UL 514A

STANDARD FOR SAFETY

Metallic Outlet Boxes

UL Standard for Safety for Metallic Outlet Boxes, UL 514A

Twelfth Edition, Dated November 15, 2024

Summary of Topics

This new Twelfth edition of ANSI/UL 514A dated November 15, 2024 includes the following changes in requirements:

- ***Installation instruction and torque values; 12.5.4***

- ***Addition of requirements for the use of electronic transmission of installation instructions; 6.6***

- ***Scope and Definition – Poke Through Floor Fitting; 1.4, 1.5 and 3.23***

- ***Editorial updates including renumbering and reformatting to align with current style.***

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated September 1, 2023 and April 5, 2024.

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NMX-J-023/1-ANCE-2024
Fourth Edition

CSA Group
CSA C22.2 No. 18.1:24
Third Edition

ULSE Inc.
UL 514A
Twelfth Edition

Metallic Outlet Boxes

November 15, 2024

Approved American National Standard

ANSI/UL 514A-2024

Commitment for Amendments

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

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This ANSI/UL Standard for Safety consists of the Twelfth Edition. The most recent designation of ANSI/UL 514A as an American National Standard (ANSI) occurred on November 15, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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Preface

This is the harmonized ANCE, CSA Group, and ULSE standard for Metallic Outlet Boxes. It is the fourth edition of NMX-J-023/1-ANCE, the third edition of CSA C22.2 No. 18.1, and the twelfth edition of UL 514A. This edition of CSA C22.2 No. 18.1 supersedes the previous edition(s) published in 2013. This edition of UL 514A supersedes the previous edition published on June 30, 2022.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and ULSE. The efforts and support of the Technical Harmonization Committee for Switch and Outlet Boxes, 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.

The present Mexican standard was developed by the CT 23, Electric Accessories from the Comité de Normalización de la Asociación de Normalización y Certificación, A.C., CONANCE, with the collaboration of the metallic outlet boxes and accessories manufacturers and users.

This standard was reviewed by the CSA Integrated Committee on Wiring 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. This standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

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 ANCE, CSA Group, and ULSE.

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 Technical Harmonization Committee identified the following IEC standard within the scope of this standard: IEC 60670 (1989-11), General requirements for enclosures for accessories for household and similar fixed electrical installations and Amendment No. 1 (1994-01). It was further recognized that significant revision of this IEC standard is in process, with participation by the IEC National Committees in each of the three countries that are party to this standard.

The THC determined that the safe use of electrical boxes is critically dependent on the design and performance of the system with which they are intended to be installed. Significant investigation is

required to assess safety and system compatibility issues that may lead to harmonization of traditional North American electrical boxes with those presently addressed in the known IEC standards. The THC agreed such future investigation might be facilitated by completion of harmonization of the North American standards for electrical boxes.

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.

Metallic Outlet Boxes

1 Scope

1.1 This standard applies to metallic outlet boxes, flush-device boxes, floor boxes, concrete boxes, extension rings, covers, conduit bodies, bar hangers, bar-hanger assemblies, and all accessories whose principal function is for support of boxes. The products covered by this standard are intended for installation in accordance with the National Electrical Code (NEC), NFPA 70, the Canadian Electrical Code (CEC), Part I, and the Standard for Electrical Installations, NOM-001-SEDE.

In Canada, conduit bodies are not evaluated as outlet boxes; they are fittings. Requirements in this standard for conduit bodies intended for use as outlet boxes do not apply in Canada.

1.2 This standard also applies to marine application metallic outlet boxes, flush-device boxes, special purpose boxes, extension rings, and covers.

1.3 This standard also applies to marine products intended for installation in accordance with the manufacturer's instructions and the applicable requirements of the United States Coast Guard (USCG), IEEE Recommended Practice for Electric Installation on Shipboard, IEEE Standard 45; the American Boat and Yacht Council (ABYC); the Standard for Pleasure and Commercial Motor Craft, NFPA 302; and the Canadian Electrical Code (CEC), Part I.

1.4 This standard also applies to poke-through floor fittings intended for use with flush, pedestal or recessed access floor box covers or for connection to surface metallic raceways and multioutlet assemblies.

1.5 This standard does not apply to cabinets and cutout boxes, boxes, and covers intended for use with raceway systems for surface wiring other than rigid or flexible conduit or electrical metallic tubing. This standard does not apply to boxes having a volume of more than 1640 cm^3 (100 in^3), other than multiple-gang boxes, flush-device boxes, and conduit bodies intended for the larger trade sizes of conduit.

1.6 This standard does not apply to cover plates for flush-mounted wiring devices.

1.7 This standard does not apply to outlet boxes or outlet box covers for use in hazardous (classified) locations as defined in the National Electrical Code (NEC), NFPA 70, the rules of the Canadian Electrical Code (CEC), Part I, and the Standard for Electrical Installations, NOM-001-SEDE.

2 Normative References

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.

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

ANCE Standards

NMX-H-146-SCFI, *Unified Screw Threads – Specifications*

NMX-J-017-ANCE, *Fittings for Outlet Boxes and Conduit*

NMX-J-235-ANCE, *Enclosures for Electrical Equipment, Part 1 and Part 2*

NMX-J-235/2-ANCE-2007, *Enclosures for Electrical Equipment, Environmental Considerations*

NMX-J-508-ANCE, *Wiring Devices – Safety Requirements – Specifications and Test Methods*

NMX-J-543-ANCE, *Wire Connectors*

NMX-W-047-SCFI, *Aluminum and its Alloys – Mechanical Properties – Determination of Tensile Strength*

CSA Group Standards

C22.1-12, *Canadian Electrical Code, Part I*

CSA C22.2 No. 0.5-1982 (R2008), *Threaded Conduit Entries*

CSA C22.2 No. 0.15-01 (R2006), *Adhesive Labels*

CAN/CSA C22.2 No. 0.17-00 (R2009), *Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 18.3-04 (R2009), *Conduit, Tubing, and Cable Fittings*

CSA C22.2 No. 45.1-07, *Electrical Rigid Metal Conduit – Steel*

CSA C22.2 No. 65-03 (R2008), *Wire Connectors*

CAN/CSA C22.2 No. 94-M91 (R2001), *Special Purpose Enclosures*

CAN/CSA C22.2 No. 94.2-07, *Enclosures for Electrical Equipment, Environmental Considerations*

UL Standards

UL 6, *Electrical Rigid Metal Conduit – Steel*

UL 50 , *Enclosures for Electrical Equipment, Non-Environmental Considerations*

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 486A-486B, *Wire Connectors*

UL 514B, *Conduit, Tubing, and Cable Fittings*

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

UL 746B, *Polymeric Materials – Long Term Property Evaluations*

UL 969, *Marking and Labeling Systems*

ASME[1] Standards

ASME B1.1-1989 (R2001), *Unified Inch Screw Threads (UN and UNR Thread Form)*

ASME B1.20.1-1983 (R2001), *Pipe Threads, General Purpose (INCH)*

ASTM[2] Standards

ASTM B117-97, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASTM D1654-92 (2000), *Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments*

ASTM F1137-00, *Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners*

ASTM G151-00, *Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources*

ASTM G153-00ae1, *Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*

IEC[3] Standards

IEC 60417-1, *Graphical symbols for use on equipment – Part 1: Overview and application*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEEE[4] Standards

IEEE 45-1998, *IEEE Recommended Practice for Electric Installations on Shipboard*

ISO[5] Standards

ISO 4892-2:1994, *Plastics – Methods of exposure to laboratory light source – Part 2: Xenon-arc sources*

Mexican Official Standards

NOM-001-SEDE, *Standard for Electrical Installations*

NFPA[6] Standards

NFPA 70-2011, *National Electrical Code*

NFPA 302-1998, *Fire Protection Standard for Pleasure and Commercial Motor Craft*

[1] American Society of Mechanical Engineers
[2] American Society for Testing and Materials
[3] International Electrotechnical Commission
[4] Institute of Electrical and Electronics Engineers
[5] International Organization for Standardization
[6] National Fire Protection Association

3 Definitions

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

3.2 ADJUSTABLE MUD RING – A sleeve intended to be mechanically secured to an adjustable sleeve. It extends the adjustable sleeve to position a flush-mounted wiring device flush with the finished wall surface.

3.3 ADJUSTABLE SLEEVE EXTENDER – A sleeve intended to be mechanically secured to an adjustable sleeve. It extends the adjustable sleeve to position a flush-mounted wiring device flush with the finished wall surface.

3.4 BAR HANGER – A means to support an outlet box, conduit box, or device box between two structural members.

3.5 CLAMP – A means intended to secure raceway, tubing, conduit, or cable to the box.

3.6 CONCRETE BOX – A box intended for use in poured concrete.

3.7 CONCRETE RING – A ring, which is not necessarily round, intended for use in poured concrete, that accommodates end-to-end extension and the application of covers on top and bottom.

3.8 CONDUIT BODY – A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction of two or more conduit or tubing sections or at the terminal point of a conduit or tubing. In Mexico and the United States, a conduit body is investigated as an outlet box. In Canada, a conduit body is not investigated as an outlet box; it is a fitting. Requirements in this standard for CONDUIT BODIES intended for use as outlet boxes do not apply in Canada.

3.9 CONDUIT BOX – A box having threaded openings or knockouts for conduit, electrical metallic tubing, or fittings.

3.10 DEVICE BOX – A box with provisions for mounting a wiring device directly to the box.

3.11 DRIPPROOF – Designation for a type of marine product that is constructed or protected so that falling drops of liquid or solid particles striking the enclosure do not interfere with the intended operation of the equipment.

3.12 EXTENSION RING – A ring, which is not necessarily round, intended to extend the sides of an outlet box or flush-device box to increase the box depth, volume, or both.

3.13 FLOOR BOX – A box mounted in the floor intended for use with a floor box cover or other components to complete the enclosure.

3.14 FLOOR BOX COVER – A component of a floor-mounted enclosure assembly intended to complete the enclosure.

3.15 FLOOR-MOUNTED ENCLOSURE – A box and cover assembly provided with a means for mounting in a floor.

3.16 FLUSH FLOOR BOX COVER – A floor box cover that, when installed as intended, is essentially flush with the floor's finished surface.

NOTE: A flush floor box cover may have openings for access to flush-mounted receptacle outlets or openings or knockouts for attachment of conduits or fittings. Openings may be provided for access to data and communications outlets.

3.17 NON-DETACHABLE HUB – An integral, non-detachable protuberance from a box intended for the attachment of a raceway essentially independent of the box. Conduit body hubs are not included.

3.18 OUTLET BOX – A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either of the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables. The box has provisions for the mounting of an outlet box cover; however, it does not have provisions for mounting a wiring device directly to the box.

3.19 OUTLET BOX COVER – A means intended to close or cover an outlet box when the cover has been mounted directly to an outlet box or to an outlet box extension ring.

3.20 PARTITION – A barrier used to separate sections of a box.

3.21 PEDESTAL FLOOR BOX COVER – A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.

NOTE: The pedestal floor box cover may provide a means for attachment of conduits or fittings above the floor's finished surface. Openings may be provided in the cover for access to data and communications outlets.

3.22 PLASTER RING COVER – A means intended for mounting directly onto a box to provide for the attachment of wiring devices or fixtures/luminaires. The center portion is raised to accommodate a specific wall or ceiling thickness and is intended for the mounting of the wiring devices or fixtures/luminaires flush with the surface.

3.23 POKE-THROUGH FLOOR FITTING – A floor box assembly intended to provide passage of wiring from one building story to another through a penetration drilled or cast through a concrete floor. It is used in conjunction with flush, pedestal, or recessed access floor box covers or for connection to surface metal raceways and multioutlet assemblies suitable for floor mounting.

3.24 RAISED COVER – A cover intended for mounting directly onto a box to provide for the attachment of accessories and to increase the internal volume of the enclosure.

3.25 RAISED-FLOOR BOX – A floor box intended for use in a raised floor, such as in an electronic computer/data processing equipment room.

3.26 RECESSED ACCESS FLOOR BOX – A floor box with provisions for mounting wiring devices below the floor surface.

3.27 RECESSED ACCESS FLOOR BOX COVER – A floor box cover that, when installed as intended, is essentially flush with the floor's finished surface and provides access to and passage of cords to recessed wiring devices mounted within a recessed floor box.

3.28 STRUCTURE, FINISHED (OLD WORK) – Construction where structural framing members are accessible for direct mounting and support of boxes.

3.29 STRUCTURE, UNFINISHED (NEW WORK) – Construction where structural framing members are accessible for direct mounting and support of boxes.

3.30 SUPPORTING-NAIL HOLE – A hole provided in a box for the purpose of mounting the box to a structure using nails or screws. The following are not considered nail holes:

a) A hole that is 3 mm (0.120 in) or smaller in diameter; and

b) A hole that is located so as to prevent insertion of a 3-mm (0.120-in) diameter drill rod through both walls.

3.31 WATERTIGHT – Designation for a type of marine product that is constructed so that moisture does not enter the enclosure.

4 General Requirements

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirement for that component. See Annex A for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the ANCE, CSA, or UL standards 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 Each part of the box shall be so designed and constructed that, when mounted and installed as for normal use, the box ensures adequate electrical and mechanical protection to the parts enclosed and minimizes danger to the user or surroundings.

4.6 Conduit bodies shall comply with the requirements for conduit bodies in UL 514B/CSA C22.2 No. 18.3/NMX-J-017-ANCE. For conduit bodies intended to contain wire splices and/or wiring devices, the requirements in UL 514B/CSA C22.2 No. 18.3/NMX-J-017-ANCE shall be supplemented or replaced by the following requirements in this standard:

a) 5.5;

b) 5.8.1;

c) 7.1 – 7.4;

d) 9.8.4 – 9.8.5; and

e) 10.4.1.

4.7 Metal surface raceways and multioutlet assemblies suitable for floor mounting and intended for supply connection to poke-through floor fittings shall comply with the requirements for metal surface raceways and multioutlet assemblies suitable for floor mounting.

5 Marking

5.1 General

5.1.1 In Canada and Mexico, units of measure for markings shall include SI (metric) units, unless otherwise specified. Markings expressed in equivalent units shall be optional.

In the United States, units of measure for markings shall be in SI (metric), equivalent units, or both, unless otherwise specified.

5.1.2 A box, and a cover intended to be shipped separately from a box, shall be marked with the manufacturer's name, trademark, or other descriptive marking identifying the organization responsible for the product. The catalog number or an equivalent designation shall be marked on the product or the smallest unit shipping carton.

5.1.3 All required markings shall be permanent and legible. All markings on the product shall be visible after the product is installed. The following types of markings or the equivalent meet the intent of this requirement with respect to permanency:

a) Etched,

b) Molded,

c) Die stamped,

d) Paint stenciled, or

e) In Canada and the United States, indelibly stamped on a pressure-sensitive label secured by adhesive and complying with CSA C22.2 No. 0.15 or UL 969, and in Mexico, indelibly stamped on a pressure-sensitive label in accordance with 12.21.

5.1.4 A box shall be marked on the inside surface of the box and the marking shall not be located on a knockout unless it is duplicated on another part of the box.

5.1.5 In the United States, when a manufacturer produces or assembles boxes or covers at more than one factory, each finished product shall have a distinctive marking to identify it as a product of a particular factory.

In Canada and Mexico, this requirement does not apply.

5.2 Box clamps

5.2.1 General

5.2.1.1 In Canada and the United States, a clamp or other securement means furnished as part of an outlet box shall be marked to indicate the type of application for which it is intended to be used. The following abbreviations marked in lieu of the name of the cable, conduit, and tubing shall apply:

a) A for armored cable, TECK cable, or aluminum sheathed cable,

b) F for flexible metal conduit,

c) N for nonmetallic-sheathed cable,

d) T for flexible tubing,

e) MCI for metal-clad interlocking armored cable (steel and aluminum type),

f) MCS for metal-clad continuous smooth sheath cable,

g) MCC for metal-clad continuous corrugated sheath cable, and

h) ALL for all types of applications.

In Mexico, this requirement does not apply.

5.2.1.2 The marking shall be on the clamp or other securement means or on the box near the securement means.

5.2.2 Box clamps for armored cable, metal-clad cable, and flexible metal conduit

5.2.2.1 In Mexico and the United States, an armored cable clamp shall be marked with the minimum and maximum cable size designation for which it is intended to be used. When the minimum cable size is 14/2, the clamp shall also be marked with the diameter of the cable for which the clamp is intended to be used. The marking shall be located on the clamp or the smallest unit shipping carton in which the box is packed.

In Canada, this requirement does not apply.

5.2.2.2 In Mexico and the United States, a metal-clad cable clamp shall be marked with the type of cable and range of cable diameters for which the clamp is intended to be used. The marking shall be located on the clamp or the smallest unit shipping carton in which the box is packed.

In Canada, this requirement does not apply.

