

UL 1746

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External Corrosion Protection Systems for Steel Underground Storage Tanks

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UL Standard for Safety for External Corrosion Protection Systems for Steel Underground Storage Tanks,
UL 1746

Third Edition, Dated January 17, 2007

SUMMARY OF TOPICS

This new edition of UL 1746 is being issued to:

- 1) Add polyurethane, polyurea to the construction materials list for jacketed systems.*
- 2) Add increased internal fluid exposure times for the Resistance to External and Internal Fluids Test for jacketed type tanks constructed of polyurethane and polyurea materials.*
- 3) Revise the construction requirements to clarify the current requirements and eliminate potential inconsistencies between UL 58 and UL 1746 by deleting duplicate requirements.*
- 4) Include requirements for heating coils and hot wells.*
- 5) Add an Indentation Test to the Part IV – Coated Tank requirements.*
- 6) Revise the test potential for the Holiday Tests.*
- 7) Clarify the test acceptance criteria for the Tank Examination and Holiday Tests for jacketed type tanks.*
- 8) Revise the Manufacturing and Production Leakage Test.*
- 9) Replace the term “clad” with the term “coated”.*
- 10) Clarify the test methods that use the solutions listed in Tables 21.1, 25.1, and 28.3 by revising the title.*
- 11) Delete the term “base” from the term “base tank”.*
- 12) For composite and coated type tanks revise the Permeance/Cladding Dissolution Test title to Permeation/Coating Dissolution Test and correct the references to these tests.*
- 13) For the permeation dissolution testing for jacketed type tanks provide consistent references to the Permeation/Jacket Dissolution Test.*
- 14) Revise the terminology in the standard to indicate a steel tank protected by cathodes is a cathodically protected tank.*
- 15) Add the number of locations that the thickness of a composite material is to be measured during the Permeation/Coating Dissolution Test for composite type tanks.*
- 16) Update the standard references due to the withdrawal and replacement of standards.*

17) Delete the edition information from some document references.

18) Editorial revisions.

The following table lists the future effective dates with the corresponding item.

Future Effective Date	References
January 17, 2009	Sections 4, 5, 6, 7, 8, 9, 10; Paragraphs 11.1.1, 16.2.1, 16.2.3, 16.3.4, 16.6.2, 16.7.1, 17.1.1, 17.6.2, 18.6.1, 20.3.1, 20.5.2, 22.7.2, 22.8.1, 24.2.3, 24.2.4, 24.4.2, 26.7.1, 26.10.1, 28.2.1, 28.9.2, 28.13.1, 28.13.2, 28.13.3, 29.7.2, 32.1; Tables 20.2, 22.1, 24.3, 28.2, 29.1

The new and/or revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated December 17, 2005 and September 22, 2006. The bulletin(s) is now obsolete and may be discarded.

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1



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Underground Storage Tanks

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January 17, 2007

The most recent designation of ANSI/UL 1746 as an American National Standard (ANSI) occurred on January 17, 2007. The ANSI approval for this standard does not include the cover page, transmittal pages or the title page.

This ANSI/UL Standard for Safety, which consists of the Third Edition is under continuous maintenance, whereby each revision is ANSI approved upon publication.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc. and is not part of the ANSI standard.

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. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover preengineered corrosion protection systems. Part I covers factory-installed galvanic-type cathodic protection. Part II covers factory assembled composite systems. Part III covers factory assembled jacket systems. Part IV covers factory assembled coated systems.

1.2 These corrosion protection systems are intended to be completely installed at the factory on carbon steel underground storage tanks.

1.3 Part II of this standard covers fiberglass reinforced plastic (FRP), materials only. Part III of this standard covers FRP, polyurethane, polyurea and high density polyethylene (HDPE) materials only. Part IV covers polyurethane materials only.

1.4 These corrosion protection systems are intended to be installed, operated and maintained in accordance with the manufacturer's instructions.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.1.2 A component is not required to comply with a specific requirement that:

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

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

2.1.4 Specific components are 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.

2.2 Units of measurements

2.2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

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.

2.4 Terminology

2.4.1 In the following text, a requirement that applies only to a particular type of tank is so identified by a specific reference in that requirement to the type or types of tank involved. Absence of such specific reference or use of the term “tank” indicates that the requirement applies to all underground storage tanks unless indicated otherwise.

