# UL 2225

## STANDARD FOR SAFETY

Cables and Cable-Fittings For Use In Hazardous (Classified) Locations

UL Standard for Safety for Cables and Cable-Fittings For Use In Hazardous (Classified) Locations, UL 2225

Fourth Edition, Dated September 30, 2013

***Summary of Topics***

***This revision to ANSI/UL 2225 dated April 11, 2022 includes the following changes in requirements:***

***– Revision to Correct Cable Type from ITC-ER-HL to ITC-HL in Clause 10.2 Flame Test.***

***– Revision to delete Rust Resistance Test Requirements in Clause 18.2.***

***– Revisions to Testing Requirements in Clause 14.1 and Section 23; 23.3, Table 23.1, 23.15A, 23.15B, 23.16, 23.17, and Table 23.4.***

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated October 15, 2021 and February 25, 2022.

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**ANSI/UL 2225-2022**



# UL 2225

## Standard for Cables and Cable-Fittings For Use In Hazardous (Classified) Locations

First Edition – July, 1996
Second Edition – December, 2005
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**Fourth Edition**

**September 30, 2013**

This ANSI/UL Standard for Safety consists of the Fourth edition including revisions through April 11, 2022.

The most recent designation of ANSI/UL 2225 as an American National Standard (ANSI) occurred on April 11, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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 https://csds.ul.com.

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The following people served as members of STP 60079 and participated in the review of this standard:

| NAME | COMPANY |
|---|---|
| *B. Zimmermann, Chair | R Stahl Inc. |
| *T. Adam | FM Approvals LLC |
| R. Allen | Honeywell International Inc. |
| F. AlSahan | Saudi Aramco |
| J. Anderson | Thermon Inc. |
| D. Ankele | UL LLC |
| P. Becker | nVent |
| S. Blais | Emerson/Appleton Group |
| K. Boegli | KBB Consulting |
| R. Brownlee | Pepperl + Fuchs Inc. |
| D. Burns | Shell P&T – Innovation / R&D |
| *J. Chambers | UL LLC |
| R. Chalmers | Industrial Scientific Corp. |
| *C. Coache | National Fire Protection Association |
| *M. Cole | Hubbell Canada LP |
| M. Coppler | LabTest Certification Inc. |
| *R. Deadman | UL LLC |
| *K. Dhillon | LabTest Certification Inc. |
| M. Dona | Beach Energy |
| S. Dormann | TUV SUD |
| T. Dubaniewicz | NIOSH |
| G. Edwards | Det-Tronics |
| M. Egloff | Montana Tech, University of Montana |
| M. Ehrmann | R Stahl Inc |
| D. El Tawy | Siemens Energy |
| A. Engler | Det Norske Veritas DNV |
| M. Fillip | National Oilwell Varco |
| W. Fiske | Intertek |
| Z. Fosse | DEKRA Certification Inc |
| G. Gurinder | Gurinder Garcha Consulting |
| D. Grady | Talema Group |
| J. Hickle | Caterpillar Inc. |
| R. Holub | DuPont |
| E. Hong | Solar Turbines Inc. |
| *B. Johnson | Thermon Mfg. Co. |
| R. Johnson | Source IEC |
| B. Keane | INNIO Waukesha Gas Engines |
| *P. Kelly | UL LLC |
| S. Kiddle | ABB Inc |

| NAME | COMPANY |
|---|---|
| *M. Kornitsky | FM Approvals LLC |
| S. Lambaz | Littelfuse Inc. |
| W. Lawrence | FM Approvals LLC |
| E. Leubner | Eaton's Crouse-Hinds Business |
| W. Lockhart | GE Gas Power |
| W. Lowers | WCL Corp. |
| *N. Ludlam | FM Approvals Ltd. |
| M. Marrington | Index |
| R. Martin | USCG |
| E. Massey | L E Massey |
| T. Michalski | Killark Electric Mfg. Co. |
| B. Miller | Mettler-Toledo LLC |
| *J. Miller | MSA Innovation LLC |
| N. Minquez | Proyelco |
| *O. Murphy | Honeywell International Inc. |
| D. Nedorostek | Bureau of Safety & Environmental Enforcement (BSEE) |
| A. Page | Bud Page |
| R. Parks | National Instruments Corp. |
| L. Ricks | ExVeritas North America LLC |
| P. Rigling | MTL – Eaton Electric Ltd. |
| *K. Robinson | Occupational Safety and Health Adm. |
| J. Ruggieri | General Machine Corp. |
| J. Scheller | ABB Motor and Mechanical Inc. |
| P. Schimmoeller | CSA Group |
| *T. Schnaare | Rosemount Inc. |
| R. Seitz | ARTECH Engineering |
| S. Sharma | Lindsay Corp. |
| J. Silliman | 3M |
| K. Singh | Ex Safet Services and Solutions |
| G. Sitnik | QPS America Inc. |
| J. Smith | SGS |
| G. Steinman | ABB Installation Products Inc. |
| *R. Teather | Det Norske Veritas Certification Inc. |
| L. Vlagea | General Monitors |
| D. Wechsler | American Chemistry Council |
| N. Wienhold | Rosemount Inc. |
| R. Wigg | E-x Solutions International Pty Ltd. |
| *K. Wolf | Intertek |
| T. Woods | Bently Nevada |
| F. Young | Pinnacle Forensics |
| R. Zalosh | Firexplo |

* Non-voting member

## INTRODUCTION

### 1 Scope

1.1 These requirements cover Type MC-HL metal-clad cable for use in hazardous (classified) locations, Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Zone 1, Groups IIA, IIB, and IIC; and Zone 20, 21, and 22, Groups IIIA, IIIB and IIIC in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements cover Type ITC-HL instrumentation tray cable for use in hazardous (classified) locations, Class I, Division 1, Groups A, B, C, and D, and Zone 1, Groups IIA, IIB, and IIC; and Zone 20, 21, and 22, Groups IIIA, IIIB and IIIC in accordance with the National Electrical Code, NFPA 70.

1.3 These requirements cover Type TC-ER-HL tray cable for use in hazardous (classified) locations, Class I, Division 1, Groups A, B, C, and D, Zone 1, Groups IIA, IIB, and IIC in accordance with the National Electrical Code, NFPA 70.

1.4 These requirements cover explosionproof and dust-ignitionproof cable sealing fittings for use in hazardous (classified) locations, Class I, Division 1 and 2, Groups A, B, C, and D; Class II, Division 1 and 2, Groups E, F, and G in accordance with the National Electrical Code, NFPA 70.

1.5 These requirements cover explosionproof and dust-ignitionproof cable sealing fittings for Type P cable intended for use on mobile offshore oil rigs and drilling platforms, and other marine vessels, and for use on land-based gas and oil mobile drilling rigs in accordance with the National Electrical Code, NFPA 70-2020. For offshore installations, investigations of these fittings include an evaluation for conformity to the installation and use provisions of Title 46 Code of Federal Regulations Sub-part 111.105 and Subpart 111.60 of the United States Coast Guard Electrical Engineering Regulations, Subchapter J (Parts 110 to 113 inclusive) as applied by the authority having jurisdiction.

1.6 These requirements cover increased safety "e" cable fittings and flameproof "d" cable sealing fittings for use in Zone 1 Groups IIA, IIB and IIC hazardous (classified) locations, in accordance with the National Electrical Code, NFPA 70.

1.7 These requirements cover increased safety "e" cable fittings and flameproof "d" cable sealing fittings for use in hazardous (classified) locations, Zone 1 for use on mobile offshore oil rigs and drilling platforms, and other marine vessels. Investigations of these fittings include an evaluation for conformity to the installation and use provisions of Title 46 Code of Federal Regulations Sub-part 111.105 and Subpart 111.60 of the United States Coast Guard Electrical Engineering Regulations, Subchapter J (Parts 110 to 113 inclusive) as applied by the authority having jurisdiction.

1.8 These requirements cover increased safety "e" cord connectors and flameproof "d" cord connectors for use only with extra-hard usage cord in hazardous (classified) locations, Zone 1 in accordance with the National Electrical Code, NFPA 70.

1.9 These requirements cover dust ignition protection by enclosure "t" and "tD" cable fittings for use in Zone 20, 21, and 22, Groups IIIA, IIIB and IIIC hazardous (classified) locations in accordance with the National Electrical Code, NFPA 70.

