UL 2459

STANDARD FOR SAFETY

Insulated Multi-Pole Splicing Wire Connectors

UL Standard for Safety for Insulated Multi-Pole Splicing Wire Connectors, UL 2459

First Edition, Dated August 22, 2008

Summary of Topics

This revision of ANSI/UL 2459 includes the following changes in requirements:

Minimum Spacings Table 4

Intermateability of Connectors

Use of Multi-Pole Splicing Wire Connectors as Disconnects in LED Applications

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated May 4, 2018.

No Text on This Page

Canadian Standards Association
CSA C22.2 No. 2459-08
First Edition

Underwriters Laboratories Inc.
UL 2459
First Edition

Insulated Multi-Pole Splicing Wire Connectors

August 22, 2008

(Title Page Reprinted: September 20, 2018)

ANSI/UL 2459-2018

Commitment for Amendments

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

ISBN 1-55436-435-3 © 2008 Canadian Standards Association

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

To purchase CSA Group Standards and related publications, visit CSA Group's Online Store at shop.csa.ca or call toll-free 1-800-463-6727 or 416-747-4044.

This ANSI/UL Standard for Safety consists of the First edition including revisions through September 20, 2018. The most recent designation of ANSI/UL 2459 as an American National Standard (ANSI) occurred on September 20, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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

To purchase UL Standards, visit UL's Standards Sales Site at http://www.shopulstandards.com/HowToOrder.aspx or call toll-free 1-888-853-3503.

CONTENTS

Preface

This is the harmonized CSA Group and UL standard for insulated multi-pole splicing wire connectors. It is the first edition of CSA C22.2 No. 2459 and the first edition of UL 2459. This harmonized standard has been jointly revised on September 20, 2018.

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

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

This standard was reviewed by the CSA Integrated Committee on Electrical Connectors, under the jurisdiction of the CSA Technical Committee on Wiring Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

Application of Standard

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

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

Level of harmonization

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

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

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

Reasons for differences from IEC

At present there is no IEC standard for insulated multi-pole splicing wire connectors. Therefore, this standard does not employ any IEC standard for base requirements.

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.

INSULATED MULTI-POLE SPLICING WIRE CONNECTORS

1 Scope

1.1 This Standard covers insulated multi-pole mating or non-mating splicing wire connectors intended for field wiring and factory wiring for use in accordance with the Canadian Electrical Code, Part I, in Canada, and NFPA 70, National Electrical Code, in the United States.

1.2 These wire connectors are intended to facilitate the connection of devices, such as prefabricated wiring assemblies, smoke detectors, and lighting products, to the branch circuit conductors of buildings.

1.2A The dimensions of these connectors are not defined in any national or international technical standard, as such, mating connectors are identified and tested with compatible mating part (or parts, if multiple exist) and are to be of the same manufacturer.

1.3 These requirements also cover luminaire disconnects that are used;

(a) internal to luminaires to facilitate replacement of the ballast or LED driver, or

(b) for LED retrofit applications where connected on the line side of the LED driver.

Luminaire disconnects are not to be directly attached to the branch circuit conductors for the purpose of interrupting (making and breaking) branch circuit conductors. Luminaire disconnects may have one or more conductors per contact.

1.4 These wire connectors are suitable for use with 30 to 6 AWG (0.05 to 13.3 mm^2) stranded copper conductors and 30 to 10 AWG (0.05 to 5.3 mm^2) solid copper conductors.

1.5 These wire connectors are suitable for currents not exceeding the ampacity of insulated conductors or as rated by the manufacturer.

Note: *The ampacity of insulated conductors 14 AWG (2.1 mm^2) and larger is determined in accordance with the values in the "Assigned maximum ampere rating" column, under the heading "Copper", in Table 7 of CAN/CSA-C22.2 No. 65 or UL 486A-486B. In Canada, the maximum ampacity of insulated conductors 14 AWG (2.1 mm^2) and smaller is determined in accordance with Table 12 of the Canadian Electrical Code, Part I.*

1.6 These wire connectors are suitable for voltages not exceeding 600 V.

1.7 This Standard does not apply to

(a) splicing wire connectors intended for direct burial;

(b) insulated splicing wire connectors intended for use at voltage levels exceeding 600 V (1000 V in a sign or luminaire);

(c) terminal wire connectors;

(d) wire binding screw terminals;

(e) built-in terminal connectors on devices having integral cable clamps;

(f) flat quick-connect terminals;

(g) devices, such as wire connectors and soldering lugs, that are covered by

(i) CAN/CSA-C22.2 No. 65 or UL 486A-486B;

(ii) CAN/CSA-C22.2 No. 188 or UL 486C; or

(iii) UL 486E;

No Text on This Page

(h) devices, such as quick-connect terminals, that are covered by CSA C22.2 No. 153 or UL 310;

(i) devices covered by CSA C22.2 No. 182.3 or UL 1977; and

(j) devices, such as pin and sleeve connectors, that are covered by CSA C22.2 No. 182.1 or UL 1682.