3 Glossary

3.1 CATHODICALLY PROTECTED TANK – A steel tank with a preengineered, factory installed galvanic type cathodic protection system which provides corrosion protection.

3.2 COMPOSITE TANK – A steel tank with a non metallic external coating bonded to the steel tank which provides for protection against corrosion.

3.3 HOLIDAY – A small fault or pin hole that results in current drainage through the dielectric coating when evaluated.

3.4 JACKETED TANK – A steel primary tank completely contained within a non metallic external tank jacket which provides both secondary containment and corrosion protection. The non metallic jacket is wrapped 360° circumference on the primary steel tank and forms an interstitial (annular) space which is monitored for leakage.

3.5 COATED TANKS – A steel tank with a minimum nonmetallic 0.070 inch (1.8 mm) thick external coating which provides protection against external corrosion.

3.6 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.

3.7 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

4 General

4 effective January 17, 2009

4.1 The construction and assembly of an external corrosion protection system shall be evaluated based on its intended application on the outside of a steel tank and use in underground flammable liquid storage systems.

4.2 Only new materials and components shall be used in the fabrication of external corrosion protection systems described in the applicable parts of this Standard.

4.3 All tanks and integral accessories or components to which the external corrosion protection system is applied shall be designed and built in accordance with the Standard for Steel Underground Tanks for Flammable and Combustible Liquids, UL 58.

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

4.5 The addition of the external corrosion protection system to the tank shall not be taken into account for measuring or calculation purposes, or revised for rating or marking purposes for compliance with capacity and dimension requirements per Capacity and Dimensions, Section 4, in the Standard for Steel Underground Tanks for Flammable and Combustible Liquids, UL 58.

4.6 Any opening shall not be blocked or covered by the external corrosion protection system.

5 Compartments

5 effective January 17, 2009

5.1 All tanks with compartments shall comply with Compartment Tanks, Section 13, in the Standard for Steel Underground Tanks for Flammable and Combustible Liquids, UL 58.

6 Pipe Connections

6 effective January 17, 2009

6.1 All tank pipe connections shall comply with Pipe Connections, Section 10, in the Standard for Steel Underground Tanks for Flammable and Combustible Liquids, UL 58 and shall be provided with external corrosion protection on all surfaces subject to soil exposure in expected use in accordance with one of the systems described in this Standard.

7 Manways

7 effective January 17, 2009

7.1 All tank manways shall comply with Manways, Section 11, in the Standard for Steel Underground Tanks for Flammable and Combustible Liquids, UL 58 and shall be provided with external corrosion protection on all surfaces subject to soil exposure in expected use in accordance with one of the systems described in this Standard.

8 Striker Plates

8 effective January 17, 2009

8.1 All tanks with striker plates shall comply with Striker Plates, Section 12, in the Standard for Steel Underground Tanks for Flammable and Combustible Liquids, UL 58. Any identification markings around marked striker plate openings shall be replaced with identical language after the external corrosion protection system is applied.

9 Heating Coils and Hot Wells

9 effective January 17, 2009

9.1 Heating coils or hot wells that are provided with the tank assembly that handles a fluid other than that stored in the tank, such as hot water, shall be evaluated for the identified system temperature and pressure, shall be compatible with the identified system fluids, and shall have no joints in the portion of coil or well located within the tank unless continuously seal welded or brazed.

9.2 The inlet and outlet connections of a heating coil or hot well shall be sealed through a steel manway cover by:

- a) Continuous welding,
- b) A threaded connection, or
- c) A flanged connection.

10 Tank Accessories, Components, and Special Constructions

10 effective January 17, 2009

10.1 All tank accessories or components shall comply with Tank Accessories, Components, and Special Constructions, Section 16, in the Standard for Steel Underground Tanks for Flammable and Combustible Liquids, UL 58 and shall be provided with external corrosion protection on all surfaces subject to soil exposure in expected use in accordance with one of the systems described in this Standard.

PART I – PREENGINEERED CATHODIC PROTECTION SYSTEMS

CONSTRUCTION

11 Components

11.1 Galvanic anodes

11.1.1 A galvanic anode for use in a cathodic protection system shall be one of the following:

- a) High-purity zinc anode with the composition specified in Table 11.1 and complying with ASTM B418 (Type II), Standard Specification for Cast and Wrought Galvanic Zinc Anodes, or
- b) Magnesium anode with one of the compositions specified in Table 11.2.

