]	NA[1]
900	1	T-901 & 902	D-2-2.4	1,903	NA	1,903	3,840
900	2	T-903	D-2-2.5	3,104	NA	3,104	11,431
900	3	T-904	D-2-2.6	3,104	NA	3,104	13,745
1200A	NA[1]	T-1201A & T-1202A	NA[1]	20,802	NA[1]	NA[1]	NA[1]
1400	1	T-1405 thru T-1420	D-2-2.7	508,333	101,939	610,272	784,264
1700A	1	Tank T-A	D-2-2.8	2,500	NA	2,500	10,714
1700B	2	Tanks T-1701 and T-1702	D-2-2.9	25,379	NA	25,379	36,543
1700C	3	Tanks T-1703 and T-1704	D-2-2.10	25,379	NA	25,379	36,543

Notes:

1) Tank T-725 (Unit 708) and Tanks T-1201A and T-1202A (Unit 1200A) are underground or in-ground tanks that utilize a double-walled design for secondary containment in accordance with the requirements of 40 CFR 264.193(e)(3) and ADEM Administrative Code Rule 335-14-5-.10(4)(e)3. Therefore, calculations of secondary containment capacity are not applicable for these tanks/tank systems.

TABLE D-2-2.2

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

CONTAINER & TANK MANAGEMENT - UNIT 520
Containment Area No. 2 (Tank T-520)
(Reference Drawing Nos. 0520-020-001, 0520-030-001, & 0520-040-001)

Note: These calculations DO NOT account for the additional containment capacity provided by the sloped floor.

I. Secondary Containment Capacity			
A. Capacity within the Perimeter Containment Curb [38'-8"× 28'-8" × 3'-11"]	=	4,346	cu. ft.
B. Capacity of Sloped Floor	=	NA	
C. Capacity in Sumps [2' × 2' × 2']	=	8	cu. ft.
Gross Secondary Containment Capacity	=	4,354	cu. ft.
D. Capacity Deductions 1) less volume of tank pedestals [4 × (1'-1 1/2" × 1'-1 1/2" × (6" + 2"))]	=	-3	cu. ft.
Capacity Deductions Subtotal	=	-3	cu. ft.
Net Secondary Containment Capacity	=	**4,351**	**cu. ft.**
	or	**32,542**	**gallons**
II. Required Secondary Containment Capacity			
A. Volume of Largest Tank	=	**25,066**	**gallons**
B. Rainfall Allowance (25-year, 24-hour storm event of 7.5") 1) Rain through roof opening on top of tank and gap around tank [(pi × (8'-3")²) × 7½"/12 × 7.48 gal/ft³]	=	**1,000**	**gallons**
2) Rain blow-in under covered portion of containment area (This area is partially covered by a roof; however allowance must be made for blow-in on longest side. Assume 30° blow-in, with an effective eave height of 12'-1", and a roof overhang of 2'.) [((tan 30° × 12'-1" eave) - 2' overhang) × 38'-8" width × (7½"/12) × 7.48 gal/ft³]	=	**900**	**gallons**
Total Capacity Required	=	**26,966**	**gallons**

TABLE D-2-2.3

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

CONTAINER & TANK MANAGEMENT - UNIT 600
Containment Area No. 3 (Tanks T-634, T-636, and T-636)
(Reference Drawing Nos. 0600-020-001, 0600-030-002, & 0600-040-001)

Note: These calculations DO NOT account for the additional containment capacity provided by the sloped floor.

I. Secondary Containment Capacity			
A. Capacity within the Perimeter Containment Curb [145'-4" × 78'-8" × 7 1/4"]	=	6,860	cu. ft.
B. Capacity of Sloped Floor	=	NA	
C. Capacity in Sumps (based on minimum depth) [(2'-6" × 138'-4" × 2'-0 3/8") + (2'-6" × 17'-6" × ((4'-0 3/8" + 10 3/4")/2)]	=	810	cu. ft.
D. Offset in SW corner (near T-634) [15'-9" × 3'-4" × 7 1/4"]	=	31	cu. ft.
Gross Secondary Containment Capacity	=	7,701	cu. ft.
E. Capacity Deductions			
1) less volume of forklift ramp (no allowance for slope) [7 1/4" × (10' + 8" + 8") × 80']	=	-544	cu. ft.
2) less volume of tank pedestals [3 × pi × (6'-6")² × 7 1/4"]	=	-239	cu. ft.
Capacity Deductions Subtotal	=	-783	cu. ft.
Net Secondary Containment Capacity	=	**6,918**	**cu. ft.**
	or	**51,750**	**gallons**
II. Required Secondary Containment Capacity			
A. Volume of Largest Tank	=	**10,152**	**gallons**
B. Rainfall Allowance (25-year, 24-hour storm event of 7.5") (Tanks are enclosed within a building. Therefore, rainfall allowance is neglected.)	=	NA	
Total Capacity Required	=	**10,152**	**gallons**

TABLE D-2-2.4

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

WHEEL WASH AND TANK STORAGE - UNIT 900
Containment Area No. 1 (Tanks T-901 and T-902)
(Reference Drawing Nos. 0900-020-001 & 0900-030-001)

Note: These calculations DO NOT account for the additional containment capacity provided by the sloped floor.

I. Secondary Containment Capacity			
A. Capacity within the Perimeter Containment Curb [47'-8" × 19'-4" × 8"]	=	617	cu. ft.
B. Capacity of Sloped Floor	=	NA	
C. Capacity in Sumps [2' × 2' × 2']	=	8	cu. ft.
Gross Secondary Containment Capacity	=	625	cu. ft.
D. Capacity Deductions			
1) less volume of roll-off box pedestal [18'-1" × 7'-3" × 8"]	=	-88	cu. ft.
2) less volume of pump pedestal [6' × 6' × 8"]	=	-24	cu. ft.
Capacity Deductions Subtotal	=	-112	cu. ft.
Net Secondary Containment Capacity	=	**513**	**cu. ft.**
	or	**3,840**	**gallons**
II. Required Secondary Containment Capacity			
A. Volume of Largest Tank	=	**1,903**	**gallons**
B. Rainfall Allowance (25-year, 24-hour storm event of 7.5") (Tanks are enclosed within a building. Therefore, rainfall allowance is neglected.)	=	NA	
Total Capacity Required	=	**1,903**	**gallons**

TABLE D-2-2.5

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

WHEEL WASH AND TANK STORAGE - UNIT 900
Containment Area No. 2 (Tank T-903)
(Reference Drawing Nos. 0900-020-001 & 0900-030-001)

Note: These calculations DO account for the additional containment capacity provided by the sloped floor.

I. Secondary Containment Capacity			
A. Capacity within the Perimeter Containment Curb [88'-8" × 18'-10" × (233.00' - 232.33')]	=	1,119	cu. ft.
B. Capacity of Sloped Floor (below 232.33') (Based on volume of a truncated pyramid) = h/3 × (A1 + A2 + (A1×A2)^1/2)) [(1/3)(232.33' - 232.13') × ((68'-8" × 18'-10")+(40' × 3')+(1293 sf × 120 sf)^1/2)]	=	120	cu. ft.
C. Capacity in Sump [40' × 3' × 3'-5 1/2"]	=	415	cu. ft.
Gross Secondary Containment Capacity	=	1,654	cu. ft.
D. Capacity Deductions 1) less volume of ramps [2 × ((1/2)(10' × 8") × 18'-10")]	=	-126	cu. ft.
Capacity Deductions Subtotal	=	-126	cu. ft.
Net Secondary Containment Capacity	=	**1,528**	**cu. ft.**
	or	**11,431**	**gallons**
II. Required Secondary Containment Capacity			
A. Volume of Largest Tank [40' × 3' × 3'-5 1/2"]	=	**3,104**	**gallons**
B. Rainfall Allowance (25-year, 24-hour storm event of 7.5") (Tank is enclosed within a building. Therefore, rainfall allowance is neglected.)	=	NA	
Total Capacity Required	=	**3,104**	**gallons**

TABLE D-2-2.6

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

WHEEL WASH AND TANK STORAGE - UNIT 900
Containment Area No. 3 (Tank T-904)
(Reference Drawing Nos. 0900-020-001 & 0900-030-001)

Note: These calculations DO account for the additional containment capacity provided by the sloped floor.

I. Secondary Containment Capacity			
A. Capacity within the Perimeter Containment Curb [88'-8" × 24'-2" × (233.00' - 232.33')]	=	1,436	cu. ft.
B. Capacity of Sloped Floor (below 232.33') (Based on volume of a truncated pyramid) = h/3 × (A1 + A2 + (A1×A2)^1/2)) [(1/3)(232.33' - 232.13') × ((68'-8" × 24'-2")+(40' × 3')+(1660 sf × 120 sf)^1/2)]	=	148	cu. ft.
C. Capacity in Sump [40' × 3' × 3'-5 1/2"]	=	415	cu. ft.
Gross Secondary Containment Capacity	=	2,000	cu. ft.
D. Capacity Deductions 1) less volume of ramps [2 × ((1/2)(10' × 8") × 24'-2")]	=	-162	cu. ft.
Capacity Deductions Subtotal	=	-162	cu. ft.
Net Secondary Containment Capacity	=	**1,838**	**cu. ft.**
	or	**13,745**	**gallons**
II. Required Secondary Containment Capacity			
A. Volume of Largest Tank [40' × 3' × 3'-5 1/2"]	=	**3,104**	**gallons**
B. Rainfall Allowance (25-year, 24-hour storm event of 7.5") (Tank is enclosed within a building. Therefore, rainfall allowance is neglected.)	=	NA	
Total Capacity Required	=	**3,104**	**gallons**

TABLE D-2-2.7

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

TANK MANAGEMENT - UNIT 1400
Containment Area No. 1 (Tanks T-1405 thru T-1420)
(Reference Drawing Nos. 1400-020-001 & -003, -030-001 & 002, & -040-001 thru 003)

Note: These calculations DO account for the additional containment capacity provided by the sloped floor.

I. Secondary Containment Capacity			
A. Capacity within the Perimeter Containment Wall			
[{((244'-8"×240'-8")-(½)(49'-7½"×49'-7½")) × (272.19'-269.94')} + {((243'-7"×239'-7")-(½)(49'-4"×49'-4"))×(269.94'-269.69')}]	=	144,005	cu. ft.
B. Capacity of Sloped Floor (below 269.69')			
[((243'-7"×239'-7")-(½)(49'-4"×49'-4")) × ½(269.69'-268.07')]	=	46,284	cu. ft.
C. Capacity in Sumps			
[4' × 4' × 5']	=	80	cu. ft.
Gross Secondary Containment Capacity	=	190,368	cu. ft.
D. Capacity Deductions			
1) less volume of tank pedestals			
[(270.92-½(269.69'+268.07')) × {(12×(½×8×16'-9 ¼"×20'-3") + (4×(½×8×22'-1 ¾"×26'-9"))}]	=	-52,591	cu. ft.
2) less volume of tank cylinders			
[(4(pi)(26')² + 12(pi)(19.5')²) × (272.19' - 270.92')]	=	-28,994	cu. ft.
3) less volume of pump platform			
[(270.92' - 267.80') × (32' × 32')]	=	-3,195	cu. ft.
4) less volume of ramp			
[(½)(272.19' - 269.50') × 26' × 12']	=	-420	cu. ft.
5) less volume of pump pedestals			
[(270.19' - 268.32') × 4'-10" × 1'-9" × 2]	=	-32	cu. ft.
6) less volume of pipe rack pedestals			
[(270.92-½(269.69'+268.07')) × (71 × 1'-6" × 1'-4")]	=	-289	cu. ft.
Capacity Deductions Subtotal	=	-85,520	cu. ft.
Net Secondary Containment Capacity	=	**104,848**	**cu. ft.**
	or	**784,264**	**gallons**

TABLE D-2-2.7

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

TANK MANAGEMENT - UNIT 1400
Containment Area No. 1 (Tanks T-1405 thru T-1420)
(Reference Drawing Nos. 1400-020-001 & -003, -030-001 & 002, & -040-001 thru 003)

II. Required Secondary Containment Capacity

A. Volume of Largest Tank	=	**508,333**	**gallons**
B. Rainfall Allowance (25-year, 24-hour storm event of 7.5")			
(Net area not covered by canopies or guttered tank roofs)			
1) Total Tank Farm Area			
[(244'-8" × 240'-8")-(½)(49'-7½" × 49'-7½")]		57,653	sf
2) less Guttered Area of Tank Roofs (all but approx. 1/6 of roof area)			
[5/6 × (4(pi)(26')² + 12(pi)(19.5')²)]		-19,025	sf
3) less Area Covered by Canopy (over pipe racks, most of perimeter)		-16,823	sf
Net Area Exposed to Rainfall	=	21,805	sf
Net Rainfall Allowance Volume Calculation			
[21,805 sq. ft. × 7.5"/12" × 7.48 gal/ft³]	=	**101,939**	**gallons**
Total Capacity Required	=	**610,272**	**gallons**

TABLE D-2-2.8

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

LEACHATE TANK STORAGE - UNIT 1700A
Containment Area No. 1 (Tank T-A)
(Reference Drawing Nos. 1700-020-002 & 1700-040-001)

Note: These calculations DO NOT account for the additional containment capacity provided by the sloped floor.

I.	**Secondary Containment Capacity**			
	A. Capacity within the Perimeter Containment Curb [21'-8" × 17'-8" × 3'-11 3/4"]	=	1,524	cu. ft.
	B. Capacity of Sloped Floor	=	NA	
	C. Capacity in Sump	=	NA	
	Gross Secondary Containment Capacity	=	1,524	cu. ft.
	D. Capacity Deductions			
	1) less volume of existing tank supports [2 × (11' × 1'-6" × 8"/12)]	=	-22	cu. ft.
	2) less volume of new tank supports [(15'-5" - (2 × 1'-6")) × 6'-1" × 8"/12]	=	-51	cu. ft.
	3) less volume of pump pad [6' × 2' × 8"/12]	=	-8	cu. ft.
	4) less volume of column supports [4 × 10" × 10" × 3'-11 3/4"]	=	-11	cu. ft.
	Capacity Deductions Subtotal	=	-92	cu. ft.
	Net Secondary Containment Capacity	=	**1,432**	**cu. ft.**
		or	**10,714**	**gallons**
II.	**Required Secondary Containment Capacity**			
	A. Volume of Largest Tank	=	**2,500**	**gallons**
	B. Rainfall Allowance (25-year, 24-hour storm event of 7.5") (Tank is enclosed within a building. Therefore, rainfall allowance is neglected.)	=	NA	
	Total Capacity Required	=	**2,500**	**gallons**

TABLE D-2-2.9

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

LEACHATE TANK STORAGE - UNIT 1700B
Containment Area No. 2 (Tanks T-1701 and T-1702)
(Reference Drawing No. 1700-020-003)

Note: These calculations DO NOT account for the additional containment capacity provided by the sloped floor.

I.	**Secondary Containment Capacity**			
	A. Capacity within the Perimeter Containment Curb [50' × 40' × 2'-6"]	=	5,000	cu. ft.
	B. Capacity of Sloped Floor	=	NA	
	C. Capacity in Sump [3' × 3' × 1']	=	9	cu. ft.
	Gross Secondary Containment Capacity	=	5,009	cu. ft.
	D. Capacity Deductions			
	1) less volume of pump pads [2 × 5'-4" × 2'-5" × 1'-6"]	=	-39	cu. ft.
	2) less volume of tank supports [6 × 11' × 1'-6" × 6"]	=	-50	cu. ft.
	3) less volume of column supports [8 × 1'-4" × 1'-4" × 2'-6"]	=	-35	cu. ft.
	Capacity Deductions Subtotal	=	-124	cu. ft.
	Net Secondary Containment Capacity	=	**4,885**	**cu. ft.**
		or	**36,543**	**gallons**
II.	**Required Secondary Containment Capacity**			
	A. Volume of Largest Tank	=	**25,379**	**gallons**
	B. Rainfall Allowance (25-year, 24-hour storm event of 7.5") (Tanks are enclosed within a building. Therefore, rainfall allowance is neglected.)	=	NA	
	Total Capacity Required	=	**25,379**	**gallons**

TABLE D-2-2.10

CALCULATIONS OF SECONDARY CONTAINMENT CAPACITY

LEACHATE TANK STORAGE - UNIT 1700C
Containment Area No. 3 (Tanks T-1703 and T-1704)
(Reference Drawing No. 1700-020-004)

Note: These calculations DO NOT account for the additional containment capacity provided by the sloped floor.

I. Secondary Containment Capacity			
A. Capacity within the Perimeter Containment Curb [50' × 40' × 2'-6"]	=	5,000	cu. ft.
B. Capacity of Sloped Floor	=	NA	
C. Capacity in Sump [3' × 3' × 1']	=	9	cu. ft.
Gross Secondary Containment Capacity	=	5,009	cu. ft.
D. Capacity Deductions			
1) less volume of pump pads [2 × 5'-4" × 2'-5" × 1'-6"]	=	-39	cu. ft.
2) less volume of tank supports [6 × 11' × 1'-6" × 6"]	=	-50	cu. ft.
3) less volume of column supports [8 × 1'-4" × 1'-4" × 2'-6"]	=	-35	cu. ft.
Capacity Deductions Subtotal	=	-124	cu. ft.
Net Secondary Containment Capacity	=	**4,885**	**cu. ft.**
	or	**36,543**	**gallons**
II. Required Secondary Containment Capacity			
A. Volume of Largest Tank	=	**25,379**	**gallons**
B. Rainfall Allowance (25-year, 24-hour storm event of 7.5") (Tanks are enclosed within a building. Therefore, rainfall allowance is neglected.)	=	NA	
Total Capacity Required	=	**25,379**	**gallons**

APPENDIX D-2-3

SECTION D-2

SUMMARY OF TANK DESIGN SHELL THICKNESSES

<u>Revision No.</u>
5.0

TABLE D-2-3.1
SUMMARY OF TANK DESIGN SHELL THICKNESSES
CHEMICAL WASTE MANAGEMENT, INC., EMELLE, ALABAMA FACILITY

				Calculated Minimum Thickness (in.) [2]						Min. Code Thickness (in.) [3] without Design Min. Corr. Allow.			Minimum Design Thickness for New Tank (in.) [4]					Calculated Minimum Thickness (in.) [5]				
						Shell Course									Shell Course					Shell Course		
Tank No.	Design Code	Material of Construction	Design Min. Corrosion Allowance (inches) [1]	Roof (or Head)	Bottom (or Cone)	One (or Base)	Two (or at Top)	Three	Four	Roof (or Head)	Bottom (or Cone)	Shell	Roof (or Head)	Bottom (or Cone)	One (or Base)	Two (or at Top)	Three/Four	Roof (or Head)	Bottom (or Cone)	One (or Base)	Two (or at Top)	Three/Four
CONTAINER & TANK MANAGEMENT UNIT 520																						
T-520	API-620	CS	0.1250	NA	NA	0.055				3/16	3/16	3/16	3/8	3/8	3/8			NA	NA	0.320		
CONTAINER AND TANK MANAGEMENT UNIT 600																						
T-634 thru T-636	API-650	CS	0.0625	NA	NA	0.042				3/16	1/4	3/16	1/4	5/16	5/16			NA	NA	0.271		
LABORATORY TANK STORAGE UNIT 708																						
T-725	UL-58 / sti-P_3	CS	NA	NA		NA							0.135 (10 ga.)	NA	0.135 (10 ga.)							
WHEEL WASH & TANK STORAGE UNIT 900																						
T-901 & T-902	API-620	CS	0.0625	NA	0.017	0.012				3/16	3/16	3/16	3/16 [6]	1/4	1/4			NA	0.233	0.238		
T-903 & T-904	ACI/AISC	CS	0.1250	NA	0.093	0.093				NA	NA	NA	NA	1/2	1/2			NA	0.407	0.407		
CONTAINMENT BUILDING/CONTAINER & TANK MANAGEMENT UNIT 1200A																						
T-1201A & T-1202A	ACI/AISC	CS	0.1250	NA	0.429	0.429				NA	NA	NA	NA	1.00	1.00			NA	0.571	0.571		
TANK MANAGEMENT UNIT 1400																						
T-1405 thru T-1408	API-650	CS	0.0625	NA	NA	0.268	0.202	0.135	0.068	3/16	1/4	1/4	5/16	5/16	7/16	5/16	5/16	NA	NA	0.170	0.111	0.178
T-1409 thru T-1420	API-650	CS	0.0625	NA	NA	0.176	0.118	0.060		3/16	1/4	3/16	1/4	5/16	5/16	1/4	1/4	NA	NA	0.137	0.132	0.190
LEACHATE TANK STORAGE UNITS 1700																						
T-A	ASTM 1998	XLHDPE	0.1250	NA	NA	NA				0.187	NA	0.187	3/4	NA	3/4			NA	NA	NA		
T-1701 thru T-1704	UL-142	CS	0.0625	NA	NA	NA				0.24	NA	0.24	3/8	NA	3/8			NA	NA	NA		

Notes:

1. The Design Minimum Corrosion Allowance is the thickness specified by the Owner (or Engineer) prior to fabrication as the minimum allowance to be included in the design calculations for determining the tank shell thickness, prior to any rounding to nominal shell thickness commonly used in fabrication.
2. The Calculated Minimum Thickness is the shell thickness calculated by the methods in the applicable code as the minimum required for structural integrity for the tank design conditions.
3. The Minimum Code Thickness is the shell thickness specified within the applicable code as the minimum required for fabrication or erection of the tank, not including any corrosion allowance.
4. The Minimum Design Thickness is the specified shell thickness for tank fabrication, considering all shell thickness calculations, code requirements, and the Design Minimum Corrosion Allowance.
5. The Allowable Service Life Corrosion is the difference between the Minimum Design Thickness and the Calculated Minimum Thickness, indicated only where both of these thicknesses are available to determine the difference.
   The Allowable Service Life Corrosion is analogous to an actual corrosion allowance and should always be equal to or greater than the Design Minimum Corrosion Allowance.
6. T-901 and T-902 are internally coated, so no corrosion allowance was included for the roof, which is specified at the minimum code thickness of 3/16".
7. CS is Carbon Steel.

APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENTS AND CERTIFICATIONS

Revision No.
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APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENTS AND CERTIFICATIONS

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SECTION D-2

TANK SYSTEM DESIGN ASSESSMENTS AND CERTIFICATIONS

D-2-4-1 Introduction

In accordance with the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), the Facility has obtained an assessment of the design of each tank system for which construction commenced after July 14, 1986 at the Facility in which hazardous wastes are managed. These assessments have been reviewed by an independent, qualified, registered Alabama Professional Engineer and certified in accordance with 40 CFR 270.16(a) and ADEM Administrative Code Rule 335-14-8-.02(2)(d). The certifications attest that the assessment of the design of the tank system demonstrates that the tank system foundation, structural supports, seams, connections, and pressure controls are adequate, and that the tanks have sufficient structural strength and compatibility with the wastes to be managed and/or protection from corrosion so that they will not collapse, rupture or fail when properly installed, operated within the design limits, and properly inspected and maintained.

D-2-4-2 Tank System Design Assessments and Certifications Included within this RCRA Part B Permit Application

In accordance with the requirements of 40 CFR 264.192(g) and 40 CFR 270.16(a), and ADEM Administrative Code Rules 335-14-5-.10(3)(g) and 335-14-8-.02(7)(a), the design assessments and certifications, prepared by an independent, qualified, registered Alabama Professional Engineer for each tank system included within this RCRA Part B Permit Application, are provided in an attachment to this appendix as follows:

- Attachment D-2-4-1 Tank Design Assessment and Certification - Unit 520;
- Attachment D-2-4-2 Tank Design Assessment and Certification - Unit 600;
- Attachment D-2-4-3 Tank Design Assessment and Certification - Unit 708;
- Attachment D-2-4-4 Tank Design Assessment and Certification - Unit 900;
- Attachment D-2-4-5 Tank Design Assessment and Certification - Unit 1200A;
- Attachment D-2-4-6 Tank Design Assessment and Certification - Unit 1400; &
- Attachment D-2-4-7 Tank Design Assessment and Certification - Units 1700A, B, & C.

D-2-4-3 Tank System Design Assessments and Certifications Maintained within the Facility Operating Record

The tank system design assessments and certifications provided within this appendix are not intended to invalidate or replace the previously prepared tank system design assessments and certifications maintained within the Facility Operating Record for the following tank systems at the Facility for which construction commenced between July 14, 1986 and the date of this RCRA Part B Permit Application:

- Tank T-520 in Unit 520 (Attachment D-2-4-1);
- Tanks T-634, T-635, and T-636 in Unit 600 (Attachment D-2-4-2);
- Tank T-725 in Unit 708 (Attachment D-2-4-3);
- Tanks T-901 through T-904 in Unit 900 (Attachment D-2-4-4);
- Tanks T-1201A and T-1202A in Unit 1200A (Attachment D-2-4-5);
- Tanks T-1405 through T-1420 in Unit 1400 (Attachment D-2-4-6); and
- Tanks T-A & T-1701 through T-1704 in Units 1700A, B, & C (Attachment D-2-4-7).

The tank system design assessments and certifications provided in the above listed attachments were prepared for the sake of consistency and completeness of this RCRA Part B Permit Application and to reflect current Facility practices and procedures. The tank system design assessments provided in these attachments shall be used by the Facility as necessary for all future modifications, repairs or replacements of tanks or tank system components within these existing tank systems.

In accordance with the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), the Facility also obtains an assessment and certification for the design of new tank systems in which hazardous waste are managed in accordance with 40 CFR 262.34(a)(1)(ii) and ADEM Administrative Code Rule 335-14-3-.03(5)(a)1.(ii). In accordance with the requirements of 40 CFR 264.192(g) and 40 CFR 270.16(a) and ADEM Administrative Code Rules 335-14-5-.10(3)(g), 335-14-2(2)(d) and 335-14-8-.02(7)(a), a design assessment and certification, prepared by an independent, qualified, registered Alabama Professional Engineer for the 90-day generator accumulation tank system in Laboratory Tank Storage Unit 708 (Tank T-726) is maintained within the Facility Operating Record.

[End of Appendix D-2-4 Text]

ATTACHMENT D-2-4-1

APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 520

Revision No.

5.0

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 520

TANK T-520

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TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 520

TANK T-520

I. Introduction

This document provides the assessment and certification for the design of the hazardous waste storage tank system at Tank Management Unit 520 at the Chemical Waste Management, Inc. Facility in Emelle, Sumter County, Alabama. The assessment was performed to address the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), regarding the design of the system within Tank Management Unit 520 which is comprised of the tanks (i.e., Tank T-520), the tank foundation, the associated ancillary equipment and the secondary containment system.

Tank Management Unit 520 is located just south of Unit 603 at the Facility as shown on Drawing No. 0100-020-001 in Appendix D-1 to Section D of the RCRA Part B Permit Application. The primary function of the tank system within Unit 520 is to enable the blending, mixing and/or bulking of organic waste liquids for loading and subsequent transfer off-site for solvent recovery, energy recovery, incineration or other appropriate treatment.

The following drawings were used in the preparation of this Assessment and Certification and are provided either in Exhibit A (Tank Data Sheets) or in Appendix D-1 to Section D of the RCRA Part B Permit Application:

Drawing No.	**Drawing Title**
0520-010-001	Container & Tank Management Unit 520 - P&ID
0520-020-001	Container & Tank Management Unit 520 - Plan View
0520-030-001	Container & Tank Management Unit 520 - Sections
0520-040-001	Container & Tank Management Unit 520 - Details
0520-080-020	Tank Data Sheet - T-520

II. Tank Design

Tank T-520 has been designed in accordance with the design codes and standards indicated within the DESIGN DATA section of the Tank Data Sheet (i.e., Drawing No. 0520-080-020) provided in Exhibit A to this tank system design assessment. The criteria utilized in the assessment of the design of the shell, structural support, and anchorage for Tank T-520 are also provided within the DESIGN DATA section of the Tank Data Sheet, as well as within the tank design calculations provided in Exhibit B to this tank system design assessment.

The calculations provided in Exhibit B to this tank system design assessment demonstrate that the tank shell, structural supports and anchorages are, as designed, adequate to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable, at the design conditions indicated on the tank data sheets.

III. Tank Foundation Design

The design of the reinforced concrete foundation for Tank T-520 is indicated in Detail 7 on Drawing No. 0520-040-001 which is provided in Appendix D-1 to Section D of the RCRA Part B Permit Application. The criteria utilized in the assessment of the design of the foundation for Tank T-520 are provided within the tank foundation design calculations provided in Exhibit C to this tank system design assessment.

The tank foundation design calculations provided in Exhibit C demonstrate that the tank foundation is, as designed, adequate to support the load of the full tank and to withstand associated environmental stresses at the design conditions indicated on the tank data sheets and provided within foundation design calculations.

IV. Ancillary Equipment Design

All tank system ancillary piping systems shall be designed, installed and tested in accordance with the American Society of Mechanical Engineers (ASME) Standard B31.3, "Chemical Plant and Petroleum Refinery Piping", or an equivalent nationally recognized standard, and in accordance with recognized good engineering practices to ensure that they are supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

All other ancillary equipment for the tank system shall be designed, installed and tested in accordance with appropriate recognized standards, if any, and in accordance with recognized good engineering practices to ensure that it is supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

In order for this tank design assessment and associated certification to be maintained, and prior to the tank system being placed in use, the Facility shall ensure that the tank system ancillary equipment is properly installed and that all required inspections, tests and repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f). Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-

.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested.

V. Secondary Containment System Design

The design features of the secondary containment system for the tank system within Unit 520 are indicated on Drawing Nos. 0520-020-001, 0520-030-001, and 0520-040-001 which are located in Appendix D-1 to Section D of the RCRA Part B Permit Application. As shown on these drawings and in accordance with the applicable requirements of 40 CFR 264.193 and ADEM Administrative Code Rule 335-14-5-.10(4), the secondary containment system design is comprised of a reinforced concrete base, with all joints sealed with chemical-resistant waterstops, and all concrete surfaces sealed with chemical-resistant concrete coating system. Information on the concrete coatings available for use on the secondary containment system is provided within Appendix D-1-3 to Section D-1 of the RCRA Part B Permit Application.

Calculations demonstrating that the design secondary containment capacity meets or exceeds the applicable requirements 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e) are provided in Appendix D-2-2 to Section D-2 of the RCRA Part B Permit Application.

VI. Tank Venting Requirements

As indicated on the P&ID for Unit 520 (i.e., Drawing No. 0520-010-001 which is located in Appendix D-1 to Section D of the RCRA Part B Permit Application), Tank T-520 is designed as closed top tank that passively vents through a closed system to an activated carbon adsorber. The P&ID and the Tank Data Sheet (i.e., Drawing No. 0520-080-020) provided in Exhibit A to this tank system design assessment also indicate that the designed tank vent system includes a pressure/vacuum relief valve (i.e., conservation vent) and an emergency relief vent on the tank. The Tank Data Sheet specifies the diameter of the pressure/vacuum relief valve nozzle and the emergency vent nozzle on the tank.

The requirements for normal (i.e., liquid displacement and thermal effects) and emergency (i.e., fire exposure) venting capacities for the Unit 520 tank were evaluated in accordance with American Petroleum Institute Standard 2000, Venting Atmospheric and Low-Pressure Storage Tank (i.e., API 2000). As shown in the venting calculations provided in Exhibit D to this tank system design assessment, the size of the conservation vent nozzle on the tank is adequate to allow the tank under normal conditions to be maintained within the design limitations for pressure and vacuum as specified on the Tank Data Sheet provided in Exhibit A and within the tank design calculations provided in Exhibit B to this tank system design assessment. The venting calculations provided in Exhibit D also demonstrate that the size of the emergency vent nozzle on the tank is adequate to allow the tank to be maintained within the design limitations for pressure in the event of exposure to fire. The venting calculations provided in Exhibit D to this tank system design assessment also indicate the design pressure and vacuum settings for the conservation vent, the design pressure setting for the emergency relief vent, and the design maximum tank fill and withdrawal rates which were used in the evaluation of the tank venting requirements.

VII. Hazardous Characteristics of the Waste Managed

In accordance with the requirements of 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., this section presents an evaluation of the compatibility of the wastes managed within the Unit 520 tank system with the materials of construction of Tank T-520 and the ancillary equipment (i.e., pumps and piping) to determine their suitability for service in this unit.

The types of wastes managed within Tank T-520 will primarily be ignitable wastes. However, due to the derived-from and mixture rules, virtually all types of hazardous wastes listed and identified in 40 CFR Part 261 and ADEM Administrative Code Rule 335-14-2, except for corrosive and reactive wastes, may be managed in the T-520 tank system as shown in Appendix D-2-1 of this Application. In addition, non-hazardous wastes and treatment residues from listed wastes may also be managed in Tank T-520. Tank T-520 and the ancillary equipment that contact wastes within this system are primarily constructed of carbon steel without internal corrosion protection.

Exhibit E to this tank system design assessment presents information which provides an indication of the relative compatibility of carbon steel with a wide variety of chemical compounds and other substances. The table in Exhibit E provides corrosion/compatibility information for carbon steel exposed to pure chemical compounds which, in general, tend to have a more severe corrosive effect than wastes which contain mixtures and complexes of these compounds. Although this table may not provide corrosion data and service recommendations for all of the potential constituents of the wastes or waste mixtures which may be managed within the tank system in Unit 520, the table does demonstrate that carbon steel is generally compatible with and, under normal conditions, should not experience an accelerated rate of corrosion or deterioration when exposed to a majority of the types and classes of wastes which are managed within the Unit 520 tank system. In addition to the compatibility/corrosion data provided in Exhibit E, the compatibility of carbon steel with the types of ignitable wastes managed within Unit 520 is further validated by the empirical data provided by many years of comparable service applications within a variety of units at the Facility.

Based on the information provided in Exhibit E of this tank system design assessment and the empirical data compiled at the Facility for comparable service applications, it is the conclusion of this evaluation that the carbon steel tank system components are generally compatible with the types of waste managed within the Unit 520 tank system. It is further concluded that these materials of construction are suitable for this service if the tank system is operated within the design limitations set forth within this assessment, and that, if the tank system is managed in accordance with the following minimum practices, these materials of construction should not experience an accelerated rate of corrosion or deterioration which may result in a catastrophic failure of the tank system, throughout its useful life:

- Prior to placement of a waste into the tank system the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. References other than Exhibit E of this document, such as publications by the National Association of Corrosion Engineers (NACE) or other recognized sources of corrosion data, may also be used to evaluate compatibilities. The Facility shall prohibit the placement into the Unit 520 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components, including hazardous wastes that exhibit the characteristic of corrosivity as defined in 40 CFR 261.22 and ADEM Administrative Code Rule 335-14-2-.03(3); and
- The Facility shall perform an annual inspection of the tank shell to ensure that minimum code thicknesses are maintained and that adequate corrosion allowance is available for continued service.

VIII. Certification of Tank System Design Assessment

In accordance with the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), this section provides a certification by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), that an assessment of the design of the following tank system demonstrates that the tank system foundation, structural supports, seams, connections, and pressure controls are adequate, and that the tank has sufficient structural strength, compatibility with the wastes to be managed and/or protection from corrosion so that it will not collapse, rupture or fail, if properly installed, operated within the design limits, and properly inspected and maintained:

Tank System Location:	Chemical Waste Management, Inc. Emelle, Alabama
Tank System Identification:	Tank Management Unit 520
Applicable Tank:	T-520

At a minimum, the assessment of the tank system design, which is incorporated herein by reference, addresses and considers the following factors with respect to the intended use of the tank system:

- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank design has been evaluated for structural integrity with regards to the ability of the designed tank shell, structural supports and anchorages to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank has been evaluated with regards to the adequacy of the designed tank to provide the necessary capacity for normal and emergency venting;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which piping and other ancillary equipment shall be designed and constructed to maintain this certification;
- In accordance with 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., the assessment of the tank system design considers the compatibility of the tank's materials of construction and/or internal coatings with the types of hazardous wastes to be managed;
- In accordance with the applicable requirements of 40 CFR 264.192(a)(5) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)5., the assessment of the tank system design considers the ability of the designed tank system foundation to support the load of the full tank and to withstand associated environmental stresses; and
- The assessment of the tank system design considers the adequacy of the capacity of the designed tank secondary containment system as required by the applicable requirements of 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e).

In order for this certification to be maintained, the Facility shall comply with the applicable requirements of 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10, and shall perform all routine management procedures, periodic inspections and reviews, and tank system functionality and integrity tests as required by the permit including, but not limited to, the following:

- The Facility shall ensure that the tank system is properly installed and that, prior to placing the tank system in use, all required inspections, tests and necessary repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f);
- Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested;
- Prior to placement of a waste into the tank system, the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the Unit 520 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components, including hazardous wastes that exhibit the characteristic of corrosivity as defined in 40 CFR 261.22 and ADEM Administrative Code Rule 335-14-2-.03(3);
- Prior to placement of a waste into the tank system, the Facility shall verify the specific gravity of the waste in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the tank system of any waste that has a specific gravity that exceeds the design maximum value specified within the tank system design assessment;
- Prior to placement of a waste into the tank system, the Facility shall verify in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application that the treatment of the waste will not cause temperatures within the tank system to exceed the design maximum value specified within the tank system design assessment;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank exterior to detect excessive corrosion or deterioration;

- The Facility shall perform a daily inspection of the visible aboveground portions of the tank secondary containment system to detect leakable cracks or gaps, or excessive deterioration of the concrete base and/or chemical-resistant concrete coatings;
- The Facility shall perform an annual inspection of the tank shell, as described in Subsection F-2-6 of Section F-2 of the RCRA Part B Permit Application, to ensure that minimum code thicknesses are maintained and that adequate corrosion allowance is available for continued service;
- The Facility shall perform an annual inspection of the tank structural supports and anchorages to ensure that their integrity is maintained;
- The Facility shall perform a periodic inspection of the tank venting and emergency relief devices to ensure that they are in good working order with the appropriate vent or relief settings to maintain the tank within the design limits for pressure as specified within the tank system design assessment. The frequencies and procedures for inspection of all tank venting devices shall be as recommended by the manufacturer;
- The Facility shall perform a periodic inspection of the tank level sensing, overfill control devices and associated interlocks to ensure that they are in good working order with the appropriate settings to prevent overfilling of the tank. The frequencies and procedures for inspection of all tank level sensing and overfill control devices shall be as recommended by the manufacturer;
- The Facility shall perform a periodic inspection of any other operational controls for the tank system to ensure that they are in good working order with the appropriate settings to maintain the tank within its design limits as specified within the tank system design assessment. The frequencies and procedures for inspection of other tank system operational controls shall be as recommended by the manufacturer;
- The Facility shall perform periodic inspections of the integrity of any tank system grounding and lightning protection systems; and
- The Facility shall perform periodic inspections of the integrity of any tank system fire protection systems.

Based on the information provided within the tank system design assessment and supporting documentation, the design of Tank T-520 within Tank Management Unit 520 meets the current RCRA requirements relative to the design of new hazardous waste tank systems. The design assessment addresses only the applicable requirements of 40 CFR 264.192 and 40 CFR 264.193, and ADEM Administrative Code Rules 335-14-5-.10(3) and (4), and does not consider compliance with other codes or regulations, including, but not limited to, the requirements of the Occupational Safety and Health Act (OSHA).

With regards to the assessment and certification of the design of hazardous waste tank systems in accordance with the applicable requirements of 40 CFR 264.192(a) and (g), and ADEM Administrative Code Rules 335-14-5-.10(3)(a) and (g), I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

William O. Hagerman, P.E.
Alabama P.E. No.: 14014
President
ETI Corporation
6799 Great Oaks Road, Suite 100
Memphis, Tennessee 38138-2500

This certification was originally submitted in 1995. As part of the 2002 Part B Application Renewal, revisions were made to the text in this attachment. These revisions consisted primarily of renaming the section for the Waste Analysis Plan to Section C to maintain consistency with the other Sections contained within this Part B Permit Application. No revisions were made to this attachment during this Part B Permit Application renewal process (Revision 5.0).

With regards to the revisions noted above, I certify under penalty of law that these modifications were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Michael T. Feeney, P.E.
Alabama P.E. No.: 15895
Jacobs Engineering Group Inc.
Ten 10th Street NW
Atlanta, Georgia 30309

[End of Attachment D-2-4-1 Text]

EXHIBIT A

TANK DATA SHEETS

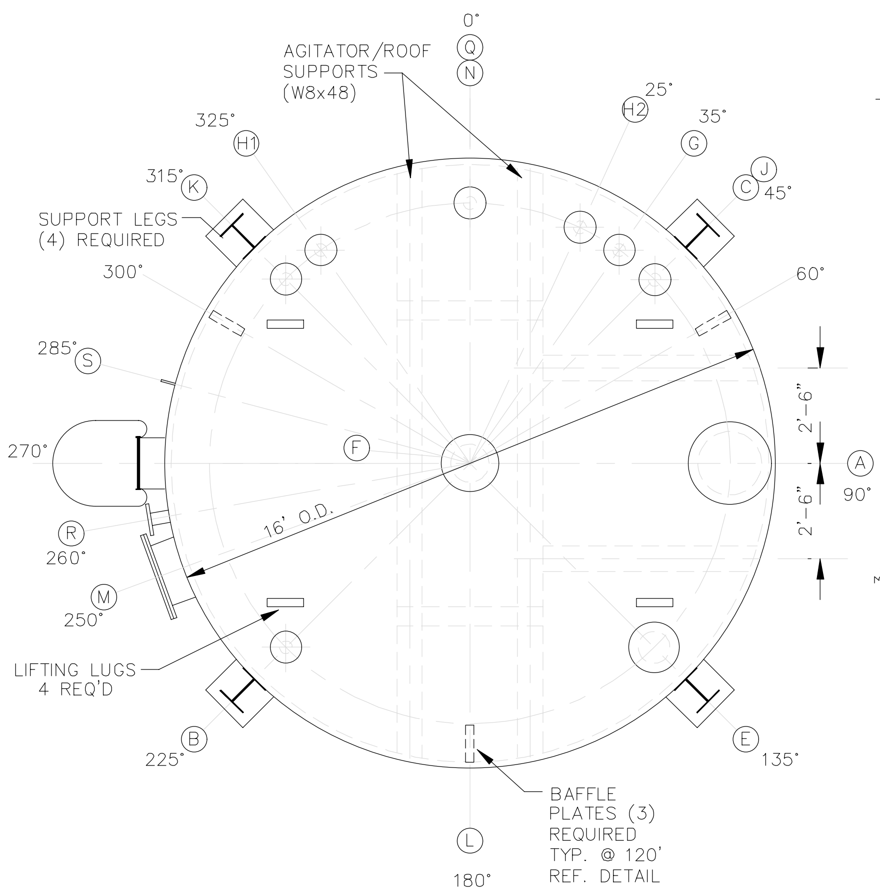
25,066 gal.
-8 oz. / +16 oz.
0° F 150° F
WASTE FUELS
1.50 24"
300 gpm 300 gpm
API 620 0.70
ANSI 58.1, EXP. C, 100 MPH
ZONE 1 / API 650, App. E
16'-0" 22'-5 3/4"

3/8"	C.S.	1/8"	VERTICAL	14'-0"
3/8"	C.S.	1/8"	CONE	8'-5 3/4"
3/8"	C.S.	1/8"	FLAT	–

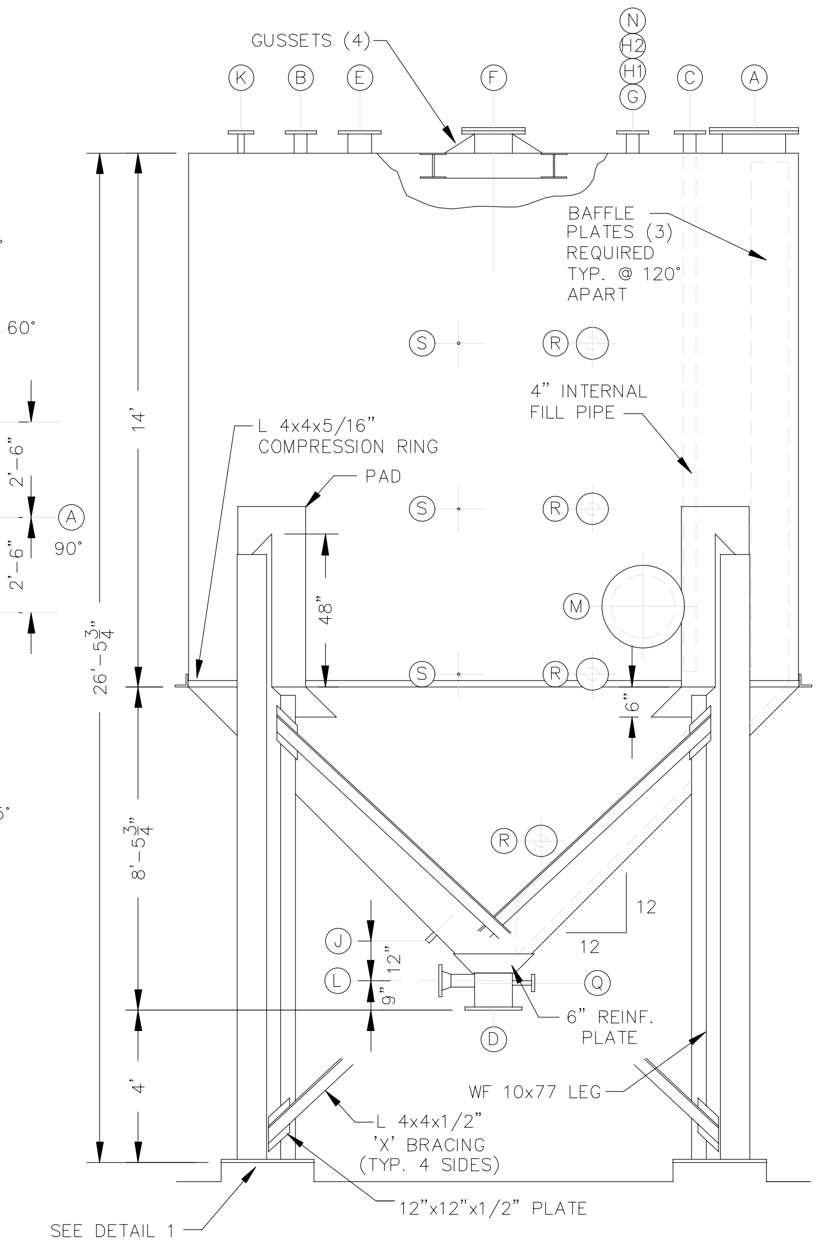
A	MANWAY	20"	MFG. STD.	TOP 90°	EMER. RELIEF
B	PRES/VAC RELIEF	4"	150# R.F.	TOP 225°	FLAME ARST.
C	INLET	4"	150# R.F.	TOP 45°	W/ FILL PIPE
D	OUTLET	12"	150# R.F.	BOTTOM CENTER	BLIND FLG.
E	LEVEL GUAGE	10"	150# R.F.	TOP 135°	–
F	AGITATOR	12"	150# R.F.	TOP CENTER	W/ GUSSETS
G	SPARE	4"	150# R.F.	TOP 35°	BLIND FLG.
H1	SPARE	4"	150# R.F.	TOP 325°	BLIND FLG.
H2	SPARE	4"	150# R.F.	TOP 25°	BLIND FLG.
J	SPARE	3/4"	2000#CPLG.	SIDE CONE @ 45°	W/ PLUG
K	HIGH LEVEL	2"	150# R.F.	TOP 315°	–
L	OUTLET	4"	150# R.F.	BOTTOM 180°	–
M	MANWAY	20"	MFG. STD.	SIDE 250°	–
N	SPARE	6"	150# R.F.	TOP 0°	BLIND FLG.
Q	SPARE	1.5"	150# R.F.	BOTTOM 0°	BLIND FLG.
R	SPARE-BLING FLG.	4"	150# R.F.	SIDE 260°	4 REQ'D
S	SAMPLE	3/4"	2000#CPLG.	SIDE 285°	3 REQ'D

COATINGS:
INTERIOR: NONE
EXTERIOR: CARBOLINE 890 EPOXY (WHITE), OR DEMONSTRATED EQUIVALENT.

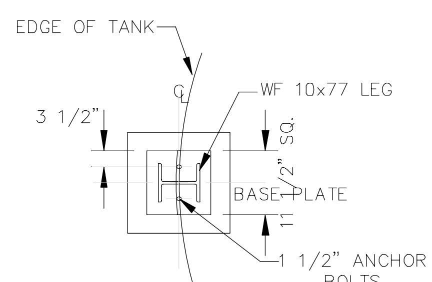
NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.



PLAN



ELEVATION



DETAIL 1
N.T.S.

Jacobs
10 Tenth Street Suite 1400 Atlanta, GA 30309 404.978.7600

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION
CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE
THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.
PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT
SHEET TITLE
TANK DATA SHEET - T-520
SHEET 0520-080-020

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

EXHIBIT B

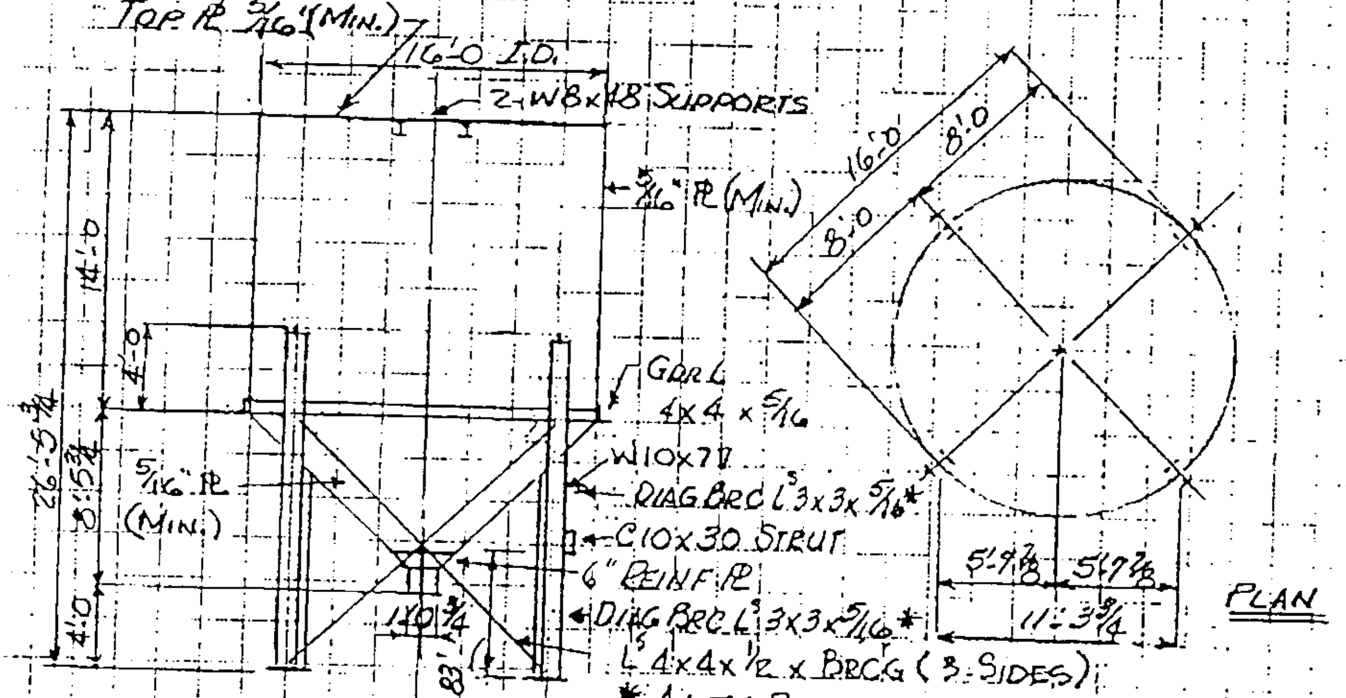
TANK DESIGN CALCULATIONS

ETI CORP
MEMPHIS, TN

TANK CERTIFICATION
EMELLE AL
T-520

#93-540
REV. 11-24-93

1/26



TANK ELEVATION

*ALT.: RELOCATE VALVES TO OUTSIDE OF DIAG. BRC. L^S AND ADD 4TH SIDE OF L^S 4X4x1/2 X " BRC. BY REMOVING C10x30 STRUT.

OPERATING PRESSURE:	ATM - 8.0z TO 16 Oz
DESIGN PRESSURE: 28" H_2O	144 PSF
DESIGN VACUUM: -14" H_2O	-72 PSF
OPERATING TEMPERATURE	0° TO 150
SERVICE:	WASTE FUELS
CAPACITY (DESIGN): 25,066 GALS	22,058 GALLONS
SPECIFICATIONS:	API 620
DESIGN METAL TEMPERATURE:	25° F (ASSUMED)
DESIGN WIND VELOCITY:	100 MPH ANSI 58.1
SEISMIC	ZONE 1 (LOCAL CONDITIONS)
MATERIAL SPECIFICATIONS: (PLATES & STRUCTS)	A36
CORROSION ALLOWANCE	1/8"
SPECIFIC GRAVITY OF LIQUID	1.50
JOINT EFFICIENCY (J.E)	70% (0.70) FACTOR

ALABAMA REGISTERED PROFESSIONAL ENGINEER No. 12522 RAY T. SAUNDERS, SR.

ETI CORP
MEMPHIS, TN

TANK CERTIFICATION
EMELLE AL
T520

#93540
REV 11-24-93

2/

SHELL RINGWALL REQUIREMENTS (API 650) (SIMILAR TO API 620 METHOD)
(SEE SHT #3 FOR API 620 CALCS.)

NOTE: USE NOMINAL DIMENSIONS D<50' ∴ 3/16" PL MIN REQD LESS CA

TANK AREA
$(16)^2(0.7854) = 201.06^{\#'}$
CIR = $\pi D = \pi 16.0' = 50.27'$
VOL = $2814.84'^3 + 424.41'^3$
$= 3239.25'^3$
CAPACITY = 24231 GALS
LIQ. WT. = 303,194 #

$t = \dfrac{2.6\,D(H-1)\,G}{E\,21{,}000} + CA$

$.04$
$= \dfrac{2.6(16.0)(14'.1)(1.5)}{0.70(21{,}000)} + 0.125 = 0.1802" < \frac{3}{16}+\frac{1}{8} = \frac{5}{16}$

$= .04 + 0.125" = 0.129" \leq \frac{3}{16}"$ MIN + CA

$S_t = \dfrac{2.6\,D(H-1)G}{t} = \dfrac{2.6(16.0)(14-1)(1.5)}{0.1875}$
$= 4326.41$ psi < 15,000 psi ∴ OK

USE 3/16" + 1/8" CA = 5/16" PL MINIMUM

ROOF STEEL REQUIREMENTS (SEE SHEET 4 FOR CALCS.)

DEAD LOAD: 5.25 PSF WT. OF PL & APPURT. w/o CA
LIVE LOAD: 25 PSF
DESIGN PRESSURES: 28" H_2O = 1.0 psi = 144.0 PSF
MINIMUM PL THICKNESS SHALL BE 3/16" + CA = 3/16 + 1/8 = 5/16" MINIMUM

EXTERNAL FORCES = (25.0 PSF + 5.25 PSF)/144 #" = 0.21 psi < 1.0 psi
INTERNAL FORCES = 1.0 psi WILL GOVERN DESIGN PRESSURES

PLATE STRESS: 1. ASSUME 3/16" EFFECTIVE THICKNESS
2. CIRCULAR FLAT PLATE STRESS CHECK BASE ON, "DESIGN OF WELDED PLATE STRUCTURES" (BY BLODGETT)

ALABAMA REGISTERED No. 12522 PROFESSIONAL ENGINEER LARRY T. SAUNDERS

ETI CORP
MEMPHIS, TN

TANK CERTIFICATION
EMELLE AL
T520

#93540
REV 11-24-93

3/

SHELL RINGWALL REQUIREMENTS API 620 (SIMILAR TO API 650)

W = 4102# TOP
5982 SHELL
10,084
605 + 6% DETAIL
10689

$R_c = R_2 = 8'(12") = 96"$

$P = 0.43(14.0)(1.5) = 9.03$ psi

$F = 303,194\#$

$A_T = A = .7854(16 \times 12)^2 = 28953 \square''$

$T_1 = \frac{R_c}{2}\left(P + \frac{W+F}{A_T}\right)$

$= \frac{96''}{2}\left(1.00 \text{ psi} + \frac{10689 + 303,194}{28953 \square''}\right)$

$= 568.37$ psi

$F_T = 15000$ psi

$t = \frac{568.37 \text{ psi}}{15000} = 0.04''$ (3/16" THK PL MINIMUM)

$0.04'' + 0.125 = 0.129''$ t < 3/16" + 1/8" CA = 5/16 MINIMUM

ALABAMA REGISTERED No. 12522 PROFESSIONAL ENGINEER ... T. SAUNDERS SR.

ETI CORP. TANK CERTIFICATION #93-540 4/
MEMPHIS, TN EMELLE AL REV 11-24-93
T520

PLATE STRESS (CONT'D)

3. ASSUME EDGES FIXED AND A UNIFORM LOAD
4. ASSUME W8x48 BEAM REINFORCEMENT

PLATE STRESS @ CENTER

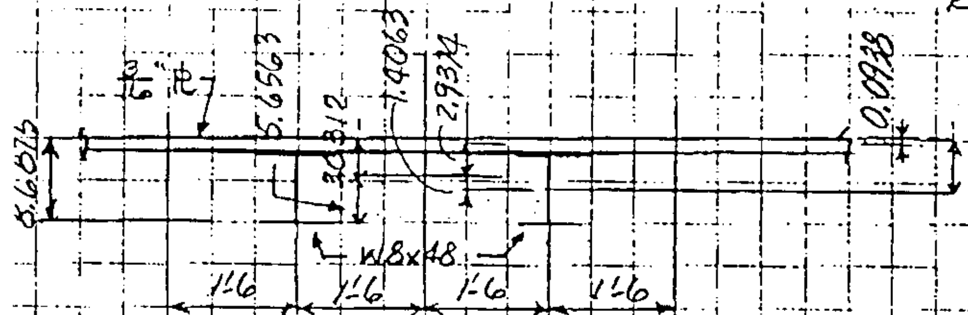
$$\sigma_r = \sigma_t = -\frac{0.488\,pr^2}{t^2} = \frac{0.488(1.0)(16.0' \times 12")^2}{(0.1875")^2} = 511{,}705 \text{ psi} > 15000 \text{ psi}$$

∴ REINFORCEMENT IS REQUIRED.

PLATE STRESS @ EDGE

$$\sigma_r = \frac{3pr^2}{4t^2} = \frac{3(1.0\text{ psi})(16.0' \times 12")^2}{4(0.1875")^2} = 786{,}432 \text{ psi} > 15000 \text{ psi}$$

∴ REINFORCEMENT IS REQUIRED



W8x48 PROPS:
A = 14.1 □"
d = 8.5"
b_f = 8.11"
I_x = 184"⁴
S_x = 43.3"³
r_x = 3.61
I_y = 60.9"⁴
S_y = 15.0"³
r_y = 2.08

C.G.

PART	AREA	ARM	MOM
PL 3/16 x 72"	13.5 □"	0.0938"	1.2656"³
2-W8x48	28.2 □"	4.4375"	125.1375"³
	41.7 □"	3.0312	126.4031"³

$\frac{bd^3}{12} = \frac{72(.1875)^3}{12}$

Ixx

PART	A	d	Ad²	Ix	Ixx
PL 3/16 x 72"	13.5 □"	2.9374	116.48	0.0396	116.52
2-W8x48	28.2 □"	1.4063	39.66	368.00	407.66
	41.7				524.18

$S_T = 524.18 / 3.0312 = 172.93"^3$ $S_B = 524.18 / 5.6563 = 92.67"^3$

STATE OF ALABAMA REGISTERED No. 12522 PROFESSIONAL ENGINEER RAY T. SAUNDERS, SR.

ETI, CORP
MEMPHIS TN

TANK CERTIFICATION
EMELLE AL
T520

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$M_{\mathbb{C}} = \frac{qr^2}{16}(1+\nu) = \frac{144\text{ PSF}(8.0)^2(1+0.11)}{16} = 639.66'\#$

$M_{(EDGE)} = \frac{-qr^2}{8} = \frac{-144\text{ PSF}(8.0)^2}{8} = 1152'\#$

TOP PLATE STRESS CHECK w/REINF

$f_{b_T} = \frac{M}{S_T} = \frac{639.7'\#(12)}{172.93''^3} = 44.39\text{ PSI} < 15{,}000\text{ PSI} \therefore OK$

$f_{b_B} = \frac{M}{S_B} = \frac{1152'\#(12'')}{92.67''^3} = 149.17\text{ PSI} < 15{,}000\text{ PSI} \therefore OK$

BOTTOM PL REQUIREMENTS (CONICAL AND ELEVATED)

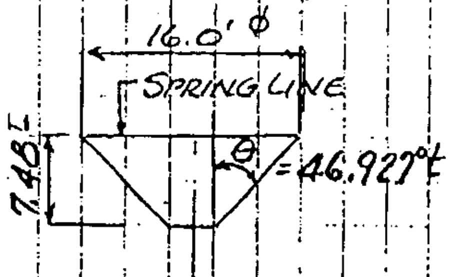
SHELL t_L = 3/16" + 1/8" CA = 5/16

MIN. PL THICKNESS = 3/16"

THE CONICAL BOTTOM SHALL BE TREATED AS PART OF SHELL OR SUSPENDED BOTTOM.

CONICAL BOTT 3/16 + 1/8 CA = 5/16" MIN.

FORMULAS PER "STRUCTURAL ENGINEERS HANDBOOK (BY GAYLORD & GAYLORD)



$T_2 = \frac{\gamma}{2\cos\theta}\left(\frac{D}{2} - h_c\tan\theta\right)\left(x + \frac{2h_c}{3} + \frac{D}{6}\cot\theta\right)$

$T_1 = \frac{\gamma}{\cos\theta}\left(\frac{D}{2} - h_c\tan\theta\right)(x + h_c)$

AT THE SPRINGLINE, THE STRESSES ARE:

$T_2 = \frac{\gamma}{2\cos\theta}(D/2)\left(x + \frac{D}{6}\cot\theta\right)$

$T_1 = \gamma D x / 2\cos\theta$

ETI, CORP TANK CERTIFICATION #93-540 6/
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7326

$$T_2 = \frac{93.60\ PCF}{2\cos 46.9271}\left(\frac{16.0'}{2} - 7.4792\tan 46.9271°\right)\left[(14.0') + \left(\frac{2\times 7.4792}{3} + \frac{16.0'}{6}\right)\left(\frac{1}{\tan 46.9271}\right)\right]$$
(68.5284 / 0 / 7.4792)
= 0

$$T_1 = \frac{93.60\ PCF}{\cos 46.9271°}\left(\frac{16.0'}{2} - 7.4792\tan 46.9271°\right)(14' + 7.4792')$$
(21.4792)

= 0 (NEGLIGIBLE)

NOTE: WHERE θ = APEX ∡, AT THE APEX $T_2 = T_1 = 0$

STRESS CHECK AT SPRING LINE

$$T_2 = \frac{93.60\ PCF}{2\cos 46.9271}\left(\frac{16}{2}\right)\left(14 + \frac{16}{6}\cdot\frac{1}{\tan 46.92}\right) = 9041.94\ \#/'$$

$$f_t = P/A = \frac{9041.94\ \#/'}{12\times 0.1875} = 4019\ psi < 15000\ psi \therefore ok$$

$$T_1 = \frac{93.60\ PCF\ (16)(14)}{2\cos 46.9271} = 15,350\ \#/'$$

$$f_t = P/A = \frac{15350\ \#/'}{12(0.1875)} = 6,822\ psi < 15,000\ psi \therefore ok$$

CHECK COMPRESSION STRESSES

$$C = \frac{\gamma}{8}\left(x + \frac{D}{6}\cot\theta\right)D^2\tan\theta$$

$$= \frac{93.6}{8}\left(14.0 + \left(\frac{16}{6}\right)\frac{1}{\tan 46.9271}\right)16^2\tan 46.9271$$

$= 49,920.0\ \#/'$

$$f_c = \frac{P}{A} = \frac{49,920^{\#}}{6\times 0.1875} = 44,313' > 15,000\ psi$$

∴ COMPRESSION GIRDER IS REQ'D

EFFECTIVE WIDTH OF CONE'S SHELL ACTING AS GIRDER

$W_s = 0.78\sqrt{(8.0'\times 12'')(0.1875'')}$
$= 3.3093''$ (ASSUMED)
$W_c = 0.78\sqrt{(5.66\times 12)(0.1875)}$
$= 2.78''$
$W_s + W_c = 6.09''$

ALABAMA REGISTERED No. 12622 PROFESSIONAL ENGINEER RAY T. SAUNDERS, SR.

ETI CORP. TANK CERTIFICATION #93-540 7/
MEMPHIS, TN EMELLE AL REV 11-24-93
T520

CHECK SHELL & CONE JUNCTION FOR COMPRESSION W/ 3/8" PLS

$A_{EFF} = 16(t_c^2 + t_1^2)$

$= 16(0.25^2 + 0.25^2)$

$= 2.0 \square''$

$f_c = P/A = \frac{49{,}920\#}{2.0\square''} = 24{,}960 \text{ psi} > 15{,}000 \text{ psi}$ ∴

GIRDER L WILL BE REQ'D WITH 5/16" PLS OR 3/8" PLS - USE 5/16 PL MIN W/ GDR L.

(SEE SHT #8 FOR GDR. L CALCS.)

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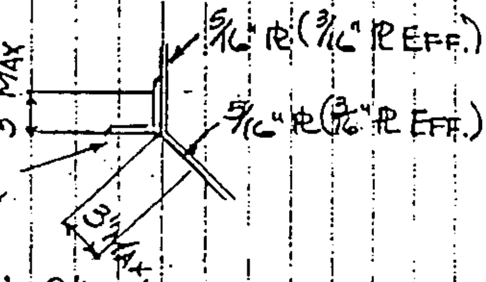
AREA REQ'D $\frac{49,920\#}{15,000 PSI} = 3.33 \square''$



$3.33 \square'' - 6(.1875'') = 2.20 \square''$

$f_c = \frac{49,920\#}{6(.1875)+2.40} = 14,162 \text{ psi} < 15000 \text{ psi} \therefore OK$

UPPER COMPRESSION RING (API 620) (SIMILAR TO API 650)

$A = \frac{D^2(P - 8t_h)}{30,800 \tan\theta} = \frac{(16)^2(1.44 PSF - 8(.1875))}{30,800 \tan 0°} = 0$

THE FLAT PLATE DESIGN WILL PLACE THE ROOF PLATE IN TENSION AT THE SHELL. THE MIDDLE ROOF SUPPORTS WILL RELIEVE SHELL OF SOME FORCES AND COMPRESSION.

WT. OF SHELL

DESCRIPTION	W/CA	+ 6%	W/O CA	+ 6%
CRS #1	8982#	9521#	5389#	5712#

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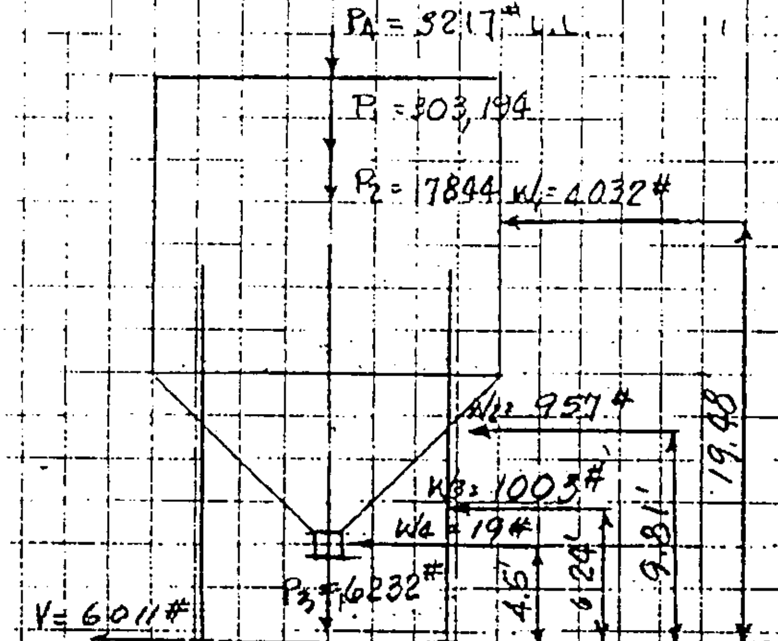
METAL LOADS:

PART	W/CA	+6%	W/O CA	+ 6%
TOP	4102	4348	3076	3260
SHELL	8982	9521	5389	5712
BOTT	3750	3975	2250	2385
	16834	17844	10715	11357
SUPPORTS	5879	6232	5879	6232
	22713	24076	16594	17589

TANK SUPPORT REQUIREMENTS



WIND LOAD DIAGRAM

MAT'LS ASTM-A36
F_t = 15.0 KSI
F_c = 15.0 KSI
F_b = 15.0 KSI
F_p = 20.0 KSI (COL PLS)
F_v = 9.75 KSI (WEB OF BMS)
F_v = 11.25 KSI (TANK PLS & STRUCT CONN MATLS

LIQUID LOAD:
P_1 = 303,194#

$V_W = \Sigma W$ = 4032# + 957# + 1003# + 19#
= 6011#
M_W = 4032#(19.48) + 957#(9.81')
+ 1003#(6.24') + 19#(4.5')
= 94,276'#

SEE SEISMIC CONDITIONS

W_1 = 18.0 PSF (14)(16) = 4032#
W_2 = (16.0' + 1.06')/2 × 7.4792 × 15 PSF = 957#
W_3 = (0.67)(12.4792)(30)(4) = 1003#
W_4 = (1.06)(1.0) × 18 = 19#

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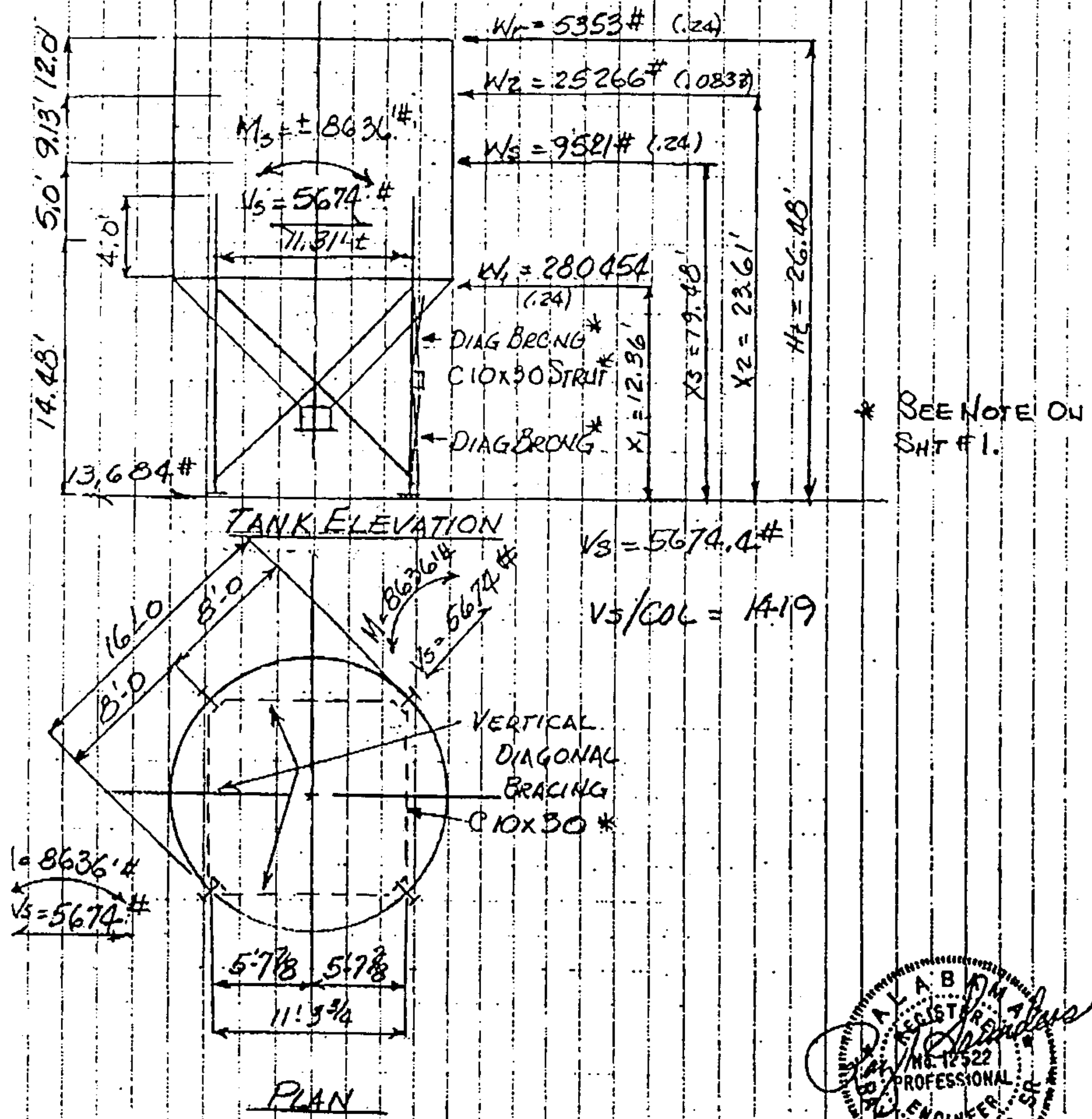
Seismic Tank Support Requirements:



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CHECK STRUCTURE FOR SEISMIC ZONE REQUIREMENTS (APPENDIX E API 650)

$M_s = Z I (C_1 W_s X_s + C_1 W_r H_t + C_1 W_1 X_1 + C_2 W_2 X_2)$

Z = 0.1875 ZONE COEFFICIENT (FIG E1 & TABLE E1
I = 1.0 ESSENTIAL FACILITIES FACTOR
C_1 = 0.24 (E.3.3.1.)
C_2 = 0.0833 (SEE BELOW)
W_s = 9521# TOTAL WT. OF TANK SHELL, IN POUNDS
X_s = 19.48 HGT FROM BASE PL TO SHELLS C of G
W_r = 4348 + 1005 = 5353# TOTAL WT TANK ROOF & PORTION SNOW LOAD
H_t = 26.48' TOTAL HT. TANK SHELL, IN FEET
W_1 = 280,454# WT OF EFFECTIVE MASS OF THE TANK CONTENTS THAT MOVE IN UNISON W/ TANK SHELL (E.3.2.1)
X_1 = 12.36' HT. FROM BOTT OF TANK SHELL TO CENTROID OF LATERAL SEISMIC FORCE APPLIED TO W_1 (E.3.2.2)
W_2 = 25,266# WT. OF EFFECTIVE MASS OF TANK CONTENTS THAT MOVE IN FIRST SLOSHING (E.3.2.1)
X_2 = 23.61' HT FROM BOTT OF TANK SHELL TO THE CETROID OF LATERAL SEISMIC FORCE APPLIED TO W_2, IN FEET (E.3.2...

W_T = 303,194# TOTAL WT OF TANK CONTENTS IN POUNDS
D = 16.0' NOMINAL DIAM. OF TANK IN FEET
H = 26.4792' MAX. DESIGN LIQUID LEVEL, IN FEET

$C_2 = \frac{0.30S}{T}$ WHEN T < 4.5 SECS. $T = K(D^{0.5})$ (SEE FIG 7 FOR K VALUE)

$C_2 = \frac{1.35S}{T^2}$ WHEN T > 4.5 SECS

WHERE S = SITE AMPLIFICATION FROM TABLE E2
T = NATURAL PERIOD OF FIRST SLOSHING MODE

$V = Z I (C_1 W_s + C_1 W_r + C_1 W_1 + C_2 W_2)$

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$D/H = \frac{16.0'}{26.4792'} = 0.378$ $K = 0.575$ (PER FIG 7) $T = 0.575(16.0')^{0.5} = 2.30$

$C_2 = \frac{0.30S}{T} = \frac{0.30(1.2)}{2.30} = 0.1565$

$\frac{X_1}{H} = 0.4667(26.4792) = 12.36'$ $\frac{X_2}{H} = 0.8917(26.4792) = 23.61'$

$\frac{W_1}{W_T} = 0.9250(303,194^{\#}) = 280,454$ $\frac{W_2}{W_T} = 0.0833(303,194) = 25,266^{\#}$

$M = (0.1875)(1.0)[(0.24)(9521^{\#})(19.48') + (0.24)(5353^{\#})(26.48')$ (44513) (34019)

$+ (0.24)(280,454)(12.36') + (0.0833)(25266)(23.61)]$ (831,938) (49691)

$= 180,030'^{\#}$ (90.1% GREATER THAN WIND MOMENTS)

$V = (0.1875)(1.0)[(0.24)(9521) + (0.24)(5353) + (0.24)(280,454) + (0.0833)(25266)]$ (2285) (1285) (67309) (2105)

$= 13684^{\#}$ (127% > THAN WIND SHEAR)

SEISMIC FORCES GOVERN - USE FOR SUPPORT DESIGN { $M_S = 180,030'^{\#}$, $V_S = 13,684^{\#}$ }

MAX. SEISMIC LOAD / LEG OR COLUMN $\frac{1}{2} M_S$

$P_S = \frac{M}{d} = \frac{180,030'^{\#}}{16.0' \pm} = 11,252^{\#}$ (AXIAL TO COL.)

NOTE: DIAGONAL BRACING SHALL BE USED TO TRANSFER SEISMIC FORCES TO THE FOUNDATION.

AXIAL LOADS ON COL LEGS

W/O LIQUID $P_{DL} = \frac{17844^{\#} + 6232^{\#}}{4 \text{ COLS}} = 6019^{\#}/\text{COL}$

W/ LIQUID $P_{TL} = \frac{303,194^{\#} + 17844^{\#} + 6232^{\#}}{4 \text{ COLS}} = 81,818^{\#}$

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LIVE LOAD (SNOW LOAD NEGLIGIBLE - APPROX. 5.0 PSF)

AREA = $(16.0)^2\, 0.7854 = 201.06\,\square'$ $\frac{201.26\,\square'(25\,PSF)}{4} = 1257\ \#/COL$

COLUMN REQUIREMENTS W/O SEISMIC OR WIND LOADS & W/LIVE LOADS

THE DIAGONAL BRACING RELIEVES THE COLUMNS OF BENDING MOMENTS

$L_u = 11.48'$ $P = 81{,}818\,\#$ COL SIZE = W10 x 77 PROPERTIES

CHK W10 x 77 $\frac{P}{A} = \left[\frac{18{,}000}{1 + \frac{L^2}{18000 r^2}}\right] = \left[\frac{18{,}000}{1 + \frac{(11.48 \times 12)^2}{18000 (2.6)^2}}\right] = 15{,}571\ psi > 15{,}000\ psi$ ∠ USE

$P = 81{,}818\,\# + 1257\,\# = 83075\,\#/COL$

$P_{(ALLOW.)} = Fa\,A = 15{,}000 (22.6\,\square'') = 339{,}000\,\# \geq 83{,}075\,\#$ ∴ OK

- $A = 22.6\,\square''$
- $d = 10.6''$
- $b_f = 10.19''$
- $I_x = 455''^4$
- $S_x = 85.9''^3$
- $r_x = 4.49''$
- $I_y = 154.0''^4$
- $S_y = 30.1''^3$
- $r_y = 2.60''$

$\frac{Kl}{r} = \frac{11.48'(12'')}{2.60} = 52.98$

Fa = 18.08 ksi PER AISC HANDBOOK

CHECK CHANNEL STRUT

$\frac{Kl}{r} \leq 200$

$\frac{Kl}{r} = \frac{11.0'(12'')}{0.669} = 197.3 \leq 200$

∴ O.K.

NOTE:
ON FUTURE TANKS SIMILAR TO T520 A LIGHTER COLUMN WILL BE ADEQUATE.

[Seal: STATE OF ALABAMA REGISTERED PROFESSIONAL ENGINEER No. 12522 RAY T. SAUNDERS SR — signed]

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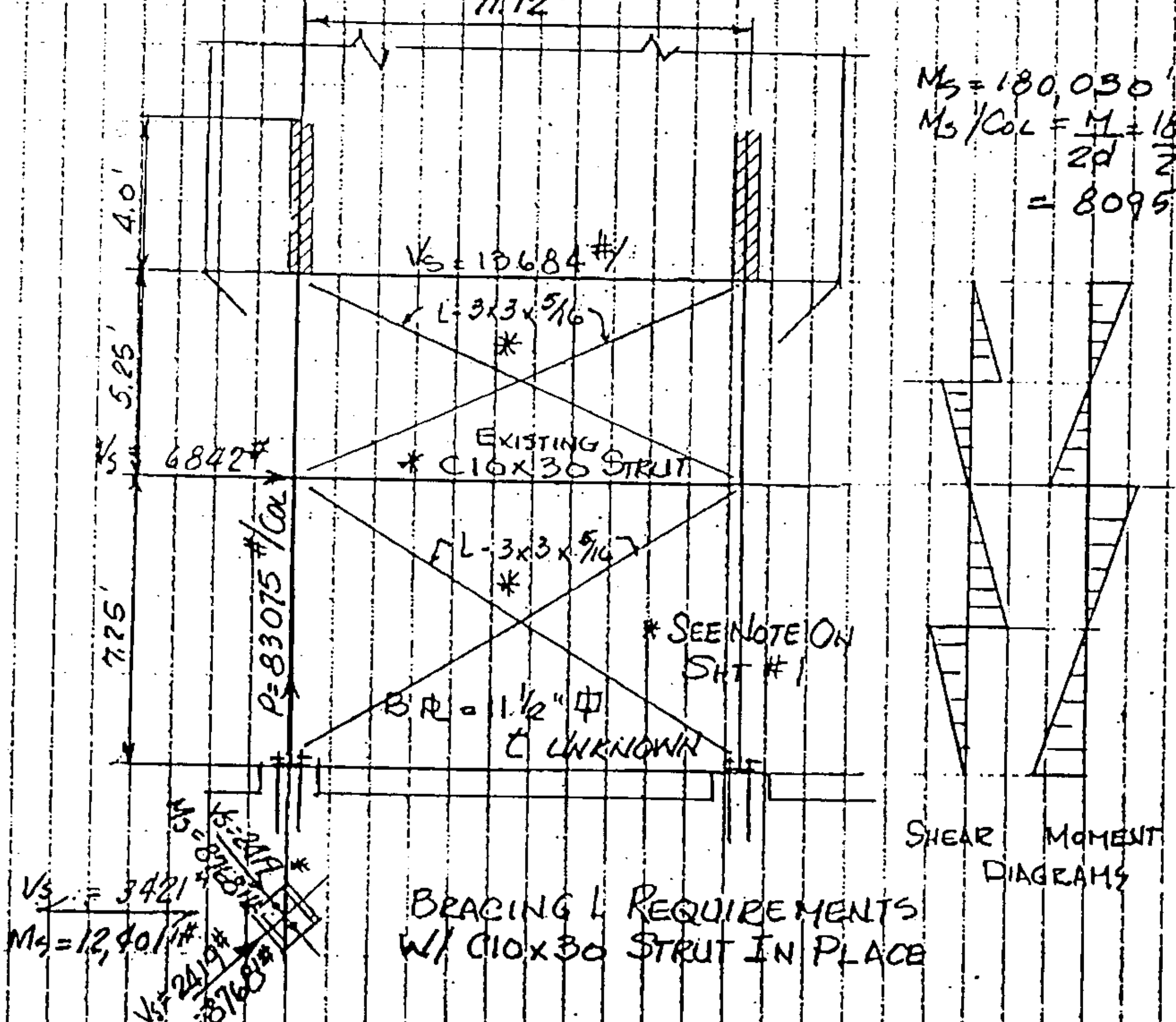
BENDING MOMENT ON COLS W/O DIAGONAL BRACING

$M_S = 180{,}030$ '#

$M_S/COL = \frac{M}{2d} = \frac{180{,}030\text{'\#}}{2(11.12')} = 8095$ '#/COL



LOAD PER COLUMN = 81,818 # (DEAD LOADS INCL LIQUID)
1257 L.L.
83075# T.L.

$V_S/COL = 13684\#/4 = 3421\# = \ell$

$M_S/COL = 3421\#(7.25)/2 = 12{,}401$ '# - ℓ

$V_S = 3421\#(.707) = 2419\#$

$M_S = 12{,}401$ '#$(.707) = 8768$ '#

ALABAMA REGISTERED No. 12522 PROFESSIONAL ENGINEER RAY T. SAUNDERS, SR.

Exhibit B

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$$f_a = \frac{P}{A} = \frac{83075^{\#}}{22.6\square''} = 3675 \text{ psi}$$

$$f_{b_Y} = M/S_Y = \frac{8768'\#(12)}{30.1''^3} = 3496 \text{ psi}$$

$$f_{b_X} = \frac{M}{S_X} = \frac{8768'\#(12)}{85.9''^3} = 1225.0 \text{ psi}$$

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \le 1.0$$

$$\frac{Kl}{r_Y} = \frac{7.25'(12'')}{2.60} = 33.46 \quad F_a = 19.65 \text{ ksi}$$

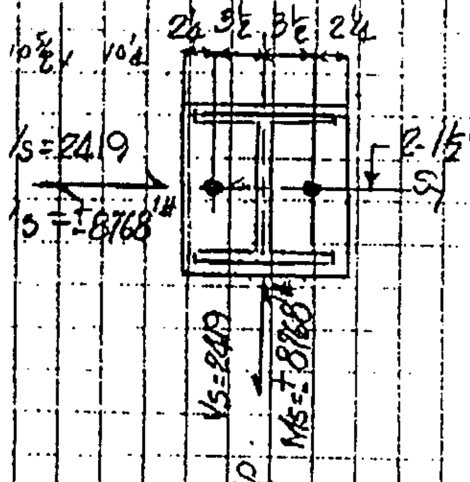
$$\frac{Kl}{r_X} = \frac{12.50'(12'')}{4.49} = 33.41 \quad F_a = 19.65 \text{ ksi}$$

$$\overset{0.19}{\frac{3675}{19650}} + \overset{.05}{\frac{1225}{18{,}000(1.33\frac{1}{3})}} + \overset{0.15}{\frac{3496}{18{,}000(1.33\frac{1}{3})}} = 0.39 \le 1.0$$

W10×77 Cols OK
W/ C10×30 Strut

Alabama Registered Professional Engineer No. 12522 Saunders Sr.

Base Plate Requirements (At Worse Condition)



$$S_X = \frac{11.5''(5.75'')^2}{6} = 63.37''^3$$

$$f_{p_X} = \frac{M}{S_X} = \frac{8768'\#(12'')}{1.33\frac{1}{3}(63.37)} = \pm 1245 \text{ psi}$$

$$S_Y = \frac{11.5''(9.25)^2}{6} = 163.99$$

$$f_{p_Y} = \frac{M}{S_Y} = \frac{8768'\#(12'')}{1.33\frac{1}{3}(163.39)} = \pm 483 \text{ psi}$$

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$f_a = \frac{P}{A} = \frac{83075}{(11.5')^2} = 628$ psi

MAX PRESSURE WILL OCCUR AT CORNER OF BASE PL

$f_1 = -628 + 1245 + 483 = +1100$ psi

$f_2 = -628 - 1245 - 483 = -2356$ psi $> 1000(1.33\frac{1}{3})$
$= 1333$ psi

ASSUMING 4000 psi CONCRETE WAS USED, THE TOE PRESSURE OVERSTRESS IS 77%. THIS REQUIRES "X" BRACING OR A REVISED ENLARGED BRG. PLATE AND A WIDE SPACED A.B.
UPLIFT ON ANCHOR BOLTS:

$f_a = \frac{P}{\#\text{BOLTS}} = \frac{83075^\#}{2\text{ BOLTS}} = -41357^\#$ PRESSURE / BOLT

$f_{bx} = \frac{M_x}{d_x \# \text{BOLTS}} = \frac{8768'^\#}{2 \times .48'} = +9133^\#$

$f_{by} = \frac{M_y}{d_x \# \text{BOLTS}} = \frac{8768'^\#}{2 \times .77} = +5694^\#$

$-26530^\#$ COMPRESSION ∴ ANCHOR BOLTS OK

BRACING WILL BE REQUIRED BELOW AND ABOVE THE CHANNEL STRUT TO PREVENT CONC PIER OVERSTRESS.

BRACING LENGTH $= \left[(7.25')^2 + (11/12)^2\right]^{1/2} = 13.27'$

$\frac{Kl}{r} \leq 300 \quad r = \frac{13.27(12)}{300} = 0.53''$

USE L's 3 x 3 x 5/16" W/ 5/16" GUSSET PLs.

ALABAMA No. 11529 PROFESSIONAL ENGINEER RAY T. SAUNDERS, SR

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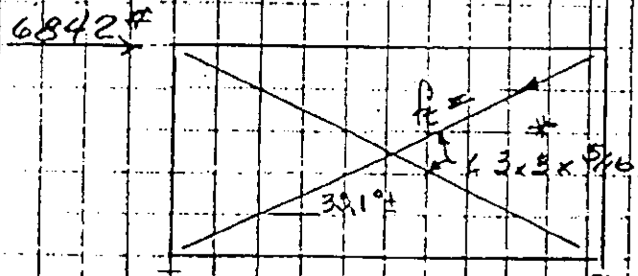
CHECK FORCES ON DIAGONAL BRACING.



$f_t = \frac{6842^{\#}}{\cos 33.10^\circ} = 8168^{\#}$

$f_t = \frac{P}{A} = \frac{8168^{\#}}{1.78} = 4589\,psi$

< 15000 psi ∴ OK

* SEE NOTE ON SHT #1

NOTE:
RECOMMENDATIONS - REMOVE C10x30 STRUT & PLACE "X" BRACING ∠s 4x4x1/2 TO MATCH OTHER 3 SIDES.

ALABAMA REGISTERED No. 17322 PROFESSIONAL ENGINEER SAUNDERS SR.

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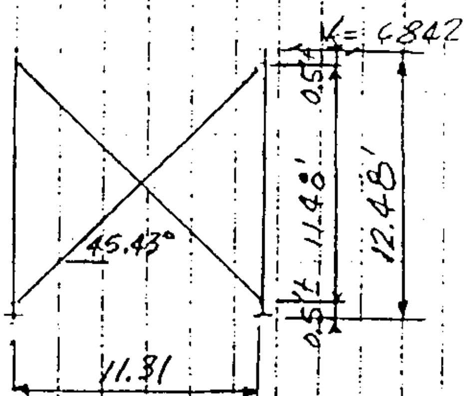
CHECK DIAGONAL BRACING REQUIREMENTS



TOTAL $V_S = 13{,}684\#$

MAX V_S WILL OCCUR WHEN SEISMIC FORCES ARE PARALLEL TO THE DIAGONAL BRACING.

$V_{S(MAX)} = 13{,}684\#/2 = 6842\#$

$\dfrac{6842\#}{\cos 45.43°} = 9749\#$

$A = \dfrac{P}{F_t} = \dfrac{9749\#}{(15000\,psi)(1\tfrac{1}{3})} = 0.49\,\square''$

$Kl/r = 300 \quad r = \dfrac{Kl}{300} = \dfrac{15.0^{\pm}(12)(1.0)}{300} = 0.60$

L^S $3\tfrac{1}{2} \times 3 \times \tfrac{5}{16}$ LLH ADEQUATE
USE L^S $4 \times 4 \times \tfrac{1}{2}$ (MINIMUM)

$\tfrac{5}{16}$" THK GUS. PLS ADEQUATE
USE $\tfrac{1}{2}$" THK GUS. PLS (MINIMUM)

CHECK TANK FOR WIND LOADS AND OVERTURNING RESISTANCE W/O LIQUID AND ½ LIVELOAD

$P_{DL} = \dfrac{17{,}844\# + 6232}{4} = \dfrac{24{,}076}{4} = 6019\#$

$P_{LL(1/2)} = 1257\#/2 = 629\#$

$P_W = \dfrac{94276'\#}{16.0'} = 5892\#$

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CHECK LIGHTER COL REQUIREMENTS:

THERE WILL NOT BE ANY WIND MOMENTS DUE TO DIAGONAL BRACING.

$f_a = \frac{P}{A} = \frac{6019+629^{\#}}{9.13} + \frac{5892^{\#}}{9.13(1/3)} = 1212\ psi < 14{,}304\ psi$

∴ W8x31 COLS OR LEGS O.K. W/ DIAGS ON 4 SIDES

CHECK ANCHOR BOLT REQUIREMENTS

FOR AN UNANCHORED TANK, THE SEISMIC MOMS SHALL NOT EXCEED 2/3 OF THE DEAD LOAD RESISTING MOMS.

$M = 2/3\left(\frac{W\,D}{2}\right) = \frac{2}{3}\left(\frac{24076 \times 16.0'}{2}\right) = 128{,}405 < 180{,}030'^{\#}$

D = DIST. BETW. COLS

ANCHOR BOLTS WILL BE REQ'D.

ANCHOR BOLT UPLIFT $= \frac{180{,}030'^{\#} - 128{,}405'^{\#}}{16.0'\pm} = 3227^{\#}$ UPLIFT/COL.

AREA REQ'D $= \frac{3227^{\#}}{2(15000 psi)(1 1/3)} = 0.0807\ \square''$ 2-3/4"ϕ ANC. BOLTS (0.334 □" NET AREA) ARE ADEQUATE W/ DIAG BRACING 4 SIDES.

$V_w = \frac{13{,}684^{\#}}{4 \times 2} = 1710.5^{\#}$ $\frac{1710.5}{0.334} = 5121\ psi < 10{,}000\ psi\ (1.33\frac{1}{3})$

CHECK ANCHOR BOLTS FOR COMBINED STRESSES

$F_t = 26.0 - 1.8 f_v \leq 15\ ksi$

$F_t = 26 - 1.8(5.21\ ksi) = 16.78\ ksi \geq 10.0\ ksi$

$f_t = \frac{P}{A} = \frac{1710.5}{0.334} = 5122\ psi < 10.0\ ksi$ ∴ OK

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CHECK BASE PL REQUIREMENTS - MAX LOADS

24,076 #	TOTAL WT OF TANK AND SUPPORTS
6019 #	WT SUPPORTED BY EACH LEG
303,194 #	TOTAL WT. OF LIQUID
75,790 #	WT. SUPPORTED BY EACH LEG
180,030'#	SEISMIC MOMENT
11,252 # MAX	SEISMIC FORCE TO COL. OR 7959 #
629 #	½ L.L. / COL (2516 # TOTAL)
93,690 #	MAX COL LOAD

M = 0

$P_1 = 6019$ # D.L.

$P_2 = 75790$ # LL (LIQUID)

$P_3 = 629$ # LL (½)

$P_4 = 11252$ # SEISMIC FORCE TO COL.

OR $P_4 = 7959$ # W/ 2 COLS RESISTING

LOAD DIAGRAM @ BASE

$$f_p = \frac{\Sigma P}{A} = \frac{82438^{\#}}{(11.5'')^2} + \frac{11252}{(11.5'')^2(4/3)}$$

$$= 687.18 \text{ psi}$$

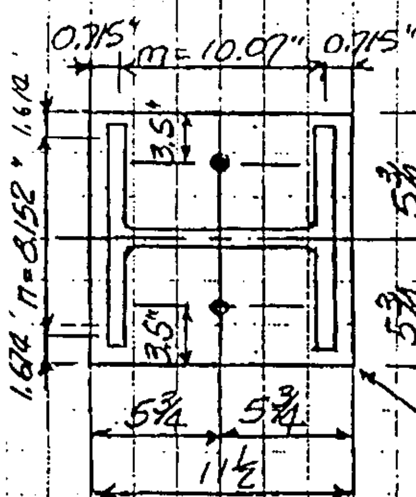
$$M = \frac{wa^2}{2} = 687.18 \text{ psi}(1.674)^2/2$$

$$= 962.8''\#$$

$$S = \frac{M}{F_b} = \frac{962.8''\#}{20,000 \text{ psi}} = 0.0481''^3$$

$$d = \sqrt{\frac{6S}{b}} = \sqrt{\frac{6(0.0481)}{1}} = 0.54$$

USE PLS 1" × 12 × 12



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CHECK COL TO TANK WALL CONNECTION FOR MOMS AND SHEARS

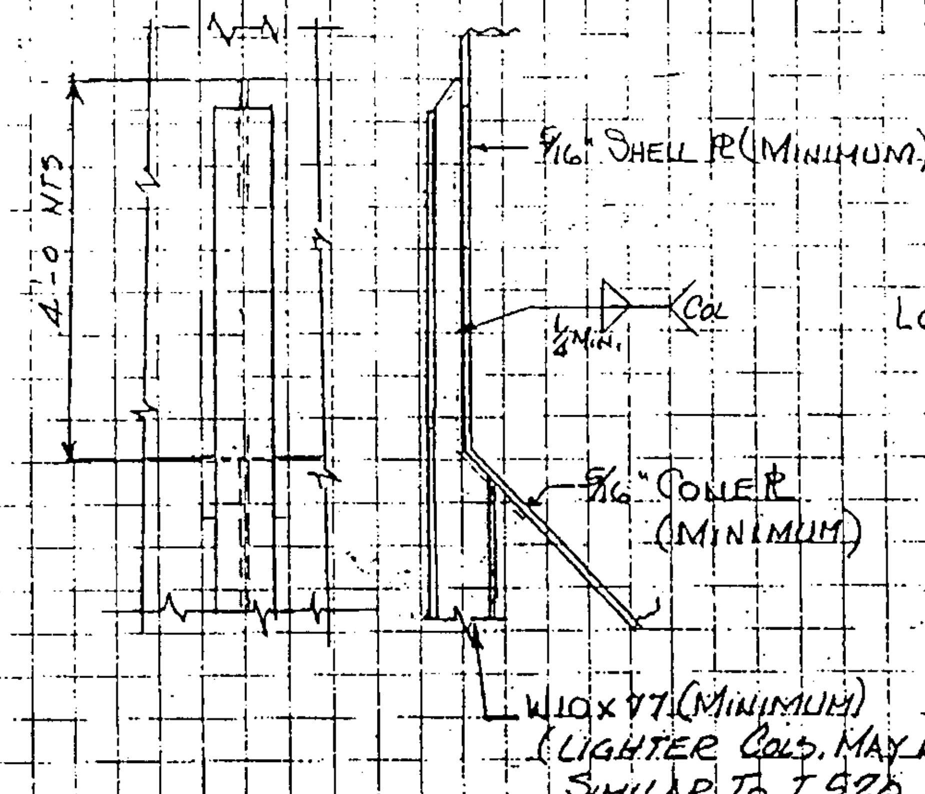
$P_{DL} = 6019^{\#}/COL$
$P_{LIQ} = 75790^{\#}/COL$
$P_{LL} = 629^{\#}/COL$
$\Sigma P_{TL} = 82438^{\#}$
$P_S = 540^{\#}$
$82978^{\#}$

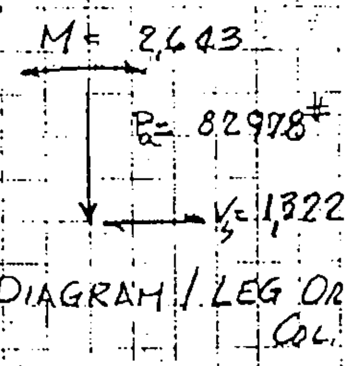
$M_S = 0.1875(1.0)[(0.24)(5353^{\#})(12.0') + (0.0833)(25266^{\#})(9.13') + (0.24)(9521)(8.0')] = 8636'^{\#}$

$f_b = \frac{M}{\Sigma S} = \frac{8636'^{\#}(12")}{2(35.0"^3)+2(22.18)} = 906.17\ psi$

CRITICAL COL MOM $= f_b S = 906.17psi\,(35.0"^3)/12" = 2643'^{\#}$

$P_S = \frac{M}{d} = \frac{8636'^{\#}}{16.0'\pm} = 540^{\#}$





COL WELDS

$S_W = d^2/3 = 48"^2/3 = 768"^2$

$S"^3 = 0.25(0.707)(768"^2)$
$= 135.74"^3$

$A_W = 2(48")(0.707)(0.25")$
$= 16.97\square"$

ALABAMA REGISTERED No. 12528 PROFESSIONAL ENGINEER T. SAUNDERS

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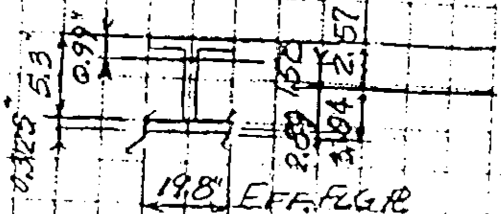


PART	AREA	ARM	MOM
5 WT 38.5	11.3	0.99"	11.19
PL 5/16" x 19.8"	6.19	5.46"	33.80
	17.49	2.57"	44.99

I^4_{xx}

PART	A	d	Ad^2	I^4_x	ΣI^4_{xx}
5WT38.5	11.3"	1.58"	28.21	17.4	54.83
PL 5/16 x 19.8	6.19"	2.89"	51.70	.03	51.73
					106.56

$\frac{I}{c} = S_x(TOP) = \frac{106.56''^4}{2.57} = 41.46''^3$

$\frac{I}{c} = S_x(BOTT) = \frac{106.56''^4}{3.04''} = 35.05''^3$

I^4_{YY}

PART	A	d	Ad^2	I^4_y	I^4_y
5 WT 38.5	11.3"	0	0		17.4"^{3}
PL 5/16 x 19.8	6.19	0	0	202.15"^{4}	202.15"^{3}
					219.55"^{3}

$S = \frac{I}{c} = \frac{219.55''^4}{19.8''/2} = 22.18''^3$

CHECK COL WELDS

$R = \sqrt{\left(\frac{V_R}{A}\right)^2 + \left(\frac{M}{S}\right)^2} = \sqrt{\left(\frac{82978}{16.97}\right)^2 + \left(\frac{2643(12)^2}{135.74}\right)} = 4895.27\,psi < 8000\,psi$

∴ OK

STATE OF ALABAMA REGISTERED No. 12522 PROFESSIONAL ENGINEER RAY T. SAUNDERS SR.

EXHIBIT C

TANK FOUNDATION DESIGN CALCULATIONS

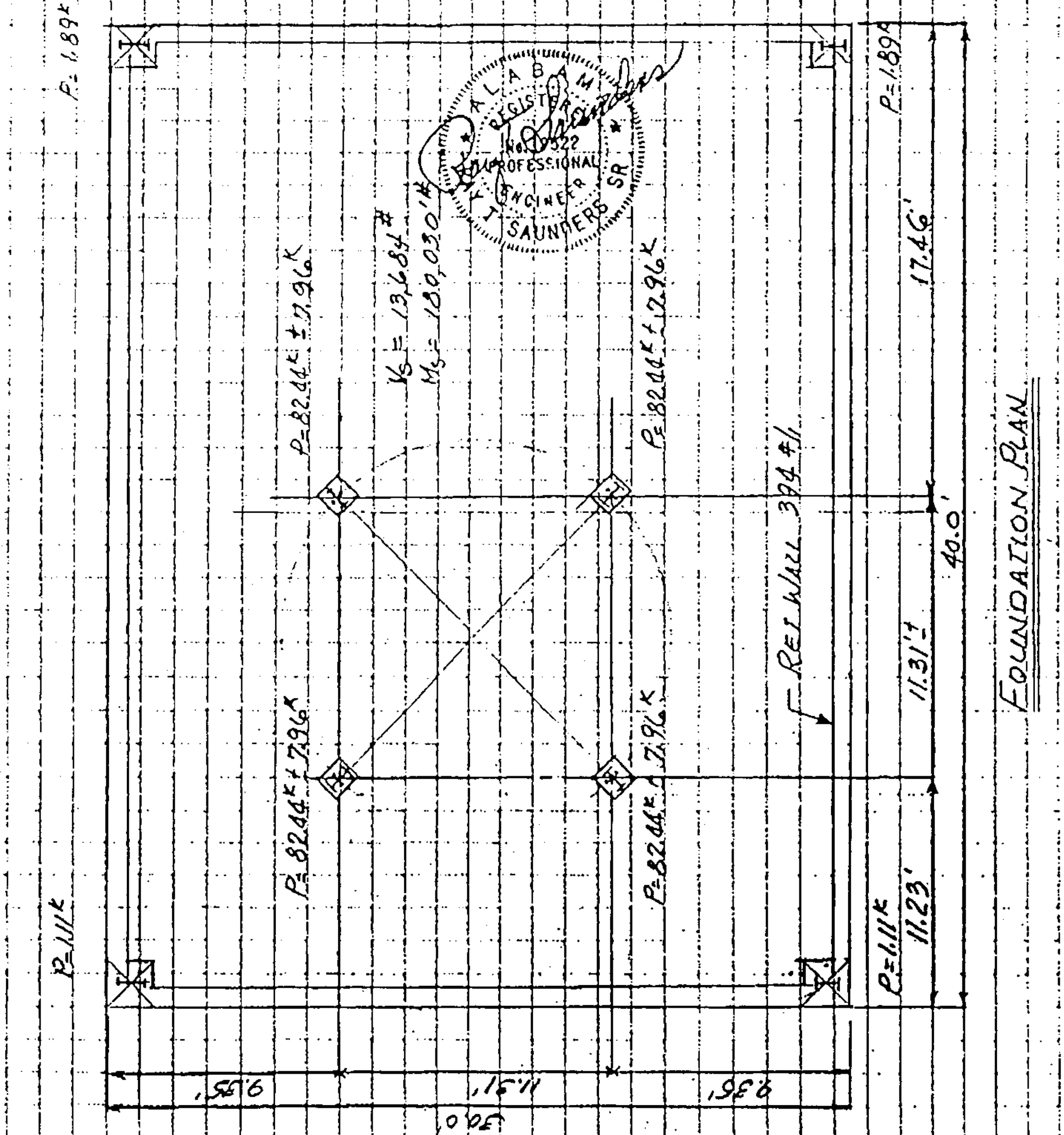
[RECEIVED 11/24 13:58 1993 AT 9017545135 PAGE 24 (PRINTED PAGE 24)]
Sentell Engineering TEL No.205-752-5569 Nov 24.93 12:05 No.003 P.24

ETI, Corp
Memphis TN

TANK CERTIFICATION
T520 FOUNDATION

#93-540
11-24-93

23/



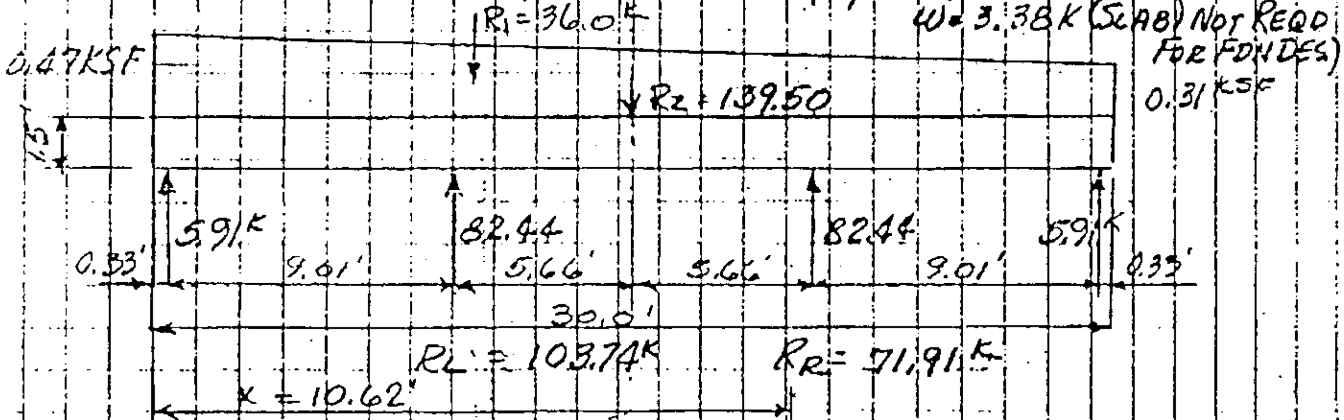
ETI, CORP. TANK CERTIFICATION #93-540 24/
MEMPHIS, TN. T520 FOUNDATION 11-22-93

WIDTH OF FDN SUPPORTING TWO (2) COLS = 15.0'

WALL LOADS = 15.0' × .67' × 3.92' × 1.0' × 150 PCF = 5.91^k

WGT OF SLAB = 0.225 KSF ; 15.0' × 0.225 = 3.38^k/' ; P = 82.44^k/COL

W = 3.38K (SLAB) NOT REQD FOR FDN DES)



$S_x = \frac{15.0(30.0)^2}{6} = 2250'^3$

$R_1 = \frac{0.47-0.31}{2}(30)(15.0') = 36.0^k$

$S_y = \frac{(30')(15.0)^2}{6} = 1125'^3$

$R_2 = 0.31^k(30.0')(15.0') = 139.50^k$

$P = 2(82.44) + 2(5.91) = 176.70$

CASE I

MAX SOIL PRESSURE = $P/A + M_x/S_x = \frac{176.7^k}{30 \times 15} + \frac{180.03'^k}{2250'^3} = 0.47$ KSF

MIN SOIL PRESSURE = $P/A - M_x/S_x = \frac{176.7^k}{30 \times 15'} - \frac{180.03'^k}{2250'^3} = 0.31$ KSF

$R_L = [+4.65^k(9.34)^2/2 - 4.65^k(20.66)^2/2 - 36^k(10.66')] \div 11.31$

$= 103.74^k$

$R_R = [-4.65^k(9.34)^2/2 + 4.65(20.66)^2/2 + 36^k(0.66')] \div 11.31$

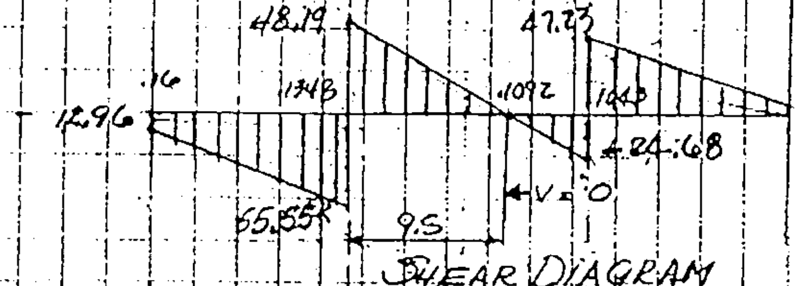
$= 71.91^k$

EII, CORP. TANK CERTIFICATION #93-540 26/
MEMPHIS, TN. T-520 FOUNDATION 11-24-93

$-5.91^k + .81(15.0') + .16(15.0) = -12.96$ $48.19^k - 4.65(11.31') = -4.4015$

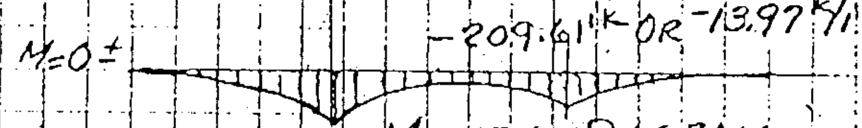
$-4.65 \times 9.34 - .01891^k(15.0)^2 = \underline{-40.59}$ $-\frac{1348+1003}{2}(15)(11.31) = \underline{-20.2817}$

-55.55^k -24.6852



-7.3062
-43.4310
$+5.91$

SHEAR DIAGRAM



MOMENT DIAGRAM

$M_{OH} = 103.74^k(9.50') - 4.65(18.84)^2/2 - 38.0^k(18.84')(2/3) + 5.91^k(18.17) = 0$

$= -209.61^{1k}$ (@ PT OF 0 SHEAR)

REBAR REQ'D/FT WIDTH

$DEPTH_{(EFF)} = 18" - 3.5"Cl. = 14.5"$

$A_s = \frac{M}{f_s j d} = \frac{13.97^{1k}(12")}{20ksi(.875)(14.5)(1.33\frac{1}{3})}$

$= 0.41$ $\square"$/1' WIDTH @ BOTT OF SLAB

$\frac{0.41\square"}{12} = \frac{0.6}{x}$ $x = 17.56" > 8"$ ∴ OK

USED #7 BRS @ 8" o.c.

∴ OK

NOTE:
BY OBSERVATION, THE SHEARS AND MOMENTS WILL BE VERY SIMILAR WITH COL LOADS. THRU THE 40' LENGTH, THEREFORE #7 AND #5 REBAR, BOTT. & TOP RESPECTIVELY WILL BE REQUIRED IN THE LONG (40') DIRECTION ∴ USE #7 BOTT BRS @ 8" o.c. E.W.
∴ " #5 TOP BRS @ 8" o.c. E.W.

ALABAMA REGISTERED No. 12522 PROFESSIONAL ENGINEER T. SAUNDERS SR.

Exhibit C
Page 3 of 4

ETI CORP. TANK CERTIFICATION #93-540 26/26
MEMPHIS, TN T520 FOUNDATION 11-24-93

CANTILEVER MOMS = $-4.65^K(9.34')^2/2 + 5.91^K(9.34')$
$+20.65^K(9.34 \times 2/3) = -274.2'^K$

$\frac{274.2'^K}{15'} = 18.41'^K$/FT WIDTH

$A_S = \frac{M}{f_s j d} = \frac{18.41'^K(12")}{(1\frac{1}{3})(24 ksi)(.875)(14.5)} = 0.5443$ $^{\#''}$/FT WIDE

$\frac{0.5443^{\#''}}{12} = \frac{0.6}{x}$ $x = 13.2''$

#7 BRS USED @ 8" O.C. E.W. ∴ OK

AREA STEEL REQUIRED PER FT. WIDTH

$12''(14.5'')(.005) = 0.87^{\#''}/1$

#7 BRS @ 8" = $\frac{.6}{8} = \frac{x}{12}$ $x = 0.9^{\#''}$/FT $\geq 0.87^{\#''}$ ∴ OK

TOP BRS. USE #5 BRS @ 8" O.C. E.W. ∴ OK

ALABAMA REGISTERED No. 12522 PROFESSIONAL ENGINEER RAY SAUNDERS, SR.

Exhibit C
Page 4 of 4

EXHIBIT D

CALCULATIONS OF TANK VENTING REQUIREMENTS

EXHIBIT D
TANK VENTING CALCULATIONS (PER API 2000)
CHEMICAL WASTE MANAGEMENT, INC., EMELLE, ALABAMA FACILITY

												IN-BREATHING					OUT-BREATHING					EMERGENCY		
Tank Nos.	Width/ Diameter (ft)	Length/ Shell Height (ft)	Depth/ Cone Height (ft)	Tank Wetted Surf. Area (sf)	Tank Capacity (gal)	Tank Rated Press. (in WG)	Tank Relief Press. (in WG)[1]	Tank Rated Vac. (in WG)	Tank Relief Vac. (in WG)[1]	Fill Rate (gpm)	With-drawal Rate (gpm)	Normal Venting (cfh)[2]	Thermal Venting (cfh)[3]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Normal Venting (cfh)[4]	Thermal Venting (cfh)[5]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Vent Capacity (cfh)[6]	Min. Area (sq in)[7]	Min. Size (in)
CONTAINER & TANK MANAGEMENT UNIT 520																								
T-520	16.00	14.00	8.00	988	25,066	28.00	14.00	14.00	7.00	300	300	2,400	597	2,997	2.68	2.00	5,143	597	5,740	3.63	3.00	520,730	136.3	14.00

NOTES:

1. Pressure and vacuum relief is assumed to be set to relieve at 50% of the design rated pressure or vacuum, unless noted. Emergency relief is assumed to be set at 75% of design pressure.
2. Normal in-breathing at 5.6 scfh per 42 gal barrel per hour of withdrawal, as specified in API 2000, 4th Edition.
3. Thermal in-breathing at 1 scfh per 42 gal barrel of tank volume, up to 20,000 barrel (840,000 gal) volume, as in API 2000.
4. Normal out-breathing at 12 scfh per 42 gal barrel per hour of fill for volatile liquids (flash point <100 deg F), as in API 2000. For non-volatile liquids 6 scfh per 42 gal barrel may be used.
5. Thermal out-breathing at 1 scfh per 42 gal barrel of tank volume for volatile liquids, up to 20,000 barrel volume, as in API 2000. For non-volatile liquids 0.6 scfh per 42 gal barrel may be used.
6. From API 2000 Appendix B on Emergency Venting, for four ranges of tank surface area, heat absorption, Q, is calculated. Vent capacity in SCFH is then calculated from the heat absorption according to the equation:
   SCFH = 70.5 * Q / [L * sqrt(M)] assuming a conservative "L * sqrt(M)" value of 1,337, that of hexane.
7. Formula for emergency vent area adapted from Protectoseal Technical Manual, on flow capacity of tank emergency venting devices for nozzles 8 in. and larger:
   CFH = 1,667 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank emergency relief setting and atmospheric conditions.
8. Formula for vent area for smaller nozzles such as normal breather vents, adapted from Crane Flow of Fluids, Eq. 2-24, very similar to, but more conservative, than Protectoseal equation:
   CFH = 845 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank relief setting and atmospheric conditions.
   The factor 845 was derived using unit conversion factors, a vapor density of 0.1875 lb/cf, and a conservative Y of 0.80 from charts on Crane p. A-21.

EXHIBIT E

TANK MATERIAL OF CONSTRUCTION

COMPATIBLITY INFORMATION

Compatibility Information

Unit 520: T-520

Carbon Steel

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Acetaldehyde	B	C	A	A	A	B	D	C	B	A
Acetamine	B		B	B	B	B	A		A	A
Acetate Solvents	C	B	A	A	A	B	D	D	D	A
Acetic Acid, aerated	D	D	A	A	A	A	C	D	D	A
Acetic Acid, Air Free	D	D	B	B	A	A	C	D		A
Acetic Acid, crude	C	C	B	B	A	B	D	D		A
Acetic Acid, glacial							C		D	A
Acetic Acid, pure	C	D	B	B	A	D	C	D		A
Acetic Acid, 10%	C	C	B	A	A	B	B	D	B	A
Acetic Acid, 80%	C	C	B	B	A	B	C	D	B	A
Acetic Acid Vapors	D		D	D	D	C	D			A
Acetic Anhydride	C	C	C	C	C	C	D	D	C	A
Acetone	A	A	A	A	A	A	D	A	A	A
Other Ketones	A	A	A	A	A	A	D	A	D	A
Acetyl Chloride	D	C	C	C	B	B	D		D	A
Acetylene	D	B	A	A	A	B	A	A	A	A
Acid Fumes	D	D	B	B	B		C			A
Acrylonitrite	B	B	B	B	B	B	D	D	D	A
Air (Oil Free)	A	A	A	A	A	A	A	A	A	A
Alcohol, Amyl	B	B	B	B	A	B	B	A	A	A
Alcohol, Butyl	A	B	A	A	A	B	B	B	C	A
Alcohol, Diacetone	B	B	B	B	B	B	D		A	A
Alcohol, Ethyl	B	B	B	B	B	B	A	A	A	A
Alcohols, Fatty	B	B	A	A	A		B			A
Alcohol, Isopropyl	B	B	B	B	B	B	B	A	A	A
Alcohol, Methyl	B	B	B	B	B	B	A	A	A	A
Alcohol, Propyl	B	B	A	A	A	B	A		A	A
Alumina	A						A		A	A
Aluminum Acetate	D		B	B	A	C	C		A	A
Aluminum Chloride dry	D	D	C	C	C	D	B	A	A	A
Aluminum Chloride solution	D	D	D	D	D	D	B		A	A
Aluminum Fluoride		D	D	D	C	C	A		A	A
Aluminum Hydroxide	B	D	A	A	A	B	A		A	A
Aluminum Nitrate	D	D		C	C	C	A		A	A
Alum (Aluminum Potassium Sulfate)	C	C	D	D	C	C	B		A	A
Aluminum Sulfate	C	D	B	C	B	B	A	A	A	A
Amines	C	D	B	B	B	B	D	A	C	A

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Ammonia, Alum				A	A		B		A	A
Ammonia, Anhydrous Liquid	C	A	B	B	A	B	B		A	A
Ammonia, Aqueous	C	A	B	B	A	B	B	A	A	A
Ammonia Gas, hot	D	C	A	A	A	D	D		B	A
Ammonia Liquor			A	A	A					A
Ammonia Solutions	D	B	A	A	A	B	B		B	A
Ammonium Acetate	D		B	B	B	B	D		A	A
Ammonium Bicarbonate	B	C	B	B	B	B	B	A	A	A
Ammonium Bromide 5%		D		C	B	B			A	A
Ammonium Carbonate	D	B	B	B	B	B	D	A	A	A
Ammonium Chloride	C	D	D	D	D	B	A	A	A	A
Ammonium Hydroxide 28%	D	B	B	B	B	D	B		A	A
Ammonium Hydroxide Concentrated	D	B	B	B	B	D	D	A	A	A
Ammonium Nitrate	D	D	A	A	A	D	A	A	A	A
Ammonium Oxalate 5%		D	B	B	B	B				A
Ammonium Persulfate	D	D	D	D	B	D	D		A	A
Ammonium Phosphate	D	D	C	B	C	C	A	B	A	A
Ammonium Phosphate Di-basic	C	D	C	B	C	C	A	A	A	A
Ammonium Phosphate Tri-basic	C	D	C	B	C	C	A	A	A	A
Ammonium Sulfate	C	D	D	D	B	B	A	A	A	A
Ammonium Sulfide	D	D		B	B	B	A		A	A
Ammonium Sulfite	C	D	C	C	B	C	B	A	B	A
Amyl Acetate	B	C	A	A	A	A	D	B	B	A
Amyl Chloride	B		B	B	B	B	D		D	A
Aniline	B	C	A	A	A	B	D	A	C	A
Aniline Dyes	C	C	A	A	A	A	D	A	C	A
Apple Juice	C	D	B	B	B	A	A	A	B	A
Aqua Regia	D	D	D	D	D		D		D	A
Aromatic Solvents	A	C	A	A	A	B	D		D	A
Arsenic Acid	B	D	B	B	B	D	A	A	A	A
Asphalt Emulsion	A	B	A	A	A	A	D	A	D	A
Asphalt Liquid	A	B	A	A	A	A	C	A	D	A

A = Excellent
B = Good
C = Poor
D = Do Not Use

	Valve Material: Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Seats & Seals: Buna N	Delrin	EPDM	Teflon
Barium Carbonate	B	B	B	B	B	B	B	A	A	A
Barium Chloride	C	C	D	D	B	B	A	A	A	A
Barium Cyanide	C		B	B	B	D	B		B	A
Barium Hydroxide	D	C	B	B	B	B	A	A	A	A
Barium Nitrate			B	B	B		A			A
Barium Sulfate	B	C	B	B	B	B	A	A	B	A
Barium Sulfide	D	C	B	B	B	C	A	A	A	A
Beer-Alcohol Industry	B	C	A	A	A	A	A	A	A	A
Beer-Beverage Industry	B	C	A	A	A	A	B	A	A	A
Beet Sugar Liquors	A	B	A	A	A	A	A	A	B	A
Benzaldehyde	A	D	A	B	A	B	D	A	A	A
Benzene (Benzol)	B	B	B	B	B	B	D	A	D	A
Benzoic Acid	B	D	B	B	B	B	D		D	A
Berryllium Sulfate	B		B	B	B	B	B		B	A
Blood (Meat Juices)	B		B	B	B	B	B		C	A
Borax (Sodium Borate)	C	C	A	A	A	A	B	A	A	A
Bordeaux Mixture	D	C	A	A	A	A	B	A	A	A
Borax Liquors	C	C	B	B	B	A	B	A	A	A
Boric Acid	C	D	B	B	B	B	A	A	A	A
Brake Fluid (Non Pet)	B			B	B	B	D		A	A
Brines, saturated	C	D	B	B	B	B	A	A	A	A
Bromine, dry	B	D	D	D	D	A	D		D	A
Bunker Oils (Fuel)	B	B	B	B	B	B	A	A	D	A
Butadiene	C	C	B	B	B	B	C	A	D	D
Butane	B	A	B	B	B	B	A	A	D	A
Butter					A		B			A
Buttermilk	D	D	A	A	A	D	A	A	B	A
Butyl Acetate	B	C	C	C	B	B	D		D	A
Butylene	B	B	B	B	A	A	C		D	A
Butyric Acid	D	D	C	C	B	C	D	A	C	A
Calcium Bisulfite	D	D	D	D	C	D	A	A	D	A
Calcium Carbonate	B	B	B	A	B	B	A	A	A	A
Calcium Chlorate	D	D	B	B	B	B	A			A
Calcium Chloride	C	C	B	B	B	B	A	A	A	A
Calcium Hydroxide	C	B	B	B	B	B	A	A	A	A
Calcium Nitrate		C			B		B		B	A
Calcium Phosphate	C			C	B		B		B	A
Calcium Silicate	C			C	B		B		B	A
Calcium Sulfate	C	D	B	B	B	C	A	A	B	A
Caliche Liquor		B		A	A	B	B		A	A
Camphor	C		C	C	C		B		B	A

	Valve Material: Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Seats & Seals: Buna N	Delrin	EPDM	Teflon
Cane Sugar Liquors	A	B	A	B	A	B	A		A	A
Carbolic Acid (phenol)	D	D	B	B	B	B	D	D	B	A
Carbonate Beverages	B	D	B	B	B	C	B		B	A
Carbonated Water	B	B	A	A	A	B	A	A	A	A
Carbon Bisulfide	B	B	B	B	B	C	D	A	D	A
Carbone Dioxide, dry	B	B	B	B	A	A	A	A	B	A
Carbonic Acid	C	C	B	B	B	C	B	A	B	A
Carbon Monoxide	A		A	A	A	A	B		A	A
Carbon Tetrachloride, dry	B	B	B	B	B	A	C	A	D	A
Carbon Tetrachloride, wet	D	D	C	C	B	B	C	A	D	A
Casein	C			C	B	C	B		B	A
Castor Oil	A	B	B	B	B	A	A	A	B	A
Caustic Potash	C	D			B	B	B			A
Caustic Soda	C	B		A	A	A	C		B	A
Cellulose Acetate	B			B	B	B	D		B	A
China Wood Oil (Tung)	C	C	A	A	A	A	A	A	D	A
Chlorinated Solvents	C	C	B	B	B	B	D	A	D	A
Chlorinated Water		D	D	D	C	D	B	A	A	A
Chlorine Gas, dry	B	B	B	B	B	A	D	A	D	A
Chlorobenzene, dry	C	B	A	B	B	B	D	A	D	A
Chloroform, dry	B	D	A	A	B	A	D	A	D	A
Chlorophyll, dry	B			B	B	B	B		B	A
Chlorosulfonic Acid, dry	C	C	D	D	D	C	D		D	A
Chrome Alum	C	B	B	B	B	B	A		A	A
Chromic Acid<50%	D	D	C	C	B	B	D	D	B	A
Chromic Acid≥50%	D	D	C	D	C	D	D	C	C	A
Chromium Sulfate	C			B	B	B	B		B	A
Cider			A	A	A	A				A
Citric Acid	D	D	C	C	A	B	A		A	A
Citrus Juices	B	D	B	B	B	A	A	A		A
Coca-Cola Syrup			A	A	A		B			A
Coconut Oil	B	C	B	B	B	B	A	A	C	A
Cod Liver Oil							A		A	A
Coffee	A		A	A	A	B	A		A	B
Coffee Extracts, hot	B	C	A	A	A	A				A
Coke Oven Gas	C	B	B	B	B	B	D		D	A
Cooking Oil	B	B	A	A	A	A	A	A	D	A
Copper Acetate	D	D	B	B	B	C	C		B	A
Copper Carbonate			B	B	B	D	D			A

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Copper Cyanide	D		B	B	B	D	A		A	A
Copper Nitrate	D	D	B	A	A	D	A	A	B	A
Copper Sulfate	D	D	B	B	B	C	A	A	A	A
Corn Oil	B	B	B	B	B	B	B	A	D	A
Cottonseed Oil	B	B	C	C	B	B	A	A	C	A
Creosol		C		B	B		D		D	A
Creosote Oil	B	B	B	B	B	B	B	D	D	A
Cresylic Acid	D	C	B	B	B	C	D	D	D	A
Crude Oil, sour	C	B	A	A	A	B	B		D	A
Crude Oil, sweet	B	B	A	A	A	A	A		D	A
Cutting Oils, Water Emulsions	A	B	A	A	A		A	A	D	A
Cyanide Plating Solution	D			B	B	D	B		B	A
Cyclohexane	A	B	A	B	A	B	B	A	D	A
Cyclohexanone	B	D	B	B	B	B	D		B	A
Detergents, synthetic	B			B	A	B	B		B	A
Dextrin	B			B	B	C	B		B	A
Dichloroethane	D	C		B	B	A	D		D	A
Dichloroethyl Ether	B			B	B		D		D	A
Diesel Oil Fuels	A	B	A	A	A	A	A	A	D	A
Diethylamine	D	D	B	B	A	B	C		C	A
Diethylene Glycol	B			A	A	B	A		A	A
Diethyl Sulfate	B			B	B	B	C	A	C	A
Dimethyl Formamide	B			A	A	B	B		D	A
Dipentane (Pinene)	A			A	A		B		D	A
Disodium Phosphate	C	B	B	B	B	C	B			A
Dowtherm	A	B	A	A	A	A	D	A	D	A
Drilling Mud	B	B	A	B	A	B	A	A	A	A
Dry Cleaning Fluids	C	B	A	A	A	B	D	A	D	A
Drying Oil	C	C	B	B	B	B	A	A	D	A
Enamel	A			A	A		B		D	A
Epsom Salts	B	C	B	B	B	B	A	A		A
Ethane	B	C	B	B	B	B	A	A	D	A
Ethers	B	B	A	A	A	B	D	C	C	A
Ethyl Acetate	B	B	B	B	B	B	D	A	C	A
Ethyl Acrylate	B	C	B	B	B	B	D		C	A
Ethyl Bromide	A		B	B	B	B	B		D	A
Ethyl Chloride, dry	B	B	A	A	A	B	B	A	B	B
Ethyl Chloride, wet	C	D	B	C	B	B	B		B	A
Ethylene Chloride		B	B	B	B	B	D		D	A
Ethylene Dichloride	D	B	B	B	B	A	D	D	D	A
Ethylene Glycol	B	B	B	B	B	B	A	C	A	A
Ethylene Oxide	C	B	B	B	B	C	D	A	D	A
Ethyl Ether	B				A	A	D		D	A
Ethyl Silicate	B			B	B	B	B		B	A
Ethyl Sulfate	B			B	B	B	C	A	C	A
Fatty Acids	C	D	B	B	A	B	B	A	D	A
Ferric Hydroxide				A	A	A	B			A
Ferric Nitrate	D	D	C	B	B	D	A	A	A	A
Ferric Sulfate	D	D	C	C	B	D	A	A	A	A
Ferrous Chloride	C	D	D	D	D	D	A	A	A	A
Ferrous Sulfate	C	D	C	B	B	B	A	A	A	A
Ferrous Sulfate, Saturated	C	C	A	B	A	B	C		B	A
Fertilizer Solutions	C	B	B	B	B	B	B	D	B	A
Fish Oils	B	B	A	A	A	A	A	B	D	A
Flue Gases	B			B	A	B	C	C	D	A
Fluoboric Acid				B	B	B	A		A	A
Fluorosilicic Acid	B	D	D	D	B	A	B		C	A
Food Fluids & Pastes	B	C	A	A	A	B	B		B	A
Formaldehyde, cold	A	A	A	A	A	A	B	A	B	A
Formaldehyde, hot	B	D	C	C	C	B	B	A	B	A
Formic Acid, cold	C	D	C	C	B	B	D	D		A
Formic Acid, hot	C	D	C	C	B	B	D	D		A
Freon Gas, dry	B	B	A	A	A	A	C	B	C	A
Freon 11, MF, 112, BF	B	D	B	B	A	B	B	B	D	
Freon 12, 13, 32, 114,115	A	D	B	B	A	B	B	B	C	
Freon 21, 31	B			A	B		D	B	D	
Freon 22	A	D	B	B	A	B	D	B	D	
Freon 113, TF	B				A	B	B		D	
Freon, wet	D		B	C	C	B	B		B	A
Fruit Juices	C	D	B	B	A	B	A	A	A	A
Fuel Oil	B	B	B	B	B	B	A	A	D	A
Fumaric Acid							B			A
Furfural	B	C	B	B	B	B	D	A	C	A
Gallic Acid 5%	B	D	B	B	B	B	B	A	B	A
Gas, Manufactured	B	B	B	B	B	A	A	A		A
Gas, Natural	B	B	B	B	B	B	A	A	B	A
Gas, Odorizers	A	B	B	B	B	B	B	A		A
Gasoline, Aviation	A	A	A	A	A	A	C	A		A
Gasoline, Leaded	A	A	A	A	A	B	C	A		A
Gasoline, Motor	A	A	A	A	A	A	C	A	D	A
Gasoline, Refined	B	B	B	B	B	B	C		D	A

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Gasoline, Sour	B	B	B	B	B	C	C	A	D	A
Gasoline, Unleaded	B	B	B	B	B	B	C	A		A
Gelatin	B	D	A	A	A	B	A	A	A	A
Glucose	B	B	B	B	A	B	A	A	A	A
Glue	B	B	B	B	B	B	A		B	A
Glycerine (Glycerol)	B	C	A	A	A	A	A	C	A	A
Glycols	B	C	B	B	B	B	B	C	A	A
Graphite	B			B	B	B	B		B	A
Grease	C	A	A	A	A	B	A		D	A
Helium Gas	B			B	B	B	B		B	A
Heptane	A	B	A	A	A	B	A	A	D	A
Hexane	B	B	B	A	A	B	A	A	D	A
Hexanol, Tertiary	B	B	B	B	A	B	A		D	A
Hydraulic Oil, Petroleum Base	B	A	A	A	A	A	A	A	D	A
Hydrazine	D	B		B	B	D	C		B	A
Hydrocyanic Acid	D	C	B	B	B	C	B	D	B	A
Hydrofluosilicic Acid	D	D	C	D	C	B	B		A	A
Hydrogen Gas, cold	A	A	A	A	A	A	A		A	A
Hydrogen Gas, hot		B			B		A		A	A
Hydrogen Peroxide, Concentrated	C	D	B	B	B	C	D		B	A
Hydrogen Peroxide, Dilute	C	D	B	B	B	B	B	B	A	A
Hydrogen Sulfide, Dry	C	B	B	B	A	B	C	A	A	A
Hydrogen Sulfide, Wet	D	B	C	C	B	D	D	A	B	A
Hypo (Sodium Thiosulfate)	C	D	A	A	A	B	A	A	A	A
Illuminating Gas	A	A	A	A	A	A	C		D	A
Ink - Newsprint	B	D	B	A	A	B	A	A	B	A
Iodoform	B	D	A	A	A	C		A	A	A
Iso-Butane					B		B		D	A
Iso-Octane	A	A	A	A	A	A	A	A	D	A
Isopropyl Acetate					B		D		A	A
Isopropyl Ether	B	B	B	B	B	B	C		D	A
J P-4 Fuel	A	B	B	B	A	B	A	A	D	A
J P-5 Fuel	A	B	B	B	A	B	B	A	D	A
J P-6 Fuel	A	B	B	B	A	B	A	A	D	A
Kerosene	A	B	A	A	A	B	A	A	D	A
Ketchup	D	D	A	A	A	B	A	A		A
Ketones	B	B	B	B	B	B	D	A	D	A

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Lacquer (and Solvent)	A	C	A	A	A	A	D	A	D	A
Lactic Acid Concentrated cold	D	D	B	B	A	D	B	D	B	A
Lactic Acid Concentrated hot	D	D	C	C	B	D	D	D	D	A
Lactic Acid Dilute cold	C	D	B	B	A	C	B	D	B	A
Lactic Acid Dilute hot	D	D	B	B	B	D	D	D	D	A
Lactose	B			B	B	B	B		B	A
Lard	B	C	B	B	B	B	B		C	A
Lard Oil	B	C	A	B	B	B	A	A	B	A
Lead Acetate	D	D	B	B	B	B	B	A	B	A
Lead Sulfate	C	D		B	B	B	B		B	A
Lecithin	C			B	B	B	D		D	A
Linoleic Acid	C	D	A	B	A	B	B	A	D	A
Linseed Oil	A	A	B	B	B	B	A	A	D	A
Lithium Chloride	D			B	B	B	B		B	A
L P G	A	B	B	B	B	B	A	A	D	A
Lubricating Oil Petroleum Base	B	A	A	A	A	B	A	A	D	A
Ludox	D			B	B	B	B		B	A
Magnesium Carbonate	B		A	B	A	B	B		B	A
Magnesium Chloride	B	C	C	C	B	B	A	A	A	A
Magnesium Hydroxide	B	B	B	A	A	B	B	A	A	A
Magnesium Hydroxide, Hot	D	B	B	A	A	B	B	A	A	A
Magnesium Nitrate	B	B	B	B	A	B	B		A	A
Magnesium Sulfate	B	B	B	B	A	A	A	A	A	A
Maleic Acid	C	D	B	B	B	B	D	A	D	A
Maleic Anhydride	C			B	B	B	D		D	A
Malic Acid	D	D	B	B	A	B	A	A	D	A
Manganese Carbonate				B	B		B			A
Manganese Sulfate	B		B	B	B	B	B		B	A
Mayonnaise	D	D	A	A	A	B	A	A		A
Meat Juices	D		B	B	B	B	B		D	A
Melamine Resins					C		B			A
Menthol	B			B	B	B	B		D	A
Mercuric Chloride	D	D	D	D	B	D	A		A	A
Mercuric Cyanide	D	D	B	B	B	C	A		A	A

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Mercurous Nitrate	D		B	B	A	D	B		B	A
Mercury	D	B	A	A	A	A	A	A	A	A
Methane	B	B	B	B	B	B	A	A	D	A
Methyl Acetate	B	B	A	B	A	B	D		B	A
Methyl Acetone	A	A	A	A	A	A	D		A	A
Methylamine	D	B	A	A	A	C	D		B	A
Methyl Cellosolve	B	C	B	B	A	B	D		B	A
Methyl Chloride	B	D	B	A	A	B	D	A	D	A
Methyl Ethyl Ketone	A	A	A	A	A	A	D	A	B	A
Methylene Chloride	A	B	A	B	A	B	D		D	A
Methyl Formate	A	C	B	B	B	B	D		B	A
Methyl Isobutyl Ketone	A	B	B	B	A	B	D			A
Milk & Milk Products	C	B	A	A	A	C	A	A	A	A
Mineral Oils	B	B	B	B	B	B	A	A	D	A
Mineral Spirits	B	C	B	A	A	B	A	A	D	A
Mine Water (Acid)	D	D	B	B	B	C	A	A	B	A
Mixed Acids (cold)	D	D	B	B	B	D	D	D	D	A
Molasses, crude	A	B	A	A	A	B	A	A	A	A
Molasses, Edible	A	B	A	A	A	B	A	A	A	A
Monochloro Benzene, Dry						B	D			A
Morpholine	B	B	B	B	B	B	D		D	A
Mustard	A	B	A	A	A	A	A	A		A
Naptha	A	B	B	B	B	B	B	A	D	A
Napthalene	B	B	B	B	B	B	D	A	D	A
Natural Gas, Sour	B			D	D	D	A		D	D
Nickel Ammonium Sulfate	D	D	B	B	B	C	A		B	A
Nickel Chloride	C	D	B	B	B	B	A	A	B	A
Nickel Nitrate	D	C	B	A	A	B	A	A	A	A
Nickel Sulfate	C	D	B	B	B	B	A	A	B	A
Nicotinic Acid	B	B	B	B	A	B	D		B	A
Nitric Acid 10%	D	D	A	A	A	D	C	D		A
Nitric Acid 30%	D	D	A	A	A	D	C	D	B	A
Nitric Acid 80%	D	D	B	B	B	D	D	D	B	A
Nitric Acid 100%	D	D	B	B	B	D	D	D	C	A
Nitric Acid Anhydrous	D	D	C	C	B	D	D		C	A
Nitrobenzene	B	B	B	B	B	B	D		D	A
Nitrogen	A	A	A	A	A	A	A	A	B	A
Nitrous Acid 10%	D	D	C	C	B	D	C			A

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Nitrous Gases	D	B	C	C	B	D				A
Nitrous Oxide	D	B	B	B	B	D	B	A		A
Oils & Fats			B	B	B		B		D	A
Oils, Animal	B	B	B	B	A	B	A		B	A
Oils, Petroleum Refined	B	A	A	A	A	A	A	A	D	A
Oils, Petroleum Sour	C	B	A	A	A	A	B		D	A
Oils, Water Mixture	A	B	A	A	A		A	A		A
Oleic Acid	B	C	B	B	B	B	B	A	B	A
Oleum	D	B	B	B	B	D	D	D	D	A
Oleum Spirits	D		B	B	B	D	C		D	A
Olive Oil	C	B	A	A	A	A	A	A	B	A
Olalic Acid	B	D	D	D	B	B	D	C	B	A
Oxygen	A	B	B	B	A	B	B	D	A	A
Ozone, Dry	A	C	A	A	A	A	D		A	A
Ozone, Wet	B	C	B	A	A	A	D		B	A
Paints & Solvents	A	A	A	A	A	A	D		D	A
Palmitic Acid	B	C	B	B	B	B	B	A	B	A
Palm Oil	B	C	B	B	B	A	B	A	D	A
Paper Pulp	B			B	B	B	B		B	
Paraffin	A	B	A	A	A	A	A	A	D	A
Paraformaldehyde	B	B	B	B	B	B	B	A	D	A
Paraldehyde							B		D	A
Pentane	A	B	A	A	A	B	A	A	D	A
Perchlorethylene, dry	B	B	B	B	B	B	D		D	A
Petrolatum (Vaseline Petroleum Jelly)	B	C	B	B	B	B	A	A	D	A
Phenol	B	D	A	B	A	A	D	D	D	A
Phosphate Ester 10%	D	B	A	A	A	A	D		A	A
Phosphoric Acid 10%	D	D	C	B	B	D	D	D	B	A
Phosphoric Acid 50% Cold	D	D	B	B	B	C	D	D	B	A
Phosphoric Acid 50% Hot	D	D	D	C	D	C	D	D	B	A
Phosphoric Acid 85% Cold	D	D	B	B	B	C	D	D	B	A
Phosphoric Acid 85% Hot	D	D	C	B	B	C	D	D		A
Phosphoric Anhydriede		D		B	B		D	B		A

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	Valve Material						Seats & Seals			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Phosphorous Trichloride		B	A	A	A		D		A	A
Phthalic Acid	B	C	B	B	A	B	C	A		A
Phthalic Anhydride	B	B	B	A	A	A	C	A	B	A
Picric Acid	D	D	B	B	B	D	C		B	A
Pineapple Juice	C	C	A	A	A	A	A	A		A
Pine Oil	B	B	A	A	A	B	A	A	D	A
Pitch (Bitumen)	A	B	A	A	A	A	C		D	A
Polysulfide Liquor	D			B	B	B	B		B	A
Polyvinyl Acetate	B			A	A	B	C		A	A
Polyvinyl Chloride	B			B	B	B			B	A
Potassium Bicarbonate			A	A	A	B	B		A	A
Potassium Bisulfate					A	B	B	A		A
Potassium Bisulfite	C	D	B	B	B	D	A	A	B	A
Potassium Bromide	C	D	B	B	B	B	A	A	A	A
Potassium Carbonate	D	B	B	A	A	B	A	A	A	A
Potassium Chlorate	D	C	B	B	A	C	A	A	A	A
Potassium Chloride	D	C	C	C	B	B	A	A	A	A
Potassium Chromate	C			B	B	B	B		B	A
Potassium Cyanide	D	B	B	B	B	B	A	A	A	A
Potassium Dichromate	B	B	B	A	A	B	A	A	A	A
Potassium Ferricyanide	C	D	B	B	B	B	A	A	A	A
Potassium Ferrocyanide	B	C	B	B	B	B	A	A		A
Potassium Hydroxide Dilute Cold	C	B	B	B	B	A	A		B	A*
Potassium Hydroxide To 70%, Cold	D	C	B	B	B	A	B		B	A*
Potassium Hydroxide Dilute Hot	D	B	B	B	B	A	B		B	A*
Potassium Hydroxide To 70%, Hot	D	C	D	D	B	B	C		A	A*
Potassium Iodide	C	D	B	B	B	C	A	A	A	A
Potassium Nitrate	B	B	B	B	B	B	A	A	A	A
Potassium Oxalate			B	B	B	B	D			A
Potassium Permanganate	C	C	B	B	B	B	C	A	A	A
Potassium Phosphate	C			B	B	B	A		A	A
Potassium Phosphate Di-basic	B	A	A	A	A	B	A	A	B	A
Potassiuum Phosphate Tri-basic		A			B	B	B		B	A
Potassium Sulfate	B	B	B	A	A	B	A	A	A	A
Potassium Sulfide	D	D	B	B	B	D	A		B	A
Potassium Sulfite	B	B	B	B	A	C	B		A	A
Producer Gas	B	B	B	B	B	A	A	A	D	A
Propane Gas	A	B	B	B	B	B	A	A	D	A
Propylene Glycol	B	B	B	B	B	B	A	C	A	A
Pyridine	B	C	B	B	B	B	D		B	A
Pyrogallic Acid	C	C	C	C	B	C	A	A		A
Pyrolignous Acid			B	B	B		D		B	A
Quench Oil	B	B	A	A	A		A	A	D	A
Quinine Bisulfate, dry			A	A	A	B				A
Quinine Sulfate dry			A	A	A	B				A
Resins & Rosins	A	C	B	B	B	A	C		D	A
Road Tar	A	A	A	A	A	A	B	A	D	A
Roof Pitch	A	A	A	A	A	A	B	A		A
Rosin Emulsion	B	C	A	A	A	A	D			A
Rubber Latex Emulsions	A	B	A	A	A			A		A
Rubber Solvents	A	A	A	A	A	A	D	C	D	A
Salad Oil	B	C	B	B	B	B	A	A	D	A
Salicylic Acid	C	D	B	B	B	C	B	A	A	A
Salt (naCl)	B	C	B	B	B	A	A	A	A	A
Salt Brine	B	D		A	A	B	A		B	A
Sea Water	C	D	B	B	A	A	A	A	A	A
Sewage	C	C	B	B	B	B	A		B	A
Shellac-bleached	A	A	A	A	A		A			A
Shellac-orange	A	A	A	A	A	A	A			A
Silicone Fluids	B		B	B	B		B		B	A
Silver Bromide			B	B	A	B				A
Silver Cyanide	D		A	B	A	B	B		B	A
Silver Nitrate	D	D	B	B	A	D	C	A	A	A
Silver Plating Sol.			A	A	A		B		B	A
Soap Solutions (Stearates)	A	A	A	A	A	A	A		A	A
Sodium Acetate	B	D	B	B	B	C	B	A	A	A
Sodium Aluminate	B	C	B	B	B	B	A	A	B	A

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	Valve Material						Seats & Seals			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Sodium Bicarbonate	B	C	A	A	A	A	A	A	A	A
Sodium Bichromate	D		B	B	B		D			A
Sodium Bisulfate 10%	C	C	A	A	A	B	A	A	A	A
Sodium Bisulfite 10%	D	D	B	B	B	B	A	A	A	A
Sodium Borate	B	C	B	B	B	B	A	A	A	A
Sodium Bromide 10%	B	C	B	B	B	B	A	A	A	A
Sodium Carbonate (Soda Ash)	B	B	B	B	B	A	A	A	A	A
Sodium Chlorate	B	C	B	B	B	B	A	A	A	A
Sodium Chloride	B	C	B	B	B	A	A	A	A	A
Sodium Chromate	C	B	B	B	B	B	A	A	A	A
Sodium Citrate			B	B	B					A
Sodium Cyanide	D	C	A	A	A	D	A	A	A	A
Sodium Ferricyanide				C	B	B			A	A
Sodium Fluoride	D	D	C	C	B	A	A	A	A	A
Sodium Hydroxide 20% Cold	B	B	A	A	A	A	B		A	A*
Sodium Hydroxide 20% Hot	B	B	A	A	A	A	B		A	A*
Sodium Hydroxide 50% Cold	C	C	A	A	A	A	B		A	A*
Sodium Hydroxide 50% Hot	C	C	B	B	A	A	B		A	A*
Sodium Hydroxide 70% Cold	C	C	B	B	B	A	B		A	A*
Sodium Hydroxide 70% Hot	D	D	C	C	C	B	D		B	A*
Sodium Hypo-sulfite			A	A	A	B				A
Sodium Lactate			A	A	A	B				A
Sodium Meta-phosphate	C	D	B	B	B	B	A		A	A
Sodium Meta-silicate Cold	B	C	A	A	A	A	B			A
Sodium Meta-silicate Hot	B	D	A	A	A	A				A
Sodium Nitrate	D	B	B	A	A	B	B	A	A	A
Sodium Nitrite			B	B	B	C	C	B	A	A
Sodium Perborate	C	B	B	B	B	B	C	A	A	A
Sodium Peroxide	D	C	B	B	B	B	C	A	A	A
Sodium Phosphate	C	C	B	B	B	B	B	B	A	A

A = Excellent
B = Good
C = Poor
D = Do Not Use

	Valve Material						Seats & Seals			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Sodium Phosphate Di-basic	C	C	B	B	B	B	A	A	A	A
Sodium Phosphate Tri-basic	C	C	B	B	B	B	B	A	A	A
Sodium Polyphosphate					B		B		A	A
Sodium Salicylate			A	A	A					A
Sodium Silicate	B	B	B	B	B	B	A	A	A	A
Sodium Silicate, hot	C	C	B	B	B	B			B	A
Sodium Sulfate	B	B	B	A	A	B	A	A	A	A
Sodium Sulfide	D	C	B	B	B	B	A	A	A	A
Sodium Sulfite	D	C	A	A	A	B	A		A	A
Sodium Tetraborate					A		A		B	A
Sodium Thiosulfate	D	D	C	C	B	B	B	A	C	A
Soybean Oil	B	C	A	A	A	A	A	A	B	A
Starch	B	C	B	B	B	A	A	A	C	A
Steam (212°F.)	A	B	A	A	A	B	D	D	B	B
Stearic Acid	B	C	B	B	A	C	B	A	B	A
Styrene	A	A	A	A	A	B	D		D	A
Succinic Acid	C		D	C	B	B				A
Sugar Liquids	A	B	A	A	A	A	A	A	B	A
Sugar, Syrups & Jam	B		B	A	A		A		A	A
Sulfate, Black Liquor	D	D	B	B	B	B	C	B	B	A
Sulfate, Green Liquor	D	D	B	B	B	B	C	A		A
Sulfate, White Liquor	D	D	B	B	B	C	C	A		A
Sulfonic Acid	B			B	B	B	D		D	A
Sulfur	D	D	B	A	A	B	D	A	A	A
Sulfur Chlorides, Dry	D	D	D	C	C	C	D	A	D	A
Sulphur Dioxide, dry	B	A	B	B	B	B	D	A	A	A
Sulfur Dioxide, wet	D	D	D	D	B	D	D		A	A
Sulfur Hexafluoride	B		A	A	A		A		A	A
Sulfur, Molten	D	D	B	B	B	D	D		D	A
Sulfur Trioxide	D	B			B	B	D		B	A
Sulfur Trioxide, dry	D	B	B	B	B	B	D	A	B	A
Sulfuric acid 0 to 77%	D	D	D	D	D	B	D	C	B	A

CORROSION CHART

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Sulfuric Acid 100%	D	C	C	C	B	D	D	D	C	A
Sulfurous Acid	D	D	D	D	B	D	B	C	B	A
Tall Oil	B	B	B	B	B	B	B	A	D	A
Tannic Acid (Tannin)	D	D	B	B	B	B	B	A	A	A
Tanning Liquors			B	B	B		B			A
Tar & Tar Oils	A	A	A	A	A	A	C		D	A
Tartaric Acid	B	D	B	A	A	B	B	A	C	A
Tetraethyl Lead	B	C	B	B	B	B	B	A	D	A
Toluol (Toluene)	A	A	A	A	A	A	D	A	D	A
Tomato Juice	C	C	B	B	B	B	A	A		A
Transformer Oil	B	B	B	B	B	B	A	A	D	A
Tributyl Phosphate	B	B	B	B	B	B	D		A	A
Trichlorethylene	B	B	B	B	B	A	D	A	D	A
Trichloroacetic Acid	D	D	D	D	D	B	C		C	A
Triethanolamine	B	C		B	B	B	D		B	A
Triethylamine	B			B	B	B	B			A

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Trisodium Phosphate		B		B	B	B	A		B	A
Tung Oil	B	B	A	A	A	C	A	A	D	A
Turpentine	B	B	A	A	A	A	B	A	D	A
Urea	B	C	B	B	B	B	B	A	B	A
Uric Acid			B	B	B					A
Varnish	A	C	A	A	A	A	C	A	D	A
Vegetable Oils	B	B	A	A	A	A	A	A	D	A
Vinegar	C	C	B	B	B	B	D		B	A
Vinyl Acetate	B			A	B	B	D		A	A
Water, Distilled	A	D	A	A	A	A	B	A	A	A
Water, Fresh	A	C	A	A	A	A	B	A	A	A
Water, Acid Mine	D	D	B	A	A	D	B		A	A
Waxes	A	A	A	A	A	A	A	A	C	A
Whiskey & Wines	B	C	A	A	A	A	A	A	A	A
Xylene (Xylol), Dry	B	B	B	B	B	B	D	A	D	A
Zinc Bromide	B			B	B	B	B		B	A
Zinc Hydrosulfite	C	A	A	A	A	B	A	A	A	A
Zinc Sulfate	C	D	B	A	A	B	A	A	A	A

ATTACHMENT D-2-4-2

APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 600

Revision No.

5.0

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 600

TANKS T-634, T-635, AND T-636

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LIST OF EXHIBITS

LIST OF REFERENCED DRAWINGS

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 600

TANKS T-634, T-635, AND T-636

I. Introduction

This document provides the assessment and certification for the design of the hazardous waste storage tank system(s) at Tank Management Unit 600 at the Chemical Waste Management, Inc. Facility in Emelle, Sumter County, Alabama. The assessment was performed to address the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), regarding the design of the system within Tank Management Unit 600 which is comprised of the tanks (i.e., Tanks T-634, T-635, and T-636), the tank foundation, the associated ancillary equipment and the secondary containment system.

Tank Management Unit 600 is located north of Unit 520 and adjoins the west side of Unit 604 as shown on Drawing No. 0100-020-001 in Appendix D-1 to Section D of the RCRA Part B Permit Application. The primary function of the tank systems within Unit 600 is to enable the accumulation, storage and bulking of PCB contaminated solvents (e.g., diesel fuel, mineral oil, etc.) resulting from the flushing of transformers, and mixed RCRA/TSCA wastes decanted from containers within Unit 604.

The following drawings were used in the preparation of this Assessment and Certification and are provided either in Exhibit A (Tank Data Sheets) or in Appendix D-1 to Section D of the RCRA Part B Permit Application:

Drawing No.	**Drawing Title**
0600-010-001	Container & Tank Management Unit 600 - P&ID
0600-020-001	Container & Tank Management Unit 600 - Plan View
0600-030-002	Container & Tank Management Unit 600 - Sections
0600-040-001	Container & Tank Management Unit 600 - Details
0600-080-034	Tank Data Sheet - T-634
0600-080-035	Tank Data Sheet - T-635
0600-080-036	Tank Data Sheet - T-636

II. Tank Design

Tanks T-634, T-635, and T-636 have been designed in accordance with the design codes and standards indicated within the DESIGN DATA section of the Tank Data Sheets (i.e., Drawing Nos. 0600-080-034, -035 and -036) provided in Exhibit A to this tank system design assessment. The criteria utilized in the assessment of the design of the shell, structural support, and anchorage for Tanks T-634, T-635, and T-636 are also provided within the DESIGN DATA section of the Tank Data Sheets, as well as within the tank design calculations provided in Exhibit B to this tank system design assessment.

The calculations provided in Exhibit B to this tank system design assessment demonstrate that the tank shell, structural supports and anchorages are, as designed, adequate to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable, at the design conditions indicated on the tank data sheets.

III. Tank Foundation Design

The design of the reinforced concrete foundation for Tanks T-634, T-635, and T-636 are indicated in Detail 8 on Drawing No. 0600-040-001 which is provided in Appendix D-1 to Section D of the RCRA Part B Permit Application. The criteria utilized in the assessment of the design of the foundation for Tanks T-634, T-635, and T-636 are provided within the tank foundation design calculations provided in Exhibit C to this tank system design assessment.

The tank foundation design calculations provided in Exhibit C demonstrate that the tank foundation is, as designed, adequate to support the load of the full tanks and to withstand associated environmental stresses at the design conditions indicated on the tanks data sheets and provided within foundation design calculations.

IV. Ancillary Equipment Design

All tank system ancillary piping systems shall be designed, installed and tested in accordance with the American Society of Mechanical Engineers (ASME) Standard B31.3, "Chemical Plant and Petroleum Refinery Piping", or an equivalent nationally recognized standard, and in accordance with recognized good engineering practices to ensure that they are supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

All other ancillary equipment for the tank system shall be designed, installed and tested in accordance with appropriate recognized standards, if any, and in accordance with recognized good engineering practices to ensure that it is supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

In order for this tank design assessment and associated certification to be maintained, and prior to the tank system being placed in use, the Facility shall ensure that the tank system ancillary equipment is properly installed and that all required inspections, tests and repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f). Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested.

V. Secondary Containment System Design

The design features of the secondary containment system for the tank systems within Unit 600 are indicated on Drawing Nos. 0600-020-001, 0600-030-002 and 0600-040-001 which is located in Appendix D-1 to Section D of the RCRA Part B Permit Application. As shown on these drawings and in accordance with the applicable requirements of 40 CFR 264.193 and ADEM Administrative Code Rule 335-14-5-.10(4), the secondary containment system design is comprised of a reinforced concrete base, with all joints sealed with chemical-resistant waterstops, and all concrete surfaces sealed with chemical resistant concrete coating system. Information on the concrete coatings available for use on the secondary containment system is provided within Appendix D-1-3 to Section D-1 of the RCRA Part B Permit Application.

Calculations demonstrating that the design secondary containment capacity meets or exceeds the applicable requirements 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e) are provided in Appendix D-2-2 to Section D-2 of the RCRA Part B Permit Application.

VI. Tank Venting Requirements

As indicated on the P&ID for Unit 600 (i.e., Drawing No. 0600-010-001 which is located in Appendix D-1 to Section D of the RCRA Part B Permit Application), Tanks T-634, T-635, and T-636 are designed as closed top tanks that passively vent through a closed system to an activated carbon absorber. Drawing No. 0600-010-001 also indicates that the designed tank vent system includes a pressure/vacuum relief valve (i.e., conservation vent) and an emergency relief vent on each of the tanks. The Tank Data Sheets (i.e., Drawing Nos. 0600-080-001, -002 and -003) provided in Exhibit A to this tank system design assessment specify the diameter of the pressure/vacuum relief valve nozzle and the emergency vent nozzle on each of the tanks.

The requirements for normal (i.e., liquid displacement and thermal effects) and emergency (i.e., fire exposure) venting capacities for the Unit 600 tanks were evaluated in accordance with American Petroleum Institute Standard 2000, Venting Atmospheric and Low-Pressure Storage

Tanks (i.e., API 2000). As shown in the venting calculations provided in Exhibit D to this tank system design assessment, the size of the conservation vent nozzle on each of the tanks is adequate to allow the tank under normal conditions to be maintained within the design limitations for pressure and vacuum as specified on the Tank Data Sheets provided in Exhibit A and within the tank design calculations provided in Exhibit B to this tank system design assessment. The venting calculations provided in Exhibit D also demonstrate that the size of the emergency vent nozzle on each of the tanks is adequate to allow the tank to be maintained within the design limitations for pressure in the event of exposure to fire. The venting calculations provided in Exhibit D to this tank system design assessment also indicate the design pressure and vacuum settings for the conservation vent, the design pressure setting for the emergency relief vent, and the design maximum tank fill and withdrawal rates which were used in the evaluation of the tank venting requirements.

VII. Hazardous Characteristics of the Waste Managed

In accordance with the requirements of 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., this section presents an evaluation of the compatibility of the wastes managed within the Unit 600 tank system with the materials of construction of Tanks T-634, T-635, and T-636 and the ancillary equipment (i.e., pumps and piping) to determine their suitability for service in this unit.

The types of wastes managed within Tanks T-634, T-635, and T-636 will primarily be mixed RCRA/TSCA organic wastes (such as halogenated and non-halogenated spent solvents) which may meet the RCRA definition of ignitability, and PCB contaminated flush agents such as diesel fuel and mineral oil. Tanks T-634, T-635, and T-636 and the ancillary equipment that contact wastes within this system are primarily constructed of carbon steel without internal corrosion protection.

Exhibit E to this tank system design assessment presents information which provides an indication of the relative compatibility of carbon steel with a wide variety of chemical compounds and other substances. The table in Exhibit E provides corrosion/compatibility information for carbon steel exposed to pure chemical compounds which, in general, tend to have a more severe corrosive effect than wastes which contain mixtures and complexes of these compounds. Although this table may not provide corrosion data and service recommendations for all of the potential constituents of the wastes or waste mixtures which may be managed within the tank system in Unit 600, the table does demonstrate that carbon steel is generally compatible with and, under normal conditions, should not experience an accelerated rate of corrosion or deterioration when exposed to a majority of the types and classes of wastes which are managed within the Unit 600 tank system. In addition to the compatibility/corrosion data provided in Exhibit E, the compatibility of carbon steel with the types of organic and PCB contaminated wastes managed within Unit 600 is further validated by the empirical data provided by many years of comparable service applications within a variety of units at the Facility.

Based on the information provided in Exhibit E of this tank system design assessment and the empirical data compiled at the Facility for comparable service applications, it is the conclusion of this evaluation that the carbon steel tank system components are generally compatible with the types of waste managed within the Unit 600 tank system. It is further concluded that these materials of construction are suitable for this service if the tank system is operated within the design limitations set forth within this assessment, and that, if the tank system is managed in accordance with the following minimum practices, these materials of construction should not experience an accelerated rate of corrosion or deterioration which may result in a catastrophic failure of the tank system, throughout its useful life:

- Prior to placement of a waste into the tank system the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. References other than Exhibit E of this document, such as publications by the National Association of Corrosion Engineers (NACE) or other recognized sources of corrosion data, may also be used to evaluate compatibilities. The Facility shall prohibit the placement into the Unit 600 tank systems any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components, including hazardous wastes that exhibit the characteristic of corrosivity as defined in 40 CFR 261.22 and ADEM Administrative Code Rule 335-14-2-.03(3); and
- The Facility shall perform an annual inspection of the tank shells to ensure that minimum code thicknesses are maintained and that adequate corrosion allowance is available for continued service.

VIII. Certification of Tank System Design Assessment

In accordance with the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), this section provides a certification by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), that an assessment of the design of the following tank system(s) demonstrates that the tank system foundation, structural supports, seams, connections, and pressure controls are adequate, and that the tanks have sufficient structural strength, compatibility with the wastes to be managed and/or protection from corrosion so that they will not collapse, rupture or fail, if properly installed, operated within the design limits, and properly inspected and maintained:

Tank System Location:	Chemical Waste Management, Inc. Emelle, Alabama
Tank System Identification:	Tank Management Unit 600
Applicable Tanks:	T-634, T-635, and T-636

At a minimum, the assessment of the tank system design, which is incorporated herein by reference, addresses and considers the following factors with respect to the intended use of the tank system:

- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank designs have been evaluated for structural integrity with regards to the ability of the designed tank shell, structural supports and anchorages to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tanks have been evaluated with regards to the adequacy of the designed tank to provide the necessary capacity for normal and emergency venting;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which piping and other ancillary equipment shall be designed and constructed to maintain this certification;
- In accordance with 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., the assessment of the tank system design considers the compatibility of the tank's materials of construction and/or internal coatings with the types of hazardous wastes to be managed;
- In accordance with the applicable requirements of 40 CFR 264.192(a)(5) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)5., the assessment of the tank system design considers the ability of the designed tank system foundation to support the load of the full tanks and to withstand associated environmental stresses; and
- The assessment of the tank system design considers the adequacy of the capacity of the designed tank secondary containment system as required by the applicable

requirements of 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e).

In order for this certification to be maintained, the Facility shall comply with the applicable requirements of 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10, and shall perform all routine management procedures, periodic inspections and reviews, and tank system functionality and integrity tests as required by the permit including, but not limited to, the following:

- The Facility shall ensure that the tank system is properly installed and that, prior to placing the tank system in use, all required inspections, tests and necessary repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f);
- Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested;
- Prior to placement of a waste into the tank system, the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the Unit 600 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components, including hazardous wastes that exhibit the characteristic of corrosivity as defined in 40 CFR 261.22 and ADEM Administrative Code Rule 335-14-2-.03(3);
- Prior to placement of a waste into the tank system, the Facility shall verify the specific gravity of the waste in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the tank system of any waste that has a specific gravity that exceeds the design maximum value specified within the tank system design assessment;
- Prior to placement of a waste into the tank system, the Facility shall verify in accordance with the procedures and requirements of the Waste Analysis Plan

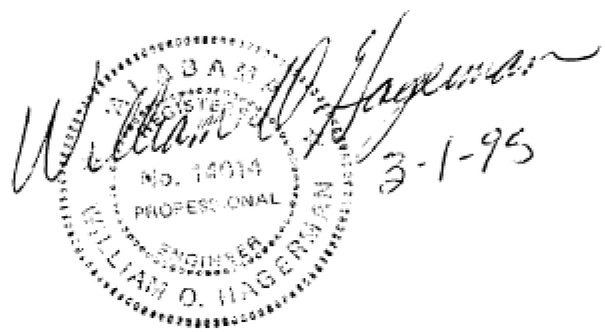
provided in Section C of the RCRA Part B Permit Application, that the treatment of the waste will not cause temperatures within the tank system to exceed the design maximum value specified within the tank system design assessment;

- The Facility shall perform a daily inspection of the visible aboveground portions of the tank exterior to detect excessive corrosion or deterioration;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank secondary containment system to detect leakable cracks or gaps, or excessive deterioration of the concrete base and/or chemical resistant concrete coatings,
- The Facility shall perform an annual inspection of the tank shells, as described in Subsection F-2-6 of Section F-2 of the RCRA Part B Permit Application, to ensure that minimum code thicknesses are maintained and that adequate corrosion allowance is available for continued service;
- The Facility shall perform an annual inspection of the tank structural supports and anchorages to ensure that their integrity is maintained;
- The Facility shall perform a periodic inspection of the tank venting and emergency relief devices to ensure that they are in good working order with the appropriate vent or relief settings to maintain the tanks within the design limits for pressure as specified within the tank system design assessment. The frequencies and procedures for inspection of all tank venting devices shall be as recommended by the manufacturer;
- The Facility shall perform a periodic inspection of the tank level sensing, overfill control devices and associated interlocks to ensure that they are in good working order with the appropriate settings to prevent overfilling of the tanks. The frequencies and procedures for inspection of all tank level sensing and overfill control devices shall be as recommended by the manufacturer;
- The Facility shall perform a periodic inspection of any other operational controls for the tank system to ensure that they are in good working order with the appropriate settings to maintain the tanks within their design limits as specified within the tank system design assessment. The frequencies and procedures for inspection of other tank system operational controls shall be as recommended by the manufacturer;
- The Facility shall perform periodic inspections of the integrity of any tank system grounding and lightning protection systems; and
- The Facility shall perform periodic inspections of the integrity of any tank system fire protection systems.