2 Reference publications and definitions

2.1 Reference publications

For undated references to Standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this Standard was approved.

For dated references to Standards, such reference shall be considered to refer to the dated edition and all revisions published to that edition up to the time the Standard was approved.

CSA (Canadian Standards Association)

Note: *For products intended for use in Canada, general requirements are given in CAN/CSA-C22.2 No. 0 .*

C22.1-06
Canadian Electrical Code, Part I

CAN/CSA-C22.2 No. 0-M91 (R2006)
General requirements – Canadian Electrical Code, Part II

CAN/CSA-C22.2 No. 0.17-00 (R2004)
Evaluation of properties of polymeric materials

CAN/CSA-C22.2 No. 65-03
Wire connectors

C22.2 No. 153 -M1981 (R2003)
Quick-connect terminals

C22.2 No. 182.1-07
Plugs, receptacles, and cable connectors of the pin and sleeve type

C22.2 No. 182.3-M1987 (R2004)
Special use attachment plugs, receptacles, and connectors

CAN/CSA-C22.2 No. 188-04
Splicing wire connectors

UL (Underwriters Laboratories Inc.)

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

UL 310
Standard for Electrical Quick-Connect Terminals

UL 486A-486B
Standard for Wire Connectors

UL 486C
Standard for Splicing Wire Connectors

UL 486E
Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

UL 746A
Standard for Polymeric Materials – Short Term Property Evaluations

UL 746B
Standard for Polymeric Materials – Long Term Property Evaluations

UL 1682
Standard for Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type

UL 1977
Standard for Component Connectors for Use in Data, Signal, Control and Power Applications

NFPA (National Fire Protection Association)

NFPA 70
National Electrical Code

2.2 Definitions

The following definitions apply in this Standard:

2.2.1 Connector (cable connector) – a receptacle that is intended to provide power with means for attachment to electrical conductors.

2.2.2 Contact – a conductive element within a connector that is intended to mate with a corresponding element or conductor to provide an electrical path.

2.2.3 Control conductor – an unbroken conductor that is included in a current-cycling test loop.

2.2.4 Crimping die – that part of a crimping tool which forms the crimps and usually incorporates the crimp anvil(s), crimp indentor, and positioner.

2.2.5 Enclosure – the case or housing into which an insulator and contacts are assembled.

2.2.6 Equalizer – a bus bar that provides for equipotential and uniform current flow in a standard conductor without adversely affecting the temperature of the connector(s).

2.2.7 Insulation-piercing or insulation-displacement connector – a connector for the connection and possible disconnection of one conductor or the interconnection of two or more conductors, the connection being made by piercing, boring through, cutting through, removing, displacing, or making ineffective in some other manner the insulation of the conductor or conductors without previous stripping.

2.2.8 Insulator – a non-conductive portion of a device that provides for separation of and/or support of contacts. It may be combined with the enclosure.

2.2.9 Latch (latching) – a mechanical locking feature that provides for an intentional additional operation by the user to disengage mated connectors.

2.2.10 Luminaire disconnect – a mating wire connector (separable-type connector) intended to facilitate replacement of the ballast.

2.2.11 Mating wire connector (separable-type connector) – a connector consisting of two separable mating members (usually consisting of a male/female connection) that can be readily engaged or disengaged without the use of tools.

2.2.12 Non-mating wire connector (non-separable-type connector) – a device used to facilitate a direct connection to branch circuit conductors.

2.2.13 Plug (attachment plug) – a device that is intended to receive power when coupled with a mating device and establishes a connection between conductors of the two assemblies.

2.2.14 Receptacle (outlet) – a device intended to provide power to an inserted plug. It is usually installed as a fixed outlet.

2.2.15 Short-time withstand current – the specified root-mean-square value of current that a grounding conductor path is able to withstand for a short time under prescribed conditions of use and behavior.