11.1.1 effective January 17, 2009

Table 11.1
Zinc anodes

Element	Percent Composition
Aluminum	0.005 maximum
Cadmium	0.003 maximum
Iron	0.0014 maximum
Zinc	Remainder

Table 11.2
Magnesium anodes

Element	Percent composition	
	Type III ^a	MG-MN Alloy ^b
Aluminum	5.3 – 6.7	0.010 maximum
Zinc	2.5 – 3.5	0.05
Manganese	0.15 minimum	0.5 – 1.30
Copper	0.02 maximum	0.02 maximum
Silicon	0.10 maximum	0.05
Iron	0.003 maximum	0.03 maximum
Nickel	0.002 maximum	0.001 maximum
Others	0.3 maximum	0.05 each or 0.3 maximum total
Magnesium	Remainder	Remainder

^a These anodes are commonly referred to as AZ-63 Type I, II, and III H1.

^b High-potential anode

11.1.2 Anodes shall be packaged in a water-permeable container and the assembly shall comply with the Anode Assembly Durability Test specified in Section 13. Anodes shall be surrounded by at least 1 inch (25.4 mm) of backfill mixture complying with the requirements of 11.2.1.

11.1.3 A cored anode shall be fabricated with a galvanized steel core situated axially within the anode.

11.1.4 A cored anode shall be provided with a No. 12 AWG Type TW or larger solid conductor copper lead wire soldered or welded to the core. The anode lead wire shall comply with the gasoline- and oil-resistance requirements of the Standard for Thermoplastic-Insulated Wires and Cables, UL 83. The lead wire-anode joint shall be insulated by filling the joint recess with an electrical potting compound.

11.1.5 A weld-on anode shall be provided with an integral weldable steel core for welding directly to the tank.

11.2 Backfill materials

11.2.1 Backfill material, used in the "bag" around the anode, shall be a low-resistivity mixture consisting of:

- a) 75 percent hydrated gypsum, 20 percent bentonite, and 5 percent anhydrous sodium sulfate by weight; or
- b) An equivalent mixture that provides a backfill resistivity of 50 ohm-cm or less and which provides equivalent resistance to anode passivation.

11.3 Insulating devices (bushings and gaskets)

11.3.1 Insulating devices shall be fabricated of nonconductive materials and shall comply with Section 17, Tests for Insulating Devices (Bushings and Gaskets). These insulating devices shall electrically isolate the tank from attached piping.

11.4 Dielectric coatings test

11.4.1 Dielectric coatings shall comply with the requirements in Section 16, Dielectric Coatings.

11.5 Pressure wire connectors

11.5.1 The clamping movement of a connector shall be constructed in such a manner that it is capable of accepting a wire size of at least No. 12 AWG (3.3 mm²).

11.5.2 Examples of clamping means include:

- a) A screw with or without a pressure plate.
- b) Deformation of the connector barrel (crimping) using a special tool, or
- c) A nut threaded onto a split screw.

11.5.3 There shall be no sharp edges or corners on the outer edge of a connector.

11.5.4 A pressure wire connector shall comply with the Pullout Test specified in Section 14.

11.6 Test station provision

11.6.1 Each tank fitted with a preengineered cathodic protection system shall be provided with a factory installed test lead or pressure wire connector welded to the tank heads or upper 3/4 portion of the tank shell, for connection to a test station. The connector shall comply with the requirements in Section 14, Torque and Pullout Tests for Pressure Wire Connectors.

12 Cathodic Protection System Assembly

12.1 General

12.1.1 Preengineered cathodic protection system shall consist of the following components:

- a) Dielectric coating
- b) Electrical insulating devices (bushings and gaskets)
- c) Galvanic anodes
- d) Test station provision

12.1.2 Cathodic protection systems shall be constructed to provide a minimum system design based upon a 4000 ohm-cm soil resistivity.

12.2 Dielectric coatings

12.2.1 Dielectric coatings shall be applied to all exposed exterior tank surfaces, including attachments such as anode holders and attachment lugs. Crevices into which the coating does not penetrate or is not properly bonded shall be seal-welded prior to application of the coating.