5.2.2.3 A flexible metal conduit clamp shall be marked in accordance with the requirements for carton markings for flexible metal conduit fittings, as specified in UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE. The marking shall be located on the clamp or the smallest unit shipping carton in which the box is packed.

5.2.3 Box clamps for nonmetallic-sheathed cable

5.2.3.1 A clamp intended to secure more than one nonmetallic-sheathed cable per opening shall be marked with the number of cables it is intended to secure. The marking shall be located on the clamp or the smallest unit shipping carton in which the box is packed.

5.2.3.2 A clamp shall secure a 14 AWG (2.08 mm^2) two-wire cable and bare ground wire up to the largest cable which can be passed through the box pryout. Otherwise, the range that the clamp can accommodate shall be marked on the clamp or the smallest unit shipping carton in which the box is packed.

5.3 Grounding screw

5.3.1 A metal box that is provided with a tapped hole for a grounding screw other than a No. 10-32 shall be marked with the symbol for grounding (⏚) (IEC 60417-1, Symbol 5019a) adjacent to the hole.

In Canada, this requirement does not apply (see 8.1.1).

In Mexico, the marking "T" or "Tierra" complies with this requirement.

In the United States, the marking "GR" or "GRD" complies with this requirement.

5.4 Closures for concrete boxes

5.4.1 When a box is provided with a sheet-metal plug or plate in accordance with 9.4.4.5, the box or the carton in which it is shipped shall be marked to indicate that the box is intended for installation only in poured concrete.

5.5 Box volume

5.5.1 A box, an extension ring, or a raised cover shall be permanently and legibly marked with a volume that does not exceed its actual volume. The marking shall be visible after installation. A box or extension ring of one of the trade sizes having the minimum volume as specified in the National Electrical Code (NEC), NFPA 70, the Canadian Electrical Code (CEC), Part I, or the Standard for Electrical Installations , NOM-001-SEDE, shall not be required to be marked. The volume of a box shall be indicated to the lower full integer or rounded up one decimal point. The marked volume shall be rounded to the nearest cm^3 or the nearest 1/4 cubic inch. Volumes of 1/4 cubic inch shall be marked as 0.3 cubic inch, and volumes of 3/4 cubic inch shall be marked as 0.8 cubic inch.

In Canada and Mexico, the volume markings shall be in cm^3 or ml.

In the United States, the volume markings shall be in cm^3 or cubic inches.

5.6 Specific conditions

5.6.1 A box that only complies for specific conditions of installation, for use with specific conduit or cable construction or sizes, or for use with a specific wiring system shall be marked with the conditions of installation or intended use. The marking shall be on the smallest unit shipping carton. See Table 1 for specific conditions of use and the associated markings. Where unusual assembly techniques are needed for proper assembly of a box, a marking on the carton or instructions for proper assembly shall be provided with the box when the box is shipped from the factory.

5.6.2 With reference to 9.5.1.7, a box support supplied separately, or a box with integral support, whose performance is dependent upon the thickness of the material to which it is intended to be mounted or its mounting position, shall be marked to indicate the material type, thickness or thickness range, and mounting position (vertical or horizontal) for which the support has been found acceptable. The marking shall appear on the product or its smallest unit shipping container.

5.7 Ceiling-suspended fan support

5.7.1 An outlet box intended to support a ceiling-suspended fan weighing a maximum of 15.9 kg (35 lb), 23 kg (50 lb), or 32 kg (70 lb) shall be marked "Acceptable for Fan Support of ___ kg (___ lb) or less." The blank spaces shall be filled in with maximum values. See 9.12.

NOTE: In Canada, a ceiling fan and all possible accessories weighing 16 kg or more is required to be supported independently of the outlet box.

5.7.2 In Mexico and the United States, an outlet box intended to support a ceiling-suspended fan that is provided with screws, or a screw and nut assembly, other than No. 8-32 or No. 10-32, shall be marked on the inside surface with the thread designation of the screws or nuts. See 9.12.1(a).

In Canada, this requirement does not apply. See 9.12.1(a).

5.8 Wet location

5.8.1 A device box, an outlet box, an outlet box cover and a conduit body intended for use in wet locations shall comply with 11.5 and 12.20.1 and shall be marked "Wet Locations." An additional marking, "Damp Locations", shall be acceptable. When a part such as a box, box cover, or a wiring device is shipped separately or when installation material such as sealing compound is specified, the part required to complete the assembly or the specified sealing compound shall be clearly identified in the installation instructions.

When a box or conduit body and its cover are shipped assembled, the box or conduit body shall not be required to be marked when the marking is provided on the cover.

5.9 Damp location boxes

5.9.1 A device box, an outlet box, and an outlet box cover intended for use in a damp location shall comply with 11.5 and 12.20.1 and shall be marked "Damp Locations."

5.10 Other application environments

5.10.1 A box intended for installation in particular environmental conditions, such as conditions with Type ratings complying with 12.22, shall be marked to indicate the enclosure Type in accordance with CAN/CSA-C22.2 No. 94.2-07, UL 50E, or NMX-J-235/2-ANCE-2007. A box that complies with the requirements for more than one Type may have multiple designations.

5.11 Fixture/luminaire support boxes

5.11.1 With reference to 9.6.2.1, the smallest unit shipping carton of an outlet box or separately supplied box support, such as a bar hanger, intended to support a fixture/luminaire weighing 23 kg (50 lb) in a ceiling shall be marked in accordance with Table 1.

5.11.2 In Mexico and the United States, with reference to 9.6.2.2 and 9.7.2.1, a box or separately supplied box support, such as a bar hanger, shall be marked for the intended end-use application "wall" or "WL" and marked "For Support of ___ kg (or ___ lb) Fixture/Luminaire or Product (or specific product identification) in the wall only." The blank shall be filled in with a number, in 0.5 kg (1 lb) increments, from 3.5 kg (7 lb) to 22.2 kg (49 lb).

In Canada, this requirement does not apply.

5.11.3 In Mexico and the United States, with reference to 9.6.2.1, an outlet box, with or without a bracket or bar hanger, or separately supplied box support, such as a bar hanger, intended to support a fixture/luminaire weighing more than 23 kg (50 lb) shall be marked "For Fixture/Luminaire Support of ___ kg (or ___ lb) or less." The blank shall be filled in with the weight intended to be supported in 4.5-kg (10-lb) increments, for example, 31.8, 36.4, 40.9, 45.5, 50.0 kg (70, 80, 90, 100, 110 lb). Marking the carton in addition to marking the box complies with the requirement.

In Canada, this requirement does not apply.

5.11.4 In Mexico and the United States, with reference to 9.6.2.1, an outlet box with a bracket or bar hanger, or separately supplied box support, such as a bar hanger tested in accordance with 12.14.1.1 shall include the following marking for each rated span. The first two blanks shall be filled in with rated weight (kg and lbs) intended to be supported in 4.5-kg (10-lb) increments and the second two blanks shall be filled in with the corresponding span (mm and in) that each weight was tested and rated for. “For Fixture Support of ___ kg (____ lbs) or less at _____ mm (____in) span.” The following is an example of a marking for a multiple span rated supporting device:

For Fixture Support of 31.7 kg (70 lbs) or less at 609.6 mm (24 in) span

For Fixture Support of 40.8 kg (90 lbs) or less at 406.4 mm (16 in) span

NOTE: A tabular format may also be used.

In Canada, this requirement does not apply.

5.12 Floor boxes

5.12.1 With reference to 12.16.1.3, a floor box cover intended for use only in a floor covered with carpet or wood shall be marked on the product or smallest unit shipping carton "Not for use with tile covered floors" or the equivalent.

5.13 Bar hangers

5.13.1 A bar hanger not intended to be used with a box for fixture/luminaire or ceiling-suspended fan support, and having provision to support a box only from a ceiling grid, such as a drop ceiling, shall be marked "Not for fixture/luminaire or fan support" or the equivalent. See 9.15.1.

5.13.2 The marking of a bar hanger intended to be used with a box for fixture/luminaire support shall be in accordance with 5.11.

5.14 Marine boxes

5.14.1 In the United States, 5.14.2 – 5.14.4 apply.

In Canada and Mexico, 5.14.2 – 5.14.4 do not apply.

5.14.2 The shipping carton or label shall be marked "Acceptable For Marine Use" or the equivalent.

5.14.3 In addition to the applicable markings required in 5.8.1, a product or the smallest unit shipping carton shall be marked "watertight" or "dripproof," as applicable.

5.14.4 In addition to 5.14.3, a product or the smallest unit shipping carton may be marked with an enclosure Type number, for example, "Type _____," indicating the environmental conditions for which the product is rated in accordance with 5.10.1.

5.15 Adjustable mud rings

5.15.1 The following markings shall be marked on an adjustable mud ring and shall be visible after installation:

a) An adjustable mud ring that relies solely on the adjustment of screws for mechanical securement between the sleeve and mud ring shall be marked:

1) "Leave adjustment screws accessible", and

2) "Torque screws after adjustment to - ____ lbs in". The blank space shall be filled in with the appropriate torque value, according to Table 5 or in accordance with the manufacturer's instructions (see 12.23.7.2).

b) An adjustable mud ring assembled and shipped as a complete assembly shall be marked: "Do not adjust after final installation".

5.15.2 The following shall be marked on an adjustable mud ring and shall be visible during installation:

a) Minimum and maximum sleeve adjustment depth,

b) Minimum depth of device box to be used, and

c) Minimum surface covering thickness, or range in millimeters.

Practical guides that are part of the product construction may be substituted for markings.

5.16 Adjustable sleeve extenders

5.16.1 Adjustable sleeve extenders shall have the following or equivalent markings on the sleeve extender:

a) "Refer to Installation Instructions".

b) "Adds ____ inches to wall thickness". The blank space shall be filled in with the appropriate additional amount of wall thickness that the extender is intended to accommodate. See 9.19.2.

c) "For Use Only With Cat. No. _____ Adjustable Sleeve". The blank space shall be filled in with the appropriate Adjustable Sleeve Catalog Number.

6 Instructions

6.1 General

6.1.1 Instructions specified in 6.3 through 6.6 may alternatively be provided via a manufacturer's website. The web address shall be marked on the unit, packaging, and/or information sheet. The web address may be in the form of a Uniform Resource Locator (URL – http://www.___.com/___/), or a machine-readable code [e.g., quick response code (such as QR Code®)]. The web address link shall take the user to an internet page containing the required information or a direct link to the required information. The file shall be a file format that is commonly used and may be downloadable.

6.2 Fixture/luminaire support boxes for use in a finished structure (old work)

6.2.1 A fixture/luminaire support box that complies with 9.7.2.1 shall be provided with:

a) Installation instructions for mounting of the box, and

b) Installation instructions that specify the type and thickness of the finished surface in which the box is intended to be mounted.

6.3 Floor boxes, floor-mounted enclosures, and poke-through floor fittings

6.3.1 Floor boxes, floor-mounted enclosures, and poke-through floor fittings shall be provided with installation instructions indicating the:

a) Type of floor structure for which they are intended to be installed (e.g. concrete, raised, etc.);

b) Model number(s) and brands of floor box covers, floor-mounted enclosure covers, or poke-through floor fitting covers for which they are intended to be installed; and

c) Type of finished floor surface for which the products are intended to be installed.

6.4 Ceiling-suspended fan support boxes

6.4.1 An outlet box intended to support a ceiling-suspended fan (see 9.12) shall be provided with:

a) Installation instructions for mounting of the box, and

b) Installation instructions for securement of the fan mounting bracket to the box specifying that only the screws provided with the outlet box shall be used.

6.5 Wet location boxes

6.5.1 All parts required to comply with the applicable requirements in 12.20 shall be provided with installation and assembly instructions.

6.6 Adjustable mud ring with adjustable sleeve not assembled to the mud ring at the factory

6.6.1 An adjustable mud ring shall be provided with instructions to ensure proper installation and to avoid damage to the mud ring during assembly of the wall finish surface and to conductors and wiring devices.

6.6.2 A mud ring or sleeve of an adjustable mud ring that is shipped separately shall be provided with instructions specifying the model number and manufacturer of the mud ring or sleeve of the adjustable mud ring for which it is intended to be assembled.

6.6.3 All adjustable sleeve extenders shall be provided with installation and assembly instructions.

7 Dimensions and volume

7.1 Sheet steel

7.1.1 In Canada, boxes, partitions and box covers made of sheet steel shall not be less than 1.3 mm (0.05 in) thick. Where used in device and outlet boxes with pryouts for nonmetallic-sheathed cable, armored cable, or flexible conduit, a sheet steel box shall not be less than 1.1 mm (0.04 in) thick. The spacer section of all sectional boxes (body of the box excluding sides) for nonmetallic-sheathed cable, armored cable, or flexible conduit shall not be less than 1.3 mm (0.05 in) thick. For all other boxes, the spacer section shall not be less than 1.5 mm (0.06 in) thick.

In Mexico and the United States, boxes, partitions, and box covers of sheet steel shall not be less than 1.59 mm (0.0625 in) thick, and the thickness at or within 6.4 mm (1/4 in) of any right-angle bend in a drawn sheet-steel box shall not be less than 1.04 mm (0.041 in). The average thickness of the sides and ends of a drawn box shall not be less than 1.47 mm (0.058 in) based on three measurements made both on the side and on the end of the box. The measurements shall be taken at points not less than 9.5 mm (3/8 in) from a right-angle bend. The three measurements shall be made in a line perpendicular to the front of the box at a point 6.4 mm (1/4 in) from the front, at a point 6.4 mm from the right-angle bend at the back, and at a point equidistant between the two. A laminated sheet-steel cover shall have a total thickness not less than 1.59 mm (0.0625 in).

7.2 Sheet aluminum

7.2.1 A sheet aluminum box and cover shall have a minimum tensile strength of 117 MPa (17,000 psi) and shall not be less than 2.31 mm (0.091 in) thick at all points. A sharply bent section having a radius of curvature of 6.4 mm (1/4 in) or less shall not be less than 2.21 mm (0.087 in) thick.

In Mexico, determination of the minimum tensile strength shall be in accordance with NMX-W-047-SCFI.

7.3 Cast metal boxes

7.3.1 A cast metal box shall not be less than 3.2 mm (1/8 in) thick. A malleable iron box and a die-cast or permanent-mold cast aluminum, brass, or bronze box shall not be less than 2.4 mm (3/32 in) thick. A box having a minimum wall thickness of 2.4 mm (3/32 in) shall be usable for the clearance of a cover screw in the area directly beneath the cover mounting lug when the area is not greater than 32.26 mm^2 (0.050 in^2) and has no straight-line dimension more than 12.7 mm (1/2 in).

7.4 Cast metal covers

7.4.1 A cast metal cover shall not be less than 3.2 mm (1/8 in) thick. A malleable iron cover and a die-cast or permanent-mold cast aluminum, brass, or bronze cover shall not be less than 2.4 mm (3/32 in) thick, when the cover is lined with a firmly attached insulating material not less than 0.8 mm (1/32 in) thick.

7.5 Box width

7.5.1 Boxes for switches rated 347 V ac

7.5.1.1 The minimum inside width of a box intended to accommodate a switch rated at 347 V ac shall not be less than 57 mm (2.24 in), except for multi-gang boxes, for which a minimum inside width of 44.4 mm (1.75 in) shall be acceptable when a partition of insulating material having a minimum thickness of 1.5 mm (0.06 in) is installed securely between sections and at each end wall of the outside sections. Where the distance between the center of the section and the end wall is at least 28.6 mm (1.13 in), the insulating material at the end wall shall not be required. Multi-gang boxes that have a 57 mm (2.24 in) distance between their sections also require a partition, which shall be of metal.

7.5.1.2 The requirement in 7.5.2 does not apply to boxes for switches rated at 347 V ac.

7.5.2 Sectional boxes

7.5.2.1 The distance between the centerlines of the device-mounting holes for sectional (gangable) boxes, as well as multi-gang boxes, shall be 46 mm (1.81 in).

7.5.3 Minimum width

7.5.3.1 A flush-device box shall have an internal width not less than 44.4 mm (1.75 in) unless it is intended to accommodate only narrow wiring devices.

7.6 Internal volume

7.6.1 Side pocket volume

7.6.1.1 The volume of a side pocket provided to increase the volume of an outlet or flush-device box shall be calculated using a depth-of-pocket not more than the smallest dimension of the opening into that side pocket.

7.6.2 Measurement

7.6.2.1 With reference to 5.5.1, the internal volume shall be determined in accordance with 12.1 or by another equivalent means. An extension ring made from a trade size box specified in 5.5.1 shall be determined to have a volume equal to that trade size box. A box provided with a partition shall have the volume of each partitioned section verified as described in 12.1 or by an equivalent means.

7.6.2.2 Plaster ring covers and raised covers shall be marked in accordance with 5.5.1 and the volume shall be measured in accordance with 12.1 or by an equivalent means.