2.2.16 Splicing wire connector – a connector that establishes a connection between two or more conductors by mechanical pressure and is not intended to be permanently mounted.

2.2.17 Spring-action-type connector – a connector that uses a spring action clamping mechanism for retaining a conductor.

2.2.18 Temperature rating – the maximum temperature of an insulated connector assigned by the manufacturer.

2.2.19 Temperature rise – the difference between the temperature of the connector, measured under load, and the ambient temperature.

2.2.20 Terminal – an accessible conductive part provided on a contact for connecting a conductor.

2.2.21 Thermoplastic – a plastic that can be repeatedly softened by heating and hardened by cooling through a temperature range characteristic of the plastic and, in the softened state, can be shaped into articles by molding or extrusion.

2.2.22 Thermoset – a material that is substantially infusible and insoluble after having been cured by heat or other means.

2.2.23 Unit container – the smallest container in which connectors are packaged.

2.2.24 Voltage rating – the maximum voltage of an insulated connector assigned by the manufacturer.

3 Units of measurement

3.1 The values given in SI (metric) units shall be normative, except for AWG/kcmil conductor sizes and other trade sizes. Any other values given shall be for information purposes only.

4 Construction

4.1 General

4.1.1 A multi-pole wire connector shall be provided with contacts of one of the following types:

(a) splicing wire connectors;

(b) insulation-piercing or insulation-displacement connectors;

(c) tool-applied compression connectors; or

(d) spring force connectors.

4.1.2 The design and construction of a connector intended for use with stranded conductors shall be such that all strands of the conductor shall be contained within the connector.

4.1.3 A connector that is suitable for compact-stranded conductors shall also accept all strands of a Class B concentric-stranded conductor of the same size.

4.1.4 The clamping or twist-on movement of a connector shall adapt it for use with conductors of different sizes, when such use is intended, without permanent removal or addition of parts.

Note: *Examples of clamping means include*

(a) direct-bearing screws, with or without use of a pressure plate;

(b) deformation of the connector barrel (crimping) using a special tool;

(c) an element for insulation piercing or insulation displacement;

(d) a spring-action clamp;

(e) a helical coiled spring; and

(f) a formed insulation cavity (no spring).

4.1.5 Any rearrangement or adjustment of a connector that is necessary to adapt it to various sizes of conductors shall be obvious unless the connector is marked as described in Clause 8.8.

4.1.6 There shall be no sharp edges or corners on the outer surface of a connector that could damage the insulation that the connector contacts.

4.2 Materials

4.2.1 General

4.2.1.1 The main current-carrying part of a connector shall be made of aluminum, an aluminum alloy, copper, a copper alloy, or another material investigated and found to meet the performance requirements of this Standard.

4.2.1.2 Except as specified in Clause 4.2.1.3, a connector body made of aluminum or aluminum alloy shall be coated with an electrically conductive coating, such as tin, that will inhibit oxidation and corrosion.

Note: *Other coatings may be used if investigated for the purpose and found suitable.*

4.2.1.3 With reference to Clause 4.2.1.2, a connector shipped pre-filled with an oxide-inhibiting compound need not be coated.

4.2.1.4 Iron or steel, if protected against corrosion, may be used for screws, plates, yokes, springs, or other parts that are employed as a means of clamping the conductor, if such parts are not the primary current-carrying members.

4.2.2 Insulating materials

4.2.2.1 General

4.2.2.1.1 Insulation employed as a part of a connector shall be suitable for the tested voltage rating of the connector in accordance with Table 1.

4.2.2.1.2 All parts that act as the electrical insulation shall comply with Clauses 4.2.2.2 to 4.2.2.5. Hard rubber shall not be employed.

4.2.2.2 Regrind

4.2.2.2.1 Molded parts of thermoplastic containing up to 25% regrind dry blended with the same grade of virgin resin shall be accepted. Thermosetting materials shall not be used as regrind.

4.2.2.2.2 Thermoplastic molded parts containing more than 25% regrind by weight shall not be used unless their acceptability has been determined by a separate investigation. The parts and test samples for the investigation shall undergo a number of moldings until the percentage of regrind from the first molded part is less than 1% in the final molded part used for testing.

