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Fire Protection Consulting Group, LLC

Water Storage Tanks, Inc.
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Fire Protection and Rainwater Harvesting – Essential Considerations

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Overview

- Sustainability vs. Life-Safety
- Dual-Use Tank Design Concepts
- Overview of NFPA 22 Criteria
- Questions

Purpose and Goals

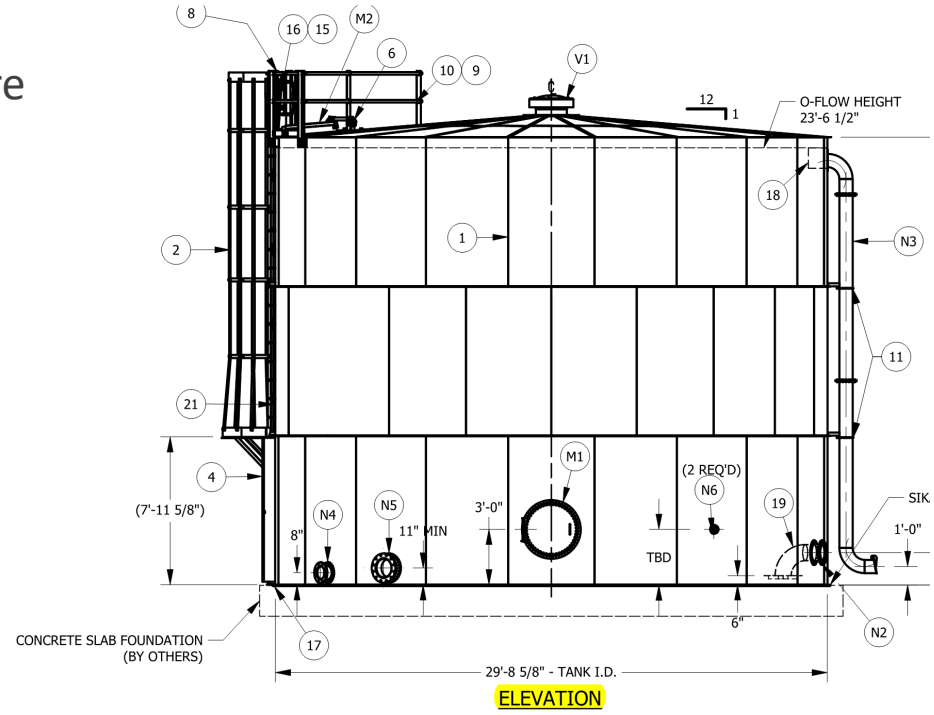
This Session is intended to give the attendee an understanding of the following:

- How do I ensure the life-safety water supply is always available for dual- or multi-use tanks?
- What are the primary components required for fire protection water storage tanks?
- How does the structural criteria differ for fire protection tanks?

Sustainability vs. Life-Safety

Bridging the Gap

- Environmental: Utilizing storm runoff to reduce municipal demand
- Safety: Ensuring 100% reliability for fire suppression systems and site fire protection
- Integration: Merging high-volume harvesting with NFPA-compliant storage



The Integrated Business Case

Footprint

One large dual-use tank replaces multiple smaller utility tanks, saving valuable real estate for developers.

Capital Cost

Shared excavation, foundation, and trenching costs significantly lower the total project expenditure.

Incentives

Combine stormwater tax credits with fire insurance premium reductions (15%–40% typical).

What are Fire Protection Tanks

Four main types:

- Gravity tanks / Elevated Tanks
- Suction or Break tanks (that supply a fire pump)
- Pressure / Bladder Tanks

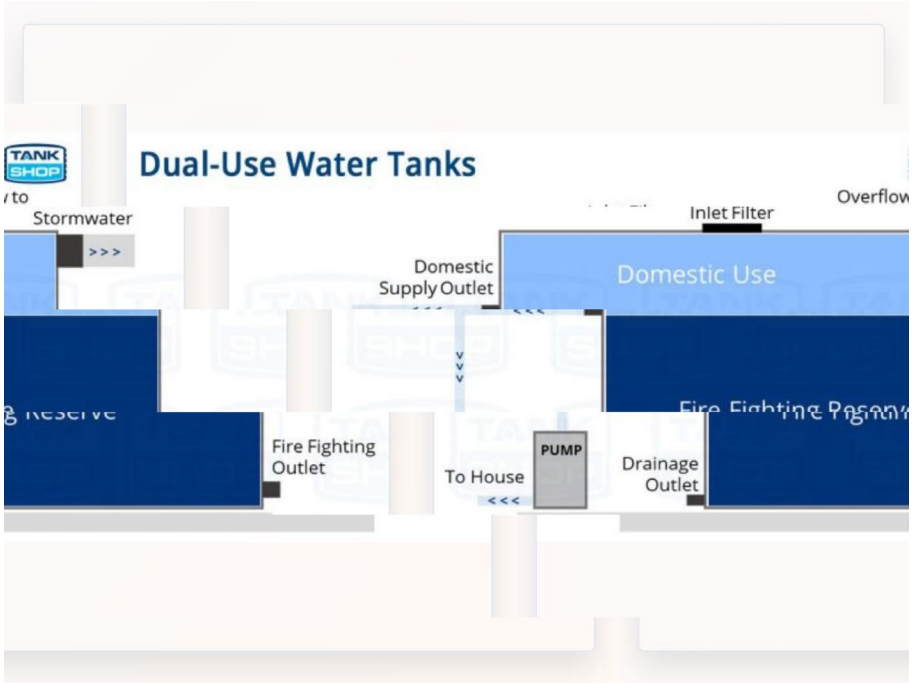
Primarily, we see ground suction tanks or break tanks.