Based on the information provided within the tank system design assessment and supporting documentation, the design of Tanks T-634, T-635, and T-636 within Tank Management Unit 600 meets the current RCRA requirements relative to the design of new hazardous waste tank systems. The design assessment addresses only the applicable requirements of 40 CFR 264.192 and 40 CFR 264.193, and ADEM Administrative Code Rules 335-14-5-.10(3) and (4), and does not consider compliance with other codes or regulations, including, but not limited to, the requirements of the Occupational Safety and Health Act (OSHA).

With regards to the assessment and certification of the design of hazardous waste tank systems in accordance with the applicable requirements of 40 CFR 264.192(a) and (g), and ADEM Administrative Code Rules 335-14-5-.10(3)(a) and (g), I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

William O. Hagerman, P.E.
Alabama P.E. No.: 14014
President
ETI Corporation
6799 Great Oaks Road, Suite 100
Memphis, Tennessee 38138-2500



This certification was originally submitted in 1995. As part of the 2002 Part B Application Renewal, revisions were made to the text in this attachment. These revisions consisted primarily of renaming the section for the Waste Analysis Plan to Section C to maintain consistency with the other Sections contained within this Part B Permit Application. No revisions were made to this attachment during this Part B Permit Application renewal process (Revision 5.0).

With regards to the revisions noted above, I certify under penalty of law that these modifications were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Michael T. Feeney, P.E.
Alabama P.E. No.: 15895
Jacobs Engineering Group Inc.
Ten 10th Street NW
Atlanta, Georgia 30309

[End of Attachment D-2-4-2 Text]

EXHIBIT A

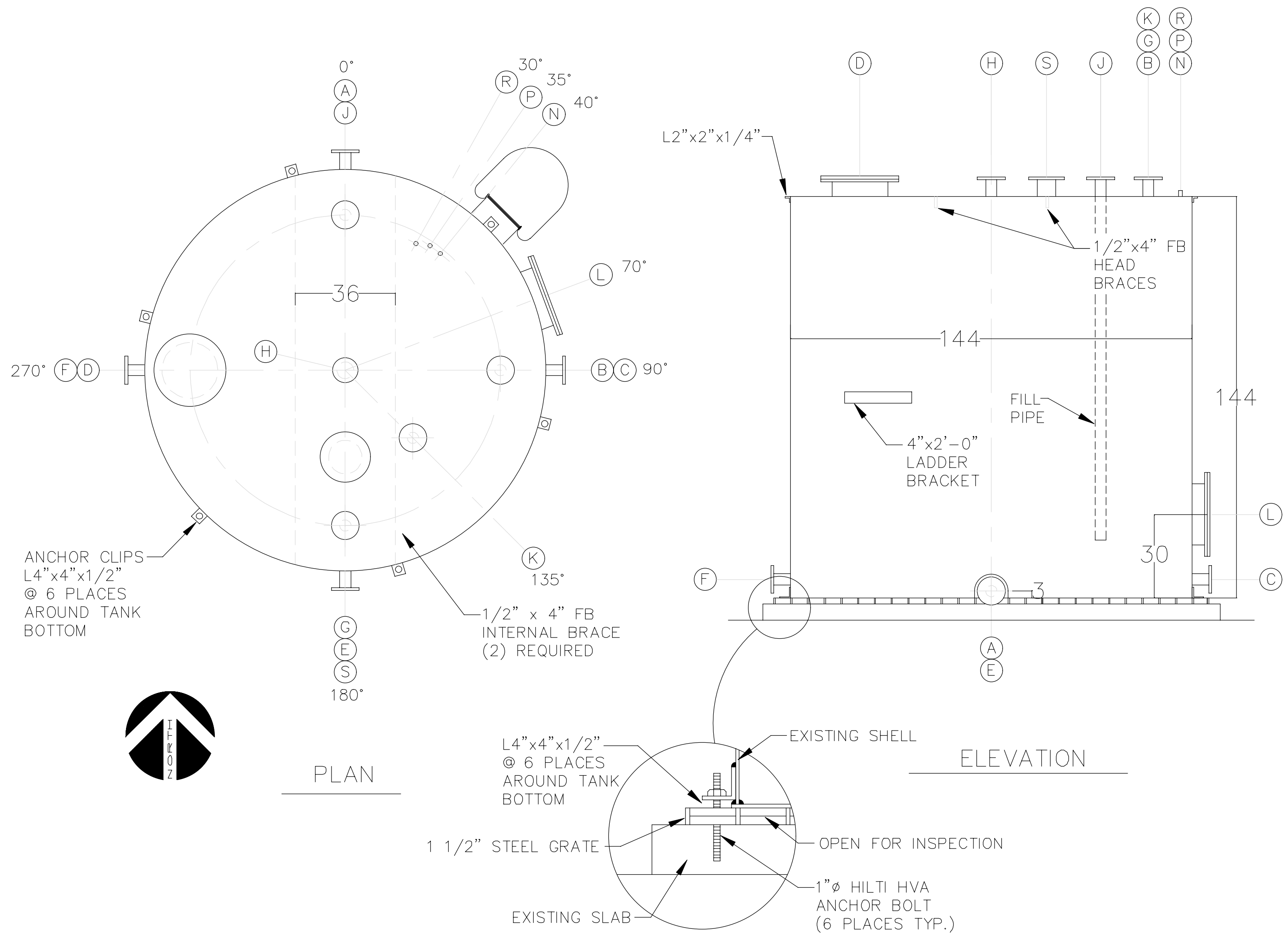
TANK DATA SHEETS

10,152 gal.
−2" w.c. / +16 oz.
0° F 150° F

WASTE SOLVENTS
1.50 12"
150 GPM 150 GPM
API 650 0.70
SBC 70 mph
ZONE 1 / API 650, App. E
12'-0" 12'-0"

5/16"	CS	1/16"	VERTICAL	12'-0"
5/16"	CS	1/16"	FLAT	–
1/4"	CS	1/16"	FLAT	–

A	SPARE	4"	150# RF	SIDE 0° H2.5"	
B	LEVEL SWITCH	4"	150# RF	TOP 90°	
C	SPARE	4"	150# RF	SIDE 90° H2.5"	
D	MANWAY	20"	150# RF	TOP 270°	BOLTED
E	OUTLET	4"	150# RF	SIDE 180° H2.5"	
F	OUTLET	4"	150# RF	SIDE 270° H2.5"	
G	PRES/VAC RELIEF	4"	150# RF	TOP 180°	
H	SPARE	6"	150# RF	TOP CENTER	BLIND FLG
J	INLET	4"	150# RF	TOP 0°	W/ FILL PIPE
K	INLET	4"	150# RF	TOP 135°	
L	MANWAY	22"	150# RF	SIDE 70° H30"	
N	SPARE	1.5"	2000#CPLG.	TOP 40°	CAPPED
P	LEVEL GAUGE	1.75"	2000#CPLG.	TOP 35°	
R	SPARE	1.75"	2000#CPLG.	TOP 30°	CAPPED
S	EMERG. RELIEF	12"	150# RF	TOP 180°	



COATINGS:

INTERIOR: NONE

EXTERIOR: CARBOLINE 890 EPOXY (WHITE), OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

NOT RELEASED FOR CONSTRUCTION

WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

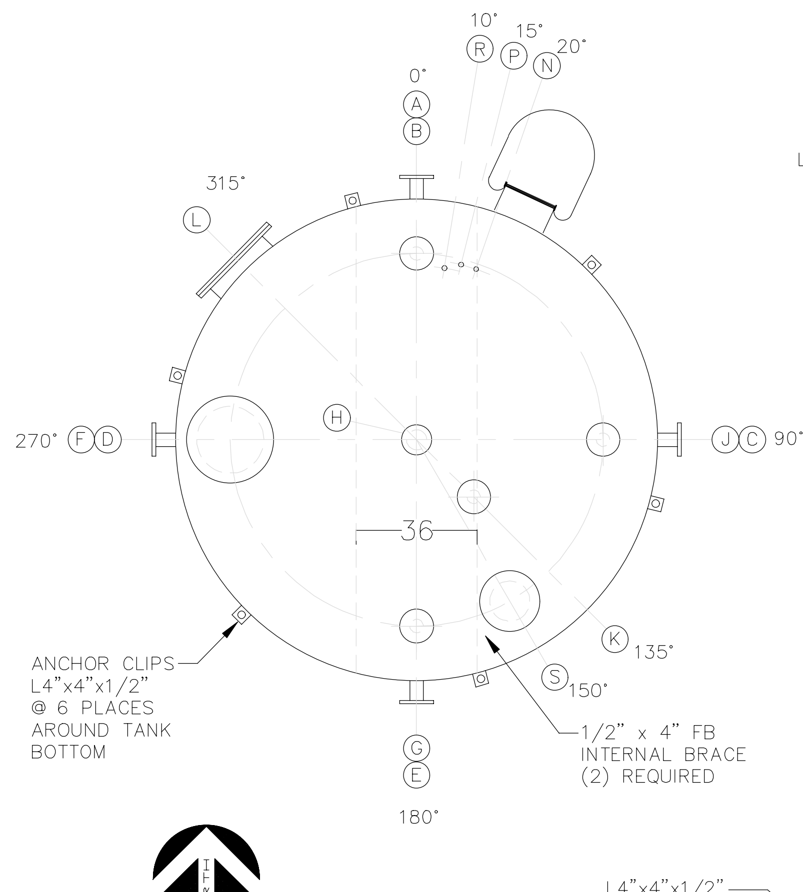
THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

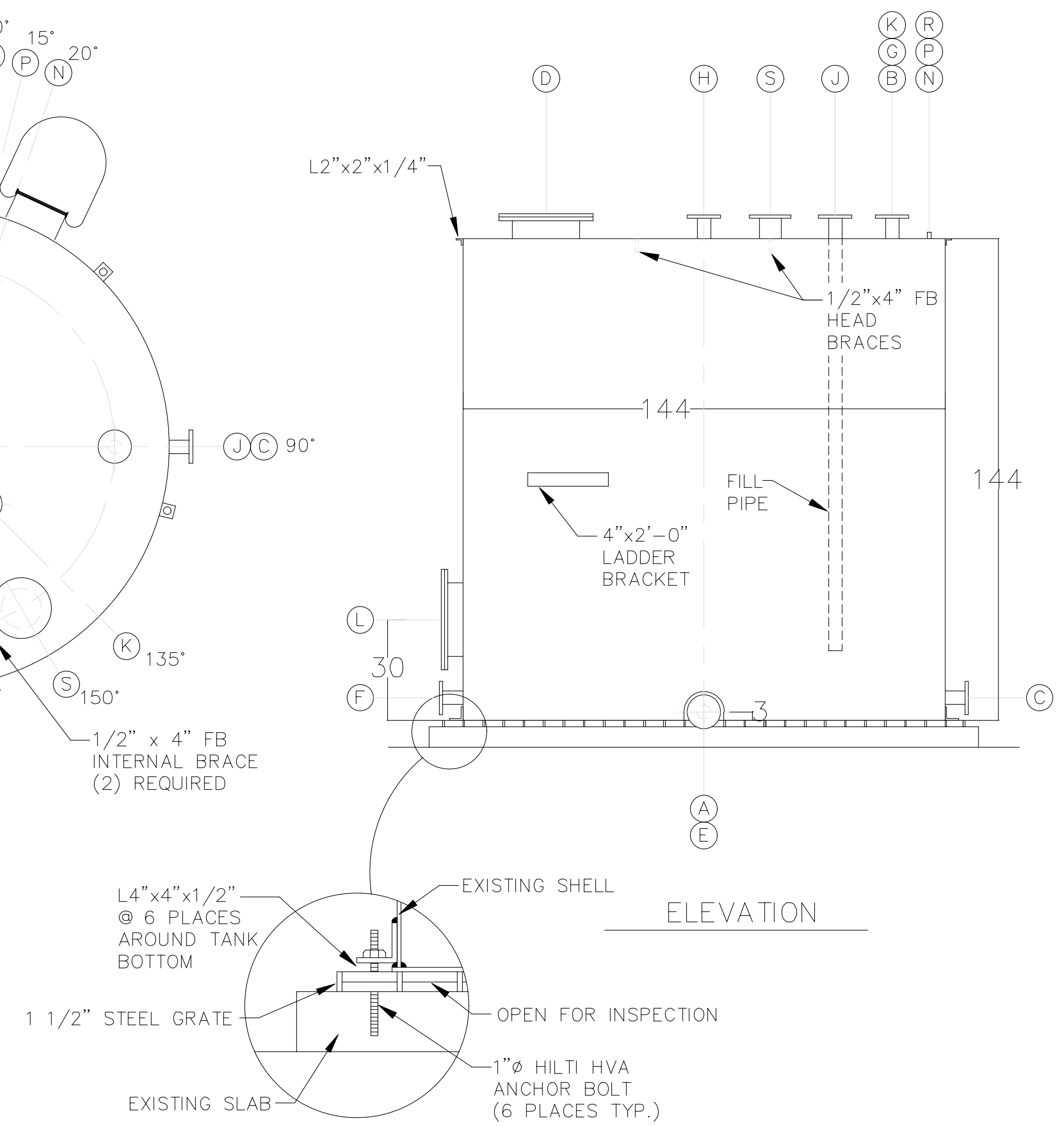
SHEET TITLE
TANK DATA SHEET - T-634

SHEET 0600-080-034

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



PLAN



ELEVATION

10,152 gal.
−2" w.c. / +16 oz.
0° F 150° F
WASTE SOLVENTS
1.50 12"
150 GPM 150 GPM
API 650 0.70
SBC 70 mph
ZONE 1 / API 650, App. E
12'–0" 12'–0"

5/16"	CS	1/16"	VERTICAL	12'–0"
5/16"	CS	1/16"	FLAT	–
1/4"	CS	1/16"	FLAT	–

A	SPARE	4"	150# RF	SIDE 0° H2.5"	
B	LEVEL SWITCH	4"	150# RF	TOP 0°	
C	SPARE	4"	150# RF	SIDE 90° H2.5"	
D	MANWAY	20"	150# RF	TOP 270°	BOLTED
E	OUTLET	4"	150# RF	SIDE 180° H2.5"	
F	OUTLET	4"	150# RF	SIDE 270° H2.5"	
G	PRES/VAC RELIEF	4"	150# RF	TOP 180°	
H	SPARE	6"	150# RF	TOP CENTER	BLIND FLG
J	INLET	4"	150# RF	TOP 90°	W/ FILL PIPE
K	INLET	4"	150# RF	TOP 135°	
L	MANWAY	22"	150# RF	SIDE 70° H30"	
N	SPARE	1.5"	2000#CPLG	TOP 10°	CAPPED
P	LEVEL GAUGE	1.75"	2000#CPLG	TOP 15°	
R	SPARE	1.75"	2000#CPLG	TOP 20°	CAPPED
S	EMERG. RELIEF	12"	150# RF	TOP 150°	

COATINGS:

INTERIOR: NONE

EXTERIOR: CARBOLINE 890 EPOXY (WHITE), OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702

DATE: AUGUST 2022

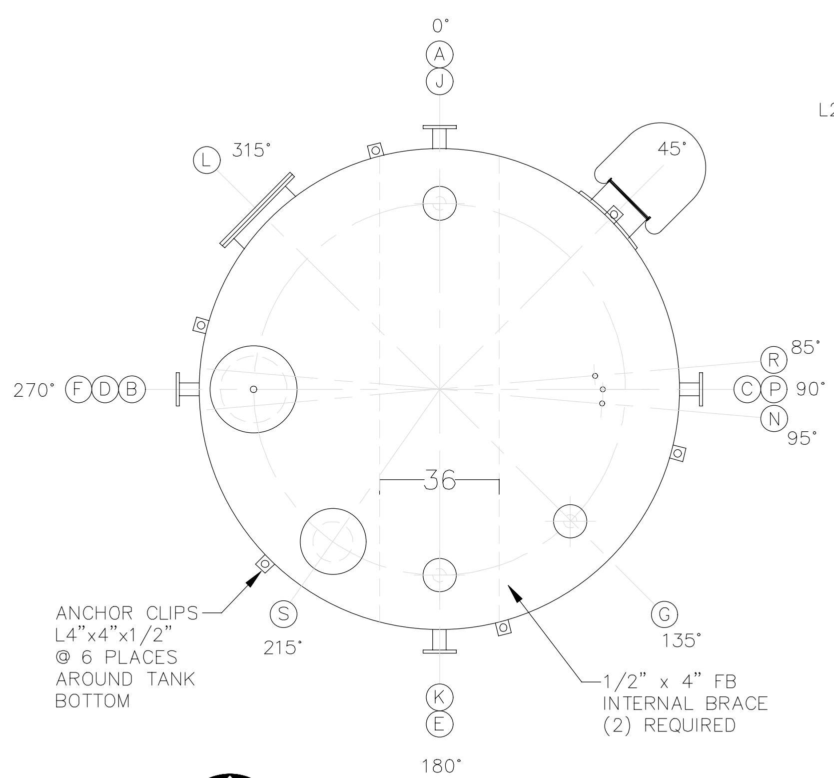
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

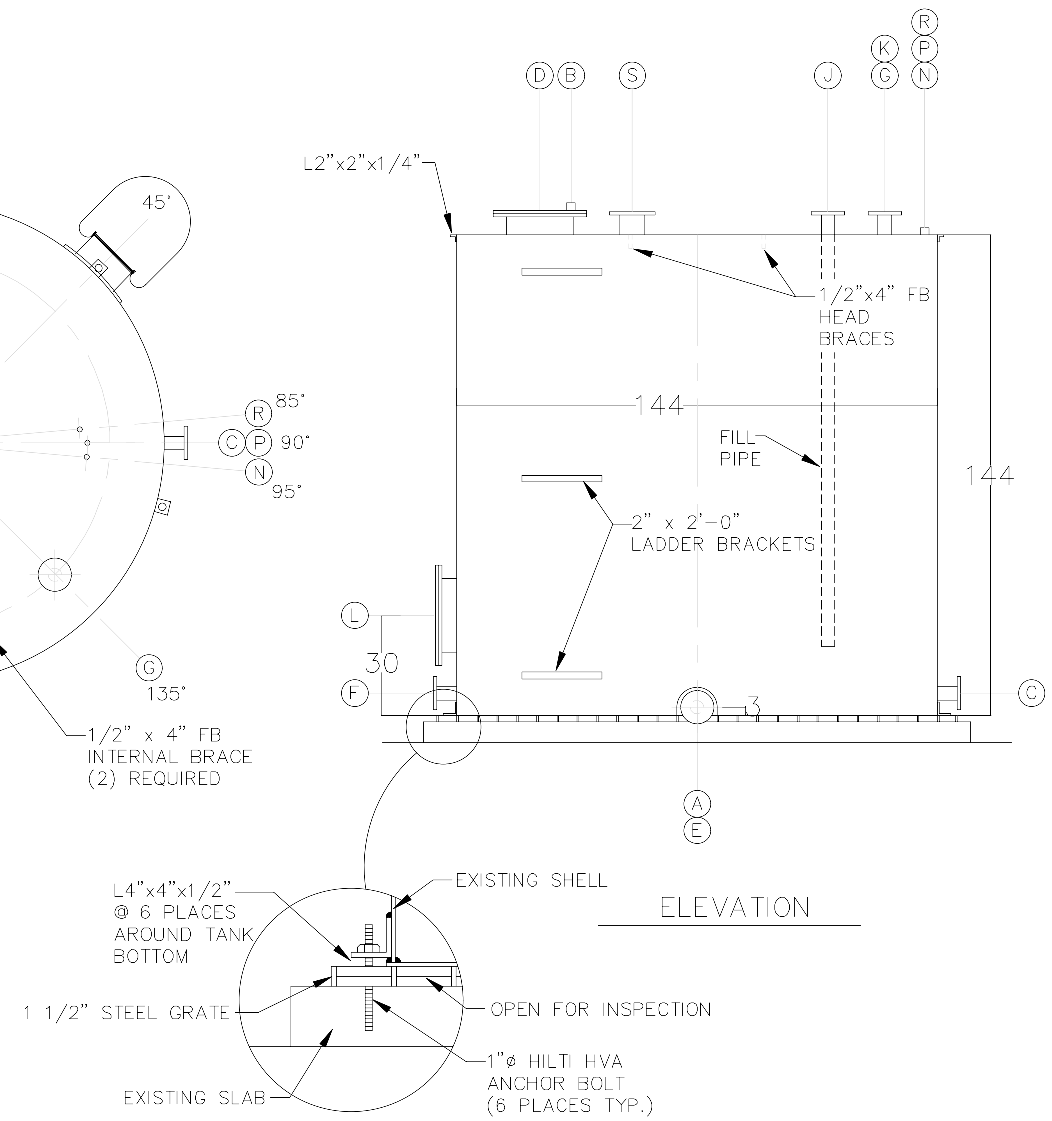
SHEET TITLE

TANK DATA SHEET - T-635

SHEET 0600-080-035

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022





10,152 gal.
−2" w.c. / +16 oz.
0° F 150° F
WASTE SOLVENTS
1.50 12"
150 GPM 150 GPM
API 650 0.70
SBC 70 mph
ZONE 1 / API 650, App. E
12'-0" 12'-0"

1/4"	CS	1/16"		VERTICAL	12'-0"
5/16"	CS	1/16"		FLAT	–
1/4"	CS	1/16"		FLAT	–

A	SPARE	4"	150# RF	SIDE 0° H2.5"	
B	LEVEL SWITCH	1"	CPLG.	TOP 270°	MANWAY D
C	SPARE	4"	150# RF	SIDE 90° H2.5"	
D	MANWAY	20"	150# RF	TOP 270°	BOLTED
E	OUTLET	4"	150# RF	SIDE 180° H2.5"	
F	OUTLET	4"	150# RF	SIDE 270° H2.5"	
G	PRES/VAC RELIEF	4"	150# RF	TOP 135°	
H	OMITTED				
J	INLET	4"	150# RF	TOP 0°	W/ FILL PIPE
K	SPARE	4"	150# RF	TOP 180°	CAPPED
L	MANWAY	22"	150# RF	SIDE 315° H30"	
N	SPARE	1.5"	2000#CPLG.	TOP 95°	CAPPED
P	LEVEL GAUGE	1.75"	2000#CPLG.	TOP 90°	
R	SPARE	1.75"	2000#CPLG.	TOP 85°	CAPPED
S	EMERG. RELIEF	12"	150# RF	TOP 215°	

COATINGS:

INTERIOR: NONE

EXTERIOR: CARBOLINE 890 EPOXY (WHITE), OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs
10 Tenth Street
Suite 1400
Atlanta, GA 30309 | 404.978.7600

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION
CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

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PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE
TANK DATA SHEET - T-636

SHEET 0600-080-036

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

EXHIBIT B

TANK DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 600

TANK NO.: T-634, T-635 & T-636

DECRIPTION: 12'Φ BY 12' CS TANK, FLAT BOTTOM

VESSEL CALCULATIONS

PREPARED BY: LANZ DATE: 9/29/94

REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
LARRY J. LANZ
49...
REGISTERED
PROFESSIONAL ENGINEER

OCT 3 1994

UNIT 600

DESIGN CALCULATIONS

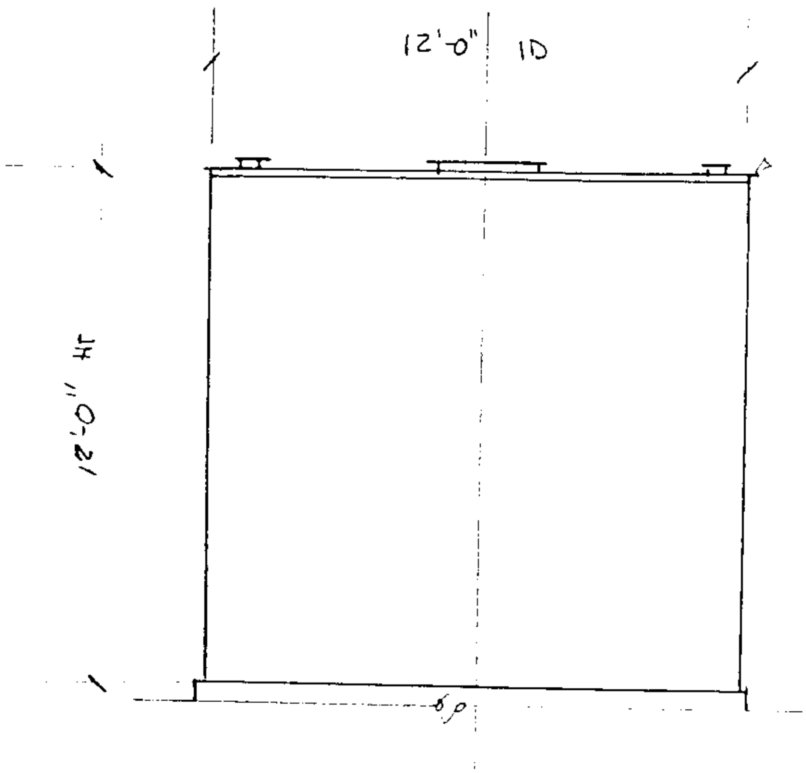
DESIGN DATA SHEET T-634, T-635, T-636 Page 1 of 7
Rev 2 11/18/94

Service: PCB Flush Agents

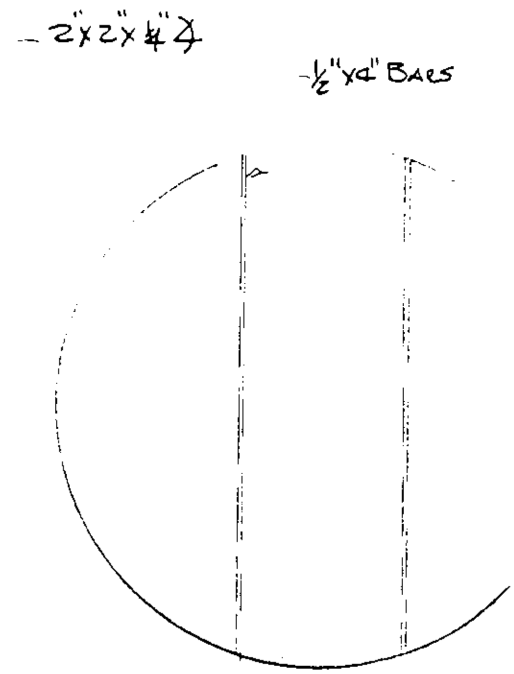
12 ft. Diameter by 12 ft. Shell, Flat Ends, no Legs

Chemical Waste Management, Emelle, AL Job No. 44228.00

Design Code		API 650
Service Status		Existing
Diameter/Length		12' - 0"
Shell/Heigth		12' - 0"
Bottom/Width		
Heads/Ends	Top	Flat
	Bottom	Flat
Legs		None
Operating Capacity		10,152 Gal
Material of Construction		Carbon Steel
Corrosion Allownce		1/16 inch
Joint Efficiency		0.70
Design Spec. Grav.		1.5
Design Pressure	16 oz\sq in Max	2 inches H20 Min
Design Temperature	150 deg F Max	0 deg F. Min
Roof Live Load psf		40 psf
Wind Load		NA
Seismic Zone		Zone 1
Agitator		NO
Location		Indoors



TANK ELEVATION



TOP VIEW

ROSSER

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO. SHEET OF

DESIGNED LANZ / / CHECKED 11/29/94

TANK DESIGN

Diameter 12 feet
Height 12 feet

Weight of Contents

Volume = Pi*H*D*D/4 = 1357.2 Cubic Feet

Weight = Volume*Unit Wt*SG = 127031 Pounds (12 ft. Depth)

Tank Wall Thickness

The 12 foot high tank will be constructed of 12 foot rolled sheet steel. Minimum thicknesses of plate are determined using Section 3.6 of API standard 650.

Min. Values are Bottom Course 3/16" + Corrosion Allowance

Thickness of the steel using the 1 foot method and Appendix F.

t = 2.6*D*(H-1+P/.433)*G/E/21,000 + Corr Allow

= 2.6*12*(12-1+1/.433)*1.5/0.7/21000 + 1/16 = 0.042 + 0.063
0.105 inches

USE 3/16 INCH PLATE

Tank Floor Thickness

USE 5/16 INCH PLATE PER API 650 (1/4" + CA)

Tank Roof Thickness

Assume a 1/4 inch plate Roof (t + c, 3/16" + 1/16") supported at 40 inch centers.

Roark, 6th Ed, Table 26, Case 1 Rect Plate, Edges simply supported

a/b = 12/4 = 3
Beta = 0.7134
Alpha = 0.1335
q = (40+10.4+10.2)/144 =
0.421 psi

Sigma =Beta*q*b*b/t/t =
= 0.7134*.421*40*40/.1875/.1875 =
13669 psi

Defl= Alpha*q*b*b*b*b/E/t/t/t=
= 0.1335*0.421*40*40*40*40/30000000/0.1875/0.1875/0.1875
= 0.728 inches

USE 1/4 INCH PLATE FOR ROOF

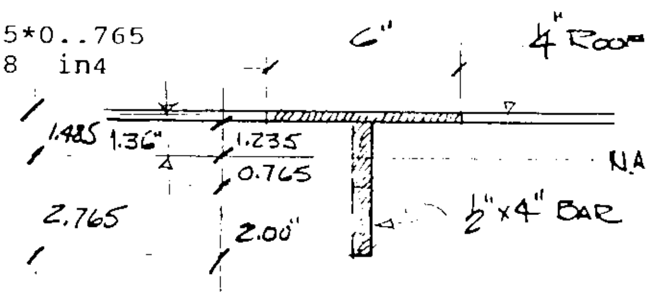
Roof Support Members.

The weight of roof to support with each member is 3.33*(40+10.2+10.4)
Wt = 202 pounds per foot

Roof member eff. length = 11' Load = 202*11 = 2220 pounds
Mom =w*l*l/8 = 202*11*11*12/8 = 36626 inch pounds
Section Modulus = Mom/Allow Stress = 36626/18000 =
2.03 inches cubed

Moment of Inertia
The roof is suported with 1/2" by 4 " flat bars. Use 6 inches of roof plate to form a composite beam.
x = (6*(3/16)*(1/8) + 4*(1/2)*(-2))/(6*(3/16) + 4*(1/2))
= (0.1406 - 4)/3.125 = 1.235 inches

I = 1.125*1.36*1.36 + 2*0.765*0..765
+ 4*4*4/2/12 = 5.918 in4



S = 5.918/2.765 = 2.14 in3
S = 5.918/1.485 = 3.99 in3

2.14 > 2.03
ROOF SUPPORT IS OK

Top Angle Attachment

Per API 650 Section 3.1.5.9, USE 2" X 2" X 1/4" ANGLE

Allowable internal pressure

Pa = Roof load*Allow Stress/ Actual Stress =
= 60.6/144*18000/13669 = 0.55 psi

INTERNAL PRESSURE CHECKS

Weight of Tank

Weight of Floor

Wt. = Area times unit weight = Pi*R*R*12.75
= Pi*6*6*12.75 = 1442 pounds

Weight of Wall

Wt. = Area times unit weight = Pi*D*h*7.65
= Pi*12*12*7.65 = 3461 pounds

Weight of Roof

Wt = Area times unit weight = Pi*R*R*12.75
= @PI*6*6*10.2 = 1154 pounds
Wt of beams = Wt/ft*Len*2 = 6.8*11*2
= 150 pounds

Weight of Nozzles and Attachemnts = 1000 pounds

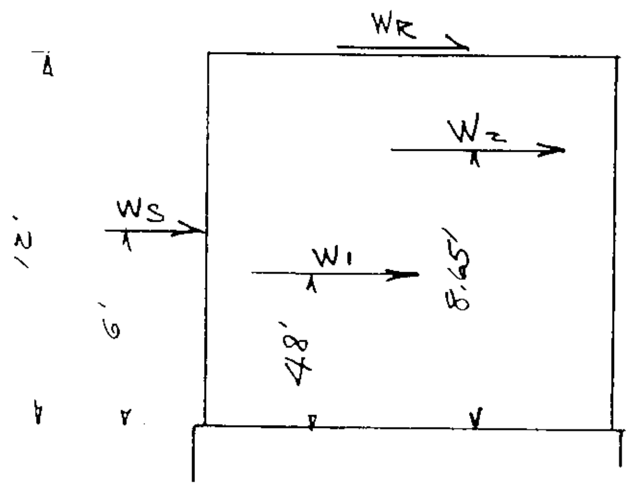
Weight of Tank

Wt = Floor + Wall + Roof + Att = 7206 Pounds

Force on Tank Roof

Force = Pressure times Area = P*Pi*R*R
= 1*Pi*6*12*6*12 = 16286 Pounds

This force is greater that the weight of the empty tank by 9080 pounds. An anchor system is required to hold the tank down.



SEISMIC LOADING ON TANK

Earthquake Forces The Site is in Zone 1. Z= 0.075

The overturning moment due to seizmic forces applied to the bottom of the shell are (API 650, App. E)

M = Z*I*(C1*Ws*Xs+C1*Wr*Ht+C1*W1*X1+C2*W2*X2)

Where

M is the overturning moment
Z is the seizmic zone factor Z = 0.075
I is the importance factor I = 1.0
C1, C2 are earthquake force coefficients, E3.3: C1 = 0.6, C2 = 0.37
Ws is the weight of the tank shell Ws = 3,461 Lb
Xs is the distance up to the shell center of gravity Xs = 6 ft
Wr is the weight of the tank roof Wr = 1,154 LB
Ht is the height of the tank shell Ht = 12 ft
W1 is the effective mass of the tank contents that move with the tank W1 = 101625
X1 is the height to the centroid of seizmic force W1 X1 = 4.8 ft
W2 is the effictive mass of the contents that move in the first sloshing mode W2 = 30487
X2 is the height to the centroid of seizmic force W2 X2 = 8.65 ft

Then
M = .075*1.0*(.6*3461*6+.6*1154*12+.6*101625*4.8+.37*30487*8.65)
= 30827 foot-pounds

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO. SHEET OF
DESIGNED LANZ / / CHECKED 11/29/94

Resistance to Overturning

Not considered for anchored tanks.

Shell Compresion

The maximum longitudinal compressive stress at the bottom of the shell is determined by the expression

b = wt + 1.273*M/D/D = 6083/Pi/12+1.273*31097/12/12
= 434 pounds/foot in shell

The maximum longitudinal compressive stress in the shell b/12/t shall not exceed the following Fa = 1,000,000*t/D when G*H*D*D/t/t >1,000,000 or Fa = 1,000,000*t/2.5/D + 600SQRT(G*H) when less than 1,000,000.

G*H*D*D/t/t = 168585.3 < 1,000,000

Maximum Stress = 1000000*.042/2.5/12+600*SQRT(1.5*12) =
3946 psi

Minimum Anchorage

The force per foot of circumference = 1.273*M/D/D-wt
= 1.273*31097/12/12-6083/Pi/D = 114 pounds

6 - 1 INCH DIAMETER ANCHOR BOLTS ARE REQUIRED FOR TIE DOWN

ROSSER

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO.	SHEET	OF
DESIGNED LANZ / /	CHECKED [signature] 11/29/94	

EXHIBIT C

TANK FOUNDATION DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 600

TANK NO.: T-634, T-635, T-636

DECRIPTION: PCB Flush Agents Tank

FOUNDATION CALCULATIONS

PREPARED BY: S. Smith DATE: 9-8-94

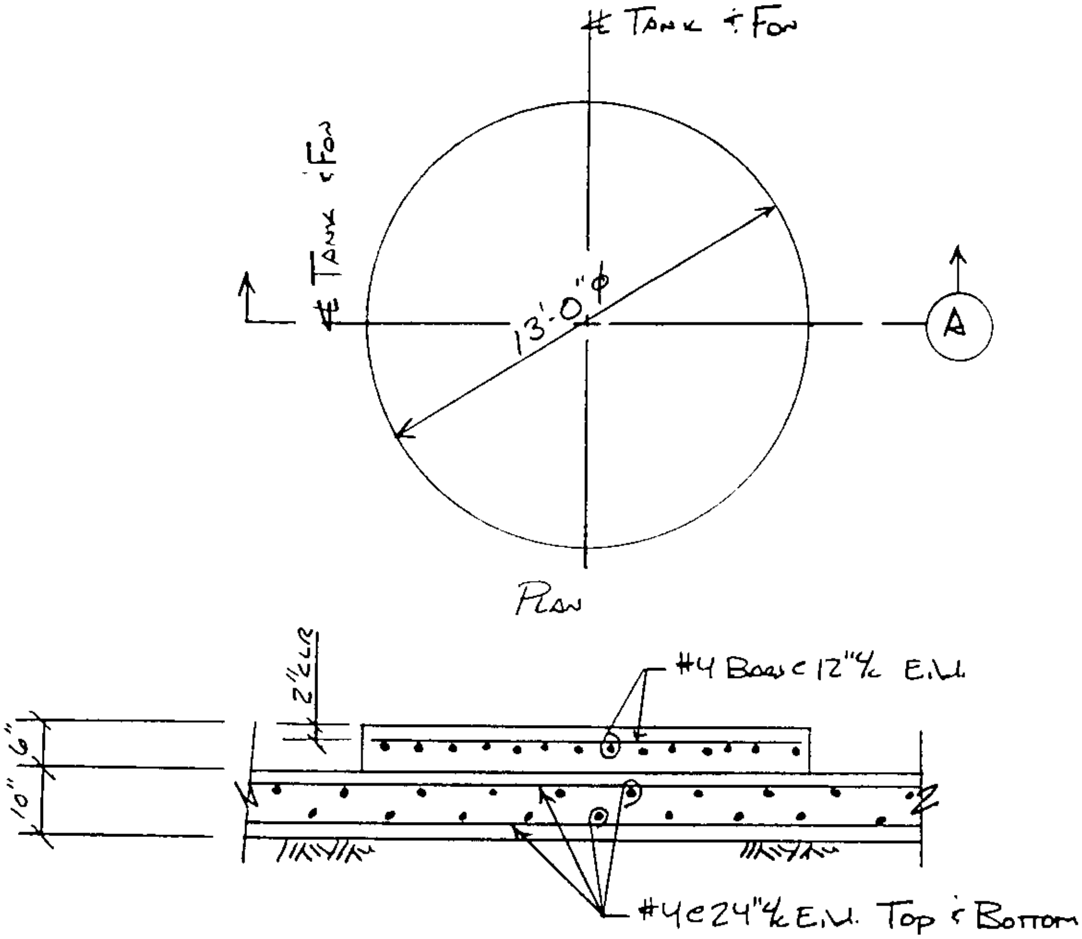
REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
SCOTT R. SMITH
60612
REGISTERED
PROFESSIONAL ENGINEER

10-3-94

FOUNDATIONS FOR TANKS T-634; T-635; T-636



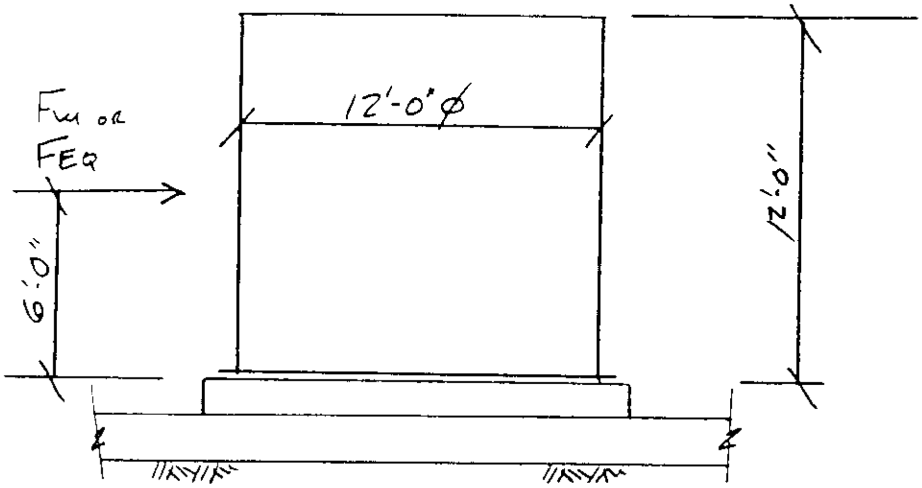
f'c = 3,000 psi
fy = 60,000 psi

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management		PROJ. NO. —	
Emelle, Ala		SHEET SK-1	OF
DESIGNED S. Smith	9/8/94	CHECKED	/ /

FOUNDATIONS FOR TANKS T-634; T-635; T-636

REF. VESSEL DWG 600-1, 600-2, 600-3



WEIGHT OF TANK

TOP = $\frac{\pi (12)^2}{4} \times 12.75$ #/SF = 1,442#

SHELL = $\pi (12.0)(12.0) \times 12.75$ #/SF = 5,767#

BOTTOM $\frac{\pi (12)^2}{4} \times 10.20$ #/SF = 1,153#

NOZZLES (5%) = 0.05 [1,442# + 5,767# + 1,153#] = 418#

W_E = 1,442# + 5,767# + 1,153# + 418# = <u>8,788#</u>

WEIGHT OF CONTENTS

TANK CAPACITY 10,152 GALLONS

SPECIFIC GRAVITY = 1.5

CONTENTS WEIGHT

W_C = 10,152 GAL × 1.5 × 8.34 #/GAL = <u>127,001</u> #

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MANAGEMENT	PROJ. NO.	
	EMELLE, ALA.	SHEET 1	OF
	DESIGNED S. SMITH 9/8/94	CHECKED	/ /

FOUNDATIONS FOR TANKS T-634; T-635; T-636

WIND LOAD (S.B.C (1994)) (ASCE 7-88)

WIND SPEED : 70 MPH

EXPOSURE : C

EXPOSURE COEFF : (@ Z = 30') : $K_z = 0.98$

GUST FACTOR : (@ Z = 30') : $G_h = 1.26$

SHAPE COEFF : $C_f = 0.8$

IMPORTANCE FACTOR $I = 1.00$

$F = q_z G_h C_f A$ $q_z = 0.00256 K_z (IV)^2 = 0.00256(0.98)(1.26)(1.0 \times 70)^2 = 12.3 psf$

$A = 12.0' \times 12.0' = 144 SF$

$F_W = 12.3 psf (1.26)(0.8)(144 SF) = \underline{1,785^{\#}}$

EARTHQUAKE LOAD (S.B.C 1994)

$F_{EQ} = A_V \times C_C \times P \times a_C \times W_T$

$A_V = 0.06$ (FIG 1607.1.5A) p 395

$C_C = 2.0$ (TABLE 1607.6.4A) p 429 (GENERAL EQUIP)

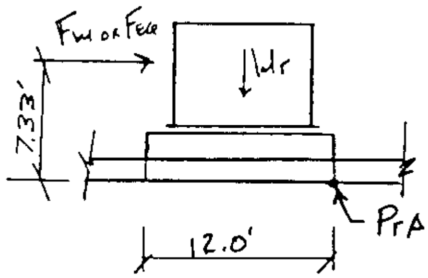
$P = 0.5$ " " " "

$a_C = 1.0$ (TABLE 1607.6.4B) p 430 (FIXED)

TOTAL $W_T = W_E + W_C = 8,788^{\#} + 127,001^{\#} = \underline{135,789^{\#}}$

$F_{EQ} = 0.06(2.0)(0.5)(1.0) \times 135,789^{\#} = \underline{8,147^{\#}}$

CHECK STABILITY



FDN DIMENSIONS : 12.0' × 12.0' × 1.16'

$A = 12.0' \times 12.0' = 144.0 FT^2$

$S = \frac{12.0' \times (12.0)^2}{6} = 288 FT^3$

W_{FF} 12.0' × 12.0' × 1.16' × 150#/CF = $\underline{25,056^{\#}}$

ROSSER BOVAY / ROSSER FABRAP / ROSSER JUSTICE SYSTEMS / ROSSER LOWE / IHT ROSSER		
PROJECT CHEM WASTE MANAGEMENT	PROJ. NO.	
EMELLE, ALA	SHEET 2	OF
DESIGNED S. SMITH 9/8/94	CHECKED / /	

FOUNDATIONS FOR TANKS T-634; T-635; T-636

CHECK STABILITY (CONT)

CASE I (DL+LL+EQ)

$W_T = 135{,}789^{\#}$
$W_F = 25{,}056^{\#}$
$160{,}845$

$M_R = 160{,}845^{\#} \times (12.0/2) = 965{,}070$ FT-lbs

$F_{EQ} = 8{,}147^{\#}$ $M_O = 8{,}147^{\#} \times 7.33' = 59{,}717$ FT-lbs

$$S.R. = \frac{M_R}{M_O} = \frac{965{,}070 \text{ FT-lbs}}{59{,}717 \text{ FT-lbs}} = 16.16 \geq 1.5 \therefore OK$$

CASE II (DL+WL)

$W_T = 8{,}788^{\#}$
$W_F = 25{,}056^{\#}$
$33{,}844^{\#}$

$M_R = 33{,}844^{\#} \times (12.0/2) = 203{,}064$ FT-lbs

$F_W = 1{,}785^{\#}$ $M_O = 1{,}785^{\#} \times 7.33' = 13{,}084$ FT-lbs

$$S.R. = \frac{M_R}{M_O} \; \frac{203{,}064 \text{ FT-lbs}}{13{,}084 \text{ FT-lbs}} = 16.51 \geq 1.5 \therefore OK$$

$\therefore$ STABILITY OF TANK FDN IS OK

CHECK SOIL BEARING

ALLOW. BEARING PRESSURE = 3,000 psf
TEMP " " = 1.33 × 3,000 psf = 3,990 psf ≈ 4,000 psf

CASE I (DL+LL)

$W_T = 160{,}845^{\#}$

$$S.B = \frac{P}{A} = \frac{160{,}845^{\#}}{144 \text{ FT}^2} = 1{,}116 \text{ psf} \leq 3{,}000 \text{ psf} \therefore OK$$

FOUNDATIONS FOR TANKS T-634; T-635; T-636

CHECK SOIL BEARING (CONT)

CASE II (DL+LL+EQ)

$W_T = 160{,}845^{\#}$

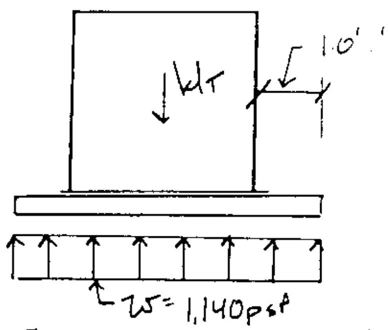
$M = 8{,}147^{\#} \times 7.33' = 59{,}717$ FT·lbs

$$S.B. = \frac{P}{A} + \frac{M}{S} = \frac{160{,}845^{\#}}{144\ FT^2} + \frac{59{,}717\ FT\cdot lbs}{288\ FT^3} =$$

$S.B. = 1{,}116 + 207 = 1{,}323$ psf $\leq 4{,}000$ psf ∴ OK

∴ SOIL BEARING IS OK

CHECK MAT BENDING (1 FT DESIGN STRIP)



$M = 1.32\ ksf \times 1.00' \times (1.00/2) = 0.66^{K\text{-}F}$

$V = 1.32\ ksf \times 1.00 = 1.32^{K}$

$M_u = 1.7 \times 0.66^{K\text{-}F} = 1.122^{K\text{-}F}$

$f'_c = 3{,}000$ psi $\quad f_y = 60{,}000$

TRY #4 BARS @ 24" o/c $\quad A_s = 0.10\ in^2$

$\phi M_N = \phi A_s f_y (d - a/2)$

$d = 10" - 3" - 0.5 - 0.5/2 = 6.25"$

$$a = \frac{A_s f_y}{0.85(b)(f'_c)} = \frac{0.10(60)}{0.85(12)(3)} = 0.19"$$

$\phi M_N = 0.9(0.10)(60)(6.25" - 0.19/2) = 33.23^{K\text{-}IN} = 2.76^{K\text{-}F}$

$\phi M_N = 2.76^{K\text{-}F} \geq M_u = 0.66^{K\text{-}F}$ ∴ BENDING OK

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM. WASTE MANAGEMENT PROJ. NO. — —
	EMELLE, ALA SHEET 4 OF
	DESIGNED S. SMITH 9/8/94 CHECKED / /

FOUNDATIONS FOR TANKS T-634; T-635; T-636

CHECK BM SHEAR (1 FT WIDE DESIGN STRIP)

$V_u = 1.7 \times V = 1.7 \times 1.32^k = 2.244^k$

$\phi V_c = \phi\, 2\sqrt{f'_c}\, b\, d = 0.85(2)\sqrt{3{,}000}(12)(6.25") = 6{,}983^{\#}$

$\phi V_c = 6{,}983^{\#} \geq V_u = 2{,}244^{\#}$ ∴ BEAM SHEAR OK

CHECK PUNCHING SHEAR

$W_T = 135{,}789^{\#}$

$P_u = 1.7 \times 135{,}789^{\#} = 230{,}841^{\#}$

TANK BASE 13'-0" ϕ ∴ $b_o = \pi(13.0' + d) =$

$b_o = \pi(13.0' + 6.25''/12) = 42.47' = 509''$

$\phi V_c = 0.85(4)\sqrt{f'_c}(b_o)(d)$

$\phi V_c = 0.85(4)\sqrt{3{,}000}(509)(6.25) = 592{,}430^{\#}$

$\phi V_c = 592{,}430^{\#} \geq P_u = 230{,}841^{\#}$ ∴ PUNCHING SHEAR OK

CHECK ANCHOR BOLTS

COEFF. OF FRICTION: STEEL TO CONCRETE 0.3

$\mu = 0.3$

CASE I (DL+LL+EQ)

RESIST FORCE $= \mu \times W_T = 0.30 \times 135{,}789^{\#} = 40{,}736^{\#}$

RESIST $: 40{,}736^{\#} \geq F_{eq} = 8{,}147^{\#}$ ∴ OK

CASE II (DL+WL)

RESIST FORCE $= \mu \times W_e = 0.30 \times 8{,}788^{\#} = 2636^{\#}$

RESIST $= 2636^{\#} \geq F_w = 1{,}785^{\#}$

∴ NO ANCHOR BOLTS REQ'D

ROSSER BOVAY / ROSSER FABRAP / ROSSER JUSTICE SYSTEMS / ROSSER LOWE / IHT ROSSER	
PROJECT: CHEM WASTE MANAGEMENT	PROJ. NO. —
EMELLE, ALA	SHEET 5 OF
DESIGNED S. SMITH 9/8/94	CHECKED / /

EXHIBIT D

CALCULATIONS OF TANK VENTING REQUIREMENTS

EXHIBIT D
TANK VENTING CALCULATIONS (PER API 2000)
CHEMICAL WASTE MANAGEMENT, INC., EMELLE, ALABAMA FACILITY

												IN-BREATHING					OUT-BREATHING					EMERGENCY		
Tank Nos.	Width/ Diameter (ft)	Length/ Shell Height (ft)	Depth/ Cone Height (ft)	Tank Wetted Surf. Area (sf)	Tank Capacity (gal)	Tank Rated Press. (in WG)	Tank Relief Press. (in WG)[1]	Tank Rated Vac. (in WG)	Tank Relief Vac. (in WG)[1]	Fill Rate (gpm)	With-drawal Rate (gpm)	Normal Venting (cfh)[2]	Thermal Venting (cfh)[3]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Normal Venting (cfh)[4]	Thermal Venting (cfh)[5]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Vent Capacity (cfh)[6]	Min. Area (sq in)[7]	Min. Size (in)
CONTAINER & TANK MANAGEMENT UNIT 600																							
T-634 thru T-636	12.00	12.00		452	10,152	28.00	14.00	2.00	1.00	150	150	1,200	242	1,442	3.41	3.00	2,571	242	2,813	1.78	2.00	334,646	87.6	11.00

NOTES:

1. Pressure and vacuum relief is assumed to be set to relieve at 50% of the design rated pressure or vacuum, unless noted. Emergency relief is assumed to be set at 75% of design pressure.
2. Normal in-breathing at 5.6 scfh per 42 gal barrel per hour of withdrawal, as specified in API 2000, 4th Edition.
3. Thermal in-breathing at 1 scfh per 42 gal barrel of tank volume, up to 20,000 barrel (840,000 gal) volume, as in API 2000.
4. Normal out-breathing at 12 scfh per 42 gal barrel per hour of fill for volatile liquids (flash point <100 deg F), as in API 2000. For non-volatile liquids 6 scfh per 42 gal barrel may be used.
5. Thermal out-breathing at 1 scfh per 42 gal barrel of tank volume for volatile liquids, up to 20,000 barrel volume, as in API 2000. For non-volatile liquids 0.6 scfh per 42 gal barrel may be used.
6. From API 2000 Appendix B on Emergency Venting, for four ranges of tank surface area, heat absorption, Q, is calculated. Vent capacity in SCFH is then calculated from the heat absorption according to the equation:
   SCFH = 70.5 * Q / [L * sqrt(M)] assuming a conservative "L * sqrt(M)" value of 1,337, that of hexane.
7. Formula for emergency vent area adapted from Protectoseal Technical Manual, on flow capacity of tank emergency venting devices for nozzles 8 in. and larger:
   CFH = 1,667 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank emergency relief setting and atmospheric conditions.
8. Formula for vent area for smaller nozzles such as normal breather vents, adapted from Crane Flow of Fluids, Eq. 2-24, very similar to, but more conservative, than Protectoseal equation:
   CFH = 845 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank relief setting and atmospheric conditions.
   The factor 845 was derived using unit conversion factors, a vapor density of 0.1875 lb/cf, and a conservative Y of 0.80 from charts on Crane p. A-21.

EXHIBIT E

TANK MATERIAL OF CONSTRUCTION
COMPATIBILITY INFORMATION

Compatibility Information

Unit 600: T-634 to T-636

Carbon Steel

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Acetaldehyde	B	C	A	A	A	B	D	C	B	A
Acetamine	B		B	B	B	B	A		A	A
Acetate Solvents	C	B	A	A	A	B	D	D	D	A
Acetic Acid, aerated	D	D	A	A	A	A	C	D	D	A
Acetic Acid, Air Free	D	D	B	B	A	A	C	D		A
Acetic Acid, crude	C	C	B	B	A	B	D	D		A
Acetic Acid, glacial							C		D	A
Acetic Acid, pure	C	D	B	B	A	D	C	D		A
Acetic Acid, 10%	C	C	B	A	A	B	B	D	B	A
Acetic Acid, 80%	C	C	B	B	A	B	C	D	B	A
Acetic Acid Vapors	D		D	D	D	C	D			A
Acetic Anhydride	C	C	C	C	C	C	D	D	C	A
Acetone	A	A	A	A	A	A	D	A	A	A
Other Ketones	A	A	A	A	A	A	D	A	D	A
Acetyl Chloride	D	C	C	C	B	B	D		D	A
Acetylene	D	B	A	A	A	B	A	A	A	A
Acid Fumes	D	D	B	B	B		C			A
Acrylonitrite	B	B	B	B	B	B	D	D	D	A
Air (Oil Free)	A	A	A	A	A	A	A	A	A	A
Alcohol, Amyl	B	B	B	B	A	B	B	A	A	A
Alcohol, Butyl	A	B	A	A	A	B	B	B	C	A
Alcohol, Diacetone	B	B	B	B	B	B	D		A	A
Alcohol, Ethyl	B	B	B	B	B	B	A	A	A	A
Alcohols, Fatty	B	B	A	A	A		B			A
Alcohol, Isopropyl	B	B	B	B	B	B	B	A	A	A
Alcohol, Methyl	B	B	B	B	B	B	A	A	A	A
Alcohol, Propyl	B	B	A	A	A	B	A		A	A
Alumina	A						A		A	A
Aluminum Acetate	D		B	B	A	C	C		A	A
Aluminum Chloride dry	D	D	C	C	C	D	B	A	A	A
Aluminum Chloride solution	D	D	D	D	D	D	B		A	A
Aluminum Fluoride		D	D	D	C	C	A		A	A
Aluminum Hydroxide	B	D	A	A	A	B	A		A	A
Aluminum Nitrate	D	D		C	C	C	A		A	A
Alum (Aluminum Potassium Sulfate)	C	C	D	D	C	C	B		A	A
Aluminum Sulfate	C	D	B	C	B	B	A	A	A	A
Amines	C	D	B	B	B	B	D	A	C	A

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Ammonia, Alum				A	A		B		A	A
Ammonia, Anhydrous Liquid	C	A	B	B	A	B	B		A	A
Ammonia, Aqueous	C	A	B	B	A	B	B	A	A	A
Ammonia Gas, hot	D	C	A	A	A	D	D		B	A
Ammonia Liquor			A	A	A					A
Ammonia Solutions	D	B	A	A	A	B	B		B	A
Ammonium Acetate	D		B	B	B	B	D		A	A
Ammonium Bicarbonate	B	C	B	B	B	B	B	A	A	A
Ammonium Bromide 5%		D		C	B	B			A	A
Ammonium Carbonate	D	B	B	B	B	B	D	A	A	A
Ammonium Chloride	C	D	D	D	D	B	A	A	A	A
Ammonium Hydroxide 28%	D	B	B	B	B	D	B		A	A
Ammonium Hydroxide Concentrated	D	B	B	B	B	D	D	A	A	A
Ammonium Nitrate	D	D	A	A	A	D	A	A	A	A
Ammonium Oxalate 5%		D	B	B	B	B				A
Ammonium Persulfate	D	D	D	D	B	D	D		A	A
Ammonium Phosphate	D	D	C	B	C	C	A	B	A	A
Ammonium Phosphate Di-basic	C	D	C	B	C	C	A	A	A	A
Ammonium Phosphate Tri-basic	C	D	C	B	C	C	A	A	A	A
Ammonium Sulfate	C	D	D	D	B	B	A	A	A	A
Ammonium Sulfide	D	D		B	B	B	A		A	A
Ammonium Sulfite	C	D	C	C	B	C	B	A	B	A
Amyl Acetate	B	C	A	A	A	A	D	B	B	A
Amyl Chloride	B		B	B	B	B	D		D	A
Aniline	B	C	A	A	A	B	D	A	C	A
Aniline Dyes	C	C	A	A	A	A	D	A	C	A
Apple Juice	C	D	B	B	B	A	A	A	B	A
Aqua Regia	D	D	D	D	D		D		D	A
Aromatic Solvents	A	C	A	A	A	B	D		D	A
Arsenic Acid	B	D	B	B	B	D	A	A	A	A
Asphalt Emulsion	A	B	A	A	A	A	D	A	D	A
Asphalt Liquid	A	B	A	A	A	A	C	A	D	A

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Barium Carbonate	B	B	B	B	B	B	B	A	A	A
Barium Chloride	C	C	D	D	B	B	A	A	A	A
Barium Cyanide	C		B	B	B	D	B		B	A
Barium Hydroxide	D	C	B	B	B	B	A	A	A	A
Barium Nitrate			B	B	B		A			A
Barium Sulfate	B	C	B	B	B	B	A	A	B	A
Barium Sulfide	D	C	B	B	B	C	A	A	A	A
Beer-Alcohol Industry	B	C	A	A	A	A	A	A	A	A
Beer-Beverage Industry	B	C	A	A	A	A	B	A	A	A
Beet Sugar Liquors	A	B	A	A	A	A	A	A	B	A
Benzaldehyde	A	D	A	B	A	B	D	A	A	A
Benzene (Benzol)	B	B	B	B	B	B	D	A	D	A
Benzoic Acid	B	D	B	B	B	B	D		D	A
Berryllium Sulfate	B		B	B	B	B	B		B	A
Blood (Meat Juices)	B		B	B	B	B	B		C	A
Borax (Sodium Borate)	C	C	A	A	A	A	B	A	A	A
Bordeaux Mixture	D	C	A	A	A	A	B	A	A	A
Borax Liquors	C	C	B	B	B	A	B	A	A	A
Boric Acid	C	D	B	B	B	B	A	A	A	A
Brake Fluid (Non Pet)	B			B	B	B	D		A	A
Brines, saturated	C	D	B	B	B	B	A	A	A	A
Bromine, dry	B	D	D	D	D	A	D		D	A
Bunker Oils (Fuel)	B	B	B	B	B	B	A	A	D	A
Butadiene	C	C	B	B	B	B	C	A	D	D
Butane	B	A	B	B	B	B	A	A	D	A
Butter					A		B			A
Buttermilk	D	D	A	A	A	D	A	A	B	A
Butyl Acetate	B	C	C	C	B	B	D		D	A
Butylene	B	B	B	B	A	A	C		D	A
Butyric Acid	D	D	C	C	B	C	D	A	C	A
Calcium Bisulfite	D	D	D	D	C	D	A	A	D	A
Calcium Carbonate	B	B	B	A	B	B	A	A	A	A
Calcium Chlorate	D	D	B	B	B	B	A			A
Calcium Chloride	C	C	B	B	B	B	A	A	A	A
Calcium Hydroxide	C	B	B	B	B	B	A	A	A	A
Calcium Nitrate		C			B		B		B	A
Calcium Phosphate	C			C	B		B		B	A
Calcium Silicate	C			C	B		B		B	A
Calcium Sulfate	C	D	B	B	B	C	A	A	B	A
Caliche Liquor		B		A	A	B	B		A	A
Camphor	C		C	C	C		B		B	A

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C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Cane Sugar Liquors	A	B	A	B	A	B	A		A	A
Carbolic Acid (phenol)	D	D	B	B	B	B	D	D	B	A
Carbonate Beverages	B	D	B	B	B	C	B		B	A
Carbonated Water	B	B	A	A	A	B	A	A	A	A
Carbon Bisulfide	B	B	B	B	B	C	D	A	D	A
Carbone Dioxide, dry	B	B	B	B	A	A	A	A	B	A
Carbonic Acid	C	C	B	B	B	C	B	A	B	A
Carbon Monoxide	A		A	A	A	A	B		A	A
Carbon Tetra-chloride, dry	B	B	B	B	B	A	C	A	D	A
Carbon Tetra-chloride, wet	D	D	C	C	B	B	C	A	D	A
Casein	C			C	B	C	B		B	A
Castor Oil	A	B	B	B	B	A	A	A	B	A
Caustic Potash	C	D			B	B	B			A
Caustic Soda	C	B		A	A	A	C		B	A
Cellulose Acetate	B			B	B	B	D		B	A
China Wood Oil (Tung)	C	C	A	A	A	A	A	A	D	A
Chlorinated Solvents	C	C	B	B	B	B	D	A	D	A
Chlorinated Water		D	D	D	C	D	B	A	A	A
Chlorine Gas, dry	B	B	B	B	B	A	D	A	D	A
Chlorobenzene, dry	C	B	A	B	B	B	D	A	D	A
Chloroform, dry	B	D	A	A	B	A	D	A	D	A
Chlorophyll, dry	B			B	B	B	B		B	A
Chlorosulfonic Acid, dry	C	C	D	D	D	C	D		D	A
Chrome Alum	C	B	B	B	B	B	A		A	A
Chromic Acid<50%	D	D	C	C	B	B	D	D	B	A
Chromic Acid≥50%	D	D	C	D	C	D	D	C	C	A
Chromium Sulfate	C			B	B	B	B		B	A
Cider			A	A	A	A				A
Citric Acid	D	D	C	C	A	B	A		A	A
Citrus Juices	B	D	B	B	B	A	A	A		A
Coca-Cola Syrup			A	A	A		B			A
Coconut Oil	B	C	B	B	B	B	A	A	C	A
Cod Liver Oil							A		A	A
Coffee	A		A	A	A	B	A		A	B
Coffee Extracts, hot	B	C	A	A	A	A				A
Coke Oven Gas	C	B	B	B	B	B	D		D	A
Cooking Oil	B	B	A	A	A	A	A	A	D	A
Copper Acetate	D	D	B	B	B	C	C		B	A
Copper Carbonate			B	B	B	D	D			A

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Copper Cyanide	D		B	B	B	D	A		A	A
Copper Nitrate	D	D	B	A	A	D	A	A	B	A
Copper Sulfate	D	D	B	B	B	C	A	A	A	A
Corn Oil	B	B	B	B	B	B	B	A	D	A
Cottonseed Oil	B	B	C	C	B	B	A	A	C	A
Creosol		C		B	B		D		D	A
Creosote Oil	B	B	B	B	B	B	B	D	D	A
Cresylic Acid	D	C	B	B	B	C	D	D	D	A
Crude Oil, sour	C	B	A	A	A	B	B		D	A
Crude Oil, sweet	B	B	A	A	A	A	A		D	A
Cutting Oils, Water Emulsions	A	B	A	A	A		A	A	D	A
Cyanide Plating Solution	D			B	B	D	B		B	A
Cyclohexane	A	B	A	B	A	B	B	A	D	A
Cyclohexanone	B	D	B	B	B	B	D		B	A
Detergents, synthetic	B			B	A	B	B		B	A
Dextrin	B			B	B	C	B		B	A
Dichloroethane	D	C		B	B	A	D		D	A
Dichloroethyl Ether	B			B	B		D		D	A
Diesel Oil Fuels	A	B	A	A	A	A	A	A	D	A
Diethylamine	D	D	B	B	A	B	C		C	A
Diethylene Glycol	B			A	A	B	A		A	A
Diethyl Sulfate	B			B	B	B	C	A	C	A
Dimethyl Formamide	B			A	A	B	B		D	A
Dipentane (Pinene)	A			A	A		B		D	A
Disodium Phosphate	C	B	B	B	B	C	B			A
Dowtherm	A	B	A	A	A	A	D	A	D	A
Drilling Mud	B	B	A	B	A	B	A	A	A	A
Dry Cleaning Fluids	C	B	A	A	A	B	D	A	D	A
Drying Oil	C	C	B	B	B	B	A	A	D	A
Enamel	A			A	A		B		D	A
Epsom Salts	B	C	B	B	B	B	A	A		A
Ethane	B	C	B	B	B	B	A	A	D	A
Ethers	B	B	A	A	A	B	D	C	C	A
Ethyl Acetate	B	B	B	B	B	B	D	A	C	A
Ethyl Acrylate	B	C	B	B	B	B	D		C	A
Ethyl Bromide	A		B	B	B	B	B		D	A
Ethyl Chloride, dry	B	B	A	A	A	B	B	A	B	B
Ethyl Chloride, wet	C	D	B	C	B	B	B		B	A
Ethylene Chloride		B	B	B	B	B	D		D	A
Ethylene Dichloride	D	B	B	B	B	A	D	D	D	A
Ethylene Glycol	B	B	B	B	B	B	A	C	A	A

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Ethylene Oxide	C	B	B	B	B	C	D	A	D	A
Ethyl Ether	B				A	A	D		D	A
Ethyl Silicate	B			B	B	B	B		B	A
Ethyl Sulfate	B			B	B	B	C	A	C	A
Fatty Acids	C	D	B	B	A	B	B	A	D	A
Ferric Hydroxide				A	A	A	B			A
Ferric Nitrate	D	D	C	B	B	D	A	A	A	A
Ferric Sulfate	D	D	C	C	B	D	A	A	A	A
Ferrous Chloride	C	D	D	D	D	D	A	A	A	A
Ferrous Sulfate	C	D	C	B	B	B	A	A	A	A
Ferrous Sulfate, Saturated	C	C	A	B	A	B	C		B	A
Fertilizer Solutions	C	B	B	B	B	B	B	D	B	A
Fish Oils	B	B	A	A	A	A	A	B	D	A
Flue Gases	B			B	A	B	C	C	D	A
Fluoboric Acid				B	B	B	A		A	A
Fluorosilicic Acid	B	D	D	D	B	A	B		C	A
Food Fluids & Pastes	B	C	A	A	A	B	B		B	A
Formaldehyde, cold	A	A	A	A	A	A	B	A	B	A
Formaldehyde, hot	B	D	C	C	C	B	B	A	B	A
Formic Acid, cold	C	D	C	C	B	B	D	D		A
Formic Acid, hot	C	D	C	C	B	B	D	D		A
Freon Gas, dry	B	B	A	A	A	A	C	B	C	A
Freon 11, MF, 112, BF	B	D	B	B	A	B	B	B	D	
Freon 12, 13, 32, 114,115	A	D	B	B	A	B	B	B	C	
Freon 21, 31	B			A	B		D	B	D	
Freon 22	A	D	B	B	A	B	D	B	D	
Freon 113, TF	B				A	B	B		D	
Freon, wet	D		B	C	C	B	B		B	A
Fruit Juices	C	D	B	B	A	B	A	A	A	A
Fuel Oil	B	B	B	B	B	B	A	A	D	A
Fumaric Acid							B			A
Furfural	B	C	B	B	B	B	D	A	C	A
Gallic Acid 5%	B	D	B	B	B	B	B	A	B	A
Gas, Manufactured	B	B	B	B	B	A	A	A		A
Gas, Natural	B	B	B	B	B	B	A	A	B	A
Gas, Odorizers	A	B	B	B	B	B	B	A		A
Gasoline, Aviation	A	A	A	A	A	A	C	A		A
Gasoline, Leaded	A	A	A	A	A	B	C	A		A
Gasoline, Motor	A	A	A	A	A	A	C	A	D	A
Gasoline, Refined	B	B	B	B	B	B	C		D	A

CORROSION CHART

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	Valve Material: Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Seats & Seals: Buna N	Delrin	EPDM	Teflon
Gasoline, Sour	B	B	B	B	B	C	C	A	D	A
Gasoline, Unleaded	B	B	B	B	B	B	C	A		A
Gelatin	B	D	A	A	A	B	A	A	A	A
Glucose	B	B	B	B	A	B	A	A	A	A
Glue	B	B	B	B	B	B	A		B	A
Glycerine (Glycerol)	B	C	A	A	A	A	A	C	A	A
Glycols	B	C	B	B	B	B	B	C	A	A
Graphite	B			B	B	B	B		B	A
Grease	C	A	A	A	A	B	A		D	A
Helium Gas	B			B	B	B	B		B	A
Heptane	A	B	A	A	A	B	A	A	D	A
Hexane	B	B	B	A	A	B	A	A	D	A
Hexanol, Tertiary	B	B	B	B	A	B	A		D	A
Hydraulic Oil, Petroleum Base	B	A	A	A	A	A	A	A	D	A
Hydrazine	D	B		B	B	D	C		B	A
Hydrocyanic Acid	D	C	B	B	B	C	B	D	B	A
Hydrofluosilicic Acid	D	D	C	D	C	B	B		A	A
Hydrogen Gas, cold	A	A	A	A	A	A	A		A	A
Hydrogen Gas, hot		B			B		A		A	A
Hydrogen Peroxide, Concentrated	C	D	B	B	B	C	D		B	A
Hydrogen Peroxide, Dilute	C	D	B	B	B	B	B	B	A	A
Hydrogen Sulfide, Dry	C	B	B	B	A	B	C	A	A	A
Hydrogen Sulfide, Wet	D	B	C	C	B	D	D	A	B	A
Hypo (Sodium Thiosulfate)	C	D	A	A	A	B	A	A	A	A
Illuminating Gas	A	A	A	A	A	A	C		D	A
Ink - Newsprint	B	D	B	A	A	B	A	A	B	A
Iodoform	B	D	A	A	A	C		A	A	A
Iso-Butane					B		B		D	A
Iso-Octane	A	A	A	A	A	A	A	A	D	A
Isopropyl Acetate					B		D		A	A
Isopropyl Ether	B	B	B	B	B	B	C		D	A
J P-4 Fuel	A	B	B	B	A	B	A	A	D	A
J P-5 Fuel	A	B	B	B	A	B	B	A	D	A
J P-6 Fuel	A	B	B	B	A	B	A	A	D	A
Kerosene	A	B	A	A	A	B	A	A	D	A
Ketchup	D	D	A	A	A	B	A	A		A
Ketones	B	B	B	B	B	B	D	A	D	A

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	Valve Material: Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Seats & Seals: Buna N	Delrin	EPDM	Teflon
Lacquer (and Solvent)	A	C	A	A	A	A	D	A	D	A
Lactic Acid Concentrated cold	D	D	B	B	A	D	B	D	B	A
Lactic Acid Concentrated hot	D	D	C	C	B	D	D	D	D	A
Lactic Acid Dilute cold	C	D	B	B	A	C	B	D	B	A
Lactic Acid Dilute hot	D	D	B	B	B	D	D	D	D	A
Lactose	B			B	B	B	B		B	A
Lard	B	C	B	B	B	B	B		C	A
Lard Oil	B	C	A	B	B	B	A	A	B	A
Lead Acetate	D	D	B	B	B	B	B	A	B	A
Lead Sulfate	C	D		B	B	B	B		B	A
Lecithin	C			B	B	B	D		D	A
Linoleic Acid	C	D	A	B	A	B	B	A	D	A
Linseed Oil	A	A	B	B	B	B	A	A	D	A
Lithium Chloride	D			B	B	B	B		B	A
L P G	A	B	B	B	B	B	A	A	D	A
Lubricating Oil Petroleum Base	B	A	A	A	A	B	A	A	D	A
Ludox	D			B	B	B	B		B	A
Magnesium Carbonate	B		A	B	A	B	B		B	A
Magnesium Chloride	B	C	C	C	B	B	A	A	A	A
Magnesium Hydroxide	B	B	B	A	A	B	B	A	A	A
Magnesium Hydroxide, Hot	D	B	B	A	A	B	B	A	A	A
Magnesium Nitrate	B	B	B	B	A	B	B		A	A
Magnesium Sulfate	B	B	B	B	A	A	A	A	A	A
Maleic Acid	C	D	B	B	B	B	D	A	D	A
Maleic Anhydride	C			B	B	B	D		D	A
Malic Acid	D	D	B	B	A	B	A	A	D	A
Manganese Carbonate				B	B		B			A
Manganese Sulfate	B		B	B	B	B	B		B	A
Mayonnaise	D	D	A	A	A	B	A	A		A
Meat Juices	D		B	B	B	B	B		D	A
Melamine Resins					C		B			A
Menthol	B			B	B	B	B		D	A
Mercuric Chloride	D	D	D	D	B	D	A		A	A
Mercuric Cyanide	D	D	B	B	B	C	A		A	A

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	Valve Material: Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Seats & Seals: Buna N	Delrin	EPDM	Teflon
Mercurous Nitrate	D		B	B	A	D	B		B	A
Mercury	D	B	A	A	A	A	A	A	A	A
Methane	B	B	B	B	B	B	A	A	D	A
Methyl Acetate	B	B	A	B	A	B	D		B	A
Methyl Acetone	A	A	A	A	A	A	D		A	A
Methylamine	D	B	A	A	A	C	D		B	A
Methyl Cellosolve	B	C	B	B	A	B	D		B	A
Methyl Chloride	B	D	B	A	A	B	D	A	D	A
Methyl Ethyl Ketone	A	A	A	A	A	A	D	A	B	A
Methylene Chloride	A	B	A	B	A	B	D		D	A
Methyl Formate	A	C	B	B	B	B	D		B	A
Methyl Isobutyl Ketone	A	B	B	B	A	B	D			A
Milk & Milk Products	C	B	A	A	A	C	A	A	A	A
Mineral Oils	B	B	B	B	B	B	A	A	D	A
Mineral Spirits	B	C	B	A	A	B	A	A	D	A
Mine Water (Acid)	D	D	B	B	B	C	A	A	B	A
Mixed Acids (cold)	D	D	B	B	B	D	D	D	D	A
Molasses, crude	A	B	A	A	A	B	A	A	A	A
Molasses, Edible	A	B	A	A	A	B	A	A	A	A
Monochloro Benzene, Dry						B	D			A
Morpholine	B	B	B	B	B	B	D		D	A
Mustard	A	B	A	A	A	A	A	A		A
Naptha	A	B	B	B	B	B	B	A	D	A
Napthalene	B	B	B	B	B	B	D	A	D	A
Natural Gas, Sour	B			D	D	D	A		D	D
Nickel Ammonium Sulfate	D	D	B	B	B	C	A		B	A
Nickel Chloride	C	D	B	B	B	B	A	A	B	A
Nickel Nitrate	D	C	B	A	A	B	A	A	A	A
Nickel Sulfate	C	D	B	B	B	B	A	A	B	A
Nicotinic Acid	B	B	B	B	A	B	D		B	A
Nitric Acid 10%	D	D	A	A	A	D	C	D		A
Nitric Acid 30%	D	D	A	A	A	D	C	D	B	A
Nitric Acid 80%	D	D	B	B	B	D	D	D	B	A
Nitric Acid 100%	D	D	B	B	B	D	D	D	C	A
Nitric Acid Anhydrous	D	D	C	C	B	D	D		C	A
Nitrobenzene	B	B	B	B	B	B	D		D	A
Nitrogen	A	A	A	A	A	A	A	A	B	A
Nitrous Acid 10%	D	D	C	C	B	D	C			A

	Valve Material: Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Seats & Seals: Buna N	Delrin	EPDM	Teflon
Nitrous Gases	D	B	C	C	B	D				A
Nitrous Oxide	D	B	B	B	B	D	B	A		A
Oils & Fats			B	B	B		B		D	A
Oils, Animal	B	B	B	B	A	B	A		B	A
Oils, Petroleum Refined	B	A	A	A	A	A	A	A	D	A
Oils, Petroleum Sour	C	B	A	A	A	A	B		D	A
Oils, Water Mixture	A	B	A	A	A		A	A		A
Oleic Acid	B	C	B	B	B	B	B	A	B	A
Oleum	D	B	B	B	B	D	D	D	D	A
Oleum Spirits	D		B	B	B	D	C		D	A
Olive Oil	C	B	A	A	A	A	A	A	B	A
Olalic Acid	B	D	D	D	B	B	D	C	B	A
Oxygen	A	B	B	B	A	B	B	D	A	A
Ozone, Dry	A	C	A	A	A	A	D		A	A
Ozone, Wet	B	C	B	A	A	A	D		B	A
Paints & Solvents	A	A	A	A	A	A	D		D	A
Palmitic Acid	B	C	B	B	B	B	B	A	B	A
Palm Oil	B	C	B	B	B	A	B	A	D	A
Paper Pulp	B			B	B	B	B		B	
Paraffin	A	B	A	A	A	A	A	A	D	A
Paraformaldehyde	B	B	B	B	B	B	B	A	D	A
Paraldehyde							B		D	A
Pentane	A	B	A	A	A	B	A	A	D	A
Perchlorethylene, dry	B	B	B	B	B	B	D		D	A
Petrolatum (Vaseline Petroleum Jelly)	B	C	B	B	B	B	A	A	D	A
Phenol	B	D	A	B	A	A	D	D	D	A
Phosphate Ester 10%	D	B	A	A	A	A	D		A	A
Phosphoric Acid 10%	D	D	C	B	B	D	D	D	B	A
Phosphoric Acid 50% Cold	D	D	B	B	B	C	D	D	B	A
Phosphoric Acid 50% Hot	D	D	D	C	D	C	D	D	B	A
Phosphoric Acid 85% Cold	D	D	B	B	B	C	D	D	B	A
Phosphoric Acid 85% Hot	D	D	C	B	B	C	D	D		A
Phosphoric Anhydriede		D		B	B		D	B		A

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	Valve Material						Seats & Seals			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Phosphorous Trichloride		B	A	A	A		D		A	A
Phthalic Acid	B	C	B	B	A	B	C	A		A
Phthalic Anhydride	B	B	B	A	A	A	C	A	B	A
Picric Acid	D	D	B	B	B	D	C		B	A
Pineapple Juice	C	C	A	A	A	A	A	A		A
Pine Oil	B	B	A	A	A	B	A	A	D	A
Pitch (Bitumen)	A	B	A	A	A	A	C		D	A
Polysulfide Liquor	D			B	B	B	B		B	A
Polyvinyl Acetate	B			A	A	B	C		A	A
Polyvinyl Chloride	B			B	B	B			B	A
Potassium Bicarbonate			A	A	A	B	B		A	A
Potassium Bisulfate					A	B	B	A		A
Potassium Bisulfite	C	D	B	B	B	D	A	A	B	A
Potassium Bromide	C	D	B	B	B	B	A	A	A	A
Potassium Carbonate	D	B	B	A	A	B	A	A	A	A
Potassium Chlorate	D	C	B	B	A	C	A	A	A	A
Potassium Chloride	D	C	C	C	B	B	A	A	A	A
Potassium Chromate	C			B	B	B	B		B	A
Potassium Cyanide	D	B	B	B	B	B	A	A	A	A
Potassium Dichromate	B	B	B	A	A	B	A	A	A	A
Potassium Ferricyanide	C	D	B	B	B	B	A	A	A	A
Potassium Ferrocyanide	B	C	B	B	B	B	A	A		A
Potassium Hydroxide Dilute Cold	C	B	B	B	B	A	A		B	A*
Potassium Hydroxide To 70%, Cold	D	C	B	B	B	A	B		B	A*
Potassium Hydroxide Dilute Hot	D	B	B	B	B	A	B		B	A*
Potassium Hydroxide To 70%, Hot	D	C	D	D	B	B	C		A	A*
Potassium Iodide	C	D	B	B	B	C	A	A	A	A
Potassium Nitrate	B	B	B	B	B	B	A	A	A	A
Potassium Oxalate			B	B	B	B	D			A
Potassium Permanganate	C	C	B	B	B	B	C	A	A	A
Potassium Phosphate	C			B	B	B	A		A	A
Potassium Phosphate Di-basic	B	A	A	A	A	B	A	A	B	A
Potassiuum Phosphate Tri-basic		A			B	B	B		B	A
Potassium Sulfate	B	B	B	A	A	B	A	A	A	A
Potassium Sulfide	D	D	B	B	B	D	A		B	A
Potassium Sulfite	B	B	B	B	A	C	B		A	A
Producer Gas	B	B	B	B	B	A	A	A	D	A
Propane Gas	A	B	B	B	B	B	A	A	D	A
Propylene Glycol	B	B	B	B	B	B	A	C	A	A
Pyridine	B	C	B	B	B	B	D		B	A
Pyrogallic Acid	C	C	C	C	B	C	A	A		A
Pyrolignous Acid			B	B	B		D		B	A
Quench Oil	B	B	A	A	A		A	A	D	A
Quinine Bisulfate, dry			A	A	A	B				A
Quinine Sulfate dry			A	A	A	B				A
Resins & Rosins	A	C	B	B	B	A	C		D	A
Road Tar	A	A	A	A	A	A	B	A	D	A
Roof Pitch	A	A	A	A	A	A	B	A		A
Rosin Emulsion	B	C	A	A	A	A	D			A
Rubber Latex Emulsions	A	B	A	A				A		A
Rubber Solvents	A	A	A	A	A	A	D	C	D	A
Salad Oil	B	C	B	B	B	B	A	A	D	A
Salicylic Acid	C	D	B	B	B	C	B	A	A	A
Salt (naCl)	B	C	B	B	B	A	A	A	A	A
Salt Brine	B	D		A	A	B	A		B	A
Sea Water	C	D	B	B	A	A	A	A	A	A
Sewage	C	C	B	B	B	B	A		B	A
Shellac-bleached	A	A	A	A	A		A			A
Shellac-orange	A	A	A	A	A	A	A			A
Silicone Fluids	B		B	B	B		B		B	A
Silver Bromide			B	B	A	B				A
Silver Cyanide	D		A	B	A	B	B		B	A
Silver Nitrate	D	D	B	B	A	D	C	A	A	A
Silver Plating Sol.			A	A	A		B		B	A
Soap Solutions (Stearates)	A	A	A	A	A	A	A		A	A
Sodium Acetate	B	D	B	B	B	C	B	A	A	A
Sodium Aluminate	B	C	B	B	B	B	A	A	B	A

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	Valve Material: Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Seats & Seals: Buna N	Delrin	EPDM	Teflon
Sodium Bicarbonate	B	C	A	A	A	A	A	A	A	A
Sodium Bichromate	D		B	B	B		D			A
Sodium Bisulfate 10%	C	C	A	A	A	B	A	A	A	A
Sodium Bisulfite 10%	D	D	B	B	B	B	A	A	A	A
Sodium Borate	B	C	B	B	B	B	A	A	A	A
Sodium Bromide 10%	B	C	B	B	B	B	A	A	A	A
Sodium Carbonate (Soda Ash)	B	B	B	B	B	A	A	A	A	A
Sodium Chlorate	B	C	B	B	B	B	A	A	A	A
Sodium Chloride	B	C	B	B	B	A	A	A	A	A
Sodium Chromate	C	B	B	B	B	B	A	A	A	A
Sodium Citrate			B	B	B					A
Sodium Cyanide	D	C	A	A	A	D	A	A	A	A
Sodium Ferricyanide				C	B	B			A	A
Sodium Fluoride	D	D	C	C	B	A	A	A	A	A
Sodium Hydroxide 20% Cold	B	B	A	A	A	A	B		A	A·
Sodium Hydroxide 20% Hot	B	B	A	A	A	A	B		A	A·
Sodium Hydroxide 50% Cold	C	C	A	A	A	A	B		A	A·
Sodium Hydroxide 50% Hot	C	C	B	B	A	A	B		A	A·
Sodium Hydroxide 70% Cold	C	C	B	B	B	A	B		A	A·
Sodium Hydroxide 70% Hot	D	D	C	C	C	B	D		B	A·
Sodium Hypo-sulfite			A	A	A	B				A
Sodium Lactate			A	A	A	B				A
Sodium Meta-phosphate	C	D	B	B	B	B	A		A	A
Sodium Meta-silicate Cold	B	C	A	A	A	A	B			A
Sodium Meta-silicate Hot	B	D	A	A	A	A				A
Sodium Nitrate	D	B	B	A	A	B	B	A	A	A
Sodium Nitrite			B	B	B	C	C	B	A	A
Sodium Perborate	C	B	B	B	B	B	C	A	A	A
Sodium Peroxide	D	C	B	B	B	B	C	A	A	A
Sodium Phosphate	C	C	B	B	B	B	B	B	A	A
Sodium Phosphate Di-basic	C	C	B	B	B	B	A	A	A	A
Sodium Phosphate Tri-basic	C	C	B	B	B	B	B	A	A	A
Sodium Polyphosphate					B		B		A	A
Sodium Salicylate			A	A	A					A
Sodium Silicate	B	B	B	B	B	B	A	A	A	A
Sodium Silicate, hot	C	C	B	B	B	B			B	A
Sodium Sulfate	B	B	B	A	A	B	A	A	A	A
Sodium Sulfide	D	C	B	B	B	B	A	A	A	A
Sodium Sulfite	D	C	A	A	A	B	A		A	A
Sodium Tetraborate					A		A		B	A
Sodium Thiosulfate	D	D	C	C	B	B	B	A	C	A
Soybean Oil	B	C	A	A	A	A	A	A	B	A
Starch	B	C	B	B	B	A	A	A	C	A
Steam (212°F)	A	B	A	A	A	B	D	D	B	B
Stearic Acid	B	C	B	B	A	C	B	A	B	A
Styrene	A	A	A	A	A	B	D		D	A
Succinic Acid	C		D	C	B	B				A
Sugar Liquids	A	B	A	A	A	A	A	A	B	A
Sugar, Syrups & Jam	B		B	A	A		A		A	A
Sulfate, Black Liquor	D	D	B	B	B	B	C	B	B	A
Sulfate, Green Liquor	D	D	B	B	B	B	C	A		A
Sulfate, White Liquor	D	D	B	B	B	C	C	A		A
Sulfonic Acid	B			B	B	B	D		D	A
Sulfur	D	D	B	A	A	B	D	A	A	A
Sulfur Chlorides, Dry	D	D	D	C	C	C	D	A	D	A
Sulphur Dioxide, dry	B	A	B	B	B	B	D	A	A	A
Sulfur Dioxide, wet	D	D	D	D	B	D	D		A	A
Sulfur Hexafluoride	B		A	A	A		A		A	A
Sulfur, Molten	D	D	B	B	B	D	D		D	A
Sulfur Trioxide	D	B			B	B	D		B	A
Sulfur Trioxide, dry	D	B	B	B	B	B	D	A	B	A
Sulfuric acid 0 to 77%	D	D	D	D	D	B	D	C	B	A

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Sulfuric Acid 100%	D	C	C	C	B	D	D	D	C	A
Sulfurous Acid	D	D	D	D	B	D	B	C	B	A
Tall Oil	B	B	B	B	B	B	B	A	D	A
Tannic Acid (Tannin)	D	D	B	B	B	B	B	A	A	A
Tanning Liquors			B	B	B		B			A
Tar & Tar Oils	A	A	A	A	A	A	C		D	A
Tartaric Acid	B	D	B	A	A	B	B	A	C	A
Tetraethyl Lead	B	C	B	B	B	B	B	A	D	A
Toluol (Toluene)	A	A	A	A	A	A	D	A	D	A
Tomato Juice	C	C	B	B	B	B	A	A		A
Transformer Oil	B	B	B	B	B	B	A	A	D	A
Tributyl Phosphate	B	B	B	B	B	B	D		A	A
Trichlorethylene	B	B	B	B	B	A	D	A	D	A
Trichloroacetic Acid	D	D	D	D	D	B	C		C	A
Triethanolamine	B	C		B	B	B	D		B	A
Triethylamine	B			B	B	B	B			A
Trisodium Phosphate		B		B	B	B	A		B	A
Tung Oil	B	B	A	A	A	C	A	A	D	A
Turpentine	B	B	A	A	A	A	B	A	D	A
Urea	B	C	B	B	B	B	B	A	B	A
Uric Acid			B	B	B					A
Varnish	A	C	A	A	A	A	C	A	D	A
Vegetable Oils	B	B	A	A	A	A	A	A	D	A
Vinegar	C	C	B	B	B	B	D		B	A
Vinyl Acetate	B			A	B	B	D		A	A
Water, Distilled	A	D	A	A	A	A	B	A	A	A
Water, Fresh	A	C	A	A	A	A	B	A	A	A
Water, Acid Mine	D	D	B	A	A	D	B		A	A
Waxes	A	A	A	A	A	A	A	A	C	A
Whiskey & Wines	B	C	A	A	A	A	A	A	A	A
Xylene (Xylol), Dry	B	B	B	B	B	B	D	A	D	A
Zinc Bromide	B			B	B	B	B		B	A
Zinc Hydrosulfite	C	A	A	A	A	B	A	A	A	A
Zinc Sulfate	C	D	B	A	A	B	A	A	A	A

A = Excellent
B = Good
C = Poor
D = Do Not Use

ATTACHMENT D-2-4-3

APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 708

Revision No.
5.0

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 708

TANK T-725

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LIST OF EXHIBITS

LIST OF REFERENCED DRAWINGS

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 708

TANK T-725

I. Introduction

This document provides the assessment and certification for the design of the hazardous waste storage tank system at Tank Management Unit 708 at the Chemical Waste Management, Inc. Facility in Emelle, Sumter County, Alabama. The assessment was performed to address the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), regarding the design of the system within Tank Management Unit 708 which is comprised of the tank (i.e., Tank T-725), the tank foundation, the associated ancillary equipment and the secondary containment system.

Tank Management Unit 708 is located just east of Unit 707/708 as shown on Drawing No. 0100-020-001 in Appendix D-1 to Section D of the RCRA Part B Permit Application. The primary function of the T-725 tank system within Unit 708 is to collect and store miscellaneous diluted organic and acidic washwater wastes generated during the operation of the laboratory. After storage in Tank T-725 these wastes are transferred to Tank T-726 or directly into tanker trucks for transfer to other units on-site.

The following drawings were used in the preparation of this Assessment and Certification and are provided either in Exhibit A (Tank Data Sheets) or in Appendix D-1 to Section D of the RCRA Part B Permit Application:

Drawing No.	**Drawing Title**
0708-010-001	Laboratory Tank Storage Unit 708 - P&ID
0708-020-001	Laboratory Tank Storage Unit 708 - Piping Layout and Tank Details
0708-080-025	Tank Data Sheet - T-725 - Sheet 1 of 2
0708-080-025A	Tank Data Sheet - T-725 - Sheet 2 of 2

II. Tank Design

Tank T-725, which is a cathodically protected, double-wall, Underground Storage Tank, has been designed in accordance with the design codes and standards indicated within the DESIGN DATA section of the Tank Data Sheets (i.e., Drawing Nos. 0708-080-025 and -025A) provided in Exhibit A to this tank system design assessment. The criteria utilized in the assessment of the design of the shell and anchorage for Tank T-725 are also provided within the DESIGN DATA section of the Tank Data Sheets.

To address the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a) regarding tank systems in contact with the soil, the integrity of Tank T-725 has been addressed with the selection of a "sti-P_3"® pre-engineered tank as designed by the Steel Tank Institute, incorporating a corrosion resistant exterior coating, cathodic protection, and electrical isolation devices at piping joints. Additionally, the tank is not likely to be affected by vehicular traffic above it, although adequate soil coverage and a concrete slab at grade are included in the design. Tank T-725 receives only dilute, aqueous rinsate from laboratory operations via a sewer system that is constructed entirely of HDPE components which have operating temperature constraints that are less than those of Tank T-725. Therefore, it is highly unlikely that wastewaters which would result in any significant temperature rise, when mixed, could be introduced into the sewer system, and hence, a temperature monitoring device is not necessary for Tank T-725.

The information provided in Exhibits B and C to this tank system design assessment demonstrates that the tank is designed as a pre-engineered tank system in accordance with proven and widely recognized standards (i.e., sti-P_3 ® and UL 58), which confirms the adequacy of the design to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, wall loads, and associated environmental stresses such as seismic loads, as applicable, at the design conditions indicated on the tank data sheets.

III. Tank Anchorage Design

The design of the reinforced concrete anchorage (hold-down slab) for Tank T-725 is indicated on Tank Data Sheet 0708-080-025 and in Sections A & B on Drawing No. 0708-020-001, which are provided in Appendix D-1 to Section D of the RCRA Part B Permit Application. The criteria utilized in the design of the anchorage for Tank T-725 are based on the installation procedures for sti-P_3 ® tanks as recommended by the Steel Tank Institute.

The tank anchorage design, as recommended by the Steel Tank Institute and based on the experience of numerous similar installations, demonstrates by inspection that the tank anchorage is, as designed, adequate to support and anchor the load of a full (or empty) tank and adequate to withstand associated environmental stresses at the design conditions indicated on the Tank Data Sheets.

IV. Ancillary Equipment Design

All tank system ancillary piping systems shall be designed, installed and tested in accordance with the American Society of Mechanical Engineers (ASME) Standard B31.3, "Chemical Plant and Petroleum Refinery Piping", or an equivalent nationally recognized standard, and in accordance with recognized good engineering practices to ensure that they are supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

All other ancillary equipment for the tank system shall be designed, installed and tested in accordance with appropriate recognized standards, if any, and in accordance with recognized good engineering practices to ensure that it is supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

In order for this tank design assessment and associated certification to be maintained, and prior to the tank system being placed in use, the Facility shall ensure that the tank system ancillary equipment is properly installed and that all required inspections, tests and repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f). Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested.

V. Secondary Containment System Design

The dual-tank wall design of Tank T-725, as indicated on the Tank Data Sheets (i.e. Drawing Nos. 0708-080-025 and -025A), in accordance with the requirements of 40 CFR 264.193(e)(3) and ADEM Administrative Code Rule 335-14-5-.10(4)(e)3., provides for secondary containment of the primary tank, continuous leak detection of both the primary and the secondary tank systems, and corrosion protection of the exterior of the primary tank. The integrity of both the primary tank and the secondary tank is continuously monitored by a vacuum-sensing system. The void space between the primary tank and the secondary tank is maintained at a negative pressure such that on the failure of either tank system, this negative pressure would diminish to atmospheric conditions. At this point, the vacuum pressure switch would initiate an audible and visual alarm to a control panel that is located within the laboratory.

VI. Tank Venting Requirements

As indicated on the P&ID for Unit 708 (i.e., Drawing No. 0708-010-001 which is located in Appendix D-1 to Section D of the RCRA Part B Permit Application), Tank T-725 is designed as a closed top tank that passively vents to atmosphere. The P&ID and the Tank Data Sheets (i.e., Drawing Nos. 0708-080-025 through -025A) provided in Exhibit A to this tank system design assessment specify the diameter of the atmospheric vent nozzle on the tank.

The requirements for normal (i.e., liquid displacement) venting capacities for the Unit 708 tank were evaluated in accordance with American Petroleum Institute Standard 2000, Venting Atmospheric and Low-Pressure Storage Tank (i.e., API 2000). As shown in the venting calculations provided in Exhibit D to this tank system design assessment, the size of the atmospheric vent nozzle on the tank is adequate to allow the tank under normal conditions to be maintained within the design limitations for pressure and vacuum as specified on the Tank Data Sheets provided in Exhibit A to this tank system design assessment. The venting calculations provided in Exhibit D to this tank system design assessment also indicate the design maximum tank fill and withdrawal rates which were used in the evaluation of the tank venting requirements.

VII. Hazardous Characteristics of the Waste Managed

In accordance with the requirements of 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., this section presents an evaluation of the compatibility of the wastes managed within the Unit 708 tank systems with the materials of construction of Tank T-725 to determine their suitability for service in this unit.

The types of wastes managed within Tank T-725, due to the nature of the operations conducted in the laboratory, will include virtually all types of hazardous wastes listed and identified in 40 CFR Part 261 and ADEM Administrative Code Rule 335-14-2, except for ignitable wastes, as indicated in Appendix D-2-1 of this Application. Tank T-725 is a double-wall tank, constructed of carbon steel, with internal corrosion protection.

Exhibit E to this tank system design assessment presents information which provides an indication of the relative compatibility of vinyl ester coating, such as Tnemec Series 120 or demonstrated equivalent, with a wide variety of chemical compounds and other substances. The table in Exhibit E provides corrosion/compatibility information for Tnemec Series 120 vinyl ester coating exposed to pure chemical compounds which, in general, tend to have a more severe corrosive effect than wastes which contain mixtures and complexes of these compounds. Although this table may not provide corrosion data and service recommendations for all of the potential constituents of the wastes or waste mixtures which may be managed within the tank system in Unit 708, the table does demonstrate that Tnemec Series 120 is generally compatible with and, under normal conditions, should not experience an accelerated rate of corrosion or deterioration when exposed to a majority of the types and classes of wastes which are managed within the Unit 708 tank system. In addition to the compatibility/corrosion data provided in Exhibit E, the compatibility of Tnemec Series 120 with the types of wastes managed within Unit 708 is further validated by the empirical data provided by many years of comparable service applications within a wide variety of chemical processing industries.

Based on the information provided in Exhibit E of this tank system design assessment and the empirical data compiled for comparable service applications within a wide variety of chemical processing industries, it is the conclusion of this evaluation that the Tnemec Series 120 coated carbon steel tank system components are generally compatible with the types of waste managed within the Unit 708 tank system. It is further concluded that these materials of construction are suitable for this service if the tank system is operated within the design limitations set forth within this assessment, and that, if the tank system is managed in accordance with the following minimum practice(s), these materials of construction should not experience an accelerated rate of corrosion or deterioration which may result in a catastrophic failure of the tank system, throughout its useful life:

- Prior to placement of a waste into the tank system the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. References other than Exhibit E of this document, such as other recognized sources of corrosion data, may also be used to evaluate compatibilities. The Facility shall prohibit the placement into the Unit 708 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components.

VIII. Certification of Tank System Design Assessment

In accordance with the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), this section provides a certification by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), that an assessment of the design of the following tank system demonstrates that the tank system anchorage, seams, connections, and pressure controls are adequate, and that the tank has sufficient structural strength, compatibility with the wastes to be managed and/or protection from corrosion so that they will not collapse, rupture or fail, if properly installed, operated within the design limits, and properly inspected and maintained:

Tank System Location:	Chemical Waste Management, Inc. Emelle, Alabama
Tank System Identification:	Tank Management Unit 708
Applicable Tank:	T-725

At a minimum, the assessment of the tank system design, which is incorporated herein by reference, addresses and considers the following factors with respect to the intended use of the tank system:

- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank design has been evaluated for structural integrity with regards to the ability of the designed tank shell and anchorages to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, wall loads, and associated environmental stresses such as seismic loads, as applicable;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank has been evaluated with regards to the adequacy of the designed tank to provide the necessary capacity for normal venting;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which piping and other ancillary equipment shall be designed and constructed to maintain this certification;
- In accordance with 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., the assessment of the tank system design considers the compatibility of the tank's materials of construction and/or internal coatings with the types of hazardous wastes to be managed;
- In accordance with the applicable requirements of 40 CFR 264.192(a)(5) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)5., the assessment of the tank system design considers the ability of the designed tank system anchorage (hold-down slab) to support the load of the full (or empty) tank and to withstand associated environmental stresses; and
- The assessment of the tank system design considers the adequacy of the capacity of the designed tank secondary containment system (i.e. the double-wall tank) as required by the applicable requirements of 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e).

In order for this certification to be maintained, the Facility shall comply with the applicable requirements of 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10, and shall perform all routine management procedures, periodic inspections and reviews, and tank system functionality and integrity tests as required by the permit including, but not limited to, the following:

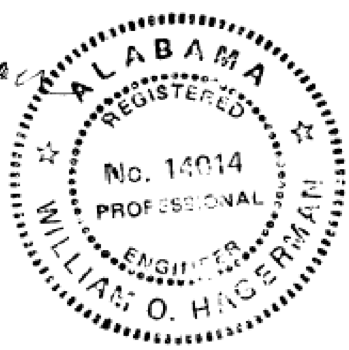
- The Facility shall ensure that the tank system is properly installed and that, prior to placing the tank system in use, all required inspections, tests and necessary repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f);
- Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested;
- Prior to placement of a waste into the tank system, the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the Unit 708 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components;
- Prior to placement of a waste into the tank system, the Facility shall verify the specific gravity of the waste in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the tank system of any waste that has a specific gravity that exceeds the design maximum value specified within the tank system design assessment;
- In accordance with the requirements of 40 CFR 264.195(c) and ADEM Administrative Code Rule 335-14-5-.10(6)(c), the Facility shall perform an inspection of the cathodic protection system within six months after installation and annually thereafter;
- The Facility shall perform a periodic inspection of the tank venting devices to ensure that they are in good working order to maintain the tank within the design limits for pressure as specified within the tank system design assessment;
- The Facility shall perform a periodic inspection of the tank level sensing, overfill control devices and associated interlocks to ensure that they are in good working order with the appropriate settings to prevent overfilling of the tank(s). The frequencies and procedures for inspection of all tank level sensing and overfill control devices shall be as recommended by the manufacturer; and

- The Facility shall perform a periodic inspection of any other operational controls for the tank system to ensure that they are in good working order with the appropriate settings to maintain the tank within its design limits as specified within the tank system design assessment. The frequencies and procedures for inspection of other tank system operational controls shall be as recommended by the manufacturer.

Based on the information provided within the tank system design assessment and supporting documentation, the design of Tank T-725 within Tank Management Unit 708 meets the current RCRA requirements relative to the design of new hazardous waste tank systems. The design assessment addresses only the applicable requirements of 40 CFR 264.192 and 40 CFR 264.193, and ADEM Administrative Code Rules 335-14-5-.10(3) and (4), and does not consider compliance with other codes or regulations, including, but not limited to, the requirements of the Occupational Safety and Health Act (OSHA).

With regards to the assessment and certification of the design of hazardous waste tank systems in accordance with the applicable requirements of 40 CFR 264.192(a) and (g), and ADEM Administrative Code Rules 335-14-5-.10(3)(a) and (g), I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

William O. Hagerman 9/28/95



William O. Hagerman, P.E.
Alabama P.E. No.: 14014
President
ETI Corporation
6799 Great Oaks Road, Suite 100
Memphis, Tennessee 38138-2500

This certification was originally submitted in 1995. As part of the 2002 Part B Application Renewal, revisions were made to the text in this attachment. These revisions consisted primarily of renaming the section for the Waste Analysis Plan to Section C to maintain consistency with the other Sections contained within this Part B Permit Application. No revisions were made to this attachment during this Part B Permit Application renewal process (Revision 5.0).

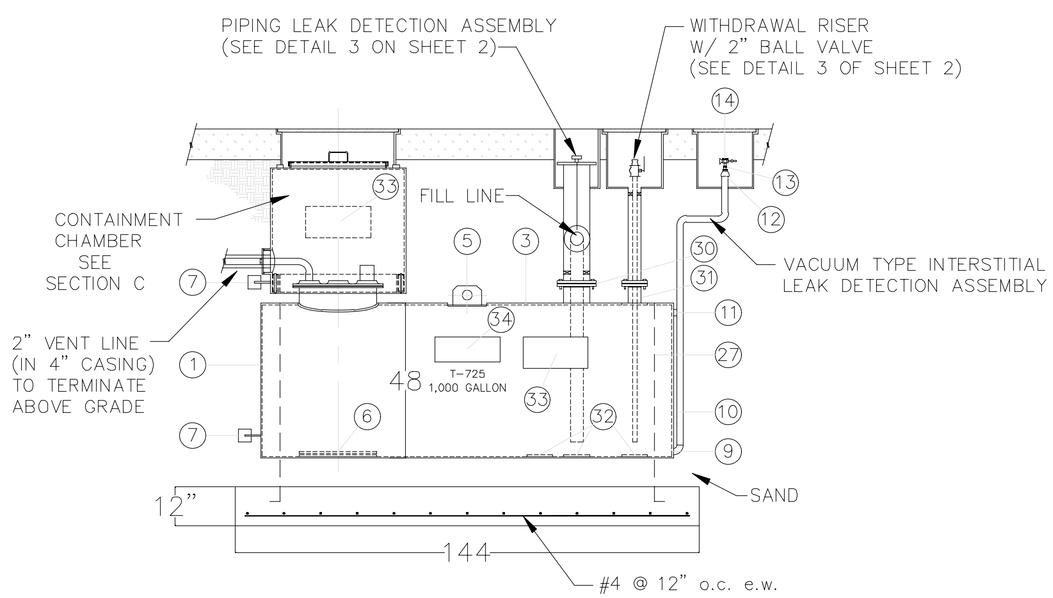
With regards to the revisions noted above, I certify under penalty of law that these modifications were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Michael T. Feeney, P.E.
Alabama P.E. No.: 15895
Jacobs Engineering Group Inc.
Ten 10th Street NW
Atlanta, Georgia 30309

[End of Attachment D-2-4-3 Text]

EXHIBIT A

TANK DATA SHEETS



A SECTION THRU T-725
REF. DWG. 0708-080-025A
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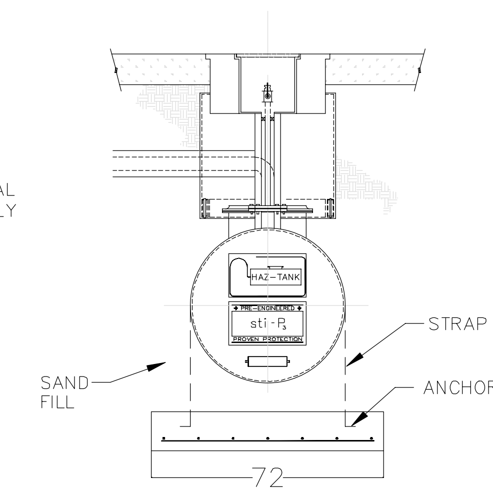

B SECTION THRU END
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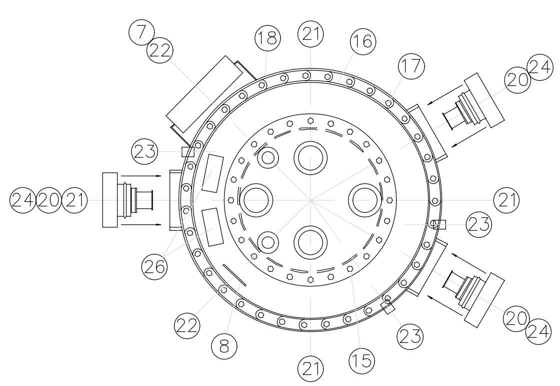
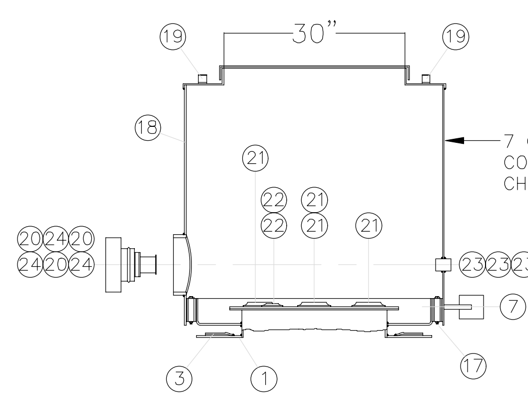


PLAN VIEW
CONTAINMENT CHAMBER
SCALE : N.T.S.



C SECTION THRU
CONTAINMENT CHAMBER
REF. DWG. 0708-080-025A
SCALE: N.T.S.

DESIGN DATA

Design Capacity	Total:	/1,003 gal.	
Design Press.	Min./Max.:	−2.5 psig / +5 psig	
Design Temp.	Min./Max.:	AMBIENT /AMBIENT	
Service:	LABORATORY WASTE		
Specific Gravity: 1.5		Vapor Space (inch): 3"	
Max. Fill Rate: 150 gpm		Max. Withdrawal Rate: 150 gpm	
Design Code: UL−58 (SEE NOTE 7 ON −025A)		Joint Efficiency: NA	
Wind Load Spec:	NA		
Seismic Zone /Code:	ZONE 1		

CONSTRUCTION

TANK I.D.: 4'−0" TANK HEIGHT: LENGTH 10'−8"

ITEM	Thickness	Material	Corrosion Allowance	Type	Height
SHELL	10 GA.	C.S.	NA	HORIZONTAL	4'−0"
BOTTOM	NA	NA	NA	NA	NA
HEAD	10 GA.	C.S.	NA	FLAT	NA

EQUIPMENT LIST

NO.	QTY.	SERVICE
1	1	10 GA. INNER SHELL
2	2	10 GA. INNER HEAD
3	1	10 GA. OUTER SHELL
4	2	10 GA. OUTER HEAD
5	1	HORIZONTAL LIFT LUG
6	1	24" x 24" x 1/4" WEAR PLATE
7	3	5 lb. SACRIFICIAL ZINC ANODE
8	1	PROTECTION PROVER II TEST STATION
9	1	2" 90 DEGREE LONG RADIUS WELD ELBOW
10	1	2" SCH. 40 PIPE x 45" LONG − T.O.E.
11	1	2" x 1/4" FLAT BAR − PIPE SUPPORT
12	1	2" x 3/4" BELL REDUCER
13	1	3/4" x 1/4" NYLON BUSHING
14	1	BRASS VACUUM GAUGE ASSEMBLY − INSTALLED ON TANK
15	1	24" DIAMETER MANHOLE WITH ISOLATION KIT AND COVER
16	1	39" O.D. CHAMBER BOWL
17	1	LINK SEAL MODEL #LS−400−0 (35 PIECES PER CHAMBER)
18	1	42−1/2" I.D. x 7 GA. CONTAINMENT CHAMBER
19	2	RAT TAIL LIFT LUG
20	3	8" SCH. 40 PIPE x 2" LONG
21	4	4" N.P.T.
22	2	2" N.P.T.
23	3	1" RIGID ELECTRICAL COUPLING
24	3	PRESS SEAL MODEL #8QRS−PSX
25	1	STI−P3 LABEL
26	1	U.L. LABEL
27	2	STRAP, ANCHOR AND PAD
28	1	3/8" DIAMETER ROUND BAR HANDLE
29	1	31" I.D. x 7 GA. COVER
30	1	8" 150# R.F.S.O.
31	1	4" 150# R.F.S.O.
32	3	8" x 8" x 1/4" WEAR PLATE
33	2	2" STENCILED LETTERS
34	1	2" STENCILED LETTERS

Jacobs
10 Tenth Street
Suite 1400
Atlanta, GA 30309 | 404.978.7600

NOT RELEASED FOR CONSTRUCTION

WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE ⎣______⎦ IS ONE INCH LONG WHEN PLOTTED FULL SCALE

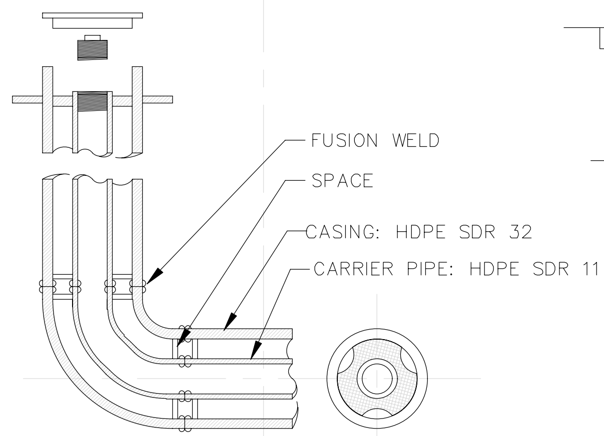
THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

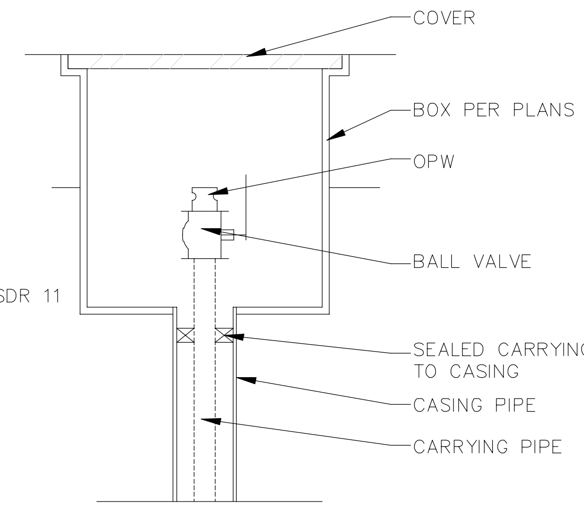
SHEET TITLE
TANK DATA SHEET - T-725

SHEET 0708-080-025

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



1 DOUBLE CONTAINMENT PIPE DETAIL (TYP.)
SCALE: N.T.S.



2 WITHDRAWAL PIPE DETAIL
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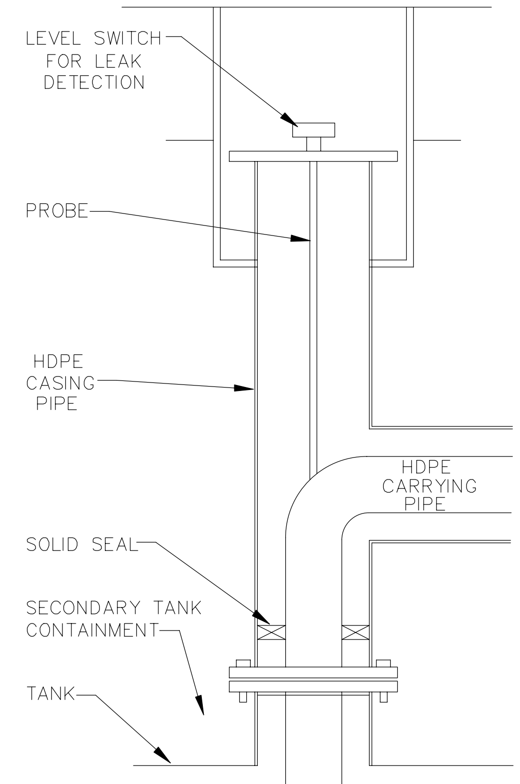
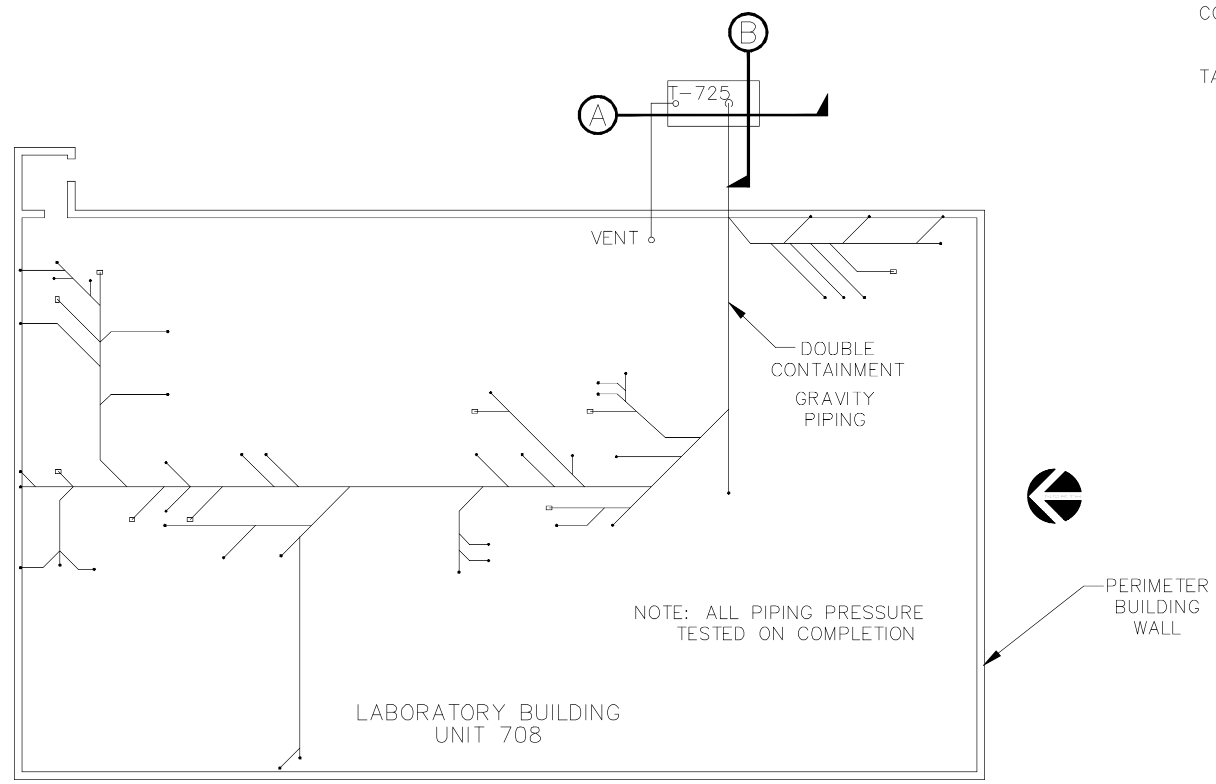


3 SECONDARY CONTAINMENT LEVEL SWITCH FOR LEAK DETECTION
SCALE: N.T.S.



PIPING LAYOUT PLAN VIEW
UNIT 708
SCALE: N.T.S.

NOTES:

1. ALL OPENINGS TO BE ELECTRICALLY ISOLATED.
2. EXTERIOR TO RECEIVE AN SSPC–SP–6 COMMERCIAL GRADE SANDBLAST FOLLOWED BY ONE MULTIPLE–PASS COAT OF CORROCOTE URETHANE ELECTRICALLY INSULATING COATING APPLIED TO HEADS AT 15 MILS. D.F.T. (DRY FILM THICKNESS) AND SHELL AT 10 MILS. D.F.T.
3. TANK TO RECEIVE CATHODIC PROTECTION BY WELDING THE CORRECT NUMBER OF SACRIFICIAL ZINC ANODES TO THE TANK HEADS. NUMBER OF ANODES IS LISTED IN THE STI–P3 PROTECTION.
4. INTERIOR TO RECEIVE TNEMEC SERIES 120 VINESTER LINING PER MFG. SPECIFICATIONS. 2 COATS AT 12 MILS. PER COAT OVER A WHITE METAL SANDBLAST.
5. ALL MATERIAL IS CARBON STEEL, UNLESS NOTED.
6. PRIMARY TANK IS DOUBLE BUTT CONSTRUCTION.
7. TANK IS CONSTRUCTED IN ACCORDANCE WITH U.L. CODE 58 AND STI–P3 SPECIFICATIONS FOR SECONDARY CONTAINMENT TANKS. TYPE–1.
8. INNER TANK WAS PRESSURE TESTED AT 5 P.S.I.G. AIR PRESSURE PRIOR TO INSTALLATION OF OUTER HEAD.
9. OUTER TANK WAS PRESSURE TESTED AT 5 P.S.I.G. BY FIRST BUBBLE TESTING OUTER SEAMS THEN TESTING INSIDE OF INNER TANK WHERE IT IS WELDED TO OUTER TANK. (INSIDE TESTING PROCEDURES ONLY APPLY TO TANKS WITH MANHOLES.)
10. AFTER SUCCESSFUL COMPLETION OF THE PREVIOUS TESTING, 10 INCHES OF MERCURY (Hg) VACUUM WAS ESTABLISHED IN THE INTERSTICE, THEN SEALED OFF AND CHECKED AFTER 24 HOURS TO ASSURE THE VACUUM REMAINED UNCHANGED FROM THE INITIAL 10 INCHES OF MERCURY (Hg).
11. TANK WAS SHIPPED WITH 10 INCHES OF MERCURY (Hg) VACUUM.
12. ALL FLANGES STRADDLE THEIR NATURAL CENTERLINES.

Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION
CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT
SHEET TITLE
TANK DATA SHEET - T-725
SHEET 0708-080-025A

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

EXHIBIT B

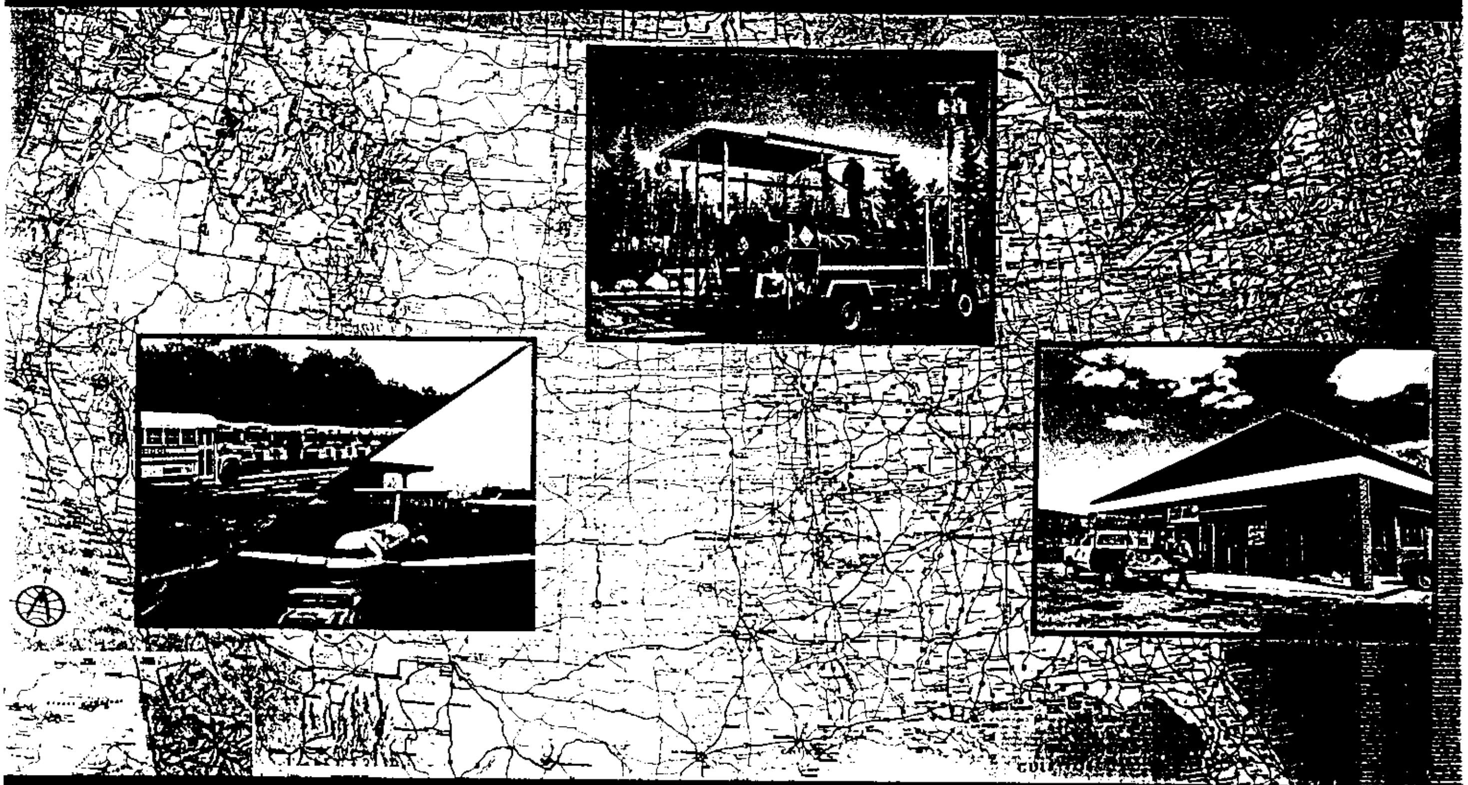
TANK DESIGN INFORMATION – STI-P_3 AND UL 58 SPECIFICATIONS

Tank Design Information - General Information on sti-P_3 Tanks

The Security of Secondary Containment
A Variety of Models

sti-P_3®
Double Wall Steel Underground Storage Tanks

Double Wall Tanks... The Extra Measure



If you want loss protection that meets or surpasses federal underground storage requirements, the sti-P_3® double wall tank options provide unrivaled long-term performance.

A steel tank within a tank combines with corrosion prevention to yield a system that will capture a leak—thereby protecting the environment and saving you money. Take a closer look at the advantages offered by double wall steel underground storage tank systems produced by sti-P_3® licensed manufacturers.

While many states, counties and municipalities have mandated the use of secondary containment for underground tank systems, users across the country are turning to sti-P_3® double wall steel tanks to get the extra measures of confidence in the difference between leak detection and leak prevention. They are investing to protect the environment and their businesses.

The Best Performance Record in the Industry

Double wall steel underground storage tanks manufactured by licensed sti-P_3® fabricators are found in thousands of locations nationwide. Users in all fields, private, industrial and governmental. . . are storing hazardous materials. . . from gasolines to alcohols to chemicals such as solvents. . . in a wide variety of soil environments. Every one of these tanks is also compatible with anticipated fuels of the future.

And, every one has been manufactured to meet Underwriters Laboratories fabrication standards as well as corrosion-prevention specifications of the Steel Tank Institute. Those guidelines are embodied in the sti-P_3® Specification which has, since 1969, provided owners with proven protection in over 150,000 single and double wall tank installations. The federal government and major national code-developing agencies have also recognized the significance of the sti-P_3® standards and have referenced them in both EPA-UST regulations and other key national codes.

sti-P_3®... A Revolutionary Concept

All sti-P_3® double wall steel underground storage tanks combine the structural strength of steel with the most comprehensive measures against corrosion in the industry.

The inherent strength of steel allows these storage tanks to withstand such geotechnical stresses as high groundwater tables while continuing to deliver years of dependable, leak-free service. And the secondary containment afforded by the STI Standard for Double Wall Tank design provides an added measure of protection which can spell the difference between a clean environment and an ecological disaster.

The three forms of protection combined for use on all sti-P_3® double wall tanks offer pre-engineered security against corrosive forces present in any underground storage situation.

1 Dielectric Coating:

Every sti-P_3* double wall underground storage tank exterior surface is coated with one of four materials: coal tar epoxy, polyurethane, isophthalic polyester resin reinforced with fiberglass, or a urethane reinforced with fiberglass. This protective finish covers the entire exposed surface of the tank. Any of these environmentally inert coatings can be applied to a blast-cleaned steel surface to offer an effective electrical insulation and moisture barrier.

Surface Preparation

2 Sacrificial Anodes:

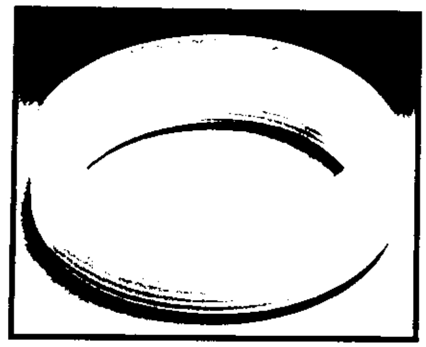
The second level of protection comes in the form of sacrificial galvanic anodes. No matter how many steps are taken to apply a high quality coating, small nicks or scratches in the finish may develop through careless handling during transportation and installation. Such coating "holidays" could bring a premature end to a tank's useful life if supplemental measures are not taken. Anodes are an sti-P_3* safeguard against corrosion in line with the National Association of Corrosion Engineers standards.

Galvanic anodes made of either zinc or magnesium attached to the tank control the direction of electrical current flow and will erode in place of the tank.

Sacrificial Anodes

3 Electrical Isolation:

Equally important in the three-way protection system, isolating bushings prevent metal-to-metal contact between the tank and piping system. Dielectric nylon bushings or flange isolation kits are used to electrically isolate the tank from a connected pipe system. The isolation appliances define the area to be protected by anodes.



Nylon Bushing

Double Wall Tanks . . . The Flexible Choice

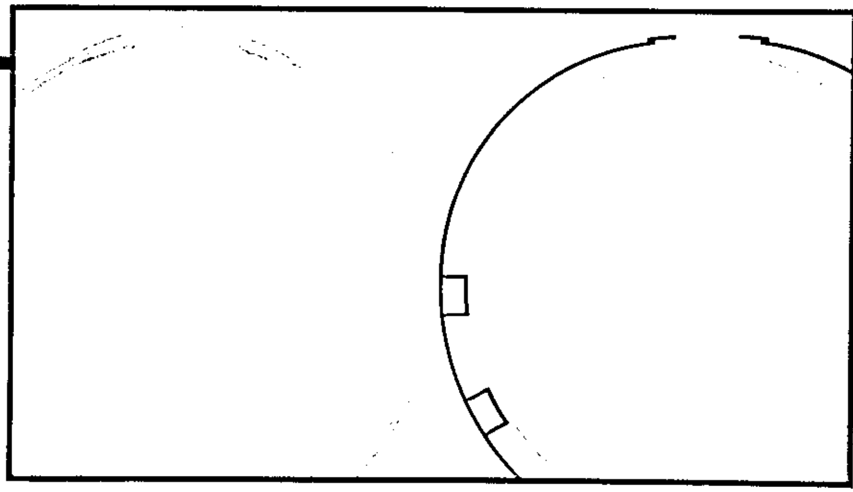
No matter what your needs are, any of over 80 STI licensed fabricating locations around the country can provide the right underground storage system based upon decades of tank building know-how. Every double wall system fabricated by these experienced professionals conforms to the most stringent design and quality control criteria in the underground storage industry.

RE-ENGINEERED sti-P3®

Several Types of Tank . . . To Give You The Choice

Some tank manufacturers offer users only one type of double wall construction . . . a 360° wrap that completely encases the inner tank in a second layer.

Because steel is fabricated differently from other tank materials, such as FRP, an STI manufacturer can provide options that will allow you to specify the storage solution that meets both environmental and economic concerns.



Type I Tank   Type II Tank

Type II . . . A Tank Within A Tank

Many fabricators who are licensed to apply the sti-P_3® corrosion-protection system offer another 360° secondary containment option, designated by Underwriters Laboratory as Type II double wall construction.

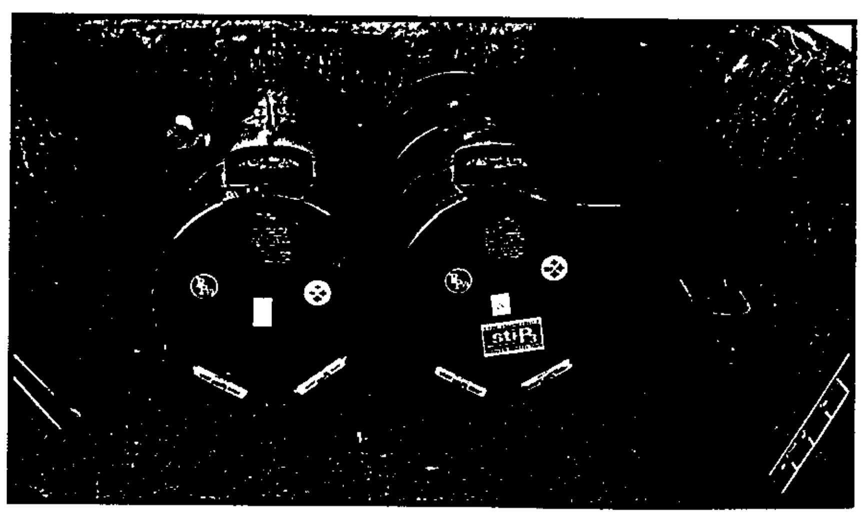
A Type II double wall steel underground storage tank consists of an outer tank that is physically separated from the inner tank by standoffs. Type II construction meets—as does Type I—the most stringent underground storage circumstances for motor fuels and hazardous materials.

Type I . . . Wall to Wall Protection

An sti-P_3® Type I tank is a primary tank wrapped by an exterior steel shell that is in direct contact with the inner vessel. This exterior shell may cover less than the full circumference of the tank. . . usually a 300° wrap. A 360° wrap Type I tank is required for use in the storage of chemical products and certain hazardous materials.

STI has developed a specification for the Type I tank because most underground storage system failures caused by corrosion occur on the lower portion of the tank. Thus, secondary containment may not be necessary for the top portion of the tank because 97% of an underground tank's capacity can be covered by a 300° wrap.

Type I construction affords the user a level of containment and leak detection capability that makes sense ecologically and economically.



Quality Control Assures Dependability

The sti-P_3* double wall tanks manufactured by STI-licensed fabricators are required to conform to practices established by Underwriters Laboratories and the Steel Tank Institute. Double wall construction has evolved from decades of tank manufacturing experience and a long history of safe usage in Europe. Tank preparation also is shaped by the STI quality control program which ensures that you are receiving the most dependable underground products available.

The four-tier quality control program includes multiple in-house inspections on every tank at all stages of fabrication. Critical tank components such as dielectric bushings, sacrificial anodes and coatings are tested for compliance to the standard. Visits by inspectors from UL or other agencies plus frequent, unannounced inspections by STI personnel keep track of tank construction practices.

And, if inspectors find a manufacturer not complying with the fabrication requirements, the company is cited and must document how any deficiencies were corrected. As a condition for maintaining an sti-P_3* license, each manufacturer must send a representative to annual STI quality control meetings.

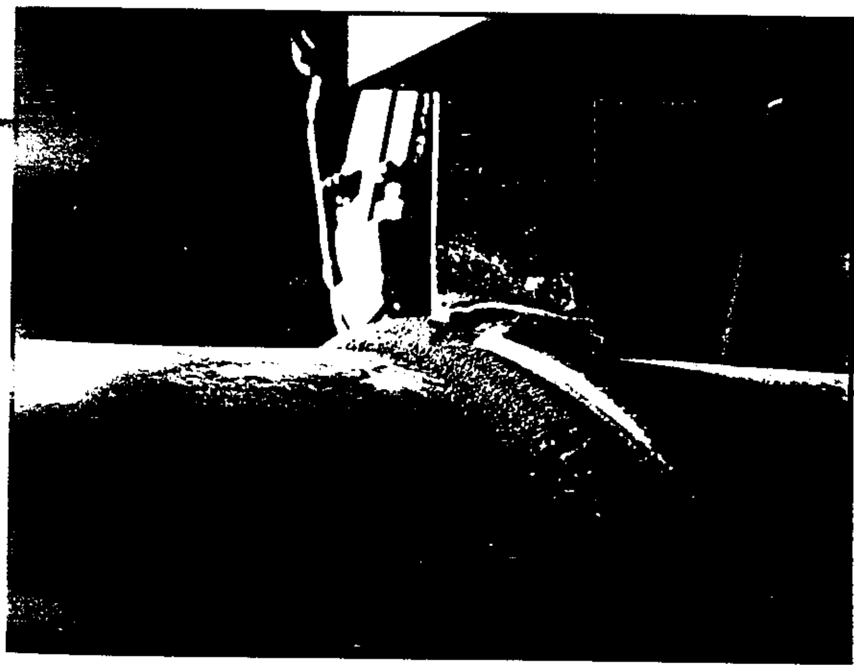
This dedication to maintaining the standards that go into the construction and installation of sti-P_3* double wall tanks assures you of consistent quality and dependability. It means that when you see the sti-P_3* label on the tank head, you can be confident in an underground storage system that is in compliance with the federal Underground Storage Tank (UST) regulations.

Monitoring . . . Providing Protection

Critical to the prevention of environmentally threatening leaks of toxic substances is the interstitial space found between the outer envelope and the inner UL-58 tank. If a leak develops in the primary containment vessel, the seepage will be restricted to this cavity, protecting the surrounding area. That is how a double wall sti-P_3® tank minimizes your operational costs. It's the difference between leak prevention and leak detection. In fact, many companies anticipate saving money on federally required leak detection systems by purchasing double wall tanks and interstitial space monitors.

The user of an sti-P_3* double wall tank can effectively detect the presence of product or water in the interstitial space by using the integral leak monitoring well provided for this purpose.

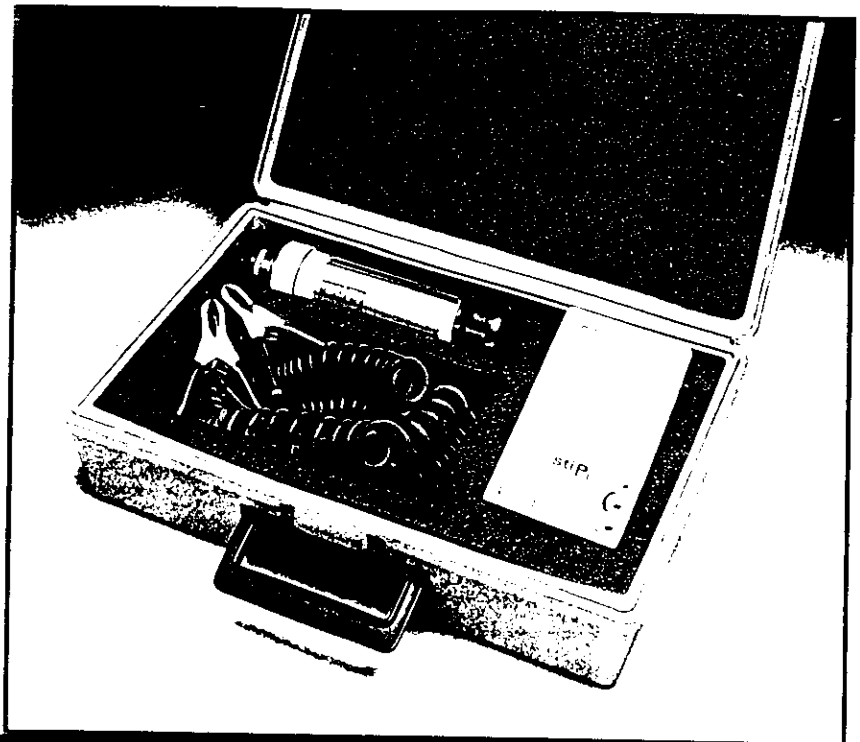
- Manual Sticking of the Interstitial Space
- Electronic Monitoring
- Mechanical (float devices)
- Pressure or Vacuum Method



sti-P_3* Quality Control Tests

Coating	Anodes	Electrical Isolation
Abrasion/impact resistance	Chemical composition exam by atomic absorb. photospectroscopy or wet chemical analy.	UL listing
Adhesion	Backfill composition & electrical resistivity	Electrical conductivity test
Cathodic disbondment	Weight tolerance	Compatibility
UV weathering & air exposure	Packaging strength	Sealant performance
In Situ performance		Dimensional quality examination
Infrared spectroscopy		

Double Wall Tanks...Protecting Your Business

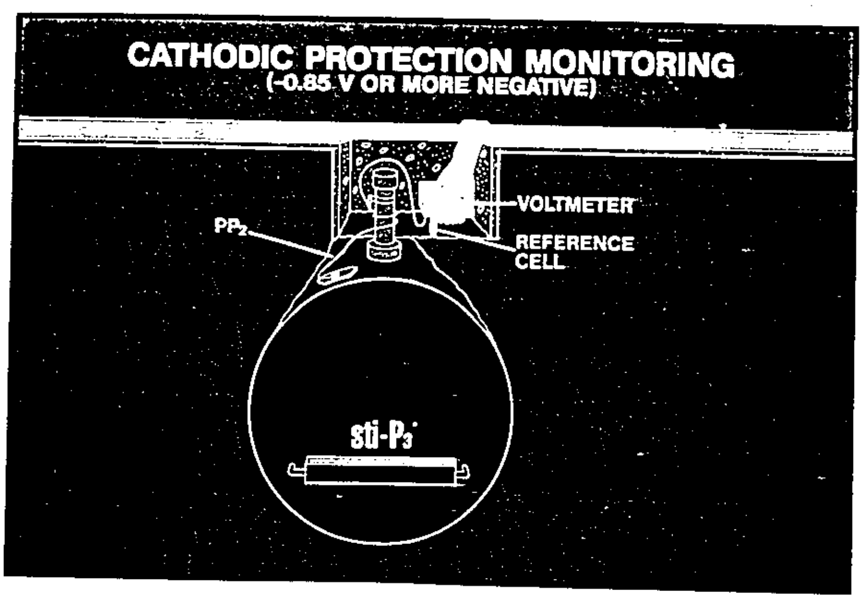


sti-P₃® Tank Monitor

STI Watchdog℠

Every sti-P₃® double wall steel underground storage tank is backed by STI's 30 year limited warranty against structural failure, external corrosion and internal corrosion. STI fabricators provide such a warranty because tests show that a properly installed sti-P₃® tank system will perform for 30 years or more without problem.

But, STI is aware that financial responsibility has become an industry byword. In an age of rapidly changing regulations, with petroleum equipment vendors appearing and disappearing, it's good to know that STI provides comprehensive, long-term security for tank owners.



Watchdog℠... Another Layer of Protection

The sti-P₃® system of cathodic protection has proven itself over the years to be the most dependable technology against the corrosive forces inflicted on underground steel tanks. Now, the Steel Tank Institute offers another dependable form of protection to ensure that your steel tanks are being properly protected by their sti-P₃® systems Watchdog℠.

The Watchdog℠ monitoring program provides owners of sti-P₃® tanks shipped after October 1, 1988 with 30 years of cathodic protection monitoring at no charge. Watchdog℠ meets all requirements of the EPA regulations for monitoring the performance of cathodic protection systems, 40 CFR 280.31. Watchdog℠ is available on all new regulated non-residential sti-P₃® tanks.

Under Watchdog℠, an STI-authorized technician will conduct the EPA-mandated tests in accordance with the federal schedule. He will verify that the cathodic protection system is functioning within nationally recognized limits.

Beyond Comparison

The sti-P₃® underground storage system offers you unparalleled efficiency, strength, dependability, durability and choice of options. Add to that the commitment of the Steel Tank Institute to back all sti-P₃® tanks with a 30 year limited warranty and the Watchdog℠ Monitoring Program and you have a complete package—the best and safest underground tank value available.

Tank Design Information - sti-P_3 Specifications

STEEL TANK INSTITUTE SPECIFICATION for sti-P_3® SYSTEM of EXTERNAL CORROSION PROTECTION of UNDERGROUND STEEL STORAGE TANKS

PREFACE

This specification covers an external corrosion control system (termed sti-P_3®) for underground steel storage tanks that was developed in 1969 for the Steel Tank Institute (STI) by leaders in the field of corrosion engineering. The system is a practical and economical means of extending the life of underground tanks from a minimum of thirty (30) years in corrosive soil conditions to an indefinite term in less severe environments. The design includes a safety factor that will allow for somewhat more than ordinary damage to the coating from shipping and handling and other accidental holidays.

Traditionally, steel tanks used for underground storage of petroleum products have been protected with an inexpensive coating to prevent corrosion of the tank during storage of the tank

aboveground and after installation underground. This practice has been adequate in some soils but has invariabily been unsatisfactory in corrosive soils. Previously, the known methods of applying stringent corrosion control to tanks were not feasible because they requied handling by experienced corrosion personnel.

The sti-P_3® method of corrosion protection overcomes these problems and still retains all the advantages of a steel tank with its structural strength and ability to take rough handling.The sti-P_3® system combines three basic methods of underground corrosion control, all installed on the tanks during manufacture: (1) Cathodic Protection, (2) Protective Coating, (3) Electrical Insulation of the tank from other underground metallic structures by use of non-conductive bushings or similar methods which isolate the tank electrically from the piping.

The salient feature of the design is that it is pre-engineered and provided by the tank fabricator as an integral part of the tank. This aspect eliminates costly on-site engineering, misunderstood installation requirements and concern over the effectiveness of the corrosion control used. Further, the sti-P_3® system turns itself on after the tank has been buried and provides cathodic protection for a minimum pre-determined length of time in a given soil.

Although the sti-P_3® system will be discussed in greater detail in later sections of this specification, several aspects related to the design concept warrant consideration in this section. Basically, the methods employed by the sti-P_3® system to prevent exterior corrosion were developed by corrosion engineers and have been successfully used on pipelines and other underground structures for more than fifty years. Although the basic methods are quite different in their way of protecting steel underground, they are related and must be used in combination with each other to achieve complete protection. For example, protective coating should not be used alone, because in practice no coating will be free of holidays. Some corrosion engineers submit that coating alone is about 75% effective against corrosion, whereas coating supplemented with cathodic protection results in an effectiveness of these combined methods approaching 100% corrosion control.

The only practical approach to a pre-engineered cathodic protection system for this application is using sacrificial anodes attached to the tank in a manner similar to that employed for ship hull protection. The protective coating serves to reduce the amount of protective current needed for cathodic protection. Electrical isolation bushings or flange isolators are installed in each tank opening. By preventing contact between the tank and other nearby metal structures through the piping system,

the chance of stray current corrosion is minimized, and the current demand such contact would add is eliminated.

Galvanic anodes develop their own protective current because of the natural potential difference between the anode metal and the metal being protected. This means that the anode system is self-activated after the tank is buried and that the cathodic protection current will continue to provide corrosion control until the anode is consumed by corrosion. Based on the estimate of the average current produced by the anodes in a given soil, useful life of the anode system can be readily calculated.

SPECIFICATION for sti-P_3® SYSTEM of EXTERNAL CORROSION PROTECTION of UNDERGROUND STEEL STORAGE TANKS

1. SCOPE

1.1. This specification covers a method of underground exterior corrosion control for steel tanks. The method, termed sti-P_3® combines three basic corrosion control approaches.

1.1.1. PROTECTIVE COATING to minimize metal exposure to the soil.

1.1.2. CATHODIC PROTECTION using galvanic anodes to protect any exposed metal.

1.1.3. ELECTRICAL ISOLATION to protect the tank from stray current corrosion and to limit and define the area to be cathodically protected.

1.2. sti-P_3® pre-engineered system utilizes a balance of each of the three corrosion control methods to achieve protection at minimum cost.

)EFINITIONS

ANODE: An electrode of a corrosion cell at which corrosion occurs and metalions enter into solution. Antonym: CATHODE.

CATHODIC PROTECTION: A technicque to prevent the corrosion of a metal surface by making that surface the cathode of a corrosion cell.

CORROSION: The deterioration of a material, usually metal, because of a reaction with its environment.

DI-ELECTRIC: A substance or medium which does not conduct an electrical current.

ELECTRICAL CONTINUITY: The condition of being capable of maintaining the flow of electrons in an electrical current.

ELECTRICAL INSULATION/ELECTRICAL ISOLATION: The condition of being electrically separated from other metallic structures or the environment.

ELECTROLYTE: Non-metallic electrical conductor in which current is carried by the movement of ions.

GALVANIC ANODE: A metal which, because of its relative position in the galvanic series, provides protection to a metal that is more noble in the series, when they are coupled in an electrolyte. Galvanic anodes are the current source on one type of cathodic protection.

HOLIDAY: A discontinuity in the coating system that exposes metal surface to the environment.

MONITORING DEVICE: A piece of equipment designed to check an operation.

PACKAGED ANODE: An anode that is supplied completely surrounded by a prepared backfill of selected conductive material. (See 6.1, 6.2 and 6.3)

SACRIFICIAL PROTECTION: Reduction or prevention of corrosion of metal in an electrolyte by galvanically coupling it to a more anodic metal.

SEAL WELD: A continous weld eliminating crevices.

STRAY CURRENT: Current flowing through paths other than the intended circuit.

STRAY CURRENT CORROSION: Corrosion resulting from direct current flow through paths other than the intended circuit.

3. LICENSE

3.1. All tanks manufactured by an sti-P_3® Licensee in strict conformance with these sti-P_3® Specifiations are covered by a limited warranty. This limited warranty is issued by the Steel Tank Institute (STI), not by the individual licensee company.

3.2. In order to control quality, STI employs a staff of Quality Control Inspectors making unannounced visits to Licensee plants. This inspection service is manadatory for all Licensees. These inspections services assure that tanks are fabricated in strict accordance with sti-P_3® Specifications, latest edition. Any tank determined not to conform to specifications must be immediately corrected and reinspected. STI may inform the Licensee that reinspection by STI staff inspector will be required prior to shipment. The sti-P_3® Board of Directors may apply penalties for non-compliance with the specification requirements in accordance with the sti-P_3® By-Laws.

3.2.1. Licensees are required to follow specified inspection and reporting procedures that are monitored and recorded by STI.

3.3. The Steel Tank Institute conducts regular quality assurance seminars on sti-P_3® Technical procedures. Licensee attendance at these seminars is mandatory.

3.4. sti-P_3® Licensees who build similarly engineered, factory fabricated steel tanks which appear similar to an sti-P_3® Tank are subject to removal of their License.

4. GENERAL REQUIREMENTS

4.1. The responsibility for supplying a tank in strict compliance with these sti-P_3® Specifications, including all current Appendices, Tables, Supplements, Addenda, etc. is the sti-P_3® Licensee's. Also careful inspection in accordance with current sti-P_3® directives to assure compliance with sti-P_3® is the Licensee's responsibility. *Under no circumstances may any part of these responsibilities be delegated or assigned to a coater, buyer, installer, hauler or any other second party.*

4.2. Underground tanks must meet the fabrication and performance requirements of the latest issue of Underwriters Laboratories, Inc. UL-58 Steel Underground Storage Tanks for Flammable and Combustible Liquids or the current edition of the ASME Code, Section VIII, Division I for Pressure Vessels. Otherwise a detailed drawing must be submitted to STI for approval prior to fabrication. All tanks and fabrications must meet the requirements of any applicable specifications, standards, codes or regulations.

4.2.1. UL-58 notwithsanding the minimum material thickness for any sti-P_3® Tank shall be #10 gauge.

4.2.2. If a tank that otherwise meets the requirement of UL-58 but has an opening or openings below the top axis they may be considered standard and not require submmission to, and approval of STI. However, any openings extending from the tank horizontally, beyond 30° from the Top centerline, must be flanged with flange isolation kits and nylon bushings may not be used. See Appendix N.

4.2.3. Satisfactory design and fabrication of the tank (or structure) for the purpose to which it is to be applied is the responsibility of the Licensee. Drawings submitted to STI for approval will only be checked for the correct application of the sti-P_3® Corrosion Control System.

4.2.4. UL-58 describes weld joints without quality standards. STI has established weld quality standards for use on sti-P_3® Tanks. See Appendix J for weld profile requirements. If difficulty is experienced in achieving quality welds, licensees should consult their welding equipment and supplies dealer for guidance.

4.2.4.1. Head joints numbered 19, 20, 21 and 22 in UL Standard 58, 8th Edition, are not considered good practice due to the difficulty of adequately coating the ends of the shell. These joints are not recommended and will be prohibited for use on sti-P_3® Tanks after July 1, 1987.

4.2.5. On All UL listed tanks carbon steel striker plates shall be installed on the interior bottoms under each opening.

4.2.5.1. The striker plates shall be 8″ x 8″ x ¼″ minimum size. Striker plates may be flat or rolled to conform to the internal surface of the tank. The effect of a flat striker plate placed in the bottom of small diameter tanks must be considered. Striker plates must also be placed under manways with fittings. The diameter of the striker plate must be equal to or greater than the diameter of the manway opening. The thickness must be ¼″ minimum.

4.2.6. Stainless steel tanks that are not completely contained within a carbon steel outer tank are not authorized by these sti-P_3® Specifications and may not bear the sti-P_3® Label.

4.2.7. Only tanks made in strict accordance with these specifications and manufactured by fabricators licensed by Steel Tank Institute may be labelled "sti-P_3®."

4.2.8. Variances from these specifications may not be made until such alterations or ammendments have been submitted in writing to STI headquarters and approved in writing.

4.2.9. Licensees should consult STI for interpretations or solutions to individual difficult or unusual problems which do not seem to be covered by these sti-P_3® Specifications. Assistance

will be given on the specific problem but are not to be interpreted as setting precedents until, and if, revisions to the specifications are issued.

4.2.10. There are certain labelling requirements for sti-P_3® Tanks. (See Appendix I).

4.3. Attachments to the tank shall be so designed that the coating will readily cover all surfaces. Such attachments shall be seal welded to eliminate cracks or crevices into which the protective coating is not likely to penetrate.

4.3.1. Lifting lugs shall be of the plate type, adequately designed for the load and seal welded as illustrated in Appendix R.

4.3.2. Major Metallic attachments to the tank, either by the fabricator or the installer, are not recommended. However, if such attachments are necessary, they shall be either electrically insulated from the tank or shall conform to the specifications for coating the tank on all surfaces that may be exposed to the underground environment. The surface area of the grounded attachments shall be included in selecting the proper size and number of anodes. Arrangements must be made so that attachments that are grounded to the tank, will be electrically isolated from the piping and other foreign structures when installed in the field.

4.4. A Protection Prover 2 (PP2), Protection Prover 1 (PP1) or equivalent custom design monitor, must be installed, as shown in Appendix H, and is required on each tank. (NOTE: The PP1 can not be used with weld-on anodes). Prior to painting, any connection shall be protected to prevent coating from later interfering with the integrity of the electrical connection. (See Appendix D for proper connection procedure).

5. ELECTRICAL ISOLATION

5.1. Tank Fabricator/Licensee must supply the tank with provision installed for electrically insulating the tank from the piping without requiring the installer to take any action except to preserve the integrity of the isolation system furnished. *It is mandatory that all electrical isolation for openings be installed and tested with the tank and that the tank leave the fabricator's plant with the electrical isolation intact and installed. Every provision must be made at the plant, before shipping, to avoid the installer having to install, remove and restore or in any way require, permit or encourage any interference with the electrical isolation.*

5.1.1. Electrical isolation must be compatible with the materials to be stored in the tank. Such compatibility shall be checked and established by the Licensee/Fabricator.

5.1.2. Electrical isolation of openings is required on any pipes attached for monitoring equipment. For example; the pipe used to monitor the interstitial space of double wall tanks.

5.2. DI-ELECTRIC BUSHINGS: General Requirements: Di-electric bushings are avialable for use in tanks containing gasoline, gasahol and hydrocarbons or such other products that are listed as satisfactory on the Chemical Resistance Chart for the particular bushing. (See Appendix A and B). Licensees shall be responsible for establishing compatibility of the bushing and the product to be stored. If there is any question as to the compatibility of the bushing with the product, flanged openings shall be used with isolation kits whose gaskets are both di-electric and compatible with the stored product.

5.2.1. *DO NOT* use Nylon Bushings in pressure tanks nor in tanks where temperatures in the tank or in the piping connected to the bushing may exceed 130°F (54°C). Use flanged openings, see below.

5.2.2. Bushings must be those tested and officially approved by the sti-P_3® Board of Directors. Bushings shall bear the sti-P_3® Mark and/or the UL Label.

5.2.2.1. Three Low Profile, Nylon, di-electric bushings are available. 5" X 4", 3" X 2" and 2-½" X 2" and each bears the sti-P_3® Mark and/or the UL Label.

5.2.2.2. Licensees may submit a request, accompanied by supporting data, to approve another material. The sti-P_3® Board of Directors shall be the sole judge of the adequacy of the data and at its sole discretion may reject, approve, approve with restrictions or require specificed, additional tests to be made on the material and resubmitted for consideration.

5.3. Bushing installation procedure is described in Appendix B. Tank shall be tested with the bushings installed.

5.3.1. If it is anticipated that a tank will be in storage for a considerable length of time prior to shipping, installation of the bushings may be done just prior to shipment, provided the tank is re-tested for leaks at outer bushing threads before shipment.

5.3.1.1. If bushings have been installed and tank has been placed in storage long enough, and under conditions that their sealing properties may become affected then the openings must be re-tested prior to shipment and any leaks corrected.

5.3.2. Bushings shall have pipe joint compound (recommended, Clemmer Sealant 3332, or John Crane Plastic Lead Sealer No. 2, or other non-hardening sealant compatible with the product to be stored) generously applied to fill the *female* steel threads of the tank flange.

5.3.2.1. At the time of any job site air test the nylon bushings must be considered as "Threaded Insulating Gaskets". The bushings must be leak tight at the time of the test. Field installation instructions are provided and must accompany

tank shipment.

5.3.2.1.1. Field installation of the piping requires that permanent piping or plugs be installed in similar manner as above and then be thoroughly tightened to the point where all leaks are eliminated. If it is necessary to remove plugs or piping after being thoroughly tightened the bushing must be carefully inspected for damage to threads and a new nylon bushing must be used unless no damage is found.

5.3.3. After a tank is tested, install either metal or plastic threaded plugs or thread protectors for storage or shipping. Only non-air pressure testable (with vent hole) plastic plugs may be installed.

5.4. FLANGED OPENINGS with Flange Isolation Kits (see suggested alternatives in Appendix N): Where bolted flanges isolation are required they must be electrically isolated by use of flange isolation kits which are commercially available. Precautions must be taken to assure that the gasket used is (1) Di-electric and (2) compatible with the product to be stored at the temperature and pressure it is to be stored. After the isolation kit is installed a continuity checker must be used to assure that there is no circuit (See Appendix E).

5.4.1. Dip pipes, coils, hot wells or any interior structure that can make an electrical path to the exterior piping must be electrically isolated. This includes any attachment to the bottom of the tank such as shipping braces, anchors, etc. Responsibility for solving these, as well as any other, design problems is the Licensee's. However, STI may be consulted (refer to paragraph 4.2.5) if difficulty interpreting these specifications for a specific problem is encountered.

5.4.1.1. Make electrical continuity check (Appendix E) from tank metal to any final metal connection installed on the tank including metal threaded reducing, flange, spool piece, nipple, etc. Test must show no circuit exists.

5.4.2. It is mandatory that the tank have the electrical insulation installed before shipping from the Licensee's plant,. therefore certain basic methods are generally used.

5.4.2.1. For example; when a bolted flange is used (150 lb. weld neck or similar) with a spool piece or threaded companion flange, a flange isolation kit is installed between the flange of the tank and its' companion flange. (See Appendix N). The isolation kit consists of di-electric sleeves and washers and metal washers to isolate the bolts plus a di-electric gasket. Such electrical isolation must be installed at Licensee's plant. Electrical isolation must not be shipped loose for installation in the field (see 5.5 below as electrical isolation for hold-down straps is an exception).

5.4.3. Flange Isolation Kits should be installed so the bolts are grounded to the tank and therefore will also be cathodically protected.

5.4.4. Flanged openings must be protected for storage or shipping by a cover of metal, plastic, wood or hardboard.

5.5. If hold-down straps are to be supplied for an sti-P_3® Tank, isolation material must be shipped to the site along with the straps to be installed between the straps and the tank to electrically isolate one from the other. (See Appendix S for isolation material specification).

5.5.1. Licensee should ship with the tank, electrical isolation for any other attachments that are not already part of the tank and are to be installed in the field because of shipping clearances. Such attachments could include, but not limited to, access manways, work chambers, etc. (See Appendix S).

6. CATHODIC PROTECTION

6.1. Anodes for use with the sti-P_3® Corrosion Control System shall be one of the following tested and approved types complying with the specifications in Appendix C. If the installed tank will be heated to a temperature greater than 100°F (38°C) *DO NOT* use Zinc anodes, Magnesium anodes *MUST* be used to avoid current reversal. The number and/or size of anodes applied to a given tank is to be determined by reference to Tables in Appendix P indicating anodes for given square footage of tank surface exposed to the earth. Different types of anodes MUST NOT be mixed on the same tank. Any attachments, which are, or may be electrically grounded to the tank, such as extended manways, work or piping chambers, etc. must be included in the calculations for determining the anode size. See Appendix S.

6.1.1. sti-P_3® Weld-on zinc or magnesium anodes

6.1.2. Wire Connected zinc or magnesium anodes

6.2. WELD-ON ZINC or MAGNESIUM ANODES: Number of anodes required for given surface area in accordance with Tables in Appendix P. Steel bar shall be bent approximately 70° to 90°

at each end and ends seal welded to tank in locations shown in Appendix O prior to tank being sand blasted and coated. (See Appendix J).

6.2.1. Plastic wrap shall remain on anode during sand blasting and coating operations and it and the anode shall be protected from damage during blasting by covering with a metal cover, rubber blanket, split PVC pipe or similar means.

6.2.1.1. Care must be taken in blasting behind the anodes to assure that the required quality of surface preparation is obtained without damage to the anode container.

6.2.2. The purpose of the plastic wrap is to prevent moisture from damaging the cardboard tube and contents during storage. Therefore, remove the wrap before shipping if the tank is to be installed upon delivery. Do not remove the plastic wrap before shipping if installation is to be delayed. If plastic wrap is not removed upon delivery, install warning label "Caution Remove Plastic Wrapping Before Backfilling" on each anode.

6.2.2.1. When shipped, it is recommended that shipping papers indicate that the plastic wrap must be removed to validate the warranty.

6.2.2.2. Tanks to be stored require a small slit to be cut in bottom center of the plastic wrap on the anode to allow drainage of moisture from condensation. Store tank in normal position. DO NOT remove cloth bag.

6.3. WIRE CONNECTED MAGNESIUM ANODES: Tank that will have wire connected Magnezium anodes installed shall have support brackets seal welded to tank in accordance with Appendix O including the approved connectors attached and connected as shown in Appendix D and checked according to Appendix E.

6.3.1. Prepare anodes by immersing completely in water in a horizontal position until thoroughly soaked (at least four (4) hours). Remove from the water and allow to drain and dry in a horizontal position to avoid deformation and damage to the cotton bag and subsequent loss of fill material.

HANDLE ANODE CAREFULLY
DO NOT LIFT BY OR PULL ON ANODE LEAD WIRE
DO NOT HANDLE USING END OF BAG.
TO LIFT, CRADLE IN BOTH HANDS

6.3.1.1. To avoid degradation of the cotton bag after wetting, soak and attach anodes as close before shipping date as possible.

6.3.1.2. To allow for accidents keep extra cotton bags and backfill in inventory to repair damage. *DO NOT* use a cloth bag made of synthetic material as such material will be di-electric, not deteriorate underground and prevent cathodic protection.

6.3.2. The integrity of the electrical connection of the anode to the tank metal is critical to the operation of the cathodic protection. Therefore, extreme care must be taken to assure that there is no contamination by the coating, etc. and that the connection is electrically clean and well protected. Instructions in Appendices D and E must be very carefully followed.

6.3.3. To attach anode to tank use No. 8 gauge solid or stranded insulated wire or ½" wide x .028" thick (13 x .71mm) nylon strap cable ties in accordance with Appendix O.

6.4. WIRE-CONNECTED ZINC ANODES: Shall be installed in the same manner as the Magnesium anodes described in Section 6.3, except the brackets holding the anodes shall be different, as shown in Appendix O.

6.4.1. These anodes must be used rather than weld-on anodes if zinc is specified and monitoring by PP1, or similar test station, is required.

7. COATING

7.1. Prior to sand blasting or coating tank shall be inspected (and precoating section of inspection form signed) to confirm that the following conditions exist:

1. Tank, or structure, is complete and conforms to governing code (UL or ASME) or to drawing submitted to and approved by STI.
2. All welding finished, weld spatter removed (maximum allowable is 2 weld spatters per any 6" x 6" (15.3 x 15.3 cm) square or 36 square inch [234 sq. cm.] area).
3. Nylon bushings are installed in threaded openings and electrical isolation installed in flanged openings.
4. Weld-on anodes attached (or anode support brackets if magnesium or packaged zinc anodes to be used).
5. Air or hydrostatic tests complete.

6. Weld-on anodes protection from sandblasting installed.
7. Label holders, metal labels, Protection Prover 2 (PP2) connector installed and taped and all other attachments seal welded to tank.
8. Threaded openings covered with pipe plugs or plastic thread protectors and shipping covers installed on flanged openings. Mask the crack between pipe plugs and bushings or thread protectors if the protectors allow threads to be exposed but do not allow masking tape to cover tank metal.
9. Greasy or oily areas removed from surface with solvent.
10. Temperature and humidity are within coating manufacturer's recommendation.

7.2. Surface Preparation. Prior to coating, entire exterior surface must be prepared by abrasive blasting in accordance with Appendix M. (Appendix G for fiberglass reinforced plastic coated tanks).

7.2.1. If weld-on anodes are installed it is especially important to assure that the required blast profile is obtained behind and near the anode.

7.2.2. Shot or wet blasting is *not permitted*.

7.2.3. After blasting carefully wipe with clean cloths or brushes to remove dust.

7.2.4. It is best to complete abrasive blasting without interruption and apply the coating immediately after, especially in conditions of high relative humidity. In normal conditions a period of up to 24 hours may elapse between start of blasting and completion of coating. Tank should be re-blasted if rust-back or more than 24 hours transpires.

7.2.5. Consult equipment suppliers, materials suppliers, Steel Structures Painting Council and/or specialists for proper blasting techniques, materials and safety procedures to conform to these specifications.

7.3. Coating. After blasting entire exterior of tank shall be coated with an approved coating as listed in Appendix F or subsequent official approval issued on STI stationary. Substitution of other coatings for these STI tested and approved coatings is not permitted. Coating manufacturer's recommendations shall be complied with in the absence of specific instructions in these specifications.

7.3.1. Procedures for testing and possible approval of other coatings are available, upon request, from STI if a Licensee is interested in using a coating that is not on the approved list.

7.3.2. Approved fiberglass reinforced coatings shall be applied over the entire exterior surface of the tank and shall be applied in accordance with the detailed instructions in Appendix G.

7.3.3. Approved Coal tar epoxy and urethane based coatings shall be applied to accomplish a minimum dry film thickness (DFT) of 10 mils on the shell and 15 mils on the heads and 15 mils DFT within a radius of four (4) feet of any anodes installed on the shell (Note: coal tar epoxies will shrink in thickness from wet to dry proportionate to their percentage of solids and this reduction must be allowed for to achieve the required DFT). Frequent use of a wet film thickness gauge by the spray painter is highly recommended to assure required film thicknesses.

7.3.3.1. For coal tar epoxy coatings airless spray is recommended as the most efficient method of application as well as the method producing the most aesthetically pleasing appearance. Other spray methods or roller or brush may be used.

7.3.3.1.1. Minimum temperature of tank surface for applying coal tar epoxy coatings is 50°F (10°C), as checked by a magnetic surface thermometer, for proper curing. Heat may be introduced into tank to assure proper curing at low ambient temperatures.

7.3.3.1.2. Moisture must not touch surface of coating until it is throughly cured. If coating turns brown and softnes it must be completely removed and the process of blasting and coating started over.

7.3.3.2. For urethane based coatings use special spray equipment and temperature and humidity parameters recommended by the coating manufacturer.

7.3.4. It is *Especially important* to assure that specified coating is applied on anode holders and in vicinity of anodes.

7.3.5. After coating has cured, inspection with DFT gauge shall be made as required by the sti-P_3® Inspection Form which shall be executed and signed. Reading shall be dispersed over entire surface including places that are hard to reach.

7.3.5.1. Problems with poor spray patterns, thick and thin streamers, blisters, etc. should be solved by consultation with spray equipment or coating supplier.

7.3.6. Coating damage, or defects caused by handling, rolling or any other cause are to be avoided. Any areas detected to have less than the required coating thickness shall be touched up and brought up to requirements.

7.3.6.1. Before touching up, abrasion blast the area to assure a bond. Coal tar epoxies may be softened with MEK, as an alternate, prior to touch-up.

