UL 2239

STANDARD FOR SAFETY

Hardware for the Support of Conduit, Tubing, and Cable

UL Standard for Safety for Hardware for the Support of Conduit, Tubing, and Cable, UL 2239

Second Edition, Dated February 20, 2015

Summary of Topics

The revisions to ANSI/UL 2239 dated January 14, 2022 includes the following changes in requirements:

> ***– Messenger-Supported Wiring Hangers Rings and Saddles for Supporting Conduit, Cable or Tubing from Messenger Cable; 3.7A, 3.7B, 3.7C, 5.1.6A, 5.1.6B, Section 10B***
>
> ***– Quantity, sizes and types of conduit, cable, or tubing intended to be supported per STAPLE; 11.6***
>
> ***– Alternate Staple without Stops (DCN701); 5.2.9, 11.6***

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 May 21, 2021.

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CSA Group
CSA C22.2 No. 18.4-15
Second Edition

Underwriters Laboratories Inc.
UL 2239
Second Edition

Hardware for the Support of Conduit, Tubing, and Cable

February 20, 2015

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Approved American National Standard

ANSI/UL 2239-2022

Commitment for Amendments

This standard is issued jointly by the Canadian Standards Association (operating as “CSA Group”) and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of CSA Group and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the Second Edition including revisions through January 14, 2022.

The most recent designation of ANSI/UL 2239 as an American National Standard (ANSI) occurred on January 14, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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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Preface

This is the harmonized CSA Group and UL standard for Hardware for the Support of Conduit, Tubing, and Cable. It is the second edition of CSA C22.2 No. 18.4 and the second edition of UL 2239. This harmonized standard has been jointly revised on January 14, 2022. For this purpose, CSA Group and UL are issuing revision pages dated January 14, 2022.

This harmonized standard was prepared by CSA Group and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Subcommittee for Conduit and Cable Hardware, of the Council on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This standard was reviewed by the CSA Subcommittee on ICCM03-Fittings, Hardware and Positioning Devices under the jurisdiction of the CSA Technical Committee on Wiring Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of Harmonization

This standard uses the IEC format but is not based on, nor is it to be considered equivalent to, an IEC standard.

This standard is published as an equivalent standard for CSA Group and UL.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Reasons for differences from IEC

The THSC investigated and found no existing IEC standards or work programs covering the scope of the products in this standard.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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Hardware for the Support of Conduit, Tubing, and Cable

1 Scope

1.1 These requirements cover hardware for the support of conduit, tubing, and cable, such as HANGERS, STAPLES, STRAPS, and similar devices for installation in accordance with the National Electrical Code, NFPA 70, and the Canadian Electrical Code (CE Code), Part I.

1.2 These requirements also cover STANDOFFS for nonmetallic-sheathed cable, PROTECTOR PLATES, and PROTECTOR BUSHINGS.

1.3 These requirements do not cover hardware for use with surface raceway, wireway, or busway systems, sprinkler systems, and other piping systems used for fire protection service, hardware for use with lighting fixtures, or hardware for grounding and bonding applications.

1.4 These requirements do not cover:

a) Hardware intended to support boxes (see UL 514A or CSA C22.2 No. 18.1),

b) Conduit and cable fittings (see UL 514B or CSA C22.2 No. 18.3),

c) Reducing washers (see UL 514B or CSA C22.2 No. 18.3),

d) Pulling grips for cable or cord (see UL 514B or CSA C22.2 No. 18.3),

e) Cable ties (see UL 62275 or CSA C22.2 No. 62275 or NMX-J-623-ANCE), or

f) POSITIONING DEVICES (see UL 1565 or CSA C22.2 No. 18.5).

2 Normative References

2.1 Products covered by this standard shall comply with the reference installation codes and standard as appropriate for the country where the product is to be used. When the product is intended for use in more than one country, the product shall comply with the installation codes and standards for all countries where it is intended to be used.

2.2 Where reference is made to any Standards, such reference shall be considered to refer to the latest editions and revisions thereto available at the time of printing, unless otherwise specified.

CSA Group Standards

C22.1-15
Canadian Electrical Code, Part I

CAN/CSA-C22.2 No. 0-10
General Requirements – Canadian Electrical Code, Part II

C22.2 No. 0.15-01 (R2012)
Adhesive Labels

CAN/CSA-C22.2 No. 0.17-00 (R2013)
Evaluation of Properties of Polymeric Materials

C22.2 No. 18.1-13
Metallic Outlet Boxes

C22.2 No. 18.3-12
Conduit, Tubing, and Cable Fittings

C22.2 No. 18.5-13
Positioning Devices

UL Standards

UL 94
Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 514A
Metallic Outlet Boxes

UL 514B
Conduit, Tubing, and Cable Fittings

UL 746A
Polymeric Materials – Short Term Property Evaluations

UL 969
Marking and Labeling Systems

UL 1565
Positioning Devices

ASTM[1] Standards

ASTM B117-11
Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM D1654-08
Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM F1137-11e1
Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners

IEC[2] Standards

IEC 60695-11-10 (2013-05-12)
Fire Hazard Testing - Part 11-10: Test Flames-50W Horizontal and Vertical Flame Test Methods

IEC 60695-11-5 (2004)
Fire hazard testing - Part 11-5: Test flames - Needle-flame test method - Apparatus, confirmatory test arrangement and guidance

ISO[3] Standards

ISO 4892-1:1999
Plastics - Methods of exposure to laboratory light sources – Part 1: General guidance

ISO 4892-2:2013
Plastics - Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps

NFPA[4] Standard

NFPA 70-2014
National Electrical Code

[1] American Society for Testing and Materials
[2] International Electrotechnical Commission
[3] International Organization for Standardization
[4] National Fire Protection Association

3 Definitions

3.1 For the purpose of this standard, the following definitions apply. Terms used throughout this standard which have been defined in this Clause are in small roman capital type font.

3.1A ABOVEGROUND SUPPORT: A HARDWARE DEVICE, other than a STAPLE, that is intended to secure conduit, cable, or tubing to a building structure or other support assembly.

3.2 AIR-HANDLING SPACE: A duct or plenum used for environmental air and other spaces used for environmental air, such as above hung ceilings or below raised floors. This does not include plenums used for the removal of dust, loose stock, or vapor, or for ventilation of commercial-type cooking equipment.

3.3 BEAM CLAMP: A HARDWARE DEVICE intended for use in conjunction with a beam.

Note: For the purpose of this standard, a flange, purlin, or other similar mounting surface is considered to be a beam.

3.3A BELOWGROUND SUPPORT: A means to provide both:

a) Support for raceways intended to be encased in concrete electrical duct banks prior to the pouring the concrete, and

b) To maintain conduit/tubing spacing in concrete electrical duct banks prior, during and after the pouring of the concrete.

3.4 ELASTOMER: Rubber or any polymer other than a thermoplastic ELASTOMER that has properties similar to those of rubber.

3.5 HANGER: A HARDWARE DEVICE intended to support conduit, cable, or tubing from a building structure or other structural support assemblies.

3.6 HARDWARE DEVICE: A means for supporting conduit, cable, or tubing from, or securing in place conduit, cable, or tubing to, a building structure or other structural support assemblies.

3.7 LOAD RATING: A maximum static load as identified by the manufacturer, in kg (lb), intended for a HARDWARE DEVICE.

3.7A MESSENGER-SUPPORTED WIRING HANGER: A HARDWARE device intended for use in conjunction with a messenger cable for the support of conduit, cable, or tubing.

3.7B MESSENGER-SUPPORTED WIRING RING: A HARDWARE device intended for use in conjunction with a messenger cable.

3.7C MESSENGER-SUPPORTED WIRING SADDLE: A HARDWARE device intended for use in conjunction with a messenger cable.

3.8 POSITIONING DEVICE: For wire management and class of workmanship-related purposes, a device used for positioning or providing limited support for conduit or tubing in addition to required supports or where supports are not required.

Note: POSITIONING DEVICES are not within the scope of this standard.

3.9 PROTECTOR BUSHING: A means to provide protection from nails or screws for cables or tubing placed in bored holes of wood framing in concealed locations.

3.10 PROTECTOR PLATE: A means to provide protection for cables or tubing from nails or screws in concealed installations.

3.11 STANDOFF: In Canada, a nonmetallic means provided to prevent direct contact of nonmetallic-sheathed cable with metal studs when installed in parallel with the stud. In the United States, STANDOFFS for nonmetallic-sheathed cable are not recognized.

3.12 STAPLE: A HARDWARE DEVICE, other than a STRAP, that is typically hammer- or tool-driven, intended to secure conduit, cable, or tubing to a building structure, such as to a wooden stud.

3.13 STRAP: A HARDWARE DEVICE, other than a STAPLE, that is intended to secure conduit, cable, or tubing to a building structure or other support assembly.

4 General Requirements

4.1 Except as indicated in Clause 4.2, a component of a product covered by this standard shall comply with the requirement for that component. A component shall comply with CSA Group or the Underwriters Laboratories Inc. standard as appropriate for the country where the product is to be used.

4.2 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.

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

4.4 The values given in SI (metric) units shall be normative. Any other values given shall be for information purposes only.

4.5 In this standard, a requirement that applies only to one or more types of hardware is so identified by a specific reference in that requirement to the type or types of hardware involved. Absence of such reference indicates that the requirement applies to all types of hardware unless the context indicates otherwise.

4.6 For products intended for use in Canada, general requirements are given in CAN/CSA-C22.2 No. 0, General Requirements – Canadian Electrical Code, Part II.