Dual-Use Tank Design Concept

Hydraulic Storage Separation

The “reserve” concept ensures fire water is never touched by secondary utility pumps.

- Utility Outlet: Placed at high elevation to prevent draining the fire reserve
- Fire Protection Outlet: Placed at the bottom with anti-vortex plate.
- Dead Storage: Accounted for below domestic use line to increase head pressure to fire pump



Dual-Use Tank Design Concept

14.8 Connections for Other Than Fire Protection.

14.8.1 Dual-Service Tanks.

Where dual service is necessary, an adequate supply of water shall be constantly and automatically reserved in the tank for fire protection purposes.

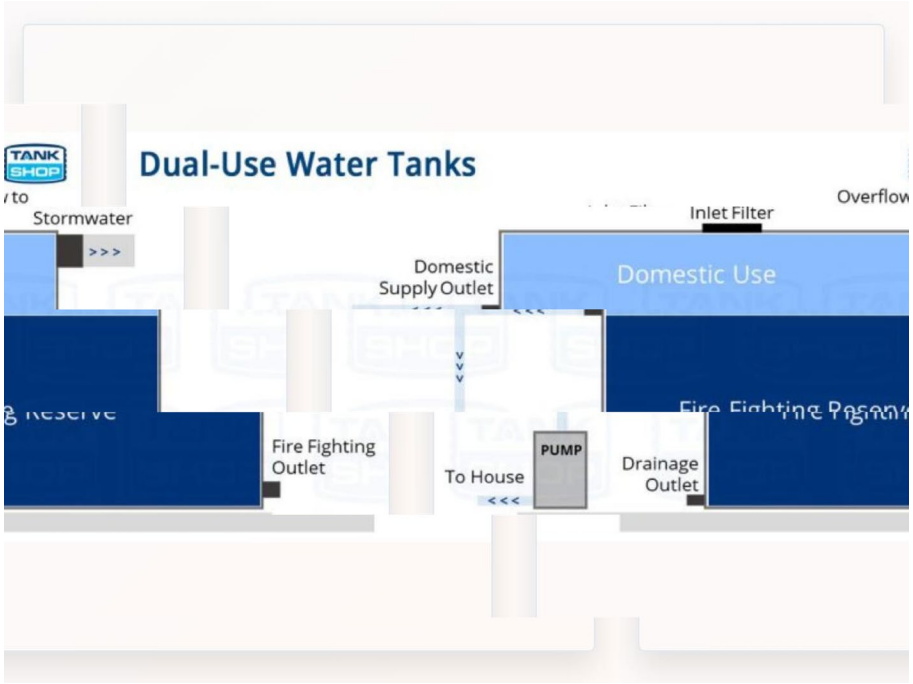
14.8.2 Pipe for Other Than Fire Protection Purposes.

14.8.2.1

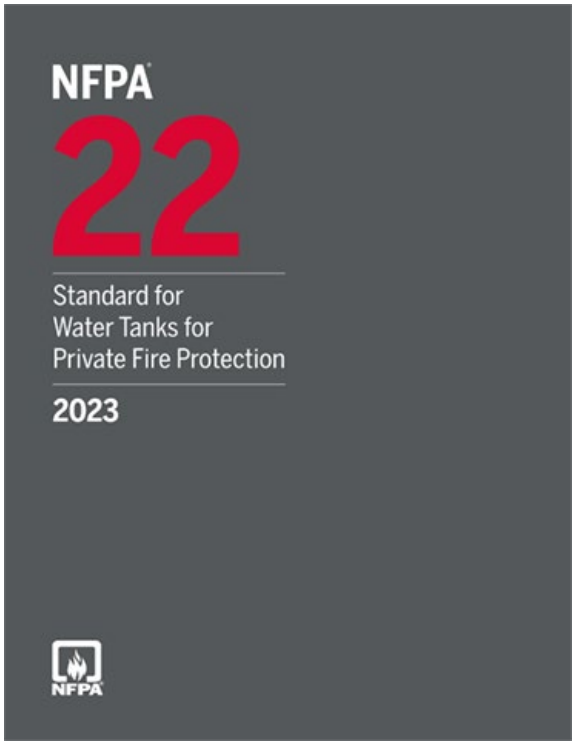
Pipe inside the tank that is used for other than fire protection purposes shall be brass.

14.8.2.2

Steel pipe shall be permitted to be used where the pipe is larger than 3 in. (75 mm), or cast iron shall be permitted where the pipe is 6 in. (150 mm) or larger.



NFPA 22 - Overview



Tank Components

NPFA 22 required tank components:

ANTI-VORTEX PLATE

HEATER/FREEZE PROTECTION

INTERNAL/EXTERNAL LADDERS*

WATER LEVEL GAUGE

AUTOMATIC FILL ASSEMBLY

MANHOLES

ROOF VENT

COATINGS

LIGHTNING PROTECTION

CONFINED ENTRY SIGNS

OVERFLOW

SHUTOFF VALVES

TEMPERATURE SENSOR

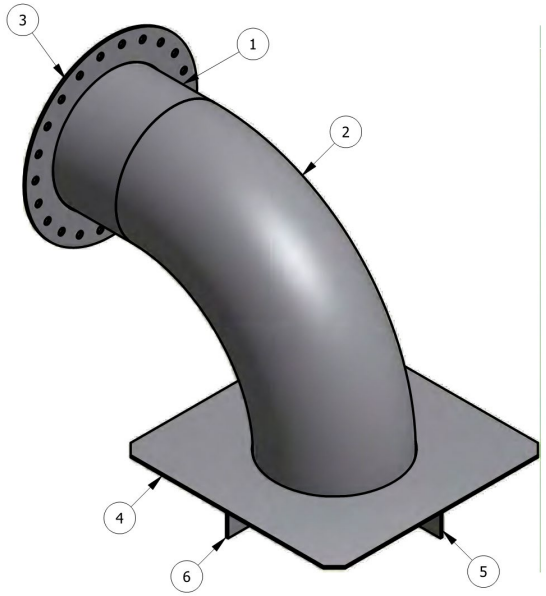
LOW LEVEL SENSOR

DRAINS

Tank Components

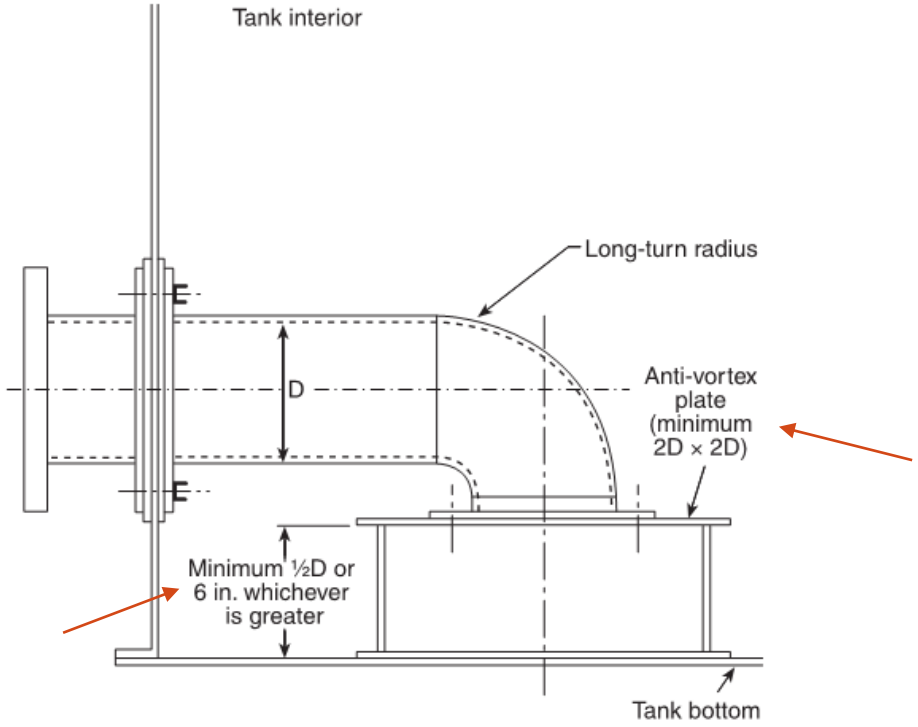
Anti-vortex plate (NFPA 20 – Fire Pumps):

> **4.16.10* Anti-Vortex Plate.** Where a tank is used as the suction source for a fire pump, the discharge outlet of the tank shall be equipped with an assembly that controls vortex flow in accordance with NFPA 22.



Tank Components

Anti-vortex plate:



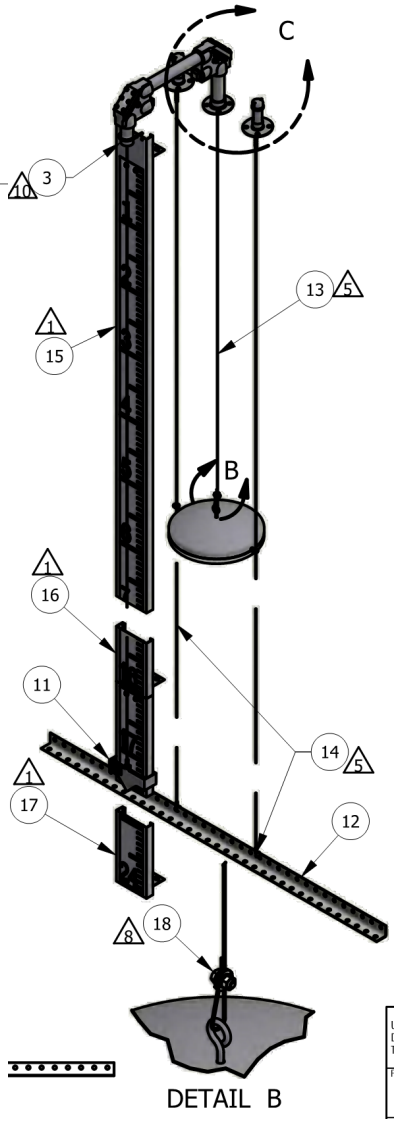
For SI units, 1 in. = 25.4 mm.

FIGURE A.4.16.10 Anti-Vortex Plate Assembly.

Tank Components

Level gauge:

14.1.8* Water-Level Gauge. A water-level gauge of suitable design shall be provided. It shall be carefully installed, adjusted, and properly maintained.



Tank Components

Confined Space Signage:

4.8.2* Confined entry requirements signs shall be posted at each shell manway.

FIGURE A.4.8.2 Confined Space Entry Sign.

Tank Components

Coatings:

- Factory coated tanks
- Welded
- Concrete
- Where does this leave internal membrane tanks?

N 6.1.3.3 Coa… AWWA D10…

10.5 Wall Tr… impermeable … that is applied … ble leakage or …

10.5.1 Tank designs that are not subject to such leakage shall not be required to be made impermeable.

1.4 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.4.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

N 5.5 Painting Inaccessible Areas.

