Shop Fabricated Aboveground Tank Construction Standards

Wayne Geyer
Steel Tank Institute
Fourth Biennial Freshwater Spills Symposium 2002
March 19-12, 2002
Cleveland, OH

Shop Fabricated Aboveground Tank Construction Standards

One key to clean freshwater is to prevent hazardous liquid spills from taking place in the first place. An important element to spill prevention is the safe storage of hazardous liquids in tanks that comply with national standards.

Tanks come in many shapes and forms. Large tanks are erected in the field. Smaller tanks are produced in a factory and shipped to the site for installation. Shop-built tanks are made for underground installations and for aboveground installations. Aboveground tanks are either oriented for horizontal or vertical installation, and are produced in either cylindrical form or rectangular form. The tanks are capable of being designed and fabricated as pressure vessels, but are more typically vented to atmosphere. The tank can have compartments internal to the tank. Tanks are often secondarily contained. The tank can be insulated for fire safety or temperature control. Corrosion protection can be given to exterior tank bottoms in contact with soil or to the tank interior with special coatings and linings. Some aboveground tanks are even installed in an underground vault or room, without backfill.

This paper presents tank standards covering shop-fabricated aboveground tank construction. A shop-fabricated tank is typically 50,000 gallons capacity or less. That capacity translates to a 12’ diameter by 60’ long tank, just small enough to fit on a transport truck and be shipped on a highway. Any truckload wider than 8.5’ requires a permit, and any truckload over 12’ in width requires a special highway escort. Bridge underpass limitations, weight restrictions, and tank trailer length capabilities further restrict highway transportation shipments, such that tanks larger than 50,000 gallons are

more economically erected in the field, rather than at the shop. Most aboveground tanks built to these standards store flammable or combustible liquids at atmospheric pressure, and are 12,000 gallons capacity or smaller. With STI labeled tanks, these smaller capacities constitute 97% of all aboveground storage tanks built to STI specifications. During a recent 12-month time interval, 30% of STI Members alone reported building over 20,000 tank units of 1100 gallons or smaller. To store product safely and effectively, tanks constructed today must meet certain minimum requirements as established by fire codes.

Third Party Test Laboratory Aboveground Tank Standards

In 1922, the requirements for aboveground storage tanks were transferred from the National Board of Fire Underwriters regulations and published in the First Edition of Underwriters Laboratories' UL 142 standard. The UL 142 standard addressed issues relating to leakage, venting, and the ability of the tank to withstand the development of internal pressures encountered during leak testing. Later, the standard covered the requirements for steel tank wall thickness, joint construction, fittings and manways.

In 1993, the UL 142 standard was significantly expanded. The Seventh Edition incorporated secondary containment tank construction, rectangular tank construction and expanded support design requirements. Secondary containment tanks could be in the form of a steel dike or in the form of a steel secondary containment tank. Rectangular tank requirements were performance based and included hydrostatic tests and top loading tests. Rectangular tanks became a desirable option for small tanks, typically less than 2000 gallons, as operators liked the accessibility of the flat top to perform operations and

maintenance without the need for special ladders or catwalks. Integral supports needed to be constructed in accordance with the standard or subjected to a tank support load test.

UL published a separate standard for small home heating oil applications under the UL 80 standard. The UL 80 standard covers an obround shaped tank construction, typically less than 1100 gallons in capacity. When the standard was first published in 1927, tanks of this capacity were considered quite large.

Underwriter Laboratories of Canada, ULC, has published standards comparable to UL for use in Canada. ULC standards are considered acceptable for installation in the United States by many jurisdictions. The Appendix contains a list of appropriate tank standards referenced within this paper.

Tanks Come Out of the Ground

By 1990, as society became more aware of the hazards with non-EPA regulatory compliant underground storage tanks, tank owners also became aware of the great costs involved in cleaning up sites underground to meet environmental regulations. The 1988 EPA underground tank regulation targeted the older tank sites, forcing owners to upgrade, remove, replace or completely close tanks that did not meet regulatory requirements before the December 1998 regulatory deadline. As result, the number of regulated underground storage tanks decreased from more than two million to less than 700,000 tanks between 1988 and 2000. Where did all of our storage capacity go?

In 1988, many underground tanks were old and seldom used. Most of these tanks were removed and not replaced. Some tank owners simply began using their local service station for motor vehicle fueling needs rather than self-store their fuel. Also, as small “Mom and Pop” gas stations were shut down, large convenient service stations took

their place, and that necessitated considerably larger tank capacities. Many owner/operators began to install their tanks aboveground instead of underground. This trend became quite noticeable after 1990, as AST production doubled or tripled. Tank buyers found greater peace of mind with AST's – due to the perception of fewer regulations, and the comforting ability to visually inspect the tank for leaks.