5 Construction

5.1 General

5.1.1 A HARDWARE DEVICE intended for assembly to conduit, cable, or tubing shall be constructed so that the device complies with the assembly test in Clause 6.2.

5.1.2 A HARDWARE DEVICE for use with more than one type or size of product shall comply with the appropriate requirements for each type or size of product when installed as intended.

5.1.3 A HARDWARE DEVICE shall comply with the applicable requirements in Clauses 7 – 10 and shall be marked as applicable in accordance with Clause 11.

5.1.4 A HARDWARE DEVICE intended for a specific condition of installation or for use with a specific wiring system shall be provided with instructions in accordance with Clause 12.

5.1.5 A HARDWARE DEVICE having any nonmetallic component, and intended for use in AIR-HANDLING SPACES, shall comply with Clause 6.9.

5.1.6 A HARDWARE DEVICE for use in wet locations, having any polymeric component, shall comply with the applicable requirements in Clauses 7 and 8 in both the as-received condition and after exposure to ultraviolet-light and water conditioning described in Clause 6.8.

Note: Products for use in wet locations are tested and considered suitable for outdoor use.

5.1.6A MESSENGER-SUPPORTED WIRING HANGERS, RINGS and SADDLES shall have smooth, rounded surfaces that contact Conduit, Cable or Tubing.

5.1.6B MESSENGER-SUPPORTED WIRING HANGERS, RINGS and SADDLES are considered suitable for outdoor use only and for use in wet locations.

5.1.7 A PROTECTOR BUSHING shall have smooth, rounded entries.

5.2 Materials

5.2.1 A HARDWARE DEVICE using an ELASTOMER other than a thermoplastic ELASTOMER shall comply with Clause 6.5.

5.2.2 A HARDWARE DEVICE using a thermoplastic ELASTOMER shall comply with Clause 6.6.

5.2.3 A polymeric HARDWARE DEVICE shall comply with Clause 6.7.

A HARDWARE DEVICE is not required to be tested if it is of a material classed HB, V-0, V-1, V-2, 5VA, or 5VB, in accordance with IEC 60695-11-10, UL 94 or CAN/CSA-C22.2 No. 0.17. Flammability classifications shall be for the minimum thickness used.

A HARDWARE DEVICE is not required to comply with Clause 6.7 when the following conditions are met:

a) It does not occupy a volume greater than 2 cm^3 (0.12 in^3), and

b) It does not have any dimension greater than 30 mm (1.2 in).

5.2.4 A PROTECTOR PLATE or PROTECTOR BUSHING shall provide sufficient resistance to penetration to create ready awareness of the presence of concealed wires and cables through a framing member beneath, and a degree of protection from driven screws and nails.

5.2.5 In the United States, a PROTECTOR PLATE shall be made of steel a minimum of 1.6 mm (1/16 in) thick, and shall be provided with corrosion protection in accordance with 5.3.1.

In Canada, a PROTECTOR PLATE shall be made of steel a minimum of 1.3 mm (0.05 in) thick, or other materials of equivalent resistance to nail penetration. A PROTECTOR PLATE of ferrous metal shall be provided with protection against corrosion in accordance with 5.3.1.

5.2.6 A PROTECTOR BUSHING shall comply with the requirements in Clause 10.

5.2.7 A nonmetallic STANDOFF for use with nonmetallic-sheathed cable shall comply with Clause 9.

5.2.8 In Canada, a STRAP provided with a hole or holes for mounting, and intended for use with rigid metal conduit or electrical metallic tubing, shall have a minimum mounting hole diameter as specified in Table 1.

In the United States, this requirement does not apply.

5.2.9 In Canada, a STAPLE intended to secure nonmetallic-sheathed cable shall have smooth edges and a maximum radius of 11 mm (0.4 in) on the surface facing the cable. A STAPLE intended to hold armored cable, flexible metal conduit, or nonmetallic-sheathed cable shall be provided with stops to indicate the depth to which the STAPLE is to be driven. The total surface area of the stop indicator shall have a minimum bearing surface of 16 mm^2 (8 mm^2 per side) [0.02 in^2 (0.01 in^2 per side)]. The minimum STAPLE dimensions shall be as specified in Figure 1. Alternatively, a staple without stops shall be used in conjunction with an installation tool that provides staple depth control as identified by the manufacturer.

In the United States, this requirement does not apply.

5.3 Protection against corrosion

5.3.1 A ferrous metal HARDWARE DEVICE shall be protected against corrosion by a coating of zinc. A zinc coating shall have a thickness in accordance with Table 2 as determined in accordance with Clause 6.3.

5.3.2 A HARDWARE DEVICE of stainless steel having a minimum of 16 percent chromium content is not required to have an additional protective coating.

5.3.3 A cut edge, a punched hole, and the threaded surface of a tapped hole of a part formed from galvanized stock is not required to be protected by a zinc coating.

5.3.4 The thickness of a zinc coating specified in Table 2 does not apply to the coating on a screw or formed surfaces not accessible by a 19.1 mm (3/4 in) diameter ball. The presence of a coating shall be determined by visual inspection.

5.3.5 The surfaces of a cast-iron or a malleable iron HARDWARE DEVICE shall be protected against corrosion by zinc or an organic coating. The thickness of a zinc coating is not required to be a specified thickness and its presence shall be determined by visual inspection. An organic coating shall be evaluated in accordance with Clause 6.4.

5.3.6 A surface that has a corrosion protection system in accordance with Clause 6.4 does not require zinc coating protection.

5.4 Conduit spacing for belowground conduit/tubing supports

5.4.1 Horizontal support intervals are limited to the maximum spacing between supports for the specific conduit type to be installed in accordance with the applicable installation codes and standards.

5.4.2 In Canada, a belowground conduit/tubing support shall space conduit a minimum of 190 mm on center.

In the United States, this requirement does not apply.

6 Product Testing for all HARDWARE DEVICES

6.1 General

6.1.1 A HARDWARE DEVICE that is provided with specific instructions shall be assembled and installed in accordance with the method specified by the manufacturer. In the absence of instructions, applicable tests shall be conducted in the most severe foreseeable manner.

6.1.2 When the performance of a HARDWARE DEVICE is dependent upon the type or thickness, or both, of the material to which it is mounted or the mounting position, the HARDWARE DEVICE shall comply with all applicable tests with the HARDWARE DEVICE assembled to each type and/or thickness of mounting surface and in each position specified by the manufacturer. See Clause 12.

6.1.3 Unless otherwise specified, a minimum of six samples of each trade size of a HARDWARE DEVICE shall be subjected to each test. When a series of four or more trade sizes of a particular design is being investigated, a minimum of three samples of each trade size shall be tested.

6.1.4 Unless otherwise specified, all tests shall be conducted at 23 ±5 °C (73 ±10 °F). When the manufacturer rates a HARDWARE DEVICE for use at an elevated or cold temperature, above 90 °C (194 °F) or below minus 5 °C (23 °F), the applicable tests shall be conducted at that temperature, on a separate set of test samples. This temperature shall be marked in accordance with Clause 11.5(c).

6.1.5 When a tensile test machine is used, it shall be capable of holding a specific load and indicating the resulting maximum force with a fixed rate of extension. The crosshead speed used during the test shall be 25.4 ± 2.5 mm per min (1 ± 0.1 in per min).

6.1.6 A device that employs a combination of components and integral attachment means that have been tested separately shall not be required to be tested in combination. The LOAD RATING as specified by the manufacturer for the combination device shall not exceed the LOAD RATING, where determined, of any separate component of the combination. If the combination includes a HANGER, STAPLE, or STRAP, the combination shall meet the minimum loading requirements in Table 6 and Table 7 or Table 8 and Table 9, whichever applies.

6.2 Assembly test

6.2.1 When assembled in accordance with Clauses 6.2.3 – 6.2.5, no part of a HARDWARE DEVICE shall crack or break, and the screw threads shall not be stripped. In addition, the assembly shall comply with Clause 5.1.1.

6.2.2 Following the test in Clauses 6.2.3 – 6.2.5:

a) The inside diameter of a non-flexible tubing or conduit shall not be reduced more than 15 percent as determined by the appropriate means described in UL 514B or CSA C22.2 No. 18.3,

b) Flexible metal conduit, armored cable, and aluminum-sheathed or other metal-clad cable shall not be deformed such that sharp edges of the conduit or cable are present and capable of damage to enclosed wires as determined by visual inspection, and

c) The jacket of nonmetallic-sheathed cable shall not be cut or punctured, as determined by visual inspection.

6.2.3 A HARDWARE DEVICE shall comply with Clause 6.2.1 when assembled as intended, for each size of conduit, cable, or tubing.

6.2.4 A screw or bolt that is provided to secure conduit, cable, or tubing to a HARDWARE DEVICE, or is intended to secure a HARDWARE DEVICE by direct bearing to a flange, shall be tightened to the torque values in accordance with Table 3. Unless otherwise specified in the manufacturer's instructions, a combination head shall be tested using the torque specified in Table 3, Column 2.

6.2.5 Unless indicated by manufacturer's instructions, a bolthead screw and nut combination other than direct bearing, and not having provision for tightening with a screwdriver, shall be tightened using a torque of 18.1 N·m (160 lbf-in).

6.3 Metallic coating thickness test

6.3.1 The test described in Clauses 6.3.2 – 6.3.9 shall be used to determine the thickness of a zinc coating where a minimum thickness is required.