1.10 These requirements cover dust ignition protection by enclosure "t" and "tD" extra-hard usage cord connectors for use in Zone 20, 21, and 22, Groups IIIA, IIIB and IIIC in accordance with the National Electrical Code, NFPA 70.

1.11 These requirements apply to cables, cable fittings and cord connectors for hazardous locations under the following atmospheric conditions:

a) A minimum ambient temperature of minus 60°C (minus 76°F);

b) An oxygen concentration of not greater than 21 percent by volume; and

c) A nominal barometric pressure of one atmosphere.

## 2 Units of Measurement

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

## 3 Undated References

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.

## 4 Glossary

4.1 The following definitions apply in this standard.

4.2 DUST-IGNITIONPROOF CABLE SEALING FITTING – A cable sealing fitting capable of meeting the requirements for dust-ignitionproof construction and performance as given in this standard.

4.3 DUST-IGNITION-PROTECTION BY ENCLOSURE FITTING – A cable or cord fitting capable of meeting the requirements for dust-ignition-protection by enclosure construction and performance as given in this standard for use in Zone 21 or Zone 22 locations.

4.4 EXPLOSIONPROOF CABLE SEALING FITTING – A device or combination of devices intended to provide a means of entry of a cable into a hazardous location explosionproof enclosure and which also provides strain relief and provides required sealing characteristics, either by an integral means or when combined with a separate sealing fitting for use in Class I, Division 1 or Division 2 locations.

4.5 FLAMEPROOF CABLE SEALING FITTING – A cable or cord sealing fitting capable of meeting the requirements for flameproof construction and performance as given in this standard for use in Zone 1 or Zone 2 locations.

4.6 INCREASED SAFETY CABLE FITTING – A cable or cord fitting capable of meeting the requirements for increased safety construction and performance as given in this standard for use in Zone 1 or Zone 2 locations.

4.7 SEALING CHARACTERISTICS – Those characteristics necessary to minimize the migration of gases through the seal and to prevent the propagation of flame from enclosures required to be explosionproof, and/or exclude hazardous dusts or readily ignitable fibers from an enclosure required to be dust-ignitionproof.

# PART I – CABLES

## CONSTRUCTION

## 5 General

5.1 Type MC-HL, ITC-HL and TC-ER-HL cables shall comply with all construction and test requirements in the Standard for Metal-Clad Cables, UL 1569, the Standard for Instrumentation Tray Cable, UL 2250 or

the Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, UL 1277, as applicable, except where modified by this standard.

5.2 *Deleted*

5.3 Type MC-HL and Type ITC-HL cables shall have the following construction features:

a) A gas/vapor tight continuous corrugated metallic sheath; and

b) An overall jacket of polymeric material.

c) Type MC-HL cable shall have separate grounding conductors.

5.4 Type TC-ER-HL cable shall have the additional following construction features:

a) Conductor insulation rating of 600 volts nominal; and

b) *Deleted*

c) At least one copper equipment grounding conductor. For constructions greater than 25 mm (1 inch) overall diameter, at least one ground conductor shall be bare and a metallic shield shall be provided over all conductors within the cable, under the outer jacket.

5.5 *Deleted*

## PERFORMANCE

### 6 General

6.1 Type MC-HL, Type ITC-HL and Type TC-ER-HL cables for use in hazardous (classified) locations shall comply with all applicable performance requirements in the Standard for Metal-Clad Cables, UL 1569, or the Standard for Instrumentation Tray Cable, UL 2250, or the Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, UL 1277, as applicable and also the requirements in Sections 7 – 10 of this standard.

6.2 *Deleted*

### 7 Impact Test – Low Temperature

7.0 The Impact Test – Low Temperature for Types TC-ER-HL, MC-HL and ITC-HL shall be conducted using cables containing 3 – 14 AWG conductors. These conductors are considered representative of the performance of finished cable of the same construction in all (18 – 4/0 AWG and 250 – 1000 kcmil) sizes.

7.1 The non-metallic components of at least eight specimens of finished cable shall not crack when the nonmetallic components of 10 specimens of finished cable are tested. The test is to consist of an impact of a 3 pound (1.36 kg) mass falling through a distance of 3 feet (0.91 m) at a temperature of minus 25 ±1°C (minus 13 ±1.8°F), or at the minimum ambient rated and marked on the cable, if rated lower than minus 25°C (minus 13°F).

7.2 The 10 specimens are to be placed in an environmental chamber and maintained at the required temperature for a period of 4 hours. Immediately following this conditioning, each of the 10 specimens are to be placed on a solid supporting surface and then subjected to the impact specified in 7.1 by means of a steel head. This steel head is to have an overall diameter of 1.1 inches (28.5 mm) and is to have a flat striking surface that is 1 inch (25.4 mm) in diameter with slightly rounded edges. Flat cable is to be placed such that the major cross-sectional axis is parallel with the supporting surface.

## 8 Mechanical Damage – Impact

8.1 An Impact Test for all types shall be conducted using the requirements, including sample selection, (cable containing 3 – 14 AWG conductors and 3 – 2 AWG conductors) specified for the Impact Test in the Standard for Metal-Clad Cables, UL 1569 with the exception that the weight of the falling mass shall be 25 pounds (11.34 kg) through a distance of 1 foot (0.31 m) for the tests with the 14 AWG conductors. ITC-HL cables are to be tested only with 14 AWG conductors to represent sizes 22 to 12. ITC-HL cables are permitted to be tested with smaller conductor sizes that represent only the size tested.

## 9 Crushing Test

9.1 A Crushing Test for all cable types shall be conducted using the requirements specified for the Crushing Test – All Cable, in the Standard for Metal-Clad Cables, UL 1569, with the following modifications.

- The sample for non-ITC-HL cables shall contain 3 – 14 AWG conductors and 3 – 2 AWG conductors.

- The sample for ITC-HL cables is permitted to contain only 14 AWG conductors (to represent all sizes from 22 AWG to 12 AWG) or small conductor sizes to represent only the size tested.

- The crushing force is to be 1500 pound-force (6670 N) for the test with the 14 AWG conductors.

## 10 Flame Test

10.1 The Flame Test shall be performed in accordance with the FT4/IEEE 1202 Flame Exposure Test in the Standard for Fire-Propagation and Smoke-Release Test for Cables, UL 1685, (smoke measurements are not applicable).

10.2 For MC-HL and ITC-HL, the test specimens for the FT4/IEEE 1202 tray flame test are the smallest size (typically 14/3) [equivalent diameter for a cable that is not round is calculated as $1.1284 \times (TW)^{1/2}$, in which T is the length of the minor axis of the cable and W is the length of the major axis of the cable] cable that the manufacturer intends to produce in each construction made.

10.3 For TC-ER-HL, the results using 9-conductor 12 AWG samples are representative of the performance of finished cable of the same construction in all (18 – 4/0 AWG and 250 – 1000 kcmil) sizes.

## MARKING

## 11 General

11.1 Cables complying with the requirements of this standard shall be surface marked Type MC-HL, Type "TC-ER-HL" or Type ITC-HL as appropriate, and shall comply with all applicable marking requirements in the Standard for Metal-Clad Cables, UL 1569, the Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, UL 1277 or the Standard for Instrumentation Tray Cable, UL 2250, as applicable.

## PART II – EXPLOSIONPROOF CABLE SEALING FITTINGS AND DUST IGNITIONPROOF CABLE FITTINGS

## CONSTRUCTION

### 12 General

12.1 Explosionproof cable sealing fittings and dust igntionproof cable fittings shall comply with the applicable construction requirements in the Standard for Conduit, Tubing, and Cable Fittings, UL 514B, in addition to the construction requirements in this standard. Where requirements conflict, the requirements in this standard shall apply.

12.2 Design tolerances of the cable sealing fitting shall be considered in determining compliance with 12.1 of this standard.

12.3 The width of all joint surfaces or the length of path through or across any joint surface or opening in the cable sealing fitting, including threadless joints and threaded joints, shall be dimensionally measured for compliance with the appropriate requirements contained in 15.1 or in the Standard for Explosionproof and Dust Ignitionproof Electrical Equipment for Use in Hazardous (Classified) Locations, UL 1203, for the specific Class and Group for which the sealing fitting is intended.

12.4 All joint surfaces shall have the gap between joint surfaces examined by means of appropriate measuring tools. The gap between the joint surfaces shall not exceed the dimensions specified in 15.1 or the requirements for Class I Joints in Enclosures or the Alternative Joints in Enclosures in the Standard for Explosionproof and Dust-ignitionproof Electrical Equipment for Use in Hazardous (Classified) Locations, UL 1203 for the specific hazardous locations for which the cable sealing fitting is intended.