7.4. If coating sub-contractor is used, the responsibility for conformance to these specifications remains with the Licensee.

7.5. A coating touch-up kit, compatible with the sti-P_3® approved coating used, must be furnished with each shipment.

8. COMPLETION

8.1. The following steps are to be completed after the above specifications have been complied with. These completion steps should be done after the tank coating has been cured, checked and inspected. However, if it is anticipated that shipment will not be made for some time those steps marked * may be delayed until before shipment in order to avoid deterioration.

8.1.1. Install cathodic protection monitor test station as specified in Appendix H. The test station can consist of a Protection Prover 1 (PP1), Protection Prover 2 (PP2), or a custom test station.

8.1.1.1.* PP-2 wire and installing instruction tag may be attached immediately prior to shipping.

8.1.2.* Install labels on each head of tank including the large sti-P_3® Label, Installation Instructions and the Steel Mark label, illustrated in Appendix I.

8.1.2.1.* If packaged magnesium or zinc anodes are used, label or stencil above anode "DO NOT DISCONNECT ANODE LEAD WIRE" as shown in Appendix I.

8.1.2.2. If weld-on anodes are used and tank is to be delivered and installed at once, remove the plastic wrap from the anodes.

8.1.2.3. If weld-on anodes are used and the delivery or installation is to be delayed, or time of installation is unknown, the plastic anode wrap should remain on the anodes and the flourescent ink "CAUTION REMOVE PLASTIC WRAPPER BEFORE BACKFILLING" label (See Appendix I) must be wrapped around *each* anode. Cut a couple of short slits in the bottom of the plastic wrap so condensed moisture can escape.

8.1.3. At each opening, or group of openings, apply the appropriate label or stencil for a threaded or flanged opening. (See Appendix I).

8.2. Inspection of sti-P_3® tanks shall be completed as soon as coating has set and prior to storage in yard (except those steps designated above). Tanks in storage will be considered complete by the STI Quality Control Inspector unless they are stored in a separate location and tagged "Do not ship until re-inspected".

8.3. Inspect tank and bring inspection papers up to date. Carefully load or store first, padding under and over loaded tank (especially if chains or cables are used) is recommended.

8.3.1. At the job site, a crane of ample capacity to lift the tank cleanly is preferred. Controlled unloading may be used. In any case, tank and appurtenances must be handled to avoid damage to the coating. Dragging or shoving the tank may cause sufficient damage to the coating to void the warranty. See Appendix Q for installation instructions that are required to be followed.

8.4. Complete required paper work (See Appendix L), check and mail to STI.

Tank Design Information - UL 58 Specifications

UL 58

STANDARD for SAFETY

STEEL UNDERGROUND TANKS

FOR FLAMMABLE AND COMBUSTIBLE LIQUIDS

AN INDEPENDENT LABORATORY
TESTING FOR PUBLIC SAFETY

UNDERWRITERS LABORATORIES INC.©

American National Standard
ANSI/UL 58-1985
Approved October 22, 1985

UL 58

STANDARD FOR STEEL UNDERGROUND TANKS FOR FLAMMABLE AND COMBUSTIBLE LIQUIDS

First Edition — October, 1925
Second Edition — September, 1929
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Fourth Edition — April, 1949
Fifth Edition — December, 1961
Sixth Edition — December, 1971
Seventh Edition — October, 1976

(The fifth and previous editions were originally titled "Underground Tanks for Flammable Liquids")

EIGHTH EDITION

April 15, 1986

Approval as an American National Standard covers the numbered paragraphs on pages dated April 15, 1986. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the approved text. Revisions of this standard will be made by issuing revised or additional pages bearing their dates of issue.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Approved as ANSI B137.1—1971, July 27, 1971
Approved as ANSI B137.1—1976, July 23, 1976
Approved as ANSI/UL 58—1985, October 22, 1985

(1—4/15/86)

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

GENERAL

1. Scope

1.1 These requirements cover horizontal atmospheric-type steel tanks intended for the storage underground of flammable and combustible liquids.

1.2 These tanks are intended for installation and use in accordance with the Standard for the Installation of Oil-Burning Equipment, NFPA 31, and the Flammable and Combustible Liquids Code, NFPA 30.

1.3 Tanks covered by these requirements are cylindrical tanks that are fabricated, inspected, and tested for leakage before shipment from the factory as completely assembled vessels.

1.4 These requirements do not apply to tanks covered by the Standard for Welded Steel Tanks for Oil Storage, ANSI/API 650, nor tanks intended for use in chemical and petrochemical plants.

2. General

2.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

CONSTRUCTION

3. Capacities, Dimensions, and Metal Thicknesses

3.1 Capacities, dimensions, and construction details shall comply with the applicable requirements of this standard.

3.2 Tables 13.1 and 13.2 give capacities for cylindrical tanks in gallons per foot of length and in liters per meter of length. For a tank with conical heads, the total capacity is obtained by adding one-third the height of the heads to the shell length.

TABLE 3.1
THICKNESS OF STEEL

Capacity		Maximum Diameter		Minimum Thickness					
				Carbon Steel				Stainless Steel	
				Uncoated		Galvanized			
U.S. Gallons	dm^3	Inches	m	Inches	mm	Inches	mm	Inches	mm
Up to 285	Up to 1078	*	*	0.067	1.70	0.070	1.78	0.071	1.80
286 to 560	1082 to 2120	48	1.22	0.093	2.36	0.097	2.46	0.071	1.80
561 to 1100	2124 to 4164	64	1.63	0.123	3.12	0.126	3.20	0.086	2.18
1101 to 4000	4168 to 15142	84	2.13	0.167	4.24			0.115	2.92
4001 to 12000	15145 to 45425	126	3.20	0.240	6.10			0.158	4.01
12001 to 20000	45429 to 75708	144	3.66	0.302	7.67			0.209	5.31
20001 to 50000	75712 to 189270	144	3.66	0.365	9.27			0.240	6.10

*42 inches (1.07 m) for carbon steel and 48 inches (1.22 m) for stainless steel.

3.3 The total capacity of a tank shall not be (1) less than the rated nominal capacity and (2) more than 105 percent of the rated nominal capacity.

Paragraph 3.3 effective June 1, 1987

3.4 The total capacity is to be determined at the level of the lowest opening when the tank is in the intended installation position.

Paragraph 3.4 effective June 1, 1987

3.5 The overall length of a tank shall not be greater than six times its diameter.

3.6 A tank shall be constructed from steel not thinner than specified in Table 3.1 for its capacity and diameter.

3.7 The thickness of steel is to be determined by five micrometer readings equally spaced along the edge of the full piece as rolled. Thickness is to be determined on the sheet not less than 3/8 inch (9.5 mm) from a cut edge and not less than 3/4 inch (19 mm) from a mill edge.

3.8 To provide for manufacturing variations in applying Table 3.1, a plus tolerance of 5 percent in maximum capacity and a plus tolerance of 5 percent in either the maximum diameter or the maximum length is permitted for tanks constructed of 0.167-inch (4.24-mm) or thicker steel.

Paragraph 3.8 effective June 1, 1987

4. Materials

4.1 A tank shall be constructed of commercial or structural grade carbon steel or of Type 304 or 316 stainless steel, as noted in paragraphs 4.2 and 4.3. Only new material shall be used.

4.2 Carbon steel shall:

A. Comply with the Specification for Structural Steel, ASTM A36—81a; or Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality, Hot-Rolled Carbon, ASTM A569—72 (Reapproved 1979); or Specification for Hot-Rolled Carbon Steel Sheet and Strip, Commercial Quality, Heavy Thickness Coils (Formerly Plate), ASTM A635—81; or

B. Have (1) a carbon content of 0.3 percent or less, or a carbon equivalency of 0.53 percent or less, and (2) mechanical strength and welding characteristics at least equivalent to one of the steels specified in item A.

4.3 Stainless steel shall comply with the Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip, ASTM A167—82; or Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels, ASTM A240—82C.

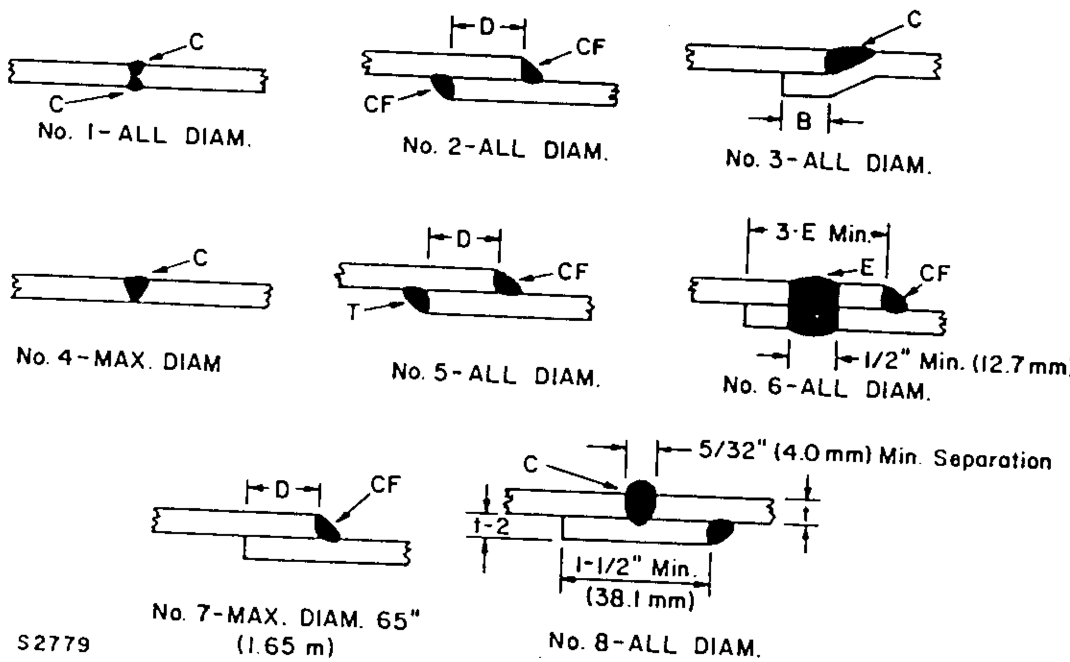
5. Shell Joints

5.1 A shell joint of a tank shall be one of the constructions illustrated in Figure 5.1 except that:

A. Shell joint No. 4 in Figure 5.1 shall not be used on a tank larger than 96 inches (2.44 m) in diameter, and

B. Shell joint No. 7 in Figure 5.1 shall not be used on a tank larger than 65 inches (1.65 m) in diameter.

FIGURE 5.1
SHELL JOINTS



B — Overlap — 1/2 inch (12.7 mm) minimum.

C — Continuous welds.

CF — All lap welds shall be continuous full fillet welds.

D — Overlap — 1/2 inch (12.7 mm) minimum for diameters 48 inches (1.2 m) or less; 3/4 inch (19.1 mm) minimum for diameters over 48 inches (1.2 m).

E — 1/2 inch (12.7 mm) minimum diameter lock weld, not over 12 inches (305 mm) apart.

T — Tack weld 1 inch (25 mm) spots, not over 12 inches (305 mm) apart.

t — Thickness of backup bar to be same as shell thickness.

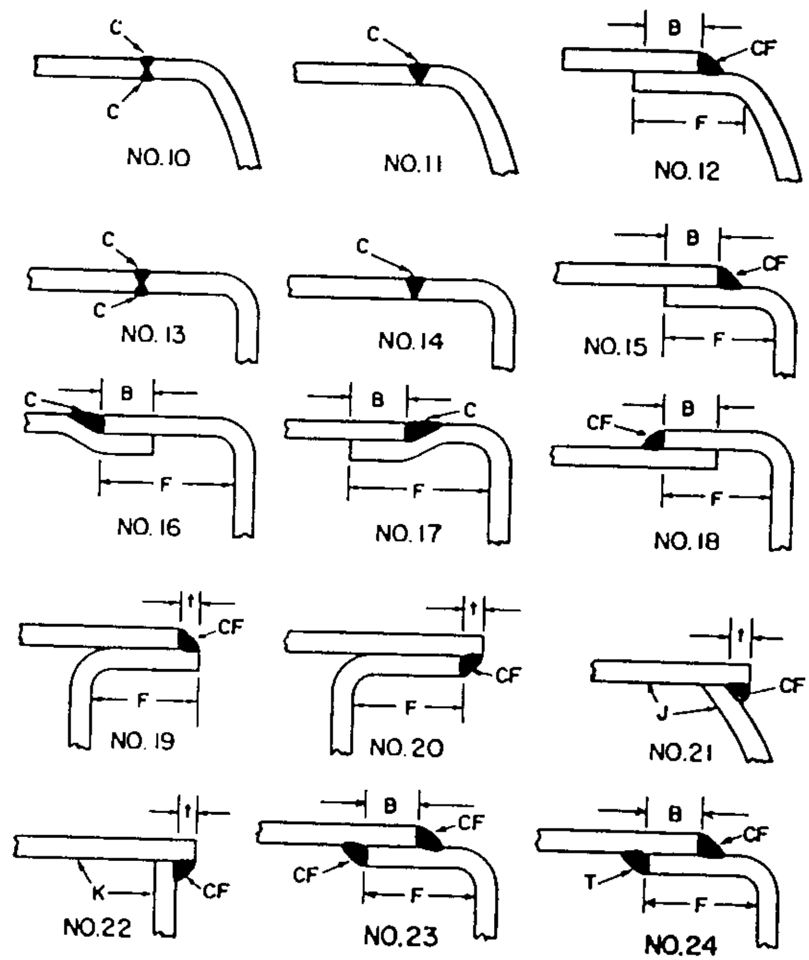
6. Heads and Head Joints

6.1 A head of a tank shall be constructed of not more than two pieces for diameters of 48 inches (1.22 m) or less, three pieces for diameters of from 49 to 96 inches (1.24 to 2.44 m), and four pieces for diameters of from 97 to 144 inches (2.46 to 3.66 m). When two or more pieces are used, joints shall comply with the requirements for shell joints in paragraph 5.1.

6.2 A head of a tank may be flat, dished, or conical.

6.3 A head of a tank shall be attached to the shell by one of the joints illustrated in Figure 6.1.

FIGURE 6.1
HEAD JOINTS FOR ALL DIAMETER TANKS



B — Overlap — 1/2 inch (12.7 mm) minimum.

C — Continuous welds.

CF — Shall be continuous full fillet welds.

F — Not less than five times head thickness — minimum 1/2 inch (12.7 mm).

J — Joint No. 21 — Minimum thickness of 0.167 inch (4.24 mm).

K — Joint No. 22 — Heads require bracing. (see No. 1 and 2 of Figure 6.2). Minimum thickness of 0.167 (4.24 mm).

T — Tack weld 1 inch (25 mm) spots, not over 12 inches (305 mm) apart.

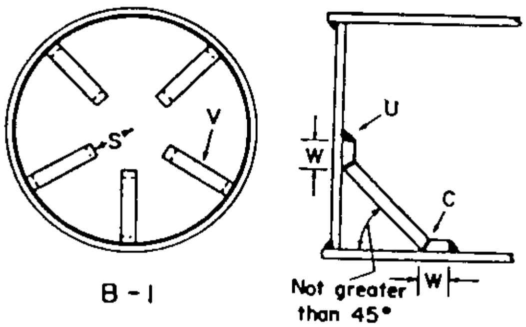
t — Minimum, 1 X shell thickness.

Heads may be flat, dished, or cone.
Height of cone heads — not less than one-twelfth diameter.
Height of dished heads shall conform to Table 6.1.

6.4 An unflanged flat head of a tank shall be braced in accordance with Figure 6.2, No. 1 or 2, and the head and shell shall be made of steel not less than 0.167 inch (4.24 mm) thick.

6.5 A flanged flat head of a tank is not required to be braced.

FIGURE 6.2
BRACING FOR UNFLANGED
FLAT HEADS AND BULKHEADS



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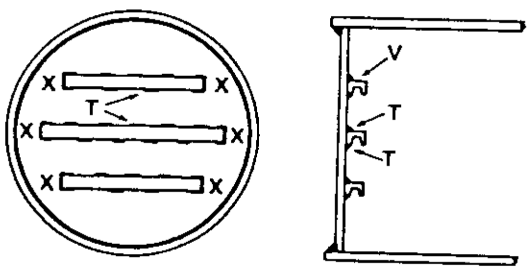

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BRACING FOR FLANGED FLAT BULKHEADS

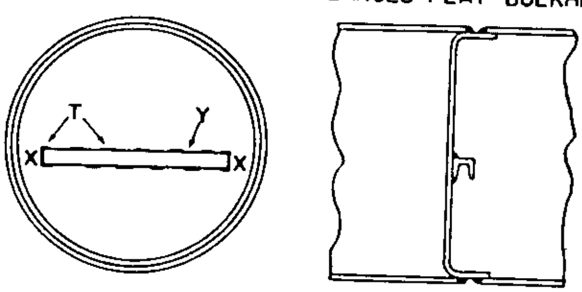

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FIGURE 6.2 (Cont'd)

C — Weld.
S — From center, approximately 1/4 of diameter.
U — Weld three sides each foot.
V — Bracing.
W — Minimum length of foot.

T — Tack welds, not over 12 inches (305 mm) apart.
V — Bracing.
X — Not over 2 inches (51 mm) from shell.

BRACING FOR FLANGED FLAT BULKHEADS

T — Tack welds, not over 12 inches (305 mm) apart.
X — Not over 2 inches (51 mm) from shell.
Y — Bracing (locate 6 inches (150 mm) below center of head).

6.6 A conical head of a tank shall have a height of not less than one-twelfth the diameter of the tank.

6.7 The depth of dish of a dished head shall not be less than that specified in Table 6.1.

6.8 Strut bracing for unflanged flat heads and bulkheads shall comply with Table 6.2.

6.9 Surface bracing for unflanged flat heads and bulkheads shall comply with Table 6.3.

6.10 Surface bracing for flanged flat bulkheads shall comply with Table 6.4.

TABLE 6.1
DISHED HEADS — MINIMUM HEIGHT

Diameter		Minimum Dish		Diameter		Minimum Dish	
Inches	m	Inches	mm	Inches	m	Inches	mm
Up to 60	Up to 1.52	1-1/2	38	97—108	2.46—2.74	4-1/2	114
61—72	1.55—1.83	2	51	109—120	2.77—3.05	5-1/2	140
73—84	1.85—2.13	2-1/2	64	121—132	3.07—3.35	7	178
85—96	2.16—2.44	3-1/2	89	133—144	3.38—3.66	8	203

NOTE — The use of standard S.I. (metric) sizes and weights of angles, channels, and I-beams as substitutes for the U.S.A. structural units specified in Tables 6.2, 6.3, and 6.4 shall be based on those sizes and weights having an equal or greater section modulus (S).

TABLE 6.2
STRUT BRACING FOR UNFLANGED FLAT HEADS AND BULKHEADS[a]

Diameter Head		Channels		Angles		W[a]	
Inches	m	Size, Inches	Section Modulus(s) In.^{3}	Size, Inches	Section Modulus(s) In.^{3}	Inches	mm
Up to — 60	Up to 1.52	1 by 3/8 by 1/8	0.048[b]	1 by 1 by 1/8	0.031	1	25.0
61—72	1.55—1.83	1 by 3/8 by 1/8	0.048[b]	1-1/4 by 1-1/4 by 1/8	0.049	1-1/4	32.0
73—84	1.85—2.13	1 by 1/2 by 1/8	0.063[b]	1-1/2 by 1-1/2 by 1/8	0.072	1-1/2	38.0
85—96	2.16—2.44	1 by 1/2 by 1/8	0.063[b]	1-3/4 by 1-3/4 by 3/16	0.140	1-3/4	44.0
97—108	2.46—2.74	1-1/2 by 3/4 by 1/8	0.147[b]	2 by 2 by 3/16	0.190	2	51.0
109—120	2.77—3.05	3 inches — 4.1 pounds	1.1[b]	2 by 2 by 1/4	0.250	2	51.0
121—132	3.07—3.35	3 inches — 4.1 pounds	1.1[b]	2-1/2 by 2-1/2 by 5/16	0.480	2-1/2	64.0
133—144	3.38—3.66	3 inches — 4.1 pounds	1.1[b]	2-1/2 by 2-1/2 by 5/16	0.480	2-1/2	64.0

[a]See Figure 6.2, No. 1.

[b]Flange of channel welded to head or bulkhead and shell.

TABLE 6.3
SURFACE BRACING FOR UNFLANGED FLAT HEADS AND BULKHEADS[a]

Diameter Head		Channels		Angles	
Inches	m	Size	Section Modulus(s) In.^{3}	Sizes, Inches	Min. Section Modulus(s) In.^{3}
Up to 60	Up to 1.52	3 inches — 4.1 pounds	1.1[b]	2 by 2 by 3/8 or 2-1/2 by 2-1/2 by 1/4	0.35
61—72	1.55—1.83	3 inches — 4.1 pounds	1.1[b]	3 by 3 by 7/16 or 3-1/2 by 3-1/2 by 5/16	0.95
73—84	1.85—2.13	4 inches — 5.4 pounds	1.9[b]	3-1/2 by 3-1/2 by 1/2 or 4 by 4 by 3/8	1.50
85—96	2.16—2.44	5 inches — 6.7 pounds	3.0[b]	4 by 4 by 1/2 or 5 by 3-1/2 by 3/8	2.00[b]
97—108	2.46—2.74	5 inches — 6.7 pounds	3.0[b]	4 by 4 by 3/4 or 6 by 4 by 3/8	2.80[b]
109—120	2.77—3.05	6 inches — 8.2 pounds	4.3[b]	5 by 5 by 5/8 or 6 by 4 by 1/2	3.90[b]
121—132	3.07—3.35	7 inches — 9.8 pounds	6.0[b]	5 by 5 by 3/4 or 6 by 4 by 9/16	4.50[b]
133—144	3.38—3.66	7 inches — 9.8 pounds	6.0[b]	5 by 5 by 3/4 or 6 by 4 by 9/16	4.50[b]

[a]See Figure 6.2, No. 2.

[b]Short leg of angle or flange of channel welded to head or bulkhead.

TABLE 6.4
SURFACE BRACING FOR FLANGED FLAT BULKHEADS[a]

Diameter Head		I-Beams		Channels	
Inches	m	Size	Section Modulus(s) In.^{3}	Size	Section Modulus(s) In.^{3}
72—84	1.83—2.13	3 inches — 5.7 pounds	1.7[b]	3 inches — 4.1 pounds	1.1[b]
85—96	2.16—2.44	3 inches — 5.7 pounds	1.7[b]	4 inches — 5.4 pounds	1.9[b]
97—108	2.46—2.74	4 inches — 7.7 pounds	3.0[b]	5 inches — 6.7 pounds	3.0[b]
109—120	2.77—3.05	5 inches — 10 pounds	4.8[b]	5 inches — 6.7 pounds	3.0[b]
121—132	3.07—3.35	5 inches — 10 pounds	4.8[b]	6 inches — 8.2 pounds	4.3[b]
133—144	3.38—3.66	5 inches — 10 pounds	4.8[b]	6 inches — 8.2 pounds	4.3[b]

[a]See Figure 6.2, No. 3.

[b]Flange of I-beam or channel welded to bulkhead.

7. Compartment Tanks

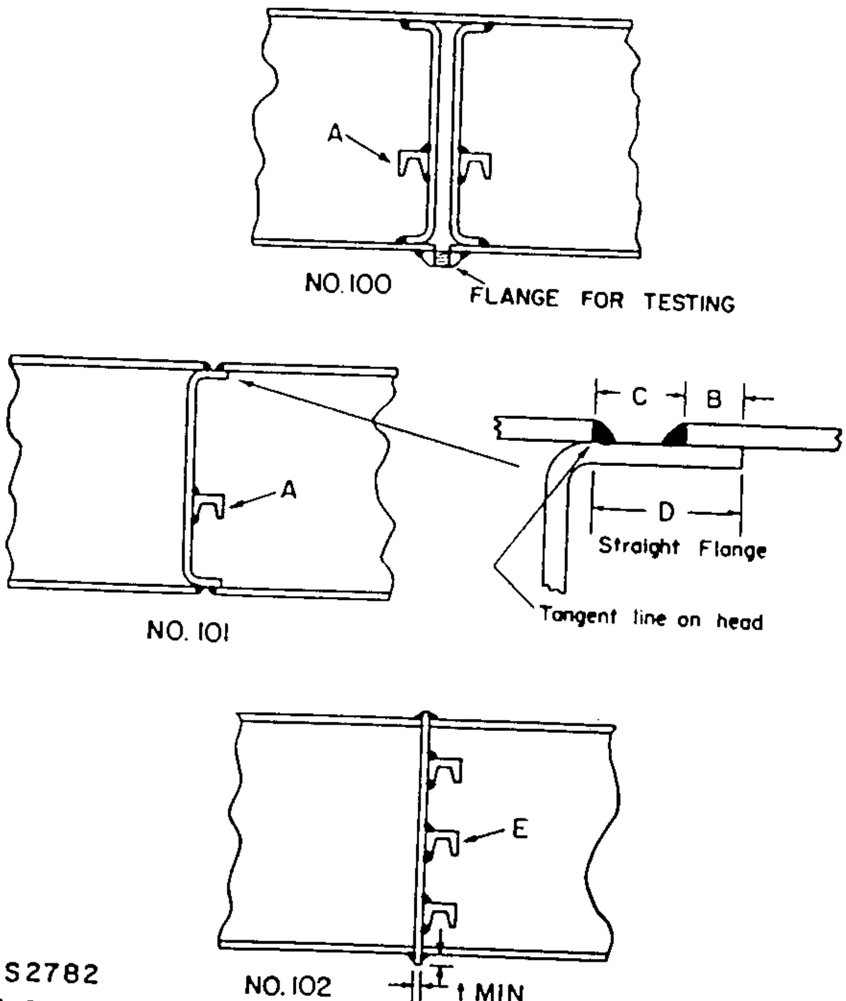
7.1 Bulkheads of a compartment tank shall be constructed so that any leakage through joints will be directed to the outside of the tank rather than from one compartment to another. See Figure 7.1 for acceptable bulkhead constructions.

7.2 A single bulkhead of a compartment tank, illustrated in Nos. 101 and 102 of Figure 7.1, shall be constructed of one piece of material and may be flat or dished. The height of a dished bulkhead shall not be less than that specified in Table 6.1.

7.3 A bulkhead of a double bulkhead tank, illustrated in No. 100 in Figure 7.1, shall be constructed of not more than two pieces for diameters of 48 inches (1.22 m) or less, three pieces for diameters of from 49 to 96 inches (1.24 to 2.44 m), and four pieces for diameters of from 97 to 144 inches (2.46 to 3.66 m). When two or more pieces are used, joints shall comply with the requirements for shell joints in paragraph 5.1.

7.4 The minimum thickness of metal employed for a bulkhead depends upon the tank diameter and shall not be less than that specified in Table 3.1.

FIGURE 7.1
BULKHEADS FOR COMPARTMENT TANKS



A — Bracing as per Table 6.4 if diameter exceeds 72 inches (1.8 m)

B — 1/2 inch (12.7 mm)

— 3/4 inch (19.1 mm)

D — 1-1/4 inch (31.8 mm)

E — Bracing as per Table 6.2 or 6.3

7.5 An unflanged flat bulkhead of a compartment tank shall be braced in accordance with Figure 6.2, No. 1 or 2, and shall be made of steel not less than 0.167 inch (4.24 mm) thick.

7.6 A flanged flat bulkhead of a compartment tank more than 72 inches (1.83 m) in diameter shall be made of steel not less than 0.302 inch (7.67 mm) thick or it shall be braced as illustrated in No. 3 of Figure 6.2.

7.7 A flanged flat bulkhead 72 inches (1.83 m) or less in diameter does not require bracing.

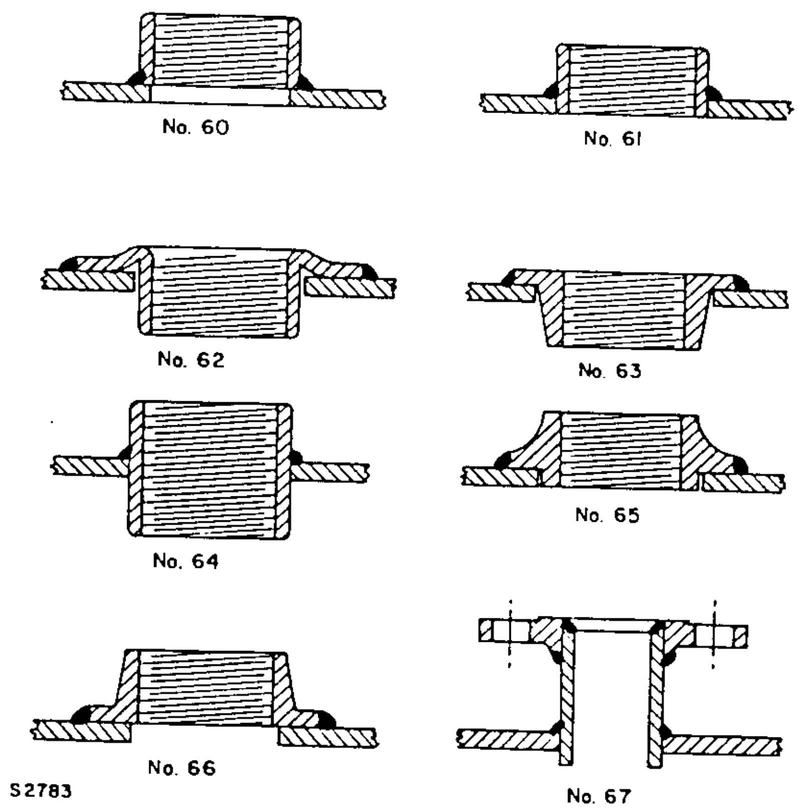
8. Pipe Connections

8.1 A pipe connection shall be provided by welding to the tank a standard threaded pipe coupling, a threaded flange, or a standard half pipe nipple, or by a bolted and gasketed flanged connection welded to a pipe nipple that in turn, is welded to the tank.

8.2 Conventional types of pipe connections are illustrated in Figure 8.1.

8.3 The minimum length of thread in a pipe connection shall be specified in Table 8.1.

FIGURE 8.1
PIPE CONNECTIONS



All welds are to be full fillet welds, at least 1/8 inch (3.2 mm) radius.

No. 60 — Half pipe coupling.
No. 61 — Half pipe coupling.
No. 62 — Pressed steel, hub inside tank only.
No. 63 — Forged steel, hub inside tank.
No. 64 — Full pipe coupling.
No. 65 — Forged steel, with pilot.
No. 66 — Forged steel, without pilot.
No. 67 — Standard pipe nipple and welding flange.

TABLE 8.1
PIPE CONNECTIONS

Pipe Size[a] Nominal	Minimum Length of Thread		Minimum Thickness of Flange Section of Pressed-Steel Fittings	
Inches	Inches	mm	Inches	mm
1/8	1/4	6.4		
1/4	3/8	9.5		
3/8	3/8	9.5		
1/2	1/2	12.7		
3/4	5/8	15.9		
1	5/8	15.9	0.123	3.12
1-1/4	11/16	17.5	0.138	3.51
1-1/2	3/4	19.1	0.138	3.51
2	3/4	19.1	0.138	3.51
2-1/2	1	25.4	0.138	3.51
3	1	25.4	0.167	4.24
3-1/2	1	25.4	0.167	4.24
4	1-1/8	28.6	0.167	4.24
5	1-3/16	30.2	0.167	4.24
6	1-1/4	31.7		
8	1-3/8	34.9		

[a]Standard for Welded and Seamless Wrought Steel Pipe, ANSI B36.10—1979

TABLE 8.2
SIZE OF VENT-PIPE FITTING

Capacity of Tank		Nominal Pipe Size[a], Inches
U.S. Gallons	L	
0 to 500	Up to 1895	1-1/4
500 to 3000	1900 to 11355	1-1/2
3001 to 10000	11360 to 37855	2
10001 to 20000	37860 to 75710	2-1/2
20001 to 35000	75715 to 132490	3
35001 to 50000	132495 to 189270	4

[a]Standard for Welded and Seamless Wrought Steel Pipe, ANSI B36.10—1979.

8.4 A pressed-steel pipe-connecting fitting shall be (1) installed with the hub section on the inside of the tank only and (2) of the form illustrated in No. 62 of Figure 8.1. The minimum thickness of the flange section shall be as specified in Table 8.1.

8.5 A half pipe nipple shall be welded to the tank as illustrated in No. 67 of Figure 8.1.

8.6 Except as indicated in paragraphs 8.7 and 8.8, all openings in a tank shall be located in the top, parallel with the longitudinal axis of the tank.

8.7 If the application of a tank is such that pipe-connecting openings in the top are required to be grouped, the openings may be located off center of the longitudinal axis under the conditions specified in paragraph 8.8.

8.8 No opening in the shell of a tank shall be located more than 12 inches (305 mm) from the longitudinal centerline of the top, and the upper end of the pipe coupling or other pipe-connecting fitting welded to the tank shall terminate above the top of the shell.

8.9 All openings in a tank shall be closed with wooden plugs, metal covers, or the equivalent, to protect the threads and exclude foreign matter while the tank is in storage or in transit.

8.10 Each tank shall have a pipe connection of a size not less than that specified in Table 8.2 for attachment of a vent pipe.

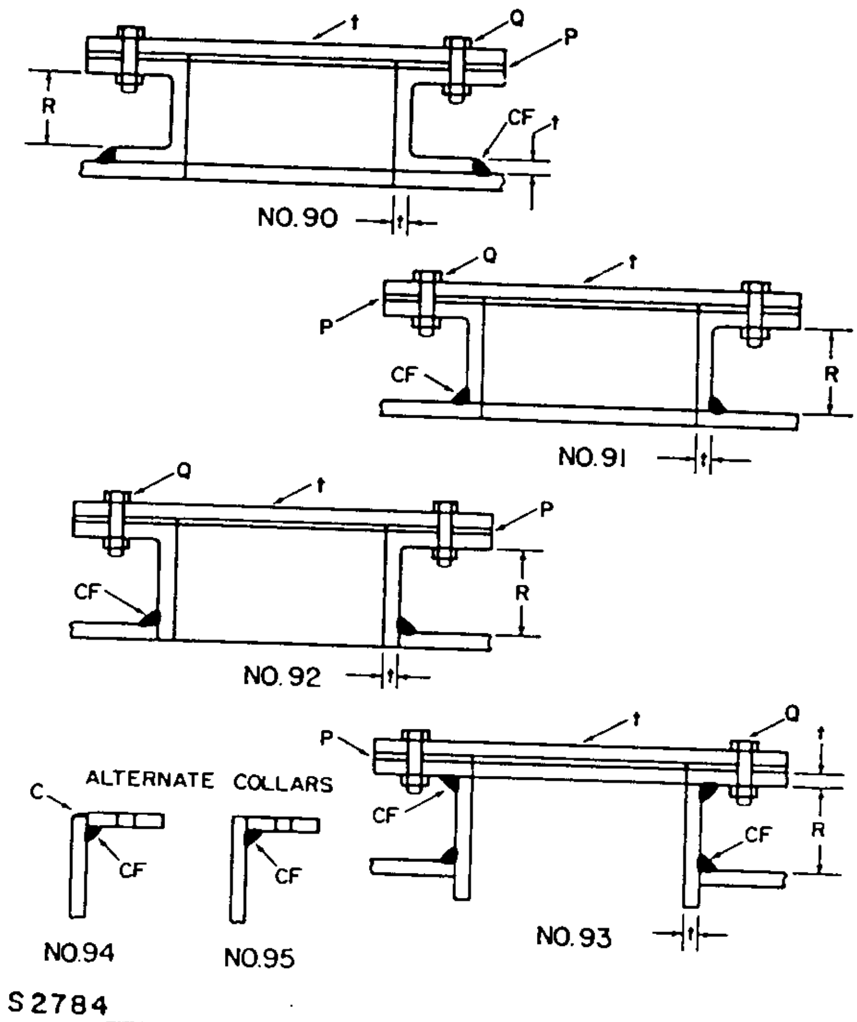
8.11 An opening for connection of a vent pipe shall not be located in a manhole cover.

9. Manholes

9.1 A manhole, if provided in a tank, shall be located above the highest intended liquid level and shall be of the bolted-cover type as illustrated in Figure 9.1.

9.2 A manhole-cover joint shall be provided with a gasket of material determined to be acceptable for the liquid to be stored and shall not be less than 1/8 inch (3.2 mm) thick.

FIGURE 9.1
CONVENTIONAL MANHOLES



CF — Continuous full fillet weld.

P — Gasket material, 1/8 inch (3.2 mm) thick minimum — ring or face gasket.

Q — Minimum, 1/2 inch (12.7 mm) bolts spaced 4 inch (102 mm) centers maximum.

R — Minimum, 2 inches (51 mm) for tanks 6 feet (1.8 m) in diameter or larger.

t — Not less than 0.167 inch (4.24 mm) thick.

10. Heating Coils and Hot Wells

10.1 A heating coil or hot well that is provided as a part of a tank assembly and that handles a fluid other than that stored in the tank, such as steam or hot water, shall have no joints in the portion of the coil or well that is located within the tank unless the joints are continuously welded or brazed.

10.2 Inlet and outlet connections of a heating coil or a hot well shall be located above the highest intended liquid level. A continuous weld shall be made where a connection pierces the shell of the tank or a manhole cover.

MANUFACTURING AND PRODUCTION TESTS

11. General

11.1 Each tank, before painting, shall be tested by the manufacturer and proved tight against leakage by:

A. Applying internal air pressure and using soapsuds, linseed oil, or equivalent material for the detection of leaks. The test pressure is to be 5—7 psig (34.5—48.3 kPa); or

B. Completely filling the tank with water and applying an additional 5 psig (34.5 kPa) pressure while the tank is placed in the position in which it will be installed.

11.2 If leaks are noted during the test, the tank shall be made tight by welding and retested. Defects in welds shall be repaired by chipping or melting out from one or both sides of the joint, as required, and rewelding.

11.3 Each compartment of compartment tanks shall be separately tested for leakage.

MARKING

12. General

12.1 Each tank shall be marked with the name of the manufacturer or a distinctive marking, which may be in code, by which it may be identified as the product of a particular manufacturer.

12.2 If a manufacturer produces tanks at more than one factory, each tank shall have a distinctive marking to identify it as the product of a particular factory.

12.3 Each tank shall be marked with the minimum gage steel used in its construction.

Paragraph 12.3 effective June 1, 1987

13. Capacity Tables

TABLE 13.1
GALLON CAPACITY PER FOOT OF LENGTH

Diameter In Inches	U.S. Gallons 1-Foot Length	Diameter In Inches	U.S. Gallons 1-Foot Length	Diameter In Inches	U.S. Gallons 1-Foot Length
24	23.50	65	172.38	105	449.82
25	25.50	66	177.72	106	458.30
26	27.58	67	183.15	107	467.70
27	29.74	68	188.66	108	475.89
28	31.99	69	194.25	109	485.00
29	34.31	70	199.92	110	493.70
30	36.72	71	205.67	111	502.70
31	39.21	72	211.51	112	511.90
32	41.78	73	217.42	113	521.40
33	44.43	74	223.42	114	530.24
34	47.16	75	229.50	115	540.00
35	49.98	76	235.66	116	549.50
36	52.88	77	241.90	117	558.51
37	55.86	78	248.23	118	568.00
38	58.92	79	254.63	119	577.80
39	62.06	80	261.12	120	587.52
40	65.28	81	267.69	121	597.70
41	68.58	82	274.34	122	607.27
42	71.97	83	281.07	123	617.26
43	75.44	84	287.88	124	627.00
44	78.99	85	294.78	125	638.20
45	82.62	86	301.76	126	647.74
46	86.33	87	308.81	127	658.60
47	90.13	88	315.95	128	668.47
48	94.00	89	323.18	129	678.95
49	97.96	90	330.48	130	690.30
50	102.00	91	337.86	131	700.17
51	106.12	92	345.33	132	710.90
52	110.32	93	352.88	133	721.71
53	114.61	94	360.51	134	732.60
54	118.97	95	368.22	135	743.58
55	123.42	96	376.01	136	754.64
56	127.95	97	383.89	137	765.78
57	132.56	98	391.84	138	776.99
58	137.25	99	399.88	139	788.30
59	142.02	100	408.00	140	799.68
60	146.88	101	416.00	141	811.14
61	151.82	102	424.48	142	822.69
62	156.83	103	433.10	143	834.32
63	161.93	104	441.80	144	846.03
64	167.12				

TABLE 13.2
LITER CAPACITY PER METER
OF LENGTH

Diameter in mm	Liters (dm^3) 1-meter Length
600	282.7
700	384.8
800	502.7
900	636.2
1000	785.4
1100	958.2
1200	1131.0
1300	1327.3
1400	1539.4
1500	1767.2
1600	2010.6
1700	2269.8
1800	2544.7
1900	2835.3
2000	3141.6
2100	3463.6
2200	3801.3
2300	4154.8
2400	4523.9
2500	4908.8
2600	5309.3
2700	5725.6
2800	6157.5
2900	6605.2
3000	7068.6
3100	7547.7
3200	8042.5
3300	8553.0
3400	9079.2
3500	9621.2
3600	10178.8
3700	10752.1
3800	11341.2

EXHIBIT C

TANK MANUFACTURER CERTIFICATION

INSPECTION OF sti-P3® TANKS

(See back of form for instructions)

Date 5/8/90 Manufacturer Identification: A+B ELECTRIC

sti-P3® Label# 169778 UL Label # 378969 ASME Label# ______

Tank ______ Capacity 1000 Diameter 48 Length 128 Gauge 7

Type I Dual Wall ✓ ______ Type II Dual Wall ______

Dimensions & Gauge of Outer Containment/Type II 48 3/8 x 128 3/8 O.D. 10 GA

Special Approval Tank Drawing # ______ (include copy) Manholes (# and size) 1-29 STI-86

Tank meeting sti-P3® Spec. para. 4.2.2 YES (with non UL-58 tanks, identify reason under remarks)

STI USE ONLY 1/89
INVOICE #
AMOUNT $
DATE

PRE-COATING INSPECTION

- ☑ Air Test Of UL-58 Tank
- ☑ Blast (per sti-P3® spec)
- ☑ Weld Spatter Removed
- ☑ Seal Welding
- ☑ Striker Plates Under All Openings
- ☑ PP2® Connectors Protected
- ☑ Anodes Spaced Properly
- ☐ Bag Anode Lead Connectors Protected

Bruce S Piper
Signature

COATING INSPECTION (dry film thickness readings)

Head Diameter	Under 64"	64" - 72"	73" - 120"	121" - 132"	Greater 133"
Req. readings for 2 heads	8	12	16	20	24
Tank Capacity	1 - 1,499 gal.	to 5,999 gal.	to 11,999 gal.	to 24,999 gal.	25,000 + gal.
Req. readings for shell	10	15	20	25	30

Heads			Shell		
No. of Readings Taken	High DFT	Low DFT	No. of Readings Taken	High DFT	Low DFT
8	23	17	10	15	10

COATING BRAND USED: Corrocote II

☐ TANK CHECKED FOR LOW COATING AND RECOATED IF NECESSARY

Bruce S Piper
Signature

ELECTRICAL INSPECTION

Isolation

☐ sti-P3® Approved Nylon Bushings Installed Properly

Weld-On Anodes

Used ______ (10#) zinc
Used 2 (5#) zinc
Used ______ (17#) magnesium

Monitoring

☑ Monitoring equipment installed
☐ PP1® ☑ PP2®

Others (specify): ______

Flange Isolation (refer to sti-P3® Spec.)

Size	Qty.	Discontinuity
6	1	yes
4	1	yes

STI-86 Electrical Discontinuity Between Tank and Manway Cover: YES
(Identify Pipe Openings in Remark Section or Attach Drawing)

Manway Extensions or Work Chambers
☐ Manway electrically isolated and discontinuity verified OR
☐ Manway considered part of tank and cathodically protected per sti-P3® Spec.

Wired-On Anodes

Used ______ Mg Bag ______ Zn Bag
Weight Used ______
☐ Anode-to-tank continuity test O.K.

Remarks: 4 - 4"
2 - 2"

Bruce S Piper
Signature

PRE-SHIPMENT INSPECTION

- ☑ Monitoring equipment attached
- ☑ Tank inspected for damage and if damaged, repaired
- ☑ sti-P3® labels affixed
- ☑ Tank properly loaded
- ☑ If weld-on anodes used, protective plastic covers removed prior to shipping
- ☐ If plastic covers are not removed, anode caution label affixed to each anode

Final Approval/Shipping Date: 5/8/90
Licensee Company: CLAW 01
City and State: CLARKSTON, MI
Robert E Lehman

Exhibit C
Page 1 of 1

EXHIBIT D

CALCULATIONS OF TANK VENTING REQUIREMENTS

EXHIBIT D
TANK VENTING CALCULATIONS (PER API 2000)
CHEMICAL WASTE MANAGEMENT, INC., EMELLE, ALABAMA FACILITY

Tank Nos.	Width/ Diameter (ft)	Length/ Shell Height (ft)	Depth/ Cone Height (ft)	Tank Wetted Surf. Area (sf)	Tank Capacity (gal)	Tank Rated Press. (in WG)	Tank Relief Press. (in WG)[1]	Tank Rated Vac. (in WG)	Tank Relief Vac. (in WG)[1]	Fill Rate (gpm)	With-drawal Rate (gpm)	IN-BREATHING Normal Venting (cfh)[2]	IN-BREATHING Thermal Venting (cfh)[3]	IN-BREATHING Total Vent Capacity (cfh)	IN-BREATHING Min. Area (sq in)[8]	IN-BREATHING Min. Size (in)	OUT-BREATHING Normal Venting (cfh)[4]	OUT-BREATHING Thermal Venting (cfh)[5]	OUT-BREATHING Total Vent Capacity (cfh)	OUT-BREATHING Min. Area (sq in)[8]	OUT-BREATHING Min. Size (in)	EMERGENCY Vent Capacity (cfh)[6]	EMERGENCY Min. Area (sq in)[7]	EMERGENCY Min. Size (in)
LABORATORY TANK STORAGE UNIT 708																								
T-725	4.00	10.67		NA	1,003	140.00	70.00	70.00	35.00	150	150	1,200	24	1,224	0.49	1.00	2,571	24	2,595	0.73	1.00	NA	NA	NA

NOTES:

1. Pressure and vacuum relief is assumed to be set to relieve at 50% of the design rated pressure or vacuum, unless noted. Emergency relief is assumed to be set at 75% of design pressure.
2. Normal in-breathing at 5.6 scfh per 42 gal barrel per hour of withdrawal, as specified in API 2000, 4th Edition.
3. Thermal in-breathing at 1 scfh per 42 gal barrel of tank volume, up to 20,000 barrel (840,000 gal) volume, as in API 2000.
4. Normal out-breathing at 12 scfh per 42 gal barrel per hour of fill for volatile liquids (flash point <100 deg F), as in API 2000. For non-volatile liquids 6 scfh per 42 gal barrel may be used.
5. Thermal out-breathing at 1 scfh per 42 gal barrel of tank volume for volatile liquids, up to 20,000 barrel volume, as in API 2000. For non-volatile liquids 0.6 scfh per 42 gal barrel may be used.
6. From API 2000 Appendix B on Emergency Venting, for four ranges of tank surface area, heat absorption, Q, is calculated. Vent capacity in SCFH is then calculated from the heat absorption according to the equation:
   SCFH = 70.5 * Q / [L * sqrt(M)] assuming a conservative "L * sqrt(M)" value of 1,337, that of hexane.
7. Formula for emergency vent area adapted from Protectoseal Technical Manual, on flow capacity of tank emergency venting devices for nozzles 8 in. and larger:
   CFH = 1,667 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank emergency relief setting and atmospheric conditions.
8. Formula for vent area for smaller nozzles such as normal breather vents, adapted from Crane Flow of Fluids, Eq. 2-24, very similar to, but more conservative, than Protectoseal equation:
   CFH = 845 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank relief setting and atmospheric conditions.
   The factor 845 was derived using unit conversion factors, a vapor density of 0.1875 lb/cf, and a conservative Y of 0.80 from charts on Crane p. A-21.

EXHIBIT E

TANK MATERIAL OF CONSTRUCTION

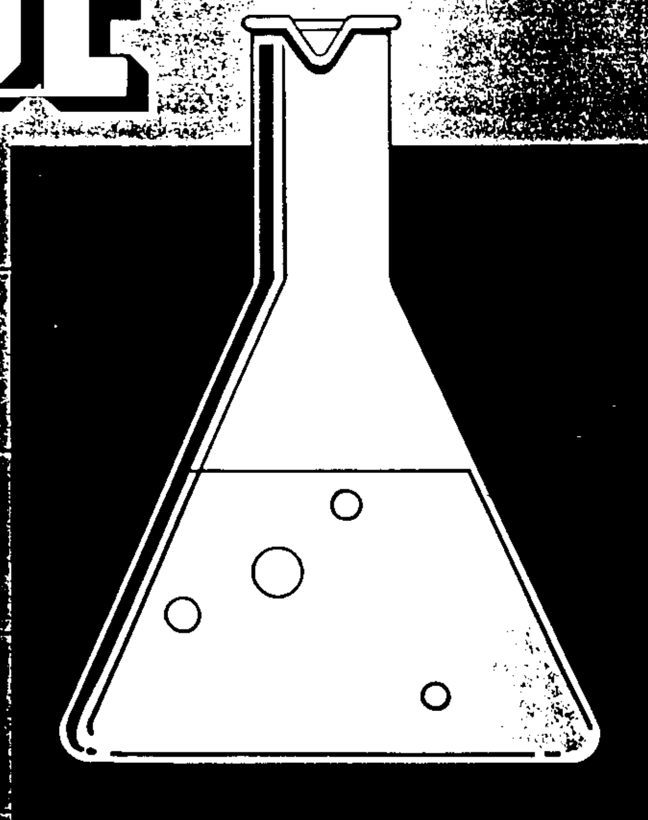
COMPATIBILITY INFORMATION

Compatibility Information

Unit 708: T-725

Tnemec Series 120 Vinyl Ester coating

CHEMICAL RESISTANCE GUIDE



Information on coatings and linings subjected to chemical immersion, splash, spillage or fumes

WARRANTY INFORMATION: For warranty, limitation of seller's liability and further product information, please refer to the product data sheets for these products, or contact your Tnemec representative.

TNEMEC COMPANY, INC.

Post Office Box 411749
K.C., Mo. 64141-1749
TEL: (816) 483-3400
FAX: (816) 483-1251

TNEMEC

Manufacturing Plants:
Kansas City, Missouri
Baltimore, Maryland
Compton, California

9810539

Harsh chemical environments are the true test of a protective coating or lining. Aggressive chemical exposure leaves no margin for error. Any mistakes in the application of the coating or lining invite rapid failure.

The principal reasons for poor coating or lining performance are:

1. Improper coating selection

Failure to match coating characteristics to conditions, such as type of chemical exposure, temperature and temperature variations, abrasiveness and mechanical stress.

2. Improper surface preparation

Failure to provide a proper anchor profile for the coating or to remove all contaminants from the substrate

3. Improper application

Failure to apply sufficient and uniform film thickness or to allow proper curing time

4. Improper substrate design

Failure to design for peak coating performance

Each year, billions of dollars are lost to corrosion because of deficiencies in these areas. Those dollars include repair of the damaged substrate, the material and labor cost of removing and replacing the coating, downtime and the cost of replacing any contaminated product.

That's why it pays to do the job right from the start. This guide will assist you in developing a coating or lining specification, and also provide references for proper surface preparation, application and safety.

We live in a chemical world. Tens of thousands of chemicals are on the market and hundreds more are added every year. There is no universal coating that can tolerate all those chemicals. That's why choosing the correct coating or lining is so difficult. What's more, a company may have several micro-environments within its walls—each requiring a different type of coating.

Of course, the most important factor in coating selection is whether the coating can withstand attack by the chemical to which it is exposed. A pocket in the back of this guide includes a chart outlining resistance of specific Tnemec coatings to different chemicals.

Chemical resistance is not the only factor to consider in coating selection. Some others are: temperature resistance, flexibility, adhesion, toxicity, moisture vapor transmission, scrubbability, pot life, drying and curing time, method and ease of application, resistance to abrasion and impact. Flash point is also an important consideration as is solids-by-volume which gives an indication of coverage potential, volatile solvent content and value. Lastly, the life-cycle cost—not just initial cost—of the coating should be weighed.

Information to aid coating selection is available from

- Tnemec Company, Inc. product data sheets
- National Association of Corrosion Engineers (NACE) publication Corrosion Prevention by Protective Coatings by Charles G. Munger

High-solids Epoxy.

Amine-cured epoxy coating offers excellent corrosion and chemical resistance to both acids and bases. Provides exceptional adhesion, and solvent and abrasion resistance. High-solids, two-component formula with over 80% solids-by-volume assures excellent coverage and value. Beige and gray high-gloss finish.

Vinyl-Copolymer Coating.

A proven high performance, one-component coating that provides good corrosion resistance for long-term protection. Dries quickly, has good flexibility, repairs easily, and can be applied in low ambient temperatures (35 F minimum). USDA approved for incidental contact. Available in select Tnemec CHROMACOLORS.

High-solids Amine-cured Epoxy.

High-solids (over 80%) formula with high-build characteristics (up to 10 mils) provides extraordinary protection, often with a single coat. Delivers strong chemical, corrosion, abrasion and stain resistance. Two-component formula is available in Tnemec CHROMACOLORS. Select colors meet USDA requirements for incidental contact.

Epoxy-Polyamide Coating.

Hi-build characteristic delivers excellent protection over properly primed steel and concrete surfaces. Two-component formula delivers exceptional corrosion, abrasion and moisture resistance. Select colors USDA approved for incidental contact. CHROMACOLORS available. Semi-gloss finish.

Vinyl-Ester Coating.

Premium high-solids coating (theoretical 92% solids-by-volume mixed) is especially formulated for lining tanks and vessels holding acid solutions. Two-component formula offers exceptional wet and dry temperature resistance. Available in beige (primer) and gray (finish coat).

High-build Coal Tar-Epoxy.

Provides exceptional adhesion and chemical resistance—especially to alkali and salt solutions. Good abrasion resistance. High-build, two-component formula permits dry film thickness up to 20 mils for one-coat coverage, one-coat savings. Black semi-gloss finish only.

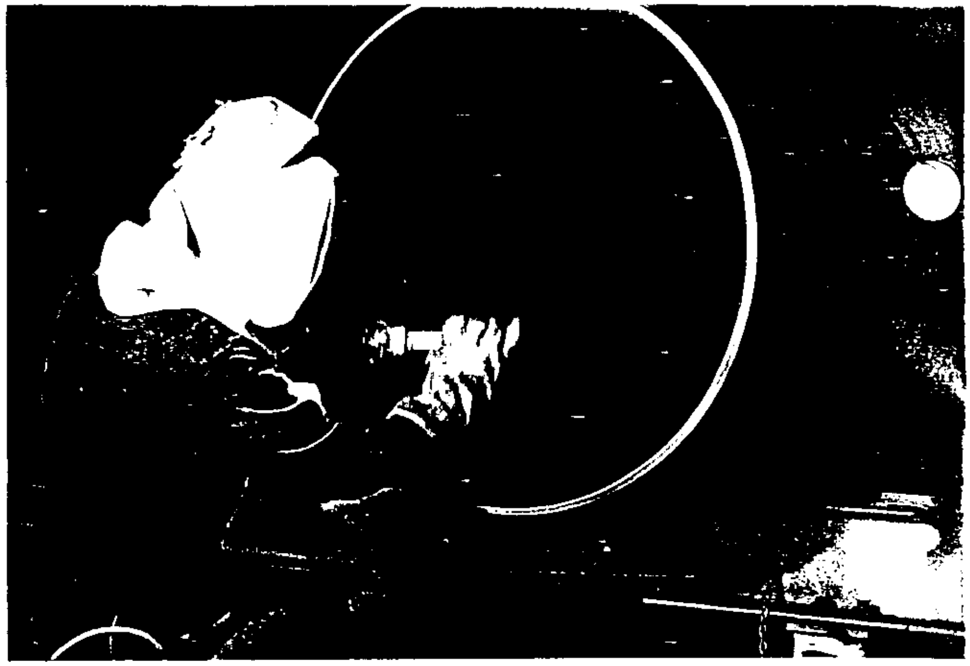
62-1400 SEAM SEALER, 63-1500 FILLER/SURFACER.

Two-component, epoxy-polyamine products include solventless, non-shrinking seam sealer and filler/surfacer. Both develop high bond strength and outstanding resistance to water. Knife or trowel-grade products seal seams, rivet and bolt heads and faying surface edges. Also used to fill and patch voids and pits. For interior or exterior use.

120-5003 VINESTER F & S.

Vinyl-ester filler and surfacer offers outstanding bond strength for use in heavy service areas and wet or corrosive environments. Two-component, trowel-grade product patches, fills and surfaces concrete.

Exhibit E
Page 5 of 16



The importance of good surface preparation cannot be overstated. The most chemical-resistant coating made will perform poorly if the surface preparation has been slighted.

Surface preparation is especially important for coatings and linings that will be subjected to chemical stress. Adhesion is directly related to the cleanliness of the surface and the surface profile.

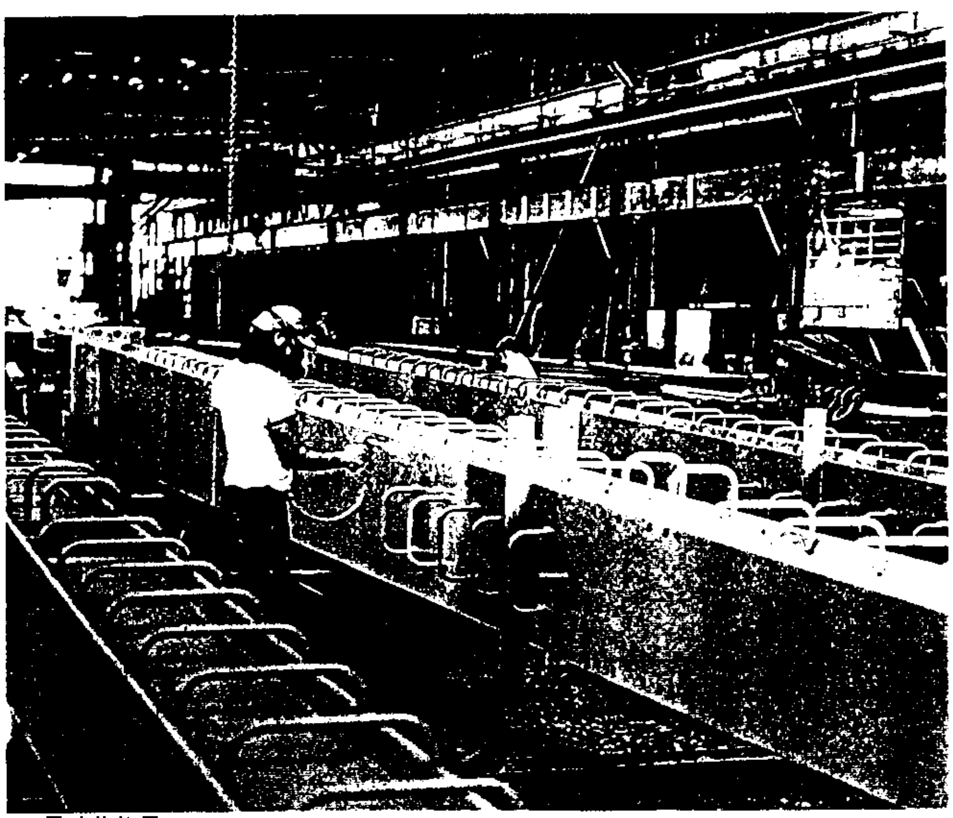
For carbon steel, the Steel Structures Painting Council describes in-depth specifications for various degrees of surface preparation to assure good adhesion. These range from simple solvent cleaning to white metal blast cleaning. The coating manufacturer should be consulted to determine the degree of surface preparation and profile or "tooth" required for the coating to adhere to.

Concrete preparation includes the removal of all laitance, surface defects and contaminants either through acid etching or abrasive blasting. In addition, in accordance with the guidelines of the American Concrete Institute, new concrete must be cured for at least 28 days.

If a previous coating has failed, the substrate is contaminated and special care must be taken to remove all contaminants. This can be very difficult. Acids, alkalies, chlorides, sulfates, sulfides, oils, waxes and silicones can remain after an abrasive blast. Combinations of dry or wet abrasive blast, water blast, chemical cleaning or steam cleaning may be required to remove contamination and to assure proper adhesion.

Detailed information on surface preparation techniques and equipment can be found in:

- [illegible] Company, Inc. "Surface Preparation and Application Guide"
- NACE publications 6F-163, "Surface Preparation of Steel or Concrete Tank Interiors"; TM-0[illegible]-70, "Visual Standard for Surfaces of New Steel Airblast Cleaned with Sand Abrasive"; 6G-164, "Surface Preparation Abrasives for Industrial Maintenance Painting"; 6G-166, "Surface Preparation of Concrete for Coating"
- SSPC's Steel Structures Painting Manual, Volumes 1 and 2



The third cornerstone of coating performance is provided by application. Here again, proper methods are critical. It is essential that a continuous, even film be applied with no discontinuities. Pinholes can quickly undermine a lining and damage the vessel.

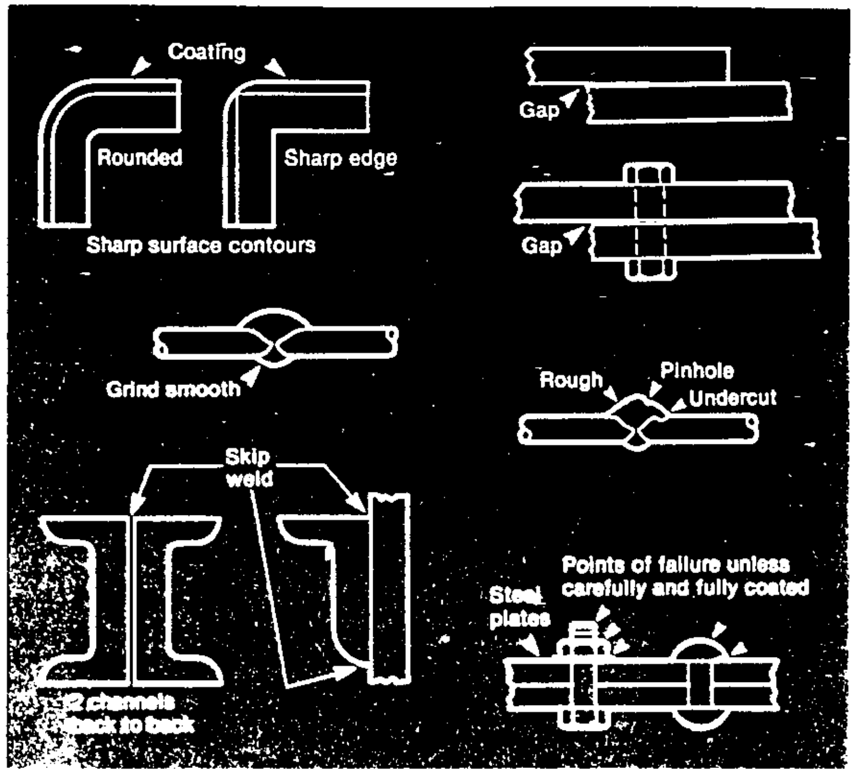
Application starts with mixing the product—a step crucial to the performance of any coating and especially two-component coatings. From there, a choice of method is chosen—brush, roller or spray.

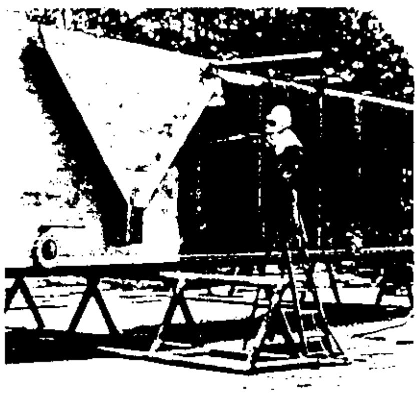
High-performance coatings are usually sprayed on. It is the only way to achieve uniform film thickness. Equipment must be in top condition, air pressure and fluid pressure must be fine-tuned, and good application practices must be followed.

Weather conditions play an important role in coating application. Wind, temperature and humidity are all factors in applying the coating and in the curing time that will be necessary. Manufacturer's literature provides data on curing times. In some instances, force-drying is required to assure desired performance.

Information on application can be found in:

- Tnemec Company, Inc. product data sheets
- SSPC's Steel Structures Painting Manual, Volumes 1 and 2
- NACE publication Corrosion Prevention by Protective Coatings by Charles G. Munger





Taking shortcuts with safety is simply a faster way to an accident. Coatings require special care at all times, especially in confined areas.

Safety involves every aspect of coating application including safe, well-maintained, carefully checked equipment, adequate ventilation; protective clothing and breathing apparatus, and adequate training in the use of equipment. It involves an understanding of environmental conditions and a state of mind—safety-conscious workers are never careless workers.

Several sources provide information on the safe use of coatings. Some of these are:

- Tnemec Company, Inc. material safety data sheets
- Occupational Safety and Health Administration
- NACE publication T-6D, "Manual for Painter Safety"
- NACE publication 6F264, "Recommended Safety Inspection Checklist for Application of Interior Linings"
- SSPC's Steel Structures Painting Manual, Volumes 1 and 2
- NACE publication Corrosion Prevention by Protective Coatings by Charles G. Munger
- Federal, state, county, city regulations

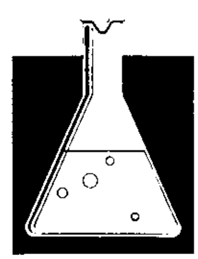
Structural design also plays a crucial role in the performance of a coating. All too often the coating is the last item for consideration by the design engineer—even though the coatings are a prime factor in determining the life of that structure. Unfortunately, by the time a coating is applied, there is usually not much that can be done to the design.

However, if an engineer plans his project with an eye toward the integrity of the coating, there are many steps that can be taken to assure maximum performance. He can strive for designs with continuous welds; avoid sharp angles, channels, edges, and corners; and seal void areas.

If these problem areas cannot be avoided, the coating contractor should pay extra attention to them. At the least, sharp edges and rough welds must be smoothed and rounded to assure good coating performance.

Guidelines for structural design that effect coating performance can be found in:

- NACE standard RP-01-77 "Design, Fabrication, and Surface Finish of Metal Tanks and Vessels to be Lined for Chemical Immersion Service"
- NACE publication Corrosion Prevention by Protective Coatings by Charles G. Munger



Chemical resistance

The Tnemec chart in the pocket at right will provide information for matching the performance of specific Tnemec coatings to expected chemical exposure. It is a compilation of Tnemec product testing to date and will be periodically revised as new data becomes available.

The chart is only a guide. Combinations of chemicals can have a completely different effect on coating performance than the chemicals separately. To be sure of a coating's performance, ask your Tnemec representative for a panel or coupon for testing.

KEY TO THE CHART

IS

IS-IMMERSION SERVICE.
Suitable for continuous contact with chemical at 70-100 F. temperature. (Higher temperatures may be indicated for insulated tanks.) Coating will show no effect except slight softening or color change after six months continuous immersion.

FC

FC-FREQUENT CONTACT.
Suitable for frequent splash or prolonged exposure to concentrated vapors. The coating will show no effects except slight softening or color change after eight hours continuous immersion in the liquid chemical or 72 hours exposure to the vapor.

OC

OC-OCCASIONAL CONTACT.
Suitable for occasional splash and spillage or occasional exposure to concentrated vapors. The coating shows no effects, except slight softening or color changes, following short exposure to splash or spillage which evaporates, is hosed off, or dried overnight or, 24 hours exposure to vapor.

NA

NA—NOT APPLICABLE.
This designation makes no statements regarding chemical resistance. The coating may in fact do the job, but other systems are judged more applicable.

NR

NR—NOT RECOMMENDED.
Suitable for mild concentrations of vapors only.

NT

NT—NOT TESTED.

This guide is for reference only and is not intended to provide complete information concerning product application, preparation or safety. Tnemec Company, Inc. does not accept responsibility for any methods discussed in this publication. The use of materials and methods is solely at the risk of the user.

Chemical resistance results were obtained in a controlled environment and Tnemec Company makes no claim that these tests accurately represent all environments.

CHEMICAL RESISTANCE

This chart is to be used in conjunction with the Tnemec **Chemical Resistance Guide** which explains abbreviations and provides information on chemical resistance. Contact your Tnemec representative for further information and technical data.

AUGUST 1988

CHEMICAL EXPOSURE	Series 35	46H413	Series 61	Series 66	Series 104	Series 120
Acetic Acid (10%)	OC	OC	FC	FC	FC	IS
Acetic Anhydride	NT	FC	FC	OC	FC	NT
Acetone	NR	OC	OC	OC	OC	NT
Activated Carbon	NT	NT	IS	FC	IS	IS
Adipic Acid (Dry)	FC	NT	FC	OC	FC	NT
Aluminum Chloride (25%)	NT	NT	FC	OC	FC	FC
Aluminum Nitrate (50%)	NT	NT	FC	FC	FC	IS
Aluminum Sulfate (49%)	NT	FC	FC	FC	FC	IS
Ammonium Chloride (50%)	NT	FC	FC	FC	FC	IS
Ammonium Hydroxide (10%)	OC	IS	IS	IS	IS	FC
Ammonium Hydroxide (28%)	OC	IS	IS	FC	FC	FC
Ammonium Nitrate (38%)	NT	IS	IS	FC	IS	NT
Ammonium Phosphate (50%)	NT	IS	IS	IS	IS	NA
Ammonium Sulfate (65%)	FC	IS	IS	IS	IS	IS
Amyl Acetate	NR	NR	FC	OC	FC	NT
Aviation Gas 100/130	NT	NT	IS	NT	NT	NA
Barium Chloride (50%)	NT	FC	FC	FC	FC	IS
Benzene	NR	OC	IS	FC	FC	NT
Boric Acid (5%)	FC	IS	IS	IS	IS	IS
n-Butyl Alcohol	NR	OC	IS	OC	FC	FC
n-Butyl Acetate	NR	NR	FC	OC	FC	NT

Chemical resistance results were obtained in a controlled environment and Tnemec Company makes no claim that these tests accurately represent all environments.

CHEMICAL EXPOSURE	Series 35	46H413	Series 61	Series 66	Series 104	Series 120
Butyl Cellosolve ®	NR	NR	FC	OC	FC	FC
Calcium Chloride (50%)	FC	FC	IS	FC	IS	IS
Calcium Hypochlorite (5%)	FC	IS	IS	IS	IS	IS
Chromic Acid (10%)	FC	FC	FC	FC	FC	IS
Citric Acid (50%)	FC	FC	IS	IS	IS	IS
Coal Oil	NR	IS	IS	IS	IS	IS
Copper Sulfate (50%)	FC	FC	IS	NT	IS	IS
Corn Mash Solution	NR	FC	IS (120 F.)	FC	FC	NA
Cyclohexane	NR	IS	IS	IS	IS	NA
n-Decyl Alcohol	NR	OC	IS	OC	FC	NT
Diesel Oil HD #2	NR	IS	IS	IS	IS	IS
Diethanolamine	FC	FC	IS	FC	IS	NR
Ethyl Alcohol	NR	FC	IS	FC	IS	FC
Ethylene Glycol	FC	FC	IS	IS	IS	NA
Furfuryl Alcohol	NT	NR	OC	OC	OC	FC
Gasoline - Leaded	NR	NT	IS	NT	IS	NA
Gasoline - Unleaded	NR	NT	IS	NT	IS	NA
Gasoline - Gasohol	NR	NR	IS	OC	IS	NT
Grease	FC	FC	IS	FC	IS	NA
Glycerin	FC	IS	IS	IS	IS	NA
Heptane	FC	IS	IS	IS	IS	NA
Hexane	FC	IS	IS	IS	IS	NA
Hydraulic Fluid	NR	IS	IS	IS	IS	NA

Chemical resistance results were obtained in a controlled environment and Tnemec Company makes no claim that these tests accurately represent all environments

CHEMICAL EXPOSURE	Series 35	46H413	Series 61	Series 66	Series 104	Series 120
Hydrochloric Acid (10%)	FC	FC	FC	FC	FC	IS (150 F.)
Hydrochloric Acid (30%)	FC	FC	FC	FC	FC	IS
Hydrochloric Acid (37%)	FC	FC	FC	FC	FC	FC
Hydrofluoric Acid (10%)	NR	NR	OC	NR	OC	FC
Hydrogen Peroxide (30%)	FC	FC	IS	FC	FC	NA
Isobutyl Alcohol	NR	OC	IS	OC	FC	FC
Isooctyl Alcohol	NR	OC	IS	OC	FC	FC
Isopropyl Alcohol	NR	FC	IS	FC	IS	FC
Isopropyl Acetate	NR	NR	FC	OC	FC	FC
JP-4 Aviation Fuel	NT	NT	IS	NT	NT	NA
JP-5 Aviation Fuel	NT	NT	IS	NT	NT	NA
Jet A Fuel	NT	NT	IS	NT	NT	NA
Kerosene	OC	NA	IS	IS	IS	NA
Lactic Acid (10%)	FC	FC	IS	FC	FC	IS
Lactic Acid (85%)	FC	OC	FC	FC	FC	IS
Lime Slurry	FC	IS	IS	IS	IS	NT
Linseed Oil	FC	IS	IS	IS	IS	NT
Magnesium Chloride (50%)	NT	FC	IS	FC	IS	IS
Magnesium Hydroxide (50%)	OC	IS	IS	IS	IS	FC
Methyl Alcohol	NR	NR	FC	OC	FC	FC
Methyl Ethyl Ketone	NR	NR	OC	OC	OC	FC
Methyl Propyl Ketone	NR	OC	FC	OC	FC	NA
N-Methyl-2-Pyrolidone	NR	NR	OC	NR	OC	NA

Chemical resistance results were obtained in a controlled environment and Tnemec Company makes no claim that these tests accurately represent all environments.

CHEMICAL EXPOSURE	Series 35	46H413	Series 61	Series 66	Series 104	Series 120
Mineral Spirits	FC	IS	IS	IS	IS	NA
Naptha	FC	FC	IS	IS	IS	NA
Nitric Acid (10%)	FC	OC	OC	OC	OC	IS
n-Octyl Alcohol	NR	OC	IS	OC	FC	FC
Oxalic Acid (10%)	FC	FC	FC	FC	FC	IS
Perchloroethylene	NR	FC	IS	FC	OC	NA
Phosphoric Acid (10%)	FC	FC	FC	FC	FC	IS (150 F.)
Phthalic Acid (90%)	FC	FC	FC	FC	FC	IS
Potassium Hydroxide (10%)	FC	FC	IS	IS	IS	FC
n-Propyl Alcohol	NR	OC	IS	OC	FC	FC
Propylene Glycol	OC	FC	IS	FC	IS	NA
Sodium Bisulfate (30%)	FC	FC	FC	FC	FC	IS
Sodium Carbonate (30%)	FC	IS	IS	IS	IS	NA
Sodium Carbonate Slurry	FC	IS	IS	IS	IS	NT
Sodium Chloride (10%)	FC	IS	IS	IS	IS	NA
Sodium Chloride (20%)	FC	IS	IS	IS	IS	NA
Sodium Chromate (50%)	NT	NT	FC	NT	FC	IS
Sodium Formate	NT	NT	NT	NT	NT	IS
Sodium Hydrosulfide (72%)	NT	NT	FC	NT	NT	IS
Sodium Hydrosulfite (10%)	NT	NT	NT	NT	NT	IS
Sodium Hydroxide (10%)	FC	IS	IS (150 F.)	IS	IS	FC
Sodium Hydroxide (50%)	OC	IS	IS (150 F.)	IS	IS	FC
Sodium Hypochlorite (5%) (Bleach)	FC	FC	FC	FC	FC	IS

Chemical resistance results were obtained in a controlled environment and Tnemec Company makes no claim that these tests accurately represent all environments.

CHEMICAL EXPOSURE	Series 35	46H413	Series 61	Series 66	Series 104	Series 120
Sodium Silicate	NT	NT	NT	NT	NT	IS
Sodium Sulfate (6%)	FC	IS	IS	IS	IS	NA
Sodium Thiosulfate (30%)	NT	NT	FC	NT	FC	IS
Sodium Tripolyphosphate	FC	IS	IS	IS	IS	NA
Sour Crude	OC	IS	IS (150 F.)	IS	IS	IS
Sweet Crude	OC	IS	IS (150 F.)	IS	IS	IS
Soybean Oil	FC	IS	IS	IS	IS	NA
Sulfuric Acid (10%)	FC	FC	FC	FC	FC	IS
Sulfuric Acid (30%)	FC	FC	FC	FC	FC	IS
Sulfuric Acid (50%)	OC	OC	OC	OC	OC	IS
Styrene	NR	NR	FC	NR	OC	IS
Tannic Acid	FC	IS	IS	IS	IS	IS
Toluene	NR	FC	IS	FC	IS	NA
Transmission Fluid	NR	IS	IS	IS	IS	IS
1,1,1-trichloroethane	NR	FC	IS	OC	FC	FC
Trisodium Phosphate (20%)	FC	FC	IS	FC	IS	IS
Turpentine	OC	IS	IS	IS	IS	NA
Vinegar	FC	OC	FC	FC	FC	IS
Water, Distilled	FC	IS	IS (200 F.)	IS	IS	NA
Water, Fresh	IS	IS	IS (200 F.)	IS	IS	NR
Water, Sea	IS	IS	IS	IS	IS	NA
Water, Sewage	NR	IS	IS	IS	IS	IS
Xylene	NR	FC	IS	FC	IS	NA

Chemical resistance results were obtained in a controlled environment and Tnemec Company makes no claim that these tests accurately represent all environments.

CHEMICAL EXPOSURE	Series 35	46H413	Series 61	Series 66	Series 104	Series 120
Zinc Chloride (40%)	NT	FC	IS	FC	FC	IS

Chemical resistance results were obtained in a controlled environment and Tnemec Company makes no claim that these tests accurately represent all environments.

T2M59

SERIES 120
Vinester

TNEMEC

PRODUCT PROFILE

GENERIC DESCRIPTION Vinyl Ester

COMMON USAGE Superior protection against organic and inorganic acids and also sour crude at elevated temperatures in insulated tanks. Sprayable lining for tanks and vessels. Provides splash, spillage and fumes protection for structural surfaces and secondary containment. Also frequently used as a topcoat for additional chemical resistance with various epoxy flooring and wall systems.
Note: Contact your Tnemec representative or Tnemec Technical Services with specific chemical exposures.

COLORS 5002 Beige (primer only) and 5001 Gray (finish coat only)
Color change will occur when Series 120 is exposed to sunlight; also, some batch-to-batch color variations can be expected.

FINISH Semi-Gloss

PERFORMANCE CRITERIA Extensive test data available. Contact your Tnemec representative for specific test results.

COATING SYSTEMS

CONCRETE FILLER & SURFACER See: 120-5003 Vinester F & S

SURFACE PREPARATION

STEEL SSPC-SP5 White Metal Blast with a minimum anchor pattern of 3.0 mils. Refer to Tnemec's Application Specification for Series 120 to Steel Substrates for specific requirements.

CONCRETE Allow to cure for 28 days. Brush-off blast. Refer to Tnemec's Application Specification for Series 120 to Concrete Substrates for specific requirements.

ALL SURFACES Must be clean, dry and free of oil, grease and other contaminants.

TECHNICAL DATA

VOLUME SOLIDS Theoretical 92% (mixed). Series 120 Vinester system contains a reactive monomer and some loss will occur during application and cure. Actual solids by volume will vary depending upon temperature and air movement. See Practical Coverage Rates.

RECOMMENDED DFT 12.0 to 18.0 mils (305 to 455 microns) per coat (minimum of one coat 5002 primer and one coat 5001 finish coat).

CURING TIME

	Temperature	*To Handle*	*To Recoat*	*Immersion*
120-5001	75°F (24°C)	4 hours	6 hours min. 72 hours max.	72 hours min.
120-5002	75°F (24°C)	6 hours	6 hours min. 72 hours max.	72 hours min.

Note: Scarification required if maximum recoat time is exceeded.
Curing time varies with air & substrate temperature, air movement, humidity and film thickness.

VOLATILE ORGANIC COMPOUNDS

Unthinned 120-5001	*Unthinned* 120-5002	*Thinned 5%* 120-5001	*Thinned 5%* 120-5002
1.40-1.90 lbs/gallon (175-230 grams/litre)	1.35-1.60 lbs/gallon (160-190 grams/litre)	1.70-2.20 lbs/gallon (200-250 grams/litre)	1.60-1.90 lbs/gallon (190-220 grams/litre)

NUMBER OF COMPONENTS Two: Part A (base) and Part B (catalyst)

PACKAGING 1 gallon (3.79L) kits. 3 gallon (11.4L) kits are available upon special request.

NET WEIGHT PER GALLON 120-5001: 10.91 ± 0.25 lbs (4.95 ± .11 kg) (mixed)
120-5002: 10.60 ± 0.25 lbs (4.81 ± .11 kg) (mixed)

STORAGE TEMPERATURE Minimum 35°F (2°C) Maximum 90°F (32°C)

SHELF LIFE Part A: 3 months at 35°F to 49°F (2°C to 9°C), 2 months at 50°F to 79°F (10°C to 26°C), 1 month at 80°F to 90°F (27°C to 32°C). Do not store at temperatures below 35°F (2°C) or above 90°F (32°C). DUE TO THE REACTIVE NATURE OF VINYL ESTER RESINS AND THE CORRESPONDING LIMITED SHELF LIFE, EXPEDITIOUS USE OF THIS PRODUCT IS RECOMMENDED. SINCE JOBSITE STORAGE CONDITIONS ARE BEYOND OUR CONTROL, THIS PRODUCT IS NON-RETURNABLE.
Part B: 12 months at recommended storage temperature.

TECHNICAL DATA (cont'd)

FLASH POINT - SETA Part A: 90°F (32°C) Part B: 190°F (88°C)

HEALTH & SAFETY Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product. **Keep out of the reach of children.**

APPLICATION

PRACTICAL COVERAGE RATES

Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m^2/Gal)
12.0-18.0 (305-455)	20.0-25.0 (510-625)	60-80 (5.6-7.4)

Practical spreading rates are based on typical field applications. Actual spreading rates will vary with surface profile, amount of overspray and surface irregularities.

Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance. THIS PRODUCT SHOULD NOT BE APPLIED BELOW 60°F (16°C) MATERIAL TEMPERATURE.

MIXING Power mix contents of Part A (base) thoroughly, making sure no pigment remains on the bottom of the can. Add the Part B (catalyst) slowly to the Part A while under agitation. Continue to agitate until thoroughly mixed. Care should be exercised so as not to entrap air in the mixed material. Do not use mixed material beyond pot life limits.

POT LIFE 3 to 4 hours at 65°F (18°C) 1-1/2 to 2-1/2 hours at 75°F (24°C)*
*At higher temperatures pot life will decrease (use caution in spray equipment). In hot weather, material should be cooled to 65°F to 80°F (18°C to 27°C) prior to mixing and application to improve workability and avoid shortened pot life.

THINNING Use No. 19 Thinner. For air or airless spray, thin up to 5% or ¼ pint (190 mL) per gallon if needed for good atomization.

SURFACE TEMPERATURE Minimum 60°F (16°C) Maximum 110°F (43°C) The surface should be dry and at least 5°F (3°C) above the dew point. At surface and ambient temperatures below 60°F (16°C), Series 120 will not cure properly or obtain maximum chemical resistance. Following application, the surface temperature must be held at or above 60°F (16°C) until the coating surface is tack free (approximately 8 hours at 60°F (16°C) surface temperature, 6 hours at 70°F (21°C) surface temperature, 4 hours at 80°F (27°C) surface temperature) to avoid incomplete polymerization.

At relative humidities above 75%, the cure of this coating may be retarded. It is also recommended that all precautions be taken to insure that adequate forced-air ventilation exists.

APPLICATION EQUIPMENT

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
Binks No. 18 or 62	66	63 PB	5/16" or 3/8" (7.9 mm or 9.5 mm)	3/8" or 1/2" (9.5 mm or 12.7 mm)	60-80 psi (4.2-5.5 bar)	10-20 psi (0.7-1.4 bar)

Low temperatures or longer hoses require higher pot pressure.

Airless Spray

Tip Orifice	Atomizing Pressure	Mat'l Hose ID	Manifold Filter
0.015"-0.021" (380-535 microns)	2400-3000 psi (165-207 bar)	1/4" or 3/8" (6.4 mm or 9.5 mm)	60 mesh (250 microns)

Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.

Brush: Recommended for small areas only. Use high quality natural or synthetic bristle brushes.
Note: Two or more coats may be required to obtain recommended film thicknesses.

CLEANUP Flush and clean all equipment immediately after use with the recommended thinner or MEK. If material begins to exotherm, flush equipment immediately.

ATTACHMENT D-2-4-4

APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 900

Revision No.
5.0

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 900

TANKS T-901 THROUGH T-904

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LIST OF EXHIBITS

LIST OF REFERENCED DRAWINGS

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 900

TANKS T-901 THROUGH T-904

I. Introduction

This document provides the assessment and certification for the design of the hazardous waste storage tank system(s) at Tank Management Unit 900 at the Chemical Waste Management, Inc. Facility in Emelle, Sumter County, Alabama. The assessment was performed to address the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), regarding the design of the system within Tank Management Unit 900 which is comprised of the tanks (i.e., Tanks T-901 through T-904), the tank foundation, the associated ancillary equipment and the secondary containment system.

Tank Management Unit 900 is located east of Unit 707/708 and south of Unit 1300 as shown on Drawing No. 0100-020-001 in Appendix D-1 to Section D of the RCRA Part B Permit Application. The management of hazardous waste in tanks in Unit 900 is performed in two (2) aboveground Tanks (T-901 and T-902) and two (2) in-ground Tanks (T-903 and T-904). T-901 and T-902 are used to store the recovered washwaters collected in Tanks T-903 and T-904 located in the automatic wheel wash and manual equipment wash bays, respectively.

The following drawings were used in the preparation of this Assessment and Certification and are provided either in Exhibit A (Tank Data Sheets) or in Appendix D-1 to Section D of the RCRA Part B Permit Application:

Drawing No.	Drawing Title
0900-010-001	Wheel Wash & Tank Storage Unit 900 - P&ID
0900-020-001	Wheel Wash & Tank Storage Unit 900 - Plan View
0900-030-001	Wheel Wash & Tank Storage Unit 900 - Sections
0900-080-001	Tank Data Sheet - T-901
0900-080-002	Tank Data Sheet - T-902
0900-080-003	Tank Data Sheet - T-903
0900-080-004	Tank Data Sheet - T-904

II. Tank Design

Tanks T-901 through T-904 have been designed in accordance with the design codes and standards indicated within the DESIGN DATA section of the Tank Data Sheets (i.e., Drawing Nos. 0900-080-001 through -004) provided in Exhibit A to this tank system design assessment.

The criteria utilized in the assessment of the design of the shell, structural support, and anchorage for Tanks T-901 through T-904 are also provided within the DESIGN DATA section of the Tank Data Sheets, as well as within the tank design calculations provided in Exhibit B to this tank system design assessment.

The calculations provided in Exhibit B to this tank system design assessment demonstrate that the tank shell, structural supports and anchorages are, as designed, adequate to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable, at the design conditions indicated on the tank data sheets.

III. Tank Foundation Design

The designs of the reinforced concrete foundations for Tanks T-901 through T-904 are indicated in Sections 5 & 6 on Drawing No. 0900-030-001 which is provided in Appendix D-1 to Section D of the RCRA Part B Permit Application. The criteria utilized in the assessment of the design of the foundation for Tanks T-901 through T-904 are provided within the tank foundation design calculations provided in Exhibit C to this tank system design assessment.

The tank foundation design calculations provided in Exhibit C demonstrate that the tank foundations are, as designed, adequate to support the load of the full tanks and to withstand associated environmental stresses at the design conditions indicated on the tanks data sheets and provided within foundation design calculations.

IV. Ancillary Equipment Design

All tank system ancillary piping systems shall be designed, installed and tested in accordance with the American Society of Mechanical Engineers (ASME) Standard B31.3, "Chemical Plant and Petroleum Refinery Piping", or an equivalent nationally recognized standard, and in accordance with recognized good engineering practices to ensure that they are supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

All other ancillary equipment for the tank system shall be designed, installed and tested in accordance with appropriate recognized standards, if any, and in accordance with recognized good engineering practices to ensure that it is supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

In order for this tank design assessment and associated certification to be maintained, and prior to the tank system being placed in use, the Facility shall ensure that the tank system ancillary equipment is properly installed and that all required inspections, tests and repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f). Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested.

V. Secondary Containment System Design

V.A. Tanks T-901 and T-902

The design features of the secondary containment system for Tanks T-901 and T-902 within Unit 900 are indicated on Drawing Nos. 0900-020-001 and 0900-030-001 which are located in Appendix D-1 to Section D of the RCRA Part B Permit Application. As shown on these drawings and in accordance with the applicable requirements of 40 CFR 264.193 and ADEM Administrative Code Rule 335-14-5-.10(4), the secondary containment system design is comprised of a reinforced concrete base, with all joints sealed with chemical-resistant waterstops, and all concrete surfaces sealed with chemical-resistant concrete coating system. Information on the concrete coatings available for use on the secondary containment system is provided within Appendix D-1-3 to Section D-1 of the RCRA Part B Permit Application.

Calculations demonstrating that the design secondary containment capacity meets or exceeds the applicable requirements 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e) are provided in Appendix D-2-2 to Section D-2 of the RCRA Part B Permit Application.

V.B. Tanks T-903 and T-904

The design features of the secondary containment system for the Tanks T-903 and T-904 within Unit 900 are indicated on Drawing Nos. 0900-020-001 and 0900-030-001 which are located in Appendix D-1 to Section D of the RCRA Part B Permit Application. As shown on these drawings and in accordance with the applicable requirements of 40 CFR 264.193(e)(3) and ADEM Administrative Code Rule 335-14-5-.10(4)(e)3., the secondary containment system design is equivalent to that for a double-walled tank, with containment by the secondary wall. Each tank is also equipped with a continuous monitoring device to detect a leak from the primary tank into the interstitial space between the tank walls.

Although secondary containment is inherently provided by the double-walled tank design, calculations including the additional containment volume up to the level of the perimeter curb demonstrate that the design secondary containment capacity meets or exceeds the applicable requirements 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e), as provided in Appendix D-2-2 to Section D-2 of the RCRA Part B Permit Application.

VI. Tank Venting Requirements

As indicated on the P&ID for Unit 900 (i.e., Drawing No. 0900-010-001 which is located in Appendix D-1 to Section D of the RCRA Part B Permit Application), Tanks T-901 and T-902 are designed as closed top tanks that passively vent to atmosphere. Tanks T-903 and T-904 are open top tanks and do not require venting. The Tank Data Sheets for Tanks T-901 and T-902 (i.e., Drawing Nos. 0900-080-001 and -002) specify the diameter of the atmospheric vent nozzle on each of the tanks.

The requirements for normal (i.e., liquid displacement and thermal effects) venting capacities for the Unit 900 tanks were evaluated in accordance with American Petroleum Institute Standard 2000, Venting Atmospheric and Low-Pressure Storage Tanks (i.e., API 2000). As shown in the venting calculations provided in Exhibit D to this tank system design assessment, the size of the vent nozzle on each of the tanks is adequate to allow the tank under normal conditions to be maintained within the design limitations for pressure and vacuum as specified on the Tank Data Sheets provided in Exhibit A and within the tank design calculations provided in Exhibit B to this tank system design assessment. The venting calculations provided in Exhibit D to this tank system design assessment also indicate the design maximum tank fill and withdrawal rates which were used in the evaluation of the tank venting requirements.

VII. Hazardous Characteristics of the Waste Managed

In accordance with the requirements of 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., this section presents an evaluation of the compatibility of the wastes managed within the Unit 900 tank system with the materials of construction of Tanks T-901 through T-904 and the ancillary equipment (i.e., pumps and piping) to determine their suitability for service in this unit.

The types of wastes managed within Tanks T-901 through T-904 will primarily be aqueous in nature and are non-hazardous. However, for permitting purposes, CWM assumes that virtually all types of hazardous wastes listed and identified in 40 CFR Part 261 and ADEM Administrative Code Rule 335-14-2, except for ignitable, corrosive and reactive wastes, may be managed in the Unit 900 as indicated in Appendix D-2-1 of this Application. Tanks T-901 through T-904 and the ancillary equipment that contact wastes within this system are primarily constructed of carbon steel with internal corrosion protection for the tanks.

Exhibit E to this tank system design assessment presents information which provides an indication of the relative compatibility of epoxy polyamide coating, such as Carboline 191 or demonstrated equivalent, with a wide variety of chemical compounds and other substances. The table in Exhibit E provides corrosion/compatibility information for Carboline 191 epoxy polyamide coating exposed to pure chemical compounds which, in general, tend to have a more severe corrosive effect than wastes which contain mixtures and complexes of these compounds. Although this table may not provide corrosion data and service recommendations for all of the potential constituents of the wastes or waste mixtures which may be managed within the tank system in Unit 900, the table does demonstrate that Carboline 191 is generally compatible with and, under normal conditions, should not experience an accelerated rate of corrosion or deterioration when exposed to a majority of the types and classes of wastes which are managed within the Unit 900 tank system. In addition to the compatibility/corrosion data provided in Exhibit E, the compatibility of Carboline 191 with the types of wastes managed within Unit 900 is further validated by the empirical data provided by many years of comparable service applications within a variety of units at the Facility.

Based on the information provided in Exhibit E of this tank system design assessment and the empirical data compiled at the Facility for comparable service applications, it is the conclusion of this evaluation that the Carboline 191 coated carbon steel tank system components are generally compatible with the types of waste managed within the Unit 900 tank system. It is further concluded that these materials of construction are suitable for this service if the tank system is operated within the design limitations set forth within this assessment, and that, if the tank system is managed in accordance with the following minimum practices, these materials of construction should not experience an accelerated rate of corrosion or deterioration which may result in a catastrophic failure of the tank system, throughout its useful life:

- Prior to placement of a waste into the tank system the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. References other than Exhibit E of this document, such as other recognized sources of corrosion data, may also be used to evaluate compatibilities. The Facility shall prohibit the placement into the Unit 900 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components; and
- The Facility shall perform an annual inspection of the tank shells to ensure that minimum code thicknesses are maintained, and that adequate corrosion allowance is available for continued service.

VIII. Certification of Tank System Design Assessment

In accordance with the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), this section provides a certification by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), that an assessment of the design of the following tank system(s) demonstrates that the tank system foundation, structural supports, seams, connections, and pressure controls are adequate, and that the tanks have sufficient structural strength, compatibility with the wastes to be managed and/or protection from corrosion so that they will not collapse, rupture or fail, if properly installed, operated within the design limits, and properly inspected and maintained:

Tank System Location:	Chemical Waste Management, Inc. Emelle, Alabama
Tank System Identification:	Tank Management Unit 900
Applicable Tanks:	T-901, T-902, T-903, and T-904

At a minimum, the assessment of the tank system design, which is incorporated herein by reference, addresses and considers the following factors with respect to the intended use of the tank system:

- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank designs have been evaluated for structural integrity with regards to the ability of the designed tank shell, structural supports and anchorages to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tanks have been evaluated with regards to the adequacy of the designed tank to provide the necessary capacity for normal venting;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which piping and other ancillary equipment shall be designed and constructed to maintain this certification;

- In accordance with 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., the assessment of the tank system design considers the compatibility of the tank's materials of construction and/or internal coatings with the types of hazardous wastes to be managed;
- In accordance with the applicable requirements of 40 CFR 264.192(a)(5) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)5., the assessment of the tank system design considers the ability of the designed tank system foundation to support the load of the full tanks and to withstand associated environmental stresses; and
- The assessment of the tank system design considers the adequacy of the capacity of the designed tank secondary containment system as required by the applicable requirements of 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e).

In order for this certification to be maintained, the Facility shall comply with the applicable requirements of 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10, and shall perform all routine management procedures, periodic inspections and reviews, and tank system functionality and integrity tests as required by the permit including, but not limited to, the following:

- The Facility shall ensure that the tank system is properly installed and that, prior to placing the tank system in use, all required inspections, tests and necessary repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f);
- Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested;
- Prior to placement of a waste into the tank system, the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the Unit 900 tank system any waste that may exhibit excessive corrosion or degradation to the

material of construction of the tank system components, including hazardous wastes that exhibit the characteristic of corrosivity as defined in 40 CFR 261.22 and ADEM Administrative Code Rule 335-14-2-.03(3);

- Prior to placement of a waste into the tank system, the Facility shall verify the specific gravity of the waste in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the tank system of any waste that has a specific gravity that exceeds the design maximum value specified within the tank system design assessment;
- Prior to placement of a waste into the tank system, the Facility shall verify in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application that the treatment of the waste will not cause temperatures within the tank system to exceed the design maximum value specified within the tank system design assessment;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank exterior to detect excessive corrosion or deterioration;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank secondary containment system to detect leakable cracks or gaps, or excessive deterioration of the concrete base and/or chemical-resistant concrete coatings;
- The Facility shall perform an annual inspection of the tank shells, as described in Subsection F-2-6 of Section F-2 of the RCRA Part B Permit Application, to ensure that minimum code thicknesses are maintained, and that adequate corrosion allowance is available for continued service;
- The Facility shall perform an annual inspection of the tank structural supports and anchorages to ensure that their integrity is maintained;
- The Facility shall perform a periodic inspection of the tank venting devices to ensure that they are in good working order to maintain the tanks within the design limits for pressure as specified within the tank system design assessment;
- The Facility shall perform a periodic inspection of the tank level sensing, overfill control devices and associated interlocks to ensure that they are in good working order with the appropriate settings to prevent overfilling of the tanks. The frequencies and procedures for inspection of all tank level sensing and overfill control devices shall be as recommended by the manufacturer;
- The Facility shall perform a periodic inspection of any other operational controls for the tank system to ensure that they are in good working order with the appropriate settings to maintain the tanks within their design limits as specified within the tank

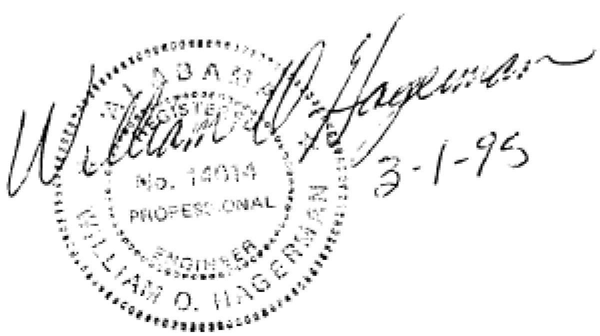
system design assessment. The frequencies and procedures for inspection of other tank system operational controls shall be as recommended by the manufacturer; and

- The Facility shall perform periodic inspections of the integrity of any tank system grounding and lightning protection systems.

Based on the information provided within the tank system design assessment and supporting documentation, the designs of Tanks T-901 through T-904 within Tank Management Unit 900 meet the current RCRA requirements relative to the design of new hazardous waste tank systems. The design assessment addresses only the applicable requirements of 40 CFR 264.192 and 40 CFR 264.193, and ADEM Administrative Code Rules 335-14-5-.10(3) and (4), and does not consider compliance with other codes or regulations, including, but not limited to, the requirements of the Occupational Safety and Health Act (OSHA).

With regards to the assessment and certification of the design of hazardous waste tank systems in accordance with the applicable requirements of 40 CFR 264.192(a) and (g), and ADEM Administrative Code Rules 335-14-5-.10(3)(a) and (g), I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

William O. Hagerman, P.E.
Alabama P.E. No.: 14014
President
ETI Corporation
6799 Great Oaks Road, Suite 100
Memphis, Tennessee 38138-2500



This certification was originally submitted in 1995. As part of the 2002 Part B Application Renewal, revisions were made to the text in this attachment. These revisions consisted primarily of renaming the section for the Waste Analysis Plan to Section C to maintain consistency with the other Sections contained within this Part B Permit Application. No revisions were made to this attachment during this Part B Permit Application renewal process (Revision 5.0).

With regards to the revisions noted above, I certify under penalty of law that these modifications were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Michael T. Feeney, P.E.
Alabama P.E. No.: 15895
Jacobs Engineering Group Inc.
Ten 10th Street NW
Atlanta, Georgia 30309

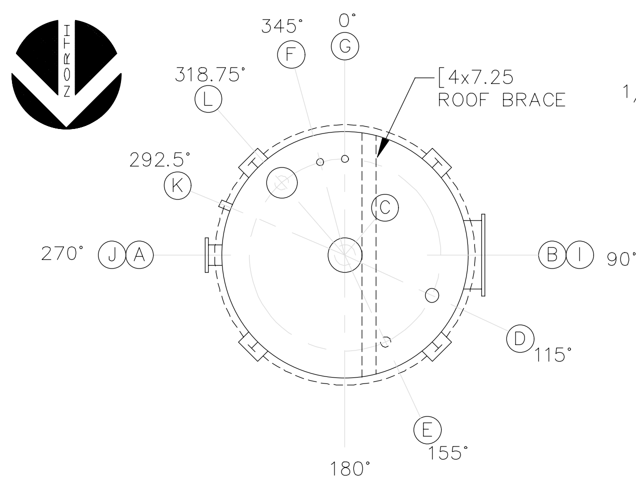
ALABAMA REGISTERED No. 15895 PROFESSIONAL ENGINEER M. T. FEENEY

8-29-22

[End of Attachment D-2-4-4 Text]

EXHIBIT A

TANK DATA SHEETS



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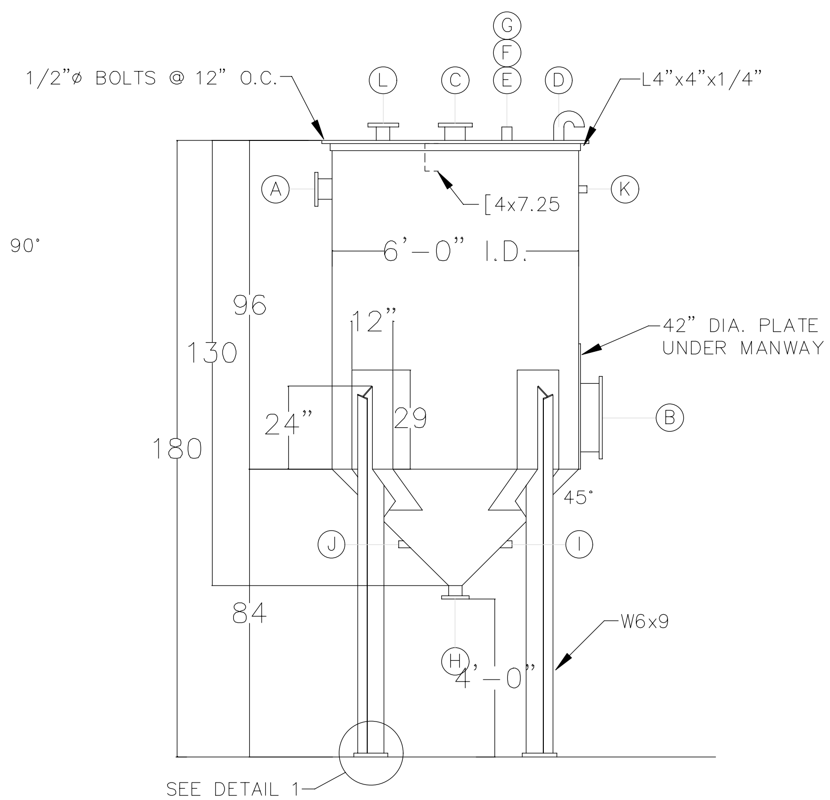

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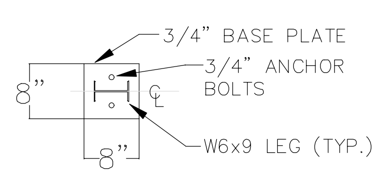


BASE PLATE
DETAIL 1
N.T.S.

1,903 gal.
ATM / ATM
0°F 150°F
WASH WATER
1.10 12"
250 gpm 250 gpm
API 620 0.70
NA
ZONE 1 / SBC
6'-0" 10'-10"

1/4"	CS	1/16"	VERTICAL	8'-0"
1/4"	CS	1/16"	CONICAL	2'-10"
3/16"	CS	0"	FLAT	NA

A	INLET	6"	150# RF	270° SIDE	
B	MANWAY	20"	MFG. STD.	90° SIDE H15"	
C	LEVEL INDICATOR	6"	150# RF	TOP CENTER	
D	VENT	4"	SCH. 40	TOP 115°	GOOSENECK
E	INLET	3"	CPLG.	TOP 155°	
F	SPARE	2"	CPLG.	TOP 345°	w/ PLUG
G	INLET	2"	CPLG.	TOP 0°	
H	OUTLET	4"	150# RF	BOTTOM CENTER	
I	SAMPLE	2"	CPLG.	CONE 90°	
J	LOW LEVEL	2"	CPLG.	CONE 270°	
K	HIGH LEVEL	2"	CPLG.	SIDE 292.5°	
L	INLET	4"	150# RF	TOP 318.75°	

COATINGS:

INTERIOR: CARBOLINE 191 EPOXY POLYAMIDE, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: CARBOLINE 191 EPOXY POLYAMIDE, OR DEMONSTRATED EQUIVALENT.

NOTES:

1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702

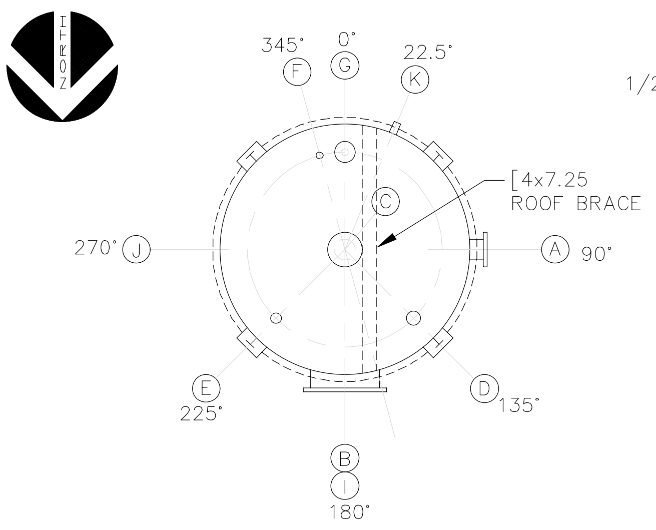
DATE: AUGUST 2022

DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE

TANK DATA SHEET - T-901

SHEET 0900-080-001



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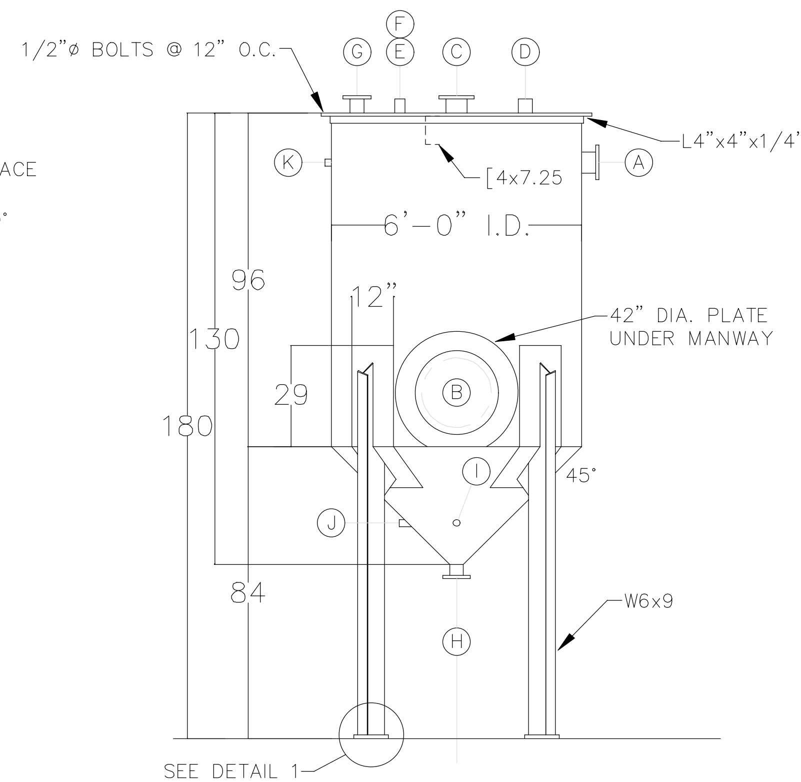

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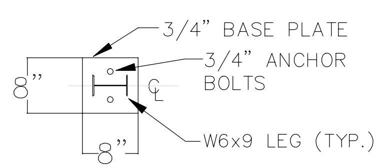

BASE PLATE
DETAIL 1
N.T.S.

1,903 gal.
ATM / ATM
0°F 150°F
WASH WATER
1.10 12"
250 gpm 250 gpm
API 620 0.70
NA
ZONE 1 / SBC
6'-0" 10'-10"

1/4" CS 1/16" VERTICAL 8'-0"
1/4" CS 1/16" CONICAL 2'-10"
3/16" CS 0" FLAT NA

A	OVERFLOW	6"	150# RF	90° SIDE	
B	MANWAY	20"	MFG. STD.	180° SIDE H15"	
C	LEVEL INDICATOR	6"	150# RF	TOP CENTER	
D	VENT	4"	SCH. 40	TOP 135°	GOOSENECK
E	INLET	3"	CPLG.	TOP 255°	
F	SPARE	2"	CPLG.	TOP 345°	w/ PLUG
G	INLET	2"	150# RF	TOP 0°	
H	OUTLET	4"	150# RF	BOTTOM CENTER	
I	SAMPLE	2"	CPLG.	CONE 180°	
J	LOW LEVEL	2"	CPLG.	CONE 270°	
K	HIGH LEVEL	2"	CPLG.	SIDE 292.5°	

COATINGS:

INTERIOR: CARBOLINE 191 EPOXY POLYAMIDE, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: CARBOLINE 191 EPOXY POLYAMIDE, OR DEMONSTRATED EQUIVALENT.

NOTES:

1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

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WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

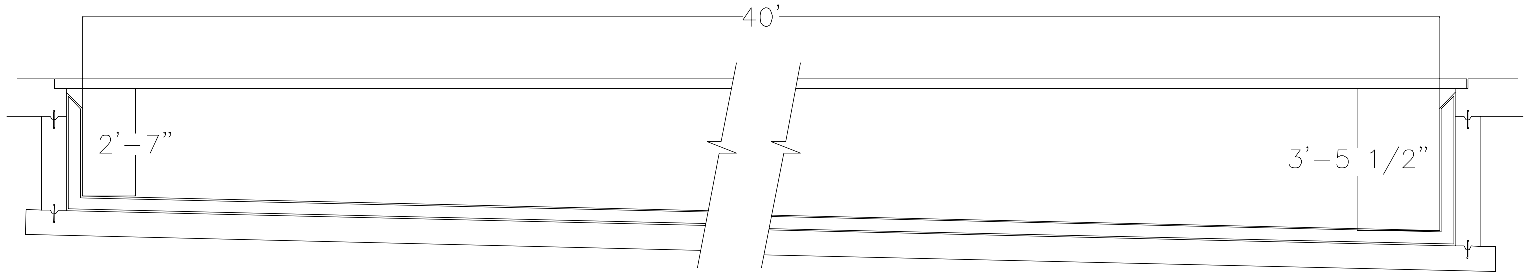
REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF DESIGNER: RAK CHECKER: SBT

SHEET TITLE
TANK DATA SHEET - T-902

SHEET 0900-080-002



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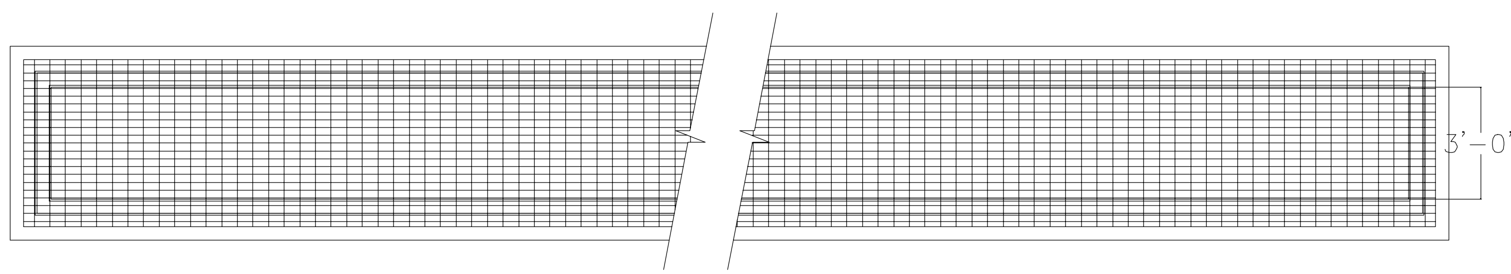
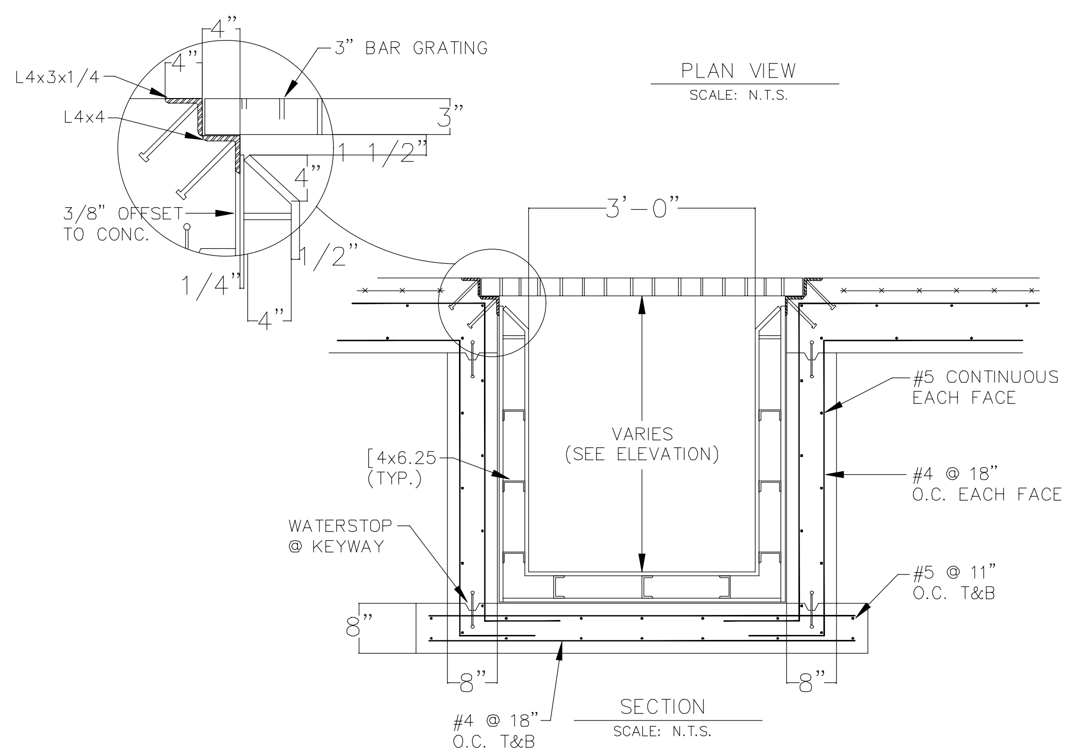


PLAN VIEW
SCALE: N.T.S.



SECTION
SCALE: N.T.S.

3,104 gal.
ATM / ATM
0°F 150°F
WASH WATER
1.10 NA
500 gpm 500 gpm
ACI/AISC 0.70
NA
NA
3'-0"W x 40'-0"L 2'-7" TO 3'-5 1/2"

1/2"	CS	1/8"	HORIZONTAL	16'-0"
1/2"	CS	1/8"	FLAT	2'-7"
–	–	–	–	–

COATINGS:

INTERIOR:	CARBOLINE 191 EPOXY POLYAMIDE, OR DEMONSTRATED EQUIVALENT.
EXTERIOR:	NOT APPLICABLE

Jacobs

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WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION
CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

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THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

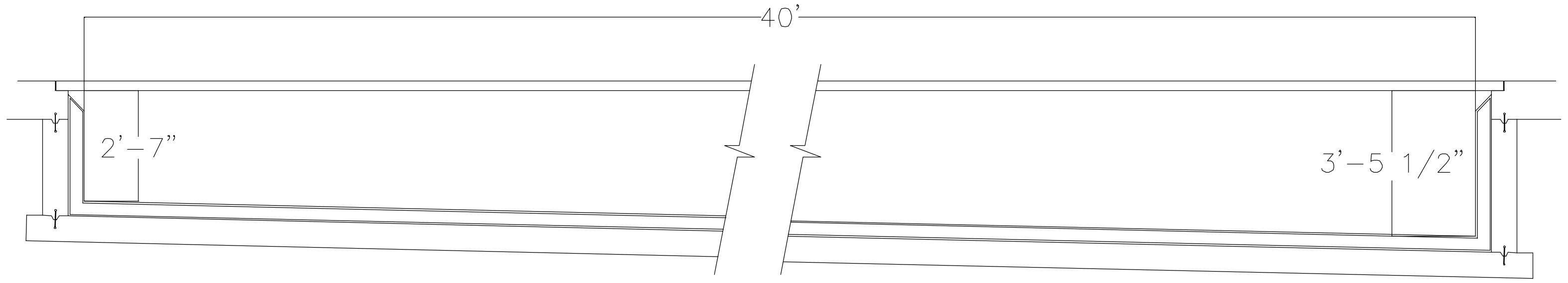
SHEET TITLE
TANK DATA SHEET - T-903

SHEET 0900-080-003

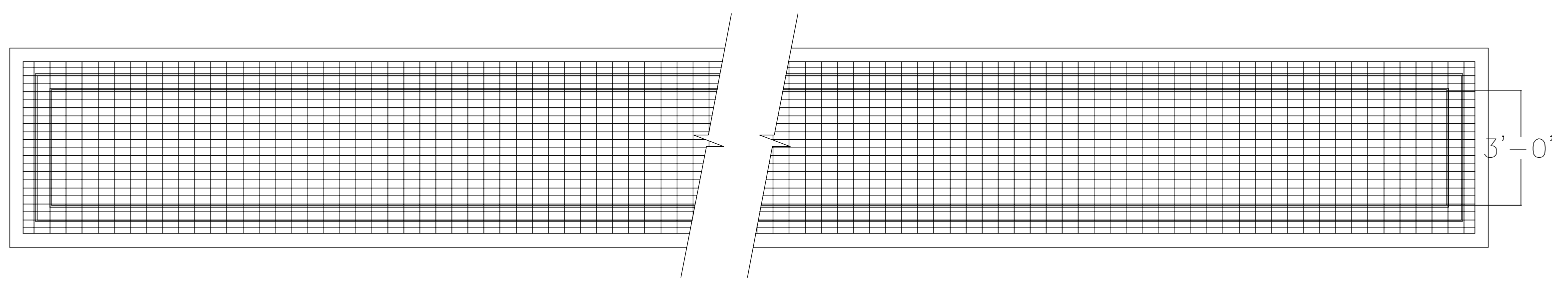
CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

3,104 gal.
ATM / ATM
0°F 150°F
WASH WATER
1.10 NA
500 gpm 500 gpm
ACI/AISC 0.70
NA
NA
3'-0"W x 40'-0"L 2'-7" TO 3'-5 1/2"

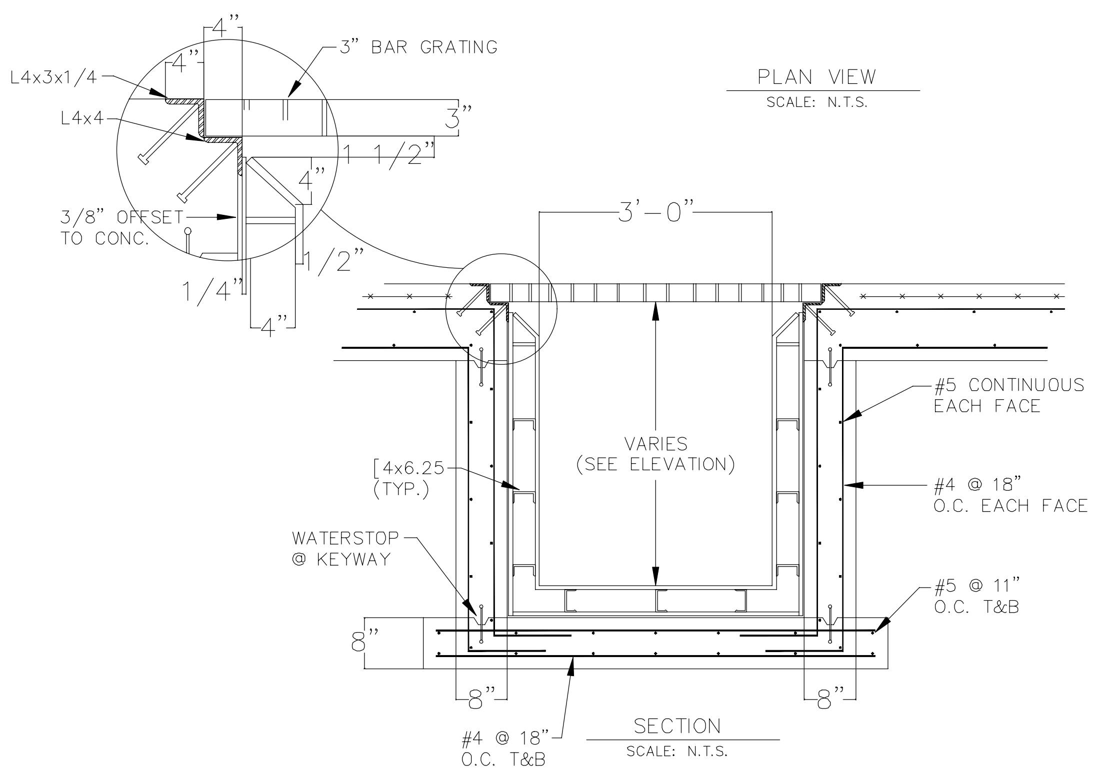
1/2"	CS	1/8"	HORIZONTAL	16'-0"
1/2"	CS	1/8"	FLAT	2'-7"
–	–	–	–	–



ELEVATION
SCALE: N.T.S.



PLAN VIEW
SCALE: N.T.S.



SECTION
SCALE: N.T.S.

COATINGS:

INTERIOR:	CARBOLINE 191 EPOXY POLYAMIDE, OR DEMONSTRATED EQUIVALENT.
EXTERIOR:	NOT APPLICABLE

Jacobs
10 Tenth Street Suite 1400 Atlanta, GA 30309 404.978.7600

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION
CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE
THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.
PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT
SHEET TITLE
TANK DATA SHEET - T-904
SHEET 0900-080-004

CREATED: 10/18/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

EXHIBIT B

TANK DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 900

TANK NO.: T-901 & T-902

DECRIPTION: 6' Ø x 8' CS TANK w/ CONE BOT

VESSEL CALCULATIONS

PREPARED BY: LANZ DATE: 9/29/94

REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
LARRY J. LANZ
49615
REGISTERED
PROFESSIONAL ENGINEER

OCT 3 1994

UNIT 900

DESIGN CALCULATIONS

DESIGN DATA SHEET T-901, T-902 Page 1 of 7

Service: Recycle Wash Water

6 ft. Diameter by 8 ft Shell, Flat Top, Conical Bottom, Legs

Chemical Waste Management, Emelle, AL Job No. 44228.00

Design Code	API-620/UL-142**
Service Status	Existing
Diameter/Length	6' - 0"
Shell/Heigth	8' - 0"
Bottom/Width	
Heads/Ends Top	Flat
Bottom	Conical
Legs	YES 4
Operating Capacity	1.903 Gal
Material of Construction	Carbon Steel
Corrosion Allownce	1/16 inch
Joint Efficiency	0.70
Design Spec. Grav.	1.10
Design Pressure	Atmospheric
Design Temperature	150 deg F. Max 0 deg Min
Roof Live Load psf	40 psf
Wind Load	NA
Seismic Zone	Zone 1
Agitator	NO
Location	Indoors

** NOTE: The design codes referenced for these tanks included UL - 142. This code was not used to design these tanks..

ROSSER
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ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO. SHEET OF

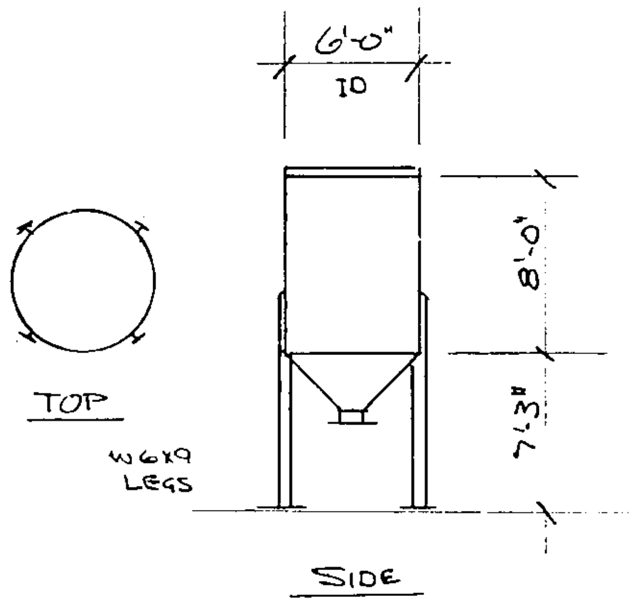
DESIGNED LANZ / / CHECKED [signature] 11/29/94

TANK DESIGN

Diameter	6′ - 0″	6.00
Shell Ln	8′ - 0″	8.00

Flat Top w/ Agitator
Conical Bottom w/Legs

Opr. Cap.	1903	
S. G.	1.10	
Cone ht	2.83	
Bot Noz.	0.33	
Agg Wt	None	pounds
Agg Mom	None	in lbs
Aff Tor	None	in lbs
Corr All	0.063	inches
Live Ld	40	pounds



Weight of Contents

Shell Volume	= Pi*R*R*H=	226.19	cubic feet
Cone Volume	= 0.2618*h*(D*D+D*d+d*d)	28.26	cubic feet
Volume of Vessel	= Shell + Cone =	254	cubic feet

Operating Weight for Vessel (less Vessel weight)

Weight = Gallons * 8.34 * Spec Grv = 17458

DESIGN CALCULATIONS

Internal Pressures

Pressure = Internal Pressure + Depth*0.433*Spec Grav

@ Top of Shell
p = 0.0 *.433*1.1 0.00 psi

@ Base of Shell
p = 8*.433*1.1 = 3.81 psi

@ Base of Cone
p = (8+2.83)*0.433*1.1 = 5.16 psi

External Pressure 0.00 psi 0 psf

VESSEL DESIGN

Material: This vessel is constructed of A 36 Carbon Steel.
Corrosion allowance is 1/16 inch

Reinforced Roof

Check stress and deflection of roof plate

Live load
Roof load + vacuum = 40 psf = 0.28 psi

Dead Load
Use 3/16 " plate for new condition = 7.65 0.053
Use 1/8 " plate for corroded cond = 5.10 0.035

Use Roark, 6th Ed, Case 27, p 437

		Beta =	0.522	
sigma r =Beta*q*a*a/t/t =	14327 psi	Beta 1 =	0.312	
sigma t =Beta1*q*a*a/t/t =	8563 psi	Alpha =	0.087	
defl = Alpha*q*a*a*a*a/E/t/t/t =	0.0229 inches		a =	36.00
			t =	0.125

USE 3/16 INCH PLATE FOR TOP

Beam Design

Assume load on the beam
Total Live Load = Pi*R*R*(0.28) = 1347 pounds
Pounds per foot = Load/Diameter = 225 pounds per foot
Weight of agitator = No agitator 0 pounds per beam
Bending Moment = 0 inch pounds
Torque = 0 inch pounds

Rl = 1/d*(W*R+B+w*D*R)= 674 pounds
Rr = 1/d*(W*R-B+w*D*R)= 674 pounds
Mctr = Rl*r-w*R*R/2 = 12125 inch pounds

Req S =Moment/All Str = 12125/18000 = 0.67 inches cubed
S of C 4 x 7.25 = 2.29 in3
USE A C 4x 7.25 CHANNEL 7.25 pounds/foot
Deflection OK by inspection

Use a 4" x 4" x 1/4" Roof to Shell Angle

Roof Load
Load =Area(DL+LL+P)+C's+Agg = Pi*R*R(40+7.65)+1*6*7.5 =
1391 1391 pounds

Shell Design

The force per lineal inch at the base of the shell is (Eq 11, p 3-13)

T2 =P*Rc = 3.81*36 137.2 pounds per inch

The shell thickness requred is (Eq 16, p 3-14)

t = T2/Sts/E + C = 0.012 + 1/16 = 0.075 inches
Min Thick = 3/16 +CA (3.10.4.1)
USE 0.250 INCH PLATE

Sts = Allow Stress
E is Joint Efficiency
C is Corrosion Allowance

ASME SEC VIII, Div 1, UG-28 (CALCULATION NOT REQUIRED)
The allowable external pressure (internal vacuum) allowable is determined by the expression

Pa = 4*B/3/(Do/t) = 7.49 psi

where
Pa is Allowable Pressure
B is 1094
Do is 36.50 inches
t is 3/16 inch 0.188

THE VESSEL WILL WITHSTAND
1/2 PSI EXTERNAL PRESSURE

Cone Design
Use Eq 16, p 3-14
where
T2 = P*R/cosa = 194.0 lb/in
T1 = R/2/Cosa*(P+(W+F)/At)
= 109.1 pounds/inch

E = joint eff. = 0.70
alpha( )= 0.7854 radians
At = Pi*R*R = 4072
W is Wt of Cone Contents
Cone Wt= 305 pounds

t = T2/Sts/E +ca = 0.017 + 1/16 = 0.080 inches

USE 0.250 INCH PLATE FOR CONE

Compression Ring
Use Eq 26, p 3-19

where
wh =.6*Sqrt(R2*t)= 1.85
wc =.6*Sqrt(R2*t)= 1.56

Q = T2*wh+T2s*wc-T1*Rc*Sina

Q = -2524

Area required for compression region is

A = Q/15000 = 0.168 square inches

Participating area = t*wh+t*wc = 0.640 square inches
0.640 > 0.218 square inches

COMPRESSION RING NOT REQUIRED

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Weight of Shell and Cone

Wt(shell) = Pi*D*H*8 =	1154 pounds		
Wt(cone) = A*Wt/sqft = 1.5708*c*(D+d) =	305 pounds		
Corr Wt (shell) = 2/3 Wt Shell =	769	pounds	1/3 of vessel
Corr Wt of Cone = 2/3 Wt Cone	203		corroded

Column Support

		Corr	New
Roof			
Top Angle = Wt/ft x Length =		137	137
Beams = Wt/ft x length =		48	48
Plate = Pi*R*R*10.2 =		174	262
Nozzles (estimated)		40	50
Agitator 1100 + 100		0	0
Total Weight of Roof		399	496
Shell			
Shell empty =		769	1154
Cone			
Weight=Area*15.3 =		203	305
Nozzels (estimated)		20	27
Total Weight of Cone		223	332
Legs			
4 legs at 8.50 lb/ft-len	7.00	238	238
4 Base Plates @ 30.60		122	122
Total Weight of Legs		360	360
TOTAL DEAD LOAD		1752	2342
Live Load			
Roof = Area*LL =PI*Ro*Ro*40 =		1368	1368
Vessel Content =		17458	17458
TOTAL LIVE LOAD		18827	18827
TOTAL LIVE AND DEAD LOAD		20579	21169

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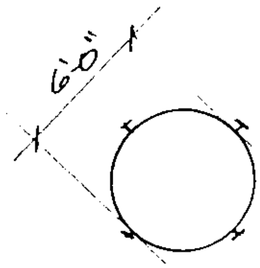
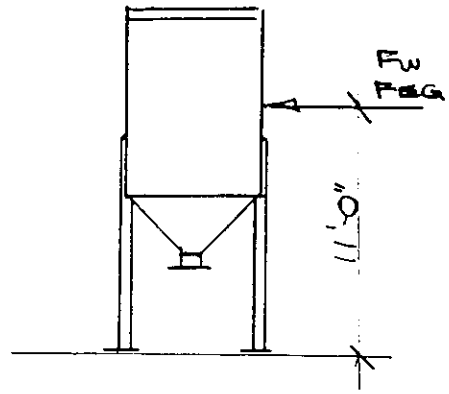
Wind Load (CS.B.C. 1994)(ASCE 7-88)
Wind speed: 0 mph (Tank Inside a Building)
Exposure: C
Exposure Coeff: (eZ=30.0'): K2=0.98
Gust Factor: (eZ=30.0'): Gh=1.26
Shape Coeff: Cf=0.8
Importance Factor: I=1.0

A = D*H*(D=d)/2*h= 57.0
Mom Arm = 11.00
q2 = 0.00256*K2*I*I*V*V =
0.0
Fw = q2*Gh*Cf*A

Fw = 0 pounds



TOP



SIDE

Earthquake Load (CS.B.C. 1994)

Feq = Av*Cc*P*Ac*Wt
Av = 0.06 (Fig 1607.1.5A) p 395
Cl = 2.0 (Table 1607.6.4A) p 429 (Gen Equip)
P = 0.5 (Table 1607.6.4A) p 429 (Gen Equip)
Ac = 1.0 (Table 1607.6.4B) p 430 (Fixed)
Wt = We + Wc = 21169 pounds
Feq = 0.06*2*0.5*1*Weight(DL+Fluid) = 1270 pounds

Wind Load Uplift and Download

Total Load per leg = 5292 pounds
Dead Load per Leg = 586
Mom@base=Fw*Mom Arm = 0 ft-lb

Ul&Dl = Mon/Len = 0 pounds
Corr Dead Load per Leg = 438 pounds

Uplift = Wind Ld-Dead Ld = -438 pounds

NO UPLIFT ANCHOR BOLTS NOT REQUIRED FOR WIND LOADING

Earthquake Loading
Col Load= Feq*Mom Arm/Leg Dia =
= 1270*11.0/6.0 = 2329 pounds

per API 620 3.5.6 Max allow stress = 133% of design stress
Percent = (Load + Col Load)/Load =
= (5307 + 2123)/5307 = 1.44
1.44 > 1.33 Feq Force Controls

Select w 6x 9 Beam K*l/r = 2*6*12/1.03 = 140

Stress Reduction = (1+K*K*l*l/r/r/1800) = 2.086

Allowable Stress =18000/2.086 = 8629 psi

Bending Moment at Base = Feq*Leg ht/Nmbr = 26673 in-lb
Stress = P/A+M/S = (LL +DL)/Nmbr/Area + Moment/Sec Mod =
Sec Mod = 3.34 11046 psi
11046 < 11477 8629 x 1.33
Stress level is OK

Base Plate

P = TotL/Leg + FeqL/Leg = 7621 pounds
fp = P/8.5/8.5 = 7621 *8.5*8.5= 105 psi Say m= 1
tp=SQRF(6/36000* 105.478) = 0.13 inch 3/4 inch Plate OK

Support Details

t/R = 0.188 dividd by 36.00 = 0.0052
Allowable Stress = 8629 psi
Pipe Dia*Plate t*All Stress 9708 psi
> 14905 no need for a col. plate

ROSSER ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJ. NO.	SHEET	OF
	DESIGNED LANZ / /	CHECKED	11 / 29 / 94

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 900

TANK NO.: T-903 & T-904

DECRIPTION: 3' x 40' x 3½' DEEP SUMP

VESSEL CALCULATIONS

PREPARED BY: LANZ DATE: 9/27/94

REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
LARRY J. LANZ
49515
REGISTERED PROFESSIONAL ENGINEER

OCT 3 1994

UNIT 900

DESIGN CALCULATIONS

DESIGN DATA SHEET T-903, T-904 Page 1 of 4

Service: Wheel Wash Unit Sump

3 ft by 40 ft by 3 1/2 ft deep Sump in Wash Unit

Chemical Waste Management, Emelle, AL Job No. 44228.00

Design Code	ACI/AISC
Service Status	Existing
Diameter/Length	40' - 0"
Shell/Heigth	3' - 0"
Bottom/Width	3' - 5 1/2"
Heads/Ends Top	Open
Bottom	
Legs	Inground
Operating Capacity	3,104 Gal
Material of Construction	Carbon Steel
Corrosion Allownce	1/8 inch
Joint Efficiency	0.70
Design Spec. Grav	1.10
Design Pressure	Atmospheric
Design Temperature	150 deg F. Max to 0 deg F. Min
Roof Live Load psf	NA
Wind Load	NA
Seismic Zone	Zone 1
Agitator	NO
Location	Inground

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PROJ. NO. SHEET OF

DESIGNED LANZ / / CHECKED [initials] 11/29/94

UNIT 900 TANKS T-903 & T-904

THESE TANKS ARE LINERS FOR CAST-IN-PLACE CONCRETE SUMPS. AND ARE USE AS THE INSIDE FORM. INTERIOR DIMENSIONS ARE 40'-0' LONG, 3' WIDE AND DEPTH FROM 2'-7" TO 3'-6". THE TANK WILL BE SET 3'-5" TO 4'-4' BELOW FINISED GRADE

WT OF TANK LINER

INNER WALL (1/2")

$A = 2.71 \cdot (2 \cdot 40 + 2 \cdot 3) + 3 \cdot 40$

$A = 353.1$

$WT = 353.1 \cdot 20.4 = 7202^{\#}$

OUTER WALL (1/4")

$A = 3.44 (2 \cdot 40.75 + 2 \cdot 3.71) + 3.79 (40.75)$

$A = 460.5^{\#}$

$WT = 460.5 \cdot 10.2 = 4697^{\#}$

CHANNELS. 4 TOD (C4x7.5)

$LENGTH = 40.75 \cdot 11 + 3.75 \cdot 4 + 2(40.75 + 3.75)$

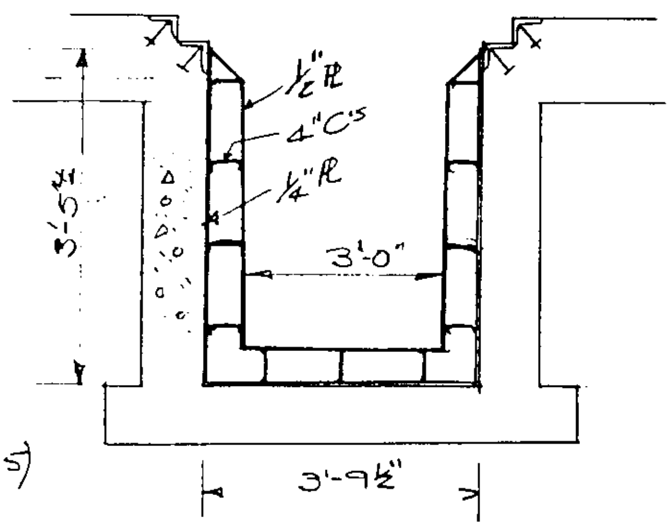
$= 537 LF$

$WT = 537 \cdot 7.5$

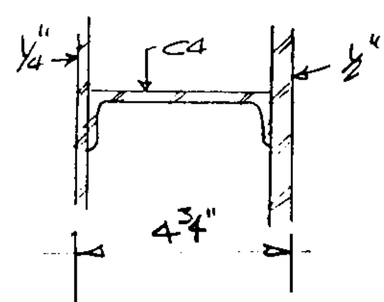
$WT = 4029^{\#}$

WT OF LINER = $15,928^{\#}$

$WT/FT = 15928/40.75 = 390^{\#}/FT$



SECTION @ MIDLENGTH



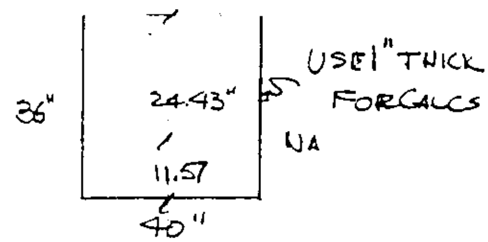
WALL SEC.

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MGT	PROJ. NO. 44228.00	
	UNIT 900 T-903, T-904	SHEET 2 OF 3	
	DESIGNED 4 9/27/94	CHECKED / /	

T-903, T-904

APPROXIMATE MOMENT OF INERTIA

$\bar{x} = \frac{36 \cdot 2 \cdot 18}{36 \cdot 2 + 40 \cdot 1} = 11.57''$



$I = 2 \cdot \frac{36^3}{12} + 2 \cdot 36(18-\bar{x})^2 + 40 \cdot 1(\bar{x})^2$

$= 7776 + 2976 + 5356$

$I = 16,108$

$S = I/12.07 = 1335$

$S = I/24.43 = 659$

MOMENT IN TANK (LIFT @ CG)

$M = WL^2/2$ (EACH END AS CANTILEVER)

$= 390 \cdot (20.5)^2/2$

$= 81948.75$ '#

$M = 983,385$ "#

$STRESS = \frac{M}{S} = \frac{983,385}{659} = 1492$ PSI

LIFTING STRESS IS (AT CG.)
< 1/10 OF ALLOW STRESS

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MGT PROJ. NO. 44228.00 TANK UNIT 900 T-903, T-904 SHEET 3 OF 3 DESIGNED 9/27/94 CHECKED / /

T-903, T-904

MAXIMUM CALCULATED WALL THICKNESS

THE MAXIMUM DEPTH OF LIQUID WILL BE 4'.

$p = 4 \cdot 1.1 \cdot .433 = 1.91$ psi

REFER TO ROARK 6TH ED. TABLE 26 CASE 8a

σ @ FIXED EDGE $= \frac{-\beta_1 q b^2}{t^2}$

where

$\beta_1 = 0.500$

$q = 1.91$ psi

$b = 12"$

$t = 1/8"$

$\sigma = \frac{-.5 \cdot (1.91) \cdot 12^2}{(1/8)^2}$

$\sigma = 8{,}801$ psi

1/8" PLATE CHECKS

MINIMUM THICKNESS IS

$t = \left(\frac{.5 \cdot (1.91) \cdot 12^2}{16{,}000} \right)^{\frac{1}{2}}$

$t = 0.093$ INCHES (3/32" NOM)

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ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT CHEM WASTE MGT		PROJ. NO. 44228.00	
UNIT 900	T-903, T-904	SHEET 3A OF 3	
DESIGNED [signature]	10/19/94	CHECKED / /	

EXHIBIT C

TANK FOUNDATION DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 900

TANK NO.: T-901 & T-902

DECRIPTION: RECYCLE WASH WATER

FOUNDATION CALCULATIONS

PREPARED BY: S. SMITH DATE: 9-9-94

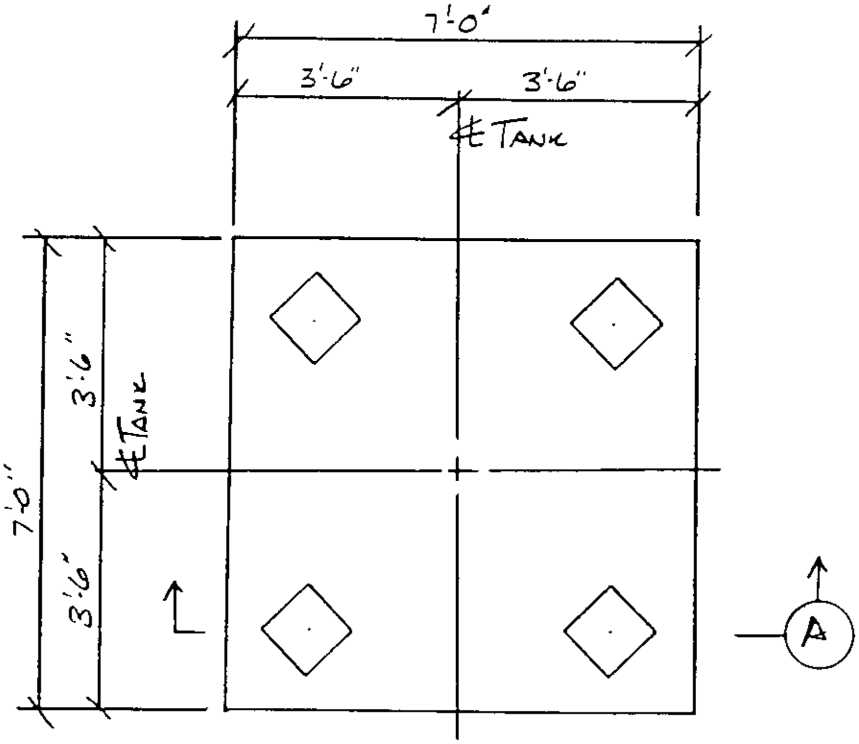
REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

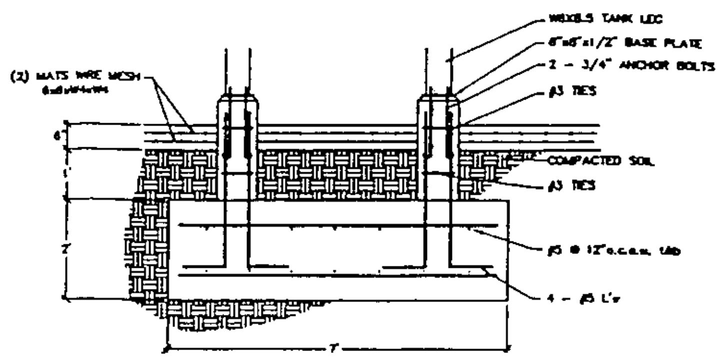
STATE OF TEXAS
SCOTT R. SMITH
60612
REGISTERED
PROFESSIONAL ENGINEER

10-3-94

Foundation For Tank T-901 & T-902



Plan



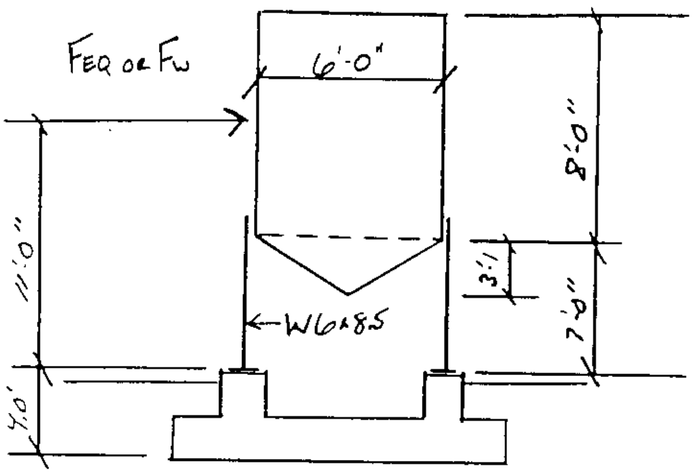
FOUNDATION DETAIL FOR
T-901 & T-902

Section A-A

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER		
	PROJECT Chem Waste Management	PROJ. NO.
	Emelle, Ala	SHEET Sk-1 OF
	DESIGNED S. Smith 9/19/94	CHECKED / /

FOUNDATIONS FOR TANKS T-901 & T-902

REF. TO VESSEL DWG 900-1



WEIGHT OF CONTENTS

TANK CAPACITY = 1,903 GALLONS

SPECIFIC GRAVITY 1.10

$W_C = 1{,}903\text{GAL} \times 1.1 \times 8.34\#/\text{GAL} = 17{,}458\#$

WEIGHT OF TANK (EMPTY)

HEAD: $\frac{\pi(6.0)^2}{4} \times 10.2\#/\text{FT}^2 = 288\#$

SHELL $\pi(6.0)(8.0) \times 10.2\#/\text{FT}^2 = 1{,}538\#$

CONE : SURFACE AREA $\pi r c$

$r = \text{RADIUS} = 3.0' = 36"$

$c = \sqrt{r^2+h^2}$ $h = 3'-1" = 37"$

$c = \sqrt{(36)^2+(37)^2} = 51.62"$

$S = \pi(36)(51.62) = 5{,}838\text{ IN}^2$

$W = 5{,}838\text{ IN}^2 \times 0.070\#/\text{IN}^2 = 413\#$

LEGS: 4 - W6x8.5 x 10' = 340#

NOZZLES (5%) = 0.05[288+1538+413] = 111#

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MANAGEMENT EMELLE ALA	PROJ. NO.
		SHEET 1 OF
	DESIGNED S SMITH 9/9/94	CHECKED / /

FOUNDATIONS FOR TANKS T-901 ; T-902

TOTAL WT OF TANK (EMPTY)

HEAD	288#
SHELL	1,538#
CONE	413#
LEGS	340#
NOZZLES	111#
W_E =	2,690#

WIND LOAD (S.B.C 1994) (ASCE 7-88)

WIND SPEED : 70 MPH
EXPOSURE : C
EXPOSURE COEFF : (@ Z = 30.0') : $K_z = 0.98$
GUST FACTOR : (@ Z = 30.0') : $G_h = 1.26$
SHAPE COEFF $C_f = 0.8$
IMPORTANCE FACTOR : $I = 1.0$

$F_W = q_z\, G_h\, C_f\, A$ $\quad q_z = 0.00256(K_z)(IV)^2 = 0.00256(0.98)(1.0 \times 70)^2 = 12.3$ psf

$A = (6.0' \times 8.0') + [(\frac{8.0+1.0}{2})(3.08)] = 61.86\ FT^2$

$F_W = 12.3\ psf \times 1.26 \times 0.8 \times 61.86\ FT^3 = $ 766#

EARTHQUAKE LOAD (S.B.C. 1994)

$F_{EQ} = A_V \times C_c \times P \times a_c \times W_T$

$A_V = 0.06$ (FIG 1607.1.5A) p 395
$C_c = 2.0$ (TABLE 1607.6.4A) p 429 (GEN EQUIP)
$P = 0.5$ (" " " ")
$a_c = 1.0$ (TABLE 1607.6.4B) p 430 (FIXED)
$W_T = 2,690\# + 17,458\# = 20,148\#$

$F_{EQ} = 0.06 \times 2.0 \times 0.5 \times 1.0 \times 20,148\# = $ 1,208#

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IHT ROSSER

PROJECT CHEM WASTE MANAGEMENT PROJ. NO.
EMELLE, ALA SHEET 2 OF
DESIGNED S. SMITH 9/9/94 CHECKED / /

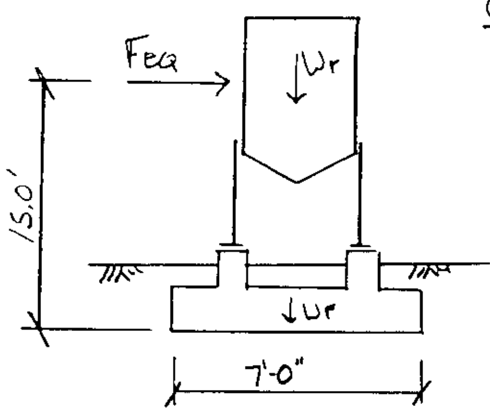
Foundations For Tanks T-901 & T-902

Check Stability

Fdn Dimensions 7'-0" x 7'-0" x 2'-0"

$A = 7.0' \times 7.0' = 49.0 \text{ FT}^2$ $S = \frac{7.0(7.0)^2}{6} = 57.16 \text{ FT}^3$

W_F = Piers $4 \times 1.0' \times 1.0' \times 2.0' \times 150\#/\text{CF}$ = 1,200#
Mat $7.0' \times 7.0' \times 2.0' \times 150\#/\text{CF}$ = 14,700#
Soil $7.0' \times 7.0' \times 1.5 \times 110\#/\text{CF}$ = 8,085#
W_F = 23,985#



Case I (DL+LL+EQ)

W_T = 20,148#
W_F = 23,985#
44,133#

$M_R = 44{,}133\# \times 3.5' = 154{,}465$ FT-lbs

F_{EQ} = 1,208#

$M_O = 1{,}208\# \times 15.0' = 18{,}120$ FT-lbs

$S.R. = \frac{M_R}{M_O} = \frac{154{,}465 \text{ FT-lbs}}{18{,}120 \text{ FT-lbs}} = 8.52 \geq 1.5$

∴ Stability OK

Check Soil Bearing

Allow S.B. = 3,000 psf Temp. S.B = 4,000 psf

Case I (DL+LL+EQ)

$W = 44{,}133\#$
$M = 1{,}208\# \times 15.0' = 18{,}120$ FT-lbs

$S.B. = \frac{P}{A} + \frac{M}{S}$ $\frac{44{,}133\#}{49 \text{ FT}^2} + \frac{18{,}120 \text{ FT-lbs}}{57.16 \text{ FT}^3} =$

SB = 900.6 psf + 317 psf = 1,217 psf ≤ 4,000 psf

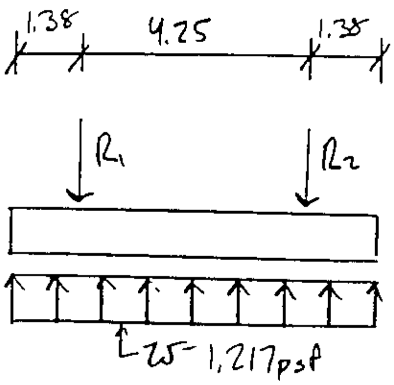
∴ Soil Bearing is OK

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

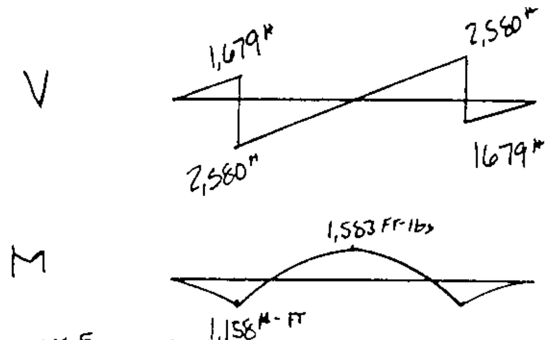
PROJECT	Chem Waste Management	PROJ. NO.	
Emelle, Ala		SHEET 3	OF
DESIGNED	S. Smith 9/9/94	CHECKED	/ /

Foundations for Tanks T-901, T-902

Check Mat Bending



$R_1 = 1{,}217\,psf \times 3.5 = 4{,}260^{\#}$



$M_u = 1.7 \times 1.58^{K\text{-}F} = 2.68^{K\text{-}F}$

$f'_c = 3{,}000\,psi$
$f_y = 60{,}000\,psi$

Try #5 @ 12" E.W. $A_s = 0.31\,in^2$

$\phi M_N = \phi A_s f_y (d - a/2)$ $d = 24 - 3 - 0.625 - 0.625/2 = 20.06\,in$

$a = \dfrac{A_s f_y}{0.85 f'_c b} = \dfrac{0.31(60)}{0.85(3)(12)} = 0.60$

$\phi M_n = 0.9(0.31)(60)(20.06 - 0.60/2) = 330.78^{K\text{-}in} = 27.56^{K\text{-}F}$

$\phi M_n = 27.56^{K\text{-}F} \geq M_u = 2.68^{K\text{-}F}$ ∴ **Bending OK**

Check Beam Shear

$V_u = 1.7 \times 2{,}580^{\#} = 4{,}386^{\#}$

$\phi V_c = 0.85(2)\sqrt{f'_c}\,bd = 0.85(2)\sqrt{3{,}000}\,(12)(20.06) = 22{,}414^{\#}$

$\phi V_c = 22{,}414^{\#} \geq V_u = 4{,}386^{\#}$ ∴ **Beam Shear OK**

Foundations for Tanks T-901 ; T-902

Check Punching Shear

Max Col Load (DL+LL+EQ)

$$P = \frac{20{,}148^{\#}}{4} + \frac{1{,}208^{\#}(11.0')}{6.0'} = 5{,}037^{\#} + 2{,}214^{\#} = 7{,}251^{\#}$$

$$P_u = 1.7 \times 7{,}251^{\#} = 12{,}327^{\#}$$

Pedestal Size 12"x12" ∴ $b_o = [(12"+d)+(12"+d)]$

$$b_o = [(12+20.6)+(12+20.6)] = 65.20^{IN}$$

$$\phi V_c = 0.85(4)\sqrt{f'_c}\, b_o d = 0.85(4)\sqrt{3{,}000}\,(65.2)(20.06) = 243{,}566^{\#}$$

$\phi V_c = 243{,}566^{\#} \geq P_u = 12{,}327^{\#}$ ∴ Punching Shear OK

Design Anchor Bolts

Check For Uplift (DL+LL+EQ)

$W = W_T = 20{,}148^{\#}/4 = 5{,}037^{\#}$ ↓

Uplift: $\frac{1{,}208^{\#}(11.0)}{6} = -2{,}214^{\#}$ ↑

2,822 ↓ ∴ No Uplift

Try 2 - 3/8"ϕ Bolts (A-307)

Shear = 1,208#/2 eff Bolts = 604#/Bolt

$V_{allow} = 4.4^k \geq V_{act} = 0.60^k$ ∴ OK

Use 2 - 3/4"ϕ A.B.

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 900

TANK NO.: T-903 & T-904

DECRIPTION: WHEEL WASH UNIT

FOUNDATION CALCULATIONS

PREPARED BY: S SMITH DATE: 9-15-94

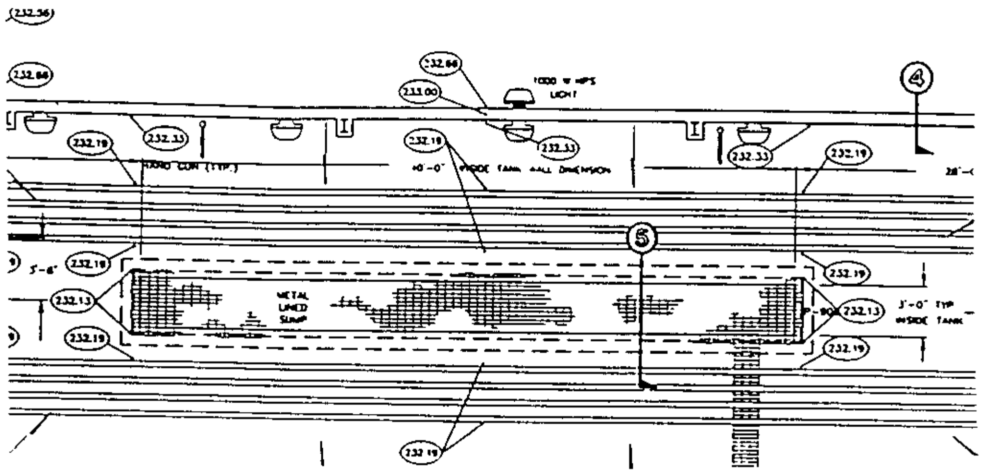
REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

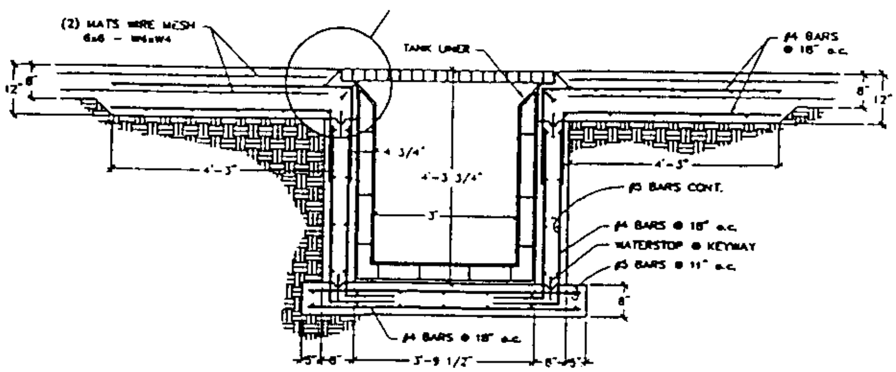
STATE OF TEXAS
SCOTT R. SMITH
60612
REGISTERED PROFESSIONAL ENGINEER

10-3-94

Foundation For Tank T-903 & T-904



Plan

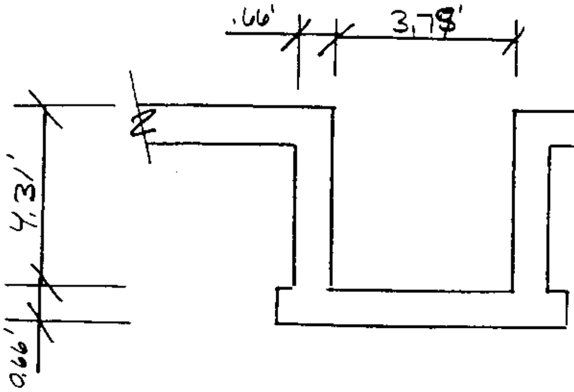


(5) SECTION THRU FLOOR SUMP
REF. DWG. 0900-020-001

$f'_c = 3{,}000\,psi$
$f_y = 60{,}000\,psi$

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT Chem Waste Management	PROJ. NO.	
	Emelle, Ala	SHEET Sk-1	OF
	DESIGNED S. Smith 9/15/94	CHECKED	/ /

FOUNDATIONS FOR TANKS T-903 + T-904



SOIL PROPERTIES

$\gamma_w = 120\,pcf$ $\quad \gamma = 110\,pcf$

$K_o = 0.63$

WATER TABLE @ GRADE

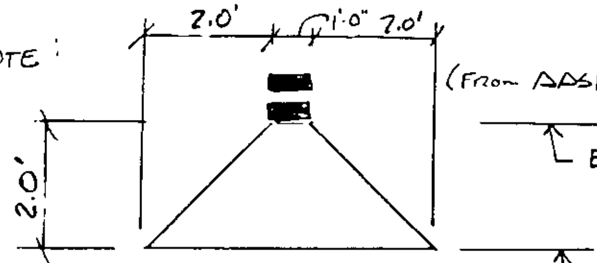
LOADING

HORIZ.

(CONDITION I)

SURCHARGE: HS-20-44 TRUCK WHEEL LOAD

DISTRIBUTE:



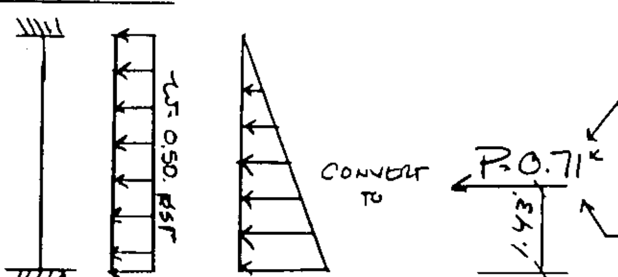
HORIZ. LOAD $\frac{16.0^k}{4 \times 5.0} = 0.80^k \times 0.63 = 0.50\,ksf$

(CONDITION II)

LATERAL EARTH PRESSURE

$w = 4.31' \times 0.120\,kcf \times 0.63 = 0.33\,ksf$

DESIGN WALL AS ONE WAY SLAB



$V_1 = \frac{0.71^k (2.88)^2}{(4.31)^3}(2.88 + 3(1.43))$

$V_1 = 0.52^k$

$M = \frac{0.71^k (2.88)^2 (1.43)}{(4.31)^2} = 0.45^{k\text{-}f}$

$M = \frac{wl^2}{12} = \frac{0.5(4.31)^2}{12} = 0.83^{k\text{-}f}$; $V = \frac{0.50(4.31)}{2} = 1.07^k$

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT CHEM WASTE MANAGEMENT PROJ. NO.

EMELLE, ALA. SHEET 1 OF

DESIGNED S. SMITH 9/15/94 CHECKED / /

FOUNDATIONS FOR TANKS T-903, T-904

WALL DESIGN

CHECK BENDING

$d = 8'' - 2'' - 0.5/2 = 5.75''$

$A_s = \#4 @ 18''$ c/c $A_s = 0.133$

$a = \frac{A_s f_y}{.85 f'_c b} = \frac{0.133(60)}{0.85(3)(12)} = 0.26''$

$\phi M_n = \phi A_s f_y (d - a/2) = 0.9(0.133)(60)(5.75'' - 0.133/2) = 40.81^{K\text{-}IN} = 3.40^{K\text{-}F}$

Total Moment $= 0.83^{K\text{-}F} + 0.45^{K\text{-}F} = 1.28^{K\text{-}F}$

$M_u = 1.4 \times 1.28^{K\text{-}F} = 1.79^{K\text{-}F}$

$\phi M_n = 3.40^{K\text{-}F} \geq M_u = 1.79^{K\text{-}F}$ ∴ BENDING OK

CHECK SHEAR

$V = 0.52^K + 1.07^K = 1.59^K \rightarrow V_u = 1.4 \times 1.59^K = 2.22^K$

$\phi V_c = 0.85(2)(\sqrt{3000})(12)(5.75'') = 6{,}424^{\#} = 6.42^K$

$\phi V_c = 6.42^K \geq V_u = 2.22^K$ ∴ SHEAR OK

SINCE NO LOAD WILL BE ON SUMP:

SOIL BEARING OK

ROSSER

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management PROJ. NO.

Emelle, Ala SHEET OF

DESIGNED S. Smith 9/15/94 CHECKED / /

EXHIBIT D

CALCULATIONS OF TANK VENTING REQUIREMENTS

EXHIBIT D
TANK VENTING CALCULATIONS (PER API 2000)
CHEMICAL WASTE MANAGEMENT, INC., EMELLE, ALABAMA FACILITY

Tank Nos.	Width/ Diameter (ft)	Length/ Shell Height (ft)	Depth/ Cone Height (ft)	Tank Wetted Surf. Area (sf)	Tank Capacity (gal)	Tank Rated Press. (in WG)	Tank Relief Press. (in WG)[1]	Tank Rated Vac. (in WG)	Tank Relief Vac. (in WG)[1]	Fill Rate (gpm)	With-drawal Rate (gpm)	IN-BREATHING Normal Venting (cfh)[2]	IN-BREATHING Thermal Venting (cfh)[3]	IN-BREATHING Total Vent Capacity (cfh)	IN-BREATHING Min. Area (sq in)[8]	IN-BREATHING Min. Size (in)	OUT-BREATHING Normal Venting (cfh)[4]	OUT-BREATHING Thermal Venting (cfh)[5]	OUT-BREATHING Total Vent Capacity (cfh)	OUT-BREATHING Min. Area (sq in)[8]	OUT-BREATHING Min. Size (in)	EMERGENCY Vent Capacity (cfh)[6]	EMERGENCY Min. Area (sq in)[7]	EMERGENCY Min. Size (in)
WHEEL WASH & TANK STORAGE UNIT 900																								
T-901 & T-902	6.00	8.00	3.00	191	1,903	6.00	3.00	3.00	1.50	250	250	2,000	45	2,045	3.95	3.00	2,143	27	2,170	2.97	2.00	NA	NA	NA
T-903 & T-904	3.00	40.00	3.46	NA	3,104	NA	NA	NA	NA	500	500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1. Pressure and vacuum relief is assumed to be set to relieve at 50% of the design rated pressure or vacuum, unless noted. Emergency relief is assumed to be set at 75% of design pressure.
2. Normal in-breathing at 5.6 scfh per 42 gal barrel per hour of withdrawal, as specified in API 2000, 4th Edition.
3. Thermal in-breathing at 1 scfh per 42 gal barrel of tank volume, up to 20,000 barrel (840,000 gal) volume, as in API 2000.
4. Normal out-breathing at 12 scfh per 42 gal barrel per hour of fill for volatile liquids (flash point <100 deg F), as in API 2000. For non-volatile liquids 6 scfh per 42 gal barrel may be used.
5. Thermal out-breathing at 1 scfh per 42 gal barrel of tank volume for volatile liquids, up to 20,000 barrel volume, as in API 2000. For non-volatile liquids 0.6 scfh per 42 gal barrel may be used.
6. From API 2000 Appendix B on Emergency Venting, for four ranges of tank surface area, heat absorption, Q, is calculated. Vent capacity in SCFH is then calculated from the heat absorption according to the equation:
   SCFH = 70.5 * Q / [L * sqrt(M)] assuming a conservative "L * sqrt(M)" value of 1,337, that of hexane.
7. Formula for emergency vent area adapted from Protectoseal Technical Manual, on flow capacity of tank emergency venting devices for nozzles 8 in. and larger:
   CFH = 1,667 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank emergency relief setting and atmospheric conditions.
8. Formula for vent area for smaller nozzles such as normal breather vents, adapted from Crane Flow of Fluids, Eq. 2-24, very similar to, but more conservative, than Protectoseal equation:
   CFH = 845 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank relief setting and atmospheric conditions.
   The factor 845 was derived using unit conversion factors, a vapor density of 0.1875 lb/cf, and a conservative Y of 0.80 from charts on Crane p. A-21.