N 5.5.1 Except for the underside of the floor on ground-supported flat-bottom tanks, faying surfaces of bolted connections that prohibit coatings, and overlapping surfaces of single-… line, parts that are subject to corrosion, … to the overlapping … e high waterline.

… l interior surfaces of … ersion or the vapor … l be cleaned by near-… SP 10 and shall be … nts of AWWA D102 … protection is used to … immersed surfaces … th AWWA D104 or …

N 5.6.2 All exterior surfaces and inside dry surfaces (pedestal tanks) shall be cleaned by commercial blasting in accordance with SSPC SP 6 and shall be coated in accordance with the requirements of AWWA D102.

N 5.6.3 Other interior or exterior paint systems shall be permitted to be used, provided permission is first obtained from the authority having jurisdiction.

N 5.6.4 After construction, all weld seams, unprimed surfaces, or any areas where the primer (if preprimed) has been damaged shall be blast-cleaned and primed with the specified coating system primer.

Tank Components

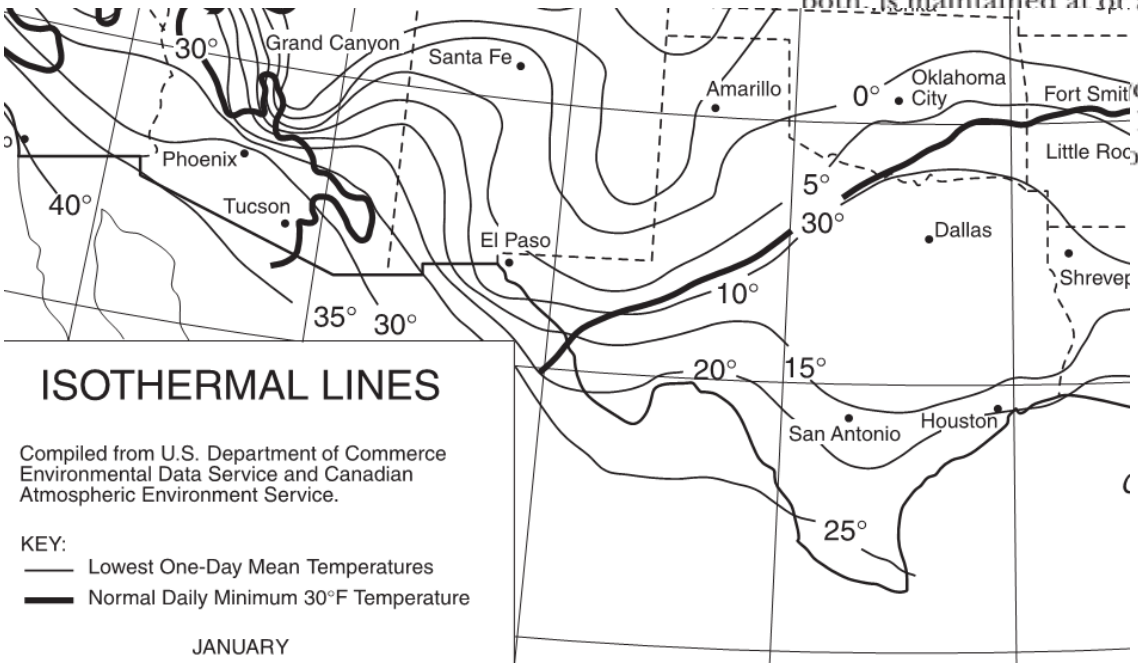
Heater/Freeze Protection:

16.1 General.

16.1.1 Tanks that are subject to freezing shall be heated.

16.1.2* The heating system shall be of such capacity that the temperature of the coldest water in the tank or tank riser, or both, is maintained at or above 42°F (5.6°C) during the coldest

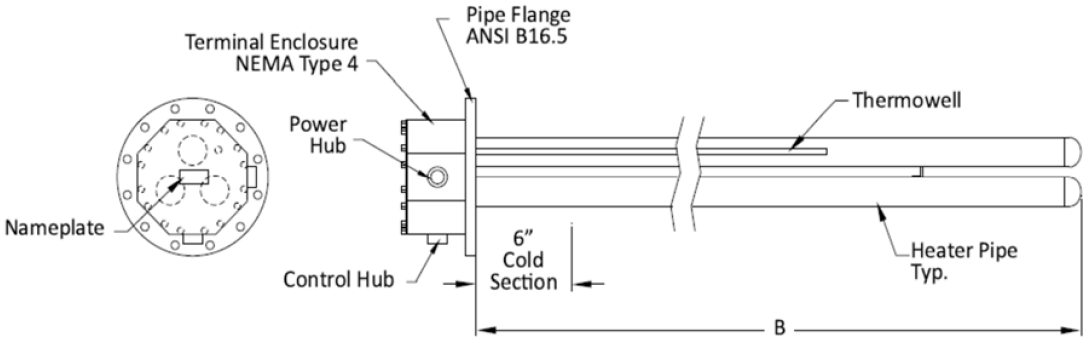
eather temperature that is used to heating shall be based on the lowest ne day, obtained from an approved



Tank Components

Heater/Freeze Protection:

- Insulation will greatly reduce the heater size required



Model 781-series tank heater
75,000 watts, 480 volts, 3phase, 50/60 HZ
12", 150#, carbon steel flange
(4) 3" schedule 40 304 SS pipe extending, "B", 144" +/- 1" into the tank
Open coil elements, (4), inside each 3" pipe, Figure 1 below
Elements removable without draining tank
Type J process control thermocouple
Type K sheath high limit thermocouple