7.7 Cover mounting hole-spacing

7.7.1 The cover mounting-hole spacing for trade sizes 4-11/16 square, 4 square, 4 octagonal, and 4 circular boxes shall be as indicated in Figure 1, Figure 2, Figure 3, and Figure 4.

8 Provisions for grounding

8.1 Connection means

8.1.1 A metal box intended for connection to a metal raceway or metal sheathed cable shall have a provision for a continuous electrical grounding connection. All exposed metal parts of a box or cover, other than parts that do not enclose wiring, shall be in electrical connection.

In Mexico and the United States, compliance shall be achieved by any of the following means:

a) A tapped hole for a No. 10-32 grounding screw,

b) A minimum 8-32 tapped hole when provided with a No. 8-32 grounding screw and marked in accordance with 5.3.1, or

c) The provision of a fastening means such as an attached wire connector or clip, or a self-threading or factory-assembled screw, that is identified for the purpose of securing the grounding conductor.

In Canada, all boxes shall be provided with a minimum of one grounding screw installed per gang or device, or other means to connect the branch circuit grounding conductors to the box and to connect a bonding jumper from the box to the grounding terminal of a wiring device.

8.1.2 The grounding means shall be located so that:

a) The means is readily accessible through the opening in the face of the box,

b) The removal of a device mounted in the box does not disturb in any way the continuity of the grounding circuit, and

c) The means is not part of a removable cover, back, or side.

8.1.3 A grounding screw provided with a box shall:

a) Be No. 8-32 or larger,

b) Have a green-colored head (in Mexico and the United States only), and

c) Be plated steel, stainless steel, copper, or copper alloy.

Only a plated or stainless steel grounding screw shall be provided in an aluminum box.

8.1.4 The diameter of the head or the integral washer of a No. 8 screw shall not be smaller than 7.8 mm (0.30 in) and a No. 10 screw shall not be smaller than 9.1 mm (0.36 in). A ferrous screw shall be protected against corrosion, particularly the underside of the head that contacts the grounding conductor. See 13.1.

8.1.5 A tapped hole provided for a grounding screw shall have a minimum of two full threads or shall comply with 12.4.

8.1.6 A grounding screw shall be used in conjunction with upturned lugs, a cupped washer, or an equivalent means capable of laterally retaining a 10 AWG (5.267 mm^2) conductor under the head of the screw. The retention means may be an integral feature of the box.

NOTE: Retention means are intended to ensure that the grounding conductor will not escape from under the head of the ground screw as the ground screw is being tightened.

8.1.7 A wire conductor provided as the means for grounding (bonding) shall be copper not smaller than 14 AWG (2.08 mm^2) or aluminum not smaller than 12 AWG (3.31 mm^2). The length shall not be less than 152 mm (6 in). A stranded wire type conductor that is factory-terminated to the box shall be captivated by upturned lugs, or the equivalent, to hold the wire strands under the head of the screw, or shall employ a factory-installed spade or ring terminal. A stranded wire type conductor less than 61 cm (24 in) in length shall be insulated and identified in accordance with 8.1.8.

In Mexico, the use of aluminum conductors smaller than 6 AWG (13.3 mm^2) is prohibited.

8.1.8 A grounding wire provided with a box as the means for grounding shall be secured to the box by a screw or by welding.

If insulated, the insulation shall be rated 600 volts and the surface of the insulation shall be green, with or without one or more yellow stripes. A screw used to secure the grounding wire in the box shall comply with 8.1.1, 8.1.3, and 8.1.4.

8.2 Screws for gangable (sectional) boxes

8.2.1 A box with removable sides, such as a flush-device box, intended for ganging in the field, shall be constructed so that the electrical bond between separable parts involves at least one threaded screw connection.

9 Construction requirements

9.1 Corrosion protection

9.1.1 Ferrous metal products or components covered by the scope of this standard shall comply with Section 13 or Section 14, whichever applies.

9.1.2 In Canada and the United States, stainless steel having a minimum of 16 percent chromium content shall not be subject to the corrosion protection requirements.

In Mexico, this requirement does not apply.

9.1.3 The outside of an aluminum outlet box, such as a floor box, that is intended for use in poured concrete or cinder fill shall be coated with asphalt-base paint, two coats of baked enamel, or the equivalent.

9.2 Knockouts

9.2.1 Location

9.2.1.1 In Canada, knockouts for the entrance of conduit or cable shall not be located in the removable sides of a sectional box.

In Mexico and the United States, this requirement does not apply.

9.2.1.2 Knockouts for the entrance of conduit or cable shall not be located in the sides of a box intended to accommodate a switch rated at 347 V ac.

9.2.2 Clearance

9.2.2.1 A knockout shall effectively cover the opening in which it is located, and the clearance between the knockout and the opening shall not be greater than 0.40 mm (0.016 in).

9.2.3 Flat surfaces surrounding knockouts

9.2.3.1 Flat surfaces surrounding a knockout on both the inside and outside of a box shall extend beyond the edge of the knockout in all directions for at least the distance given in Table 3, and shall comply with 12.7.1. Projections or indentations in the flat surface area shall be prohibited; however, holes shall not be prohibited. The flat surface areas of adjacent knockouts that partially or wholly overlap meet the intent of this requirement.

9.2.3.2 Other than as noted in 9.2.3.3, a box shall be provided with a means for connection to a wiring system.

9.2.3.3 A flat area as specified in 9.2.3.1 shall be provided for the connection of conduit to a cast box for drilling and tapping a hole in the field. The thickness of the box wall where drilling is to be done shall not be less than 6.7 mm (17/64 in).

9.2.4 Boxes for narrow wiring devices

9.2.4.1 A box intended for a narrow wiring device and having an internal width less than 29.3 mm (1.15 in) shall not be required to comply with 9.2.3 when:

a) The box is used only with nonmetallic-sheathed cable or flexible nonmetallic tubing, and

b) The proper connection of those wiring systems is demonstrated for the internal width.

9.2.5 Diameters

9.2.5.1 A knockout shall have a diameter that accommodates the corresponding trade sizes of rigid steel conduit specified in Table 3. The diameter of the knockout shall be measured at points other than where a tab remains after the knockout has been removed.

9.2.6 Strength of knockouts

9.2.6.1 A knockout shall comply with 12.6.

9.3 Partitions

9.3.1 A partition shall comply with 9.3.2 – 9.3.7. A box intended for use with a partition shall have provision for proper location of the partition during and after installation.

9.3.2 A partition shall fit the inside of the box in which it is intended to be used. Any openings or gaps between the partition and the inside surface of the box shall not be greater than 2.0 mm (0.08 in).

9.3.3 In Canada and the United States, a partition constructed from a polymeric material shall have a relative thermal index (RTI) for electrical properties, and mechanical without impact (RTI-strength) properties, of not less than 80 °C (176 °F) in accordance with UL 746B or CAN/CSA-C22.2 No. 0.17.

In Mexico, this requirement does not apply.

9.3.4 A partition constructed from a polymeric material shall comply with the flammability requirements for materials in accordance with UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE, where the duration of the test flame application shall be 15 s on and 15 s off. Testing of a material designated 5VA, in accordance with IEC 60695-11-10, shall not be required.

9.3.5 When assembled as intended in a box, a partition constructed from a polymeric material shall comply with 12.9.1.

9.3.6 A partition constructed from a polymeric material shall comply with 12.9.2.

9.3.7 A partition constructed from a polymeric material shall not ignite within 15 s after application of the test current, when subjected to the hot-wire ignition test in accordance with UL 746A, CAN/CSA-C22.2 No. 0.17, or NMX-J-508-ANCE. Testing of a polymeric material with a minimum hot-wire ignition (HWI) rating of 15 s (PLC 3) shall not be required.

9.4 Openings for rigid conduit, electrical metallic tubing, and conduit hubs

9.4.1 Threaded entries

9.4.1.1 The threads of a conduit entry shall be straight or tapered, having a thread form that complies with ASME B1.20.1, CSA C22.2 No. 0.5, or NMX-H-146-SCFI.

9.4.1.2 If threads for the connection of conduit are tapped completely through a hole in the wall of a box or if an equivalent construction is employed, there shall not be less than 3-1/2 nor more than five threads in the metal, and the construction shall accommodate attachment of a conduit bushing as intended.

9.4.1.3 If threads for the connection of conduit are not tapped completely through a hole in the wall of a box, conduit hub, or an equivalent construction, there shall not be less than five full threads in the metal, and there shall be a smooth, rounded inlet hole that provides protection to the conductors. The throat diameter of an inlet hole shall be within the limits specified in Table 2.

9.4.2 Electrical metallic tubing entries

9.4.2.1 An electrical metallic tubing entry that is integral with the box shall comply with the applicable requirements covering threadless electrical metallic tubing fittings in UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE.

9.4.3 Conduit hubs – nondetachable

9.4.3.1 A hub that is not detachable from the box shall withstand a bending moment in any direction at the values specified in Table 11 and a torque in the direction for tightening the conduit at the values specified in Table 12. The test procedure specified in UL 50, CAN/CSA-C22.2 No. 94, or NMX-J-235-ANCE for conduit connections and bending shall be followed.

9.4.4 Plugs

9.4.4.1 General

9.4.4.1.1 A plug or plate that is intended to close an opening in an outlet box shall be made of material that complies with 9.4.4.2 – 9.4.4.5. A plug or plate that employs a securing screw shall be such that the construction of the enclosure remains effective in the event the screw becomes slightly loosened.

9.4.4.2 Thickness

9.4.4.2.1 Other than as noted in 9.4.4.2.3, a sheet-metal plug or plate intended to close an opening in a metal box shall have a minimum thickness of 1.38 mm (0.054 in) when made of steel, and 2.06 mm (0.081 in) when made of aluminum.

9.4.4.2.2 When a plug or plate is made of laminated steel, the total thickness shall not be less than 1.38 mm (0.054 in).

9.4.4.2.3 A cast-metal plug intended to close an opening in an outlet box shall have a thickness not less than 1.6 mm (1/16 in) when made of die-cast zinc, die-cast aluminum, or malleable iron, and not less than 3.2 mm (1/8 in) when made of sand-cast aluminum or cast iron. A die-cast zinc plug shall not be larger than trade size 1.

9.4.4.2.4 A phenolic plug intended to close an opening in a box shall not be less than 2.54 mm (0.100 in) thick.

9.4.4.3 Nonmetallic plugs

9.4.4.3.1 A nonmetallic plug or equivalent closure of other than thermosetting material, intended to be assembled to a box surface, shall comply with 12.8. A plug made of rubber or other elastomeric material shall also comply with 12.20.2.

9.4.4.4 Corrosion protection

9.4.4.4.1 A metallic closure plug or plate of ferrous metal shall comply with Section 13.

9.4.4.5 Plugs for floor boxes

9.4.4.5.1 A sheet steel plug or plate having a thickness of not less than 0.25 mm (0.010 in) may close threaded openings not greater than 1-1/2 trade size in a floor box intended for installation in poured concrete and marked in accordance with 5.4.1, when it complies with 12.16.6.

9.4.5 Cover holding screws

9.4.5.1 A circular, octagonal, or square outlet box shall have metal ears or an equivalent means of securing the cover to the box. Holes provided for securement of a cover with screws shall be tapped for No. 8 screws.

9.4.5.2 A cover-holding screw shall engage at least two full threads in metal ears when a steel cover is installed. When the cover is assembled securely into position, the screws shall not extend more than 16 mm (0.63 in) beyond the ear.

NOTE: This requires that composition covers be supplied with screws appropriate for the cover thickness involved, and that means be provided to reduce the risk of such screws becoming lost in handling before installation.

9.4.5.3 An outlet box intended to support a fixture/luminaire and not a ceiling-suspended fan shall be provided with threaded retaining screw holes for No. 8-32 screws. No. 8-32 screws shall not be required to be provided.

9.4.6 Covers for dry locations

9.4.6.1 For a metal cover constructed such that a receptacle is to be mounted to the underside of the cover, the construction shall be such that the face of the receptacle projects not less than 0.38 mm (0.015 in) above the outer plane of the opening in the cover.

9.4.6.2 In Canada, nonmetallic covers shall comply with the applicable requirements in CSA C22.2 No. 18.2. In the United States, nonmetallic covers shall comply with the applicable requirements in UL 514C. In Mexico, no requirements for nonmetallic covers are specified.

9.4.6.3 In the United States, an outlet box cover constructed to support a flush duplex receptacle shall be provided with more than one securement point for the receptacle.

In Canada and Mexico, this requirement does not apply.

9.5 Box brackets and supports

9.5.1 General

9.5.1.1 A box shall have a means for support such that it is fastened securely in place independent of support furnished by any wiring system.

9.5.1.2 A means for support is not required for a box intended for installation in concrete, for a cast metal box having a flat back in which mounting screw holes are to be drilled, or for a cast metal box having threaded hubs.

9.5.1.3 Separately supplied box supports, including bar hangers, shall comply with the requirements for support of the boxes for which they are intended to be used. Where applicable, they shall be marked in accordance with the applicable requirements in 5.11.

9.5.1.4 The area of any one open hole when a support bracket is placed between the box and the cover shall not exceed 142.24 mm^2 (0.220 in^2). See Figure 5, which represents a cut through the bracket of a combination of a box, mounting bracket, and mud or plaster ring. The nominal dimensions of this opening shall not exceed 1.6 by 88.9 mm (1/16 by 3-1/2 in). The mounting bracket shall be placed between the box and the mud or plaster ring. In determining the area of the opening, any open area between a box and a flat cover installed on the box without the bracket shall not be counted in the calculation.

9.5.1.5 A bar hanger intended for use in a ceiling installation shall have means to secure the box into position on the bar hanger.

9.5.1.6 Supporting ears made of galvanized sheet steel, provided with a box, shall have a thickness not less than 1.0 mm (0.039 in), shall be attached to the box, and shall be prevented from turning. Screws used to attach the ears to a box shall be not smaller than No. 6-32. The assembly of adjustable ears to a box shall not hinder the ears from being placed flush with the open face or at least 12.7 mm (0.50 in) from the open face of the box.

9.5.1.7 When the performance of a box support is dependent upon the thickness of the material to which it is mounted and the mounting position, the support shall comply with all applicable tests with the support

assembled to each mounting surface, the minimum and maximum material thickness, and in each position for which it is intended to be installed. The support shall be marked in accordance with 5.6.2.

9.5.2 Boxes supported by nails

9.5.2.1 A supporting-nail hole provided in a box shall be located so that the nail does not interfere with the entry of cable or conductors into the box or interfere with the intended use of box fittings. No part of the nail shank shall be located more than 6.4 mm (1/4 in) from the interior surface of the back or ends of the box when the box is installed as intended. This requirement does not apply to a hole located so that the nail passes through the exterior of the box. See Figure 6.

9.5.2.2 A supporting-nail hole as described in 9.5.2.1 that enables a nail to pass through the wiring space may be located such that the nail interferes with the use of knockouts or pryouts when both of the following conditions are met:

a) The nail renders the affected knockouts and/or pryouts completely unusable for attaching the intended wiring system(s), and

b) Other provisions for attaching the intended wiring system(s) are provided and remain accessible.

9.5.2.3 In Canada, supporting-nail holes in the side of a box with face dimensions less than 76.2 by 76.2 mm (3 by 3 inches) that enable nails to pass through the wiring space shall be located so as to provide a clear space extending at least 38.1 mm (1-1/2 in) from the face of the box to the nail hole. See Figure 6.

In the United States and Mexico, this requirement does not apply.

9.5.2.4 The following are not supporting-nail holes:

a) A hole that is 3 mm (0.120 in) or smaller in diameter, and

b) A hole that is located so as to prevent the insertion of a 3-mm (0.120-in) drill rod through both walls.

9.5.2.5 Locating a supporting-nail hole in the side of an outlet box with face dimensions not less than 76.2 by 76.2 mm (3 by 3 in) shall be allowed.

9.6 Boxes for unfinished structures (new work)

9.6.1 General

9.6.1.1 The supporting means of a box or boxes intended to be installed in a wall or ceiling in an unfinished structure (new work) shall comply with the applicable requirements in 12.11.

9.6.1.2 A separately supplied box support, including a bar hanger, intended for use in a ceiling installation in an unfinished structure (new work) shall have means for securing the box into position on the support.

9.6.2 Boxes for support of a fixture/luminaire or other product in an unfinished structure (new work)

9.6.2.1 In Mexico and the United States, an outlet box or separate support for an outlet box, intended to support a fixture/luminaire weighing 23 kg (50 lb) or more, for ceiling installation in unfinished structures (new work), and marked in accordance with 5.11.1, 5.11.3, or 5.11.4 shall comply with 12.14.1.1.

In Canada, an outlet box or separate support for an outlet box, intended to support a fixture/luminaire weighing 23 kg (50 lb) for ceiling installation in unfinished structures (new work), and marked in accordance with 5.11.1, shall comply with 12.14.1.1. Luminaires weighing more than 23 kg (50 lb) shall be supported independently of the box.