Fire Code Jurisdiction with Aboveground Storage Tanks

EPA's underground tank rule did not extend to aboveground storage tanks. Due to the manner in which aboveground storage tank legislation was promulgated in 1972 for protection of surface waters from oil pollution, state environmental agencies did not receive similar jurisdiction as they did within the recent underground storage tanks rules. Nonetheless, many states are presently regulating aboveground storage tanks through other means, and federal tank inspections continue to assure compliance with minimum federal Environmental Protection Agency aboveground storage tanks requirements.

Since many of these tanks were storing flammable and combustible liquids, fire safety codes served as the predominant regulatory documents dictating requirements for aboveground storage tanks, AST's. But fire marshals were not prepared. The most common new use for aboveground tank installation was for motor vehicle fueling at a private fleet fueling facility. In some parts of the country, aboveground tanks were being installed at service stations, but with complete disregard for the fire codes, which generally prohibited such installations.

The 1990's saw a tremendous level of activity in the fire codes. New language was adopted in the codes to allow aboveground storage tank installations, with improved safety features built in. The goal was to prevent releases from taking place so that fire

hazards were not created and the associated environmental damage would not occur. This included the use of secondary containment, insulated/protected tank construction, overfill prevention, thermal expansion and anti-siphon devices, and special emergency vents.

One of the more significant changes that took place in the mid-1990's was with the spill control requirements of the fire codes. The codes adopted secondary containment tanks, up to 12,000 gallons in capacity, as an equivalent to traditional concrete dike installations.

The culmination of this effort was with the expansion on requirements for aboveground tanks storing flammable and combustible liquids within several fire codes. Principal codes offering jurisdiction of tanks includes:

- NFPA 30A, Code for Motor Fuel Dispensing Facilities and Repair Garages,
- Uniform Fire Code,
- International Fire Code, as supported by BOCA, SBCCI, and ICBO, and
- National Fire Code of Canada

In order to demonstrate compliance with the new requirements of the Codes, tank manufacturers needed recognized listings, and third party test laboratories needed to develop new tank test standards. Underwriters Laboratories developed UL 2085 for protected tank construction, UL 2080 for fire resistant tank construction, UL 2244 for AST system construction, and UL 2245 for vaulted construction (to hold an AST in a below grade room). Southwest Research Institute developed similar third party test laboratory standards, including SwRI 93-01 for protected tank construction and SwRI 97-04 for fire resistant tank construction.

The protected tank is referenced in all three American codes and represents a major change in tank construction. The protected tank must be insulated to withstand a 2000 degree two hour pool fire environment exposure without leakage and with a limited temperature rise, necessitating insulation around the tank. All tanks must incorporate secondary containment and are normally qualified against impact by vehicles and ballistics resistance.

New Industry Standards

Industry trade groups like Petroleum Equipment Institute, American Petroleum Institute, and Steel Tank Institute also responded to the new demand for aboveground tanks by developing additional tank construction, installation, and maintenance standards to address the rapidly popular aboveground tank market and the new safety concerns created by their popularity.

One widely acclaimed publication for proper shop fabricated tank installations was PEI's RP 200, *Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling*.

Environmental Rules for Aboveground Storage Tanks

As aboveground storage tanks became more prevalent, environmental safety awareness of our groundwater resources, once focused primarily on underground storage tanks, began drifting towards aboveground tanks. By 2000, Minnesota, Florida, Wisconsin, California, Oklahoma, Missouri, New Mexico, Michigan, and other states either had adopted or were in process of adopting new regulations for aboveground storage tanks. Several times throughout the 1990's, the Environmental Protection Agency proposed revisions to their Spill Prevention Control and Countermeasure, SPCC,

regulation (as part of the 1972 Amendment to the Federal Water Pollution Control Act, currently known as the Clean Water Act) and these nearly became officially promulgated as the Clinton administration concluded their reign in 2001. The SPCC rule requires a tank owner to have a plan prepared by a professional engineer to prevent and control oil from spilling into surface waters.

The first revision to the SPCC rule proposed in 1991 was to require secondary containment that was impermeable for at least 72 hours after a release occurred. This created a whole new movement towards secondary contained AST's. No longer focusing most of its efforts on underground tanks and on releases to surface waters from aboveground tanks, the environmental community further investigated concerns from aboveground tank system releases that could permeate through soil into groundwater and then eventually pollute surface waters. Steel became a popular option for secondary containment of factory built aboveground tanks due to its non-permeable nature.