Use of a nondestructive test method to determine the thickness of a zinc coating is not prohibited. Whenever referee measurements are required, the test described in Clauses 6.3.2 – 6.3.9 shall be used.

6.3.2 The solution to be used for the test shall consist of distilled water containing 200 g/L of reagent grade chromic acid, CrO_3, and 50 g/L of reagent grade concentrated sulfuric acid, H_2SO_4. The latter is equivalent to 27 ml/L of reagent grade concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of H_2SO_4.

6.3.3 The test solution shall be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube having an inside bore of 0.64 mm (0.025 in) and a length of 140 mm (5.5 in). The lower end of the capillary tube shall be tapered to form a tip, the drops from which are close to 0.05 milliliter each. To preserve an effectively constant level, a small glass tube shall be inserted in the top of the funnel through a rubber stopper, and its position shall be adjusted so that, when the stopcock is open, the rate of dropping is 100 ± 5 drops per min. An additional stopcock shall be used in place of the glass tube to control the rate of dropping.

6.3.4 The test shall be conducted at a room temperature of 21.1 – 32.2 °C (70 – 90 °F). The sample and the test solution shall be kept in the test room until the temperature of the room, which shall be recorded, is attained.

6.3.5 Each sample shall be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings shall be removed completely by means of solvents. The samples shall then be thoroughly rinsed in water and dried with clean cheesecloth. Care shall be exercised to avoid contact of the cleaned surface by the hands or any foreign material.

6.3.6 The sample to be tested shall be supported 17.8 – 25.4 mm (0.7 – 1 in) below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested shall be inclined close to 45 degrees from horizontal.

6.3.7 After cleaning, the sample to be tested shall be put in place under the orifice. The stopcock shall be opened and the time in seconds shall be measured with a stopwatch until the dropping solution dissolves the protective metallic coating, exposing the base metal. The end point is the first appearance of the base metal, recognizable by a change in color at that point.

6.3.8 Each sample shall be subjected to the test at three or more points – excluding cut, stenciled, and threaded surfaces – on the inside surface and at an equal number of points on the outside surface, at places where the metallic coating is the thinnest.

6.3.9 The thickness of the coating being tested shall be calculated by determining the thickness factor corresponding to the temperature at which the test was conducted from Table 4, multiplying by 0.0003 mm (0.00001 in), and then multiplying by the time in seconds required to expose the base metal as determined in accordance with Clause 6.3.7.

6.4 Alternative corrosion protection systems tests

6.4.1 General

6.4.1.1 A coating, other than zinc plating, that is not intended for use in wet locations shall comply with Clause 6.4.3. Sample preparation and conditioning shall be in accordance with Clauses 6.4.1.3, 6.4.1.4, and 6.4.2.

6.4.1.2 A coating, other than zinc plating, that is intended for use in wet locations shall comply with Clauses 6.4.3 – 6.4.5. Sample preparation and conditioning shall be in accordance with Clauses 6.4.1.3, 6.4.1.4, and 6.4.2. The resistance to ultraviolet light and water exposure is only applicable for painted or polymeric coatings.

6.4.1.3 For a corrosion protection system intended for use in wet locations, a minimum of 50 samples of the finished product that is representative of an alternative corrosion protection system and has maximum significant surface area, or, where appropriate for the system under investigation, steel panels measuring 100 by 150 mm (4 by 6 in) of any thickness, shall be provided. A minimum of 30 samples shall be tested. For corrosion protection systems not intended for use in wet locations, a minimum of 20 samples shall be provided. A minimum of 12 samples shall be tested. The additional samples shall be used in case of damage to the original samples during preparation or handling.

6.4.1.4 The edges or unprotected surfaces of all panels or finished products shall be covered with moisture-resistant tape or compound. For painted coatings, half of the samples to be exposed shall be scribed in accordance with ASTM D1654. The samples shall be free of dirt or foreign matter. Samples shall be suitably cleaned. The cleaning method shall be optional depending on the nature of the surface and the contaminants. Care should be taken that samples are not re-contaminated after cleaning by excessive or careless handling. The coating thickness of each sample shall be measured prior to exposure to the test environments.

6.4.2 Air-oven conditioning exposure

6.4.2.1 Not less than six unscribed, and where appropriate, six scribed samples (see Clause 6.4.1.4) of each system shall be conditioned for 240 h in an air-circulating oven at 87 ±1 °C (189 ±2 °F). These samples shall be used for Clauses 6.4.3 and 6.4.4.

6.4.3 Resistance to salt-spray (fog) test

6.4.3.1 A minimum of six as-received and a minimum of six air-oven conditioned samples shall be exposed to the salt spray (fog) for a duration as specified in Table 5. Exposure shall be in accordance with ASTM B117. Where applicable, three of the as-received and three of the air-oven conditioned samples shall be scribed as specified in Clause 6.4.1.4.

6.4.3.2 For a painted or polymeric coating, as a result of the exposure in Table 5, the unscribed samples shall not be greater than Rating No. 5 (11 – 20 percent area failure) as designated in Procedure B of ASTM D1654. For the scribed samples, the average creeping distance of corrosion products from the scribe shall not be greater than Rating No. 5 [3 – 5 mm (1/8 – 3/16 in)] as designated in Procedure A, Method 2 of ASTM D1654, with maximum isolated spot not exceeding 9.5 mm (3/8 in).

6.4.3.3 For other than a painted or polymeric coating, the samples shall not exhibit red rust over more than 5 percent of their surface after exposure for the duration indicated in Table 5. For products intended for use in other than wet locations, if the results are inconclusive, all samples shall remain in the salt (fog) spray chamber for a total period of 168 h. The coating shall be considered to be in compliance if none of the samples exhibit red rust over more than 50 percent of their surface after this additional exposure.

Note: For the purpose of this standard, for phosphate/oil or phosphate/organic coatings, red rust is determined as base metal corrosion in accordance with Clause 8.2 of ASTM D1654.

6.4.4 Resistance to moist carbon dioxide-sulfur dioxide-air test

6.4.4.1 Six as-received and six air-oven conditioned samples shall be exposed to the moist carbon dioxide-sulfur dioxide-air for 1200 h. The apparatus used for this exposure shall consist of a chamber having a volume of at least 0.085 cubic meters (3 cubic feet) with a water jacket and thermostatically controlled heater to maintain a temperature of 35 ±2 °C (95 ±3 °F). Three of the as-received and three of the air-oven conditioned samples shall be scribed as described in Clause 6.4.1.4.

6.4.4.2 For painted coatings, as a result of the conditioning, the unscribed samples shall not show more than a light corrosion beneath the coating system, with no visual pitting of the substrate and only the beginning of a buildup or weeping of corrosion products. For the scribed samples, the average creeping distance of corrosion products from the scribe shall not be greater than Rating No. 6 [1.6 – 3.2 mm (1/16 – 1/8 in)] as designated in Procedure A, Method 2 of ASTM D1654, with maximum isolated spot not exceeding 9.5 mm (3/8 in).

6.4.4.3 For other than a painted coating, as a result of the exposure, the samples shall not show evidence of red rust.

Note: For the purpose of this standard, red rust is determined as base metal corrosion in accordance with ASTM F1137.

6.4.4.4 The carbon dioxide and sulfur dioxide shall be supplied to the test chamber from commercial cylinders containing the gases under pressure. An amount of carbon dioxide equivalent to 1 percent of the volume of the test chamber and an equal volume of sulfur dioxide shall be introduced into the chamber each working day. Prior to introducing the new charge of gas each day, the remaining gas-air mixture from the previous day shall be purged from the chamber. A small amount of water shall be maintained at the bottom of the chamber for humidity. This water shall not be changed during the exposure. The samples shall be supported in plastic racks at an angle of 15 degrees from the vertical.

6.4.5 Resistance to ultraviolet light and water test

6.4.5.1 Three unscribed and, where applicable, three scribed samples (see Clause 6.4.1.4) shall be exposed to ultraviolet light and water by the method specified in Clause 6.4.5.3.

6.4.5.2 As a result of the exposure, the unscribed samples shall not show base metal corrosion (red rust) or blisters. For the scribed samples, the average creeping distance of corrosion products from the scribe shall not be greater than Rating No. 6 [1.6 – 3.2 mm (1/16 – 1/8 in)] as designated in Procedure A, Method 2 of ASTM D1654, with maximum isolated spot not exceeding 9.5 mm (3/8 in). There shall not be visual evidence of pitting of the substrate and only the beginning of a build-up of corrosion products beneath the coating uplifted from the scribe.

6.4.5.3 In Canada, the samples shall be exposed for 1000 h to ultraviolet light and water in accordance with ISO 4892-1 and the xenon-arc, Method A, Cycle No. 2 in accordance with ISO 4892-2. Continuous exposure to light and intermittent exposure to water spray, with a programmed cycle of 120 min consisting of a 102 min light exposure and an 18 min exposure to water spray with light, shall be used. The apparatus shall operate with a 6500 W, water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of 0.35 W/m^2/nm at 340 nm and a black-panel temperature of 63 ±3 °C (145 ±5 °F).

In the United States, the samples shall be exposed for 500 h.

6.5 ELASTOMERIC materials test

6.5.1 An ELASTOMER other than a thermoplastic ELASTOMER shall not crack or show a change in hardness of more than ten numbers after the conditioning specified in Clause 6.5.3.

6.5.2 Three samples of each trade size of the HARDWARE DEVICE being tested shall be conditioned in accordance with Clause 6.5.3.

