Shop Fabricated Aboveground Storage Tanks Standards

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Steel Tank Institute
STI-SPFA
Facilities with a mix of tanks

Shop Fabricated Tanks

Field erected Tanks

Portable Containers
50,000 Gallons
AST Standards for Shop Fabricated Tanks

- **API** - American Petroleum Institute
  - API 12F
  - API 650, Appendix J

- **UL** - Underwriters Laboratories
  - UL 142
  - UL 2085

- **SwRI** - Southwest Research Institute
  - SwRI 97-04
  - SwRI 93-01
API Specifications

- API 12F
  - “Specification for Shop Welded Tanks for Storage of Production Liquids”
  - Vertical, cylindrical only

- API 650, Appendix J
  - “Shop Assembled Welded Steel Tanks for Oil Storage”
  - Vertical, cylindrical only
Table 1 “Tank Dimensions” includes:
- Capacity
- Outside diameter
- Height
- Connection details
Specifies steel thickness

- **BOTTOM:**
  - 1/4 in. (except sump to be 3/8 in.)
- **SHELL:**
  - 3/16 in. or 1/4 in. as requested by purchaser
- **DECK (TOP):**
  - same as shell except
  - 15 ft.-6 in. diameter tanks to be 1/4 in.
Figure 1
Tank Dimensions

1. Dome
2. Nameplate (See 8.2)
3. Anti-channel Drain (Optional)
4. Overflow Line Connection (C-4)
5. Overflow Line Connection (C-5)
6. Fill-line Line Connection (C-2)
7. Pipe-line Connection (C-6)
8. Shell Plate
9. Thief-hatch Cutout
10. Vent-line Connection (C-3)
11. Lugs
12. Drain-line Connection (C-7)
13. 9/16 in. Diameter Bolt Holes
14. 24 in. x 36 in. Cleanout
15. Tank
16. Walkway Bracket Lugs
17. 10 3/8 in. B.C. 16 9/16 in. Holes
18. Outside Edge of Tank
19. 8-in. Hole
<table>
<thead>
<tr>
<th>Nominal Capacity bbl</th>
<th>Design Pressure oz/in.²</th>
<th>Approximate Working Capacity bbl (See Note)</th>
<th>Outside Diameter ft, in. A</th>
<th>Height B</th>
<th>Height of Overflow Connection ft, in. C</th>
<th>Height of Walkway Lugs ft, in. D</th>
<th>Location of Fill-line Connection a in. E</th>
<th>Size of Connections in. C-1, C-2, C-3, C-7 C-4, C-5, C-6</th>
<th>Tolerance (all sizes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>16, 1/2</td>
<td>72</td>
<td>7, 11</td>
<td>10</td>
<td>9, 6</td>
<td>7, 7</td>
<td>14</td>
<td>3</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>100</td>
<td>16, 1/2</td>
<td>79</td>
<td>9, 6</td>
<td>8</td>
<td>7, 6</td>
<td>5, 7</td>
<td>14</td>
<td>3</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>150</td>
<td>16, 1/2</td>
<td>129</td>
<td>9, 6</td>
<td>12</td>
<td>11, 6</td>
<td>9, 7</td>
<td>14</td>
<td>3</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>200</td>
<td>16, 1/2</td>
<td>166</td>
<td>12, 0</td>
<td>10</td>
<td>9, 6</td>
<td>7, 7</td>
<td>14</td>
<td>3</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>210</td>
<td>16, 1/2</td>
<td>200</td>
<td>10, 0</td>
<td>15</td>
<td>14, 6</td>
<td>12, 7</td>
<td>14</td>
<td>4</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>250</td>
<td>16, 1/2</td>
<td>224</td>
<td>11, 0</td>
<td>15</td>
<td>14, 6</td>
<td>12, 7</td>
<td>14</td>
<td>4</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>300</td>
<td>16, 1/2</td>
<td>266</td>
<td>12, 0</td>
<td>15</td>
<td>14, 6</td>
<td>12, 7</td>
<td>14</td>
<td>4</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>400</td>
<td>16, 1/2</td>
<td>366</td>
<td>12, 0</td>
<td>20</td>
<td>19, 6</td>
<td>17, 7</td>
<td>14</td>
<td>4</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>500</td>
<td>16, 1/2</td>
<td>466</td>
<td>12, 0</td>
<td>25</td>
<td>24, 6</td>
<td>22, 7</td>
<td>14</td>
<td>4</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>500</td>
<td>8, 1/2</td>
<td>479</td>
<td>15, 6</td>
<td>16</td>
<td>15, 6</td>
<td>13, 7</td>
<td>14</td>
<td>4</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
<tr>
<td>750</td>
<td>8, 1/2</td>
<td>746</td>
<td>15, 6</td>
<td>24</td>
<td>23, 6</td>
<td>21, 7</td>
<td>14</td>
<td>4</td>
<td>± 1/8 in.  ± 3/8 in.  ± 1/8 in.  ± 1/8 in.</td>
</tr>
</tbody>
</table>