4.2.2.3 Flammability

4.2.2.3.1 A polymeric material used for electrical insulation of live parts shall have a flame class rating of V-2, V-1, V-0, VTM-2, VTM-1, or VTM-0 in accordance with CAN/CSA-C22.2 No. 0.17 or UL 94. The flame class rating of the material shall be judged at the minimum thickness employed at the walls and barriers that are critical to the functioning of the insulation.

4.2.2.4 Electrical properties

4.2.2.4.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a comparative tracking index (CTI) rating of 175 V or greater or a performance level class (PLC) of at least 3. However, the following exceptions shall apply:

(a) polymeric material used for electrical insulation of live parts shall not be required to comply with this requirement when it complies with the comparative tracking index test described in CAN/CSA-C22.2 No. 0.17 or UL 746C; and

(b) polymeric material that is separated by air by more than 0.8 mm (1/32 in) from uninsulated live parts and more than 12.7 mm (1/2 in) from arcing parts shall not be required to comply with this requirement.

4.2.2.4.2 A polymeric material used for electrical insulation of live parts shall have hot wire ignition (HWI) and high-current arc resistance to ignition (HAI) ratings or performance level classes of at least those specified in Table 2 for the flame class rating determined in accordance with Clause 4.2.2.3. For materials with other than VTM flammability classifications, the HWI and HAI ratings of the material shall be evaluated using the specimen thickness employed in the connector. However, the following exceptions shall apply:

(a) polymeric material used for electrical insulation of live parts shall not be required to comply with the HWI requirements when it complies with the glow wire test described in CAN/CSA-C22.2 No. 0.17 and UL 746C;

(b) polymeric material used for electrical insulation of live parts shall not be required to comply with the HAI requirements when it complies with the high-current arc resistance to ignition test described in CAN/CSA-C22.2 No. 0.17 and UL 746C; and

(c) polymeric material that is separated by air by more than 0.8 mm (1/32 in) from uninsulated live parts and more than 12.7 mm (1/2 in) from arcing parts shall not be required to comply with the HWI and HAI requirements.

4.2.2.5 Thermal properties

4.2.2.5.1 Polymeric materials used for electrical insulation of live parts shall have the applicable minimum relative thermal index temperature shown in Table 3. For materials with other than VTM flammability classifications, the material shall be evaluated using the specimen thickness. The thermal rating of the material shall be judged at the minimum thickness employed at the walls and barriers that are critical to the functioning of the insulation.

4.3 Accessibility of parts

4.3.1 A connector shall have live parts protected against contact

(a) when fully assembled;

(b) when installed in the intended manner;

(c) while engaged; and

(d) when disengaged.

The load side of a disengaged mating-type connector need not meet this requirement when marked "LOAD".

4.3.2 The probe shown in Figure 1 shall be applied with a force of not more than 13.3 N (3 lbf) to any depth that recessing will permit. The probe shall be rotated, changed in configuration, or angled before, during, and after application to any position that is necessary to examine the device. A live or dead metal part shall be determined to be accessible when

(a) the part is contacted by the probe; or

(b) the part is located in an opening larger than 7.1 mm (9/32 in) in diameter and recessed less than 4.8 mm (3/16 in).

4.3.3 In order to judge the accessibility of a live or dead metal part, the device shall be wired and assembled in accordance with the manufacturer's instructions, except that any parts that can be opened or removed by the user without a tool shall be opened or removed.

4.3.4 Accessible dead metal parts of a connector shall be conductively connected to the grounding conductor path.

4.4 Spacings

4.4.1 Minimum spacings on a connector shall be as specified in Table 4. Spacings shall be measured between the following:

(a) uninsulated live parts of opposite polarity; and

(b) an uninsulated live part and a dead metal part that is likely to be grounded or is accessible to contact when the device is installed as intended, including a metal surface on which the device is mounted in the intended manner.

4.4.2 In applying spacings, it shall be assumed that

(a) adjacent poles are at opposite polarity;

(b) any mounting surface is at ground potential; and

(c) any exterior surface will be in contact with a grounded surface.

4.4.3 Spacings shall also be measured through cracks or between mating parts of a separable-type connector when assembled.

4.4.4 An isolated dead metal part interposed between parts under evaluation shall be considered to reduce the spacing by an amount equal to the dimension of the isolated dead metal part in the direction of the measurement.

4.4.5 Spacings shall be evaluated in all conditions of use, both with and without mating devices of the intended configuration installed and any movable parts displaced to the position of minimum spacings.