The initial tank industry solution was to install a single wall aboveground tank into a steel dike. While this design could contain a release, rain could also collect in the dike and, if contaminated, had to be disposed of as a hazardous material. So manufacturers began to provide rain shields over the dike opening or completely over the tank. In order to prevent spills during fill operations from being diverted over the rain shield and onto the ground, overfill limiting valves were introduced for pressurized filling operations. The valves shut-off delivered flow into the tank at a specific pre-set level or tank capacity.

First National Construction Standard for Secondary Containment Tanks

Tank owners quickly realized that a double-wall steel aboveground tank, similar in construction to the double-wall steel underground tank, could fulfill the same function as a diked AST with rain shield. Soon, the double-wall aboveground tank became available in both horizontal and vertical construction as a popular installation option.

Secondary containment tanks first appeared in the United States in the early 1980's, when local and state jurisdictions were just beginning to investigate tank leakage and promulgate rules for hazardous wastes and chemical storage. In 1984, Steel Tank Institute (STI) introduced the first national construction standard for underground secondary containment tanks. It provided a design for a Type I, intimate wrap, steel secondary containment tank, with several alternative construction methods for enabling the interstice to be monitored for releases (i.e., liquid or pressure sensors, gauge stick, etc.). The STI standard was based on German technology, which had already been in place for a number of years. The aboveground secondary containment tanks paralleled this intimate wrap construction method. However, emergency vents were required for the interstitial space with the aboveground tanks. By the year 2000, secondary containment had established itself as one of the solutions to the developing concerns of aboveground storage tank releases.

STI AST Construction Standards

STI responded to the needs of the industry to standardize construction by developing the diked AST F911 standard in 1991 (qualifies under UL 142), the double wall AST F921 standard in 1992 (qualifies under UL 142), the Fireguard fire-protected standard in 1994 (qualifies under UL 2085), and the Flameshield fire-resistant tank

standard in 1999 (qualifies under SwRI 97-04). Each one of the STI standards incorporates secondary containment into the design.

The trend towards secondary containment makes perfect sense. It provides containment to prevent releases into the soil, groundwater, or surface waters and all the undesirable elements that go with a release – report writing, cleanup, lawsuits, business interruptions, and potential regulatory enforcement acts. It provides an extra insurance policy, just in case the tank was improperly installed or maintained. It offers peace of mind to the tank owner.

Clearly, the trend toward secondary containment tanks was a reality. Manufacturers saw their secondary contained AST construction orders increase from almost nothing in 1990 to 50 percent or more by the turn of the century, particularly with larger AST construction. In 1998 alone, STI saw its Members register nearly 5000 secondary containment AST's that were built to STI specifications.

STI has also developed several other recommended practices for shop-fabricated aboveground tanks. This included installation instructions, corrosion control of vertical tank bottoms, testing of secondary containment tanks, and inspection standards. The STI SP001 Inspection Standard was the most recent standard developed and represents the only inspection standard available applicable only to shop fabricated aboveground storage tanks.

American Petroleum Institute has standards for shop fabricated tanks also. The API 12F standard is often required for upstream oil production tanks and the API 650 standard can be applied to smaller tank construction. API publishes a very diverse set of recommended practices for ASTs of all types.

System Containment

A secondary containment tank is certainly a valuable commodity. However, the tank in itself will not ensure full compliance with the spill control requirements of environmental regulations and fire safety codes. A holistic approach to containment must be given to the entire system, including operations. Spill prevention and containment must be given at tank fill areas and truck loading areas. Containment considerations must also be given to the pipe system, pumps, valves, and other important aboveground tank system components, even if these components are below grade!

Future Trends

New trends continue to evolve with the need for storage tanks. Many industries are opting for the installation of stand-by power generators. In many cases, such generators are installed directly atop generator base tanks, either in the form of single wall, double wall, or protected tank construction.

New designs have been introduced for vertical aboveground storage tank supports. As regulatory agencies further investigate releases from vertical tank floors resting on grade, the ability to see the tank bottom becomes more and more attractive.

With significant advances in steel storage tank construction standards over the past 20 years, tank owners now have many new viable options for the safe storage of hazardous liquids. With the introduction of secondary tank construction standards in the past decade, tank owners are now given the choice of an economic and environmentally sound tank installation.

Bibliography

Geyer, Wayne. LUSTLINE. The Sense of Secondary Containment," Lowell Massachusetts, June 2001.