**NOTE** The approximate working capacities shown in Column 3 apply to flat-bottom tanks.

Type A (unskirted) cone-bottom tanks have 6 in. more working height than the corresponding flat-bottom tanks. The approximate increase is 4 bbl for the 7-ft, 11-in. diameter tanks, 6 bbl for the 9-ft, 6-in. diameter tanks, 7 bbl for the 10-ft diameter tanks, 8 bbl for the 11-ft diameter tanks, 10 bbl for the 12-ft diameter tanks, and 17 bbl for the 15-ft, 6-in. diameter tanks.

Type B (skirted) cone-bottom tanks have 8 in. less working height than the corresponding flat-bottom tanks. The approximate decrease in capacity is 6 bbl for the 7-ft, 11-in. diameter tanks, 8 bbl for the 9-ft, 6-in. diameter tanks, 9 bbl for the 10-ft diameter tanks, 11 bbl for the 11-ft diameter tanks, 13 bbl for the 12-ft diameter tanks, and 15 bbl for the 15-ft, 6-in. diameter tanks.

a **Viscous Oil Option.** When so specified on the purchaser order, tanks shall be furnished for viscous oil service. On such tanks, dimension C of the overflow-line connections shall be 6 in. less than shown in Column 6, Table 1 and dimension E of the fill-line connection shall be 6 in., ± 1/8 in.
API 12F continued

- Emergency venting per Table C-1
  - based on tank dimensions given in Table 1
- Pressure testing with air at 1 1/2 times design pressure and apply soap solution
- Nameplate
  - Manufacturer, serial number, year built
  - Nominal diameter, height, capacity
  - Thickness of bottom, shell, deck
  - Design pressure
API 12F Painting

- Metal primer required
- Finish coating optional
- Limited to 20 ft. diameter
- Steel thickness:
  - BOTTOM: 1/4 in.
  - SHELLS: calculations required and
    | Diameter     | Minimum |
    |--------------|---------|
    | to 10.5 ft.  | 3/16 in.|
    | over 10.5 ft.| 1/4 in. |
- ROOFS: calculations required
  cone, dome and umbrella
Shell thickness

\[
t = \frac{2.6D(H - 1)G}{(E)(21,000)} + CA
\]

- \( t \) = minimum thickness
- \( D \) = nominal diameter
- \( H \) = liquid level
- \( G \) = liquid specific gravity
- \( E \) = joint efficiency
- \( CA \) = corrosion allowance

Diameter
- to 10.5 ft. minimum thickness: 3/16 in.
- over 10.5 ft. minimum thickness: 1/4 in.
API 650, App. J (continued)

- Relies on Fire Codes for emergency venting requirements
- Pressure testing
  - diameters to 12 ft.=5 psig
  - diameters over 12 ft.=2 to 3 psig
- Nameplate
  - API 650, App. J, serial number, year built
  - Nominal diameter, height, maximum capacity
  - Design pressure, temperature, liquid level
API 650, App. J (continued)

- Does include:
  - Qualified welders requirement
  - X-ray of some welds and magnetic particle testing of nozzles

- Does not include:
  - requirements for secondary containment
  - requirements for painting
Underwriters Laboratories

- UL 142  “Steel Aboveground Tanks for Flammable and Combustible Liquids”
- UL 2085  “Protected Aboveground Tanks for Flammable and Combustible Liquids”
- Atmospheric Tank
  - -0.5 to 1 psig
- Single wall
- Double wall
- Steel Diked Tanks
  - Open or Closed Top
- Carbon or stainless steel
- Stationary use only
Capacities up to 75,000 gallons
- Specifies steel thicknesses
  - Primary tank
  - Secondary tank
  - Shells and heads
# UL 142 Steel thickness