6.5.3 The hardness of the unaged material shall be determined as the average of five readings using a gauge such as the Rex hardness gauge or the Shore Durometer. The samples shall then be conditioned for 70 h in an air-circulating oven at 100 ±1 °C (212 ±2 °F). After conditioning, the samples shall rest at room temperature for not less than 4 h, and the hardness shall then be determined again as the average of five readings. The difference between the original hardness reading and the reading taken after the conditioning is the change in hardness.

6.6 Mold stress-relief test

6.6.1 A thermoplastic ELASTOMER product or a metal product with thermoplastic ELASTOMER components shall not show evidence of cracking or change in any dimension greater than 10 percent when the sample is conditioned in accordance with Clause 6.6.2. A part employing only thermosetting materials is not required to be subjected to this test.

6.6.2 A minimum of six unassembled samples shall be conditioned for 7 h at a temperature of 70 ±1 °C (158 ±2 °F) in an air-circulating oven. Following removal from the oven, the samples shall cool to room temperature in still air for not less than 4 h before being examined. After cooling, each sample shall be examined to determine compliance with Clause 6.6.1.

6.7 Flammability test

6.7.1 Unless otherwise specified in Clause 5.2.3, a polymeric product or a metal product with polymeric components shall have a minimum flammability classification of HB, or be tested in accordance with Clause 6.7.2.

6.7.2 The finished product material shall be tested in accordance with IEC 60695-11-5. As a result of this test, the finished product material shall not:

a) Openly flame for more than one minute after the final application of the test flame,

b) Be consumed,

c) Have any opening in the material that accommodates a 6.4 mm (1/4 in) diameter rod to be passed through after the material has returned to ambient temperature. The rod shall be applied without force, or

d) Have a visible flame on the opposite surface to which the test flame has been applied.

6.8 Wet location use

6.8.1 As a result of the conditioning described in Clause 6.8.2, a polymeric product or metal product with an exposed polymeric component shall not crack or break. When the product is provided in more than one color, the color having the heaviest organic pigment loading, and any other colors (such as red or yellow) known to have particular critical effects, shall be subjected to this test. All sets tested are determined to be representative of the entire color range of the material.

This requirement does not apply where the exposed polymeric component of a metal product is not depended upon for the intended function of the product in accordance with this standard.

6.8.2 Each sample shall be exposed for 1000 h to ultraviolet light and water in accordance with ISO 4892-1 and the xenon-arc, Method A, Cycle No. 2 in accordance with ISO 4892-2. Continuous exposure to light and intermittent exposure to water spray, with a programmed cycle of 120 min consisting of a 102 min light exposure and an 18 min exposure to water spray with light, shall be used. The apparatus shall operate with a 6500 W, water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiant of 0.35 W/m^2/nm at 340 nm, and a black-panel temperature of 63 ±3 °C (145 ±5 °F).

6.8.3 The samples shall be mounted on the inside of the cylinder in the ultraviolet-light apparatus so they do not touch each other. After the exposure, the samples shall be removed from the cylinder and visually compared to the unconditioned samples.

6.8.4 Ultraviolet exposure is not required for a coated metallic HARDWARE DEVICE when the non-coated version complies with Clause 6.3.

6.9 Smoke and heat release test

6.9.1 A HARDWARE DEVICE having any nonmetallic element, and intended for use in an AIR-HANDLING SPACE as defined in Clause 3.2, shall be tested in accordance with Annex A, Smoke and Heat Release Test. Due to the variability of the types of products within the scope of this standard, the mounting means and quantity of samples for this test shall be determined prior to testing.

Note: For guidance in determining the appropriate test quantity, see UL 1565 or CSA C22.2 No. 18.5.

6.9.2 The test shall consist of two sample sets. Where appropriate, a thin wire mesh basket or similar means that is representative of the mounting of the product in normal use shall be determined. The means shall contain the set of samples and ensure that the polymeric material of the devices remains within the range of the flame source throughout the test. The wire mesh shall be galvanized steel screening with approximately 1.2 mm (3/64 in) openings.

6.9.3 To determine compliance with Clause 6.9.1, each of the following properties shall be evaluated and be within the specified limits:

a) The peak rate of heat release (HRR_s) measured during each test shall be 100 kilowatts or less,

b) The peak normalized optical density measured during each test shall be 0.50 or less (0.21 m^2/s or less peak smoke release rate, SRR_S), and

c) The average normalized optical density (10 minute test duration) shall be 0.15 or less (75m^2 total or less released, TSR).

7 Product Testing for HANGERS, STAPLES, and STRAPS

7.1 General

7.1.1 In addition to the requirements in Clause 5, HANGERS, STAPLES, and STRAPS shall comply with Clauses 7.1.2 and 7.2.1 – 7.2.8.

7.1.2 A polymeric STAPLE or STRAP that uses nails for installation shall be tested in accordance with Clause 7.3.

7.2 Pull test

7.2.1 As a result of the test described in Clauses 7.2.4 – 7.2.8:

a) The conduit, cable, or tubing shall not pull free from the HANGER, STAPLE, or STRAP,

b) Bending or other damage to a HANGER, STAPLE, or STRAP shall not enable the removal of the conduit, cable, or tubing without force, and

c) A STAPLE or STRAP provided with nails, or a STRAP or STAPLE having an integral means for nailing shall not pull free from the mounting surface.

7.2.2 Unless otherwise specified by the manufacturer's instructions, samples capable of assembly with a screwdriver shall be tightened to a torque of 3.96 N·m (35 lbf-in), and samples capable of assembly only with a wrench shall be tightened to a torque of 18.1 N·m (160 lbf-in).

7.2.3 The pull force specified in Clause 7.2.4 shall be used for the test specified in 7.2.5 to 7.2.8 and shall be one of the following for HANGERS, STAPLES, and STRAPS based on the intended use to secure or support:

a) Non-flexible conduits and tubing: as specified in Table 6 to Table 9 or three times the manufacturer's marked LOAD RATING, whichever is greater. If the device is not constructed to accommodate a specific size(s) of non-flexible conduits and tubing, then the pull force shall be three times the manufacturer's marked LOAD RATING. The minimum LOAD RATING is 228 N (50 lbf),

b) Flexible conduits or tubing or cables: the force shall be 228 N (50 lbf) for all sizes, and

c) Low voltage telecommunications cables – three times the manufacturer's marked LOAD RATING.

7.2.4 Each assembly from Clauses 7.2.6 and 7.2.7 shall be subjected to, and maintain, a pull force for 5 min, applied normal to the mounting surface.

7.2.5 In addition to compliance with Clause 7.2.4, combination devices, such as a conduit HANGER integrally attached to a BEAM CLAMP, the BEAM CLAMP shall comply with Clause 8.2.

7.2.6 HANGERS and STRAPS shall be mounted rigidly to a test fixture, and STAPLES shall be secured to stud-grade pine or spruce wood. When a range of cable, conduit, or tubing sizes is specified, each test shall be conducted on the largest and smallest specified sizes in that range. Cable, conduit, or tubing used for this test shall be 152.4 mm (6 in) long. The assembled samples shall be tested in accordance with the applicable requirements in Clauses 7.2.7 and 7.2.8.

7.2.7 For a HANGER, STAPLE, or STRAP of a polymeric material, or having a polymeric component, each assembly from Clause 7.2.6 shall be tested in accordance with Clause 6.6 prior to conducting the pull test described in Clause 7.2.4. The samples shall cool to room temperature before being subjected to the pull test. The Mold Stress-Relief Test is not required for test samples tested in accordance with Clause 6.4.5.

7.2.8 The test apparatus for a HARDWARE DEVICE for attachment to drop wire shall ensure that both ends of the wire are secured and the wire is taut.

7.3 Impact test

7.3.1 Following the test described in Clause 7.3.2, the samples shall not crack or break.

7.3.2 Samples shall be conditioned for 5 h in a chamber at minus 20 ±1 °C (minus 4 ±2 °F). Immediately after removal from the conditioning chamber, each sample shall be placed on a 12.7 mm (1/2 in) thick steel plate covered with a nominal 12.7 mm (1/2 in) thick sheet of marine plywood. The sample shall be positioned with the nailing surface perpendicular to the surface of the plywood. Cable, conduit, or tubing of the type and minimum size specified by the manufacturer shall be positioned under the STAPLE or STRAP as intended. A 1.36 kg (3 lb), 28.6 mm (1-1/8 in) diameter cylindrical steel weight having a flat 25.4 mm (1 in) diameter impact surface with no sharp edges shall be dropped through a vertical distance of 279.4 mm (11 in). References shall be employed so that the impact face of the test weight strikes the nailing attachment at the point where the nail head normally projects, without any nails in place. Not more than 15 s shall elapse between the time the sample is removed from the conditioning chamber and the impact is applied.

8 Product Testing for BEAM CLAMPS

8.1 General

8.1.1 In addition to Clause 5, a BEAM CLAMP shall comply with Clauses 8.2.1 – 8.2.5.

8.2 Pull test

8.2.1 As a result of the test described in Clauses 8.2.2 – 8.2.5, the BEAM CLAMP shall remain on the beam while under load, and:

a) The BEAM CLAMP shall not crack or break,

b) The screw threads shall not strip, and

c) The threaded stud or HARDWARE DEVICE being supported shall remain secured to the BEAM CLAMP.

8.2.2 Each test assembly shall include the BEAM CLAMP, beam, threaded stud (where a BEAM CLAMP has such provision), and the product intended to be supported as specified in the installation instructions (when specified for use). Each individual component of a combination device, such as a conduit HANGER integrally attached to a BEAM CLAMP, shall comply with the requirements for that component. A threaded stud shall be standard grade unless a hardened grade stud is specified by the manufacturer.