9.6.2.2 In Mexico and the United States, a box, including a device box, or a separate support for a box, intended to support a fixture/luminaire or other product weighing more than 2.7 kg (6 lb) and 22.2 kg (49 lb) or less for wall installation in an unfinished structure (new work), and marked in accordance with 5.11.2, shall comply with 12.14.1.2.

In Canada, this requirement does not apply. Canada does not have separate weight classifications.

9.7 Boxes for finished structures (old work)

9.7.1 General

9.7.1.1 The supporting means of a box intended to be installed in a wall or ceiling in a finished structure (old work) shall comply with 12.13.1 when tested in accordance with 12.13.2 – 12.13.4.

9.7.1.2 When the supporting means is constructed of a polymeric material, it shall also comply with 12.15.

9.7.2 Boxes for support of a fixture/luminaire or other product in a finished structure (old work)

9.7.2.1 In Mexico and the United States, a box, including a device box, or a separate support for a box, intended to support a fixture/luminaire or other product weighing more than 2.7 kg (6 lb) and 22.2 kg (49 lb) or less for wall installation in a finished structure (old work), and marked in accordance with 5.11.2, shall comply with 12.14.2.1. Installation instructions shall be provided in accordance with 6.2.1.

In Canada, this requirement does not apply.

9.8 Device attachment means

9.8.1 A means for attachment of a wiring device shall be supplied at each end of the device box. The attachment means shall be usable with a screw not smaller than No. 6 on 83.4-mm (3.28-in) centers for a switch rated 300 V or less or for a receptacle. For a switch rated 347 V ac, the on-center dimension shall be 89.7 mm (3.53 in).

9.8.2 A provision for supporting a device to be enclosed in a box shall be independent of the screws used to support the box.

9.8.3 A box intended to accommodate a switch rated 347 V ac shall not be capable of accommodating a flush-mounted receptacle or a switch rated 300 V or less.

9.8.4 A conduit body having a volume greater than 1640 cm^3 (100 in^3) shall not have provision for mounting of a switch, fuse holder, or other control device.

9.8.5 A provision for mounting a wiring device may be provided on a conduit body having a volume of 1640 cm^3 (100 in^3) or less when the conduit body is marked in accordance with 5.5.1 and the volume is verified in accordance with Clause 7.8. See 9.8.1.

9.9 Mounting brackets

9.9.1 Mounting brackets shall comply with 12.11.

9.10 Supports for use with metal studs

9.10.1 In Canada, supports for use with metal studs shall comply with 12.12.

In Mexico and the United States, this requirement does not apply.

9.11 Luminaire studs

9.11.1 A luminaire stud shall be of malleable iron, steel, or equivalent material. The threaded portion shall not have less than five full threads (NPS). A stud and its attachment to a box or cover shall comply with 12.17.

9.12 Ceiling-suspended fan support

9.12.1 An outlet box intended to support a ceiling-suspended fan shall:

a) Be provided with a minimum of two steel cover-retaining or fan-mounting screws and matching threaded or unthreaded holes,

In Mexico and the United States, where screws other than No. 8-32 or No. 10-32 are provided, the box shall be marked in accordance with 5.7.2.

In Canada, only No. 10-32 retaining screws and external tooth lockwashers shall be supplied with the outlet box or outlet box with outlet box cover.

A box having unthreaded holes shall be provided with:

1) Screws of the thread-cutting type, or

2) A screw and nut assembly for use with clearance holes. The screws shall be held such that they are not able to rotate.

b) Comply with the support tests in 12.14.1.1 and 12.5,

c) Be marked in accordance with 5.7.1, and

d) Be provided with installation instructions in accordance with 6.4.1.

9.12.2 Screws intended to secure a ceiling-suspended fan-mounting bracket to an outlet box in accordance with 9.12.1(a) shall not have more than 14.3 mm (9/16 in) of exposed screw threads when a 3.2 mm (1/8 in) thick bracket is secured to the box.

Screws with more exposed threads comply with the requirement when a means to reduce the risk of contact between the screw threads and the wire insulation is employed.

9.13 Securement of wiring systems at openings

9.13.1 Clamps or fasteners shall be supplied as a part of any metal box provided with a pryout.

9.13.2 A clamp or fastener provided as a part of a box and intended for the attachment of conduit, tubing, or cable shall comply with UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE for the appropriate fitting. See 5.2.1.1, 5.2.2.1, and 12.10.1.

9.13.3 A clamp provided as part of a box and intended for use with nonmetallic-sheathed cable shall secure cable ranging from 14 AWG (2.08 mm^2) two-wire cable with an uninsulated grounding wire to the largest oval or round multi-conductor cable that can be accommodated by the clamp unless the clamp is marked to indicate its use with other cable sizes. See 5.2.3.1 and 5.2.3.2.

9.14 Closure of openings in pryouts

9.14.1 A clamp provided as part of a box and intended to secure flexible conduit or cable shall close the opening in the box surrounding the cable or conduit.

9.15 Bar hangers: ceiling installations

9.15.1 A bar hanger marked in accordance with 5.13.1 shall comply with the applicable requirements for ceiling installations in 12.11.

9.15.2 A bar hanger marked in accordance with 5.13.2 and intended for use in a ceiling installation shall have means to secure the box into position on the bar hanger and shall comply with the requirements of 12.14.1.1.

9.16 Assembly screws

9.16.1 An assembly screw employed in a box shall be in accordance with ASME B1.1 or NMX-H-146-SCFI.

9.16.2 A sheet metal screw shall not be used for assembly of a box.

9.17 Clamps for cable, conduit, and tubing

9.17.1 The construction of a clamp for cable, conduit, or tubing shall comply with UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE for the appropriate fitting.

9.18 Adjustable mud rings

9.18.1 General

9.18.1.1 In addition to the sheet steel thickness requirements in 7.1 and corrosion protection requirements in 9.1, an adjustable mud ring shall be provided with a means to mechanically secure the adjustable sleeve to the mud ring and shall provide effective bonding between the adjustable sleeve and the mud ring in accordance with 9.18.2 and 9.18.3.

9.18.1.2 When an adjustable mud ring is assembled to:

a) The minimum finished surface that the adjustable mud ring is marked for use with, and

b) A box having the minimum depth with which the adjustable mud ring is identified for use,

there shall be no less than 25.4 mm (1 in) clearance from the bottom of the inside of the box to the most inward projecting part of the adjustable sleeve.

9.18.2 Mechanical securement

9.18.2.1 Screw-type mechanical securement

9.18.2.1.1 An adjustable mud ring that relies solely on the adjustment of screws for mechanical securement between the mud ring and the sleeve shall comply with the test sequences in 12.23.5 and 12.23.6.

9.18.2.2 Spring-action type mechanical securement

9.18.2.2.1 An adjustable mud ring that relies upon spring action for mechanical securement between the mud ring and the sleeve shall comply with the test sequences in 12.23.5 and 12.23.6.

9.18.3 Electrical connection

9.18.3.1 By flexible bonding jumper

9.18.3.1.1 An adjustable mud ring according to 9.18.2.1 and 9.18.2.2 having a flexible bonding jumper or similar means to achieve the permanent electrical connection between the mud ring and sleeve need not be subjected to the test sequences in 12.23.2 – 12.23.4.

9.18.3.2 By other means

9.18.3.2.1 An adjustable mud ring in accordance with 9.18.2.1 with a provision for electrical connection between the mud ring and sleeve other than those as described in 9.18.3.1, shall be subjected to the test sequences in 12.23.5 and 12.23.6, in addition to those of 12.23.1 – 12.23.4.

9.19 Adjustable sleeve extenders

9.19.1 Adjustable sleeve extenders shall be provided with machine screw-type fasteners. The machine screw-type fasteners shall mechanically secure an adjustable sleeve extender to an adjustable sleeve and shall:

a) Engage not less than two threads in to the adjustable sleeve extender,

b) Engage not less than two threads in to the adjustable sleeve, or

c) Be secured with a nut.

9.19.2 The depth of an adjustable sleeve extender shall be the same amount as the intended wall thickness marked in accordance with 5.16.1(b).

9.19.3 In addition to the sheet steel thickness requirements in 7.1 and corrosion protection requirements in 9.1, an adjustable sleeve extender shall be provided with a means to mechanically secure the adjustable sleeve and shall provide effective bonding from the sleeve extender through the adjustable sleeve to the mud ring in accordance with 9.18.2 and 9.18.3.

10 Resistance to ingress of solid objects

10.1 Closure of openings

10.1.1 Unless threaded or provided with a threadless connector, an opening in an outlet box intended for the entrance of a wiring system shall be closed.

10.1.2 All openings in an adjustable mud ring shall be closed unless they are provided for one of the following purposes:

a) For the placement of a wiring device,

b) Threaded for securing a wiring device, or

c) For securement to the box.

10.1.3 When an adjustable mud ring's adjustable sleeve is not secured to the mud ring at the factory, a protective plate shall be provided that fits in the opening of the mud ring. The material thickness of the insert plate shall not be less than 0.76 mm (0.030 in) for ferrous metal (including stainless steel) or 1.0 mm (0.040 in) for nonferrous metal.

10.1.4 All openings between the adjustable sleeve extender and the adjustable sleeve shall be closed such that a 2 mm (0.080 in) diameter probe cannot pass between the adjustable sleeve extender and the adjustable sleeve when they are secured together.

10.2 Boxes for use in concrete slabs

10.2.1 In Canada, an outlet box for use in concrete slab ceilings shall be of appropriate depth and have knockouts located to allow the conduit to be installed above crossed reinforcing bars without being offset or bent.

In Mexico and the United States, this requirement does not apply.

10.2.2 In Canada, for an outlet or conduit box without integral hubs for conduit, a removable cover shall be supplied with the box on the face nearest the conduit openings to facilitate the tightening of the locknuts and bushings.

In Mexico and the United States, this requirement does not apply.

10.2.3 A floor box or a floor-mounted enclosure and its specified accessories intended for installing in poured concrete that, by a construction or installation method specified in the manufacturer's instructions, will not obviously prevent entrance of concrete aggregate into the box during normal installation, shall be subjected to the concrete-tightness test described in 12.18.

10.3 Area of open holes

10.3.1 The total area of all open holes such as mounting-screw holes, pryout holes, or slots in any one side of an outlet box shall not exceed 129 mm^2 (0.2 in^2). The total area of all open holes in the box, including all open holes in the bottom, shall not exceed the areas specified in Table 4. An open hole such as a mounting-screw hole shall not exceed 6.8 mm (0.27 in) in any dimension. The area of a pryout hole or slot shall not exceed 26 mm^2 (0.04 in^2).

10.3.2 An open hole adjacent to an integral ear provided for die clearance only shall be disregarded in computing the area of the open holes. The area of one hole per gang or per sectioned wiring compartment intended for use with a grounding screw shall be disregarded. In computing the area of open holes, an oblique side of a box, as illustrated in Figure 7, shall be included as a part of the end of the box.

10.3.3 An outlet box, provided with and intended only for installation using an adjustable bar hanger assembly may, in its sides, have slots in its sides that have a dimension greater than 6.8 mm (0.27 in) provided that the total area of all openings in any one side of the outlet box does not exceed 129 mm^2 (0.2 in^2) and that the total area of all open holes in the box shall not exceed the areas specified in Table 4.

10.3.4 The area of an open hole in a removable back of a box shall be calculated with the removable face installed as intended. Any area covered by the box mounting tabs shall be disregarded in computing the area of the open holes in a removable back/cover.

10.4 Holes in conduit bodies

10.4.1 In Mexico and the United States, unless provided for the connection of conduit, electrical metallic tubing, or mounting the cover, there shall not be holes in a conduit body.

In Canada, conduit bodies shall not be evaluated as outlet boxes; they are fittings, and this requirement does not apply.

10.5 Pryout holes and slots

10.5.1 A pryout hole or slot shall not be provided in a knockout of the 1/2 or larger trade size.

10.5.2 With reference to 10.3.1, the area of a pryout hole or slot in a location where a clamp is provided shall be disregarded. When the pryout hole or slot extends outside the area of the pryout, one-half the area of the hole or slot shall be used in computing the total area of the openings. The area of a pryout slot or hole in a location where a clamp is not provided shall be included, without reduction, in computing the total area of openings.

10.6 Covers

10.6.1 Number and type of open holes

10.6.1.1 A box cover shall not have open holes other than those for mounting to a box as described in 10.6.1.2 – 10.6.1.4. See 10.6.1.4 and 10.6.2.1.

10.6.1.2 Other than in a cover for a multiple-gang flush-device box, there shall not be more than four open holes provided for mounting a cover to a box. Each opening shall be a round hole, a single (not forked) slot, or a keyhole slot. A round hole shall not be larger than 5.6 mm (7/32 inch) in diameter. A slot shall not be larger than as specified in Figure 8.

10.6.1.3 A cover provided with a mounting slot, keyhole slot, or both, and no mounting holes may have a single hole not exceeding 5.08 mm (0.200 in) diameter and located not more than 6.4 mm (1/4 in) from the outer edge of the cover. A hole in a raised cover shall be located not more than 12.7 mm (1/2 in) from the outer edge of the cover.

10.6.1.4 A hole intended to be closed in the field by a wiring device, such as a switch, receptacle, or lampholder, or by a flush-device cover plate, shall not be considered to be an open hole as specified in 10.6.1.1.

10.6.2 Wire holes

10.6.2.1 A cover provided with a hole through which flexible cord is intended to pass shall have smooth, well-rounded surfaces upon which the cord bears, or the hole shall be provided with an insulating bushing. When a hole or holes in a metal cover are designed to accommodate wires other than flexible cord, there shall be a separate hole for each wire and each hole shall be provided with an insulating bushing.

11 Resistance to ingress of water in marine use and other wet locations

11.1 General

11.1.1 A box intended for use in wet locations shall be constructed so that it prevents the ingress of moisture and shall comply with 12.20.

11.1.2 A cover marked in accordance with 5.8.1 and requiring a gasket in order to exclude water from the installed assembly shall be supplied with the gasket.

11.2 Openings for conduit

11.2.1 An opening for conduit shall be threaded unless an integral or factory-assembled fitting for use in wet locations is provided.

11.3 Gaskets

11.3.1 A material intended for installation between a box and its cover that is depended upon to exclude water or moisture shall comply with 11.3.2 and 11.3.3 as applicable.

11.3.2 Elastomeric materials shall comply with 12.20.2.

11.3.3 Expanded (foam) closed cell materials shall comply with 12.20.3.

11.4 Boxes for marine use

11.4.1 In the United States, 11.4.2 – 11.4.4 apply to a box for marine use.

In Canada and Mexico, 11.4.2 – 11.4.4 do not apply.

11.4.2 A box intended for marine use (see 1.3) shall comply with 5.14 and 12.19, in addition to all other applicable requirements in this standard.

11.4.3 A box marked "watertight" shall comply with 12.19.2, and shall have a provision for external mounting. There shall not be holes or knockouts, other than for supply connections in the side walls or bottom of the box.

11.4.4 A box not intended to be watertight shall comply with 12.19.3. See 3.11 and 3.31.

11.5 Wet and damp locations

11.5.1 When installed as intended, a device box, an outlet box, and an outlet box cover intended for use in wet or damp locations shall comply with 11.5.2 and 12.20.1.1 – 12.20.1.7.

11.5.2 A bushed hole for open wiring shall not be located in the top or back of a box unless a hood is provided. When a hole is located in a side or under a hood, the hole and the hood shall be formed to direct a wire leaving the enclosure downward. There shall be a provision for drainage in a box containing a knockout, an unthreaded hole, or a hole bushed for open wiring.

12 Product testing

12.1 Volume measurement of boxes and raised covers

12.1.1 Each box, partitioned section, raised cover, or extension cover shall hold a volume of water equal to or greater than the marked volume when three samples are tested in accordance with 12.1.2 – 12.1.5.

12.1.2 All cable clamps, fixture/luminaire studs, grounding conductors, internal screws, and other internal accessories shall be removed. Any projections that extend outside the plane of the open face of a box, such as ears for mounting a cover or a flush device, shall be ground flush with the face of the box.

12.1.3 All large openings shall be closed by flat, rigid plates clamped in place across the openings. One of the plates shall contain two small holes, one for the entrance of water and the other for venting air. See Figure 9 and Figure 10.

12.1.4 Using modeling clay, putty, glazing compound, or similar material:

a) Holes through the side or bottom of the sample and a hole between the sample and the plate specified in 12.1.3 shall be filled flush with the inside surface.

b) Internal hubs, when tapped through, shall be filled flush with the end of the hub.

c) Openings that are bushed shall be filled flush with the conduit stop.