12.5 Cable sealing fittings intended to seal cables with optical-fiber members shall be subjected to special investigation.

### 13 Material

13.1 A cable sealing fitting shall be made of ferrous materials, copper, brass, bronze, or aluminum or its alloys containing not less than 80 percent aluminum. A metal such as zinc or magnesium, or their alloys, shall not be used.

13.2 Non-metallic sealing fitting material shall be subjected to the Non-Metallic Materials Test in Section 28.

### 14 Bonding Continuity

14.1 A cable sealing fitting intended for use with multiconductor metal-clad (Type MC) cables shall be constructed in a manner such that connection between the metallic covering of the cable and the cable connector complies with the construction and test requirements of the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

14.2 Non-metal parts relied upon to create compression to maintain the bonding path between the cable fitting and the Type MC metal-clad cable armor shall be determined to comply with the Current Test requirements of the Standard for Conduit, Tubing, and Cable Fittings, UL 514B after being aged. The Air-Oven aging temperature shall use the maximum rated temperature of the cable fitting as the maximum service temperature of the cable fitting, in accordance with the Table 4.3 of Standard for Gaskets and Seals, UL 157.

## 15 Joints

15.1 For Groups A, B, C and D; IIA, IIB, and IIC, a flamepath having a cylindrical cross-section shall have a length of not less than 1 inch (25.4 mm). The diametrical clearance (difference in diameters) shall not be greater than 0.0033 inch (0.083 mm). The diametrical clearance of a path longer than 1-1/4 inch (31.8 mm) shall not be more than 0.0045 inch (0.114 mm). For flamepath lengths greater than 1 inch (25.4 mm) but less than 1-1/4 inch (31.8 mm) the clearance shall be as given in the Standard for Explosionproof and Dust-ignitionproof Electrical Equipment for Use in Hazardous (Classified) Locations, UL 1203.

15.2 All other explosionproof joints in cable sealing fittings shall comply with the requirements for Class I Joints in Enclosures or the Alternative Joints in Enclosures in the Standard for Explosionproof and Dust-ignitionproof Electrical Equipment for Use in Hazardous (Classified) Locations, UL 1203.

15.3 A cable sealing fitting shall be so constructed that positive mechanical retention is provided, independent of any ground clamp or strain relief, to prevent movement of any part that could then result in a reduction of any internal flame path or an increase of any internal gap.

15.4 In determining compliance with 15.3, non-metallic parts shall not be relied upon to secure parts forming a flame path.

## 16 Supply Connection Threads for Flameproof "d", Explosionproof, and Dust Ignitionproof Fittings

16.1 Fittings with external NPT threads shall have a threaded length not less than the L4 dimension in accordance with ANSI/ASME B1.20.1 from the end of the fitting to the face of a shoulder or to an interruption.

16.2 Fittings with external NPT threads made from metal other than stainless steel, shall gauge ±1 turn of the ring gauge from being flush with the end of the thread in accordance with ANSI/ASME B1.20.1.

16.3 Fittings with external NPT threads made from stainless steel shall use a modified National Standard Pipe Taper (NPT). The pipe thread form shall comply with the Standard for Pipe Threads, ANSI/ASME B1.20.1, except that male threads shall gauge with +1/2 to +1-1/2 turns beyond the L-1 gauging notch in lieu of the ±1 turns described in ANSI/ASME B1.20.1.

16.4 A fitting having Metric threads intended for installation in a threaded entry of a flameproof equipment enclosure, the threaded part shall be at least 8 mm in length and be comprised of at least eight full threads. If the thread is provided with an undercut, regardless of the size of the undercut, then a non-detachable and non-compressible washer or equivalent device shall be provided by the manufacturer as a part of the fitting to ensure the required length of thread engagement. The thread shall have a tolerance Class of 6g or better according to ISO 965-1 and ISO 965-3.

NOTE The above requirement for at least eight full threads serves to ensure that at least five full threads will be engaged when the cable gland is installed in a threaded entry – taking into account the presence of an chamfer or undercut.

**Table 16.1**
**Number of threads versus class of fit**
Table deleted

16.5 Metric threaded cable fittings shall be marked with the thread size in accordance with 37.1(c).

## 17 Explosionproof and Flameproof Seal

17.1 A seal shall be provided between the end of the fitting intended for the connection of the cable and the end of the fitting intended for connection to the explosionproof or flameproof equipment as indicated in 17.2 – 17.5.

17.2 A sealing compound or a cement used for the seal shall:

a) Not be less than 5/8 inch (16.9 mm) deep;

b) Neither soften nor crack under the service conditions;

c) Ensure a tight seal and to retain the compound in place;

d) Not be affected adversely by the hazardous vapors in which it is intended to be used; and

e) Seal each individual conductor or subassembly and any metal jacket on the cable.

17.3 The sealing compound shall neither flow nor creep at the operating temperature of the device. A sealing compound of the softening type shall have a softening point of not less than 93°C (200°F) as determined by the Standard Test Method for Softening Point by Ring-and-Ball Apparatus, ASTM E28. Polymeric sealing compounds shall be subjected to the Solvent Vapor Tests specified in Tests on Epoxy Sealing Compounds, Section 29.

17.4 These specified values shall ensure that, throughout the required compound length, at least 20 percent of the cross-sectional area is filled with compound.

17.5 Cable fittings which are capable of being fitted and removed from the electrical equipment into which it is installed, shall be formed such that the fitting can be disassembled without disturbing the compound seal within the portion of the fitting into which it had cured.

## 18 Protection Against Corrosion

18.1 All ferrous-metal parts other than stainless steel shall be protected against corrosion, except at joint surfaces and conduit threads, for example, by zinc or cadmium coating, plating, enameling, painting, varnishing, or lacquering. Joint surfaces and conduit threads may be electroplated.

18.2 *Deleted*

## 19 Materials Applied to Joint Surfaces

19.1 A corrosion inhibiting grease such as petrolatum or soap-thickened mineral oils may be applied to the metal joint surfaces before assembly.

19.2 The grease shall be of a type that does not:

a) Harden because of aging;

b) Contain an evaporating solvent; and

c) Cause corrosion of the joint surfaces.

19.2A A corrosion inhibiting, non-drying, thickened mineral oil-based sealant that does not contain metal particles shall be permitted to be applied to threaded joints.

19.3 Paint or a sealing material shall not be applied to the contacting surfaces of a joint.

*Exception: A threaded joint surface or a threaded opening for conduit may be provided with a metallic paint or other noninsulating coating if the joint surface or opening with the paint or coating applied:*

*a) For Class I locations, prevents the passage of flame, hot particles, or sparks capable of igniting the surrounding atmosphere during the explosion tests. See Explosion Tests in the Standard for Explosionproof and Dust-ignitionproof Electrical Equipment for Use in Hazardous (Classified) Locations, UL 1203.*

*b) For Class I and Class II locations, complies with the Electrical Resistance Test requirements in the Standard for Explosionproof and Dust-ignitionproof Electrical Equipment for Use in Hazardous (Classified) Locations, UL 1203.*

## PERFORMANCE

### 20 General

20.1 Cable sealing fittings for use in hazardous locations shall comply with all applicable performance requirements in the Standard for Conduit, Tubing, and Cable Fittings, UL 514B in addition to the requirements of this standard. Fittings for Type (Marine Shipboard) cable shall comply with the requirements for Type TC cable fittings.

### 21 Torque

21.1 A cable sealing fitting is to be assembled with the intended cable and the cable sealing fitting shall be screwed into a mating tapped hole the depth of which is greater than the length of thread on the cable sealing fitting and which is tapped square to the surface.

21.2 The cable sealing fitting is to be tightened with a manually operated torque wrench to the torque values specified in Table 21.1, the wrench being applied first to the main body of the connector, then to each successive component.

**Table 21.1**
**Tightening torque for conduit hubs**

| Conduit hub trade size | | Tightening torque | |
|---|---|---|---|
| Inches | (mm O.D.) | Pound-inches | (N·m) |
| 1/2 – 3/4 | (21.3 – 26.7) | 800 | (90) |
| 1 – 1-1/2 | (33.4 – 48.3) | 1000 | (113) |
| 2 and larger | (60.3 and larger) | 1600 | (181) |

21.3 The assembled cable sealing fitting shall withstand the torque test without breakage. At the completion of the test, the cable sealing fitting is to be dismantled and examined and shall show no visible evidence of damage to the cable sealing fitting components, nor shall there be breakage of the cable outer covering.