8.2.3 BEAM CLAMPS with screws for attachment to the beam shall be assembled to the torque indicated in Table 3, Column 1. If there is no provision for tightening with a screwdriver, the BEAM CLAMP shall be assembled in accordance with Table 3, Column 2.

8.2.4 The BEAM CLAMP shall be assembled as intended to a section of a beam having a flange thickness in accordance with the manufacturer's ratings. When a flange thickness is not specified by the manufacturer, the BEAM CLAMP shall be assembled to a beam section with a flange 3.2 mm (1/8 in) thick.

When a range of flange thicknesses is specified, the BEAM CLAMP shall be tested with the smallest and largest specified flange thicknesses.

8.2.5 Each assembly shall be subjected to a pull force for 5 min, applied from the threaded stud or product being supported from the BEAM CLAMP. For a combination device that includes a BEAM CLAMP, the force shall be applied to the BEAM CLAMP from the threaded stud or product being directly supported. The force shall be three times the manufacturer's marked LOAD RATING. Where a LOAD RATING is not provided, a force in accordance with Table 6 – Table 9 for the largest trade size conduit or tubing for which the clamp is rated shall be applied.

9 Product Testing for STANDOFFS

9.1 Mold stress

9.1.1 There shall not be a dimensional change greater than 5 percent in a nonmetallic STANDOFF after being conditioned in an air-circulating oven for 168 h at 112 ±1 °C (234 ±2 °F).

9.2 Voltage withstand

9.2.1 A STANDOFF shall be capable of withstanding an ac voltage of 1.0 kV without breakdown for a period of 1 min at a temperature of 23 ±5 °C (73 ±10 °F). The STANDOFF shall be installed to a steel stud in the intended manner. Voltage shall be applied to a metal mandrel that is held in place by the STANDOFF. The voltage shall be applied through an electrode attached to the steel stud with the mandrel connected to ground.

10 Product Testing for PROTECTOR BUSHINGS

10.1 General

10.1.1 In addition to the requirements in Clause 5, PROTECTOR BUSHINGS shall comply with Clauses 10.2 – 10.5.

10.1.2 After performing the test in described in Clauses 10.2 – 10.5, none of the six samples of PROTECTOR BUSHINGS shall be pierced or have encroaching burrs. A material that has been found in compliance with the following Clauses is acceptable for other bushing ranges without testing.

10.2 Assembly preparation

10.2.1 Three holes shall be bored into the wider side of two separate 2 x 4 spruce wood studs a minimum 610 mm (24 in) long. The diameter of the holes shall be the smallest of the range of the BUSHING PROTECTORS according to the manufacturer's instructions. The circumference of the holes shall be at 25 mm (1 in) from the front of the stud. No. 6 drywall screws 41.3 mm (1-5/8 in) long, not of the self-drilling type shall be used. Holes shall be at least 100 mm (4 in) apart from each other.

10.2.2 The screw specified in Clause 10.2.1 shall be driven until the tip of the screw is flush with the inside of the bore hole. The PROTECTOR BUSHING shall then be inserted with the joint facing the wall, or in accordance with the manufacturer's instructions.

10.3 Dislodge test

10.3.1 The PROTECTOR BUSHING shall not be removable without the use of a tool. If the manufacturer's instructions includes a range of hole sizes in which the protector bushing can be installed, the test shall be carried out on the smallest and largest hole sizes in the range.

10.4 Test sequence

10.4.1 The screw shall be driven by means of a corded screw gun with variable torque capability for no more than 4 seconds, with the screw gun operating at a rotational speed greater than 500 rpm and set at maximum torque. The PROTECTOR BUSHING shall be considered in compliance with Clause 10.1.2 if the screw gun turns freely due to shearing of the threads formed in the wood stud.

10.4.2 The PROTECTOR BUSHING is not considered to comply with Clause 10.1.2 if the screw penetrates through the wall of the PROTECTOR BUSHING.

10.5 Inspection

10.5.1 The screws shall be withdrawn. The PROTECTOR BUSHING shall be removed for visual inspection.

10A Product Testing for Aboveground (Free Floating or Roof-Top) and Belowground Conduit/Tubing Supports

10A.1 Load test

10A.1.1 As a result of the test described in 10A.1.2 to 10A.1.5, the conduit or tubing support for use above ground and/or below ground shall not crack, break, or show other damage that could impair the devices performance.

10A.1.2 For conduit or tubing support for use:

a) Aboveground the LOAD FORCE specified in 10A.1.3 or three times the manufacturer's marked LOAD RATING, whichever is greater, shall be used for the tests specified in 10A.1.4 and 10A.1.5, and

b) Belowground the LOAD FORCE specified in 10A.1.3, shall be used for the tests specified in 10A.1.4 and 10A.1.5.

10A.1.3 Each sample from 10A.1.4 and 10A.1.5 shall be subjected to, and maintain, a compressive LOAD FORCE for 5 min, applied normal to the mounting surface. The LOAD FORCE shall be as specified in Table 10 and Table 11.

10A.1.4 Conduit or tubing supports shall be placed between two flat rigid plates at least 150 mm (6.0 in) long and 10 mm (0.4 in) thick, and a compressive force equal to that specified in Table 10 and Table 11 shall be applied with a tension/compression type machine at a rate of 12.7 mm/min (0.5 in/min). For above ground supports the load shall be applied through a conduit or tubing with an external diameter equivalent to the largest trade size raceway the support is intended for use with. For below ground supports, the load shall be directly applied to a vertically oriented sample by the plates.

10A.1.5 For a conduit or tubing support of a polymeric material, or having a polymeric component, each support from 10A.1.4 shall be tested in accordance with and deemed compliant with 6.6 prior to conducting the load test described in 10A.1.3. The samples shall cool to room temperature before being subjected to the load test.

10A.2 Resistance to impact (aboveground supports only)

10A.2.1 As a result of the test described in 10A.2.2, the conduit or tubing support for use above ground only shall not crack, break, or show other damage that could impair the devices performance.

10A.2.2 Six samples of each type of conduit support being tested shall be exposed for 5 hours to air maintained at minus 35 ± 1°C (minus 31 ± 2°F). Immediately after being removed from the cold chamber, each sample shall be dropped onto a concrete floor from a height of 1.52 m (5 ft).

10A.3 Water absorption

10A.3.1 The material used for a support shall be conditioned as described in 10A.3.2. The conditioning shall not result in:

a) Any dimensional change of the specimen, including thickness, of more than 3 percent, or

b) An increase in the weight of the specimen of more than 3 percent.

10A.3.2 To determine whether a material used for a support complies with the requirements in 10A.3.1, three specimens of the molded material of a support, each being 25.4 mm (1 in) by 76.2 mm (3 in) shall be tested. Each specimen shall be dried in a calcium chloride desiccator for 24 hours. After being dried, each specimen shall be measured, weighed, and then immersed for 24 hours in distilled water maintained at a temperature of 23.0 ±2°C (73 ±4°F). Following removal from the water, each specimen shall be wiped dry of excess moisture, and the change in the dimensions and weight shall be determined. The percentage of change shall then be calculated in accordance with the method for measuring water absorption of plastics in the UL 746A.

10B Product Testing for Messenger-Supported Wiring Hangers, Rings and Saddles

10B.1 General

10B.1.1 In addition to the requirements in Clause 5, Messenger Supported Wiring HANGERS, Rings and Saddles shall comply with Clauses 6.1, 6.2, 6.3, 6.4, 6.6, 7.2, 10B.2 and 10B.3.

10B.2 Voltage withstand

10B.2.1 A HANGER, RING or SADDLE shall be capable of withstanding an ac voltage of 1.0 kV without breakdown for a period of 1 min at a temperature of 23 ±5 °C (73 ±10 °F).

10B.2.2 Six specimens of a HANGER, RING or SADDLE shall each be installed in the intended manner. Voltage shall be applied to a metal mandrel representing the max diameter cable that is held in place by the HANGER, RING or SADDLE. The voltage shall be applied through the messenger cable or an electrode representing the messenger cable to the mandrel secured by the hanger.

10B.3 Low temperature handling

10B.3.1 A HANGER, RING or SADDLE shall not shatter, chip, or crack when handled at low temperature as indicated in Clause 10B.3.2.

10B.3.2 Six specimens shall be cooled in circulating air for five hours to a temperature of minus 20.0 ±1.0 °C (minus 4.0 ± 2.0 °F). While still at the low temperature, each specimen shall be dropped onto a concrete floor twice in quick succession from a height of 1525 mm (60 inches). During the first drop, the sample shall contact the floor at an angle of approximately 45 degrees so that one end of it reaches the floor first. For the second drop, the sample shall fall parallel to the floor.

11 Markings

11.1 Markings shall be permanent, legible, and visible after the product is installed. The following types of markings or the equivalent are permanent:

a) Etched,

b) Molded,

c) Die stamped, or

d) Indelibly stamped on a pressure sensitive label secured by adhesive and complying with UL 969 or CSA C22.2 No. 0.15.

11.2 A marking in addition to a required marking shall not conflict with or be able to be confused with a required marking.

11.3 Units of measure for markings shall be in SI (metric), equivalent units, or both.

11.4 Each HARDWARE DEVICE shall be marked with the manufacturer's name, trademark, or other descriptive marking identifying the organization responsible for the product.