Tank Components

Heater/Freeze Protection:

- Don’t forget freeze protection for fill and discharge piping

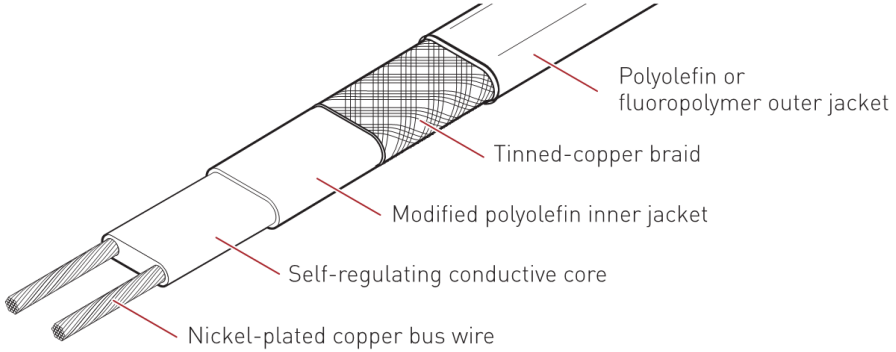


Fig. 1 XL-Trace heating cable construction

Tank Components

Automatic Fill Assembly:

- Except when an *AHJ Approved* plan is in place to re-fill manually (*within 8-hours)

14.4 Filling.

14.4.1 A permanent pipe connected to a water supply shall be provided to fill the tank, except as provided in 14.4.1.1.

14.4.1.1 Where a permanent water supply is not available to refill the tank, an approved plan shall be permitted for manually refilling the tank.

14.4.1.2 During the time that the tank does not have sufficient capacity to meet the demand of the fire protection system(s), the impairment procedures of NFPA 25 shall be followed.

14.4.2 The means to fill the tank shall be sized in accordance with 4.2.1.4.

4.2.1.4 The water supply shall be capable of filling the minimum required fire protection volume within the tank in a maximum of 8 hours.

Tank Components

Filling by rainwater collection:

- Reliability of rainwater is not guaranteed but can be an alternate source.
- A primary fill source must be provided (refill in 8-hours)
- Filtration to prevent sediment build-up is imperative to prevent clogging of life-safety systems such as fire pumps and automatic sprinkler heads
- Domestic use introduces complexities such as chlorine residuals or other treatment
- Rainwater collection can help keep tanks full. Example: 4” in a 36ft diameter tank is ~2,500gallons.

14.4.3

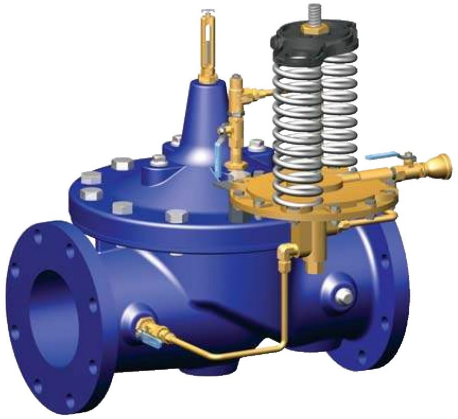
The tank shall be kept filled, and the water level shall never be more than 4 in. (102 mm) below the designated fire service level.

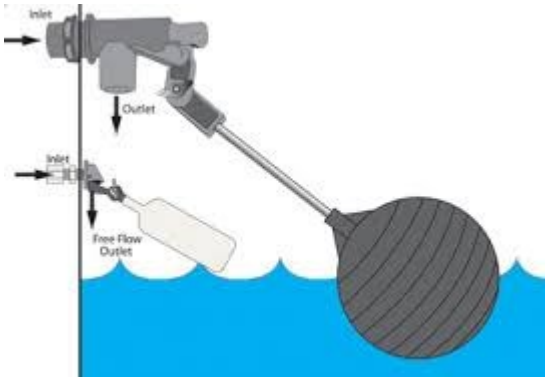
Tank Components

Automatic Fill Assembly:

Schematic Diagram

Item	Description
1	Hytrol (Main Valve)





Tank Components

Level and Temperature Sensors:

- Some of this is for pressure tanks only!

14.9 Sensors.

14.9.1 Provisions shall be made for the installation of sensors in accordance with *NFPA 72* for two critical water temperatures, two critical water levels, and two critical pressure readings (for pressure tanks only).

14.9.2 Where supervision is required, supervision shall be provided as follows:

(1) Water temperature below 40°F (4.4°C)
(2) Return of water temperature to 40°F (4.4°C)
(3) Water level 3 in. (76.2 mm) (pressure tanks) or 12 in. (300 mm) (all other tanks)
(4) Return of water level to normal
(5) Pressure in pressure tank 10 psi (0.48 kPa) below normal
(6) Pressure in pressure tank 10 psi (0.48 kPa) above normal

Tank Components

Level and Temperature Sensors:

POTTER
The Symbol of Protection

TTS
TANK TEMPERATURE SUPERVISORY SWITCH

TTS-S

CUL, UL and CSFM Listed, FM Approved, and NYMEA Accepted

2 1/2" DIA x 17 1/2"L
(63,5mm DIA x 445mm L)

Ordering Information

Model Number	Stock Number
TTS-S (steel)	1010040
TTS-W (wood)	1010041

Accessories	
1" Flange	5020012
Buttress Nut	5020105
Gasket	5330035

Tank Components

Overflow pipe:

- Drain away from the tank so no undermining of foundation
- Cover or screen on drain outlet to limit pest entry

14.6 Overflow.

14.6.1 Size. The overflow pipe shall have a capacity greater than the fill connection but shall not be less than 3 in. (75 mm) throughout.