EXHIBIT E

TANK MATERIAL OF CONSTRUCTION COMPATIBILITY INFORMATION

Compatibility Information

Unit 900: T-901 to T-904

Carboline 191 Epoxy Polyamide coating

Or Equivalent

GUIDE FOR SELECTION OF CARBOLINE LININGS AND HEAVY DUTY SYSTEMS

A tank lining performs a dual function in that it has to prevent product contamination and protect the tank itself from corrosion. For these reasons stricter procedures and standards must be followed than for any other type of coating application. In tank lining work a first class application with no compromise is required, therefore, only applicators experienced in lining tanks should be used.

This guide is designed to assist engineers, maintenance personnel, inspectors and applicators involved in tank lining work in the proper selection, application and inspection of Carboline Tank Lining Systems.

Carboline Company has over 40 years of experience in supplying coatings for lining tanks so we have tried to include much of the knowledge gained from this experience in this guide. We do realize, however, that unusual design problems or exposures not covered herein may occur. In these cases, please contact our Technical Service Department or your local Sales Representative for the necessary recommendations.

Carboline Company also has a wide range of protective coatings for the protection of tank exteriors covering many different types of exposures and service conditions. The Technical Service Department or your local Sales Representative can assist you in proper recommendations.

carboline

350 Hanley Industrial Ct. • St. Louis, MO 63144-1599
an RPM company • 314-644-1000

4/89 Replaces 2/85

USE OF CHART:

The recommendations shown in this chart should be used as a guide in selecting a tank lining system for a specific exposure. Additional factors such as existing condition of surface, other chemicals present, degree of agitation, presence of solids, temperature variations, vibration, rigidity of construction, conditions under which the lining must be applied, etc. must also be considered when making this selection.

EXPLANATION OF CHART:

Systems shown under each temperature are suitable for that service, and are for the most part listed in order of preference, with the first one being the preferred Carboline recommendation. All systems referenced, however, are suitable for that exposure. All systems shown as suitable for higher temperatures and/or concentration are also suitable for the lower ranges of both.

NR indicates Not Recommended.

A blank space indicates a lack of test data.

Cost, ease of application, field experience, etc., were taken into consideration in picking the systems order of preference.

For exposures not shown, cryogenic service or other questions, contact Carboline Technical Service Department.

CHART NOTES:

N 1. Additives

Because additives may change the chemical characteristics of the solution, check with Carboline Technical Service Department for specific recommendations.

N 2. Amines

Most amines which are free from moisture can be stored in CARBO ZINC® 11 lined tanks. When moisture is present, their alkalinity may increase to a pH of more than 10. To ensure freedom from water contamination, the product and tank must be completely dry to begin with and product must be stored under a dry nitrogen or carbon dioxide blanket.

N 3. Discoloration

Test results show a discoloration of the coating, but chemical resistance and durability of coating is not affected.

N 4. Zinc Pickup and pH

CARBO ZINC® 11 is not resistant to strong acids or alkalies. It is suitable for products within the pH range of 5.5 to 10. For animal and vegetable oils, the free fatty acid content should be less than 2.5% or the acid value less than 5.0. Zinc pickup may occur when any zinc coating is used as a lining.

N 5. Hydrolyzable Solvents

Products such as esters, acetates, and halogenated compounds tend to hydrolyze in the presence of water and form organic or mineral acids. Chlorinated solvents should be properly stabilized. Water should not exceed 100 parts per million (0.01%). In the case of the products which are not dry or properly stabilized, material should be carried or stored in dry tanks and water leaks must be avoided. *Temperatures must not exceed 105°F (40°C)*

N 6. Non-Stable Liquid Chemicals

The linings are resistant to the chemical as shown. Since stability of this type of chemical may be affected by foreign contaminants from the lining, caution should be exercised to keep tanks clean. Each product should be checked for stability and compatibility with the lining.

N 7. Phenol

CARBO ZINC® 11 is resistant to Phenol (carbolic acid). Since phenol discolors if exposed to sunlight and/or trace alkalies, freedom from discoloration cannot be guaranteed.

N 8. Beverages and Potable Liquids

The listed coatings are unaffected by these liquids but no warranties can be made on effect of taste or odor imparted to the liquids from the linings.

SYSTEM	DESCRIPTION				REMARKS
	Steel Tanks		Concrete Tanks		
	Product	Dry Film Thickness	Product	Dry Film Thickness	
1	CARBO ZINC® 11	Total 3 mils (75 microns)	Not Recommended Over Concrete		Inorganic zinc, self-curing coating. Excellent solvent resistance. Meets FDA requirements (21 CFR 175.390) in gray only
2	CARBOGLAS® 1601 SG CARBOGLAS® 1601 SG	20 mils (500 microns) 20 mils (500 microns) TOTAL 40 mils (1000 microns)	Not Recommended Over Concrete		Chemically resistant flakeglas filled polyester coating. Excellent for mineral and organic acids, chlorine and hypochlorites
3	For steel system, consult Carboline Technical Service Department. Not recommended over steel		CARBOLINE® Surfacer (optional) See Use of Concrete Surfacers-Sec #4 CARBOLINE® 1340 Clear CARBOLINE® 1346 *CARBOLINE® 1346	 2 mils (50 microns) 20 mils (500 microns) 20 mils (500 microns) TOTAL 42 mils (1050 microns)	System has unique combination of chemical resistance and elasticity. Will bridge hairline cracks in substrate. Outstanding resistance to fresh and salt water. Excellent abrasion resistance on concrete
4	CARBOLINE® 187 Primer *CARBOLINE® 187 Finish	5 mils (125 microns) 5 mils (125 microns) TOTAL 10 mils (250 microns)	CARBOLINE® Surfacer (optional) See Use of Concrete Surfacers-Sec #4 CARBOLINE® 187 Finish *CARBOLINE® 187 Finish	 5 mils (125 microns) 5 mils (125 microns) TOTAL 10 mils (250 microns)	Epoxy phenolic coating. Excellent economical lining for many petrochemical services. Carboline 187 meets FDA criteria (21 CFR 175.300) for direct food contact surfaces in appropriate color
5 5 A	COAL TAR EPOXY CARBOMASTIC® 14 *CARBOMASTIC® 14	 8 mils (200 microns) 8 mils (200 microns) TOTAL 16 mils (400 microns)	CARBOLINE® Surfacer (optional) See Use of Concrete Surfacers-Sec #4 CARBOMASTIC® 14 *CARBOMASTIC® 14	 8 mils (205 microns) 8 mils (205 microns) TOTAL 16 mils (410 microns)	Epoxy-coal tar with excellent resistance to dilute acids and alkalies, salt and water. Low material cost per square foot
5 B	CARBOMASTIC® 18	16 mils (400 microns)	CARBOLINE® Surfacer (optional) See Use of Concrete Surfacers-Sec #4 CARBOMASTIC® 18	 16 mils (400 microns) TOTAL 16 mils (400 microns)	High build epoxy coal tar where single coat application is desired.
6	PHENOLINE® 300 Orange PHENOLINE® 302 PHENOLINE® 302	8 mils (200 microns) 8 mils (200 microns) 8 mils (200 microns) TOTAL 24 mils (600 microns)	CARBOLINE® Surfacer (optional) See Use of Concrete Surfacer-Sec #4 PHENOLINE® 300 Orange PHENOLINE® 302 PHENOLINE® 302	 8 mils (200 microns) 8 mils (200 microns) 8 mils (200 microns) TOTAL 24 mils (600 microns)	System has excellent overall chemical resistance and 20 years of field experience. PHENOLINE® 300 Finish may be used as the last coat for light color, smoothness and gloss. Best phenolic system for combined acidic/caustic service
7	PHENOLINE® 376 Primer *PHENOLINE® 376 Finish	5 mils (125 microns) 5 mils (125 microns) TOTAL 10 mils (250 microns)	CARBOLINE® Surfacer (optional) See Use of Concrete Surfacers-Sec. #4 PHENOLINE® 376 Primer *PHENOLINE® 376 Finish	 5 mils (125 microns) 5 mils (125 microns) TOTAL 10 mils (250 microns)	Modified phenolic coating. Best phenolic system for organic services. Meets FDA criteria (21 CFR 175.300) for direct food contact surfaces in appropriate color.
8	CARBOLINE® 191 Primer *CARBOLINE® 191 Finish	5 mils (125 microns) 5 mils (125 microns) TOTAL 10 mils (250 microns)	CARBOLINE® Surfacer (optional) See Use of Concrete Surfacers-Sec. #4 CARBOLINE® 191 Finish *CARBOLINE® 191 Finish	 5 mils (125 microns) 5 mils (125 microns) TOTAL 10 mils (250 microns)	Epoxy polyamide system. Excellent choice for fresh or salt water tanks and potable water service. Fast dry time allows short turn around. Meets FDA criteria (21 CFR 175.300) for direct food contact surfaces in appropriate color.

*Two coat systems will provide adequate substrate protection to surfaces in reasonably good condition and give good service life. Three coat systems (extra intermediate or topcoat) should be considered if substrate is pitted, extremely rough, difficult configuration to properly protect, or exposed to a very corrosive environment.

CHART #18

EXPOSURES	100°F	130°F	160°F
Acetaldehyde	NR	NR	NR
Acetic Acid, 5%	2	2	NR
Acetic Anhydride	NR	NR	NR
Acetone	1	1	1
Acetonitrile	1(N5)	NR	NR
Acetophenone	1	1	1
Acetylene Tetrachloride	1(N5)	NR	NR
Acrylic Acid	NR	NR	NR
Acrylonitrile	1(N6)	1(N6)	1(N6)
Adiponitrile	4(N3),1(N5)	NR	NR
Aliphatic Esters	1(N5)	NR	NR
Aliphatic Hydrocarbons	1,4,7	1,4,7	1
Alkyl Benzene	1,7	1	1
Allyl Acetate	1(N5),8	NR	NR
Allyl Alcohol	1,7	1,7	1
Alum Solution, 15%	5,4,7	NR	NR
Alum Solution, 35%	5	NR	NR
Aluminum Chloride, 30%	5,6,7(N3)	5,6	6
Aluminum Hydroxide (Dry)	4,7	4,7	4,7
Aluminum Nitrate, 80%	4,7(N3)	NR	NR
Aluminum Sulfate, 30%	4,5,3(N3)	NR	NR
Aluminum Sulfide, 100% (Dry)	5	5	NR
Ammonium Chloride (Dry)	4,5	4,5	4,5
Ammonium Nitrate, 20%	4,5	4,5	4,5
Ammonium Nitrate, 50%	4,5	4,5	4,5
Ammonium Nitrate, Dry	4,5	4,5	4,5
Ammonium Perchlorate, Dry	4,5	4,5	4,5
Ammonium Phosphate Dibasic, Dry	4,5	4,5	4,5
Ammonium Phosphate Monobasic, Dry	4,5	4,5	4,5
Ammonium Sulfate, 40%	4,5	4,5	4,5
Ammonium Sulfate, Dry	4,5	4,5	4,5
Amyl Acetate	1(N5),7	NR	NR
Aniline	1(N2)	1(N2)	1(N2)
Atrazine, Technical	7	NR	NR
Aviation Gas	4,1	4,1,7	1
Benzaldehyde	NR	NR	NR
Benzene	1,7	1	1
Benzoic Acid, 10%	7(N3)		
Benzyl Chloride	1(N5),7	NR	NR
Black Liquor	7(N3)	7(N3)	7(N3)
Bleach, Commercial	2	2	
Boric Acid, 10%	4,5	4,5	
Brine, Saturated	5,7,8	5,7,8	7
Bromine Water	2(N3)	2(N3)	2(N3)
Butadiene	1,4(N6)	1,4(N6)	1(N6)
Butane	1,4	1,4	1
Butyl Acetate	1(N5),7	1(N5)	1(N5)
Butyl Acrylate (Inhibited)	1(N5)	NR	NR
Butyl Alcohol	1,4	1,4	1
Butyl Aldehyde	NR	NR	NR
Butyl Amines	1(N2)	1(N2)	1(N2)
Butyl Cellosolve	1,7	1	1
Butyl Cellosolve Acetate	1(N5),7	NR	NR
Butyl Glycidal Ether	1	1	1
Butyl Glycol	1,4,7	1,7	1,7

EXPOSURES	100°F	130°F	160°F
Butyl Lactate	8(N3)	NR	NR
Butyraldehyde	NR	NR	NR
Calcium Chloride, Saturated	5,7,8	5,7,8	NR
Calcium Hypochlorite, 15%	2	2	NR
Calcium Oxide (Dry)	4,5	4,5	4,5
Calcium Sulfate (Dry)	4,5	4,5	4,5
Carbitol	1,7	1,7	1
Carbolic Acid (Phenol) (Dry), 100%	1(N7)	NR	NR
Carbon Disulfide	1(N5),7	NR	NR
Carbon Dioxide (Gas), 100% (Dry)	1,4	1,4	1
Carbon Tetrabromide	1(N5),7	NR	NR
Carbon Tetrachloride	1(N5),7	NR	NR
Carbonic Acid, 10%	7,8	7,8	NR
Caustic Soda (NaOH), 20%	7	7	7
Caustic Soda (NaOH), 50%	7	7	7
Cellosolve	1,7	1,7	1
Cellosolve Acetate	1(N5),7	NR	NR
Chlorine Dioxide, 2%	2	2	
Chlorine Water, Saturated	2(N3)	2(N3)	
Chlorobenzene	1(N5)	NR	NR
Chloroethane	1(N5)	NR	NR
Chloroethylene	1(N5)	NR	NR
Chloroform	1(N5)	NR	NR
Chlorosulfonic Acid	NR	NR	NR
Chlorox	2	2	NR
Choline Chloride, 70%	7	NR	NR
Chromic Acid, 5%	2	2	NR
Chromic Acid, 10%	2	2	NR
Chromic Sulfate, 40%	5	NR	NR
Citric Acid, 5%	7	NR	NR
Coal Tar	7	7	7
Coconut Oil	4,7	4,7	4,7
Copper Chloride (Dry)	5,6	5,6	6
Copper Sulfate (Dry)	5,6	5,6	6
Cottonseed Oil	1,4,7		
Creosote, 1.5% Water	1	1	
Cresylic Acid, 10%	NR	NR	NR
Cresylic Acid, 100%	1(N5)	NR	NR
Crotonaldehyde	NR	NR	NR
Crude Oil, Sour	5,4,7	5,4,7	7
Crude Oil, Sweet	1,5,4	1,5,7	1,5,7
Cumene	1,4	1	1
Cumol	4		
Cupric Sulfate (Dry)	5,6	5,6	6
Cyclohexane	1,4	1,4	1
Cyclohexanol	1,7	1,7	1
Cyclohexanone	1,7	1	1
Cyclohexylamine	1(N2,N3)		
Detergent Alkylates	1,7	1	1
Detergent, Synthetic, 10%	1(N4)		
Diacetone Alcohol	1,7	1	1
Di-Butyl Amine	1(N2)	1(N2)	1(N2)
Dichloroethane	7,1(N5)	NR	NR
Dichloroethylene	1(N5)	NR	NR
Dichloroethyl Ether	1(N5)	NR	NR

CHART #18

EXPOSURES	100°F	130°F	160°F
Dichloroisopropyl Ether	1(N5)	NR	NR
Dichloropropane	1(N5)	NR	NR
Dicyclohexylamine	1(N2)	1(N2)	NR
Dicyclopentadiene	1,4(N6)	1(N6)	NR
Diesel Oil	1,4	1,4	1
Diethanol Amine	1(N2,N3),7		
Diethyl Sulfate (Dry)	7	7	
Diethylene Glycol	1,4,7	1,7	1,7
Diethylene Glycol Ethyl Ether	1,7	1,7	1
Diethylene Triamine	1(N2)	NR	NR
Diisobutylene	1(N6),7		
Diethylmaleate	1(N5),7	NR	NR
Diethylphthalate	1,4,7	1,7	1
Dimethylformamide	1(N2)	1(N2)	
Dimethylphthalate	1,4	1	1
Dimethylsulfoxide	1(N5)	NR	NR
Dioctyl Phthalate	1,4	1,4	1
Dioxane	1,7	1	
Dipropylene Glycol	1,4,7	1,7	1,7
Diphenylene Oxide	1	1	
Divinyl Acetate	1(N5,N6)	NR	NR
Dodecyl Benzene	1,4	1,4	1
Epichlorohydrin	1(N5)	NR	NR
Ethanolamine	NR		
Ethyl Acetate	1(N5),7	NR	NR
Ethyl Acrylate	1(N5,N6)	NR	NR
Ethyl Alcohol	1	1	1
Ethyl Amyl Ketone	1,7	1	1
Ethyl Benzene	1,7	1	1
Ethyl Cellosolve	1,7	1	1
Ethyl Ether	1	1	1
Ethyl Ortho Silicate	1,7	1	1
Ethylene Chloride (EDC)	1,7(N6)	NR	NR
Ethylene Chlorohydrin	1(N5)	NR	NR
Ethylenediamine Tetraacetic Acid, 10%	7		
Ethylene Dibromide	1(N5)	NR	NR
Ethylene Dichloride (EDC)	1,7(N5)	NR	NR
Ethylene Glycol	1,4,7	1,7	1,7
Fatty Acids (Greater than C_6)	7	7	7
Ferric Chloride, 20%	5,6,4(N3)	5,6,2	2
Ferric Sulfate, 20%	5,4,6	5,6,2	2
Ferrous Chloride, 40%	6,2	6,2	2
Formaldehyde, 37%	2	2	2
Formamide	1(N2)		
Formic Acid, 10%	2	NR	NR
Fuel Oil	1,5,7	1,5	1
Furfuryl Alcohol	1	1	1
Gas, Aviation and Commercial	1,4,7	1,7	1
Gluconic Acid, 50%	7,4	7	
Glycerine	1,4,7	1,7	1,7
Green Liquor	7(N3)	7(N3)	7(N3)
Heptane	1,4,7	1,4,7	1,7
Hexachlorocyclopentadiene	1(N5),7	NR	NR
Hexachloropentadiene	1(N5),4,7	NR	NR

EXPOSURES	100°F	130°F	160°F
Hexane	1,4,7	1,4,7	1,7
Hexylene Glycol	1,4,7	1,7	1,7
Hydraulic Fluids	1(N1)	1(N1)	1(N1)
Hydrazine, 5%	5		
Hydrochloric Acid, 10%	2,6	2	2
Hydrochloric Acid, 28%	2,8	2	2
Hydrochloric Acid, 37%	2	2	2
Hydrofluoric Acid, 10%	NR	NR	NR
Hydrogen Peroxide, 3%	2	2	
Hydrogen Sulfide, Saturated	5,6,2,7	5,6,2	2
Hypochlorite Bleach, 5%	2	2	
Isobutyl Alcohol	1,7	1	1
Isobutyl Aldehyde	NR	NR	NR
Isobutyl Ketone	1	1	1
Isophorone	1	1	1
Isoprene	1,4(N6)	1(N6)	1(N6)
Isopropanolamine	1(N2)		
Isopropyl Alcohol	1,4,7	1,7	1
JP-4 Jet Fuel	4,1,7	4,1,7	1,7
Kerosene	3,1,4,7	3,1,4,7	1,7
Lactic Acid, 5%	4,6,7(N3)	7(N3),6	
Lithium Chloride, Saturated	5,7,8	5,7,8	7
Lube Oil SAE 10-30	1,4,7	1,7	1,7
Magnesium Chloride, Saturated	5,7,8	5,7,8	7,8
Magnesium Hydroxide, 20%	7	7	
Maleic Acid (Dry)	7	7	
Maleic Acid, 10%	2	2	2
Mesitylene	1(N5),7	NR	NR
Mesityloxide	NR	NR	NR
Methacrylic Acid	NR	NR	NR
Methyl Acrylate	1(N5)	NR	NR
Methyl Alcohol	1	1	1
Methyl Cellosolve	1,7	1	1
Methyl Cellosolve Acetate	1(N5),7	NR	NR
Methyl Ethyl Ketone (MEK)	1	1	1
Methylene Chloride, Dry	1(N5)	NR	NR
Methyl Isobutyl Carbinol	1,7	1,7	1
Methyl Isobutyl Ketone (MIBK)	1	1	1
Methyl Methacrylate Monomer	1(N5,N6)	NR	NR
Methyl Naphthalene	1,4,7	1,7	1
Methyl Pyrrolidine	NR	NR	NR
Mineral Oil	1,4,7	1,7	1,7
Monochlorobenzene	1(N5),7	NR	NR
Motor Oils	1,5,4	1,5,4	1,7
Naphtha	1,4,7	1,7	1
Naphthalene	1	1	1
Nitric Acid, 15%	2(N3)	2(N3)	
Nitric Acid, 30%	2(N3)	NR	NR
Nitrobenzene	1(N5),7	NR	NR
Nitropropane	1(N5),7	NR	NR
Nonyl Phenol	1,7		
O-Cresol	1		
O-Dichlorobenzene	1(N5)	NR	NR
Octyl Alcohol	1,4,7	1,7	1
Octyl Chloride	1(N5),7(N3)	NR	NR

CHART #18

EXPOSURES	100°F	130°F	160°F
Oil Vegetable	1(N4).4	1(N4).7	1(N4).7
Oleic Acid	4.7	7	
Oxalic Acid, Dry	4.7	7	
P-Toluene Sulfonic Acid	NR	NR	NR
Paraffin Wax	1.4	1.4	1.4.7
Peanut Oil	1(N4).4	1(N4).4	1(N4).8
Pentaerythritol	1.4	1.4	1
Pentaerythritol, 10%	4	4	
Pentoxone	1.4.7	1.7	1
Petrolatum	1.4.7	1.4.7	1.7
Petroleum Ether	1.4.7	1.4.7	1.7
Perchloric Acid	NR		
Perchloroethylene	1(N5).7	NR	NR
Phenol, 99.9% (Dry)	1(N7)	NR	NR
Phenyglycidyl Ether	1	1	1
Phosphoric Acid, 20%	2	2	2
Phosphoric Acid, 30%	2	2	2
Phosphoric Acid, 50%	2	2	2
Phosphoric Acid, 70%	2(N3)		
Phthalic Acid (Dry)	7		
Phthalic Anhydride (Dry)	7		
Pine Oil	1(N4).4.7	1(N4).4.7	1(N4).7
Pine Tar	1(N4).4.7	1(N4).4.7	1(N4).7
Pinene 80%	4		
Pluracol	1.4.7	1	1
Polyethylene Glycol	1.4.7	1.7	1.7
Polyethylene Pellets (Dry)	1.4	1.4	1.4
Polypropylene (Dry)	1.4	1.4	1.4
Polypropylene Glycol	1.4.7	1.7	1.7
Potash Slurry	7	7	
Potassium Bromide, 10%	5.7.8	5.7.8	7
Potassium Hydroxide, 20%	7	7	7
Potassium Hydroxide, 50%	7	7	7
Potassium Permanganate, .3M	2		
Propane	1.4	1.4	1.4
Propionic Acid, 50%	2	NR	NR
Propyl Alcohol	1.4.7	1.7	1
Propylene Dichloride	1(N5).7	NR	NR
Propylene Glycol	1.4.7	1.7	1.7
Propylene Oxide	1		
Pyridene	1(N2)	NR	NR
Sea Water	5.8.7.3	5.8.7.3	7
Sodium Bisulfite, 20%	6	6	
Sodium Borate, 10%	5.7.8	5.7.8	7
Sodium Bromide, 5%	5.8.7	5.8.7	7
Sodium Carbonate (Saturated)	5.7.8	5.7	7.5
Sodium Chlorate, 50%	5.8.7	5.8.7	7
Sodium Chloride (Saturated)	5.8.7	5.8.7	7
Sodium Dichromate, 10%	5.8.2	2.8	2
Sodium Fluoride (Saturated)	5.8	8	
Sodium Formate, 10%	5.8.7	5.8.7	7
Sodium Hydroxide, 10%	5.7	7	7
Sodium Hydroxide, 20%	7	7	7
Sodium Hydroxide, 50%	7	7	7
Sodium Hydroxide, 70%	7	7	7
Sodium Hypochlorite, 5%	2	2	2
Sodium Pentachlorophenate	6		
Sodium Silicate	7	7	7
Sodium Sulfate, 15%	7.6	7.8	7
Sodium Sulfate (Saturated)	7.8	7.8	7
Sodium Sulfide, 22.5%	4	NR	NR
Sodium Tripolyphosphate	5.7	7	7
Soybean Oil	7	7	7
Soybean Oil, Crude, Degummed	7	7	7
Starch, 10% Water	7	7	7
Styrene Monomer	NR	NR	NR
Styrene Monomer (Inhibited)	1.7(N6)	1(N6)	1(N6)
Sugar (Saturated)	7.6	7.8	7.6
Sugar Syrup	7	7	
Sulfuric Acid, 15%	3(N3).6.2	3(N3).6.2	2
Sulfuric Acid, 30%	6.2	6.2	2
Sulfuric Acid, 65%	NR	NR	NR
Sulfuric Acid, 95%	NR	NR	NR
Sulfurous Acid, Conc	2(N3)	2(N3)	NR
Tall Oil	7.4	7.4	NR
Tall Oil, Crude Residue	7.4	7.4	7
Tallow, Bleachable, Fancy	7	7	7
Tallow, Top White	7	7	7
Tartaric Acid, 10%	7.8.4	7.8	7
Tert-Butylamine	1(N2)	NR	NR
Tetraethylene Pentamine	1(N2)	NR	NR
Tetrahydrofuran	1	1	1
Toluene	1.7	1.7	1
Toluene Diisocyanate (TDI)	1(N6)	1(N6)	
Triacetin	1(N5).4.7	NR	NR
Tribasic Sodium Phosphate (Dry)	4.7(N3)	4.7(N3)	4.7(N3)
Trichloroethane	1(N5)	NR	NR
Trichloroethylene	1(N5).7	NR	NR
Tricresylphosphate	1.7	1.7	1.7
Triethanolamine	1(N2).7	1(N2).7	NR
Triethylenetetramine (TETA)	1(N2)	1(N2)	NR
Trisodium Polyphosphate 55%	7	7	7
Turpentine	1.7	1.7	1
Urea (Saturated)	6.7	6.7	6.7
Vinegar	2	2	NR
Vinyl Acetate Monomer	1(N5,N6)	NR	NR
Vinyl Pellets (Dry)	4	4	4
Water, Condensate	6.7	8.7	NR
Water, Deionized	8	8	NR
Water, Demineralized	8	8	NR
Water, Distilled	6.7(N6)	7.8(N6)	NR
Water, Potable	8(N6)	8(N6)	NR
Water, Salt	3.5.8.7	3.5.8.7	7
Water, Tap	3.8(N6)	3.8(N6)	NR
Wax	1.7	1.7	1.7
White Liquor	7	7	7
Xylene	1.7	1.7	1
Yellow Grease	7	7	
Zinc Bromide (Dry)	4	4	4
Zinc Sulfate (Dry)	4	4	4
Zinc Sulfate, 10%	4		

product data sheet

carboline

CARBOLINE® 191 PRIMER AND FINISH

0916

SELECTION DATA

GENERIC TYPE: Epoxy-polyamide. Part A and Part B mixed prior to application.

GENERAL PROPERTIES: A tank lining system for fresh water, including potable water service.

RECOMMENDED USES: CARBOLINE 191 Primer and Finish is recommended for use as a tank lining and heavy duty service system for protection of steel and concrete in water. CARBOLINE 191 Primer and Finish complies with AWWA Standard for Painting Steel Water Storage Tanks, Inside Paint System No. 1, 3.2 (3).

NOT RECOMMENDED FOR: Immersion [illegible] 130 F (54 C), strong mineral and organic acids, or solvents.

CHEMICAL RESISTANCE GUIDE:

Exposure*	Immersion	Splash and Spillage
Acids	NR	NR
Alkalies	Excellent to 150 F (66 C)	Excellent
Solvents	NR	Poor Fair
Salt	Excellent to 150 F (66 C)	Excellent
Water	Excellent to 130 F (54 C)	Excellent
Sugar Solutions	Excellent to 150 F (66 C)	Excellent

TEMPERATURE RESISTANCE: Not affected by steam cleaning. See specific exposure for temperature resistance.

FLEXIBILITY: Good **WEATHERING:** Very Good (chalks)

ABRASION RESISTANCE: Very Good

SUBSTRATES: CARBOLINE 191 Primer may be applied to properly prepared steel or concrete.

TOPCOAT REQUIRED: CARBOLINE 191 Primer may be topcoated with catalyzed epoxies, vinyls, modified phenolics, or others as recommended.

COMPATIBILITY WITH OTHER COATINGS: May be applied over CARBO ZINC® 11 or others as recommended. When applied over inorganic zincs such as CARBO ZINC 11, a mist coat is required to minimize bubbling.

March 87 Replaces July 86

SPECIFICATION DATA

THEORETICAL SOLIDS CONTENT OF MIXED MATERIAL:

	By Volume
CARBOLINE 191 Primer	71% ± 2%
CARBOLINE 191 Finish	69% ± 2%

RECOMMENDED SYSTEM: One coat CARBOLINE 191 Primer at 5 mils (125 microns) dry film thickness, plus one coat CARBOLINE 191 Finish at 5 mils (125 microns) dry film thickness. Service life is greatly increased with two coats of 191 Finish. An alternate system is one or two coats CARBOLINE 191 Finish over CARBO ZINC 11.

THEORETICAL COVERAGE PER MIXED GALLON*:

CARBOLINE 191 Primer

[illegible]

[illegible]

CARBOLINE 191 Finish

1107 mil sq. ft. (27.6 sq. m.) at 25 microns)

221 sq. ft. at 5 mils (5.5 sq. m.) at 125 microns)

*NOTE: Material losses during mixing and application will vary and must be taken into consideration when estimating job requirements.

SHELF LIFE: Twenty four months minimum when stored at 75 F (24 C).

COLORS: CARBOLINE 191 Primer — Brick Red [illegible]. CARBOLINE 191 Finish — White (S800) and Gray [illegible] and (C705) are standard. Other colors are available on special order.

GLOSS: Finish — semi-gloss.

ORDERING INFORMATION

Prices may be obtained from your local Carboline Sales Representative or Main Office.

APPROXIMATE SHIPPING WEIGHT:

	1-1 2 Gal. Kit	7-1 2 Gal. Kit
CARBOLINE 191 Primer	20 lbs (9 kg)	94 lbs (43 kg)
CARBOLINE 191 Finish	20 lbs (9 kg)	94 lbs (43 kg)
CARBOLINE Thinner #76	8 lbs (4 kg) in 1's	37 lbs (17 kg) in 5's

FLASHPOINT: (Pensky-Martens Closed Cup)

CARBOLINE 191 Primer Part A	68 F (20 C)
CARBOLINE 191 Finish Part A	67 F (19 C)
CARBOLINE 191 Part B	70 F (21 C)
CARBOLINE Thinner #76	21 F (-6 C)

APPLICATION INSTRUCTIONS

These instructions are not intended to show product recommendations for specific service. They are issued as an aid in determining correct surface preparation, mixing instructions, and application procedure. It is assumed that the proper product recommendations have been made. These instructions should be followed closely to obtain the maximum service from the materials.

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SURFACE PREPARATION: Remove any oil or grease from surface to be coated with clean rags soaked in CARBOLINE Thinner #76 in accordance with SSPC-SP 1

Steel: Abrasive blast to a White Metal Finish in accordance with SSPC SP 5 to a degree of cleanliness in accordance with NACE #1 to obtain a 1-2 mil (25–50 micron) blast profile

Concrete: Do not coat concrete treated with hardening solutions unless test patch indicates satisfactory adhesion. Do not apply coating unless concrete has cured at least 28 days at 70 F (21 C) and 50% R.H. or equivalent time. Apply to properly prepared dry concrete that was acid etched and neutralized or thoroughly and uniformly sweep sand blasted.

MIXING. Mix separately, then combine and mix in the following proportions:

	1 1 2 Gal. Kit	7-1 2 Gal Kit
CARBOLINE 191 Primer Part A		
or		
CARBOLINE 191 Finish Part A	gallon	[illegible]
CARBOLINE 191 Part B	1 2 gallon	[illegible]

May be thinned up to 20% by volume with CARBOLINE Thinner #76.

NOTE. Use of thinners other than those supplied or approved by Carboline may adversely affect product performance and void product warranty, whether express or implied.

POT LIFE: Two hours at 75 F (24 C) and less at higher temperatures. Pot life ends when coating loses body and begins to sag.

APPLICATION TEMPERATURES

	Material	Surfaces	Ambient	Humidity
Normal	65 85 F (18 29 C)	65 85 F (18 29 C)	65 85 F (18 29 C)	50
Minimum	55 F (23 C)	50 F (10 C)	50 F (10 C)	0
Maximum	90 F (32 C)	110 F (43 C)	110 F (43 C)	90

Do not apply when the surface temperature is less than 5 F (or 2 °C) above the dew point.

Special thinning and application techniques may be required above or below normal conditions.

SPRAY: Use sufficient air volume for correct operation of equipment.

Use a 50% overlap with each pass of the gun. On irregular surfaces, coat the edges first, making an extra pass later.

NOTE: The following equipment has been found suitable, however equivalent equipment may be substituted.

Conventional: Use a 3 8" minimum I.D. material hose. Hold gun approximately 12–14 inches from the surface and at a right angle to the surface.

Mfr. & Gun	Fluid Tip	Air Cap
Binks #18 or #62	66	63PB
DeVilbiss P-MBC or JGA	E	704
	Approx. .070" I.D.	

Airless. Use a 3 8" minimum I.D. material hose. Hold gun approximately 18–20 inches from the surface and at a right angle to the surface.

Mfr. & Gun	Pump*
DeVilbiss JGB 507	QFA 514 or QFA 519
Graco 205 591	President 30 1 or Bulldog 30 1
Binks Model 700	Mercury 5C or B8 36 37 1

*Teflon packings are recommended and are available from the manufacturer.

Use a .017 .021 tip with 2400 psi

BRUSH OR ROLLER. For touch up or small areas only. Use a natural bristle brush applying with full strokes. Avoid rebrushing. If rolled, use a short nap mohair roller with phenolic core. Avoid rerolling.

DRYING TIMES

	CARBOLINE 191 Primer	CARBOLINE 191 Finish
Between Coats		
50 F (10 C)	5 days	5 days
60 F (16 C)	2 days	2 days
75 F (24 C)	18 hours	18 hours
90 F (32 C)	12 hours	12 hours
Final cure		
60 F (16 C)	3 weeks	3 weeks
75 F (24 C)	10 days	10 days
90 F (32 C)	7 days	7 days

Force curing at 150 F (66 C) is recommended for all tank lining service after an initial period of 18 hours at 75 F (24 C).

CLEANUP: Use CARBOLINE Thinner #76.

STORAGE CONDITIONS: (Store Indoors)
Temperature:* 45–110 F (7–43 C) Humidity: 0–90%

*Return to minimum material temperature of 55 °F (13 °C) before use

CAUTION: CONTAINS FLAMMABLE SOLVENTS. KEEP AWAY FROM SPARKS AND OPEN FLAMES. IN CONFINED AREAS WORKMEN MUST WEAR FRESH AIRLINE RESPIRATORS. HYPERSENSITIVE PERSONS SHOULD WEAR GLOVES OR USE PROTECTIVE CREAM. ALL ELECTRIC EQUIPMENT AND INSTALLATIONS SHOULD BE MADE AND GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. IN AREAS WHERE EXPLOSION HAZARDS EXIST, WORKMEN SHOULD BE REQUIRED TO USE NONFERROUS TOOLS AND TO WEAR CONDUCTIVE AND NONSPARKING SHOES.

CARBOLINE COMPANY
350 Hanley Industrial Ct. • St. Louis, MO 63144 • (314) 644-1000

ATTACHMENT D-2-4-5

APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 1200A

Revision No.
5.0

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 1200A

TANKS T-1201A AND T-1202A

TABLE OF CONTENTS

LIST OF EXHIBITS

LIST OF REFERENCED DRAWINGS

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 1200A

TANKS T-1201A AND T-1202A

I. Introduction

This document provides the assessment and certification for the design of the hazardous waste storage tank system(s) at Tank Management Unit 1200A at the Chemical Waste Management, Inc. Facility in Emelle, Sumter County, Alabama. The assessment was performed to address the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), regarding the design of the system within Tank Management Unit 1200A which is comprised of the tanks (i.e., Tanks T-1201A and T-1202A), the tank foundation, the associated ancillary equipment and the secondary containment system.

Tank Management Unit 1200A is located to the south of existing Unit 1400 and to the east of Unit 2000 as shown on Drawing No. 0100-020-001 in Appendix D-1 to Section D of the RCRA Part B Permit Application. The primary function of Tanks T-1201A and T-1202A within Unit 1200A is for waste storage and various waste treatment methods such as mixing, neutralization, chemical treatment, chemical and physical extraction, immobilization, separation of components, encapsulation, size reduction, and/or stabilization.

The following drawings were used in the preparation of this Assessment and Certification and are provided either in Exhibit A (Tank Data Sheets) or in Appendix D-1 to Section D of the RCRA Part B Permit Application:

Drawing No.	Drawing Title
1200A-010-002A	Tank Management Unit 1200A - P&ID
1200A-020-001	Tank Management Unit 1200A - Plan View
1200A-020-002	Tank Management Unit 1200A - Plan View
1200A-030-005	Tank Management Unit 1200A – Details and Sections
1200A-040-001	Tank Management Unit 1200A – Ground Floor and Foundation Sections and Details
1200A-040-002	Tank Management Unit 1200A – Batch Stabilization Mixing Tanks
1200A-080-001	Tank Data Sheet - T-1201A & T-1202A
1200A-080-002	Tank Data Sheet - T-1201A & T-1202A

II. Tank Design

Tanks T-1201A and T-1202A have been designed in accordance with the design codes and standards indicated within the DESIGN DATA section of the Tank Data Sheets (i.e., Drawing Nos. 1200A-080-001 and -002) provided in Exhibit A to this tank system design assessment. The criteria utilized in the assessment of the design of the shell, structural support, and anchorage for Tanks T-1201A and T-1202A are also provided within the DESIGN DATA section of the Tank Data Sheets, as well as within the tank design calculations provided in Exhibit B to this tank system design assessment.

The calculations provided in Exhibit B to this tank system design assessment demonstrate that the tank shell, structural supports and anchorages are, as designed, adequate to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable, at the design conditions indicated on the tank data sheets.

Each tank within Unit 1200A is a double-walled, steel tank that is recessed in a reinforced concrete foundation vault that is integral to the reinforced concrete foundation for the building. Each tank is supported within its foundation vault by a continuous steel frame that is integral to the building foundation. Each tank is bolted to the steel frame at its top perimeter, and therefore, continuity (i.e., grounding) of these tanks is inherent to their design. Since each tank is located completely within the metal building frame of Unit 1200A, the possibility of lightning striking the tanks or their contents is precluded.

III. Tank Foundation Design

The designs of the reinforced concrete foundations for Tanks T-1201A and T-1202A are indicated on the Tank Data Sheets (i.e., Drawing Nos. 1200A-080-001 and -002) and on Drawing Nos. 1200A-040-001 and 002 which are provided in Appendix D-1 to Section D of the RCRA Part B Permit Application. The criteria utilized in the assessment of the design of the foundation for Tanks T-1201A and T-1202A are provided within the tank foundation design calculations provided in Exhibit C to this tank system design assessment.

The tank foundation design calculations provided in Exhibit C demonstrate that the tank foundations are, as designed, adequate to support the load of the full tanks and to withstand associated environmental stresses at the design conditions indicated on the tank data sheets and provided within foundation design calculations.

IV. Ancillary Equipment Design

All tank system ancillary piping systems shall be designed, installed and tested in accordance with the American Society of Mechanical Engineers (ASME) Standard B31.3, "Chemical Plant and Petroleum Refinery Piping", or an equivalent nationally recognized standard, and in accordance with recognized good engineering practices to ensure that there are supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

All other ancillary equipment for the tank system shall be designed, installed and tested in accordance with appropriate recognized standards, if any, and in accordance with recognized good engineering practices to ensure that it is supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

In order for this tank design assessment and associated certification to be maintained, and prior to the tank system being placed in use, the Facility shall ensure that the tank system ancillary equipment is properly installed and that all required inspections, tests and repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f). Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested.

V. Secondary Containment System Design

The design features of the secondary containment system for the tank systems within Unit 1200A are indicated on Drawing Nos. 1200A-020-001 and -002, and 1200A-030-005which are located in Appendix D-1 to Section D of the RCRA Part B Permit Application. As shown on these drawings and in accordance with the applicable requirements of 40 CFR 264.193(e)(3) and ADEM Administrative Code Rule 335-14-5-.10(4)(e)3., the secondary containment system design is equivalent to that for a double-walled tank, with containment by the secondary wall. Each tank is also equipped with a continuous monitoring device to detect a leak from the primary tank into the interstitial space between the tank walls. Further details on the secondary containment system design for Tanks T-1201A and T-1202A are provided in Section D-2 to this Application.

VI. Tank Venting Requirements

As indicated on the Tank Data Sheets (i.e., Drawing Nos. 1200A-080-001 and -002) provided in Exhibit A to this tank system design assessment and on the P&ID for Unit 1200A (i.e., Drawing No. 1200A-010-002A which is located in Appendix D-1 to Section D of the RCRA Part B Permit Application), Tanks T-1201A and T-1202A are designed as open top tanks and, therefore, do not require venting.

VII. Hazardous Characteristics of the Waste Managed

VII.A. Tanks T-1201A and T-1202A

In accordance with the requirements of 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., this section presents an evaluation of the compatibility of the wastes managed within the Unit 1200A tank systems with the materials of construction of Tanks T-1201A and T-1202A and the ancillary equipment (i.e., pumps and piping) to determine their suitability for service in this unit.

The types of wastes managed within Tanks T-1201A and T-1202A will include virtually every type of hazardous waste listed and identified in 40 CFR Part 261 and ADEM Administrative Code Rule 335-14-2, except for ignitable and reactive wastes. In addition, TSCA-regulated PCB wastes, non-hazardous wastes, and treatment residues from listed wastes are managed in tank systems in Unit 1200A. Certain wastes that contain volatile organic compounds in concentrations not in excess of 10% by volume may also be managed in tank systems in this unit. Tanks T-1201A and T-1202A and the ancillary equipment that contact wastes within this system are primarily constructed of carbon steel without internal corrosion protection.

Exhibit E to this tank system design assessment presents information which provides an indication of the relative compatibility of carbon steel with a wide variety of chemical compounds and other substances. The table in Exhibit E provides corrosion/compatibility information for carbon steel exposed to pure chemical compounds which, in general, tend to have a more severe corrosive effect than wastes which contain mixtures and complexes of these compounds. Although this table may not provide corrosion data and service recommendations for all of the potential constituents of the wastes or waste mixtures which may be managed within the tank system in Unit 1200A, the table does demonstrate that carbon steel is generally compatible with and, under normal conditions, should not experience an accelerated rate of corrosion or deterioration when exposed to a majority of the types and classes of wastes which are managed within the Unit 1200A tank system. In addition to the compatibility/corrosion data provided in Exhibit E, the compatibility of carbon steel with the types of wastes managed within Unit 1200A is further validated by the empirical data provided by many years of comparable service applications within a variety of units at the Facility.

VIII. Certification of Tank System Design Assessment

In accordance with the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), this section provides a certification by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), that an assessment of the design of the following tank system(s) demonstrates that the tank system foundation, structural supports, seams, connections, and pressure controls are adequate, and that the tanks have sufficient structural strength, compatibility with the wastes to be managed and/or protection from corrosion so that they will not collapse, rupture or fail, if properly installed, operated within the design limits, and properly inspected and maintained:

Tank System Location:	Chemical Waste Management, Inc. Emelle, Alabama
Tank System Identification:	Tank Management Unit 1200A
Applicable Tanks:	T-1201A and T-1202A

At a minimum, the assessment of the tank system design, which is incorporated herein by reference, addresses and considers the following factors with respect to the intended use of the tank system:

- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank designs have been evaluated for structural integrity with regards to the ability of the designed tank shell, structural supports and anchorages to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which piping and other ancillary equipment shall be designed and constructed to maintain this certification;
- In accordance with 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., the assessment of the tank system design considers the compatibility of the tank's materials of construction and/or internal coatings with the types of hazardous wastes to be managed;
- In accordance with the applicable requirements of 40 CFR 264.192(a)(5) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)5., the assessment of the tank

system design considers the ability of the designed tank system foundation to support the load of the full tanks and to withstand associated environmental stresses; and

- The assessment of the tank system design considers the adequacy of the capacity of the designed tank secondary containment system as required by the applicable requirements of 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e).

In order for this certification to be maintained, the Facility shall comply with the applicable requirements of 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10, and shall perform all routine management procedures, periodic inspections and reviews, and tank system functionality and integrity tests as required by the permit including, but not limited to, the following:

- The Facility shall ensure that the tank system is properly installed and that, prior to placing the tank system in use, all required inspections, tests and necessary repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f);
- Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment was properly designed, installed and tested;
- Prior to placement of a waste into the tank system, the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the Unit 1200A tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components, including hazardous wastes that exhibit the characteristic of corrosivity as defined in 40 CFR 261.22 and ADEM Administrative Code Rule 335-14-2-.03(3);
- Prior to placement of a waste into the tank system, the Facility shall verify the specific gravity of the waste in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit

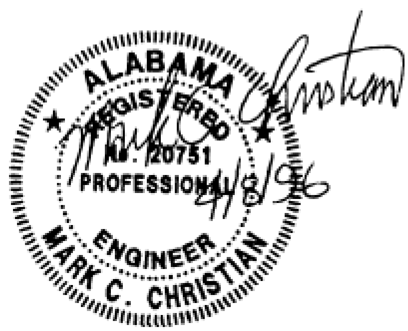
Application. The Facility shall prohibit the placement into the tank system of any waste that has a specific gravity that exceeds the design maximum value specified within the tank system design assessment;

- Prior to placement of a waste into the tank system the Facility shall verify in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application that the treatment of the waste will not cause temperatures within the tank system to exceed the design maximum value specified within the tank system design assessment;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank exterior to detect excessive corrosion or deterioration;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank secondary containment system to detect leakable cracks or gaps, or excessive deterioration of the concrete base and/or chemical resistant concrete coatings;
- The Facility shall perform an annual inspection of the tank shells, as described in Subsection F-2-6 of Section F-2 of the RCRA Part B Permit Application, to ensure that minimum code thicknesses are maintained and that adequate corrosion allowance is available for continued service;
- The Facility shall perform an annual inspection of the tank structural supports and anchorages to ensure that their integrity is maintained;
- The Facility shall perform a periodic inspection of the tank level sensing, overfill control devices and associated interlocks to ensure that they are in good working order with the appropriate settings to prevent overfilling of the tanks. The frequencies and procedures for inspection of all tank level sensing and overfill control devices shall be as recommended by the manufacturer; and
- The Facility shall perform a periodic inspection of any other operational controls for the tank system to ensure that they are in good working order with the appropriate settings to maintain the tanks within their design limits as specified within the tank system design assessment. The frequencies and procedures for inspection of other tank system operational controls shall be as recommended by the manufacturer.

Based on the information provided within the tank system design assessment and supporting documentation, the designs of Tanks T-1201A and T-1202A within Tank Management Unit 1200A meet the current RCRA requirements relative to the design of new hazardous waste tank systems. The design assessment addresses only the applicable requirements of 40 CFR 264.192 and 40 CFR 264.193, and ADEM Administrative Code Rules 335-14-5-.10(3) and (4), and does not consider compliance with other codes or regulations, including, but not limited to, the requirements of the Occupational Safety and Health Act (OSHA).

With regards to the assessment and certification of the design of hazardous waste tank systems in accordance with the applicable requirements of 40 CFR 264.192(a) and (g), and ADEM Administrative Code Rules 335-14-5-.10(3)(a) and (g), I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Mark C. Christian, P.E
Alabama P.E. No.: 20751
Principal
ETI Corporation
6799 Great Oaks Road, Suite 100
Memphis, Tennessee 38138-2500



This certification was originally submitted in 1996. As part of the 2002 Part B Application Renewal, revisions were made to the text in this attachment. These revisions consisted primarily of renaming the section for the Waste Analysis Plan to Section C to maintain consistency with the other Sections contained within this Part B Permit Application. As part of the 2009 Part B Application Renewal, additional revisions were made to the text in this attachment. These revisions consisted primarily of removing references to Tanks T-1203A and T-1204A, which were not built and are no longer proposed. During this Part B Permit Application renewal process (Revision 5.0), one revision was made to the secondary containment calculations for Unit 1200A in Section D-2.

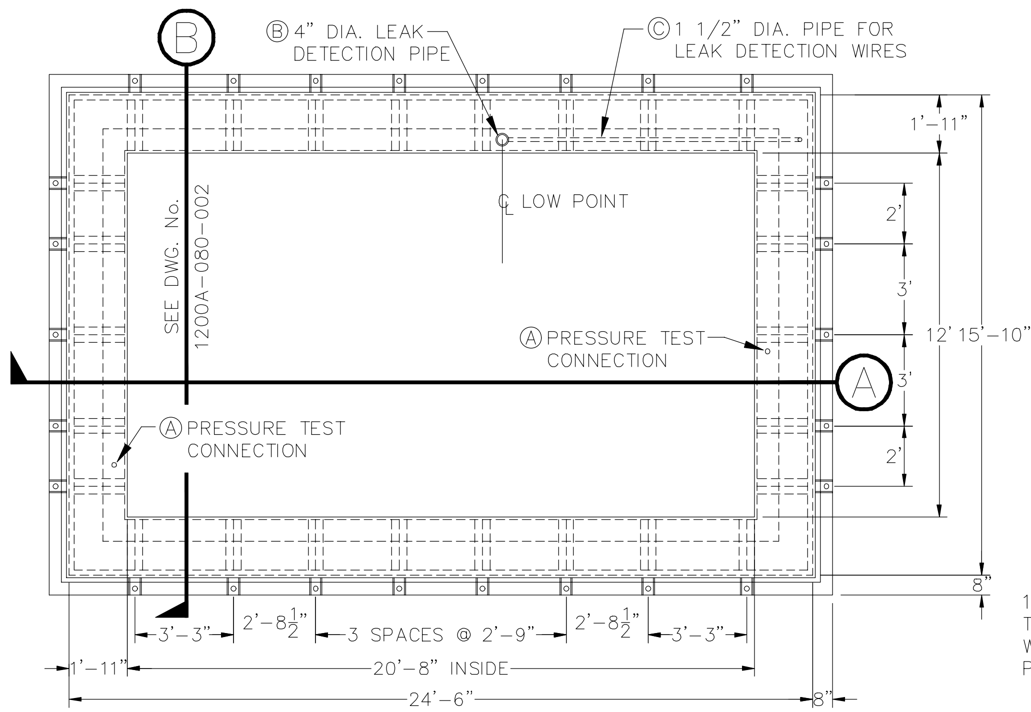
With regards to the revisions noted above, I certify under penalty of law that these modifications were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Michael T. Feeney, P.E.
Alabama P.E. No.: 15895
Jacobs Engineering Group Inc.
Ten 10th Street NW
Atlanta, Georgia 30309

[End of Attachment D-2-4-5 Text]

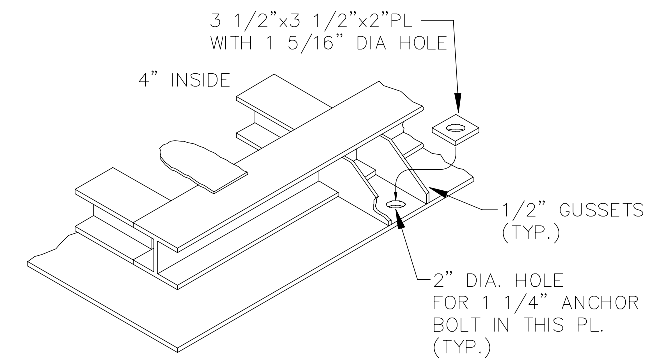
EXHIBIT A

TANK DATA SHEETS



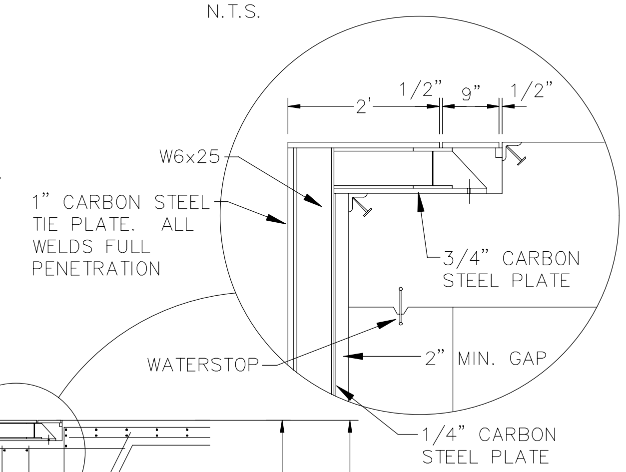
PLAN VIEW

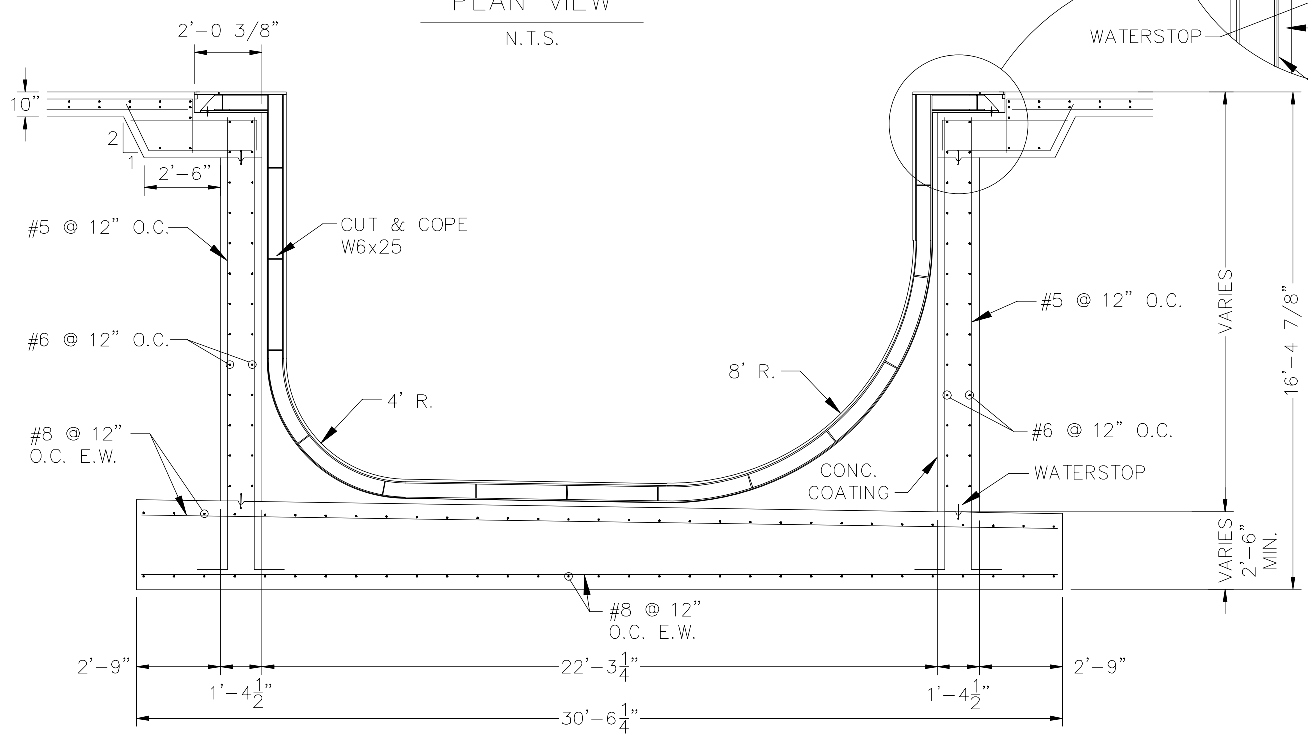
N.T.S.



ANCHOR BOLT DETAIL

N.T.S.





SECTION A

3/16" = 1'-0"

20,802 gal.
ATM / ATM
0°F 150°F
SOLIDS MIXING
2.40 24"
NA NA
ACI/AISC 0.70
NA
ZONE 1
12'-0" x 20'-8" 12'-0"

NOZZLE LIST

NO.	SERVICE	SIZE	RATING	ORIENTATION	REMARKS
		1"	CS	1/8"	–	–
		1"	CS	1/8"	–	–
		–	–	–	–	–
A	PRESSURE TEST	1"	SCH. 80	AS SHOWN	–
B	LEAK DETECTION	4"	SCH. 40	AS SHOWN	–
C	WIRE HOUSING	1.5"	SCH. 80	AS SHOWN	LEAK DETEC.

Jacobs

10 Tenth Street Suite 1400 Atlanta, GA 30309 404.978.7600

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY

SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702

DATE: AUGUST 2022

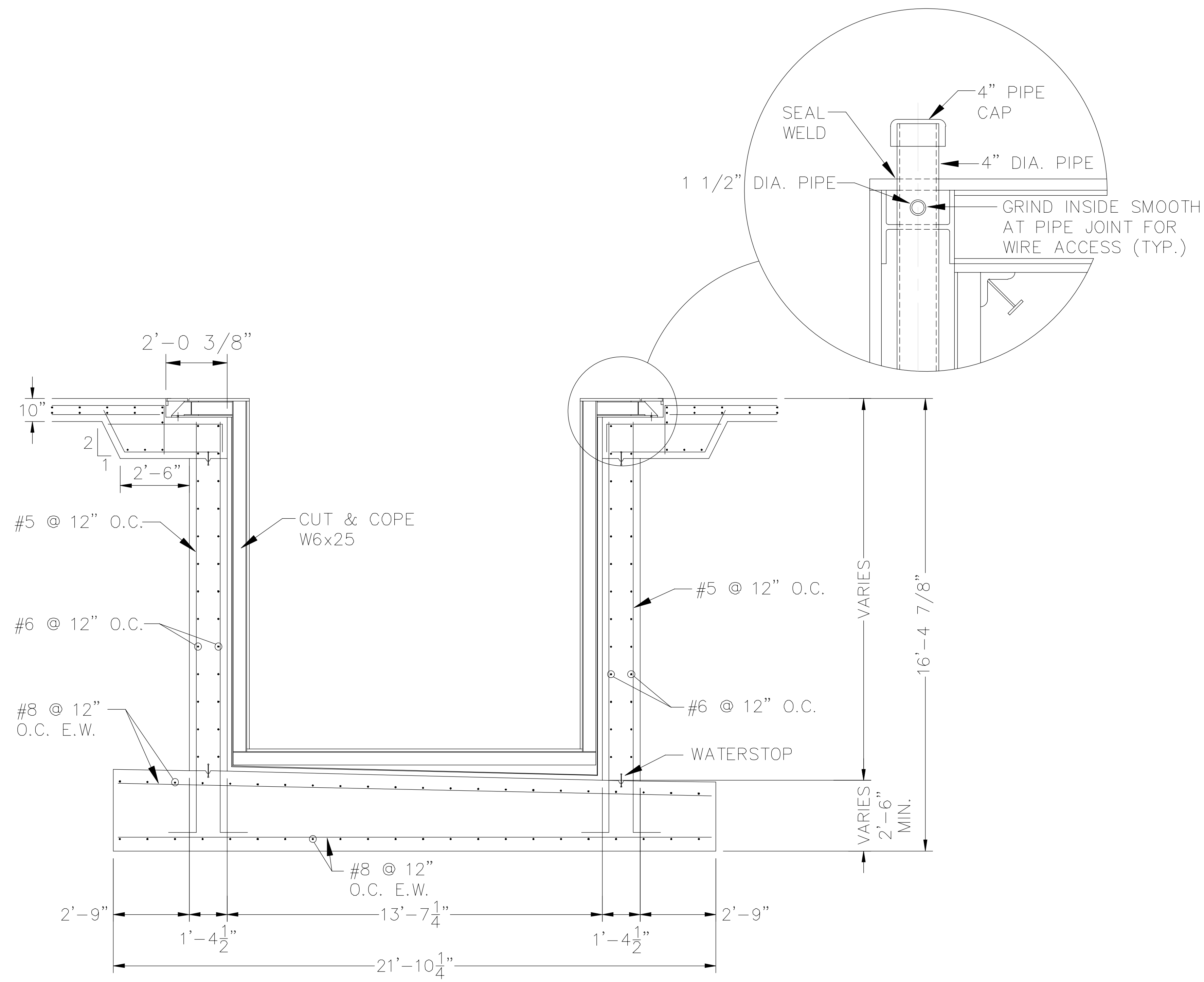
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE

TANK DATA SHEET - T-1201A & T-1202A

SHEET 1200A-080-001

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



SECTION B

REF. DWG. 1200A-080-001

SCALE: 3/16" = 1'-0"

NOT RELEASED FOR CONSTRUCTION

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY

SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702

DATE: AUGUST 2022

DISC. LEAD:	DESIGNER:	CHECKER:
MTF	RAK	SBT

SHEET TITLE

TANK DATA SHEET - T-1201A & T-1202A

SHEET 1200A-080-002

EXHIBIT B

TANK DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 1200 A

TANK NO.: T-1201 A & T-1202A

DECRIPTION: BATCH STABILIZATION MIXING TANKS

VESSEL CALCULATIONS

PREPARED BY: LANZ DATE: 9/26/94

REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
LARRY J. LANZ
...
REGISTERED
PROFESSIONAL ENGINEER

SEP 26 1994

UNIT 1200 A

DESIGN CALCULATIONS

DESIGN DATA SHEET   T-1201A, T-1202A

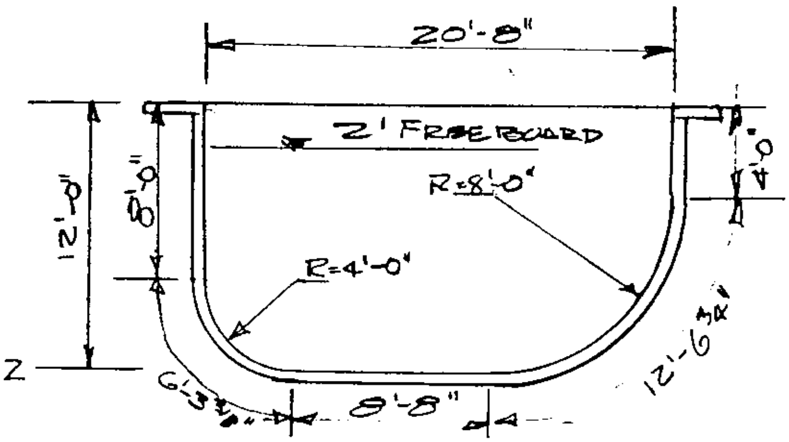
Service: Batch Stabilization Mixing Tanks

12' by 12' by 20 2/3' Batch Stabilization Tank - in Ground

Chemical Waste Management, Emelle, AL   Job No. 44228.00

Design Code	ACI/AISC
Service Status	Existing
Diameter/Length	20' - 8"
Shell/Heigth	12' - 0"
Bottom/Width	12' - 0"
Heads/Ends Top	Open
Bottom	
Legs	Inground - None
Operating Capacity	20,802 Gal
Material of Construction	Carbon Steel
Corrosion Allownce	1/8 inch
Joint Efficiency	0.70
Design Spec. Grav	2.40
Design Pressure	Atmospheric
Design Temperature	150 deg F. Max to 0deg F. Min.
Roof Live Load psf	NA
Wind Load	NA
Seismic Zone	Zone 1
Agitator	No
Location	Indoors

UNIT 1200A – TANKS T-1201A, T-1202A



VOLUME

$V = bwh - (4-\pi)(R^2+r^2)$

$V = 12 \cdot 12 \cdot 20\frac{2}{3}$

$- (4-\pi)(8^2+4^2) \cdot 12/4$

$= 2976 - .2146(64+16) \cdot 12$

$= 2976 - 206.$

$V = 2770\ FT^3$

= 20719 GAL AT 12' DEPTH

MAXIMUM WT = VOL · UNIT WT · SG. = 2770 · 62.4 · 2.40

= 414835 POUNDS = 207.4 TONS

$P_{BOT} = 12 \cdot .433 \cdot 2.4 = 12.47\ PSI = 1796\ PSF$

LENGTH OF INNER SHELL

$L = 8' + \frac{\pi}{4} \cdot 4 + (20\frac{2}{3} - 4 - 8) + \frac{\pi}{4} \cdot 8 + 4' =$

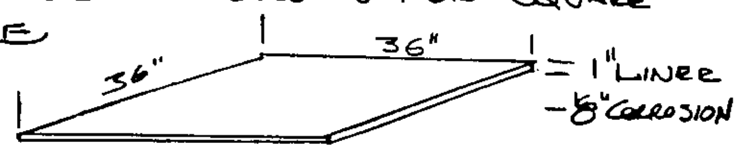
$= 8 + 8\frac{2}{3} + 4 + \frac{\pi}{4}(4 \cdot 12) = 20\frac{2}{3} + 4\pi = 33.23'$

LENGTH OF OUTER SHELL

$= 20\frac{2}{3} + 4\frac{29}{48}\pi = 20\frac{2}{3} + \pi\, 4.604 = 35.13'$

USE 3' x 3' MAX SIZE PANELS TO FOR SQUARE GRID STRUCTURE

USE 12' DEPTH FOR DESIGN



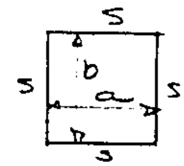
PRESSURE ON FLOOR = 12.47 PSI

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MGT PROJ. NO. 44228.00
	UNIT 1200A, TANK T-1201A & 02A SHEET 2 OF 15
	DESIGNED [signature] 9/26/94 CHECKED / /

TANKS T-1201A, T-1201B

USE ROARK 6TH ED TABLE 26 CASE 1 & CASE 8
1. RETANGULAR PLATE ALL EDGES SIMPLY SUPPORTED
8. RECTANGULAR PLATE ALL EDGES SIMPLY SUPPORTED.

CASE 1 SIMPLE SUPPORT



$$MAX\ \sigma = \sigma_b = \frac{\beta q b^2}{t^2} \qquad MAX\ y = \frac{-\alpha q b^4}{t^3}$$

$$\sigma = \frac{.2874(12.47)36^2}{.875^2}$$

$$\sigma = \underline{\underline{6066\ PSI}}$$

$$y = \frac{-.0444(12.47)36^4}{29\times10^6 \cdot .875^3}$$

$$y = \underline{\underline{0.0479\ IN.}}$$

$\beta_s = 0.2874$
$\alpha_s = 0.0444$
$a = 36$
$b = 36$
$q = 12.47$
$t = 1 - CA = 7/8$
$E = 29\times10^6$
$\beta_1 = 0.3078$
$\alpha_{FIX} = 0.0138$
$\beta_2 = 0.1386$

CASE 8 ALL EDGES FIXED

$$MAX\ \sigma = \frac{-\beta_1 q b^2}{t^2}$$

$$\sigma_M = \frac{-0.3078(12.47)36^2}{(7/8)^2}$$

$$\sigma_M = -8072\ PSI$$

@ CENTER OF EDGE

$$\sigma @ CENTER = \frac{\beta_2 q b^2}{t^2}$$

$$\sigma = \frac{0.1386(12.47)36^2}{.875^2}$$

$$\sigma @ CENT = \underline{2926\ PSI}$$

@ CENTER OF GRID

DEFLECTION @ CENTER

$$y_{max} = \frac{\alpha q b^4}{E t^3}$$

$$y_m = \frac{0.0138(12.47)36^4}{29\times10^6 \cdot .875^3}$$

$$y = \underline{\underline{0.0149\ IN}} \quad @ CENTER$$

STRESSES CALC ARE < 8100 PSI < 27,000 PSI ALLOW

CALCULATED δ'S ARE 1/20 & 3/200 INCHES

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MGT	PROJ. NO. 44228.00
	UNIT 1200A TANKS T-1201A, T-1202A	SHEET 3 OF 5
	DESIGNED [signature] 9/25/94	CHECKED / /

TANKS T-1201A, T-1202A

MINIMUM THICKNESS

CASE 1 SIMPLE SUPPORT $\sigma = \frac{\beta q b^2}{t^2}$ $t = \left(\frac{\beta q b^2}{\sigma}\right)^{\frac{1}{2}}$

$t = \left(\frac{.2874\,(12.47)\,36^2}{27{,}000}\right)^{\frac{1}{2}}$

$t =$ 0.415 INCHES

CASE 8 ALL EDGES FIXED $\sigma = \frac{\beta q b^2}{t^2}$ $t = \left(\frac{\beta q b^2}{\sigma}\right)^{\frac{1}{2}}$

$t = \left(\frac{.3078 \cdot 12.47 \cdot 36^2}{27{,}000}\right)^{\frac{1}{2}}$

$t =$ 0.429 INCHES

7/16" PLATE REQD W/O CORROSION ALLOW

ROSSER ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MGT PROJ. NO. 44228.00 UNIT 1200 T-1201A & T-1202A SHEET 3A OF 15 DESIGNED [signature] 11/18/94 CHECKED [signature] 11/29/94

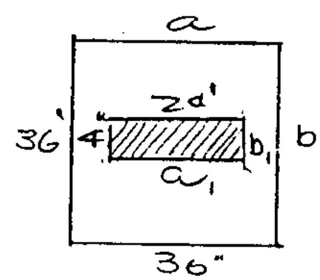
TANKS T-1201A & T-1202A

BACKHOE LOADING

ASSUME LOAD IS APPLIED TO A 4" x 24" AREA.

USE ROARK, 6TH ED, TBL 26, CASE 1c.

$MAX\ \sigma = \sigma_b = \frac{\beta W}{t}$ $W = q a_1 b_1$



IF σ = 27,000 PSI

W = $\sigma \cdot t / \beta$

= 27000 · 7/8 / .937

W = 25,213 POUNDS

& IF IMPACT IS 2.0

W = 12,607#

a/b = 2/3

b1/b = 1/9

a = b

1.0 .037

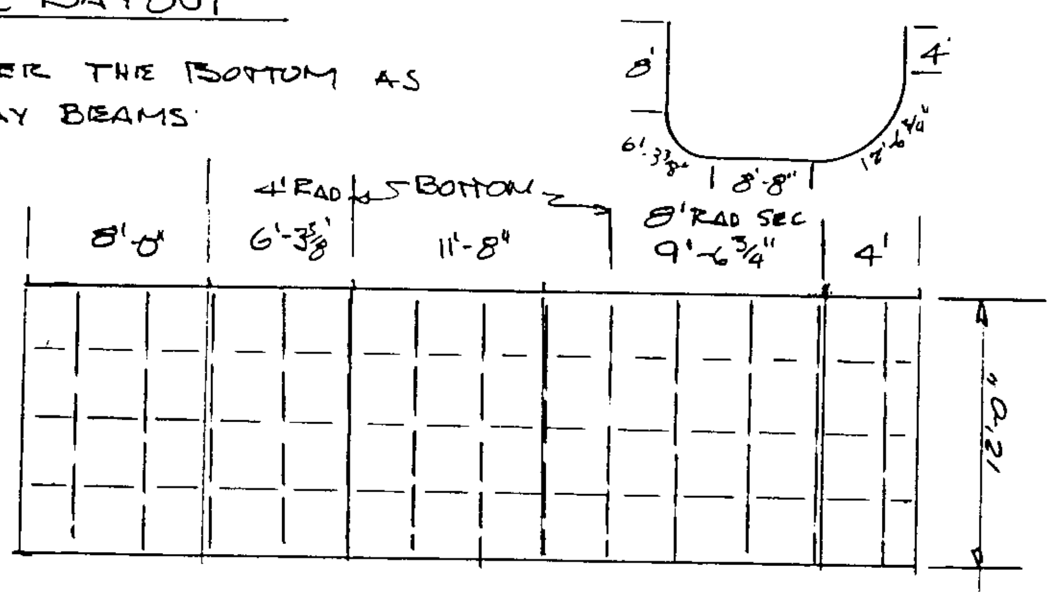
β .937

a/b / b1/b	0.6	0.8
0	1.12	0.93
0.2	0.90	0.76

THE BACKHOE WILL NOT LOAD A PLATE LIKE THIS IF MORE THAN 1-2' OF PRODUCT IS IN THE TANK

PANEL LAYOUT

CONSIDER THE BOTTOM AS ONE WAY BEAMS



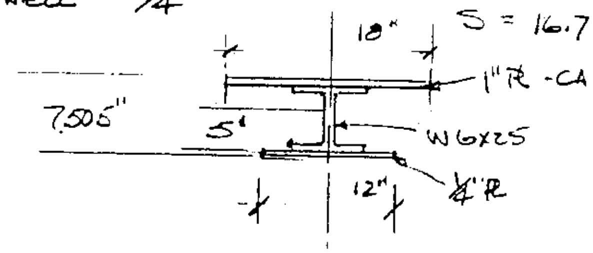
TANKS T-1201A, T-1202A

BOTTOM BEAMS

USE W6 25 BEAMS

A = 7.34
d = 6.38
I = 53.4
S = 16.7

INNER SHELL 1" - CA = 7/8"
OUTER SHELL 1/4"



LIVE LOAD = 12.47 PSI
= 1796 PSF

DEAD LOAD = PL's + 1/3 OF BEAM
= 35.7 + 10.2 + 25/3
= 54.23 PSF

TOTAL LOAD = 1850 PSF

MOMENT OF INERTIA

$\bar{x} = \frac{7.34 \cdot 3.19 + 18 \cdot \frac{7}{8}(6\frac{3}{8} + \frac{7}{16}) - 12 \cdot \frac{1}{4} \cdot \frac{1}{8}}{7.34 + 18 \cdot \frac{7}{8} + 12/4}$

$= \frac{23.41 + 107.3 - .375}{7.34 + 15\frac{3}{4} + 3}$

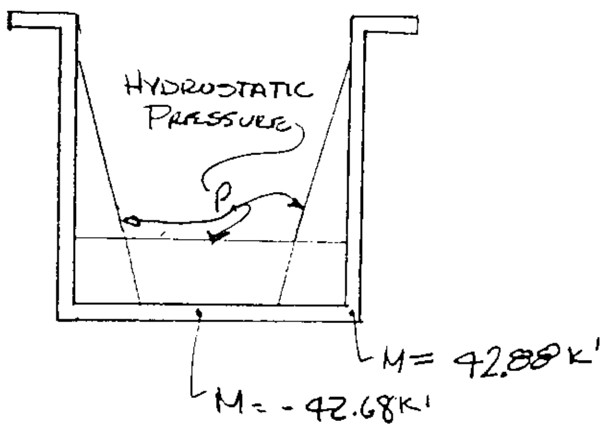
$= \frac{130.34}{26.09} = 4.995"$

$I = 53.4 + \frac{\frac{7}{8}^3 \cdot 18}{12} + \frac{\frac{1}{4}^3 \cdot 12}{12}$

$+ 7.34(5 - 3.19)^2 + 15\frac{3}{4} \cdot (6.885)^2 + 3 \cdot (5 + \frac{1}{8})^2$

$= 53.4 + 1.0 + .02 + 52.02 + 24.1 + 78.8$

$= 209.3 \text{ IN}^4$



MOMENT CALCULATIONS ARE ATTACHED (STAAD - III)

$S_1 = \frac{209.3}{2.26} = 92.61 \text{ IN}^3$

$S_2 = \frac{209.3}{5.25} = 39.87 \text{ IN}^3$

THE BOTTOM MEMBER HAS THE MOMENTS SHOWN ABOVE

STRESS @ CORNER = 42.88 • 12 / S_1 = 5.56 KSI TOP PLATE

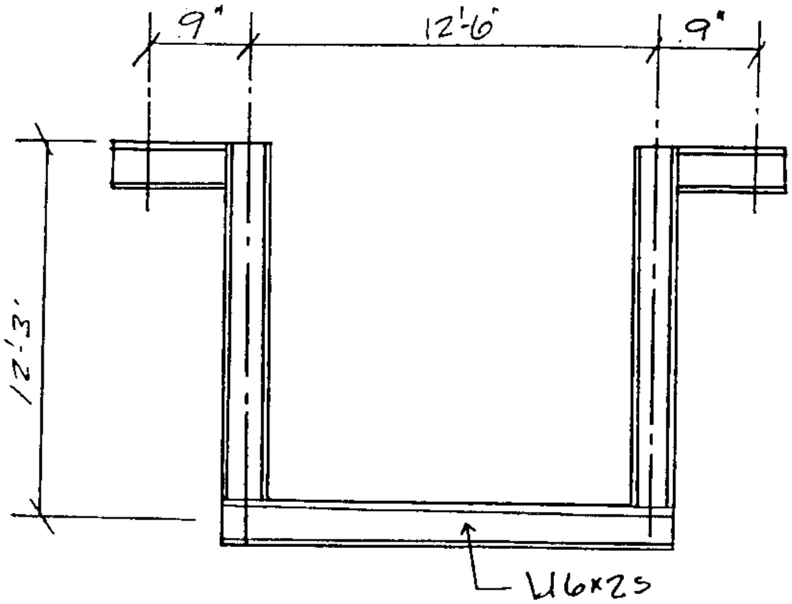
/ S_2 = 12.91 KSI BOTTOM PLATE

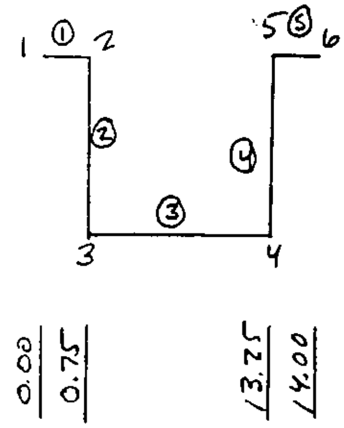
STRESS @ CENTER = -42.68 12 / S_1 = 5.53 KSI TOP PLATE

/ S_2 = 12.85 KSI BOTTOM PLATE

ALL STRESS OK

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MGT	PROJ. NO. 44228.00
	UNIT 1200A T-1201A, T-1202A	SHEET 5 OF 15
	DESIGNED [signature] 9/26/94	CHECKED / /





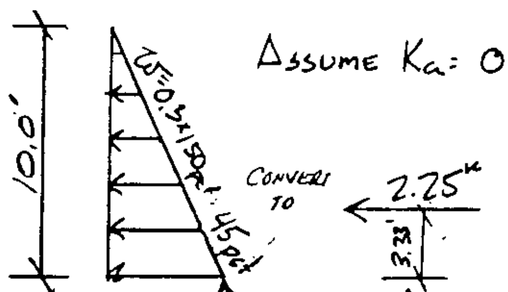
Max. Trib. Area: 2'-9"

Dead Load: 1" + 1/4" Stl Pl = 52.0#/sf x 2.75' = 143.0# = 0.143 k/ft

Live Load:

Bottom: 2.75' x 10.0' x 62.42#/ft³ x 2.40 = 4,119.0#/LF = 4.119 k/ft

Sides:



Assume K_a = 0.3 γ = 2.4 x 62.42 = 149.81 pcf

0.045 ksf x 10 = 0.45 k/f

ROSSER	ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT Chem Waste Mgt	PROJ. NO. 44228.00
		Unit 1200A T-1201A, T-1202A	SHEET 6 OF 15
		DESIGNED SRS 9/26/94	CHECKED / /

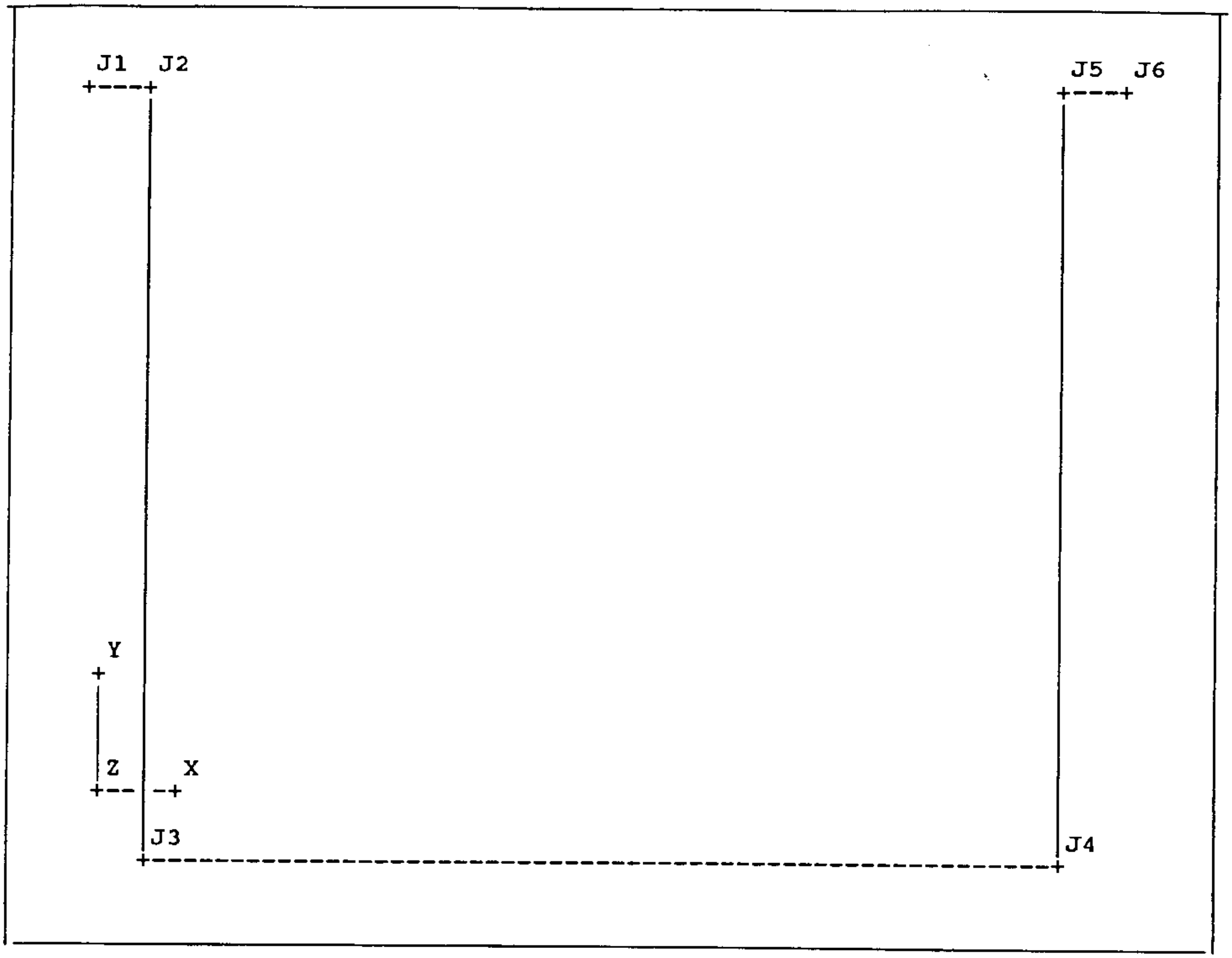
5

```
**************************************************
*                                                *
*           S T A A D - III                      *
*           REVISION 15.0 (VERSION 15 LEVEL 0)   *
*           PROPRIETARY PROGRAM OF               *
*           RESEARCH ENGINEERS,INC.              *
*           DATE=    SEP 26, 1994                *
*           TIME=    10:29:40                    *
*                                                *
**************************************************

   1. STAAD PLANE
   2. *     CHEMWASTE MANAGEMENT
   3. *     EMELLE, ALABAMA
   4. *     UNIT 1200
   5. *     TANK 1201A
   6. *FILE NAME"ETI1200"
   7. *DESIGNED BY SCOTT SMITH
   8. *
   9. *CHECKED BY:___________________________  DATE:_____________
  10. ********************************************************************
  11. UNITS KIP FEET
  12. ********************************************************************
  13. JOINT COORDINATES
  14.  1   0.00  12.25  ;  2   0.75   12.25  ;  3   0.75    0.00
  15.  4  13.25   0.00  ;  5  13.25   12.25  ;  6  14.00   12.25
  16. ********************************************************************
  17. MEMBER INCIDENCES
  18.  1   1   2 ;  2   2   3 ;  3   3   4 ;  4   4   5
  19.  5   5   6
  20. ********************************************************************
  21. SUPPORTS
  22. *
  23. 1 6               FIXED BUT  MZ
  24. ********************************************************************
  25. UNITS INCH
  26. ********************************************************************
  27. MEMBER PROPERTIES
  28. 1 2 3 4 5 6          TA ST W6X25
** WARNING - PROPERTY FOR MEMBER    2 DUPLICATED. LAST VALUE USED

  29. ********************************************************************
  30. CONSTANTS
  31. E 29000.0 ALL
  32. DENSITY 0.000283565 ALL
  33. ********************************************************************
  34. DRAW SECTION XY 0.0  0.0 JOINTS ALL
```

7/15



8/15

```
*     CHEMWASTE MANAGEMENT
35. ***********************************************************************
36. UNITS FEET
37. ***********************************************************************
38. LOADING 1 (DEAD LOAD)
39. SELFWEIGHT GY -1.0
40. *
41. MEMBER LOAD
42. 3 UNI GY -0.143
43. 2 4 UNI GY -0.143
44. *
45. ***********************************************************************
46. LOADING 2 (LIVE LOAD)
47. *
48. MEMBER LOAD
49. 3 UNI GY -4.119
50. 2 CON GX -2.25  8.67
51. 4 CON GX 2.25  8.67
52. ***********************************************************************
53. SECTION 0.25 .5 .75 MEMB 1 TO 5
54. PERFORM ANALYSIS PRINT STATICS CHECK
```

P R O B L E M   S T A T I S T I C S

```
NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =      6/     5/     2
ORIGINAL/FINAL BAND-WIDTH =     1/     1
TOTAL PRIMARY LOAD CASES  =     2, TOTAL DEGREES OF FREEDOM =     14
SIZE OF STIFFNESS MATRIX =      84 DOUBLE PREC. WORDS
TOTAL REQUIRED DISK SPACE =   12.01 MEGA-BYTES
```

9/15

```
***TOTAL APPLIED LOAD ( KIP  FEET ) SUMMARY (LOADING     1 )
    SUMMATION FORCE-X =        0.00
    SUMMATION FORCE-Y =       -6.25
    SUMMATION FORCE-Z =        0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=           0.00  MY=            0.00  MZ=          -43.77

***TOTAL APPLIED LOAD ( KIP  FEET ) SUMMARY (LOADING     2 )
    SUMMATION FORCE-X =        0.00
    SUMMATION FORCE-Y =      -51.49
    SUMMATION FORCE-Z =        0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=           0.00  MY=            0.00  MZ=         -371.86

++ PROCESSING ELEMENT STIFFNESS MATRIX.                 10:29:43
++ PROCESSING GLOBAL STIFFNESS MATRIX.                  10:29:43
++ PROCESSING TRIANGULAR FACTORIZATION.                 10:29:44
++ CALCULATING JOINT DISPLACEMENTS.                     10:29:44
++ CALCULATING ELEMENT FORCES.                          10:29:44

***TOTAL REACTION ( KIP  FEET ) SUMMARY

LOADING    1

SUM-X=        0.00  SUM-Y=        6.25  SUM-Z=         0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=           0.00  MY=           0.00  MZ=          43.77

LOADING    2

SUM-X=        0.00  SUM-Y=       51.49  SUM-Z=         0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=           0.00  MY=           0.00  MZ=         371.87

************ END OF DATA FROM INTERNAL STORAGE ************

 55. PRINT MEMBER FORCES
```

10/15

MEMBER END FORCES   STRUCTURE TYPE = PLANE

ALL UNITS ARE -- KIP FEET

MEMB	LOAD	JT	AXIAL	SHEAR-Y	SHEAR-Z	TORSION	MOM-Y	MOM-Z
1	1	1	-0.34	3.13	0.00	0.00	0.00	0.00
		2	0.34	-3.11	0.00	0.00	0.00	2.34
	2	1	-3.53	24.93	0.00	0.00	0.00	0.00
		2	3.53	-24.93	0.00	0.00	0.00	18.69
2	1	2	-3.11	-0.34	0.00	0.00	0.00	-2.34
		3	1.05	0.34	0.00	0.00	0.00	-1.77
	2	2	-24.93	-3.53	0.00	0.00	0.00	-18.69
		3	24.93	5.78	0.00	0.00	0.00	-32.65
3	1	3	-0.34	1.05	0.00	0.00	0.00	1.77
		4	0.34	1.05	0.00	0.00	0.00	-1.77
	2	3	-5.78	24.93	0.00	0.00	0.00	32.65
		4	5.78	26.56	0.00	0.00	0.00	-42.88
4	1	4	-1.05	0.34	0.00	0.00	0.00	1.77
		5	3.11	-0.34	0.00	0.00	0.00	2.34
	2	4	-26.56	5.78	0.00	0.00	0.00	42.88
		5	26.56	-3.53	0.00	0.00	0.00	19.92
5	1	5	-0.34	-3.11	0.00	0.00	0.00	-2.34
		6	0.34	3.13	0.00	0.00	0.00	0.00
	2	5	-3.53	-26.56	0.00	0.00	0.00	-19.92
		6	3.53	26.56	0.00	0.00	0.00	0.00

************** END OF LATEST ANALYSIS RESULT **************

56. PRINT SECTION FORCES

11/15

MEMBER FORCES AT INTERMEDIATE SECTIONS

ALL UNITS ARE -- KIP FEET

MEMB	LOAD	SEC	SHEAR-Y	SHEAR-Z	MOM-Y	MOM-Z
1	1	0.25	3.12	0.00	0.00	-0.59
		0.50	3.12	0.00	0.00	-1.17
		0.75	3.11	0.00	0.00	-1.75
	2	0.25	24.93	0.00	0.00	-4.67
		0.50	24.93	0.00	0.00	-9.35
		0.75	24.93	0.00	0.00	-14.02
2	1	0.25	-0.34	0.00	0.00	-1.31
		0.50	-0.34	0.00	0.00	-0.28
		0.75	-0.34	0.00	0.00	0.74
	2	0.25	-3.53	0.00	0.00	-7.87
		0.50	-3.53	0.00	0.00	2.95
		0.75	-5.78	0.00	0.00	14.94
3	1	0.25	0.52	0.00	0.00	-0.69
		0.50	0.00	0.00	0.00	-1.51
		0.75	-0.52	0.00	0.00	-0.69
	2	0.25	12.05	0.00	0.00	-25.13
		0.50	-0.82	0.00	0.00	-42.68
		0.75	-13.69	0.00	0.00	-20.02
4	1	0.25	0.34	0.00	0.00	0.74
		0.50	0.34	0.00	0.00	-0.28
		0.75	0.34	0.00	0.00	-1.31
	2	0.25	5.78	0.00	0.00	25.16
		0.50	5.78	0.00	0.00	7.45
		0.75	3.53	0.00	0.00	-9.10
5	1	0.25	-3.11	0.00	0.00	-1.75
		0.50	-3.12	0.00	0.00	-1.17
		0.75	-3.12	0.00	0.00	-0.59
	2	0.25	-26.56	0.00	0.00	-14.94
		0.50	-26.56	0.00	0.00	-9.96
		0.75	-26.56	0.00	0.00	-4.98

************** END OF LATEST ANALYSIS RESULT **************

57. PRINT SUPPORT REACTIONS

12/15

SUPPORT REACTIONS -UNIT KIP FEET   STRUCTURE TYPE = PLANE

JOINT	LOAD	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM Z
1	1	-0.34	3.13	0.00	0.00	0.00	0.00
	2	-3.53	24.93	0.00	0.00	0.00	0.00
6	1	0.34	3.13	0.00	0.00	0.00	0.00
	2	3.53	26.56	0.00	0.00	0.00	0.00

************** END OF LATEST ANALYSIS RESULT **************

58. PRINT JOINT DISPLACEMENTS

13/15

JOINT DISPLACEMENT (INCH RADIANS) STRUCTURE TYPE = PLANE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
1	1	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00065
	2	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00582
2	1	0.00001	-0.00651	0.00000	0.00000	0.00000	-0.00056
	2	0.00015	-0.05798	0.00000	0.00000	0.00000	-0.00517
3	1	-0.00012	-0.00794	0.00000	0.00000	0.00000	-0.00024
	2	-0.40153	-0.07519	0.00000	0.00000	0.00000	-0.00987
4	1	0.00012	-0.00794	0.00000	0.00000	0.00000	0.00024
	2	-0.39746	-0.01933	0.00000	0.00000	0.00000	0.00858
5	1	-0.00001	-0.00651	0.00000	0.00000	0.00000	0.00056
	2	-0.00015	-0.00099	0.00000	0.00000	0.00000	-0.00125
6	1	0.00000	0.00000	0.00000	0.00000	0.00000	0.00065
	2	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00056

************** END OF LATEST ANALYSIS RESULT **************

59. FINISH

*************** END OF STAAD-III ***************

****** DATE= SEP 26,1994 TIME= 10:29:45 ******

14/15

T-1201A, T-1202A

LATERAL LOADING

USE SBC & ZONE 1

ART 1206.6.4

$F_p = A_v C_c P a_c W_c$

WHERE

$LL = 414.8$ KIPS

$DL = 57.0$ KIPS

$W_c = 478{,}820$ POUNDS

$A_v = 0.06$

$C_c = 2.0$

$P = 0.5$

$a_c = 1.0$

$F_{EQ} = 0.06 \cdot 2 \cdot \frac{1}{2} \cdot 1 \cdot 478{,}820$

$F_{EQ} = 28{,}309$ POUNDS

THIS FORCE IS RESISTED BY THE 1" & 1/4" PLATES AT EACH END (SHEAR) AND BY THE HORZ & VERT MEMBERS (?) EACH SIDE.

CONSIDER A SIDE RESISTING WITH A PLATE OF THICKNESS EQUAL TO THE CALCULATED COMPOSITE STRENGTH

$DL = 40.8 \cdot 12 \cdot (33\frac{1}{4} + 2 \cdot 20\frac{2}{3} + 4 \cdot 2)$
$+ 10.2 \cdot 12 (35\frac{1}{8} + 2 \cdot 20\frac{2}{3})$
$+ 30.6 \cdot 2 \cdot 74$
$+ 25(13 \cdot 12 + 5(34 + 21))$
$= 40431 + 9358 + 4529 + 12025$
$= 56{,}985$

FOR $S' = S = 39.87\,IN^3$

$39.87 = \frac{bh^2}{6} = \frac{36 \cdot h^2}{6} \therefore h^2 = 6.645$, $h = 2.58''$

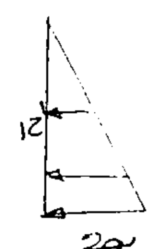
$q = \frac{F_{EQ}}{20 \cdot 12 \cdot 144} = 0.819\,PSI$

ROARK 6TH ED CHAP 26 CASE 1d

$a/b = 1\frac{2}{3}$

$\beta = 0.28$

$\alpha = .0049$



$\sigma_m = \frac{\beta q b^2}{2.58^2}$

$= \frac{0.28 \cdot .819 \cdot 144^2}{2.58^2} = 2150\,PSI$ OK

$y_m = -\frac{\alpha q b^4}{E t^3}$

$= \frac{0.049 \cdot .819^4\, 144^4}{E \quad 2.58^3} = 0.035\,IN$ OK

EARTHQUAKE FORCE IS $\frac{2.819}{12.47} = 0.1313$ 13% OF LIVE LOAD

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MGT	PROJ. NO. 44228.00	
	UNIT 1200A	T-1201A, T-1202A	SHEET 15 OF 15
	DESIGNED 4	9/26/94	CHECKED / /

EXHIBIT C

TANK FOUNDATION DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 1200A

TANK NO.: T-1201A & T-1202A

DECRIPTION: Batch Stabilization Mixing Tanks

FOUNDATION CALCULATIONS

PREPARED BY: S. Smith DATE: 9-15-94

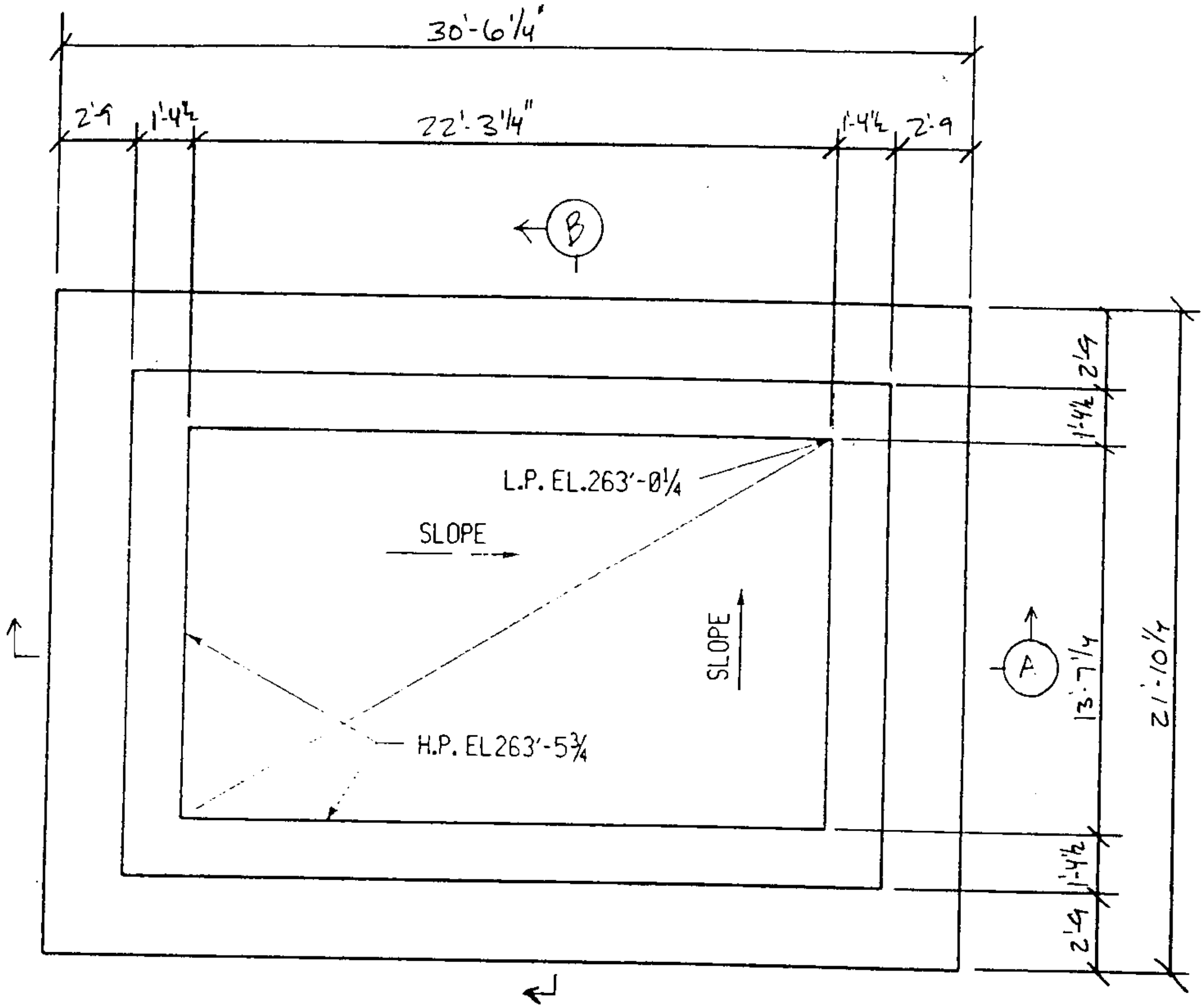
REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
SCOTT R. SMITH
60612
REGISTERED PROFESSIONAL ENGINEER

9-26-94

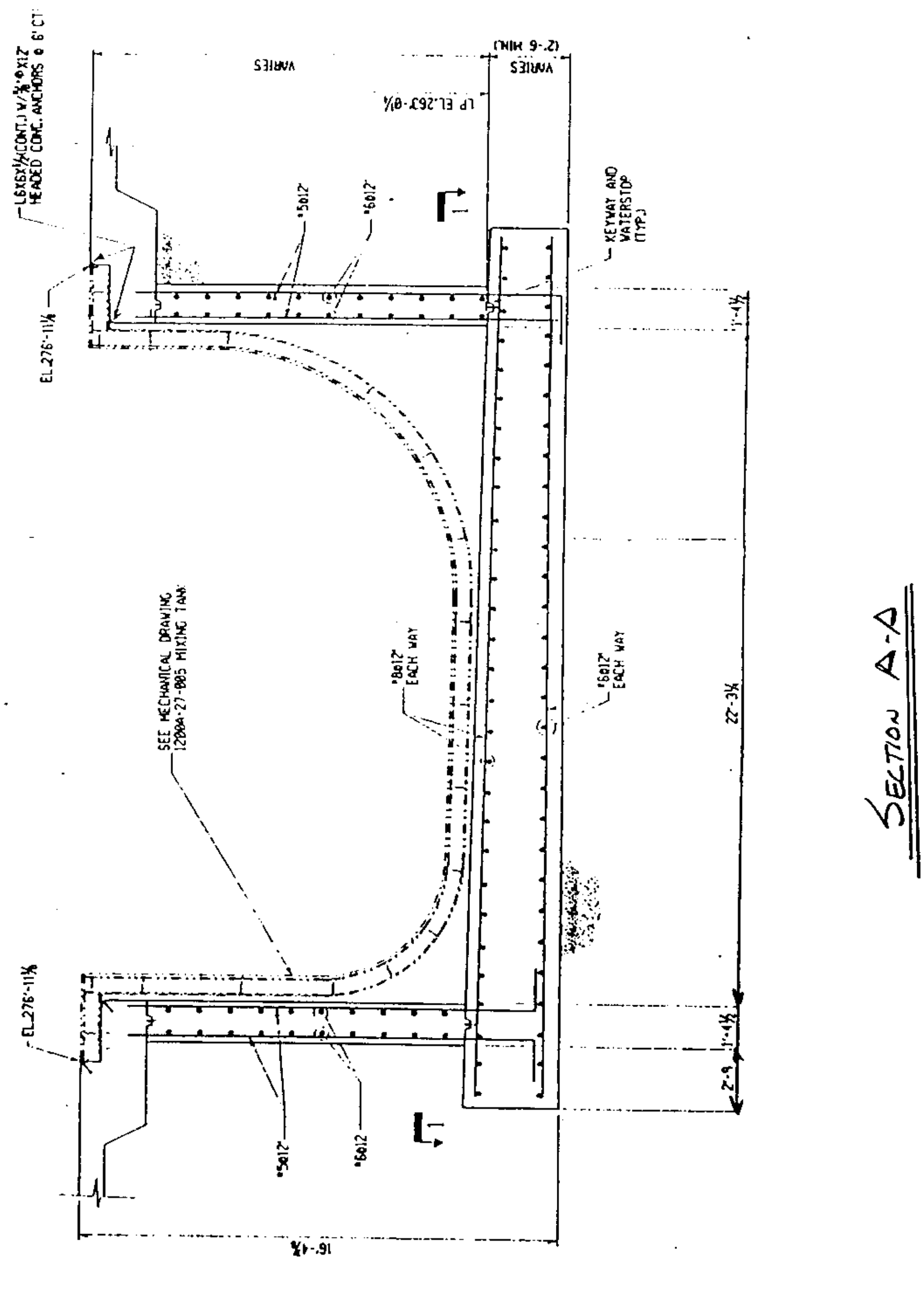
FOUNDATIONS FOR TANKS T-1201A & T-1201B



FTG. PLAN

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT Chem Waste Management Emelle, Ala. DESIGNED S.Smith 9/15/94	PROJ. NO. SHEET SK-1 OF CHECKED / /

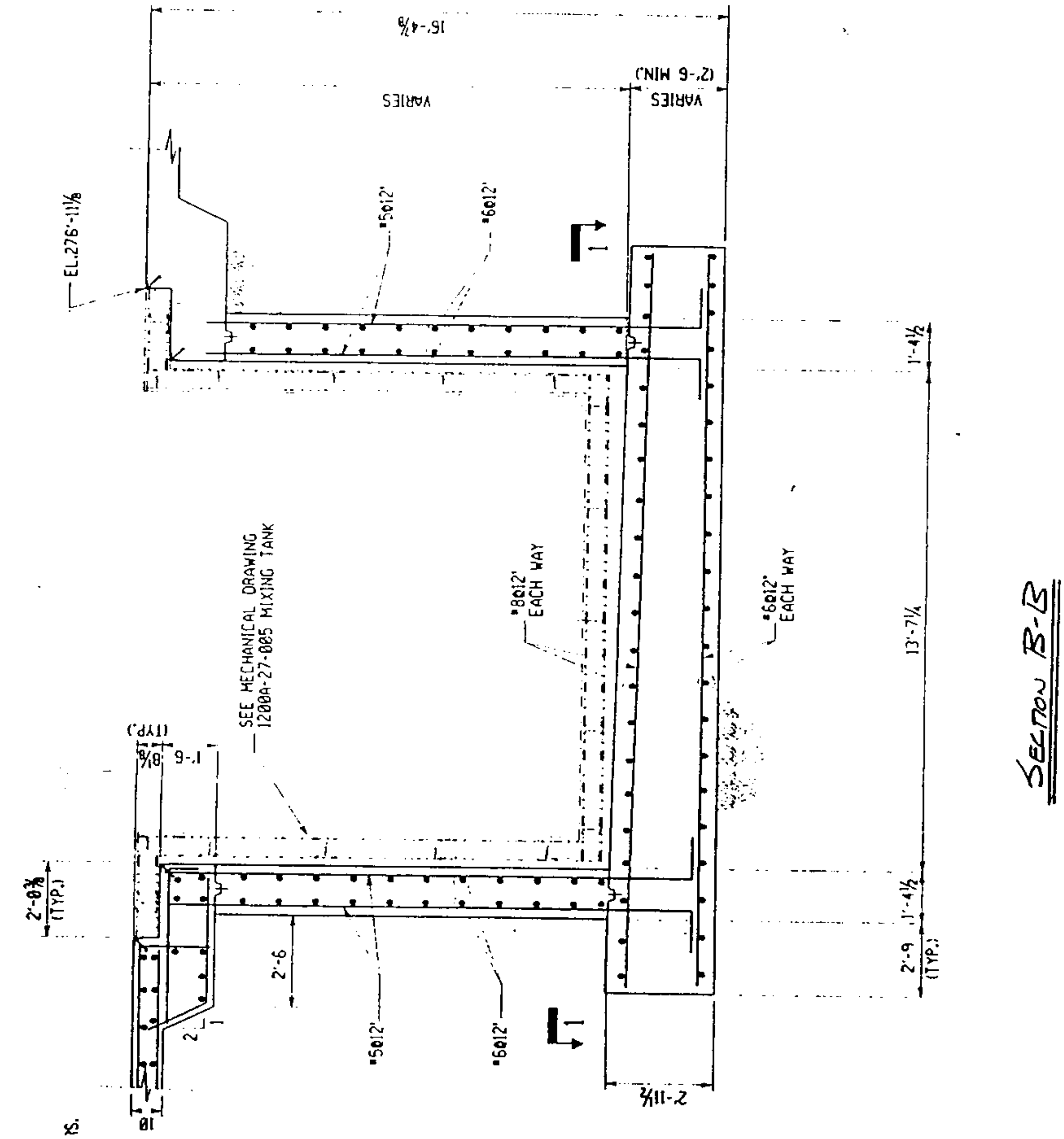
FOUNDATION FOR TANK T-1201A & T-1201B



SECTION A-A

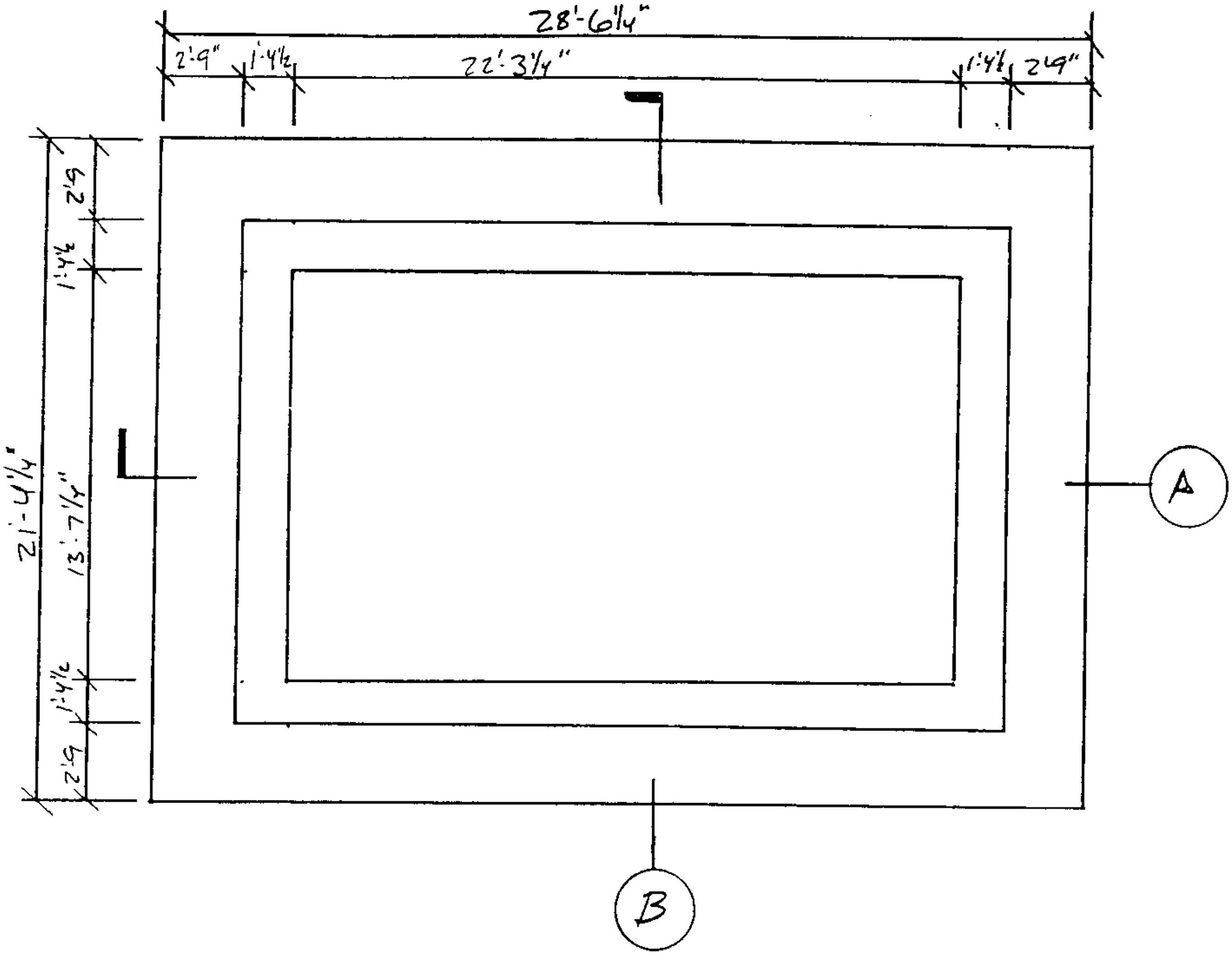
ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT Chem Waste Management	PROJ. NO.
	Emelle, Ala.	SHEET Sk-2 OF
	DESIGNED S.Smith 9/15/94	CHECKED / /

Foundation for Tank T-1201A & T-1201B



ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT Chem Waste Management	PROJ. NO.
	Emelle, Ala.	SHEET SK-3 OF
	DESIGNED S. Smith 9/15/94	CHECKED / /

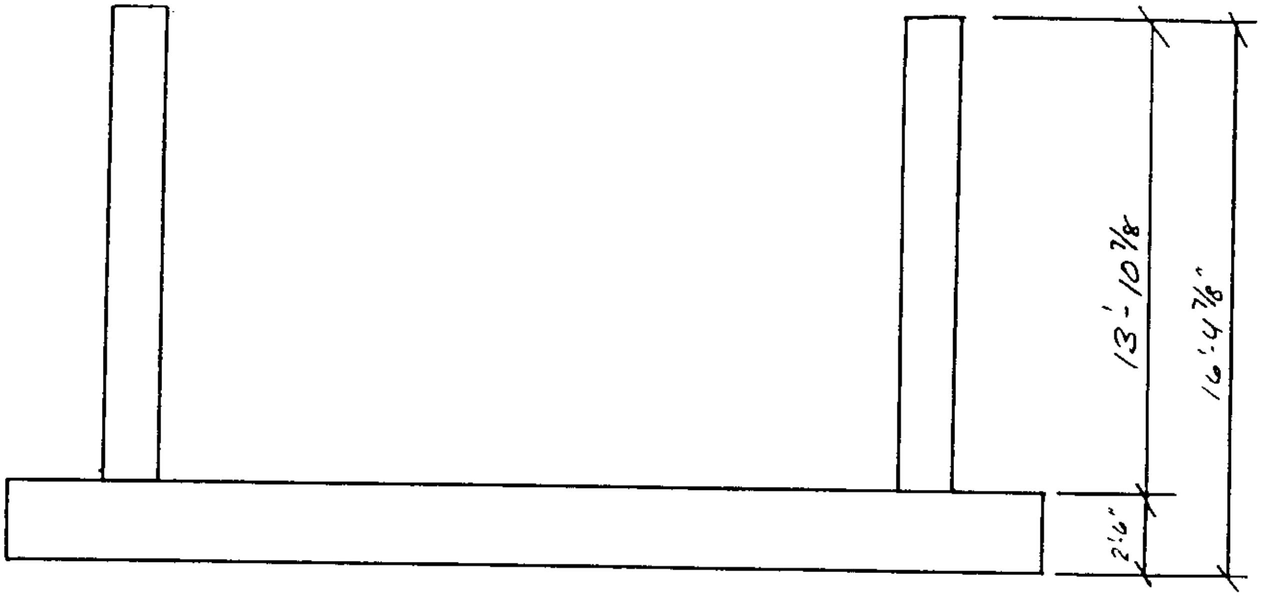
FOUNDATIONS FOR TANKS T-1201A & T-1201B



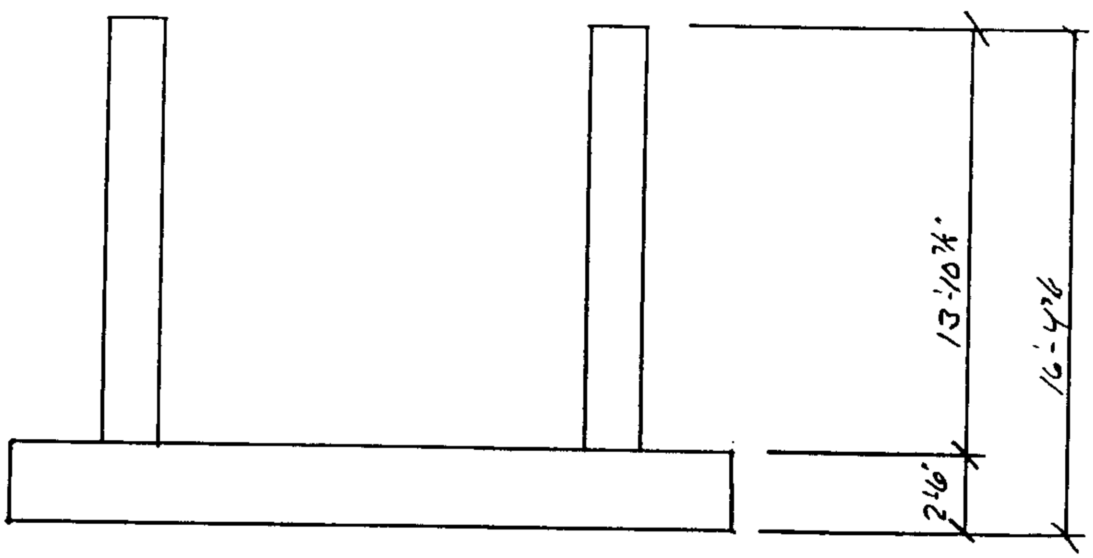
PLAN OF BASIN FOR
T-1201A OR T-1201B

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MANAGEMENT	PROJ. NO.	
	EMELLE, ALA.	SHEET 1	OF
	DESIGNED S. SMITH 9/15/94	CHECKED	/ /

FOUNDATIONS FOR TANKS T-1201A & T-1201B



SECTION A-A



SECTION B-B

ROSSER

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT CHEM WASTE MANAGEMENT EMELLE, ALA. PROJ. NO.

SHEET 2 OF

DESIGNED S. SMITH 9/15/94 CHECKED / /

Foundations for Tanks T-120A & T-120B

Soil Parameters

γ_w = 110 pcf γ = 105 pcf
K_a = 0.45
K_o = 0.63

Use Water Table @ Grade (conserv.)

Loadings

Wall: 300 psf Surcharge

Base: Backhoe Mixing Load ≈ 10k
Tank & Contents
Tank Wt.
Liner 1" thk Steel PL

41'-0" × 12'-0" × 40.8 #/sf =	20,073 #
2 × 20'-0' × 12'-0" × 40.8 #/sf =	19,584 #
5 × 41'-0' × 25 #/lf =	5,125 #
8 × 37'-0" × 25 #/lf =	7,400 #
Subtotal	52,182 #
Misc (+10%)	5,218 #
	57,400 #

Contents

Volume 103 cy (Ref Vessel Dwg 01-27-005)
Specific Gravity = 2.4
1 cy of Water = 202 gallons of Water
Wt. = 103 cy × 202 gal/cy × 8.34 #/gal × 2.4 = 416,452 #

Foundations For T-1201A & T-1201B

Wall Design

Vertical Load

Wt of Wall / ft = 1.21' × 13.9 × 150#/cf = 2,522 #/LF

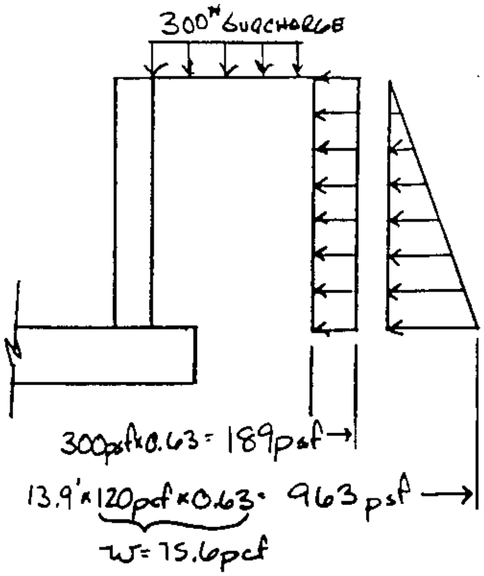
Tank & Cont = 57,400# + 416,452# = 473,852#

Wall Perimeter: 2 [24.0' + 13.54'] = 75.08'

Load/LF of Wall: $\frac{473{,}852^{\#}}{75.08'}$ = 6,311#/LF

Total Vert. Load: 2,522# + 6,311#/LF = <u>8,833#</u>

Lateral Load



Calculate Moments in Wall By U.S. Dept of Interior "Water Resource Tech. Pub." "Engr Monograph No 27" "Moments & Reactions for Rect. Plates" By Moody

Assume Wall to Be Fixed @ Bottom, & Sides, Free @ Top

Condition I: Surcharge p = 300psf × 0.63 = 189psf

a = 22.25/2 = 11.13' b = 13.90'

Use Fig. 1 (p.5) a/b = 11.13/13.9 = 0.80 ≈ 0.75

Condition II: Lateral Earth Press. p = 13.9' × 120pcf × 0.63 = 963psf

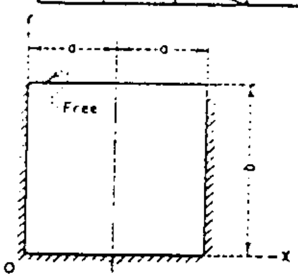
a = 11.13' b = 13.9'

Use Fig 4 (p.6) a/b = 0.8 ≈ 0.75

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management		PROJ. NO.	
Emelle, Ala		SHEET 4	OF
DESIGNED S. Smith	9/15/94	CHECKED	/ /

a/b	y/b	R_x \ x/a	M_x 0	M_x 0.2	M_x 0.4	M_x 0.6	M_x 0.8	M_x 1.0	M_y 0	M_y 0.2	M_y 0.4	M_y 0.6	M_y 0.8	M_y 1.0
a/b = 1/8	1.0	+.1249	+.0052	+.0024	+.0002	−.0014	−.0024	−.0027	0	0	0	0	0	0
	0.8	+.1248	+.0051	+.0023	+.0002	−.0014	−.0023	−.0026	+.0010	+.0005	+.0000	−.0003	−.0005	−.0005
	0.6	+.1247	+.0052	+.0023	+.0002	−.0014	−.0023	−.0027	+.0010	+.0005	+.0000	−.0003	−.0005	−.0005
	0.4	+.1250	+.0051	+.0023	+.0001	−.0014	−.0023	−.0027	+.0010	+.0005	+.0000	−.0003	−.0005	−.0006
	0.2	+.1185	+.0048	+.0021	+.0001	−.0013	−.0021	−.0024	+.0010	+.0004	−.0001	−.0004	−.0006	−.0007
	0	+.0504	0	+.0001	+.0003	+.0005	+.0006	+.0007	0	+.0006	+.0016	+.0025	+.0031	+.0035
		R_x \ R_y	+.0504	+.0116	+.0568	+.0893	+.1064	+.1141						
a/b = 1/4	1.0	+.2483	+.0209	+.0096	+.0007	−.0057	−.0096	−.0109	0	0	0	0	0	0
	0.8	+.2523	+.0206	+.0093	+.0006	−.0056	−.0093	−.0105	+.0041	+.0019	+.0002	−.0009	−.0016	−.0019
	0.6	+.2513	+.0205	+.0093	+.0006	−.0056	−.0093	−.0105	+.0041	+.0018	+.0000	−.0013	−.0021	−.0023
	0.4	+.2512	+.0196	+.0085	+.0003	−.0054	−.0088	−.0099	+.0039	+.0016	−.0004	−.0018	−.0027	−.0030
	0.2	+.1905	+.0137	+.0053	−.0003	−.0039	−.0059	−.0065	+.0027	+.0007	−.0011	−.0024	−.0032	−.0034
	0	+.0295	0	+.0005	+.0013	+.0020	+.0025	+.0027	0	+.0023	+.0063	+.0101	+.0126	+.0135
		R_x \ R_y	+.0295	+.0236	+.1131	+.1786	+.2174	+.2301						
a/b = 3/8	1.0	+.3711	+.0476	+.0219	+.0016	−.0130	−.0218	−.0247	0	0	0	0	0	0
	0.8	+.3896	+.0466	+.0208	+.0012	−.0126	−.0208	−.0235	+.0093	+.0042	+.0004	−.0022	−.0038	−.0043
	0.6	+.3757	+.0442	+.0193	+.0007	−.0122	−.0198	−.0223	+.0088	+.0036	−.0007	−.0039	−.0059	−.0065
	0.4	+.3541	+.0379	+.0155	−.0003	−.0107	−.0167	−.0186	+.0076	+.0024	−.0021	−.0054	−.0075	−.0082
	0.2	+.2133	+.0210	+.0075	−.0009	−.0059	−.0085	−.0093	+.0042	+.0009	−.0017	−.0034	−.0044	−.0047
	0	−.0015	0	+.0010	+.0027	+.0043	+.0054	+.0058	0	+.0050	+.0135	+.0215	+.0269	+.0288
		R_x \ R_y	−.0015	+.0303	+.1666	+.2644	+.3220	+.3410						
a/b = 1/2	1.0	+.5101	+.0852	+.0384	+.0022	−.0233	−.0383	−.0432	0	0	0	0	0	0
	0.8	+.5331	+.0807	+.0349	+.0013	−.0218	−.0353	−.0397	+.0161	+.0068	−.0001	−.0049	−.0077	−.0086
	0.6	+.4805	+.0712	+.0298	−.0000	−.0199	−.0313	−.0350	+.0142	+.0051	−.0026	−.0084	−.0120	−.0132
	0.4	+.4148	+.0545	+.0209	−.0014	−.0156	−.0233	−.0258	+.0109	+.0026	−.0043	−.0094	−.0125	−.0135
	0.2	+.1928	+.0250	+.0087	−.0009	−.0063	−.0089	−.0096	+.0050	+.0015	−.0003	−.0008	−.0008	−.0007
	0	−.0294	0	+.0019	+.0050	+.0080	+.0100	+.0107	0	+.0094	+.0252	+.0399	+.0499	+.0534
		R_x \ R_y	−.0294	+.0482	+.2263	+.3559	+.4322	+.4572						
a/b = 3/4	1.0	+.8592	+.1788	+.0716	−.0010	−.0471	−.0726	−.0807	0	0	0	0	0	0
	0.8	+.7864	+.1552	+.0607	−.0020	−.0414	−.0630	−.0698	+.0310	+.0112	−.0027	−.0119	−.0172	−.0190
	0.6	+.5989	+.1207	+.0460	−.0033	−.0336	−.0498	−.0549	+.0241	+.0071	−.0067	−.0166	−.0225	−.0245
	0.4	+.4378	+.0786	+.0280	−.0033	−.0214	−.0306	−.0333	+.0157	+.0036	−.0049	−.0100	−.0127	−.0135
	0.2	+.1185	+.0289	+.0109	+.0009	−.0034	−.0049	−.0055	+.0058	+.0060	+.0115	+.0186	+.0241	+.0262
	0	−.0694	0	+.0042	+.0115	+.0182	+.0227	+.0242	0	+.0212	+.0576	+.0911	+.1135	+.1212
		R_x \ R_y	−.0694	+.0806	+.3383	+.5271	+.6368	+.6725						
a/b = 1	1.0	+1.2115	+.2613	+.0885	−.0105	−.0654	−.0927	−.1008	0	0	0	0	0	0
	0.8	+.9558	+.2146	+.0727	−.0097	−.0551	−.0774	−.0840	+.0429	+.0134	−.0051	−.0164	−.0224	−.0245
	0.6	+.6250	+.1547	+.0525	−.0085	−.0411	−.0566	−.0611	+.0309	+.0090	−.0069	−.0169	−.0222	−.0238
	0.4	+.3984	+.0916	+.0305	−.0043	−.0216	−.0290	−.0310	+.0183	+.0069	+.0029	+.0030	+.0045	+.0053
	0.2	+.0434	+.0303	+.0127	+.0047	+.0033	+.0042	+.0044	+.0061	+.0149	+.0339	+.0542	+.0689	+.0742
	0	−.0939	0	+.0074	+.0199	+.0311	+.0384	+.0409	0	+.0369	+.0996	+.1556	+.1919	+.2043
		R_x \ R_y	−.0939	+.1167	+.4453	+.6760	+.8043	+.8450						
a/b = 3/2	1.0	+1.6267	+.3304	+.0700	−.0345	−.0730	−.0844	−.0865	0	0	0	0	0	0
	0.8	+1.0875	+.2609	+.0565	−.0286	−.0589	−.0670	−.0683	+.0522	+.0116	−.0069	−.0143	−.0165	−.0169
	0.6	+.5876	+.1778	+.0399	−.0195	−.0385	−.0422	−.0422	+.0356	+.0115	+.0017	+.0011	+.0035	+.0049
	0.4	+.3166	+.0981	+.0239	−.0056	−.0116	−.0101	−.0090	+.0196	+.0177	+.0315	+.0495	+.0634	+.0685
	0.2	−.0540	+.0302	+.0140	+.0140	+.0211	+.0273	+.0296	+.0060	+.0389	+.0912	+.1388	+.1699	+.1805
	0	−.1168	0	+.0159	+.0388	+.0565	+.0668	+.0702	0	+.0796	+.1939	+.2823	+.3340	+.3508
		R_y	−.1168	+.2429	+.6510	+.8793	+.9832	+1.0123						



Moment : (Coefficient) (pa²)
Reaction : (Coefficient) (pa)

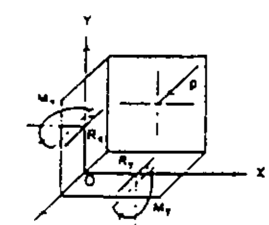


FIGURE 1.—*Plate fixed along three edges, moment and reaction coefficients, Load I, uniform load.*

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT Chem Waste Managment	PROJ. NO.	
	Emelle, Ala	SHEET 5	OF
	DESIGNED S. Smith 9/15/94	CHECKED	/ /

	y/b	R_x \ x/a	M_x 0	M_x 0.2	M_x 0.4	M_x 0.6	M_x 0.8	M_x 1.0	M_y 0	M_y 0.2	M_y 0.4	M_y 0.6	M_y 0.8	M_y 1.0
a/b = 1/8	1.0	+.0082	+.0004	+.0002	+.0000	-.0001	-.0002	-.0002	0	0	0	0	0	0
	0.8	+.0251	+.0011	+.0005	+.0000	-.0003	-.0005	-.0005	+.0002	+.0001	+.0000	-.0000	-.0001	-.0001
	0.6	+.0496	+.0021	+.0009	+.0001	-.0006	-.0009	-.0011	+.0004	+.0002	+.0000	-.0001	-.0002	-.0002
	0.4	+.0751	+.0031	+.0014	+.0001	-.0008	-.0014	-.0016	+.0006	+.0003	+.0000	-.0002	-.0003	-.0003
	0.2	+.0942	+.0038	+.0016	+.0000	-.0010	-.0017	-.0019	+.0008	+.0003	-.0000	-.0003	-.0005	-.0005
	0	+.0460	0	+.0001	+.0003	+.0005	+.0006	+.0006	0	+.0005	+.0014	+.0023	+.0028	+.0030
		R_x \ R_y	+.0460	+.0136	+.0543	+.0839	+.1004	+.1056						
a/b = 1/4	1.0	+.0147	+.0022	+.0012	+.0002	-.0006	-.0012	-.0014	0	0	0	0	0	0
	0.8	+.0523	+.0046	+.0022	+.0002	-.0012	-.0021	-.0024	+.0009	+.0005	+.0002	-.0000	-.0002	-.0002
	0.6	+.1015	+.0083	+.0037	+.0002	-.0023	-.0038	-.0042	+.0017	+.0007	-.0000	-.0005	-.0009	-.0010
	0.4	+.1514	+.0114	+.0049	+.0001	-.0032	-.0051	-.0057	+.0023	+.0008	-.0004	-.0013	-.0019	-.0021
	0.2	+.1494	+.0102	+.0037	-.0004	-.0030	-.0043	-.0047	+.0020	+.0004	-.0011	-.0022	-.0029	-.0031
	0	+.0304	0	+.0004	+.0010	+.0016	+.0020	+.0021	0	+.0020	+.0052	+.0081	+.0100	+.0107
		R_x \ R_y	+.0304	+.0309	+.1052	+.1563	+.1856	+.1950						
a/b = 3/8	1.0	+.0189	+.0066	+.0040	+.0008	-.0020	-.0039	-.0045	0	0	0	0	0	0
	0.8	+.0885	+.0117	+.0056	+.0006	-.0031	-.0054	-.0062	+.0023	+.0012	+.0004	-.0002	-.0005	-.0007
	0.6	+.1541	+.0176	+.0075	+.0001	-.0049	-.0079	-.0088	+.0035	+.0013	-.0006	-.0020	-.0029	-.0032
	0.4	+.2107	+.0208	+.0079	-.0007	-.0061	-.0090	-.0099	+.0042	+.0009	-.0019	-.0042	-.0056	-.0061
	0.2	+.1691	+.0145	-.0045	-.0012	-.0042	-.0057	-.0061	+.0029	+.0001	-.0022	-.0039	-.0048	-.0051
	0	+.0102	0	+.0008	+.0020	+.0030	+.0038	+.0040	0	+.0039	+.0099	+.0152	+.0188	+.0200
		R_x \ R_y	+.0102	+.0474	+.1486	+.2154	+.2526	+.2645						
a/b = 1/2	1.0	-.0526	+.0151	+.0088	+.0015	-.0046	-.0084	-.0097	0	0	0	0	0	0
	0.8	+.1315	+.0216	+.0099	+.0007	-.0059	-.0099	-.0112	+.0043	+.0020	+.0002	-.0011	-.0019	-.0022
	0.6	+.1972	+.0273	+.0108	-.0005	-.0079	-.0119	-.0132	+.0055	+.0015	-.0020	-.0047	-.0064	-.0070
	0.4	+.2421	+.0277	+.0092	-.0019	-.0082	-.0115	-.0125	+.0055	+.0004	-.0042	-.0076	-.0097	-.0104
	0.2	+.1607	+.0160	+.0041	-.0017	-.0044	-.0055	-.0058	+.0032	-.0002	-.0026	-.0039	-.0044	-.0046
	0	-.0045	0	+.0014	+.0033	+.0050	+.0061	+.0065	0	+.0068	+.0167	+.0252	+.0307	+.0325
		R_x \ R_y	-.0045	+.0744	+.1942	+.2699	+.3108	+.3236						
a/b = 3/4	1.0	-.1061	+.0406	+.0196	+.0013	-.0115	-.0190	-.0214	0	0	0	0	0	0
	0.8	+.2077	+.0433	+.0177	-.0003	-.0119	-.0184	-.0205	+.0087	+.0031	-.0012	-.0042	-.0061	-.0067
	0.6	+.2408	+.0426	+.0145	-.0026	-.0124	-.0174	-.0189	+.0085	+.0010	-.0055	-.0102	-.0130	-.0139
	0.4	+.2542	+.0349	+.0091	-.0039	-.0102	-.0130	-.0138	+.0070	-.0011	-.0075	-.0115	-.0137	-.0143
	0.2	+.1337	+.0163	+.0031	-.0017	-.0031	-.0033	-.0033	+.0033	+.0001	-.0000	+.0014	+.0029	+.0035
	0	-.0196	0	+.0028	+.0064	+.0093	+.0111	+.0117	0	+.0139	+.0320	+.0465	+.0554	+.0584
		R_x \ R_y	-.0196	+.1256	+.2666	+.3496	+.3923	+.4055						
a/b = 1	1.0	-.1985	+.0644	+.0253	-.0013	-.0172	-.0252	-.0276	0	0	0	0	0	0
	0.8	+.2564	+.0601	+.0210	-.0028	-.0161	-.0226	-.0245	+.0120	+.0034	-.0026	-.0065	-.0088	-.0095
	0.6	+.2485	+.0515	+.0149	-.0047	-.0145	-.0189	-.0201	+.0103	+.0003	-.0075	-.0125	-.0151	-.0159
	0.4	+.2411	+.0372	+.0078	-.0049	-.0100	-.0118	-.0122	+.0074	-.0021	-.0076	-.0099	-.0106	-.0107
	0.2	+.1108	+.0154	-.0025	-.0006	-.0006	-.0000	+.0003	+.0031	+.0018	+.0060	+.0116	+.0160	+.0175
	0	-.0241	0	+.0044	+.0096	+.0137	+.0161	+.0169	0	+.0220	+.0482	+.0683	+.0804	+.0845
		R_x \ R_y	-.0241	+.1691	+.3199	+.4038	+.4457	+.4584						
a/b = 3/2	1.0	+.3127	+.0857	+.0207	-.0087	-.0199	-.0232	-.0238	0	0	0	0	0	0
	0.8	+.2929	+.0730	+.0158	-.0086	-.0172	-.0194	-.0198	+.0146	+.0023	-.0042	-.0072	-.0082	-.0085
	0.6	+.2352	+.0560	+.0094	-.0083	-.0134	-.0142	-.0141	-.0112	-.0013	-.0077	-.0096	-.0096	-.0094
	0.4	+.2148	+.0359	+.0038	-.0053	-.0065	-.0057	-.0053	+.0072	-.0021	-.0023	+.0012	+.0046	+.0059
	0.2	+.0897	+.0132	+.0021	+.0025	-.0050	+.0069	+.0076	+.0026	+.0077	+.0220	+.0356	+.0444	+.0474
	0	-.0204	0	+.0079	+.0158	+.0212	+.0243	+.0252	0	+.0396	+.0791	+.1062	+.1214	+.1262
		\ R_y	-.0204	+.2452	+.3964	+.4668	+.4966	+.5047						

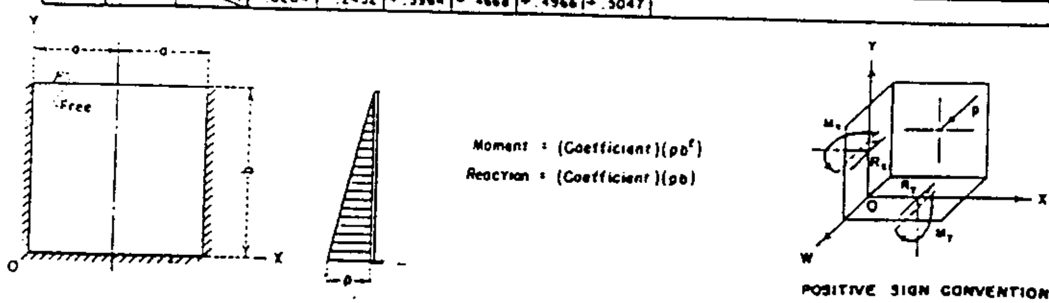


FIGURE 4.—*Plate fixed along three edges, moment and reaction coefficients, Load IV, uniformly varying load.*

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management PROJ. NO.
Emelle, Ala SHEET 6 OF
DESIGNED S. Smith 9/15/94 CHECKED / /

FOUNDATIONS FOR TANKS 1201A & 1201B

WALL DESIGN

MAX MOMENT (CONDITION I) (@ $y/b = 1.0$ & $x/a = 0$) (p.5)

$M_x = 0.1788(189\,psf)(13.9)^2 = 6,529$ FT-lbs

MAX MOMENT (CONDITION II) (@ $y/b = 1.0$ & $x/a = 0$) (p.6)

$M_x = 0.0406(963\,psf)(13.9)^2 = 7,554.0$ FT-lbs

TOTAL MOMENT: $6.52^{K\text{-}F} + 7.55^{K\text{-}F} = \underline{14.07^{K\text{-}F}}$

MAX SHEAR (COND. I) ($y/b = 1.0$)

$R = 0.8592(189\,psf)(13.9) = 2,257^{\#}$

MAX SHEAR (COND. II ($y/b = 1.0$)

$R = 0.1061(963\,psf)(13.9) = 1,420^{\#}$

TOTAL SHEAR $= 2,257^{\#} + 1,420^{\#} = \underline{3,677^{\#}}$

CHECK BENDING

$d = 16\tfrac{1}{2} - 2" - 0.625/2 = 14.18"$

$A_s = \#5 @ 12"$ o/c $A_s = 0.31\,in^2$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.31(60)}{0.85(3)(12)} = 0.61"$$

$\phi M_n = \phi A_s f_y (d - a/2) = 0.9(0.31)(60)(14.18" - 0.61/2) = 232^{K\text{-}in} = 19.35^{K\text{-}F}$

$M_u = 1.4 \times 14.07^{K\text{-}F} = 19.69^{K\text{-}F}$

$\phi M_n = 19.35^{K\text{-}F} \ngeq M_u = 19.69^{K\text{-}F}$ SLIGHTLY OVER BUT OK

CHECK SHEAR

$V = 3,677^{\#} \rightarrow V_u = 1.4 \times 3,677 = 5,147^{\#}$

$\phi V_c = \phi 2\sqrt{f'_c}\, bd = 0.85(2)\sqrt{3,000}\,(12)(14.18") = 15,844^{\#}$

$\phi V_c = 15,844^{\#} \geq V_u = 5,147^{\#}$ ∴ SHEAR OK

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT CHEM WASTE MANAGEMENT PROJ. NO.
EMELLE, ALA SHEET 7 OF
DESIGNED S. SMITH 9/15/94 CHECKED / /

FOUNDATIONS FOR TANKS 1201A & 1201B

CHECK SOIL BEARING

WT. OF CONC. TANK

WALLS: 2 × 24.02' × 13.90' × 1.375 × 150#/CF = 137,724#
2 × 13.60' × 13.90' × 1.375 × 150#/CF = 77,979#
BASE 28.5' × 21.33' × 2.5' × 150#/CF = 227,964#
WT CONC. 443,667#

WT. CONTENTS = 416,452#

WT. STEEL TANK 57,400#

WT. = 443,667# + 416,452# + 57,400# = 917,519#

$S.B. = \frac{P}{A} = \frac{917,519\#}{(28.5' \times 21.33')} = 1,509 \text{ psf} \leq 3,000 \text{ psf}$ ∴ S.B OK

CHECK BOUYANCY (JUST CONC. TANK)

DISPLACED VOLUME

WALLS 24.02' × 13.60' × 13.90' = 4,540 CF

BASE 28.50 × 21.33 × 2.5' = 1519 CF
6,059 CF

BOUYANT FORCE = 6,059 CF × 62.42#/CF = 378,249# ↑

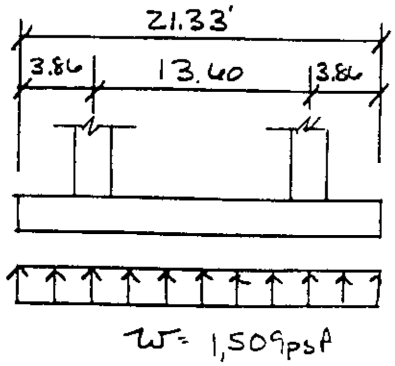
$\frac{\text{WT CONC. TK} = 443,667\#}{\text{BOUYANT FORCE} = 378,249\#}$ S.F = 1.17 ∴ OK

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

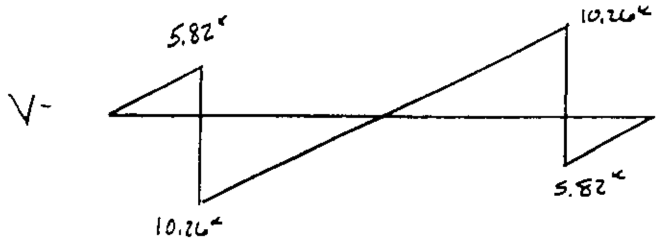
PROJECT CHEM WASTE MANAGEMENT		PROJ. NO.	
EMELLE, ALA		SHEET 8	OF
DESIGNED S. SMITH	9/15/94	CHECKED	/ /

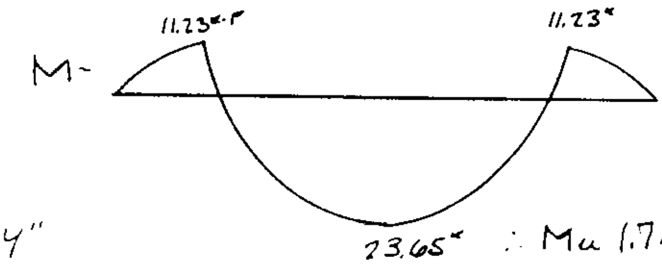
Foundations for Tanks T-1201A & T1201B

Check Bottom of Tank



$R = 1{,}509\text{psf}(21.33/2) = 16{,}093^{\#} = 16.09^{k}$





$\therefore M_u\ 1.7 \times 23.65$

$M_u\ 40.20^{k\text{-}f}$

$d = 30" - 3" - 1.00 - 1.0/2 = 25.50"$

$A_s = \#8 @ 12"$ $\quad A_s = 0.79_{in}$

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.79(60)}{0.85(3)(12)} = 1.54"$

$\phi M_n = \phi A_s f_y (d - a/2) = 0.9(0.79)(60)(25.5 - 1.54/2) = 1{,}054^{k\text{-}in} \quad 87.89^{k\text{-}f}$

$\phi M_n = 87.89^{k\text{-}f} \geq M_u\ 40.20^{k\text{-}f}$ $\therefore$ **Bending Ok**

Check Shear

$V = 10.26^{k} \qquad V_u = 1.7 \cdot 10.26^{k}\ 17.44^{k}$

$\phi V_c = \phi 2\sqrt{f'_c}\, b d = 0.85(2)(\sqrt{3000})(12)(25.50") = 28{,}492^{\#} = 28.5^{k}$

$\phi V_c = 28.5^{k} \geq V_u = 17.44^{k}$ $\therefore$ **Shear OK**

ROSSER BOVAY / ROSSER FABRAP / ROSSER JUSTICE SYSTEMS / ROSSER LOWE / IHT ROSSER	PROJECT Chem Waste Management	PROJ. NO.	
	Emelle, Ala	SHEET 9	OF
	DESIGNED S. Smith 9/15/94	CHECKED / /	

EXHIBIT D

CALCULATIONS OF TANK VENTING REQUIREMENTS

EXHIBIT D
TANK VENTING CALCULATIONS (PER API 2000)
CHEMICAL WASTE MANAGEMENT, INC., EMELLE, ALABAMA FACILITY

												IN-BREATHING					OUT-BREATHING					EMERGENCY		
Tank Nos.	Width/ Diameter (ft)	Length/ Shell Height (ft)	Depth/ Cone Height (ft)	Tank Wetted Surf. Area (sf)	Tank Capacity (gal)	Tank Rated Press. (in WG)	Tank Relief Press. (in WG)[1]	Tank Rated Vac. (in WG)	Tank Relief Vac. (in WG)[1]	Fill Rate (gpm)	With-drawal Rate (gpm)	Normal Venting (cfh)[2]	Thermal Venting (cfh)[3]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Normal Venting (cfh)[4]	Thermal Venting (cfh)[5]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Vent Capacity (cfh)[6]	Min. Area (sq in)[7]	Min. Size (in)
CONTAINMENT BUILDING/CONTAINER & TANK MANAGEMENT UNIT 1200A																								
T-1201A & T-1202A	20.67	12.00	12.00	NA	20,802	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1. Pressure and vacuum relief is assumed to be set to relieve at 50% of the design rated pressure or vacuum, unless noted. Emergency relief is assumed to be set at 75% of design pressure.
2. Normal in-breathing at 5.6 scfh per 42 gal barrel per hour of withdrawal, as specified in API 2000, 4th Edition.
3. Thermal in-breathing at 1 scfh per 42 gal barrel of tank volume, up to 20,000 barrel (840,000 gal) volume, as in API 2000.
4. Normal out-breathing at 12 scfh per 42 gal barrel per hour of fill for volatile liquids (flash point <100 deg F), as in API 2000. For non-volatile liquids 6 scfh per 42 gal barrel may be used.
5. Thermal out-breathing at 1 scfh per 42 gal barrel of tank volume for volatile liquids, up to 20,000 barrel volume, as in API 2000. For non-volatile liquids 0.6 scfh per 42 gal barrel may be used.
6. From API 2000 Appendix B on Emergency Venting, for four ranges of tank surface area, heat absorption, Q, is calculated. Vent capacity in SCFH is then calculated from the heat absorption according to the equation:
   SCFH = 70.5 * Q / [L * sqrt(M)] assuming a conservative "L * sqrt(M)" value of 1,337, that of hexane.
7. Formula for emergency vent area adapted from Protectoseal Technical Manual, on flow capacity of tank emergency venting devices for nozzles 8 in. and larger:
   CFH = 1,667 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank emergency relief setting and atmospheric conditions.
8. Formula for vent area for smaller nozzles such as normal breather vents, adapted from Crane Flow of Fluids, Eq. 2-24, very similar to, but more conservative, than Protectoseal equation:
   CFH = 845 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank relief setting and atmospheric conditions.
   The factor 845 was derived using unit conversion factors, a vapor density of 0.1875 lb/cf, and a conservative Y of 0.80 from charts on Crane p. A-21.

EXHIBIT E

TANK MATERIAL OF CONSTRUCTION

COMPATIBLITY INFORMATION

Compatibility Information

Unit 1200A: T-1201A & T-1202A

Carbon Steel

Or Equivalent for Unconstructed Tanks

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Acetaldehyde	B	C	A	A	A	B	D	C	B	A
Acetamine	B		B	B	B	B	A		A	A
Acetate Solvents	C	B	A	A	A	B	D	D	D	A
Acetic Acid, aerated	D	D	A	A	A	A	C	D	D	A
Acetic Acid, Air Free	D	D	B	B	A	A	C	D		A
Acetic Acid, crude	C	C	B	B	A	B	D	D		A
Acetic Acid, glacial							C		D	A
Acetic Acid, pure	C	D	B	B	A	D	C	D		A
Acetic Acid, 10%	C	C	B	A	A	B	B	D	B	A
Acetic Acid, 80%	C	C	B	B	A	B	C	D	B	A
Acetic Acid Vapors	D		D	D	D	C	D			A
Acetic Anhydride	C	C	C	C	C	C	D	D	C	A
Acetone	A	A	A	A	A	A	D	A	A	A
Other Ketones	A	A	A	A	A	A	D	A	D	A
Acetyl Chloride	D	C	C	C	B	B	D		D	A
Acetylene	D	B	A	A	A	B	A	A	A	A
Acid Fumes	D	D	B	B	B		C			A
Acrylonitrite	B	B	B	B	B	B	D	D	D	A
Air (Oil Free)	A	A	A	A	A	A	A	A	A	A
Alcohol, Amyl	B	B	B	B	A	B	B	A	A	A
Alcohol, Butyl	A	B	A	A	A	B	B	B	C	A
Alcohol, Diacetone	B	B	B	B	B	B	D		A	A
Alcohol, Ethyl	B	B	B	B	B	B	A	A	A	A
Alcohols, Fatty	B	B	A	A	A		B			A
Alcohol, Isopropyl	B	B	B	B	B	B	B	A	A	A
Alcohol, Methyl	B	B	B	B	B	B	A	A	A	A
Alcohol, Propyl	B	B	A	A	A	B	A		A	A
Alumina	A						A		A	A
Aluminum Acetate	D		B	B	A	C	C		A	A
Aluminum Chloride dry	D	D	C	C	C	D	B	A	A	A
Aluminum Chloride solution	D	D	D	D	D	D	B		A	A
Aluminum Fluoride		D	D	D	C	C	A		A	A
Aluminum Hydroxide	B	D	A	A	A	B	A		A	A
Aluminum Nitrate	D	D		C	C	C	A		A	A
Alum (Aluminum Potassium Sulfate)	C	C	D	D	C	C	B		A	A
Aluminum Sulfate	C	D	B	C	B	B	A	A	A	A
Amines	C	D	B	B	B	B	D	A	C	A
Ammonia, Alum				A	A		B		A	A
Ammonia, Anhydrous Liquid	C	A	B	B	A	B	B		A	A
Ammonia, Aqueous	C	A	B	B	A	B	B	A	A	A
Ammonia Gas, hot	D	C	A	A	A	D	D		B	A
Ammonia Liquor			A	A	A					A
Ammonia Solutions	D	B	A	A	A	B	B		B	A
Ammonium Acetate	D		B	B	B	B	D		A	A
Ammonium Bicarbonate	B	C	B	B	B	B	B	A	A	A
Ammonium Bromide 5%		D		C	B	B			A	A
Ammonium Carbonate	D	B	B	B	B	B	D	A	A	A
Ammonium Chloride	C	D	D	D	D	B	A	A	A	A
Ammonium Hydroxide 28%	D	B	B	B	B	D	B		A	A
Ammonium Hydroxide Concentrated	D	B	B	B	B	D	D	A	A	A
Ammonium Nitrate	D	D	A	A	A	D	A	A	A	A
Ammonium Oxalate 5%		D	B	B	B	B				A
Ammonium Persulfate	D	D	D	D	B	D	D		A	A
Ammonium Phosphate	D	D	C	B	C	C	A	B	A	A
Ammonium Phosphate Di-basic	C	D	C	B	C	C	A	A	A	A
Ammonium Phosphate Tri-basic	C	D	C	B	C	C	A	A	A	A
Ammonium Sulfate	C	D	D	D	B	B	A	A	A	A
Ammonium Sulfide	D	D		B	B	B	A		A	A
Ammonium Sulfite	C	D	C	C	B	C	B	A	B	A
Amyl Acetate	B	C	A	A	A	A	D	B	B	A
Amyl Chloride	B		B	B	B	B	D		D	A
Aniline	B	C	A	A	A	B	D	A	C	A
Aniline Dyes	C	C	A	A	A	A	D	A	C	A
Apple Juice	C	D	B	B	B	A	A	A	B	A
Aqua Regia	D	D	D	D	D		D		D	A
Aromatic Solvents	A	C	A	A	A	B	D		D	A
Arsenic Acid	B	D	B	B	B	D	A	A	A	A
Asphalt Emulsion	A	B	A	A	A	A	D	A	D	A
Asphalt Liquid	A	B	A	A	A	A	C	A	D	A

CORROSION CHART

A = Excellent
B = Good
C = Poor
D = Do Not Use

	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Barium Carbonate	B	B	B	B	B	B	B	A	A	A
Barium Chloride	C	C	D	D	B	B	A	A	A	A
Barium Cyanide	C		B	B	B	D	B		B	A
Barium Hydroxide	D	C	B	B	B	B	A	A	A	A
Barium Nitrate			B	B	B		A			A
Barium Sulfate	B	C	B	B	B	B	A	A	B	A
Barium Sulfide	D	C	B	B	B	C	A	A	A	A
Beer-Alcohol Industry	B	C	A	A	A	A	A	A	A	A
Beer-Beverage Industry	B	C	A	A	A	A	B	A	A	A
Beet Sugar Liquors	A	B	A	A	A	A	A	A	B	A
Benzaldehyde	A	D	A	B	A	B	D	A	A	A
Benzene (Benzol)	B	B	B	B	B	B	D	A	D	A
Benzoic Acid	B	D	B	B	B	B	D		D	A
Berryllium Sulfate	B		B	B	B	B	B		B	A
Blood (Meat Juices)	B		B	B	B	B	B		C	A
Borax (Sodium Borate)	C	C	A	A	A	A	B	A	A	A
Bordeaux Mixture	D	C	A	A	A	A	B	A	A	A
Borax Liquors	C	C	B	B	B	A	B	A	A	A
Boric Acid	C	D	B	B	B	B	A	A	A	A
Brake Fluid (Non Pet)	B			B	B	B	D		A	A
Brines, saturated	C	D	B	B	B	B	A	A	A	A
Bromine, dry	B	D	D	D	D	A	D		D	A
Bunker Oils (Fuel)	B	B	B	B	B	B	A	A	D	A
Butadiene	C	C	B	B	B	B	C	A	D	D
Butane	B	A	B	B	B	B	A	A	D	A
Butter					A		B			A
Buttermilk	D	D	A	A	A	D	A	A	B	A
Butyl Acetate	B	C	C	C	B	B	D		D	A
Butylene	B	B	B	B	A	A	C		D	A
Butyric Acid	D	D	C	C	B	C	D	A	C	A
Calcium Bisulfite	D	D	D	D	C	D	A	A	D	A
Calcium Carbonate	B	B	B	A	B	B	A	A	A	A
Calcium Chlorate	D	D	B	B	B	B	A			A
Calcium Chloride	C	C	B	B	B	B	A	A	A	A
Calcium Hydroxide	C	B	B	B	B	B	A	A	A	A
Calcium Nitrate		C			B		B		B	A
Calcium Phosphate	C			C	B		B		B	A
Calcium Silicate	C			C	B		B		B	A
Calcium Sulfate	C	D	B	B	B	C	A	A	B	A
Caliche Liquor		B		A	A	B	B		A	A
Camphor	C		C	C	C		B		B	A
Cane Sugar Liquors	A	B	A	B	A	B	A		A	A
Carbolic Acid (phenol)	D	D	B	B	B	B	D	D	B	A
Carbonate Beverages	B	D	B	B	B	C	B		B	A
Carbonated Water	B	B	A	A	A	B	A	A	A	A
Carbon Bisulfide	B	B	B	B	B	C	D	A	D	A
Carbone Dioxide, dry	B	B	B	B	A	A	A	A	B	A
Carbonic Acid	C	C	B	B	B	C	B	A	B	A
Carbon Monoxide	A		A	A	A	A	B		A	A
Carbon Tetra-chloride, dry	B	B	B	B	B	A	C	A	D	A
Carbon Tetra-chloride, wet	D	D	C	C	B	B	C	A	D	A
Casein	C			C	B	C	B		B	A
Castor Oil	A	B	B	B	B	A	A	A	B	A
Caustic Potash	C	D			B	B	B			A
Caustic Soda	C	B		A	A	A	C		B	A
Cellulose Acetate	B			B	B	B	D		B	A
China Wood Oil (Tung)	C	C	A	A	A	A	A	A	D	A
Chlorinated Solvents	C	C	B	B	B	B	D	A	D	A
Chlorinated Water		D	D	D	C	D	B	A	A	A
Chlorine Gas, dry	B	B	B	B	B	A	D	A	D	A
Chlorobenzene, dry	C	B	A	B	B	B	D	A	D	A
Chloroform, dry	B	D	A	A	B	A	D	A	D	A
Chlorophyll, dry	B			B	B	B	B		B	A
Chlorosulfonic Acid, dry	C	C	D	D	D	C	D		D	A
Chrome Alum	C	B	B	B	B	B	A		A	A
Chromic Acid<50%	D	D	C	C	B	B	D	D	B	A
Chromic Acid≥50%	D	D	C	D	C	D	D	C	C	A
Chromium Sulfate	C			B	B	B	B		B	A
Cider			A	A	A	A				A
Citric Acid	D	D	C	C	A	B	A		A	A
Citrus Juices	B	D	B	B	B	A	A	A		A
Coca-Cola Syrup			A	A	A		B			A
Coconut Oil	B	C	B	B	B	B	A	A	C	A
Cod Liver Oil							A		A	A
Coffee	A		A	A	A	B	A		A	B
Coffee Extracts, hot	B	C	A	A	A	A				A
Coke Oven Gas	C	B	B	B	B	B	D		D	A
Cooking Oil	B	B	A	A	A	A	A	A	D	A
Copper Acetate	D	D	B	B	B	C	C		B	A
Copper Carbonate			B	B	B	D	D			A

CORROSION CHART

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Copper Cyanide	D		B	B	B	D	A		A	A
Copper Nitrate	D	D	B	A	A	D	A	A	B	A
Copper Sulfate	D	D	B	B	B	C	A	A	A	A
Corn Oil	B	B	B	B	B	B	B	A	D	A
Cottonseed Oil	B	B	C	C	B	B	A	A	C	A
Creosol		C		B	B		D		D	A
Creosote Oil	B	B	B	B	B	B	B	D	D	A
Cresylic Acid	D	C	B	B	B	C	D	D	D	A
Crude Oil, sour	C	B	A	A	A	B	B		D	A
Crude Oil, sweet	B	B	A	A	A	A	A		D	A
Cutting Oils, Water Emulsions	A	B	A	A	A		A	A	D	A
Cyanide Plating Solution	D			B	B	D	B		B	A
Cyclohexane	A	B	A	B	A	B	B	A	D	A
Cyclohexanone	B	D	B	B	B	B	D		B	A
Detergents, synthetic	B			B	A	B	B		B	A
Dextrin	B			B	B	C	B		B	A
Dichloroethane	D	C		B	B	A	D		D	A
Dichloroethyl Ether	B			B	B		D		D	A
Diesel Oil Fuels	A	B	A	A	A	A	A	A	D	A
Diethylamine	D	D	B	B	A	B	C		C	A
Diethylene Glycol	B			A	A	B	A		A	A
Diethyl Sulfate	B			B	B	B	C	A	C	A
Dimethyl Formamide	B			A	A	B	B		D	A
Dipentane (Pinene)	A			A	A		B		D	A
Disodium Phosphate	C	B	B	B	B	C	B			A
Dowtherm	A	B	A	A	A	A	D	A	D	A
Drilling Mud	B	B	A	B	A	B	A	A	A	A
Dry Cleaning Fluids	C	B	A	A	A	B	D	A	D	A
Drying Oil	C	C	B	B	B	B	A	A	D	A
Enamel	A			A	A		B		D	A
Epsom Salts	B	C	B	B	B	B	A	A		A
Ethane	B	C	B	B	B	B	A	A	D	A
Ethers	B	B	A	A	A	B	D	C	C	A
Ethyl Acetate	B	B	B	B	B	B	D	A	C	A
Ethyl Acrylate	B	C	B	B	B	B	D		C	A
Ethyl Bromide	A		B	B	B	B	B		D	A
Ethyl Chloride, dry	B	B	A	A	A	B	B	A	B	B
Ethyl Chloride, wet	C	D	B	C	B	B	B		B	A
Ethylene Chloride		B	B	B	B	B	D		D	A
Ethylene Dichloride	D	B	B	B	B	A	D	D	D	A
Ethylene Glycol	B	B	B	B	B	B	A	C	A	A

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Ethylene Oxide	C	B	B	B	B	C	D	A	D	A
Ethyl Ether	B				A	A	D		D	A
Ethyl Silicate	B			B	B	B	B		B	A
Ethyl Sulfate	B			B	B	B	C	A	C	A
Fatty Acids	C	D	B	B	A	B	B	A	D	A
Ferric Hydroxide				A	A	A	B			A
Ferric Nitrate	D	D	C	B	B	D	A	A	A	A
Ferric Sulfate	D	D	C	C	B	D	A	A	A	A
Ferrous Chloride	C	D	D	D	D	D	A	A	A	A
Ferrous Sulfate	C	D	C	B	B	B	A	A	A	A
Ferrous Sulfate, Saturated	C	C	A	B	A	B	C		B	A
Fertilizer Solutions	C	B	B	B	B	B	B	D	B	A
Fish Oils	B	B	A	A	A	A	A	B	D	A
Flue Gases	B			B	A	B	C	C	D	A
Fluoboric Acid				B	B	B	A		A	A
Fluorosilicic Acid	B	D	D	D	B	A	B		C	A
Food Fluids & Pastes	B	C	A	A	A	B	B		B	A
Formaldehyde, cold	A	A	A	A	A	A	B	A	B	A
Formaldehyde, hot	B	D	C	C	C	B	B	A	B	A
Formic Acid, cold	C	D	C	C	B	B	D	D		A
Formic Acid, hot	C	D	C	C	B	B	D	D		A
Freon Gas, dry	B	B	A	A	A	A	C	B	C	A
Freon 11, MF, 112, BF	B	D	B	B	A	B	B	B	D	
Freon 12, 13, 32, 114,115	A	D	B	B	A	B	B	B	C	
Freon 21, 31	B			A	B		D	B	D	
Freon 22	A	D	B	B	A	B	D	B	D	
Freon 113, TF	B				A	B	B		D	
Freon, wet	D		B	C	C	B	B		B	A
Fruit Juices	C	D	B	B	A	B	A	A	A	A
Fuel Oil	B	B	B	B	B	B	A	A	D	A
Fumaric Acid							B			A
Furfural	B	C	B	B	B	B	D	A	C	A
Gallic Acid 5%	B	D	B	B	B	B	B	A	B	A
Gas, Manufactured	B	B	B	B	B	A	A	A		A
Gas, Natural	B	B	B	B	B	B	A	A	B	A
Gas, Odorizers	A	B	B	B	B	B	B	A		A
Gasoline, Aviation	A	A	A	A	A	A	C	A		A
Gasoline, Leaded	A	A	A	A	A	B	C	A		A
Gasoline, Motor	A	A	A	A	A	A	C	A	D	A
Gasoline, Refined	B	B	B	B	B	B	C		D	A

CORROSION CHART

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Gasoline, Sour	B	B	B	B	B	C	C	A	D	A
Gasoline, Unleaded	B	B	B	B	B	B	C	A		A
Gelatin	B	D	A	A	A	B	A	A	A	A
Glucose	B	B	B	B	A	B	A	A	A	A
Glue	B	B	B	B	B	B	A		B	A
Glycerine (Glycerol)	B	C	A	A	A	A	A	C	A	A
Glycols	B	C	B	B	B	B	B	C	A	A
Graphite	B			B	B	B	B		B	A
Grease	C	A	A	A	A	B	A		D	A
Helium Gas	B			B	B	B	B		B	A
Heptane	A	B	A	A	A	B	A	A	D	A
Hexane	B	B	B	A	A	B	A	A	D	A
Hexanol, Tertiary	B	B	B	B	A	B	A		D	A
Hydraulic Oil, Petroleum Base	B	A	A	A	A	A	A	A	D	A
Hydrazine	D	B		B	B	D	C		B	A
Hydrocyanic Acid	D	C	B	B	B	C	B	D	B	A
Hydrofluosilicic Acid	D	D	C	D	C	B	B		A	A
Hydrogen Gas, cold	A	A	A	A	A	A	A		A	A
Hydrogen Gas, hot		B			B		A		A	A
Hydrogen Peroxide, Concentrated	C	D	B	B	B	C	D		B	A
Hydrogen Peroxide, Dilute	C	D	B	B	B	B	B	B	A	A
Hydrogen Sulfide, Dry	C	B	B	B	A	B	C	A	A	A
Hydrogen Sulfide, Wet	D	B	C	C	B	D	D	A	B	A
Hypo (Sodium Thiosulfate)	C	D	A	A	A	B	A	A	A	A
Illuminating Gas	A	A	A	A	A	A	C		D	A
Ink - Newsprint	B	D	B	A	A	B	A	A	B	A
Iodoform	B	D	A	A	A	C		A	A	A
Iso-Butane					B		B		D	A
Iso-Octane	A	A	A	A	A	A	A	A	D	A
Isopropyl Acetate					B		D		A	A
Isopropyl Ether	B	B	B	B	B	B	C		D	A
J P-4 Fuel	A	B	B	B	A	B	A	A	D	A
J P-5 Fuel	A	B	B	B	A	B	B	A	D	A
J P-6 Fuel	A	B	B	B	A	B	A	A	D	A
Kerosene	A	B	A	A	A	B	A	A	D	A
Ketchup	D	D	A	A	A	B	A	A		A
Ketones	B	B	B	B	B	B	D	A	D	A

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Lacquer (and Solvent)	A	C	A	A	A	A	D	A	D	A
Lactic Acid Concentrated cold	D	D	B	B	A	D	B	D	B	A
Lactic Acid Concentrated hot	D	D	C	C	B	D	D	D	D	A
Lactic Acid Dilute cold	C	D	B	B	A	C	B	D	B	A
Lactic Acid Dilute hot	D	D	B	B	B	D	D	D	D	A
Lactose	B			B	B	B	B		B	A
Lard	B	C	B	B	B	B	B		C	A
Lard Oil	B	C	A	B	B	B	A	A	B	A
Lead Acetate	D	D	B	B	B	B	B	A	B	A
Lead Sulfate	C	D		B	B	B	B		B	A
Lecithin	C			B	B	B	D		D	A
Linoleic Acid	C	D	A	B	A	B	B	A	D	A
Linseed Oil	A	A	B	B	B	B	A	A	D	A
Lithium Chloride	D			B	B	B	B		B	A
L P G	A	B	B	B	B	B	A	A	D	A
Lubricating Oil Petroleum Base	B	A	A	A	A	B	A	A	D	A
Ludox	D			B	B	B	B		B	A
Magnesium Carbonate	B		A	B	A	B	B		B	A
Magnesium Chloride	B	C	C	C	B	B	A	A	A	A
Magnesium Hydroxide	B	B	B	A	A	B	B	A	A	A
Magnesium Hydroxide, Hot	D	B	B	A	A	B	B	A	A	A
Magnesium Nitrate	B	B	B	B	A	B	B		A	A
Magnesium Sulfate	B	B	B	B	A	A	A	A	A	A
Maleic Acid	C	D	B	B	B	B	D	A	D	A
Maleic Anhydride	C			B	B	B	D		D	A
Malic Acid	D	D	B	B	A	B	A	A	D	A
Manganese Carbonate				B	B		B			A
Manganese Sulfate	B		B	B	B	B	B		B	A
Mayonnaise	D	D	A	A	A	B	A	A		A
Meat Juices	D		B	B	B	B	B		D	A
Melamine Resins					C		B			A
Menthol	B			B	B	B	B		D	A
Mercuric Chloride	D	D	D	D	B	D	A		A	A
Mercuric Cyanide	D	D	B	B	B	C	A		A	A

A = Excellent
B = Good
C = Poor
D = Do Not Use

	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
	VALVE MATERIAL						SEATS & SEALS			
Mercurous Nitrate	D		B	B	A	D	B		B	A
Mercury	D	B	A	A	A	A	A	A	A	A
Methane	B	B	B	B	B	B	A	A	D	A
Methyl Acetate	B	B	A	B	A	B	D		B	A
Methyl Acetone	A	A	A	A	A	A	D		A	A
Methylamine	D	B	A	A	A	C	D		B	A
Methyl Cellosolve	B	C	B	B	A	B	D		B	A
Methyl Chloride	B	D	B	A	A	B	D	A	D	A
Methyl Ethyl Ketone	A	A	A	A	A	A	D	A	B	A
Methylene Chloride	A	B	A	B	A	B	D		D	A
Methyl Formate	A	C	B	B	B	B	D		B	A
Methyl Isobutyl Ketone	A	B	B	B	A	B	D			A
Milk & Milk Products	C	B	A	A	A	C	A	A	A	A
Mineral Oils	B	B	B	B	B	B	A	A	D	A
Mineral Spirits	B	C	B	A	A	B	A	A	D	A
Mine Water (Acid)	D	D	B	B	B	C	A	A	B	A
Mixed Acids (cold)	D	D	B	B	B	D	D	D	D	A
Molasses, crude	A	B	A	A	A	B	A	A	A	A
Molasses, Edible	A	B	A	A	A	B	A	A	A	A
Monochloro Benzene, Dry						B	D			A
Morpholine	B	B	B	B	B	B	D		D	A
Mustard	A	B	A	A	A	A	A	A		A
Naptha	A	B	B	B	B	B	B	A	D	A
Napthalene	B	B	B	B	B	B	D	A	D	A
Natural Gas, Sour	B			D	D	D	A		D	D
Nickel Ammonium Sulfate	D	D	B	B	B	C	A		B	A
Nickel Chloride	C	D	B	B	B	B	A	A	B	A
Nickel Nitrate	D	C	B	A	A	B	A	A	A	A
Nickel Sulfate	C	D	B	B	B	B	A	A	B	A
Nicotinic Acid	B	B	B	B	A	B	D		B	A
Nitric Acid 10%	D	D	A	A	A	D	C	D		A
Nitric Acid 30%	D	D	A	A	A	D	C	D	B	A
Nitric Acid 80%	D	D	B	B	B	D	D	D	B	A
Nitric Acid 100%	D	D	B	B	B	D	D	D	C	A
Nitric Acid Anhydrous	D	D	C	C	B	D	D		C	A
Nitrobenzene	B	B	B	B	B	B	D		D	A
Nitrogen	A	A	A	A	A	A	A	A	B	A
Nitrous Acid 10%	D	D	C	C	B	D	C			A

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	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
	VALVE MATERIAL						SEATS & SEALS			
Nitrous Gases	D	B	C	C	B	D				A
Nitrous Oxide	D	B	B	B	B	D	B	A		A
Oils & Fats			B	B	B		B		D	A
Oils, Animal	B	B	B	B	A	B	A		B	A
Oils, Petroleum Refined	B	A	A	A	A	A	A	A	D	A
Oils, Petroleum Sour	C	B	A	A	A	A	B		D	A
Oils, Water Mixture	A	B	A	A	A		A	A		A
Oleic Acid	B	C	B	B	B	B	B	A	B	A
Oleum	D	B	B	B	B	D	D	D	D	A
Oleum Spirits	D		B	B	B	D	C		D	A
Olive Oil	C	B	A	A	A	A	A	A	B	A
Olalic Acid	B	D	D	D	B	B	D	C	B	A
Oxygen	A	B	B	B	A	B	B	D	A	A
Ozone, Dry	A	C	A	A	A	A	D		A	A
Ozone, Wet	B	C	B	A	A	A	D		B	A
Paints & Solvents	A	A	A	A	A	A	D		D	A
Palmitic Acid	B	C	B	B	B	B	B	A	B	A
Palm Oil	B	C	B	B	B	A	B	A	D	A
Paper Pulp	B			B	B	B	B		B	
Paraffin	A	B	A	A	A	A	A	A	D	A
Paraformaldehyde	B	B	B	B	B	B	B	A	D	A
Paraldehyde							B		D	A
Pentane	A	B	A	A	A	B	A	A	D	A
Perchlorethylene, dry	B	B	B	B	B	B	D		D	A
Petrolatum (Vaseline Petroleum Jelly)	B	C	B	B	B	B	A	A	D	A
Phenol	B	D	A	B	A	A	D	D	D	A
Phosphate Ester 10%	D	B	A	A	A	A	D		A	A
Phosphoric Acid 10%	D	D	C	B	B	D	D	D	B	A
Phosphoric Acid 50% Cold	D	D	B	B	B	C	D	D	B	A
Phosphoric Acid 50% Hot	D	D	D	C	D	C	D	D	B	A
Phosphoric Acid 85% Cold	D	D	B	B	B	C	D	D	B	A
Phosphoric Acid 85% Hot	D	D	C	B	B	C	D	D		A
Phosphoric Anhydriede		D		B	B		D	B		A

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Phosphorous Trichloride		B	A	A	A		D		A	A
Phthalic Acid	B	C	B	B	A	B	C	A		A
Phthalic Anhydride	B	B	B	A	A	A	C	A	B	A
Picric Acid	D	D	B	B	B	D	C		B	A
Pineapple Juice	C	C	A	A	A	A	A	A		A
Pine Oil	B	B	A	A	A	B	A	A	D	A
Pitch (Bitumen)	A	B	A	A	A	A	C		D	A
Polysulfide Liquor	D			B	B	B	B		B	A
Polyvinyl Acetate	B			A	A	B	C		A	A
Polyvinyl Chloride	B			B	B	B			B	A
Potassium Bicarbonate			A	A	A	B	B		A	A
Potassium Bisulfate					A	B	B	A		A
Potassium Bisulfite	C	D	B	B	B	D	A	A	B	A
Potassium Bromide	C	D	B	B	B	B	A	A	A	A
Potassium Carbonate	D	B	B	A	A	B	A	A	A	A
Potassium Chlorate	D	C	B	B	A	C	A	A	A	A
Potassium Chloride	D	C	C	C	B	B	A	A	A	A
Potassium Chromate	C			B	B	B	B		B	A
Potassium Cyanide	D	B	B	B	B	B	A	A	A	A
Potassium Dichromate	B	B	B	A	A	B	A	A	A	A
Potassium Ferricyanide	C	D	B	B	B	B	A	A	A	A
Potassium Ferrocyanide	B	C	B	B	B	B	A	A		A
Potassium Hydroxide Dilute Cold	C	B	B	B	B	A	A		B	A*
Potassium Hydroxide To 70%, Cold	D	C	B	B	B	A	B		B	A*
Potassium Hydroxide Dilute Hot	D	B	B	B	B	A	B		B	A*
Potassium Hydroxide To 70%, Hot	D	C	D	D	B	B	C		A	A*
Potassium Iodide	C	D	B	B	B	C	A	A	A	A
Potassium Nitrate	B	B	B	B	B	B	A	A	A	A
Potassium Oxalate			B	B	B	B	D			A
Potassium Permanganate	C	C	B	B	B	B	C	A	A	A
Potassium Phosphate	C			B	B	B	A		A	A
Potassium Phosphate Di-basic	B	A	A	A	A	B	A	A	B	A
Potassiuum Phosphate Tri-basic		A			B	B	B		B	A
Potassium Sulfate	B	B	B	A	A	B	A	A	A	A
Potassium Sulfide	D	D	B	B	B	D	A		B	A
Potassium Sulfite	B	B	B	B	A	C	B		A	A
Producer Gas	B	B	B	B	B	A	A	A	D	A
Propane Gas	A	B	B	B	B	B	A	A	D	A
Propylene Glycol	B	B	B	B	B	B	A	C	A	A
Pyridine	B	C	B	B	B	B	D		B	A
Pyrogallic Acid	C	C	C	C	B	C	A	A		A
Pyrolignous Acid			B	B	B		D		B	A
Quench Oil	B	B	A	A	A		A	A	D	A
Quinine Bisulfate, dry			A	A	A	B				A
Ouinine Sulfate dry			A	A	A	B				A
Resins & Rosins	A	C	B	B	B	A	C		D	A
Road Tar	A	A	A	A	A	A	B	A	D	A
Roof Pitch	A	A	A	A	A	A	B	A		A
Rosin Emulsion	B	C	A	A	A	A	D			A
Rubber Latex Emulsions	A	B	A	A	A			A		A
Rubber Solvents	A	A	A	A	A	A	D	C	D	A
Salad Oil	B	C	B	B	B	B	A	A	D	A
Salicylic Acid	C	D	B	B	B	C	B	A	A	A
Salt (naCl)	B	C	B	B	B	A	A	A	A	A
Salt Brine	B	D		A	A	B	A		B	A
Sea Water	C	D	B	B	A	A	A	A	A	A
Sewage	C	C	B	B	B	B	A		B	A
Shellac-bleached	A	A	A	A	A		A			A
Shellac-orange	A	A	A	A	A	A	A			A
Silicone Fluids	B		B	B	B		B		B	A
Silver Bromide			B	B	A	B				A
Silver Cyanide	D		A	B	A	B	B		B	A
Silver Nitrate	D	D	B	B	A	D	C	A	A	A
Silver Plating Sol.			A	A	A		B		B	A
Soap Solutions (Stearates)	A	A	A	A	A	A	A		A	A
Sodium Acetate	B	D	B	B	B	C	B	A	A	A
Sodium Aluminate	B	C	B	B	B	B	A	A	B	A

CORROSION CHART

A = Excellent
B = Good
C = Poor
D = Do Not Use

	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
	VALVE MATERIAL						SEATS & SEALS			
Sodium Bicarbonate	B	C	A	A	A	A	A	A	A	A
Sodium Bichromate	D		B	B	B		D			A
Sodium Bisulfate 10%	C	C	A	A	A	B	A	A	A	A
Sodium Bisulfite 10%	D	D	B	B	B	B	A	A	A	A
Sodium Borate	B	C	B	B	B	B	A	A	A	A
Sodium Bromide 10%	B	C	B	B	B	B	A	A	A	A
Sodium Carbonate (Soda Ash)	B	B	B	B	B	A	A	A	A	A
Sodium Chlorate	B	C	B	B	B	B	A	A	A	A
Sodium Chloride	B	C	B	B	B	A	A	A	A	A
Sodium Chromate	C	B	B	B	B	B	A	A	A	A
Sodium Citrate			B	B	B					A
Sodium Cyanide	D	C	A	A	A	D	A	A	A	A
Sodium Ferricyanide				C	B	B			A	A
Sodium Fluoride	D	D	C	C	B	A	A	A	A	A
Sodium Hydroxide 20% Cold	B	B	A	A	A	A	B		A	A•
Sodium Hydroxide 20% Hot	B	B	A	A	A	A	B		A	A•
Sodium Hydroxide 50% Cold	C	C	A	A	A	A	B		A	A•
Sodium Hydroxide 50% Hot	C	C	B	B	A	A	B		A	A•
Sodium Hydroxide 70% Cold	C	C	B	B	B	A	B		A	A•
Sodium Hydroxide 70% Hot	D	D	C	C	C	B	D		B	A•
Sodium Hypo-sulfite			A	A	A	B				A
Sodium Lactate			A	A	A	B				A
Sodium Meta-phosphate	C	D	B	B	B	B	A		A	A
Sodium Meta-silicate Cold	B	C	A	A	A	A	B			A
Sodium Meta-silicate Hot	B	D	A	A	A	A				A
Sodium Nitrate	D	B	B	A	A	B	B	A	A	A
Sodium Nitrite			B	B	B	C	C	B	A	A
Sodium Perborate	C	B	B	B	B	B	C	A	A	A
Sodium Peroxide	D	C	B	B	B	B	C	A	A	A
Sodium Phosphate	C	C	B	B	B	B	B	B	A	A
Sodium Phosphate Di-basic	C	C	B	B	B	B	A	A	A	A
Sodium Phosphate Tri-basic	C	C	B	B	B	B	B	A	A	A
Sodium Polyphosphate					B		B		A	A
Sodium Salicylate			A	A	A					A
Sodium Silicate	B	B	B	B	B	B	A	A	A	A
Sodium Silicate, hot	C	C	B	B	B	B			B	A
Sodium Sulfate	B	B	B	A	A	B	A	A	A	A
Sodium Sulfide	D	C	B	B	B	B	A	A	A	A
Sodium Sulfite	D	C	A	A	A	B	A		A	A
Sodium Tetraborate					A		A		B	A
Sodium Thiosulfate	D	D	C	C	B	B	B	A	C	A
Soybean Oil	B	C	A	A	A	A	A	A	B	A
Starch	B	C	B	B	B	A	A	A	C	A
Steam (212°F.)	A	B	A	A	A	B	D	D	B	B
Stearic Acid	B	C	B	B	A	C	B	A	B	A
Styrene	A	A	A	A	A	B	D		D	A
Succinic Acid	C		D	C	B	B				A
Sugar Liquids	A	B	A	A	A	A	A	A	B	A
Sugar, Syrups & Jam	B		B	A	A		A		A	A
Sulfate, Black Liquor	D	D	B	B	B	B	C	B	B	A
Sulfate, Green Liquor	D	D	B	B	B	B	C	A		A
Sulfate, White Liquor	D	D	B	B	B	C	C	A		A
Sulfonic Acid	B			B	B	B	D		D	A
Sulfur	D	D	B	A	A	B	D	A	A	A
Sulfur Chlorides, Dry	D	D	D	C	C	C	D	A	D	A
Sulphur Dioxide, dry	B	A	B	B	B	B	D	A	A	A
Sulfur Dioxide, wet	D	D	D	D	B	D	D		A	A
Sulfur Hexafluoride	B		A	A	A		A		A	A
Sulfur, Molten	D	D	B	B	B	D	D		D	A
Sulfur Trioxide	D	B			B	B	D		B	A
Sulfur Trioxide, dry	D	B	B	B	B	B	D	A	B	A
Sulfuric acid 0 to 77%	D	D	D	D	D	B	D	C	B	A

A = Excellent
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C = Poor
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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Sulfuric Acid 100%	D	C	C	C	B	D	D	D	C	A
Sulfurous Acid	D	D	D	D	B	D	B	C	B	A
Tall Oil	B	B	B	B	B	B	B	A	D	A
Tannic Acid (Tannin)	D	D	B	B	B	B	B	A	A	A
Tanning Liquors			B	B	B		B			A
Tar & Tar Oils	A	A	A	A	A	A	C		D	A
Tartaric Acid	B	D	B	A	A	B	B	A	C	A
Tetraethyl Lead	B	C	B	B	B	B	B	A	D	A
Toluol (Toluene)	A	A	A	A	A	A	D	A	D	A
Tomato Juice	C	C	B	B	B	B	A	A		A
Transformer Oil	B	B	B	B	B	B	A	A	D	A
Tributyl Phosphate	B	B	B	B	B	B	D		A	A
Trichlorethylene	B	B	B	B	B	A	D	A	D	A
Trichloroacetic Acid	D	D	D	D	D	B	C		C	A
Triethanolamine	B	C		B	B	B	D		B	A
Triethylamine	B			B	B	B	B			A

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	VALVE MATERIAL						SEATS & SEALS			
	Bronze	Carbon Steel	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	Monel	Buna N	Delrin	EPDM	Teflon
Trisodium Phosphate		B		B	B	B	A		B	A
Tung Oil	B	B	A	A	A	C	A	A	D	A
Turpentine	B	B	A	A	A	A	B	A	D	A
Urea	B	C	B	B	B	B	B	A	B	A
Uric Acid			B	B	B					A
Varnish	A	C	A	A	A	A	C	A	D	A
Vegetable Oils	B	B	A	A	A	A	A	A	D	A
Vinegar	C	C	B	B	B	B	D		B	A
Vinyl Acetate	B			A	B	B	D		A	A
Water, Distilled	A	D	A	A	A	A	B	A	A	A
Water, Fresh	A	C	A	A	A	A	B	A	A	A
Water, Acid Mine	D	D	B	A	A	D	B		A	A
Waxes	A	A	A	A	A	A	A	A	C	A
Whiskey & Wines	B	C	A	A	A	A	A	A	A	A
Xylene (Xylol), Dry	B	B	B	B	B	B	D	A	D	A
Zinc Bromide	B			B	B	B	B		B	A
Zinc Hydrosulfite	C	A	A	A	A	B	A	A	A	A
Zinc Sulfate	C	D	B	A	A	B	A	A	A	A

ATTACHMENT D-2-4-6

APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 1400

<u>Revision No.</u>

5.0

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 1400

TANKS T-1405 THROUGH T-1420

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TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNIT 1400

TANKS T-1405 THROUGH T-1420

I. Introduction

This document provides the assessment and certification for the design of the hazardous waste storage tank system(s) at Tank Management Unit 1400 at the Chemical Waste Management, Inc. Facility in Emelle, Sumter County, Alabama. The assessment was performed to address the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), regarding the design of the system within Tank Management Unit 1400 which is comprised of the tanks (i.e., Tanks T-1405 through T-1420), the tank foundation, the associated ancillary equipment and the secondary containment system.