12.1.5 A clean, graduated vessel, pipette, or the equivalent, having a volume equal to or greater than the marked volume of the test sample, shall be filled with water at room temperature, and the volume of the water shall be measured. The water shall then be transferred from the vessel to the test sample through the hole in the plate as specified in 12.1.3 until the test sample is filled. The difference in the volume of water in the supply vessel, as measured before and after the filling of the test sample, indicates the volume of the test sample.

12.2 Strength of fastening of boxes

12.2.1 In Canada, the test in 12.2.2 shall be performed on three boxes. See 12.2.5.

In Mexico and the United States, 12.2.1 – 12.2.5 do not apply.

12.2.2 The strength of the fastening where the sides are formed and secured permanently together by lugs, spot welding, and the like, and that are limited to use with nonmetallic-sheathed cable, armoured cable (metal-sheathed cable) up to size 10 AWG 4-wire, and flexible conduit up to 1/2 (16) trade size, shall be such that the assembly withstands a pull force of 450 N (100 lbf) without a permanent opening of the joint of more than 1.6 mm (0.063 in). The pull shall be applied for 1 min between opposite sides of the box at a point 13 mm (0.5 in) from the face of the box and 13 mm (0.5 in) from the corner.

12.2.3 A box intended to be used with conduit, or cable other than that described in 12.2.2, shall comply with the requirements in 12.2.2 when a 1100 N (247 lbf) pull force is applied.

12.2.4 A box equipped with an integral wall clamping mechanism and one knockout in the back only shall be subjected to the test in 12.2.2.

12.2.5 For a drawn-type box or a sectional (gangable) box, 12.2.1 – 12.2.4 do not apply.

12.2.6 For special purpose boxes where forces will not be applied to the box sides during installation or subsequent pulling of conductors, e.g. boxes for door switches, 12.2.1 – 12.2.4 do not apply.

12.3 Boxes with attached device-mounting straps

12.3.1 Three boxes with an attached device-mounting strap shall be tested in accordance with 12.3.2 and 12.3.3. As a result, there shall not be stripping of the threads, and the mounting strap shall remain securely fastened to the box. A deformed strap that is securely fastened to the box does not constitute a failure of this requirement.

12.3.2 A bridge, as shown in Figure 11, shall be placed on the box, over the threaded cover holes used for the mounting covers or wiring devices. Steel washers that comply with Table 5 shall be provided under the head of each screw. The screws shall be the size and type supplied by the manufacturer and shall be threaded into each hole as intended. Each screw shall be torqued to the value specified in Table 5.

12.3.3 When the attached strap is provided with three tapped holes, the two outer screws shall first be torqued to the value specified in Table 5. Straps with untapped holes shall be tapped or formed prior to testing. After compliance with the test, three additional specimens shall have the center screw torqued to the same value. Both specimens shall then be supported horizontally in a face-down manner and each strap subjected to a force of 90 N (20 lbf) for 1 min.

12.4 Threaded holes for ground screws

12.4.1 Two boxes shall be tested in accordance with 12.4.2.

12.4.2 The threads of holes provided in a box for attachment of a ground screw having fewer than 2 full threads shall not strip when a No. 8 screw is tightened to a torque of 2.26 N·m (20 lbf-in), or a No. 10 screw is tightened to a torque of 3.96 N·m (35 lbf-in). During the test, a plated flat steel washer of a size appropriate for the screw shall be centered under the head of the screw. Holes having at least two full threads are not required to be tested.

12.5 Ceiling-suspended fan support

12.5.1 An outlet box intended to support a ceiling-suspended fan (see 9.12) shall comply with 12.14.1.1. As a result of the test specified in 12.5.2 – 12.5.6, there shall not be cracking, crazing, breaking, or visible damage to the outlet box, mounting ears, or box supporting system (other than bending). Additionally, there shall not be stripping of threads in the outlet box or box supporting system. The box or supporting system shall not be pulled loose from the test structure. One sample shall be tested in the horizontal position, and one additional sample shall be tested in the inclined position.

12.5.2 An outlet box shall be mounted in accordance with the manufacturer's installation instructions (see 6.4.1) to a supporting test structure and tested while:

a) In the horizontal position, and

b) Inclined 30 degrees from the horizontal with the mounting screws perpendicular to the ceiling and the fan blades parallel to the floor. See Figure 12.

12.5.3 An outlet box shall be subjected to the tests specified in 12.5.4 – 12.5.6 using:

a) A fan weighing 15.9 kg (35 lb) or 23 kg (50 lb) for a box marked in accordance with 5.7.1, or

b) In Mexico and the United States, a fan weighing 15.9 kg (35 lb), 23 kg (50 lb), or 32 kg (70 lb) for a box marked in accordance with 5.7.1.

In Canada, the requirement in (b) does not apply.

12.5.4 A 1320 ±25 mm (52 ±1 in) diameter test fan having four blades shall be used for the tests. A 40-g (1.4-oz) imbalance shall be placed 387.4 mm (15-1/4 in) from the center of the motor shaft. The fan shall be provided with a downrod of rigid metal pipe of a length to position the lower edge of the fan blades 305 ±25 mm (12 ±1 in) below the surface of the ceiling after mounting. The downrod shall be welded at the upper end to a 7.9-mm (5/16-in) thick fan-mounting bracket. The fan-mounting bracket shall be secured to the outlet box in accordance with the outlet box installation instructions. When not specified in the installation instructions, No. 8-32 screws or nuts shall be tightened to 2.26 N·m (20 lbf-in), and No. 10-32 screws or nuts shall be tightened to 3.96 N·m (35 lbf-in). A universal-type joint mounting construction shall not be used for the test. The fan motor shall be an adjustable speed type.

12.5.5 The fan shall be connected to a variable voltage supply adjusted to maintain a tip speed of 1220 m (4000 ft) per minute (294 rpm). The blade pitch shall be reduced to a minimum. The fan shall be operated continuously at the prescribed speed for 24 h.

12.5.6 After testing as described in 12.5.2 – 12.5.5, one of the cover-retaining or fan-mounting screws or nuts shall be loosened two full turns, and the fan shall operate as specified for an additional 24 h for each mounting condition specified in 12.5.2. The screws or nuts shall not be loosened for a construction that employs cover-retaining or fan-mounting screws and locknuts with captive washers and an external star gripping pattern.

12.6 Strength of knockouts

12.6.1 Mechanical test

12.6.1.1 Two knockouts on each of three boxes shall be subjected to a force of 44.5 N (10 lbf) for 60 s, applied at right angles by means of a mandrel with a 6.4 mm (1/4 in) diameter flat end. The mandrel shall be applied on the knockout at the point of least strength. The clearance between the knockout and the box shall not be more than 0.40 mm (0.016 in) when measured 60 min after the force has been removed. When a box is provided with a concentric or eccentric knockout, the force shall be applied to the smallest knockout.

12.6.2 Electrical test

12.6.2.1 A box provided with a concentric or eccentric knockout shall carry the specified current for the time indicated in Table 6. As a result of the application of the current, the outer knockout shall remain in place, and there shall be continuity between the box and conduit. Arcing and burning during the test is acceptable.

12.6.2.2 One sample of each trade size concentric or eccentric knockout shall be tested. The box shall be assembled to a minimum 150-mm (6-in) length of rigid metal conduit as shown in Figure 13.

12.6.2.3 One locknut shall be reversed and threaded on the conduit. The smallest knockout shall be removed and the raceway shall be assembled to the box using a second locknut inside the box. The locknut shall be hand-tightened and then further tightened 1/4 turn with a hammer and a standard screwdriver or by an equivalent method. A copper wire lead shall be connected to:

a) The box by a pressure wire connector; and

b) The conduit by a ground clamp of the appropriate size, 12.7 mm (1/2 in) from the locknut.

The pressure wire connector shall be tightened to a torque specified in UL 486A-486B, CSA C22.2 No. 65, or NMX-J-543-ANCE. The test current shall be passed through the assembly.

12.6.2.4 After having carried the current, continuity shall exist between the parts of the test assembly when measured between a point on the raceway and a point on the box 6.4 mm (1/4 in) from the knockout. A device, such as an ohmmeter or battery-and-buzzer combination, shall be used to determine whether continuity exists.

12.6.2.5 A box provided with a multiple concentric or eccentric ring knockout shall be tested in accordance with 12.6.2.1 – 12.6.2.4 with the smallest part of the knockout removed and then again with the next-to-largest knockout ring removed.

12.7 Flat areas surrounding knockouts

12.7.1 With reference to 9.2.3.1, compliance of the flat surface that surrounds the knockouts near a radius shall be determined using a test gauge, as shown in Figure 14. To apply the test gauge, a knockout from each side of one box shall be removed and, when required, the remaining tab shall be filed or ground flush with the inside and outside surface of the box as well as at the edge surrounding the opening. An appropriate trade size test gauge shall be used, offset from the center of the knockout in a direction opposite to the area to be tested. When testing knockouts located adjacent to a box radius, a steel feeler gauge, 0.13 mm (0.005 in) thick and 2.5 mm (0.10 in) wide, shall be used to verify the space between the inner box surface and the flat surface of the test gauge, as shown in Figure 15. The test gauge shall not be canted or tilted to make the required contact with the surface of the box. Successful insertion of the steel feeler gauge between the box surface and the test gauge surface verifies that the box's corner radius encroaches on the required flat surface and that the box is not in compliance.

NOTE: The purpose of this test is to verify that a locknut seats flush with the surface of the box.

12.8 Nonmetallic plug or other nonmetallic closure

12.8.1 Nonmetallic materials flammability test

12.8.1.1 A nonmetallic plug or other nonmetallic closure intended to close an unused opening shall maintain the integrity of the enclosure in which it is installed when subjected to the nonmetallic materials flammability test as specified in UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE. The plug shall be installed as intended in the opening of a metal box for this test. A plug of thermosetting material shall not be required to be tested in accordance with the nonmetallic materials flammability test.

12.8.2 Conditioning

12.8.2.1 Six samples for each of the following conditions of each nonmetallic plug or other nonmetallic closure shall be tested as specified in 12.8.3:

a) As received,

b) At room temperature after exposure for 168 h at a temperature of 90.0 ±2.0 °C (194.0 ±3.6 °F) in an air-circulating oven that has been preheated at full draft, and

c) Immediately after exposure for 24 h to a temperature of minus 25.0 ±1.0 °C (minus 13.0 ±1.8 °F).

12.8.3 Installation test

12.8.3.1 A nonmetallic plug or other nonmetallic closure intended to be assembled to a sheet-metal box without a locknut shall not be damaged or its effectiveness impaired when subjected to the test specified in 12.8.3.2.

12.8.3.2 After being conditioned in accordance with 12.8.2.1, the plug or other closure shall be installed in plated steel or painted steel having the size opening with which the plug or other closure is intended to be used. The steel shall have a thickness of 0.66 mm (0.026 in) and 1.91 mm (0.075 in) for trade sizes 3/8 (13) – 1-1/4 (35), and 0.75 mm (0.030 in) and 2.31 mm (0.091 in) for trade sizes 1-1/2 (41) and larger.

12.8.4 Force test

12.8.4.1 The samples conditioned in accordance with 12.8.2.1(a) and (b) and installed in accordance with 12.8.3 shall not be dislodged when subjected to the test specified in 12.8.4.2. Threaded closure plugs shall not be required to be subjected to this test.

12.8.4.2 A force of 44.5 N (10 lbf) shall be applied without impact to the plug or closure using a 6.4 mm (1/4 in) diameter flat end mandrel, in a direction that tends to dislodge the plug or other closure from the opening in the test plate.

12.9 Partitions

12.9.1 Mold stress-relief test

12.9.1.1 A partition shall not show a change in any dimension greater than 10 percent as a result of the conditioning described in 12.9.1.2.

12.9.1.2 Three samples of a partition of each mold configuration and each thermoplastic material shall be installed in the box as intended and then conditioned for 7 h at a temperature of 90.0 ±2.0 °C (194.0 ±3.6 °F) in an air-circulating oven that has been preheated at full draft. After the boxes have been removed from the oven and cooled to room temperature, they shall be examined to determine whether they comply with the requirements of 12.9.1.1.

12.9.2 Water absorption test

12.9.2.1 A partition shall not absorb more water than 0.5 percent of its weight as a result of being immersed for 24 h in tap water at a temperature of 23 ±2 °C (73 ±3.6 °F).

12.9.2.2 Three samples of each thermoplastic material shall be cleaned and then dried in a desiccator for 24 h. Each sample shall be weighed and then immersed in water at the specified temperature. After removal from the water, each sample shall be dried with a clean piece of soft, lint-free cloth to remove all surface water before re-weighing.

12.10 Clamps for cable, conduit, tubing, and flexible cord

12.10.1 A clamp for the attachment of cable, conduit, tubing, or flexible cord shall comply with the performance requirements in UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE for the appropriate fitting.

12.11 Boxes and box supports for unfinished structures (new work)

12.11.1 Other than as noted in 12.11.4, three samples of a bracket or other device used for securing a flush-device box or other box not intended to support a fixture/luminaire to a structural wall stud or ceiling joist shall be capable of supporting the mass described in 12.11.3. A bracket that bends shall not break, and the box shall not pull loose from the bracket.

12.11.2 For a bracket or other device intended to support more than one box, the load shall be suspended from the center of the bottom of the box closest to the mid-span of the bracket. Only one box

shall be mounted to the bracket and shall be located at the position on the bracket closest to its mid-span. See Figure 16. Unless the bracket or supporting device is designed for a specific box, a standard 100 mm by 54 mm by 38 mm (4 in by 2-1/8 in by 1-1/2 in) or 100 mm by 54 mm by 48 mm (4 in by 2-1/8 in by 1-7/8 in) device box shall be used for the test.

12.11.3 In Canada and Mexico, the bracket shall be secured so that the plane of the front of the box is vertical, and a 23-kg (50-lb) mass shall be suspended centrally from the lower end of the box for 5 min.

In the United States, the bracket shall be secured so that the plane of the front of the box is vertical, and a 23-kg (50-lb) mass shall be suspended from the lower end of the box at the location of the outermost raceway entry for 5 min.

12.11.4 The test specified in 12.11.1 shall not be required to be performed when the bracket is steel, has dimensions not less than the two bracket types shown in Figure 17, and the bracket is secured to the box by not less than two rivets, spot-welds, or the equivalent.

12.12 Supports for use with metal studs

12.12.1 In Canada, two boxes for use with metal studs shall be mounted in the intended manner and shall not deflect more than 2 mm (0.08 in) in either direction while being subjected to a straight force of 180 N (40.5 lbf). See Figure 18. The force shall be gradually applied at the center of the box for 5 min, first in one direction, tending to push the box into the wall opening, and then in the opposite direction, tending to pull the box out of the opening.

In the United States and Mexico, this requirement does not apply.

12.13 Boxes intended to be installed in a finished structure (old work)

12.13.1 As a result of the test described in 12.13.2 – 12.13.4, the box supporting means shall not crack or break, or result in the face of the box being permanently displaced more than 3.2 mm (1/8 in) from the plane of the face of the test surface when measured 1 min after the test load is removed.

12.13.2 Boxes shall be installed in a rigidly supported 9.5 mm (3/8 in) thick plywood sheet. The plywood sheet shall be reinforced with a support 151.8 mm (6 in) from the opening for the boxes. For products requiring special instructions, in accordance with 6.2.1, a finished surface that is in compliance with the manufacturer's instructions shall be used for testing instead of the 9.5 mm (3/8 in) thick plywood sheet.

Screws for the box-supporting means shall be tightened to a torque in accordance with the manufacturer's instructions. See 5.6.1. In the absence of instructions, screws larger than No. 8 shall be tightened with a torque of 3.96 N·m (35 lbf-in). A No. 8 screw shall be tightened with a torque of 2.26 N·m (20 lbf-in). A No. 6 screw shall be tightened with a torque of 1.36 N·m (12 lbf-in). A screw that strips before being tightened to the torque specified shall not override more than once. Following the test in 12.13.3, the screw shall be removable with a screwdriver.

12.13.3 After installation as specified in 12.13.2, a force of 222 N (50 lbf) shall be applied for 5 min consecutively to each of two boxes. The force shall be applied in a direction normal to the plane of the face of the test surface along the centerline of the box, and tending to push the box into the opening. The same force shall be applied to each of two previously untested boxes, in a direction tending to pull the box out of the opening.

12.13.4 After installation as specified in 12.13.2, a part other than a clamp that is an integral part of a box having pryouts shall be subjected to a force as specified in (a) – (c) for 5 min. The force shall be applied in a direction perpendicular to the wall of two boxes at any pryout or punchout where a wiring system can be

attached. A box that accommodates more than one wiring system shall be tested using the greatest applicable force from the following:

a) Armored cable, metal-clad cable, or flexible metal conduit, 334 N (75 lbf),

In Canada, metal-clad cable is not applicable.

b) Nonmetallic-sheathed cable, 267 N (60 lbf), or

c) Flexible nonmetallic tubing, 667 N (150 lbf).