Tank Components

Drains:

- Many AHJ's will ask for a hose connection. Here is your chance!

14.7.4.1 A drain pipe of at least 2 in. (50 mm) that is fitted with a controlling valve and a ½ in. (13 mm) drip valve shall be connected into the tank discharge pipe near its base and on the tank side of all valves.

14.7.4.2 Where the outlet is an open end outlet, it shall be fitted with a 2½ in. (65 mm) hose connection unless it discharges into a funnel or cistern piped to a sewer.

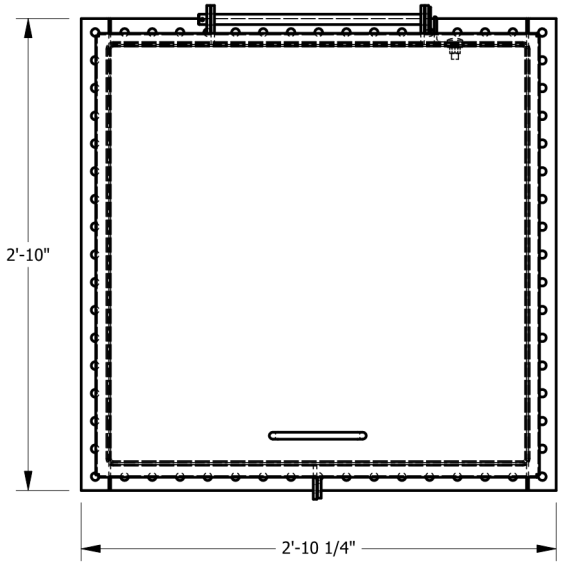
14.7.4.3 Where the drain is piped directly to a sewer, a sight glass or a ¾ in. (19.1 mm) test valve on the underside of the pipe shall be provided.

14.7.4.4 Where the drain pipe is to be used for a hose stream, the controlling valve shall be a listed gate valve or angle valve.

Tank Components

Manholes/Access:

- No requirement for top access hatch, BUT…
- …if you don't want to drain the tank every time you inspect, you need one.



14.7.2 Manholes.

14.7.2.1 Two manholes shall be provided in the first ring of the steel suction tank shell at locations to be designated by the purchaser.

14.7.2.1.1 The design of the manholes for steel tanks shall be in accordance with AWWA D100 for welded steel tanks, and AWWA D103 for bolted steel tanks.

For Wood Tanks (technically)

8.6.5.1

A hatch not less than 20 in. × 22 in. (508 mm × 559 mm) shall be built in the conical roof and shall be accessible from the tank ladder.

Tank Components

Manholes/Access:

- Once roof access is provided:

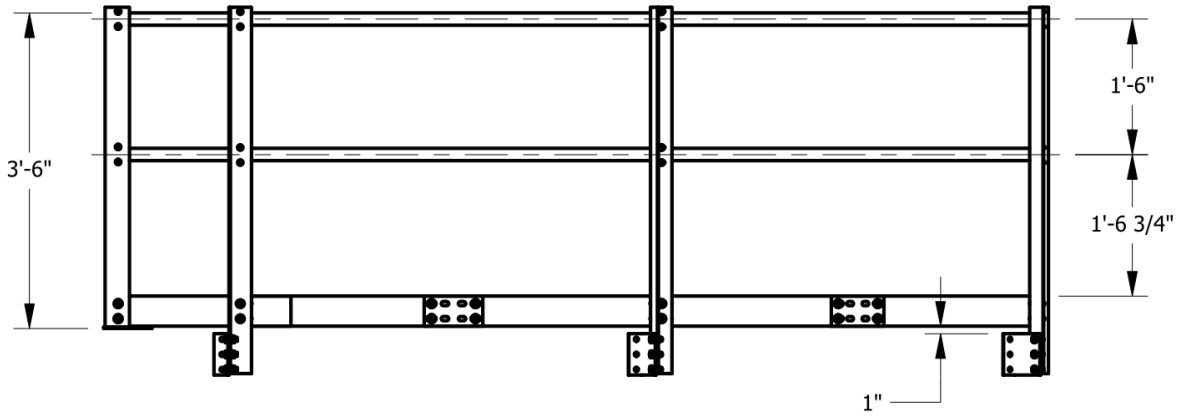
4.14 Roofs.

4.14.1* All tanks shall have roofs.

4.14.1.1 OSHA-compliant (29 CFR 1910) standard railing shall be placed around the roof hatch(es) and other accessories that require access.

4.14.2 A perimeter roof guardrail shall not be required on lap-jointed bolted steel tanks when fitted with a manway platform, roof walkway, and guardrails.

4.14.3 Guardrails shall be constructed in accordance with OSHA 29 CFR 1910.



Tank Components

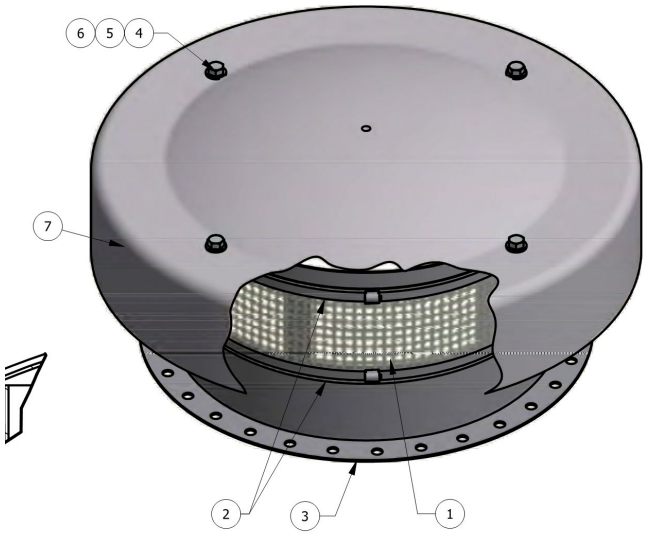
Ladders:

Not actually required for bolted steel tanks…but they should be.