Handbook of Storage Tank Systems – Code, Regulations, and Designs," Edited by Wayne Geyer and Jim Wisuri. Marcel Dekker, Inc. New York, New York. 2000.

"Secondary Containment Options for Aboveground and Underground Tanks," NLGI, Palm Beach, FL October 2001.

Tank Talk, Steel Tank Institute, June/July 2000.

Tank Talk, Steel Tank Institute, September/October 2000.

The Industry's AST Construction Publications

UL Publications

Steel Tanks for Oil Burner Fuel (UL 80)

Steel Aboveground Tanks for Flammable and Combustible Liquids (UL 142)

Fire Resistant Tanks for Flammable and Combustible Liquids (UL 2080)

Protected Aboveground Tanks for Flammable and Combustible Liquids (UL 2085)

Aboveground Flammable Liquid Tank Systems (UL2244)

Belowgrade Vaults for Flammable Liquid Storage Tanks (UL 2245)

ULC Publications

Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids (ULC S601)

Shop Fabricated Steel Aboveground Vertical Tanks for Flammable and Combustible Liquids (ULC S630)

Shop Fabricated Steel Utility Tanks for Flammable and Combustible Liquids (ULC S643)

Aboveground Steel Contained Assemblies for Flammable and Combustible Liquids (ULC S653)

Aboveground Protected Tank Assemblies for Flammable and Combustible Liquids (ULC S655)

Secondary Containment for Aboveground Flammable and Combustible Liquid Storage Tanks (ULC/ORD C142.20)

Aboveground Steel Tanks for Fuel Oil and Lubrication Oil (ULC S602)

SwRI Publications

Testing Requirements for Protected Aboveground Flammable Liquid/Fuel Storage Tanks (93-01)

Testing Requirements for Fire Resistant Aboveground Flammable Liquid/Fuel Storage Tanks (94-01)

API Publications

Shop Welded Tanks for Storage of Production Liquids (API 12F)

Setting, Maintenance, Inspection, Operation, and Repair of Tanks in Production Service (RP 12R1)

Inspection of Atmospheric & Low Pressure Storage Tanks (RP 575)

Fitness-For-Service (RP 579)

Welded Steel Tanks for Oil Storage (API Standard 650)

Lining of Aboveground Storage Tank Bottoms (API 652)

Tank Inspection, Repair, Alteration, and Reconstruction (API Standard 653)

PEI Publications

Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling (PEI/RP 200-99)

Recommended Practices for Installation and Testing of Vapor Recovery Systems at Vehicle Fueling Sites (PEI/RP 300-97)

Steel Tank Institute

F921® Standard for Aboveground Tanks with Integral Secondary Containment

Standard for Fire Resistant Tanks (Flameshield™)

Standard for Fireguard® Thermally Insulated Aboveground Storage Tanks

F911 Standard for Diked Aboveground Storage Tanks

Installation Instructions for Shop Fabricated Aboveground Storage Tanks for Flammable, Combustible Liquids (R912-00)

Standard for Inspection of In-Service Shop Fabricated Aboveground Tanks for Storage of Combustible and Flammable Liquids (SP001-00)

RP for External Corrosion Protection of Shop Fabricated Storage Tank Floors (RP 893-89)

Canadian Petroleum Products Institute

Contact the following organizations for access to their publications:

American Petroleum Institute
1220 L Street, Northwest
Washington, DC 20005-4070
202-682-8000
www.api.org

Petroleum Equipment Institute
6514 E 69th St.
Tulsa, OK 74133-1719
918-494-9696
www.peinet.org

Steel Tank Institute
570 Oakwood Road
Lake Zurich, IL 60047
847-438-8265
www.steeltank.com

Underwriters Laboratories
333 Pfingsten Road
Northbrook, IL 60062-2096
847-272-8800
www.ul.com

Underwriters Laboratories of Canada
7 Crouse Road.
Scarborough, Ontario, Canada
416-757-3611
www.ulc.ca

Southwest Research Inst.
8220 Culebra Road
San Antonio, TX 78228
210-684-5111
www.swri.org

National Fire Protection Agency
1 Batterymarch Park
Quincy, MA 02269-9101
800-344-3555
www.nfpa.org

International Code Council
5203 Leesburg Pike, Suite 600
Falls Church, VA 22041
703-931-4533
www.intlcode.org

Uniform Fire Code Association
1260 Lake Blvd. Suite 250
Davis, CA 95616
530-757-1456
www.ufca.net

Canadian Petroleum Products Institute
www.cppi.ca