## Table 13.1

Minimum steel thickness – horizontal tanks

Revised Table 13.1 effective December 15, 2009

<table>
<thead>
<tr>
<th>Actual capacity, U.S. gallons (kL)</th>
<th>Maximum diameter, inches (m)</th>
<th>Minimum steel thickness, inch (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Carbon steel</td>
</tr>
<tr>
<td>550 or less</td>
<td>(2.08)</td>
<td>48 (1.22)</td>
</tr>
<tr>
<td>551 – 1100</td>
<td>(2.14 – 4.16)</td>
<td>64 (1.63)</td>
</tr>
<tr>
<td>1101 – 9000</td>
<td>(4.17 – 34.07)</td>
<td>76 (1.93)</td>
</tr>
<tr>
<td>1101 – 35,000</td>
<td>(4.17 – 132.49)</td>
<td>144 (3.66)</td>
</tr>
<tr>
<td>35,001 – 50,000</td>
<td>(132.50 – 189.27)</td>
<td>144 (3.66)</td>
</tr>
<tr>
<td>50,001 – 75,000</td>
<td>(189.27 – 283.6)</td>
<td>156 (3.97)</td>
</tr>
</tbody>
</table>
Performance testing required for:
- Rectangular tanks
- Optional support designs
- Ladders and other optional tank accessories

Manufacturing tests required:
- Air test at 1-1/2 to 5 psig with soap suds (based on tank type)
- Hydrostatic pressure (with water)
Performance testing required for:
- Rectangular tanks
- Optional support designs
- Ladders and other optional tank accessories

Manufacturing tests required:
- Air test at 1-1/2 to 5 psig with soap suds (based on tank type)
- Hydrostatic pressure (with water)
STI AST Technologies (UL 142)

UNITIZED\ABOVEGROUND
Steel Tank Institute
STORAGE TANK
F911®

DOUBLE WALL\ABOVEGROUND
Steel Tank Institute
STORAGE TANK
F921®

FLAMESHIELD™
- Horizontal Cylindrical
  - Steel thickness specified, including shell and heads
  - Optional support design requires testing or calculations
  - Diameters to 13 feet
  - Air test at 5 psi
Vertical cylindrical
- Steel thickness specified
- Manufacturing air test at 1 1/2 to 2 1/2 psi
- Dished or conical roof required
Underwriters Laboratories
UL 142

- Rectangular
  - Requires performance testing to prove design
  - Manufacturing air test at 3 psi

18 Performance
18.1 Hydrostatic strength test
18.1.1 The tank shall be tested to demonstrate that the strength of the assembly and the welded joints are in accordance with these requirements.
18.1.2 The tank shall not rupture or leak when subjected to the Hydrostatic Strength Test, Section 40.

18.2 Top load test
18.2.1 After being subjected to the Top Load Test, Section 41, the tank shall then be subjected to the Leakage Test, Section 39, and shall not leak.
Open Diked Tanks (F911)
Diked Tanks with Rainshields
Closed Diked Tanks
UL 142 Supports

- Maximum height of 12 inches
- Must withstand 2 times the weight of a full tank
- Design using calculations approved by UL
- Design using Performance Test
UL 142 Welding

- Specifies weld joint designs
- Does not require "qualified" welders
UL 142 Venting Requirements

- Normal vents
  - Allow air to enter the tank when fluid is being withdrawn and also exhausts air when the tank is being filled
  - Required on Primary tank (each compartment)
  - Size per Table 8.2 in UL 142
Emergency vents

Prevent damage to the tank by allowing excess pressure to be vented. They are designed to relieve excess pressure in the event of an emergency, such as a fire.

Required on
- Primary tank and
- Secondary tank
Emergency vent device size

“Wetted surface area”

- Horizontal cylindrical tanks = 75% of total surface area
- Vertical tanks = shell surface area (and bottom if elevated)
- Rectangular tanks = surface area of sides and bottom

Table 8.1 in UL 142 gives

- Emergency vent capacity
- Size
UL 142 Painting

- **No** paint required on *Stainless steel* tanks
- **One coat** of paint required on *Carbon steel* tanks
UL 142 Label

UL Serial No.__________

Will have one of these statements:

- Aboveground Tank for Flammable Liquids
- Aboveground Tank for Flammable Liquids on Supports
- Secondary Containment Aboveground Tank for Flammable Liquids
- Open Top Diked Aboveground Tank for Flammable Liquids
- Open Top Diked Secondary Containment Aboveground Tank for Flammable Liquids
- Closed Top Diked Aboveground Tank for Flammable Liquids
- Closed Top Diked Secondary Containment Aboveground Tank for Flammable Liquids
“Protected Tank”

- “Integral” Secondary containment
  - Part of the construction of the tank, monitorable
- Insulation
- Reduce heat in a fire
- Protection from physical damage

Protected Aboveground Tanks for Flammable and Combustible Liquids
2 Hour
2000 Degree Exposure
Vehicle Impact Resistance Option
Ballistics Resistance Option
UL 2085
Tank Construction

- Refer to UL 142
  - Steel thickness
  - Welding
  - Support design
  - Vents
  - Emergency vents

- Must have provisions for monitoring interstitial space
Cutaway of Insulated Tank Technology
Concrete Encased
Cylindrical Tanks
Rectangular Tanks
Vertical Cylindrical
Fireguard® passed the Standing Loss Control portion of CARB EVR certification requirement in 2008.