- Access to equipment such as float valves, level sensors, etc. make ladders a “passive” requirement
- Must meet OSHA requirements when provided.

Tank Components

Roof Vent:



4.15 Roof Vent.

4.15.1 Where the steel roof is essentially airtight, there shall be a substantial vent above the maximum water level.

4.15.2 A vent pipe shall have a cross-sectional area equal to a minimum of one-half the area of the discharge pipe(s) or fill pipe, whichever is the larger.

4.15.3 A corrosion-resistant screen or perforated plate with ⅜ in. (9.5 mm) holes, to exclude birds or other animals, shall be provided and have a net area at least equal to the vent line.

4.15.4 In the case of a screen, a gross area at least one and one-half times the cross-sectional area of the discharge pipe(s) or fill pipe, whichever is larger, shall be required.

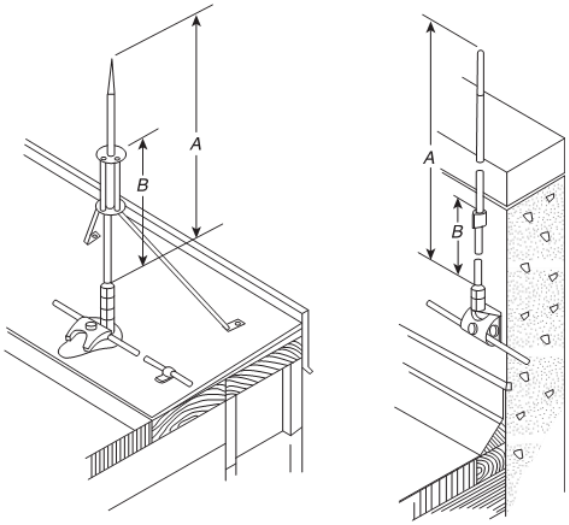
4.15.5 The screen or perforated plate shall be protected against the accumulation of sleet.

4.15.6 The weather hood above the perforated plate or screen, or its equivalent, shall be readily removable.

Tank Components

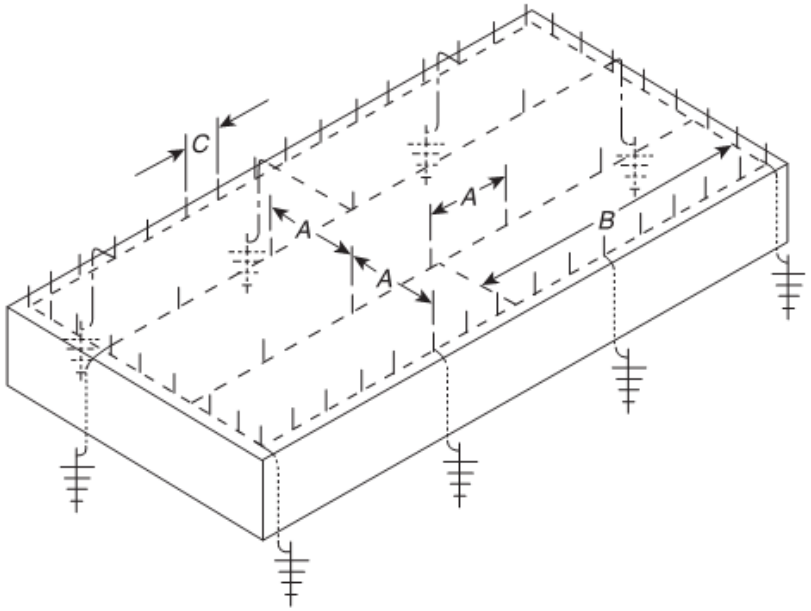
Lightning Protection:

4.9 Lightning Protection. To prevent lightning damage to tanks, protection shall be installed in accordance with NFPA 780.



A: Air terminals over 24 in. (600 mm) high are supported.
B: Air terminal supports are located at a point not less than one-half the height of the air terminal.
Note: Air terminal tip configurations can be sharp or blunt.

FIGURE 4.6.2.2.2 Air Terminal Support.



A: 50 ft (15 m) maximum spacing between air terminals
B: 150 ft (45 m) maximum length of cross-run conductor permitted without a connection from the cross-run conductor to the main perimeter or down conductor
C: 20 ft (6 m) or 25 ft (7.6 m) maximum spacings between air terminals along edge

FIGURE 4.7.5.1(a) Air Terminals on a Flat Roof.

Tank Components

Shutoff Valves:

- FPCG highly recommends isolation valves for fill and suction lines, located as close as possible to the tank.
- Underground gate valves with PIV are ideal for freeze protection and monitoring.

14.2.12.4 Where a tank is used as a suction source for a fire pump, the listed indicating control valve shall be of the OS&Y type.