Tank Management Unit 1400 is centrally located within the active portion of the Facility to the south of PK-1000 and to the north of Unit 2000 as shown on Drawing No. 0100-020-001 in Appendix D-1 to Section D of the RCRA Part B Permit Application. The primary function of the tank systems within Unit 1400 is to store and treat all types of aqueous wastes including off-site receipts and Facility generated wastes such as landfill leachate, landfill berm surface waters, secondary containment system catchment waters, and aqueous residues from treatment of other wastes. Additionally, Unit 1400 will house clean water storage tank(s) for the biological treatment system. The majority of the underground pipe chase is considered to be ancillary to Unit 1400. Only the portions of the underground pipe chase between the limits of the landfill trenches and the Unit 1700A, B & C tanks are considered to be ancillary to Unit 1700. The underground pipe chase enables the collection of leachate from the landfill trenches, catchment waters from various tank secondary containment systems, blowdown from Unit 900 and wastewaters from Unit 708, and subsequent underground transfer of these wastewaters to Unit 1400. Schematic Diagrams for the underground pipe chase are provided in Drawing Nos. 0100-010-003 and 0100-010-004, which are all located in Appendix D-1 of this Application. The underground pipe chase is constructed in phases as required to support the management of leachate generated from new landfill trenches and other wastewaters generated on-site.

The following drawings were used in the preparation of this Assessment and Certification and are provided either in Exhibit A (Tank Data Sheets) or in Appendix D-1 to Section D of the RCRA Part B Permit Application:

Drawing No.	**Drawing Title**
1400-010-003	Tank Management Unit 1400 - P&ID
1400-010-004	Tank Management Unit 1400 - P&ID

1400-010-005	Tank Management Unit 1400 - P&ID
1400-010-006	Tank Management Unit 1400 - P&ID
1400-010-007	Tank Management Unit 1400 - P&ID
1400-020-001	Tank Management Unit 1400 - Area Foundation Location Plan – Phase 1
1400-020-003	Tank Management Unit 1400 - Area Paving Plan – Phase 1
1400-030-001	Tank Management Unit 1400 - Sections
1400-030-002	Tank Management Unit 1400 - Sections
1400-040-001	Tank Management Unit 1400 - Details
1400-040-002	Tank Management Unit 1400 - Details
1400-040-003	Tank Management Unit 1400 - Details
1400-080-005	Tank Data Sheet - T-1405
1400-080-006	Tank Data Sheet - T-1406
1400-080-007	Tank Data Sheet - T-1407
1400-080-008	Tank Data Sheet - T-1408
1400-080-009	Tank Data Sheet - T-1409
1400-080-010	Tank Data Sheet - T-1410
1400-080-011	Tank Data Sheet - T-1411
1400-080-012	Tank Data Sheet - T-1412
1400-080-013	Tank Data Sheet - T-1413
1400-080-014	Tank Data Sheet - T-1414
1400-080-015	Tank Data Sheet - T-1415
1400-080-016	Tank Data Sheet - T-1416
1400-080-017	Tank Data Sheet - T-1417
1400-080-018	Tank Data Sheet - T-1418
1400-080-019	Tank Data Sheet - T-1419
1400-080-020	Tank Data Sheet - T-1420

II. Tank Design

Tanks T-1405 through T-1420 have been designed in accordance with the design codes and standards indicated within the DESIGN DATA section of the Tank Data Sheets (i.e., Drawing Nos. 1400-080-005 through -020,) provided in Exhibit A to this tank system design assessment. The criteria utilized in the assessment of the design of the shell, structural support, and anchorage for Tanks T-1405 through T-1420 are also provided within the DESIGN DATA section of the Tank Data Sheets, as well as within the tank design calculations provided in Exhibit B to this tank system design assessment.

The calculations provided in Exhibit B to this tank system design assessment demonstrate that the tank shell, structural supports and anchorages are, as designed, adequate to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable, at the design conditions indicated on the tank data sheets.

III. Tank Foundation Design

The design of the reinforced concrete foundations for Tanks T-1405 through T-1420 is indicated in the foundation detail Plan View and Details 2, 3, and 5 on Drawing No. 1400-040-003 which is provided in Appendix D-1 to Section D of the RCRA Part B Permit Application. The criteria utilized in the assessment of the design of the foundation for Tanks T-1405 through T-1420 are provided within the tank foundation design calculations provided in Exhibit C to this tank system design assessment.

The tank foundation design calculations provided in Exhibit C demonstrate that the tank foundation is, as designed, adequate to support the load of the full tanks and to withstand associated environmental stresses at the design conditions indicated on the tanks data sheets and provided within foundation design calculations.

IV. Ancillary Equipment Design

All tank system ancillary piping systems shall be designed, installed and tested in accordance with the American Society of Mechanical Engineers (ASME) Standard B31.3, "Chemical Plant and Petroleum Refinery Piping", or an equivalent nationally recognized standard, and in accordance with recognized good engineering practices to ensure that they are supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

All other ancillary equipment for the tank system shall be designed, installed and tested in accordance with appropriate recognized standards, if any, and in accordance with recognized good engineering practices to ensure that it is supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

In order for this tank design assessment and associated certification to be maintained, and prior to the tank system being placed in use, the Facility shall ensure that the tank system ancillary equipment is properly installed and that all required inspections, tests and repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f). Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative

Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment was properly designed, installed and tested.

V. Secondary Containment System Design

The design features of the secondary containment system for the tank system within Unit 1400 are indicated on Drawing Nos. 1400-020-001 & -003, 1400-030-001 & -002, and 1400-040-001 through -003, which are located in Appendix D-1 to Section D of the RCRA Part B Permit Application. As shown on these drawings and in accordance with the applicable requirements of 40 CFR 264.193 and ADEM Administrative Code Rule 335-14-5-.10(4), the secondary containment system design is comprised of a reinforced concrete base, with all joints sealed with chemical-resistant waterstops, and all concrete surfaces sealed with chemical resistant concrete coating system. Information on the concrete coatings available for use on the secondary containment system is provided within Appendix D-1-3 to Section D-1 of the RCRA Part B Permit Application.

Calculations demonstrating that the design secondary containment capacity meets or exceeds the applicable requirements 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e) are provided in Appendix D-2-2 to Section D-2 of the RCRA Part B Permit Application.

VI. Tank Venting Requirements

As indicated on the P&ID's for Unit 1400 (i.e., Drawing Nos. 1400-010-001 through -007 which are located in Appendix D-1 to Section D of the RCRA Part B Permit Application), Tanks T-1405 through T-1420 are designed as closed top tanks that passively vent to atmosphere. The Tank Data Sheets (i.e., Drawing Nos. 1400-080-005 through -020,) specify the diameter of the atmospheric vent nozzle on each of the tanks.

The requirements for normal (i.e., liquid displacement and thermal effects) venting capacities for the Unit 1400 tanks were evaluated in accordance with American Petroleum Institute Standard 2000, Venting Atmospheric and Low-Pressure Storage Tanks (i.e., API 2000). As shown in the venting calculations provided in Exhibit D to this tank system design assessment, the size of the atmospheric vent nozzle on each of the tanks is adequate to allow the tank under normal conditions to be maintained within the design limitations for pressure and vacuum as specified on the Tank Data Sheets provided in Exhibit A and within the tank design calculations provided in Exhibit B to this tank system design assessment. The venting calculations provided in Exhibit D to this tank system design assessment also indicate the design maximum tank fill and withdrawal rates which were used in the evaluation of the tank venting requirements.

VII. Hazardous Characteristics of the Waste Managed

In accordance with the requirements of 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., this section presents an evaluation of the compatibility of the wastes managed within the Unit 1400 tank system with the materials of construction of Tanks T-1405 through T-1420 and the ancillary equipment (i.e., pumps and piping) to determine their suitability for service in this unit.

The types of wastes managed within Tanks T-1405 through T-1420 will include virtually every type of hazardous waste listed and identified in 40 CFR Part 261 and ADEM Administrative Code Rule 335-14-2, except for ignitable and reactive wastes. In addition, non-hazardous wastes, as well as treatment residues from listed wastes are managed in tank systems in Unit 1400. Tanks T-1405 through T-1420 and the ancillary equipment that contact wastes within this system are primarily constructed of carbon steel with internal corrosion protection for the tanks.

Exhibit E to this tank system design assessment presents information which provides an indication of the relative compatibility of epoxy coating, such as Devoe Chemline 253 or demonstrated equivalent, with a wide variety of chemical compounds and other substances. The table in Exhibit E provides corrosion/compatibility information for Chemline 253 epoxy coating exposed to pure chemical compounds which, in general, tend to have a more severe corrosive effect than wastes which contain mixtures and complexes of these compounds. Although this table may not provide corrosion data and service recommendations for all of the potential constituents of the wastes or waste mixtures which may be managed within the tank system in Unit 1400, the table does demonstrate that Chemline 253 is generally compatible with and, under normal conditions, should not experience an accelerated rate of corrosion or deterioration when exposed to a majority of the types and classes of wastes which are managed within the Unit 1400 tank system. In addition to the compatibility/corrosion data provided in Exhibit E, the compatibility of Chemline 253 with the types of wastes managed within Unit 1400 is further validated by the empirical data provided by many years of comparable service applications within a variety of units at the Facility.

Based on the information provided in Exhibit E of this tank system design assessment and the empirical data compiled at the Facility for comparable service applications, it is the conclusion of this evaluation that the Chemline 253 coated carbon steel tank system components are generally compatible with the types of waste managed within the Unit 1400 tank system. It is further concluded that these materials of construction are suitable for this service if the tank system is operated within the design limitations set forth within this assessment, and that, if the tank system is managed in accordance with the following minimum practices, these materials of construction should not experience an accelerated rate of corrosion or deterioration which may result in a catastrophic failure of the tank system, throughout its useful life:

- Prior to placement of a waste into the tank system, the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. References other than Exhibit E of this document, such as other recognized sources of corrosion data, may also be used to evaluate compatibilities. The Facility shall prohibit the placement into the Unit 1400 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components; and
- The Facility shall perform an annual inspection of the tank shells to ensure that minimum code thicknesses are maintained, and that adequate corrosion allowance is available for continued service.

VIII. Certification of Tank System Design Assessment

In accordance with the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), this section provides a certification by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), that an assessment of the design of the following tank system(s) demonstrates that the tank system foundation, structural supports, seams, connections, and pressure controls are adequate, and that the tanks have sufficient structural strength, compatibility with the wastes to be managed and/or protection from corrosion so that they will not collapse, rupture or fail, if properly installed, operated within the design limits, and properly inspected and maintained:

Tank System Location:	Chemical Waste Management, Inc. Emelle, Alabama
Tank System Identification:	Tank Management Unit 1400
Applicable Tanks:	T-1405 through T-1420

At a minimum, the assessment of the tank system design, which is incorporated herein by reference, addresses and considers the following factors with respect to the intended use of the tank system:

- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank designs have been evaluated for structural integrity with regards to the ability of the designed tank shell, structural supports and anchorages to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable;

- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tanks have been evaluated with regards to the adequacy of the designed tank to provide the necessary capacity for normal venting;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which piping and other ancillary equipment shall be designed and constructed to maintain this certification;
- In accordance with 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., the assessment of the tank system design considers the compatibility of the tank's materials of construction and/or internal coatings with the types of hazardous wastes to be managed;
- In accordance with the applicable requirements of 40 CFR 264.192(a)(5) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)5., the assessment of the tank system design considers the ability of the designed tank system foundation to support the load of the full tanks and to withstand associated environmental stresses; and
- The assessment of the tank system design considers the adequacy of the capacity of the designed tank secondary containment system as required by the applicable requirements of 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e).

In order for this certification to be maintained, the Facility shall comply with the applicable requirements of 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10, and shall perform all routine management procedures, periodic inspections and reviews, and tank system functionality and integrity tests as required by the permit including, but not limited to, the following:

- The Facility shall ensure that the tank system is properly installed and that, prior to placing the tank system in use, all required inspections, tests and necessary repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f);

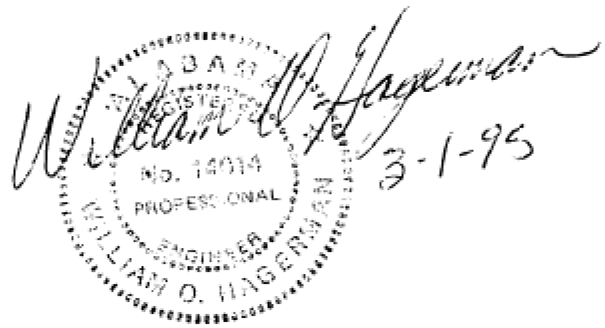
- Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested;
- Prior to placement of a waste into the tank system, the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the Unit 1400 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components;
- Prior to placement of a waste into the tank system, the Facility shall verify the specific gravity of the waste in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the tank system of any waste that has a specific gravity that exceeds the design maximum value specified within the tank system design assessment;
- Prior to placement of a waste into the tank system, the Facility shall verify in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application that the treatment of the waste will not cause temperatures within the tank system to exceed the design maximum value specified within the tank system design assessment;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank exterior to detect excessive corrosion or deterioration;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank secondary containment system to detect leakable cracks or gaps, or excessive deterioration of the concrete base and/or chemical resistant concrete coatings;
- The Facility shall perform an annual inspection of the tank shells, as described in Subsection F-2-6 of Section F-2 of the RCRA Part B Permit Application, to ensure that minimum code thicknesses are maintained, and that adequate corrosion allowance is available for continued service;
- The Facility shall perform an annual inspection of the tank structural supports and anchorages to ensure that their integrity is maintained;

- The Facility shall perform a periodic inspection of the tank venting devices to ensure that they are in good working order to maintain the tanks within the design limits for pressure as specified within the tank system design assessment;
- The Facility shall perform a periodic inspection of the tank level sensing, overfill control devices and associated interlocks to ensure that they are in good working order with the appropriate settings to prevent overfilling of the tanks. The frequencies and procedures for inspection of all tank level sensing and overfill control devices shall be as recommended by the manufacturer;
- The Facility shall perform a periodic inspection of any other operational controls for the tank system to ensure that they are in good working order with the appropriate settings to maintain the tanks within their design limits as specified within the tank system design assessment. The frequencies and procedures for inspection of other tank system operational controls shall be as recommended by the manufacturer; and
- The Facility shall perform periodic inspections of the integrity of any tank system grounding and lightning protection systems.

Based on the information provided within the tank system design assessment and supporting documentation, the design of Tanks T-1405 through T-1420 within Tank Management Unit 1400 meets the current RCRA requirements relative to the design of new hazardous waste tank systems. The design assessment addresses only the applicable requirements of 40 CFR 264.192 and 40 CFR 264.193, and ADEM Administrative Code Rules 335-14-5-.10(3) and (4), and does not consider compliance with other codes or regulations, including, but not limited to, the requirements of the Occupational Safety and Health Act (OSHA).

With regards to the assessment and certification of the design of hazardous waste tank systems in accordance with the applicable requirements of 40 CFR 264.192(a) and (g), and ADEM Administrative Code Rules 335-14-5-.10(3)(a) and (g), I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

William O. Hagerman, P.E.
Alabama P.E. No.: 14014
President
ETI Corporation
6799 Great Oaks Road, Suite 100
Memphis, Tennessee 38138-2500



This certification was originally submitted in 1995. As part of the 2002 Part B Application Renewal, revisions were made to the text in this attachment. These revisions consisted primarily of renaming the section for the Waste Analysis Plan to Section C to maintain consistency with the other Sections contained within this Part B Permit Application. As part of the 2009 Part B Application Renewal, additional revisions were made to the text in this attachment. These revisions consisted primarily of removing references to Tanks T-1421 through T-1436, which were not built and are no longer proposed. No revisions were made to this attachment during this Part B Permit Application renewal process (Revision 5.0).

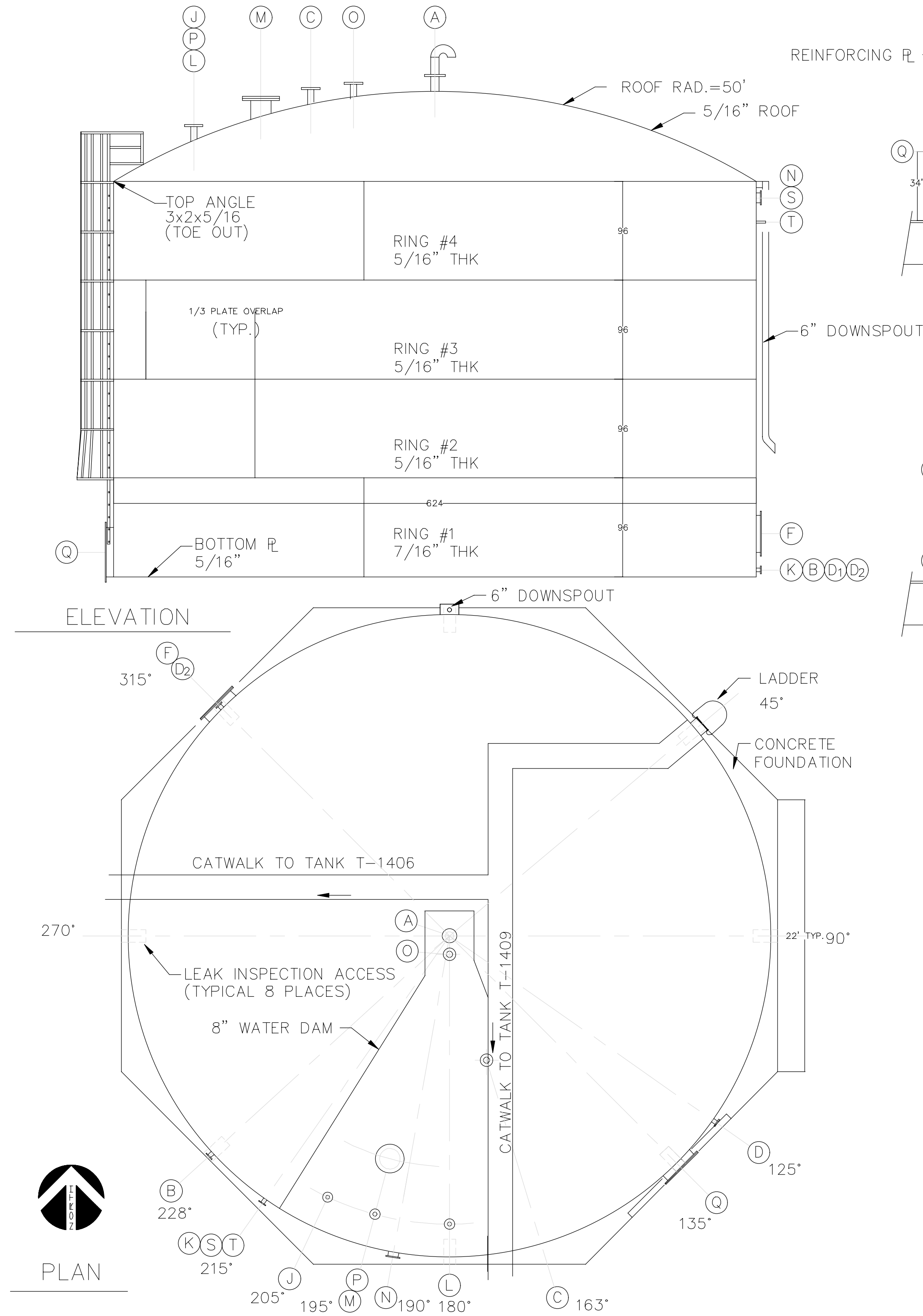
With regards to the revisions noted above, I certify under penalty of law that these modifications were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

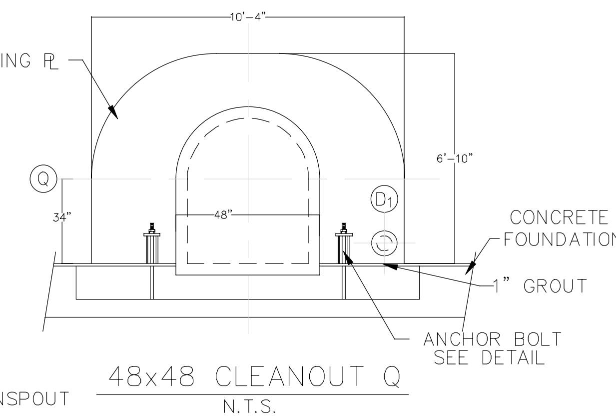
Michael T. Feeney, P.E.
Alabama P.E. No.: 15895
Jacobs Engineering Group Inc.
Ten 10th Street NW
Atlanta, Georgia 30309

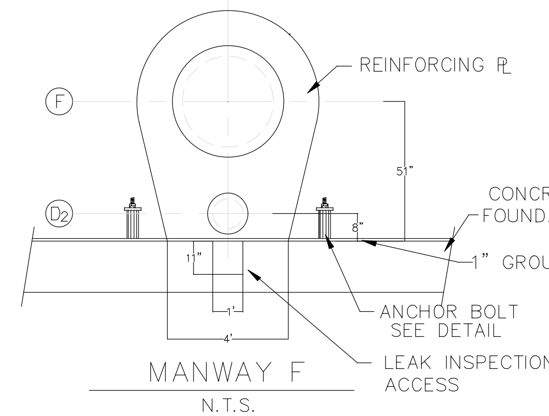
[End of Attachment D-2-4-6 Text]

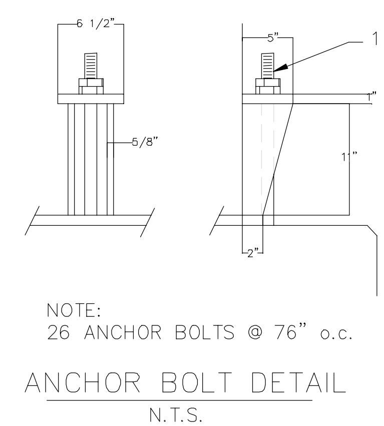
EXHIBIT A

TANK DATA SHEETS









508,333 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
52'-0" 32'-0"

VARIES	A36	1/16"	VERTICAL	32'-0"
5/16"	A36	1/16"	FLAT	–
5/16"	A36	1/16"	DOME	R 50'

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 228° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 163°	–
D	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 125°/315°	H 8"
F	MANWAY	36"	MFG. STD.	SIDE 315° H51"	W/ DAVIT
J	LEVEL INDICATOR	4"	150# R.F.	TOP 205°	–
K	PH METER	4"	150# R.F.	SIDE 215° H36"	.5" INT. PROJ
L	INLET	4"	150# R.F.	TOP 180°	–
M	MANWAY	20"	–	TOP 195°	–
N	SPARE	10"	150# R.F.	SIDE 190°H26'-6"	BLIND FLG.
O	CABLE SUPPORT	6"	–	TOP 180°	–
P	SPARE	6"	150# R.F.	TOP 195°	–
Q	CLEANOUT	48"	–	SIDE 135° H34"	W/ DAVIT
S	HIGH LEVEL	2"	150# R.F.	SIDE 215° H30'	–
T	SPARE	2"	150# R.F.	SIDE 215° H26'	BLIND FLG.

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:

1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs
10 Tenth Street
Suite 1400
Atlanta, GA 30309|t 404.978.7600

NOT RELEASED FOR CONSTRUCTION

WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE ⎯⎯⎯ IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702

DATE: AUGUST 2022

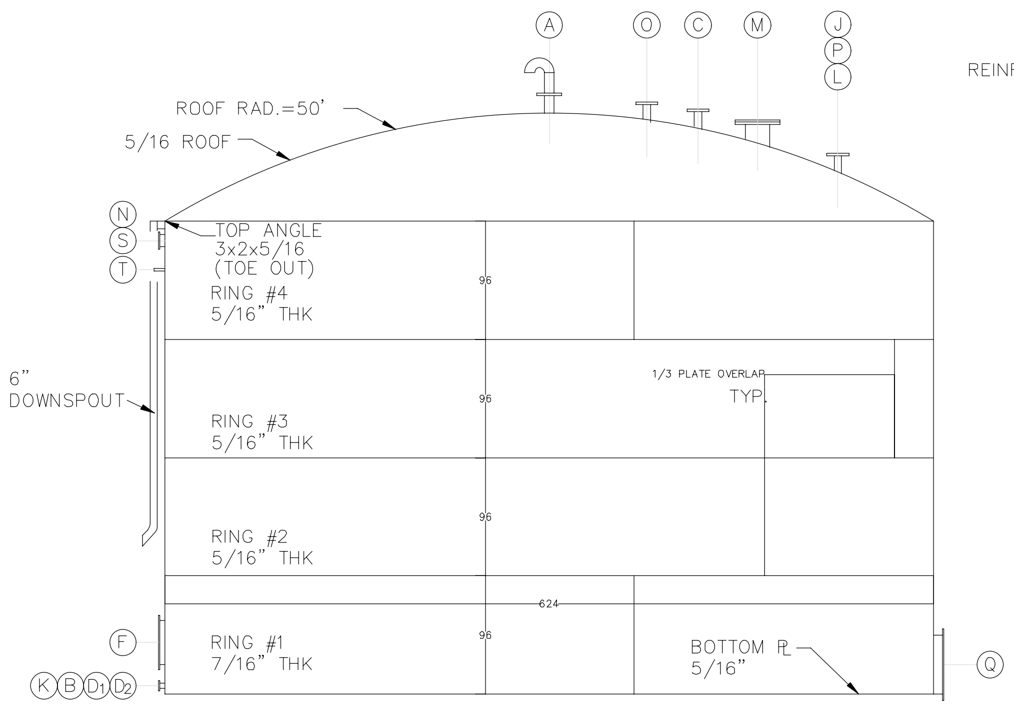
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE

TANK DATA SHEET - T-1405

SHEET 1400-080-005

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



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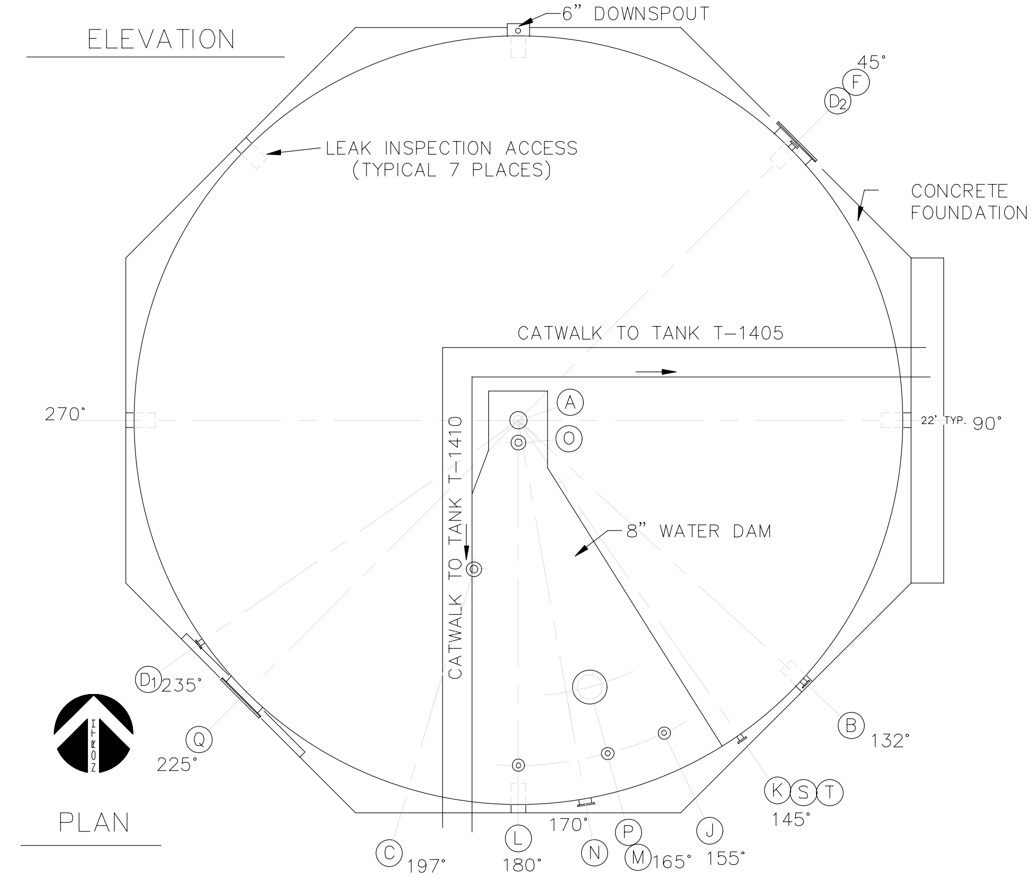

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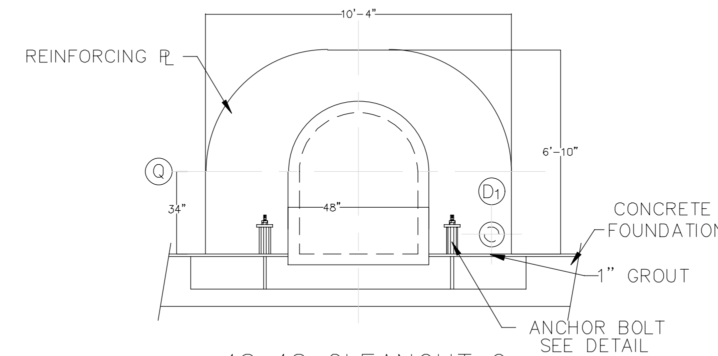
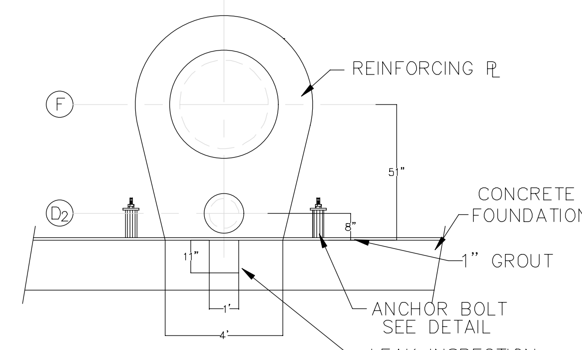


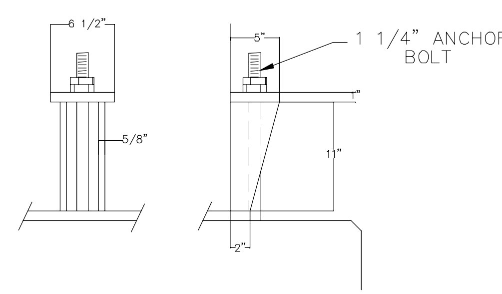
48x48 CLEANOUT Q

N.T.S.



MANWAY F

N.T.S.



NOTE:
26 ANCHOR BOLTS @ 76" o.c.

ANCHOR BOLT DETAIL

N.T.S.

508,333 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
52'-0" 32'-0"

VARIES A36 1/16" VERTICAL 32'-0"
5/16" A36 1/16" FLAT –
5/16" A36 1/16" DOME R 50'

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 132° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 197°	–
D	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 45°/235°	H 8"
F	MANWAY	36"	MFG. STD.	SIDE 45° H51"	W/ DAVIT
J	LEVEL INDICATOR	4"	150# R.F.	TOP 155°	–
K	PH METER	4"	150# R.F.	SIDE 145° H36"	.5" INT. PROJ
L	INLET	4"	150# R.F.	TOP 180°	–
M	MANWAY	20"	–	TOP 165°	–
N	SPARE	10"	150# R.F.	SIDE 170°H26'-6"	BLIND FLG.
O	CABLE SUPPORT	6"	–	TOP 180°	–
P	SPARE	6"	150# R.F.	TOP 165°	–
Q	CLEANOUT	48"	–	SIDE 225° H34"	W/ DAVIT
S	HIGH LEVEL	2"	150# R.F.	SIDE 145° H30'	–
T	SPARE	2"	150# R.F.	SIDE 145° H26'	BLIND FLG.

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Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

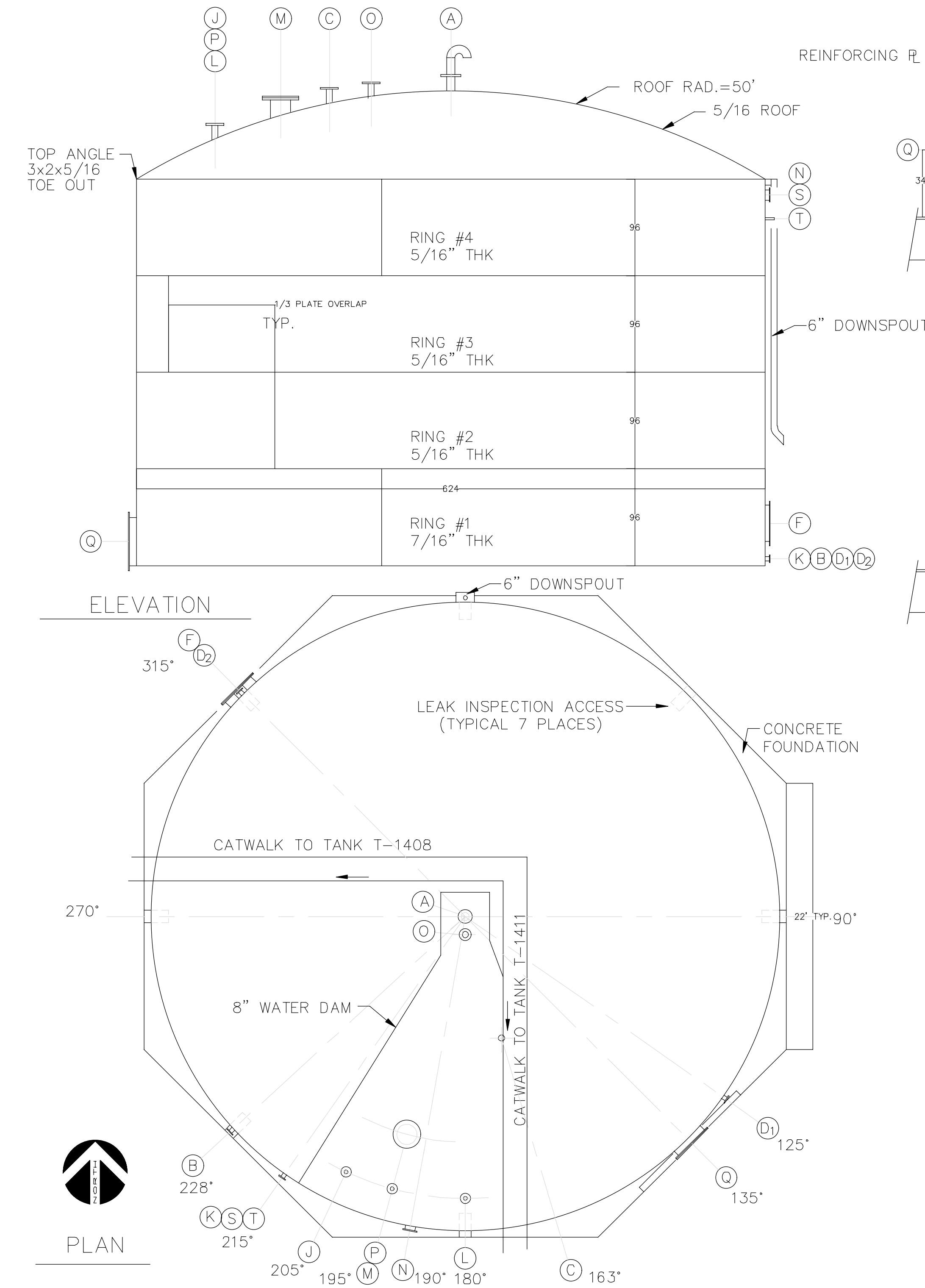
THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF DESIGNER: RAK CHECKER: SBT

SHEET TITLE
TANK DATA SHEET - T-1406

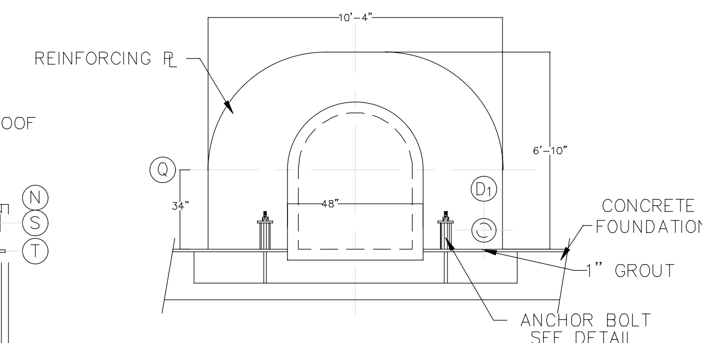
SHEET 1400-080-006

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

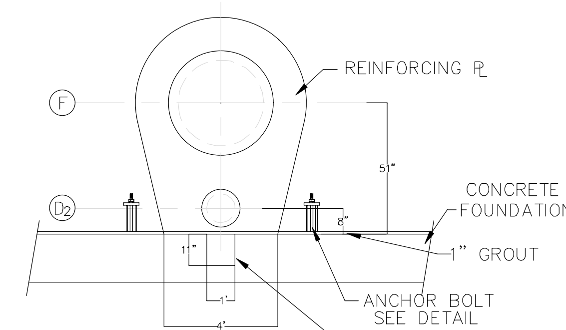


ELEVATION

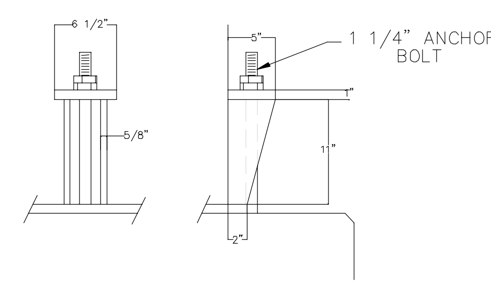
PLAN



48x48 CLEANOUT Q
N.T.S.



MANWAY F
N.T.S.



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300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
52'-0" 32'-0"

VARIES A36 1/16" VERTICAL 32'-0"
5/16" A36 1/16" FLAT –
5/16" A36 1/16" DOME R 50'

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 228° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 163°	–
D	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 125°/315°	H 8"
F	MANWAY	36"	MFG. STD.	SIDE 315° H51"	W/ DAVIT
J	LEVEL INDICATOR	4"	150# R.F.	TOP 205°	–
K	PH METER	4"	150# R.F.	SIDE 215° H36"	.5" INT. PROJ
L	INLET	4"	150# R.F.	TOP 180°	–
M	MANWAY	20"	–	TOP 195°	–
N	SPARE	10"	150# R.F.	SIDE 190°H26'-6"	BLIND FLG.
O	CABLE SUPPORT	6"	–	TOP 180°	–
P	SPARE	6"	150# R.F.	TOP 195°	–
Q	CLEANOUT	48"	–	SIDE 135° H34"	W/ DAVIT
S	HIGH LEVEL	2"	150# R.F.	SIDE 215° H30'	–
T	SPARE	2"	150# R.F.	SIDE 215° H26'	BLIND FLG.

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

NOT RELEASED FOR CONSTRUCTION

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

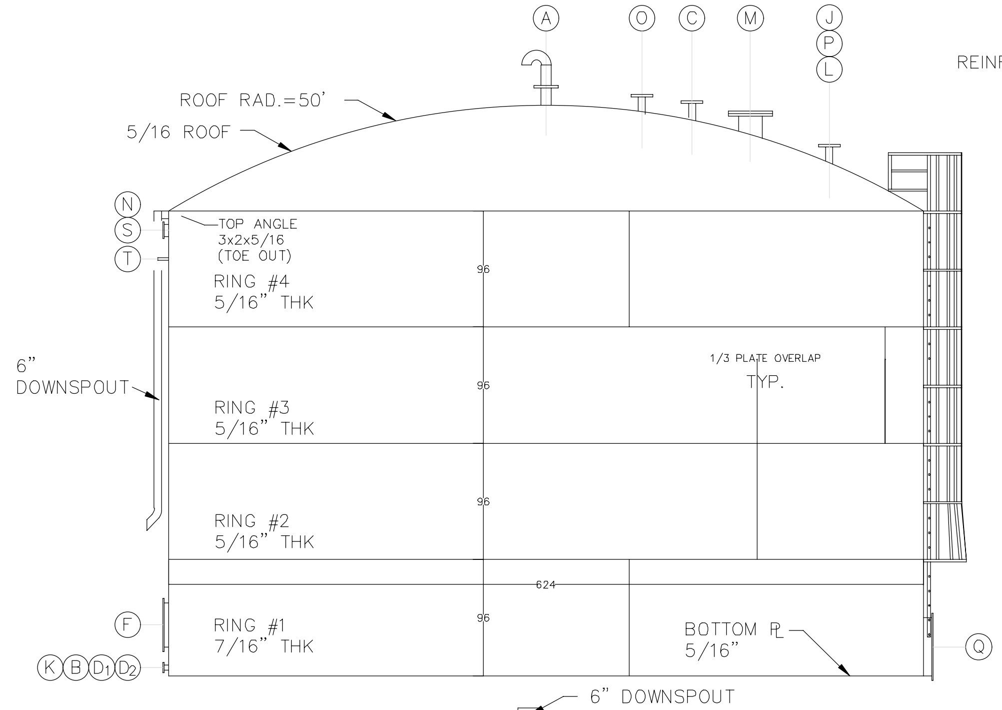
THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

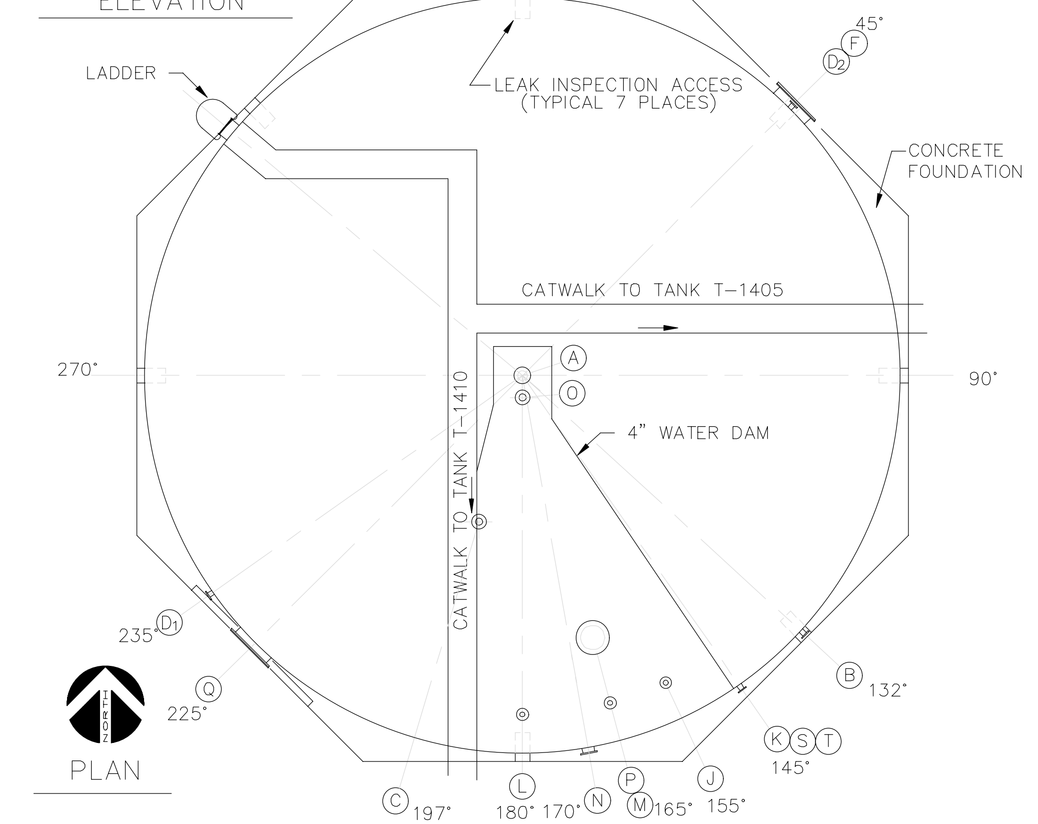
SHEET TITLE
TANK DATA SHEET - T-1407

SHEET 1400-080-007

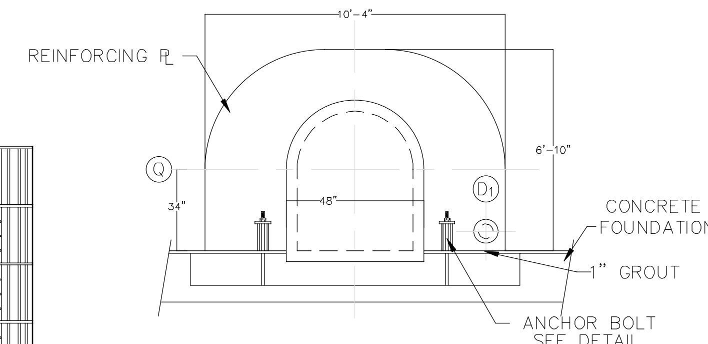
CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



ELEVATION

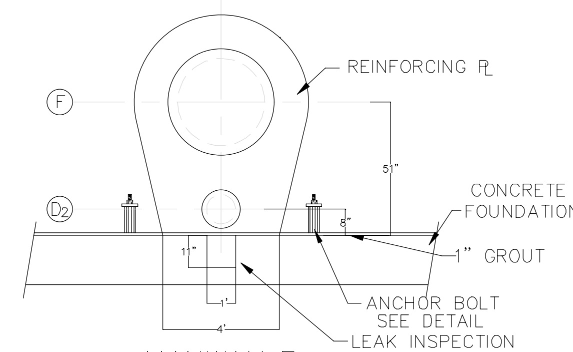


PLAN



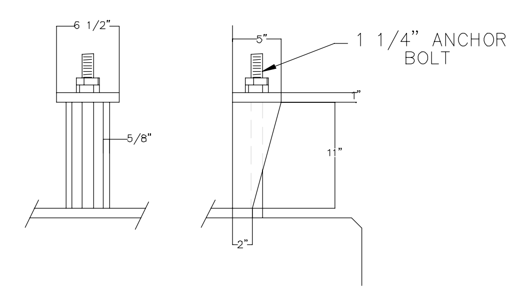
48x48 CLEANOUT Q

N.T.S.



MANWAY F

N.T.S.



NOTE:
26 ANCHOR BOLTS @ 76" o.c.

ANCHOR BOLT DETAIL

N.T.S.

508,333 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
52'-0" 32'-0"

VARIES	A36	1/16"	VERTICAL	32'-0"
5/16"	A36	1/16"	FLAT	–
5/16"	A36	1/16"	DOME	R 50'

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 132° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 197°	–
D	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 45°/235°	H 8"
F	MANWAY	36"	MFG. STD.	SIDE 45° H51"	W/ DAVIT
J	LEVEL INDICATOR	4"	150# R.F.	TOP 155°	–
K	PH METER	4"	150# R.F.	SIDE 145° H36"	.5" INT. PROJ
L	INLET	4"	150# R.F.	TOP 180°	–
M	MANWAY	20"	–	TOP 165°	–
N	SPARE	10"	150# R.F.	SIDE 170° 26'-6"	BLIND FLG.
O	CABLE SUPPORT	6"	–	TOP 180°	–
P	SPARE	6"	150# .F.	TOP 165°	–
Q	CLEANOUT	48"	–	SIDE 225° H34"	W/ DAVIT
S	HIGH LEVEL	2"	150# R.F.	SIDE 145° H30'	–
T	SPARE	2"	150# R.F.	SIDE 145° H26'	BLIND FLG.

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:

1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

NOT RELEASED FOR CONSTRUCTION

WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY

SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702

DATE: AUGUST 2022

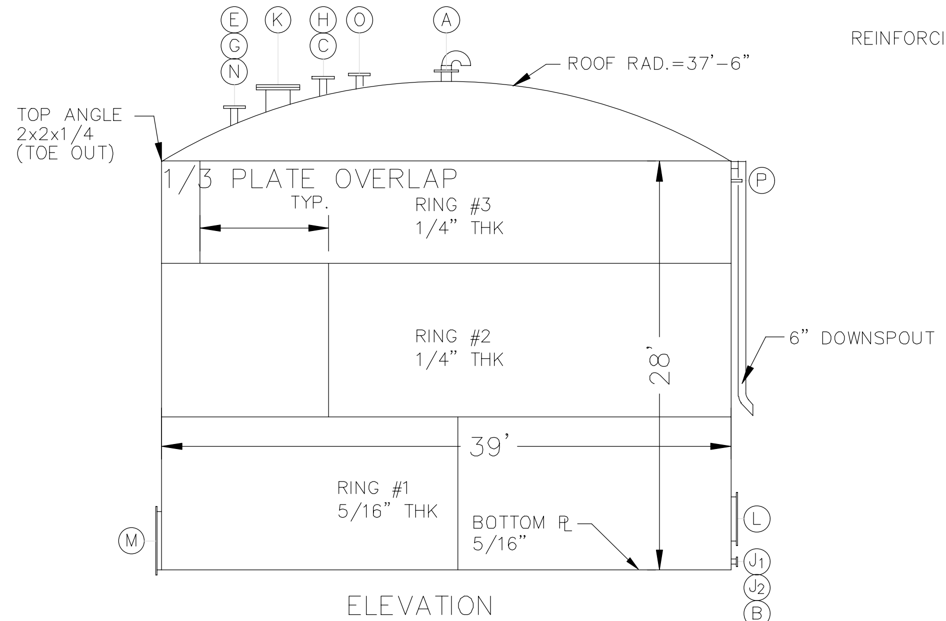
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

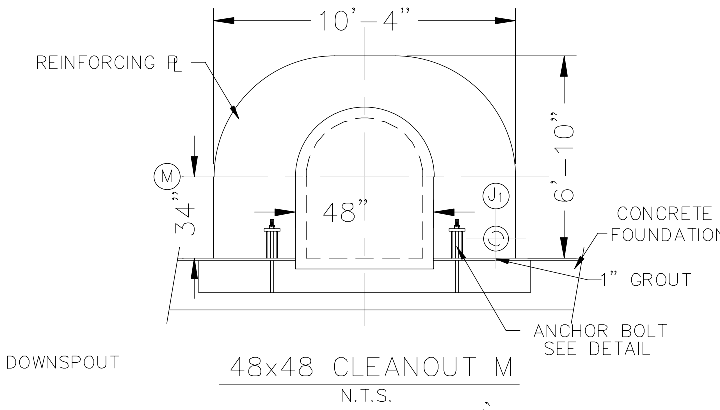
SHEET TITLE

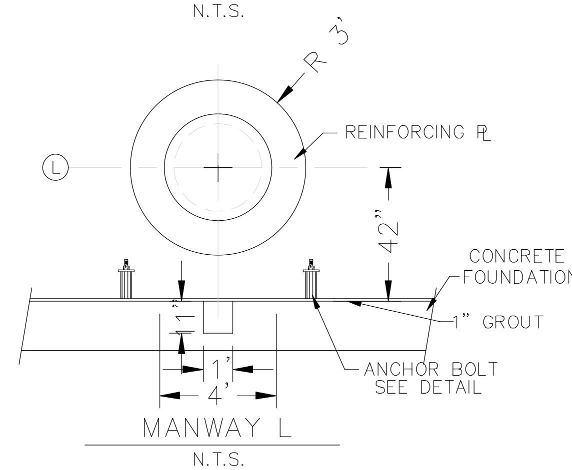
TANK DATA SHEET - T-1408

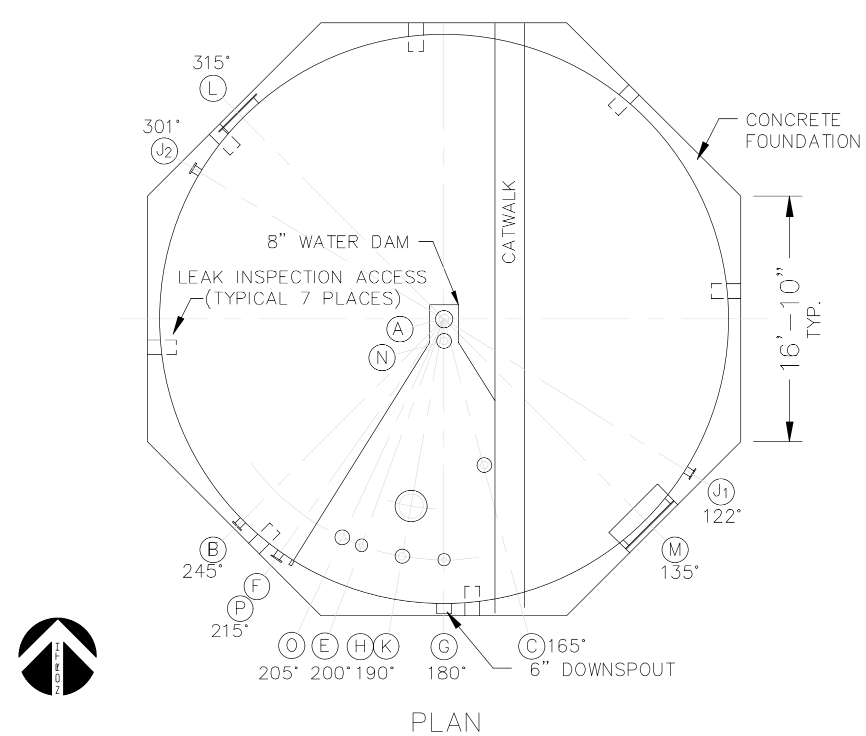
SHEET 1400-080-008

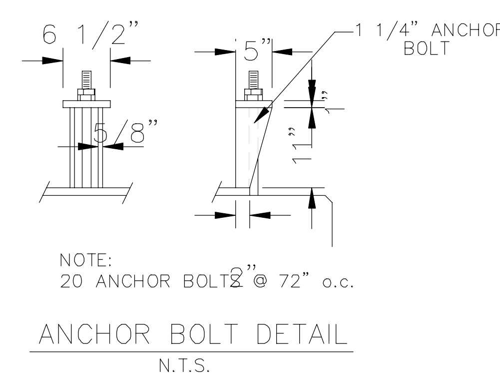
CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022











250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"		VERTICAL	28'-0"
5/16"	A36	1/16"		FLAT	–
1/4"	A36	1/16"		DOME	R 37'-6"

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 245° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 165°	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 200°	–
F	PH METER	4"	150# R.F.	SIDE 215° H36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
H	SPARE	6"	150# R.F.	TOP 190°	–
J	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 122°/301°	H 8"
K	MANWAY	20"	150# R.F.	TOP 190°	–
L	MANWAY	36"	150# R.F.	SIDE 315° H42"	–
M	CLEANOUT	48"	–	SIDE 135° H34"	–
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 205°	–
P	HIGH LEVEL	2"	150# R.F.	SIDE215° H26'-6"	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

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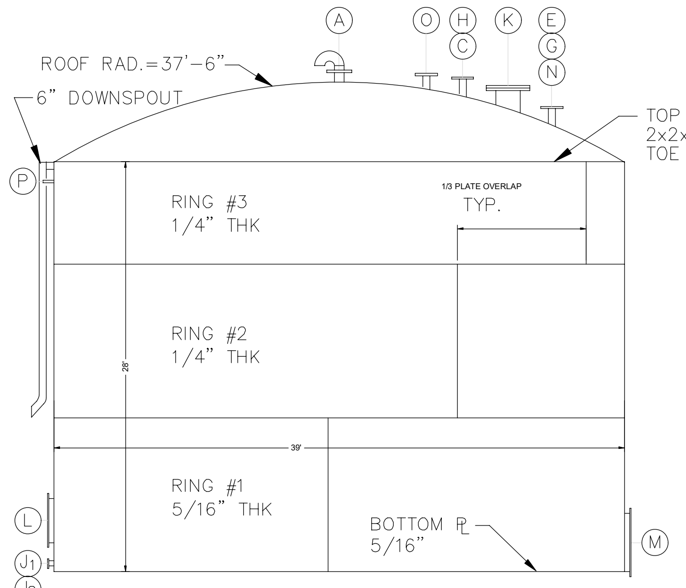
PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

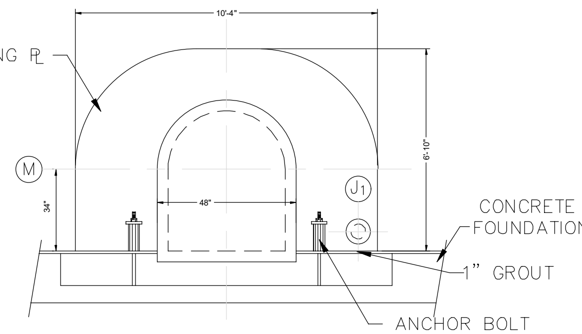
SHEET TITLE
TANK DATA SHEET - T-1409

SHEET 1400-080-009

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

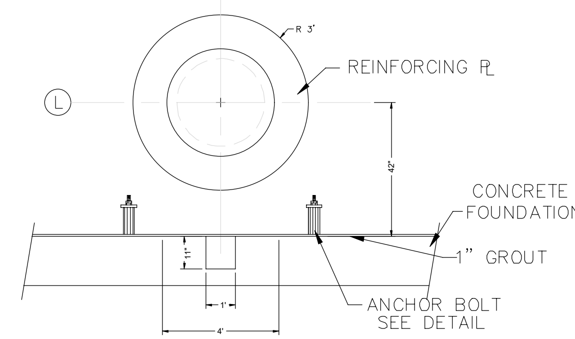


ELEVATION



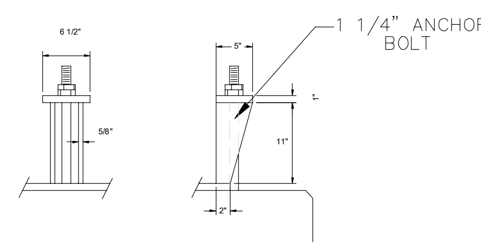
48x48 CLEANOUT M

N.T.S.



MANWAY L

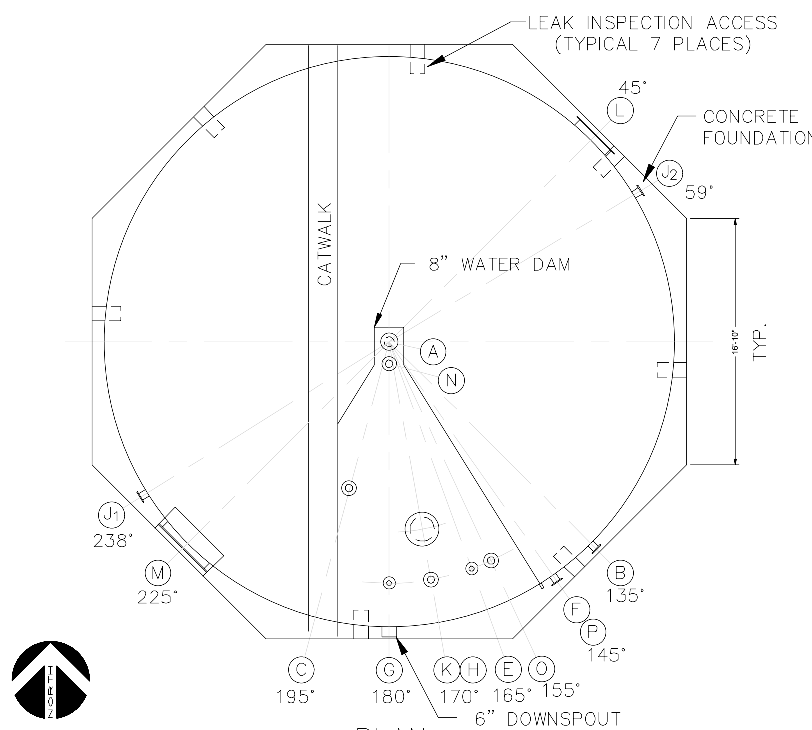
N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL

N.T.S.



PLAN

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"	VERTICAL	28'-0"
5/16"	A36	1/16"	FLAT	–
1/4"	A36	1/16"	DOME	R 37'-6"

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 135° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 195°	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 160°	–
F	PH METER	4"	150# R.F.	SIDE 145° H36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
H	SPARE	6"	150# R.F.	TOP 170°	–
J	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 238°/59°	H 8"
K	MANWAY	20"	150# R.F.	TOP 170°	–
L	MANWAY	36"	150# R.F.	SIDE 45° H42"	–
M	CLEANOUT	48"	–	SIDE 225° H34"	–
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 155°	–
P	HIGH LEVEL	2"	150# R.F.	SIDE 145°H26'-6"	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:

1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

NOT RELEASED FOR CONSTRUCTION

WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

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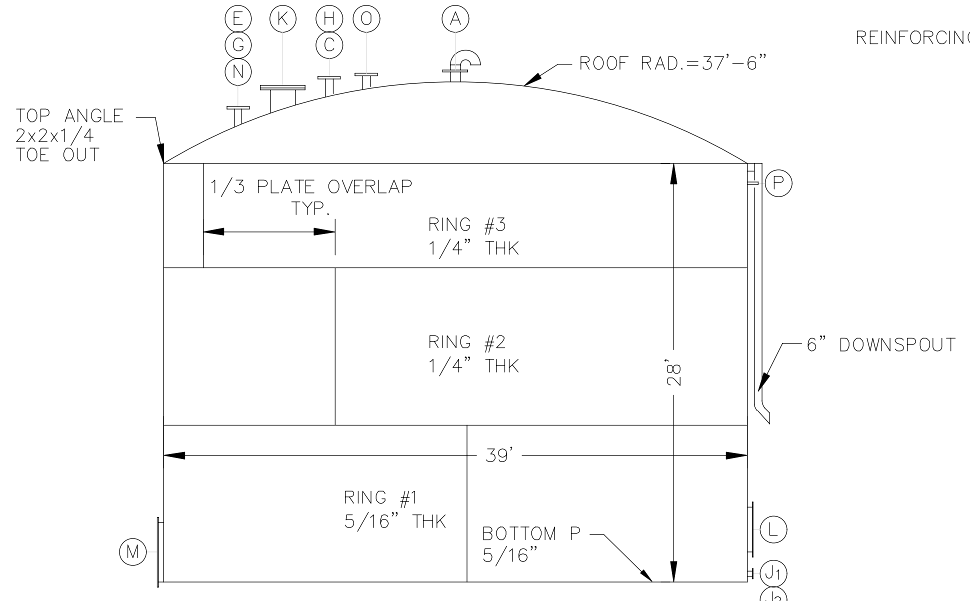
PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

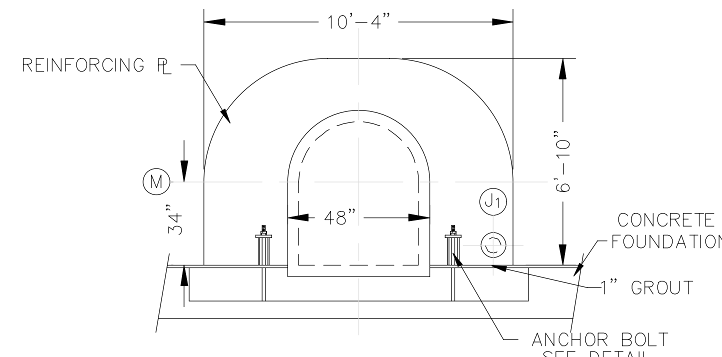
SHEET TITLE
TANK DATA SHEET - T-1410

SHEET 1400-080-010

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

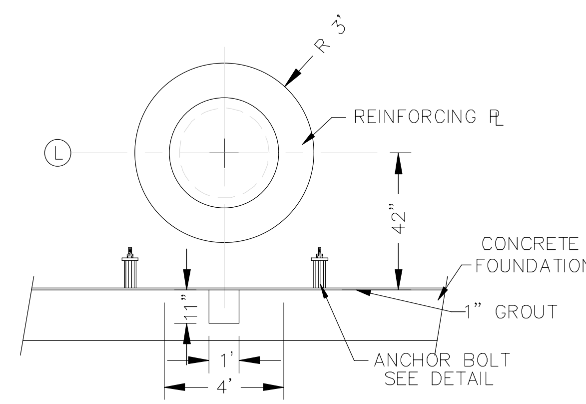


ELEVATION



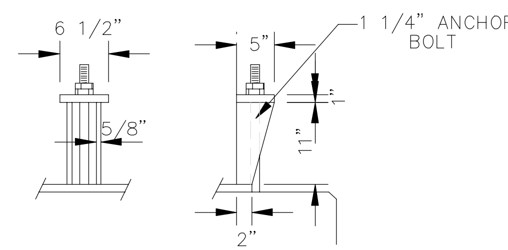
48x48 CLEANOUT M

N.T.S.



MANWAY L

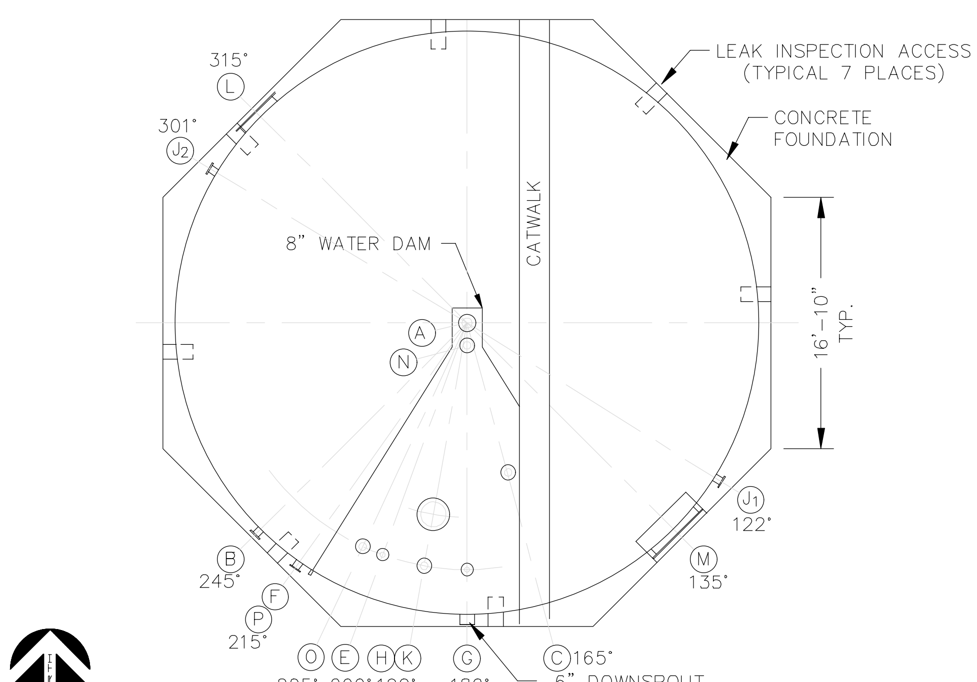
N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL

N.T.S.



PLAN

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"		VERTICAL	28'-0"
5/16"	A36	1/16"		FLAT	–
1/4"	A36	1/16"		DOME	R 37'-6"

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 245° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 165°	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 200°	–
F	PH METER	4"	150# R.F.	SIDE 215° H36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
H	SPARE	6"	150# R.F.	TOP 190°	–
J	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 122°/301°	H 8"
K	MANWAY	20"	150# R.F.	TOP 190°	–
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O	SPARE	6"	150# R.F.	TOP 205°	–
P	HIGH LEVEL	2"	150# R.F.	SIDE 215°H26'-6"	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:

1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

NOT RELEASED FOR CONSTRUCTION

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

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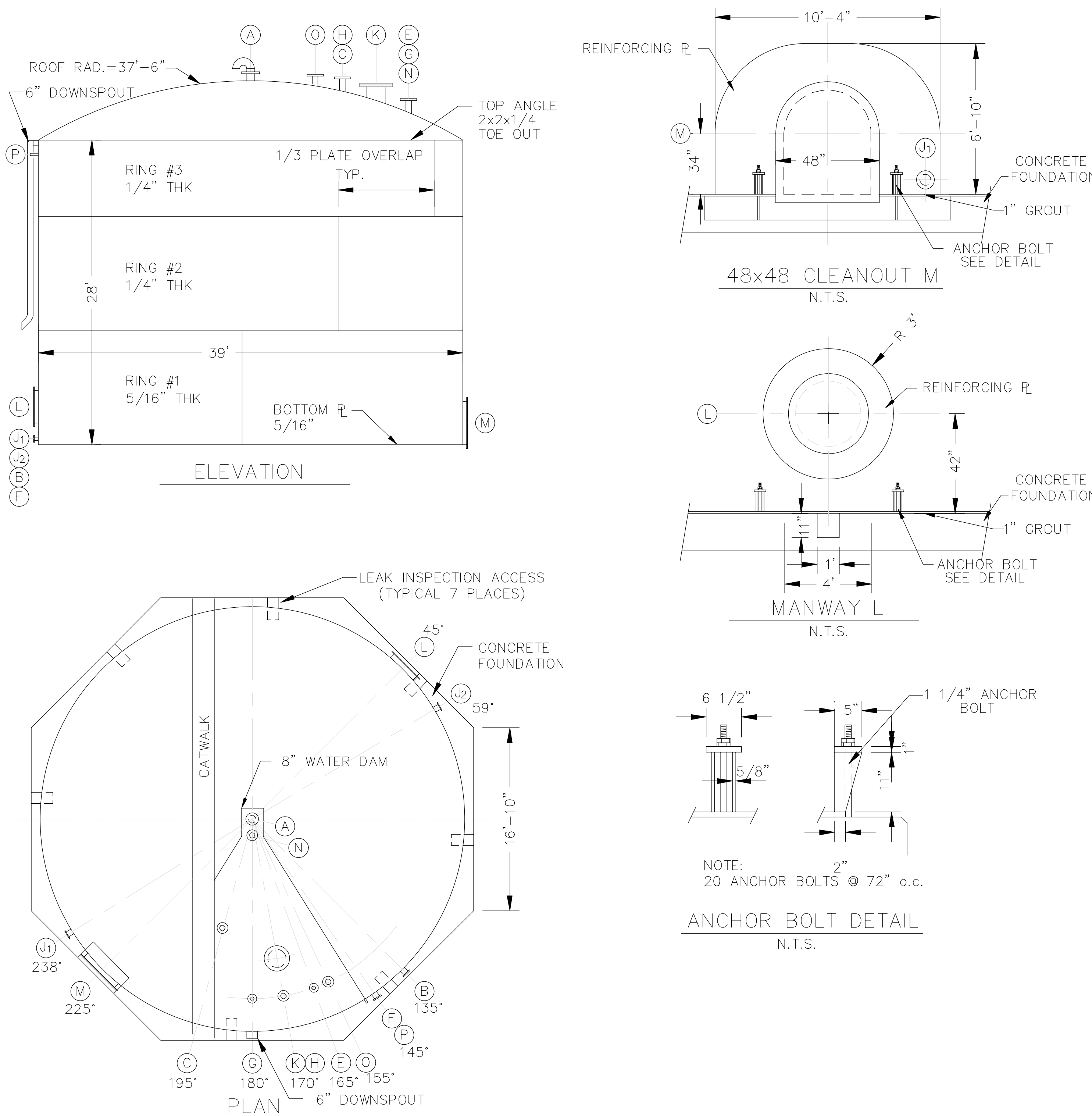
PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE
TANK DATA SHEET - T-1411

SHEET 1400-080-011

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"	VERTICAL	28'-0"
5/16"	A36	1/16"	FLAT	–
1/4"	A36	1/16"	DOME	R 37'-6"

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B	OUTLET	6"	150# R.F.	SIDE 135° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 195°	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 160°	–
F	PH METER	4"	150# R.F.	SIDE 145° H36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
H	SPARE	6"	150# R.F.	TOP 170°	–
J	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 238°/59°	H 8"
K	MANWAY	20"	150# R.F.	TOP 170°	–
L	MANWAY	36"	150# R.F.	SIDE 45° H42"	–
M	CLEANOUT	48"	–	SIDE 225° H34"	–
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 155°	–
P	HIGH LEVEL	2"	150# R.F.	SIDE 145°H26'-6"	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

Jacobs
10 Tenth Street Suite 1400 Atlanta, GA 30309 1.404.978.7600

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

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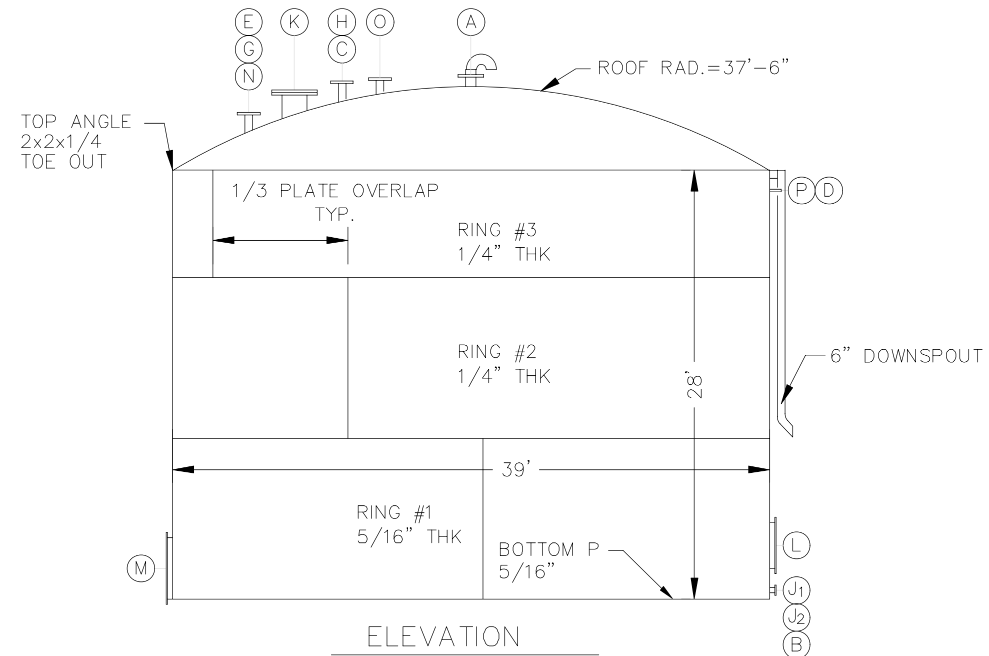
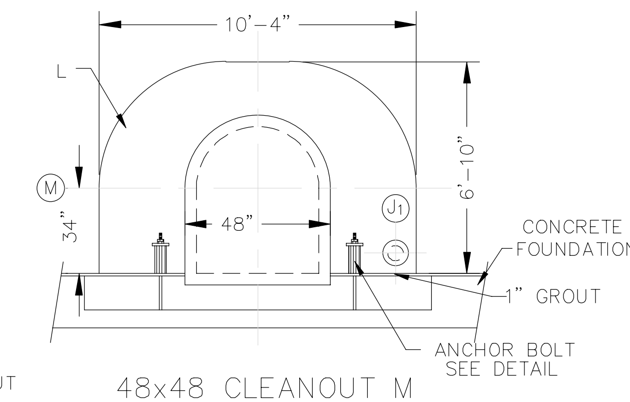
PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE
TANK DATA SHEET - T-1412

SHEET 1400-080-012

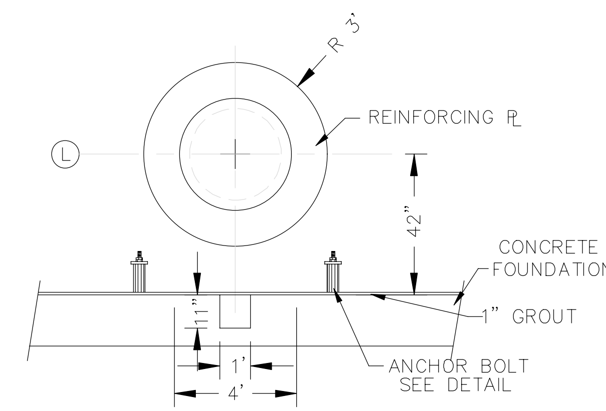


ELEVATION



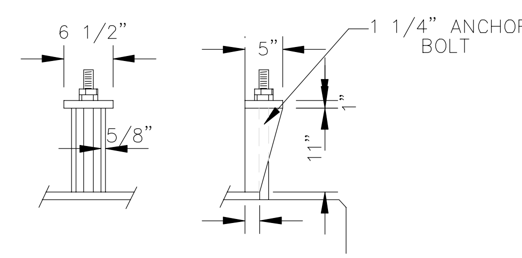
48x48 CLEANOUT M

N.T.S.



MANWAY L

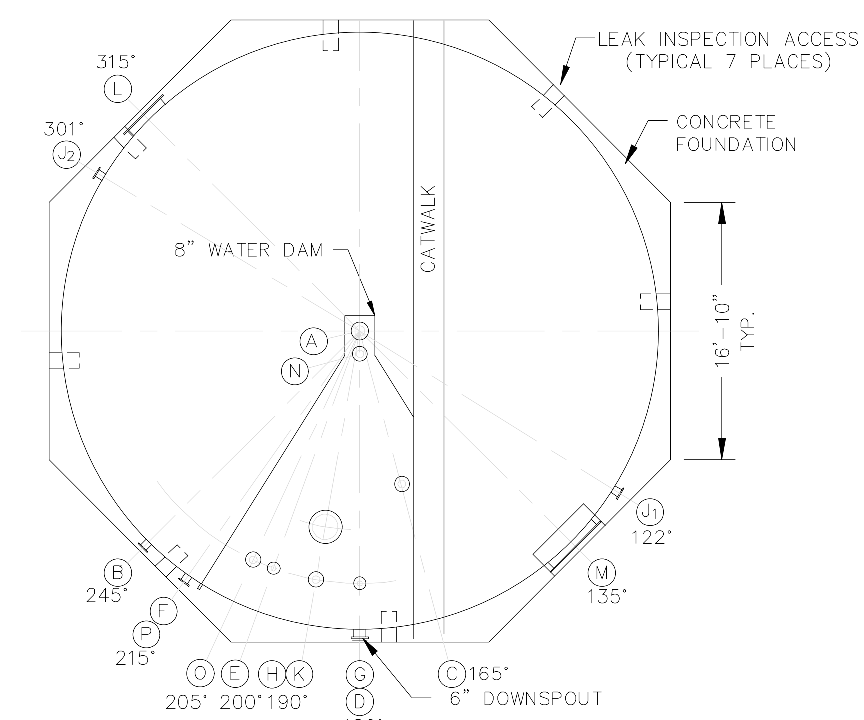
N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL

N.T.S.



PLAN

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"	VERTICAL	28'-0"
5/16"	A36	1/16"	FLAT	-
1/4"	A36	1/16"	DOME	R 37'-6"

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 245° H10.5"	-
C	GAUGE HATCH	6"	150# R.F.	TOP 165°	-
D	SPARE	10"	150# R.F.	SIDE 180° H27'	-
E	LEVEL INDICATOR	4"	150# R.F.	TOP 200°	-
F	PH METER	4"	150# R.F.	SIDE 215° H36"	-
G	INLET	4"	150# R.F.	TOP 180°	-
H	SPARE	6"	150# R.F.	TOP 190°	-
J	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 122°/301°	H 8"
K	MANWAY	20"	150# R.F.	TOP 190°	-
L	MANWAY	36"	150# R.F.	SIDE 315° H42"	-
M	CLEANOUT	48"	-	SIDE 135° H34"	-
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 205°	-
P	HIGH LEVEL	2"	150# R.F.	SIDE 215°H26'-6"	-

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

10 Tenth Street Suite 1400 Atlanta, GA 30309 404.978.7600

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WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY

SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

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PROJECT NO: D3279702

DATE: AUGUST 2022

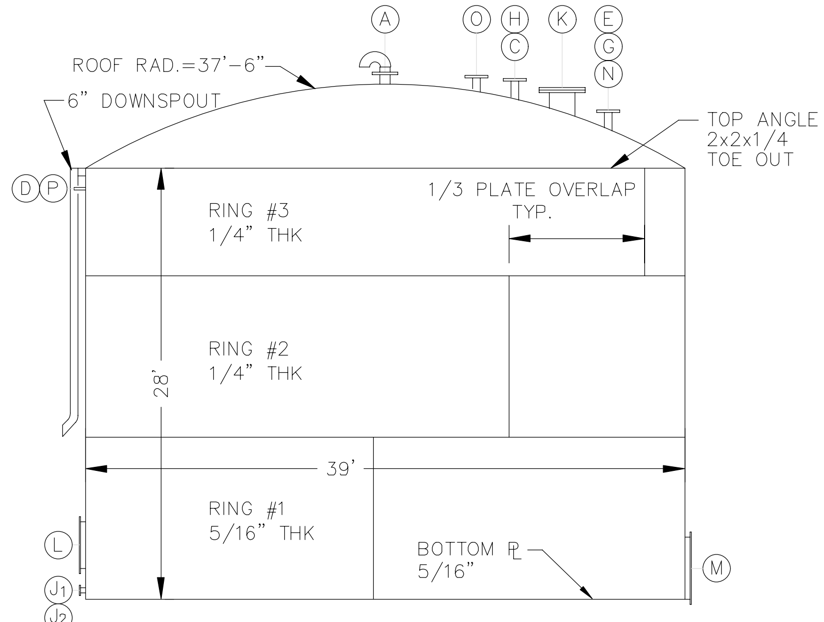
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE

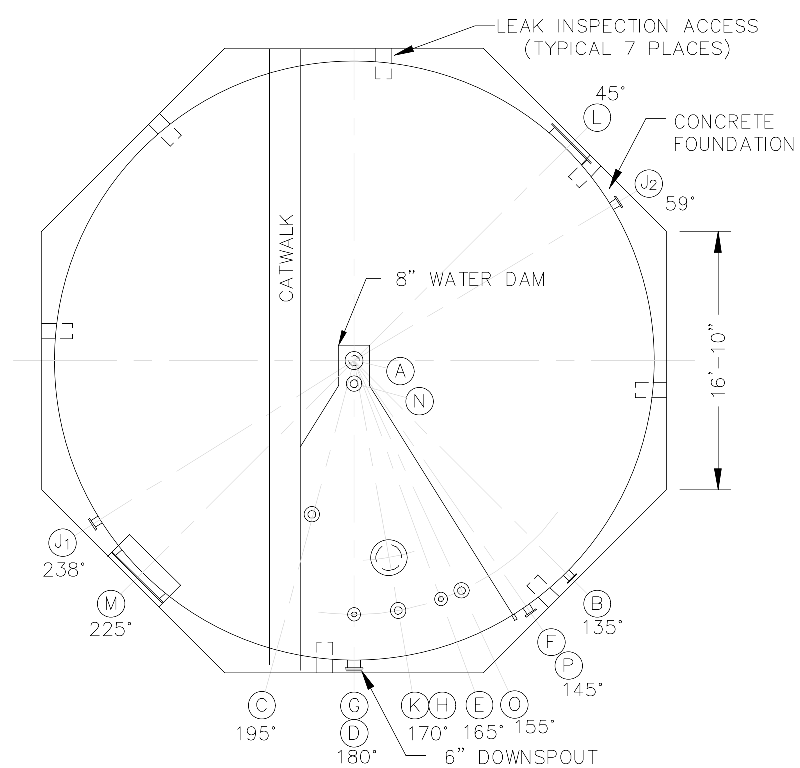
TANK DATA SHEET - T-1413

SHEET 1400-080-013

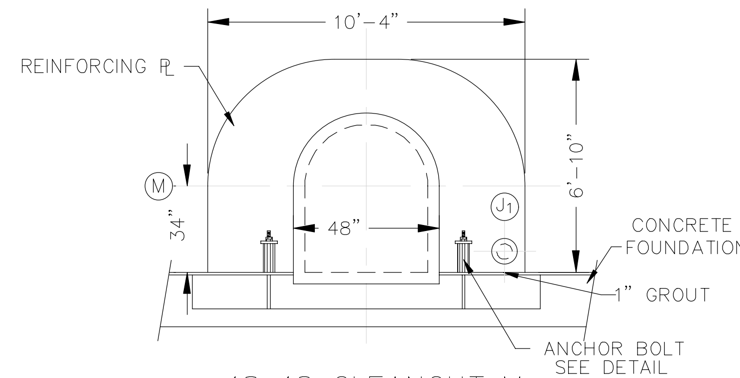
CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



ELEVATION

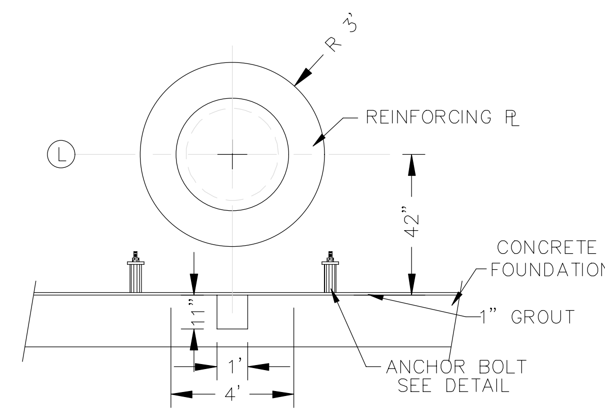


PLAN



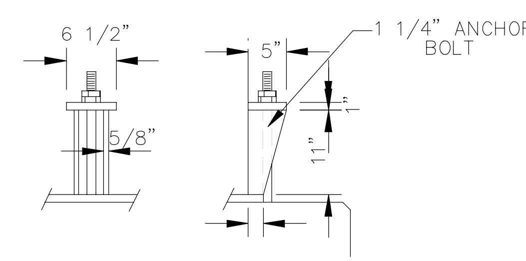
48x48 CLEANOUT M

N.T.S.



MANWAY L

N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL

N.T.S.

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"	VERTICAL	28'-0"
5/16"	A36	1/16"	FLAT	-
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A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 135° H10.5"	-
C	GAUGE HATCH	6"	150# R.F.	TOP 195°	-
D	SPARE	10"	150# R.F.	SIDE 180° H27'	-
E	LEVEL INDICATOR	4"	150# R.F.	TOP 160°	-
F	PH METER	4"	150# R.F.	SIDE 145° H36"	-
G	INLET	4"	150# R.F.	TOP 180°	-
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K	MANWAY	20"	150# R.F.	TOP 170°	-
L	MANWAY	36"	150# R.F.	SIDE 45° H42"	-
M	CLEANOUT	48"	-	SIDE 225° H34"	-
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 155°	-
P	HIGH LEVEL	2"	150# R.F.	SIDE 145°H26'-6"	-

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

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10 Tenth Street
Suite 1400
Atlanta, GA 30309 404.978.7600

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WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY

SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

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PROJECT NO: D3279702

DATE: AUGUST 2022

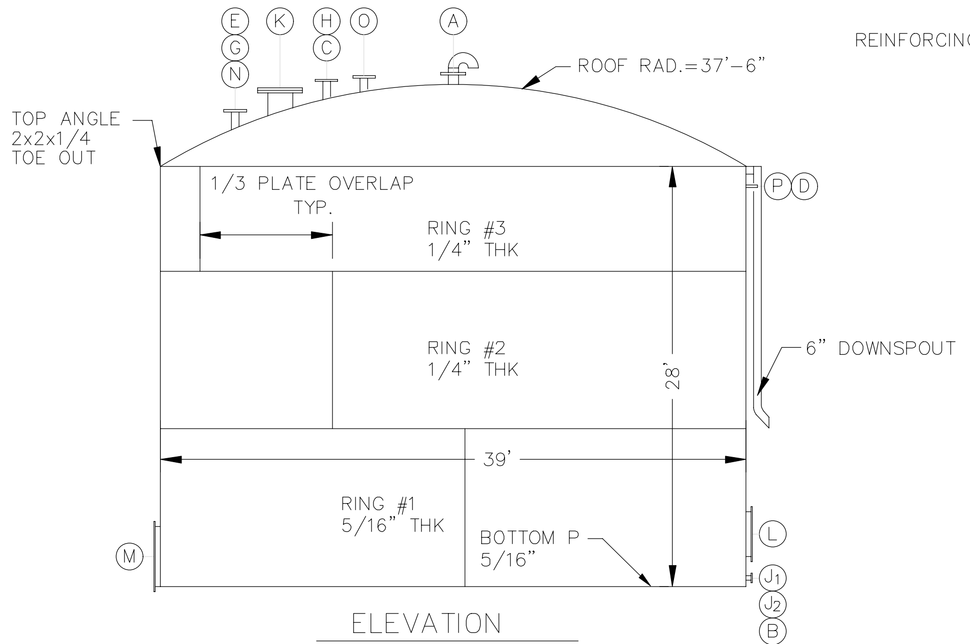
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE

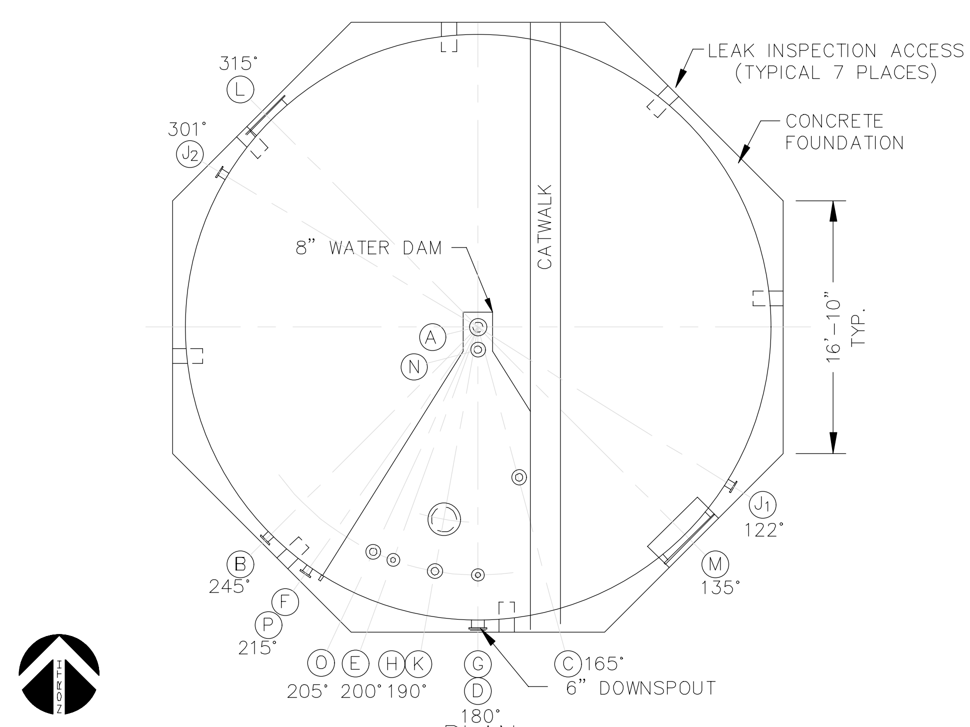
TANK DATA SHEET - T-1414

SHEET 1400-080-014

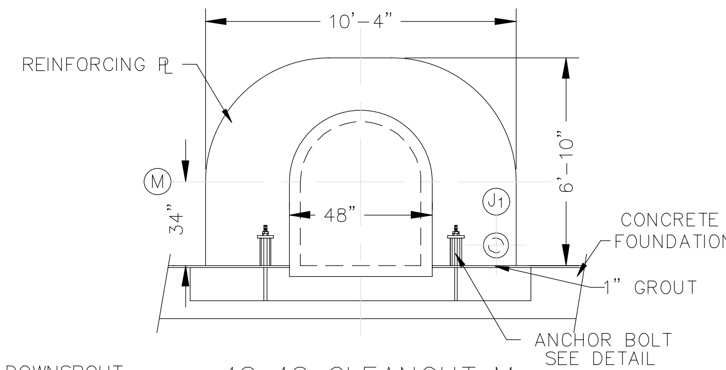
CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



ELEVATION

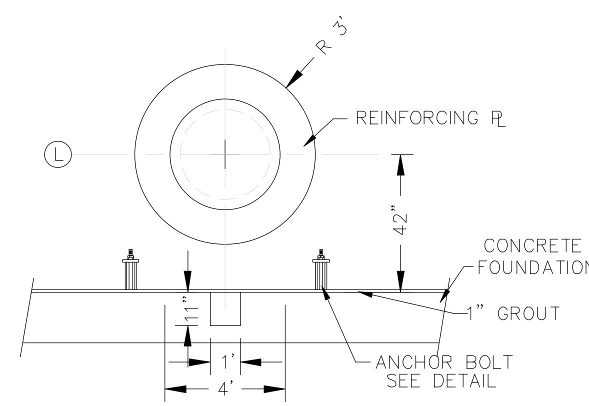


PLAN



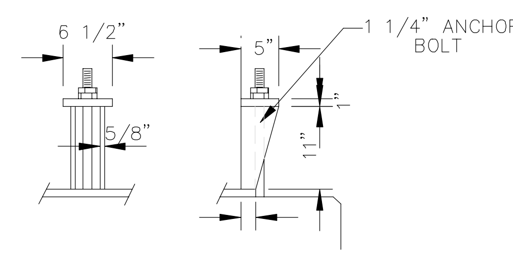
48x48 CLEANOUT M

N.T.S.



MANWAY L

N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL

N.T.S.

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"	VERTICAL	28'-0"
5/16"	A36	1/16"	FLAT	-
1/4"	A36	1/16"	DOME	R 37'-6"

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 245° H10.5"	-
C	GAUGE HATCH	6"	150# R.F.	TOP 165°	-
D	SPARE	10"	150# R.F.	SIDE 180° H27'	-
E	LEVEL INDICATOR	4"	150# R.F.	TOP 200°	-
F	PH METER	4"	150# R.F.	SIDE 215° H 36"	-
G	INLET	4"	150# R.F.	TOP 180°	-
H	SPARE	6"	150# R.F.	TOP 190°	-
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P	HIGH LEVEL	2"	150# R.F.	SIDE 215°H26'-6"	-

COATINGS:
INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.
EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

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10 Tenth Street Suite 1400 Atlanta, GA 30309 | 404.978.7600

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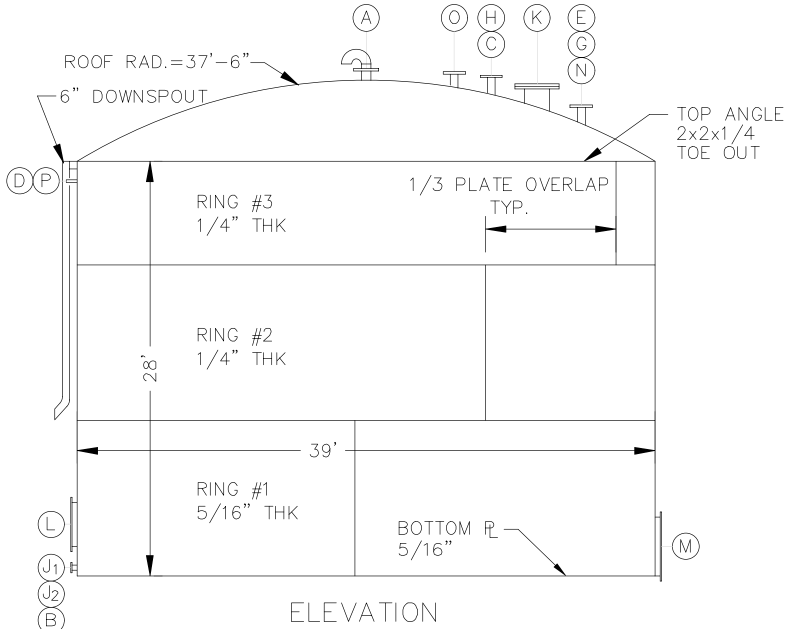
WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION
CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

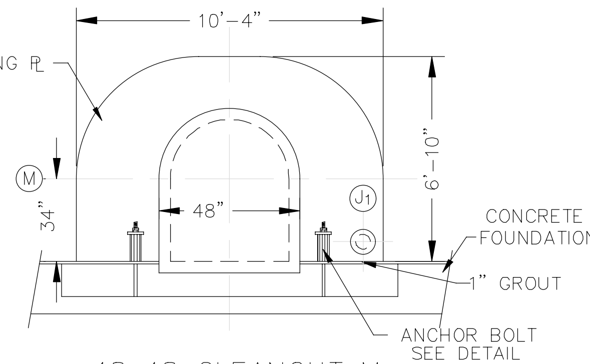
REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE
THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.
PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT
SHEET TITLE
TANK DATA SHEET - T-1415
SHEET 1400-080-015

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

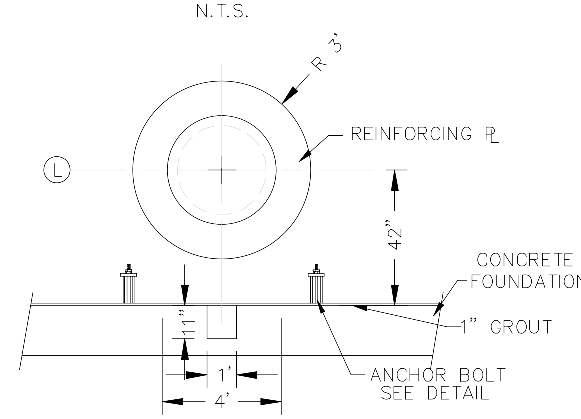


ELEVATION



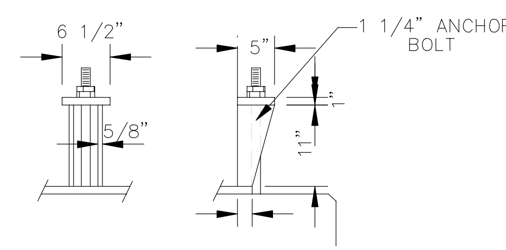
48x48 CLEANOUT M

N.T.S.



MANWAY L

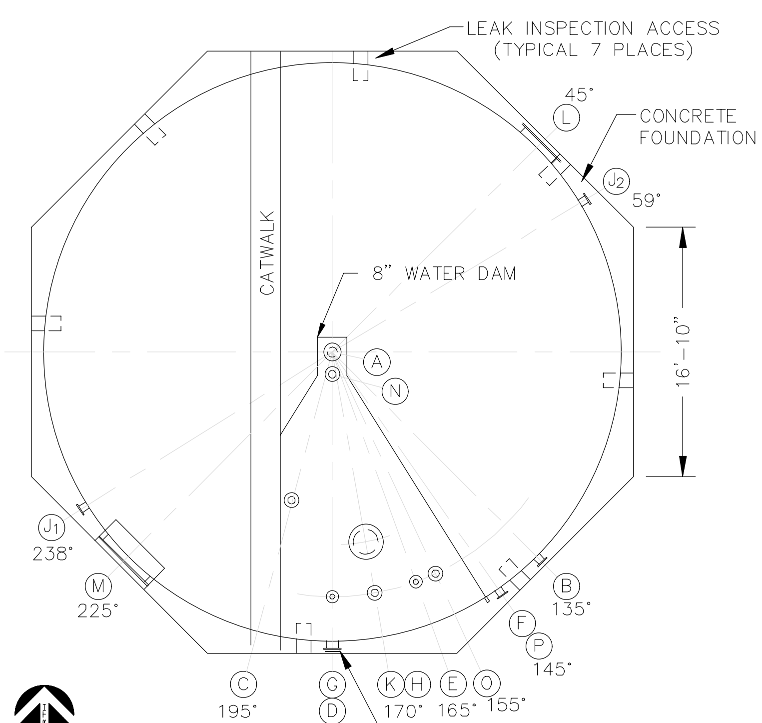
N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL

N.T.S.



PLAN

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"	VERTICAL	28'-0"
5/16"	A36	1/16"	FLAT	–
1/4"	A36	1/16"	DOME	R 37'-6"

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET	6"	150# R.F.	SIDE 135° H10.5"	–
C	GAUGE HATCH	6"	150# R.F.	TOP 195°	–
D	SPARE	10"	150# R.F.	SIDE 180° H27'	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 160°	–
F	PH METER	4"	150# R.F.	SIDE 145° H 36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
H	SPARE	6"	150# R.F.	TOP 170°	–
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K	MANWAY	20"	150# R.F.	TOP 170°	–
L	MANWAY	36"	150# R.F.	SIDE 45° H42"	–
M	CLEANOUT	48"	–	SIDE 225° H34"	–
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 155°	–
P	HIGH LEVEL	2"	150# R.F.	SIDE 145°H26'-6"	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:
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CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

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WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

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PROJECT NO: D3279702

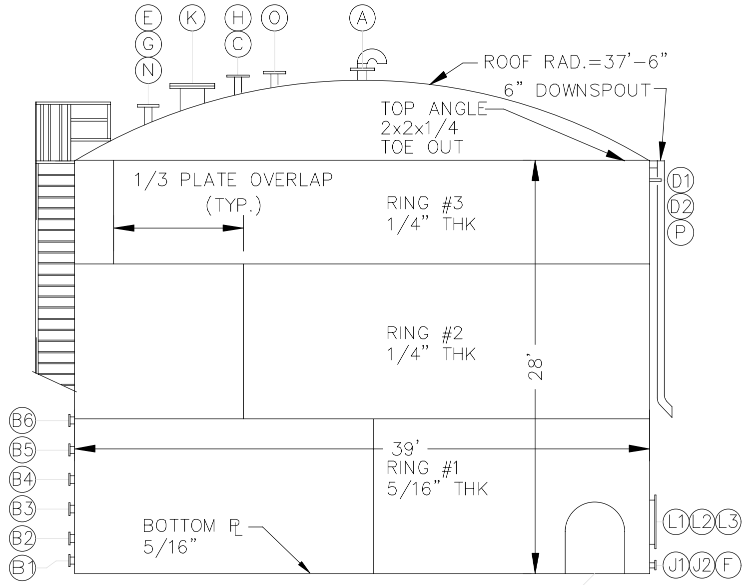
DATE: AUGUST 2022

DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

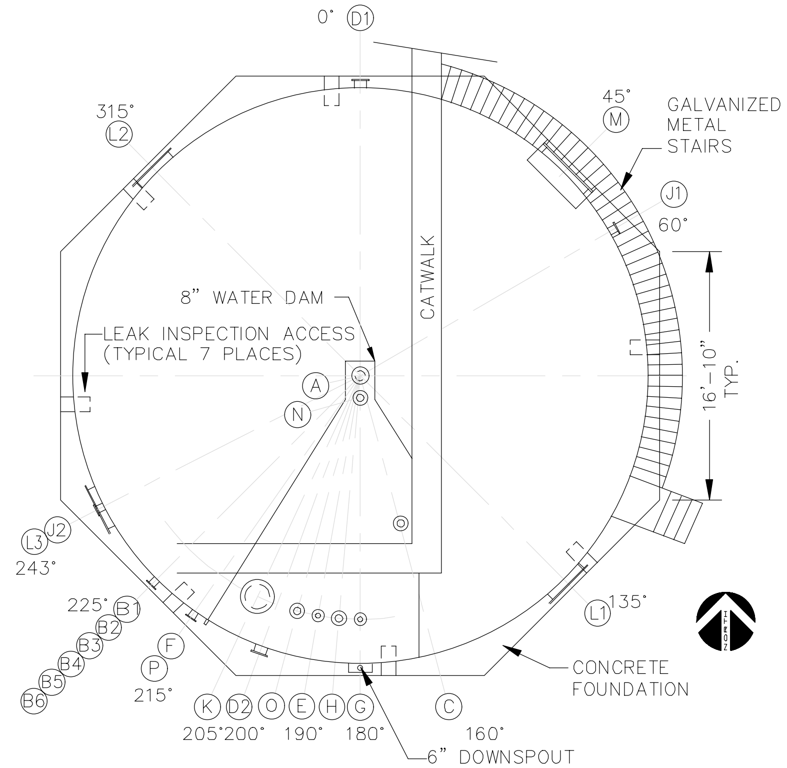
SHEET TITLE

TANK DATA SHEET - T-1416

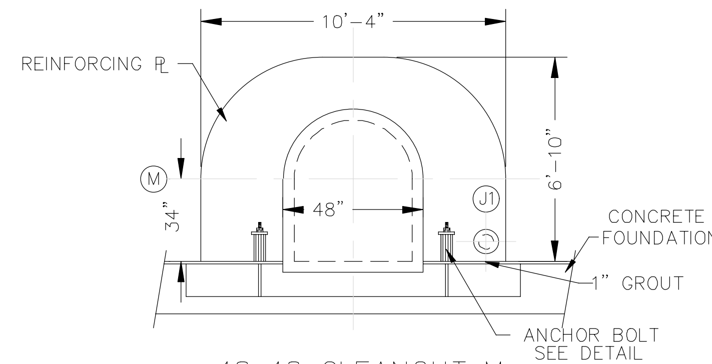
SHEET 1400-080-016



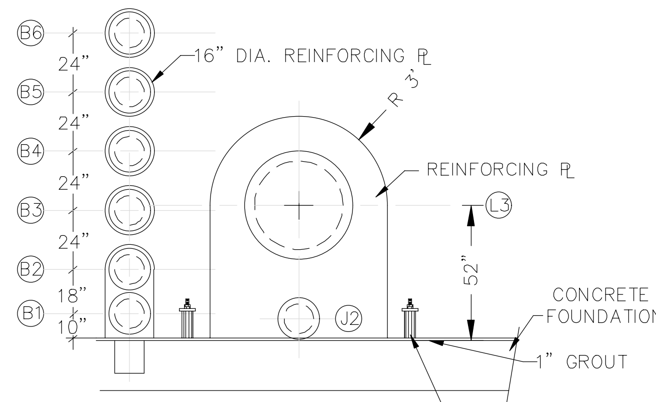
ELEVATION



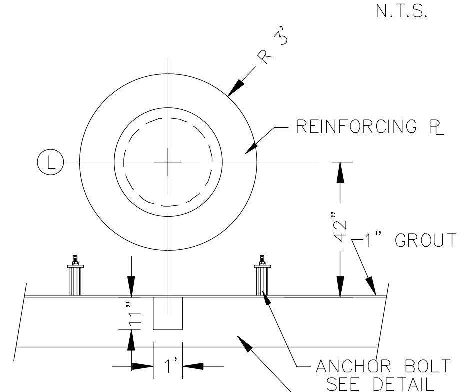
PLAN



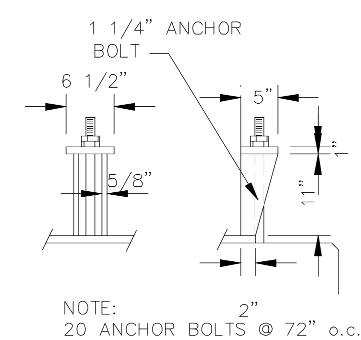
48x48 CLEANOUT M
N.T.S.



MANWAY L3
N.T.S.



MANWAY L1, L2
N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL
N.T.S.

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES A36 1/16" VERTICAL 28'-0"
5/16" A36 1/16" FLAT –
1/4" A36 1/16" DOME R 37'-6"

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET (6 REQ'D)	6"	150# R.F.	SIDE 225°	B1–B6
C	GAUGE HATCH	6"	150# R.F.	TOP 165°	–
D1	SPARE	10"	150# R.F.	SIDE 0° H27'	–
D2	SPARE	10"	150# R.F.	SIDE 200° H27'	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 190°	–
F	PH METER	4"	150# R.F.	SIDE 215° H 36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
H	INLET	4"	150# R.F.	TOP 185°	–
J	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 60°/243°	H 8"
K	MANWAY	20"	150# R.F.	TOP 205°	–
L1,2	MANWAY (2 REQ'D)	36"	150# R.F.	SIDE 135°/315°	H 42"
L3	MANWAY	36"	150# R.F.	SIDE 243° H52"	
M	CLEANOUT	48"	–	SIDE 45° H34"	–
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 195°	–
P	HIGH LEVEL	2"	150# R.F.	SIDE 215°H26'-6"	–

COATINGS:

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EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:

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NOT RELEASED FOR CONSTRUCTION

WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION
CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE		REVISION DESCRIPTION
5.0	08/22		RCRA PART B PERMIT RENEWAL

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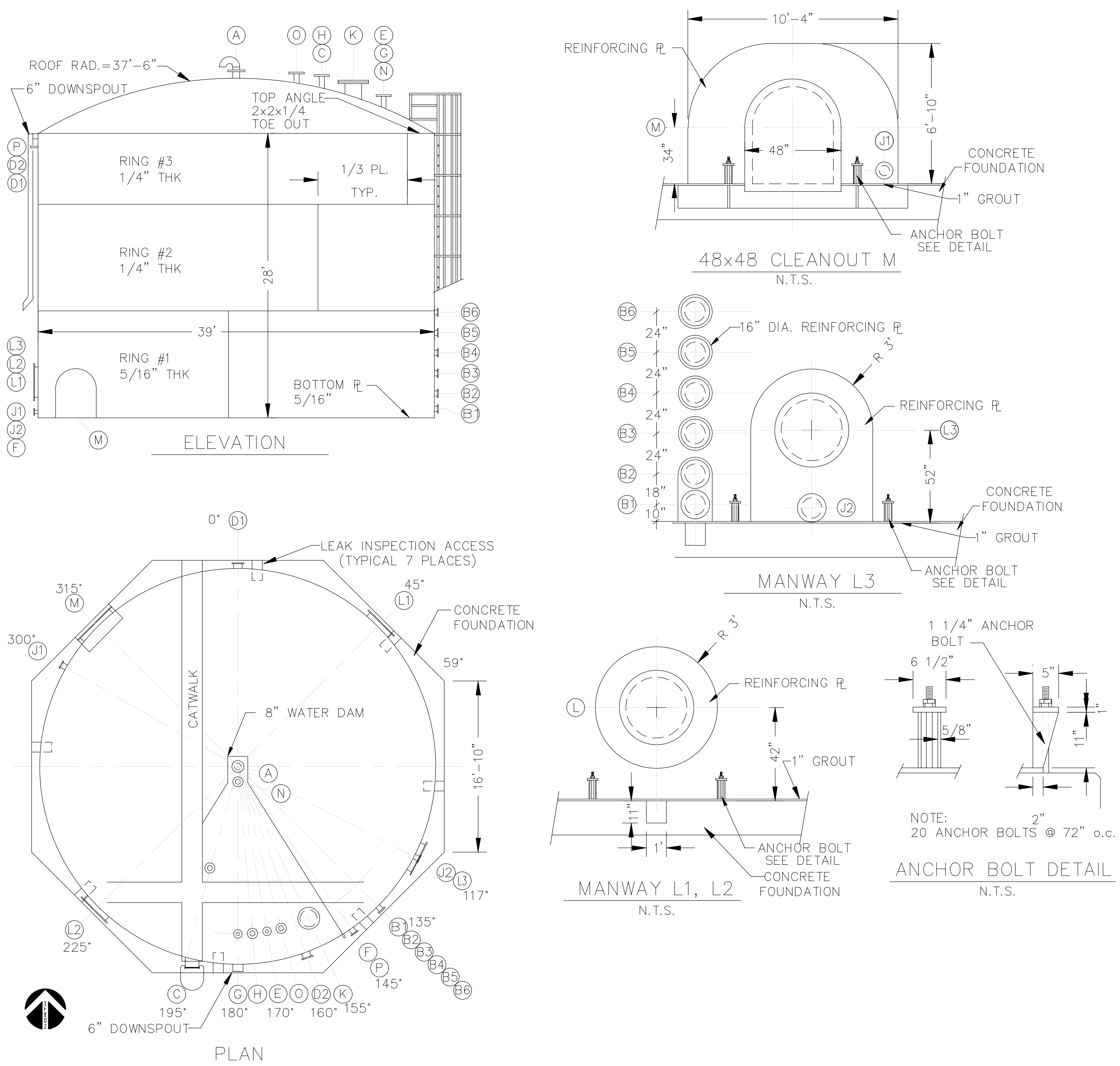
PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF DESIGNER: RAK CHECKER: SBT
SHEET TITLE
TANK DATA SHEET - T-1417
SHEET 1400-080-017

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



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-2" W.C. / +8 oz.
0'F 150'F
AQUEOUS WASTE STORAGE
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300 gpm 300 gpm
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70 mph (SBC)
ZONE 1 / API 650, APP. E
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D1	SPARE	10"	150# R.F.	SIDE 0° H27'	–
D2	SPARE	10"	150# R.F.	SIDE 160° H27'	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 170°	–
F	PH METER	4"	150# R.F.	SIDE 145° H 36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
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NOTES:

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RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

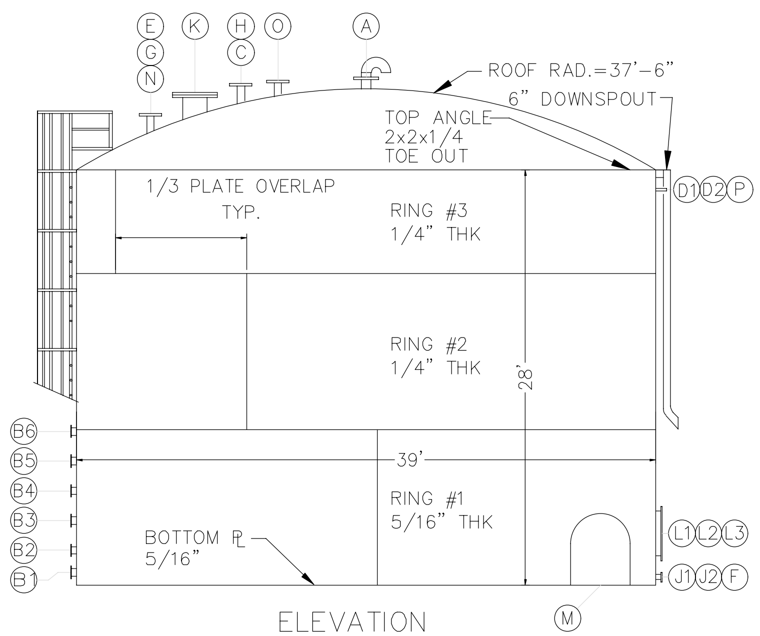
REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT
SHEET TITLE
TANK DATA SHEET - T-1418
SHEET 1400-080-018

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



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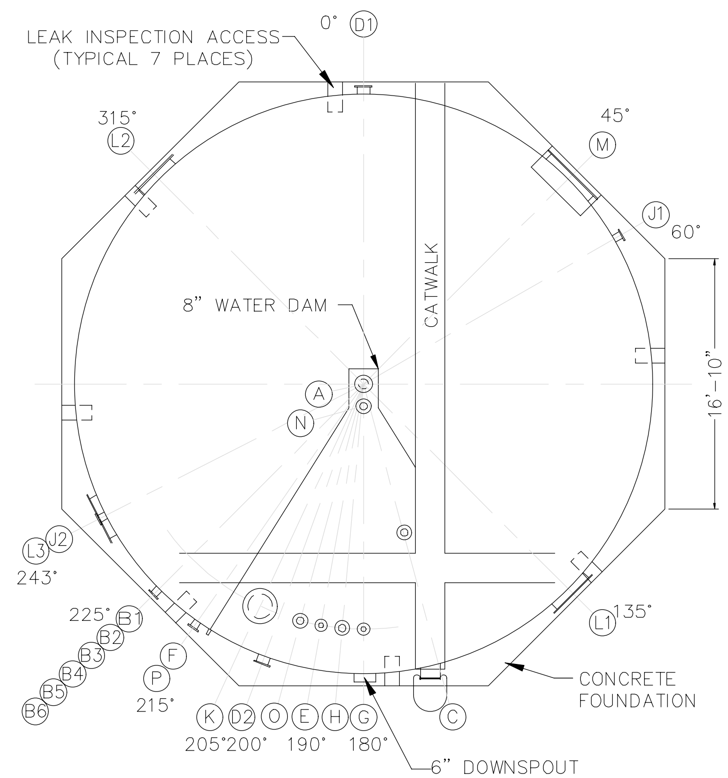
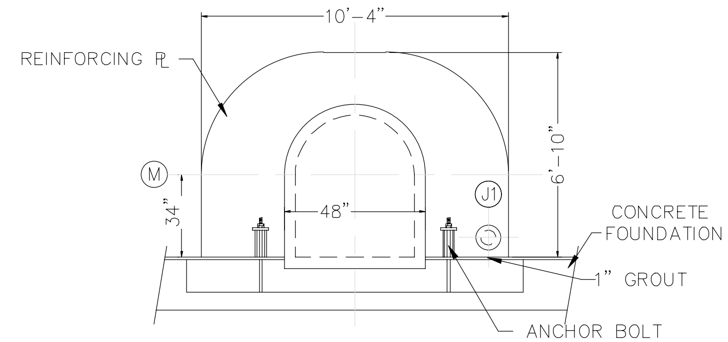
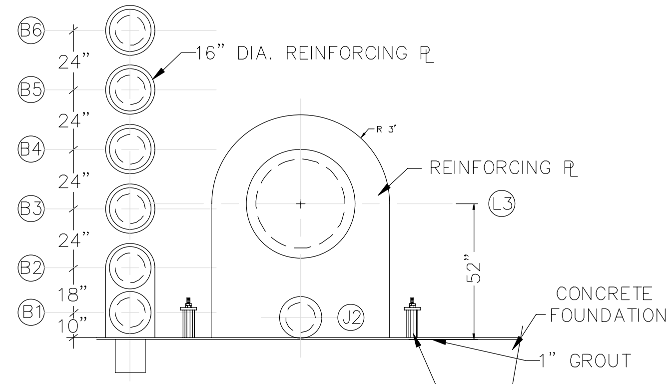


PLAN



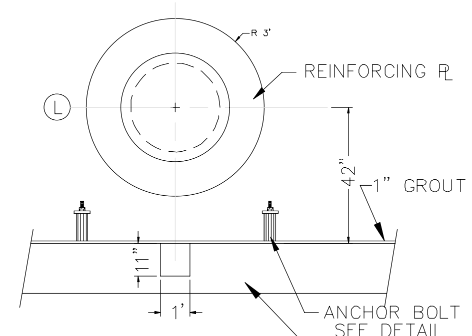
48x48 CLEANOUT M

N.T.S.



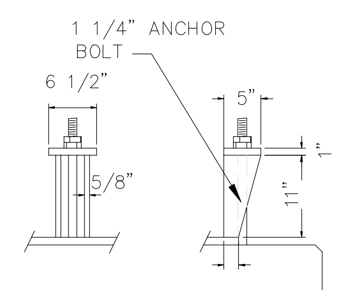
MANWAY L3

N.T.S.



MANWAY L1, L2

N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL

N.T.S.

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
300 gpm 300 gpm
API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"		VERTICAL	28'-0"
5/16"	A36	1/16"		FLAT	–
1/4"	A36	1/16"		DOME	R 37'-6"

A	VENT	8"	150# R.F.	TOP CENTER	GOOSE NECK
B	OUTLET (6 REQ'D)	6"	150# R.F.	SIDE 225°	B1–B6
C	GAUGE HATCH	6"	150# R.F.	TOP 165°	–
D1	SPARE	10"	150# R.F.	SIDE 0° H27'	–
D2	SPARE	10"	150# R.F.	SIDE 200° H27'	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 190°	–
F	PH METER	4"	150# R.F.	SIDE 145° H 36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
H	INLET	4"	150# R.F.	TOP 185°	–
J	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 60°/243°	H 8"
K	MANWAY	20"	150# R.F.	TOP 205°	–
L1,2	MANWAY (2 REQ'D)	36"	150# R.F.	SIDE 135°/315°	H 42"
L3	MANWAY	36"	150# R.F.	SIDE 243° H52"	–
M	CLEANOUT	48"	–	SIDE 45° H34"	–
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 195°	–
P	HIGH LEVEL	2"	150# R.F.	SIDE 215°H26'-6"	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:

1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY

SUMTER COUNTY, AL

REV	DATE		REVISION DESCRIPTION
5.0	08/22		RCRA PART B PERMIT RENEWAL

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PROJECT NO: D3279702

DATE: AUGUST 2022

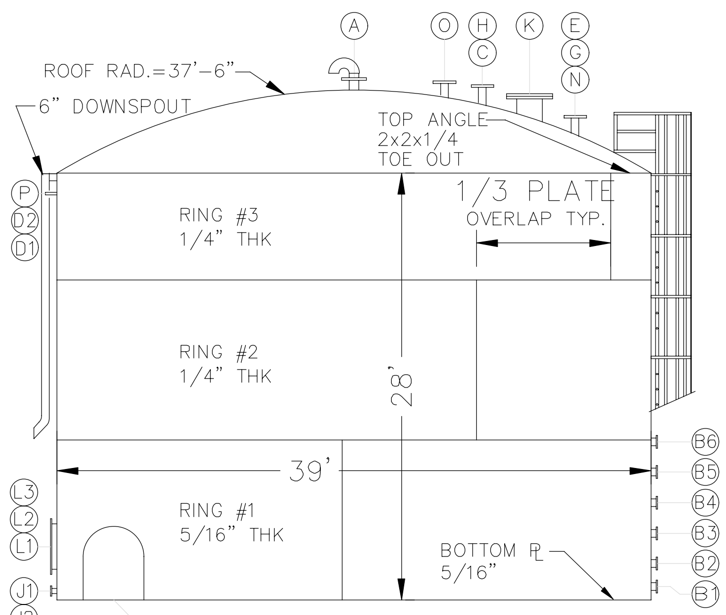
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE

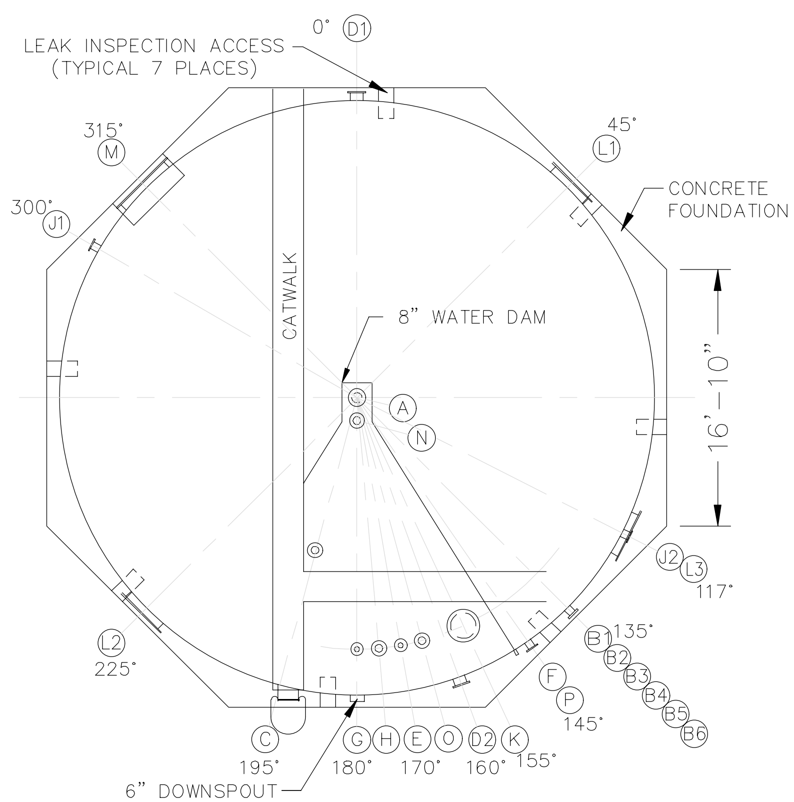
TANK DATA SHEET - T-1419

SHEET 1400-080-019

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022



ELEVATION



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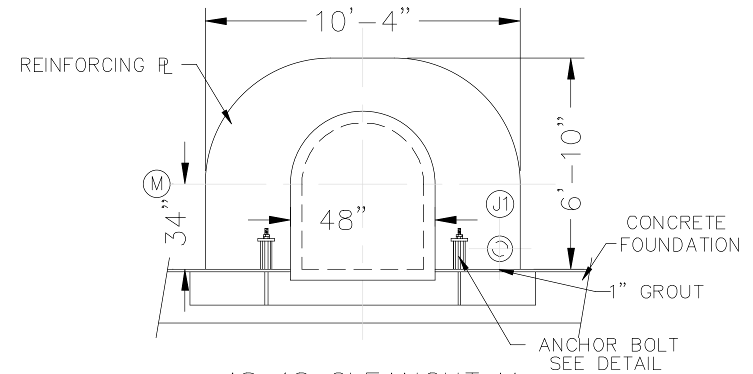
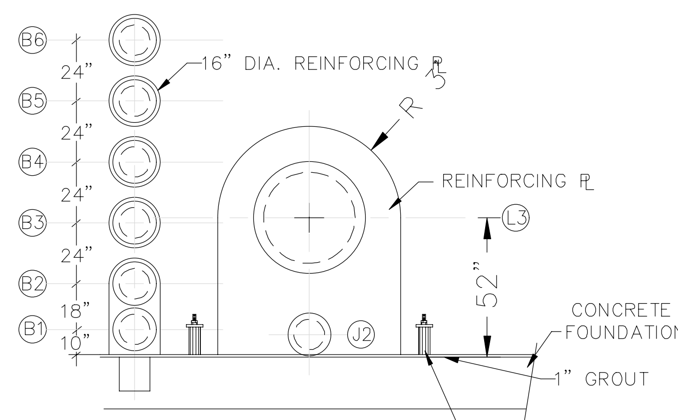


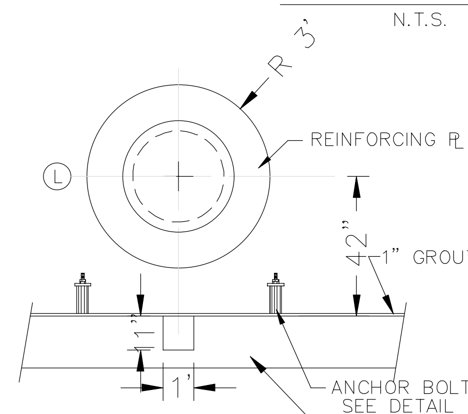
48x48 CLEANOUT M

N.T.S.



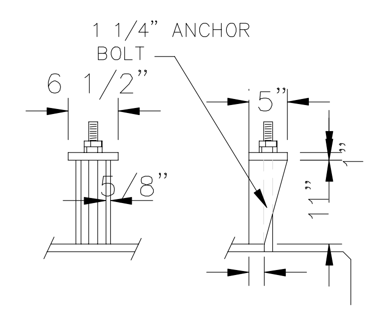
MANWAY L3

N.T.S.



MANWAY L1, L2

N.T.S.



NOTE:
20 ANCHOR BOLTS @ 72" o.c.

ANCHOR BOLT DETAIL

N.T.S.

250,195 gal.
-2" W.C. / +8 oz.
0°F 150°F
AQUEOUS WASTE STORAGE
1.10 12"
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API 650 0.85
70 mph (SBC)
ZONE 1 / API 650, APP. E
39'-0" 28'-0"

VARIES	A36	1/16"		VERTICAL	28'-0"
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B	OUTLET (6 REQ'D)	6"	150# R.F.	SIDE 135°	B1–B6
C	GAUGE HATCH	6"	150# R.F.	TOP 195°	–
D1	SPARE	10"	150# R.F.	SIDE 0° H27'	–
D2	SPARE	10"	150# R.F.	SIDE 160° H27'	–
E	LEVEL INDICATOR	4"	150# R.F.	TOP 170°	–
F	PH METER	4"	150# R.F.	SIDE 145° H 36"	–
G	INLET	4"	150# R.F.	TOP 180°	–
H	INLET	4"	150# R.F.	TOP 175°	–
J	DRAIN (2 REQ'D)	6"	150# R.F.	SIDE 300°/117°	H 8"
K	MANWAY	20"	150# R.F.	TOP 155°	–
L1,2	MANWAY (2 REQ'D)	36"	150# R.F.	SIDE 45°/225°	H 42"
L3	MANWAY	36"	150# R.F.	SIDE 117°H52"	–
M	CLEANOUT	48"	–	SIDE 315° H34"	–
N	CABLE SUPPORT	6"	150# R.F.	TOP 180°	BLIND FLG.
O	SPARE	6"	150# R.F.	TOP 165°	–
P	HIGH LEVEL	2"	150# R.F.	SIDE 145°H26'-6"	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: DEVOE DEVTHANE 369 ALIPHATIC URETHANE GLOSS ENAMEL, OR DEMONSTRATED EQUIVALENT.

NOTES:
1. NOZZLE ORIENTATIONS ARE SUBJECT TO CHANGE BY OWNER.

Jacobs
10 Tenth Street Suite 1400 Atlanta, GA 30309 404.978.7600

NOT RELEASED FOR CONSTRUCTION

WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

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PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE
TANK DATA SHEET - T-1420

SHEET 1400-080-020

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

EXHIBIT B

TANK DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 1400

TANK NO.: T-1405 TO T-1408 & T-1421 TO T-1424

DECRIPTION: 52'Ø BY 32' TANK W/ SPHEICAL TOP

VESSEL CALCULATIONS

PREPARED BY: LANZ DATE: 9/29/94

REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
LARRY [illegible] LANZ
40615
REGISTERED
PROFESSIONAL ENGINEER

OCT 3 1994

UNIT 1400

DESIGN CALCUALTIONS

DESIGN DATA SHEET T-1405, T-1406, T-1407, T-1408 T-1421, T-1422, T-1423, T-1424 Page 1 of 8

Service: Bulk Storage

52 ft. Diameter by 32 ft. High Spherical Roofed Flat Bot. Storage Tanks.

Chemical Waste Management, Emelle, AL Job No. 44228.00

Design Code	API 650
Service Status	Existing/Proposed
Diameter/Length	52' - 0"
Shell/Heigth	32' - 0"
Bottom/Width	
Heads/Ends Top	Spherical
Bottom	Flat
Legs	N/A
Operating Capacity	508,333 Gal
Material of Construction	Carbon Steel
Corrosion Allownce	1/16 inch
Joint Efficiency	0.85
Design Spec. Grav	1.10
Design Pressure	0.5 psig Max and 2 inches H20 Vacuum (Min)
Design Temperature	150 deg F. Max and 0 deg F. Min
Roof Live Load psf	20 psf
Wind Load	SBC, 70 mph
Seismic Zone	Zone 1
Agitator	NA
Location	Outdoors

ROSSER

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO. SHEET OF

DESIGNED LANZ / / CHECKED 11/29/94

TANK DESIGN

Diameter 52 feet
Height 32 feet

Weight of Contents

Volume = Pi*H*D*D/4 = 67958.93 Cubic Feet

Weight = Volume*Unit Wt*SG = 4664701. Pounds (32 ft. Depth)

Operating Weight = Vol * Den = 4664701. pounds

Tank Wall Thickness

The 32 foot high tank will be constructed of 4 courses of 8 foot wide rolled sheet carbon steel. Minimum thicknesses of plate are determined using the expressions in Section 3.6 in API Standard 650.

Min. Values are
Bottom Course 1/4" + Corrosion Allowance
2nd, 3rd & 4th Courses - 1/4" + CA

Thickness of the bottom (1st) course, 8 feet high, using the 1 foot method and Appendix F.

t = 2.6*D*(H-1+P/.433)*G/E/21,000 + Corr Allow

= 2.6*52*(32-1+.5/.433)*1.1/.85/21000 + 1/16 = 0.330 inches

3/8 INCH PLATE ACCEPTABLE, USE 7/16 INCH PLATE FURNISHED

Thickness of the second course

t = 2.6*D*(H-1+P/.433)*G/E/21,000 + Corr Allow

= 2.6*52*(24-1+.5/.433)*1.1/.85/21000 + 1/16 = 0.264 inches

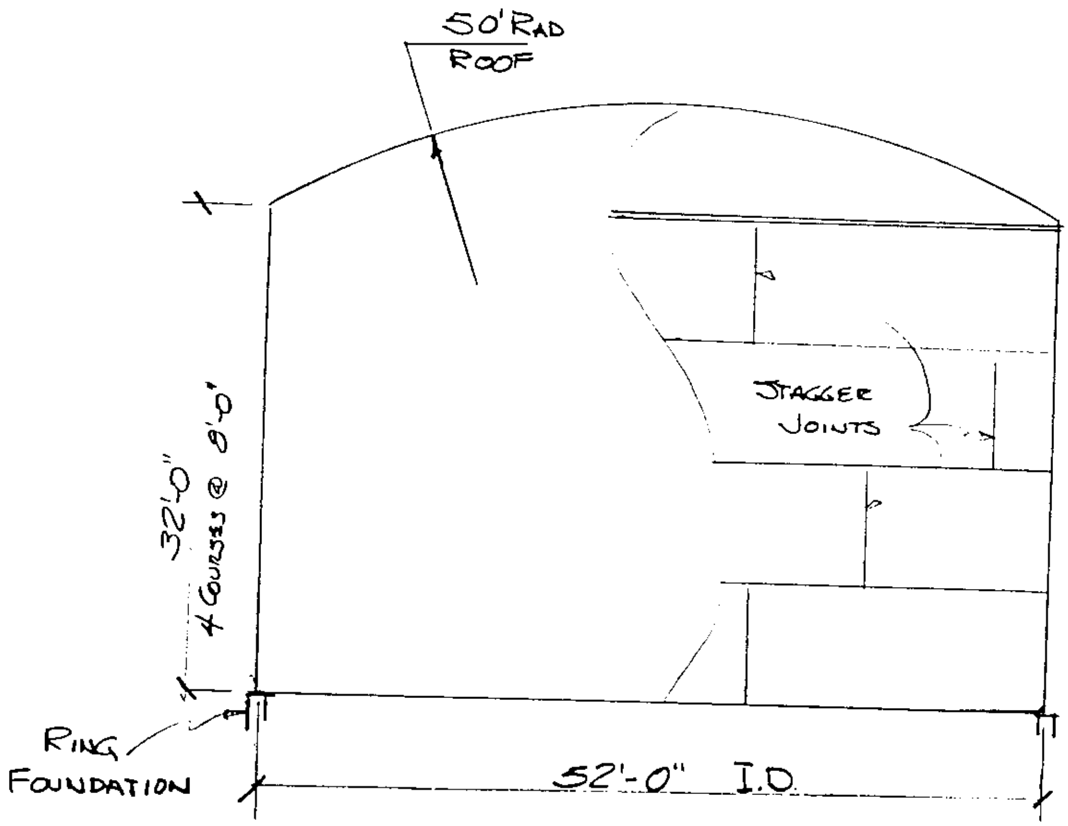
USE 5/16 INCH PLATE

Thickness of the 3rd and top courses

USE 5/16" PLATE PER API 650 (1/4" + CA)
Calc Values are 0.197 inches & 0.130 inches

Tank Floor Thickness

USE 5/16 INCH PLATE PER API 650 (1/4" + CA)



ELEVATION 52' ϕ TANK

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJ. NO.	SHEET	OF
	DESIGNED LANZ / /	CHECKED	11/29/94

Tank Roof Thickness

Use a Spherical Roof for these tanks.
Try 50 foot radius

Check 0.8*D<50<1.2*D

41.6 < 50' R < 62.4

The 50 foot radius is acceptable

Thickness of Roof Per API 650, Section 3.10.6

Min Thickness = R/200 > 3/16"

Design Thickness = R/200 = 50/200 = 0.25 inches

Check for increased thickness = sqrt(LL+DL/45) =
= Sqrt((20 + 12.65 + 10.4)/45) = < 1.0 OK

USE 5/16" PLATE (1/4" + 1/16" Corr Allow)

Top Angle Attachment

Per API 650 Section 3.1.5.9, USE 3" X 2" X 5/16" ANGLE

Allowable internal pressure

Pa = 30,800*A*tanO/d/d+8*th   tanO = asin26/50 = 0.60878
8*th = 8*0.250 = 2.0
A = 1.06 + (.3*SQRT(Rr*th)+.6*SQRT(Rc*tc))*.25
= 1.71 sq in

Pa = 13.84 inches of water = 0.50 psi, allowable > 0.5 psi

INTERNAL PRESSURE CHECKS

Weight of Tank

Weight of Floor

Wt. = Area times unit weight = Pi*R*R*12.75
= Pi*26*26*12.75 = 27077 pounds

Weight of tank (cont)

Weight of Wall

Wt. = Area times unit weight = Pi*D*h*12.75
= Pi*(52*24*12.75+52*8*15.3)
= 69985 pounds

Weight of Roof

Wt = Area times unit weight = Pi*R*Height
= 2*@PI*50*(50-50*@SIN(@ACOS(26/50)))*12.75
= 29207.07 Pounds

Weight of Nozzles and Attachemnts = 10000 pounds

Weight of Tank

Wt = Floor + Wall + Roof + Att = 136269.0 Pounds

Force on Tank Roof

Force = Pressure times Area = P*Pi*R*R
= 0.5*Pi*26*12*26*12 = 152907.5 Pounds

This force is greater that the weight of the empty tank by 16638.50 pounds. An anchor system is required to hold the tank down.

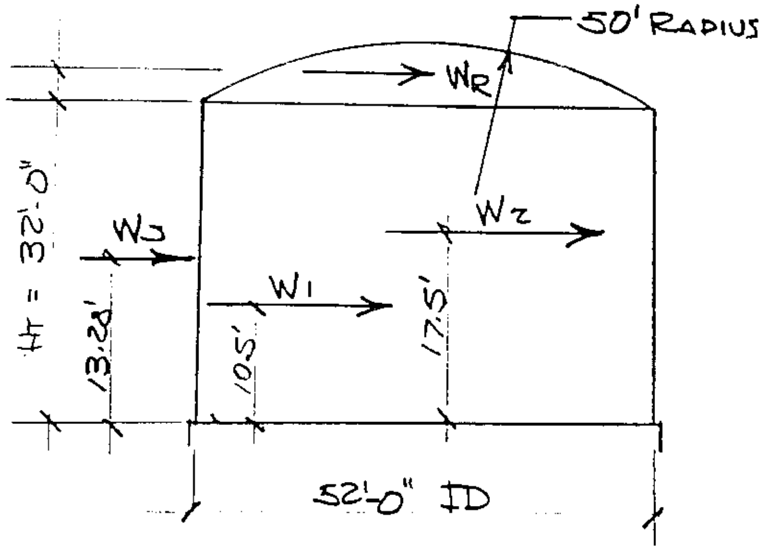
ANCHOR BOLTS AREA REQUIRED FOR TIE DOWN

Resisting Area at Design Pressure

wh = 0.3Sqrt(R2tn)
3.67 inches
wc = 0.6*Sqrt(Rc*tc)
5.30 inches

Area = wh*th+wc*tc 2.24 sq inches

Area Required = D*D*(P-8th)/30800/tan theta
1.71 sq inches
1.71 < 2.24 Resisting Area OK



Earthquake Forces The Site is in Zone 1. Z= 0.075

The overturning moment due to seizmic forces applied to the bottom of the shell are (API 650, App. E)

M = Z*I*(C1*Ws*Xs+C1*Wr*Ht+C1*W1*X1+C2*W2*X2)

Where

M is the overturning moment
Z is the seizmic zone factor Z = 0.075
I is the importance factor I = 1.0
C1, C2 are earthquake force coefficients, E3.3: C1 = 0.6, C2 = 0.173
Ws is the weight of the tank shell Ws = 69,985 Lb
Xs is the distance up to the shell center of gravity Xs = 15.78 ft
Wr is the weight of the tank roof Wr = 29,210 LB
Ht is the height of the tank shell Ht = 32 ft
W1 is the effective mass of the tank contents that move with the tank W = 3,032,250
X1 is the height to the centroid of seizmic force W1 X1 = 12 ft
W2 is the effictive mass of the contents that move in the first sloshing mode W2 = 1,749,400
X2 is the height to the centroid of seizmic force W2 H2 = 20.0 t

Then

M = .075*1.0*(.6*69985*15.78+.6*29210*32+.6*3032250*12+.17*1749400*20)
= 2183143. foot-pounds

Resistance to Overturning

Not considered for anchored tanks.

Shell Compresion

The maximum longitudinal compressive stress at the bottom of the shell is determined by the expression

b = wt + 1.273*M/D/D = 136270/Pi/52+1.273*2183143/52/52
= 1861.94

The maximum longitudinal compressive stress in the shell b/12/t shall not excees the following Fa = 1,000,000*t/D when G*H*D*D/t/t >1,000,000 G*H*D*D/t/t = 1335140.
Maximum Stress = 1000000*.267/52 = 5135 psi

Minimum Anchorage

The force per foot of circumference = 1.273*M/D/D-wt
= 301 pounds

Tanks T-1405, T-1406, T-1407, T-1408
T-1421, T-1422, T-1423, T-1424

Wind Loading

Stresses from wind loading will be bending and axial stresses in the shell.

Fw = q2*Gh*Cf*A

At = 52*32
Ar = 52*7.29*2/3
Mom = At*Lt + Ar*Lr

Fw =12.3*1.26*0.8*1916.7
23764 pounds

Mom = 4031667 ft lb

Sben =M/Z = 53 psi
Saxl = P/A = 223 psi

q2 = 0.00256*K2I*I*V*V = 12.3
V = 70 mph Exposure C
Exp Coeff. = K@ = 0.98 eZ=30'
Gust Factor = 1.26
Shape Factor = 0.8
Importance Factor = 1.0
At = 1664
Ar = 252.72
1916.72

Z = Pi*R*R*t = 76454 in 3
P = tank Wt = 109192 lb
As = Pi*D*t 490

Stressed are low and do not significantly contribute to the overall stresses.

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO. SHEET OF
DESIGNED LANZ / / CHECKED [signature] 11/29/94

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 1400

TANK NO.: T-1409 TO T-1420 & T-1425 TO T-1436 (24)

DECRIPTION: 39'Ø BY 28' TANK W/SPHERICAL DOME

VESSEL CALCULATIONS

PREPARED BY: LANZ DATE: 9/30/94

REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
LARRY J. LANZ
49416
REGISTERED PROFESSIONAL ENGINEER

OCT 3 1994

UNIT 1400

DESIGN CALCULATIONS

DESIGN DATA SHEET - T-1409, T-1410, T-1411, T-1412, T-1413
T-1414, T-1415, T-1416, T-1417, T-1418, T-1419, T-1420
T-1425, T-1426, T-1427, T-1428, T-1429, Y-1430, T-1431
T-1432, T-1433, T-1434, T-1435, T-1436

Service: Bulk Storage

39 ft. Diameter by 28 ft. Shell, Spherical Roof, Ring Foundation

Chemical Waste Management, Emelle, AL — Job No. 44228.00

Design Code	API 650
Service Status	Existing/Proposed
Diameter/Length	39' - 0"
Shell/Heigth	28' - 0"
Bottom/Width	
Heads/Ends Top	Spherical
Bottom	Flat
Legs	None
Operating Capacity	250,195
Material of Construction	Carbon Steel
Corrosion Allownce	1/16 inch
Joint Efficiency	0.85
Design Spec. Grav	1.10
Design Pressure	0.5 psig Max and 2 inches H2O vacuum (min)
Design Temperature	150 deg F Max 0 deg F. Min
Roof Live Load psf	20 psf
Wind Load	SBC, 70 mph
Seismic Zone	Zone 1
Agitator	NO
Location	Outdoors

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO. SHEET OF

DESIGNED LANZ / / CHECKED [signature] 11/29/94

TANK DESIGN

Diameter 39 feet
Height 28 feet

Weight of Contents

Volume = Pi*H*D*D/4 = 33448.53 Cubic Feet

Weight = Volume*Unit Wt*SG = 2295907. Pounds (28 ft. Depth)

Operating Weight = Vol * Den = 2295907. pounds

Tank Wall Thickness

The 28 foot high tank will be constructed of 3 courses of 9.33 foot wide rolled sheet carbon steel. Minimum thicknesses of plate are determined using the expressions in Section 3.6 in API Standard 650.

Min. Values are Bottom Course 3/16" + Corrosion Allowance
2nd and 3rd Courses - 3/16" + CA

Thickness of the bottom (1st) course, 9.33 feet high, using the 1 foot method and Appendix F.

t = 2.6*D*(H-1+P/.433)*G/E/21,000 + Corr Allow

= 2.6*39*(28-1+.5/.433)*1.1/.85/21000 + 1/16 =
0.176 = 1/16 = 0.238 inches

1/4 INCH PLATE ACCEPTABLE, USE 5/16 INCH PLATE FURNISHED

Thickness of the second course

t = 2.6*D*(H-1+P/.433)*G/E/21,000 + Corr Allow

= 2.6*39*(18.67-1+.5/.433)*1.1/.85/21000 + 1/16 =
= 0.118 = 1/16 = 0.180 inches

USE 1/4 INCH PLATE

Thickness of the top course

Calc Value is 0.059 +1/16 = 0.122 inches
USE 1/4" PLATE (3/16 " + 1/16" CA)

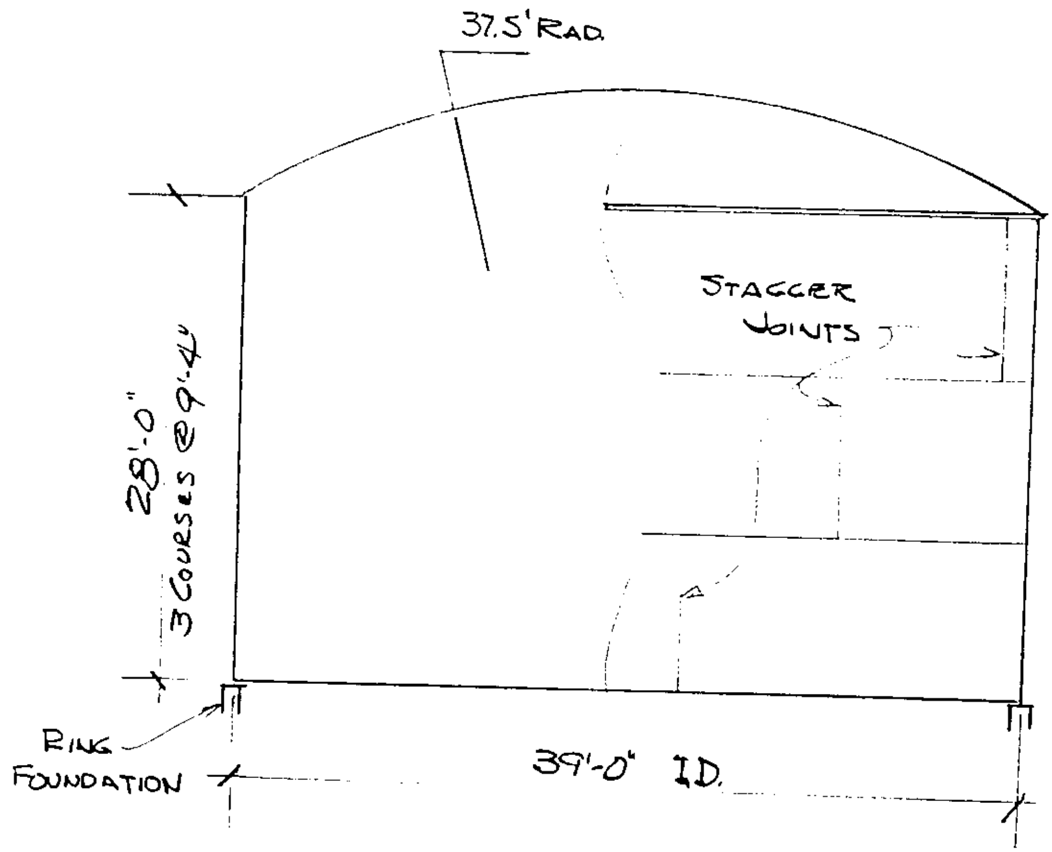
Tank Floor Thickness

USE 5/16 INCH PLATE PER API 650 (1/4" + CA)

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO. SHEET OF
DESIGNED LANZ / / CHECKED 11/29/94

Tanks T-1409 to T-1420 and T-1425 to T-1436



ELEVATION 39' ϕ TANK

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJ. NO.	SHEET	OF
	DESIGNED LANZ / /	CHECKED	11/29/94

Tank Roof

Use a Spherical Roof for these tanks.
Try 37.5 foot radius

Check 0.8*D < 37.5 < 1.2*D

31.2 <37.5'R < 46.8
The 37.5 foot radius is acceptable

Thickness of Roof Per API 650, Section 3.10.6

Min Thickness = R/200 > 3/16"

Design Thickness = R/200 = 37.5/200 0.1875 inches

Check for increased thickness = sqrt((LL+DL)/45) =
= sqrt((20 + 10.2 + 10.4)/45) = < 1.0 OK

USE 1/4" PLATE (3/16" + 1/16" Corr Allow)

Top Angle Attachment

Per API 650 Section 3.1.5.9, USE 2" X 2" X 1/4" ANGLE

Allowable internal pressure

Pa = 30,800*A*tanO/d/d+8*th tanO = asin19.5/37.5 = 0.60878
8*th = 8*0.1875 = 1.5
A = 1.06 + (.3*SQRT(Rr*th)+.6*SQRT(Rc*tc))*.25
= 1.42 sq in

Pa = 19.56 inches of water = 0.71 psi, allowable > 0.5 psi

INTERNAL PRESSURE CHECKS

Weight of Tank

Weight of Floor

Wt. = Area times unit weight = Pi*R*R*10.2
= Pi*19.5*19.5*12.75 = 15231 pounds

Weight of tank (cont)

Weight of Wall

Wt. = Area times unit weight = Pi*D*h*12.75
= Pi*(39*18.67*10.2+39*9.33*12.75)
= 37907 pounds

Weight of Roof

Wt = Area times unit weight = Pi*R*Height
= 2*@PI*37.5*(37.5-37.5*@SIN(@ACOS(19.5/37.5)))*10.2
= 12732.61 Pounds

Weight of Nozzles and Attachemnts = 8000 pounds

Weight of Tank

Wt = Floor + Wall + Roof + Att = 73871 Pounds

Force on Tank Roof

Force = Pressure times Area = P*Pi*R*R
= 0.5*Pi*19.5*12*19.5*12 152908 Pounds

This force is greater that the weight of the empty tank by 79037 pounds. An anchor system is required to hold the tank down.