### 22 Resistance to Impact Test

22.1 Cable fittings shall not result in a risk of fire or explosion by cracking, breaking, or having loosened parts when subjected to the impact as specified in 22.2 – 22.10.

22.2 The cable sealing fitting is to be subjected to impact from a mass of 2.2 pounds (1 kg) falling vertically from a height of 2.1 feet (0.7 m). The weight shall be fitted with an impact head of hardened steel in the form of a hemisphere of 1 inch (25.4 mm) diameter.

22.3 Two samples of each trade size of cable sealing fitting determined to be the weakest, are each to be impacted at two separate places as specified in 22.4.

22.4 The points of impact are to be at the location furthest from the supply connection threads.

22.5 The cable sealing fitting sample is to be mounted on a steel base so that the direction of the impact is normal to the surface being tested. The base shall have a mass of at least 44 pounds (20 kg) or be rigidly fixed or inserted into the floor. Figure 22.1 and Figure 22.2 give an example of a suitable test rig.

22.6 The cable sealing fitting is to be tested with the cable fitted.

22.7 For impact purposes, the cable sealing fitting is fixed on a rigidly mounted steel plate or secured as specified by the manufacturer's instruction sheet for the cable fitting.

22.8 The torque applied in fixing the cable sealing fitting is to be as specified in Torque, Section 21.

22.9 The samples are to be impacted in an ambient temperature of 20 ±5°C (68 ±9°F).

22.10 Following the impact, the samples shall be subjected to a visual examination to determine compliance with the requirement that there shall be no cracking, breaking or loosening of parts (see 22.1). Should it not be possible to visually make this determination, then the samples shall comply with the Explosion Tests, Section 23, and the Hydrostatic Pressure Test, Section 24.

**Figure 22.1**

**Example of fixture for resistance to impact test**

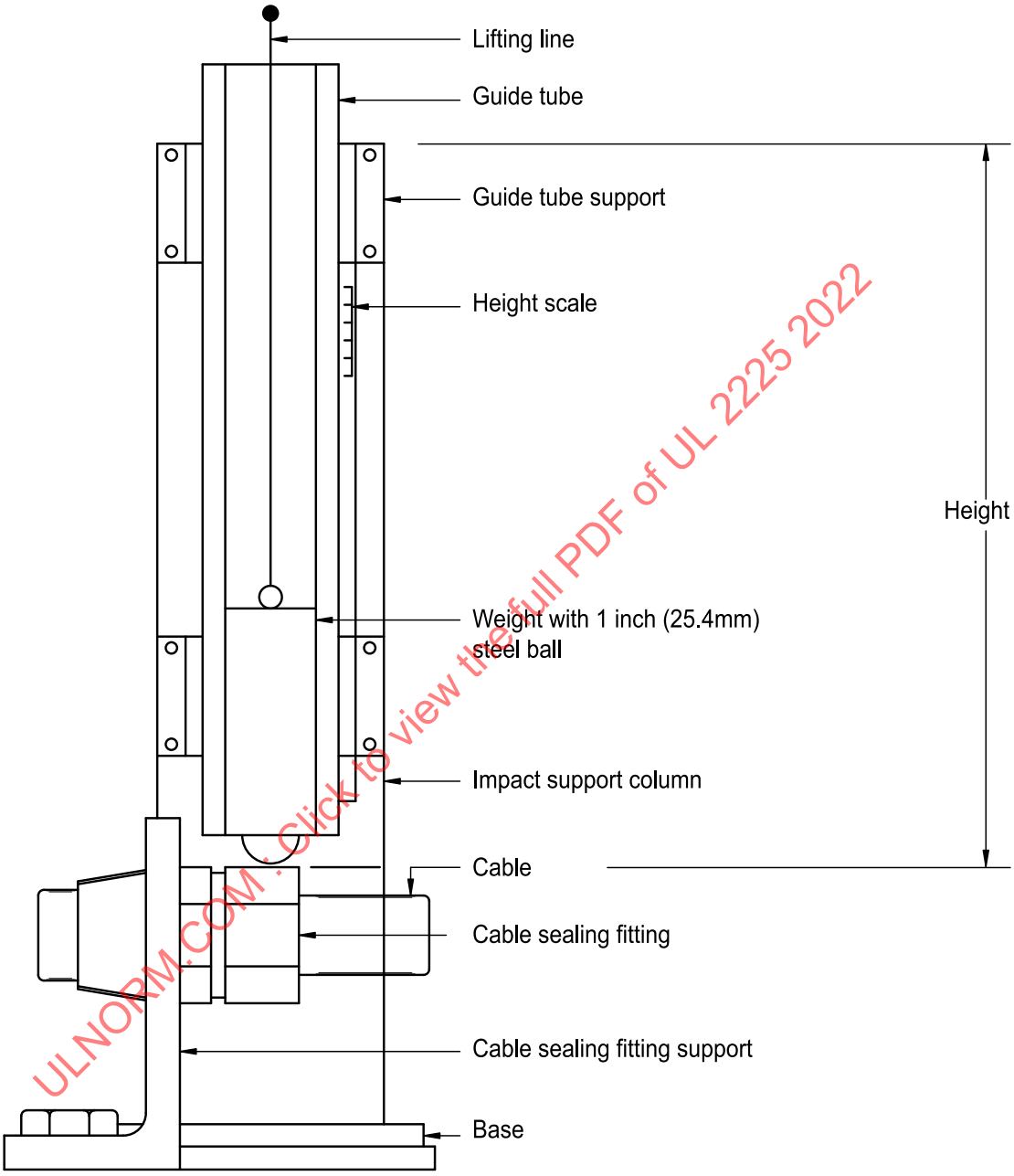


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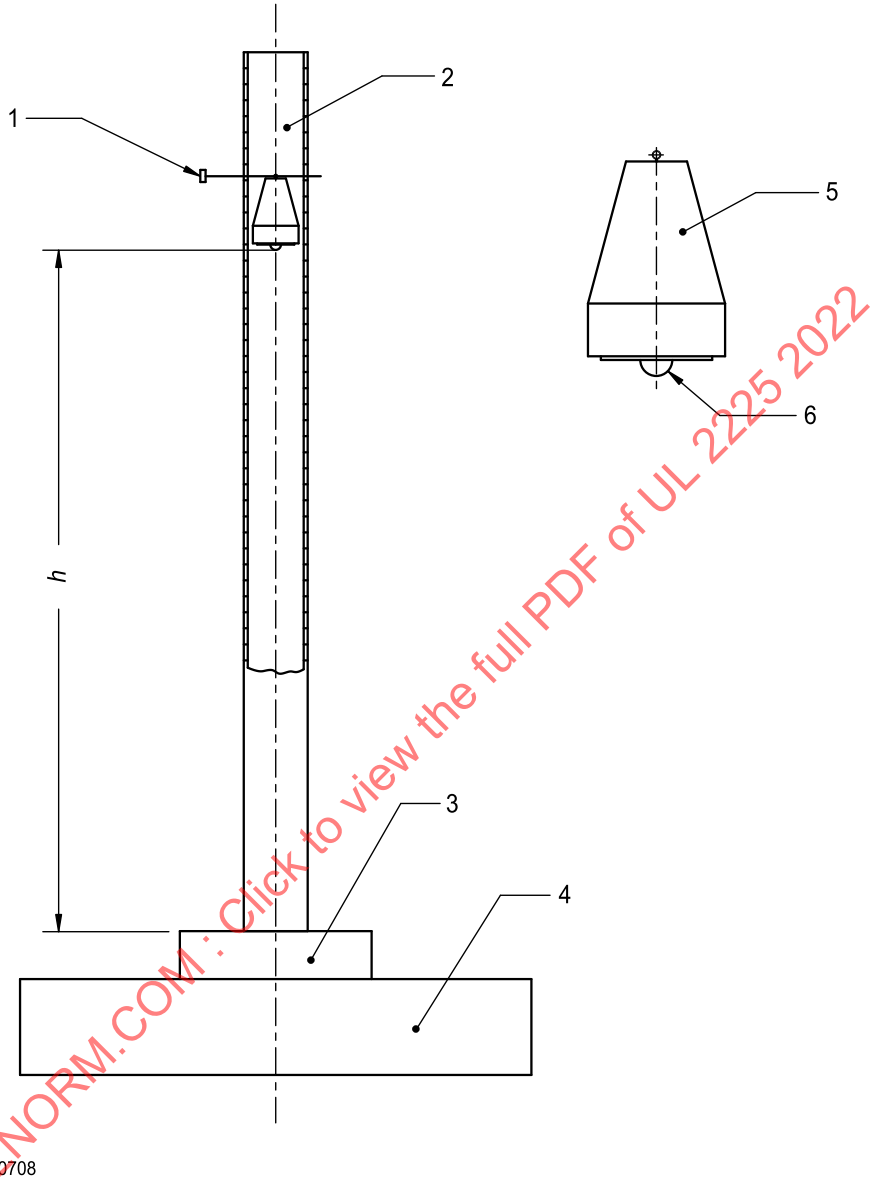
**Figure 22.2**

