

UL 58

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Steel Underground Tanks for Flammable and Combustible Liquids

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UL Standard for Safety
for
Steel Underground Tanks for Flammable and Combustible Liquids, UL 58

Ninth Edition, Dated December 13, 1996

Revisions: This Standard contains revisions through and including July 27, 1998.

UL is in the process of converting its Standards for Safety to the Standard Generalized Markup Language (SGML). SGML -- an international standard (ISO 8879 - 1986) -- is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on the page. Significant benefits that will result from UL's use of SGML are increased productivity and reduced turnaround times, and data and information consistency, reusability, shareability, and portability. The changes noted in these revised pages are needed to modify the format and layout of this Standard to allow it to be converted to SGML. These editorial changes are now in effect.

Announcement Bulletin: This Standard contains the announcement bulletin dated July 3, 1997. The announcement bulletin is located at the end of the Standard.

A change is indicated by a note following the affected item. The note is preceded and followed by an asterisk.

As indicated on the title page (page 1), this UL Standard for Safety has been adopted by the Department of Defense.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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This Standard consists of pages dated as shown in the following checklist:

Page	Date
tr1 – tr4	July 27, 1998
1	December 13, 1996 (Reprinted: July 27, 1998)
2 – 6	December 13, 1996
7	November 3, 1997
8	December 13, 1996
9	November 3, 1997
10 – 14	December 13, 1996
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17 – 26	December 13, 1996
27	December 12, 1997
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DECEMBER 13, 1996

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UL 58

Standard for

Steel Underground Tanks for Flammable and Combustible Liquids

The First through Third editions were titled Construction and Performance of Underground Storage Tanks.

The Fourth edition was titled Underground Storage Tanks.

First Edition – October, 1925

Second Edition – September, 1929

Third Edition – February, 1937

Fourth Edition – April, 1949

Fifth Edition – December, 1961

Sixth Edition – December, 1971

Seventh Edition – October, 1976

Eighth Edition – April, 15, 1986

Ninth Edition

December 13, 1996

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

The Department of Defense (DoD) has adopted UL 58 on January 21, 1992. The publication of revised pages or a new edition of this standard will not invalidate the DoD adoption.

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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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.

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INTRODUCTION

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 requirements cover single wall tanks, secondary containment tanks, multiple compartment single wall and multiple compartment secondary containment tanks.

1.3 These tanks are intended for installation and use in accordance with the Standard for the Installation of Oil-Burning Equipment, NFPA 31, the Flammable and Combustible Liquids Code, NFPA 30, the Automotive and Marine Service Station Code, NFPA 30A, and the Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37, and the Uniform Fire Code, published by the International Fire Code Institute.

1.4 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.

1.5 These requirements do not apply to tanks covered by the Standard for Welded Steel Tanks for Oil Storage, API 650, nor tanks intended for use in chemical and petrochemical plants.

1.6 This Standard does not cover corrosion protection which may be required by local, state or federal authorities. Corrosion protection systems installed at the factory on carbon steel underground storage tanks are covered in UL 1746, External Corrosion Protection System for Steel Underground Storage Tanks.

1.7 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Units of measurements

2.1.1 When a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

2.2 Components

2.2.1 Except as indicated in 2.2.2, a component of a product covered by this standard shall comply with the requirements for that component.

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2.2.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.2.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

2.2.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

3.1 For the purpose of this standard, the following definitions apply.

3.2 TYPE I TANK – A primary tank wrapped by an exterior steel shell that is in direct contact with the primary tank; where, the exterior shell is wrapped from 300 to 360 degrees of the primary tank circumference.

3.3 TYPE II TANK – An outer tank physically separated from the inner primary containment tank by standoffs; where, the inner tank is completely contained within the outer tank.

CONSTRUCTION

ALL TANKS

4 Capacities and Dimensions

4.1 Capacities, dimensions, and construction details shall comply with the applicable requirements of this standard.

4.2 Tables 1 and 2 of Appendix A 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. For a compartment tank, the total tank capacity is the sum of the capacity of each compartment.

4.3 The total capacity of a tank shall not be:

- a) less than the rated nominal capacity and
- b) more than 105 percent of the rated nominal capacity.

4.4 The total capacity is to be determined at the level of the lowest opening when the tank is in the intended installation position.

4.5 The overall length of a tank shall not be greater than 8 times its diameter.

4.5 revised November 3, 1997

5 Steel Thickness

5.1 General

5.1.1 Tanks shall comply with the Roark Equation or the External Pressure Test described in 18.1.

5.1.1 effective September 30, 1997

5.1.2 The minimum steel shell thickness for a primary tank is 0.123 inches (3.12 mm). The minimum steel shell thickness for a secondary tank is 0.093 inches (2.36 mm).

5.1.2 effective September 30, 1997

5.1.3 The minimum head thicknesses for all tanks, except the outer head of Type I tanks, are noted in Table 5.1. The minimum head thicknesses for the outer head of Type I tanks are noted in Table 5.2.

5.1.3 effective September 30, 1997

5.1.4 When the external pressure test, described in 18.1 is conducted successfully, the minimum steel thickness for the shell is reduced 25% from the calculated value using the Roark equation for the same length and diameter tanks.