12.3 Electrical isolation devices

12.3.1 All tank openings shall be supplied with electrical insulating devices (bushings or gaskets) installed prior to shipment.

12.3.2 Tank openings and insulating devices shall be closed with a wooden plug, metal cover, or equivalent to protect the threads or flange and gasket face from damage and to exclude foreign material while the tank is in storage or transit.

12.4 Galvanic anodes

12.4.1 The effective coverage radius of galvanic anodes as used in this standard shall be 17 feet (5.2 m). Therefore, tanks greater than 34 feet (10.4 m) long require both head- and shell-mounted anode assemblies.

12.4.2 A minimum of two anodes shall be installed on each tank. Anodes shall be mounted a distance of one-sixth the tank diameter from the tank bottom. Multiple head-mounted anodes shall be centered about this location.

Exception: Shell-mounted anodes shall not be mounted in other positions when required for shipping purposes unless they are mounted below the diametrical midpoint of the tank.

12.4.3 Anodes shall be located so as to distribute the anode system current uniformly about the length of the tank. When the tank length is 34 feet (10.4 m) or less, anodes shall be equally distributed on each head of the tank. When the tank length is greater than 34 feet (10.4 m), anodes shall be equally distributed on the tank heads and shell.

12.4.4 Galvanic anode requirements for each tank are to be calculated in accordance with the method specified in 12.4.5 – 12.4.8, or by a method shown to be equivalent by test or derivation.

12.4.5 The sum of the available anode current for the individual anode shall be equal to or greater than the total system current requirements. The total system current requirement is to be calculated as follows:

$$I = 0.025 \times 10^{-3} \frac{\text{amperes}}{\text{ft}^2} \times A$$

in which:

I = total system current requirement, amperes

A = total tank exterior surface area including welded-on attachments, square feet

12.4.6 The resistance of galvanic anodes in soil shall be calculated by the following equation:

$$R = \frac{250.4 \times (\ln(4 \times L/r) - 1)}{L}$$

in which:

R = anode resistance, ohms

L = anode length, inches

r = equivalent radius, inches = radius of cylindrical anodes, or square root (*A*/π) for noncylindrical anodes

A = cross-sectional area of anode, square inches

12.4.7 Available galvanic anode current shall be calculated on the basis of anode-cathode driving potential and the resistance of the anode in soil as follows:

$$i = \frac{EC - EA}{R}$$

in which:

i = available anode current, amperes

EC = cathode solution potential, volts = minus 0.85 volts

EA = anode solution potential, volts as specified in Table 12.1

R = anode resistance, ohms

12.4.8 The galvanic anode weight shall be greater than the value determined by the following equation:

$$W = \frac{262,800 \times i}{C \times N \times U}$$

in which:

W = minimum required anode weight, pounds

i = available anode current, amperes

See Table 12.1 for definition and values of C, N, and U.

Table 12.1
Anode data

Item	Anode type		
	Zinc	Magnesium	
		AZ-63	Mg-Mn
C	372	1000	1000
N	0.9	0.50	0.50
U	0.85	0.85	0.85
EA	-1.1	-1.55	-1.73
C – Anode energy capability, ampere-hours per pound. N – Anode efficiency. U – Anode utilization factor. EA – Anode solution potential, volts.			

12.4.9 The lead wire of cored anodes shall be: thermite-welded; brazed or; mechanically fastened to the tank using a weldable steel pressure wire connector complying with the requirements of Section 14, Torque and Pullout Tests for Pressure Wire Connectors. Prior to connecting the lead wire or pressure connector to the tank, the weld area is to be cleaned by scraping or an equivalent method. Anodes shall be installed with a loop consisting of at least 8 inches (203 mm) of free wire to provide strain relief.

12.4.10 Cored anodes shall be secured to the tank by means of anode holder assemblies complying with Section 13, Anode Pull and Durability Test.

12.4.11 Wire connectors and any exposed bare lead wire conductor shall be covered with insulating tape complying with the requirements for weather resistant insulating tape as described in the Standard for Insulating Tape, UL 510, or equivalent means.

12.4.12 Weld-on anodes shall be seal-welded directly to the tank. Weld-on anodes shall be installed with a gap of at least 2 inches (50.8 mm) between the anode and the tank.