**Typical Arrangement for Impact Test**






Key

1. Adjustment pin
2. Plastics guide tube
3. Test piece
4. Steel base (mass ≥ 44 pounds (20 kg)
5. Steel mass of 2.2 pounds (1 kg)
6. Impact head 1 inch (25.4 mm) diameter in hardened steel

*h* Height of fall

## 23 Explosion Tests

23.1 The requirements in 23.2 – 23.15 shall be applied to all explosionproof and flameproof cable sealing fittings.

23.2 All gaskets are to be removed for this test. All material applied to the joint surfaces in accordance with Materials Applied to Joint Surface, Section 19, is to be removed.

23.3 Explosionproof and flameproof cable sealing fittings and cord connectors are to be subjected to a series of tests in the presence of specific gas- or vapor-air mixtures over the range of flammable or explosive concentrations to determine the maximum explosion-pressure effects of the gas- or vapor-air mixture over the test range specified in Table 23.1 and the maximum propagation effects of the gas- or vapor-air mixture as specified in either Table 23.2 (when tested according to 23.10 – 23.13) or Table 23.3 (when tested according to 23.15).

*Exception: Cable sealing fittings not exceeding 4 inches trade size and not using labyrinth or polymeric-to-polymeric joint constructions need not be subjected to explosion tests when the fitting complies with either (a) or (b) below in addition to being subjected to a hydrostatic pressure test in accordance with Exception No. 3 to 24.1:*

*a) The fitting is for use in Group C, Group D, Group IIA, or IIB, locations; or*

*b) The fitting is for use in Group A, Group B, or Group IIC, locations and all joints are of the tapered, threaded type, with taper of 1 in 16 (3/4 inch taper per foot).*

**Table 23.1**
**Gas-air mixtures for maximum pressure tests**

| Group | Gas | Test range percent in air | Minimum number of tests |
|---|---|---|---|
| A, IIC | Acetylene | 5 – 20 | 10 |
| B, IIB plus Hydrogen, IIC | Hydrogen | 15 – 35 | 15 |
| C, IIB | Ethylene | 4 – 9 | 10 |
| D, IIA | Propane | 3 – 7 | 10 |

**Table 23.2**
**Gas-air mixtures for flame propagation tests with factors applied to joints**

| Class I group | Explosive test mixture | Minimum number of tests |
|---|---|---|
| A, IIC | Acetylene, 7.5% ±1% | 5 |
| B, IIB plus Hydrogen IIC | Hydrogen, 27% ±1% | 5 |
| C, IIB | Ethylene 6.5% ± 0.5% | 5 |
| D, IIA | Propane, 4.2% ±1% | 5 |

**Table 23.3**
**Gas-air mixtures for flame propagation tests with factors applied to the mixtures**

| Class I group | Explosive test mixture | Minimum number of tests |
|---|---|---|
| A, IIC | Acetylene – 10.0 ±1%<br>Oxygen – 9.5% ±1%<br>Hydrogen – 40.0% ±1% | 5 |
| B, IIB plus Hydrogen, IIC | Oxygen – 9.5% ±1% | 5 |
| C, IIB | Hydrogen – 37% ±1% | 5 |
| D, IIA | Hydrogen – 55%±1% | 5 |

23.4 During the explosion tests, the cable sealing fitting shall prevent the passage of sparks or flame to the surrounding atmosphere which are capable of igniting the surrounding atmosphere.

23.5 Tests are to be conducted with cables assembled to the fittings.

23.6 Short lengths of cable having end fittings assembled in accordance with the manufacturer's instructions are to be connected to a sample enclosure representative of explosionproof equipment. The representative test enclosure is to have a free internal volume of 1800 – 2100 cubic inches (29.5 – 34.4 dm) or (1 cubic foot – 1.2 cubic foot). Representative samples of the cable assemblies under investigation are to be installed in the enclosure. For cable sealing fittings for Class I, Division 1 or Zone 1 locations, the inlet of the enclosure is to be provided with 5, 10, and 15 feet (1.5, 3.0, and 4.6 m) of 1-1/2 inch trade-size (48.3 mm outside diameter) conduit. For Class I, Division 2 or Zone 2, the lengths of conduit are to be omitted.

23.7 For the explosion tests, the cable sealing fitting and the representative test enclosure is to be installed in a test chamber that has inlet and outlet connections to the lines carrying the explosive mixture. The representative test enclosure is to be tapped with threaded holes for connection to the inlet or outlet lines carrying the explosive mixture, attachment of explosion-pressure recording device, and insertion of a spark plug for ignition. The length of conduit attached to the representative test enclosure is to be used for inlet or outlet connection to the line carrying the explosive mixture. For cable sealing fittings for Class I, Division 1 or Class I, Zone 1 locations, a spark plug is to be located in the length of conduit approximately 4 inches (102 mm) from the outer end of the conduit. For Class I, Division 2 or Zone 2 the spark is to be initiated within the representative test enclosure. The explosive mixture is to be prepared by auxiliary equipment capable of maintaining predetermined concentrations of the mixture.

23.8 The explosive mixture is to be allowed to flow into the test assembly and into the surrounding test chamber until all of the original air has been displaced. The mixture within the test assembly is then to be ignited by the spark plug.

23.9 If a cable sealing fitting is intended to be provided with a metallic paint or other noninsulating coating on a threaded joint surface or on threaded supply connections, the explosion tests are also to be conducted on a sample provided with such coating. See 19.3, Exception (a). Grease or other material applied to joints is to be removed before the test.

23.10 A cable sealing fitting for Class I, Groups A and B, or IIC locations, that has flat, cylindrical, or rabbet-type joints is to be tested with test factors applied by having the metal-to-metal joints reduced to 75 percent of the total joint width to be used and with the joints shimmed to give a clearance of 50 percent greater than the clearance to be used. A fitting that has threaded joints not tapered 3/4 inch per foot, is to be tested with a threaded engagement of 75 percent of the total number of engaging threads to be used. The lateral clearance at a threaded joint is to be the maximum obtainable in production fittings, including maximum manufacturing tolerances.

23.11 A device with a labyrinth joint is to be tested with the joint reduced to 75 percent of the total joint width and the joint clearance increased by 50 percent.

23.12 A threaded polymeric-to-polymeric joint is to be tested with a thread engagement of 75 percent of the total number of engaging threads to be used.

23.13 Serrated joints shall be tested with an engagement of 75 percent of the total number of engaging serrations to be used. The lateral clearance at the serrated joints is to be the maximum obtainable in production equipment, including maximum manufacturing tolerances.

23.14 Products having other polymeric joints shall be subjected to the test program specified in Non-Metallic Materials Tests, Section 28.

23.15 All joints having production maximum clearance and production minimum length may alternatively be tested with test factors applied to the test gas mixtures by using the gas-air mixtures given for the gas group in Table 23.3.