Exception: Tanks with a length to diameter ratio exceeding 6 to 1 shall not have reductions in the shell thickness.

5.1.4 revised November 3, 1997

Table 5.1
Tank head thickness

Tank diameter,		Minimum head thickness,	
Inches	m	Inches	mm
Up to 64	Up to 1.62	.123	3.12
64.1 to 90	1.63 to 2.28	.167	4.24
90.1 to 126	2.29 to 3.20	.240	6.10
126.1 to 144	3.20 to 3.66	.302	7.67

Table 5.1 effective September 30, 1997

Table 5.2
Type I tank outer head thickness

Tank Diameter		Minimum Head Thickness	
Inches	m	Inches	mm
Up to 64	Up to 1.62	0.123	(3.12)
64.1 to 96	1.63 to 2.44	0.167	(4.24)
96.1 to 144	2.45 to 3.66	0.240	(6.10)

Table 5.2 effective September 30, 1997

5.2 Roark equation

5.2.1 The calculated pressure from the Roark equation shall be equal to or greater than the external pressure at the bottom of the tank surrounded by only water and submerged 5 feet (1.52 m) or at a depth equal to the manufacturer's specified maximum burial depth, whichever is greater. The buckling pressure shall be calculated using the following equation:

$$\text{Roark equation: } P = \left[.807 E_s t_s^2 / (Lr) \right] [(1 - u^2)^{-3} (t_s / r)^2]^{.25}$$

in which:

P is buckling pressure, psi

E_s is modulus of elasticity of steel (29.5×10^6 psi for structural grade A36 carbon steel)

t_s is thickness of steel tank shell (inches)

L is length of tank (inches)

r is radius of tank (inches), and

u is Poisson's Ration (0.287 for structural grade A36 carbon steel)

Reference: Roark's Formulas for Stress and Strain, 6th Edition, Warren Young, Table 35, Case 19b, Page 690
5.2.1 effective September 30, 1997

5.2.2 Using the Roark formula, minimum steel shell thickness ($t_{s \min}$) or the maximum tank length ($L_{\max}$) can be calculated using the following equations, respectively:

$$t_{s \min} = [(P_1 L r^{3/2} (1 - u^2)^{3/4}) / (.807 E_s)]^{.4}$$

$$L_{\max} = [.807 E_s t_s^2 / P_1 r] [(1 - u^2)^{-3} (t_s / r)^2]^{.25}$$

in which:

P_1 is calculated external pressure at the bottom of a submerged tank in water, psi. The water depth equals 5 feet (1.52 m) or the maximum burial depth for the tank, whichever is greater, plus the tank diameter.

E_s is Modulus of Elasticity of steel, (29.5×10^6 psi for structural grade A36 carbon steel),

t_s is thickness of steel tank shell (inches),

L is length of tank (inches),

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r is radius of tank (inches), and

u is Poisson's Ratio (0.287 for structural grade A36 carbon steel)

Note – Values for " E_s " and " u " for other than A36 structural grade carbon steel shall be from recognized technical reference books or established by an engineering evaluation of the material.

5.2.2 effective September 30, 1997

5.2.3 The equivalent steel thickness (t_{eq}) for a Type I double wall steel tank is $(t_{inner}^{2.5} + t_{outer}^{2.5})^{.4}$. This value is substituted into Roark's Equation.

5.2.3 effective September 30, 1997

5.2.4 The steel thickness for the inner and outer walls of a Type II tank is calculated independently using Roark's Equation.

5.2.4 effective September 30, 1997

5.3 Stiffeners

5.3.1 With the addition of one stiffener to the midpoint of a tank, the tank length can be increased 25%. When two stiffeners are placed at the 1/3 and 2/3 positions of a tank, the tank length can be increased 40%. With reference to 4.5, the overall length of a tank shall not be greater than 8 times its diameter. Other arrangements of stiffeners shall require an engineering evaluation. The thickness for the shell shall not be less than that specified by the Roark Equation for any tank with a length to diameter ratio exceeding 6 to 1.

5.3.1 revised November 3, 1997

5.3.2 Stiffeners shall be intermittently welded with 1 inch (25.4 mm) spots, not over 12 inches (304.8 mm) apart, and extend 360 degrees around the tank. The stiffeners shall have an opening at the top and bottom so that liquid and vapor can move past the stiffeners.

5.3.2 effective September 30, 1997

5.3.3 The required moment of inertia (I_{req}) of the stiffener is described below:

$$I_{req} = (0.11 PL D^3) / E_s \text{ in}^4$$

in which:

P is calculated external pressure at the bottom of a submerged tank in water. The water depth equals 5 feet (1.52 m) or the maximum burial depth for the tank, whichever is greater, plus the tank diameter. psi

L is rib spacing (inches)

D is outer diameter of tank (inches), and

E_s is modulus of steel (29.5×10^6 psi for structural grade A36 carbon steel)

The moment of inertia of the stiffener shall be verified from tables or calculations from recognized technical reference books, or the tank with stiffeners shall be subjected to the External Pressure Test, Section 18.

5.3.3 effective September 30, 1997