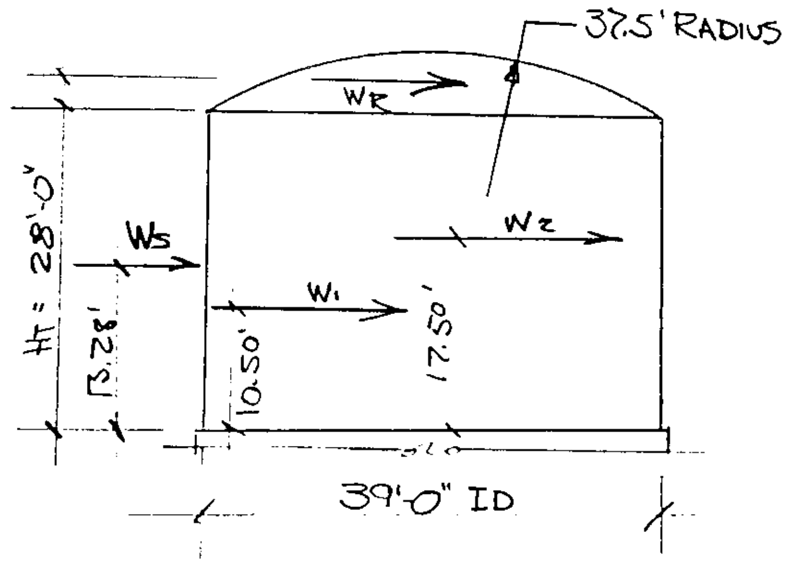
ANCHOR BOLTS AREA REQUIRED FOR TIE DOWN

Resisting Area at Design Pressure

wh = 0.3Sqrt(R2tn)
3.18 inches
wc = 0.6*Sqrt(Rc*tc)
4.59 inches

Area = wh*th+wc*tc 1.94 sq inches

Area Required = D*D*(P-8th)/30800/tan theta
0.96 sq inches
0.96 < 1.94 Resisting Area OK



SEISMIC LOADING ON TANK

Earthquake Forces   The Site is in Zone 1.   Z=   0.075

The overturning moment due to seizmic forces applied to the bottom of the shell are (API 650, App. E)

M = Z*I*(C1*Ws*Xs+C1*Wr*Ht+C1*W1*X1+C2*W2*X2)

Where

M is the overturning moment
Z is the seizmic zone factor — Z = 0.075
I is the importance factor — I = 1.0
C1, C2 are earthquake force coefficients, E3.3: C1 = 0.6, C2 = 0.204
Ws is the weight of the tank shell — Ws = 37,907 Lb
Xs is the distance up to the shell center of gravity — Xs = 13.28 ft
Wr is the weight of the tank roof — Wr = 12,733 lb
Ht is the height of the tank shell — Ht = 28 ft
W1 is the effective mass of the tank contents that move with the tank — W = 1,492,435
X1 is the height to the centroid of seizmic force W1 — X1 = 10.5 ft
W2 is the effictive mass of the contents that move in the first sloshing mode — W2 = 861,032
X2 is the height to the centroid of seizmic force W2 — H2 = 17.5 ft

Then
M=.075*1.0*(.6*37907*13.28+.6*12733*28+.6*1492435*10.5+.26*861032*17.5)
= 1037699. foot-pounds

Resistance to Overturning

Not considered for anchored tanks.

Shell Compresion

The maximum longitudinal compressive stress at the bottom of the shell is determined by the expression (E.5.2)

b = wt + 1.273*M/D/D = 73871/Pi/39+1.273*1037699/39/39
= 1471 psi Allowable

The maximum longitudinal compressive stress in the shell b/12/t shall not excees the following Fa = 1,000,000*t/D when G*H*D*D/t/t >1,000,000 G*H*D*D/t/t = 1529691.
Maximum Stress = 1000000*.175/52 = 4487 psi
Stresses are OK

Minimum Anchorage

The force per foot of circumference = 1.273*M/D/D-wt
= 350 pounds
ANCHOR BOLTS ARE REQUIRED

Wind Loading

Stresses from wind loading will be bending and axial stresses in the shell.

Fw = q2*Gh*Cf*A	q2 = 0.00256*K2I*I*V*V = 12.3
	V = 70 mph Exposure C
At = 39*28	Exp Coeff. = K@ = 0.98 eZ=30'
Ar = 39*5.47*2/3	Gust Factor = 1.26
Mom = At*Lt + Ar*Lr	Shape Factor = 0.8
	Importance Factor = 1.0
	At = 1092
Fw =12.3*1.26*0.8*1234.2	Ar = 142.22
15302 pounds	1234.22
Mom = 2299562 ft lb	Z = Pi*R*R*t = 32254 in 3
	P = tank Wt = 58640 lb
Sben =M/Z = 71 psi	As = Pi*D*t 276
Saxl = P/A = 213 psi	

Stressed are low and do not significantly contribute to the overall stresses.

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO.
SHEET OF
DESIGNED LANZ / /
CHECKED 11/29/94

EXHIBIT C

TANK FOUNDATION DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 1400

TANK NO.: T-1405 TO T-1408 & T-1421 TO T-1424

DECRIPTION: STORAGE TANKS

FOUNDATION CALCULATIONS

PREPARED BY: S. SMITH DATE: 9-20-94

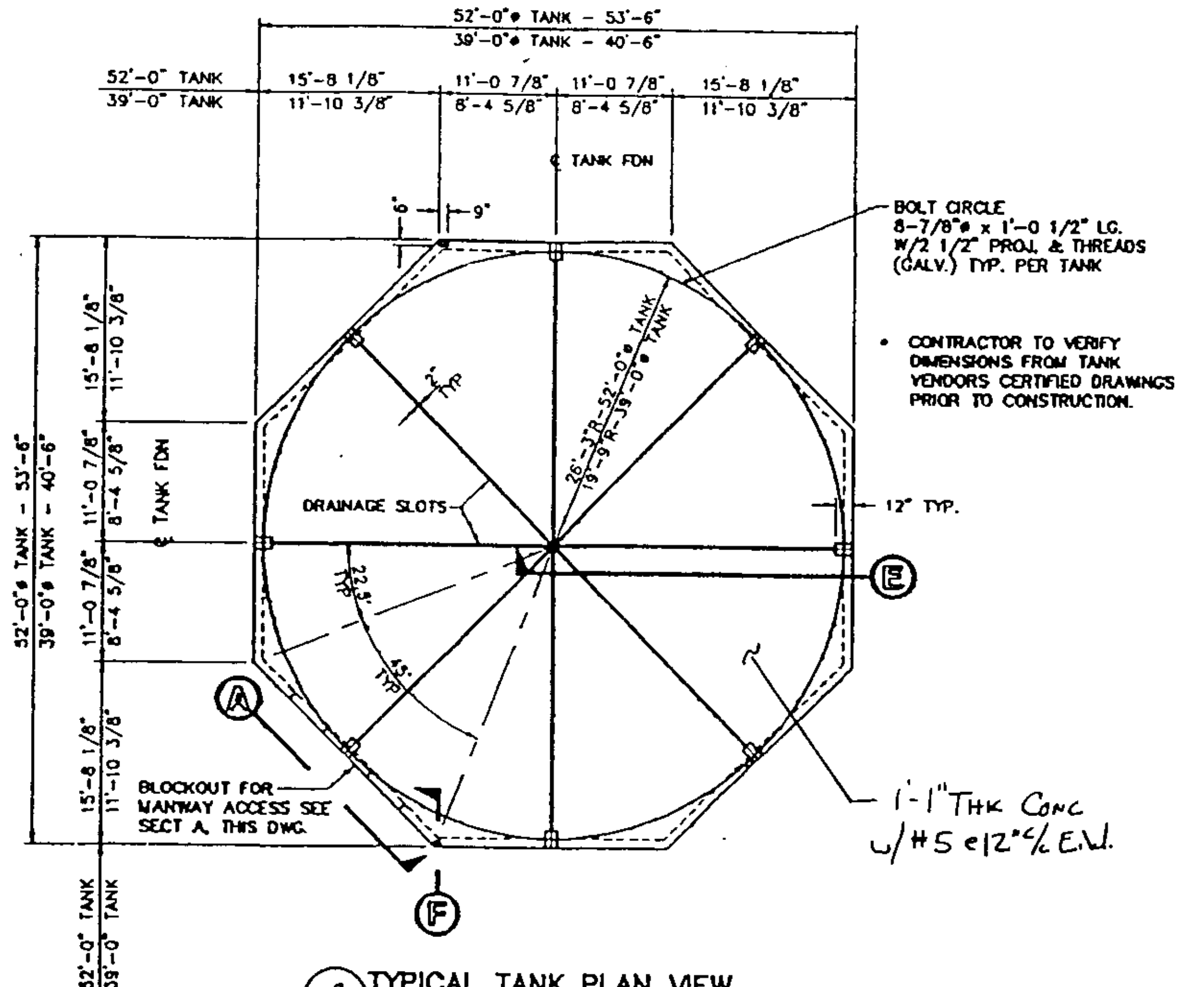
REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
SCOTT R. SMITH
60612
REGISTERED
PROFESSIONAL ENGINEER

10-3-94

FOUNDATIONS FOR TANKS T-1405 TO T-1408 & T14-21 TO T-1424



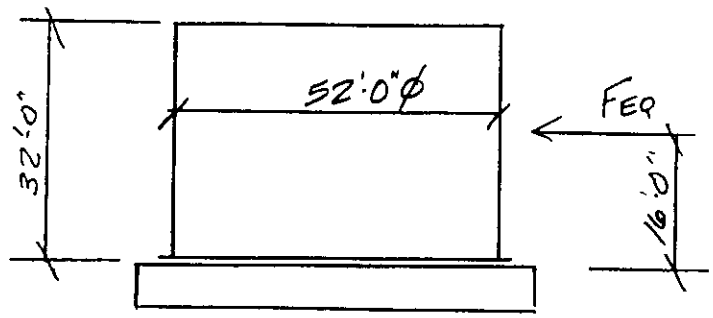
1 TYPICAL TANK PLAN VIEW

SCALE: 1/8" = 1'-0"

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT	CHEM WASTE MANAGEMENT		PROJ. NO.
EMELLE, ALA			SHEET SK-1 OF
DESIGNED	S. SMITH	9/20/94	CHECKED / /

FOUNDATIONS FOR TANKS T-1405 TO T-1408 & T-1421 TO T-1424



TANK WEIGHT (Empty)

TOP: $\frac{\pi(52.0')^2}{4} \times 10.2\#/SF = 21,661\#$

SHELL: $\pi(52.0')(32.0)(15.3\#/SF) = 79,982\#$

BOTTOM: $\frac{\pi(52.0)^2}{4} \times 12.8\#/SF = 27,182\#$

SUBTOTAL: 128,825#

NOZZLES & VALVES (5%) 6,441#

W_E = 135,266#

WEIGHT OF CONTENTS

CAPACITY 508,333 GALLON

SP. GR. 1.10

$W_C = 508,333 \text{ GAL} \times 1.10 \times 8.34\#/\text{GAL} = 4,663,446\#$

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MANAGEMENT PROJ. NO. EMELLE, ALA SHEET 1 OF DESIGNED S. SMITH 9/20/94 CHECKED / /

FOUNDATIONS FOR TANKS T-1405 TO T-1408 & T-1421 TO T-1424

EARTHQUAKE LOAD (SBC 1994)

$F_{EQ} = A_V \times C_C \times P \times a_C \times W_T$

$A_V = 0.06$

$C_C = 2.0$ GEN EQUIP

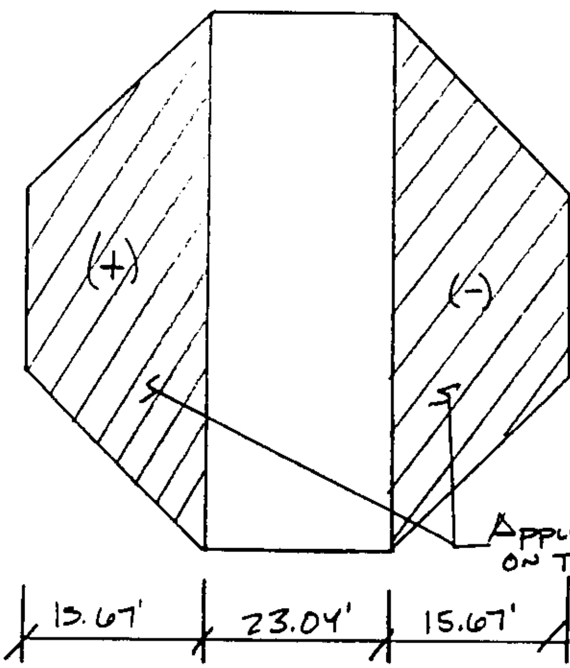
$P = 0.5$ " "

$a_C = 1.0$ FIXED

$W_T = W_E + W_L = 135{,}266^{\#} + 4{,}663{,}466^{\#} = 4{,}798{,}732^{\#}$

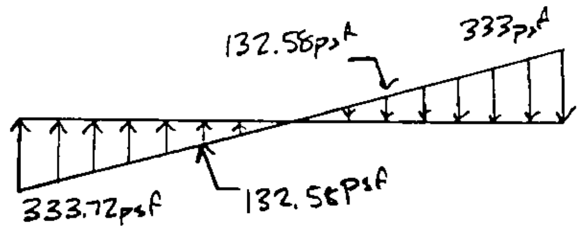
$F_{EQ} = 0.06 \times 2.0 \times 0.5 \times 1.0 \times 4{,}798{,}732^{\#} = 287{,}923^{\#}$ @ EL 16.0'

$M = 287{,}923^{\#} \times 16.0' = \underline{4{,}606{,}768}$ FT-lbs



$P = \frac{M}{S} = \frac{4{,}606{,}768 \text{ FT-lb}}{13{,}804 \text{ FT}^3} = 333.72 \text{ psf}$

$S = \frac{\pi (D)^3}{32} = \frac{\pi (52)^3}{32} = 13{,}804 \text{ FT}^3$

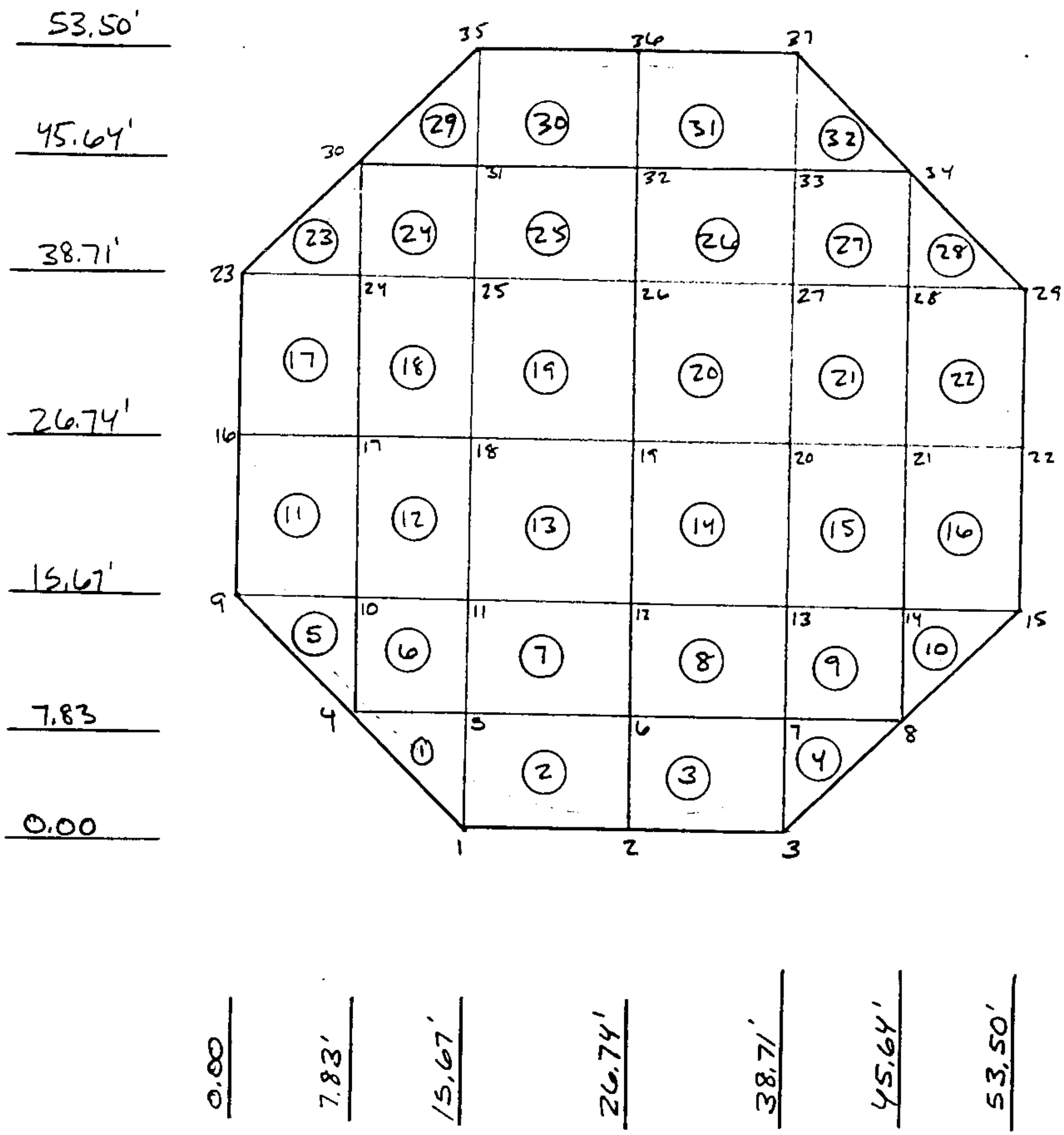


AVG LOAD:

$\frac{333.72 + 132.58}{2} = 233.15 \text{ psf}$

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MANAGEMENT PROJ. NO. EMELLE, ALA SHEET 2 OF DESIGNED S. SMITH 9/20/94 CHECKED / /

Foundations for Tanks T-1405 to T-1408 & T-1421 to 1424



ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management PROJ. NO.

Emelle, Ala SHEET 3 OF

DESIGNED S. Smith 9/20/94 CHECKED / /

Foundations for Tanks T-1405 to T-1408 & T-1421 to T-1424

STAAD III Input

Fdn Area = $0.8284 D^2 = 0.8284(53.5)^2 = 2{,}371.08\,sf$

Loading (Element Loads)

Dead Load: $\dfrac{135{,}266^{\#}}{2{,}371.08\,sf} = 57.04\,psf = \underline{0.057\,ksf}$

Live Load: $\dfrac{4{,}663{,}466^{\#}}{2{,}371.08\,sf} = 1{,}966\,psf = \underline{1.97\,ksf}$

Earthquake:

Up = 233.15 psf = 0.23 ksf (1) (5) (6) (11) (12) (17) (18) (23) (24) (29)

Dn = 233.15 psf = 0.23 ksf (4) (9) (10) (15) (16) (21) (22) (27) (28) (32)

Check Soil Bearing

Maximum Joint Displ

@ Jt. 8 $\Delta = 0.115''$

$S.B. = 0.115'' \times 0.073\,kci \times 144\,in^2/ft^2 = 1.21\,ksf \le 4.00\,ksf \therefore OK$

Check Bending

Max. Moment: Elem 32 $M_u = 1.44^{k\text{-}f}$

$d = 13'' - 3'' - 0.625 - 0.625/2 = 9.06''$

$A_s = \#5 @ 12''\,c/c \quad A_s = 0.31\,in^2$

$a = \dfrac{A_s f_y}{0.85(f'_c)b} = \dfrac{0.31(60)}{0.85(3)(12)} = 0.60''$

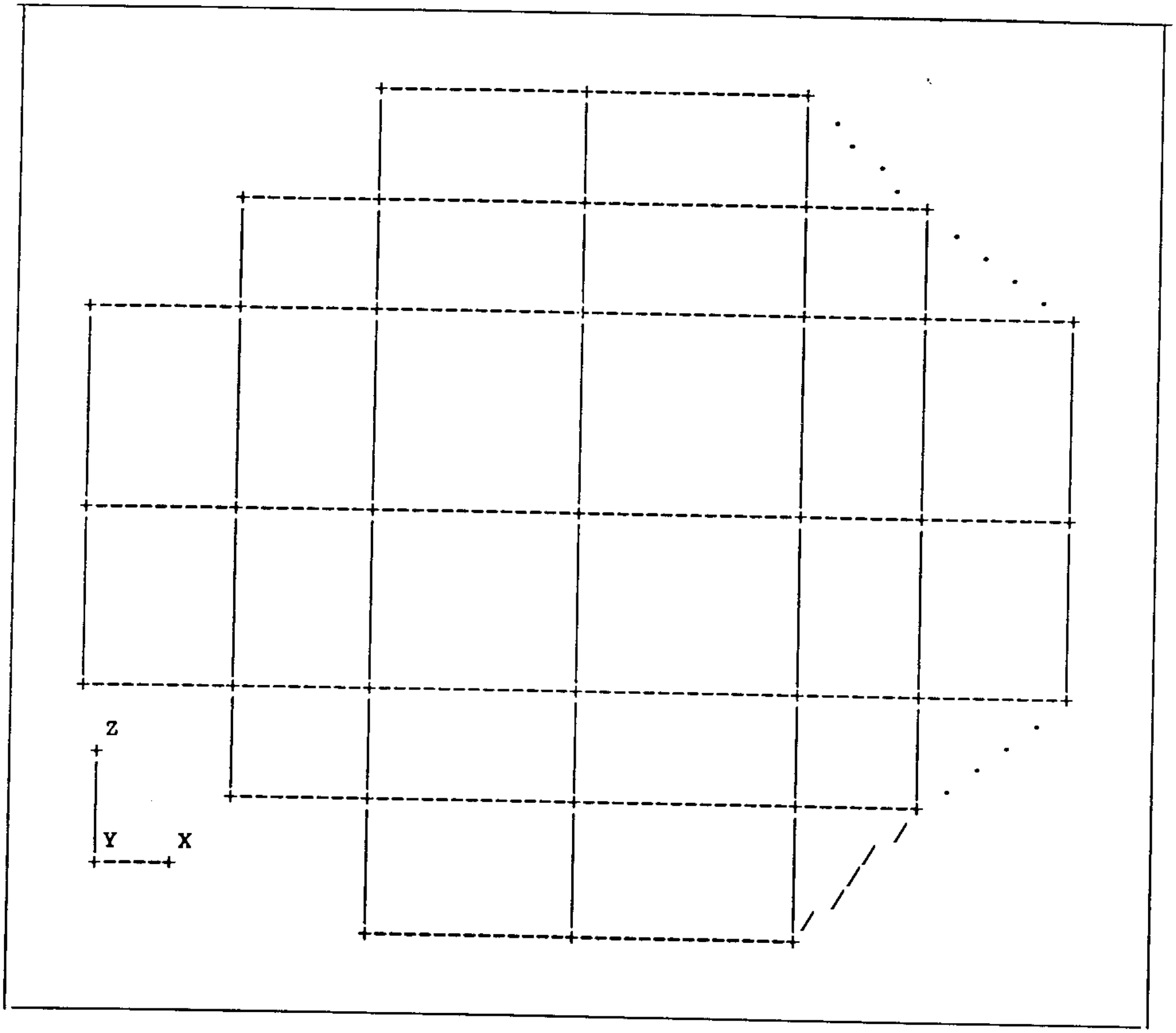
$\phi M_n = \phi A_s f_y (d - a/2) = 0.9(0.31)(60)(9.06'' - 0.60/2) = 146.6^{k\text{-}in} = 12.2^{k\text{-}f}$

$\phi M_n = 12.2^{k\text{-}f} \ge M_u = 1.44^{k\text{-}f} \therefore$ Bending OK

```
*************************************************
*                                               *
*             S T A A D - III                   *
*             REVISION 15.0 (VERSION 15 LEVEL 0)*
*             PROPRIETARY PROGRAM OF            *
*             RESEARCH ENGINEERS,INC.           *
*             DATE=     SEP 21, 1994            *
*             TIME=       7:25:56               *
*                                               *
*************************************************

  1. STAAD SPACE "CHEM WASTE MANAGEMENT"
  2. *
  3. ***********************************************************************
  4. *              CHEM WASTE MANAGEMENT
  5. *              EMELLE, ALABAMA
  6. *
  7. *              TANK NO. T-1405 TO T-1408 ; T-1421 TO T-1424
  8. *
  9. *      FILE NAME "T1405"
 10. *
 11. *      DESIGNED BY SCOTT SMITH
 12. *
 13. ***********************************************************************
 14. UNIT KIPS FEET
 15. *
 16. *
 17. JOINT COORDINATES
 18. 1    15.67 0   0.00  ;  2  26.74  0   0.00  ;  3  38.71  0.0   0.00
 19. 4     7.83 0   7.83  ;  5  15.67  0   7.83  ;  6  26.74  0.0   7.83
 20. 7    38.71 0   7.83  ;  8  45.64  0   7.83  ;  9   0.00  0.0  15.67
 21. 10    7.83 0  15.67  ; 11  15.67  0  15.67  ; 12  26.74  0.0  15.67
 22. 13   38.71 0  15.67  ; 14  45.64  0  15.67  ; 15  53.50  0.0  15.67
 23. 16    0.00 0  26.74  ; 17   7.83  0  26.74  ; 18  15.67  0.0  26.74
 24. 19   26.74 0  26.74  ; 20  38.71  0  26.74  ; 21  45.64  0.0  26.74
 25. 22   53.50 0  26.74  ; 23   0.00  0  38.71  ; 24   7.83  0.0  38.71
 26. 25   15.67 0  38.71  ; 26  26.74  0  38.71  ; 27  38.71  0.0  38.71
 27. 28   45.64 0  38.71  ; 29  53.50  0  38.71  ; 30   7.83  0.0  45.64
 28. 31   15.67 0  45.64  ; 32  26.74  0  45.64  ; 33  38.71  0.0  45.64
 29. 34   45.64 0  45.64  ; 35  15.67  0  53.50  ; 36  26.74  0.0  53.50
 30. 37   38.71 0  53.50
 31. ***********************************************************************
 32. *
 33. *      MAT FOUNDATION  ELEMENTS
 34. *
 35. ***********************************************************************
 36. ELEMENT INCIDENCES
 37. 1     4   5   1     ; 2   5   6   2   1 ;  3   6   7   3   2
 38. 4     7   8   3     ; 5   9  10   4     ;  6  10  11   5   4
 39. 7    11  12   6   5; 8  12  13   7   6 ;  9  13  14   8   7
 40. 10   14  15   8     ;11  16  17  10   9 ; 12  17  18  11  10
 41. 13   18  19  12  11;14  19  20  13  12 ; 15  20  21  14  13
 42. 16   21  22  15  14;17  23  24  17  16 ; 18  24  25  18  17
 43. 19   25  26  19  18;20  26  27  20  19 ; 21  27  28  21  20
 44. 22   28  29  22  21;23  30  24  23     ; 24  30  31  25  24
 45. 25   31  32  26  25;26  32  33  27  26 ; 27  33  34  28  27
 46. 28   34  29  28    ;29  35  31  30     ; 30  35  36  32  31
 47. 31   36  37  33  32;32  37  34  33
 48. *
```

```
*
*************************************************************************
UNITS KIP INCHES
*
*
* MAT FOUNDATION ELEMENTS
*
ELEMENT PROPERTIES
1       TO    32          TH  13
*************************************************************************
SUPPORTS
1 3 9 15 23 29 35 37                 FIXED BUT MX MY MZ KFY  798.95
2 16 22 36                           FIXED BUT MX MY MZ KFY  972.93
4 8 30 34                            FIXED BUT MX MY MZ KFY  658.76
5 7 10 14 24 28 31 33                FIXED BUT MX MY MZ KFY 1595.86
6 11 13 17 21 25 27 32               FIXED BUT MX MY MZ KFY 1943.38
12 18 20 26                          FIXED BUT MX MY MZ KFY 2353.95
19                                   FIXED BUT MX MY MZ KFY 2866.54
*
*************************************************************************
*
UNITS KIP FEET
*
*  CONCRETE STRENGTH = 3000 PSI
*  CONCRETE UNIT WT. = 150 PCF
*       E(CONC.) = 57000(SQ. RT. OF CONC. STRENGTH)
*
CONSTANTS
E  449571  ALL
POIS   0.2 ALL
DEN  0.15  ALL
*************************************************************************
PLOT PLAN XZ 0.
```


Z
Y
X

```
*
***********************************************************************
*
LOADING 1  DEAD LOAD
*
SELFWEIGHT
*
ELEMENT LOAD
1 TO 32               PR  -0.057
*
*********************************************************************
LOADING 2 LIVE LOAD
*
ELEMENT LOAD
1 TO 32               PR -1.970
*
***********************************************************************
LOADING 3 EARTHQUAKE LOAD
*
ELEMENT LOAD
1 5 6 11 12 17 18 23 24 29            PR 0.233
4 9 10 15 16 21 22 27 28 32           PR -0.233
*
***********************************************************************
LOAD COMBINATION 4
1 1.0  2 1.0  3 1.0
***********************************************************************
LOAD COMBIMATION 5
1 1.4  2  1.7
***********************************************************************
LOAD COMBINATION 6
1  1.05  2  1.275  3  1.275
***********************************************************************
PERFORM ANALYSIS PRINT ALL
```

P R O B L E M   S T A T I S T I C S

```
NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     37/    32/    37
ORIGINAL/FINAL BAND-WIDTH =     8/     8
TOTAL PRIMARY LOAD CASES  =     3, TOTAL DEGREES OF FREEDOM =    222
SIZE OF STIFFNESS MATRIX =   11988 DOUBLE PREC. WORDS
TOTAL REQUIRED DISK SPACE =    12.38 MEGA-BYTES
```

LOADING 1 DEAD LOAD

SELFWEIGHT Y -1.000

ACTUAL WEIGHT OF THE STRUCTURE = 387.454 KIP

ELEMENT LOAD (UNITS ARE KIP FEET)

ELEMENT	PRESSURE
1	-0.057000
2	-0.057000
3	-0.057000
4	-0.057000
5	-0.057000
6	-0.057000
7	-0.057000
8	-0.057000
9	-0.057000
10	-0.057000
11	-0.057000
12	-0.057000
13	-0.057000
14	-0.057000
15	-0.057000
16	-0.057000
17	-0.057000
18	-0.057000
19	-0.057000
20	-0.057000
21	-0.057000
22	-0.057000
23	-0.057000
24	-0.057000
25	-0.057000
26	-0.057000
27	-0.057000
28	-0.057000
29	-0.057000
30	-0.057000
31	-0.057000
32	-0.057000

***TOTAL APPLIED LOAD (KIP FEET) SUMMARY (LOADING 1)
SUMMATION FORCE-X = 0.00
SUMMATION FORCE-Y = -523.36
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= 14018.57 MY= 0.00 MZ= -14019.35

LOADING 2 LIVE LOAD

ELEMENT LOAD (UNITS ARE KIP FEET)

ELEMENT	PRESSURE
1	-1.970000
2	-1.970000
3	-1.970000
4	-1.970000
5	-1.970000
6	-1.970000
7	-1.970000
8	-1.970000
9	-1.970000
10	-1.970000
11	-1.970000
12	-1.970000
13	-1.970000
14	-1.970000
15	-1.970000
16	-1.970000
17	-1.970000
18	-1.970000
19	-1.970000
20	-1.970000
21	-1.970000
22	-1.970000
23	-1.970000
24	-1.970000
25	-1.970000
26	-1.970000
27	-1.970000
28	-1.970000
29	-1.970000
30	-1.970000
31	-1.970000
32	-1.970000

***TOTAL APPLIED LOAD (KIP FEET) SUMMARY (LOADING 2)
SUMMATION FORCE-X = 0.00
SUMMATION FORCE-Y = -4697.14
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= 125799.74 MY= 0.00 MZ= -125826.52

LOADING 3 EARTHQUAKE LOAD

```
ELEMENT LOAD (UNITS ARE KIP  FEET )

  ELEMENT         PRESSURE


       1          0.233000
       5          0.233000
       6          0.233000
      11          0.233000
      12          0.233000
      17          0.233000
      18          0.233000
      23          0.233000
      24          0.233000
      29          0.233000
       4         -0.233000
       9         -0.233000
      10         -0.233000
      15         -0.233000
      16         -0.233000
      21         -0.233000
      22         -0.233000
      27         -0.233000
      28         -0.233000
      32         -0.233000
***TOTAL APPLIED LOAD ( KIP  FEET ) SUMMARY (LOADING    3 )
    SUMMATION FORCE-X =          0.00
    SUMMATION FORCE-Y =          9.47
    SUMMATION FORCE-Z =          0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=        -201.66  MY=             0.00  MZ=       -4622.39

++ PROCESSING ELEMENT STIFFNESS MATRIX.                   7:26: 4
++ PROCESSING GLOBAL STIFFNESS MATRIX.                   7:26:19
++ PROCESSING TRIANGULAR FACTORIZATION.                  7:26:22

***WARNING - IMPROPER LOAD WILL CAUSE INSTABILITY AT JOINT   37
   DIRECTION = MY  PROBABLE CAUSE MODELING PROBLEM     0.373E-08
++ CALCULATING JOINT DISPLACEMENTS.                      7:26:29
++ CALCULATING ELEMENT FORCES.                           7:26:32


***TOTAL REACTION ( KIP  FEET ) SUMMARY


LOADING    1

SUM-X=        0.00  SUM-Y=       523.36  SUM-Z=        0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=      -14018.57  MY=             0.00  MZ=       14019.34


LOADING    2
```

*

```
SUM-X=          0.00  SUM-Y=      4697.14  SUM-Z=          0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=     -125799.75  MY=           0.00  MZ=      125826.52

LOADING    3

SUM-X=          0.00  SUM-Y=        -9.47  SUM-Z=          0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=         201.66  MY=           0.00  MZ=        4622.39

LOAD COMBINATION NO.      4

LOADING-    1.     2.     3.
FACTOR -  1.00   1.00   1.00

LOAD COMBINATION NO.      5

LOADING-    1.     2.
FACTOR -  1.40   1.70

LOAD COMBINATION NO.      6

LOADING-    1.     2.     3.
FACTOR -  1.05   1.27   1.27

************ END OF DATA FROM INTERNAL STORAGE ************

114. LOAD LIST 1 2 3 4
115. PRINT JOINT DISPLACEMENTS
```

JOINT DISPLACEMENT (INCH RADIANS) STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
1	1	0.00000	-0.00927	0.00000	0.00001	0.00000	0.00000
	2	0.00000	-0.09113	0.00000	-0.00001	0.00000	0.00003
	3	0.00000	0.00440	0.00000	0.00000	0.00000	-0.00005
	4	0.00000	-0.09600	0.00000	0.00000	0.00000	-0.00002
2	1	0.00000	-0.01002	0.00000	-0.00001	0.00000	0.00000
	2	0.00000	-0.08989	0.00000	-0.00005	0.00000	0.00001
	3	0.00000	0.00009	0.00000	0.00000	0.00000	-0.00001
	4	0.00000	-0.09982	0.00000	-0.00006	0.00000	0.00000
3	1	0.00000	-0.00895	0.00000	0.00001	0.00000	0.00000
	2	0.00000	-0.07663	0.00000	0.00015	0.00000	0.00005
	3	0.00000	-0.00224	0.00000	0.00002	0.00000	-0.00004
	4	0.00000	-0.08782	0.00000	0.00019	0.00000	0.00002
4	1	0.00000	-0.01117	0.00000	-0.00002	0.00000	0.00002
	2	0.00000	-0.10358	0.00000	-0.00021	0.00000	0.00016
	3	0.00000	0.01180	0.00000	0.00003	0.00000	-0.00008
	4	0.00000	-0.10295	0.00000	-0.00020	0.00000	0.00010
5	1	0.00000	-0.00974	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08706	0.00000	-0.00002	0.00000	0.00004
	3	0.00000	0.00421	0.00000	0.00000	0.00000	-0.00006
	4	0.00000	-0.09259	0.00000	-0.00002	0.00000	-0.00001
6	1	0.00000	-0.01006	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.09009	0.00000	0.00003	0.00000	0.00001
	3	0.00000	0.00009	0.00000	0.00000	0.00000	-0.00002
	4	0.00000	-0.10006	0.00000	0.00003	0.00000	-0.00001
7	1	0.00000	-0.00968	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08539	0.00000	0.00003	0.00000	0.00000
	3	0.00000	-0.00377	0.00000	0.00001	0.00000	-0.00005
	4	0.00000	-0.09883	0.00000	0.00004	0.00000	-0.00006
8	1	0.00000	-0.01033	0.00000	-0.00001	0.00000	-0.00001
	2	0.00000	-0.09495	0.00000	-0.00011	0.00000	-0.00013
	3	0.00000	-0.01045	0.00000	-0.00002	0.00000	-0.00009
	4	0.00000	-0.11573	0.00000	-0.00014	0.00000	-0.00022
9	1	0.00000	-0.00880	0.00000	0.00000	0.00000	-0.00002
	2	0.00000	-0.07487	0.00000	0.00004	0.00000	-0.00018
	3	0.00000	0.00954	0.00000	-0.00001	0.00000	0.00002
	4	0.00000	-0.07414	0.00000	0.00003	0.00000	-0.00018
10	1	0.00000	-0.00968	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08526	0.00000	-0.00004	0.00000	-0.00005
	3	0.00000	0.00931	0.00000	0.00001	0.00000	-0.00003
	4	0.00000	-0.08564	0.00000	-0.00003	0.00000	-0.00009
11	1	0.00000	-0.01004	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08965	0.00000	0.00001	0.00000	-0.00001
	3	0.00000	0.00469	0.00000	-0.00001	0.00000	-0.00005
	4	0.00000	-0.09501	0.00000	0.00000	0.00000	-0.00007
12	1	0.00000	-0.01014	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.09072	0.00000	0.00003	0.00000	-0.00001
	3	0.00000	0.00005	0.00000	0.00000	0.00000	-0.00002
	4	0.00000	-0.10081	0.00000	0.00003	0.00000	-0.00003

JOINT DISPLACEMENT (INCH RADIANS) STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
13	1	0.00000	-0.00994	0.00000	0.00000	0.00000	0.00001
	2	0.00000	-0.08869	0.00000	0.00001	0.00000	0.00005
	3	0.00000	-0.00437	0.00000	0.00001	0.00000	-0.00005
	4	0.00000	-0.10300	0.00000	0.00001	0.00000	0.00000
14	1	0.00000	-0.00930	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08310	0.00000	-0.00001	0.00000	0.00000
	3	0.00000	-0.00877	0.00000	-0.00001	0.00000	-0.00005
	4	0.00000	-0.10117	0.00000	-0.00002	0.00000	-0.00004
15	1	0.00000	-0.00916	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.09009	0.00000	-0.00002	0.00000	-0.00007
	3	0.00000	-0.01144	0.00000	0.00000	0.00000	-0.00001
	4	0.00000	-0.11068	0.00000	-0.00002	0.00000	-0.00008
16	1	0.00000	-0.01002	0.00000	0.00000	0.00000	0.00001
	2	0.00000	-0.08968	0.00000	0.00005	0.00000	0.00006
	3	0.00000	0.01124	0.00000	-0.00001	0.00000	-0.00001
	4	0.00000	-0.08845	0.00000	0.00004	0.00000	0.00005
17	1	0.00000	-0.01006	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.09003	0.00000	0.00003	0.00000	-0.00003
	3	0.00000	0.00985	0.00000	0.00000	0.00000	-0.00003
	4	0.00000	-0.09024	0.00000	0.00003	0.00000	-0.00007
18	1	0.00000	-0.01014	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.09074	0.00000	0.00000	0.00000	-0.00003
	3	0.00000	0.00484	0.00000	0.00000	0.00000	-0.00005
	4	0.00000	-0.09604	0.00000	0.00000	0.00000	-0.00008
19	1	0.00000	-0.01022	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.09180	0.00000	0.00000	0.00000	0.00000
	3	0.00000	0.00007	0.00000	0.00000	0.00000	-0.00003
	4	0.00000	-0.10195	0.00000	0.00000	0.00000	-0.00003
20	1	0.00000	-0.01004	0.00000	0.00000	0.00000	0.00001
	2	0.00000	-0.08984	0.00000	0.00001	0.00000	0.00006
	3	0.00000	-0.00450	0.00000	0.00000	0.00000	-0.00005
	4	0.00000	-0.10438	0.00000	0.00001	0.00000	0.00002
21	1	0.00000	-0.00966	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08658	0.00000	-0.00001	0.00000	0.00003
	3	0.00000	-0.00918	0.00000	0.00000	0.00000	-0.00004
	4	0.00000	-0.10543	0.00000	-0.00001	0.00000	-0.00001
22	1	0.00000	-0.00995	0.00000	0.00000	0.00000	-0.00001
	2	0.00000	-0.08927	0.00000	-0.00001	0.00000	-0.00009
	3	0.00000	-0.01129	0.00000	0.00000	0.00000	-0.00002
	4	0.00000	-0.11051	0.00000	-0.00001	0.00000	-0.00012
23	1	0.00000	-0.00937	0.00000	0.00000	0.00000	-0.00001
	2	0.00000	-0.09127	0.00000	0.00001	0.00000	0.00001
	3	0.00000	0.01146	0.00000	0.00000	0.00000	-0.00001
	4	0.00000	-0.08918	0.00000	0.00001	0.00000	0.00000
24	1	0.00000	-0.00973	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08724	0.00000	0.00001	0.00000	0.00003
	3	0.00000	0.00955	0.00000	-0.00001	0.00000	-0.00004
	4	0.00000	-0.08742	0.00000	0.00000	0.00000	-0.00001

JOINT DISPLACEMENT (INCH RADIANS) STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
25	1	0.00000	-0.00994	0.00000	-0.00001	0.00000	0.00000
	2	0.00000	-0.08876	0.00000	-0.00005	0.00000	0.00000
	3	0.00000	0.00465	0.00000	0.00001	0.00000	-0.00005
	4	0.00000	-0.09404	0.00000	-0.00005	0.00000	-0.00005
26	1	0.00000	-0.01004	0.00000	-0.00001	0.00000	0.00000
	2	0.00000	-0.08986	0.00000	-0.00006	0.00000	0.00000
	3	0.00000	0.00009	0.00000	0.00000	0.00000	-0.00002
	4	0.00000	-0.09981	0.00000	-0.00006	0.00000	-0.00002
27	1	0.00000	-0.00983	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08775	0.00000	-0.00004	0.00000	0.00004
	3	0.00000	-0.00430	0.00000	-0.00001	0.00000	-0.00005
	4	0.00000	-0.10188	0.00000	-0.00005	0.00000	0.00000
28	1	0.00000	-0.00926	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08173	0.00000	-0.00001	0.00000	0.00005
	3	0.00000	-0.00860	0.00000	0.00001	0.00000	-0.00004
	4	0.00000	-0.09959	0.00000	-0.00001	0.00000	0.00001
29	1	0.00000	-0.00881	0.00000	-0.00001	0.00000	0.00000
	2	0.00000	-0.07534	0.00000	-0.00008	0.00000	0.00007
	3	0.00000	-0.00965	0.00000	-0.00002	0.00000	0.00000
	4	0.00000	-0.09380	0.00000	-0.00010	0.00000	0.00008
30	1	0.00000	-0.01038	0.00000	0.00001	0.00000	0.00001
	2	0.00000	-0.09672	0.00000	0.00010	0.00000	0.00017
	3	0.00000	0.01103	0.00000	-0.00002	0.00000	-0.00008
	4	0.00000	-0.09606	0.00000	0.00009	0.00000	0.00010
31	1	0.00000	-0.00925	0.00000	-0.00001	0.00000	0.00000
	2	0.00000	-0.08149	0.00000	-0.00007	0.00000	0.00001
	3	0.00000	0.00382	0.00000	0.00001	0.00000	-0.00005
	4	0.00000	-0.08692	0.00000	-0.00006	0.00000	-0.00004
32	1	0.00000	-0.00966	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08650	0.00000	-0.00003	0.00000	-0.00003
	3	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00001
	4	0.00000	-0.09616	0.00000	-0.00003	0.00000	-0.00005
33	1	0.00000	-0.00930	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08339	0.00000	0.00002	0.00000	0.00001
	3	0.00000	-0.00374	0.00000	0.00000	0.00000	-0.00005
	4	0.00000	-0.09643	0.00000	0.00001	0.00000	-0.00004
34	1	0.00000	-0.00963	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08901	0.00000	0.00009	0.00000	-0.00006
	3	0.00000	-0.00994	0.00000	0.00002	0.00000	-0.00008
	4	0.00000	-0.10858	0.00000	0.00012	0.00000	-0.00015
35	1	0.00000	-0.00869	0.00000	-0.00001	0.00000	0.00000
	2	0.00000	-0.07384	0.00000	-0.00013	0.00000	-0.00004
	3	0.00000	0.00243	0.00000	0.00002	0.00000	-0.00004
	4	0.00000	-0.08009	0.00000	-0.00012	0.00000	-0.00008
36	1	0.00000	-0.00994	0.00000	0.00001	0.00000	0.00000
	2	0.00000	-0.08905	0.00000	0.00009	0.00000	-0.00006
	3	0.00000	-0.00006	0.00000	0.00000	0.00000	-0.00001
	4	0.00000	-0.09905	0.00000	0.00010	0.00000	-0.00007

JOINT DISPLACEMENT (INCH RADIANS)   STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
37	1	0.00000	-0.00924	0.00000	0.00000	0.00000	0.00001
	2	0.00000	-0.09000	0.00000	0.00009	0.00000	0.00002
	3	0.00000	-0.00382	0.00000	0.00000	0.00000	-0.00004
	4	0.00000	-0.10306	0.00000	0.00010	0.00000	-0.00001

************** END OF LATEST ANALYSIS RESULT **************

116. LOAD LIST 5 6
117. PRINT ELEMENT FORCES

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ELEMENT FORCES       FORCE,LENGTH UNITS= KIP  FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD      QX          QY          MX          MY          MXY
                               FX          FY          FXY

  1       5        1.10        0.18           1.39      0.10             -0.82
                               0.00           0.00      0.00
  TOP :  SMAX=       9.13  SMIN=   -1.54  TMAX=     5.33  ANGLE= -25.9
  BOTT:  SMAX=       1.54  SMIN=   -9.13  TMAX=     5.33  ANGLE= -25.9
          6        0.70        0.10           0.85      0.03             -0.53
                               0.00           0.00      0.00
  TOP :  SMAX=       5.66  SMIN=   -1.20  TMAX=     3.43  ANGLE= -26.2
  BOTT:  SMAX=       1.20  SMIN=   -5.66  TMAX=     3.43  ANGLE= -26.2

  2       5       -0.31       -0.18           0.25      0.41              0.05
                               0.00           0.00      0.00
  TOP :  SMAX=       2.16  SMIN=    1.21  TMAX=     0.48  ANGLE= -16.9
  BOTT:  SMAX=      -1.21  SMIN=   -2.16  TMAX=     0.48  ANGLE= -16.9
          6       -0.21       -0.10          -0.05      0.27              0.01
                               0.00           0.00      0.00
  TOP :  SMAX=       1.40  SMIN=   -0.25  TMAX=     0.82  ANGLE=   -2.4
  BOTT:  SMAX=       0.25  SMIN=   -1.40  TMAX=     0.82  ANGLE=   -2.4

  3       5        0.33        0.02          -0.15     -0.26             -0.45
                               0.00           0.00      0.00
  TOP :  SMAX=       1.28  SMIN=   -3.34  TMAX=     2.31  ANGLE= -41.6
  BOTT:  SMAX=       3.34  SMIN=   -1.28  TMAX=     2.31  ANGLE= -41.6
          6        0.29       -0.01           0.05     -0.20             -0.41
                               0.00           0.00      0.00
  TOP :  SMAX=       1.82  SMIN=   -2.59  TMAX=     2.20  ANGLE= -36.3
  BOTT:  SMAX=       2.59  SMIN=   -1.82  TMAX=     2.20  ANGLE= -36.3

  4       5       -1.13        0.43           1.32     -1.08              0.47
                               0.00           0.00      0.00
  TOP :  SMAX=       7.18  SMIN=   -5.99  TMAX=     6.59  ANGLE=   10.7
  BOTT:  SMAX=       5.99  SMIN=   -7.18  TMAX=     6.59  ANGLE=   10.7
          6       -1.01        0.38           1.28     -0.88              0.40
                               0.00           0.00      0.00
  TOP :  SMAX=       6.89  SMIN=   -4.85  TMAX=     5.87  ANGLE=   10.1
  BOTT:  SMAX=       4.85  SMIN=   -6.89  TMAX=     5.87  ANGLE=   10.1

  5       5       -0.54       -1.25          -1.15      1.72             -0.65
                               0.00           0.00      0.00
  TOP :  SMAX=       9.52  SMIN=   -6.62  TMAX=     8.07  ANGLE=   12.2
  BOTT:  SMAX=       6.62  SMIN=   -9.52  TMAX=     8.07  ANGLE=   12.2
          6       -0.28       -0.80          -0.47      1.21             -0.39
                               0.00           0.00      0.00
  TOP :  SMAX=       6.61  SMIN=   -2.85  TMAX=     4.73  ANGLE=   12.5
  BOTT:  SMAX=       2.85  SMIN=   -6.61  TMAX=     4.73  ANGLE=   12.5

  6       5        0.23       -0.02           0.74      1.27             -1.18
                               0.00           0.00      0.00
  TOP :  SMAX=      11.32  SMIN=   -1.04  TMAX=     6.18  ANGLE=   38.7
  BOTT:  SMAX=       1.04  SMIN=  -11.32  TMAX=     6.18  ANGLE=   38.7
```

```
 ELEMENT FORCES      FORCE,LENGTH UNITS= KIP  FEET
 --------------
 FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD        QX          QY            MX             MY            MXY
                                 FX            FY             FXY

            6       0.08       -0.05          0.52           0.85          -0.72
                                0.00          0.00           0.00
      TOP :  SMAX=      7.27  SMIN=     -0.30  TMAX=      3.78  ANGLE=   38.5
      BOTT:  SMAX=      0.30  SMIN=     -7.27  TMAX=      3.78  ANGLE=   38.5

    7       5      -0.35        0.18          0.15           0.20          -0.28
                                0.00          0.00           0.00
      TOP :  SMAX=      2.32  SMIN=     -0.52  TMAX=      1.42  ANGLE=   42.7
      BOTT:  SMAX=      0.52  SMIN=     -2.32  TMAX=      1.42  ANGLE=   42.7
            6      -0.23        0.12         -0.11           0.08          -0.22
                                0.00          0.00           0.00
      TOP :  SMAX=      1.13  SMIN=     -1.29  TMAX=      1.21  ANGLE=   33.2
      BOTT:  SMAX=      1.29  SMIN=     -1.13  TMAX=      1.21  ANGLE=   33.2

    8       5       0.12        0.15         -0.20          -0.15           0.10
                                0.00          0.00           0.00
      TOP :  SMAX=     -0.34  SMIN=     -1.44  TMAX=      0.55  ANGLE=  -37.4
      BOTT:  SMAX=      1.44  SMIN=      0.34  TMAX=      0.55  ANGLE=  -37.4
            6       0.14        0.12          0.03          -0.09           0.06
                                0.00          0.00           0.00
      TOP :  SMAX=      0.28  SMIN=     -0.60  TMAX=      0.44  ANGLE=   23.5
      BOTT:  SMAX=      0.60  SMIN=     -0.28  TMAX=      0.44  ANGLE=   23.5

    9       5       0.28       -0.36          1.17           0.63           0.83
                                0.00          0.00           0.00
      TOP :  SMAX=      9.07  SMIN=      0.11  TMAX=      4.48  ANGLE=   36.0
      BOTT:  SMAX=     -0.11  SMIN=     -9.07  TMAX=      4.48  ANGLE=   36.0
            6       0.11       -0.26          1.03           0.53           0.77
                                0.00          0.00           0.00
      TOP :  SMAX=      8.15  SMIN=     -0.15  TMAX=      4.15  ANGLE=   36.1
      BOTT:  SMAX=      0.15  SMIN=     -8.15  TMAX=      4.15  ANGLE=   36.1

   10       5      -0.10       -0.87          1.00           1.24           0.61
                                0.00          0.00           0.00
      TOP :  SMAX=      8.93  SMIN=      2.54  TMAX=      3.19  ANGLE=  -39.4
      BOTT:  SMAX=     -2.54  SMIN=     -8.93  TMAX=      3.19  ANGLE=  -39.4
            6       0.01       -0.75          0.49           0.96           0.56
                                0.00          0.00           0.00
      TOP :  SMAX=      6.81  SMIN=      0.61  TMAX=      3.10  ANGLE=  -33.7
      BOTT:  SMAX=     -0.61  SMIN=     -6.81  TMAX=      3.10  ANGLE=  -33.7

   11       5       0.06        0.44         -0.22           0.26           0.63
                                0.00          0.00           0.00
      TOP :  SMAX=      3.51  SMIN=     -3.33  TMAX=      3.42  ANGLE=  -34.5
      BOTT:  SMAX=      3.33  SMIN=     -3.51  TMAX=      3.42  ANGLE=  -34.5
            6       0.10        0.29          0.13           0.22           0.40
                                0.00          0.00           0.00
      TOP :  SMAX=      2.96  SMIN=     -1.18  TMAX=      2.07  ANGLE=  -41.7
      BOTT:  SMAX=      1.18  SMIN=     -2.96  TMAX=      2.07  ANGLE=  -41.7
```

```
 ELEMENT FORCES      FORCE,LENGTH UNITS= KIP   FEET
 --------------
 FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH
ELEMENT  LOAD          QX          QY            MX            MY            MXY
                                   FX            FY            FXY

   12      5        -0.13        0.22         -0.15          0.21          -0.04
                                 0.00          0.00          0.00
     TOP :  SMAX=       1.11  SMIN=    -0.80   TMAX=        0.95   ANGLE=    5.8
     BOTT:  SMAX=       0.80  SMIN=    -1.11   TMAX=        0.95   ANGLE=    5.8
           6        -0.17        0.14          0.03          0.17           0.00
                                 0.00          0.00          0.00
     TOP :  SMAX=       0.87  SMIN=     0.14   TMAX=        0.37   ANGLE=    1.0
     BOTT:  SMAX=      -0.14  SMIN=    -0.87   TMAX=        0.37   ANGLE=    1.0

   13      5         0.04       -0.02         -0.15         -0.16          -0.05
                                 0.00          0.00          0.00
     TOP :  SMAX=      -0.54  SMIN=    -1.02   TMAX=        0.24   ANGLE=   90.0
     BOTT:  SMAX=       1.02  SMIN=     0.54   TMAX=        0.24   ANGLE=   90.0
           6         0.04       -0.01         -0.27         -0.13          -0.05
                                 0.00          0.00          0.00
     TOP :  SMAX=      -0.60  SMIN=    -1.47   TMAX=        0.43   ANGLE=   17.3
     BOTT:  SMAX=       1.47  SMIN=     0.60   TMAX=        0.43   ANGLE=   17.3

   14      5        -0.07       -0.04         -0.49         -0.20           0.06
                                 0.00          0.00          0.00
     TOP :  SMAX=      -0.98  SMIN=    -2.54   TMAX=        0.78   ANGLE=  -11.2
     BOTT:  SMAX=       2.54  SMIN=     0.98   TMAX=        0.78   ANGLE=  -11.2
           6        -0.02       -0.03         -0.23         -0.14           0.02
                                 0.00          0.00          0.00
     TOP :  SMAX=      -0.68  SMIN=    -1.20   TMAX=        0.26   ANGLE=  -14.7
     BOTT:  SMAX=       1.20  SMIN=     0.68   TMAX=        0.26   ANGLE=  -14.7

   15      5         0.43        0.33          0.49          0.11           0.16
                                 0.00          0.00          0.00
     TOP :  SMAX=       2.78  SMIN=     0.28   TMAX=        1.25   ANGLE=   19.8
     BOTT:  SMAX=      -0.28  SMIN=    -2.78   TMAX=        1.25   ANGLE=   19.8
           6         0.23        0.28          0.32          0.08           0.16
                                 0.00          0.00          0.00
     TOP :  SMAX=       2.04  SMIN=    -0.01   TMAX=        1.02   ANGLE=   26.1
     BOTT:  SMAX=       0.01  SMIN=    -2.04   TMAX=        1.02   ANGLE=   26.1

   16      5        -0.32        0.28          1.10          0.26          -0.01
                                 0.00          0.00          0.00
     TOP :  SMAX=       5.64  SMIN=     1.35   TMAX=        2.15   ANGLE=   -0.5
     BOTT:  SMAX=      -1.35  SMIN=    -5.64   TMAX=        2.15   ANGLE=   -0.5
           6        -0.20        0.23          0.60          0.16          -0.02
                                 0.00          0.00          0.00
     TOP :  SMAX=       3.09  SMIN=     0.82   TMAX=        1.13   ANGLE=   -2.7
     BOTT:  SMAX=      -0.82  SMIN=    -3.09   TMAX=        1.13   ANGLE=   -2.7

   17      5         0.09       -0.26          0.30         -0.17           0.03
                                 0.00          0.00          0.00
     TOP :  SMAX=       1.52  SMIN=    -0.88   TMAX=        1.20   ANGLE=    3.9
     BOTT:  SMAX=       0.88  SMIN=    -1.52   TMAX=        1.20   ANGLE=    3.9
```

```
ELEMENT FORCES     FORCE,LENGTH UNITS= KIP  FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT   LOAD        QX          QY           MX           MY           MXY
                                  FX           FY           FXY

           6          0.12       -0.17         0.47        -0.07          0.03
                                  0.00         0.00         0.00
     TOP :  SMAX=      2.39  SMIN=     -0.37   TMAX=        1.38  ANGLE=   3.6
     BOTT:  SMAX=      0.37  SMIN=     -2.39   TMAX=        1.38  ANGLE=   3.6

  18       5         -0.19       -0.24         0.12        -0.26          0.35
                                  0.00         0.00         0.00
     TOP :  SMAX=      1.66  SMIN=     -2.41   TMAX=        2.03  ANGLE=  30.6
     BOTT:  SMAX=      2.41  SMIN=     -1.66   TMAX=        2.03  ANGLE=  30.6
           6         -0.21       -0.15         0.19        -0.17          0.21
                                  0.00         0.00         0.00
     TOP :  SMAX=      1.50  SMIN=     -1.36   TMAX=        1.43  ANGLE=  25.0
     BOTT:  SMAX=      1.36  SMIN=     -1.50   TMAX=        1.43  ANGLE=  25.0

  19       5          0.01        0.09        -0.19        -0.48          0.05
                                  0.00         0.00         0.00
     TOP :  SMAX=     -0.90  SMIN=     -2.48   TMAX=        0.79  ANGLE=  10.2
     BOTT:  SMAX=      2.48  SMIN=      0.90   TMAX=        0.79  ANGLE=  10.2
           6          0.01        0.06        -0.30        -0.36          0.06
                                  0.00         0.00         0.00
     TOP :  SMAX=     -1.34  SMIN=     -2.03   TMAX=        0.34  ANGLE=  30.7
     BOTT:  SMAX=      2.03  SMIN=      1.34   TMAX=        0.34  ANGLE=  30.7

  20       5         -0.07        0.05        -0.50        -0.49         -0.06
                                  0.00         0.00         0.00
     TOP :  SMAX=     -2.22  SMIN=     -2.86   TMAX=        0.32  ANGLE=  90.0
     BOTT:  SMAX=      2.86  SMIN=      2.22   TMAX=        0.32  ANGLE=  90.0
           6         -0.03        0.04        -0.24        -0.37         -0.03
                                  0.00         0.00         0.00
     TOP :  SMAX=     -1.20  SMIN=     -1.90   TMAX=        0.35  ANGLE= -12.4
     BOTT:  SMAX=      1.90  SMIN=      1.20   TMAX=        0.35  ANGLE= -12.4

  21       5          0.40       -0.11         0.14        -0.15         -0.01
                                  0.00         0.00         0.00
     TOP :  SMAX=      0.73  SMIN=     -0.77   TMAX=        0.75  ANGLE=  -2.2
     BOTT:  SMAX=      0.77  SMIN=     -0.73   TMAX=        0.75  ANGLE=  -2.2
           6          0.22       -0.10         0.03        -0.13         -0.03
                                  0.00         0.00         0.00
     TOP :  SMAX=      0.19  SMIN=     -0.71   TMAX=        0.45  ANGLE= -10.8
     BOTT:  SMAX=      0.71  SMIN=     -0.19   TMAX=        0.45  ANGLE= -10.8

  22       5         -0.09       -0.30         0.51        -0.17          0.42
                                  0.00         0.00         0.00
     TOP :  SMAX=      3.63  SMIN=     -1.89   TMAX=        2.76  ANGLE=  25.6
     BOTT:  SMAX=      1.89  SMIN=     -3.63   TMAX=        2.76  ANGLE=  25.6
           6         -0.01       -0.25         0.12        -0.20          0.37
                                  0.00         0.00         0.00
     TOP :  SMAX=      1.85  SMIN=     -2.28   TMAX=        2.07  ANGLE=  33.6
     BOTT:  SMAX=      2.28  SMIN=     -1.85   TMAX=        2.07  ANGLE=  33.6
```

```
ELEMENT FORCES     FORCE,LENGTH UNITS= KIP   FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD        QX          QY            MX            MY             MXY
                                 FX            FY            FXY

   23      5        1.09        0.14          1.11         -0.07          -0.70
                                0.00          0.00          0.00
    TOP :  SMAX=     7.35   SMIN=    -2.01   TMAX=          4.68  ANGLE= -24.9
    BOTT:  SMAX=     2.01   SMIN=    -7.35   TMAX=          4.68  ANGLE= -24.9
           6        0.69        0.01          0.81          0.24          -0.43
                                0.00          0.00          0.00
    TOP :  SMAX=     5.33   SMIN=     0.05   TMAX=          2.64  ANGLE= -28.4
    BOTT:  SMAX=    -0.05   SMIN=    -5.33   TMAX=          2.64  ANGLE= -28.4

   24      5        0.15       -0.03          1.18          0.70           0.95
                                0.00          0.00          0.00
    TOP :  SMAX=     9.79   SMIN=    -0.18   TMAX=          4.99  ANGLE=  37.9
    BOTT:  SMAX=     0.18   SMIN=    -9.79   TMAX=          4.99  ANGLE=  37.9
           6        0.02        0.02          0.80          0.47           0.56
                                0.00          0.00          0.00
    TOP :  SMAX=     6.27   SMIN=     0.26   TMAX=          3.01  ANGLE=  36.9
    BOTT:  SMAX=    -0.26   SMIN=    -6.27   TMAX=          3.01  ANGLE=  36.9

   25      5       -0.21       -0.39          0.21          0.11          -0.09
                                0.00          0.00          0.00
    TOP :  SMAX=     1.34   SMIN=     0.30   TMAX=          0.52  ANGLE= -28.8
    BOTT:  SMAX=    -0.30   SMIN=    -1.34   TMAX=          0.52  ANGLE= -28.8
           6       -0.13       -0.29         -0.05          0.05          -0.04
                                0.00          0.00          0.00
    TOP :  SMAX=     0.33   SMIN=    -0.31   TMAX=          0.32  ANGLE=  18.8
    BOTT:  SMAX=     0.31   SMIN=    -0.33   TMAX=          0.32  ANGLE=  18.8

   26      5        0.23       -0.43         -0.25          0.44          -0.26
                                0.00          0.00          0.00
    TOP :  SMAX=     2.71   SMIN=    -1.72   TMAX=          2.21  ANGLE=  18.6
    BOTT:  SMAX=     1.72   SMIN=    -2.71   TMAX=          2.21  ANGLE=  18.6
           6        0.23       -0.34          0.01          0.41          -0.18
                                0.00          0.00          0.00
    TOP :  SMAX=     2.42   SMIN=    -0.31   TMAX=          1.37  ANGLE=  21.0
    BOTT:  SMAX=     0.31   SMIN=    -2.42   TMAX=          1.37  ANGLE=  21.0

   27      5       -0.02       -0.19          0.67          1.13          -0.63
                                0.00          0.00          0.00
    TOP :  SMAX=     8.03   SMIN=     1.19   TMAX=          3.42  ANGLE=  35.1
    BOTT:  SMAX=    -1.19   SMIN=    -8.03   TMAX=          3.42  ANGLE=  35.1
           6       -0.14       -0.18          0.61          0.94          -0.61
                                0.00          0.00          0.00
    TOP :  SMAX=     7.21   SMIN=     0.71   TMAX=          3.25  ANGLE=  37.5
    BOTT:  SMAX=    -0.71   SMIN=    -7.21   TMAX=          3.25  ANGLE=  37.5

   28      5        0.59        0.76          0.31          1.02           0.62
                                0.00          0.00          0.00
    TOP :  SMAX=     7.06   SMIN=    -0.27   TMAX=          3.67  ANGLE= -30.3
    BOTT:  SMAX=     0.27   SMIN=    -7.06   TMAX=          3.67  ANGLE= -30.3
```

```
ELEMENT FORCES     FORCE,LENGTH UNITS= KIP  FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD         QX          QY           MX           MY          MXY
                                  FX           FY           FXY

           6         0.57        0.57        -0.01         0.70         0.63
                                 0.00         0.00         0.00
   TOP :  SMAX=       5.48  SMIN=    -1.94  TMAX=      3.71  ANGLE= -30.3
   BOTT:  SMAX=       1.94  SMIN=    -5.48  TMAX=      3.71  ANGLE= -30.3

  29       5        -0.30       -1.10        -0.29         1.67        -0.54
                                 0.00         0.00         0.00
   TOP :  SMAX=       9.28  SMIN=    -2.23  TMAX=      5.75  ANGLE=  14.5
   BOTT:  SMAX=       2.23  SMIN=    -9.28  TMAX=      5.75  ANGLE=  14.5
           6        -0.18       -0.70        -0.18         1.06        -0.36
                                 0.00         0.00         0.00
   TOP :  SMAX=       5.90  SMIN=    -1.41  TMAX=      3.65  ANGLE=  15.1
   BOTT:  SMAX=       1.41  SMIN=    -5.90  TMAX=      3.65  ANGLE=  15.1

  30       5        -0.42        0.22         0.33         0.46        -0.59
                                 0.00         0.00         0.00
   TOP :  SMAX=       5.06  SMIN=    -1.03  TMAX=      3.05  ANGLE=  41.8
   BOTT:  SMAX=       1.03  SMIN=    -5.06  TMAX=      3.05  ANGLE=  41.8
           6        -0.28        0.14         0.05         0.33        -0.38
                                 0.00         0.00         0.00
   TOP :  SMAX=       3.04  SMIN=    -1.06  TMAX=      2.05  ANGLE=  34.7
   BOTT:  SMAX=       1.06  SMIN=    -3.04  TMAX=      2.05  ANGLE=  34.7

  31       5         0.22        0.18        -0.23         1.07        -0.09
                                 0.00         0.00         0.00
   TOP :  SMAX=       5.48  SMIN=    -1.20  TMAX=      3.34  ANGLE=   3.8
   BOTT:  SMAX=       1.20  SMIN=    -5.48  TMAX=      3.34  ANGLE=   3.8
           6         0.19        0.16         0.01         0.85        -0.03
                                 0.00         0.00         0.00
   TOP :  SMAX=       4.36  SMIN=     0.03  TMAX=      2.16  ANGLE=   2.0
   BOTT:  SMAX=      -0.03  SMIN=    -4.36  TMAX=      2.16  ANGLE=   2.0

  32       5        -0.29        0.93         0.74         1.44        -0.01
                                 0.00         0.00         0.00
   TOP :  SMAX=       7.35  SMIN=     3.77  TMAX=      1.79  ANGLE=   0.6
   BOTT:  SMAX=      -3.77  SMIN=    -7.35  TMAX=      1.79  ANGLE=   0.6
           6        -0.29        0.81         0.72         1.29        -0.08
                                 0.00         0.00         0.00
   TOP :  SMAX=       6.68  SMIN=     3.60  TMAX=      1.54  ANGLE=   7.8
   BOTT:  SMAX=      -3.60  SMIN=    -6.68  TMAX=      1.54  ANGLE=   7.8

********************END OF ELEMENT FORCES*******************

 118. UNIT KIP INCHES
 119. START CONCRETE DESIGN
1
 120. CODE ACI
 121. FC 3
 122. TRACK 2.0
 123. DESIGN ELEMENTS 1 TO 32
```

ELEMENT DESIGN SUMMARY

ELEMENT		LONG. REINF (SQ.IN/FT)	MOM-X /LOAD (K-FT/FT)	TRANS. REINF (SQ.IN/FT)	MOM-Y /LOAD (K-FT/FT)
1	TOP :	0.281	1.39 / 5	0.281	0.10 / 5
	BOTT:	0.281	0.00 / 34	0.281	0.00 /***
2	TOP :	0.281	0.25 / 5	0.281	0.41 / 5
	BOTT:	0.281	-0.05 / 6	0.281	0.00 /***
3	TOP :	0.281	0.05 / 6	0.281	0.00 / 5
	BOTT:	0.281	-0.15 / 5	0.281	-0.26 / 5
4	TOP :	0.281	1.32 / 5	0.281	0.00 / 5
	BOTT:	0.281	0.00 / 5	0.281	-1.08 / 5
5	TOP :	0.281	0.00 / 5	0.281	1.72 / 5
	BOTT:	0.281	-1.15 / 5	0.281	0.00 / 5
6	TOP :	0.281	0.74 / 5	0.281	1.27 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
7	TOP :	0.281	0.15 / 5	0.281	0.20 / 5
	BOTT:	0.281	-0.11 / 6	0.281	0.00 / 5
8	TOP :	0.281	0.03 / 6	0.281	0.00 / 5
	BOTT:	0.281	-0.20 / 5	0.281	-0.15 / 5
9	TOP :	0.281	1.17 / 5	0.281	0.63 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
10	TOP :	0.281	1.00 / 5	0.281	1.24 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
11	TOP :	0.281	0.13 / 6	0.281	0.26 / 5
	BOTT:	0.281	-0.22 / 5	0.281	0.00 / 5
12	TOP :	0.281	0.03 / 6	0.281	0.21 / 5
	BOTT:	0.281	-0.15 / 5	0.281	0.00 / 5
13	TOP :	0.281	0.00 / 6	0.281	0.00 / 5
	BOTT:	0.281	-0.27 / 6	0.281	-0.16 / 5
14	TOP :	0.281	0.00 / 6	0.281	0.00 / 5
	BOTT:	0.281	-0.49 / 5	0.281	-0.20 / 5
15	TOP :	0.281	0.49 / 5	0.281	0.11 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
16	TOP :	0.281	1.10 / 5	0.281	0.26 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
17	TOP :	0.281	0.47 / 6	0.281	0.00 / 5
	BOTT:	0.281	0.00 / 5	0.281	-0.17 / 5

18	TOP :	0.281	0.19 / 6	0.281	0.00 / 5
	BOTT:	0.281	0.00 / 5	0.281	-0.26 / 5
19	TOP :	0.281	0.00 / 6	0.281	0.00 / 5
	BOTT:	0.281	-0.30 / 6	0.281	-0.48 / 5
20	TOP :	0.281	0.00 / 6	0.281	0.00 / 5
	BOTT:	0.281	-0.50 / 5	0.281	-0.49 / 5
21	TOP :	0.281	0.14 / 5	0.281	0.00 / 5
	BOTT:	0.281	0.00 / 5	0.281	-0.15 / 5
22	TOP :	0.281	0.51 / 5	0.281	0.00 / 5
	BOTT:	0.281	0.00 / 5	0.281	-0.20 / 6
23	TOP :	0.281	1.11 / 5	0.281	0.24 / 6
	BOTT:	0.281	0.00 / 5	0.281	-0.07 / 5
24	TOP :	0.281	1.18 / 5	0.281	0.70 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
25	TOP :	0.281	0.21 / 5	0.281	0.11 / 5
	BOTT:	0.281	-0.05 / 6	0.281	0.00 / 5
26	TOP :	0.281	0.01 / 6	0.281	0.44 / 5
	BOTT:	0.281	-0.25 / 5	0.281	0.00 / 5
27	TOP :	0.281	0.67 / 5	0.281	1.13 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
28	TOP :	0.281	0.31 / 5	0.281	1.02 / 5
	BOTT:	0.281	-0.01 / 6	0.281	0.00 / 5
29	TOP :	0.281	0.00 / 5	0.281	1.67 / 5
	BOTT:	0.281	-0.29 / 5	0.281	0.00 / 5
30	TOP :	0.281	0.33 / 5	0.281	0.46 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
31	TOP :	0.281	0.01 / 6	0.281	1.07 / 5
	BOTT:	0.281	-0.23 / 5	0.281	0.00 / 5
32	TOP :	0.281	0.74 / 5	0.281	1.44 / 5
	BOTT:	0.281	0.00 / 5	0.281	0.00 / 5

```
****************************END OF ELEMENT DESIGN****************************

124. END CONCRETE DESIGN
125. *
126. FINISH


*************** END OF STAAD-III ***************

****** DATE= SEP 21,1994   TIME=  7:26:54 ******

   ************************************************************
   *       FOR QUESTIONS ON STAAD-III/ISDS, CONTACT:          *
   *       RESEARCH ENGINEERS, INC AT (714) 974-2500          *
   *       TELEX:  4994385       FAX:  (714) 974-4771         *
   ************************************************************
```

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 1400

TANK NO.: T-1409 TO T-1420 & T-1425 TO T-1436

DECRIPTION: STORAGE TANKS

FOUNDATION CALCULATIONS

PREPARED BY: S. SMITH DATE: 9/21/94

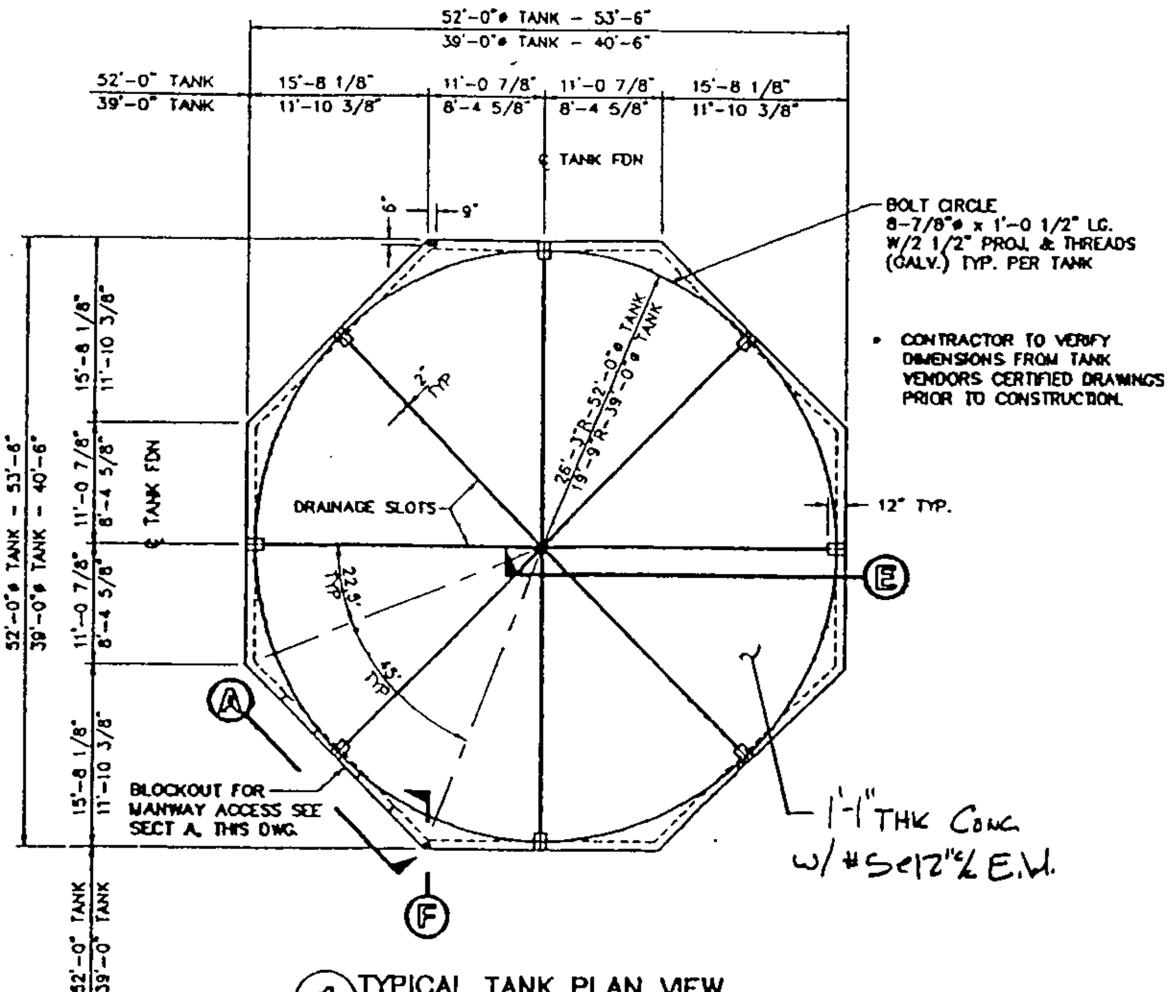
REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
SCOTT R. SMITH
60612
REGISTERED
PROFESSIONAL ENGINEER

10-3-94

FOUNDATION FOR TANKS T-1409 TO T-1420 & T-1425 TO T-1436

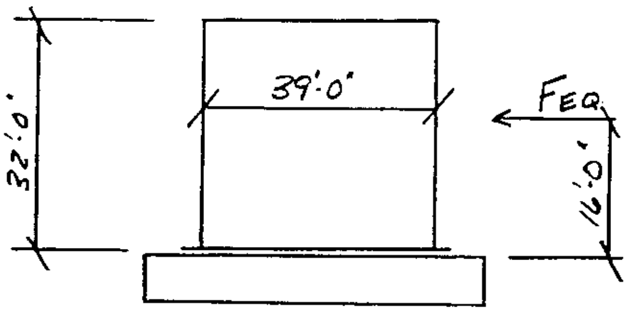


1 TYPICAL TANK PLAN VIEW
SCALE: 1/8" = 1'-0"

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem. Waste Management PROJ. NO.
Emelle, Ala SHEET SK-1 OF
DESIGNED S. Smith 9/21/94 CHECKED / /

FOUNDATIONS FOR TANKS T-1409 TO T-1420 & T-1425 TO T-1436



TANK WEIGHT (EMPTY)

TOP = $\frac{\pi(39.0)^2}{4}$ × 10.2#/SF = 12,184#

SHELL = π(39.0)(32.0) × 15.3#/SF = 59,986#

BOTTOM = $\frac{\pi(39.0)^2}{4}$ × 12.8#/SF = 15,290#

SUBTOTAL = 87,460#

NOZZLES & VALVES (5%) 4,373#

WE = 91,833#

WEIGHT OF CONTENTS

CAPACITY 250,195 GAL

SP. GR 1.10

WC = 250,195 GAL × 1.1 × 8.34#/GAL = 2,295,288#

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MANAGEMENT PROJ. NO. EMELLE, ALA SHEET OF DESIGNED S. SMITH 9/21/94 CHECKED / /

FOUNDATIONS FOR TANKS T-1409 TO T-1420 & T-1425 TO T-1436

EARTHQUAKE LOAD (SBC (1994))

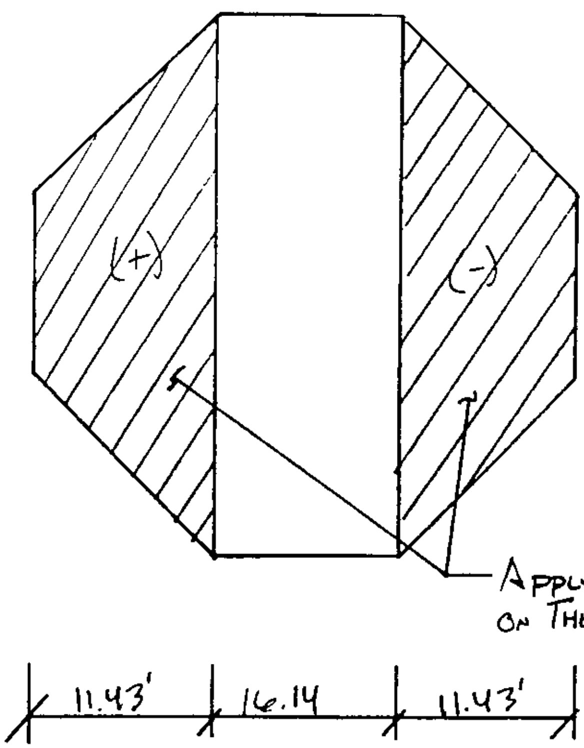
$F_{EQ} = A_V \times C_C \times P \times a_C \times W_T$

$A_V = 0.06$
$C_C = 2.00$ "GEN EQUIP"
$P = 0.5$ " "
$a_C = 1.0$ "FIXED"

$W_T = W_E + W_C = 91{,}833^{\#} + 2{,}295{,}288^{\#} = 2{,}387{,}121^{\#}$

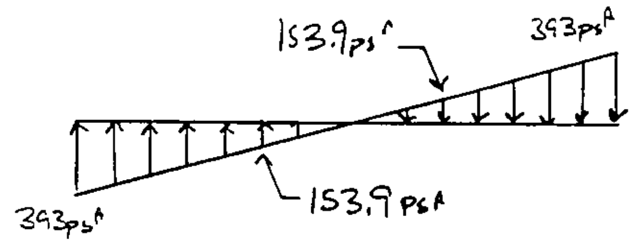
$F_{EQ} = 0.06 \times 2.0 \times 0.5 \times 1.0 \times 2{,}387{,}121^{\#} = \underline{143{,}227^{\#}}$ @ EL 16'-0"

$M = 143{,}227^{\#} \times 16.0' = \underline{2{,}291{,}637}$ FT-lbs



$P = \frac{M}{S} = \frac{2{,}291{,}637 \text{ FT-lb}}{5{,}823 \text{ FT}^3} = 393.5\text{ psf}$

$S = \frac{\pi(D)^3}{32} = \frac{\pi(39)^3}{32} = 5{,}823 \text{ FT}^3$

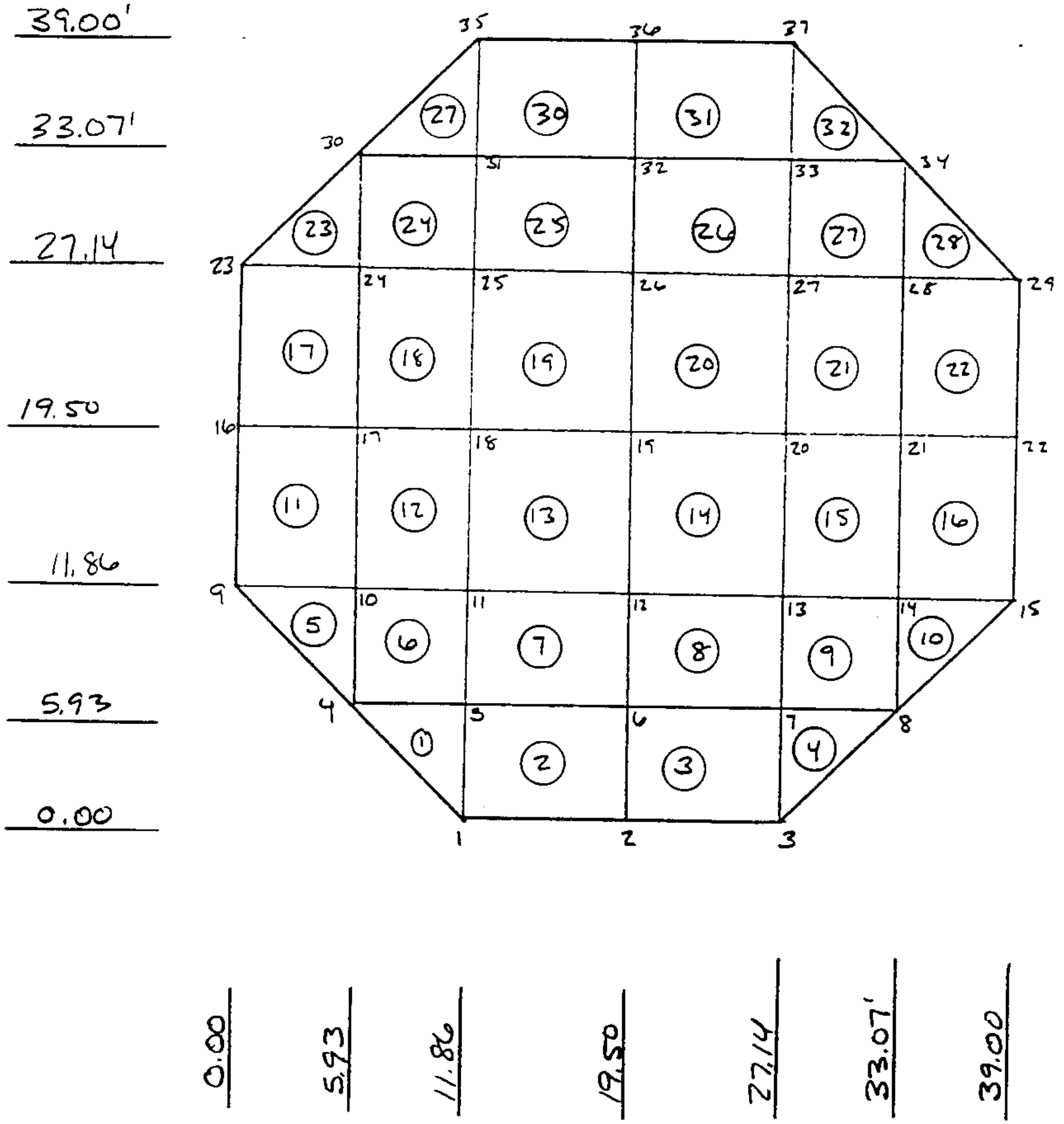


AVG. LOAD:

$\frac{393 + 154}{2} = 273.5\text{psf}$

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT CHEM WASTE MANAGEMENT PROJ. NO.
EMELLE, ALA. SHEET 2 OF
DESIGNED S. SMITH 9/21/94 CHECKED / /



ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management PROJ. NO.
Emelle, Ala SHEET 3 OF
DESIGNED S. Smith / / CHECKED / /

FOUNDATIONS FOR TANKS T-1409 TO T-1420 & T-1425 TO T-1436

STAAD III INPUT

FDN AREA = 0.8284 D² = 0.8284 (39.0)² = 1,259.9 SF

LOADING (ELEMENT LOADS)

DEAD LOAD = $\frac{91,833^{\#}}{1,259.9 \text{ FT}^2}$ = 72.9 psf = 0.073 KSF

LIVE LOAD = $\frac{2,295,288^{\#}}{1,259.9 \text{ FT}^2}$ = 1,821 psf   1.821 KSF

EARTHQUAKE:

UP - 273 psf = 0.273 KSF ① ⑤ ⑥ ⑪ ⑫ ⑰ ⑱ ㉓ ㉔ ㉙

DN: 273 psf = 0.273 KSF ④ ⑨ ⑩ ⑮ ⑯ ㉑ ㉒ ㉗ ㉘ ㉜

CHECK SOIL BEARING

MAXIMUM JOINT DISPL.

@ JT 8   Δ = 0.113"

S.B. = 0.113" × 0.073 kci × 144 IN²/FT² = 1.187 KSF ≤ 4.00 KSF ∴ OK

CHECK BENDING

MAX. MOMENT: M_u = 1.45 K-F   @ ELEM 4

d = 13" - 3" - 0.625 - 0.625/2 = 9.06"

A_s = #5 @ 12" o/c A_s = 0.31 in²

$a = \frac{A_s f_y}{0.85 (f'_c) b} = \frac{0.31 (60)}{0.85 (3)(12)} = 0.60"$

$\phi M_n = \phi A_s f_y (d - a/2) = 0.9 (0.31)(60)(9.06 - 0.6/2) = 146.6^{K\text{-}IN} = 12.2^{K\text{-}F}$

$\phi M_n = 12.2^{K\text{-}F} \geq M_u = 1.45^{K\text{-}F}$ ∴ BENDING OK

ROSSER

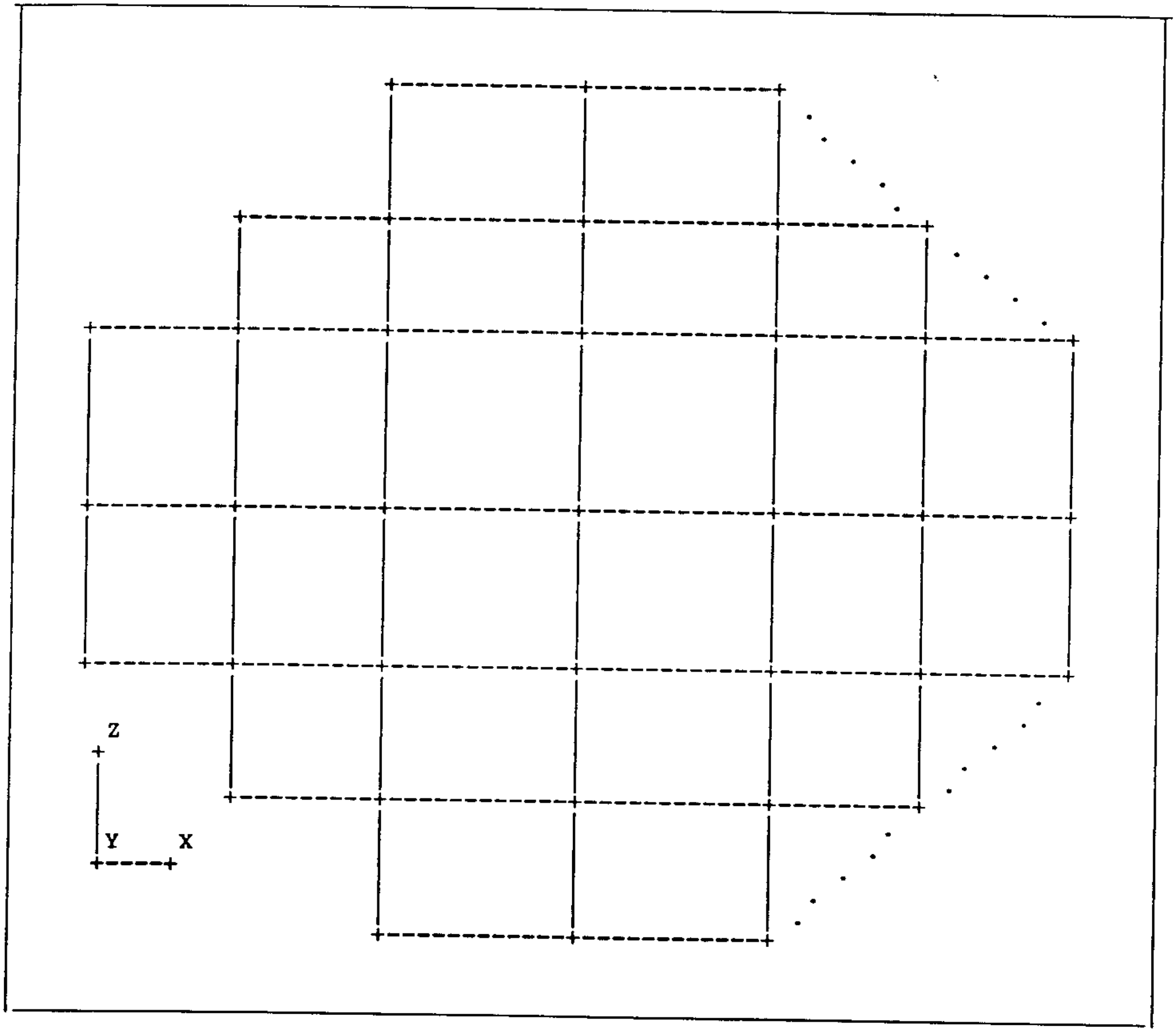
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT CHEM WASTE MANAGEMENT PROJ. NO.
EMELLE, ALA. SHEET 4 OF
DESIGNED S. SMITH 9/21/94 CHECKED / /

```
****************************************************
*                                                  *
*           S T A A D - III                        *
*           REVISION 15.0 (VERSION 15 LEVEL 0)     *
*           PROPRIETARY PROGRAM OF                 *
*           RESEARCH ENGINEERS,INC.                *
*           DATE=    SEP 21, 1994                  *
*           TIME=     8:42:53                      *
*                                                  *
****************************************************
```

```
STAAD SPACE "CHEM WASTE MANAGEMENT"
*
***********************************************************************
*          CHEM WASTE MANAGEMENT
*          EMELLE, ALABAMA
*
*          TANK NO. T-1409 TO T-1420 ; T-1425 TO T-1436
*
*    FILE NAME "T1409"
*
*    DESIGNED BY SCOTT SMITH
*
***********************************************************************
UNIT KIPS FEET
*
*
JOINT COORDINATES
1    11.86 0    0.00  ;  2  19.50   0   0.00  ;   3  27.14  0.0   0.00
4     5.93 0    5.93  ;  5  11.86   0   5.93  ;   6  19.50  0.0   5.93
7    27.14 0    5.93  ;  8  33.07   0   5.93  ;   9   0.00  0.0  11.86
10    5.93 0   11.86  ; 11  11.86   0  11.86  ;  12  19.50  0.0  11.86
13   27.14 0   11.86  ; 14  33.07   0  11.86  ;  15  39.00  0.0  11.86
16    0.00 0   19.50  ; 17   5.93   0  19.50  ;  18  11.86  0.0  19.50
19   19.50 0   19.50  ; 20  27.14   0  19.50  ;  21  33.07  0.0  19.50
22   39.00 0   19.50  ; 23   0.00   0  27.14  ;  24   5.93  0.0  27.14
25   11.86 0   27.14  ; 26  19.50   0  27.14  ;  27  27.14  0.0  27.14
28   33.07 0   27.14  ; 29  39.00   0  27.14  ;  30   5.93  0.0  33.07
31   11.86 0   33.07  ; 32  19.50   0  33.07  ;  33  27.14  0.0  33.07
34   33.07 0   33.07  ; 35  11.86   0  39.00  ;  36  19.50  0.0  39.00
37   27.14 0   39.00
***********************************************************************
*
*    MAT FOUNDATION  ELEMENTS
*
***********************************************************************
ELEMENT INCIDENCES
1     4   5   1     ; 2   5   6   2   1 ;  3   6   7   3   2
4     7   8   3     ; 5   9  10   4     ;  6  10  11   5   4
7    11  12   6    5; 8  12  13   7   6 ;  9  13  14   8   7
10   14  15   8     ;11  16  17  10   9 ; 12  17  18  11  10
13   18  19  12   11;14  19  20  13  12 ; 15  20  21  14  13
16   21  22  15   14;17  23  24  17  16 ; 18  24  25  18  17
19   25  26  19   18;20  26  27  20  19 ; 21  27  28  21  20
22   28  29  22   21;23  30  24  23     ; 24  30  31  25  24
25   31  32  26   25;26  32  33  27  26 ; 27  33  34  28  27
28   34  29  28     ;29  35  31  30     ; 30  35  36  32  31
31   36  37  33   32;32  37  34  33
*
```

```
*
**********************************************************************
UNITS KIP INCHES
*
*
* MAT FOUNDATION ELEMENTS
*
ELEMENT PROPERTIES
1       TO    32           TH  13
**********************************************************************
SUPPORTS
1 3 9 15 23 29 35 37                       FIXED BUT MX MY MZ KFY  435.59
2 16 22 36                                 FIXED BUT MX MY MZ KFY  490.12
4 8 30 34                                  FIXED BUT MX MY MZ KFY  378.50
5 7 10 14 24 28 31 33                      FIXED BUT MX MY MZ KFY  868.25
6 11 13 17 21 25 27 32                     FIXED BUT MX MY MZ KFY  976.94
12 18 20 26                                FIXED BUT MX MY MZ KFY 1120.51
19                                         FIXED BUT MX MY MZ KFY 1260.78
*
**********************************************************************
*
UNITS KIP FEET
*
*  CONCRETE STRENGTH = 3000 PSI
*  CONCRETE UNIT WT. = 150 PCF
*       E(CONC.) = 57000(SQ. RT. OF CONC. STRENGTH)
*
CONSTANTS
E  449571  ALL
POIS   0.2 ALL
DEN  0.15  ALL
**********************************************************************
PLOT PLAN XZ 0.
```


Z
Y
X

```
*
**********************************************************************
*
LOADING 1  DEAD LOAD
*
SELFWEIGHT
*
ELEMENT LOAD
1 TO 32              PR  -0.073
*
*******************************************************************
LOADING 2 LIVE LOAD
*
ELEMENT LOAD
1 TO 32              PR -1.821
*
*********************************************************************
LOADING 3 EARTHQUAKE LOAD
*
ELEMENT LOAD
1 5 6 11 12 17 18 23 24 29          PR 0.273
4 9 10 15 16 21 22 27 28 32         PR -0.273
*
*********************************************************************
LOAD COMBINATION 4
1 1.0  2 1.0  3 1.0
*********************************************************************
LOAD COMBIMATION 5
1 1.4  2  1.7
*********************************************************************
LOAD COMBINATION 6
1  1.05  2  1.275  3  1.275
**********************************************************************
PERFORM ANALYSIS PRINT ALL
```

P R O B L E M   S T A T I S T I C S

```
NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =    37/   32/   37
ORIGINAL/FINAL BAND-WIDTH =     8/    8
TOTAL PRIMARY LOAD CASES  =     3, TOTAL DEGREES OF FREEDOM =   222
SIZE OF STIFFNESS MATRIX =   11988 DOUBLE PREC. WORDS
TOTAL REQUIRED DISK SPACE =   12.38 MEGA-BYTES
```

LOADING 1 DEAD LOAD

SELFWEIGHT Y -1.000

ACTUAL WEIGHT OF THE STRUCTURE = 201.448 KIP

ELEMENT LOAD (UNITS ARE KIP FEET)

ELEMENT	PRESSURE
1	-0.073000
2	-0.073000
3	-0.073000
4	-0.073000
5	-0.073000
6	-0.073000
7	-0.073000
8	-0.073000
9	-0.073000
10	-0.073000
11	-0.073000
12	-0.073000
13	-0.073000
14	-0.073000
15	-0.073000
16	-0.073000
17	-0.073000
18	-0.073000
19	-0.073000
20	-0.073000
21	-0.073000
22	-0.073000
23	-0.073000
24	-0.073000
25	-0.073000
26	-0.073000
27	-0.073000
28	-0.073000
29	-0.073000
30	-0.073000
31	-0.073000
32	-0.073000

***TOTAL APPLIED LOAD (KIP FEET) SUMMARY (LOADING 1)
SUMMATION FORCE-X = 0.00
SUMMATION FORCE-Y = -291.94
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= 5692.92 MY= 0.00 MZ= -5692.93

LOADING 2 LIVE LOAD

ELEMENT LOAD (UNITS ARE KIP FEET)

ELEMENT	PRESSURE
1	-1.821000
2	-1.821000
3	-1.821000
4	-1.821000
5	-1.821000
6	-1.821000
7	-1.821000
8	-1.821000
9	-1.821000
10	-1.821000
11	-1.821000
12	-1.821000
13	-1.821000
14	-1.821000
15	-1.821000
16	-1.821000
17	-1.821000
18	-1.821000
19	-1.821000
20	-1.821000
21	-1.821000
22	-1.821000
23	-1.821000
24	-1.821000
25	-1.821000
26	-1.821000
27	-1.821000
28	-1.821000
29	-1.821000
30	-1.821000
31	-1.821000
32	-1.821000

***TOTAL APPLIED LOAD (KIP FEET) SUMMARY (LOADING 2)
SUMMATION FORCE-X = 0.00
SUMMATION FORCE-Y = -2257.46
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= 44020.45 MY= 0.00 MZ= -44020.45

LOADING 3 EARTHQUAKE LOAD

ELEMENT LOAD (UNITS ARE KIP FEET)

ELEMENT	PRESSURE
1	0.273000
5	0.273000
6	0.273000
11	0.273000
12	0.273000
17	0.273000
18	0.273000
23	0.273000
24	0.273000
29	0.273000
4	-0.273000
9	-0.273000
10	-0.273000
15	-0.273000
16	-0.273000
21	-0.273000
22	-0.273000
27	-0.273000
28	-0.273000
32	-0.273000

```
***TOTAL APPLIED LOAD ( KIP  FEET ) SUMMARY (LOADING    3 )
    SUMMATION FORCE-X =          0.00
    SUMMATION FORCE-Y =          0.00
    SUMMATION FORCE-Z =          0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=          28.46  MY=          0.00  MZ=        -2242.56

++ PROCESSING ELEMENT STIFFNESS MATRIX.                  8:43: 0
++ PROCESSING GLOBAL STIFFNESS MATRIX.                   8:43:10
++ PROCESSING TRIANGULAR FACTORIZATION.                  8:43:13

 ***WARNING - IMPROPER LOAD WILL CAUSE INSTABILITY AT JOINT   37
   DIRECTION = MY  PROBABLE CAUSE MODELING PROBLEM   -0.224E-07
++ CALCULATING JOINT DISPLACEMENTS.                      8:43:20
++ CALCULATING ELEMENT FORCES.                           8:43:22

 ***TOTAL REACTION ( KIP  FEET ) SUMMARY

 LOADING    1

 SUM-X=        0.00  SUM-Y=       291.94  SUM-Z=         0.00

 SUMMATION OF MOMENTS AROUND ORIGIN-

 MX=      -5692.92  MY=          0.00  MZ=       5692.92

 LOADING    2
```

```
 *
SUM-X=          0.00  SUM-Y=      2257.46  SUM-Z=          0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=       -44020.45  MY=            0.00  MZ=       44020.45


LOADING     3

SUM-X=          0.00  SUM-Y=         0.00  SUM-Z=          0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=          -28.46  MY=            0.00  MZ=        2242.56

LOAD COMBINATION NO.      4


LOADING-    1.     2.     3.
FACTOR -  1.00   1.00   1.00

LOAD COMBINATION NO.      5


LOADING-    1.     2.
FACTOR -  1.40   1.70

LOAD COMBINATION NO.      6


LOADING-    1.     2.     3.
FACTOR -  1.05   1.27   1.27


************ END OF DATA FROM INTERNAL STORAGE ************


114. LOAD LIST 1 2 3 4
115. PRINT JOINT DISPLACEMENTS
```

JOINT DISPLACEMENT (INCH RADIANS)   STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
1	1	0.00000	-0.01012	0.00000	0.00001	0.00000	0.00000
	2	0.00000	-0.08395	0.00000	0.00000	0.00000	0.00004
	3	0.00000	0.00561	0.00000	-0.00001	0.00000	-0.00007
	4	0.00000	-0.08845	0.00000	0.00001	0.00000	-0.00003
2	1	0.00000	-0.01044	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08078	0.00000	-0.00003	0.00000	0.00005
	3	0.00000	0.00029	0.00000	0.00000	0.00000	-0.00004
	4	0.00000	-0.09093	0.00000	-0.00003	0.00000	0.00001
3	1	0.00000	-0.00961	0.00000	0.00002	0.00000	0.00000
	2	0.00000	-0.07126	0.00000	0.00018	0.00000	0.00004
	3	0.00000	-0.00374	0.00000	0.00003	0.00000	-0.00006
	4	0.00000	-0.08460	0.00000	0.00023	0.00000	-0.00002
4	1	0.00000	-0.01135	0.00000	-0.00001	0.00000	0.00001
	2	0.00000	-0.08959	0.00000	-0.00015	0.00000	0.00008
	3	0.00000	0.01240	0.00000	0.00003	0.00000	-0.00009
	4	0.00000	-0.08854	0.00000	-0.00013	0.00000	0.00000
5	1	0.00000	-0.01059	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08234	0.00000	-0.00001	0.00000	0.00003
	3	0.00000	0.00570	0.00000	0.00000	0.00000	-0.00008
	4	0.00000	-0.08722	0.00000	-0.00001	0.00000	-0.00004
6	1	0.00000	-0.01065	0.00000	0.00001	0.00000	0.00000
	2	0.00000	-0.08208	0.00000	0.00004	0.00000	0.00003
	3	0.00000	0.00013	0.00000	0.00000	0.00000	-0.00005
	4	0.00000	-0.09261	0.00000	0.00005	0.00000	-0.00002
7	1	0.00000	-0.01050	0.00000	0.00001	0.00000	0.00000
	2	0.00000	-0.08003	0.00000	0.00007	0.00000	-0.00003
	3	0.00000	-0.00542	0.00000	0.00001	0.00000	-0.00006
	4	0.00000	-0.09595	0.00000	0.00009	0.00000	-0.00011
8	1	0.00000	-0.01135	0.00000	-0.00001	0.00000	-0.00001
	2	0.00000	-0.08959	0.00000	-0.00008	0.00000	-0.00015
	3	0.00000	-0.01244	0.00000	-0.00002	0.00000	-0.00010
	4	0.00000	-0.11338	0.00000	-0.00011	0.00000	-0.00026
9	1	0.00000	-0.00961	0.00000	0.00000	0.00000	-0.00002
	2	0.00000	-0.07126	0.00000	0.00004	0.00000	-0.00018
	3	0.00000	0.01201	0.00000	-0.00001	0.00000	0.00000
	4	0.00000	-0.06886	0.00000	0.00004	0.00000	-0.00020
10	1	0.00000	-0.01050	0.00000	0.00000	0.00000	-0.00001
	2	0.00000	-0.08003	0.00000	-0.00003	0.00000	-0.00007
	3	0.00000	0.01064	0.00000	0.00001	0.00000	-0.00005
	4	0.00000	-0.07989	0.00000	-0.00002	0.00000	-0.00012
11	1	0.00000	-0.01087	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08363	0.00000	0.00000	0.00000	-0.00002
	3	0.00000	0.00598	0.00000	0.00000	0.00000	-0.00007
	4	0.00000	-0.08852	0.00000	0.00000	0.00000	-0.00009
12	1	0.00000	-0.01087	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08361	0.00000	0.00003	0.00000	0.00000
	3	0.00000	-0.00002	0.00000	0.00000	0.00000	-0.00006
	4	0.00000	-0.09450	0.00000	0.00004	0.00000	-0.00006

JOINT DISPLACEMENT (INCH RADIANS) STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
13	1	0.00000	-0.01087	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08364	0.00000	0.00002	0.00000	0.00000
	3	0.00000	-0.00604	0.00000	0.00001	0.00000	-0.00007
	4	0.00000	-0.10055	0.00000	0.00002	0.00000	-0.00007
14	1	0.00000	-0.01059	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08234	0.00000	-0.00003	0.00000	-0.00001
	3	0.00000	-0.01100	0.00000	-0.00001	0.00000	-0.00006
	4	0.00000	-0.10394	0.00000	-0.00004	0.00000	-0.00007
15	1	0.00000	-0.01012	0.00000	0.00000	0.00000	0.00001
	2	0.00000	-0.08396	0.00000	-0.00004	0.00000	0.00000
	3	0.00000	-0.01391	0.00000	-0.00001	0.00000	-0.00003
	4	0.00000	-0.10799	0.00000	-0.00004	0.00000	-0.00001
16	1	0.00000	-0.01044	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08078	0.00000	0.00005	0.00000	0.00003
	3	0.00000	0.01337	0.00000	-0.00001	0.00000	-0.00003
	4	0.00000	-0.07785	0.00000	0.00005	0.00000	0.00000
17	1	0.00000	-0.01065	0.00000	0.00000	0.00000	-0.00001
	2	0.00000	-0.08208	0.00000	0.00003	0.00000	-0.00004
	3	0.00000	0.01089	0.00000	0.00000	0.00000	-0.00005
	4	0.00000	-0.08185	0.00000	0.00003	0.00000	-0.00009
18	1	0.00000	-0.01087	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08361	0.00000	0.00000	0.00000	-0.00003
	3	0.00000	0.00607	0.00000	0.00000	0.00000	-0.00007
	4	0.00000	-0.08840	0.00000	0.00000	0.00000	-0.00010
19	1	0.00000	-0.01098	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08473	0.00000	0.00000	0.00000	0.00000
	3	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00006
	4	0.00000	-0.09571	0.00000	0.00000	0.00000	-0.00006
20	1	0.00000	-0.01087	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08357	0.00000	0.00000	0.00000	0.00003
	3	0.00000	-0.00607	0.00000	0.00000	0.00000	-0.00007
	4	0.00000	-0.10051	0.00000	0.00000	0.00000	-0.00003
21	1	0.00000	-0.01065	0.00000	0.00000	0.00000	0.00001
	2	0.00000	-0.08209	0.00000	-0.00003	0.00000	0.00004
	3	0.00000	-0.01089	0.00000	0.00000	0.00000	-0.00005
	4	0.00000	-0.10364	0.00000	-0.00004	0.00000	-0.00001
22	1	0.00000	-0.01045	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08084	0.00000	-0.00005	0.00000	-0.00002
	3	0.00000	-0.01338	0.00000	-0.00001	0.00000	-0.00003
	4	0.00000	-0.10467	0.00000	-0.00005	0.00000	-0.00006
23	1	0.00000	-0.01012	0.00000	0.00000	0.00000	-0.00001
	2	0.00000	-0.08395	0.00000	0.00004	0.00000	0.00000
	3	0.00000	0.01391	0.00000	-0.00001	0.00000	-0.00003
	4	0.00000	-0.08015	0.00000	0.00003	0.00000	-0.00004
24	1	0.00000	-0.01059	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08234	0.00000	0.00003	0.00000	0.00001
	3	0.00000	0.01100	0.00000	-0.00001	0.00000	-0.00006
	4	0.00000	-0.08193	0.00000	0.00003	0.00000	-0.00005

JOINT DISPLACEMENT (INCH RADIANS)   STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
25	1	0.00000	-0.01087	0.00000	0.00000	0.00000	0.00000
	2	0.00000	-0.08364	0.00000	-0.00002	0.00000	0.00000
	3	0.00000	0.00603	0.00000	0.00001	0.00000	0.00000
	4	0.00000	-0.08848	0.00000	-0.00001	0.00000	-0.00007
26	1	0.00000	-0.01087	0.00000	0.00000	0.00000	-0.00008
	2	0.00000	-0.08356	0.00000	-0.00003	0.00000	0.00000
	3	0.00000	0.00003	0.00000	0.00000	0.00000	0.00000
	4	0.00000	-0.09440	0.00000	-0.00004	0.00000	-0.00006
27	1	0.00000	-0.01087	0.00000	0.00000	0.00000	-0.00006
	2	0.00000	-0.08358	0.00000	0.00000	0.00000	0.00000
	3	0.00000	-0.00598	0.00000	0.00000	0.00000	0.00002
	4	0.00000	-0.10042	0.00000	-0.00001	0.00000	-0.00007
28	1	0.00000	-0.01051	0.00000	0.00000	0.00000	-0.00006
	2	0.00000	-0.08015	0.00000	0.00004	0.00000	0.00001
	3	0.00000	-0.01064	0.00000	0.00001	0.00000	0.00006
	4	0.00000	-0.10130	0.00000	0.00005	0.00000	-0.00005
29	1	0.00000	-0.00955	0.00000	-0.00001	0.00000	0.00002
	2	0.00000	-0.07072	0.00000	-0.00007	0.00000	0.00002
	3	0.00000	-0.01188	0.00000	-0.00001	0.00000	0.00016
	4	0.00000	-0.09216	0.00000	-0.00009	0.00000	0.00000
30	1	0.00000	-0.01135	0.00000	0.00001	0.00000	0.00018
	2	0.00000	-0.08959	0.00000	0.00008	0.00000	0.00001
	3	0.00000	0.01244	0.00000	-0.00002	0.00000	0.00015
	4	0.00000	-0.08850	0.00000	0.00007	0.00000	-0.00010
31	1	0.00000	-0.01050	0.00000	-0.00001	0.00000	0.00006
	2	0.00000	-0.08004	0.00000	-0.00007	0.00000	0.00000
	3	0.00000	0.00542	0.00000	0.00001	0.00000	0.00003
	4	0.00000	-0.08512	0.00000	-0.00006	0.00000	-0.00008
32	1	0.00000	-0.01065	0.00000	-0.00001	0.00000	-0.00005
	2	0.00000	-0.08206	0.00000	-0.00004	0.00000	0.00000
	3	0.00000	-0.00012	0.00000	0.00000	0.00000	-0.00003
	4	0.00000	-0.09284	0.00000	-0.00004	0.00000	-0.00005
33	1	0.00000	-0.01060	0.00000	0.00000	0.00000	-0.00008
	2	0.00000	-0.08248	0.00000	0.00001	0.00000	0.00000
	3	0.00000	-0.00573	0.00000	0.00000	0.00000	-0.00004
	4	0.00000	-0.09880	0.00000	0.00001	0.00000	-0.00008
34	1	0.00000	-0.01143	0.00000	0.00001	0.00000	-0.00012
	2	0.00000	-0.09025	0.00000	0.00015	0.00000	-0.00001
	3	0.00000	-0.01260	0.00000	0.00003	0.00000	-0.00010
	4	0.00000	-0.11428	0.00000	0.00019	0.00000	-0.00010
35	1	0.00000	-0.00961	0.00000	-0.00002	0.00000	-0.00021
	2	0.00000	-0.07126	0.00000	-0.00018	0.00000	0.00000
	3	0.00000	0.00374	0.00000	0.00003	0.00000	-0.00004
	4	0.00000	-0.07714	0.00000	-0.00017	0.00000	-0.00006
36	1	0.00000	-0.01045	0.00000	0.00000	0.00000	-0.00010
	2	0.00000	-0.08081	0.00000	0.00002	0.00000	0.00000
	3	0.00000	-0.00030	0.00000	0.00000	0.00000	-0.00006
	4	0.00000	-0.09155	0.00000	0.00002	0.00000	-0.00005
							-0.00010

JOINT DISPLACEMENT (INCH RADIANS)   STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
37	1	0.00000	-0.01007	0.00000	-0.00001	0.00000	0.00000
	2	0.00000	-0.08356	0.00000	0.00001	0.00000	-0.00001
	3	0.00000	-0.00551	0.00000	0.00000	0.00000	-0.00007
	4	0.00000	-0.09914	0.00000	0.00000	0.00000	-0.00008

************** END OF LATEST ANALYSIS RESULT **************

116. LOAD LIST 5 6
117. PRINT ELEMENT FORCES

```
ELEMENT FORCES     FORCE,LENGTH UNITS= KIP  FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD        QX          QY            MX           MY            MXY
                                 FX            FY           FXY

  1       5         1.19        0.21          0.73        -0.11          -0.86
                                0.00          0.00         0.00
   TOP :  SMAX=        6.48  SMIN=     -3.29  TMAX=        4.89  ANGLE= -31.9
   BOTT:  SMAX=        3.29  SMIN=     -6.48  TMAX=        4.89  ANGLE= -31.9
          6         0.70        0.10          0.39        -0.09          -0.54
                                0.00          0.00         0.00
   TOP :  SMAX=        3.79  SMIN=     -2.23  TMAX=        3.01  ANGLE= -33.0
   BOTT:  SMAX=        2.23  SMIN=     -3.79  TMAX=        3.01  ANGLE= -33.0

  2       5        -0.30       -0.19          0.01         0.36          -0.10
                                0.00          0.00         0.00
   TOP :  SMAX=        1.95  SMIN=     -0.08  TMAX=        1.02  ANGLE=  14.5
   BOTT:  SMAX=        0.08  SMIN=     -1.95  TMAX=        1.02  ANGLE=  14.5
          6        -0.19       -0.10         -0.20         0.26          -0.13
                                0.00          0.00         0.00
   TOP :  SMAX=        1.50  SMIN=     -1.18  TMAX=        1.34  ANGLE=  14.3
   BOTT:  SMAX=        1.18  SMIN=     -1.50  TMAX=        1.34  ANGLE=  14.3

  3       5         0.59       -0.02          0.32        -0.31          -0.83
                                0.00          0.00         0.00
   TOP :  SMAX=        4.57  SMIN=     -4.48  TMAX=        4.53  ANGLE= -34.6
   BOTT:  SMAX=        4.48  SMIN=     -4.57  TMAX=        4.53  ANGLE= -34.6
          6         0.52       -0.04          0.40        -0.28          -0.74
                                0.00          0.00         0.00
   TOP :  SMAX=        4.49  SMIN=     -3.87  TMAX=        4.18  ANGLE= -32.7
   BOTT:  SMAX=        3.87  SMIN=     -4.49  TMAX=        4.18  ANGLE= -32.7

  4       5        -1.51        0.76          1.45        -1.42           0.52
                                0.00          0.00         0.00
   TOP :  SMAX=        7.85  SMIN=     -7.71  TMAX=        7.78  ANGLE=   9.9
   BOTT:  SMAX=        7.71  SMIN=     -7.85  TMAX=        7.78  ANGLE=   9.9
          6        -1.35        0.69          1.31        -1.22           0.46
                                0.00          0.00         0.00
   TOP :  SMAX=        7.09  SMIN=     -6.67  TMAX=        6.88  ANGLE=  10.0
   BOTT:  SMAX=        6.67  SMIN=     -7.09  TMAX=        6.88  ANGLE=  10.0

  5       5        -0.76       -1.51         -1.42         1.45          -0.52
                                0.00          0.00         0.00
   TOP :  SMAX=        7.86  SMIN=     -7.72  TMAX=        7.79  ANGLE=   9.9
   BOTT:  SMAX=        7.72  SMIN=     -7.86  TMAX=        7.79  ANGLE=   9.9
          6        -0.37       -0.92         -0.58         0.99          -0.26
                                0.00          0.00         0.00
   TOP :  SMAX=        5.25  SMIN=     -3.18  TMAX=        4.22  ANGLE=   9.2
   BOTT:  SMAX=        3.18  SMIN=     -5.25  TMAX=        4.22  ANGLE=   9.2

  6       5         0.17       -0.01          0.21         0.99          -1.14
                                0.00          0.00         0.00
   TOP :  SMAX=        9.19  SMIN=     -3.10  TMAX=        6.14  ANGLE=  35.5
   BOTT:  SMAX=        3.10  SMIN=     -9.19  TMAX=        6.14  ANGLE=  35.5
```

```
ELEMENT FORCES       FORCE,LENGTH UNITS= KIP   FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT   LOAD          QX          QY            MX           MY            MXY
                                    FX            FY           FXY

          6            0.01       -0.05          0.18         0.64          -0.66
                                   0.00          0.00         0.00
    TOP :  SMAX=        5.65  SMIN=      -1.45  TMAX=         3.55  ANGLE=   35.3
    BOTT:  SMAX=        1.45  SMIN=      -5.65  TMAX=         3.55  ANGLE=   35.3

   7      5           -0.32        0.22         -0.07         0.00          -0.41
                                   0.00          0.00         0.00
    TOP :  SMAX=        1.96  SMIN=      -2.28  TMAX=         2.12  ANGLE=   42.7
    BOTT:  SMAX=        2.28  SMIN=      -1.96  TMAX=         2.12  ANGLE=   42.7
          6           -0.20        0.13         -0.21        -0.05          -0.33
                                   0.00          0.00         0.00
    TOP :  SMAX=        1.08  SMIN=      -2.44  TMAX=         1.76  ANGLE=   38.3
    BOTT:  SMAX=        2.44  SMIN=      -1.08  TMAX=         1.76  ANGLE=   38.3

   8      5            0.16        0.20          0.23        -0.39          -0.01
                                   0.00          0.00         0.00
    TOP :  SMAX=        1.16  SMIN=      -1.98  TMAX=         1.57  ANGLE=   -1.2
    BOTT:  SMAX=        1.98  SMIN=      -1.16  TMAX=         1.57  ANGLE=   -1.2
          6            0.16        0.17          0.32        -0.32          -0.04
                                   0.00          0.00         0.00
    TOP :  SMAX=        1.65  SMIN=      -1.67  TMAX=         1.66  ANGLE=   -3.8
    BOTT:  SMAX=        1.67  SMIN=      -1.65  TMAX=         1.66  ANGLE=   -3.8

   9      5           -0.01       -0.17          0.98         0.21           1.13
                                   0.00          0.00         0.00
    TOP :  SMAX=        9.16  SMIN=      -3.10  TMAX=         6.13  ANGLE=   35.6
    BOTT:  SMAX=        3.10  SMIN=      -9.16  TMAX=         6.13  ANGLE=   35.6
          6           -0.10       -0.10          0.79         0.17           1.05
                                   0.00          0.00         0.00
    TOP :  SMAX=        8.04  SMIN=      -3.14  TMAX=         5.59  ANGLE=   36.7
    BOTT:  SMAX=        3.14  SMIN=      -8.04  TMAX=         5.59  ANGLE=   36.7

  10      5            0.20       -1.19         -0.10         0.74           0.86
                                   0.00          0.00         0.00
    TOP :  SMAX=        6.53  SMIN=      -3.28  TMAX=         4.90  ANGLE=  -32.0
    BOTT:  SMAX=        3.28  SMIN=      -6.53  TMAX=         4.90  ANGLE=  -32.0
          6            0.29       -1.08         -0.42         0.58           0.81
                                   0.00          0.00         0.00
    TOP :  SMAX=        5.26  SMIN=      -4.44  TMAX=         4.85  ANGLE=  -29.2
    BOTT:  SMAX=        4.44  SMIN=      -5.26  TMAX=         4.85  ANGLE=  -29.2

  11      5            0.02        0.59         -0.31         0.33           0.83
                                   0.00          0.00         0.00
    TOP :  SMAX=        4.57  SMIN=      -4.48  TMAX=         4.53  ANGLE=  -34.5
    BOTT:  SMAX=        4.48  SMIN=      -4.57  TMAX=         4.53  ANGLE=  -34.5
          6            0.10        0.38          0.11         0.25           0.53
                                   0.00          0.00         0.00
    TOP :  SMAX=        3.64  SMIN=      -1.79  TMAX=         2.72  ANGLE=  -41.2
    BOTT:  SMAX=        1.79  SMIN=      -3.64  TMAX=         2.72  ANGLE=  -41.2
```

ELEMENT FORCES   FORCE,LENGTH UNITS= KIP   FEET

FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

```
ELEMENT  LOAD        QX          QY           MX           MY             MXY
                                 FX           FY           FXY

  12        5      -0.20        0.15        -0.39         0.22            0.01
                                0.00         0.00         0.00
    TOP :  SMAX=      1.15  SMIN=   -1.99  TMAX=       1.57  ANGLE=  -1.0
    BOTT:  SMAX=      1.99  SMIN=   -1.15  TMAX=       1.57  ANGLE=  -1.0
            6      -0.24        0.09        -0.06         0.18            0.03
                                0.00         0.00         0.00
    TOP :  SMAX=      0.93  SMIN=   -0.32  TMAX=       0.62  ANGLE=  -7.3
    BOTT:  SMAX=      0.32  SMIN=   -0.93  TMAX=       0.62  ANGLE=  -7.3

  13        5       0.05       -0.02        -0.33        -0.27           -0.10
                                0.00         0.00         0.00
    TOP :  SMAX=     -0.98  SMIN=   -2.07  TMAX=       0.55  ANGLE=  36.5
    BOTT:  SMAX=      2.07  SMIN=    0.98  TMAX=       0.55  ANGLE=  36.5
            6       0.05       -0.02        -0.32        -0.20           -0.09
                                0.00         0.00         0.00
    TOP :  SMAX=     -0.81  SMIN=   -1.89  TMAX=       0.54  ANGLE=  28.1
    BOTT:  SMAX=      1.89  SMIN=    0.81  TMAX=       0.54  ANGLE=  28.1

  14        5      -0.02       -0.06        -0.27        -0.34            0.11
                                0.00         0.00         0.00
    TOP :  SMAX=     -0.96  SMIN=   -2.11  TMAX=       0.57  ANGLE=  35.9
    BOTT:  SMAX=      2.11  SMIN=    0.96  TMAX=       0.57  ANGLE=  35.9
            6      -0.01       -0.04        -0.12        -0.26            0.07
                                0.00         0.00         0.00
    TOP :  SMAX=     -0.48  SMIN=   -1.49  TMAX=       0.50  ANGLE=  22.2
    BOTT:  SMAX=      1.49  SMIN=    0.48  TMAX=       0.50  ANGLE=  22.2

  15        5       0.21        0.32         0.00        -0.09            0.42
                                0.00         0.00         0.00
    TOP :  SMAX=      1.92  SMIN=   -2.36  TMAX=       2.14  ANGLE=  42.0
    BOTT:  SMAX=      2.36  SMIN=   -1.92  TMAX=       2.14  ANGLE=  42.0
            6       0.07        0.29        -0.19        -0.11            0.38
                                0.00         0.00         0.00
    TOP :  SMAX=      1.19  SMIN=   -2.69  TMAX=       1.94  ANGLE= -42.0
    BOTT:  SMAX=      2.69  SMIN=   -1.19  TMAX=       1.94  ANGLE= -42.0

  16        5      -0.18        0.31         0.33         0.02            0.08
                                0.00         0.00         0.00
    TOP :  SMAX=      1.79  SMIN=   -0.01  TMAX=       0.90  ANGLE=  13.6
    BOTT:  SMAX=      0.01  SMIN=   -1.79  TMAX=       0.90  ANGLE=  13.6
            6      -0.07        0.26        -0.02        -0.03            0.06
                                0.00         0.00         0.00
    TOP :  SMAX=      0.20  SMIN=   -0.45  TMAX=       0.33  ANGLE=  90.0
    BOTT:  SMAX=      0.45  SMIN=   -0.20  TMAX=       0.33  ANGLE=  90.0

  17        5       0.19       -0.30         0.36         0.01            0.10
                                0.00         0.00         0.00
    TOP :  SMAX=      1.95  SMIN=   -0.08  TMAX=       1.02  ANGLE=  14.5
    BOTT:  SMAX=      0.08  SMIN=   -1.95  TMAX=       1.02  ANGLE=  14.5
```

```
 ELEMENT FORCES     FORCE,LENGTH UNITS= KIP   FEET
 --------------
 FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT   LOAD         QX          QY           MX           MY           MXY
                                   FX           FY           FXY

           6          0.21       -0.20         0.53         0.05          0.07
                                  0.00         0.00         0.00
     TOP :  SMAX=      2.78   SMIN=     0.20  TMAX=       1.29   ANGLE=    7.7
     BOTT:  SMAX=     -0.20   SMIN=    -2.78  TMAX=       1.29   ANGLE=    7.7

   18      5         -0.22       -0.32         0.00        -0.06          0.41
                                  0.00         0.00         0.00
     TOP :  SMAX=      1.96   SMIN=    -2.27  TMAX=       2.11   ANGLE=   42.7
     BOTT:  SMAX=      2.27   SMIN=    -1.96  TMAX=       2.11   ANGLE=   42.7
           6         -0.25       -0.19         0.19        -0.01          0.24
                                  0.00         0.00         0.00
     TOP :  SMAX=      1.80   SMIN=    -0.88  TMAX=       1.34   ANGLE=   34.0
     BOTT:  SMAX=      0.88   SMIN=    -1.80  TMAX=       1.34   ANGLE=   34.0

   19      5          0.02        0.06        -0.27        -0.33          0.11
                                  0.00         0.00         0.00
     TOP :  SMAX=     -0.97   SMIN=    -2.11  TMAX=       0.57   ANGLE=   37.8
     BOTT:  SMAX=      2.11   SMIN=     0.97  TMAX=       0.57   ANGLE=   37.8
           6          0.03        0.04        -0.28        -0.24          0.09
                                  0.00         0.00         0.00
     TOP :  SMAX=     -0.84   SMIN=    -1.82  TMAX=       0.49   ANGLE=  -37.9
     BOTT:  SMAX=      1.82   SMIN=     0.84  TMAX=       0.49   ANGLE=  -37.9

   20      5         -0.05        0.02        -0.32        -0.26         -0.10
                                  0.00         0.00         0.00
     TOP :  SMAX=     -0.92   SMIN=    -2.03  TMAX=       0.55   ANGLE=   37.2
     BOTT:  SMAX=      2.03   SMIN=     0.92  TMAX=       0.55   ANGLE=   37.2
           6         -0.03        0.01        -0.16        -0.19         -0.07
                                  0.00         0.00         0.00
     TOP :  SMAX=     -0.54   SMIN=    -1.25  TMAX=       0.35   ANGLE=  -39.0
     BOTT:  SMAX=      1.25   SMIN=     0.54  TMAX=       0.35   ANGLE=  -39.0

   21      5          0.21       -0.17        -0.36         0.29         -0.01
                                  0.00         0.00         0.00
     TOP :  SMAX=      1.48   SMIN=    -1.84  TMAX=       1.66   ANGLE=    0.9
     BOTT:  SMAX=      1.84   SMIN=    -1.48  TMAX=       1.66   ANGLE=    0.9
           6          0.07       -0.15        -0.50         0.21         -0.03
                                  0.00         0.00         0.00
     TOP :  SMAX=      1.10   SMIN=    -2.58  TMAX=       1.84   ANGLE=    2.4
     BOTT:  SMAX=      2.58   SMIN=    -1.10  TMAX=       1.84   ANGLE=    2.4

   22      5          0.06       -0.57        -0.24         0.18          0.87
                                  0.00         0.00         0.00
     TOP :  SMAX=      4.42   SMIN=    -4.74  TMAX=       4.58   ANGLE=  -38.3
     BOTT:  SMAX=      4.74   SMIN=    -4.42  TMAX=       4.58   ANGLE=  -38.3
           6          0.14       -0.48        -0.51         0.10          0.76
                                  0.00         0.00         0.00
     TOP :  SMAX=      3.13   SMIN=    -5.22  TMAX=       4.17   ANGLE=  -34.1
     BOTT:  SMAX=      5.22   SMIN=    -3.13  TMAX=       4.17   ANGLE=  -34.1
```

```
ELEMENT FORCES      FORCE,LENGTH UNITS= KIP   FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT   LOAD        QX          QY           MX          MY            MXY
                                  FX           FY          FXY

  23        5        1.19        0.21          0.73        -0.11          -0.86
                                 0.00          0.00         0.00
    TOP :  SMAX=       6.48  SMIN=     -3.29   TMAX=       4.88   ANGLE= -31.9
    BOTT:  SMAX=       3.29  SMIN=     -6.48   TMAX=       4.88   ANGLE= -31.9
            6        0.72        0.02          0.53         0.26          -0.48
                                 0.00          0.00         0.00
    TOP :  SMAX=       4.57  SMIN=     -0.55   TMAX=       2.56   ANGLE= -37.2
    BOTT:  SMAX=       0.55  SMIN=     -4.57   TMAX=       2.56   ANGLE= -37.2

  24        5        0.01        0.16          0.98         0.20           1.14
                                 0.00          0.00         0.00
    TOP :  SMAX=       9.17  SMIN=     -3.11   TMAX=       6.14   ANGLE=  35.5
    BOTT:  SMAX=       3.11  SMIN=     -9.17   TMAX=       6.14   ANGLE=  35.5
            6       -0.09        0.15          0.68         0.14           0.65
                                 0.00          0.00         0.00
    TOP :  SMAX=       5.72  SMIN=     -1.53   TMAX=       3.62   ANGLE=  33.7
    BOTT:  SMAX=       1.53  SMIN=     -5.72   TMAX=       3.62   ANGLE=  33.7

  25        5       -0.16       -0.19          0.20        -0.39          -0.01
                                 0.00          0.00         0.00
    TOP :  SMAX=       1.03  SMIN=     -2.01   TMAX=       1.52   ANGLE=  -0.5
    BOTT:  SMAX=       2.01  SMIN=     -1.03   TMAX=       1.52   ANGLE=  -0.5
            6       -0.08       -0.12          0.00        -0.26           0.03
                                 0.00          0.00         0.00
    TOP :  SMAX=       0.01  SMIN=     -1.36   TMAX=       0.68   ANGLE=   6.6
    BOTT:  SMAX=       1.36  SMIN=     -0.01   TMAX=       0.68   ANGLE=   6.6

  26        5        0.34       -0.24          0.01         0.05          -0.44
                                 0.00          0.00         0.00
    TOP :  SMAX=       2.43  SMIN=     -2.10   TMAX=       2.26   ANGLE=  43.8
    BOTT:  SMAX=       2.10  SMIN=     -2.43   TMAX=       2.26   ANGLE=  43.8
            6        0.30       -0.23          0.19         0.10          -0.31
                                 0.00          0.00         0.00
    TOP :  SMAX=       2.34  SMIN=     -0.87   TMAX=       1.61   ANGLE= -41.1
    BOTT:  SMAX=       0.87  SMIN=     -2.34   TMAX=       1.61   ANGLE= -41.1

  27        5       -0.12        0.01          0.29         1.02          -1.23
                                 0.00          0.00         0.00
    TOP :  SMAX=       9.91  SMIN=     -3.21   TMAX=       6.56   ANGLE=  36.8
    BOTT:  SMAX=       3.21  SMIN=     -9.91   TMAX=       6.56   ANGLE=  36.8
            6       -0.20       -0.02          0.21         0.86          -1.13
                                 0.00          0.00         0.00
    TOP :  SMAX=       8.77  SMIN=     -3.30   TMAX=       6.04   ANGLE=  37.0
    BOTT:  SMAX=       3.30  SMIN=     -8.77   TMAX=       6.04   ANGLE=  37.0

  28        5        1.32        0.69         -0.22         0.52           1.31
                                 0.00          0.00         0.00
    TOP :  SMAX=       7.76  SMIN=     -6.21   TMAX=       6.99   ANGLE= -37.1
    BOTT:  SMAX=       6.21  SMIN=     -7.76   TMAX=       6.99   ANGLE= -37.1
```

```
 ELEMENT FORCES     FORCE,LENGTH UNITS= KIP   FEET
 --------------
 FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD          QX          QY           MX           MY           MXY
                                   FX           FY           FXY

           6          1.23        0.52        -0.45         0.34          1.26
                                  0.00         0.00         0.00
      TOP :  SMAX=        6.45  SMIN=     -7.04  TMAX=      6.74  ANGLE= -36.3
      BOTT:  SMAX=        7.04  SMIN=     -6.45  TMAX=      6.74  ANGLE= -36.3

    29     5         -0.76       -1.51        -1.42         1.45         -0.52
                                  0.00         0.00         0.00
      TOP :  SMAX=        7.87  SMIN=     -7.71  TMAX=      7.79  ANGLE=  10.0
      BOTT:  SMAX=        7.71  SMIN=     -7.87  TMAX=      7.79  ANGLE=  10.0
           6         -0.46       -0.91        -0.90         0.86         -0.32
                                  0.00         0.00         0.00
      TOP :  SMAX=        4.70  SMIN=     -4.90  TMAX=      4.80  ANGLE=   9.9
      BOTT:  SMAX=        4.90  SMIN=     -4.70  TMAX=      4.80  ANGLE=   9.9

    30     5         -0.59        0.02         0.34        -0.32         -0.84
                                  0.00         0.00         0.00
      TOP :  SMAX=        4.64  SMIN=     -4.58  TMAX=      4.61  ANGLE= -34.3
      BOTT:  SMAX=        4.58  SMIN=     -4.64  TMAX=      4.61  ANGLE= -34.3
           6         -0.37       -0.01         0.10        -0.20         -0.51
                                  0.00         0.00         0.00
      TOP :  SMAX=        2.45  SMIN=     -2.96  TMAX=      2.70  ANGLE= -37.0
      BOTT:  SMAX=        2.96  SMIN=     -2.45  TMAX=      2.70  ANGLE= -37.0

    31     5          0.29        0.11        -0.08         0.40         -0.07
                                  0.00         0.00         0.00
      TOP :  SMAX=        2.11  SMIN=     -0.48  TMAX=      1.29  ANGLE=   8.5
      BOTT:  SMAX=        0.48  SMIN=     -2.11  TMAX=      1.29  ANGLE=   8.5
           6          0.25        0.11         0.13         0.32          0.00
                                  0.00         0.00         0.00
      TOP :  SMAX=        1.61  SMIN=      0.65  TMAX=      0.48  ANGLE=  -0.5
      BOTT:  SMAX=       -0.65  SMIN=     -1.61  TMAX=      0.48  ANGLE=  -0.5

    32     5         -0.80        0.92        -0.16         1.18         -0.41
                                  0.00         0.00         0.00
      TOP :  SMAX=        6.63  SMIN=     -1.42  TMAX=      4.02  ANGLE=  15.9
      BOTT:  SMAX=        1.42  SMIN=     -6.63  TMAX=      4.02  ANGLE=  15.9
           6         -0.74        0.81        -0.07         1.08         -0.39
                                  0.00         0.00         0.00
      TOP :  SMAX=        6.12  SMIN=     -0.98  TMAX=      3.55  ANGLE=  17.1
      BOTT:  SMAX=        0.98  SMIN=     -6.12  TMAX=      3.55  ANGLE=  17.1

 ********************END OF ELEMENT FORCES********************

 118. UNIT KIP INCHES
 119. START CONCRETE DESIGN
1
 120. CODE ACI
 121. FC 3
 122. TRACK 2.0
 123. DESIGN ELEMENTS 1 TO 32
```

ELEMENT DESIGN SUMMARY

ELEMENT	LONG. REINF (SQ.IN/FT)	MOM-X /LOAD (K-FT/FT)	TRANS. REINF (SQ.IN/FT)	MOM-Y /LOAD (K-FT/FT)
1 TOP :	0.281	0.73 / 5	0.281	0.00 /***
BOTT:	0.281	0.00 / 34	0.281	-0.11 / 5
2 TOP :	0.281	0.01 / 5	0.281	0.36 / 5
BOTT:	0.281	-0.20 / 6	0.281	0.00 / 5
3 TOP :	0.281	0.40 / 6	0.281	0.00 / 5
BOTT:	0.281	0.00 / 6	0.281	-0.31 / 5
4 TOP :	0.281	1.45 / 5	0.281	0.00 / 5
BOTT:	0.281	0.00 / 6	0.281	-1.42 / 5
5 TOP :	0.281	0.00 / 5	0.281	1.45 / 5
BOTT:	0.281	-1.42 / 5	0.281	0.00 / 5
6 TOP :	0.281	0.21 / 5	0.281	0.99 / 5
BOTT:	0.281	0.00 / 5	0.281	0.00 / 5
7 TOP :	0.281	0.00 / 5	0.281	0.00 / 5
BOTT:	0.281	-0.21 / 6	0.281	-0.05 / 6
8 TOP :	0.281	0.32 / 6	0.281	0.00 / 5
BOTT:	0.281	0.00 / 6	0.281	-0.39 / 5
9 TOP :	0.281	0.98 / 5	0.281	0.21 / 5
BOTT:	0.281	0.00 / 6	0.281	0.00 / 5
10 TOP :	0.281	0.00 / 5	0.281	0.74 / 5
BOTT:	0.281	-0.42 / 6	0.281	0.00 / 5
11 TOP :	0.281	0.11 / 6	0.281	0.33 / 5
BOTT:	0.281	-0.31 / 5	0.281	0.00 / 5
12 TOP :	0.281	0.00 / 6	0.281	0.22 / 5
BOTT:	0.281	-0.39 / 5	0.281	0.00 / 5
13 TOP :	0.281	0.00 / 6	0.281	0.00 / 5
BOTT:	0.281	-0.33 / 5	0.281	-0.27 / 5
14 TOP :	0.281	0.00 / 6	0.281	0.00 / 5
BOTT:	0.281	-0.27 / 5	0.281	-0.34 / 5
15 TOP :	0.281	0.00 / 5	0.281	0.00 / 5
BOTT:	0.281	-0.19 / 6	0.281	-0.11 / 6
16 TOP :	0.281	0.33 / 5	0.281	0.02 / 5
BOTT:	0.281	-0.02 / 6	0.281	-0.03 / 6
17 TOP :	0.281	0.53 / 6	0.281	0.05 / 6
BOTT:	0.281	0.00 / 6	0.281	0.00 / 6

```
18 TOP :   0.281     0.19 /  6     0.281     0.00 /  6
   BOTT:   0.281     0.00 /  6     0.281    -0.06 /  5

19 TOP :   0.281     0.00 /  6     0.281     0.00 /  6
   BOTT:   0.281    -0.28 /  6     0.281    -0.33 /  5

20 TOP :   0.281     0.00 /  6     0.281     0.00 /  6
   BOTT:   0.281    -0.32 /  5     0.281    -0.26 /  5

21 TOP :   0.281     0.00 /  6     0.281     0.29 /  5
   BOTT:   0.281    -0.50 /  6     0.281     0.00 /  5

22 TOP :   0.281     0.00 /  6     0.281     0.18 /  5
   BOTT:   0.281    -0.51 /  6     0.281     0.00 /  5

23 TOP :   0.281     0.73 /  5     0.281     0.26 /  6
   BOTT:   0.281     0.00 /  6     0.281    -0.11 /  5

24 TOP :   0.281     0.98 /  5     0.281     0.20 /  5
   BOTT:   0.281     0.00 /  6     0.281     0.00 /  5

25 TOP :   0.281     0.20 /  5     0.281     0.00 /  5
   BOTT:   0.281     0.00 /  6     0.281    -0.39 /  5

26 TOP :   0.281     0.19 /  6     0.281     0.10 /  6
   BOTT:   0.281     0.00 /  6     0.281     0.00 /  5

27 TOP :   0.281     0.29 /  5     0.281     1.02 /  5
   BOTT:   0.281     0.00 /  6     0.281     0.00 /  5

28 TOP :   0.281     0.00 /  5     0.281     0.52 /  5
   BOTT:   0.281    -0.45 /  6     0.281     0.00 /  5

29 TOP :   0.281     0.00 /  5     0.281     1.45 /  5
   BOTT:   0.281    -1.42 /  5     0.281     0.00 /  5

30 TOP :   0.281     0.34 /  5     0.281     0.00 /  5
   BOTT:   0.281     0.00 /  5     0.281    -0.32 /  5

31 TOP :   0.281     0.13 /  6     0.281     0.40 /  5
   BOTT:   0.281    -0.08 /  5     0.281     0.00 /  5

32 TOP :   0.281     0.00 /  6     0.281     1.18 /  5
   BOTT:   0.281    -0.16 /  5     0.281     0.00 /  5

****************************END OF ELEMENT DESIGN***************************

124. END CONCRETE DESIGN
125. *
126. FINISH


*************** END OF STAAD-III ***************

****** DATE= SEP 21,1994    TIME=  8:43:38 ******

  ************************************************************
  *      FOR QUESTIONS ON STAAD-III/ISDS, CONTACT:            *
  *      RESEARCH ENGINEERS, INC AT (714) 974-2500            *
  *      TELEX:  4994385       FAX:  (714) 974-4771           *
  ************************************************************
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EXHIBIT D

CALCULATIONS OF TANK VENTING REQUIREMENTS

EXHIBIT D
TANK VENTING CALCULATIONS (PER API 2000)
CHEMICAL WASTE MANAGEMENT, INC., EMELLE, ALABAMA FACILITY

												IN-BREATHING					OUT-BREATHING					EMERGENCY		
Tank Nos.	Width/ Diameter (ft)	Length/ Shell Height (ft)	Depth/ Cone Height (ft)	Tank Wetted Surf. Area (sf)	Tank Capacity (gal)	Tank Rated Press. (in WG)	Tank Relief Press. (in WG)[1]	Tank Rated Vac. (in WG)	Tank Relief Vac. (in WG)[1]	Fill Rate (gpm)	With-drawal Rate (gpm)	Normal Venting (cfh)[2]	Thermal Venting (cfh)[3]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Normal Venting (cfh)[4]	Thermal Venting (cfh)[5]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Vent Capacity (cfh)[6]	Min. Area (sq in)[7]	Min. Size (in)
TANK MANAGEMENT UNIT 1400																								
T-1405 thru T-1408	52.00	32.00		5,228	508,333	14.00	7.00	2.00	1.00	300	300	2,400	12,103	14,503	34.33	7.00	2,571	7,262	9,833	8.80	4.00	NA	NA	NA
T-1409 thru T-1420	39.00	28.00		3,431	250,195	14.00	7.00	2.00	1.00	300	300	2,400	5,957	8,357	19.78	6.00	2,571	3,574	6,146	5.50	3.00	NA	NA	NA

NOTES:

1. Pressure and vacuum relief is assumed to be set to relieve at 50% of the design rated pressure or vacuum, unless noted. Emergency relief is assumed to be set at 75% of design pressure.
2. Normal in-breathing at 5.6 scfh per 42 gal barrel per hour of withdrawal, as specified in API 2000, 4th Edition.
3. Thermal in-breathing at 1 scfh per 42 gal barrel of tank volume, up to 20,000 barrel (840,000 gal) volume, as in API 2000.
4. Normal out-breathing at 12 scfh per 42 gal barrel per hour of fill for volatile liquids (flash point <100 deg F), as in API 2000. For non-volatile liquids 6 scfh per 42 gal barrel may be used.
5. Thermal out-breathing at 1 scfh per 42 gal barrel of tank volume for volatile liquids, up to 20,000 barrel volume, as in API 2000. For non-volatile liquids 0.6 scfh per 42 gal barrel may be used.
6. From API 2000 Appendix B on Emergency Venting, for four ranges of tank surface area, heat absorption, Q, is calculated. Vent capacity in SCFH is then calculated from the heat absorption according to the equation:
   SCFH = 70.5 * Q / [L * sqrt(M)] assuming a conservative "L * sqrt(M)" value of 1,337, that of hexane.
7. Formula for emergency vent area adapted from Protectoseal Technical Manual, on flow capacity of tank emergency venting devices for nozzles 8 in. and larger:
   CFH = 1,667 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank emergency relief setting and atmospheric conditions.
8. Formula for vent area for smaller nozzles such as normal breather vents, adapted from Crane Flow of Fluids, Eq. 2-24, very similar to, but more conservative, than Protectoseal equation:
   CFH = 845 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank relief setting and atmospheric conditions.
   The factor 845 was derived using unit conversion factors, a vapor density of 0.1875 lb/cf, and a conservative Y of 0.80 from charts on Crane p. A-21.

EXHIBIT E

TANK MATERIAL OF CONSTRUCTION

COMPATIBILITY INFORMATION

Compatibility Information

Unit 1400: T-1405 to T-1436

Devoe Chemline 253 Epoxy coating

Or Equivalent for Proposed Tanks

Since 1754

DEVOE COATINGS

Marine·Industrial·Offshore

Devchem® 253

Chemical Resistant Lining

Catalog Number 253-K-XXXX

FEATURES

- Exceptional resistance to a wide range of chemicals and solvents
- Provides exceptional resistance over a wide range of temperatures and pressures
- Realistic application properties and cure schedules
- Does not require baking to cure
- High volume solids; two coat system

RECOMMENDED USES

- Cargo tanks in chemical tankers and barges
- Industrial storage and process chemical tanks and pipelines
- High pressure crude oil pipe and separation tanks
- Protective coating for highly corrosive environments

See the Devoe Coatings **Tank Lining Chemical Resistance Table** for specific resistance properties.

SPECIFICATION DATA

Coating Type	Advanced technology epoxy
Colors	Catalog Number
Tank White	253-K-3530
Tank Pale Blue	253-K-4132
Tank Pastel Red	253-K-7130
Packaging	5 Gallon Two-component kits
Component Ratio	4 to 1 by volume
Gloss	Semigloss
Flash Point	100°F (38°C) Setaflash
Thinner	Devoe T-10 Thinner
Pot Life	4 hours at 77°F (25°C)
Induction Time	15 minutes
Shelf Life	More than 2 years
Density	11.6 Lbs./Gal (1.39 kg/l)

VOC EPA 24	1.67 Lbs/Gal (200 Grams per liter)
Temp. Resistance	300°F (149°C) dry
Volume Solids ASTM D2697 (7 day)	72%
Theoretical Spreading Rate	1155 Sq. Ft/Gal at 1 mil 28.4 Sq. m/l at 25 microns

Recommended Film Thickness

Two Coat System

6.9—8.3 mils wet to obtain 5.0—6.0 mils dry
(173—208µ wet to obtain 125—150µ dry)

Three Coat System

5.5 mils wet to obtain 4 mils dry
(140µ wet to obtain 100µ dry)

Total recommended dry film thickness

10-12 mils (250 - 300µ) dry

Maximum dry film thickness is 20 mils (500µ)

Application Spray

Application Guide

Surface Preparation

All surfaces must be free of oil, grease, salts and moisture before abrasive blasting to near whit metal equivalent to Steel Structures Painting Council SP10 or Swedish Standard Sa 2½. The steel profile after blasting should be 1½ to 2½ mils (38 to 63µ) in depth and be of a jagged nature as opposed to a peen pattern. Surfaces must be free of grit dust. Dehumidification equipment should be employed to prevent rerusting. Before applying the first coat, be sure all surfaces are clean and dust free.

Mixing and Thinning

Devchem 253 Lining is a two component product supplied in 5 Gallon kits which contain the proper ratio of ingredients. the entire contents of each container must be mixed together. Stir the base portion first to obtain a smooth, homogeneous condition. After mixing the base portion, add the convertor slowly while continuing to mix at slow speeds. **Be sure all convertor is added.** After the convertor add is complete, continue to mix slowly until the combined components are thoroughly mixed. Thinning is not normally required or desired; however, at lower temperatures, small amounts (5% or less) of the solvent on the reverse page can be added depending on local VOC and air quality regulations. Any solvent addition should be made after the two components are thoroughly mixed. The pot life of the mixed material is 4 hours at 77°F (25°C); 2 hours at 90°F (32°C); and 1 hour at 100°F ((38°C). Higher temperatures will reduce working life of the coating; lower temperatures will increase it.

Application

Devchem 253 Lining should be applied only by air or airless spray. Brushing can be used for touch up or striping, do not use rollers. For air spray, use agitated spray pots, 1/2" ID air hoses and 1/2" fluid hose. DeVilbiss MBC-510 gun with and E or D tip and needle and a 704 air cap, or equivalent. equipment is recommended. For airless spray application, use 100 PSI air pressure, 3/8" ID fluid hoses not exceeding 100 feet in length, a 30 to 1 or larger heavy duty Graco pump or equivalent, and 0.021" to 0.025" range tip sizes.

Ventilation —It is very important for the safety of the applicator and the proper performance of the Devchem 253 Coating that good ventilation be provided to all portions of the enclosed area. Recommended tank ventilation involves two important phases. Phase one is to pump fresh, dehumidified air into all areas of the tank, especially "dead air" areas. Phase two is to exhaust, via an explosion proof exhaust fan, the solvent vapors from the lowest portion of the tank. This practice of pumping fresh air into the tank and exhausting solvent vapors out of the lowest part of the tank should be provided throughout the application and curing processes. This practice is to insure that all solvents are removed from the coating. Tanks must be cured 7 days at 77°F (25°C) with ventilation before being put into service. At lower temperatures, longer cure times are required.

System —2 stripe coats on all sharp edges, cutouts and welds.
—2 coats of Devchem 253 Lining, 5—6 mils (125—150µ) per coat. Use contrasting colors for each coat and strip coat.

Note: The maximum dry film thickness of the Devchem 253 system is 20 mils (500µ). Dry film thickness above 20 mils (500µ) could reduce the service life of the coating. See the Devoe Coatings Tank Lining Chemical Resistance Table or your Devoe Coatings Representative for additional Information.

Recoating Schedule:

If paint and surface temperatures exceed 90°F (37°C), reduce recoat time by one half.

See Application Guide Supplement

Surface Temperature °Fahrenheit	Recoat Time Minimum	Recoat Time Maximum
40—49	36 hours	7 days
50—59	24 hours	6 days
60—69	16 hours	5 days
70—79	10 hours	4 days
80—89	7 hours	60 hours
90—99	4 hours	24 hours
100—109	3 hours	18 hours
110—120	3 hours	18 hours

Cure to put tank into service: 7 days with ventilation at 77°F (25°C) for maximum chemical resistance. If forced heat cure is desired, contact your Devoe Coatings Representative

Precautions

See the material safety data sheet and product label for complete safety and precaution requirements.

253/Nov, 1993

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Since 1754

DEVOE COATINGS

MARINE • INDUSTRIAL • OFFSHORE

Catha-Coat® 305 Coating
Devchem® 253 Lining
Devchem® 255 Lining
Tank Lining Chemical Resistance Table

This table contains a listing of most of the solvents and chemicals which are transported in bulk quantities and a coatings resistance rating for Catha-Coat 305 Water Based Inorganic Zinc Coating, Devchem 253 Chemical Resistant Lining, and Devchem 255 FDA Epoxy Lining. The indicated resistance ratings are based on laboratory tests, actual field experience and other studies believed by Devoe Coatings to be reliable.

Since many of the commercial products contained in this cargo resistance table may vary in composition, and product specifications may change, Devoe Coatings cannot assume any responsibility for the condition of the coating and/or the products carried or stored in Devoe Coatings lined tanks. The listed resistance ratings are based solely on the effects of the cargoes on tank linings themselves. Neither the contamination of cargoes by tank linings nor the effects of contaminated cargoes on tank linings has been tested and is not implied by the listed resistance tables.

Devoe maintains an ongoing research and tank lining testing program. If there are chemicals or solvents, or special conditions not found in this table, please contact a Devoe Coatings Representative.

Devoe Coatings reserves the right to alter this resistance table without notice.

Tank Lining Systems

Lining	Dry Film Thickness(1)	Alternate Dry Film Thickness(1)
Catha-Coat 305 System(2)		
Catha-Coat 305 Coating	3–5 mils (75–125 microns)	
Devchem 253 System		
Devchem 253 Lining	5 mils (125 microns)	4 mils (100 microns)
Devchem 253 Lining	5 mils (125 microns)	4 mils (100 microns)
Devchem 253 Lining		4 mils (100 microns)
Devchem 255 System		
Devchem 255 Lining	5 mils (125 microns)	
Devchem 255 Lining	5 mils (125 microns)	

Stripe coats in way of edges, cutouts, welds, pits, brackets and other difficult to paint areas are required.

(1) Surface roughness or special resistance requirements may alter the film thickness specification or number of coats.

(2) To insure a holiday-free lining and obtain extended service life, two coats of Catha-Coat 305 Coating at 3 mils (75 microns) per coat are recommended.

General Remarks

When using this cargo resistance table, the following points should be read very thoroughly and noted.

A. All cargoes having low viscosities, like solvents which do not require heating to be loaded or unloaded, are tested at 120°F (49°C). High viscosity cargoes which are normally heated to facilitate loading are tested at 180°F (82°C). Cargoes carried or loaded in excess of these temperatures can be detrimental to the lining. Devoe Coatings should be consulted for specific recommendations where these temperatures are exceeded.

B. All cargo resistance ratings, including ballast water, are based upon a normal shipping and storage period not to exceed sixty days. Ratings are not based upon prolonged periods of time nor repeated storage or shipping of the same product. Should the possibility of shipping and storage periods in excess of sixty days arise, a Devoe Coatings Technical Representative should be consulted.

C. Tank cleaning may be accomplished by employing normal Butterworthing procedures, with solution temperatures up to but not exceeding 190°F (88°C). Special care must be exercised in choosing solvents or detergents used in tank cleaning so as not to cause damage to the lining. If the coating is soft, forced ventilation for at least 24 hours after discharge, or longer if the coating system has not yet fully recovered, is mandatory to allow the coating to recover prior to cleaning.

Alkaline and acidic cleaning compounds can damage Catha-Coat 305 Coating and should be avoided.

Cleaning chemicals which are normally used in the industry have all been tested and are approved for use. Special cleaning chemicals should be tested and approved prior to use.

D. Catha-Coat 305 Coating, as all inorganic zinc coatings, is sensitive to, and may be damaged by, strong acids or alkalies. The pH of the cargo must fall within the 5.5 – 10.0 range.

When any zinc coating is used as a tank lining, the possibility exists for a cargo to pick up slight metallic zinc contamination. Sour crude oil cargoes are not recommended for Catha-Coat 305 Coating.

E. Due to the large number of possible combinations of cargo sequence, it is nearly impossible to predict overall resistance in practice. Most problems can be avoided by using common sense, employing measures such as forced ventilation and thorough cleaning of tanks between cargoes.

Non-aggressive cargoes of similar generic types should not usually cause problems. Such cargoes as fuels and oils are examples of these types.

Limited service category 1 (LS-1) water miscible cargoes should not be followed by water cleaning, ballast or aqueous cargoes until the tank has been completely ventilated and freed of all traces of the LS-1 cargo. All traces of water must also be removed from a tank before LS-1 water miscible cargoes or chlorinated solvents or ester solvents (LS-4) are loaded. The improper sequence of cargoes or improper tank cleaning and preparation can have adverse effects on tank linings.

F. In the majority of cargoes, cargo contamination from the coating is highly unlikely, and is limited to initial cargoes after coating application. Avoid loading high purity chemicals before the coating is properly cured as per manufactuer's recommendation.

Cargo contamination is also possible from improper cleaning of tanks after carriage. To prevent contamination of subsequent cargoes and the chance of by-product forming chemical reaction, tanks must be properly cleaned between cargoes.

G. This Cargo Resistance Table is not based on the use of shop primers under the tank coatings listed. Devoe Coatings requires that all tank coatings be applied directly to blasted steel.

H. A Devoe Coatings Representative should be consulted for the cargo resistance rating of chemicals not included in this list.

I. Certain cargoes, such as carbon containing cargoes or impure or crude cargoes, may discolor the lining and may be very difficult to clean. There may be delays until the inspector is satisfied that the discoloration cannot be removed.

J. The normal requirement is to cure a tank lining for 7 days after application. Most coating systems do not completely cure or crosslink in 7 days, especially if the temperatures during this period are below normal.

The chemicals on the attached list were all tested after a 7 day cure at 77°F (25°C). The tank linings will, however, become more resistant with time, or if a hot, weak solvent cargo, such as mineral oils or heavy fuel oils, is carried. Very strong solvent cargoes (LS-1) should not be loaded as the first cargo after lining a tank.

K. Although Devoe Coatings Company believes the recommendations given in this Cargo Resistance Table to be reliable, due to the wide variation in product composition and specification, good engineering practice may indicate field testing the coating prior to large scale application.

Key to Resistance Table

S	Suitable
LS	Limitations on service (see Limited Service Notes)
LS (X 30)	Recommended for maximum of 30 days continuous immersion
LS (X 60)	Recommended for maximum of 60 days continuous immersion
U	Unsuitable
X	Not tested at this time Contact your Devoe Coatings Representative for the latest test information.

Limited Service Notes

LS-1 These products will cause some softening of the Devoe Coatings system, leading to reduced mechanical resistance. LS-1 products, and especially methanol, ethylene dichloride, acetone, vinyl acetate monomer, and cyclohexanone, should not be loaded in newly lined tanks before the coating system is fully cured.

Full cure will be obtained after a service period of one month with Suitable (S notation) cargoes. Full cure can also be achieved by carrying hot cargoes such as lubricating oil, mineral oil, vegetable oils, animal oils or molasses for a period of at least four days at 50°C or 3 days at 60°C. LS-1 cargoes, LS(X30) cargoes that are limited to 30 day carriage, or LS(X60) cargoes that are limited to 60 day carriage can not be carried until tanks have been fully cured.

After carriage of LS-1, LS(X30), and LS(X60) cargoes, the next immediate cargo must be a Suitable (S) cargo—without a LS, LS(X30), or LS(X60) notation—and be loaded after the tanks have been forced-air ventilated for at least 24 hours, or longer if the coating system has not yet fully recovered. Under no circumstances must water or ballast be introduced into the tanks before ventilating.

Water containing cargoes like caustic soda or potash should not be loaded immediately after LS-1, LS(X30), or LS(X60) cargoes.

LS-2 **Crude Oil**

Catha-Coat 305 Coating can safely carry sweet crude oil. Sour crudes, however, are acidic and will attack zinc, and are not recommended. Crude oils with a hydrogen sulfide content in excess of 300 ppm or a neutralization number greater than 0.4 are considered unsatisfactory.

LS-3 Fats, Oils, Greases

Animal and vegetable fats and oils contain variable amounts of free fatty acids. The free fatty acid (f.f.a.) content limitation is 2.5% or less; the acid number limitation is 5.0 or less.

Free radical acids can form with age or under warm storage conditions, and therefore, we also recommend measuring the pH before loading into a Catha-Coat 305 lined tank. A ph of 5.5 to 10.0 is suitable.

Products like lard and tallow have to be carried at elevated temperatures. The formation of free organic acids occurs rapidly, especially around heating coils. Rancid products are very high in f.f.a.

LS-4 Hydrolyzable Cargoes

Certain classes of chemicals will hydrolyze in the presence of water to form aggressive acidic by-products. Cargoes such as esters (acetates) and halogenated compounds (chlorinated or brominated solvents) must be kept stabilized and kept moisture-free. The water content must be limited to 100 ppm. The temperature of the cargo should not exceed 100°F (38°C).

LS-5 Molasses

Crude molasses may be quite acidic. Molasses can be carried in a Catha-Coat 305 Coating lined tank if the pH is between 5.5 and 10.0. After discharging, the residual molasses has to be completely washed and rinsed. An alkaline buffer compound can be added to the rinse to insure any acid residues are neutralized.

LS-6 Beverages and Potable Water

Although Devchem 253 Lining is unaffected by these liquids, no warranties can be made with regard to taste or odor.

LS-7 Phenol

Phenol (carbolic acid) and phenol compounds can form staining color bodies when exposed to oxygen, sunlight or trace alkalies. The lining may become discolored. A nitrogen gas blanket may prevent discoloration.

LS-8 Discoloration

Certain chemicals, crude cargoes and carbon containing products can stain the lining and may be very difficult, if not impossible, to clean. The effect of this discoloration on subsequent cargo cannot be generalized.

LS-9 Monomers and Other Non-Stable Chemicals

The linings are resistant and inert to these products. If the products are not properly stabilized, contain a foreign contaminant or if the heat limitations are exceeded, these products may polymerize or break down. Care should be taken to insure the stabilizing agents are compatible with the tank lining.

LS-10 pH

Cargoes for Catha-Coat Coating lined tanks must fall within a pH range of 5.5 to 10.0. Traces of zinc metal or zinc salts may contaminate the cargo.

LS-11 Crude Cargoes

Products like coal tar and xylenol can vary in composition from grade to grade and even batch to batch. Samples of the specific cargo should be tested or evaluated before loading.

LS-12 Similar Cargoes

These products are believed to be suitable for transport in the indicated lining since they are reportedly similar to cargoes successfully carried. No confirming tests have been conducted.

LS-13 Water Immersion

Catha-Coat 305 Coating withstands intermittent exposure to seawater, but continuous immersion over a long period will reduce the life of the coating.

LS-14 Cargoes Sequenced with Methanol

Methanol and the following cargoes—ethylene dichloride, vinyl acetate monomer, acetone or cyclohexanone—should not be sequenced more than once, without prior approval from the coating manufacturer. If in doubt about loading a cargo after methanol, please contact the Devoe Coatings Company Laboratory for advice.

LS-15 Organic Fatty Acids

Organic fatty acids will hydrolize in the presence of water to form aggressive acidic by-products. Cargoes such as tall oil fatty acid and palm oil fatty acid must be kept stabilized and moisture-free. The water content must be limited to 1% maximum with no traces of inorganic acids or mineral acids.

LS-16 Amines

Amines can be carried when free from moisture. If water is present, alkalinity may increase to a pH of more than 9.