23.15A *Deleted*

23.15B *Deleted*

23.16 For explosionproof cable fittings specified and marked for use at ambient temperatures lower than minus 25°C (minus 13°F) or for flameproof cable fittings specified and marked for use at ambient temperatures lower than minus 20°C (minus 4°F), the Explosion Tests shall be determined by one of the following methods:

a) The Explosion Tests shall be performed at the minimum ambient specified, ±5°C (±9°F). When the ambient specified is such that common materials within the Group are not flammable, a test temperature shall be specified that represents the minimum temperature at which the test gasses shown in Table 23.3 remain gasses; or

b) For explosionproof cable fittings for use in Group A, B, C or D classified locations, rated less than minus 25°C (minus 13°F) but not less than minus 50°C (minus 58°F) or flameproof cable fittings for use in Groups IIA, IIB or IIC classified locations, rated less than minus 20°C (minus 4°F) but not less than minus 50°C (minus 58°F), the equipment shall be permitted to alternatively be subjected to the Hydrostatic Pressure Test in accordance with 24.4 and 24.5; or

c) Whenever lengths of conduit are not required as part of the test setup described in 23.6, the reference pressure shall be permitted at room ambient temperature ($T_a$) using the defined test mixture(s), but at increased pressure. The absolute pressure of the test mixture (P) shall be calculated by the following formula, using $T_a$ in °C:

$$P = 100\left[\frac{293}{(T_a,\ \min + 273)}\right]\ (kPa)$$

or

$$P = 14.6959\left[\frac{293}{(T_a,\ \min\ +\ 273)}\right]\ (psi)$$

23.17 For explosionproof and flameproof fittings specified for use at ambient temperatures greater than 60°C (140°F), the explosion tests shall be performed under one of the following conditions:

a) At a temperature not less than the specified maximum ambient temperature; or

b) At normal ambient temperature using the defined test mixture at increased pressure according to the factors in Table 23.4; or

c) At normal atmospheric pressure and temperature, but with the test gap increased by the factors noted in Table 23.4.

**Table 23.4**
**Test factors to increase pressure or joint test gap**

| Temperature up to °C | Groups A & B<br>Group IIB plus Hydrogen<br>Group IIC<br>27.5% $H_2$<br>7.5% $C_2H_2$ | Group C<br>Group IIB<br>37% $H_2$ | Group D<br>Group IIA<br>55% $H_2$ |
|---|---|---|---|
| 60 | 1.00 | 1.00 | 1.00 |
| 70 | 1.11 | 1.04 | 1.05 |
| 80 | 1.13 | 1.05 | 1.06 |
| 90 | 1.15 | 1.06 | 1.07 |
| 100 | 1.16 | 1.06 | 1.08 |
| 110 | 1.18 | 1.07 | 1.09 |
| 120 | 1.20 | 1.08 | 1.10 |
| 130 | 1.22 | 1.09 | 1.11 |

## 24 Hydrostatic Pressure Tests

24.1 A cable sealing fitting shall withstand for 10 seconds, without rupture or permanent distortion, a hydrostatic test pressure on the end of the seal of four times the maximum internal explosion pressure developed during the explosion tests.

*Exception No. 1: The hydrostatic pressure test may be omitted if calculations indicate an acceptable factor of safety based on the maximum internal explosion pressure. The safety factor shall be five for all calculations.*

*Exception No. 2: If excess leakage occurs, resulting in the inability of the test apparatus to maintain the required pressure in a test of a 2 inch (50.8 mm outside diameter) or larger trade size cable sealing fitting with wires sealed in the fitting, a fitting with a seal but without wires may be used.*

*Exception No. 3: For a cable sealing fitting as described in 24.2 that is not subjected to explosion tests, the hydrostatic test pressure is to be as specified in Table 24.1.*

**Table 24.1**
**Hydrostatic pressures for cable fitting seals**

| Class I area classification | Required hydrostatic pressure in psig (MPa) | | | |
|---|---|---|---|---|
| | Group A | Group B or IIC | Group C or IIB | Group D or IIA |
| Division 1 or Zone 1 | 2,000 (13.7) | 2,000 (13.7) | 1,200 (8.27) | 600 (4.13) |
| Division 2 or Zone 2 | 500 (3.45) | 500 (3.45) | 500 (3.45) | 500 (3.45) |

24.2 The hydrostatic pressure test on the seal in a fitting is to be conducted on a seal prepared at room temperature, and immediately following the specified minimum cure time on a seal prepared at the minimum temperature specified in the sealing compound instructions.

24.3 The hydrostatic pressure is to be applied at the rate of approximately 100 – 600 psig (690 – 4137 kPa) per minute until the required internal pressure is reached. Gaskets or other means may be employed if necessary to prevent leakage of water during application of pressure.

24.4 For explosionproof cable sealing fittings for use in Groups A, B, C, or D classified locations, rated less than minus 25°C (minus 13°F) but not less than minus 50°C (minus 58°F), that have been determined to comply with the Explosion Tests requirements in Section 23 at 20 ±5°C (68°F), the fittings shall be subjected to the Hydrostatic Pressure Test of Section 24 using the test factor of six times the maximum explosion test pressures (based on room ambient explosion testing) or the values from Table 24.2.

24.5 For flameproof cable sealing fittings for use in Groups IIA, IIB, or IIC classified locations, rated less than minus 20°C (minus 4°F) but not less than minus 50°C (minus 58°F), that have been determined to comply with the Explosion Tests requirements in Section 23 at 20 ±5°C (68°F), the fittings shall be subjected to the Hydrostatic Pressure Test of Section 24 using the test factor of six times the maximum explosion test pressures (based on room ambient explosion testing) or the values from Table 24.2.

**Table 24.2**
**Hydrostatic pressures for cable fitting seals rated and marked as low as minus 50°C (minus 58°F)**

| Class I area classification | Required hydrostatic pressure in psig (MPa) | | | |
|---|---|---|---|---|
| | Group A | Group B or IIC | Group C or IIB | Group D or IIA |
| Division 1 or Zone 1 | 3,000 (20.7) | 3,000 (20.7) | 1,800 (12.4) | 900 (6.2) |
| Division 2 or Zone 2 | 750 (5.17) | 750 (5.17) | 750 (5.17) | 750 (5.17) |

## 25 Dust Penetration Test

25.1 A cable sealing fitting for Class II locations is to be exposed to a circulating dust-air atmosphere to determine that the enclosure is dust-tight. During this test there shall be no entrance of the dust into the box or the fitting.

*Exception: A cable sealing fitting need not be exposed to the circulating dust-air atmosphere if all joints:*

*a) Are of the threaded type; or*

*b) Are ungasketed and comply with the requirements for Class I joints.*

25.2 For the dust penetration test, cable sealing fittings assembled as described in 23.5 are to be used in the test, except that the lengths of inlet conduit are to be omitted.

25.2.1 Elastomeric materials relied upon to prevent the entrance of dust shall be aged using the maximum rated temperature of the cable fitting as the maximum service temperature of the fitting, in accordance with the Table 4.3 of Standard for Gaskets and Seals, UL 157 before being subjected to the tests of 25.3 or 25.7.

25.3 The box or the fitting is to be installed in a test chamber to permit free circulation of dust-air mixtures around the device. The test chamber is to be provided with a cover and with dust-air inlet and outlet connections. The fitting in the representative test enclosure is to be exposed to the dust-air atmosphere that is to be produced by auxiliary apparatus and introduced into the test chamber. The test is to be

continued for at least 30 hours while the box or the fitting is continuously exposed to the circulating dust-air atmosphere.

25.4 Grain dust consisting of wheat or corn dust, or both, that has passed through a U.S.A. Standard 150 micron (100 mesh) wire cloth is to be used for the dust-air atmosphere if the box or the fitting is for use in Class II, Group F, Group G, or Groups F and G locations.

25.5 Magnesium dust, all of which has passed through a U.S.A. Standard 250 micron (60 mesh) wire cloth, 66 percent of which has passed through 150 micron (100 mesh) wire cloth, and 22 percent of which has passed through a 75 micron (200 mesh) wire cloth is to be used for the dust-air atmosphere if the box or the fitting is for use in Class II, Group E, Groups E and F, or Groups E, F, and G locations.

25.6 The wire cloth is to conform to the dimensional requirements of the Standard Specification for Wire-Cloth Sieves for Testing Purposes, ASTM E11.

25.7 As an alternative to the tests of 25.3, cable fittings are permitted to be subjected to the tests in Section 36.8 after being assembled to a clean polished mandrel as described in 36.2.2.

## 26 Leakage of Sealing Fittings Test

26.1 A cable sealing fitting having wires sealed with compound specified for use with the fitting shall not permit the passage of more than 0.007 cubic foot (0.2 L) of air per hour at a pressure of 6 inches (152 mm) of water.

26.2 The test is to be conducted on seals prepared at room temperature and on seals prepared at the minimum temperature specified in the sealing compound instructions.

26.3 Regarding the number and size of wires that are to be sealed in each sealing fitting, consideration is to be given to the maximum number of conductors for use in each trade size cable sealing fitting and the maximum available number of conductors for use in each trade size cable sealing fitting is to be used.