12.14 Boxes intended to support a fixture/luminaire or other product

12.14.1 Boxes for unfinished structures (new work)

12.14.1.1 In Canada, three samples of a hanger or box-supporting device intended for the support of a fixture/luminaire in an unfinished structure (new work) shall be mounted as intended, and a perpendicular force of 890 N (200 lbf) shall be applied from the open face of the box for 5 min. A supporting device that bends shall not break, and the box shall not pull loose from the supporting device. In addition, three new samples of the hanger or box-supporting device shall be capable of supporting for 5 min a mass of 23 kg (50 lb) applied normal to the face of the box without more than a 6.4-mm (1/4-in) deflection measured with the load attached. The measurement shall be taken at the point of maximum deflection either on the back or open face of the box.

In Mexico and the United States, three samples of a hanger or box-supporting device intended for the support of a fixture/luminaire intended to be installed in an unfinished structure (new work) shall be mounted as intended. The applicable force specified in Table 7 shall be applied in a direction perpendicular from the open face of the box for 5 min. A box-supporting means that bends shall not break, and the box shall not pull loose from the supporting device. In addition, three new samples of the hanger or box-supporting device shall be capable of supporting a load applied normal to the face of the box for 5 min without more than a 6.4-mm (1/4-in) deflection measured with the load attached. The measurement shall be taken at the point of maximum deflection either on the back or open face of the box. The load shall be the rated load when a load rating is specified by the manufacturer, or a mass of 23 kg (50 lb) when a load rating is not specified.

A supporting device that can be adjusted for use with various spacing of structural members shall be tested at the widest spacing acceptable in accordance with the manufacturer's ratings.

An adjustable supporting device may be rated by the manufacturer and marked for one or more intermediate spacing. If the intermediate spacing allows for a higher rating than the widest spacing, the supporting device shall be tested at this intermediate spacing for the higher rating.

12.14.1.2 In Mexico and the United States, three samples of a hanger or box shall be installed as intended, and a steel bar having minimum dimensions of 6.4-mm (1/4-in) thick, 25.4-mm (1-in) wide, and a length not greater than the appropriate box cover shall be secured to each box using the cover-retaining or device-mounting screws. A threaded rod having a minimum length of 508 mm (20 in) shall be threaded into the center hole in the steel bar. The rod used for this test shall be capable of withstanding the applied force without deformation. With the box face in the vertical plane, and with the rod extending in the horizontal direction from the box face, a force four times the marked value in 5.11.2 shall be applied to the rod. The force shall be applied 406 mm (16 in) from the face of the box in a direction perpendicular to the rod. The force shall be maintained 406 mm (16 in) from the face of the box by any convenient means, such as by a V-shaped groove cut into the rod. The force shall be applied for 5 min. As a result of the test, the box-supporting means shall not crack or break, or result in the face of the box being permanently displaced more than 3.2 mm (1/8 in) from the plane of the face of the test surface when measured 1 min after the test load is removed.

In Canada, this requirement does not apply.

12.14.2 Boxes for finished structures (old work)

12.14.2.1 In Mexico and the United States, three samples of a hanger or box shall be installed in accordance with 12.13.2 and a steel bar having minimum dimensions of 6.4-mm (1/4-in) thick, 25.4-mm (1-in) wide, and a length not greater than the appropriate box cover shall be secured to each box using the cover-retaining or device-mounting screws. A threaded rod having a minimum length of 508 mm (20 in) shall be threaded into the center hole in the steel bar. The rod used for this test shall be capable of withstanding the applied force without deformation. With the box face in the vertical plane, and with the rod extending in the horizontal direction from the box face, a force four times the marked value in 5.11.2 shall be applied to the rod. The force shall be applied 406 mm (16 in) from the face of the box in a direction perpendicular to the rod. The force shall be maintained 406 mm (16 in) from the face of the box by any convenient means, such as by a V-shaped groove cut into the rod. The force shall be applied for 5 min. As a result of the test, the box-supporting means shall not crack or break, or result in the face of the box being permanently displaced more than 3.2 mm (1/8 in) from the plane of the face of the test surface when measured 1 min after the test load is removed.

In Canada, this requirement does not apply.

12.15 Polymeric supporting means

12.15.1 A polymeric supporting means of a box intended to be installed in an existing structure shall not exhibit any cracks or change in any dimension greater than 10 percent following conditioning of the box as described in 12.15.2.

12.15.2 Three sample boxes shall be conditioned for 7 h at a temperature of 70 ±1 °C (158 ±1.8 °F) in an air-circulating oven that has been preheated at full draft. After conditioning, the box shall be removed from the oven and cooled to room temperature.

12.16 Floor boxes, floor-mounted enclosures, poke-through floor fittings, and floor box covers

12.16.1 General

12.16.1.1 Floor Boxes, floor-mounted enclosures, and poke-through floor fittingS shall be subjected to the applicable tests described in 12.16.2 – 12.16.6.

12.16.1.2 The tests in 12.16.1 and 12.16.5 do not apply to a raised-floor box.

12.16.1.3 The test in 12.16.3.5 shall be performed on a floor-mounted enclosure and a poke-through floor fitting intended for use in carpet- or wood-covered floors only and marked in accordance with 5.12.1. The test in 12.16.3.4 shall be performed for all other floor-mounted enclosures and a poke-through floor fittings.

12.16.2 Support test

12.16.2.1 Poke-through floor fittings and floor boxes intended to be installed in a wood-floor structure or raised-floor structure shall be subjected to the test described in 12.16.2.2 and 12.16.2.3. The support means, such as clamps, clips, or similar components, shall not break or result in the displacement of the box more than 3.2 mm (1/8 in) from the plane of the surface of the floor when measured 1 min after the test load is removed.

12.16.2.2 Six floor boxes shall be installed one at a time in a 19.1-mm (3/4-in) thick plywood sheet. The plywood shall be mounted on supports spaced 406 mm (16 in) on center with the box mounted in the middle of the supports. Screws for the box supporting means shall be tightened to a torque in accordance with the manufacturer's instructions. See 5.6.1. In the absence of instructions, screws larger than No. 8 shall be tightened with a torque of 3.96 N·m (35 lbf-in). A No. 8 screw shall be tightened with a torque of 2.26 N·m (20 lbf-in). A No. 6 screw shall be tightened with a torque of 1.36 N·m (12 lbf-in). A screw that strips before being tightened to the torque specified shall not override more than once. Following the test in 12.16.2.3, the screw shall be removable with a screwdriver.

12.16.2.3 After installation as specified in 12.16.2.2, a force of 222 N (50 lbf) shall be applied for 5 min consecutively to each of three boxes. The force shall be applied in a direction normal to the plane of the face of the plywood sheet. The force shall be applied at the center of each box, tending to push the box into the opening. The same force shall be applied to each of the remaining three boxes in a direction tending to pull the box out of the opening.

12.16.3 Resistance to ingress of scrub-water

12.16.3.1 For the purposes of the resistance to ingress of scrub-water test, the term "joints" shall be used to refer to points of potential water entry and points of access to conductors or connections for power or light circuits. All distances from the plane of the floor to the joints shall be measured after the box is installed as intended.

12.16.3.2 Floor-mounted enclosures and poke-through floor fittings shall be subjected to the applicable tests described in 12.16.3.3 – 12.16.3.5. There shall be no entrance of scrub-water at the floor level into the box, through the box cover, cover flange, or other openings. Any water that enters under the cover flange, but does not enter the floor box, shall not be able to contact live parts, connections, or conductors of power or light circuits. Scrub-water solution shall not enter the interior of any mounted wiring device employed in the assembly or installed for the purpose of conducting this test. Scrub-water may be present in the hand-access area of a recessed-access floor box. Scrub-water may enter a part of the enclosure that is not intended specifically for connections or conductors of power or lighting circuits.

12.16.3.3 A floor-mounted enclosure or poke-through floor fitting assembly shall be installed in a section of a floor of an impermeable material constructed to represent an installation as intended by the manufacturer. The cover plate shall be fully secured. All means provided for closing plug attachment openings shall be in the closed position. Cable exit openings of recessed floor box covers shall be closed.

12.16.3.4 A floor-mounted enclosure and a poke-through floor fitting assembly that uses a cover intended for use in tile, vinyl or similar floor surfaces shall be tested as described in this Clause. A leveled dam of sealing compound, or other suitable impermeable material shall be constructed around the leveled section of floor and shall be no closer than 50 mm (2 in) from the edge of the floor-mounted enclosure or poke-through floor assembly in order to retain the scrub-water solution at a depth of 3.2 mm (1/8 in) above the plane of the leveled floor section. A scrub-water solution shall be prepared by mixing 59 mL (4 tablespoons) of floor cleaning soap with 3.79 L (1.0 gal) of water. A portion of the solution shall be poured at a steady rate within 10 s over the floor box cover of the floor-mounted enclosure or poke-through floor fitting assembly so that it collects to a depth of 3.2 mm (1/8 in) above the leveled plane of the floor section.

All joints of the floor box cover of the floor-mounted enclosure or poke-through floor assembly greater than 19 mm (3/4 in) above the plane of the floor may be masked by impermeable tape or other suitable impermeable material. The solution shall be poured only over the joint(s) below 19 mm (3/4 in). The solution shall be allowed to run off the top and the sides of the cover and to overflow the dam. The solution retained by the dam shall remain on the floor assembly for 1 min. The solution shall then be removed, the cover exterior dried, and the interior and area underneath the cover of the floor box examined for entrance of scrub-water.

12.16.3.5 For a floor-mounted enclosure or poke-through floor fitting assembly intended for installation in a carpet- or wood-covered floor, a scrub-water solution shall be prepared by mixing 15 mL (1 tablespoon) of floor cleaning soap with 0.94 L (1.0 qt) of water. The solution shall be poured at a steady rate within 10 s over the floor box cover of the floor-mounted enclosure or poke-through floor fitting assembly. No dam shall be constructed for retaining the soap solution on the floor assembly. The poured solution shall be allowed to drain away.

If the floor box assembly has joints located higher than 19 mm (3/4 inch) and additional joints located lower than 19 mm above the plane of the floor, all joints of the floor box cover of the floor-mounted enclosure or poke-through floor fitting assembly greater than 19 mm above the plane of the floor may be masked by impermeable tape or other suitable impermeable material. The solution shall be poured only over the joints(s) below 19 mm.

The solution shall be allowed to run off the top and sides of the cover. The cover exterior shall be dried and the interior and area underneath the cover of the floor box examined for entrance of scrub-water.

12.16.4 Floor box cover loading test

12.16.4.1 A flush floor box cover or recessed access floor box cover intended for use as part of a floor-mounted enclosure or poke-through floor fitting assembly shall be subjected to the test described in 12.16.4.4. The cover and the floor box or poke-through floor fitting shall support the test load for 1 min without deflecting more than 3.2 mm (1/8 in). For a recessed access floor box, the cover door over the hand-access cavity shall support the test load for 1 min without deflecting more than 12.7 mm (1/2 in). The deflection, exclusive of gasket compression and/or test frame deflection, shall be measured when the applied force reaches the specified value. The permanent deformation at any point on the cover, exclusive of gasket compression, shall not exceed 0.8 mm (1/32 in), measured 1 h after the test load is removed. A floor box utilizing mounting hardware shall withstand the loading without structural failure to the mounting hardware.

12.16.4.2 For a flush floor box cover or recessed access floor box cover, one sample shall be tested. The cover shall be assembled to a floor box or poke-through floor fitting in accordance with the manufacturer's installation instructions. Appropriate wiring devices shall be installed.

12.16.4.3 For a raised-floor box, one sample of the box shall be installed in accordance with the manufacturer's installation instructions in the center of a 19.1-mm (3/4-in) thick plywood sheet that is 610 mm (24 in) longer and 610 mm (24 in) wider than the panel opening specified by the manufacturer. The assembly shall be supported on each side so that the box hangs freely beneath the panel, as shown in Figure 19. The supports shall be placed 150 mm (6 in) from the outermost edge of the mounting flange of the box.

12.16.4.4 The assembly described in 12.16.4.2 and 12.16.4.3 shall be subjected to the application of a load by means of a weight. The weight shall exert a force of 1334 N (300 lbf) through the flat end of a solid, right circular cylinder, 76.2 mm (3 in) in diameter and a minimum of 25.4 mm (1 in) long, as shown in Figure 19. The force shall be applied to the cover at the point resulting in maximum deflection.

12.16.5 Resistance test

12.16.5.1 One sample of a cast-metal floor box and a device shall be subjected to the test described in 12.16.5.2. The voltage drop between the box and the device shall not be more than 10 mV.

12.16.5.2 The resistance shall be determined by causing a current of 30 A to flow through the assembly of the box and the device mounting yoke. The voltage shall be measured between a point on the box 1.6 mm (1/16 in) from the nearest wireway connection and any point on the device mounting yoke.

12.16.6 Plug retention

12.16.6.1 One sample of a sheet steel plug or plate of a thickness not less than 0.25 mm (0.010 in) shall withstand a force of 88.9 N (20 lbf). The force shall be applied by means of a mandrel with a 6.4 mm (1/4 in) diameter flat end in any direction most probable to remove plug or plate.

12.17 Fixture/luminaire studs: studs and attachment to a box or cover

12.17.1 Three samples of a fixture/luminaire stud shall be investigated as a part of a box assembly, with a bar hanger, or as a separately supplied fitting with integral mounting means. In determining compliance with 12.17.2 – 12.17.4, one new sample shall be used for each test. A separate stud or one provided with a bar hanger shall be assembled to a standard octagonal outlet box for each test described in 12.17.3 and 12.17.4.

12.17.2 A stud and its attachment to a box, cover, bar hanger, or other device shall withstand for 5 min a direct pull of 4 times the manufacturer's rated load or 890 N (200 lbf), whichever is greater, without pulling apart or breaking.

12.17.3 A stud and its attachment to a box, cover, bar hanger, or similar device shall withstand for 1 min, without visible damage, the application of a load as specified in Table 8. The load applied at the end of the stem shall be reduced an appropriate amount to accommodate the bending moment due to the weight of the stem. The load shall be applied at the end of a 500 mm (19.7 in) rigid fixture/luminaire stem attached to the stud, with the stud assembly mounted as intended on the underside of a platform that is at a 30 degree angle with the horizontal. Provision shall be made to rotate the platform around the axis of the fixture/luminaire stud. The platform shall be rotated for six complete revolutions during the test.

12.17.4 A stud and its attachment to a box, cover, bar hanger, or other device shall withstand for 1 min, without visible damage or movement between the stud and its mounting system, the application of a torque having the value specified in Table 9. With reference to 12.17.2, the stud shall be rigidly supported as intended. The torque shall be applied at the end of the lever arm attached to the stud or an extension member attached to the stud. The torque shall be applied in the direction tending to tighten the screw connections. The lever arm shall be measured from the axis of the stud to the point of application of the torque, and the lever arm shall be perpendicular to the axis of the stud.

12.18 Concrete-tightness test

12.18.1 One sample of a concrete-tight box shall be subjected to the applicable tests described in 12.18.4 – 12.18.9. There shall not be entrance of concrete aggregate into the box.

12.18.2 A box that is constructed so that it obviously excludes concrete aggregate, such as a concrete ring, shall not be required to be tested.

12.18.3 A box that excludes water in accordance with 11.5 shall not be required to be tested.

12.18.4 A box shall be assembled in the intended manner in accordance with the installation instructions. When no instructions are provided, a box shall be assembled in the normal mounting position. A box that is provided with an adjusting means shall be tested in an adjusted position with the greatest potential for concrete entry. The box shall be secured to the bottom of the formwork used to contain the concrete. The formwork shall be filled with concrete prepared in accordance with 12.18.6.

12.18.5 The concrete shall be vibrated immediately after the concrete is poured using a vibrator in accordance with 12.18.7. A box intended to be used in a wall or ceiling shall be tested in accordance with 12.18.8. A box intended for use in a floor shall be tested in accordance with 12.18.9. Twenty-four hours

after the concrete has been poured, the box shall be broken loose from the concrete and the interior of the box shall be examined.

12.18.6 Portland-type cement shall be used in the preparation of the concrete for the test required by 12.18.5. The sand shall be of the type known to the construction industry as mason sand. The cement-to-sand ratio shall be 1:2 by volume. There shall be a 1.6-mm (1/16-in) deep film of water on the surface of the mixture after the mixture has stood for 1 min in the mixing vat.

12.18.7 The concrete shall be vibrated with a commercially-available, internal-type concrete vibrator until fully mixed. The vibrator head shall have:

a) A circumference not less than 95.3 mm (3-3/4 in) and not greater than 140 mm (5.5 in), and

b) A length not less than 356 mm (14 in) and not greater than 406 mm (16 in).