To prevent contamination by water, both the cargo and the tank must be completely dry at the time of loading, and the amines must be transported under a dry nitrogen or carbon dioxide blanket

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Devoe Coatings Company
Tank Lining Chemical Resistance Table

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Acetaldehyde	U	U	U
Acetic acid 5%	U	U	U
Acetic anhydride	U	U	U
Acetone	S	LS-1, 14, (X30)	U
Acetone cyanohydrin	LS-12	X	X
Acetonitrile	LS-4	LS-1, 4, (X 60)	U
Acetophenone (Phenyl methyl ketone)	S	LS-8, (X 60)	U
Acetylene, gas	S	S	S
Acetylene dichloride (Dichlorethylene)	LS-4	X	U
Actinol	U	S	X
Acrolein	U	U	U
Acropol (Mixed linear alcohols)	S	S	X
Acrylic acid	U	LS-1, 4, (X30)	X
Acrylic monomers	LS-4, 9	U	U
Acrylonitrile	LS-9	U	U
Acrylonitrile-styrene copolymer dispersion in polyether polyol	X	LS-12	X
Adiponitrile	X	U	U
Aircraft gasoline	S	S	S
Airturbo fuel	S	S	S
Alcohol, linear primary C12-C15	S	S	X
Alcohol ethoxylate, linear primary	S	S	X
Alcohol ethoxylate, ammonium salt solution	S	S	X
Alcohol ethoxysulfate, sodium salt solution	S	S	X
Alcoholic Beverages, N.O.S.	X	S	U
Aldol	U	U	U
Alkalate	X	LS-12	X
Alkali soybean oil	LS-3	S	S
Alkane (Dodecyl benzene)	S	S	S
Alkyl benzene	S	S	S
Alkyl benzene sulfonic acid	U	LS-8	X
Alkyl phosphate	S	LS-11	X
Alkyl phthalate	X	S	X
Alkylate bottom (Dodecyl benzene)	S	S	S
Alkylate detergent	S	S	X
Alkylate 22 (Dodecyl benzene)	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Alkylate 130 (Monsanto)	S	S	S
Allyl alcohol	S	S	U
Allyl aldehyde	U	U	U
Allyl chloride (3-Chloroprene)	U	LS (X 60)	U
Almond oil, sweet	LS-3	S	S
Alpha olefins	S	S	S
Alpha olefin C-6/7	S	S	S
Alpha olefin C-7/8	S	S	S
Alpha olefin C-7/14	S	S	S
Alpha olefin C-10/15	S	S	S
Alpha olefin C-15/18	S	S	S
Alpha-hydroxytoluol (Benzyl alcohol)	S	S	X
Alpha-N-amylene (1-Pentene)	S	S	X
Alum solution 15%	U	S	X
Alumina slurry concentrate	U	S	X
Aluminum chloride 10%	U	LS-8	X
Aluminum chloride 30%	U	LS-8	X
Aluminum hydroxide dry	U	S	X
Aluminum nitrate 30%	U	S	X
ʼluminum sulfate 10%	U	S	X
Aluminum sulfate 30%	U	S	X
Aluminum sulfide 100%	U	U	U
Aminoethane (Ethylamine)	U	U	U
Aminoethanolamine	U	U	U
Aminoethoxy ethanol	U	U	U
Aminoethyl ethanolamine	U	U	U
Aminoethyl piperazine	X	X	X
Aminoform (HMTA)	U	U	U
2-Amino-2-methyl-1-propanol (90% or less)	X	S	X
Ammonia, anhydrous	U	U	U
Ammonia 26° Bé (< 25°C)	U	LS-1, (X30)	U
Ammonia 28% aqueous solution/ammonium hydroxide (< 25°C)	U	LS-1, (X30)	U
Ammonia fertilizer solutions	U	S	X
Ammonia water 10% (not over°25C)	U	LS-1, (X30)	U
Ammonium carbonate 50%	U	S	X
Ammonium chloride, quarternary	X	LS (X 30)	U
Ammonium hydrogen phosphate solution	X	X	X
Ammonium hydroxide/ammonia 28%aqueous solution (<25°C)	U	LS-1 (X30)	X
Ammonium hydroxide (10% solution in water)	U	LS (X60)	X
ֿnmonium hydroxide (25% solution in water)	U	LS (X60)	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Ammonium nitrate 10% solution in water	U	S	X
Ammonium nitrate 30% solution in water	U	S	X
Ammonium nitrate 50% solution in water	U	S	X
Ammonium phosphate, urea solution	X	X	X
Ammonium phosphate solution	X	X	X
Ammonium sulfate 40% (no heat)	X	S	X
Ammonium thiocyanate (25% or less)/ammonium thiosulfate solution (60% or less)	X	X	X
Amyl acetate (iso, normal, secondary)	LS-4	LS-1,4	U
Amyl alcohol (iso, normal, secondary, tertiary)	S	S	X
Amyl aldehyde	U	U	U
Amyl carbinol (Hexanol)	S	S	X
Amylene (1-Pentene)	S	S	S
Amylene hydrate (Amyl alcohol)	S	S	X
Amyl hydride (Pentane)	S	S	S
Anchovy oil	LS-3	S	S
Anglanoil 99	LS-8	LS-8	X
Aniline	U	U	U
Animal oil	LS-3	S	S
Anivax SX 3158	S	S	X
Ansulite FFF	X	S	X
Anthracene (C14) nonliquid	S	S	X
Anthracene oil	X	S	S
Antifreeze (glycol based)	S	S	X
Apricot kernel oil	X	S	S
Arachis oil	LS-3	S	S
Arco carbon black oil (Carbon black/feed stock)	S	S	X
Aroma (Extender oils)	S	S	S
Aromatic 100	S	S	S
Aromatic concentrate (Carbon black/feed stock)	S	S	X
Aromatic hydrocarbons	S	S	S
Aromatic oils (Extender oils)	S	S	S
Aromatic petroleum solvents	S	S	S
Aromatic sulfonic acids	U	U	U
Asphalt	X	LS-8	X
Asphalt cut back (Mix-asphalt, Gasoline, Naphtha and solvents)	S	S	S
Atrazine	U	S	X
Aviation alkylates (C8 paraffins and iso-parraffins, BP 95-120°C)	S	S	S
Aviation gasoline	S	S	S
Aviation kerosene	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Avocado Oil	X	S	S
Axle oil (Lube oil)	S	S	S
Babassu oil	LS-3	S	S
Beechnut oil	LS-3	S	S
Benzaldehyde	U	U	U
Benzene	S	S	S
Benzene, industrial nitration grade	S	S	S
Benzene trimethyl	S	S	S
Benzenesulfonyl chloride	X	X	X
Benzol	S	S	S
Benzyl acetate	LS-4	LS-1,4	U
Benzyl alcohol	S	S	X
Benzyl chloride	X	S	X
Beta-methacrylic acid	U	U	U
Black oil	LS-2	S	S
Blandol (White mineral oil)	S	S	S
Blown oils	LS-3	S	S
Boric acid 10%	U	S	U
Brake fluid (glycol base)	S	S	S
Brake fluid (glycol ether base)	U	S	S
Brandy	X	LS-6	X
Brine	U	S	S
Bromine	U	U	U
Bunker C oil and solvent	S	S	S
Bunker oil	S	S	S
Butadiene	S	S	X
Butadiene, inhibited	X	X	X
Butane	S	S	S
1,3-Butane diol (Butylene glycol)	S	S	X
Butanoic acid (Butyric acid)	U	U	U
Butanol (iso, normal, secondary, tertiary)	S	S	X
Butene oligomer	X	S	X
Butenoic acid (Crotonic acid)	U	U	U
2-Butoxy ethanol (Butyl cellosolve)	S	S	X
Butyl acetate (iso, normal, secondary)	LS-4	LS-1,4	U
Butyl acrylate (inhibited)	LS-4	LS-4	X
Butyl alcohol (iso, normal, secondary, tertiary)	S	S	X
Butyl amines	U	U	U
Butyl benzyl phthalate (BBP)	S	S	X
Butyl butyrate	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Butyl carbinol (N-Amyl alcohol)	S	S	X
Butyl carbitol (Diethylene glycol monobutyl ether)	S	S	X
Butyl carbitol acetate (Diethylene glycol monobutyl ether acetate)	LS-4	LS-1,4	U
Butyl cellosolve (Ethylene glycol monobutyl ether)	S	S	X
Butyl cellosolve acetate (Ethylene glycol monobutyl ether acetate)	LS-4	LS-1,4	U
Butyl chloride	X	LS-4	X
Butyl/decyl/cetyl eicosyl methacrylate mixture	LS-4,9	X	X
Butyl decyl phthalate	S	S	X
Butyl dioxitol	S	S	X
Butylene, alpha, 2	S	S	S
Butylene glycol	S	S	X
Butylene, poly	S	S	S
n-Butyl ether	S	X	X
Butyl formate	X	X	X
Butyl glycidyl ether (BGE)	S	X	X
Butyl glycol acetate	LS-4	LS-1, 4	U
Butyl glycol ether	S	S	X
Butyl heptyl ketone	S	S	U
Butyl lactate (no heat)	U	LS-8	X
Butyl methacrylate monomer	LS-4,9	LS-1,4,9	U
Butyl oxitol (Ethylene glycol monobutyl ether)	S	S	X
Butylphenol (ortho, tertiary)	S	S	X
Butyl phthalate	S	S	X
n-Butylraldehyde	U	X	X
Butyl stearate	X	S	X
Butyric acid	U	U	U
Butyrolactone	U	X	X
gamma-Butyrolactone	U	X	X
Butyrone (Heptanone)	S	S	U
Cajaputene (Dipentene)	S	S	S
Calcium alkyl salicylate	S	S	X
Calcium bromide 48%	S	S	X
Calcium bromide 53%	X	S	X
Calcium carbonate solution (130°F maximum)	X	S	X
Calcium chloride (saturated)	U	S	X
Calcium hydroxide 10%	U	S	S
Calcium hydroxide 30%	U	S	S
Calcium hydroxide 50%	U	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Calcium hypochlorite 15%	U	S	X
Calcium hypochlorite solution (over 15%)	U	X	X
Calcium naphthenate (in mineral oil)	X	S	S
Camphor oil	X	S	S
Candelilla oil (Montan)	X	S	S
Candlenut oil	LS-3	S	S
Canola oil, refined	X	LS-6	S
Capoc oil	LS-3	S	S
Capric acid	U	S	U
Caproic acid	U	S	U
Caprolactone	X	U	U
Capryl alcohol	S	S	X
Caprylic acid (Oxylic acid)	U	S	U
Carbitol acetate	LS-4	LS-1, 4	U
Carbitol solvent (Diethylene gylcol monoethyl ether)	S	S	X
Carbolic Acid (Phenol 100%)	LS-7	U	U
Carbolic oil (Middle oil)	S	S	S
Carbon black oil	LS-8	LS-8	LS-8
Carbon dioxide (gas) 100%	S	S	S
Carbon disulfide 10%	U	U	U
Carbon disulfide 100%	LS-4	U	U
Carbon tetrabromide	LS-4	S	X
Carbon tetrachloride	LS-4	S	X
Carbonic acid 10%	S	S	U
Carbowax 200	S	S	X
Carbowax 300 (Polyethylene glycol)	S	S	X
Carbowax 600	S	S	X
Cardura E	LS-4	S	X
Carnation oil (Petrolatum)	S	S	S
Carnation white mineral oil	S	S	S
Carnauba wax	X	S	S
Cashew nutshell oil	X	S	S
Castor oil	LS-3	S	S
Caustic potash	U	S	S
Caustic soda (NaOH) 10%	U	S	S
Caustic soda (NaOH) 20%	U	S	S
Caustic soda (NaOH) 50%	U	S	S
Caustic soda 50% spent (no heat)	U	S	X
Cellosolve (Ethylene glycol monoethyl ether)	S	S	X
Cellosolve acetate (Ethylene glycol monoethyl ether acetate)	LS-4	LS-1,4	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Cement	U	S	X
Certrex's mineral spirits	S	S	S
Cetyl alcohol (Primary hexadecyl alcohol)	S	S	X
Chinawood oil (Tung oil)	LS-3	S	S
Chlorinated diphenyl	LS-4	S	X
Chlorinated paraffins	LS-4	S	U
Chlorine, available in solution as NaClO (up to 200 ppm)	U	LS (X 30)	U
Chlorine, wet (saturated)	U	U	U
Chlorine dioxide	U	U	U
Chloroacetic acid	U	U	U
Chloracetyl chloride	U	U	U
Chlorobenzene	LS-4	LS-4	U
p-Chloro-m-cresol	S	U	U
2-Chloroethanol	LS-4	X	U
Chloroethene	LS-4	U	U
Chloroethylene	LS-4	U	U
Chloroform	LS-4	X	U
Chloropropionic acid	U	U	U
Chloropropylene oxide (Epichlorohydrin)	LS-4	U	U
Chlorosulfonic acid	U	U	U
Chlorothene (1,1,1-Trichlorethane)	LS-4	LS-1, 4	U
Chlorotoluene (all isomers)	LS-4	S	U
Choline chloride	U	S	U
Chromic acid 5%	U	LS-8	U
Chromic acid 10%	U	LS-8	U
Chromic acid 20%	U	U	U
Chromic acid 50%	U	U	U
Cinene (Dipentene)	S	S	S
Circo light oils -	S	S	S
Circo light oil (extender oil)	S	S	S
Circo process oil (extender oil)	S	S	S
Circosol oil (extender oil)	S	S	S
Citric acid 5%	U	S	U
Citric acid 25%	U	S	U
Citroflex A-4	S	S	X
Clorox	U	S	U
Coal tar benzene	S	S	S
Coal tar naphtha	S	S	S
Cocoa butter	X	S	S
Cocoa butter oil	LS-4	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Cocoa nut oil, crude	LS-3	S	S
Cocoa oil	LS-3	S	S
Coco fatty acid	U	LS-15	U
Coco fatty alcohol	S	S	X
Coco methyl ester	LS-3	S	X
Coconut fatty acid, topped	U	LS-15	U
Coconut fatty acid, whole distilled	U	LS-15	U
Coconut oil, esterfied	U	S	S
Cod liver oil	LS-3	S	S
Cohune oil	X	S	S
Colza oil	LS-3	S	S
Copra oil (Coconut oil)	LS-3	S	S
Coray 40 (lubricant)	S	S	S
Core Lube 670 catalyst	X	U	X
Core Lube 674 catalyst	X	U	U
Corn oil	LS-3	S	S
Corn syrup	X	S	S
Cotton seed fatty acid	X	LS-15	U
Cottonseed oil (sulfuric acid free)	LS-3	S	S
Cottonseed oil stearine	S	S	X
Coumarone naphtha solvent	S	S	S
Creosote	LS-1,4	LS-1,4	U
Creosote (coal tar)	S	U	U
Cresol (ortho, meta, para)	LS-7	U	U
Cresyl diphenyl phosphate (Santicizer 140)	S	S	X
Cresylic acid 10%	U	U	U
Cresylic acid 100%	X	U	U
Crotonaldehyde	U	U	U
Croton oil	LS-3	S	S
Crude condensate (naphtha, petroleum)	S	S	S
Crude glycerine	U	S	S
Crude hard fraction PKO (Palm kernel oil)	U	S	S
Crude oil (high and low sulfur)	LS-2	S	X
Cumene	S	S	X
Cumene, pseudo	S	S	X
Cumol	S	S	X
Cyclo-Sol 53	S	S	X
1,5,9-Cyclododecatriene	X	X	X
Cycloheptane	S	S	S
Cyclohexane	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Cyclohexanol	S	S	X
Cyclohexanone	S	LS-1, 14, (X30)	U
Cyclohexanone/cyclohexanol mixture	S	LS-1, 14, (X30)	U
Cyclohexene	S	S	S
Cyclohexyl acetate	LS-4	LS-1,4	U
Cyclohexylamine	U	U	U
Cyclopentane	S	S	S
Cyclopentene	S	S	S
Cycosol (Mineral spirits)	S	S	S
Cylinder bright stock oil	S	S	S
Cylinder steam refined stock oil	S	S	S
p-Cymene (Isopropyltoluene)	S	S	S
Dalapon (2,2-Dichloropropionic acid)	U	U	U
Dalatinol [Di-(2-ethylhexyl) phthalate]	S	S	X
Dasanit	S	S	X
Decahydronaphthalene	X	S	X
Decalin (Decahydronaphthalene)	S	S	X
Decane (Decyl hydride)	S	S	S
Decanoic acid (Capric acid)	U	LS-4, (X60)	U
Decanol	S	S	X
Decene	S	S	S
Decyl alcohol (all isomers)	S	S	X
Decyl acrylate	LS-4,9	LS-1,4	U
Decyl benzene	X	S	S
Decyl carbinol (1-Undecanol)	S	S	S
Decyl octyl alcohol	S	S	X
D-D-Soil fumigant (1,3-Dichloro propylene and Propylene dichloride)	U	U	U
De-icing fluids (glycol based)	S	S	X
De-Monomer (Shell)	S	X	X
Detergent alkylate (Dodecyl benzene)	S	S	S
Dextrose solution	X	S	S
Diacetone alcohol	S	S	X
Dialkyl benzene	X	S	X
Dialkyl phthalate	S	S	X
Diallyl phthalate (DAP)	LS-4	S	X
Dibenzofuran (Diphenylene oxide)	S	U	X
1,2-Dibromo-3-dichloropropane	LS-4	X	X
Dibutylamine	U	U	U
Dibutyl carbitol (Diethtylene glycol dibutyl ether)	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Dibutyl Cellosolve (Ethylene glycol dibutyl ether)	S	LS-1	U
Dibutyl Maleate	LS-4	X	X
Dibutyl phthalate (DBP)	S	S	X
Dibutyl sebacate (DBS)	LS-4	S	X
Dicaprocate (Triethylene glycol)	S	S	X
Dichloroaniline	U	X	X
Dichlorobenzene (all isomers)	LS-4	U	U
Dichlorodifluoromethane	LS-4	X	X
Dichloroethane (Ethylene dichloride) (no heat)	LS-4	LS-1,4, 14	U
Dichloroethylene	LS-4	U	U
Dichloroethyl ether	LS-4	U	U
Dichlorohexane	LS-4	U	U
Dichloromethane (Methylene chloride)	LS-4	U	U
Dichlorophenol	LS-4	X	U
Dichloropropane	LS-4	U	U
Dichloropropene	LS-4	S	U
Dichloropentane	LS-4	S	U
Dichloropropionic acid	U	X	U
Dicyclohexylamine	U	U	U
Dicylopentadiene	S	S	S
Diesel fuel	S	S	S
Diesel oil	S	S	S
Diethanolamine (DEA)	U	S	X
Diethylamine (no heat)	U	U	U
Diethylaminoethanol (no heat)	X	LS-1, (X60)	U
2,6-Diethylaniline	X	X	X
Diethylbenzene	S	S	X
Diethyl carbonate	LS-4	S	X
Diethylethanolamine (no heat)	U	LS-1, (X60)	U
Diethyl ether	S	U	U
Diethyl phthalate	S	S	X
Diethyl sulfate	X	X	X
Diethylene alcohol	S	S	X
Diethylene chloride	LS-4	U	U
Diethydichloroformal	X	X	U
Diethylene ether (Dioxane)	S	S	S
Diethylene glycol (Dihydroxydiethyl ether)	S	S	X
Diethylene glycol butyl ether acetate	LS-4	LS-1,4	U
Diethylene glycol dibutyl ether	S	S	X
Diethylene glycol diethyl ether	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Diethylene glycol ethyl ether acetate	LS-4	LS-1,4	U
Diethylene glycol methyl ether	S	S	X
Diethylene glycol methyl ether acetate	LS-4	LS-1,4	U
Diethylene glycol monobutyl ether	S	S	X
Diethylene glycol phenol ether	S	X	X
Diethylene glycol phenyl ether	S	S	X
Diethylene glycol phthalate	X	S	X
Diethylenetriamine	X	U	U
Di(2-ethylhexyl)adipate	X	S	X
Di(2-ethylhexyl)phosphoric acid	U	U	U
Di(2-ethylhexyl)phthalate	S	S	X
Diglycidyl ether of bisphenol A	X	S	X
Diglycidyl ether of bisphenol F	X	S	X
Di-hard-tallow-methylamine	X	S	X
Di-n-hexyl adipate	LS-4	S	X
Diisobutylene	S	S	S
Diisobutyl ketone (DIBK)	S	S	U
Diisobutyl phthalate	S	S	X
Diisodecyl phthalate	S	S	X
Diisononyl adipate	LS-4	S	X
Diisooctyl adipate	LS-4	S	X
Diisooctyl phthalate (DIOP)	S	S	X
Diisopropanolamine	X	X	X
Diisopropylamine	X	U	X
Diisopropylbenzene	S	S	X
Diisopropylether	S	X	X
Diisopropyl naphthalene	S	S	X
Dimethanolamine	X	U	U
Dimethyl adipate	X	S	X
Dimethylamine (DMA)	U	U	U
Dimethylamine, 40% aqueous solution	U	U	U
Dimethylaminoethanol	U	U	U
Dimethylcarbinol (Isopropyl alcohol)	S	S	X
n,n-Dimethyl cyclohexyl amine	U	X	X
Dimethylethanolamine	U	U	U
Dimethyl formamide	LS-1, (X60)	U	U
Dimethylglutarate (no heat)	S	LS (X 60)	X
Dimethylketone (Acetone)	S	LS-1, 14, (X30)	U
Dimethyl naphthalene sulfonic acid sodium salt solution	LS-12	LS-12	X
Dimethyl phthalate	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
2,2-Dimethyl-1,3-propanediol	X	X	X
Dimethyl sebacate	LS-4	S	X
Dimethyl succinate	LS-4	S	X
Dimethyl sulfoxide (DMSO)	S	X	X
Dimonene (Dipentene)	S	S	S
Dinitrotoluene (DNT)	LS-4	S	X
Dinonyl phthalate (DNP)	S	S	X
Dioctyl adipate	LS-4	S	X
Dioctyl phthalate (DOP)	S	S	X
Diol 80 (lube oil)	S	S	S
Dioxane	S	S	X
Dioxitol (Diethylene glycol monoethyl ether)	S	S	X
Dipentene	S	S	S
Diphenyl ether	S	LS-1	U
Diphenylmethane 4,4-diisocyanate (MDI)	S	S	X
Diphenylmethane isocyanate	X	U	U
Diphenyl oxide (Diphenyl ether)	S	LS-1	U
Diphenylene oxide	S	U	X
Diphenylol propane-epichlorohydrin resins	X	S	S
Diphenyl oxide/diphenyl phenyl ether mixture	S	U	U
Di-n-propylamine	U	U	U
Dipropyl ketone (Heptanone)	S	S	U
Dipropylene glycol	S	S	X
Dipropylene glycol methyl ether	S	LS-1	U
Dipropylene glycol monomethyl ether	S	LS-1	U
Distearyl dimethyl ammonium chloride	X	S	X
Distilled water	S	S	S
Ditallow dimethyl ammonium chloride	X	S	X
Ditridecyl phthalate (DTDP)	S	S	X
Diundecyl phthalate	S	S	X
Divinyl acetate	LS-4,9	U	U
Dobanes	S	S	S
Dobanols (fatty alcohols)	S	S	X
Dodecane	S	S	S
Dodecanoic acid (Lauric acid)	U	S	U
Dodecanol (Lauryl alcohol)	S	S	X
Dodecene (Tetrapropylene)	S	S	X
Dodecyl alcohol	S	S	X
Dodecyl amine	U	X	X
Dodecyl amine/tetradecyl amine mixture	X	X	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Dodecylbenzene (Alkane)	S	S	S
Dodecyl methacrylate	LS-4,11	X	X
Dodecyl/pentadecyl methacrylate solution	LS-4,11	X	X
Dodecylphenol	LS-7	S	X
Dow Corning FX16	S	S	X
Dowanol DB (Diethylene glycol butyl ether)	S	S	X
Dowanol DE (Diethylene glyclol ethyl ether)	S	S	X
Dowanol DESG (Modified Dowanol DE)	S	S	X
Dowanol DM (Diethylene glycol methyl ether)	S	S	X
Dowanol EB (Ethylene glycol n-butyl ether)	S	S	X
Dowanol EE (Ethylene glycol ethyl ether)	S	S	X
Dowanol EM (Ethylene glycol methyl ether)	S	S	X
Dowanol EP (Ethylene glycol phenyl ether)	S	S	X
Dowanol PM (Propylene glycol methyl ether)	S	S	X
Dowanol PMIX (PM + DPM + TPM)	S	S	X
Dowanol TPM (Tripropylene glycol methyl ether)	S	S	X
Dow 6X (Hexachlorodiphenyl oxide)	LS-4	S	X
Dow Epoxy Resin 331 (DGE)	X	S	X
Drilling brine	X	S	S
Drilling mud	X	S	S
Emulsified vegetable oils	LS-3	S	S
Engine oil	S	S	S
Epichlorohydrin	LS-4	U	U
Ervol (Petrolatum)	S	S	S
Ethanol (technical)	S	S	U
Ethanolamine (MEA)	U	U	U
Ether	S	U	U
Ethidene (Norbonene)	S	S	X
Ethoxol (Ethylene glycol monoethyl ether)	S	S	X
Ethoxyethanol (Cellosolve)	S	S	X
Ethoxyethyl acetate (Cellosolve acetate)	LS-4	LS-1,4	U
beta-Ethoxyethylmethacrylate monomer	LS-4	S	X
Ethoxylated fatty alcohols (Shell)	LS-3	S	X
Ethyl acetate (no heat)	LS-4	LS-1,4	U
Ethylacetic acid (Butyric acid)	U	U	U
Ethyl acetoacetate	LS-4	LS-1,4	U
Ethyl alcohol (denatured)	S	S	U
Ethylamine 70%	U	U	U
Ethyl amino toluol	X	U	U
Ethyl amyl ketone (EAK)	S	S	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Ethylbenzene	S	S	S
2-Ethylbutanol	S	S	X
Ethyl-n-butylamine	U	X	X
Ethyl butyrate	X	S	X
Ethyl Cellosolve	S	S	X
Ethyl chloride	LS-4	X	X
Ethylcyclohexane	S	S	S
Ethyl cyclohexanone	S	U	U
Ethyl cyclohexylamine	U	X	X
Ethylene (Ethene)	S	S	S
Ethylene carbonate	X	X	X
Ethylene chloride (Ethylene dichloride) (no heat)	LS-4	LS-1,4, 14	U
Ethylene chlorohydrin	LS-4	U	U
Ethylene cyanohydrin	X	X	X
Ethylenediamine	U	U	X
Ethylenediaminetetraacetic acid 10% (EDTA)	U	S	U
Ethylenediaminetetraacetic acid, tetrasodium salt solution	X	X	X
Ethylene dibromide	LS-4	U	U
Ethylene dichloride (no heat)	LS-4	LS-1,4, 14	U
Ethylene glycol (Ethylene alcohol)	S	S	X
Ethylene glycol (fiber grade)	S	S	X
Ethylene glycol acetate	LS-4	LS-1,4	U
Ethylene glycol butyl ether acetate	LS-4	LS-1,4	U
Ethylene glycol diacetate (Glycol diacetate)	LS-4	LS-1,4	U
Ethylene glycol dibutyl ether	S	LS-1	U
Ethylene glycol isopropyl ether	S	LS-1	U
Ethylene glycol methyl butyl ether	S	LS-1	U
Ethylene glycol methyl ether	S	S	X
Ethylene glycol monobutyl ether (2-Butoxyethanol)	S	S	X
Ethylene glycol monobutyl ether acetate	LS-4	LS-1,4	U
Ethylene glycol monoethyl ether (2-Ethoxyethanol)	S	S	X
Ethylene glycol monoethyl ether acetate	LS-4	LS-1,4	U
Ethylene glycol monomethyl ether (2-Methoxyethanol)	S	S	X
Ethylene glycol monomethyl ether acetate	LS-4	LS-1,4	U
Ethylene glycol monophenyl ether	S	S	X
Ethylene glycol phenyl ether	S	S	X
Ethyleneimine	X	X	X
Ethylene oxide (Epoxyethane)	U	U	U
Ethylene polyglycol	S	S	X
Ethyl ether	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Ethyl-3-ethoxypropionate	S	S	X
Ethylhexanoic acid	U	X	X
Ethylhexanol	S	S	X
2-Ethylhexanol	S	S	X
Ethyl hexoic acid (2-Ethyl hexoic acid)	U	X	X
2-Ethylhexyl acetate	LS-4	LS-1,4	U
2-Ethylhexyl acrylate	X	X	X
2-Ethylhexyl alcohol	S	S	X
2-Ethylhexylamine	U	U	U
2-Ethylhexyl 2-mercapto acetate	X	X	X
Ethylidene chloride (1,1-Dichloroethane)	X	X	X
Ethyl lactate	LS-4	LS (X 30)	X
Ethyl methacrylate monomer	X	U	U
Ethyl ortho silicate	S	S	X
Ethyl PCT	X	X	X
Ethyl phthalate	S	S	X
o-Ethylphenol	X	U	U
Ethyl propionate	S	S	X
2-Ethyl-3-propylacrolein	X	X	X
Ethyl silicate, condensed	S	S	X
Ethyltoluene	S	S	S
Extender/process oils	S	S	S
Fatty acids, refined (animal and vegetable derived)	LS-3	LS-15	U
Fatty alcohol, natural	LS-3	S	X
Fatty alcohols, synthetic	LS-3	S	X
Ferric chloride 20%	U	LS-8	X
Ferric sulfate (up to 20%)	U	S	X
Fertilizer solutions	U	S	X
Fire fighting foams:			
Aer-O-Lite 3 (Chubb National)	X	S	X
Aer-O-Lite 3 Cold Foam (Chubb National)	X	S	X
Aer-O-Water (Chubb National)	X	S	X
High Expansion (Chubb National)	X	S	X
Universal Gold (Chubb National)	X	S	X
Universal Plus (Chubb National)	X	S	X
Fish liver oil	X	S	S
Fish oil	LS-3	S	S
Fish oil solubles	LS-3	LS-15	X
Flexindra (process extender oil)	S	S	X
Flexol DIOP (Diisooctyl phthalate, 10-10 Diisodecyl phthalate)	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Flexol DOP (Di-2-ethylhexyl phthalate)	S	S	X
Flexol EOP (Epoxidized soybean oil)	LS-3	S	X
Flexol NHDP (Normal, hexyl, n-octyl, n-decyl phthalate)	S	S	X
Flexon process oil	S	S	X
Fluorosilicic acid (Fluosilicic acid)	U	U	U
Foots soapstock oil (sulfuric acid free)	U	S	S
Formaldehyde 100% (HCHO)	U	U	U
Formaldehyde solution 37%	U	U	U
Formaldehyde solution 38%—50% by weight	U	U	U
Formalin	U	U	U
Formamide	U	U	U
Formic acid 10%	U	U	U
Fuel, jet JP4, JP5	S	S	S
Fuel oil	S	S	S
Fuel oil #2	S	S	S
Fumaric adduct of rosin (water dispersion)	X	X	X
Furfural, corn, oat or rice extract (Ant oil)	LS-3,4	U	X
Furfuryl alcohol (Furyl carbinol) (no heat)	S	LS-1 (X30)	U
Fusel oil, acid free (Amyl alcohol)	S	S	X
Gas oil	S	S	S
Gasoline	S	S	S
Gasoline (with tetraethyl lead)	S	S	S
Gas plant naphtha (Petroleum naphtha)	S	S	S
Gentrex (Lube oil)	S	S	S
Getty antifreeze	S	S	X
Glacial acetic acid	U	U	U
Gluconic acid 50%	U	S	U
Glucose	S	S	S
Glucose Syrup	X	S	S
Glutaraldehyde solution	X	X	X
Glycerin, crude (Glycerine)	U	S	X
Glycerin, synthetic	S	S	X
Glycerol	LS-3	S	X
Glyceryl triacetate (Triacetin)	LS-4	S	X
Glycine, sodium salt solution	X	X	X
Glycol (Dihydric alcohol)	S	S	X
Glycol alkyl ethers	S	S	X
Glycol diacetate	LS-4	LS-1,4	U
Glycol monoethers	S	S	X
Glyoxal solution (40% or less)	U	LS-12	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Grain oil (Fusel oil)	S	S	S
Grapeseed oil	LS-3	S	S
Grapestone oil	LS-3	S	S
Gravex (lube oil)	S	S	S
Grease, animal	X	S	S
Grease, yellow	U	S	S
Gulf (Lube oils)	S	S	S
Gulf Base Stock 900	S	S	X
Hard fraction oil	LS-3	S	X
Hazelnut oil	LS-3	S	S
Heart cut distillate (Exxon solvent blend)	S	S	S
Heavy aromatic naphtha	S	S	S
Heptadecane	S	S	S
Heptadecane 3-heptanol	S	S	X
Heptane (all isomers)	S	S	S
Heptanoic acid	U	LS (X 30)	U
1-Heptanol (Enanthic alcohol)	S	S	X
3-Heptanol	S	S	X
2-Heptanone (Methyl n-amyl ketone)	S	S	U
3-Heptanone (Ethyl butyl ketone)	S	S	U
1-Heptene (1-Heptylene)	S	S	S
Heptyl acetate	LS-4	LS-1,4	U
Heptyl alcohol (all isomers)	S	S	X
Hexachlorocyclopentadiene	X	X	U
Hexachloropentadiene	S	S	U
Hexachlorodiphenyl oxide	S	X	U
Hexadecane (Cetane)	S	S	S
1-Hexadecanol (Hexadecyl alcohol)	S	S	S
Hexadecanoic acid (Palmitic acid)	U	S	U
Hexadecenoic acid (Palmitoleic acid)	U	S	U
Hexahydroaniline (Cyclohexylamine)	U	U	U
Hexahydrobenzene (Cyclohexane)	S	S	S
Hexahydro cymol	S	S	X
Hexahydrophenol (Cyclohexanol)	S	S	X
Hexalin	S	S	X
Hexamethylene (Cyclohexane)	S	S	S
Hexamethylenediamine	U	U	U
Hexamethylenediamine solution	U	U	U
Hexamethylenediamine adipate (50% in water)	U	U	U
Hexamethylenimine	X	X	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Hexamethylenetetramine (HMTA)	U	U	U
Hexanaphthene (Cyclohexane)	S	S	S
Hexane (all isomers)	S	S	S
Hexane triol	S	S	X
Hexanol (all isomers)	S	S	X
Hexanoic acid (Caproic acid)	U	S	U
Hexene	S	S	S
Hexoic acid (Caproic acid)	U	S	U
Hexone (Methyl isobutyl ketone)	S	LS-1 (X60)	U
Hexyl acetate	LS-4	LS-1,4	U
Hexyl alcohol (iso, normal)	S	S	X
Hexylene glycol	S	S	X
Hexylic acid (Caproic acid)	U	S	U
Hydrazine 5%	LS (X 60)	S	X
Hydrazine 30%	LS (X 30)	X	X
Hydrocarbons, aliphatic	S	S	S
Hydrocarbons, alpha	S	S	S
Hydrocarbons, aromatic	S	S	S
Hydrochloric acid 5%	U	U	U
Hydrochloric acid 10%	U	U	U
Hydrochloric acid 20%	U	U	U
Hydrochloric acid 37%	U	U	U
Hydro crackate (gasoline)	S	S	S
Hydrofluoric acid 10%	U	U	U
Hydrogen chloride gas, dry	U	U	U
Hydrogen fluoride	U	U	U
Hydrogen sulfide, saturated	U	S	X
Hydroxyethyl acrylate	X	X	X
Hydroxylamine, solution	U	S	X
Hydroxymethyl benzene (Cresol)	S	U	U
2-Hydroxy-4-(methylthio)butanoic acid	X	X	U
Illipe butter (Mowrah butter)	X	S	S
Inedible tallow (01986)	U	S	X
Intermediate detergent (fatty alcohol)	LS-3	S	X
Isoamyl acetate	LS-4	LS-1,4	U
Isoamyl alcohol	S	S	X
Isoamylene	S	S	S
Isobutyl acetate	LS-4	LS-1,4	U
Isobutyl acrylate	X	LS-4	X
Isobutyl alcohol	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Isobutyl aldehyde	U	U	U
Isobutyl carbinol (Isoamyl alcohol)	S	S	X
Isobutyl formate	X	LS-12	X
Isobutyl isobutyrate	S	S	X
Isobutyric acid	U	U	U
Isodecane	S	S	S
Isodecanol	S	S	X
Isohexanol	S	S	X
Isononanoic acid	X	X	U
Isononyl alcohol	S	S	X
Isooctane	S	S	S
Isooctyl alcohol (Isooctanol)	S	S	X
Isopar E (Esso Iso paraffin)	S	S	S
Isopar G (Esso Iso paraffin)	S	S	S
Isopar H (Esso Iso paraffin)	S	S	S
Isopar K (Esso Iso paraffin)	S	S	S
Isopar L (Esso Iso paraffin)	S	S	S
Isopar M (Esso Iso paraffin)	S	S	S
Isopentane	S	S	S
Isophorone	S	U	U
Isophorone diamine	U	U	U
Isophorone diisocyanate	X	X	X
Isoprene	S	S	X
Isopropanolamine	U	U	X
Isopropyl acetate	LS-4	LS-1,4	U
Isopropyl alcohol	S	S	X
Isopropylamine 50%	U	U	U
Isopropylamine 100% (no heat)	U	U	U
Isopropyl benzene (Cumene)	S	S	X
Isopropyl cyclohexane	S	S	S
Isopropyl ether	S	S	X
Isopropyl oxitol	S	S	X
Japan wax	LS-3	S	S
Jeffersol (Ethylene glycol monomethyl ether)	S	S	X
Jet fuel, JP4, JP5, JP6	S	S	S
Jojoba oil	X	S	S
Kapoc oil	LS-3	S	S
Kasil (Potassium silicate)	U	S	X
Kaydol (mineral oil)	S	S	S
Kaydol (petrolatum)	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Kellin (Linseed oil)	LS-3	S	S
Kerex (Mineral spirits)	S	S	S
Kerosene	S	S	S
Ketohexamethylene (Cyclohexanone)	S	LS-1, 14 (X30)	U
Klearol (petrolatum)	S	S	S
KMC-113 Solvent (Diisopropyl naphthalene)	S	S	S
KMC Oil (Diisopropyl naphthalene)	S	S	S
Kodaflex (Hexanol isobutyrate)	S	S	X
Lactic Acid	U	LS-8	U
Laktane (normal paraffin solvent)	S	S	S
Lamp oil (Kerosene)	S	S	S
Lanolin	LS-3	S	S
Lard	LS-3	S	S
Lard oil	LS-3	S	S
Larex	LS-3	S	X
Lasso herbicide (no heat)	X	S	X
Latex rubber, natural (Ammonia stabilized)	U	S	X
Lauric acid (fatty acid)	U	LS-15	U
Lauric/myristic acid mixture	U	LS-15	U
! auryl alcohol	LS-3	S	X
Law (Mineral spirits)	S	S	S
Lignosite (50% lignin liquor)	U	S	X
Ligroin	S	S	X
Lime slurry	X	S	X
Limonene (Dipentene)	S	S	S
Linear alcohols (Tergitols)	S	S	X
Linear paraffin (Tridecane)	S	S	S
Linevol	S	S	X
Linoleic acid (fatty acid)	U	LS-15	U
Linolenic acid (fatty acid)	U	LS-15	U
Linseed oil	LS-3	S	S
Low aromatic white spirit (Mineral spirits)	S	S	S
Lube Oil	S	S	S
Lycopersicum esculentum oil (Tomato seed oil)	X	S	S
Lye, potassium 50% (KOH, Potassium hydroxide)	U	S	S
Lye, sodium 50% (NaOH, Sodium hydroxide)	U	S	S
M-300 (lube additive)	S	S	S
M-400	S	S	S
MDI (Diphenyl methane 4,4 diisocyanate)	X	S	X
Magnesium chloride 35%	U	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Magnesium hydroxide	U	S	X
Magnesium sulfonate	X	S	X
Maize oil	LS-3	S	S
Maleic acid 10%	U	LS (X 30)	U
Maleic anhydride	X	S	X
Margaric acid (Heptadecanoic acid)	U	LS (X 30)	U
Meadow foam oil	X	S	X
Menhaden oil	LS-3	S	S
Mercaptans	U	LS (X 30)	X
Mercaptobenzothiazol sodium salt solution	X	X	X
Mesamoll (Phenol/cresol alkyl sulfonic esters)	S	X	X
Mesitylene	S	S	X
Mesityl oxide	U	S	X
Metam sodium solution	X	S	X
Meta-toluene diisocyanate (TDI)	LS-9	LS-9	X
Methacrylate monomer	U	U	X
Methacrylic acid	U	U	U
Methacrylonitrile	LS-9	X	X
Methallyl alcohol	S	S	X
Methanol (1% maximum water content)	S	LS-1, 14	U
Methenamine (HMTA)	U	U	U
3-Methoxybutyl acetate	LS-4	LS-1,4	U
2-Methoxyethanol (Methyl Cellosolve)	S	S	X
Methoxypropylene glycol	S	S	X
Methyl acetate	LS-4	LS-1,4	U
Methyl acetoacetate	LS-4	LS-1,4	U
Beta-methyl acrolein (Crotonaldehyde)	U	U	U
Methyl acrylate, inhibited	LS-4	LS-4	X
Methyl acrylic acid	U	U	U
Methyl alcohol (1% maximum water content)	S	LS-1, 14	U
Methylallyl alcohol	S	S	X
Methylallyl chloride	LS-4	S	X
Methylamine solutions	X	S	X
2-Methylamyl acetate	LS-4	LS-1,4	U
2-Methylamyl alcohol	S	S	X
Methylamyl ketone	S	LS-1	U
Methylbenzene (Toluol)	S	S	S
Methyl bromide	X	X	X
2-Methyl butanol	S	S	X
Methyl butenol	S	S	X

argoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Methyl tertiary-butyl ether (MTBE)	S	S	S
Methyl butyl ketone	S	LS-1	U
Methyl butynol	S	S	X
Methylbutyraldehyde	U	U	X
Methyl butyrate	S	S	X
Methyl carbitol (Diethylene glycol monomethyl ether)	S	S	X
Methyl cellosolve (Ethylene glycol monomethyl ether)	S	S	X
Methyl cellosolve Acetate (Ethylene glycol monomethyl ether acetate)	LS-4	LS-1,4	U
Methyl chloride	X	X	X
Methylchloroform (1,1,1-Trichlorethane)	LS-4	S	U
Methylcyclohexane	S	S	S
Methylcyclopentadiene	S	X	S
Methyldiethanolamine (MDEA)	U	U	X
Methyl dioxitol (Diethylene glycol monomethyl ether)	S	S	X
Methyl ester CE810 (Cocoa methyl ester)	LS-3	S	X
Methylene chloride	LS-4	U	U
Methylene diisocyanate	X	X	X
Methylene dichloride	LS-4	U	U
Methyl-6-ethylaniline (Ethylamino toluol)	X	X	X
Methylethylcarbinol	S	S	X
Methyl ethyl ketone (MEK)	S	LS-1, (X 30)	U
2-Methyl-5-ethylpyridine	X	U	X
Methyl formate	U	U	X
Methyl glycol (Propylene glycol)	S	S	X
Methyl glycol acetate	LS-4	LS-1, 4	U
Methyl heptyl ketone	S	S	U
2-Methyl hexyl acrylate	S	S	X
2-Methyl-2-hydroxy-3-butene	LS-12	LS-12	X
2-Methyl-2-hydroxy-3-butyne	LS-12	LS-12	X
Methyl isoamyl ketone (MIAK)	S	LS-1, (X 60)	U
Methylisobutyl carbinol	S	S	X
Methyl isobutyl ketone (MIBK)	S	LS-1, (X 60)	U
Methyl laurate	S	S	X
Methyl methacrylate monomer	LS-4,9	X	X
Methyl naphthalene (alpha/beta)	S	S	X
Methyl naphthalene fractions	S	S	X
Methyl oxitol (Methyl Cellosolve)	S	S	X
Methyl oxitol acetate	S	LS-1,4	U
Methyl-1-pentene	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
4-Methyl-1-pentene	S	S	S
Methyl phenol (Cresol)	LS-7	U	X
2-Methylpropionic acid	U	U	U
Methyl propyl glycol	S	S	X
2-Methylpyridine	U	U	X
n-Methyl-2-pyrrolidone	U	U	U
Methylpyrrolidone	U	U	U
Methyl salicylate	X	X	X
Methylstyrene, alpha (inhibited)	LS-9	LS-9	X
Methyl sulfoxide (DMSO)	S	X	X
Methyl tertiary butyl ether (MTBE)	S	S	S
Middle oil (Coal tar)	S	S	X
Mineral oil—white (petrolatum)	S	S	S
Mineral seal oil (lube oil)	S	S	S
Mineral spirits	S	S	S
Mineral spirit #3	S	S	S
Mineral spirit #4	S	S	S
Mineral spirit #10	S	S	S
Molasses	LS-5	S	S
Monobutylamine	U	U	U
Monochlorobenzene	LS-4	S	U
Monoethanolamine	U	U	U
Monoethylamine 70% in water	U	U	U
Monoethylene gylcol	S	S	X
Monoethylene glycol ether	S	S	X
Monoisopropanolamine	U	U	U
Monomethylamine	U	U	U
Mononitrobenzene	LS-4	S	X
Monopropylene glycol	S	S	X
Monsanto Resin Plasticizer HB40	S	S	X
Monsanto Santicizer 140	S	S	X
Monsanto Santicizer 148	S	S	X
Morpholine (Tetrahydro-1,4-oxazine)	X	X	X
Motor fuel antiknock compounds	X	X	S
Motor oils	S	S	S
MTBE	S	S	S
Murumuru fat	X	S	S
Myrcene	S	S	X
Myristic acid	U	S	U
Myristyl alcohol	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Nalkylene (detergent alkylates)	S	S	X
Naphtha	S	S	S
Naphtha, crude condensate	S	S	S
Naphtha, gasplant	S	S	S
Naphtha, grade	S	S	S
Naphtha, heavy (Coal tar)	S	S	X
Naphtha, light	S	S	S
Naphtha, M50	S	S	S
Naphtha, natural liquid	S	S	S
Naphtha, petroleum	S	S	S
Naphtha solvent (160° benzol)	S	S	S
Naphtha, unfinished	S	S	S
Naphtha, unfinished virgin	S	S	S
Naphtha, whole	S	S	S
Naphthalene 100%	S	S	S
Naphthalene oil (maximum heat 80°C)	X	X	X
Naphthenic acid ($C_6H_{11}COOH$)	U	S	U
Naphthenic oils (extended oils)	S	S	S
Naprex 50 (lube oil)	S	S	S
Natrium (Sodium)	X	X	X
Natural liquid gas (Petroleum naphtha)	S	S	S
Natural rubber latex	U	LS-9	X
Neatsfoot oil	LS-3	S	S
Necton 78	S	S	X
Neodecanoic acid	U	S	U
Neodol (fatty acid)	LS-3	LS-15	U
NeoLine	S	S	X
Neu-Tri (Dow Trichlorethylene)	LS-4	LS-4	U
Niax Diol	S	S	X
Nitration grade toluene	X	S	S
Nitric acid 5%	U	U	U
Nitric acid 15%	U	U	U
Nitric acid 30%	U	U	U
Nitric acid 70% aqueous solution	U	U	U
Nitrobenzene	LS-4	S	X
o-Nitrochlorobenzene	LS-4	X	X
Nitroethane	LS-4	S	S
Nitrogen fertilizers	U	S	X
Nitromethane	LS-4	LS-1, (X-30)	U
Nitrophenol (ortho, meta, and para)	X	X	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
1-Nitropropane	LS-4	S	S
2-Nitropropane	LS-4	S	S
Nitropropane 60%/nitroethane 40% mixture	LS-4	S	S
Nitrotoluene (ortho and para)	S	S	X
Nonane (all isomers)	S	S	S
Nonanol	S	S	X
Nonene	S	S	S
n-Nonanoic acid (n-Nonic acid)	U	S	U
Nonyl alcohol	S	S	X
Nonylenes	S	S	X
n-Nonylic acid	U	S	U
Nonyl methacrylate monomer	LS-9	X	X
Nonyl phenol	LS-7	S	X
Nonyl phenol ethoxylate	S	S	X
Normal amyl acetate	LS-4	LS-1,4	U
Normal amyl alcohol	S	S	X
Normal hexanol	S	S	S
Normal paraffin	S	S	S
Normal propyl acetate	LS-4	LS-1,4	U
Normal propyl alcohol	S	S	X
Nutmeg butter	X	S	S
Octadecane	S	S	S
1-Octadecanol	U	S	X
Octadecene	S	S	S
Octane (iso and normal)	S	S	S
Octadecatrienoic acid (Linolenic acid)	U	S	U
Octadecenoamide solution	X	X	X
Octanoic acid (Caprylic acid)	U	S	U
Octanol	S	S	X
Octene	S	S	S
Octyl acetate	LS-4	LS-1,4	U
Octyl alcohol (iso and normal)	S	S	X
Octyl aldehydes	X	X	X
Octylol	S	S	X
Octyl chloride	LS-4	LS-8	X
n-octyl n-decyl adipate (NODA)	LS-4	S	X
Oiticica oil	LS-3	S	S
Olefins	S	S	S
alpha-Olefin mixture (C6-C18)	S	S	S
Olefin mixture (C5-C7)	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Olefin mixture (C8-C12)	S	S	S
Oleic acid (fatty acid)	U	LS-15	U
Oleum (Fuming sulfuric acid)	U	U	U
Oleyl alcohol	S	S	X
Olive oil	U	LS-6	S
Orange oil (Dipentene)	S	S	S
Ortho cresol	S	U	U
Ortho dichlorobenzene (no heat)	LS-4	LS (X 60)	U
Ortho nitrochlorobenzene	LS-4	X	U
Ortho nitrotoluene	S	S	X
Oxalic acid, dry	U	S	U
Oxirane (Ethylene oxide)	X	U	U
Oxitol (Ethylene glycol monoethyl ether)	S	S	X
Oxo alcohol (Isooctyl alcohol)	S	S	X
Palatinol AH (Diethyl hexyl phthalate)	S	S	X
Palatinol BB (Butylbenzylphthalate)	S	S	X
Palatinol C (Dibutylphthalate)	S	S	X
Pale oil (lube oil)	LS-12	LS-12	S
Palmac 55-16	X	S	X
Palmac 98-12	X	S	X
Palmac 505	X	S	X
Palm acid oil	U	LS-15	X
Palm kernel fatty acid, split	X	LS-15	U
Palm kernel oil (sulfuric acid free)	LS-3	S	S
Palm kernel residue	X	S	X
Palm nut oil	LS-3	S	S
Palm nut oil fatty acid	S	LS-1, 15	U
Palm nut oil fatty acid methyl ester	X	X	X
Palm oil, crude (sulfuric acid free)	LS-3	S	S
Palm oil fatty acid ($C_{12}-C_{18}$)	X	LS-15	U
Palm oil, processed (sulfuric acid free)	LS-3	S	S
Palm oil, refined (sulfuric acid free)	LS-3	S	S
Palm oil, sterin (sulfuric acid free)	LS-3	S	S
Palm oil fatty acid methyl ester	X	X	X
Palm oil methyl ester	X	LS-4	X
Palm olein, crude	LS-3	S	S
Palm olein, neutralized	LS-3	S	S
Palm residue	X	S	X
Palmitic acid	U	S	U
Paper mill green liquor	X	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Paper mill heavy liquor	X	S	X
Paper mill white liquor	X	S	X
Paper mill white/green liquor	X	S	X
Paraldehyde	LS-4	U	U
Para chlorometacresol	S	U	U
Para cresol	X	U	U
Paraffin	S	S	S
Paraffin, chlorinated	LS-4	LS-4, 12	X
Paraffins	S	S	S
Paraffin sulfonates	S	S	X
Paraffin wax	S	S	S
Paraffinic oil, white (petrolatum)	S	S	S
Paraffinic sulfonate (petrolatum)	S	S	S
Peanut oil	LS-3	S	S
Peel oil (oranges and lemons)	LS-3	S	S
Pelargonic acid	U	S	U
Pentachlorethane	LS-4	S	U
1,3-Pentadiene	LS-9	X	X
Pentaerythritol 10%	S	S	X
Pentaethylene hexamine	U	U	U
Pentalin (Pentachloroethane)	S	S	U
Pentane (iso and normal)	S	S	S
Pentanoic acid	X	X	U
1-Pentene	S	S	S
Pentoxone	S	S	X
Perchloric acid	U	X	U
Perchlorethylene	LS-4	LS-4	U
Perilla oil	LS-3	S	S
Petrol	S	S	S
Petrolatum	S	S	S
Petrolatum liquid (white mineral oil)	S	S	S
Petroleum, crude	LS-2	S	S
Petroleum, refined	S	S	S
Petroleum ethers	S	LS-11	S
Petroleum naphtha	S	S	S
Petroleum solvents	S	S	S
Petroleum solvents, aromatic	S	S	S
Petroleum sulfonate oils (lube additive)	S	S	X
Petroleum wax	S	S	S
Phenol 10%—99%	LS-7	U	U

argoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Phenol 100% (Carbolic acid)	LS-7	U	U
Phenol, dodecyl	LS-7	S	X
Phenol, nonyl	LS-7	S	X
Phenolate lye	LS-7	S	X
Phenolic oil (Cresylic acid)	U	U	U
Phenylamine (Aniline)	U	X	X
Phenylcarbinol (Benzyl alcohol)	S	S	X
Phenylethane (Ethyl benzene)	S	S	S
Phenylether (Diphenyl oxide)	S	U	X
Phenylethylene (Styrene monomer)	LS-9	LS-9	LS-9
Phenylformic acid (Benzoic acid	U	S	U
Phenylglycidyl ether	S	U	X
Phenylmethane (Toluol)	S	S	S
Phenylmethanol (Benzyl alcohol)	S	S	X
Phenylmethyl acetate (Benzyl acetate)	U	S	X
1-Phenyl-1-xylyl ethane	S	S	X
Phosgene	LS-4	U	U
Phosphate ester	S	S	X
Phosphoric acid 10%	U	U	U
osphoric acid 20%	U	U	U
Phosphoric acid 30%	U	U	U
Phosphoric acid 85% aqueous solutions	U	U	U
Phosphorus trichloride	U	U	U
Phosphoryl chloride (Phosphorous oxychloride)	U	U	U
Phthalate plasticizers	LS-4	S	X
Phthalate 79 (Diisooctyl phthalate)	S	S	X
Phthalate 911 (DIOP)	S	S	X
Phthalic anhydride	U	X	X
Pilchard oil	LS-3	S	S
Pinene (alpha, beta and mixed)	S	S	S
Pine oil	S	S	S
Pine tar	S	S	S
Piperylene (1,3-Pentadiene)	LS-9	X	X
Pluracol	S	S	X
Pluronic (Wyandotte polyol)	S	S	X
Polyalkyl (C18-C22) acrylate in xylene	X	X	X
Polyalkylene glycols/polyalkylene glycol monoalkyl ethers mixture	X	X	X
Polyalkylene oxide polyol	X	X	X
lybutene	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Polybutylene	S	S	X
Polybutylene 24, Chevron	S	S	X
Polyether glycols	S	S	X
Polyethylene pellets (dry)	S	S	S
Polyethylene glycol	S	S	X
Polyethylene glycol monoalkyl ether	S	S	X
Polyethylene polyamines	X	X	X
Polyisobutylene (Polybutene)	S	S	S
Poly (20) oxyethylene sorbitan monooleate	X	X	X
Poly pluracol	S	S	X
Polypropylenebenzene	S	S	X
Polypropylene glycol	S	S	X
Poly Solv D	S	S	X
Poppy seed oil	LS-3	S	S
Potassium chloride (50%)	X	S	X
Potassium hydroxide 20%	U	S	S
Potassium hydroxide 50%	U	S	S
Potassium oleate	X	S	X
Potassium silicate	U	S	X
Potato oil (Fusel oil)	LS-3	S	S
Premium mogas 98	S	S	X
Priminox R-1M	X	S	X
Process-H oils (extender oils)	S	S	S
Process naphtha	S	S	S
Propane	S	S	S
Propane diol	S	S	X
Propanol	S	S	X
n-Propanolamine	X	U	U
2-Propenal (Acrolein)	U	U	U
Propenenitrile (Acrylonitrile)	LS-4	U	U
Propiolactone (USAN, BPL)	U	U	U
Propionaldehyde	U	U	U
Propionic Acid	U	U	U
Propionic anhydride	X	U	U
Propionitrile	LS-4	X	X
Propyl acetate (iso and normal)	S	LS-1,4	U
n-Propyl alcohol	S	S	X
Propylamine (iso and normal)	U	U	X
Propylbenzene, (iso and normal)	S	S	X
Propylcarbinol (n-Butyl alcohol)	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Propylene	S	S	S
Propylene chloride	LS-4	S	U
Propylene dichloride	LS-4	S	U
Propylene dimer	S	S	S
Propylene glycol	S	S	X
Propylene glycol ethyl ether	S	LS-1	U
Propylene glycol monoalkyl ether	S	LS-1	U
Propylene glycol monomethyl ether	S	LS-1, (X 30)	U
Propylene glycol monomethyl ether acetate	LS-4	LS (X 30)	X
Propylene glycol-poly	S	S	X
Propylene oxide	S	U	X
Propylene polymer	S	S	S
Propylene tetramer	S	S	S
Propylene trimer	S	S	S
Pseudo-cumene	S	S	X
Pumpkinseed oil	LS-3	S	S
Pyridine	U	U	U
Pyrolsis fuel (fuel oil)	S	S	S
Quakersol	S	S	X
Quaternary ammonium chloride	X	LS (X 30)	X
Quenching oil	S	S	S
Raisin seed oil	LS-3	S	S
Rape oil (Rapeseed oil)	LS-3	S	S
Rapeseed oil, hydrogenated	X	S	S
Rectified spirit (Ethyl alcohol)	S	S	U
Red oil (Oleic acid)	U	S	U
Reproxal (Texaco Alfol 610 Phthalate)	S	S	X
Resin oil (Coumarone oil)	S	S	X
Resin concentrate (Esso)	S	S	X
Resin Plasticizer HB40 (Monsanto partially hydrogenated terphenyl)	S	S	X
Resolube	S	S	X
Retardsol	S	S	X
Rexonic N7	X	S	X
Rhoplex AC388	LS-9	S	X
Rice bran oil	LS-3	S	S
Ricinus oil (Castor oil)	LS-3	S	S
Rohm & Haas Emulsion E-1440	U	S	X
Rohm & Haas Solvent 2026	S	S	X
Rosin	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Rosin soap	X	S	X
SA 119 (Exxon)	U	U	U
Safflower oil	LS-3	LS-6	S
Sal fat	X	S	S
Salad oil	LS-3	S	S
Sangajol	S	S	S
Santalol	S	S	S
Santicizer 140 (Monsanto Mixed cresyl diphenyl phosphate)	S	S	X
Santicizer 148 (Monsanto Iso decyl diphenyl phosphate)	S	S	X
Santicizer 160 (Monsanto Butyl benzyl phthalate)	S	S	X
Santicizer 711 (Monsanto Di normal alkyl phthalate)	S	S	X
Santicizer 790 (Monsanto)	S	S	X
Santochlor (Monsanto p-Dichloro benzene)	LS-4	U	U
Sardine oil	LS-3	S	S
Savory oil	LS-3	S	S
Sea water (ballast)	LS-13	S	S
Sea water (hot Butterworthing)	LS-13	S	S
Secondary amyl acetate	LS-4	LS-1,4	U
Secondary amyl alcohol	S	S	X
Secondary butyl acetate	LS-4	LS-1,4	U
Secondary butyl alcohol	S	S	X
Sesame oil	S	S	S
Shark Oil	X	S	S
Shea Oil	X	S	S
Shell Brand A	S	S	X
Shell Cardura ester	S	S	X
Shell Cerex	S	S	X
Shell AC45C (lube additive)	S	S	S
Shell Kerex (mineral spirits)	S	S	S
Shellflex N (process extender oil)	LS-12	LS-12	LS-12
Shellflex 312 (process extender oil)	LS-12	LS-12	LS-12
Shell lube oils:			
Shell HVI-55	LS-12	LS-12	LS-12
Shell HVI-56	LS-12	LS-12	LS-12
Shell HVI-57	LS-12	LS-12	LS-12
Shell HVI-58	LS-12	LS-12	LS-12
Shell HVI-59	LS-12	LS-12	LS-12
Shell HVI-60	LS-12	LS-12	LS-12
Shell HVI-61	LS-12	LS-12	LS-12
Shell HVI-62	LS-12	LS-12	LS-12

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Shell HVI-63	LS-12	LS-12	LS-12
Shell HVI-64	LS-12	LS-12	LS-12
Shell HVI-65	LS-12	LS-12	LS-12
Shell HVI-95	LS-12	LS-12	LS-12
Shell HVI-160	LS-12	LS-12	LS-12
Shell HVI-1605	LS-12	LS-12	LS-12
Shell HVI-1608	LS-12	LS-12	LS-12
Shell HVI-270—HVI-350	LS-12	LS-12	LS-12
Shell HVI-650	LS-12	LS-12	LS-12
Shell LVI-50	LS-12	LS-12	LS-12
Shell LVI-143	LS-12	LS-12	LS-12
Shell LVI-375—LVI-450	LS-12	LS-12	LS-12
Shell LVI-1100	LS-12	LS-12	LS-12
Shell MVI-N-40	LS-12	LS-12	LS-12
Shell MVI-N-41	LS-12	LS-12	LS-12
Shell MVI-N-42	LS-12	LS-12	LS-12
Shell MVI-N-43	LS-12	LS-12	LS-12
Shell MVI-N-44	LS-12	LS-12	LS-12
Shell MVI-N-45	LS-12	LS-12	LS-12
Shell MVI-N-65	LS-12	LS-12	LS-12
Shell MVI-N-170	LS-12	LS-12	LS-12
Shell MVI-P-50	LS-12	LS-12	LS-12
Shell MVI-P-1300	LS-12	LS-12	LS-12
Shell Diala B	LS-12	LS-12	LS-12
Shell Diala D	LA-12	LA-12	LS-12
Shell Limea Oil 968	LS-12	LS-12	LS-12
Shell S6412	LS-12	LS-12	LS-12
Aero Shell 100	LS-12	LS-12	LS-12
Aero Shell 120	LS-12	LS-12	LS-12
Aero Shell W80	LS-12	LS-12	LS-12
Aero Shell W100	LS-12	LS-12	LS-12
Shell Heavy Axle Oil 65809	LS-12	LS-12	LS-12
Shell Rotella 30	LS-12	LS-12	LS-12
Shell NSR 45	LS-12	LS-12	LS-12
Shell NSR-S-5789	LS-12	LS-12	LS-12
Shell NND-40	LS-12	LS-12	LS-12
Shell NND-225	LS-12	LS-12	LS-12
Shell NND-240	LS-12	LS-12	LS-12
Shell NND-260-LVI	LS-12	LS-12	LS-12
Shell 100 ES Neutral	LS-12	LS-12	LS-12

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Shell 501 Spindle 69110	LS-12	LS-12	LS-12
Shell HW9B 69961	LS-12	LS-12	LS-12
Shell Cabismas Distillate	LS-12	LS-12	LS-12
Shell Dutrex 33 (aromatic process/extender oils)	LS-12	LS-12	LS-12
Shell Dutrex 55C	LS-12	LS-12	LS-12
Shell Dutrex 713	LS-12	LS-12	LS-12
Shell Dutrex 726	LS-12	LS-12	LS-12
Shell Dutrel 786	LS-12	LS-12	LS-12
Shell HVI-N-40	LS-12	LS-12	LS_12
Shell HVI-100 Neutral	LS-12	LS-12	LS-12
Shell HVI-150-D Bright Stock	LS-12	LS-12	LS-12
Shell HVI-170	LS-12	LS-12	LS-12
Shell HVI-210C	LS-12	LS-12	LS-12
Shell HVI-250 Neutral	LS-12	LS_12	LS-12
Shell HVI-500 Neutral	LS-12	LS-12	LS-12
Shell HVI-575-C Neutral	LS-12	LS-12	LS-12
Shell LVI-100C Neutral	LS-12	LS-12	LS-12
Shell LVI-570	LS-12	LS-12	LS-12
Shell LVI-750	LS-12	LS-12	LS-12
Shell MVI-P	LS-12	LS-12	LS-12
Shell Nassa 89	LS-12	LS-12	LS-12
Shell NVI-76	LS-12	LS-12	LS-12
Shellsols:			
Shellsol 350	LS-12	LS-12	LS-12
Shellsol 360	S	S	S
Shellsol A (Minersl spirits)	S	S	S
Shellsol B (Mineral spirits)	S	S	S
Shellsol E (Mineral spirits)	S	S	S
Shellsol H (Mineral spirits)	S	S	S
Shellsol K (Mineral spirits)	S	S	S
Shellsol N (Mineral spirits)	S	S	S
Shellsol PD (Mineral spirits)	S	S	S
Shellsol PP (Mineral spirits)	S	S	S
Shellsol R (Mineral spirits)	S	S	S
Shellsol RA (Mineral spirits)	S	S	S
Shellsol T (Mineral spirits)	S	S	S
Shellsol TD-7 (Mineral spirits)	S	S	S
Shell Spray oil	LS-12	LS-12	LS-12
Shell Tergol 180L-BS	LS-12	LS-12	LS-12
Shell Transformer Oil	LS-12	LS-12	LS-12

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Shell Veova 10	LS-12	LS-12	LS-12
Shellflex (extender oils)	LS-12	LS-12	LS-12
Silica slurry	X	X	X
Silicon tetrachloride (Silicon chloride)	LS-4	X	X
Sirlene (Dow Propylene glycol)	S	S	X
Skellysolv	S	S	X
Skydrol 500	S	S	X
Skydrol Y-91	LS-12	S	X
Slackwax (petrolatum)	S	S	S
Sodium acetate solution	X	X	S
Sodium alkylnaphthalene sulfonate	LS-12	LS-12	X
Sodium benzoate	X	S	X
Sodium alumina silicate slurry	X	X	X
Sodium bisulfide (50% or less)	X	S	X
Sodium bisulfite (50% or less)	U	S	X
Sodium borohydrate solution (also Sodium borohydride)	X	X	X
Sodium borohydride (15% or less)/sodium hydroxide solution	X	LS-12	X
Sodium carbonate (saturated)	U	S	X
Sodium chlorate R-2 solution	X	S	X
Sodium chloride 10% in water	S	S	S
Sodium chloride (saturated)	S	S	S
Sodium dichromate	U	U	U
Sodium formate 10%	U	S	X
Sodium hydrogen sulfide (50% or less)	U	S	X
Sodium hydrogen sulfide (6% or less), sodium carbonate (3% or less) solution	U	S	X
Sodium hydrogen sulfite solution	U	X	X
Sodium hydrosulfide (50% or less)	X	S	X
Sodium hydrosulfide (32%), sodium sulfide (2%) solution	U	S	X
Sodium hydroxide 10%—20%	U	S	S
Sodium hydroxide 50%	U	S	S
Sodium hypochlorite (15% or less)	U	LS-1, (X60)	U
Sodium nitrite solution	X	S	X
Sodium pentachlorophenate	LS-4	LS (X 30)	X
Sodium perborate	U	U	U
Sodium silicate	U	S	X
Sodium sulfate (50% or less)	U	S	X
Sodium sulfhydrate (50% or less)	X	S	X
Sodium sulfide solution (50% or less)	U	S	X
Sodium sulfide spent caustic	U	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Sodium sulfite (50% or less)	X	S	X
Sodium tetraborate	X	S	X
Sodium thiocyanate (56% or less)	X	S	X
Softanols (fatty alcohol)	S	S	X
Solinox (treated soybean oil)	LS-3	S	S
Solvenol	S	S	X
Solvent naphtha	S	S	S
Solvesso (Mineral spirits)	S	S	S
Solvesso 100 (Mineral spirits)	S	S	S
Solvesso 150 (Mineral spirits)	S	S	S
Sorbitol	S	S	S
Sorbitol 70% solution	S	S	S
Sour crude oil	LS-2	S	X
Soybean oil (crude degummed)	LS-3	S	S
Special palm oil, bleachable	LS-3	S	S
Spent caustic (no heat)	U	S	X
SPB (Palm oil)	LS-3	S	S
Sperm oil	LS-3	S	S
Sperm oil pressings	LS-3	S	S
Sperm oil residue	LS-3	S	S
Spike oil	LS-3	S	S
Spindle oil (lube oil)	LS-3	S	S
Spirits (aromatic)	S	S	S
Stearic acid (fatty acid)	U	LS-15	U
Stearin (dry, 80°C)	LS-3	S	X
Stearyl alcohol	S	S	X
Stoddard solvent	S	S	X
Styrene, inhibited	LS-9	LS-9	LS-9
Styrene butadiene	U	U	U
Styrene monomer	LS-9	LS-9	LS-9
Styrene monomer, inhibited	LS-9	LS-9	LS-9
Sulfonate oils (lube additive)	S	S	S
Sulfonic acid 86%—90% (Exxon)	U	U	U
Sulfonic alkylate (Exxon SA119)	U	U	X
Sulfonyl chloride	U	U	U
Sulfur (liquid or molten)	U	S	X
Sulfur dioxide	U	U	U
Sulfur trioxide	U	U	U
Sulfuric acid 10%	U	U	U
Sulfuric acid 30%	U	U	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Sulfuric acid 65%	U	U	U
Sulfuric acid 98%	U	U	U
Sulfurous acid	U	U	U
Sulfuryl chloride	U	U	U
Sulfur crude	U	S	X
Sulfur solvent	X	LS-1,8 (X30)	U
Sundex 8125 (extender oil)	S	S	X
Sunflower oil	LS-3	LS-6	S
Supersol (Mineral spirits)	S	S	S
Surchem 306 (Sulfonate oil)	S	S	X
Sweet oil (Olive oil)	LS-3	S	S
Synthenol (Refined castor oil)	LS-3	S	S
Tall oil (crude and refined)	U	LS-15	U
Tall oil fatty acid (Rosin acids less than 5%)	U	LS-15	U
Tall oil soap solution	U	LS-15	U
Tallow	U	S	X
Tallow acid (crude and refined)	U	LS-15	U
Tallow acid (acidulated oil)	U	LS-15	U
Tallow alcohol	S	S	X
Tallow fatty acid	U	LS-15	U
Tap water	S	S	S
Tartaric acid 10%	U	S	U
Tar acid	U	U	U
Tar oil (Creosote coal tar)	S	U	U
Teaseed oil	X	S	S
Tergitols (Union Carbide linear detergent alcohol):			
Tergitol 15-S-3	S	S	X
Tergitol 15-S-7	S	S	X
Tergitol 15-S-9	S	S	X
Tergitol 15-S-12	S	S	X
Tergitol 45-S-3	S	S	X
Terpenes	S	S	S
Terpentine (Turpentine)	S	S	S
Terpineol	S	S	X
Tertiary amyl alcohol	S	S	X
Tertiary butyl alcohol	S	S	X
Tetrachloroethane	LS-4	S	U
Tetrachloroethylene	LS-4	S	U
Tetrachloro pentamine	U	U	U
Tetradecanol	X	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Tetradecylamine	U	X	X
Tetradecylbenzene	S	S	X
Tetraethylenepentamine	U	U	U
Tetraethyl lead	U	S	X
1,2,3,4-Tetrahydrobenzene (Cyclohexene)	S	S	S
Tetrahydrofuran	S	U	U
Tetrahydrofurfuryl alcohol	S	U	U
Tetrahydronaphthalene	S	S	X
Tetraline	S	S	X
1,2,3,5-Tetramethylbenzene	S	S	X
Tetramethylene sulfone	S	U	U
Tetramethyl lead	X	X	X
Tetra propylene	S	S	X
Tiglium oil (Croton oil)	LS-3	S	S
Toluene diamine	U	X	X
Toluene diisocyanate (TDI)	LS-9	LS-9	X
Toluene, industrial	S	S	S
Toluene, nitration grade	X	S	S
p-Toluenesulfonic acid	U	U	U
o-Toluidine	X	X	X
Toluol (Toluene)	S	S	S
Transformer oil (insulating oil)	LS-12	LS-12	S
Transmission oil (lube oil)	S	S	S
Triacetin	S	S	X
1,1,2-Trichloro-1,2,2-trifluoroethane	LS-4	LS-4	X
Trialkyl phosphate	S	S	X
Tribasic sodium phosphate (TSP)	LS-4	S	X
Tributylethylhexyl phosphate	S	S	X
Tributyl phosphate	S	S	X
Trichlorobenzene	LS-4	X	U
1,1,1-Trichloroethane	LS-4	LS-1,4	U
1,1,2-Trichloroethane	LS-4	LS-1,4	U
Trichlorethylene	LS-4	LS-1,4	U
Trichloropropane (all isomers)	LS-4	LS-1,4	U
Tricresyl phosphate	LS-4	S	X
Tridecane	S	S	S
Tridecanol	S	S	X
Tridecene	X	S	S
Tridecyl alcohol	S	S	X
Tridecyl benzene	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Triethane (Trichloroethane)	S	LS-1, 4	U
Triethanolamine	U	S	X
Triethylene glycol	S	S	X
Triethylene glycol ethyl ether	S	LS-1	U
Triethylene glycol di-2-ethylbutyrate	S	S	X
Triethylene glycol methyl ether	S	LS-1	U
Triethylene tetramine (TETA), no heat	U	U	U
Triethyl amine	U	U	U
Triethyl benzene	S	S	S
Triethyl phosphate	LS-4	S	X
Triisobutylene	S	S	S
Triisopropanolamine	X	X	X
Trimethylacetic acid	U	U	U
Trimethylamine	U	U	U
Trimethyl benzene	S	S	S
Trimethyl cyclohexanol	S	S	X
Trimethylhexamine diamine	U	X	X
Trimethylol propane polyethoxylate	S	S	X
2,2,4-Trimethyl-1,3-pentanediol-1-isobutyrate	S	S	X
Trimethyl phosphite	X	X	X
Trimethyl propane glycol	S	S	X
Trimethylene glycol	S	S	S
Tripropylene	S	S	X
Tripropylene glycol	S	S	X
Tripropylene glycol monomethyl ether	S	LS-1	U
Triptane	S	S	S
Trisodium phosphate	LS-4	S	X
Tritolyl phosphate	LS-4	S	X
Triton GR7	X	S	S
Triton X100	S	S	X
Trixylenyl phosphate (Trixylyl phosphate)	S	S	X
Troluoil	S	S	X
TSP (Trisodium phosphate)	LS-4	S	X
Tucum oil	LS-3	S	S
Tung oil	LS-3	S	S
Turkey red oil	LS-3	S	S
Turpentine, oil and gum	S	S	S
U-Cane alkylate II (Dodecyl benzene)	S	S	S
Undecane	S	S	S
Undecanoic acid	X	S	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Undecanol (all isomers)	S	S	X
Undecanone	S	S	X
1-Undecene	S	S	X
Undecyl alcohol	S	S	X
Undecyl benzene	S	S	S
Unfinished kerosene (Kerosene)	S	S	S
Uran 32 (fertilizer)	U	S	X
Urea (saturated)	U	S	X
Urea, ammonium nitrate solutions	U	S	X
Urea ammonium phosphate solution	U	S	X
Urea water	U	S	X
U.S. White oil	S	S	S
VM&P Naphtha	S	S	S
Valeraldehyde	U	U	U
Valeric aldehyde	U	U	U
Varsol (Mineral spirits)	S	S	S
Vaseline	LS-3	S	S
Vegetable oils	LS-3	S	S
Vegetable protein solution (hydrolyzed)	X	X	X
Versene (Dow)	X	X	X
Versenex	X	X	X
Versenol	X	X	X
Vestal LPH	S	U	U
Vidden-D (Dichloropropane and dichloropropene)	LS-4	U	U
Vinegar	U	U	U
Vinyl (pellets, dry)	S	S	S
Vinyl acetate	X	X	X
Vinyl acetate monomer (no heat)	LS-4, 9	LS-1,9, 14, (X30)	U
Vinyl acetate monomer (Borden 400PPMH_2O) (no heat)	LS-9	LS-1,9, 14, (X30)	U
Vinyl chloride	LS-4, 9	U	U
Vinyl ethyl ether	LS-4	U	U
Vinylidene chloride	LS-4, 9	U	U
Vinylmethyl ether liquid	LS-4	U	U
Vinyl neodecanoate (VNDC, Veova)	LS-4, 9	S	X
Vinyl propionate	U	U	U
Vinyl trichloride (Trichloroethane)	S	LS-1, 4	U
Vinyl toluene	LS-9	LS-9	X
Virgillio 50 (Union Carbide)	S	S	X
Vitriol (Sulfuric acid)	U	U	U
Voranol (Polyols)	S	S	X

'argoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Walnut oil	LS-3	S	S
Water, ballast	S	S	S
Water, deionized	S	S	S
Water, distilled	S	S	S
Water, sea	LS-13	S	S
Water, sea (hot Butterworthing)	LS-13	S	S
Wax, petroleum (maximum temperature 80°C)	S	S	S
Wax, paraffin (maximum temperature 80°C)	S	S	S
Well pack fluid (Calcium bromide)	U	S	X
Wetting agent, nonionic	S	S	X
Whale oil	LS-3	S	S
White mineral oil (Petrol, liquid)	S	S	S
White oil	S	S	S
White spirits (Mineral spirits)	S	S	S
White spirit 100 (Mineral spirits)	S	S	S
White spirit 150 (Mineral spirits)	S	S	S
White spirit 160/180	S	S	S
Wood oil	S	S	S
Wool fat	LS-3	S	S
›il (petrolatum, liquid)	S	S	S
Xylene (meta, ortho and para)	S	S	S
Xylenol	LS-11	X	X
Yarmor oils	LS-3	S	S
Yellow grease	U	S	S
Zinc Bromide 9% (No heat)	X	S	X
Zinc Calcium Bromide (50%)	X	S	X
Zolex	S	S	X
Zymol	LS-3	S	X

ATTACHMENT D-2-4-7

APPENDIX D-2-4

SECTION D-2

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNITS 1700A, B, & C

Revision No.

5.0

TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNITS 1700A, B, & C

TANKS T-A AND T-1701 THROUGH T-1704

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TANK SYSTEM DESIGN ASSESSMENT AND CERTIFICATION

TANK MANAGEMENT UNITS 1700A, B, & C

TANKS T-A AND T-1701 THROUGH T-1704

I. Introduction

This document provides the assessment and certification for the design of the hazardous waste storage tank system(s) at Tank Management Units 1700A, B, & C at the Chemical Waste Management, Inc. Facility in Emelle, Sumter County, Alabama. The assessment was performed to address the applicable requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), regarding the design of the system within Tank Management Units 1700A, B, & C which is comprised of the tanks (i.e., Tanks T-A and T-1701 through T-1704), the tank foundation, the associated ancillary equipment and the secondary containment system.

The general layout of and location of the underground pipe chase and the components of Units 1700A, B, & C are shown on Drawing No. 0100-020-001 and on Drawing No. 1700-020-001 in Appendix D-1 to Section D of the RCRA Part B Permit Application. Units 1700A, B, & C tank systems and the Underground Pipe Chase are constructed in phases as required to support the management of leachate generated from new landfill trenches and other wastewaters generated on-site. The primary function of the tank systems within Unit 1700 is to accumulate and store leachate and berm surface waters resulting from the disposal in landfill trenches 19, 21, and 22.

The following drawings were used in the preparation of this Assessment and Certification and are provided either in Exhibit A (Tank Data Sheets) or in Appendix D-1 to Section D of the RCRA Part B Permit Application:

Drawing No.	**Drawing Title**
1700-010-001	Leachate Tank Storage Units 1700B & C (T-1701 thru T-1704) - P&ID
1700-010-003	Leachate Tank Storage Unit 1700A (Tank T-A) - P&ID
1700-020-001	Underground Pipe Chase Unit 1700A, B, & C Site Plan
1700-020-002	Leachate Tank T-A, Unit 1700A - Plan & Sections
1700-020-003	Leachate Tanks T-1701 & T-1702, Unit 1700B - Plan, Sections, & Details
1700-020-004	Leachate Tanks T-1703 & T-1704, Unit 1700C - Plan, Sections, & Details
1700-040-001	Leachate Tank T-A, Unit 1700A – Details
1700-080-001	Tank Data Sheet - T-1701
1700-080-001A	Tank Data Sheet - T-A
1700-080-002	Tank Data Sheet - T-1702
1700-080-003	Tank Data Sheet - T-1703 through T-1704

II. Tank Design

Tanks T-A and T-1701 through T-1704 have been designed in accordance with the design codes and standards indicated within the DESIGN DATA section of the Tank Data Sheets (i.e., Drawing Nos. 1700-080-001, -001A, -002 and -003) provided in Exhibit A to this tank system design assessment. The criteria utilized in the assessment of the design of the shell, structural support, and anchorage for Tanks T-A and T-1701 through T-1704 are also provided within the DESIGN DATA section of the Tank Data Sheets, as well as within the tank design calculations provided in Exhibit B to this tank system design assessment.

The calculations provided in Exhibit B to this tank system design assessment demonstrate that the tank shell, structural supports and anchorages are, as designed, adequate to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable, at the design conditions indicated on the tank data sheets.

III. Tank Foundation Design

The designs of the reinforced concrete foundations for Tanks T-A and T-1701 through T-1704 are indicated in Detail 3 on Drawing No. 1700-040-001 and Detail 7 on Drawing Nos. 1700-020-003 through -004 which are provided in Appendix D-1 to Section D of the RCRA Part B Permit Application. The criteria utilized in the assessment of the design of the foundation for Tanks T-A and T-1701 through T-1704 are provided within the tank foundation design calculations provided in Exhibit C to this tank system design assessment.

The tank foundation design calculations provided in Exhibit C demonstrate that the tank foundation is, as designed, adequate to support the load of the full tanks and to withstand associated environmental stresses at the design conditions indicated on the tanks data sheets and provided within foundation design calculations.

IV. Ancillary Equipment Design

All tank system ancillary piping systems shall be designed, installed and tested in accordance with the American Society of Mechanical Engineers (ASME) Standard B31.3, "Chemical Plant and Petroleum Refinery Piping", or an equivalent nationally recognized standard, and in accordance with recognized good engineering practices to ensure that they are supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

All other ancillary equipment for the tank system shall be designed, installed and tested in accordance with appropriate recognized standards, if any, and in accordance with recognized good engineering practices to ensure that it is supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.

In order for this tank design assessment and associated certification to be maintained, and prior to the tank system being placed in use, the Facility shall ensure that the tank system ancillary equipment is properly installed and that all required inspections, tests and repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f). Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested.

V. Secondary Containment System Design

The design features of the secondary containment system for the tank systems within Units 1700A, B, & C are indicated on Drawing Nos. 1700-020-002 through -004 and 1700-040-001 which are located in Appendix D-1 to Section D of the RCRA Part B Permit Application. As shown on these drawings and in accordance with the applicable requirements of 40 CFR 264.193 and ADEM Administrative Code Rule 335-14-5-.10(4), the secondary containment system design is comprised of a reinforced concrete base, with all joints sealed with chemical-resistant waterstops, and all concrete surfaces sealed with chemical-resistant concrete coating system. Information on the concrete coatings available for use on the secondary containment system is provided within Appendix D-1-3 to Section D-1 of the RCRA Part B Permit Application.

Calculations demonstrating that the design secondary containment capacity meets or exceeds the applicable requirements 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e) are provided in Appendix D-2-2 to Section D-2 of the RCRA Part B Permit Application.

VI. Tank Venting Requirements

As indicated on the P&ID's for Units 1700A, B, & C (i.e., Drawing Nos. 1700-010-001 and -003 which are located in Appendix D-1 to Section D of the RCRA Part B Permit Application), Tanks T-A and T-1701 through T-1704 are designed as closed top tanks that passively vent to atmosphere. The Tank Data Sheets (i.e., Drawing Nos. 1700-080-001, -001A, -002 and -003) provided in Exhibit A to this tank system design assessment specify the diameter of the atmospheric vent nozzle on each of the tanks.

The requirements for normal (i.e., liquid displacement and thermal effects) venting capacities for the Unit 1700A, B, & C tanks were evaluated in accordance with American Petroleum Institute Standard 2000, Venting Atmospheric and Low-Pressure Storage Tanks (i.e., API 2000). As shown in the venting calculations provided in Exhibit D to this tank system design assessment, the size of the atmospheric vent nozzle on each of the tanks is adequate to allow the tank under normal conditions to be maintained within the design limitations for pressure and vacuum as specified on the Tank Data Sheets provided in Exhibit A and within the tank design calculations provided in Exhibit B to this tank system design assessment. The venting calculations provided in Exhibit D to this tank system design assessment also indicate the design maximum tank fill and withdrawal rates which were used in the evaluation of the tank venting requirements.

VII. Hazardous Characteristics of the Waste Managed

VII.A. Tank T-A

In accordance with the requirements of 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., this section presents an evaluation of the compatibility of the wastes managed within the Unit 1700A tank system with the materials of construction of Tank T-A and the ancillary equipment (i.e., pumps and piping) to determine their suitability for service in this unit.

The Unit 1700A tank system is only used to accumulate and store leachate and berm surface waters resulting from the disposal in landfill trench 19of more than one of the restricted wastes classified as hazardous under Subpart D of 40 CFR Part 261 and ADEM Administrative Code Rule 335-14-2-.04 (e.g., EPA Hazardous Waste No. F039). The EPA Hazardous Waste No. F039 waste generated in the landfill trenches is a dilute, aqueous solution which is listed in 40 CFR 261.31(a) and ADEM Administrative Code Rule 335-14-2-.04(2)(a) based solely on a Toxic Waste (T) Hazard Code. However, as indicated in Appendix D-2-1 of this Application, the F039 wastes generated in landfill Trench 19 at the Facility have been (or are expected to be) determined to be capable of also meeting the characteristics of corrosivity (C) and/or toxicity characteristic (E), but have not been (and are not expected to be) determined to be capable of meeting the characteristics of ignitability (I) or reactivity (R). Tank T-A and the ancillary equipment that contact wastes within this system are constructed of corrosion resistant high-density polyethylene plastic.

Exhibit E to this tank system design assessment presents information which provides an indication of the relative compatibility of Cross-Linked High-Density Polyethylene (XLHDPE) with a wide variety of chemical compounds and other substances. The table in Exhibit E provides corrosion/compatibility information for XLHDPE exposed to pure chemical compounds which, in general, tend to have a more severe corrosive effect than wastes which contain mixtures and complexes of these compounds. Although this table may not provide corrosion data and service recommendations for all of the potential constituents of the wastes or waste mixtures which may be managed within the tank system in Unit 1700A, the table does demonstrate that XLHDPE is generally compatible with and, under normal conditions, should not experience an accelerated rate of corrosion or deterioration when exposed to a majority of the types and classes of wastes which are managed within the Unit 1700A tank system. In addition to the compatibility/corrosion data provided in Exhibit E, the compatibility of XLHDPE with the types of wastes managed within Unit 1700A is further validated by the empirical data provided by many years of comparable service applications within a variety of units at the Facility.

VII.B. Tank T-1701 through T-1704

In accordance with the requirements of 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., this section presents an evaluation of the compatibility of the wastes managed within the Unit 1700B & C tank systems with the materials of construction of Tanks T-1701 through T-1704 and the ancillary equipment (i.e., pumps and piping) to determine their suitability for service in this unit.

The Unit 1700B & C tank systems are only used to accumulate and store leachate and berm surface waters resulting from the disposal in landfill trenches 21 and 22 of more than one of the restricted wastes classified as hazardous under Subpart D of 40 CFR Part 261 and ADEM Administrative Code Rule 335-14-2-.04 (e.g., EPA Hazardous Waste No. F039). The EPA Hazardous Waste No. F039 waste generated in the landfill trenches is a dilute, aqueous solution which is listed in 40 CFR 261.31(a) and ADEM Administrative Code Rule 335-14-2-.04(2)(a) based solely on a Toxic Waste (T) Hazard Code. However, as indicated in Appendix D-2-1 of this Application, the F039 wastes generated in landfill Trenches 21 and 22 at the Facility have been (or are expected to be) determined to be capable of also meeting the characteristics of corrosivity (C) and/or toxicity characteristic (E), but have not been (and are not expected to be) determined to be capable of meeting the characteristics of ignitability (I) or reactivity (R). Tanks T-1701 through T-1704 are constructed of carbon steel with internal corrosion protection.

Exhibit E to this tank system design assessment presents information which provides an indication of the relative compatibility of epoxy coating, such as Devoe Chemline 253 or demonstrated equivalent, with a wide variety of chemical compounds and other substances. The table in Exhibit E provides corrosion/compatibility information for Chemline 253 epoxy coating exposed to pure chemical compounds which, in general, tend to have a more severe corrosive effect than wastes which contain mixtures and complexes of these compounds.

Although this table may not provide corrosion data and service recommendations for all of the potential constituents of the wastes or waste mixtures which may be managed within the tank systems in Units 1700B & C, the table does demonstrate that Chemline 253 is generally compatible with and, under normal conditions, should not experience an accelerated rate of corrosion or deterioration when exposed to a majority of the types and classes of wastes which are managed within the Unit 1700B & C tank systems. In addition to the compatibility/corrosion data provided in Exhibit E, the compatibility of Chemline 253 with the types of wastes managed within Units 1700B & C is further validated by the empirical data provided by many years of comparable service applications within a variety of units at the Facility.

Based on the information provided in Exhibit E of this tank system design assessment and the empirical data compiled at the Facility for comparable service applications, it is the conclusion of this evaluation that the XLHDPE and Chemline 253 coated carbon steel tank system components are generally compatible with the types of waste managed within the Unit 1700 tank system. It is further concluded that these materials of construction are suitable for this service if the tank systems are operated within the design limitations set forth within this assessment, and that, if the tank systems are managed in accordance with the following minimum practices, these materials of construction should not experience an accelerated rate of corrosion or deterioration which may result in a catastrophic failure of the tank systems, throughout their useful life:

- Prior to placement of a waste into the tank system the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. References other than Exhibit E of this document, such as other recognized sources of corrosion data, may also be used to evaluate compatibilities. The Facility shall prohibit the placement into the Unit 1700 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components; and
- The Facility shall perform an annual inspection of the tank shells to ensure that minimum code thicknesses are maintained, and that adequate corrosion allowance is available for continued service.

VIII. Certification of Tank System Design Assessment

In accordance with the requirements of 40 CFR 264.192(a) and ADEM Administrative Code Rule 335-14-5-.10(3)(a), this section provides a certification by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), that an assessment of the design of the following tank system(s) demonstrates that the tank system foundation, structural supports, seams, connections, and pressure controls are adequate, and that the tanks have sufficient structural strength, compatibility with the wastes to be managed and/or protection from corrosion so that they will not collapse, rupture or fail, if properly installed, operated within the design limits, and properly inspected and maintained:

Tank System Location:	Chemical Waste Management, Inc. Emelle, Alabama
Tank System Identification:	Tank Management Units 1700A, B, & C
Applicable Tanks:	T-A, T-1701, T-1702, T-1703, and T-1704

At a minimum, the assessment of the tank system design, which is incorporated herein by reference, addresses and considers the following factors with respect to the intended use of the tank system:

- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tank designs have been evaluated for structural integrity with regards to the ability of the designed tank shell, structural supports and anchorages to withstand the static and dynamic stresses associated with pressures resulting from vapor and liquids heads, filling and withdrawal of liquids, diurnal heating and cooling of the tank and contents, roof and wall loads, and associated environmental stresses such as wind and seismic loads, as applicable;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which the tanks have been evaluated with regards to the adequacy of the designed tank to provide the necessary capacity for normal venting;
- In accordance with 40 CFR 264.192(a)(1) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)1., the assessment of the tank system design provides the standards according to which piping and other ancillary equipment shall be designed and constructed to maintain this certification;
- In accordance with 40 CFR 264.192(a)(2) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)2., the assessment of the tank system design considers the compatibility of the tank's materials of construction and/or internal coatings with the types of hazardous wastes to be managed;
- In accordance with the applicable requirements of 40 CFR 264.192(a)(5) and ADEM Administrative Code Rule 335-14-5-.10(3)(a)5., the assessment of the tank

system design considers the ability of the designed tank system foundation to support the load of the full tanks and to withstand associated environmental stresses; and

- The assessment of the tank system design considers the adequacy of the capacity of the designed tank secondary containment system as required by the applicable requirements of 40 CFR 264.193(e) and ADEM Administrative Code Rule 335-14-5-.10(4)(e).

In order for this certification to be maintained, the Facility shall comply with the applicable requirements of 40 CFR 264 Subpart J and ADEM Administrative Code Rule 335-14-5-.10, and shall perform all routine management procedures, periodic inspections and reviews, and tank system functionality and integrity tests as required by the permit including, but not limited to, the following:

- The Facility shall ensure that the tank system is properly installed and that, prior to placing the tank system in use, all required inspections, tests and necessary repairs are performed in accordance with the applicable requirements of 40 CFR 264.192(b) through (f) and ADEM Administrative Code Rules 335-14-5-.10(3)(b) through (f);
- Prior to the tank system being placed in use, the Facility shall obtain and place within the Facility Operating Record in accordance with the requirements of 40 CFR 264.192(g) and ADEM Administrative Code Rule 335-14-5-.10(3)(g), an assessment of the tank system installation, prepared by an independent, qualified, registered Alabama Professional Engineer in accordance with ADEM Administrative Code Rule 335-14-8-.02(2)(d), which certifies that the tank system and ancillary equipment were properly designed, installed and tested;
- Prior to placement of a waste into the tank system, the Facility shall verify the compatibility of the waste with the material of construction and/or internal coatings of the tank system components in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the Unit 1700 tank system any waste that may exhibit excessive corrosion or degradation to the material of construction of the tank system components;
- Prior to placement of a waste into the tank system, the Facility shall verify the specific gravity of the waste in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application. The Facility shall prohibit the placement into the tank system of any

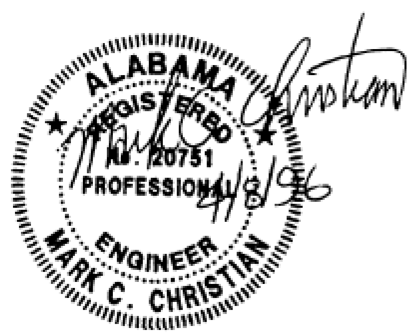
waste that has a specific gravity that exceeds the design maximum value specified within the tank system design assessment;

- Prior to placement of a waste into the tank system, the Facility shall verify in accordance with the procedures and requirements of the Waste Analysis Plan provided in Section C of the RCRA Part B Permit Application that the treatment of the waste will not cause temperatures within the tank system to exceed the design maximum value specified within the tank system design assessment;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank exterior to detect excessive corrosion or deterioration;
- The Facility shall perform a daily inspection of the visible aboveground portions of the tank secondary containment system to detect leakable cracks or gaps, or excessive deterioration of the concrete base and/or chemical-resistant concrete coatings;
- The Facility shall perform an annual inspection of the tank shells, as described in Subsection F-2-6 of Section F-2 of the RCRA Part B Permit Application, to ensure that minimum code thicknesses are maintained, and that adequate corrosion allowance is available for continued service;
- The Facility shall perform an annual inspection of the tank structural supports and anchorages to ensure that their integrity is maintained;
- The Facility shall perform a periodic inspection of the tank venting devices to ensure that they are in good working order to maintain the tanks within the design limits for pressure as specified within the tank system design assessment;
- The Facility shall perform a periodic inspection of the tank level sensing, overfill control devices and associated interlocks to ensure that they are in good working order with the appropriate settings to prevent overfilling of the tanks. The frequencies and procedures for inspection of all tank level sensing and overfill control devices shall be as recommended by the manufacturer;
- The Facility shall perform a periodic inspection of any other operational controls for the tank system to ensure that they are in good working order with the appropriate settings to maintain the tanks within their design limits as specified within the tank system design assessment. The frequencies and procedures for inspection of other tank system operational controls shall be as recommended by the manufacturer; and
- The Facility shall perform periodic inspections of the integrity of any tank system grounding and lightning protection systems.

Based on the information provided within the tank system design assessment and supporting documentation, the designs of Tanks T-A and T-1701 through T-1704 within Tank Management Units 1700A, B, & C meet the current RCRA requirements relative to the design of new hazardous waste tank systems. The design assessment addresses only the applicable requirements of 40 CFR 264.192 and 40 CFR 264.193, and ADEM Administrative Code Rules 335-14-5-.10(3) and (4), and does not consider compliance with other codes or regulations, including, but not limited to, the requirements of the Occupational Safety and Health Act (OSHA).

With regards to the assessment and certification of the design of hazardous waste tank systems in accordance with the applicable requirements of 40 CFR 264.192(a) and (g), and ADEM Administrative Code Rules 335-14-5-.10(3)(a) and (g), I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Mark C. Christian, P.E
Alabama P.E. No.: 20751
Principal
ETI Corporation
6799 Great Oaks Road, Suite 100
Memphis, Tennessee 38138-2500



This certification was originally submitted in 1996. As part of the 2002 Part B Application Renewal, revisions were made to the text in this attachment. These revisions consisted primarily of renaming the section for the Waste Analysis Plan to Section C to maintain consistency with the other Sections contained within this Part B Permit Application. As part of the 2009 Part B Application Renewal, additional revisions were made to the text in this attachment. These revisions consisted primarily of renaming Unit 1700 to more specific Units 1700A, B, & C. No revisions were made to this attachment during this Part B Permit Application renewal process (Revision 5.0).

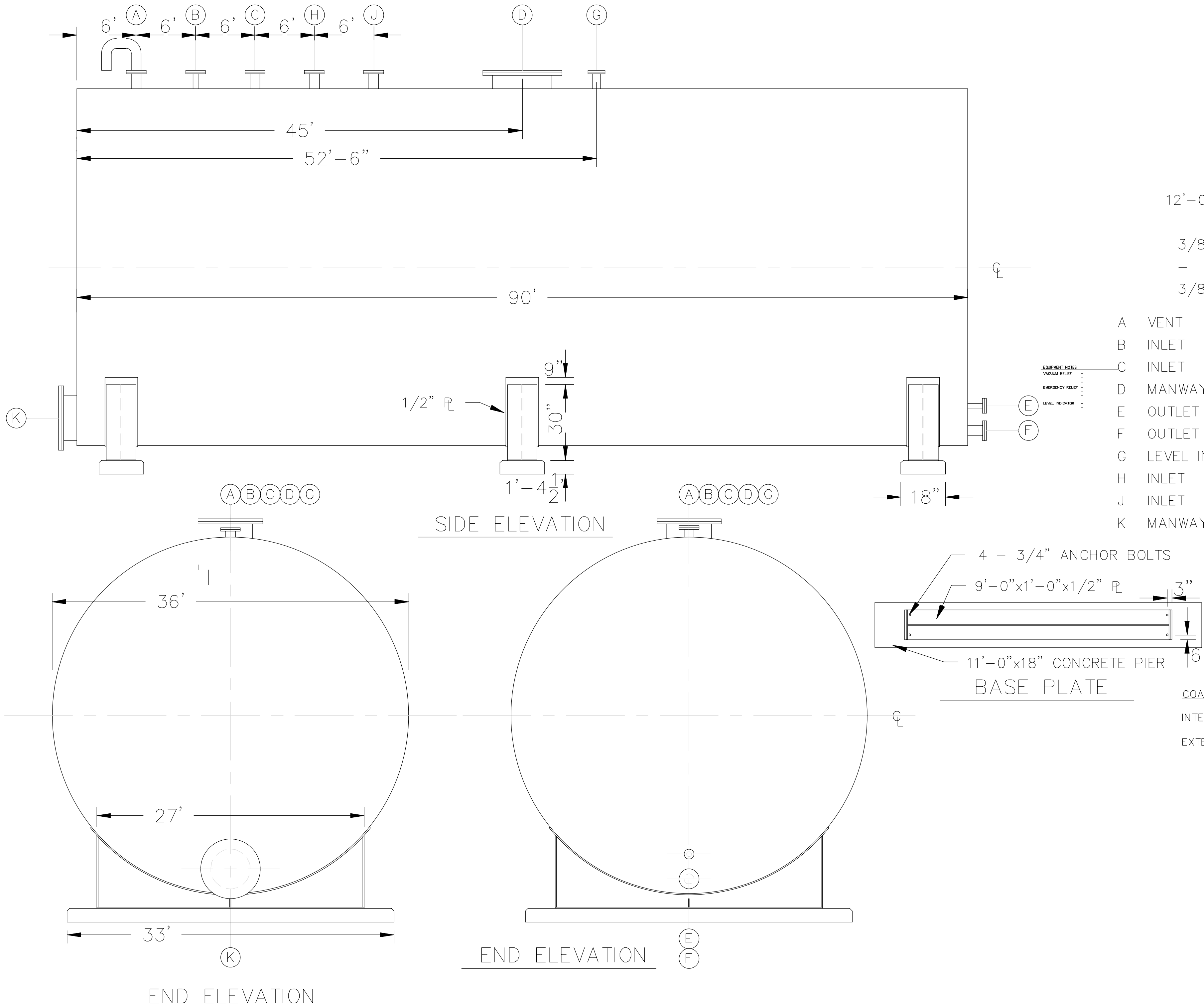
With regards to the revisions noted above, I certify under penalty of law that these modifications were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Michael T. Feeney, P.E.
Alabama P.E. No.: 15895
Jacobs Engineering Group Inc.
Ten 10th Street NW
Atlanta, Georgia 30309

[End of Attachment D-2-4-7 Text]

EXHIBIT A

TANK DATA SHEETS



25,379 gal.
ATM ATM
35° F 140° F
LEACHATE
1.10 6"
300 gpm 300 gpm
UL-142 NA
70 mph (SBC)
ZONE 1 / SBC
12'-0" 30'-0"

3/8" C.S. 1/16" HORIZONTAL –
– – – – –
3/8" C.S. 1/16" FLAT –

A	VENT	4"	150# R.F.	TOP	–
B	INLET	2"	150# R.F.	TOP	–
C	INLET	4"	150# R.F.	TOP	–
D	MANWAY	24"	MFG. STD.	TOP CENTER	–
E	OUTLET	2"	150# R.F.	EAST SIDE H16"	–
F	OUTLET	4"	150# R.F.	EAST SIDE H6"	–
G	LEVEL INDICATOR	3"	150# R.F.	TOP	–
H	INLET	4"	150# R.F.	TOP	–
J	INLET	4"	150# R.F.	TOP	–
K	MANWAY	18"	MFG. STD.	WEST SIDE H11"	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: ALKYD ENAMEL PAINT

Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY

SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702

DATE: AUGUST 2022

DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE

TANK DATA SHEET - T-1701

SHEET 1700-080-001

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

DESIGN DATA

Design Capacity	Total	2,500 gal.	
Design Press.	Min./Max.:	ATMOSPHERIC	
Design Temp.	Min./Max.:	0° F / 120° F	
Service:	LEACHATE COLLECTION		
Specific Gravity:	1.10	Vapor Space (inch):	6"
Max. Fill Rate:	300 gpm	Max. Withdrawal Rate:	300 gpm
Design Code:	ASTM D-1998	Joint Efficiency:	NA
Wind Load Spec:	ANSI 58.1, EXP. C, 100 MPH		
Seismic Zone / Code:	ZONE 1 (SBC)		

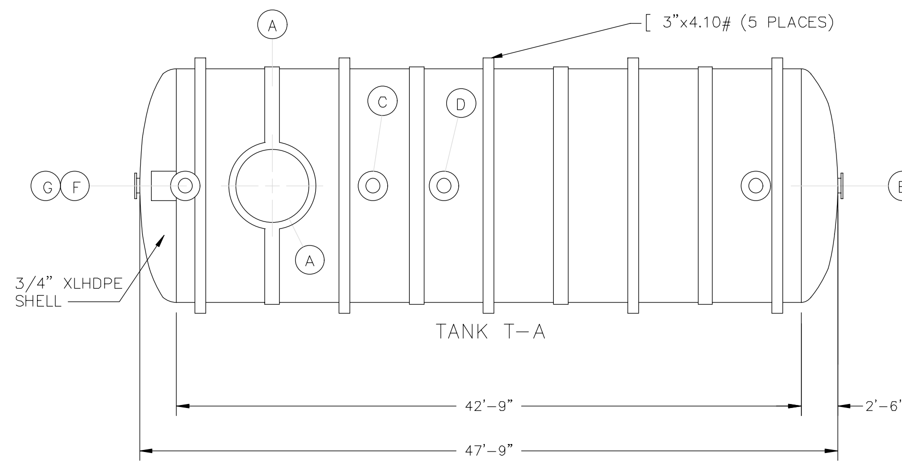
CONSTRUCTION

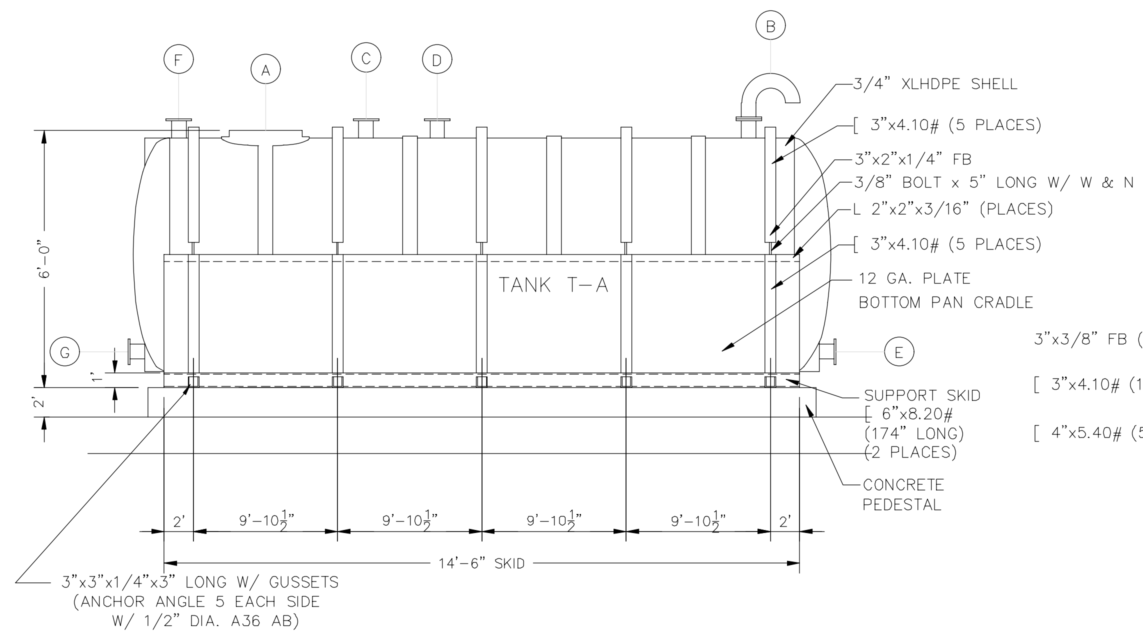
TANK I.D.: 5'-4" TANK LENGTH: 15'-11"

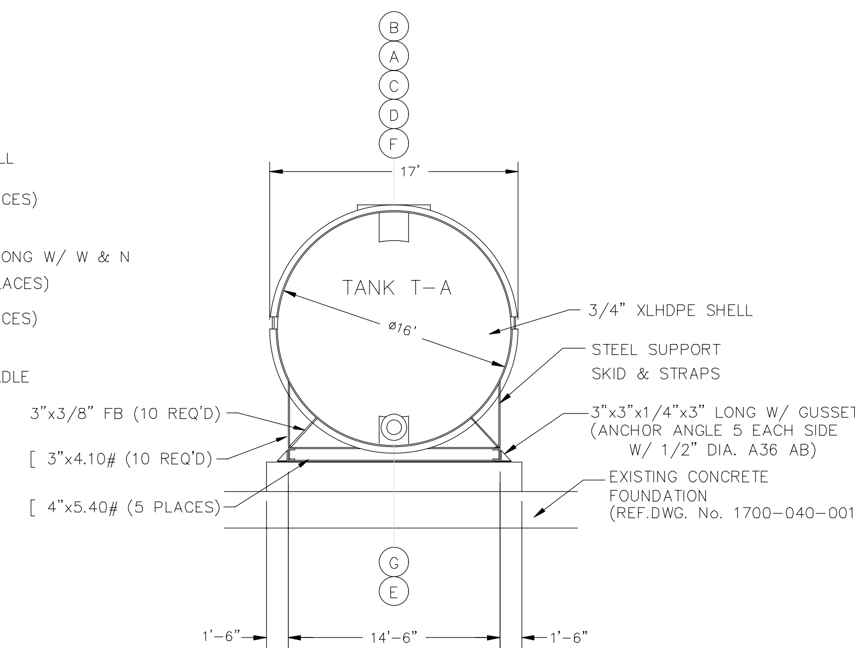
ITEM	Thickness	Material	Design Min. CA	Type	Height
SHELL	0.75"	XLHDPE	0.125"	HORIZONTAL	14'-3"
BOTTOM	–	–	–	–	–
HEAD	0.75"	XLHDPE	0.125"	DISHED	10"

NOZZLE LIST

NO.	SERVICE	SIZE	RATING	ORIENTATION	REMARKS
A	MANWAY	19"	MANUF.	TOP	COMBINATION
B	VENT	4"	FLANGED	TOP	
C	SPARE	2"	FLANGED	TOP	W/BLIND FLG
D	LEVEL	2"	FLANGED	TOP	
E	OUTLET	4"	FLANGED	END	
F	INLET	4"	FLANGED	TOP	
G	PRESSURE SWITCH	4"	FLANGED	END	







NOTES:

1. ALL FITTINGS TO BE ENCAPSULATED BOLT HEADS IN BLACK GLASSFILLED PP, 316 SS BOLTS, WITH VITON GASKETS.
2. NOZZLES ARE 25 PSI RATING WITH 150# A.S.A. DRILLING.
3. SKID SHALL BE MATCHED TO FIT TANK AND SHALL BE SAND BLASTED AND COATED WITH EPOXY COATING SYSTEM, OR DEMONSTRATED EQUIVALENT.

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

Jacobs
10 Tenth Street Suite 1400 Atlanta, GA 30309 | 404.978.7600

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WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

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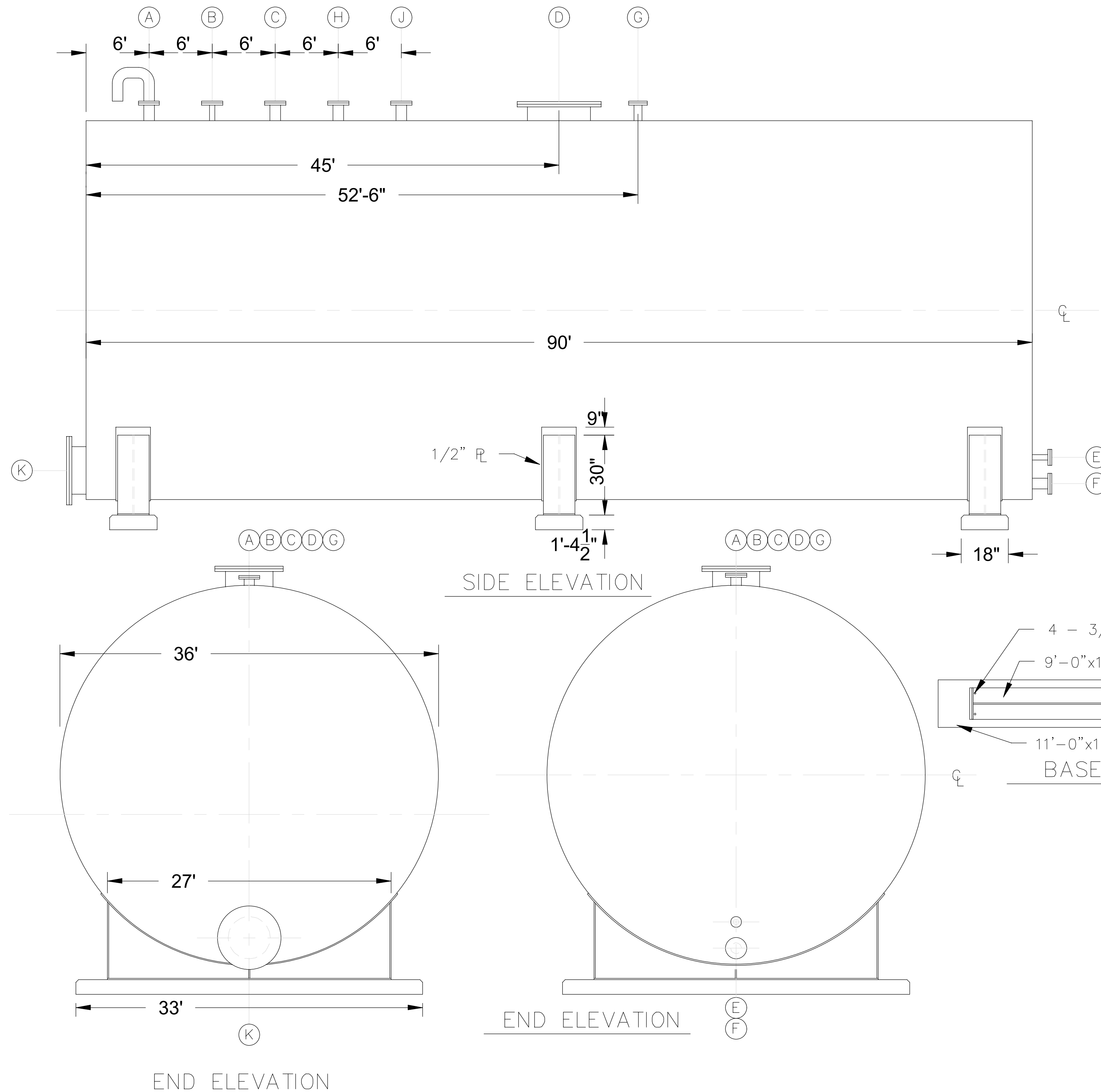
PROJECT NO: D3279702

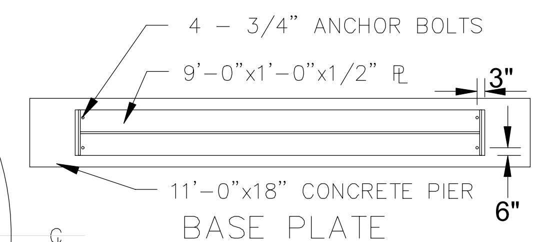
DATE: AUGUST 2022

DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

SHEET TITLE: TANK DATA SHEET - T-A

SHEET 1700-080-001A





25,379 gal.
ATM ATM
35° F 140° F
LEACHATE
1.10 6"
300 gpm 300 gpm
UL–142 NA
70 mph (SBC)
ZONE 1 / SBC
12'–0" 30'–0"

3/8"	C.S.	1/16"	HORIZONTAL	–
–	–	–	–	–
3/8"	C.S.	1/16"	FLAT	–

A	VENT	4"	150# R.F.	TOP		–
B	INLET	2"	150# R.F.	TOP		–
C	INLET	4"	150# R.F.	TOP		–
D	MANWAY	24"	MFG. STD.	TOP CENTER		–
E	OUTLET	2"	150# R.F.	EAST SIDE H16"		–
F	OUTLET	4"	150# R.F.	EAST SIDE H6"		–
G	LEVEL INDICATOR	3"	150# R.F.	TOP		–
H	INLET	4"	150# R.F.	TOP		–
J	INLET	4"	150# R.F.	TOP		–
K	MANWAY	18"	MFG. STD.	WEST SIDE H11"		–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.

EXTERIOR: ALKYD ENAMEL PAINT

Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE		REVISION DESCRIPTION
5.0	08/22		RCRA PART B PERMIT RENEWAL

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PROJECT NO: D3279702

DATE: AUGUST 2022

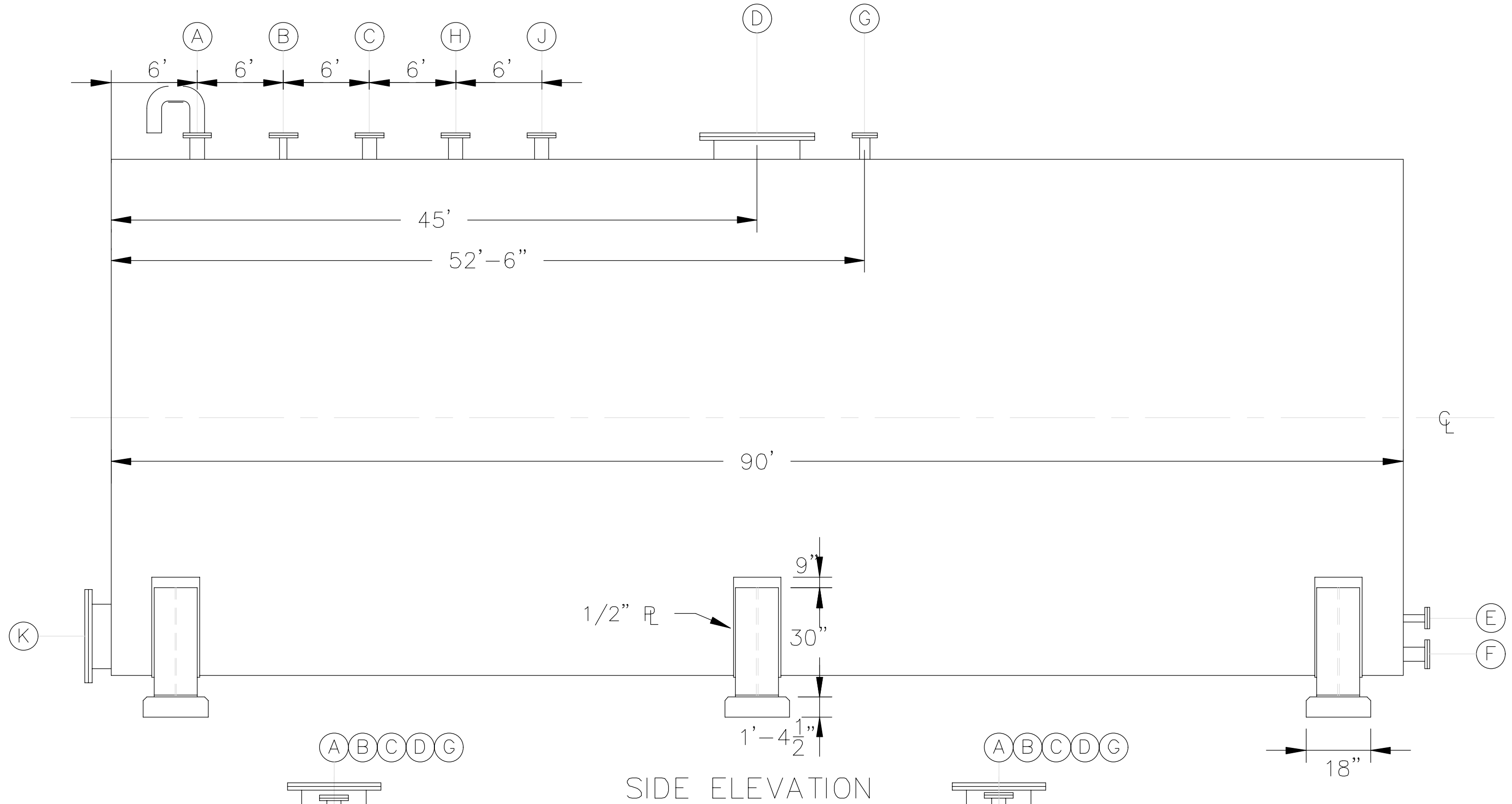
DISC. LEAD: MTF | DESIGNER: RAK | CHECKER: SBT

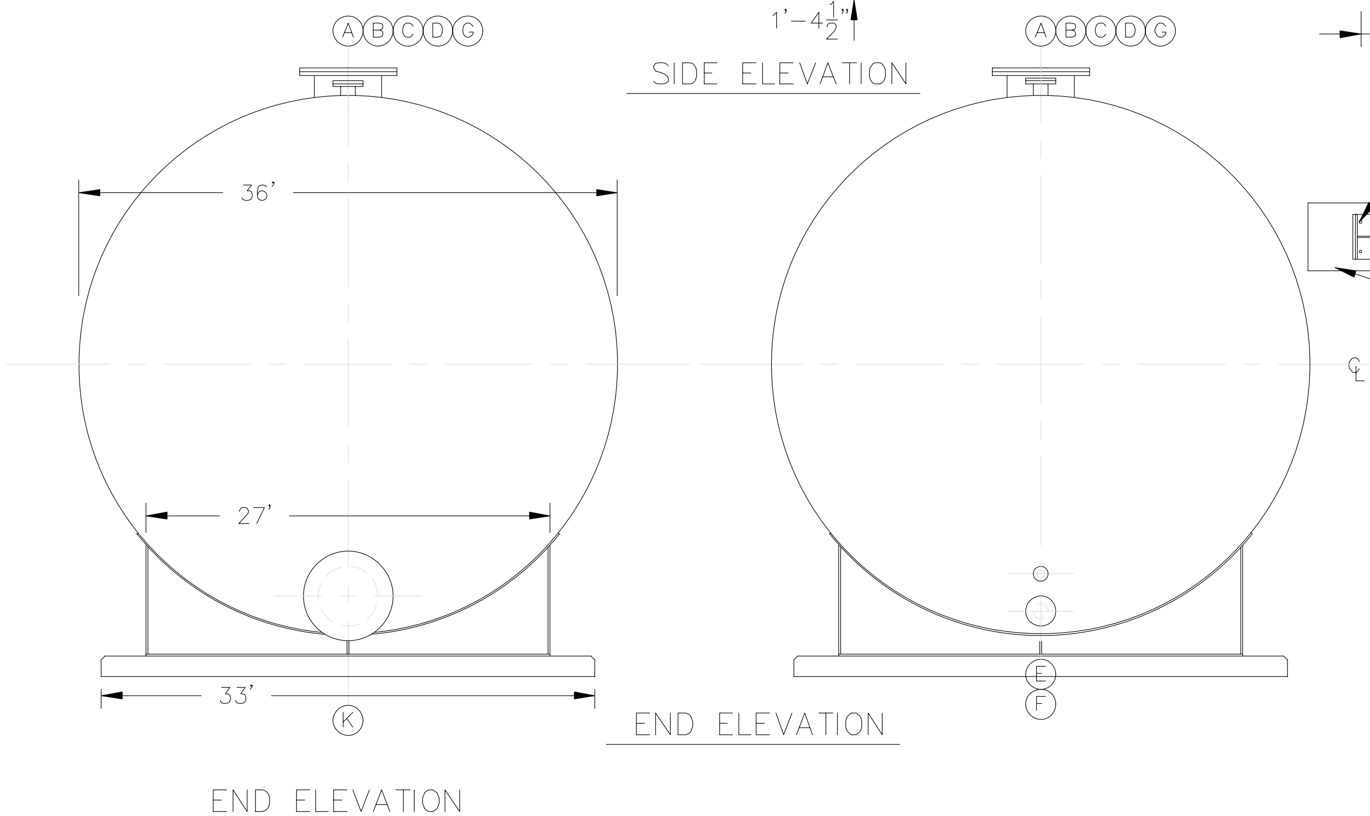
SHEET TITLE

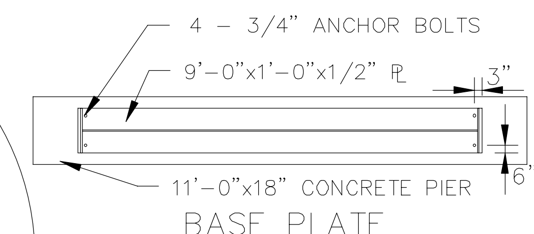
TANK DATA SHEET - T-1702

SHEET 1700-080-002

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022







25,379 gal.
ATM ATM
35° F 140° F
LEACHATE
1.10 6"
300 gpm 300 gpm
UL-142 NA
70 mph (SBC)
ZONE 1 / SBC
12'-0" 30'-0"

3/8" C.S. 1/16" HORIZONTAL –
– – – – –
3/8" C.S. 1/16" FLAT –

A	VENT	4"	150# R.F.	SEE NOTE 1	–
B	INLET	2"	150# R.F.	SEE NOTE 1	–
C	INLET	4"	150# R.F.	SEE NOTE 1	–
D	MANWAY	24"	MFG. STD.	SEE NOTE 1	–
E	OUTLET	2"	150# R.F.	SEE NOTE 1	–
F	OUTLET	4"	150# R.F.	SEE NOTE 1	–
G	LEVEL INDICATOR	3"	150# R.F.	SEE NOTE 1	–
H	INLET	4"	150# R.F.	SEE NOTE 1	–
J	INLET	4"	150# R.F.	SEE NOTE 1	–
K	MANWAY	18"	MFG. STD.	SEE NOTE 1	–

COATINGS:

INTERIOR: DEVOE DEVCHEM 253 EPOXY, OR DEMONSTRATED EQUIVALENT.
EXTERIOR: ALKYD ENAMEL PAINT

NOTES:

1. NOZZLE ORIENTATIONS ARE TYPICAL AND MAY BE SUBJECT TO CHANGE BY OWNER.

CREATED: 10/19/2020 LAST SAVED: 12/3/2020 BY: COSNERM PLOT DATE: 8/23/2022

Jacobs

NOT RELEASED FOR CONSTRUCTION

WM WASTE MANAGEMENT

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF DESIGNER: RAK CHECKER: SBT

SHEET TITLE

TANK DATA SHEET - T-1703 THRU T-1710

SHEET 1700-080-003

EXHIBIT B

TANK DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 1700

TANK NO.: T-1701 TO T-1710 (10 TANKS)

DECRIPTION: 12' Φ x 30' LONG ON 3 SADDLES

VESSEL CALCULATIONS

PREPARED BY: LANZ DATE: 9/30/94

REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
LARRY J. LANG
REGISTERED PROFESSIONAL ENGINEER

OCT 3 1994

UNIT 1700

DESIGN CALCULATIONS

DESIGN DATA SHEET T-1701,T-1702, T-1703, T-1704 Page 1 of 3
T-1705, T-1706, T-1707, T-1708, T-1709, T-1710

Service: Leachate Storage

12 ft Diameter by 30 ft Horizontal Tank on Three Supports

Chemical Waste Management, Emelle, AL Job No. 44228.00

Design Code	UL-142
Service Status	Existing/Proposed
Diameter/Length	12' - 0"
Shell/Heigth	30' - 0"
Bottom/Width	
Heads/Ends Top	Flat
Bottom	
Legs/Wheels	3 Saddles
Operating Capacity	25,379 Gal
Material of Construction	Carbon Steel
Corrosion Allownce	1/16 inch
Joint Efficiency	0.70
Design Spec. Grav	1.10
Design Pressure	Atmospheric
Design Temperature	150 deg F. Max to 0 deg F. MIn.
Roof Live Load psf	NA
Wind Load	SBC, 70 mph
Seismic Zone	Zone 1
Agitator	No
Location	Outdoors

ROSSER
ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJ. NO. SHEET OF

DESIGNED / / CHECKED 11/29/94

UNIT 1700

TANKS T-1701 THRU T-1710 (10)

THESE TANKS ARE 12'-0" DIAMETER, 30'-0" LONG AND FABRICATED OF CARBON STEEL.

TANK VOLUME = AREA · LENGTH

$= \pi R^2 \cdot H = \pi \cdot 6^2 \cdot 30 = \underline{3392.9\ FT^3}$

$= \underline{25,380\ GAL}$

REFERRING TO TABLE 6-1

FOR 1101 TO 35000 GAL

MAX DIAMETER → 144" (12'-0")

MIN METAL THKK = 0.240"

THICKNESS = 0.240 + 1/16" = <u>0.3025"</u>

<u>USE 3/8" PLATE FOR TANK</u>

MAX WEIGHT = VOLUME · DENSITY

= 3392.9 · 62.4 · 1.1 = <u>232,888 #</u>

TANK WEIGHT = AREA · WT/AREA

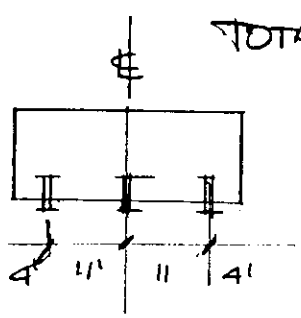
$= (\pi D H + 2\pi R^2)\,15.3 + \text{SADDLES}$

$= 15.3\pi(12 \times 30 + 2 \cdot 12 \cdot 12) + 3000\ (\text{EST})$

= 31,147 + 3000 = <u>34147 POUNDS</u>

TOTAL WEIGHT = <u>264,035 POUNDS</u>

= 8,800#/FT



WT DIST (ASSUME) END SADDLES 96,800#

CENT. SADDLE 83,600#

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT CHEM WASTE MGT PROJ. NO. 4422800

UNIT 1700 T-1701 TO T-1710 SHEET OF

DESIGNED [initials] 9/28/94 CHECKED / /

T-1701 → T-1710

ASSUME MAX MOMENT = $WL^2/8 = \frac{8800 \cdot 12.5^2}{8}$

$= 171,875$ '#

SEC. MOD. $= Z = \pi r^2 t$

$= \pi \cdot 72^2 \cdot 5/16$

$= 5089 \text{ in}^3$

STRESS $= \frac{M}{Z} = \frac{171,875}{5089} \cdot 12$

$= 405$ PSI

STRESS WITH TANK SUPPORTED AT CENTER

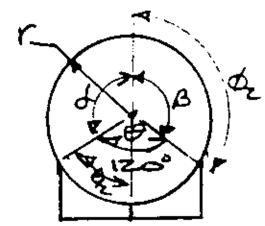
$$M = \frac{WL^2}{2} = \frac{8800 \cdot 15^2}{2} \cdot 12 = 990,000 \cdot 12$$

$$S = \pi r^2 t = \pi \tfrac{5}{16}\left(72 - \tfrac{5}{16}\tfrac{1}{2}\right) = 50673 \text{ in}^3$$

$$\sigma = \frac{990,000 \cdot 12}{5067.3} = 2344 \text{ psi}$$

SHEAR STRESS AT A SADDLE SUPPORTING ONE HALF OF THE TANK WEIGHT

$V = 15 \cdot 8800 = 132,000$ #

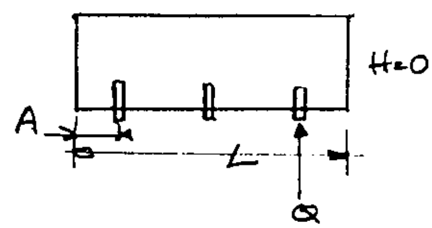


$$S'_2 = (K'_2 Q/rt)\left[\frac{L - 2A - H}{L + H}\right]$$

$K'_2 = 1.171$ when $\phi = \alpha = 120°$

$$S'_2 = 1.171 \cdot 132,000/71.83/.3125 \left[\frac{30 - 2 \cdot 2.5}{30}\right]$$

$$= 6886\left[\frac{25}{30}\right] = 5738 \text{ psi}$$



STRESS ARE ACCEPTABLE FOR 5/8" PLATE

ROSSER BOVAY / ROSSER FABRAP / ROSSER JUSTICE SYSTEMS / ROSSER LOWE / IHT ROSSER	
PROJECT CHEM WASTE MGT	PROJ. NO. 94228.00
UNIT 1700, T-1701 to T-1710	SHEET OF
DESIGNED [signature] 9/28/94	CHECKED / /

11-10-93

LEACHATE TANK T-A

UNIT 1700

CWM - EMELLE, AL

REF. DWG 1700-080-001, 1700-020-002, 1700-040-001 } 11-4-93

DESIGN OF FOUNDATION

A) EMPTY TANK + WIND LOAD

API 650 SECT. 3.11

O.D. = 5'-8" ≈ 5.67'

LENGTH, L = 14.5' + 1.5 = 17'

EMPTY TANK = 700 ~ 800 lbs

CONTENT = 2500 GAL.

S.G. = 1.1

$W_t = \frac{2500 \text{ GAL}}{7.48 \text{ GAL}} \times \frac{1 FT^3}{1 FT} \times 62.4 \times 1.1$

W_t = 22941 lbs ≈ 23000

$q = \left(\frac{100}{100}\right)^2 \times 16 = 16$ PSF

$V_\omega = 16 \times 5.67 \times 17 = 1543$ lbs

$M_\omega = 1543 \times \frac{5.67}{2} = 4375$ FT-lbs

RESISTING MOM, $M_R = 700 \times \frac{4.83}{2} = 1692$ FT-lbs

$\Delta M = 4375 - 1692 = 2683$ FT-lbs

F.S. = 2

11-15-93

ALABAMA REGISTERED No. 18084 PROFESSIONAL ENGINEER SAM M. SHOJAE

ANC. BOLTS FORCE $= \frac{2 \times 2683}{4.83} = 1111.0$ lbs

5 ANC. BOLTS EA. SIDE $= \frac{1111}{5} = 222.2$ lbs

L 3x3x1/4 x 0'-3" W/ GUSSETS OK

USE 1/2"Φ A36 ANC. BOLTS (1/2"Φ THREADED A36 ROD W/ DOUBLE WASHER & DOUBLE NUTS.

11-10-93

DESIGN FOR SEISMIC LOADS (API 650)

$$M = ZI\left(C_1 W_s X_s + \cancel{C_2 W_r H_r}^{\,\to 0} + C_1 W_1 X_1 + C_2 W_2 X_2\right)$$

SEISMIC ZONE 1 → $I = 1.0$ & $Z = 0.1875$

$W_s = 800 = 0.8^{K}$

$X_s = 5.83/2 = 2.915'$

$W_T = 23000$ lbs

ASSUME EQUIV. ROUND TANK WITH $Ht = \sqrt{\frac{5.83^2 \pi}{4}} = 5.16$

$VOL = 2500 \text{ GAL} \times \frac{FT^3}{7.48 \text{ GAL}} = 334.2 \text{ FT}^3$

EQUIV. BASE AREA $= 334.2/5.16 = 64.77 \text{ FT}^2$

EQUIV. DIAMETER $= \sqrt{\frac{64.77 \times 4}{\pi}} = 9.1 \text{ FT}$

$D/H = \frac{9.1}{5.16} = 1.76$

FIG. E-2 $W_1/W_T = 0.68$ — FIG E-3 $X_1/H = 0.38$

$W_2/W_T = 0.40$ — $X_2/H = 0.6$

$0.68 = \frac{W_1}{23000}$ — $W_1 = 15.64^{K}$

$0.40 = \frac{W_2}{23000}$ — $W_2 = 9.2K$

ALABAMA REGISTERED No. 18094 PROFESSIONAL ENGINEER SAM M. SHOJAE

$\frac{X_2}{5.16} = 0.6$ $X_2 = 3.1$

$\frac{X_1}{5.16} = 0.38$ $X_1 = 1.96$

$C_1 = 0.24$ $C_2 = \frac{0.30S}{T}$ $T \leqslant 4.5$

$C_2 = \frac{1.35S}{T^2}$ $T > 4.5$

$S = 1.5$

$T = K(D^{0.5}) = K\sqrt{D}$

$K = 0.6$ FIG. E-4

$T = 0.6\sqrt{9.1} = 1.81 < 4.5$

$C_2 = \frac{0.30 \times 1.5}{1.81} = 0.25$

$M_s = 0.1875 \times 1 \left(0.24 \times 0.8 \times \frac{5.83}{2} + 0.24 \times 15.64 \times 1.96 \right.$

$\left. + 0.25 \times 9.2 \times 3.1 \right)$

$M_s = (0.1875)(15.047)$ $M_s = 2.82^{1K} > M_{WIND}$

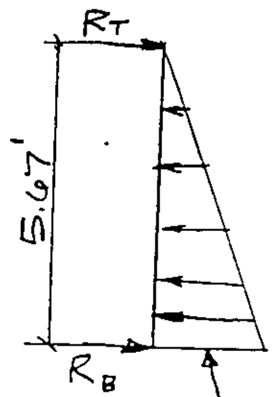
$V_s = 0.1875 \times 1 (0.24 \times 0.8 + 0.24 \times 15.64 + 0.25 \times 9.2) = 1.17$

5 ANC. BOLT FORCE $= \frac{2.82 \times 2 \text{ F.S.}}{4.83} = 1.168^K$

EA. ANC. BOLT $= \frac{1.168}{5} = 0.234^K$ EA.

$\frac{1}{2}$"ϕ A36 <u>OK</u>

CHECK SHELL



ATMOSPHERIC PRESSURE
NO INTERNAL PRESSURE

$H = 5.67'$

$S.G. = 1.1$ BUT USE 1.3 FOR DESIGN

$q = \gamma h = 1.3 \times 62.4 \times 5.67 = 460 \ lbs/FT^2$

$F = 460 \times 5.67/2 = 1304.10$ lbs

$R_T = \frac{1304.1}{3} = 434.7 \ lbs/FT \times 1 FT = 434.7$ lbs

$R_B = \frac{2}{3}(1304.1) = 869.4 \ lbs/FT \times 1 FT = 869.4$ lbs

SHELL THICKNESS = $3/4''$ USE $3/4 - 1/8 = \frac{5}{8} = 0.625''$ (1/8 = C.A.)

ALLOWABLE TENSILE STRESS = $2600 \times 0.5 = 1300$

WORKING HOOP STRESS = $\frac{869.4 \ lbs}{0.625 \times 12} = 115.9$ PSI << 1300 **OK**

CHECK LONGITUDINAL STRESSES.

ASSUME UNIF. PRESS OF 460 PSF. @ ENDS FOR SIMPLICITY

$A = \frac{\pi D^2}{4} = \frac{\pi \times 5.67^2}{4} = 25.23$

$F_{LONG.} = 25.23 \times \frac{460}{1000} = 11.61 \ K$

ALABAMA REGISTERED No. 18054 PROFESSIONAL ENGINEER SAM M. SHOJAE

11-10-93

RESISTING FORCE = 0.625 x CIRC.

$= (0.625 \times \pi \times 5.67') \times 12'' \times \frac{1300}{1000} = 173.6^{K}$

$F.S. = \frac{173.6}{11.61} = 14.95$ OK

CHECK FOR FLEXTURAL STRESSES

SUPPORTS @ $\frac{14.5}{3} = 4.83'$ O/C.

$W = 0.8 + 23 = 23.8^{K}$ TOTAL $\div 14.5' = 1.64$ K/FT

$\ominus M_{MAX} = 0.1071 \times 1.64 \times 4.83^2 = 4.1$ 'K REF AISC

$+M_{MAX} = 0.0772 \times 1.64 \times 4.83^2 = 2.96$ 'K

$f_b = \frac{M}{S}$

$d_O = 5.67 \times 12 = 68''$

$d_I = 68 - (0.75 \times 2) = 66.5$

$S = 0.098175 \left(\frac{d_o^4 - d_I^4}{d_o} \right) =$

$S = 0.09817 \left(\frac{68^4 - 66.5^4}{68} \right) = 26839.4 \ IN^3$

$f_b = \frac{2.96 \times 12}{26839.4} \times 1000 = 1.32$ PSI TOO SMALL

OK 1.32 ≪ 1300 PSI

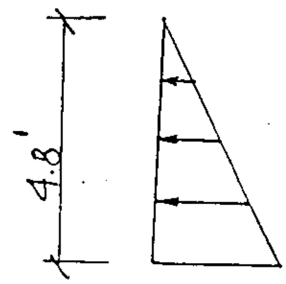
TENSION & COMPRESSION BOTH OK (TOO SMALL)

ALABAMA REGISTERED No. 18694 PROFESSIONAL ENGINEER SAM M. SHOJAE

11-10-93

P.6

CHECK CONTAINMENT CURB:



$q = 1.3 \times 62.4 \times 4.8 = 389.4 \frac{lbs}{FT}$

$m = 389.4 \times \frac{4.8^2}{2 \times 3} = 1495$ FT-lbs

$m_u = 1.7 \times \frac{1495}{1000} = 2.54^{1K}$

VERT. REINFORCING #4@6" O.C. $= 0.2 \times 2 = 0.4 \frac{IN^2}{FT}$

$a = \frac{60 \times 0.4}{0.85 \times 3 \times 12} = 0.78''$

$\phi M_n = 0.9 \times \frac{60}{12} \times 0.4 \left(4'' - \frac{0.78}{2}\right) = 6.5^{1K} > 2.54^{1K}$ OK ✓

COLUMNS ARE OK CHECK BY INPECTION
BRACED BOTH DIRECTION

CHECK BEARING: ASSUME $q_{ALLOW} = 2500$

$Wt = 23^K$ CONTENT $+ 1^K$ TANK $= 24^K$

SLAB = 2' THICK = $2 \times 0.15 = 0.3$ KSF

$q_b = \frac{23+1}{14 \times 8} = 0.215$ KSF ASSUME 8' WIDE

$q_T = 0.215 + 0.3 = 0.315$ TOO SMALL $\ll 2500$

OK

ALABAMA REGISTERED PROFESSIONAL ENGINEER No. 18094 SAM M. SHOJAE

EXHIBIT C

TANK FOUNDATION DESIGN CALCULATIONS

CHEMICAL WASTE MANAGEMENT CO.

EMELLE, ALABAMA FACILITY

CALCULATION COVER SHEET

UNIT: 1700

TANK NO.: T-1701 THRU T-1710

DECRIPTION: LEACHATE TANKS

FOUNDATION CALCULATIONS

PREPARED BY: S.SMITH DATE: 9-19-94

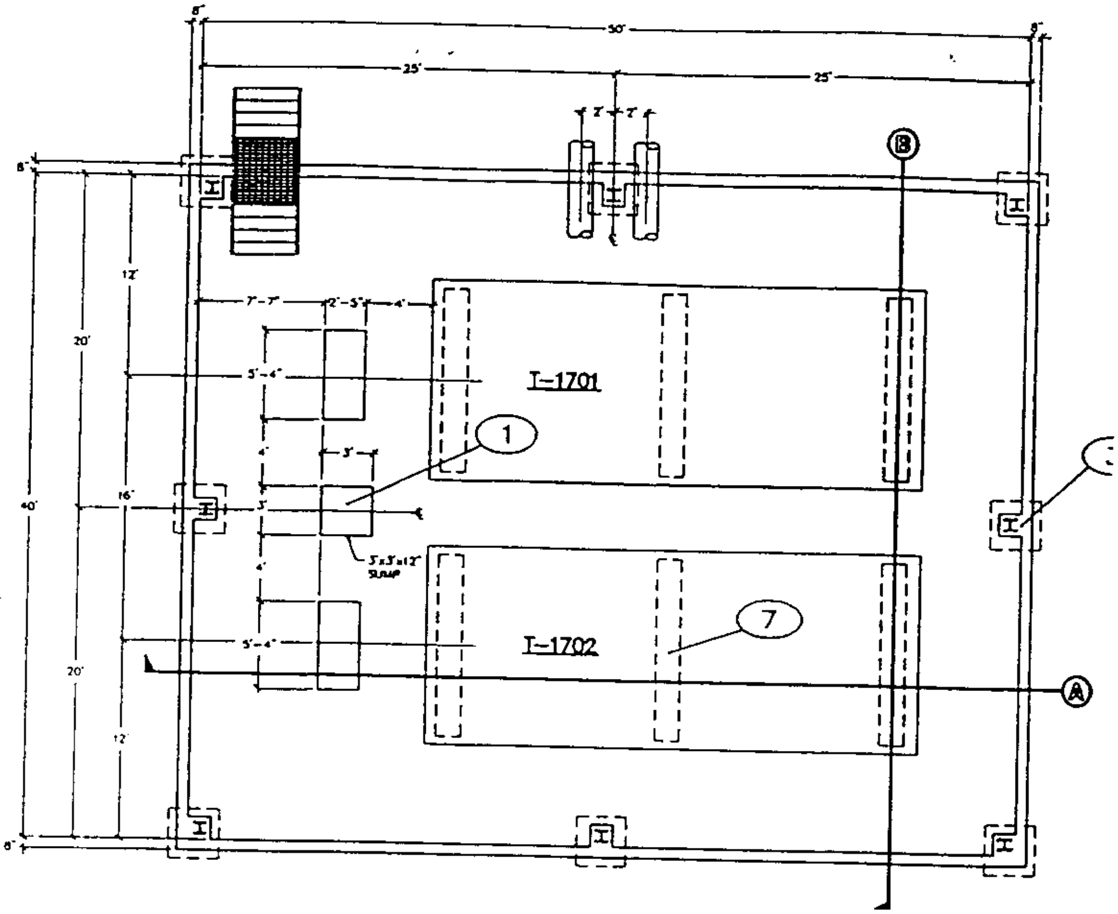
REV. NO.	DATE	BY	CHK	APPVD.	PAGES	REMARKS

ATTACHMENTS: PRIOR CALCULATIONS HAVE BEEN INCLUDED TO SUPPLEMENT THE DATA USED IN THE CALCULATIONS.

STATE OF TEXAS
SCOTT R. SMITH
60612
REGISTERED
PROFESSIONAL ENGINEER

10-3-94

FOUNDATIONS FOR TANKS T-1701 TO T-1710



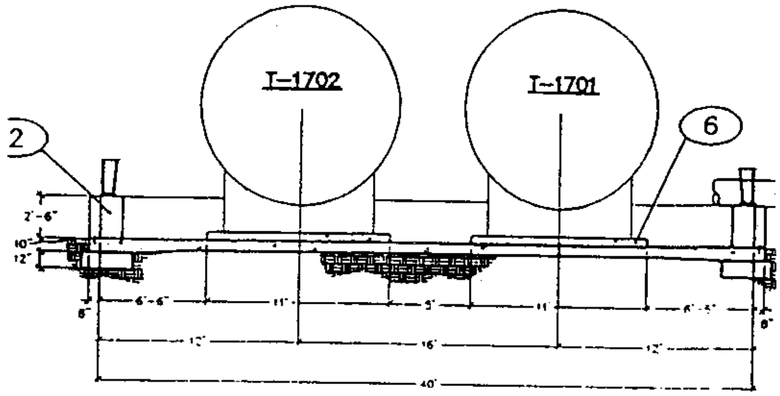
PLAN

f'_c - 3,000 psi

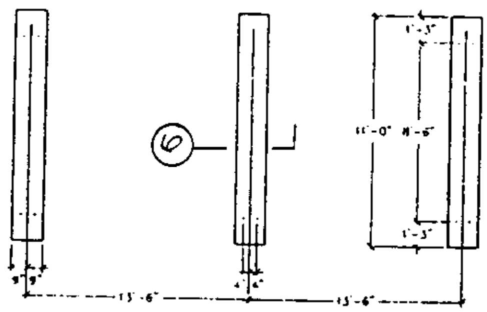
f_y = 60,000 psi

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT Chem Waste Management Emelle, Ala DESIGNED S. Smith 9/19/94	PROJ. NO. SHEET SK-1 OF CHECKED / /

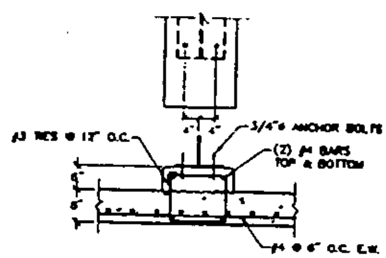
FOUNDATIONS FOR TANKS T-1701 TO T-1710



(B) SECTION THRU LEACHATE STORAGE UNIT
REF. DWG 1700-020-003
SCALE: 1/4" = 1'-0"



(7) PLAN VIEW OF TANK PEDESTAL
REF. DWG 1700-020-003
SCALE: 1" = 1'-0"



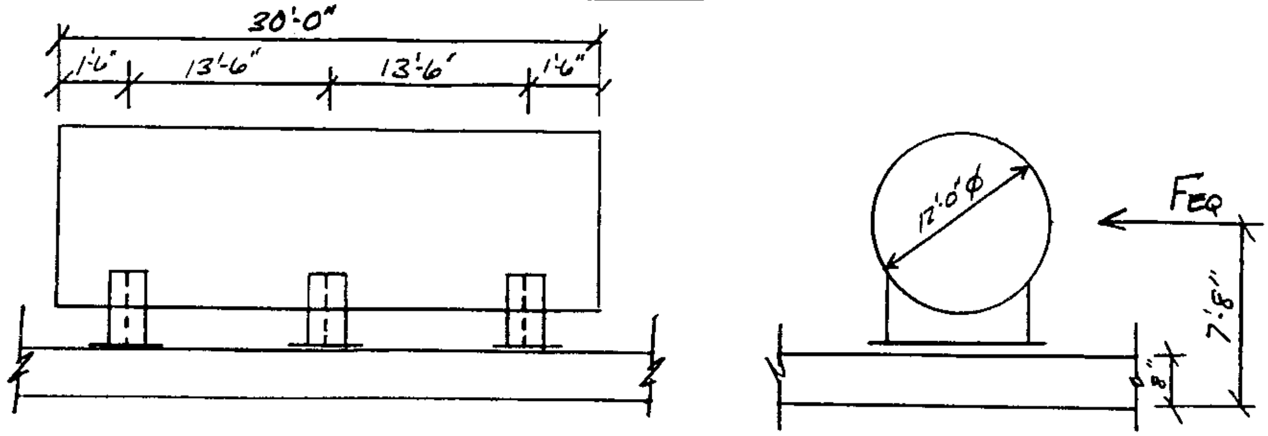
(6) SECTION THRU TANK PEDESTAL
REF. DWG 1700-020-003
SCALE: 1" = 1'-0"

ROSSER

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management		PROJ. NO.	
Emelle, Ala.		SHEET SK-2	OF
DESIGNED S. Smith	9/19/94	CHECKED	/ /

FOUNDATIONS FOR TANKS T-1701 TO T-1710



WEIGHT OF TANK

ENDS $\frac{\pi (12)^2}{4} \times 15.3\#/SF = 1{,}703\#$

SHELL $= \pi (12.0)(30) \times 15.3\#/SF = 17{,}303\#$

SADDLES ≈ 3,000#

SUBTOTAL = 22,006#

NOZZLES & VALVES (5%) = 1,100#

W_E = 23,106#

WEIGHT OF CONTENTS

CAPACITY = 25,379 GALLONS

SP. GR. = 1.1

$W_C = 25{,}379\ GAL \times 1.1 \times 8.34\#/GAL = 232{,}826\#$

EARTHQUAKE LOAD (S.B.C. 1994)

$F_{EQ} = A_V \times C_C \times P \times a_C \times W_T$

$A_V = 0.06$
$C_C = 2.00$ (GEN EQUIP.)
$P = 0.50$ (" ")
$a_C = 1.0$ (FIXED)
$W_T = W_E + W_C = 23{,}106\# + 232{,}826\# = 255{,}932\#$

$F_{EQ} = 0.06 \times 2.00 \times 0.50 \times 1.0 \times 255{,}932\# = 15{,}355\#$

ROSSER BOVAY ROSSER FABRAP ROSSER JUSTICE SYSTEMS ROSSER LOWE IHT ROSSER	PROJECT CHEM WASTE MANAGEMENT	PROJ. NO.
	EMELLE, ALA	SHEET 1 OF
	DESIGNED S. SMITH 9/19/94	CHECKED / /

FOUNDATIONS FOR TANKS T-1701 TO T-1710

SADDLE REACTIONS

CENTER SADDLE = DL = $13.5/30 \times 23{,}106^{\#}$ = 10,397#

LL = $13.5/30 \times 232{,}826^{\#}$ = 104,771#

END SADDLES = DL $8.25/30 \times 23{,}106^{\#}$ = 6,354#

LL $8.25/30 \times 232{,}826^{\#}$ = 64,027#

STAAD III INPUT (LOADING)

DEAD LOAD

ELEMENT LOAD = 10,397#/4EL = 2,599#/16FT² = 162# (5) (14) (23) (32)

JOINT LOAD = 6,354#/3 JOINTS = 2,118# JTS 12, 22, 32, 19, 29, 39

LIVE LOAD

ELEMENT LOAD = 104,771#/4EL = 26,192#/16 = 1,637# (5) (14) (23) (32)

JOINT LOAD = 64,027#/3 JOINTS = 21,342# JTS 12, 22, 32, 19, 29, 39

EARTHQUAKE LOAD

FEQ = 15,355# $S = \frac{1.5(11.0)^2}{6} = 30.25 FT^3$

M = 15,355# × 7.66' = 117,619#

$R = \frac{M}{S} = \frac{117{,}619^{\#}}{30.25(3)} = 1{,}296^{\#}$

ELEMENT LOAD 1,296#/16FT² = 81.00# ↓ (32)

81.00# ↑ (5)

JOINT LOAD 1,296# ↓ JT 32, 39

1,296# ↑ JT 12, 19

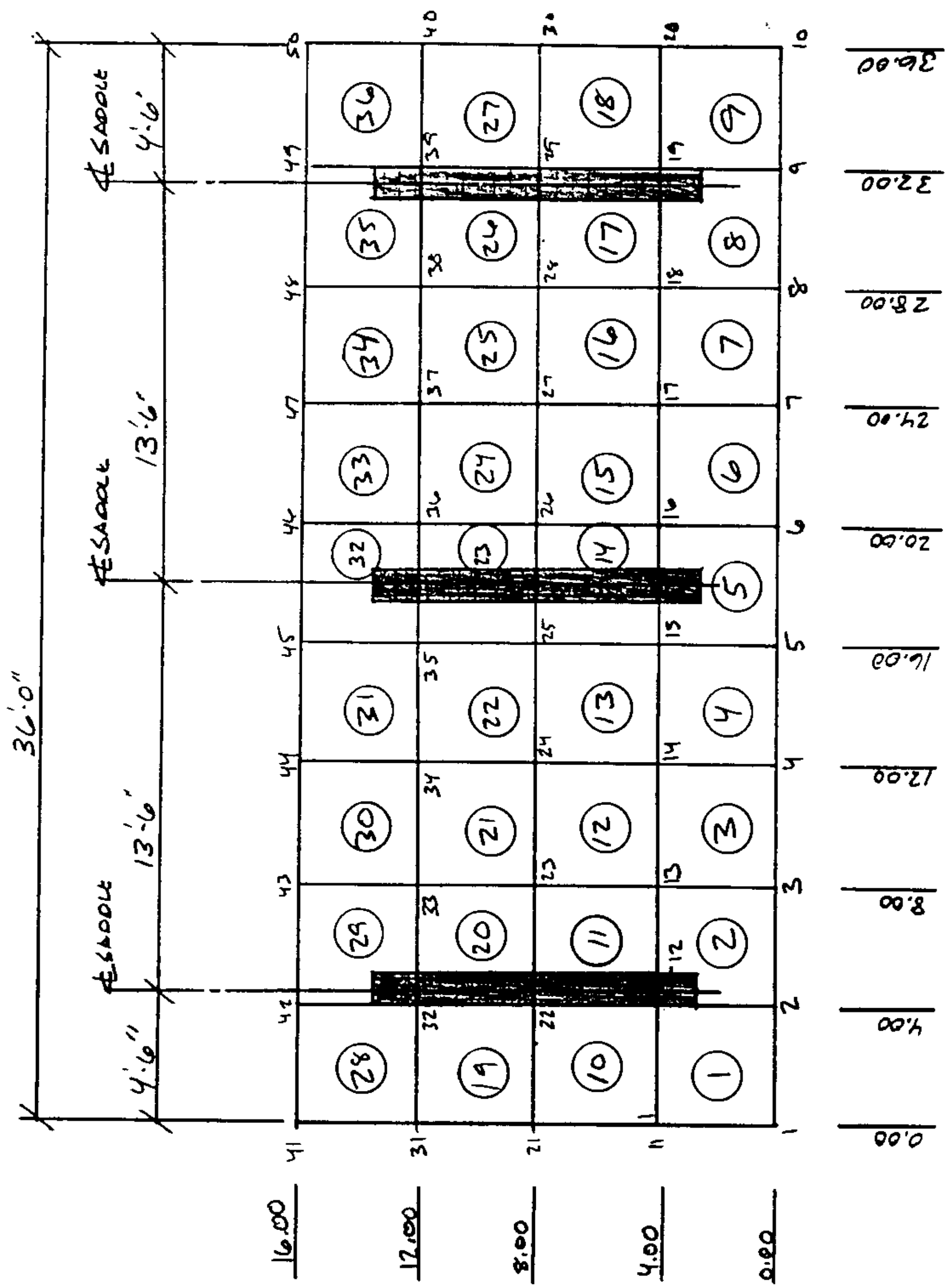
ROSSER

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT CHEM WASTE MANAGEMENT PROJ. NO.

EMELLE, ALA SHEET 2 OF

DESIGNED S. SMITH 9/19/94 CHECKED / /



ROSSER

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management PROJ. NO.

Emelle, Ala SHEET 3 OF

DESIGNED S. Smith 9/19/94 CHECKED / /

FOUNDATIONS FOR TANKS T-1701 TO T-1710

CHECK SOIL BEARING

MAXIMUM JOINT DISPLACEMENT
OCCURS @ JT 6

S.B. = 0.1877 × 0.073 $^{K}/_{ci}$ × 144 $^{IN^2}/_{FT}$ 1.97 KSF ≤ 4,000 psf ∴ OK

MAXIMUM MOMENT @ ELEMENT 5 LOAD CASE 5

$M_u = 4.74^{K\text{-}F}$

TRY #4 @ 6" % $A_s = 0.40 \text{ IN}^2$

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.40(60)}{0.85(3)(12)} = 0.78 \text{ in}$

$d = 8" - 3" - 0.5/2 = 4.75"$

$\phi M_n = 0.9(0.40)(60)(4.75" - 0.78/2) = 94.17^{K\text{-}IN} = 7.85^{K\text{-}F}$

$\phi M_n = 7.85^{K\text{-}F} \geq M_u = 4.74^{K\text{-}F}$ ∴ BENDING OK

USE #4 @ 6" % E.W.

DESIGN ANCHOR BOLTS

MAX SHEAR = 15,355# / 6 EFF BOLTS = 2,555#

TRY 3/4"Ø A-307 ANCHOR BOLTS

$V_{ALLOW} = 4.4^K \geq V_{ACT} = 2.56^K$ ∴ OK

USE 3/4"Ø (A-307) A.B.

ROSSER BOVAY
ROSSER FABRAP
ROSSER JUSTICE SYSTEMS
ROSSER LOWE
IHT ROSSER

PROJECT Chem Waste Management PROJ. NO.