11.5 The following, where applicable, shall be marked on the HARDWARE DEVICE or the smallest unit shipping carton:

a) A catalog number or equivalent designation,

b) "Wet locations" in accordance with Clause 5.1.6,

c) Application temperatures in accordance with Clause 6.1.4, and

d) In the United States, "Suitable for maximum 3.05 m (10.0 ft) support interval" or equivalent, for HANGERS or STRAPS for use with rigid and intermediate metal conduit trade sizes 2-1/2 (63) and larger, when tested as specified in Table 6 – Table 9 using the values for maximum 3.05 m (10.0 ft) intervals. See footnote (a) in the Tables.

In Canada, (d) does not apply.

11.6 The following, where applicable, shall be marked on the smallest unit shipping carton or installation instructions provided on or in the smallest unit carton:

a) Types or range of thicknesses of a beam flange, drop wire, or rod according to Clause 6.1.2,

b) Intended mounting orientations, if restricted (for example, vertical or horizontal),

c) Sizes and types of conduit, cable, or tubing intended to be supported for HANGERS and STRAPS,

d) Quantity, sizes and types of conduit, cable, or tubing intended to be supported for STAPLES,

e) LOAD RATING when tested to values greater than as specified in Table 6 – Table 9, or Clause 7.2.4, for the intended applications,

f) Manufacturer designated assembly torque when other than indicated in Table 3. See Clauses 6.2.4 and 6.2.5, and

g) For staples without stops, the manufacturers designated installation tool.

11.7 In the United States, when the manufacturer produces HARDWARE DEVICES at more than one factory, each product shall be marked with a distinctive designation identifying it as the product of a particular factory.

In Canada, this requirement does not apply.

11.8 The smallest unit shipping carton, or installation instructions when provided, for a HARDWARE DEVICE that complies with Clause 6.9 may be marked as follows:

a) For devices of all metallic construction, “Suitable for use in AIR HANDLING SPACES (plenums) in accordance with Section 300.22 (B), (C), and (D) of the National Electrical Code, and Rules 12-010 (3), (4), and (5), and 12-020 of the Canadian Electrical Code, Part I” or an equivalent wording. Marking of the code “AH-1” meets the intent of this requirement.

b) For devices constructed of polymeric materials, “Suitable for use in AIR HANDLING SPACES (plenums) in accordance with Section 300.22 (C) and (D) of the National Electrical Code, and Rules 12-010 (3), (4), and (5), and 12-020 of the Canadian Electrical Code, Part I” or an equivalent wording. Marking of the code “AH-2” meets the intent of this requirement.

11.9 A HARDWARE DEVICE complying with the applicable pull force requirements of Clause 7.2.4 shall be allowed to be marked on the device or the smallest unit shipping carton with the reference LOAD RATING corresponding to the pull force as specified in Table 6 – Table 9.

11.10 The following, where applicable, shall be marked on the conduit or tubing support for use (free-floating or roof-top) above ground:

a) A catalog number or equivalent designation, and

b) The largest size and type of raceway the support is intended for use with (see Table 10 and Table 11 for sizes and types of raceways).

11.11 A conduit or tubing support for use aboveground and complying with the applicable load requirements of 10A.1.3 may be marked on the device or on the smallest unit shipping carton with the reference LOAD RATING corresponding to the LOAD RATING as specified in Table 10 and Table 11.

11.12 The following shall be marked on the conduit/tubing support belowground:

a) A catalog number or equivalent designation.

b) "Not for lifting or rigging of raceway bundles", or equivalent wording.

c) “Not for use with DB-2 PVC Conduit”, or equivalent wording.

12 Installation Instructions

12.1 With reference to Clauses 5.1.4 and 6.1.2, where separate installation instructions are provided with a HARDWARE DEVICE, they shall include the information specified in Clauses 11.5 and 11.6.

Table 1
Minimum mounting hole diameter for STRAPS for rigid metal conduit or electrical metallic tubing

(See Clause 5.2.8.)

Trade size (metric designator)		Minimum diameter mm (in)	
		One-hole STRAP	Two-hole STRAP
1/2 and 3/4	(16) and (21)	4.7 (3/16)	4.7 (3/16)
1	(27)	6.3 (1/4)	4.7 (3/16)
1-1/4 to 1-1/2	(35) to (41)	6.3 (1/4)	5.6 (7/32)
2 to 3	(53) to (78)	9.5 (3/8)	7.2 (9/32)
3-1/2 to 6	(91) to (155)	12.7 (1/2)	8.7 (11/32)

Table 2
Thickness of zinc coating

(See Clauses 5.3.1 and 5.3.4.)

Type of HARDWARE DEVICE and material	Thickness of zinc coating, mm (in)	
	Average[a]	Minimum
A steel HARDWARE DEVICE for use in other than wet locations	0.0038 (0.00015)	0.0025 (0.0001)
Malleable or cast-iron HARDWARE DEVICES	b	b
Screws	b	b
A steel HARDWARE DEVICE for use in wet locations	0.0127 (0.0005)	0.010 (0.0004)

[a] The average thickness shall be determined by averaging at least three measurements. Unless size prohibits such measurements, each measurement shall be taken on a different surface. Where multiple measurements are taken on a single surface, they shall be spaced equally over that surface.

[b] The minimum thickness of the zinc coating on these HARDWARE DEVICES and components is not specified. Evidence of zinc corrosion protection shall be verified by visual inspection.

Table 3
Assembly torque

(See Clauses 6.2.4, 8.2.3, and 11.6.)

Screw/bolt size	Column 1 Screw tightened with a screwdriver  N·m (lbf-in)	Column 2 Bolt tightened with a wrench  N·m (lbf-in)
No. 6	1.36 (12)	–
No. 8	2.26 (20)	–
No. 10	3.96 (35)	3.96 (35)
1/4	3.96 (35)	4.52 (40)
5/16	3.96 (35)	6.78 (60)
3/8	3.96 (35)	6.78 (60)
7/16	3.96 (35)	10.17 (90)
1/2	3.96 (35)	14.13 (125)
9/16	3.96 (35)	20.34 (180)
5/8	3.96 (35)	28.25 (250)
3/4	3.96 (35)	45.20 (400)
7/8	–	75.15 (665)
1	–	111.87 (990)

NOTE 1 These screwhead figures are shown as examples only, and are not intended to represent all possible configurations.

NOTE 2 With reference to Clause 8.2.3, the screwhead figures are not applicable.

Table 4
Thickness of zinc coating

(See Clause 6.3.9.)

Temperature, degrees C (F)	Thickness factors for zinc coating
21.1 (70)	0.980
21.7 (71)	0.990
22.2 (72)	1.000
22.8 (73)	1.010
23.3 (74)	1.015
23.9 (75)	1.025
24.4 (76)	1.033
25.0 (77)	1.042
25.6 (78)	1.050
26.1 (79)	1.060
26.7 (80)	1.070
27.2 (81)	1.080
27.8 (82)	1.085
28.3 (83)	1.095
28.9 (84)	1.100
29.4 (85)	1.110
30.0 (86)	1.120
30.6 (87)	1.130
31.1 (88)	1.141
31.7 (89)	1.150
32.2 (90)	1.160

Table 5
Salt spray (fog) test exposure

(See Clauses 6.4.3.1, 6.4.3.2, and 6.4.3.3.)

Wet locations		Other than wet locations	
Steel products	Iron products	Steel products	Iron products
400 h	80 h	72 h	24 h

Table 6
Pull force requirements and LOAD RATINGS for STAPLES and STRAPS

(See Clauses 6.1.6, 7.2.4, 8.2.5, 11.5, 11.6, and 11.9.)

Trade size	(Metric designator)	Pull force/LOAD RATING					
		Electrical metallic tubing (EMT)[a]		Rigid metal conduit (RMC), intermediate metal conduit (IMC)[a, c]		Rigid PVC conduit	
		Pull force (N)	Reference LOAD RATING (kg)	Pull force (N)	Reference LOAD RATING (kg)	Pull force (N)	Reference LOAD RATING (kg)
1/2	(16)	334	11	445	14	667	23
3/4	(21)	445	14	667	23	667	23
1	(27)	556	18	845[b]	27[b]	712	23
1-1/4	(35)	667	23	1001[b]	34[b]	778	25
1-1/2	(41)	1112	36	1112[b]	36[b]	801	27
2	(53)	1334	45	1334[b]	45[b]	890	29
2-1/2	(63)	1557	50	1668	57	1112	36
				2113[b]	73[b]		
3	(78)	1779	59	2224	75	1334	45
				3892[b]	134[b]		
3-1/2	(91)	2224	73	2668	91	1668	57
				5004[b]	170[b]		
4	(103)	2669	91	3114	150	2002	68
				6228[b]	213[b]		
5	(129)	–	–	4448	150	2669	91
				8452[b]	288[b]		
6	(155)	–	–	4448	197	4003	136
				8452[b]	404[b]		

[a] Horizontal support intervals are limited to 3.05 m (10 ft) maximum.

[b] In the United States, suitable for horizontal support intervals greater than 3.05 m (10 ft), not exceeding 3.7 m (12 ft) for trade size 1 (27), 4.3 m (14 ft) for trade sizes 1-1/4 (35) and 1-1/2 (41), 4.9 m (16 ft) for trade sizes 2 and 2-1/2 (63), and 6.10 m (20 ft) for trade size 3 and larger. In Canada, this does not apply.

[c] In Canada, intermediate metal conduit is not recognized by the Canadian Electrical Code.

NOTE: This table includes SI (metric) units. See Table 7 for equivalent values.