12.18.8 A box intended to be used in a concrete wall or ceiling shall be covered with not less than 0.61 m (2 ft) of concrete. The vibrator head shall be placed into the concrete so that:

a) Its major axis is vertical, and

b) Its free end is within 25.4 mm (1 in) of the bottom of the formwork and within 25.4 mm of the assembly.

The head shall then be withdrawn at a rate not less than 25.4 mm/s (1 in/s) and not more than 50.8 mm/s (2 in/s). This procedure shall be repeated until all the concrete has been vibrated as indicated by an overlap of vibration patterns over the entire surface. The vibrator head shall not come in contact with the assembly or the formwork. The total vibration time shall be 10 s per 0.03 m^3 (1.0 ft^3) of concrete used.

12.18.9 A box intended to be used in a concrete floor shall be covered with not less than 12.7 mm (1/2 in) of concrete. The vibrator head shall be placed into the concrete and then pulled completely around the assembly in a continuous circular motion. During this procedure, all of the concrete shall be vibrated as indicated by an overlap of vibration patterns over the entire surface. The vibrator head shall not come in contact with the assembly or the formwork. The total vibration time shall be 10 s per 0.03 m^3 (1.0 ft^3) of concrete used.

12.19 Marine use

12.19.1 General

12.19.1.1 In the United States, 12.19.2 – 12.19.5 apply for products intended for marine use.

In Canada and Mexico, 12.19.2 – 12.19.5 do not apply.

12.19.2 Watertight test

12.19.2.1 For a box marked "watertight" in accordance with 5.14.3, there shall not be evidence of water leakage when one sample is tested as specified in 12.19.2.2 and 12.19.2.3.

12.19.2.2 The assembly, including the method of wiring, shall be mounted in the intended manner. A solid stream of water from a 25.4-mm (1-in) diameter nozzle at a flow rate of 246 L/min (65 gal/min), measured at the nozzle, shall be directed at the enclosure from a distance of 3.05 m (10 ft) for 5 min.

12.19.2.3 Any water on the exterior of the enclosure shall be removed with a cloth and the enclosure then opened and examined for any evidence of water leakage.

12.19.3 Dripproof test

12.19.3.1 As a result of the test specified in 12.19.3.3, one sample of a box marked "dripproof" in accordance with 5.14.3 shall not have an accumulation of water retained by the box.

12.19.3.2 A box marked "watertight" complies with 12.19.3.1 and shall not be required to be tested.

12.19.3.3 A box shall be mounted beneath a drip pan that produces both splashing and dripping and extends beyond all exposed sides of the enclosure. The bottom of the drip pan shall be equipped with uniformly distributed spouts, one spout for each 129 cm^2 (20 in^2) of pan area. Each spout shall drip water at a rate of 20 drops/min. The box shall be oriented from 0 – 15 degrees from the vertical and shall be subjected to continuously dripping water for 30 min.

12.19.4 Air-circulating oven conditioning test for gaskets

12.19.4.1 Three samples of an elastomeric gasket shall not crack or show visible evidence of deterioration after conditioning for 168 h at a temperature of 100 ±2 °C (212 ±3.6 °F) in an air-circulating oven that has been preheated at full draft.

12.19.4.2 At the conclusion of the conditioning, the gasket shall be removed from the oven, manually flexed, and examined for compliance with 12.19.4.1.

12.19.5 Salt spray test

12.19.5.1 Three samples of a box shall be conditioned in accordance with the Standard Method of Salt Spray (Fog) Testing, ASTM B117. The exposure time shall be 1008 h. After the conditioning, there shall not be signs of corrosion such as pitting, cracking, blistering, or similar signs.

12.19.5.2 A box constructed in accordance with Section 13 shall not be required to be tested.

12.19.5.3 The apparatus for salt-spray (fog) testing shall consist of:

a) A fog chamber, the inside of which measures 1220 by 760 by 910 mm (48 by 30 by 36 in),

b) A salt solution reservoir,

c) A supply of conditioned compressed air,

d) A dispersion tower constructed in accordance with ASTM B117 for producing a salt fog,

e) Specimen supports,

f) Provision for heating the chamber, and

g) The required means of control.

12.19.5.4 The dispersion tower producing the salt fog shall be located in the center of the chamber and shall be supplied with humidified air at a pressure of 117 – 131 kPa (17 – 19 psi) so that the salt solution is aspirated as a fine mist or fog into the interior of the chamber.

12.20 Resistance to ingress of water

12.20.1 Wet and damp locations test

12.20.1.1 When tested as described in 12.20.1.3 – 12.20.1.7, an assembly of parts – hereafter referred to as the test assembly – shall comply with 12.20.1.2.

12.20.1.2 In Mexico and the United States, when tested as described in 12.20.1.1 – 12.20.1.7, an assembly of parts specified in 12.3 shall not allow the entrance of more than 0.1 gram of water into the enclosure formed by a box and a cover.

In Canada, when tested as described in 12.20.1.3 – 12.20.1.7, water that enters the enclosure shall not come into contact with the apparatus that may be installed in normal use within the enclosure or accumulate in such quantity as to submerge windings or leads and form a short-circuit path to ground.

12.20.1.3 Two samples of a cover employing a hood, a rain shield, or a similar device that requires positioning or movement in normal use shall remain functional and comply with 12.20.1.4 – 12.20.1.7 after 1000 cycles of operation.

12.20.1.4 The test assembly shall be installed as intended in accordance with the installation instructions. When the instructions do not provide enough details, a cover shall be installed to represent the worst case condition. The interior of the test assembly shall be vented to equalize the atmospheric pressure during the test. The vent shall be protected so that water does not enter through the vent. All components such as gaskets, covers for boxes, or boxes for covers, that are intended for use with the part under test, or are required to complete the enclosure shall be installed for the test.

12.20.1.5 One test assembly shall be located under the water-spray apparatus described in 12.20.1.7. A flat surface 300 mm (1 ft) wide by 610 mm (2 ft) long shall be positioned so that:

a) The surface is horizontal and 300 mm below the centerline of the test assembly, and

b) The long side of the surface is parallel to the test assembly or to the wall in which the test assembly is mounted.

The spray shall be applied for 1 h, with the water pressure maintained at 34.5 kPa (5 psi). Following the spray, the test assembly shall be examined to determine compliance with 12.20.1.1.

12.20.1.6 One additional test assembly shall be located 910 mm (3 ft) horizontally from and 610 mm (2 ft) above a spray head. The spray head shall be positioned so that the spray is aimed directly at the test assembly. The water pressure shall be maintained at 103.4 kPa (15 psi). The spray shall be applied for 1 h. After the spray, the test assembly shall be examined to determine compliance with 12.20.1.1.

12.20.1.7 The water-spray apparatus shall consist of three spray heads constructed in accordance with Figure 20 and mounted in a water supply pipe rack as illustrated in Figure 21. The assembly shall be brought into the focal area of the three spray heads in such a position and under such conditions that water will be most likely to enter with consideration given to the normal mounting position.

12.20.2 Gasket aging test

12.20.2.1 When tested in accordance with 12.20.2.2, two samples of the material used for a gasket or similar component intended to prevent the entrance of water having minimum dimensions of 50.8 mm × 50.8 mm (2 in × 2 in) shall not crack, break, or have a change in hardness of more than 10 units.

12.20.2.2 The hardness of each sample shall be determined as the average of five readings using a gauge such as a Rex hardness gauge or a Shore durometer. The samples shall be conditioned for 70 h at a temperature of 100 ±2 °C (212 ±3.6 °F) in an air-circulating oven that has been preheated at full draft. After conditioning, the component 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.

12.20.3 Compression-set test

12.20.3.1 Samples of an expanded (foam) closed-cell material shall be tested as described in 12.20.3.2. The thickness of a sample after conditioning shall not be less than five-sixths of its original (before conditioning) thickness.

12.20.3.2 Three specimens, each 29.0 ±0.5 mm (1.14 ±0.02 in) in diameter and 12.7 ±0.5-mm (0.50 ±0.02-in) thick shall be prepared, using as many layers of the material as required. Each specimen shall be conditioned for 24 h at a temperature of 23 ±2 °C (73 ±3.6 °F) while compressed by one-third the original material thickness between flat steel plates. At the end of 24 h, the specimens shall be removed from between the compression plates. After an additional 24 h, the thickness shall be measured at the center of each specimen.

12.21 Permanence of marking

12.21.1 In Mexico, 12.21.2 and 12.21.3 apply.

In Canada and the United States, 12.21.2 and 12.21.3 do not apply.

12.21.2 An indelibly stamped marking shall be legible after rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

12.21.3 The petroleum spirit used shall consist of a solvent hexane with an aromatic content of maximum 0.1 percent by volume, a kauributanol value of approximately 29, an initial boiling point of approximately 65 °C (149 °F), a dry point of approximately 69 °C (156.2 °F), and a density of approximately 0.68 g/cm^3 (0.025 lb/in^3).

12.22 Other application environments

12.22.1 A box intended for installation in particular environmental conditions such as those with type ratings shall comply with the applicable performance requirements specified in CAN/CSA C22.2 No. 94.2-07, UL 50E, or NMX-J-235/2-ANCE-2007.

12.23 Adjustable mud rings

12.23.1 General

12.23.1.1 An adjustable mud ring shall comply with the appropriate test sequences in 12.23.2 – 12.23.6 in accordance with 9.18.

12.23.2 Electrical test sequence

12.23.2.1 Six as-received samples of an adjustable mud ring shall be subjected to the following test sequence:

a) Assembly test, 12.23.7, during which the adjustable sleeve shall be extended to 50 % of its maximum extension and positioned essentially parallel to the mud ring (50 % extension, no misalignment). The securement means shall be tightened using the prescribed torque or assembled per the manufacturer's instructions, followed by,

b) Resistance test, 12.23.8, followed by,

c) Pull test, 12.23.9, followed by,

d) Repeated resistance test, 12.23.11, followed by,

e) Current test, 12.23.12.

The same samples shall be used throughout the test sequence.

12.23.2.2 Six additional as-received samples of the adjustable mud ring shall be subjected to the following test sequence:

a) Assembly test, 12.23.7, during which the adjustable sleeve shall be extended to 100 % of its maximum extension and positioned at its maximum angle along the axis of the strap described in 12.23.7.1 (100 % extension, maximum misalignment along the axis of the strap). The securement means shall be tightened using the prescribed torque, or assembled per the manufacturer's instructions, followed by,

b) Resistance test, 12.23.8, followed by,

c) Pull test, 12.23.9, followed by,

d) Repeated resistance test, 12.23.11, followed by,

e) Current test, 12.23.12.

The same samples shall be used throughout the test sequence.

12.23.3 Electro-mechanical cycling sequence

12.23.3.1 Six as-received samples of an adjustable mud ring shall be subjected to the following test sequence:

a) Assembly test, 12.23.7, during which the adjustable sleeve shall be extended to 50 % of its maximum extension and positioned essentially parallel to the mud ring (50 % extension, no misalignment). The securement means shall be tightened using the prescribed torque or assembled per the manufacturer's instructions, followed by,

b) Resistance test, 12.23.8, followed by,

c) Push in and pull out test, 12.23.10, followed by,

d) Repeated resistance test, 12.23.11, followed by,

e) Current test, 12.23.12.

The same samples shall be used throughout the test sequence.

12.23.4 Abnormal current test sequence

12.23.4.1 Six as-received samples of an adjustable mud ring shall be subjected to the following test sequence:

a) Assembly test, 12.23.7, during which the adjustable sleeve shall be extended to 50 % of its maximum extension and positioned essentially parallel to the outer ring (50 % extension, no misalignment). The securement means shall be tightened using a screw torque at 50 % of the prescribed torque (___ lbs.-in). The blank spaces shall be filled in with appropriate torque value), or assembled per the manufacturer's instructions, followed by,

b) Abnormal Current test, 12.23.13.1, followed by,

c) Continuity test, 12.23.13.2.

The same samples shall be used throughout the test sequence.

12.23.5 Mechanical securement test sequence

12.23.5.1 Six as-received samples of an adjustable mud ring with the sleeve essentially parallel to the outer ring shall be subjected to the following test sequence:

a) Assembly test, 12.23.7, during which the adjustable sleeve shall be extended to 50 % of its maximum extension and positioned essentially parallel to the outer ring (50 % extension, no misalignment) followed by,

b) Pull test, 12.23.9.

The same samples shall be used throughout the test sequence.

12.23.5.2 Six additional as-received samples of an adjustable mud ring shall be subjected to the following test sequence:

a) Assembly test, 12.23.7, during which the adjustable sleeve shall be extended to 100 % of its maximum extension and positioned at its maximum angle along the axis of the strap described in 12.23.7.1 (100 % extension, maximum misalignment along the axis of the strap), followed by,

b) Pull test, 12.23.9.

The same samples shall be used throughout the test sequence.

12.23.5.3 Six additional as-received samples of an adjustable mud ring, whose adjustable sleeve is not secured to the mud ring at the factory, shall be subjected to the following test sequence:

a) Assembly test, 12.23.7, during which the adjustable sleeve shall be positioned to 50 % of its maximum extension and positioned at its maximum angle along the axis of the strap described in 12.23.7.1 (50 % extension, maximum misalignment along the axis of the strap). The securement means shall be tightened using the prescribed torque, or assembled per the manufacturer's instructions followed by,

b) Removal of the adjustable sleeve per the manufacturer's instructions, followed by,

c) The assembly and disassembly described in (a) and (b) repeated an additional three times, followed by,

d) Reassembly of the samples with the adjustable sleeve positioned to 50 % of its maximum extension and essentially parallel to the mud ring (50 % extension, no misalignment), followed by,

e) Resistance test, 12.23.8, followed by,

f) Pull test, 12.23.9, followed by,

g) Repeated resistance test, 12.23.11.

The same samples shall be used throughout the test sequence.

12.23.6 Mechanical cycling sequence

12.23.6.1 Six as-received samples of an adjustable mud ring shall be subjected to the following test sequence:

a) Assembly test, 12.23.7, during which the adjustable sleeve shall be extended to 50 % of its maximum extension and positioned essentially parallel to the outer ring (50 % extension, no misalignment), followed by,

b) Push in and pull out test, 12.23.10. As a result, the assembly shall comply with 12.23.9.3.

The same samples shall be used throughout the test sequence.

12.23.7 Adjustable mud ring assembly test

12.23.7.1 Six samples of the mud ring assembly shall be assembled as intended to an outlet box that is securely supported. A metal strap representing a wiring device shall be mounted and secured in turn to each available wiring device position as a wiring device would be intended, on the adjustable sleeve. An attachment point shall be placed in the center of the strap for attaching the load.

12.23.7.2 The adjustable sleeve of an adjustable mud ring that relies on the adjustment of screws for mechanical securement between the mud ring and the sleeve shall be secured as intended. The tightening torque shall be as described in Table 5, or per the manufacturer's instructions.

12.23.7.3 An adjustable mud ring that relies upon spring action for mechanical securement between the mud ring and the sleeve shall be assembled per the manufacturer's instructions. The engagement force for each sample shall be recorded employing the measuring technique described in 12.23.7.4. The engagement force shall not exceed the value of 200 N (45 lbf) to secure the sleeve to the mud ring.

12.23.7.4 To measure the initial engagement force of an adjustable mud ring that relies upon spring action for mechanical securement between the mud ring and the sleeve, the outlet box shall be placed in a horizontal position with the opening in the mud ring for the sleeve directed upward. The sleeve shall be aligned over the opening and inserted to a depth just prior to the engagement of any spring latching or securement mechanism to allow the intended securement of the sleeve. A force shall be applied to the strap until the sleeve is secured into the mud ring at the point of the maximum extension declared for the product.

12.23.8 Resistance test

12.23.8.1 Each sample shall be subjected to the resistance test in accordance with UL 514B, CSA C22.2 No. 18.3, NMX-J-017-ANCE. The resistance reading shall be taken across the junction between the adjustable sleeve and the mud ring. The voltage drop of the assembly shall be measured between two points, one on the adjustable sleeve and one on the mud ring. The point on the adjustable sleeve shall be approximately 1.6 mm (1/16 in) from the securement point of the wiring device (strap). The point on the

mud ring shall be approximately 1.6 mm (1/16 in) from the securement point of the mud ring to the box. As a result of the test, the voltage drop shall not exceed 10 millivolts.

12.23.9 Pull test

12.23.9.1 The strap that represents the wiring device shall be attached in turn to each available wiring device position as a wiring device would be intended. A mark shall be placed on the adjustable sleeve at the securement means so slippage can be measured. A weight exerting 111 N (25 lbf) shall be mechanically secured to the attachment point of the strap by any convenient means. With the outlet box in the horizontal position (strap directed towards the ground) and the weight initially resting on a horizontal surface, the mud ring/box assembly shall be gradually raised vertically or the weight shall be lowered until the strap supports the weight. The weight shall be supported for 60 seconds. The test shall be repeated with the strap in each of the other wiring device positions.