## 27 High Humidity Tests

27.1 These requirements apply to cement-type sealing compounds.

27.2 Sample cable sealing fittings, conditioned as described in 27.3, shall be subjected to Hydrostatic Pressure Tests, Section 24, and Leakage of Sealing Fittings Test, Section 26.

27.3 Cable sealing fittings prepared in accordance with 26.2 and 26.3 are to be subjected to the following environmental conditioning:

a) Sixty days at 60°C (140°F) and a relative humidity of 95 – 100 percent.

b) Sixty days at 20°C (68°F) and relative humidity of 95 – 100 percent with a 1 inch (25.4 mm) column of water maintained on the top of the seal.

## 28 Non-Metallic Materials Tests

### 28.1 General

28.1.1 Non-metallic materials shall comply with either 28.2 or 28.3 and shall comply with 28.4.

### 28.2 Chemical compatibility by material samples

#### 28.2.1 Sample preparation

28.2.1.1 Thirty-nine samples with like dimensions are to be prepared. The dimensions of these samples are to be at least 5 by 1/2 by 1/8 inch (127 by 12.7 by 3.2 mm).

28.2.1.2 The initial linear dimension of each sample is to be measured.

28.2.1.3 The initial weight of each sample is to be measured.

#### 28.2.2 Solvent vapor exposure tests

28.2.2.1 For each of the following test chemicals, a set of three samples are to be exposed to a 100 percent saturated vapor in air of the chemical at 20°C – 25°C (68°F – 77°F) for a period of 7 days:

a) Acetic Acid (Glacial);

b) Acetone;

c) Ammonium Hydroxide (20 percent by weight);

d) ASTM reference fuel C;

e) Diethyl Ether;

f) Ethyl Acetate;

g) Ethylene Dichloride;

h) Furfural;

i) n-Hexane;

j) Methyl Ethyl Ketone;

k) Methanol;

l) 2-Nitropropane; and

m) Toluene.



*Exception: The manufacturer may mark specific chemical atmospheres in which the product is to be used and test for those chemical exposures only.*

#### 28.2.3 Sample evaluation

28.2.3.1 The values for the following physical properties are to be determined using as-received specimens and specimens that have been subjected to chemical exposure:

a) Resistance to impact in accordance with Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics, ASTM D256;

b) Flexural properties in accordance with Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials, ASTM D790;

c) Changes in weight and dimensions.

28.2.3.2 The values after chemical exposure shall not be less than 85 percent of the values determined using as-received samples for 28.2.3.1 (a) and (b). A material that has values less than 85 percent and not less than 50 percent of the as-received values meets the intent of this requirement when it complies with the explosion and hydrostatic tests conducted on the complete sample subjected to the chemical exposure.

28.2.3.3 The linear dimension(s) of each sample is to be measured within one hour after removal from the solvent vapor. The dimensional changes shall not indicate shrinkage of more than 1 percent of the initial value. A material with shrinkage that exceeds 1 percent of the as-received values meets the intent of this requirement when it complies with the explosion and hydrostatic tests conducted on the complete sample subjected to the chemical exposure.

28.2.3.4 Each sample is to be weighed within one hour after removal from the solvent vapor. Change in mass shall not exceed 1 percent. A material with weight loss that exceeds 1 percent of the as-received values meets the intent of this requirement when it complies with the explosion and hydrostatic tests conducted on the complete sample subjected to the chemical exposure.

### 28.2.4 Accelerated aging tests

28.2.4.1 A set of three complete enclosure samples shall be subjected to the following tests:

a) Accelerated aging tests per 28.3.3; and

b) Flamepath erosion per 28.3.4.2.

## 28.3 Chemical compatibility by complete end product tests

### 28.3.1 Sample preparation

28.3.1.1 Sixteen complete samples are required.

### 28.3.2 Solvent vapor exposure tests

28.3.2.1 For each of the following test chemicals, one enclosure is to be exposed to a 100 percent saturated vapor in air of the chemical at 20°C – 25°C (68°F – 77°F) for a period of 7 days:

a) Acetic Acid (Glacial);

b) Acetone;

c) Ammonium Hydroxide (20 percent by weight);

d) ASTM reference fuel C;

e) Diethy Ether;

f) Ethylene Dichloride;

g) Furfural;

h) n-Hexane;

i) Methyl ethyl ketone;

j) Methanol;

k) 2-Nitropropane; and

l) Toluene.

*Exception: The manufacturer may mark specific chemical atmospheres in which the product is to be used and test for those chemical exposures only.*

### 28.3.3 Accelerated aging tests

28.3.3.1 Three separate enclosure samples are to be conditioned in an oven at a temperature (T2) and for a length of time (D) determined in accordance with the following:

$$D = \frac{18262.5}{2^{(\Delta\ T/10)}}$$

$$T_2 = T_1 + 10\left(\frac{In\frac{18262.5}{D}}{In\ \ 2}\right)$$

*in which:*

*D is the test time in days.*

*$T_1$ is the maximum temperature in degrees C obtained on the enclosure in a temperature test under normal 1 operating conditions.*

*$T_2$ is the test oven temperature in degrees C.*

*$\Delta T$ is $T_2$ minus $T_1$.*

Either the test time in days (D) or the test temperature ($T_2$) is to be selected by the manufacturer based upon the aging properties of the material. The number of days (D) selected shall not be less than 30.

*Exception: Aging less than 30 days, for polymers with known aging behavior (such as having an assigned Relative Temperature Index, RTI), meets the intent of this requirement. However, no test temperature shall be greater than 50°C (122°F) above the maximum temperature used to establish the RTI.*

28.3.3.2 Hygroscopic materials (most notably nylons) are to be rehydrated in an ambient of 50 ±10 percent Relative Humidity, 23 ±1°C (122°F) for 48 hours prior to materials testing.

### 28.3.4 Sample evaluation

28.3.4.1 The three samples subjected to the Accelerated Aging Tests of 28.3.3 and each of the samples subjected to the Solvent Vapor Exposure Tests shall be individually subjected to the Hydrostatic Pressure Tests, Section 24, based on the test pressure obtained during the Explosion Pressure Tests conducted as described in Explosion Tests, Section 23.

28.3.4.2 Samples subjected to the Solvent Vapor Exposure Tests of 28.3.2 or Accelerated Aging Tests of 28.2.4, shall exhibit no visual erosion of any flamepath when subjected to 100 additional flame propagation tests according to the test method of 23.2 – 23.15.

### 28.4 Test for accumulation of static electricity

#### 28.4.1 General

28.4.1.1 A non-metallic external part with an area greater than 15.5 inches$^2$ (100 cm$^2$) shall comply with either the requirements in 28.4.2 or 28.4.3.

#### 28.4.2 Method A

28.4.2.1 Any non-metallic surface with area greater than 15.5 inches$^2$ (100 cm$^2$) shall have a surface resistivity of 1 G-Ohm or less at 23°C (73.4°F) and 50 percent relative humidity as defined by the material specifications or be determined by the test in 28.4.2.2.

28.4.2.2 The resistance is to be tested on the enclosure or on parts of the enclosure. Two parallel electrodes 0.04 inch (1 mm) in width, 4 inches (100 mm) in length, 0.4 inch (10 mm) apart are to be centered on a 6 × 2.4 inch (150 mm × 60 mm) sample. The sample is to be cleaned with distilled water, then with isopropyl alcohol, then once more with distilled water before being dried. Untouched by bare hands, it is to be conditioned for 24 hours at 23°C and 50 percent relative humidity. The test is to be carried out under the same conditions. A direct voltage of 500 ±10 Vdc is to be applied for one minute. The resistance is the quotient of the direct voltage applied at the electrodes to the total current flowing between them when the direct voltage has been applied for one minute.

#### 28.4.3 Method B

28.4.3.1 A non-metallic external part with an area greater than 15.5 inches$^2$ (100 cm$^2$) shall comply with the requirements in 28.4.3.2 – 28.4.3.5.

28.4.3.2 No sparks shall be observed when a grounded metal sphere is brought into gradual contact with the non-metallic part, mounted as intended, after it has been electrostatically charged.

28.4.3.3 Three samples of the part are to be conditioned for at least 48 hours at a relative humidity of 25 ±10 percent.

28.4.3.4 Immediately after removal from the low-humidity chamber, the samples are to be supported by means of insulators in a room having a relative humidity not more than 35 percent and having all sources of light, other than electrical sparks, eliminated. An electrostatic charge is to be sprayed on nonconductive parts of the product using a Van de Graaf generator limited to 5000 volts.