Table 7
Pull force requirements and LOAD RATINGS for STAPLES and STRAPS

(See Clauses 6.1.6, 7.2.4, 8.2.5, 11.5, 11.6, and 11.9.)

Trade size	(Metric designator)	Pull force/LOAD RATING					
		Electrical metallic tubing (EMT)[a]		Rigid metal conduit (RMC), intermediate metal conduit (IMC)[a, c]		Rigid PVC conduit	
		Pull force (lbf)	Reference LOAD RATING (lb)	Pull force (lbf)	Reference LOAD RATING (lb)	Pull force (lbf)	Reference LOAD RATING (lb)
1/2	(16)	75	25	100	30	150	50
3/4	(21)	100	30	150	50	150	50
1	(27)	125	40	190[b]	60[b]	160	50
1-1/4	(35)	150	50	225[b]	75[b]	175	55
1-1/2	(41)	250	80	250[b]	80[b]	180	60
2	(53)	300	100	300[b]	100[b]	200	65
2-1/2	(63)	350	110	375	125	250	80
				475[b]	160[b]		
3	(78)	400	130	500	165	300	100
				875[b]	295[b]		
3-1/2	(91)	500	160	600	200	375	125
				1125[b]	375[b]		
4	(103)	600	200	700	330	450	150
				1400[b]	470[b]		
5	(129)	–	–	1000	330	600	200
				1900[b]	635[b]		
6	(155)	–	–	1000	435	900	300
				1900[b]	890[b]		

[a] Horizontal support intervals are limited to 3.05 m (10 ft) maximum.

[b] In the United States, suitable for horizontal support intervals greater than 3.05 m (10 ft), not exceeding 3.7 m (12 ft) for trade size 1 (27), 4.3 m (14 ft) for trade sizes 1-1/4 (35) and 1-1/2 (41), 4.9 m (16 ft) for trade sizes 2 and 2-1/2 (63), and 6.10 m (20 ft) for trade size 3 and larger. In Canada, this does not apply.

[c] In Canada, intermediate metal conduit is not recognized by the Canadian Electrical Code.

Table 8
Pull force requirements for HANGERS

(See Clauses 6.1.6, 7.2.4, 8.2.5, 11.5, 11.6, and 11.9.)

Trade size	(Metric designator)	Pull force/LOAD RATING					
		Electrical metallic tubing (EMT)[a]		Rigid metal conduit (RMC), intermediate metal conduit (IMC)[a, c]		Rigid PVC conduit	
		Pull force (N)	Reference LOAD RATING (kg)	Pull force (N)	Reference LOAD RATING (kg)	Pull force (N)	Reference LOAD RATING (kg)
1/2	(16)	667	23	667	23	667	23
3/4	(21)	667	23	667	23	667	23
1	(27)	845	27	845	27	712	23
1-1/4	(35)	1001	34	1001	34	778	25
1-1/2	(41)	1112	36	1112	36	801	27
2	(53)	1334	45	1334	45	890	29
2-1/2	(63)	1668	57	1668	57	1112	36
				2113[b]	73[b]		
3	(78)	2224	73	2224	75	1334	45
				3892[b]	134[b]		
3-1/2	(91)	2669	91	2668	91	1668	57
				5004[b]	170[b]		
4	(103)	3114	150	3114	150	2002	68
				6228[b]	213[b]		
5	(129)	–	–	4448	150	2669	91
				8452[b]	288[b]		
6	(155)	–	–	4448	197	4003	136
				8452[b]	404[b]		

[a] Horizontal support intervals are limited to 3.05 m (10 ft) maximum.

[b] In the United States, suitable for horizontal support intervals greater than 3.05 m (10 ft), not exceeding 3.7 m (12 ft) for trade size 1 (27), 4.3 m (14 ft) for trade sizes 1-1/4 (35) and 1-1/2 (41), 4.9 m (16 ft) for trade sizes 2 and 2-1/2 (63), and 6.10 m (20 ft) for trade size 3 and larger. In Canada, this does not apply.

[c] In Canada, intermediate metal conduit is not recognized by the Canadian Electrical Code.

NOTE: This table includes SI (metric) units. See Table 9 for equivalent values.

Table 9
Pull force requirements for HANGERS

(See Clauses 6.1.6, 7.2.4, 8.2.5, 11.5, 11.6, and 11.9.)

Trade size	(Metric designator)	Pull force/LOAD RATING					
		Electrical metallic tubing (EMT)[a]		Rigid metal conduit (RMC), intermediate metal conduit (IMC)[a, c]		Rigid PVC conduit	
		Pull force (lbf)	Reference LOAD RATING (lb)	Pull force (lbf)	Reference LOAD RATING (lb)	Pull force (lbf)	Reference LOAD RATING (lb)
1/2	(16)	150	50	150	50	150	50
3/4	(21)	150	50	150	50	150	50
1	(27)	190	60	190	60	160	50
1-1/4	(35)	225	75	225	75	175	55
1-1/2	(41)	250	80	250	80	180	60
2	(53)	300	100	300	100	200	65
2-1/2	(63)	375	125	375	125	250	80
				475[b]	160[b]		
3	(78)	500	160	500	165	300	100
				875[b]	295[b]		
3-1/2	(91)	600	200	600	200	375	125
				1125[b]	375[b]		
4	(103)	700	230	700	230	450	150
				1400[b]	470[b]		
5	(129)	–	–	1000	330	600	200
				1900[b]	635[b]		
6	(155)	–	–	1000	435	900	300
				1900[b]	890[b]		

[a] Horizontal support intervals are limited to 3.05 m (10 ft) maximum.

[b] In the United States, suitable for horizontal support intervals greater than 3.05 m (10 ft), not exceeding 3.7 m (12 ft) for trade size 1 (27), 4.3 m (14 ft) for trade sizes 1-1/4 (35) and 1-1/2 (41), 4.9 m (16 ft) for trade sizes 2 and 2-1/2 (63), and 6.10 m (20 ft) for trade size 3 and larger. In Canada, this does not apply.

[c] In Canada, intermediate metal conduit is not recognized by the Canadian Electrical Code.

Table 10
LOAD FORCE requirements for conduit / tubing support for use aboveground/belowground

(See Clauses 10A.1.3, 10A.1.4, 11.10, and 11.11.)

		Load					
		Electrical metallic tubing (EMT)		Rigid metal conduit (RMC), intermediate metal conduit (IMC)		Rigid PVC conduit	
Trade size	(Metric designator)	Load Force (N)	Reference load rating (kg)	Load Force (N)	Reference load rating (kg)	Load Force (N)	Reference load rating (kg)
1/2	(16)	667	23	667	23	667	23
3/4	(21)	667	23	667	23	667	23
1	(27)	845	(27)	845	(27)	712	23
1-1/4	(35)	1001	34	1001	34	778	25
1-1/2	41	1112	36	1112	36	801	27
2	53	1334	45	1334	45	890	29
2-1/2	63	1668	57	1668	57	1112	36
3	78	2224	73	2224	75	1334	45
3-1/2	91	2669	91	2668	91	1668	57
4	103	3114	150	3114	150	2002	91
5	129	–	–	4448	150	2669	91
6	155	–	–	4448	197	4003	136

NOTE: This table includes SI (metric) units. See Table 11 for equivalent values.

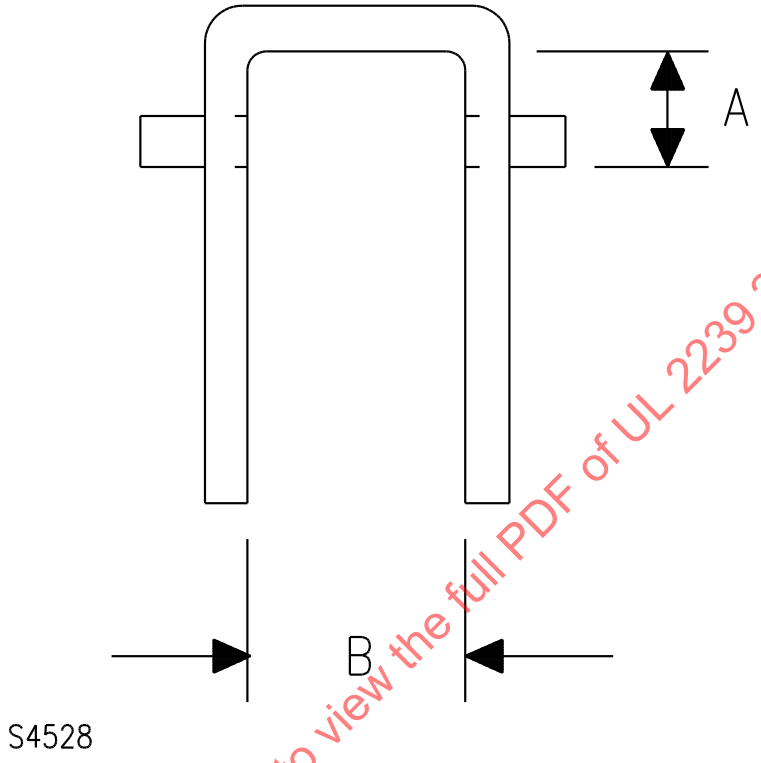
Table 11
LOAD FORCE requirements for conduit / tubing support for use aboveground/belowground

(See Clauses 10A.1.3, 10A.1.4, 11.10, and 11.11.)