CARB requirement of

Emission Factor < 0.57/1000 gallons corresponds to a 90% reduction in emissions

- As compared to a single-wall tank without a P/V vent.
Standing Loss Control
Temperature Attenuation

Insulated Tank
PROTECTED SECONDARY CONTAINMENT ABOVEGROUND TANK
FOR FLAMMABLE LIQUIDS  UL serial number XXXXXXXX

FIREGUARD®
UL 2085, STI MH 17883

LISTED

- FOLLOW INSTALLATION INSTRUCTIONS
- TANK IS INTENDED FOR STATIONARY INSTALLATION ONLY.
- PRESSURIZE PRIMARY TANK WHEN PRESSURE TESTING ANNULAR SPACE.
- VEHICLE IMPACT RESISTANT
- THIS TANK SHALL BE INVESTIGATED TO DETERMINE ACCEPTABILITY OF USE AFTER FIRE EXPOSURE DAMAGE, OTHER PHYSICAL DAMAGE, OR MISUSE.
- IF A LEAK IS DETECTED (WATER OR FUEL) THIS TANK IS TO BE REMOVED FROM SERVICE. THE LOCAL CODE AUTHORITY AND TANK MANUFACTURER SHOULD BE CONTACTED TO DETERMINE IF THE INSULATION CAN BE REPLACED OR REPAIRED.
- THIS TANK IS INTENDED FOR INSTALLATION IN ACCORDANCE WITH NFPA 30, NFPA30A, NFPA 31 OR THE UNIFORM FIRE CODE STANDARD A-II-F-1
- INSULATED ABOVEGROUND TANK, PROTECTED TYPE
- TANK LISTED AS A FIRE RESISTANT SECONDARY CONTAINMENT TANK
- PROJECTILE RESISTANT (IF PUNCHED, STEEL THICKNESS MEETS REQUIREMENTS)
Generator Base Tank
UL Listed Generator Base Tank
UL Listed Generator Base Tank
Generator Base Tanks

- UL 142 Special Purpose Tank
- Provides sturdy support for emergency power generator
- Stores fuel supply
Southwest Research Institute

- Listing and Labeling of ASTs
- Qualification testing of ASTs
SwRI Tank Test Procedures

- SwRI 97-04
  “Testing Requirements for Fire Resistant Tanks”
- SwRI 93-01
  “Testing Requirements for Protected Tanks”
- SwRI 95-03
  “Testing Requirements for Multi–Hazard Tanks”
# Fire Resistive Tank Technologies

## Comparison of AST Standards Used with Motor Vehicle Fuelling

<table>
<thead>
<tr>
<th>Standard</th>
<th>Fire Test Performed</th>
<th>Pass/Fail Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 2085 Protected Tank</td>
<td>2 hour, 2000° fire</td>
<td>Temperature limit: 260° avg., 400° max. at any one thermocouple</td>
</tr>
<tr>
<td>SwRI 93-01 Protected Tank</td>
<td>2 hour, 2000° fire</td>
<td>Temperature limit: 260° avg., 400° max. at any one thermocouple</td>
</tr>
<tr>
<td>UL 2080 Fire Resistant Tank</td>
<td>2 hour, 2000° fire</td>
<td>Temperature limit: 800° avg., 1000° max. at any one thermocouple</td>
</tr>
<tr>
<td>SwRI 97-04 Fire Tested Tank</td>
<td>2 hour, 2000° fire</td>
<td>Primary tank must pass 5 psi air pressure test for one hour. No temperature limits.</td>
</tr>
<tr>
<td>UL 142 Aboveground Storage Tank</td>
<td>No fire test required</td>
<td>Tests do not address fire issues</td>
</tr>
</tbody>
</table>
SwRI 97-04
Fire Tested Tank

- Test procedure only, no construction requirements
- Same fire test as UL 2085, but no temperature limits
Fire-Tested Tanks SwRI 97-04

- STI Flameshield™
- Construction per F921®
- and UL 142
SwRI 93-01
Protected Aboveground Tanks

- Test procedure only, no construction requirements
- Same fire test requirements as UL 2085
- Same temperature limits as UL 2085
- Fire test duration may be longer than 2 hours, typically 4 hours
- Includes vehicle impact and ballistics testing
SwRI 95-03
Multi–Hazard Tanks

- Test procedure only, no construction requirements
- Same fire test requirements as UL 2085
- Same temperature limits as UL 2085
- Includes vehicle impact and ballistics testing
- After successful testing above, the same tank is subjected to these tests a second time.