Structural Design

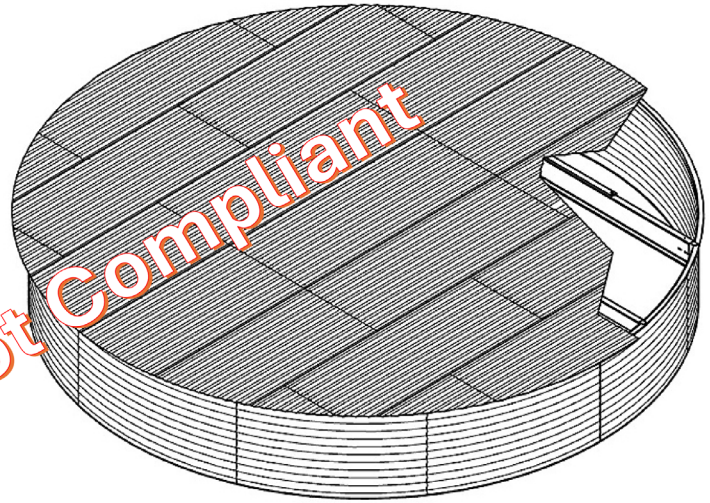
NFPA 22 requires rigorous engineering, often absent in standard utility or poly tanks:

- Seismic bracing: Tanks must withstand site-specific earth movement
- Wind loads: Calculated for 145mph gusts (Houston), but depends on location and ASCE 7 structural design standard
- Foundations: Engineered slabs to support 250,000lbs+ loads, minimum (~30,000gallons)
  - The same 36ft diameter tank, 20 feet tall = 1.27M pounds (~150,000 gallons)

Structural Design

NFPA 22 requires rigorous engineering, often absent in standard utility or poly tanks:

- Structural design must be performed by a qualified licensed engineer
- Seismic risk Category IV per IBC
- Roof slopes less than 30 degrees must have a live load of 25lbs/ft^2



Structural Design

NFPA 22 requires rigorous engineering:

- Wind loading

4.12.3 Wind Load.

4.12.3.1

Under normal conditions, the wind load or pressure shall be assumed to be 30 lb/ft^2 (147 kg/m^2) on vertical plane surfaces, 18 lb/ft^2 (88 kg/m^2) on projected areas of cylindrical surfaces, and 15 lb/ft^2 (73 kg/m^2) on projected areas of conical and double-curved plate surfaces.

4.12.3.2

Structures shall comply with the locally adopted building code and applicable standards for wind load requirements.

4.12.3.3

The larger of the wind load or load in **4.12.3.1** shall be used.

- Earthquake loading – Use locally adopted building codes
- Snow loading – Use locally adopted building codes

Design Plans

4.6 Plans.

4.6.1

The contractor shall furnish stress sheets and plans required by the purchaser and the authority having jurisdiction for approval or for obtaining building permits and licenses for the erection of the structure.

4.6.2 Approval of Layouts.

4.6.2.1

Complete information regarding the tank piping on the tank side of the connection to the yard or sprinkler system shall be submitted to the authority having jurisdiction for approval.

4.6.2.2

The information submitted shall include the following:

(1) Size and arrangement of all pipes

(2) Size, location, and type of all valves, tank heater, and other accessories

(3) Steam pressures available at the heater

(4) Arrangement of, and full information regarding, the steam supply and return system together with pipe sizes

(5) Details of construction of the frostproof casing

(6) Where heating is required, heat loss calculations

(7) Structural drawings and calculations

(8) Seismic bracing details and calculations

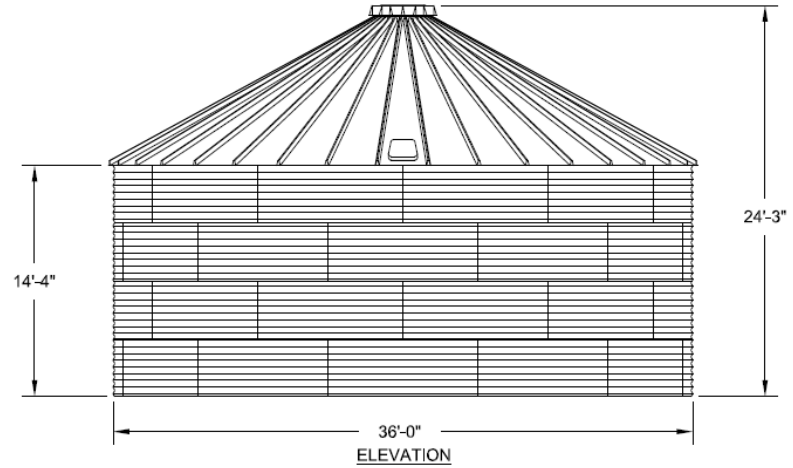
(9) Operational settings and sequence of operation

(10) Monitoring equipment and connections

(11) Underground details including foundations, compaction, and backfill details and calculations

(12) Buoyancy calculations for buried tanks

Hypothetical Scenario



MODEL 3604-WT-CHR
CORGAL STEEL WATER STORAGE TANK
NOMINAL CAPACITY - 108,000 GALLONS (U.S.)

Overall Structural WEIGHT		
	SD A (Austin)	SD D (El Paso)
RISK CAT II	7015	8197
RISK CAT IV	7529	8830

	SD A	SD D
RISK CAT II	0	17%
RISK CAT IV	7%	26%

Refer to the ASCE Hazard Tool for site specific load requirements

Fire Protection Tanks

Key Takeaways:

You should always have an engineered design or specification for the tank design.

Either a Professional Engineer or a Responsible Managing Employee (General) must size the tank.

A structural engineer must design the foundation and confirm all required loading has been accounted for your location to size the sheet thickness, roof structure, support columns, bolts/bolt pattern, tie-downs, etc.

QUESTIONS?