		Load					
		Electrical metallic tubing (EMT)		Rigid metal conduit (RMC), intermediate metal conduit (IMC)		Rigid PVC conduit	
Trade size	(Metric designator)	Load Force (lb)	Reference load rating (lb)	Load Force (lb)	Reference load rating (lb)	Load Force (lb)	Reference load rating (lb)
1/2	16	150	50	150	50	150	50
3/4	21	150	50	150	50	150	50
1	27	190	60	190	60	160	50
1-1/4	35	225	75	225	75	175	55
1-1/2	41	250	80	250	80	180	60
2	53	300	100	300	100	200	65
2-1/2	63	375	125	375	125	250	80
3	78	500	160	500	165	300	100
3-1/2	91	600	200	600	200	375	125
4	103	700	230	700	230	450	150
5	129	–	–	1000	330	600	200
6	155	–	–	1000	435	900	300

Figure 1
STAPLE dimensions

(See Clause 5.2.9.)



where:

A = distance from underneath of stop to bottom of STAPLE bridge (affecting minor cable axis or cable diameter)

B = distance between STAPLE legs (nails) (affecting major cable axis or cable diameter)

Minimum dimensions, mm (in)								
Flat cable, 2-conductor			Round cable, 2-conductor			Round cable, 3-conductor		
	A	B		A	B		A	B
14 – 2	5.72 (0.225)	11.02 (0.434)	–	–	–	14 – 3	10.03 (0.395)	10.03 (0.395)
12 – 2	6.22 (0.245)	12.12 (0.477)	–	–	–	12 – 3	11.02 (0.434)	11.02 (0.434)
10 – 2	6.73 (0.265)	13.69 (0.539)	–	–	–	10 – 3	12.32 (0.485)	12.32 (0.485)
8 – 2	8.64 (0.340)	17.63 (0.694)	8 – 2	15.14 (0.596)	15.14 (0.596)	8 – 3	16.13 (0.635)	16.13 (0.635)
6 – 2	10.13 (0.399)	21.62 (0.851)	6 – 2	18.14 (0.714)	18.14 (0.714)	6 – 3	19.23 (0.757)	19.23 (0.757)

Note: The design in this Figure is shown as an example only; it is not intended to represent all possible designs.

ANNEX A
(normative)

Smoke and Heat Release Test

(See Clause 6.9.1.)

A.1 Scope

A.1.1 This is a fire test method for determining the fire performance response of a HARDWARE DEVICE having any nonmetallic component, intended for use in AIR-HANDLING SPACES, such as above suspended ceilings. These products are subjected to an open flame ignition source and evaluated using a product calorimeter.

A.1.2 The purpose of this test is to determine the rate of heat release and the rate of smoke release of the burning product samples as they relate to the requirements for fire-resistant and low-smoke-producing characteristics.

A.1.3 This test method does not provide information on the performance of products in other fire or test conditions. This test does not investigate the toxicity of the products of combustion.

A.1.4 This test does not cover the constructional, electrical, or other performance requirements of the product.

A.2 Apparatus

A.2.1 General

A.2.1.1 The apparatus shall include the following main components: an ignition source, a steel angle frame enclosure, a collection hood and exhaust duct, velocity measuring instrumentation, gas sampling and analysis equipment, smoke measuring instruments, and a data acquisition system.

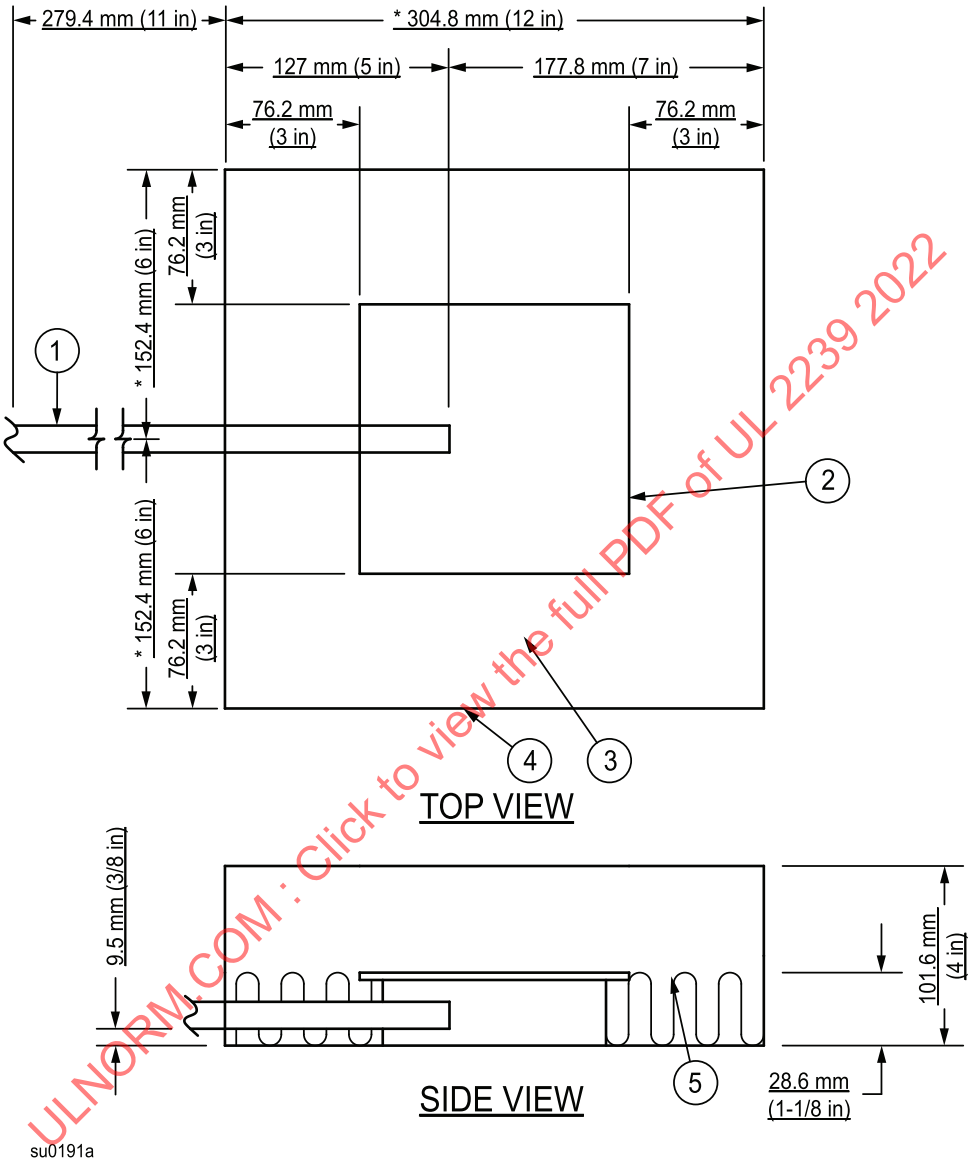
A.2.1.2 The test building in which the test apparatus is located shall have vents for the discharge of the combustion products and have provision for fresh air intake.

A.2.2 Ignition source

A.2.2.1 The propane gas burner used as the ignition source shall have dimensions of 318 by 318 by 102 mm (12-1/2 by 12-1/2 by 4 in). The burner shall be constructed of nominal 6.4 mm (1/4 in) steel with a nominal 12.7 mm (1/2 in) diameter steel gas inlet pipe. The pipe shall extend into the burner 127 mm (5 in), and a 152 mm (6 in) nominal metal diffuser plate shall be positioned over the outlet of the gas pipe. A fine mesh metal screen shall be placed on top of the diffuser plate. The burner field shall be filled with silica sand. The ignition source is illustrated in Figure A.1, Propane Gas Burner.

Figure A.1
Propane gas burner

(See Clause A.2.2.1.)



1. NOM. 12.7 mm (1/2 in) I.D. STL. PIPE

2. DIFFUSER PLATE

3. SAND (NOT SHOWN. FILLS THE 304.8 mm x 304.8 mm x 101.6 mm (12 in x 12 in x 4 in) PAN, POURED OVER STEEL WOOL AND DIFFUSER PLATE.)

4. 304.8 mm x 304.8 mm x 101.6 mm (12 in x 12 in x 4 in) DEEP STL. PAN (* = INSIDE DIMENSIONS.) 6.4 mm (1/4 in) THICK STL.

5. STEEL WOOL

NOTE: 25.4 mm = 1 in

A.2.3 Test frame enclosure and burner

A.2.3.1 A steel angle frame shall be used to support the test specimen. The frame shall measure 914 mm (36 in) high by 106 mm (28 in) wide by 1.2 m (48 in) long and be composed of nominal 38 by 38 mm (1-1/2 by 1-1/2 in) angles as shown in Figure A.2, Test Frame Enclosure and Burner. Other construction shall not be used except where the alternative construction has been shown to provide equivalent results.

A.2.3.2 Nominal 12.7 mm (1/2 in) thick by 1067 mm (42 in) wide ceramic boards shall be secured to the steel angle frame to form an enclosure as shown in Figure A.2, Test Frame Enclosure and Burner. The boards shall be secured to the frame to extend 457 mm (18 in) above the top of the steel angle frame, creating a 305 mm (12 in) gap at the base of the frame. The ceramic board enclosure may contain glazed observation windows for visual and photographic documentation.

A.2.3.3 The test frame enclosure and burner shall be positioned on a ceramic fiber blanket. The gas burner shall be positioned in the center of the test frame on top of a nominal 203 mm (8 in) high inorganic support.

Figure A.2

Test frame enclosure and burner

(See Clauses A.2.3.1 and A.2.3.2.)