28.4.3.5 A 3/8 inch (9.5 mm) diameter grounded metal sphere is to be brought into gradual contact with the nonconductive area of the sample.



## 29 Tests on Epoxy Sealing Compounds

29.1 Epoxy sealing compound used in Class I equipment shall be subjected to the tests described in 29.2 – 29.7 to determine its resistance to chemicals.

29.2 The resistance to crushing of the epoxy sealing compound is to be determined on as-received specimens and specimens exposed to chemical vapors. The crushing force after exposure is to be at least 85 percent of the value determined using as-received samples. In addition, changes in dimensions and weight after exposure are to be determined. Shrinkage or loss of weight of more than 1 percent or an increase in weight or swelling that changes the intended properties of the sealing compound is not acceptable. See 29.8.

29.3 Cylindrical epoxy specimens 1/2 inch (12.7 mm) in diameter and 3/4 inch (19.1 mm) long are to be used for the tests. At least 81 specimens are required – six for each chemical and three for as-received tests. The samples shall be of uniform size and shape, having both ends perpendicular to the side of the cylinder.

29.4 The epoxy specimens are to be exposed for 168 hours (7 days) to saturated vapors in air of the chemicals specified in 28.2.2.

29.5 During and after the exposure, the epoxy specimens are to be observed for discoloration, swelling, crazing, cracking, leaching, or dissolving.

29.6 After the exposure, three epoxy specimens from each chemical exposure are to be weighed and measured immediately after removal from the chemical vapor.

29.7 The other three exposed specimens and the as-received specimens are to be placed between two parallel plates and crushed with a compression-testing machine having a crosshead speed of 0.1 inch (2.54 mm) per minute. The load is to be applied perpendicular to the axis of the cylindrical specimens and the compressive force required to crack and break the specimens is to be recorded.

29.8 As an alternative, tests to determine resistance of the epoxy sealing compound to chemicals shall be permitted to be conducted on a complete sample that incorporates the epoxy seal assembled in the fitting as described in the assembly instruction sheet provided with each fitting in accordance with 35.10, but without cable or conductors. These tests are to consist of Explosion and Hydrostatic Pressure Tests in accordance with Sections 23 and 24 on the complete sample after the sample has been exposed to the chemicals specified in 28.3.2. There shall be no flame propagation, rupture, cracking, breakage, or other damage to the sealing compound.

29.9 Following the solvent exposures, the samples shall be visually inspected for reaction to the solvent exposure. Samples that show signs of reaction to the solvent exposure shall be subjected to the Leakage of Sealing Fittings Test, Section 26. There shall be no air leakage in excess of 0.007 cu ft/hr.

29.10 Samples that have leakage in excess of the limit in 29.9 shall be permitted to be subjected to Explosion and Hydrostatic Pressure Tests in accordance with Sections 23 and 24 on the complete sample. There shall be no flame propagation, rupture, cracking, breakage, or other damage to the sealing compound following these tests.

## 30 Enclosure Types and Degree of Protection

30.1 A cable sealing fitting that complies with the applicable requirements of this standard:

a) For use in Class I, Groups A, B, C, or D locations may be marked with the enclosure designation Type 7; or

b) For use in Class II, Groups E, F, or G locations may be marked with the enclosure designation Type 9.

*Exception: This requirement does not apply to a cable sealing fitting marked for use only in Zone 1 or Zone 2.*

30.2 A cable sealing fitting that is intended for use in environmental conditions that has a marked enclosure type designation, shall also comply with the applicable requirements for each enclosure type, as specified in the Standard for Enclosures For Electrical Equipment, Environmental Considerations, UL 50; for example, Type 3, 4X, or 6.

30.3 A cable sealing fitting marked Type 3, 3R, 3S, 4, 4X, 6, or 6P enclosure may also be marked "Raintight" if no water enters the enclosure. Compliance with these requirements shall be determined by the applicable tests in the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50.

30.4 Degree of Protection (IP) ratings shall comply with the requirements in ANSI/IEC 60529.

## PART III – AEX CABLE FITTINGS AND EXTRA-HARD USAGE CORD CONNECTORS

## CONSTRUCTION

### 31 General

31.1 The requirements for the construction, testing and marking of AEx flameproof "d", increased safety "e", and dust ignition protection by enclosure "t" or "tD" cable fittings and cord connectors are as follows.

### 32 All AEx Cable Fittings and Cord Connectors

32.1 Cable fittings and extra-hard usage cord connectors shall comply with the applicable construction requirements in the Standard for Conduit, Tubing, and Cable Fittings, UL 514B, except as modified by this standard. Where requirements conflict, the requirements in this standard shall apply.

32.2 Cable fittings intended for use with metal-clad cables shall provide a bonding means in accordance with Bonding Continuity, Section 14.

32.3 Cable entries shall not have sharp edges capable of damaging the cable.

32.4 The point of entry for extra hard usage cord connectors shall have a rounded edge at an angle of at least 75 degrees. The radius of the rounded section shall equal the larger of 0.118 inch (3 mm) or one quarter of the diameter of the maximum admissible cable in the entry.

### 33 Flameproof "d" Construction

33.1 The width of all joint surfaces or the length of path through or across any joint surface or opening in the cable sealing fitting, including threadless joints and threaded joints, shall be dimensionally measured for compliance with the appropriate requirements contained in 15.1.

33.2 All joint surfaces shall have the gap between joint surfaces examined by means of appropriate measuring tools. The gap between the joint surfaces shall not exceed the dimensions specified in 15.1.

33.3 Materials applied to joint surfaces shall comply with Materials Applied to Joint Surfaces, Section 19.

33.4 Cable sealing fittings shall have a seal that complies with Seal, Section 17. Inorganic cement-type seal material shall comply with High Humidity Tests, Section 27. Epoxy seal materials shall comply with Tests on Epoxy Sealing Compounds, Section 29.

33.5 Supply connection threads on "d" cable or cord fittings shall be NPT or metric in compliance with Supply Connections for Flameproof "d" and Explosionproof Fittings, Section 16.

### 34 Increased Safety "e" Construction

34.1 The fitting shall be tested in accordance with Section 36.

34.2 Elastomeric seals relied upon to maintain the degree of protection shall comply with 36.7.1, Method 1 or Method 2.

34.3 Supply connection threads of metal "e" cable fittings shall be:

a) NPT or metric threads in compliance with Supply Connections for Flameproof "d" and Explosionproof Fittings, Section 16; or

b) In accordance with the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

34.4 Metal cable fittings for installation in plain holes in metallic enclosures shall be provided with bonding locknuts. Metal cable fittings for installation in plain holes in nonmetallic enclosures shall be provided with bonding locknuts having a supplemental means of bonding to the fitting.

34.5 Supply connection threads of "e" cord connectors shall be:

a) NPT or metric threads in compliance with Supply Connections for Flameproof "d" and Explosionproof Fittings, Section 16; or

b) In accordance with the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

## 35 Dust Ignition Protection by Enclosure "t" or "tD"

35.1 Cable fittings and cord connectors having type of protection "t" or "tD" shall comply with the following construction requirements. Cable fittings having type of protection "t" or "tD" shall be subjected to the tests of All AEx Cable Fittings and Cord Connectors, Section 36.

35.2 NPT entry thread of a cable fitting or cord connector in compliance with Supply Connections Threads, Section 16 need not be tested to determine compliance with 36.8.

35.3 Cable fittings and cord connectors having type of protection “t” or “tD” can be evaluated as equipment.

35.4 Supply connection threads of metal "t" or "tD" cable fittings shall be:

a) NPT or metric threads in compliance with Supply Connection Threads, Section 16; or

b) In accordance with the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

35.5 Metal cable fittings for installation in plain holes in metallic enclosures shall be provided with bonding locknuts. Metal cable fittings for installation in plain holes in nonmetallic enclosures shall be provided with bonding locknuts having a supplemental means of bonding to the fitting.

35.6 Supply connection threads of "t" or "tD" cord connectors shall be:

a) NPT or metric threads in compliance with Supply Connection Threads, Section 16; or

b) In accordance with the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

35.7 All joints in the cable glands or cord connectors shall fit closely together such that the joint forms a positive seal against the ingress of dust. Compliance with this requirement is determined in accordance with 35.10 – 35.11 and shall be subjected to the test of 36.8.1. The use of grease alone to maintain the integrity of the seal is not considered to satisfy this requirement.