12.23.9.2 The test shall be repeated with the box inclined 30 degrees from the horizontal position described in 12.23.9.1 prior to suspending the load. The direction of the tilt relative to the wiring device (strap) shall be in the direction most certain to cause separation. The load shall then be applied. The test shall be repeated with the strap in each of the other wiring device positions.

12.23.9.3 The strap shall remain fully secured and there shall be no slippage (displacement) of the adjustable sleeve at the adjustable sleeve securement means greater than 0.8 mm (1/32 in), with an average amount of slippage for six samples of 0.4 mm (1/64 in). The ring or adjustable sleeve may bend but shall not break.

12.23.10 Push-in and pullout test

12.23.10.1 The strap shall be attached in turn to each available wiring device position as a wiring device would be intended. A machine shall be attached to the center of the strap to apply a push-in and pullout force of 66.7 N (15 lbf). The machine shall cycle at a rate of no more than 10 cycles per minute for 500 cycles applied to the strap at each wiring device position. An adjustable mud ring with only one wiring device position shall be subjected to 1000 cycles.

12.23.11 Repeated resistance test

12.23.11.1 Each sample shall be subjected again to the resistance test according to 12.23.8. As a result of the test, the voltage drop shall not be greater than 15 millivolts.

12.23.12 Current test

12.23.12.1 Each sample shall be subjected to a current of 1530 A for six seconds in accordance with UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE with the strap representing the wiring device removed. A 0.61 m (2-ft) length of 6 AWG (13.3 mm^2) or larger copper wire shall be connected in series with both wiring device connection points of any one device mounting position, and to two points on the bottom of the outlet box.

12.23.12.2 As a result of the test, there shall be electrical continuity between the adjustable sleeve and the mud ring, indicated using an ohmmeter, battery-and-buzzer combination, or other similar indicating device.

12.23.13 Abnormal current test

12.23.13.1 Each sample, with the strap representing the device removed, shall be subjected to a current of 1000 A for six seconds. A 0.61 m (2-ft) length of 6 AWG (13.3 mm^2) or larger copper wire shall be connected in series to both wiring device connection points of any one device mounting position, and to

two points on the bottom of the outlet box. The free ends of the conductors shall be connected to a source capable of delivering a test current of 1000 A at the 120 volts to ground with a power factor of 75 to 80 percent. A circuit breaker intended for branch circuit protection rated at 20 A shall be installed in series with the conductor connected to the outlet box.

12.23.13.2 As a result of the test, there shall be electrical continuity between the adjustable sleeve and the mud ring, indicated using an ohmmeter, battery-and-buzzer combination, or other similar indicating device.

13 Corrosion protection

13.1 A zinc coating on one sample of a box partition, an interior surface of a box, and the area beneath adjustable or removable parts, such as beneath mounting ears and clamps, shall not have an average thickness less than 0.0038 mm (0.00015 in) or have a minimum thickness less than 0.0025 mm (0.0001 in). A zinc coating on an exterior surface shall not have an average thickness less than 0.013 mm (0.0005 in) or a thickness of less than 0.0102 mm (0.0004 in).

In Canada, plating thickness on the outside of pre-plated sheet steel boxes, having an average coating thickness of 0.0089 mm (0.00035 in) and a minimum thickness of 0.0045 mm (0.00018 in), complies with this requirement. The combined thickness of both the inside and outside of the same portion shall have a total thickness not less than 0.0178 mm (0.00070 in).

The following are not required to be so protected: cut edges and punched holes in a surface formed from galvanized stock, the area under the heads of screws securing the sides of a gangable switch box, and the threaded surfaces of tapped holes in a box.

In the United States and Mexico, a spot or projection weld shall have a protective coating as determined by visual inspection.

In Canada, a spot or projection weld shall not be required to be so protected.

The plating thickness on a screw or on an interior surface not contacted by a 19.1-mm (3/4-in) diameter ball is not specified. A protective coating shall be present as determined by visual inspection.

The surfaces of a cast iron or a malleable iron box and cover shall be protected against corrosion by zinc or organic coating. The thickness of the protective coating is not specified. A protective coating shall be present as determined by visual inspection. The coating shall be smooth and continuous without flaking or uncovered areas.

Surfaces that have a corrosion protection system in accordance with Section 14 shall not be required to be so protected.

13.2 Other than as specified in 13.3, the test described in 13.5 – 13.11 shall be used to determine the thickness of a zinc coating. The test only applies when a coating thickness is specified.

13.3 With reference to 13.1, the average thickness shall be determined by averaging a minimum of three readings, on three different surfaces, when practical. When the readings are taken on the same surface, the locations at which these readings are taken shall be equally spaced along the surface.

When agreeable to those concerned, a nondestructive test method is acceptable to determine the thickness of a zinc coating. For a referee measurement, the test described in 13.5 – 13.11 shall be used.

The 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 shall be expected to be the thinnest. On boxes made from pre-coated sheets, the external corners that are subjected to the greatest deformation shall be tested.

13.4 Unless it is apparent that one surface of a box cover or similar part is intended for use only on the side toward the interior of the box, both surfaces shall be provided with corrosion protection as required for exterior surfaces.

13.5 The solution used for the test shall be made from distilled water and shall contain 200 g/L of American Chemical Society (ACS) reagent grade chromic acid (CrO_3) and 50 g/L of ACS 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.

13.6 The container for the test solution shall be 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 about 0.05 ml each. To preserve an effectively constant level, a small glass tube shall be inserted in the top of the funnel through a rubber stopper. The position of the tube shall be adjusted so that, when the stopcock is open, the rate of dropping is 100 ±5 drops/min. An additional stopcock may be used in place of the glass tube to control the rate of dropping.

13.7 The sample and the test solution shall be kept in the test room long enough to acquire the temperature of the room, which shall be noted and recorded. The test shall be conducted at an ambient temperature of 21.1 – 32.2 °C (70.0 – 90.0 °F).

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

13.9 The sample to be tested shall be supported 17.8 – 25.4 mm (0.7 – 1.0 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 45 degrees from horizontal.

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

13.11 The thickness of the coating being tested shall be calculated by specifying the thickness factor for the temperature at which the test was conducted from Table 10, multiplying by 0.0003 mm (0.00001 in), and then multiplying by the time in seconds required to expose the base metal as measured in 13.10.

14 Tests on alternate corrosion protection systems

14.1 In Canada and the United States, a surface having an alternate corrosion protection system shall be evaluated in accordance with Annex B.

In Mexico, this requirement does not apply.

Table 1
Carton Marking Specifications

Condition of use or installation	Carton marking[a]
For use in poured concrete	Concrete-tight
For floor use	Floor Box
For the support of electric fixtures/luminaires	For fixture/luminaire support
For use with specific sizes and types of cables or conduits	For [b]
For marine use	Acceptable for Marine Use

[a] On carton markings, the use of the prefix "Suitable For" and the use of the word "only" shall be optional as desired or appropriate.

[b] The marking shall include the size and type of cable or conduit, such as flexible tubing, armored cable, flexible conduit, or nonmetallic sheathed cable.

Table 2
Throat Diameter of Inlet Hole of Box or Hub

Trade size of conduit (metric designator)	Minimum		Maximum	
3/8 (12)	11.28	(0.444)	12.52	(0.493)
1/2 (16)	14.22	(0.560)	15.80	(0.622)
3/4 (21)	18.85	(0.742)	20.93	(0.824)
1 (27)	23.98	(0.944)	26.64	(1.049)
1-1/4 (35)	31.55	(1.242)	35.05	(1.380)
1-1/2 (41)	36.80	(1.449)	40.89	(1.610)
2 (53)	47.24	(1.860)	52.50	(2.067)
2-1/2 (63)	56.44	(2.222)	62.71	(2.469)
3 (78)	70.13	(2.761)	77.92	(3.068)
3-1/2 (91)	81.10	(3.193)	90.12	(3.548)
4 (103)	92.02	(3.623)	102.26	(4.026)
5 (129)	115.37	(4.542)	128.19	(5.047)
6 (155)	138.63	(5.458)	154.05	(6.065)

Table 3
Knockout Diameters and Width of Flat Surface Surrounding Knockouts

Trade size of conduit (metric designator)	Minimum width of flat surface surrounding knockout, mm (in)	Knockout diameters, mm (in)		
		Minimum	Nominal	Maximum
1/2 (16)	3.38 (0.133)	21.84[a] (0.860)	22.23 (0.875)	22.61 (0.890)
3/4 (21)	3.68 (0.145)	27.79[b] (1.094)	28.17 (1.109)	28.96 (1.140)
1 (27)	4.72 (0.186)	34.52 (1.359)	34.93 (1.375)	35.71 (1.406)
1-1/4 (35)	6.45 (0.254)	43.66 (1.719)	44.04 (1.734)	44.83 (1.765)
1-1/2 (41)	7.80 (0.307)	49.73 (1.958)	50.39 (1.984)	51.20 (2.016)
2 (53)	8.97 (0.353)	61.80 (2.433)	62.71 (2.469)	63.50 (2.500)

[a] In Canada, a reduced diameter of 21.46 mm (0.8 in) on a multiple knockout shall be allowed.

[b] In Canada, a reduced diameter of 27.05 mm (1.065 in) on a multiple knockout shall be allowed.

Table 4
Openings in a Box

Type of box, Number of gangs	Maximum area of openings, mm^2 (in^2)	
	All openings	Openings in bottom
Single	291 (0.45)	215 (0.33)
2	355 (0.55)	270 (0.42)
3	420 (0.65)	330 (0.51)
4	484 (0.75)	385 (0.60)
5	549 (0.85)	450 (0.70)
6	613 (0.95)	515 (0.80)
7	678 (1.05)	580 (0.90)
8 [a]	742 (1.15)	645 (1.0)

NOTE 1: A pryout slot in the area of the box where a clamp is provided shall be disregarded, except when the pryout slot extends outside the area of the knockout, in which case, one-half of the area of the pryout slot or opening not covered by the clamp shall be used in computing the total area.

NOTE 2: An opening adjacent to an integral ear provided for die clearance only shall be disregarded in computing the total area.

NOTE 3: The oblique side of a box with bevelled corners shall be included as part of the end of the box.

[a] For each additional gang over 8, add 65 mm^2 (0.100 in^2) to all openings and the openings in the bottom.

Table 5
Screw Specifications for Test of Screw Holes

Screw size number	Washer thickness, mm (in)	OD, mm (in)	Tightening torque, N·m (lbf-in)
6	1.2 (0.05)	11.1 (0.44)	1.36 (12)
8	1.2 (0.05)	11.1 (0.44)	2.26 (20)
10	1.2 (0.05)	11.1 (0.44)	3.96 (35)

Table 6
Test Currents and Times

Trade size of smallest knockout (metric designator)	Test time, s	Current, A	Minimum size of copper leads used to connect sample assembly to current source, AWG	(mm^2)
1/2 (16)	4	1180	8	(8.4)
3/4 (21), 1 (27)	6	1530	6	(13.3)
1-1/4 (35), 1-1/2 (41)	6	2450	4	(21.2)

Table 7
Fixture/Luminaire Support Test Pull Forces

Weight of fixture/luminaire,[a]		Pull force,	
kg	(lb)	N	(lbf)
23.0	(50)	890	(200)
27.0	(60)	1068	(240)
31.8	(70)	1246	(280)
36.4	(80)	1424	(320)
40.9	(90)	1602	(360)
45.5	(100)	1780	(400)
50.0	(110)	1958	(440)
54.5	(120)	2136	(480)
59.1	(130)	2314	(520)

NOTE: Values for fixtures/luminaires exceeding 59.1 kg (130 lb) not shown in the table are to be extrapolated using 4.5-kg (10-lb) increments for the fixture/luminaire weight and 178-N (40-lbf) increments for the corresponding pull force values.

[a] The weight of the fixture/luminaire shall be determined by the marking required in 5.1.1 and 5.11.3. There is no limit on the weight of the fixture/luminaire.

Table 8
Load for Fixture/Luminaire Studs

Trade size of stud	Load, kg	(lb)
1/8	9.07	(20)
1/4 and larger	13	(30)

Table 9
Torque for Fixture/Luminaire Studs

Trade size of stud	Torque, N·m	(lbf-in)
1/8	22.6	(200)
1/4 and larger	45.2	(400)

Table 10
Coating Thickness Factors

Temperature, °C	(°F)	Thickness factors, zinc platings
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

Table 10 Continued on Next Page

Table 10 Continued

Temperature, °C	Temperature, (°F)	Thickness factors, zinc platings
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 11
Bending Moment

Bending moment, N·m [a]			
Normal mounting plan of enclosure surface	Conduit size (metric designators)	Metallic conduit	Nonmetallic conduit
Horizontal	All	34	34
Vertical	1/2 – 3/4 (16 – 21)	34	34
	1 and up (27 and up)	68	34

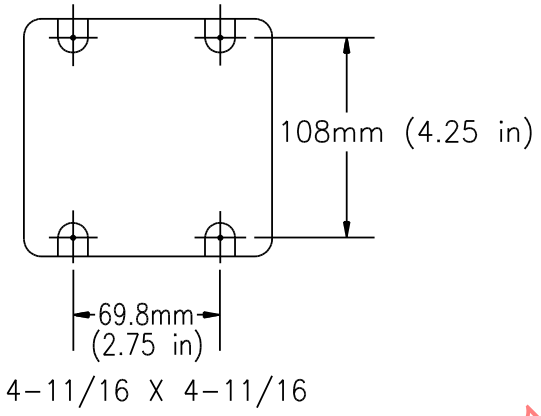
[a] The test may be terminated prior to attaining the values specified if the deflection of the conduit exceeds 250 mm for a 3 m length of conduit.

Table 12
Tightening Torques

Conduit size (metric designators)	N·m
1/2 (16)	90.4
3/4 (21)	90.4
1 (27)	113.0
1-1/4 (35)	113.0
1-1/2 (41)	113.0
2 and larger (53 and larger)	181.0

Figure 1

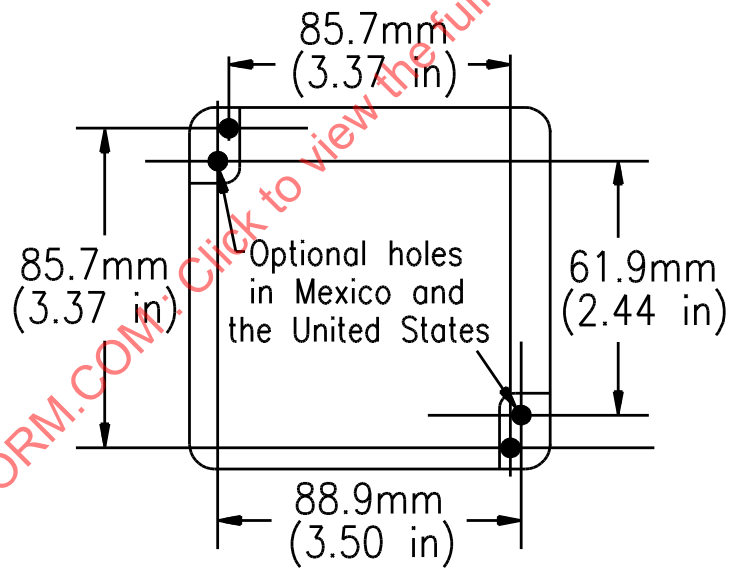
Mounting Hole Spacing for Trade Size 4 – 11/16 Square Outlet Boxes



S4230C

Figure 2

Mounting Hole Spacing for Trade Size 4 Square Outlet Boxes



4 X 4

S4231A

Figure 3

Mounting Hole Spacing for Trade Size 4 Octagonal Box

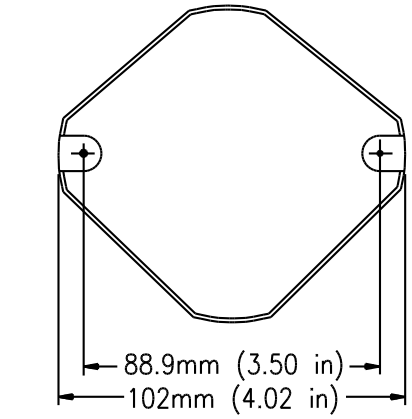


Figure 4

Mounting Hole Spacing for Trade Size 4 Circular Box

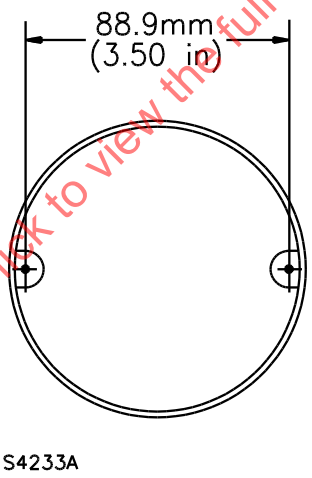


Figure 5

Support Bracket Opening