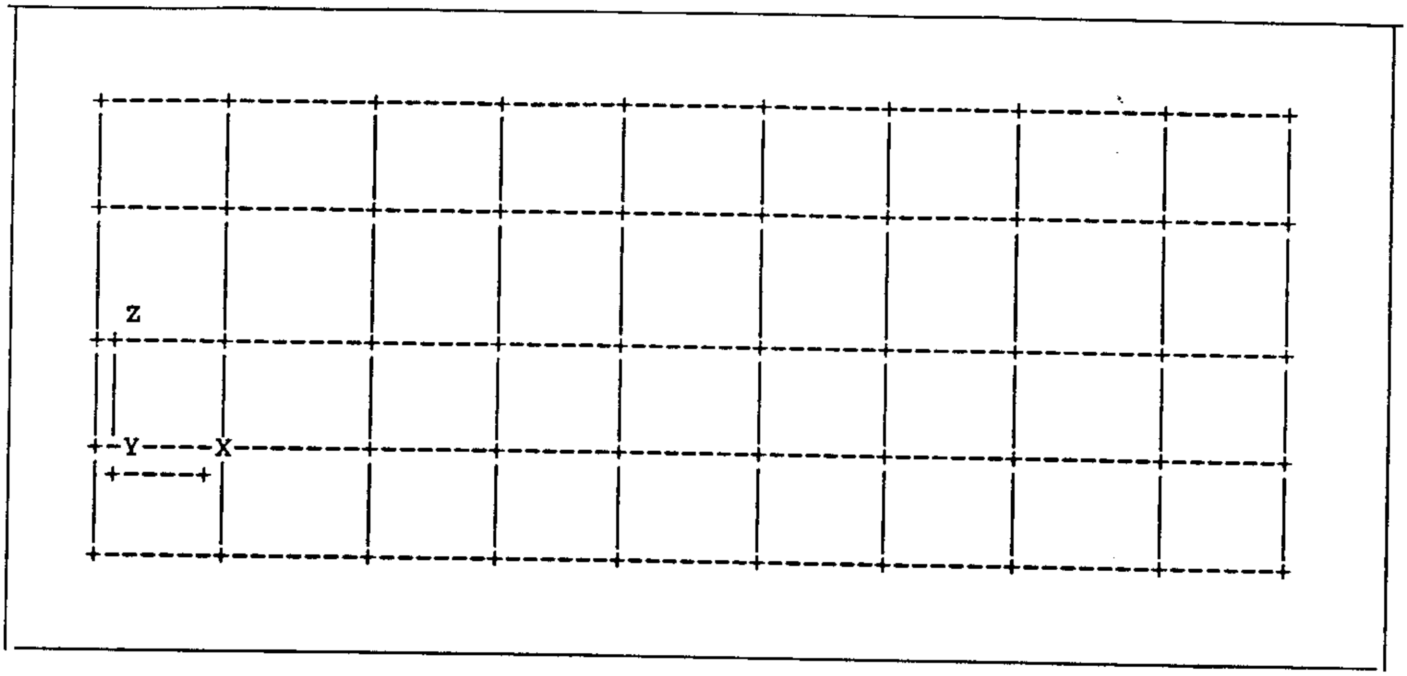
Emelle, Ala SHEET 4 OF

DESIGNED S. Smith 9/19/94 CHECKED / /

```
**************************************************
*                                                *
*              S T A A D - III                   *
*              REVISION 15.0 (VERSION 15 LEVEL 0) *
*              PROPRIETARY PROGRAM OF            *
*              RESEARCH ENGINEERS,INC.           *
*              DATE=    SEP 20, 1994             *
*              TIME=    10:26: 7                 *
*                                                *
**************************************************
```

```
STAAD SPACE "CHEM WASTE MANAGEMENT"
*
*******************************************************************
*            CHEM WASTE MANAGEMENT
*            EMELLE, ALABAMA
*
*            TANK NO. T-1701 TO T-1710
*
*     FILE NAME "
*
*     DESIGNED BY SCOTT SMITH
*
*******************************************************************
UNIT KIPS FEET
*
*
JOINT COORDINATES
1    0    0    0     ; 2    4.00   0   0      9   32.00  0.0  0.0
10  36.0  0    0
11   0    0   4.0    ; 12   4.00   0   4.0    19   32.00  0.0  4.0
20  36.0  0   4.0
21   0    0   8.00   ; 22   4.00   0   8.00   29   32.00  0.0  8.0
30  36.0  0   8.00
31   0    0  12.00   ; 32   4.00   0   12.00  39   32.00  0.0  12.00
40  36.0  0  12.00
41   0    0  16.00   ; 42   4.00   0   16.00  49   32.00  0.0  16.00
50  36.0  0  16.00
*
*******************************************************************
*
*    MAT FOUNDATION  ELEMENTS
*
*******************************************************************
ELEMENT INCIDENCES
1    11    12    2    1    TO    9
10   21    22    12   11   TO    18
19   31    32    22   21   TO    27
28   41    42    32   31   TO    36
*
*******************************************************************
UNITS KIP INCHES
*
*
* MAT FOUNDATION ELEMENTS
*
ELEMENT PROPERTIES
1      TO   36        TH   8
*******************************************************************
```

```
*
SUPPORTS
*
*  MODULUS OF SUBGRADE REACTION, K = 0.073 K/IN^3 X 144 IN^2/FT^2
*                                  = 10.52 K/FT^2/IN
*  SPRING CONSTANT
* JOINTS 1, 10, 41 50              = 1/4(4X4)(K) =42.080 K/IN
* JOINTS 11 20 21 30 31 40 41 50 =1/2(4X4)(K) = 84.160 K/IN
* JOINTS 12 13 14 15 16 17 18 19 = (4X4)(K) = 168.320 K/IN
* JOINTS 22 23 24 25 26 27 28 29 = (4X4)(K) = 168.320 K/IN
* JOINTS 32 33 34 35 36 37 38 39 = (4X4)(K) = 168.320 K/IN
* JOINTS 42 43 44 45 46 47 48 49 = (4X4)(K) = 168.320 K/IN
*
*
1 10 41 50                          FIXED BUT MX MY MZ KFY 42.080
11 20 21 30 31 40 41 50             FIXED BUT MX MY MZ KFY 84.160
12 TO 19 22 TO 29 32 TO 39 42 TO 49 FIXED BUT MX MY MZ KFY 168.32
*
*********************************************************************
*
UNITS KIP FEET
*
*  CONCRETE STRENGTH = 3000 PSI
*  CONCRETE UNIT WT. = 150 PCF
*       E(CONC.) = 57000(SQ. RT. OF CONC. STRENGTH)
*
CONSTANTS
E  449571  ALL
POIS   0.2 ALL
DEN  0.15  ALL
*********************************************************************
PLOT PLAN XZ 0.
```


Z
Y
X

```
*********************************************************************
*
LOADING 1  DEAD LOAD
*
SELFWEIGHT
*
ELEMENT LOAD
5 14 23 32            PR  -0.162
*
JOINT LOADS
12 22 32    FY -2.118
19 29 39    FY -2.118
*******************************************************************
LOADING 2 LIVE LOAD
*
ELEMENT LOAD
5 14 23 32            PR -1.637
*
JOINT LOADS
12 22 32    FY -21.342
19 29 39    FY -21.342
*********************************************************************
LOADING 3 EARTHQUAKE LOAD
*
ELEMENT LOAD
5             PR 0.081
32            PR -0.081
*
JOINT LOADS
12 19         FY 1.296
32 39         FY 1.296
*********************************************************************
LOAD COMBINATION 4
1 1.0  2 1.0  3 1.0
*********************************************************************
LOAD COMBIMATION 5
1 1.4  2  1.7
*********************************************************************
LOAD COMBINATION 6
1  1.05  2  1.275  3  1.275
**********************************************************************
PERFORM ANALYSIS PRINT ALL
```

P R O B L E M   S T A T I S T I C S

```
NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     50/    36/    44
ORIGINAL/FINAL BAND-WIDTH =   11/   10
TOTAL PRIMARY LOAD CASES  =    3, TOTAL DEGREES OF FREEDOM =    300
SIZE OF STIFFNESS MATRIX =   19800 DOUBLE PREC. WORDS
TOTAL REQUIRED DISK SPACE =   12.54 MEGA-BYTES
```

LOADING 1 DEAD LOAD

SELFWEIGHT Y -1.000

ACTUAL WEIGHT OF THE STRUCTURE = 57.600 KIP

ELEMENT LOAD (UNITS ARE KIP FEET)

ELEMENT	PRESSURE
5	-0.162000
14	-0.162000
23	-0.162000
32	-0.162000

JOINT LOAD - UNIT KIP FEET

JOINT	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM-Z
12	0.00	-2.12	0.00	0.00	0.00	0.00
22	0.00	-2.12	0.00	0.00	0.00	0.00
32	0.00	-2.12	0.00	0.00	0.00	0.00
19	0.00	-2.12	0.00	0.00	0.00	0.00
29	0.00	-2.12	0.00	0.00	0.00	0.00
39	0.00	-2.12	0.00	0.00	0.00	0.00

***TOTAL APPLIED LOAD (KIP FEET) SUMMARY (LOADING 1)
SUMMATION FORCE-X = 0.00
SUMMATION FORCE-Y = -80.68
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= 645.41 MY= 0.00 MZ= -1452.17

LOADING 2 LIVE LOAD

ELEMENT LOAD (UNITS ARE KIP FEET)

ELEMENT	PRESSURE
5	-1.637000
14	-1.637000
23	-1.637000
32	-1.637000

JOINT LOAD - UNIT KIP FEET

JOINT	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM-Z
12	0.00	-21.34	0.00	0.00	0.00	0.00
22	0.00	-21.34	0.00	0.00	0.00	0.00
32	0.00	-21.34	0.00	0.00	0.00	0.00
19	0.00	-21.34	0.00	0.00	0.00	0.00
29	0.00	-21.34	0.00	0.00	0.00	0.00
39	0.00	-21.34	0.00	0.00	0.00	0.00

***TOTAL APPLIED LOAD (KIP FEET) SUMMARY (LOADING 2)
SUMMATION FORCE-X = 0.00
SUMMATION FORCE-Y = -232.82
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= 1862.56 MY= 0.00 MZ= -4190.76

LOADING 3 EARTHQUAKE LOAD

ELEMENT LOAD (UNITS ARE KIP FEET)

ELEMENT	PRESSURE
5	0.081000
32	-0.081000

JOINT LOAD - UNIT KIP FEET

JOINT	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM-Z
12	0.00	1.30	0.00	0.00	0.00	0.00
19	0.00	1.30	0.00	0.00	0.00	0.00
32	0.00	1.30	0.00	0.00	0.00	0.00
39	0.00	1.30	0.00	0.00	0.00	0.00

***TOTAL APPLIED LOAD (KIP FEET) SUMMARY (LOADING 3)
SUMMATION FORCE-X = 0.00
SUMMATION FORCE-Y = 5.18
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= -25.92 MY= 0.00 MZ= 93.31

++ PROCESSING ELEMENT STIFFNESS MATRIX. 10:26:14
++ PROCESSING GLOBAL STIFFNESS MATRIX. 10:26:16
++ PROCESSING TRIANGULAR FACTORIZATION. 10:26:20

```
***WARNING - IMPROPER LOAD WILL CAUSE INSTABILITY AT JOINT   50
  DIRECTION = MY  PROBABLE CAUSE MODELING PROBLEM     0.587E-06
++ CALCULATING JOINT DISPLACEMENTS.                  10:26:28
++ CALCULATING ELEMENT FORCES.                       10:26:32


***TOTAL REACTION ( KIP  FEET ) SUMMARY


LOADING     1

SUM-X=          0.00  SUM-Y=       81.75  SUM-Z=          0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=          -662.56  MY=           0.00  MZ=         1471.46

LOADING     2

SUM-X=          0.00  SUM-Y=      234.72  SUM-Z=          0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=         -1893.00  MY=           0.00  MZ=         4225.00

LOADING     3

SUM-X=          0.00  SUM-Y=       -5.31  SUM-Z=          0.00

SUMMATION OF MOMENTS AROUND ORIGIN-

MX=            28.00  MY=           0.00  MZ=          -95.65

LOAD COMBINATION NO.      4
 4

LOADING-    1.    2.    3.
FACTOR -  1.00  1.00  1.00

LOAD COMBINATION NO.      5
 5

LOADING-    1.    2.
FACTOR -  1.40  1.70

LOAD COMBINATION NO.      6
 6

LOADING-    1.    2.    3.
FACTOR -  1.05  1.27  1.27

************ END OF DATA FROM INTERNAL STORAGE ************

122. LOAD LIST 1 2 3 4
123. PRINT JOINT DISPLACEMENTS
```

JOINT DISPLACEMENT (INCH RADIANS)   STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
1	1	0.00000	-0.02082	0.00000	-0.00012	0.00000	-0.00022
	2	0.00000	-0.03592	0.00000	0.00032	0.00000	-0.00053
	3	0.00000	0.00231	0.00000	0.00000	0.00000	0.00003
	4	0.00000	-0.05442	0.00000	0.00020	0.00000	-0.00072
2	1	0.00000	-0.03216	0.00000	-0.00030	0.00000	-0.00014
	2	0.00000	-0.05715	0.00000	0.00000	0.00000	-0.00021
	3	0.00000	0.00360	0.00000	0.00002	0.00000	0.00001
	4	0.00000	-0.08571	0.00000	-0.00028	0.00000	-0.00034
3	1	0.00000	-0.03788	0.00000	-0.00040	0.00000	-0.00007
	2	0.00000	-0.06720	0.00000	-0.00038	0.00000	-0.00011
	3	0.00000	0.00401	0.00000	0.00004	0.00000	0.00000
	4	0.00000	-0.10107	0.00000	-0.00075	0.00000	-0.00018
4	1	0.00000	-0.04262	0.00000	-0.00048	0.00000	-0.00010
	2	0.00000	-0.09416	0.00000	-0.00087	0.00000	-0.00086
	3	0.00000	0.00478	0.00000	0.00006	0.00000	0.00003
	4	0.00000	-0.13200	0.00000	-0.00129	0.00000	-0.00094
5	1	0.00000	-0.04839	0.00000	-0.00058	0.00000	-0.00007
	2	0.00000	-0.14597	0.00000	-0.00176	0.00000	-0.00063
	3	0.00000	0.00669	0.00000	0.00011	0.00000	0.00002
	4	0.00000	-0.18767	0.00000	-0.00223	0.00000	-0.00067
6	1	0.00000	-0.04839	0.00000	-0.00058	0.00000	0.00007
	2	0.00000	-0.14597	0.00000	-0.00176	0.00000	0.00063
	3	0.00000	0.00669	0.00000	0.00011	0.00000	-0.00002
	4	0.00000	-0.18767	0.00000	-0.00223	0.00000	0.00067
7	1	0.00000	-0.04262	0.00000	-0.00048	0.00000	0.00010
	2	0.00000	-0.09416	0.00000	-0.00087	0.00000	0.00086
	3	0.00000	0.00478	0.00000	0.00006	0.00000	-0.00003
	4	0.00000	-0.13200	0.00000	-0.00129	0.00000	0.00094
8	1	0.00000	-0.03788	0.00000	-0.00040	0.00000	0.00007
	2	0.00000	-0.06720	0.00000	-0.00038	0.00000	0.00011
	3	0.00000	0.00401	0.00000	0.00004	0.00000	0.00000
	4	0.00000	-0.10107	0.00000	-0.00075	0.00000	0.00018
9	1	0.00000	-0.03216	0.00000	-0.00030	0.00000	0.00014
	2	0.00000	-0.05715	0.00000	0.00000	0.00000	0.00021
	3	0.00000	0.00360	0.00000	0.00002	0.00000	-0.00001
	4	0.00000	-0.08571	0.00000	-0.00028	0.00000	0.00034
10	1	0.00000	-0.02082	0.00000	-0.00012	0.00000	0.00022
	2	0.00000	-0.03592	0.00000	0.00032	0.00000	0.00053
	3	0.00000	0.00231	0.00000	0.00000	0.00000	-0.00003
	4	0.00000	-0.05442	0.00000	0.00020	0.00000	0.00072
11	1	0.00000	-0.01527	0.00000	-0.00012	0.00000	-0.00016
	2	0.00000	-0.04363	0.00000	0.00016	0.00000	-0.00057
	3	0.00000	0.00183	0.00000	0.00001	0.00000	0.00003
	4	0.00000	-0.05707	0.00000	0.00006	0.00000	-0.00070
12	1	0.00000	-0.02049	0.00000	-0.00018	0.00000	-0.00006
	2	0.00000	-0.06146	0.00000	0.00002	0.00000	0.00002
	3	0.00000	0.00291	0.00000	0.00002	0.00000	0.00000
	4	0.00000	-0.07904	0.00000	-0.00013	0.00000	-0.00004

JOINT DISPLACEMENT (INCH RADIANS) STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
13	1	0.00000	-0.02094	0.00000	-0.00027	0.00000	0.00000
	2	0.00000	-0.04710	0.00000	-0.00031	0.00000	0.00022
	3	0.00000	0.00210	0.00000	0.00003	0.00000	-0.00001
	4	0.00000	-0.06593	0.00000	-0.00054	0.00000	0.00021
14	1	0.00000	-0.02214	0.00000	-0.00033	0.00000	-0.00006
	2	0.00000	-0.05276	0.00000	-0.00073	0.00000	-0.00050
	3	0.00000	0.00190	0.00000	0.00005	0.00000	0.00001
	4	0.00000	-0.07300	0.00000	-0.00101	0.00000	-0.00055
15	1	0.00000	-0.02495	0.00000	-0.00036	0.00000	-0.00004
	2	0.00000	-0.07973	0.00000	-0.00095	0.00000	-0.00044
	3	0.00000	0.00235	0.00000	0.00007	0.00000	0.00001
	4	0.00000	-0.10233	0.00000	-0.00124	0.00000	-0.00048
16	1	0.00000	-0.02495	0.00000	-0.00036	0.00000	0.00004
	2	0.00000	-0.07973	0.00000	-0.00095	0.00000	0.00044
	3	0.00000	0.00235	0.00000	0.00007	0.00000	-0.00001
	4	0.00000	-0.10233	0.00000	-0.00124	0.00000	0.00048
17	1	0.00000	-0.02214	0.00000	-0.00033	0.00000	0.00006
	2	0.00000	-0.05276	0.00000	-0.00073	0.00000	0.00050
	3	0.00000	0.00190	0.00000	0.00005	0.00000	-0.00001
	4	0.00000	-0.07300	0.00000	-0.00101	0.00000	0.00055
18	1	0.00000	-0.02094	0.00000	-0.00027	0.00000	0.00000
	2	0.00000	-0.04710	0.00000	-0.00031	0.00000	-0.00022
	3	0.00000	0.00210	0.00000	0.00003	0.00000	0.00001
	4	0.00000	-0.06593	0.00000	-0.00054	0.00000	-0.00021
19	1	0.00000	-0.02049	0.00000	-0.00018	0.00000	0.00006
	2	0.00000	-0.06146	0.00000	0.00002	0.00000	-0.00002
	3	0.00000	0.00291	0.00000	0.00002	0.00000	0.00000
	4	0.00000	-0.07904	0.00000	-0.00013	0.00000	0.00004
20	1	0.00000	-0.01527	0.00000	-0.00012	0.00000	0.00016
	2	0.00000	-0.04363	0.00000	0.00016	0.00000	0.00057
	3	0.00000	0.00183	0.00000	0.00001	0.00000	-0.00003
	4	0.00000	-0.05707	0.00000	0.00006	0.00000	0.00070
21	1	0.00000	-0.01269	0.00000	-0.00003	0.00000	-0.00007
	2	0.00000	-0.04715	0.00000	-0.00005	0.00000	-0.00051
	3	0.00000	0.00165	0.00000	0.00000	0.00000	0.00002
	4	0.00000	-0.05819	0.00000	-0.00008	0.00000	-0.00056
22	1	0.00000	-0.01493	0.00000	-0.00007	0.00000	0.00001
	2	0.00000	-0.05916	0.00000	-0.00011	0.00000	0.00020
	3	0.00000	0.00183	0.00000	0.00001	0.00000	-0.00001
	4	0.00000	-0.07226	0.00000	-0.00017	0.00000	0.00020
23	1	0.00000	-0.01307	0.00000	-0.00009	0.00000	0.00005
	2	0.00000	-0.03632	0.00000	-0.00017	0.00000	0.00053
	3	0.00000	0.00113	0.00000	0.00001	0.00000	-0.00003
	4	0.00000	-0.04826	0.00000	-0.00025	0.00000	0.00056
24	1	0.00000	-0.01251	0.00000	-0.00010	0.00000	-0.00002
	2	0.00000	-0.03153	0.00000	-0.00024	0.00000	-0.00028
	3	0.00000	0.00020	0.00000	0.00002	0.00000	-0.00001
	4	0.00000	-0.04384	0.00000	-0.00032	0.00000	-0.00031

JOINT DISPLACEMENT (INCH RADIANS) STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
25	1	0.00000	-0.01444	0.00000	-0.00011	0.00000	-0.00003
	2	0.00000	-0.05214	0.00000	-0.00031	0.00000	-0.00035
	3	0.00000	-0.00010	0.00000	0.00004	0.00000	0.00000
	4	0.00000	-0.06668	0.00000	-0.00038	0.00000	-0.00039
26	1	0.00000	-0.01444	0.00000	-0.00011	0.00000	0.00003
	2	0.00000	-0.05214	0.00000	-0.00031	0.00000	0.00035
	3	0.00000	-0.00010	0.00000	0.00004	0.00000	0.00000
	4	0.00000	-0.06668	0.00000	-0.00038	0.00000	0.00039
27	1	0.00000	-0.01251	0.00000	-0.00010	0.00000	0.00002
	2	0.00000	-0.03153	0.00000	-0.00024	0.00000	0.00028
	3	0.00000	0.00020	0.00000	0.00002	0.00000	0.00001
	4	0.00000	-0.04384	0.00000	-0.00032	0.00000	0.00031
28	1	0.00000	-0.01307	0.00000	-0.00009	0.00000	-0.00005
	2	0.00000	-0.03632	0.00000	-0.00017	0.00000	-0.00053
	3	0.00000	0.00113	0.00000	0.00001	0.00000	0.00003
	4	0.00000	-0.04826	0.00000	-0.00025	0.00000	-0.00056
29	1	0.00000	-0.01493	0.00000	-0.00007	0.00000	-0.00001
	2	0.00000	-0.05916	0.00000	-0.00011	0.00000	-0.00020
	3	0.00000	0.00183	0.00000	0.00001	0.00000	0.00001
	4	0.00000	-0.07226	0.00000	-0.00017	0.00000	-0.00020
30	1	0.00000	-0.01269	0.00000	-0.00003	0.00000	0.00007
	2	0.00000	-0.04715	0.00000	-0.00005	0.00000	0.00051
	3	0.00000	0.00165	0.00000	0.00000	0.00000	-0.00002
	4	0.00000	-0.05819	0.00000	-0.00008	0.00000	0.00056
31	1	0.00000	-0.01089	0.00000	-0.00008	0.00000	-0.00003
	2	0.00000	-0.03660	0.00000	-0.00050	0.00000	-0.00033
	3	0.00000	0.00139	0.00000	0.00001	0.00000	0.00001
	4	0.00000	-0.04610	0.00000	-0.00057	0.00000	-0.00034
32	1	0.00000	-0.01185	0.00000	-0.00008	0.00000	0.00001
	2	0.00000	-0.04629	0.00000	-0.00047	0.00000	0.00018
	3	0.00000	0.00201	0.00000	0.00001	0.00000	-0.00001
	4	0.00000	-0.05613	0.00000	-0.00055	0.00000	0.00018
33	1	0.00000	-0.00973	0.00000	-0.00007	0.00000	0.00004
	2	0.00000	-0.02494	0.00000	-0.00035	0.00000	0.00039
	3	0.00000	0.00072	0.00000	0.00001	0.00000	-0.00003
	4	0.00000	-0.03396	0.00000	-0.00041	0.00000	0.00040
34	1	0.00000	-0.00928	0.00000	-0.00005	0.00000	-0.00003
	2	0.00000	-0.02202	0.00000	-0.00019	0.00000	-0.00029
	3	0.00000	-0.00045	0.00000	0.00001	0.00000	-0.00002
	4	0.00000	-0.03176	0.00000	-0.00023	0.00000	-0.00033
35	1	0.00000	-0.01111	0.00000	-0.00005	0.00000	-0.00003
	2	0.00000	-0.04165	0.00000	-0.00020	0.00000	-0.00033
	3	0.00000	-0.00127	0.00000	0.00001	0.00000	-0.00001
	4	0.00000	-0.05402	0.00000	-0.00023	0.00000	-0.00037
36	1	0.00000	-0.01111	0.00000	-0.00005	0.00000	0.00003
	2	0.00000	-0.04165	0.00000	-0.00020	0.00000	0.00033
	3	0.00000	-0.00127	0.00000	0.00001	0.00000	0.00001
	4	0.00000	-0.05402	0.00000	-0.00023	0.00000	0.00037

JOINT DISPLACEMENT (INCH RADIANS)   STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
37	1	0.00000	-0.00928	0.00000	-0.00005	0.00000	0.00003
	2	0.00000	-0.02202	0.00000	-0.00019	0.00000	0.00029
	3	0.00000	-0.00045	0.00000	0.00001	0.00000	0.00002
	4	0.00000	-0.03176	0.00000	-0.00023	0.00000	0.00033
38	1	0.00000	-0.00973	0.00000	-0.00007	0.00000	-0.00004
	2	0.00000	-0.02494	0.00000	-0.00035	0.00000	-0.00039
	3	0.00000	0.00072	0.00000	0.00001	0.00000	0.00003
	4	0.00000	-0.03396	0.00000	-0.00041	0.00000	-0.00040
39	1	0.00000	-0.01185	0.00000	-0.00008	0.00000	-0.00001
	2	0.00000	-0.04629	0.00000	-0.00047	0.00000	-0.00018
	3	0.00000	0.00201	0.00000	0.00001	0.00000	0.00001
	4	0.00000	-0.05613	0.00000	-0.00055	0.00000	-0.00018
40	1	0.00000	-0.01089	0.00000	-0.00008	0.00000	0.00003
	2	0.00000	-0.03660	0.00000	-0.00050	0.00000	0.00033
	3	0.00000	0.00139	0.00000	0.00001	0.00000	-0.00001
	4	0.00000	-0.04610	0.00000	-0.00057	0.00000	0.00034
41	1	0.00000	-0.00637	0.00000	-0.00012	0.00000	-0.00002
	2	0.00000	-0.01130	0.00000	-0.00074	0.00000	-0.00016
	3	0.00000	0.00077	0.00000	0.00002	0.00000	0.00001
	4	0.00000	-0.01690	0.00000	-0.00083	0.00000	-0.00017
42	1	0.00000	-0.00639	0.00000	-0.00012	0.00000	0.00001
	2	0.00000	-0.01140	0.00000	-0.00074	0.00000	0.00009
	3	0.00000	0.00082	0.00000	0.00003	0.00000	-0.00001
	4	0.00000	-0.01697	0.00000	-0.00083	0.00000	0.00010
43	1	0.00000	-0.00576	0.00000	-0.00010	0.00000	0.00003
	2	0.00000	-0.00561	0.00000	-0.00052	0.00000	0.00024
	3	0.00000	0.00033	0.00000	0.00001	0.00000	-0.00003
	4	0.00000	-0.01103	0.00000	-0.00060	0.00000	0.00024
44	1	0.00000	-0.00597	0.00000	-0.00008	0.00000	-0.00003
	2	0.00000	-0.00864	0.00000	-0.00039	0.00000	-0.00037
	3	0.00000	-0.00066	0.00000	0.00000	0.00000	-0.00002
	4	0.00000	-0.01526	0.00000	-0.00047	0.00000	-0.00043
45	1	0.00000	-0.00828	0.00000	-0.00006	0.00000	-0.00003
	2	0.00000	-0.03251	0.00000	-0.00012	0.00000	-0.00036
	3	0.00000	-0.00184	0.00000	0.00001	0.00000	-0.00001
	4	0.00000	-0.04263	0.00000	-0.00016	0.00000	-0.00040
46	1	0.00000	-0.00828	0.00000	-0.00006	0.00000	0.00003
	2	0.00000	-0.03251	0.00000	-0.00012	0.00000	0.00036
	3	0.00000	-0.00184	0.00000	0.00001	0.00000	0.00001
	4	0.00000	-0.04263	0.00000	-0.00016	0.00000	0.00040
47	1	0.00000	-0.00597	0.00000	-0.00008	0.00000	0.00003
	2	0.00000	-0.00864	0.00000	-0.00039	0.00000	0.00037
	3	0.00000	-0.00066	0.00000	0.00000	0.00000	0.00002
	4	0.00000	-0.01526	0.00000	-0.00047	0.00000	0.00043
48	1	0.00000	-0.00576	0.00000	-0.00010	0.00000	-0.00003
	2	0.00000	-0.00561	0.00000	-0.00052	0.00000	-0.00024
	3	0.00000	0.00033	0.00000	0.00001	0.00000	0.00003
	4	0.00000	-0.01103	0.00000	-0.00060	0.00000	-0.00024

JOINT DISPLACEMENT (INCH RADIANS) STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
49	1	0.00000	-0.00639	0.00000	-0.00012	0.00000	-0.00001
	2	0.00000	-0.01140	0.00000	-0.00074	0.00000	-0.00009
	3	0.00000	0.00082	0.00000	0.00003	0.00000	0.00001
	4	0.00000	-0.01697	0.00000	-0.00083	0.00000	-0.00010
50	1	0.00000	-0.00637	0.00000	-0.00012	0.00000	0.00002
	2	0.00000	-0.01130	0.00000	-0.00074	0.00000	0.00016
	3	0.00000	0.00077	0.00000	0.00002	0.00000	-0.00001
	4	0.00000	-0.01690	0.00000	-0.00083	0.00000	0.00017

*************** END OF LATEST ANALYSIS RESULT ***************

124. LOAD LIST 5 6
125. PRINT ELEMENT FORCES

```
ELEMENT FORCES      FORCE,LENGTH UNITS= KIP   FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD           QX           QY            MX            MY            MXY
                                     FX            FY            FXY

  1       5           -2.08         0.89         -2.63         -0.59          0.95
                                    0.00          0.00          0.00
  TOP :  SMAX=        -2.90   SMIN=   -40.55  TMAX=         18.83   ANGLE=  -21.6
  BOTT:  SMAX=        40.55   SMIN=     2.90  TMAX=         18.83   ANGLE=  -21.6
          6           -1.48         0.62         -1.87         -0.40          0.68
                                    0.00          0.00          0.00
  TOP :  SMAX=        -1.80   SMIN=   -28.91  TMAX=         13.55   ANGLE=  -21.5
  BOTT:  SMAX=        28.91   SMIN=     1.80  TMAX=         13.55   ANGLE=  -21.5

  2       5            2.01         0.11         -0.86          0.57          1.53
                                    0.00          0.00          0.00
  TOP :  SMAX=        20.82   SMIN=   -24.70  TMAX=         22.76   ANGLE=  -32.5
  BOTT:  SMAX=        24.70   SMIN=   -20.82  TMAX=         22.76   ANGLE=  -32.5
          6            1.42         0.07         -0.59          0.43          1.11
                                    0.00          0.00          0.00
  TOP :  SMAX=        15.35   SMIN=   -17.57  TMAX=         16.46   ANGLE=  -32.7
  BOTT:  SMAX=        17.57   SMIN=   -15.35  TMAX=         16.46   ANGLE=  -32.7

  3       5           -0.65        -2.35          4.04          1.87          1.77
                                    0.00          0.00          0.00
  TOP :  SMAX=        67.85   SMIN=    11.90  TMAX=         27.97   ANGLE=   29.2
  BOTT:  SMAX=       -11.90   SMIN=   -67.85  TMAX=         27.97   ANGLE=   29.2
          6           -0.47        -1.71          2.93          1.36          1.27
                                    0.00          0.00          0.00
  TOP :  SMAX=        49.12   SMIN=     8.77  TMAX=         20.17   ANGLE=   29.1
  BOTT:  SMAX=        -8.77   SMIN=   -49.12  TMAX=         20.17   ANGLE=   29.1

  4       5           -4.05        -2.38         -0.19          2.93          1.78
                                    0.00          0.00          0.00
  TOP :  SMAX=        50.48   SMIN=   -13.51  TMAX=         32.00   ANGLE=  -24.4
  BOTT:  SMAX=        13.51   SMIN=   -50.48  TMAX=         32.00   ANGLE=  -24.4
          6           -2.93        -1.72         -0.15          2.11          1.27
                                    0.00          0.00          0.00
  TOP :  SMAX=        36.16   SMIN=    -9.73  TMAX=         22.95   ANGLE=  -24.1
  BOTT:  SMAX=         9.73   SMIN=   -36.16  TMAX=         22.95   ANGLE=  -24.1

  5       5            0.00        -2.50         -4.74          3.73          0.00
                                    0.00          0.00          0.00
  TOP :  SMAX=        50.38   SMIN=   -64.05  TMAX=         57.21   ANGLE=    0.0
  BOTT:  SMAX=        64.05   SMIN=   -50.38  TMAX=         57.21   ANGLE=    0.0
          6            0.00        -1.78         -3.47          2.69          0.00
                                    0.00          0.00          0.00
  TOP :  SMAX=        36.26   SMIN=   -46.87  TMAX=         41.56   ANGLE=    0.0
  BOTT:  SMAX=        46.87   SMIN=   -36.26  TMAX=         41.56   ANGLE=    0.0

  6       5            4.05        -2.38         -0.19          2.93         -1.78
                                    0.00          0.00          0.00
  TOP :  SMAX=        50.48   SMIN=   -13.51  TMAX=         32.00   ANGLE=   24.4
  BOTT:  SMAX=        13.51   SMIN=   -50.48  TMAX=         32.00   ANGLE=   24.4
```

```
 ELEMENT FORCES     FORCE,LENGTH UNITS= KIP  FEET
 --------------
 FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD         QX          QY            MX           MY           MXY
                                  FX            FY           FXY

           6         2.93        -1.72         -0.15         2.11         -1.27
                                  0.00          0.00         0.00
     TOP :  SMAX=    36.16   SMIN=    -9.73  TMAX=    22.95  ANGLE=   24.1
     BOTT:  SMAX=     9.73   SMIN=   -36.16  TMAX=    22.95  ANGLE=   24.1

   7       5         0.65        -2.35          4.04         1.87         -1.77
                                  0.00          0.00         0.00
     TOP :  SMAX=    67.85   SMIN=    11.90  TMAX=    27.97  ANGLE=  -29.2
     BOTT:  SMAX=   -11.90   SMIN=   -67.85  TMAX=    27.97  ANGLE=  -29.2
           6         0.47        -1.71          2.93         1.36         -1.27
                                  0.00          0.00         0.00
     TOP :  SMAX=    49.12   SMIN=     8.77  TMAX=    20.17  ANGLE=  -29.1
     BOTT:  SMAX=    -8.77   SMIN=   -49.12  TMAX=    20.17  ANGLE=  -29.1

   8       5        -2.01         0.11         -0.86         0.57         -1.53
                                  0.00          0.00         0.00
     TOP :  SMAX=    20.82   SMIN=   -24.70  TMAX=    22.76  ANGLE=   32.5
     BOTT:  SMAX=    24.70   SMIN=   -20.82  TMAX=    22.76  ANGLE=   32.5
           6        -1.42         0.07         -0.59         0.43         -1.11
                                  0.00          0.00         0.00
     TOP :  SMAX=    15.35   SMIN=   -17.57  TMAX=    16.46  ANGLE=   32.7
     BOTT:  SMAX=    17.57   SMIN=   -15.35  TMAX=    16.46  ANGLE=   32.7

   9       5         2.08         0.89         -2.63        -0.59         -0.95
                                  0.00          0.00         0.00
     TOP :  SMAX=    -2.90   SMIN=   -40.55  TMAX=    18.83  ANGLE=   21.6
     BOTT:  SMAX=    40.55   SMIN=     2.90  TMAX=    18.83  ANGLE=   21.6
           6         1.48         0.62         -1.87        -0.40         -0.68
                                  0.00          0.00         0.00
     TOP :  SMAX=    -1.80   SMIN=   -28.91  TMAX=    13.55  ANGLE=   21.5
     BOTT:  SMAX=    28.91   SMIN=     1.80  TMAX=    13.55  ANGLE=   21.5

  10       5        -2.55         0.81         -3.66        -1.18          0.64
                                  0.00          0.00         0.00
     TOP :  SMAX=   -13.84   SMIN=   -51.46  TMAX=    18.81  ANGLE=  -13.6
     BOTT:  SMAX=    51.46   SMIN=    13.84  TMAX=    18.81  ANGLE=  -13.6
           6        -1.86         0.66         -2.65        -0.91          0.46
                                  0.00          0.00         0.00
     TOP :  SMAX=   -10.76   SMIN=   -37.35  TMAX=    13.30  ANGLE=  -13.8
     BOTT:  SMAX=    37.35   SMIN=    10.76  TMAX=    13.30  ANGLE=  -13.8

  11       5         5.51         0.81         -1.39         0.28          1.05
                                  0.00          0.00         0.00
     TOP :  SMAX=    10.69   SMIN=   -25.69  TMAX=    18.19  ANGLE=  -25.7
     BOTT:  SMAX=    25.69   SMIN=   -10.69  TMAX=    18.19  ANGLE=  -25.7
           6         4.02         0.67         -0.99         0.16          0.76
                                  0.00          0.00         0.00
     TOP :  SMAX=     7.27   SMIN=   -18.54  TMAX=    12.90  ANGLE=  -26.4
     BOTT:  SMAX=    18.54   SMIN=    -7.27  TMAX=    12.90  ANGLE=  -26.4
```

```
ELEMENT FORCES     FORCE,LENGTH UNITS= KIP  FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH
ELEMENT  LOAD        QX          QY           MX           MY           MXY
                                 FX           FY           FXY

  12      5         1.26        0.81         4.50         3.17          1.13
                                0.00         0.00         0.00
    TOP :  SMAX=    69.52   SMIN=    34.04  TMAX=    17.74  ANGLE=   29.7
    BOTT:  SMAX=   -34.04   SMIN=   -69.52  TMAX=    17.74  ANGLE=   29.7
          6         0.92        0.56         3.29         2.27          0.80
                                0.00         0.00         0.00
    TOP :  SMAX=    50.39   SMIN=    24.68  TMAX=    12.86  ANGLE=   28.6
    BOTT:  SMAX=   -24.68   SMIN=   -50.39  TMAX=    12.86  ANGLE=   28.6

  13      5        -2.50        1.17         0.79         3.76          0.66
                                0.00         0.00         0.00
    TOP :  SMAX=    52.59   SMIN=     8.78  TMAX=    21.91  ANGLE=  -12.0
    BOTT:  SMAX=    -8.78   SMIN=   -52.59  TMAX=    21.91  ANGLE=  -12.0
          6        -1.86        0.86         0.55         2.69          0.45
                                0.00         0.00         0.00
    TOP :  SMAX=    37.55   SMIN=     6.16  TMAX=    15.69  ANGLE=  -11.4
    BOTT:  SMAX=    -6.16   SMIN=   -37.55  TMAX=    15.69  ANGLE=  -11.4

  14      5         0.00        1.18        -3.40         3.32          0.00
                                0.00         0.00         0.00
    TOP :  SMAX=    44.87   SMIN=   -45.96  TMAX=    45.41  ANGLE=    0.0
    BOTT:  SMAX=    45.96   SMIN=   -44.87  TMAX=    45.41  ANGLE=    0.0
          6         0.00        0.91        -2.56         2.37          0.00
                                0.00         0.00         0.00
    TOP :  SMAX=    31.97   SMIN=   -34.50  TMAX=    33.23  ANGLE=    0.0
    BOTT:  SMAX=    34.50   SMIN=   -31.97  TMAX=    33.23  ANGLE=    0.0

  15      5         2.50        1.17         0.79         3.76         -0.66
                                0.00         0.00         0.00
    TOP :  SMAX=    52.59   SMIN=     8.78  TMAX=    21.91  ANGLE=   12.0
    BOTT:  SMAX=    -8.78   SMIN=   -52.59  TMAX=    21.91  ANGLE=   12.0
          6         1.86        0.86         0.55         2.69         -0.45
                                0.00         0.00         0.00
    TOP :  SMAX=    37.55   SMIN=     6.16  TMAX=    15.69  ANGLE=   11.4
    BOTT:  SMAX=    -6.16   SMIN=   -37.55  TMAX=    15.69  ANGLE=   11.4

  16      5        -1.26        0.82         4.50         3.17         -1.13
                                0.00         0.00         0.00
    TOP :  SMAX=    69.52   SMIN=    34.04  TMAX=    17.74  ANGLE=  -29.7
    BOTT:  SMAX=   -34.04   SMIN=   -69.52  TMAX=    17.74  ANGLE=  -29.7
          6        -0.92        0.56         3.29         2.27         -0.80
                                0.00         0.00         0.00
    TOP :  SMAX=    50.39   SMIN=    24.68  TMAX=    12.86  ANGLE=  -28.6
    BOTT:  SMAX=   -24.68   SMIN=   -50.39  TMAX=    12.86  ANGLE=  -28.6

  17      5        -5.51        0.81        -1.39         0.28         -1.05
                                0.00         0.00         0.00
    TOP :  SMAX=    10.69   SMIN=   -25.69  TMAX=    18.19  ANGLE=   25.7
    BOTT:  SMAX=    25.69   SMIN=   -10.69  TMAX=    18.19  ANGLE=   25.7
```

```
 ELEMENT FORCES     FORCE,LENGTH UNITS= KIP   FEET
 --------------
 FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT   LOAD          QX          QY            MX           MY           MXY
                                    FX            FY           FXY

          6          -4.02         0.67         -0.99         0.16         -0.76
                                   0.00          0.00         0.00
     TOP :  SMAX=        7.27  SMIN=    -18.54  TMAX=      12.90  ANGLE=  26.4
     BOTT:  SMAX=       18.54  SMIN=     -7.27  TMAX=      12.90  ANGLE=  26.4

  18      5           2.55         0.81         -3.66        -1.18         -0.64
                                   0.00          0.00         0.00
     TOP :  SMAX=      -13.84  SMIN=    -51.46  TMAX=      18.81  ANGLE=  13.6
     BOTT:  SMAX=       51.46  SMIN=     13.84  TMAX=      18.81  ANGLE=  13.6
          6           1.86         0.66         -2.65        -0.91         -0.46
                                   0.00          0.00         0.00
     TOP :  SMAX=      -10.76  SMIN=    -37.35  TMAX=      13.30  ANGLE=  13.8
     BOTT:  SMAX=       37.35  SMIN=     10.76  TMAX=      13.30  ANGLE=  13.8

  19      5          -3.03         0.62         -3.66        -2.75          0.26
                                   0.00          0.00         0.00
     TOP :  SMAX=      -36.24  SMIN=    -50.32  TMAX=       7.04  ANGLE= -14.9
     BOTT:  SMAX=       50.32  SMIN=     36.24  TMAX=       7.04  ANGLE= -14.9
          6          -2.21         0.36         -2.65        -2.04          0.19
                                   0.00          0.00         0.00
     TOP :  SMAX=      -26.81  SMIN=    -36.55  TMAX=       4.87  ANGLE= -15.7
     BOTT:  SMAX=       36.55  SMIN=     26.81  TMAX=       4.87  ANGLE= -15.7

  20      5           4.85         0.44         -1.74        -1.60         -0.22
                                   0.00          0.00         0.00
     TOP :  SMAX=      -19.46  SMIN=    -25.71  TMAX=       3.12  ANGLE=  35.9
     BOTT:  SMAX=       25.71  SMIN=     19.46  TMAX=       3.12  ANGLE=  35.9
          6           3.55         0.23         -1.24        -1.20         -0.17
                                   0.00          0.00         0.00
     TOP :  SMAX=      -14.16  SMIN=    -18.70  TMAX=       2.27  ANGLE=  41.5
     BOTT:  SMAX=       18.70  SMIN=     14.16  TMAX=       2.27  ANGLE=  41.5

  21      5           0.58         1.23          3.90         0.62         -0.25
                                   0.00          0.00         0.00
     TOP :  SMAX=       52.98  SMIN=      8.15  TMAX=      22.41  ANGLE=  -4.4
     BOTT:  SMAX=       -8.15  SMIN=    -52.98  TMAX=      22.41  ANGLE=  -4.4
          6           0.43         0.88          2.89         0.43         -0.21
                                   0.00          0.00         0.00
     TOP :  SMAX=       39.19  SMIN=      5.51  TMAX=      16.84  ANGLE=  -4.8
     BOTT:  SMAX=       -5.51  SMIN=    -39.19  TMAX=      16.84  ANGLE=  -4.8

  22      5          -3.06         1.04          0.45         0.68          0.10
                                   0.00          0.00         0.00
     TOP :  SMAX=        9.63  SMIN=      5.56  TMAX=       2.03  ANGLE= -19.9
     BOTT:  SMAX=       -5.56  SMIN=     -9.63  TMAX=       2.03  ANGLE= -19.9
          6          -2.31         0.76          0.28         0.44          0.05
                                   0.00          0.00         0.00
     TOP :  SMAX=        6.08  SMIN=      3.64  TMAX=       1.22  ANGLE= -15.1
     BOTT:  SMAX=       -3.64  SMIN=     -6.08  TMAX=       1.22  ANGLE= -15.1
```

```
ELEMENT FORCES      FORCE,LENGTH UNITS= KIP   FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH
ELEMENT  LOAD        QX          QY          MX          MY          MXY
                                 FX          FY          FXY

  23      5         0.00        1.02       -3.47        0.05        0.00
                                0.00        0.00        0.00
    TOP :  SMAX=     0.64  SMIN=   -46.79  TMAX=     23.71  ANGLE=   0.0
    BOTT:  SMAX=    46.79  SMIN=    -0.64  TMAX=     23.71  ANGLE=   0.0
           6        0.00        0.78       -2.66       -0.05        0.00
                                0.00        0.00        0.00
    TOP :  SMAX=    -0.68  SMIN=   -35.92  TMAX=     17.62  ANGLE=   0.0
    BOTT:  SMAX=    35.92  SMIN=     0.68  TMAX=     17.62  ANGLE=   0.0

  24      5         3.06        1.04        0.45        0.68       -0.10
                                0.00        0.00        0.00
    TOP :  SMAX=     9.63  SMIN=     5.56  TMAX=      2.03  ANGLE=  19.9
    BOTT:  SMAX=    -5.56  SMIN=    -9.63  TMAX=      2.03  ANGLE=  19.9
           6        2.31        0.76        0.28        0.44       -0.05
                                0.00        0.00        0.00
    TOP :  SMAX=     6.08  SMIN=     3.64  TMAX=      1.22  ANGLE=  15.1
    BOTT:  SMAX=    -3.64  SMIN=    -6.08  TMAX=      1.22  ANGLE=  15.1

  25      5        -0.58        1.23        3.90        0.62        0.25
                                0.00        0.00        0.00
    TOP :  SMAX=    52.98  SMIN=     8.15  TMAX=     22.41  ANGLE=   4.4
    BOTT:  SMAX=    -8.15  SMIN=   -52.98  TMAX=     22.41  ANGLE=   4.4
           6       -0.43        0.88        2.89        0.43        0.21
                                0.00        0.00        0.00
    TOP :  SMAX=    39.19  SMIN=     5.51  TMAX=     16.84  ANGLE=   4.8
    BOTT:  SMAX=    -5.51  SMIN=   -39.19  TMAX=     16.84  ANGLE=   4.8

  26      5        -4.85        0.44       -1.74       -1.60        0.22
                                0.00        0.00        0.00
    TOP :  SMAX=   -19.46  SMIN=   -25.71  TMAX=      3.12  ANGLE= -35.9
    BOTT:  SMAX=    25.71  SMIN=    19.46  TMAX=      3.12  ANGLE= -35.9
           6       -3.55        0.23       -1.24       -1.20        0.17
                                0.00        0.00        0.00
    TOP :  SMAX=   -14.16  SMIN=   -18.70  TMAX=      2.27  ANGLE= -41.5
    BOTT:  SMAX=    18.70  SMIN=    14.16  TMAX=      2.27  ANGLE= -41.5

  27      5         3.03        0.62       -3.66       -2.75       -0.26
                                0.00        0.00        0.00
    TOP :  SMAX=   -36.24  SMIN=   -50.32  TMAX=      7.04  ANGLE=  14.9
    BOTT:  SMAX=    50.32  SMIN=    36.24  TMAX=      7.04  ANGLE=  14.9
           6        2.21        0.36       -2.65       -2.04       -0.19
                                0.00        0.00        0.00
    TOP :  SMAX=   -26.81  SMIN=   -36.55  TMAX=      4.87  ANGLE=  15.7
    BOTT:  SMAX=    36.55  SMIN=    26.81  TMAX=      4.87  ANGLE=  15.7

  28      5        -1.52       -1.44       -2.30       -1.81        0.08
                                0.00        0.00        0.00
    TOP :  SMAX=   -24.28  SMIN=   -31.20  TMAX=      3.46  ANGLE=  -8.6
    BOTT:  SMAX=    31.20  SMIN=    24.28  TMAX=      3.46  ANGLE=  -8.6
```

```
ELEMENT FORCES        FORCE,LENGTH UNITS= KIP   FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT  LOAD        QX          QY           MX           MY            MXY
                                 FX           FY           FXY

          6         -1.07       -1.02        -1.64        -1.27           0.06
                                 0.00         0.00         0.00
     TOP :  SMAX=   -17.09    SMIN=   -22.20  TMAX=        2.56   ANGLE=   -8.8
     BOTT:  SMAX=    22.20    SMIN=    17.09  TMAX=        2.56   ANGLE=   -8.8

  29      5          2.09       -1.70        -1.22        -1.40          -0.61
                                 0.00         0.00         0.00
     TOP :  SMAX=    -9.42    SMIN=   -25.97  TMAX=        8.27   ANGLE=  -40.8
     BOTT:  SMAX=    25.97    SMIN=     9.42  TMAX=        8.27   ANGLE=  -40.8
          6          1.50       -1.21        -0.83        -0.98          -0.44
                                 0.00         0.00         0.00
     TOP :  SMAX=    -6.22    SMIN=   -18.32  TMAX=        6.05   ANGLE=  -40.1
     BOTT:  SMAX=    18.32    SMIN=     6.22  TMAX=        6.05   ANGLE=  -40.1

  30      5          0.02        0.75         3.23        -0.34          -0.55
                                 0.00         0.00         0.00
     TOP :  SMAX=    44.68    SMIN=    -5.73  TMAX=       25.20   ANGLE=   -8.6
     BOTT:  SMAX=     5.73    SMIN=   -44.68  TMAX=       25.20   ANGLE=   -8.6
          6          0.02        0.54         2.41        -0.26          -0.41
                                 0.00         0.00         0.00
     TOP :  SMAX=    33.34    SMIN=    -4.32  TMAX=       18.83   ANGLE=   -8.5
     BOTT:  SMAX=     4.32    SMIN=   -33.34  TMAX=       18.83   ANGLE=   -8.5

  31      5         -2.56       -0.22         0.01        -0.35          -0.40
                                 0.00         0.00         0.00
     TOP :  SMAX=     3.59    SMIN=    -8.20  TMAX=        5.89   ANGLE=  -32.9
     BOTT:  SMAX=     8.20    SMIN=    -3.59  TMAX=        5.89   ANGLE=  -32.9
          6         -1.97       -0.19        -0.04        -0.29          -0.32
                                 0.00         0.00         0.00
     TOP :  SMAX=     2.39    SMIN=    -6.86  TMAX=        4.63   ANGLE=  -34.2
     BOTT:  SMAX=     6.86    SMIN=    -2.39  TMAX=        4.63   ANGLE=  -34.2

  32      5          0.00       -0.88        -3.56        -0.35           0.00
                                 0.00         0.00         0.00
     TOP :  SMAX=    -4.68    SMIN=   -48.06  TMAX=       21.69   ANGLE=    0.0
     BOTT:  SMAX=    48.06    SMIN=     4.68  TMAX=       21.69   ANGLE=    0.0
          6          0.00       -0.68        -2.76        -0.28           0.00
                                 0.00         0.00         0.00
     TOP :  SMAX=    -3.83    SMIN=   -37.26  TMAX=       16.71   ANGLE=    0.0
     BOTT:  SMAX=    37.26    SMIN=     3.83  TMAX=       16.71   ANGLE=    0.0

  33      5          2.56       -0.22         0.01        -0.35           0.40
                                 0.00         0.00         0.00
     TOP :  SMAX=     3.59    SMIN=    -8.20  TMAX=        5.89   ANGLE=   32.9
     BOTT:  SMAX=     8.20    SMIN=    -3.59  TMAX=        5.89   ANGLE=   32.9
          6          1.97       -0.19        -0.04        -0.29           0.32
                                 0.00         0.00         0.00
     TOP :  SMAX=     2.39    SMIN=    -6.86  TMAX=        4.63   ANGLE=   34.2
     BOTT:  SMAX=     6.86    SMIN=    -2.39  TMAX=        4.63   ANGLE=   34.2
```

```
ELEMENT FORCES     FORCE,LENGTH UNITS= KIP  FEET
--------------
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH
ELEMENT  LOAD        QX          QY             MX            MY            MXY
                                 FX             FY            FXY

  34       5       -0.02        0.75           3.23          -0.34           0.55
                                0.00           0.00           0.00
   TOP :  SMAX=    44.68   SMIN=    -5.73   TMAX=    25.20   ANGLE=    8.6
   BOTT:  SMAX=     5.73   SMIN=   -44.68   TMAX=    25.20   ANGLE=    8.6
           6       -0.02        0.54           2.41          -0.26           0.41
                                0.00           0.00           0.00
   TOP :  SMAX=    33.34   SMIN=    -4.32   TMAX=    18.83   ANGLE=    8.5
   BOTT:  SMAX=     4.32   SMIN=   -33.34   TMAX=    18.83   ANGLE=    8.5

  35       5       -2.09       -1.70          -1.22          -1.40           0.61
                                0.00           0.00           0.00
   TOP :  SMAX=    -9.42   SMIN=   -25.97   TMAX=     8.27   ANGLE=   40.8
   BOTT:  SMAX=    25.97   SMIN=     9.42   TMAX=     8.27   ANGLE=   40.8
           6       -1.50       -1.21          -0.83          -0.98           0.44
                                0.00           0.00           0.00
   TOP :  SMAX=    -6.22   SMIN=   -18.32   TMAX=     6.05   ANGLE=   40.1
   BOTT:  SMAX=    18.32   SMIN=     6.22   TMAX=     6.05   ANGLE=   40.1

  36       5        1.52       -1.44          -2.30          -1.81          -0.08
                                0.00           0.00           0.00
   TOP :  SMAX=   -24.28   SMIN=   -31.20   TMAX=     3.46   ANGLE=    8.6
   BOTT:  SMAX=    31.20   SMIN=    24.28   TMAX=     3.46   ANGLE=    8.6
           6        1.07       -1.02          -1.64          -1.27          -0.06
                                0.00           0.00           0.00
   TOP :  SMAX=   -17.09   SMIN=   -22.20   TMAX=     2.56   ANGLE=    8.8
   BOTT:  SMAX=    22.20   SMIN=    17.09   TMAX=     2.56   ANGLE=    8.8

********************END OF ELEMENT FORCES********************

  126. UNIT KIP INCHES
  127. START CONCRETE DESIGN
1
  128. CODE ACI
  129. FC 3
  130. TRACK 2.0
  131. DESIGN ELEMENTS 1 TO 36
```

ELEMENT DESIGN SUMMARY

ELEMENT	LONG. REINF (SQ.IN/FT)	MOM-X /LOAD (K-FT/FT)	TRANS. REINF (SQ.IN/FT)	MOM-Y /LOAD (K-FT/FT)
1 TOP :	0.173	0.00 /***	0.173	0.00 /***
BOTT:	0.173	-2.63 / 5	0.173	-0.59 / 5
2 TOP :	0.173	0.00 /***	0.173	0.57 / 5
BOTT:	0.173	-0.86 / 5	0.173	0.00 / 5
3 TOP :	0.173	4.04 / 5	0.173	1.87 / 5
BOTT:	0.173	0.00 / 5	0.173	0.00 / 5
4 TOP :	0.173	0.00 / 5	0.173	2.93 / 5
BOTT:	0.173	-0.19 / 5	0.173	0.00 / 5
5 TOP :	0.173	0.00 / 5	0.173	3.73 / 5
BOTT:	0.173	-4.74 / 5	0.173	0.00 / 5
6 TOP :	0.173	0.00 / 5	0.173	2.93 / 5
BOTT:	0.173	-0.19 / 5	0.173	0.00 / 5
7 TOP :	0.173	4.04 / 5	0.173	1.87 / 5
BOTT:	0.173	0.00 / 5	0.173	0.00 / 5
8 TOP :	0.173	0.00 / 5	0.173	0.57 / 5
BOTT:	0.173	-0.86 / 5	0.173	0.00 / 5
9 TOP :	0.173	0.00 / 5	0.173	0.00 / 5
BOTT:	0.173	-2.63 / 5	0.173	-0.59 / 5
10 TOP :	0.173	0.00 / 5	0.173	0.00 / 5
BOTT:	0.173	-3.66 / 5	0.173	-1.18 / 5
11 TOP :	0.173	0.00 / 5	0.173	0.28 / 5
BOTT:	0.173	-1.39 / 5	0.173	0.00 / 5
12 TOP :	0.173	4.50 / 5	0.173	3.17 / 5
BOTT:	0.173	0.00 / 5	0.173	0.00 / 5
13 TOP :	0.173	0.79 / 5	0.173	3.76 / 5
BOTT:	0.173	0.00 / 5	0.173	0.00 / 5
14 TOP :	0.173	0.00 / 5	0.173	3.32 / 5
BOTT:	0.173	-3.40 / 5	0.173	0.00 / 5
15 TOP :	0.173	0.79 / 5	0.173	3.76 / 5
BOTT:	0.173	0.00 / 5	0.173	0.00 / 5
16 TOP :	0.173	4.50 / 5	0.173	3.17 / 5
BOTT:	0.173	0.00 / 5	0.173	0.00 / 5
17 TOP :	0.173	0.00 / 5	0.173	0.28 / 5
BOTT:	0.173	-1.39 / 5	0.173	0.00 / 5

18	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-3.66 / 5	0.173	-1.18 / 5
19	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-3.66 / 5	0.173	-2.75 / 5
20	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-1.74 / 5	0.173	-1.60 / 5
21	TOP :	0.173	3.90 / 5	0.173	0.62 / 5
	BOTT:	0.173	0.00 / 5	0.173	0.00 / 5
22	TOP :	0.173	0.45 / 5	0.173	0.68 / 5
	BOTT:	0.173	0.00 / 5	0.173	0.00 / 5
23	TOP :	0.173	0.00 / 5	0.173	0.05 / 5
	BOTT:	0.173	-3.47 / 5	0.173	-0.05 / 6
24	TOP :	0.173	0.45 / 5	0.173	0.68 / 5
	BOTT:	0.173	0.00 / 5	0.173	0.00 / 6
25	TOP :	0.173	3.90 / 5	0.173	0.62 / 5
	BOTT:	0.173	0.00 / 5	0.173	0.00 / 6
26	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-1.74 / 5	0.173	-1.60 / 5
27	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-3.66 / 5	0.173	-2.75 / 5
28	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-2.30 / 5	0.173	-1.81 / 5
29	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-1.22 / 5	0.173	-1.40 / 5
30	TOP :	0.173	3.23 / 5	0.173	0.00 / 5
	BOTT:	0.173	0.00 / 5	0.173	-0.34 / 5
31	TOP :	0.173	0.01 / 5	0.173	0.00 / 5
	BOTT:	0.173	-0.04 / 6	0.173	-0.35 / 5
32	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-3.56 / 5	0.173	-0.35 / 5
33	TOP :	0.173	0.01 / 5	0.173	0.00 / 5
	BOTT:	0.173	-0.04 / 6	0.173	-0.35 / 5
34	TOP :	0.173	3.23 / 5	0.173	0.00 / 5
	BOTT:	0.173	0.00 / 6	0.173	-0.34 / 5
35	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-1.22 / 5	0.173	-1.40 / 5
36	TOP :	0.173	0.00 / 5	0.173	0.00 / 5
	BOTT:	0.173	-2.30 / 5	0.173	-1.81 / 5

```
****************************END OF ELEMENT DESIGN****************************

132. END CONCRETE DESIGN
133. *
134. FINISH

*************** END OF STAAD-III ***************

****** DATE= SEP 20,1994   TIME= 10:26:40 ******

************************************************************
*       FOR QUESTIONS ON STAAD-III/ISDS, CONTACT:          *
*       RESEARCH ENGINEERS, INC AT (714) 974-2500          *
*       TELEX:  4994385      FAX:  (714) 974-4771          *
************************************************************
```

PLEASE NOTE:

Foundation calculations for Tank T-A in Unit 1700 are integrated with the tank design calculations for Tank T-A which are found in Exhibit B of this Attachment.

EXHIBIT D

CALCULATIONS OF TANK VENTING REQUIREMENTS

EXHIBIT D
TANK VENTING CALCULATIONS (PER API 2000)
CHEMICAL WASTE MANAGEMENT, INC., EMELLE, ALABAMA FACILITY

												IN-BREATHING					OUT-BREATHING					EMERGENCY		
Tank Nos.	Width/ Diameter (ft)	Length/ Shell Height (ft)	Depth/ Cone Height (ft)	Tank Wetted Surf. Area (sf)	Tank Capacity (gal)	Tank Rated Press. (in WG)	Tank Relief Press. (in WG)[1]	Tank Rated Vac. (in WG)	Tank Relief Vac. (in WG)[1]	Fill Rate (gpm)	With-drawal Rate (gpm)	Normal Venting (cfh)[2]	Thermal Venting (cfh)[3]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Normal Venting (cfh)[4]	Thermal Venting (cfh)[5]	Total Vent Capacity (cfh)	Min. Area (sq in)[8]	Min. Size (in)	Vent Capacity (cfh)[6]	Min. Area (sq in)[7]	Min. Size (in)
LEACHATE TANK STORAGE UNITS 1700																								
T-A						6.00	3.00	3.00	1.50	300	300	2,400		2,400	4.64	3.00	2,571		2,571	3.51	3.00	NA	NA	NA
T-1701 thru T-1704						6.00	3.00	3.00	1.50	300	300	2,400		2,400	4.64	3.00	2,571		2,571	3.51	3.00	NA	NA	NA

NOTES:

1. Pressure and vacuum relief is assumed to be set to relieve at 50% of the design rated pressure or vacuum, unless noted. Emergency relief is assumed to be set at 75% of design pressure.
2. Normal in-breathing at 5.6 scfh per 42 gal barrel per hour of withdrawal, as specified in API 2000, 4th Edition.
3. Thermal in-breathing at 1 scfh per 42 gal barrel of tank volume, up to 20,000 barrel (840,000 gal) volume, as in API 2000.
4. Normal out-breathing at 12 scfh per 42 gal barrel per hour of fill for volatile liquids (flash point <100 deg F), as in API 2000. For non-volatile liquids 6 scfh per 42 gal barrel may be used.
5. Thermal out-breathing at 1 scfh per 42 gal barrel of tank volume for volatile liquids, up to 20,000 barrel volume, as in API 2000. For non-volatile liquids 0.6 scfh per 42 gal barrel may be used.
6. From API 2000 Appendix B on Emergency Venting, for four ranges of tank surface area, heat absorption, Q, is calculated. Vent capacity in SCFH is then calculated from the heat absorption according to the equation:
   SCFH = 70.5 * Q / [L * sqrt(M)] assuming a conservative "L * sqrt(M)" value of 1,337, that of hexane.
7. Formula for emergency vent area adapted from Protectoseal Technical Manual, on flow capacity of tank emergency venting devices for nozzles 8 in. and larger:
   CFH = 1,667 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank emergency relief setting and atmospheric conditions.
8. Formula for vent area for smaller nozzles such as normal breather vents, adapted from Crane Flow of Fluids, Eq. 2-24, very similar to, but more conservative, than Protectoseal equation:
   CFH = 845 * Cf * A * sqrt(Pt - Pa) using Cf (flow coefficient) of 0.5 and where "Pt - Pa" is differential pressure between tank relief setting and atmospheric conditions.
   The factor 845 was derived using unit conversion factors, a vapor density of 0.1875 lb/cf, and a conservative Y of 0.80 from charts on Crane p. A-21.

EXHIBIT E

TANK MATERIAL OF CONSTRUCTION

COMPATIBILITY INFORMATION

Compatibility Information

Unit 1700: T-1701 to T-1710

Epoxy coating

Or Equivalent

Since 1754

DEVOE COATINGS

Marine·Industrial·Offshore

Devchem® 253

Chemical Resistant Lining

Catalog Number 253-K-XXXX

FEATURES

- **Exceptional resistance to a wide range of chemicals and solvents**
- **Provides exceptional resistance over a wide range of temperatures and pressures**
- **Realistic application properties and cure schedules**
- **Does not require baking to cure**
- **High volume solids; two coat system**

RECOMMENDED USES

- **Cargo tanks in chemical tankers and barges**
- **Industrial storage and process chemical tanks and pipelines**
- **High pressure crude oil pipe and separation tanks**
- **Protective coating for highly corrosive environments**

See the Devoe Coatings **Tank Lining Chemical Resistance Table** for specific resistance properties.

SPECIFICATION DATA

Coating Type	Advanced technology epoxy
Colors	Catalog Number
Tank White	253-K-3530
Tank Pale Blue	253-K-4132
Tank Pastel Red	253-K-7130
Packaging	5 Gallon Two-component kits
Component Ratio	4 to 1 by volume
Gloss	Semigloss
Flash Point	100°F (38°C) Setaflash
Thinner	Devoe T-10 Thinner
Pot Life	4 hours at 77°F (25°C)
Induction Time	15 minutes
Shelf Life	More than 2 years
Density	11.6 Lbs./Gal (1.39 kg/l)

VOC EPA 24	1.67 Lbs/Gal (200 Grams per liter)
Temp. Resistance	300°F (149°C) dry
Volume Solids ASTM D2697 (7 day)	72%
Theoretical Spreading Rate	1155 Sq. Ft/Gal at 1 mil 28.4 Sq. m/l at 25 microns

Recommended Film Thickness

Two Coat System
6.9—8.3 mils wet to obtain 5.0—6.0 mils dry
(173—208μ wet to obtain 125—150μ dry)

Three Coat System
5.5 mils wet to obtain 4 mils dry
(140μ wet to obtain 100μ dry)

Total recommended dry film thickness
10-12 mils (250 - 300μ) dry

Maximum dry film thickness is 20 mils (500μ)

Application Spray

Application Guide

Surface Preparation

All surfaces must be free of oil, grease, salts and moisture before abrasive blasting to near whit metal equivalent to Steel Structures Painting Council SP10 or Swedish Standard Sa 2½. The steel profile after blasting should be 1½ to 2½ mils (38 to 63μ) in depth and be of a jagged nature as opposed to a peen pattern. Surfaces must be free of grit dust. Dehumidification equipment should be employed to prevent rerusting. Before applying the first coat, be sure all surfaces are clean and dust free.

Mixing and Thinning

Devchem 253 Lining is a two component product supplied in 5 Gallon kits which contain the proper ratio of ingredients. the entire contents of each container must be mixed together. Stir the base portion first to obtain a smooth, homogeneous condition. After mixing the base portion, add the convertor slowly while continuing to mix at slow speeds. **Be sure all convertor is added.** After the convertor add is complete, continue to mix slowly until the combined components are thoroughly mixed. Thinning is not normally required or desired; however, at lower temperatures, small amounts (5% or less) of the solvent on the reverse page can be added depending on local VOC and air quality regulations. Any solvent addition should be made after the two components are thoroughly mixed. The pot life of the mixed material is 4 hours at 77°F (25°C); 2 hours at 90°F (32°C); and 1 hour at 100°F ((38°C). Higher temperatures will reduce working life of the coating; lower temperatures will increase it.

Application

Devchem 253 Lining should be applied only by air or airless spray. Brushing can be used for touch up or striping, do not use rollers. For air spray, use agitated spray pots, 1/2" ID air hoses and 1/2" fluid hose. DeVilbiss MBC-510 gun with and E or D tip and needle and a 704 air cap, or equivalent. equipment is recommended. For airless spray application, use 100 PSI air pressure, 3/8" ID fluid hoses not exceeding 100 feet in length, a 30 to 1 or larger heavy duty Graco pump or equivalent, and 0.021" to 0.025" range tip sizes.

Ventilation —It is very important for the safety of the applicator and the proper performance of the Devchem 253 Coating that good ventilation be provided to all portions of the enclosed area. Recommended tank ventilation involves two important phases. Phase one is to pump fresh, dehumidified air into all areas of the tank, especially "dead air" areas. Phase two is to exhaust, via an explosion proof exhaust fan, the solvent vapors from the lowest portion of the tank. This practice of pumping fresh air into the tank and exhausting solvent vapors out of the lowest part of the tank should be provided throughout the application and curing processes. This practice is to insure that all solvents are removed from the coating. Tanks must be cured 7 days at 77°F (25°C) with ventilation before being put into service. At lower temperatures, longer cure times are required.

System —2 stripe coats on all sharp edges, cutouts and welds.
—2 coats of Devchem 253 Lining, 5—6 mils (125—150μ) per coat. Use contrasting colors for each coat and strip coat.

Note: The maximum dry film thickness of the Devchem 253 system is 20 mils (500μ). Dry film thickness above 20 mils (500μ) could reduce the service life of the coating. See the Devoe Coatings Tank Lining Chemical Resistance Table or your Devoe Coatings Representative for additional Information.

Recoating Schedule:

If paint and surface temperatures exceed 90°F (37°C), reduce recoat time by one half.

See Application Guide Supplement

Surface Temperature °Fahrenheit	Recoat Time Minimum	Recoat Time Maximum
40—49	36 hours	7 days
50—59	24 hours	6 days
60—69	16 hours	5 days
70—79	10 hours	4 days
80—89	7 hours	60 hours
90—99	4 hours	24 hours
100—109	3 hours	18 hours
110—120	3 hours	18 hours

Cure to put tank into service: 7 days with ventilation at 77°F (25°C) for maximum chemical resistance. If forced heat cure is desired, contact your Devoe Coatings Representative

Precautions

See the material safety data sheet and product label for complete safety and precaution requirements.

253/Nov, 1993

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CONSULT YOUR DEVOE CATALOG FOR COMPLETE LIST OF OFFICES

Since 1754

DEVOE COATINGS

MARINE • INDUSTRIAL • OFFSHORE

Catha-Coat® 305 Coating
Devchem® 253 Lining
Devchem® 255 Lining
Tank Lining Chemical Resistance Table

This table contains a listing of most of the solvents and chemicals which are transported in bulk quantities and a coatings resistance rating for Catha-Coat 305 Water Based Inorganic Zinc Coating, Devchem 253 Chemical Resistant Lining, and Devchem 255 FDA Epoxy Lining. The indicated resistance ratings are based on laboratory tests, actual field experience and other studies believed by Devoe Coatings to be reliable.

Since many of the commercial products contained in this cargo resistance table may vary in composition, and product specifications may change, Devoe Coatings cannot assume any responsibility for the condition of the coating and/or the products carried or stored in Devoe Coatings lined tanks. The listed resistance ratings are based solely on the effects of the cargoes on tank linings themselves. Neither the contamination of cargoes by tank linings nor the effects of contaminated cargoes on tank linings has been tested and is not implied by the listed resistance tables.

Devoe maintains an ongoing research and tank lining testing program. If there are chemicals or solvents, or special conditions not found in this table, please contact a Devoe Coatings Representative.

Devoe Coatings reserves the right to alter this resistance table without notice.

Tank Lining Systems

Lining	Dry Film Thickness[1]	Alternate Dry Film Thickness[1]
Catha-Coat 305 System[2]		
Catha-Coat 305 Coating	3–5 mils (75–125 microns)	
Devchem 253 System		
Devchem 253 Lining	5 mils (125 microns)	4 mils (100 microns)
Devchem 253 Lining	5 mils (125 microns)	4 mils (100 microns)
Devchem 253 Lining		4 mils (100 microns)
Devchem 255 System		
Devchem 255 Lining	5 mils (125 microns)	
Devchem 255 Lining	5 mils (125 microns)	

Stripe coats in way of edges, cutouts, welds, pits, brackets and other difficult to paint areas are required.

(1) Surface roughness or special resistance requirements may alter the film thickness specification or number of coats.

(2) To insure a holiday-free lining and obtain extended service life, two coats of Catha-Coat 305 Coating at 3 mils (75 microns) per coat are recommended.

General Remarks

When using this cargo resistance table, the following points should be read very thoroughly and noted.

A. All cargoes having low viscosities, like solvents which do not require heating to be loaded or unloaded, are tested at 120°F (49°C). High viscosity cargoes which are normally heated to facilitate loading are tested at 180°F (82°C). Cargoes carried or loaded in excess of these temperatures can be detrimental to the lining. Devoe Coatings should be consulted for specific recommendations where these temperatures are exceeded.

B. All cargo resistance ratings, including ballast water, are based upon a normal shipping and storage period not to exceed sixty days. Ratings are not based upon prolonged periods of time nor repeated storage or shipping of the same product. Should the possibility of shipping and storage periods in excess of sixty days arise, a Devoe Coatings Technical Representative should be consulted.

C. Tank cleaning may be accomplished by employing normal Butterworthing procedures, with solution temperatures up to but not exceeding 190°F (88°C). Special care must be exercised in choosing solvents or detergents used in tank cleaning so as not to cause damage to the lining. If the coating is soft, forced ventilation for at least 24 hours after discharge, or longer if the coating system has not yet fully recovered, is mandatory to allow the coating to recover prior to cleaning.

Alkaline and acidic cleaning compounds can damage Catha-Coat 305 Coating and should be avoided.

Cleaning chemicals which are normally used in the industry have all been tested and are approved for use. Special cleaning chemicals should be tested and approved prior to use.

D. Catha-Coat 305 Coating, as all inorganic zinc coatings, is sensitive to, and may be damaged by, strong acids or alkalies. The pH of the cargo must fall within the 5.5 – 10.0 range.

When any zinc coating is used as a tank lining, the possibility exists for a cargo to pick up slight metallic zinc contamination. Sour crude oil cargoes are not recommended for Catha-Coat 305 Coating.

E. Due to the large number of possible combinations of cargo sequence, it is nearly impossible to predict overall resistance in practice. Most problems can be avoided by using common sense, employing measures such as forced ventilation and thorough cleaning of tanks between cargoes.

Non-aggressive cargoes of similar generic types should not usually cause problems. Such cargoes as fuels and oils are examples of these types.

Limited service category 1 (LS-1) water miscible cargoes should not be followed by water cleaning, ballast or aqueous cargoes until the tank has been completely ventilated and freed of all traces of the LS-1 cargo. All traces of water must also be removed from a tank before LS-1 water miscible cargoes or chlorinated solvents or ester solvents (LS-4) are loaded. The improper sequence of cargoes or improper tank cleaning and preparation can have adverse effects on tank linings.

F. In the majority of cargoes, cargo contamination from the coating is highly unlikely, and is limited to initial cargoes after coating application. Avoid loading high purity chemicals before the coating is properly cured as per manufactuer's recommendation.

Cargo contamination is also possible from improper cleaning of tanks after carriage. To prevent contamination of subsequent cargoes and the chance of by-product forming chemical reaction, tanks must be properly cleaned between cargoes.

G. This Cargo Resistance Table is not based on the use of shop primers under the tank coatings listed. Devoe Coatings requires that all tank coatings be applied directly to blasted steel.

H. A Devoe Coatings Representative should be consulted for the cargo resistance rating of chemicals not included in this list.

I. Certain cargoes, such as carbon containing cargoes or impure or crude cargoes, may discolor the lining and may be very difficult to clean. There may be delays until the inspector is satisfied that the discoloration cannot be removed.

J. The normal requirement is to cure a tank lining for 7 days after application. Most coating systems do not completely cure or crosslink in 7 days, especially if the temperatures during this period are below normal.

The chemicals on the attached list were all tested after a 7 day cure at 77°F (25°C). The tank linings will, however, become more resistant with time, or if a hot, weak solvent cargo, such as mineral oils or heavy fuel oils, is carried. Very strong solvent cargoes (LS-1) should not be loaded as the first cargo after lining a tank.

K. Although Devoe Coatings Company believes the recommendations given in this Cargo Resistance Table to be reliable, due to the wide variation in product composition and specification, good engineering practice may indicate field testing the coating prior to large scale application.

Key to Resistance Table

S	Suitable
LS	Limitations on service (see Limited Service Notes)
LS (X 30)	Recommended for maximum of 30 days continuous immersion
LS (X 60)	Recommended for maximum of 60 days continuous immersion
U	Unsuitable
X	Not tested at this time Contact your Devoe Coatings Representative for the latest test information.

Limited Service Notes

LS-1 These products will cause some softening of the Devoe Coatings system, leading to reduced mechanical resistance. LS-1 products, and especially methanol, ethylene dichloride, acetone, vinyl acetate monomer, and cyclohexanone, should not be loaded in newly lined tanks before the coating system is fully cured.

Full cure will be obtained after a service period of one month with Suitable (S notation) cargoes. Full cure can also be achieved by carrying hot cargoes such as lubricating oil, mineral oil, vegetable oils, animal oils or molasses for a period of at least four days at 50°C or 3 days at 60°C. LS-1 cargoes, LS(X30) cargoes that are limited to 30 day carriage, or LS(X60) cargoes that are limited to 60 day carriage can not be carried until tanks have been fully cured.

After carriage of LS-1, LS(X30), and LS(X60) cargoes, the next immediate cargo must be a Suitable (S) cargo—without a LS, LS(X30), or LS(X60) notation—and be loaded after the tanks have been forced-air ventilated for at least 24 hours, or longer if the coating system has not yet fully recovered. Under no circumstances must water or ballast be introduced into the tanks before ventilating.

Water containing cargoes like caustic soda or potash should not be loaded immediately after LS-1, LS(X30), or LS(X60) cargoes.

LS-2 **Crude Oil**
Catha-Coat 305 Coating can safely carry sweet crude oil. Sour crudes, however, are acidic and will attack zinc, and are not recommended. Crude oils with a hydrogen sulfide content in excess of 300 ppm or a neutralization number greater than 0.4 are considered unsatisfactory.

LS-3 Fats, Oils, Greases

Animal and vegetable fats and oils contain variable amounts of free fatty acids. The free fatty acid (f.f.a.) content limitation is 2.5% or less; the acid number limitation is 5.0 or less.

Free radical acids can form with age or under warm storage conditions, and therefore, we also recommend measuring the pH before loading into a Catha-Coat 305 lined tank. A ph of 5.5 to 10.0 is suitable.

Products like lard and tallow have to be carried at elevated temperatures. The formation of free organic acids occurs rapidly, especially around heating coils. Rancid products are very high in f.f.a.

LS-4 Hydrolyzable Cargoes

Certain classes of chemicals will hydrolyze in the presence of water to form aggressive acidic by-products. Cargoes such as esters (acetates) and halogenated compounds (chlorinated or brominated solvents) must be kept stabilized and kept moisture-free. The water content must be limited to 100 ppm. The temperature of the cargo should not exceed 100°F (38°C).

LS-5 Molasses

Crude molasses may be quite acidic. Molasses can be carried in a Catha-Coat 305 Coating lined tank if the pH is between 5.5 and 10.0. After discharging, the residual molasses has to be completely washed and rinsed. An alkaline buffer compound can be added to the rinse to insure any acid residues are neutralized.

LS-6 Beverages and Potable Water

Although Devchem 253 Lining is unaffected by these liquids, no warranties can be made with regard to taste or odor.

LS-7 Phenol

Phenol (carbolic acid) and phenol compounds can form staining color bodies when exposed to oxygen, sunlight or trace alkalies. The lining may become discolored. A nitrogen gas blanket may prevent discoloration.

LS-8 Discoloration

Certain chemicals, crude cargoes and carbon containing products can stain the lining and may be very difficult, if not impossible, to clean. The effect of this discoloration on subsequent cargo cannot be generalized.

LS-9 Monomers and Other Non-Stable Chemicals

The linings are resistant and inert to these products. If the products are not properly stabilized, contain a foreign contaminant or if the heat limitations are exceeded, these products may polymerize or break down. Care should be taken to insure the stabilizing agents are compatible with the tank lining.

LS-10 pH

Cargoes for Catha-Coat Coating lined tanks must fall within a pH range of 5.5 to 10.0. Traces of zinc metal or zinc salts may contaminate the cargo.

LS-11 Crude Cargoes

Products like coal tar and xylenol can vary in composition from grade to grade and even batch to batch. Samples of the specific cargo should be tested or evaluated before loading.

LS-12 Similar Cargoes

These products are believed to be suitable for transport in the indicated lining since they are reportedly similar to cargoes successfully carried. No confirming tests have been conducted.

LS-13 **Water Immersion**

Catha-Coat 305 Coating withstands intermittent exposure to seawater, but continuous immersion over a long period will reduce the life of the coating.

LS-14 **Cargoes Sequenced with Methanol**

Methanol and the following cargoes—ethylene dichloride, vinyl acetate monomer, acetone or cyclohexanone—should not be sequenced more than once, without prior approval from the coating manufacturer. If in doubt about loading a cargo after methanol, please contact the Devoe Coatings Company Laboratory for advice.

LS-15 **Organic Fatty Acids**

Organic fatty acids will hydrolize in the presence of water to form aggressive acidic by-products. Cargoes such as tall oil fatty acid and palm oil fatty acid must be kept stabilized and moisture-free. The water content must be limited to 1% maximum with no traces of inorganic acids or mineral acids.

LS-16 **Amines**

Amines can be carried when free from moisture. If water is present, alkalinity may increase to a pH of more than 9.

To prevent contamination by water, both the cargo and the tank must be completely dry at the time of loading, and the amines must be transported under a dry nitrogen or carbon dioxide blanket

Devoe Coatings Company
Tank Lining Chemical Resistance Table

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Acetaldehyde	U	U	U
Acetic acid 5%	U	U	U
Acetic anhydride	U	U	U
Acetone	S	LS-1, 14, (X30)	U
Acetone cyanohydrin	LS-12	X	X
Acetonitrile	LS-4	LS-1, 4, (X 60)	U
Acetophenone (Phenyl methyl ketone)	S	LS-8, (X 60)	U
Acetylene, gas	S	S	S
Acetylene dichloride (Dichlorethylene)	LS-4	X	U
Actinol	U	S	X
Acrolein	U	U	U
Acropol (Mixed linear alcohols)	S	S	X
Acrylic acid	U	LS-1, 4, (X30)	X
Acrylic monomers	LS-4, 9	U	U
Acrylonitrile	LS-9	U	U
Acrylonitrile-styrene copolymer dispersion in polyether polyol	X	LS-12	X
Adiponitrile	X	U	U
Aircraft gasoline	S	S	S
Airturbo fuel	S	S	S
Alcohol, linear primary C12-C15	S	S	X
Alcohol ethoxylate, linear primary	S	S	X
Alcohol ethoxylate, ammonium salt solution	S	S	X
Alcohol ethoxysulfate, sodium salt solution	S	S	X
Alcoholic Beverages, N.O.S.	X	S	U
Aldol	U	U	U
Alkalate	X	LS-12	X
Alkali soybean oil	LS-3	S	S
Alkane (Dodecyl benzene)	S	S	S
Alkyl benzene	S	S	S
Alkyl benzene sulfonic acid	U	LS-8	X
Alkyl phosphate	S	LS-11	X
Alkyl phthalate	X	S	X
Alkylate bottom (Dodecyl benzene)	S	S	S
Alkylate detergent	S	S	X
Alkylate 22 (Dodecyl benzene)	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Alkylate 130 (Monsanto)	S	S	S
Allyl alcohol	S	S	U
Allyl aldehyde	U	U	U
Allyl chloride (3-Chloroprene)	U	LS (X 60)	U
Almond oil, sweet	LS-3	S	S
Alpha olefins	S	S	S
Alpha olefin C-6/7	S	S	S
Alpha olefin C-7/8	S	S	S
Alpha olefin C-7/14	S	S	S
Alpha olefin C-10/15	S	S	S
Alpha olefin C-15/18	S	S	S
Alpha-hydroxytoluol (Benzyl alcohol)	S	S	X
Alpha-N-amylene (1-Pentene)	S	S	X
Alum solution 15%	U	S	X
Alumina slurry concentrate	U	S	X
Aluminum chloride 10%	U	LS-8	X
Aluminum chloride 30%	U	LS-8	X
Aluminum hydroxide dry	U	S	X
Aluminum nitrate 30%	U	S	X
Aluminum sulfate 10%	U	S	X
Aluminum sulfate 30%	U	S	X
Aluminum sulfide 100%	U	U	U
Aminoethane (Ethylamine)	U	U	U
Aminoethanolamine	U	U	U
Aminoethoxy ethanol	U	U	U
Aminoethyl ethanolamine	U	U	U
Aminoethyl piperazine	X	X	X
Aminoform (HMTA)	U	U	U
2-Amino-2-methyl-1-propanol (90% or less)	X	S	X
Ammonia, anhydrous	U	U	U
Ammonia 26° Bé (< 25°C)	U	LS-1, (X30)	U
Ammonia 28% aqueous solution/ammonium hydroxide (< 25°C)	U	LS-1, (X30)	U
Ammonia fertilizer solutions	U	S	X
Ammonia water 10% (not over°25C)	U	LS-1, (X30)	U
Ammonium carbonate 50%	U	S	X
Ammonium chloride, quarternary	X	LS (X 30)	U
Ammonium hydrogen phosphate solution	X	X	X
Ammonium hydroxide/ammonia 28%aqueous solution (<25°C)	U	LS-1 (X30)	X
Ammonium hydroxide (10% solution in water)	U	LS (X60)	X
Ammonium hydroxide (25% solution in water)	U	LS (X60)	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Ammonium nitrate 10% solution in water	U	S	X
Ammonium nitrate 30% solution in water	U	S	X
Ammonium nitrate 50% solution in water	U	S	X
Ammonium phosphate, urea solution	X	X	X
Ammonium phosphate solution	X	X	X
Ammonium sulfate 40% (no heat)	X	S	X
Ammonium thiocyanate (25% or less)/ammonium thiosulfate solution (60% or less)	X	X	X
Amyl acetate (iso, normal, secondary)	LS-4	LS-1,4	U
Amyl alcohol (iso, normal, secondary, tertiary)	S	S	X
Amyl aldehyde	U	U	U
Amyl carbinol (Hexanol)	S	S	X
Amylene (1-Pentene)	S	S	S
Amylene hydrate (Amyl alcohol)	S	S	X
Amyl hydride (Pentane)	S	S	S
Anchovy oil	LS-3	S	S
Anglanoil 99	LS-8	LS-8	X
Aniline	U	U	U
Animal oil	LS-3	S	S
Anivax SX 3158	S	S	X
Ansulite FFF	X	S	X
Anthracene (C14) nonliquid	S	S	X
Anthracene oil	X	S	S
Antifreeze (glycol based)	S	S	X
Apricot kernel oil	X	S	S
Arachis oil	LS-3	S	S
Arco carbon black oil (Carbon black/feed stock)	S	S	X
Aroma (Extender oils)	S	S	S
Aromatic 100	S	S	S
Aromatic concentrate (Carbon black/feed stock)	S	S	X
Aromatic hydrocarbons	S	S	S
Aromatic oils (Extender oils)	S	S	S
Aromatic petroleum solvents	S	S	S
Aromatic sulfonic acids	U	U	U
Asphalt	X	LS-8	X
Asphalt cut back (Mix-asphalt, Gasoline, Naphtha and solvents)	S	S	S
Atrazine	U	S	X
Aviation alkylates (C8 paraffins and iso-parraffins, BP 95-120°C)	S	S	S
Aviation gasoline	S	S	S
Aviation kerosene	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Avocado Oil	X	S	S
Axle oil (Lube oil)	S	S	S
Babassu oil	LS-3	S	S
Beechnut oil	LS-3	S	S
Benzaldehyde	U	U	U
Benzene	S	S	S
Benzene, industrial nitration grade	S	S	S
Benzene trimethyl	S	S	S
Benzenesulfonyl chloride	X	X	X
Benzol	S	S	S
Benzyl acetate	LS-4	LS-1,4	U
Benzyl alcohol	S	S	X
Benzyl chloride	X	S	X
Beta-methacrylic acid	U	U	U
Black oil	LS-2	S	S
Blandol (White mineral oil)	S	S	S
Blown oils	LS-3	S	S
Boric acid 10%	U	S	U
Brake fluid (glycol base)	S	S	S
Brake fluid (glycol ether base)	U	S	S
Brandy	X	LS-6	X
Brine	U	S	S
Bromine	U	U	U
Bunker C oil and solvent	S	S	S
Bunker oil	S	S	S
Butadiene	S	S	X
Butadiene, inhibited	X	X	X
Butane	S	S	S
1,3-Butane diol (Butylene glycol)	S	S	X
Butanoic acid (Butyric acid)	U	U	U
Butanol (iso, normal, secondary, tertiary)	S	S	X
Butene oligomer	X	S	X
Butenoic acid (Crotonic acid)	U	U	U
2-Butoxy ethanol (Butyl cellosolve)	S	S	X
Butyl acetate (iso, normal, secondary)	LS-4	LS-1,4	U
Butyl acrylate (inhibited)	LS-4	LS-4	X
Butyl alcohol (iso, normal, secondary, tertiary)	S	S	X
Butyl amines	U	U	U
Butyl benzyl phthalate (BBP)	S	S	X
n-Butyl butyrate	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Butyl carbinol (N-Amyl alcohol)	S	S	X
Butyl carbitol (Diethylene glycol monobutyl ether)	S	S	X
Butyl carbitol acetate (Diethylene glycol monobutyl ether acetate)	LS-4	LS-1,4	U
Butyl cellosolve (Ethylene glycol monobutyl ether)	S	S	X
Butyl cellosolve acetate (Ethylene glycol monobutyl ether acetate)	LS-4	LS-1,4	U
Butyl chloride	X	LS-4	X
Butyl/decyl/cetyl eicosyl methacrylate mixture	LS-4,9	X	X
Butyl decyl phthalate	S	S	X
Butyl dioxitol	S	S	X
Butylene, alpha, 2	S	S	S
Butylene glycol	S	S	X
Butylene, poly	S	S	S
n-Butyl ether	S	X	X
Butyl formate	X	X	X
Butyl glycidyl ether (BGE)	S	X	X
Butyl glycol acetate	LS-4	LS-1, 4	U
Butyl glycol ether	S	S	X
Butyl heptyl ketone	S	S	U
Butyl lactate (no heat)	U	LS-8	X
Butyl methacrylate monomer	LS-4,9	LS-1,4,9	U
Butyl oxitol (Ethylene glycol monobutyl ether)	S	S	X
Butylphenol (ortho, tertiary)	S	S	X
Butyl phthalate	S	S	X
n-Butylraldehyde	U	X	X
Butyl stearate	X	S	X
Butyric acid	U	U	U
Butyrolactone	U	X	X
gamma-Butyrolactone	U	X	X
Butyrone (Heptanone)	S	S	U
Cajaputene (Dipentene)	S	S	S
Calcium alkyl salicylate	S	S	X
Calcium bromide 48%	S	S	X
Calcium bromide 53%	X	S	X
Calcium carbonate solution (130°F maximum)	X	S	X
Calcium chloride (saturated)	U	S	X
Calcium hydroxide 10%	U	S	S
Calcium hydroxide 30%	U	S	S
Calcium hydroxide 50%	U	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Calcium hypochlorite 15%	U	S	X
Calcium hypochlorite solution (over 15%)	U	X	X
Calcium naphthenate (in mineral oil)	X	S	S
Camphor oil	X	S	S
Candelilla oil (Montan)	X	S	S
Candlenut oil	LS-3	S	S
Canola oil, refined	X	LS-6	S
Capoc oil	LS-3	S	S
Capric acid	U	S	U
Caproic acid	U	S	U
Caprolactone	X	U	U
Capryl alcohol	S	S	X
Caprylic acid (Oxylic acid)	U	S	U
Carbitol acetate	LS-4	LS-1, 4	U
Carbitol solvent (Diethylene gylcol monoethyl ether)	S	S	X
Carbolic Acid (Phenol 100%)	LS-7	U	U
Carbolic oil (Middle oil)	S	S	S
Carbon black oil	LS-8	LS-8	LS-8
Carbon dioxide (gas) 100%	S	S	S
Carbon disulfide 10%	U	U	U
Carbon disulfide 100%	LS-4	U	U
Carbon tetrabromide	LS-4	S	X
Carbon tetrachloride	LS-4	S	X
Carbonic acid 10%	S	S	U
Carbowax 200	S	S	X
Carbowax 300 (Polyethylene glycol)	S	S	X
Carbowax 600	S	S	X
Cardura E	LS-4	S	X
Carnation oil (Petrolatum)	S	S	S
Carnation white mineral oil	S	S	S
Carnauba wax	X	S	S
Cashew nutshell oil	X	S	S
Castor oil	LS-3	S	S
Caustic potash	U	S	S
Caustic soda (NaOH) 10%	U	S	S
Caustic soda (NaOH) 20%	U	S	S
Caustic soda (NaOH) 50%	U	S	S
Caustic soda 50% spent (no heat)	U	S	X
Cellosolve (Ethylene glycol monoethyl ether)	S	S	X
Cellosolve acetate (Ethylene glycol monoethyl ether acetate)	LS-4	LS-1,4	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Cement	U	S	X
Certrex's mineral spirits	S	S	S
Cetyl alcohol (Primary hexadecyl alcohol)	S	S	X
Chinawood oil (Tung oil)	LS-3	S	S
Chlorinated diphenyl	LS-4	S	X
Chlorinated paraffins	LS-4	S	U
Chlorine, available in solution as NaClO (up to 200 ppm)	U	LS (X 30)	U
Chlorine, wet (saturated)	U	U	U
Chlorine dioxide	U	U	U
Chloroacetic acid	U	U	U
Chloracetyl chloride	U	U	U
Chlorobenzene	LS-4	LS-4	U
p-Chloro-m-cresol	S	U	U
2-Chloroethanol	LS-4	X	U
Chloroethene	LS-4	U	U
Chloroethylene	LS-4	U	U
Chloroform	LS-4	X	U
Chloropropionic acid	U	U	U
Chloropropylene oxide (Epichlorohydrin)	LS-4	U	U
Chlorosulfonic acid	U	U	U
Chlorothene (1,1,1-Trichlorethane)	LS-4	LS-1, 4	U
Chlorotoluene (all isomers)	LS-4	S	U
Choline chloride	U	S	U
Chromic acid 5%	U	LS-8	U
Chromic acid 10%	U	LS-8	U
Chromic acid 20%	U	U	U
Chromic acid 50%	U	U	U
Cinene (Dipentene)	S	S	S
Circo light oils	S	S	S
Circo light oil (extender oil)	S	S	S
Circo process oil (extender oil)	S	S	S
Circosol oil (extender oil)	S	S	S
Citric acid 5%	U	S	U
Citric acid 25%	U	S	U
Citroflex A-4	S	S	X
Clorox	U	S	U
Coal tar benzene	S	S	S
Coal tar naphtha	S	S	S
Cocoa butter	X	S	S
Cocoa butter oil	LS-4	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Cocoa nut oil, crude	LS-3	S	S
Cocoa oil	LS-3	S	S
Coco fatty acid	U	LS-15	U
Coco fatty alcohol	S	S	X
Coco methyl ester	LS-3	S	X
Coconut fatty acid, topped	U	LS-15	U
Coconut fatty acid, whole distilled	U	LS-15	U
Coconut oil, esterfied	U	S	S
Cod liver oil	LS-3	S	S
Cohune oil	X	S	S
Colza oil	LS-3	S	S
Copra oil (Coconut oil)	LS-3	S	S
Coray 40 (lubricant)	S	S	S
Core Lube 670 catalyst	X	U	X
Core Lube 674 catalyst	X	U	U
Corn oil	LS-3	S	S
Corn syrup	X	S	S
Cotton seed fatty acid	X	LS-15	U
Cottonseed oil (sulfuric acid free)	LS-3	S	S
Cottonseed oil stearine	S	S	X
Coumarone naphtha solvent	S	S	S
Creosote	LS-1,4	LS-1,4	U
Creosote (coal tar)	S	U	U
Cresol (ortho, meta, para)	LS-7	U	U
Cresyl diphenyl phosphate (Santicizer 140)	S	S	X
Cresylic acid 10%	U	U	U
Cresylic acid 100%	X	U	U
Crotonaldehyde	U	U	U
Croton oil	LS-3	S	S
Crude condensate (naphtha, petroleum)	S	S	S
Crude glycerine	U	S	S
Crude hard fraction PKO (Palm kernel oil)	U	S	S
Crude oil (high and low sulfur)	LS-2	S	X
Cumene	S	S	X
Cumene, pseudo	S	S	X
Cumol	S	S	X
Cyclo-Sol 53	S	S	X
1,5,9-Cyclododecatriene	X	X	X
Cycloheptane	S	S	S
Cyclohexane	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Cyclohexanol	S	S	X
Cyclohexanone	S	LS-1, 14, (X30)	U
Cyclohexanone/cyclohexanol mixture	S	LS-1, 14, (X30)	U
Cyclohexene	S	S	S
Cyclohexyl acetate	LS-4	LS-1,4	U
Cyclohexylamine	U	U	U
Cyclopentane	S	S	S
Cyclopentene	S	S	S
Cycosol (Mineral spirits)	S	S	S
Cylinder bright stock oil	S	S	S
Cylinder steam refined stock oil	S	S	S
p-Cymene (Isopropyltoluene)	S	S	S
Dalapon (2,2-Dichloropropionic acid)	U	U	U
Dalatinol (Di-(2-ethylhexyl) phthalate)	S	S	X
Dasanit	S	S	X
Decahydronaphthalene	X	S	X
Decalin (Decahydronaphthalene)	S	S	X
Decane (Decyl hydride)	S	S	S
Decanoic acid (Capric acid)	U	LS-4, (X60)	U
Decanol	S	S	X
Decene	S	S	S
Decyl alcohol (all isomers)	S	S	X
Decyl acrylate	LS-4,9	LS-1,4	U
Decyl benzene	X	S	S
Decyl carbinol (1-Undecanol)	S	S	S
Decyl octyl alcohol	S	S	X
D-D-Soil fumigant (1,3-Dichloro propylene and Propylene dichloride)	U	U	U
De-icing fluids (glycol based)	S	S	X
De-Monomer (Shell)	S	X	X
Detergent alkylate (Dodecyl benzene)	S	S	S
Dextrose solution	X	S	S
Diacetone alcohol	S	S	X
Dialkyl benzene	X	S	X
Dialkyl phthalate	S	S	X
Diallyl phthalate (DAP)	LS-4	S	X
Dibenzofuran (Diphenylene oxide)	S	U	X
1,2-Dibromo-3-dichloropropane	LS-4	X	X
Dibutylamine	U	U	U
Dibutyl carbitol (Diethtylene glycol dibutyl ether)	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Dibutyl Cellosolve (Ethylene glycol dibutyl ether)	S	LS-1	U
Dibutyl Maleate	LS-4	X	X
Dibutyl phthalate (DBP)	S	S	X
Dibutyl sebacate (DBS)	LS-4	S	X
Dicaprocate (Triethylene glycol)	S	S	X
Dichloroaniline	U	X	X
Dichlorobenzene (all isomers)	LS-4	U	U
Dichlorodifluoromethane	LS-4	X	X
Dichloroethane (Ethylene dichloride) (no heat)	LS-4	LS-1,4, 14	U
Dichloroethylene	LS-4	U	U
Dichloroethyl ether	LS-4	U	U
Dichlorohexane	LS-4	U	U
Dichloromethane (Methylene chloride)	LS-4	U	U
Dichlorophenol	LS-4	X	U
Dichloropropane	LS-4	U	U
Dichloropropene	LS-4	S	U
Dichloropentane	LS-4	S	U
Dichloropropionic acid	U	X	U
Dicyclohexylamine	U	U	U
Dicylopentadiene	S	S	S
Diesel fuel	S	S	S
Diesel oil	S	S	S
Diethanolamine (DEA)	U	S	X
Diethylamine (no heat)	U	U	U
Diethylaminoethanol (no heat)	X	LS-1, (X60)	U
2,6-Diethylaniline	X	X	X
Diethylbenzene	S	S	X
Diethyl carbonate	LS-4	S	X
Diethylethanolamine (no heat)	U	LS-1, (X60)	U
Diethyl ether	S	U	U
Diethyl phthalate	S	S	X
Diethyl sulfate	X	X	X
Diethylene alcohol	S	S	X
Diethylene chloride	LS-4	U	U
Diethydichloroformal	X	X	U
Diethylene ether (Dioxane)	S	S	S
Diethylene glycol (Dihydroxydiethyl ether)	S	S	X
Diethylene glycol butyl ether acetate	LS-4	LS-1,4	U
Diethylene glycol dibutyl ether	S	S	X
Diethylene glycol diethyl ether	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Diethylene glycol ethyl ether acetate	LS-4	LS-1,4	U
Diethylene glycol methyl ether	S	S	X
Diethylene glycol methyl ether acetate	LS-4	LS-1,4	U
Diethylene glycol monobutyl ether	S	S	X
Diethylene glycol phenol ether	S	X	X
Diethylene glycol phenyl ether	S	S	X
Diethylene glycol phthalate	X	S	X
Diethylenetriamine	X	U	U
Di(2-ethylhexyl)adipate	X	S	X
Di(2-ethylhexyl)phosphoric acid	U	U	U
Di(2-ethylhexyl)phthalate	S	S	X
Diglycidyl ether of bisphenol A	X	S	X
Diglycidyl ether of bisphenol F	X	S	X
Di-hard-tallow-methylamine	X	S	X
Di-n-hexyl adipate	LS-4	S	X
Diisobutylene	S	S	S
Diisobutyl ketone (DIBK)	S	S	U
Diisobutyl phthalate	S	S	X
Diisodecyl phthalate	S	S	X
Diisononyl adipate	LS-4	S	X
Diisooctyl adipate	LS-4	S	X
Diisooctyl phthalate (DIOP)	S	S	X
Diisopropanolamine	X	X	X
Diisopropylamine	X	U	X
Diisopropylbenzene	S	S	X
Diisopropylether	S	X	X
Diisopropyl naphthalene	S	S	X
Dimethanolamine	X	U	U
Dimethyl adipate	X	S	X
Dimethylamine (DMA)	U	U	U
Dimethylamine, 40% aqueous solution	U	U	U
Dimethylaminoethanol	U	U	U
Dimethylcarbinol (Isopropyl alcohol)	S	S	X
n,n-Dimethyl cyclohexyl amine	U	X	X
Dimethylethanolamine	U	U	U
Dimethyl formamide	LS-1, (X60)	U	U
Dimethylglutarate (no heat)	S	LS (X 60)	X
Dimethylketone (Acetone)	S	LS-1, 14, (X30)	U
Dimethyl naphthalene sulfonic acid sodium salt solution	LS-12	LS-12	X
Dimethyl phthalate	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
2,2-Dimethyl-1,3-propanediol	X	X	X
Dimethyl sebacate	LS-4	S	X
Dimethyl succinate	LS-4	S	X
Dimethyl sulfoxide (DMSO)	S	X	X
Dimonene (Dipentene)	S	S	S
Dinitrotoluene (DNT)	LS-4	S	X
Dinonyl phthalate (DNP)	S	S	X
Dioctyl adipate	LS-4	S	X
Dioctyl phthalate (DOP)	S	S	X
Diol 80 (lube oil)	S	S	S
Dioxane	S	S	X
Dioxitol (Diethylene glycol monoethyl ether)	S	S	X
Dipentene	S	S	S
Diphenyl ether	S	LS-1	U
Diphenylmethane 4,4-diisocyanate (MDI)	S	S	X
Diphenylmethane isocyanate	X	U	U
Diphenyl oxide (Diphenyl ether)	S	LS-1	U
Diphenylene oxide	S	U	X
Diphenylol propane-epichlorohydrin resins	X	S	S
Diphenyl oxide/diphenyl phenyl ether mixture	S	U	U
Di-n-propylamine	U	U	U
Dipropyl ketone (Heptanone)	S	S	U
Dipropylene glycol	S	S	X
Dipropylene glycol methyl ether	S	LS-1	U
Dipropylene glycol monomethyl ether	S	LS-1	U
Distearyl dimethyl ammonium chloride	X	S	X
Distilled water	S	S	S
Ditallow dimethyl ammonium chloride	X	S	X
Ditridecyl phthalate (DTDP)	S	S	X
Diundecyl phthalate	S	S	X
Divinyl acetate	LS-4,9	U	U
Dobanes	S	S	S
Dobanols (fatty alcohols)	S	S	X
Dodecane	S	S	S
Dodecanoic acid (Lauric acid)	U	S	U
Dodecanol (Lauryl alcohol)	S	S	X
Dodecene (Tetrapropylene)	S	S	X
Dodecyl alcohol	S	S	X
Dodecyl amine	U	X	X
Dodecyl amine/tetradecyl amine mixture	X	X	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Dodecylbenzene (Alkane)	S	S	S
Dodecyl methacrylate	LS-4,11	X	X
Dodecyl/pentadecyl methacrylate solution	LS-4,11	X	X
Dodecylphenol	LS-7	S	X
Dow Corning FX16	S	S	X
Dowanol DB (Diethylene glycol butyl ether)	S	S	X
Dowanol DE (Diethylene glyclol ethyl ether)	S	S	X
Dowanol DESG (Modified Dowanol DE)	S	S	X
Dowanol DM (Diethylene glycol methyl ether)	S	S	X
Dowanol EB (Ethylene glycol n-butyl ether)	S	S	X
Dowanol EE (Ethylene glycol ethyl ether)	S	S	X
Dowanol EM (Ethylene glycol methyl ether)	S	S	X
Dowanol EP (Ethylene glycol phenyl ether)	S	S	X
Dowanol PM (Propylene glycol methyl ether)	S	S	X
Dowanol PMIX (PM + DPM + TPM)	S	S	X
Dowanol TPM (Tripropylene glycol methyl ether)	S	S	X
Dow 6X (Hexachlorodiphenyl oxide)	LS-4	S	X
Dow Epoxy Resin 331 (DGE)	X	S	X
Drilling brine	X	S	S
Drilling mud	X	S	S
Emulsified vegetable oils	LS-3	S	S
Engine oil	S	S	S
Epichlorohydrin	LS-4	U	U
Ervol (Petrolatum)	S	S	S
Ethanol (technical)	S	S	U
Ethanolamine (MEA)	U	U	U
Ether	S	U	U
Ethidene (Norbonene)	S	S	X
Ethoxol (Ethylene glycol monoethyl ether)	S	S	X
Ethoxyethanol (Cellosolve)	S	S	X
Ethoxyethyl acetate (Cellosolve acetate)	LS-4	LS-1,4	U
beta-Ethoxyethylmethacrylate monomer	LS-4	S	X
Ethoxylated fatty alcohols (Shell)	LS-3	S	X
Ethyl acetate (no heat)	LS-4	LS-1,4	U
Ethylacetic acid (Butyric acid)	U	U	U
Ethyl acetoacetate	LS-4	LS-1,4	U
Ethyl alcohol (denatured)	S	S	U
Ethylamine 70%	U	U	U
Ethyl amino toluol	X	U	U
Ethyl amyl ketone (EAK)	S	S	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Ethylbenzene	S	S	S
2-Ethylbutanol	S	S	X
Ethyl-n-butylamine	U	X	X
Ethyl butyrate	X	S	X
Ethyl Cellosolve	S	S	X
Ethyl chloride	LS-4	X	X
Ethylcyclohexane	S	S	S
Ethyl cyclohexanone	S	U	U
Ethyl cyclohexylamine	U	X	X
Ethylene (Ethene)	S	S	S
Ethylene carbonate	X	X	X
Ethylene chloride (Ethylene dichloride) (no heat)	LS-4	LS-1,4, 14	U
Ethylene chlorohydrin	LS-4	U	U
Ethylene cyanohydrin	X	X	X
Ethylenediamine	U	U	X
Ethylenediaminetetraacetic acid 10% (EDTA)	U	S	U
Ethylenediaminetetraacetic acid, tetrasodium salt solution	X	X	X
Ethylene dibromide	LS-4	U	U
Ethylene dichloride (no heat)	LS-4	LS-1,4, 14	U
Ethylene glycol (Ethylene alcohol)	S	S	X
Ethylene glycol (fiber grade)	S	S	X
Ethylene glycol acetate	LS-4	LS-1,4	U
Ethylene glycol butyl ether acetate	LS-4	LS-1,4	U
Ethylene glycol diacetate (Glycol diacetate)	LS-4	LS-1,4	U
Ethylene glycol dibutyl ether	S	LS-1	U
Ethylene glycol isopropyl ether	S	LS-1	U
Ethylene glycol methyl butyl ether	S	LS-1	U
Ethylene glycol methyl ether	S	S	X
Ethylene glycol monobutyl ether (2-Butoxyethanol)	S	S	X
Ethylene glycol monobutyl ether acetate	LS-4	LS-1,4	U
Ethylene glycol monoethyl ether (2-Ethoxyethanol)	S	S	X
Ethylene glycol monoethyl ether acetate	LS-4	LS-1,4	U
Ethylene glycol monomethyl ether (2-Methoxyethanol)	S	S	X
Ethylene glycol monomethyl ether acetate	LS-4	LS-1,4	U
Ethylene glycol monophenyl ether	S	S	X
Ethylene glycol phenyl ether	S	S	X
Ethyleneimine	X	X	X
Ethylene oxide (Epoxyethane)	U	U	U
Ethylene polyglycol	S	S	X
Ethyl ether	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Ethyl-3-ethoxypropionate	S	S	X
Ethylhexanoic acid	U	X	X
Ethylhexanol	S	S	X
2-Ethylhexanol	S	S	X
Ethyl hexoic acid (2-Ethyl hexoic acid)	U	X	X
2-Ethylhexyl acetate	LS-4	LS-1,4	U
2-Ethylhexyl acrylate	X	X	X
2-Ethylhexyl alcohol	S	S	X
2-Ethylhexylamine	U	U	U
2-Ethylhexyl 2-mercapto acetate	X	X	X
Ethylidene chloride (1,1-Dichloroethane)	X	X	X
Ethyl lactate	LS-4	LS (X 30)	X
Ethyl methacrylate monomer	X	U	U
Ethyl ortho silicate	S	S	X
Ethyl PCT	X	X	X
Ethyl phthalate	S	S	X
o-Ethylphenol	X	U	U
Ethyl propionate	S	S	X
2-Ethyl-3-propylacrolein	X	X	X
Ethyl silicate, condensed	S	S	X
Ethyltoluene	S	S	S
Extender/process oils	S	S	S
Fatty acids, refined (animal and vegetable derived)	LS-3	LS-15	U
Fatty alcohol, natural	LS-3	S	X
Fatty alcohols, synthetic	LS-3	S	X
Ferric chloride 20%	U	LS-8	X
Ferric sulfate (up to 20%)	U	S	X
Fertilizer solutions	U	S	X
Fire fighting foams:			
Aer-O-Lite 3 (Chubb National)	X	S	X
Aer-O-Lite 3 Cold Foam (Chubb National)	X	S	X
Aer-O-Water (Chubb National)	X	S	X
High Expansion (Chubb National)	X	S	X
Universal Gold (Chubb National)	X	S	X
Universal Plus (Chubb National)	X	S	X
Fish liver oil	X	S	S
Fish oil	LS-3	S	S
Fish oil solubles	LS-3	LS-15	X
Flexindra (process extender oil)	S	S	X
Flexol DIOP (Diisooctyl phthalate, 10-10 Diisodecyl phthalate)	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Flexol DOP (Di-2-ethylhexyl phthalate)	S	S	X
Flexol EOP (Epoxidized soybean oil)	LS-3	S	X
Flexol NHDP (Normal, hexyl, n-octyl, n-decyl phthalate)	S	S	X
Flexon process oil	S	S	X
Fluorosilicic acid (Fluosilicic acid)	U	U	U
Foots soapstock oil (sulfuric acid free)	U	S	S
Formaldehyde 100% (HCHO)	U	U	U
Formaldehyde solution 37%	U	U	U
Formaldehyde solution 38%—50% by weight	U	U	U
Formalin	U	U	U
Formamide	U	U	U
Formic acid 10%	U	U	U
Fuel, jet JP4, JP5	S	S	S
Fuel oil	S	S	S
Fuel oil #2	S	S	S
Fumaric adduct of rosin (water dispersion)	X	X	X
Furfural, corn, oat or rice extract (Ant oil)	LS-3,4	U	X
Furfuryl alcohol (Furyl carbinol) (no heat)	S	LS-1 (X30)	U
Fusel oil, acid free (Amyl alcohol)	S	S	X
Gas oil	S	S	S
Gasoline	S	S	S
Gasoline (with tetraethyl lead)	S	S	S
Gas plant naphtha (Petroleum naphtha)	S	S	S
Gentrex (Lube oil)	S	S	S
Getty antifreeze	S	S	X
Glacial acetic acid	U	U	U
Gluconic acid 50%	U	S	U
Glucose	S	S	S
Glucose Syrup	X	S	S
Glutaraldehyde solution	X	X	X
Glycerin, crude (Glycerine)	U	S	X
Glycerin, synthetic	S	S	X
Glycerol	LS-3	S	X
Glyceryl triacetate (Triacetin)	LS-4	S	X
Glycine, sodium salt solution	X	X	X
Glycol (Dihydric alcohol)	S	S	X
Glycol alkyl ethers	S	S	X
Glycol diacetate	LS-4	LS-1,4	U
Glycol monoethers	S	S	X
Glyoxal solution (40% or less)	U	LS-12	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Grain oil (Fusel oil)	S	S	S
Grapeseed oil	LS-3	S	S
Grapestone oil	LS-3	S	S
Gravex (lube oil)	S	S	S
Grease, animal	X	S	S
Grease, yellow	U	S	S
Gulf (Lube oils)	S	S	S
Gulf Base Stock 900	S	S	X
Hard fraction oil	LS-3	S	X
Hazelnut oil	LS-3	S	S
Heart cut distillate (Exxon solvent blend)	S	S	S
Heavy aromatic naphtha	S	S	S
Heptadecane	S	S	S
Heptadecane 3-heptanol	S	S	X
Heptane (all isomers)	S	S	S
Heptanoic acid	U	LS (X 30)	U
1-Heptanol (Enanthic alcohol)	S	S	X
3-Heptanol	S	S	X
2-Heptanone (Methyl n-amyl ketone)	S	S	U
3-Heptanone (Ethyl butyl ketone)	S	S	U
1-Heptene (1-Heptylene)	S	S	S
Heptyl acetate	LS-4	LS-1,4	U
Heptyl alcohol (all isomers)	S	S	X
Hexachlorocyclopentadiene	X	X	U
Hexachloropentadiene	S	S	U
Hexachlorodiphenyl oxide	S	X	U
Hexadecane (Cetane)	S	S	S
1-Hexadecanol (Hexadecyl alcohol)	S	S	S
Hexadecanoic acid (Palmitic acid)	U	S	U
Hexadecenoic acid (Palmitoleic acid)	U	S	U
Hexahydroaniline (Cyclohexylamine)	U	U	U
Hexahydrobenzene (Cyclohexane)	S	S	S
Hexahydro cymol	S	S	X
Hexahydrophenol (Cyclohexanol)	S	S	X
Hexalin	S	S	X
Hexamethylene (Cyclohexane)	S	S	S
Hexamethylenediamine	U	U	U
Hexamethylenediamine solution	U	U	U
Hexamethylenediamine adipate (50% in water)	U	U	U
Hexamethylenimine	X	X	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Hexamethylenetetramine (HMTA)	U	U	U
Hexanaphthene (Cyclohexane)	S	S	S
Hexane (all isomers)	S	S	S
Hexane triol	S	S	X
Hexanol (all isomers)	S	S	X
Hexanoic acid (Caproic acid)	U	S	U
Hexene	S	S	S
Hexoic acid (Caproic acid)	U	S	U
Hexone (Methyl isobutyl ketone)	S	LS-1 (X60)	U
Hexyl acetate	LS-4	LS-1,4	U
Hexyl alcohol (iso, normal)	S	S	X
Hexylene glycol	S	S	X
Hexylic acid (Caproic acid)	U	S	U
Hydrazine 5%	LS (X 60)	S	X
Hydrazine 30%	LS (X 30)	X	X
Hydrocarbons, aliphatic	S	S	S
Hydrocarbons, alpha	S	S	S
Hydrocarbons, aromatic	S	S	S
Hydrochloric acid 5%	U	U	U
Hydrochloric acid 10%	U	U	U
Hydrochloric acid 20%	U	U	U
Hydrochloric acid 37%	U	U	U
Hydro crackate (gasoline)	S	S	S
Hydrofluoric acid 10%	U	U	U
Hydrogen chloride gas, dry	U	U	U
Hydrogen fluoride	U	U	U
Hydrogen sulfide, saturated	U	S	X
Hydroxyethyl acrylate	X	X	X
Hydroxylamine, solution	U	S	X
Hydroxymethyl benzene (Cresol)	S	U	U
2-Hydroxy-4-(methylthio)butanoic acid	X	X	U
Illipe butter (Mowrah butter)	X	S	S
Inedible tallow (01986)	U	S	X
Intermediate detergent (fatty alcohol)	LS-3	S	X
Isoamyl acetate	LS-4	LS-1,4	U
Isoamyl alcohol	S	S	X
Isoamylene	S	S	S
Isobutyl acetate	LS-4	LS-1,4	U
Isobutyl acrylate	X	LS-4	X
sobutyl alcohol	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Isobutyl aldehyde	U	U	U
Isobutyl carbinol (Isoamyl alcohol)	S	S	X
Isobutyl formate	X	LS-12	X
Isobutyl isobutyrate	S	S	X
Isobutyric acid	U	U	U
Isodecane	S	S	S
Isodecanol	S	S	X
Isohexanol	S	S	X
Isononanoic acid	X	X	U
Isononyl alcohol	S	S	X
Isooctane	S	S	S
Isooctyl alcohol (Isooctanol)	S	S	X
Isopar E (Esso Iso paraffin)	S	S	S
Isopar G (Esso Iso paraffin)	S	S	S
Isopar H (Esso Iso paraffin)	S	S	S
Isopar K (Esso Iso paraffin)	S	S	S
Isopar L (Esso Iso paraffin)	S	S	S
Isopar M (Esso Iso paraffin)	S	S	S
Isopentane	S	S	S
Isophorone	S	U	U
Isophorone diamine	U	U	U
Isophorone diisocyanate	X	X	X
Isoprene	S	S	X
Isopropanolamine	U	U	X
Isopropyl acetate	LS-4	LS-1,4	U
Isopropyl alcohol	S	S	X
Isopropylamine 50%	U	U	U
Isopropylamine 100% (no heat)	U	U	U
Isopropyl benzene (Cumene)	S	S	X
Isopropyl cyclohexane	S	S	S
Isopropyl ether	S	S	X
Isopropyl oxitol	S	S	X
Japan wax	LS-3	S	S
Jeffersol (Ethylene glycol monomethyl ether)	S	S	X
Jet fuel, JP4, JP5, JP6	S	S	S
Jojoba oil	X	S	S
Kapoc oil	LS-3	S	S
Kasil (Potassium silicate)	U	S	X
Kaydol (mineral oil)	S	S	S
Kaydol (petrolatum)	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Kellin (Linseed oil)	LS-3	S	S
Kerex (Mineral spirits)	S	S	S
Kerosene	S	S	S
Ketohexamethylene (Cyclohexanone)	S	LS-1, 14 (X30)	U
Klearol (petrolatum)	S	S	S
KMC-113 Solvent (Diisopropyl naphthalene)	S	S	S
KMC Oil (Diisopropyl naphthalene)	S	S	S
Kodaflex (Hexanol isobutyrate)	S	S	X
Lactic Acid	U	LS-8	U
Laktane (normal paraffin solvent)	S	S	S
Lamp oil (Kerosene)	S	S	S
Lanolin	LS-3	S	S
Lard	LS-3	S	S
Lard oil	LS-3	S	S
Larex	LS-3	S	X
Lasso herbicide (no heat)	X	S	X
Latex rubber, natural (Ammonia stabilized)	U	S	X
Lauric acid (fatty acid)	U	LS-15	U
Lauric/myristic acid mixture	U	LS-15	U
Lauryl alcohol	LS-3	S	X
Law (Mineral spirits)	S	S	S
Lignosite (50% lignin liquor)	U	S	X
Ligroin	S	S	X
Lime slurry	X	S	X
Limonene (Dipentene)	S	S	S
Linear alcohols (Tergitols)	S	S	X
Linear paraffin (Tridecane)	S	S	S
Linevol	S	S	X
Linoleic acid (fatty acid)	U	LS-15	U
Linolenic acid (fatty acid)	U	LS-15	U
Linseed oil	LS-3	S	S
Low aromatic white spirit (Mineral spirits)	S	S	S
Lube Oil	S	S	S
Lycopersicum esculentum oil (Tomato seed oil)	X	S	S
Lye, potassium 50% (KOH, Potassium hydroxide)	U	S	S
Lye, sodium 50% (NaOH, Sodium hydroxide)	U	S	S
M-300 (lube additive)	S	S	S
M-400	S	S	S
MDI (Diphenyl methane 4,4 diisocyanate)	X	S	X
Magnesium chloride 35%	U	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Magnesium hydroxide	U	S	X
Magnesium sulfonate	X	S	X
Maize oil	LS-3	S	S
Maleic acid 10%	U	LS (X 30)	U
Maleic anhydride	X	S	X
Margaric acid (Heptadecanoic acid)	U	LS (X 30)	U
Meadow foam oil	X	S	X
Menhaden oil	LS-3	S	S
Mercaptans	U	LS (X 30)	X
Mercaptobenzothiazol sodium salt solution	X	X	X
Mesamoll (Phenol/cresol alkyl sulfonic esters)	S	X	X
Mesitylene	S	S	X
Mesityl oxide	U	S	X
Metam sodium solution	X	S	X
Meta-toluene diisocyanate (TDI)	LS-9	LS-9	X
Methacrylate monomer	U	U	X
Methacrylic acid	U	U	U
Methacrylonitrile	LS-9	X	X
Methallyl alcohol	S	S	X
Methanol (1% maximum water content)	S	LS-1, 14	U
Methenamine (HMTA)	U	U	U
3-Methoxybutyl acetate	LS-4	LS-1,4	U
2-Methoxyethanol (Methyl Cellosolve)	S	S	X
Methoxypropylene glycol	S	S	X
Methyl acetate	LS-4	LS-1,4	U
Methyl acetoacetate	LS-4	LS-1,4	U
Beta-methyl acrolein (Crotonaldehyde)	U	U	U
Methyl acrylate, inhibited	LS-4	LS-4	X
Methyl acrylic acid	U	U	U
Methyl alcohol (1% maximum water content)	S	LS-1, 14	U
Methylallyl alcohol	S	S	X
Methylallyl chloride	LS-4	S	X
Methylamine solutions	X	S	X
2-Methylamyl acetate	LS-4	LS-1,4	U
2-Methylamyl alcohol	S	S	X
Methylamyl ketone	S	LS-1	U
Methylbenzene (Toluol)	S	S	S
Methyl bromide	X	X	X
2-Methyl butanol	S	S	X
Methyl butenol	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Methyl tertiary-butyl ether (MTBE)	S	S	S
Methyl butyl ketone	S	LS-1	U
Methyl butynol	S	S	X
Methylbutyraldehyde	U	U	X
Methyl butyrate	S	S	X
Methyl carbitol (Diethylene glycol monomethyl ether)	S	S	X
Methyl cellosolve (Ethylene glycol monomethyl ether)	S	S	X
Methyl cellosolve Acetate (Ethylene glycol monomethyl ether acetate)	LS-4	LS-1,4	U
Methyl chloride	X	X	X
Methylchloroform (1,1,1-Trichlorethane)	LS-4	S	U
Methylcyclohexane	S	S	S
Methylcyclopentadiene	S	X	S
Methyldiethanolamine (MDEA)	U	U	X
Methyl dioxitol (Diethylene glycol monomethyl ether)	S	S	X
Methyl ester CE810 (Cocoa methyl ester)	LS-3	S	X
Methylene chloride	LS-4	U	U
Methylene diisocyanate	X	X	X
Methylene dichloride	LS-4	U	U
?-Methyl-6-ethylaniline (Ethylamino toluol)	X	X	X
Methylethylcarbinol	S	S	X
Methyl ethyl ketone (MEK)	S	LS-1, (X 30)	U
2-Methyl-5-ethylpyridine	X	U	X
Methyl formate	U	U	X
Methyl glycol (Propylene glycol)	S	S	X
Methyl glycol acetate	LS-4	LS-1, 4	U
Methyl heptyl ketone	S	S	U
2-Methyl hexyl acrylate	S	S	X
2-Methyl-2-hydroxy-3-butene	LS-12	LS-12	X
2-Methyl-2-hydroxy-3-butyne	LS-12	LS-12	X
Methyl isoamyl ketone (MIAK)	S	LS-1, (X 60)	U
Methylisobutyl carbinol	S	S	X
Methyl isobutyl ketone (MIBK)	S	LS-1, (X 60)	U
Methyl laurate	S	S	X
Methyl methacrylate monomer	LS-4,9	X	X
Methyl naphthalene (alpha/beta)	S	S	X
Methyl naphthalene fractions	S	S	X
Methyl oxitol (Methyl Cellosolve)	S	S	X
Methyl oxitol acetate	S	LS-1,4	U
?-Methyl-1-pentene	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
4-Methyl-1-pentene	S	S	S
Methyl phenol (Cresol)	LS-7	U	X
2-Methylpropionic acid	U	U	U
Methyl propyl glycol	S	S	X
2-Methylpyridine	U	U	X
n-Methyl-2-pyrrolidone	U	U	U
Methylpyrrolidone	U	U	U
Methyl salicylate	X	X	X
Methylstyrene, alpha (inhibited)	LS-9	LS-9	X
Methyl sulfoxide (DMSO)	S	X	X
Methyl tertiary butyl ether (MTBE)	S	S	S
Middle oil (Coal tar)	S	S	X
Mineral oil—white (petrolatum)	S	S	S
Mineral seal oil (lube oil)	S	S	S
Mineral spirits	S	S	S
Mineral spirit #3	S	S	S
Mineral spirit #4	S	S	S
Mineral spirit #10	S	S	S
Molasses	LS-5	S	S
Monobutylamine	U	U	U
Monochlorobenzene	LS-4	S	U
Monoethanolamine	U	U	U
Monoethylamine 70% in water	U	U	U
Monoethylene gylcol	S	S	X
Monoethylene glycol ether	S	S	X
Monoisopropanolamine	U	U	U
Monomethylamine	U	U	U
Mononitrobenzene	LS-4	S	X
Monopropylene glycol	S	S	X
Monsanto Resin Plasticizer HB40	S	S	X
Monsanto Santicizer 140	S	S	X
Monsanto Santicizer 148	S	S	X
Morpholine (Tetrahydro-1,4-oxazine)	X	X	X
Motor fuel antiknock compounds	X	X	S
Motor oils	S	S	S
MTBE	S	S	S
Murumuru fat	X	S	S
Myrcene	S	S	X
Myristic acid	U	S	U
Myristyl alcohol	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Nalkylene (detergent alkylates)	S	S	X
Naphtha	S	S	S
Naphtha, crude condensate	S	S	S
Naphtha, gasplant	S	S	S
Naphtha, grade	S	S	S
Naphtha, heavy (Coal tar)	S	S	X
Naphtha, light	S	S	S
Naphtha, M50	S	S	S
Naphtha, natural liquid	S	S	S
Naphtha, petroleum	S	S	S
Naphtha solvent (160° benzol)	S	S	S
Naphtha, unfinished	S	S	S
Naphtha, unfinished virgin	S	S	S
Naphtha, whole	S	S	S
Naphthalene 100%	S	S	S
Naphthalene oil (maximum heat 80°C)	X	X	X
Naphthenic acid ($C_6H_{11}COOH$)	U	S	U
Naphthenic oils (extended oils)	S	S	S
Naprex 50 (lube oil)	S	S	S
'atrium (Sodium)	X	X	X
Natural liquid gas (Petroleum naphtha)	S	S	S
Natural rubber latex	U	LS-9	X
Neatsfoot oil	LS-3	S	S
Necton 78	S	S	X
Neodecanoic acid	U	S	U
Neodol (fatty acid)	LS-3	LS-15	U
NeoLine	S	S	X
Neu-Tri (Dow Trichlorethylene)	LS-4	LS-4	U
Niax Diol	S	S	X
Nitration grade toluene	X	S	S
Nitric acid 5%	U	U	U
Nitric acid 15%	U	U	U
Nitric acid 30%	U	U	U
Nitric acid 70% aqueous solution	U	U	U
Nitrobenzene	LS-4	S	X
o-Nitrochlorobenzene	LS-4	X	X
Nitroethane	LS-4	S	S
Nitrogen fertilizers	U	S	X
Nitromethane	LS-4	LS-1, (X-30)	U
trophenol (ortho, meta, and para)	X	X	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
1-Nitropropane	LS-4	S	S
2-Nitropropane	LS-4	S	S
Nitropropane 60%/nitroethane 40% mixture	LS-4	S	S
Nitrotoluene (ortho and para)	S	S	X
Nonane (all isomers)	S	S	S
Nonanol	S	S	X
Nonene	S	S	S
n-Nonanoic acid (n-Nonic acid)	U	S	U
Nonyl alcohol	S	S	X
Nonylenes	S	S	X
n-Nonylic acid	U	S	U
Nonyl methacrylate monomer	LS-9	X	X
Nonyl phenol	LS-7	S	X
Nonyl phenol ethoxylate	S	S	X
Normal amyl acetate	LS-4	LS-1,4	U
Normal amyl alcohol	S	S	X
Normal hexanol	S	S	S
Normal paraffin	S	S	S
Normal propyl acetate	LS-4	LS-1,4	U
Normal propyl alcohol	S	S	X
Nutmeg butter	X	S	S
Octadecane	S	S	S
1-Octadecanol	U	S	X
Octadecene	S	S	S
Octane (iso and normal)	S	S	S
Octadecatrienoic acid (Linolenic acid)	U	S	U
Octadecenoamide solution	X	X	X
Octanoic acid (Caprylic acid)	U	S	U
Octanol	S	S	X
Octene	S	S	S
Octyl acetate	LS-4	LS-1,4	U
Octyl alcohol (iso and normal)	S	S	X
Octyl aldehydes	X	X	X
Octylol	S	S	X
Octyl chloride	LS-4	LS-8	X
n-octyl n-decyl adipate (NODA)	LS-4	S	X
Oiticica oil	LS-3	S	S
Olefins	S	S	S
alpha-Olefin mixture (C6-C18)	S	S	S
Olefin mixture (C5-C7)	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Olefin mixture (C8-C12)	S	S	S
Oleic acid (fatty acid)	U	LS-15	U
Oleum (Fuming sulfuric acid)	U	U	U
Oleyl alcohol	S	S	X
Olive oil	U	LS-6	S
Orange oil (Dipentene)	S	S	S
Ortho cresol	S	U	U
Ortho dichlorobenzene (no heat)	LS-4	LS (X 60)	U
Ortho nitrochlorobenzene	LS-4	X	U
Ortho nitrotoluene	S	S	X
Oxalic acid, dry	U	S	U
Oxirane (Ethylene oxide)	X	U	U
Oxitol (Ethylene glycol monoethyl ether)	S	S	X
Oxo alcohol (Isooctyl alcohol)	S	S	X
Palatinol AH (Diethyl hexyl phthalate)	S	S	X
Palatinol BB (Butylbenzylphthalate)	S	S	X
Palatinol C (Dibutylphthalate)	S	S	X
Pale oil (lube oil)	LS-12	LS-12	S
Palmac 55-16	X	S	X
Palmac 98-12	X	S	X
Palmac 505	X	S	X
Palm acid oil	U	LS-15	X
Palm kernel fatty acid, split	X	LS-15	U
Palm kernel oil (sulfuric acid free)	LS-3	S	S
Palm kernel residue	X	S	X
Palm nut oil	LS-3	S	S
Palm nut oil fatty acid	S	LS-1, 15	U
Palm nut oil fatty acid methyl ester	X	X	X
Palm oil, crude (sulfuric acid free)	LS-3	S	S
Palm oil fatty acid ($C_{12}-C_{18}$)	X	LS-15	U
Palm oil, processed (sulfuric acid free)	LS-3	S	S
Palm oil, refined (sulfuric acid free)	LS-3	S	S
Palm oil, sterin (sulfuric acid free)	LS-3	S	S
Palm oil fatty acid methyl ester	X	X	X
Palm oil methyl ester	X	LS-4	X
Palm olein, crude	LS-3	S	S
Palm olein, neutralized	LS-3	S	S
Palm residue	X	S	X
Palmitic acid	U	S	U
Paper mill green liquor	X	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Paper mill heavy liquor	X	S	X
Paper mill white liquor	X	S	X
Paper mill white/green liquor	X	S	X
Paraldehyde	LS-4	U	U
Para chlorometacresol	S	U	U
Para cresol	X	U	U
Paraffin	S	S	S
Paraffin, chlorinated	LS-4	LS-4, 12	X
Paraffins	S	S	S
Paraffin sulfonates	S	S	X
Paraffin wax	S	S	S
Paraffinic oil, white (petrolatum)	S	S	S
Paraffinic sulfonate (petrolatum)	S	S	S
Peanut oil	LS-3	S	S
Peel oil (oranges and lemons)	LS-3	S	S
Pelargonic acid	U	S	U
Pentachlorethane	LS-4	S	U
1,3-Pentadiene	LS-9	X	X
Pentaerythritol 10%	S	S	X
Pentaethylene hexamine	U	U	U
Pentalin (Pentachloroethane)	S	S	U
Pentane (iso and normal)	S	S	S
Pentanoic acid	X	X	U
1-Pentene	S	S	S
Pentoxone	S	S	X
Perchloric acid	U	X	U
Perchlorethylene	LS-4	LS-4	U
Perilla oil	LS-3	S	S
Petrol	S	S	S
Petrolatum	S	S	S
Petrolatum liquid (white mineral oil)	S	S	S
Petroleum, crude	LS-2	S	S
Petroleum, refined	S	S	S
Petroleum ethers	S	LS-11	S
Petroleum naphtha	S	S	S
Petroleum solvents	S	S	S
Petroleum solvents, aromatic	S	S	S
Petroleum sulfonate oils (lube additive)	S	S	X
Petroleum wax	S	S	S
Phenol 10%—99%	LS-7	U	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Phenol 100% (Carbolic acid)	LS-7	U	U
Phenol, dodecyl	LS-7	S	X
Phenol, nonyl	LS-7	S	X
Phenolate lye	LS-7	S	X
Phenolic oil (Cresylic acid)	U	U	U
Phenylamine (Aniline)	U	X	X
Phenylcarbinol (Benzyl alcohol)	S	S	X
Phenylethane (Ethyl benzene)	S	S	S
Phenylether (Diphenyl oxide)	S	U	X
Phenylethylene (Styrene monomer)	LS-9	LS-9	LS-9
Phenylformic acid (Benzoic acid	U	S	U
Phenylglycidyl ether	S	U	X
Phenylmethane (Toluol)	S	S	S
Phenylmethanol (Benzyl alcohol)	S	S	X
Phenylmethyl acetate (Benzyl acetate)	U	S	X
1-Phenyl-1-xylyl ethane	S	S	X
Phosgene	LS-4	U	U
Phosphate ester	S	S	X
Phosphoric acid 10%	U	U	U
Phosphoric acid 20%	U	U	U
Phosphoric acid 30%	U	U	U
Phosphoric acid 85% aqueous solutions	U	U	U
Phosphorus trichloride	U	U	U
Phosphoryl chloride (Phosphorous oxychloride)	U	U	U
Phthalate plasticizers	LS-4	S	X
Phthalate 79 (Diisooctyl phthalate)	S	S	X
Phthalate 911 (DIOP)	S	S	X
Phthalic anhydride	U	X	X
Pilchard oil	LS-3	S	S
Pinene (alpha, beta and mixed)	S	S	S
Pine oil	S	S	S
Pine tar	S	S	S
Piperylene (1,3-Pentadiene)	LS-9	X	X
Pluracol	S	S	X
Pluronic (Wyandotte polyol)	S	S	X
Polyalkyl (C18-C22) acrylate in xylene	X	X	X
Polyalkylene glycols/polyalkylene glycol monoalkyl ethers mixture	X	X	X
Polyalkylene oxide polyol	X	X	X
Polybutene	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Polybutylene	S	S	X
Polybutylene 24, Chevron	S	S	X
Polyether glycols	S	S	X
Polyethylene pellets (dry)	S	S	S
Polyethylene glycol	S	S	X
Polyethylene glycol monoalkyl ether	S	S	X
Polyethylene polyamines	X	X	X
Polyisobutylene (Polybutene)	S	S	S
Poly (20) oxyethylene sorbitan monooleate	X	X	X
Poly pluracol	S	S	X
Polypropylenebenzene	S	S	X
Polypropylene glycol	S	S	X
Poly Solv D	S	S	X
Poppy seed oil	LS-3	S	S
Potassium chloride (50%)	X	S	X
Potassium hydroxide 20%	U	S	S
Potassium hydroxide 50%	U	S	S
Potassium oleate	X	S	X
Potassium silicate	U	S	X
Potato oil (Fusel oil)	LS-3	S	S
Premium mogas 98	S	S	X
Priminox R-1M	X	S	X
Process-H oils (extender oils)	S	S	S
Process naphtha	S	S	S
Propane	S	S	S
Propane diol	S	S	X
Propanol	S	S	X
n-Propanolamine	X	U	U
2-Propenal (Acrolein)	U	U	U
Propenenitrile (Acrylonitrile)	LS-4	U	U
Propiolactone (USAN, BPL)	U	U	U
Propionaldehyde	U	U	U
Propionic Acid	U	U	U
Propionic anhydride	X	U	U
Propionitrile	LS-4	X	X
Propyl acetate (iso and normal)	S	LS-1,4	U
n-Propyl alcohol	S	S	X
Propylamine (iso and normal)	U	U	X
Propylbenzene, (iso and normal)	S	S	X
Propylcarbinol (n-Butyl alcohol)	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Propylene	S	S	S
Propylene chloride	LS-4	S	U
Propylene dichloride	LS-4	S	U
Propylene dimer	S	S	S
Propylene glycol	S	S	X
Propylene glycol ethyl ether	S	LS-1	U
Propylene glycol monoalkyl ether	S	LS-1	U
Propylene glycol monomethyl ether	S	LS-1, (X 30)	U
Propylene glycol monomethyl ether acetate	LS-4	LS (X 30)	X
Propylene glycol-poly	S	S	X
Propylene oxide	S	U	X
Propylene polymer	S	S	S
Propylene tetramer	S	S	S
Propylene trimer	S	S	S
Pseudo-cumene	S	S	X
Pumpkinseed oil	LS-3	S	S
Pyridine	U	U	U
Pyrolsis fuel (fuel oil)	S	S	S
Quakersol	S	S	X
Quaternary ammonium chloride	X	LS (X 30)	X
Quenching oil	S	S	S
Raisin seed oil	LS-3	S	S
Rape oil (Rapeseed oil)	LS-3	S	S
Rapeseed oil, hydrogenated	X	S	S
Rectified spirit (Ethyl alcohol)	S	S	U
Red oil (Oleic acid)	U	S	U
Reproxal (Texaco Alfol 610 Phthalate)	S	S	X
Resin oil (Coumarone oil)	S	S	X
Resin concentrate (Esso)	S	S	X
Resin Plasticizer HB40 (Monsanto partially hydrogenated terphenyl)	S	S	X
Resolube	S	S	X
Retardsol	S	S	X
Rexonic N7	X	S	X
Rhoplex AC388	LS-9	S	X
Rice bran oil	LS-3	S	S
Ricinus oil (Castor oil)	LS-3	S	S
Rohm & Haas Emulsion E-1440	U	S	X
Rohm & Haas Solvent 2026	S	S	X
Rosin	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Rosin soap	X	S	X
SA 119 (Exxon)	U	U	U
Safflower oil	LS-3	LS-6	S
Sal fat	X	S	S
Salad oil	LS-3	S	S
Sangajol	S	S	S
Santalol	S	S	S
Santicizer 140 (Monsanto Mixed cresyl diphenyl phosphate)	S	S	X
Santicizer 148 (Monsanto Iso decyl diphenyl phosphate)	S	S	X
Santicizer 160 (Monsanto Butyl benzyl phthalate)	S	S	X
Santicizer 711 (Monsanto Di normal alkyl phthalate)	S	S	X
Santicizer 790 (Monsanto)	S	S	X
Santochlor (Monsanto p-Dichloro benzene)	LS-4	U	U
Sardine oil	LS-3	S	S
Savory oil	LS-3	S	S
Sea water (ballast)	LS-13	S	S
Sea water (hot Butterworthing)	LS-13	S	S
Secondary amyl acetate	LS-4	LS-1,4	U
Secondary amyl alcohol	S	S	X
Secondary butyl acetate	LS-4	LS-1,4	U
Secondary butyl alcohol	S	S	X
Sesame oil	S	S	S
Shark Oil	X	S	S
Shea Oil	X	S	S
Shell Brand A	S	S	X
Shell Cardura ester	S	S	X
Shell Cerex	S	S	X
Shell AC45C (lube additive)	S	S	S
Shell Kerex (mineral spirits)	S	S	S
Shellflex N (process extender oil)	LS-12	LS-12	LS-12
Shellflex 312 (process extender oil)	LS-12	LS-12	LS-12
Shell lube oils:			
Shell HVI-55	LS-12	LS-12	LS-12
Shell HVI-56	LS-12	LS-12	LS-12
Shell HVI-57	LS-12	LS-12	LS-12
Shell HVI-58	LS-12	LS-12	LS-12
Shell HVI-59	LS-12	LS-12	LS-12
Shell HVI-60	LS-12	LS-12	LS-12
Shell HVI-61	LS-12	LS-12	LS-12
Shell HVI-62	LS-12	LS-12	LS-12

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Shell HVI-63	LS-12	LS-12	LS-12
Shell HVI-64	LS-12	LS-12	LS-12
Shell HVI-65	LS-12	LS-12	LS-12
Shell HVI-95	LS-12	LS-12	LS-12
Shell HVI-160	LS-12	LS-12	LS-12
Shell HVI-1605	LS-12	LS-12	LS-12
Shell HVI-1608	LS-12	LS-12	LS-12
Shell HVI-270—HVI-350	LS-12	LS-12	LS-12
Shell HVI-650	LS-12	LS-12	LS-12
Shell LVI-50	LS-12	LS-12	LS-12
Shell LVI-143	LS-12	LS-12	LS-12
Shell LVI-375—LVI-450	LS-12	LS-12	LS-12
Shell LVI-1100	LS-12	LS-12	LS-12
Shell MVI-N-40	LS-12	LS-12	LS-12
Shell MVI-N-41	LS-12	LS-12	LS-12
Shell MVI-N-42	LS-12	LS-12	LS-12
Shell MVI-N-43	LS-12	LS-12	LS-12
Shell MVI-N-44	LS-12	LS-12	LS-12
Shell MVI-N-45	LS-12	LS-12	LS-12
Shell MVI-N-65	LS-12	LS-12	LS-12
Shell MVI-N-170	LS-12	LS-12	LS-12
Shell MVI-P-50	LS-12	LS-12	LS-12
Shell MVI-P-1300	LS-12	LS-12	LS-12
Shell Diala B	LS-12	LS-12	LS-12
Shell Diala D	LA-12	LA-12	LS-12
Shell Limea Oil 968	LS-12	LS-12	LS-12
Shell S6412	LS-12	LS-12	LS-12
Aero Shell 100	LS-12	LS-12	LS-12
Aero Shell 120	LS-12	LS-12	LS-12
Aero Shell W80	LS-12	LS-12	LS-12
Aero Shell W100	LS-12	LS-12	LS-12
Shell Heavy Axle Oil 65809	LS-12	LS-12	LS-12
Shell Rotella 30	LS-12	LS-12	LS-12
Shell NSR 45	LS-12	LS-12	LS-12
Shell NSR-S-5789	LS-12	LS-12	LS-12
Shell NND-40	LS-12	LS-12	LS-12
Shell NND-225	LS-12	LS-12	LS-12
Shell NND-240	LS-12	LS-12	LS-12
Shell NND-260-LVI	LS-12	LS-12	LS-12
Shell 100 ES Neutral	LS-12	LS-12	LS-12

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Shell 501 Spindle 69110	LS-12	LS-12	LS-12
Shell HW9B 69961	LS-12	LS-12	LS-12
Shell Cabismas Distillate	LS-12	LS-12	LS-12
Shell Dutrex 33 (aromatic process/extender oils)	LS-12	LS-12	LS-12
Shell Dutrex 55C	LS-12	LS-12	LS-12
Shell Dutrex 713	LS-12	LS-12	LS-12
Shell Dutrex 726	LS-12	LS-12	LS-12
Shell Dutrel 786	LS-12	LS-12	LS-12
Shell HVI-N-40	LS-12	LS-12	LS-12
Shell HVI-100 Neutral	LS-12	LS-12	LS-12
Shell HVI-150-D Bright Stock	LS-12	LS-12	LS-12
Shell HVI-170	LS-12	LS-12	LS-12
Shell HVI-210C	LS-12	LS-12	LS-12
Shell HVI-250 Neutral	LS-12	LS-12	LS-12
Shell HVI-500 Neutral	LS-12	LS-12	LS-12
Shell HVI-575-C Neutral	LS-12	LS-12	LS-12
Shell LVI-100C Neutral	LS-12	LS-12	LS-12
Shell LVI-570	LS-12	LS-12	LS-12
Shell LVI-750	LS-12	LS-12	LS-12
Shell MVI-P	LS-12	LS-12	LS-12
Shell Nassa 89	LS-12	LS-12	LS-12
Shell NVI-76	LS-12	LS-12	LS-12
Shellsols:			
Shellsol 350	LS-12	LS-12	LS-12
Shellsol 360	S	S	S
Shellsol A (Minersl spirits)	S	S	S
Shellsol B (Mineral spirits)	S	S	S
Shellsol E (Mineral spirits)	S	S	S
Shellsol H (Mineral spirits)	S	S	S
Shellsol K (Mineral spirits)	S	S	S
Shellsol N (Mineral spirits)	S	S	S
Shellsol PD (Mineral spirits)	S	S	S
Shellsol PP (Mineral spirits)	S	S	S
Shellsol R (Mineral spirits)	S	S	S
Shellsol RA (Mineral spirits)	S	S	S
Shellsol T (Mineral spirits)	S	S	S
Shellsol TD-7 (Mineral spirits)	S	S	S
Shell Spray oil	LS-12	LS-12	LS-12
Shell Tergol 180L-BS	LS-12	LS-12	LS-12
Shell Transformer Oil	LS-12	LS-12	LS-12

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Shell Veova 10	LS-12	LS-12	LS-12
Shellflex (extender oils)	LS-12	LS-12	LS-12
Silica slurry	X	X	X
Silicon tetrachloride (Silicon chloride)	LS-4	X	X
Sirlene (Dow Propylene glycol)	S	S	X
Skellysolv	S	S	X
Skydrol 500	S	S	X
Skydrol Y-91	LS-12	S	X
Slackwax (petrolatum)	S	S	S
Sodium acetate solution	X	X	S
Sodium alkylnaphthalene sulfonate	LS-12	LS-12	X
Sodium benzoate	X	S	X
Sodium alumina silicate slurry	X	X	X
Sodium bisulfide (50% or less)	X	S	X
Sodium bisulfite (50% or less)	U	S	X
Sodium borohydrate solution (also Sodium borohydride)	X	X	X
Sodium borohydride (15% or less)/sodium hydroxide solution	X	LS-12	X
Sodium carbonate (saturated)	U	S	X
Sodium chlorate R-2 solution	X	S	X
Sodium chloride 10% in water	S	S	S
Sodium chloride (saturated)	S	S	S
Sodium dichromate	U	U	U
Sodium formate 10%	U	S	X
Sodium hydrogen sulfide (50% or less)	U	S	X
Sodium hydrogen sulfide (6% or less), sodium carbonate (3% or less) solution	U	S	X
Sodium hydrogen sulfite solution	U	X	X
Sodium hydrosulfide (50% or less)	X	S	X
Sodium hydrosulfide (32%), sodium sulfide (2%) solution	U	S	X
Sodium hydroxide 10%—20%	U	S	S
Sodium hydroxide 50%	U	S	S
Sodium hypochlorite (15% or less)	U	LS-1, (X60)	U
Sodium nitrite solution	X	S	X
Sodium pentachlorophenate	LS-4	LS (X 30)	X
Sodium perborate	U	U	U
Sodium silicate	U	S	X
Sodium sulfate (50% or less)	U	S	X
Sodium sulfhydrate (50% or less)	X	S	X
Sodium sulfide solution (50% or less)	U	S	X
Sodium sulfide spent caustic	U	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Sodium sulfite (50% or less)	X	S	X
Sodium tetraborate	X	S	X
Sodium thiocyanate (56% or less)	X	S	X
Softanols (fatty alcohol)	S	S	X
Solinox (treated soybean oil)	LS-3	S	S
Solvenol	S	S	X
Solvent naphtha	S	S	S
Solvesso (Mineral spirits)	S	S	S
Solvesso 100 (Mineral spirits)	S	S	S
Solvesso 150 (Mineral spirits)	S	S	S
Sorbitol	S	S	S
Sorbitol 70% solution	S	S	S
Sour crude oil	LS-2	S	X
Soybean oil (crude degummed)	LS-3	S	S
Special palm oil, bleachable	LS-3	S	S
Spent caustic (no heat)	U	S	X
SPB (Palm oil)	LS-3	S	S
Sperm oil	LS-3	S	S
Sperm oil pressings	LS-3	S	S
Sperm oil residue	LS-3	S	S
Spike oil	LS-3	S	S
Spindle oil (lube oil)	LS-3	S	S
Spirits (aromatic)	S	S	S
Stearic acid (fatty acid)	U	LS-15	U
Stearin (dry, 80°C)	LS-3	S	X
Stearyl alcohol	S	S	X
Stoddard solvent	S	S	X
Styrene, inhibited	LS-9	LS-9	LS-9
Styrene butadiene	U	U	U
Styrene monomer	LS-9	LS-9	LS-9
Styrene monomer, inhibited	LS-9	LS-9	LS-9
Sulfonate oils (lube additive)	S	S	S
Sulfonic acid 86%—90% (Exxon)	U	U	U
Sulfonic alkylate (Exxon SA119)	U	U	X
Sulfonyl chloride	U	U	U
Sulfur (liquid or molten)	U	S	X
Sulfur dioxide	U	U	U
Sulfur trioxide	U	U	U
Sulfuric acid 10%	U	U	U
Sulfuric acid 30%	U	U	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Sulfuric acid 65%	U	U	U
Sulfuric acid 98%	U	U	U
Sulfurous acid	U	U	U
Sulfuryl chloride	U	U	U
Sulfur crude	U	S	X
Sulfur solvent	X	LS-1,8 (X30)	U
Sundex 8125 (extender oil)	S	S	X
Sunflower oil	LS-3	LS-6	S
Supersol (Mineral spirits)	S	S	S
Surchem 306 (Sulfonate oil)	S	S	X
Sweet oil (Olive oil)	LS-3	S	S
Synthenol (Refined castor oil)	LS-3	S	S
Tall oil (crude and refined)	U	LS-15	U
Tall oil fatty acid (Rosin acids less than 5%)	U	LS-15	U
Tall oil soap solution	U	LS-15	U
Tallow	U	S	X
Tallow acid (crude and refined)	U	LS-15	U
Tallow acid (acidulated oil)	U	LS-15	U
Tallow alcohol	S	S	X
Tallow fatty acid	U	LS-15	U
Tap water	S	S	S
Tartaric acid 10%	U	S	U
Tar acid	U	U	U
Tar oil (Creosote coal tar)	S	U	U
Teaseed oil	X	S	S
Tergitols (Union Carbide linear detergent alcohol):			
Tergitol 15-S-3	S	S	X
Tergitol 15-S-7	S	S	X
Tergitol 15-S-9	S	S	X
Tergitol 15-S-12	S	S	X
Tergitol 45-S-3	S	S	X
Terpenes	S	S	S
Terpentine (Turpentine)	S	S	S
Terpineol	S	S	X
Tertiary amyl alcohol	S	S	X
Tertiary butyl alcohol	S	S	X
Tetrachloroethane	LS-4	S	U
Tetrachloroethylene	LS-4	S	U
Tetrachloro pentamine	U	U	U
Tetradecanol	X	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Tetradecylamine	U	X	X
Tetradecylbenzene	S	S	X
Tetraethylenepentamine	U	U	U
Tetraethyl lead	U	S	X
1,2,3,4-Tetrahydrobenzene (Cyclohexene)	S	S	S
Tetrahydrofuran	S	U	U
Tetrahydrofurfuryl alcohol	S	U	U
Tetrahydronaphthalene	S	S	X
Tetraline	S	S	X
1,2,3,5-Tetramethylbenzene	S	S	X
Tetramethylene sulfone	S	U	U
Tetramethyl lead	X	X	X
Tetra propylene	S	S	X
Tiglium oil (Croton oil)	LS-3	S	S
Toluene diamine	U	X	X
Toluene diisocyanate (TDI)	LS-9	LS-9	X
Toluene, industrial	S	S	S
Toluene, nitration grade	X	S	S
p-Toluenesulfonic acid	U	U	U
o-Toluidine	X	X	X
Toluol (Toluene)	S	S	S
Transformer oil (insulating oil)	LS-12	LS-12	S
Transmission oil (lube oil)	S	S	S
Triacetin	S	S	X
1,1,2-Trichloro-1,2,2-trifluoroethane	LS-4	LS-4	X
Trialkyl phosphate	S	S	X
Tribasic sodium phosphate (TSP)	LS-4	S	X
Tributylethylhexyl phosphate	S	S	X
Tributyl phosphate	S	S	X
Trichlorobenzene	LS-4	X	U
1,1,1-Trichloroethane	LS-4	LS-1,4	U
1,1,2-Trichloroethane	LS-4	LS-1,4	U
Trichlorethylene	LS-4	LS-1,4	U
Trichloropropane (all isomers)	LS-4	LS-1,4	U
Tricresyl phosphate	LS-4	S	X
Tridecane	S	S	S
Tridecanol	S	S	X
Tridecene	X	S	S
Tridecyl alcohol	S	S	X
Tridecyl benzene	S	S	S

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Triethane (Trichloroethane)	S	LS-1, 4	U
Triethanolamine	U	S	X
Triethylene glycol	S	S	X
Triethylene glycol ethyl ether	S	LS-1	U
Triethylene glycol di-2-ethylbutyrate	S	S	X
Triethylene glycol methyl ether	S	LS-1	U
Triethylene tetramine (TETA), no heat	U	U	U
Triethyl amine	U	U	U
Triethyl benzene	S	S	S
Triethyl phosphate	LS-4	S	X
Triisobutylene	S	S	S
Triisopropanolamine	X	X	X
Trimethylacetic acid	U	U	U
Trimethylamine	U	U	U
Trimethyl benzene	S	S	S
Trimethyl cyclohexanol	S	S	X
Trimethylhexamine diamine	U	X	X
Trimethylol propane polyethoxylate	S	S	X
2,2,4-Trimethyl-1,3-pentanediol-1-isobutyrate	S	S	X
Trimethyl phosphite	X	X	X
Trimethyl propane glycol	S	S	X
Trimethylene glycol	S	S	S
Tripropylene	S	S	X
Tripropylene glycol	S	S	X
Tripropylene glycol monomethyl ether	S	LS-1	U
Triptane	S	S	S
Trisodium phosphate	LS-4	S	X
Tritolyl phosphate	LS-4	S	X
Triton GR7	X	S	S
Triton X100	S	S	X
Trixylenyl phosphate (Trixylyl phosphate)	S	S	X
Troluoil	S	S	X
TSP (Trisodium phosphate)	LS-4	S	X
Tucum oil	LS-3	S	S
Tung oil	LS-3	S	S
Turkey red oil	LS-3	S	S
Turpentine, oil and gum	S	S	S
U-Cane alkylate II (Dodecyl benzene)	S	S	S
Undecane	S	S	S
'Jndecanoic acid	X	S	U

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Undecanol (all isomers)	S	S	X
Undecanone	S	S	X
1-Undecene	S	S	X
Undecyl alcohol	S	S	X
Undecyl benzene	S	S	S
Unfinished kerosene (Kerosene)	S	S	S
Uran 32 (fertilizer)	U	S	X
Urea (saturated)	U	S	X
Urea, ammonium nitrate solutions	U	S	X
Urea ammonium phosphate solution	U	S	X
Urea water	U	S	X
U.S. White oil	S	S	S
VM&P Naphtha	S	S	S
Valeraldehyde	U	U	U
Valeric aldehyde	U	U	U
Varsol (Mineral spirits)	S	S	S
Vaseline	LS-3	S	S
Vegetable oils	LS-3	S	S
Vegetable protein solution (hydrolyzed)	X	X	X
Versene (Dow)	X	X	X
Versenex	X	X	X
Versenol	X	X	X
Vestal LPH	S	U	U
Vidden-D (Dichloropropane and dichloropropene)	LS-4	U	U
Vinegar	U	U	U
Vinyl (pellets, dry)	S	S	S
Vinyl acetate	X	X	X
Vinyl acetate monomer (no heat)	LS-4, 9	LS-1,9, 14, (X30)	U
Vinyl acetate monomer (Borden 400PPM $_2$O) (no heat)	LS-9	LS-1,9, 14, (X30)	U
Vinyl chloride	LS-4, 9	U	U
Vinyl ethyl ether	LS-4	U	U
Vinylidene chloride	LS-4, 9	U	U
Vinylmethyl ether liquid	LS-4	U	U
Vinyl neodecanoate (VNDC, Veova)	LS-4, 9	S	X
Vinyl propionate	U	U	U
Vinyl trichloride (Trichloroethane)	S	LS-1, 4	U
Vinyl toluene	LS-9	LS-9	X
Virgillio 50 (Union Carbide)	S	S	X
Vitriol (Sulfuric acid)	U	U	U
Voranol (Polyols)	S	S	X

Cargoes to be carried:	Catha-Coat 305 Coating	Devchem 253 Lining	Devchem 255 Lining
Walnut oil	LS-3	S	S
Water, ballast	S	S	S
Water, deionized	S	S	S
Water, distilled	S	S	S
Water, sea	LS-13	S	S
Water, sea (hot Butterworthing)	LS-13	S	S
Wax, petroleum (maximum temperature 80°C)	S	S	S
Wax, paraffin (maximum temperature 80°C)	S	S	S
Well pack fluid (Calcium bromide)	U	S	X
Wetting agent, nonionic	S	S	X
Whale oil	LS-3	S	S
White mineral oil (Petrol, liquid)	S	S	S
White oil	S	S	S
White spirits (Mineral spirits)	S	S	S
White spirit 100 (Mineral spirits)	S	S	S
White spirit 150 (Mineral spirits)	S	S	S
White spirit 160/180	S	S	S
Wood oil	S	S	S
Wool fat	LS-3	S	S
WSX1 oil (petrolatum, liquid)	S	S	S
Xylene (meta, ortho and para)	S	S	S
Xylenol	LS-11	X	X
Yarmor oils	LS-3	S	S
Yellow grease	U	S	S
Zinc Bromide 9% (No heat)	X	S	X
Zinc Calcium Bromide (50%)	X	S	X
Zolex	S	S	X
Zymol	LS-3	S	X

Compatibility Information

Unit 1700: T-A

Cross-Linked High Density Polyethylene (XLHDPE)

Or Equivalent

CHEMICAL RESISTANCE DATA

CHEM-TAINER INDUSTRIES uses only the highest quality raw materials available. These raw materials have outstanding resistance to both physical and chemical attack. The following chart should be used as a guide for evaluating the suitability of our products with the chemical agent to be used. Special consideration must be given to the expected service temperature, stress involved in the application and length and type of exposure (i.e. intermittent or continuous). Contact our technical staff for information on chemicals not listed or when uncertain conditions exist.

REAGENT	CONC.	LDPE 70°	LDPE 140°	HDPE 70°	HDPE 140°	PP 70°	PP 140°	XLPE 70°	XLPE 140°
Acetone		B	C	B	C	A	A	C	C
Acetaldehyde*	100%	B	C	B	C	A	B	B	C
Acetic Acid*	10%	A	A	A	A	A	A	A	A
Acetic Acid*	60%	A	B	A	B	A	A	A	A
Acetic Anhydride*		C	C	C	C	—	—	C	C
Air		A	A	A	A	A	A	A	A
Aluminum Chloride	all conc	A	A	A	A	A	A	A	A
Aluminum Fluoride	all conc	A	A	A	A	A	A	A	A
Aluminum Sulphate	all conc	A	A	A	A	A	A	A	A
Alums	all types	A	A	A	A	A	A	A	A
Ammonia	100% dry gas	A	A	A	A	A	A	A	A
Ammonium Carbonate		A	A	A	A	A	A	A	A
Ammonium Chloride	sat'd	A	A	A	A	A	A	A	A
Ammonium Fluoride	sat'd	A	A	A	A	A	A	A	A
Ammonium Hydroxide	10%	A	A	A	A	A	A	A	A
Ammonium Hydroxide	28%	A	A	A	A	A	A	A	A
Ammonium Nitrate	sat'd	A	A	A	A	A	A	A	A
Ammonium Persulphate	sat'd	A	A	A	A	A	A	A	A
Ammonium Sulphate	sat'd	A	A	A	A	A	A	A	A
Ammonium Metaphosphate	sat'd	A	A	A	A	A	A	A	A
Ammonium Sulfide	sat'd	A	A	A	A	A	A	A	A
Amyl Acetate*#	100%	C	C	C	C	B	C	C	C
Amyl Alcohol*#	100%	A	A	A	A	A	B	A	A
Amyl Chloride#	100%	C	C	C	C	C	C	C	C
Aniline*#	100%	A	C	C	B	A	A	A	C
Aqua Regia†		C	C	C	C	C	C	C	C
Arsenic Acid	all conc	A	A	A	A	A	A	A	A
Aromatic Hydrocarbons*#		C	C	C	C	—	—	C	C
Ascorbic Acid	10%	A	A	A	A	—	—	A	A
Barium Carbonate	sat'd	A	A	A	A	A	A	A	A
Barium Chloride	sat'd	A	A	A	A	A	A	A	A
Barium Hydroxide		A	A	A	A	A	A	A	A
Barium Sulphate	sat'd	A	A	A	A	A	A	A	A
Barium Sulphide	sat'd	A	A	A	A	A	A	A	A
Beer		A	A	A	A	A	A	C	C
Benzene*#		C	C	C	C	B	C	C	C
Benzoic Acid	all conc	A	A	A	A	A	A	A	A
Bismuth Carbonate	sat'd	A	A	A	A	A	A	A	A
Bleach Lye	10%	A	A	A	A	A	A	A	A
Borax	sat'd	A	A	A	A	A	A	A	A
Boric Acid	all conc	A	A	A	A	A	A	A	A
Boron Trifluoride		A	A	A	A	—	—	A	A
Brine		A	A	A	A	A	A	A	A
Bromine†	liquid	C	C	C	C	C	C	C	C
Bromine Water#	sat'd	C	C	C	C	C	—	C	C
Butanediol*	10%	A	A	A	A	A	A	A	A
Butanediol*	60%	A	A	A	A	A	A	A	A
Butanediol*	100%	A	A	A	A	A	A	A	A
Butter*		A	A	A	A	A	A	C	C
n-Butyl Acetate*#	100%	B	C	A	B	C	C	A	C
n-Butyl Alcohol	100%	A	A	A	A	A	—	A	A
Butyric Acid#	conc	C	C	C	C	—	—	—	—
Calcium Bisulphide		A	A	A	A	A	A	A	A
Calcium Carbonate	sat'd	A	A	A	A	A	A	A	A
Calcium Chlorate	sat'd	A	A	A	A	A	A	A	A
Calcium Chloride	sat'd	A	A	A	A	A	A	A	A
Calcium Hydroxide	conc	A	A	A	A	A	A	A	A
Calcium Hypochlorite	bleach sol'n	A	A	A	A	A	B	A	A
Calcium Nitrate	50%	A	A	A	A	A	A	A	A
Calcium Oxide	sat'd	A	A	A	A	—	—	A	A
Calcium Sulphate		A	A	A	A	A	A	A	A
Camphor Oil*#		C	C	B	C	C	C	C	C
Carbon Dioxide	all conc	A	A	A	A	A	A	A	A
Carbon Disulphide		C	C	C	C	B	C	C	C
Carbon Monoxide		A	A	A	A	A	A	A	A
Carbon Tetrachloride#		C	C	B	C	C	C	C	C
Carbonic Acid		A	A	A	A	A	A	A	A
Caster Oil*	conc	A	A	A	A	A	A	A	A
Chlorine†	100% dry gas	B	C	C	C	C	C	B	C
Chlorine Liquid†		C	C	C	C	C	C	C	A
Chlorine Water†	2% sat'd sol'n	A	A	A	A	A	B	A	A
Chlorobenzene*#		C	C	C	C	C	C	C	C
Chlorofoam*#		C	C	B	C	C	C	C	C
Chlorosulphonic Acid	100%	C	C	C	C	C	C	C	C
Chrome Alum	sat'd	A	A	A	A	A	A	A	A
Chromic Acid	80%	—	—	—	—	A	—	—	—
Chromic Acid	50%	A	B	A	B	A	A	A	B
Chromic Acid	10%	A	A	A	A	A	A	A	A
Cider*		A	A	A	A	A	A	C	C
Citric Acid*	sat'd	A	A	A	A	A	A	A	A
Coconut Oil Alcohols*		A	A	A	A	A	A	A	A
Coffee		A	A	A	A	A	A	A	A
Cola Concentrates*		A	A	A	A	A	A	A	A
Copper Chloride	sat'd	A	A	A	A	A	A	A	A
Copper Cyanide	sat'd	A	A	A	A	A	A	A	A
Copper Fluoride	2%	A	A	A	A	A	A	A	A
Copper Nitrate	sat'd	A	A	A	A	A	A	A	A
Copper Sulphate	sat'd	A	A	A	A	A	A	A	A
Corn Oil*		A	A	A	A	A	A	A	A
Cottonseed Oil*		A	A	A	A	A	A	A	A
Cuprous Chloride	sat'd	A	A	A	A	A	A	A	A
Detergents, synthetic*		A	A	A	A	A	A	A	A
Developers, photographic		A	A	A	A	A	A	A	A
Dextrin	sat'd	A	A	A	A	A	A	A	A
Destrose	sat'd	A	A	A	A	A	A	A	A
Diazo Salts		A	A	A	A	A	A	A	A
Dibutylphthalate*		B	B	B	B	A	B	B	B
Dichlorobenzene*#		C	C	C	C	—	—	C	C
Diethyl Kentone*#		B	C	B	B	—	—	B	C
Diethylene Glycol*		A	A	A	A	A	A	A	A
Diglycolic Acid*		A	A	A	A	—	—	A	A
Dimethylamine		C	C	C	C	—	—	C	C
Disodium Phosphate		A	A	B	A	A	A	A	A
Emulsions, photographic*		A	A	A	A	A	A	A	A
Ethyl Acetate*#	100%	B	C	B	C	B	B	B	C
Ethyl Alcohol*	100%	A	A	A	A	A	A	A	A
Ethyl Alcohol*	35%	A	A	A	A	A	A	A	A
Ethyl Benzene*#		C	C	C	C	C	C	C	C
Ethyl Chloride#		C	C	C	C	C	C	C	C
Ethyl Ether#		C	C	C	C	B	C	C	C
Ethylene Chloride*#		C	C	C	C	C	C	C	C
Ethylene Glycol*		A	A	A	A	A	A	A	A
Fatty Acids*		A	A	A	A	A	A	A	A
Ferric Chloride	sat'd	A	A	A	A	A	A	A	A
Ferric Nitrate	sat'd	A	A	A	A	A	A	A	A
Ferrous Chloride	sat'd	A	A	A	A	A	A	A	A
Ferrous Sulphate		A	A	A	A	A	A	A	A
Fish Solubles*		A	A	A	A	A	A	A	A
Fluoboric Acid		A	A	A	A	A	A	A	A
Fluosillic Acid	conc	A	B	A	B	A	B	A	A
Fluosillic Acid	32%	A	A	A	A	A	A	A	A
Formic Acid	all conc	A	A	A	A	A	A	A	A
Fructose	sat'd	A	A	A	A	A	A	A	A
Fruit Pulp*		A	A	A	A	A	A	A	A
Furfural#	100%	C	C	B	C	C	C	C	C
Furfuryl Alcohol*#		C	C	B	C	C	C	C	C
Gallic Acid*	sat'd	A	A	A	A	A	A	A	A
Gasoline*#		C	C	B	B	B	C	A	C
Glucose		A	A	A	A	A	A	A	A
Glycerine*		A	A	A	A	A	A	A	A
Glycol*		A	A	A	A	A	A	A	A
Glycolic Acid*	30%	A	A	A	A	A	A	A	A
Grape Sugar	sat. ag.	A	A	A	A	A	A	A	A
n-Heptane*#		C	C	B	B	—	—	A	C
Hexachlorobenzens		A	A	A	—	—	—	A	A
Hexanol, tertiary*		A	A	A	A	—	—	A	A
Hydrobromic Acid	50%	A	A	A	A	A	A	A	A
Hydrochloric Acid	all conc	A	A	A	A	A	A	A	A
Hydrocyanic Acid	sat'd	A	A	A	A	—	—	A	A
Hydrofluoric Acid*	60%	A	A	A	A	A	A	A	A
Hydrogen	100%	A	A	A	A	A	A	A	A
Hydrogen Chloride	dry gas	A	A	A	A	A	A	A	A
Hydrogen Peroxide	30%	A	A	A	A	A	—	A	A
Hydrogen Peroxide	10%	A	A	A	A	A	B	A	A
Hydrogen Sulphide		A	A	A	A	A	A	A	A
Hydroquinone		A	A	A	A	A	A	A	A

*Contact Sales Office regarding chemical concentration and temperature ranges.

Exhibit E
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* Stress-crack agent—Certain surface-active materials, although they have no chemical effect on polyethylene, can accelerate the cracking of polyethylene when it is under stress. Although our tanks are generally stress free, caution should be used when large tanks are unsupported and welded fittings are used.

* Plasticizer—Certain types of chemicals are absorbed to varying degrees by polyethylene causing swelling, weight gain, softening and some loss of yield strength. These plasticizing materials cause no actual chemical degradation of the resin. Some of these chemicals have a strong plasticizing effect (e.g. aromatic hydrocarbons benzene), whereas others have weaker effects (e.g. gasoline). Certain plasticizers are sufficiently volatile that if they are removed from contact with the polyethylene, the part will "dry" out and return to its original condition with no loss of properties.

† Oxidizers—Oxidizers are the only group of materials capable of chemically degrading polyethylene. The effects on the polyethylene may be gradual even for strong oxidizers and short-term effects may not be measurable. However, if continuous, long-term exposure is intended, the chemical effects should be checked.

CODE
A Resistant, no indication that serviceability would be impaired.
B Variable resistance, depending on conditions of use.
C Unresistant, not recommended for service applications under any conditions.
— Information not yet available.

REAGENT	CONC.	LDPE 70°	LDPE 140°	HDPE 70°	HDPE 140°	PP 70°	PP 140°	XLPE 70°	XLPE 140°
Hypochlorous Acid	conc	A	A	A	A	A	A	A	A
Inks*		A	A	A	A	A	A	A	A
Iodine†	in KI sol'n	B	C	B	—	—	—	B	C
Isopropyl Alcohol	100%	—	—	—	—	A	A	A	A
Lead Acetate	sat'd	A	A	A	A	A	A	A	A
Lead Nitrate		A	A	A	A	—	—	A	A
Lactic Acid*	20%	A	A	A	A	A	A	A	A
Linseed Oil*	100%	B	C	B	C	A	A	A	C
Magnesium Carbonate	sat'd	A	A	A	A	A	A	A	A
Magnesium Chloride	sat'd	A	A	A	A	A	A	A	A
Magnesium Hydroxide	sat'd	A	A	A	A	A	A	A	A
Magnesium Nitrate	sat'd	A	A	A	A	A	A	A	A
Magnesium Sulphate	sat'd	A	A	A	A	A	A	A	A
Mercuric Chloride	40%	A	A	A	A	A	A	A	A
Mercuric Cyanide	sat'd	A	A	A	A	A	A	A	A
Mercury		A	A	A	A	A	A	A	A
Methyl Alcohol*	100%	A	A	A	A	A	A	A	A
Methylethyl Ketone**	100%	B	C	B	C	A	B	B	C
Methylene Chloride**	100%	C	C	B	B	B		C	C
Milk		A	A	A	A	A	A	C	C
Mineral Oils*		B	C	B	C	A	B	A	C
Molasses		A	A	A	A	A	A	A	A
Naphtha**		B	C	B	C	—	—	B	C
Naphthalene**		C	C	B	—	A	A	C	C
Nickel Chloride	conc	A	A	A	A	A	A	A	A
Nickel Nitrate	sat'd	A	A	A	A	A	A	A	A
Nickel Sulphate	conc	A	A	A	A	A	A	A	A
Nicotine*	dilute	A	A	A	A	A	A	A	A
Nitric Acid	0-30%	A	A	A	A	C	C	A	A
Nitric Acid†	30-50%	A	B	A	B	C	C	A	B
Nitric Acid†	70%	A	B	A	B	C	C	A	B
Nitric Acid†	95-98%	C	C	C	C	C	C	C	C
Nitrobenzene**	100%	C	C	C	C	A	A	C	C
n-Octane		A	A	A	A	—	—	A	A
Oleic Acid		B	C	B	C	A	B	A	C
Oxalic Acid*	sat'd	A	A	A	A	A	B	A	A
Perchloroethylene*		C	C	C	C	—	—	C	C
Phosphoric Acid	95%	A	B	A	A	A	A	A	B
Photographic Solutions		A	A	A	A	A	A	A	A
Plating Solutions*									
Brass		A	A	A	A	A	A	A	A
Cadmium		A	A	A	A	A	A	A	A
Chromium		A	A	A	A	A	A	A	A
Copper		A	A	A	A	A	A	A	A
Gold		A	A	A	A	A	A	A	A
Indium		A	A	A	A	A	A	A	A
Lead		A	A	A	A	A	A	A	A
Nickel		A	A	A	A	A	A	A	A
Rhodium		A	A	A	A	A	A	A	A
Silver		A	A	A	A	A	A	A	A
Tin		A	A	A	A	A	A	A	A
Zinc		A	A	A	A	A	A	A	A
Potassium Bicarbonate	sat'd	A	A	A	A	A	A	A	A
Potassium Bromide	sat'd	A	A	A	A	A	A	A	A
Potassium Bromate	10%	A	A	A	A	A	A	A	A
Potassium Carbonate		A	A	A	A	A	A	A	A
Potassium Chlorate	sat'd	A	A	A	A	A	A	A	A
Potassium Chloride	sat'd	A	A	A	A	A	A	A	A
Potassium Chromate	40%	A	A	A	A	A	A	A	A
Potassium Cyanide	sat'd	A	A	A	A	A	A	A	A
Potassium Dichromate	40%	A	A	A	A	A	A	A	A
Potassium Ferri/Ferro Cyanide	sat'd	A	A	A	A	A	A	A	A
Potassium Fluoride		A	A	A	A	A	A	A	A
Potassium Hydroxide	conc	A	A	A	A	A	A	A	A
Potassium Nitrate	sat'd	A	A	A	A	A	A	A	A
Potassium Perborate	sat'd	A	A	A	A	A	A	A	A
Potassium Perchlorate	10%	A	A	A	A	A	A	A	A
Potassium Permanganate	20%	A	A	A	A	A	A	A	A
Potassium Persulphate	sat'd	A	A	A	A	—	—	A	A
Potassium Sulphate	conc	A	A	A	A	A	A	A	A
Potassium Sulphide	conc	A	A	A	A	A	A	A	A
Potassium Sulphite	conc	A	A	A	A	A	A	A	A
Propargyl Alcohol*		A	A	A	A	—	—	A	A
n-Propyl Alcohol*		A	A	A	A	A	A	A	A
Propylene Dichloride**	100%	C	C	C	—	C	C	C	C
Propylene Glycol*		A	A	A	A	—	—	A	A
Pyridine*		A	—	A	—	A	—	A	C
Resorcinol	sat'd	A	A	A	A	—	—	A	A
Salicylic Acid	sat'd	A	A	A	A	—	—	A	A
Sea Water		A	A	A	A	A	A	A	A
Selenic Acid		A	A	A	A	—	—	A	A
Shortening*		A	A	A	A	A	A	A	A
Silver Nitrate Solution		A	A	A	A	A	A	A	A
Soap Solution*	any con	A	A	A	A	A	A	A	A
Sodium Acetate	sat'd	A	A	A	A	A	A	A	A
Sodium Benzoate	35%	A	A	A	A	A	A	A	A
Sodium Biscarbonate	sat'd	A	A	A	A	A	A	A	A
Sodium Bisulphate	sat'd	A	A	A	A	A	A	A	A
Sodium Bisulphite	sat'd	A	A	A	A	A	A	A	A
Sodium Borate		A	A	A	A	A	A	A	A
Sodium Bromide	dilute	A	A	A	A	A	A	A	A
Sodium Carbonate	conc	A	A	A	A	A	A	A	A
Sodium Chlorate	sat'd	A	A	A	A	A	A	A	A
Sodium Chloride	sat'd	A	A	A	A	A	A	A	A
Sodium Cyanide		A	A	A	A	A	A	A	A
Sodium Dichromate	sat'd	A	A	A	A	A	A	A	A
Sodium Ferri/Ferro Cyanide	sat'd	A	A	A	A	A	A	A	A
Sodium Fluoride	sat'd	A	A	A	A	A	A	A	A
Sodium Hydroxide	conc	A	A	A	A	A	A	A	A
Sodium Hypochlorite		A	A	A	A	A	B	A	A
Sodium Nitrate		A	A	A	A	A	A	A	A
Sodium Sulphate		A	A	A	A	A	A	A	A
Sodium Sulphide	sat'd	A	A	A	A	A	A	A	A
Sodium Sulphite	sat'd	A	A	A	A	A	A	A	A
Stannic Chloride	sat'd	A	A	A	A	A	A	A	A
Stannous Chloride	sat'd	A	A	A	A	A	A	A	A
Starch Solution*	sat'd	A	A	A	A	A	A	A	A
Stearic Acid*	100%	A	A	A	A	A	A	A	A
Sulphuric Acid	0-50%	A	A	A	A	A	B	A	A
Sulphuric Acid†	70%	A	B	A	B	A	B	A	B
Sulphuric Acid†	80%	A	C	A	C	C	C	A	C
Sulphuric Acid†	96%	B	C	B	C	C	—	C	C
Sulphuric Acid†	98-conc	B	C	B	C	C	—	C	C
Sulphuric Acid†	fuming	C	C	C	C	C	C	C	C
Sulphurous Acid		A	A	A	A	A	A	A	A
Tallow*		A	B	A	—	A	A	A	B
Tannic Acid*	sat'd	A	A	A	A	A	A	A	A
Tartaric Acid		A	A	A	A	A	A	A	A
Tetrolydrofuran**		C	C	B	C	C	C	C	C
Titanium Tetrachloride*	sat'd	C	C	C	—	—	—	C	C
Toluene*		C	C	B	B	C	C	C	C
Trichloroethylene**		C	C	C	C	C	C	C	C
Triethylene Glycol*		A	A	A	A	—	—	A	A
Trisodium Phosphate	sat'd	A	A	A	A	A	A	A	A
Turpentine*		C	C	B	B	C	C	C	C
Urea	0-30%	A	A	A	A	A	A	A	A
Urine		A	A	A	A	A	A	A	A
Vanilla Extract*		A	A	A	A	A	A	A	A
Vinegar		A	A	A	A	A	A	A	A
Water		A	A	A	A	A	A	A	A
Wetting Agents*		A	A	A	A	A	A	A	A
Whiskey*		A	A	A	A	A	A	C	C
Wines*		A	A	A	A	A	A	C	C
Xylene*		C	C	B	B	C	C	C	C
Yeast		A	A	A	A	A	A	A	A
Zinc Bromide	sat'd	A	A	A	A	—	—	A	A
Zinc Carbonate	sat'd	A	A	A	A	—	—	A	A
Zinc Chloride	sat'd	A	A	A	A	A	A	A	A
Zinc Oxide	sat'd	A	A	A	A	A	A	A	A
Zinc Stearate		A	A	A	A	—	—	A	A
Zinc Sulphate	sat'd	A	A	A	A	A	A	A	A

*Contact Sales Office regarding chemical concentrations and temperature ranges.