4.4.6 Spacings shall be measured with the terminals/contacts connected to the rated conductor that creates the most onerous condition.

Note: *In most situations the conductor of maximum size creates the most onerous condition. In some situations, the conductor of minimum size creates smaller spacings.*

4.4.7 An insulating barrier or liner used as the sole separation between an uninsulated live part and a non-current-carrying metal part (including a grounded metal part) or between uninsulated live parts of opposite polarity shall be made of a material that complies with Clauses 4.2.2.2 to 4.2.2.5 and is not less than 0.71 mm (0.028 in) thick.

4.4.8 An insulating barrier or liner that is used in addition to an air space in place of the required spacing through air shall not be less than 0.8 mm (1/32 in) thick. When the barrier or liner is made of fibre, the air space shall not be less than 0.8 mm (1/32 in) wide. When the barrier or liner is made of material of a type that is not suitable for contact with an uninsulated live metal part in accordance with Clauses 4.2.2.2 to 4.2.2.5, the air space shall be such that, upon investigation, it is found to be adequate for the particular application.

4.4.9 Insulating material of a thickness less than the applicable thickness specified in Clause 4.4.7 or 4.4.8 may be used when, upon investigation, it is found to be adequate for the particular application.

4.5 Mating-type (separable-type) connectors

4.5.1 General

4.5.1.1 A mating-type connector shall

(a) have a mechanical means, such as a lock or latch, that prevents unintentional separation when the connector halves are fully engaged in the mated condition and shall comply with the latching mechanism test specified in Clause 5.3;

(b) be reliably keyed to limit interconnection to only like voltage and ampacities; and

(c) be subjected to the abnormal overload test, specified in Clause 5.4.

4.5.1.2 With regard to Clause 4.5.1.1(a), a luminaire disconnect need not be subjected to the latching mechanism test and need not be provided with a latch or locking mechanism, but shall comply with Items (b) and (c) of Clause 4.5.1.1.

4.5.1.3 Suitable means shall be provided for retaining live parts within limits of alignment that reasonably ensure that plugs will enter devices, such as receptacles and connectors, in the intended manner.

4.5.1.4 When the two halves of a grounding-type connector are mated as intended, the grounding-conductor contacts shall engage before the supply contacts. During disconnection, the supply contacts shall disconnect before the grounding-conductor contacts.

4.6 Integral pigtail leads

4.6.1 Integral pigtail leads shall

(a) be assembled at the factory;

(b) have insulation rated for the voltage; and

(c) have insulation rated to at least 90°C.

4.6.2 Insulation on a lead intended to be connected to the grounded branch circuit conductor (neutral) shall be white or grey.

4.6.3 Insulation on a lead intended to be connected to the branch circuit equipment grounding conductor shall be green or green with a yellow stripe.

5 Test requirements

5.1 General

5.1.1 A connector shall meet the test requirements of Clause 5 when separate sets of specimens are subjected to the tests in Table 5, as applicable for the design of the connector.

5.1.2 For the current-cycling, temperature, and mechanical sequence tests, when more than a single conductor is secured by a single securing means, tests on duplicate specimens shall be conducted to represent the most severe conductor position conditions that could result when conductors are assembled into the connector.

5.1.3 A connector need not be subjected to the current-cycling test using copper conductors, unless the connector depends on insulation piercing, insulation displacement, or spring action.

5.1.4 Conductor sizes 30 to 20 AWG (0.05 to 0.52 mm^2) need not be subjected to the secureness test in the mechanical sequence.

5.1.5 Tests conducted on a connector with compact-stranded conductors shall be considered representative of concentric and compressed stranded conductors of the same size.

5.2 Grounding contact – Short-time withstand current

5.2.1 The grounding contacts shall not crack, break, or melt when subjected to the current specified in Table 6.

5.2.2 After having carried the specified current, continuity of the grounding connection shall be demonstrated in accordance with Clause 7.2.6.

5.2.3 Following the demonstration required by Clause 5.2.2, the connector shall comply with the dielectric voltage withstand test specified in Clause 7.6.

5.3 Latching mechanism

5.3.1 General

5.3.1.1 A connector employing a latching mechanism for locking a mating connector in accordance with Clause 4.5.1.1(a) shall be subjected to the tests specified in Clause 7.3.

5.3.1.2 There shall be no damage to the connector or its latching mechanism and the latching mechanism shall remain capable of functioning as intended.

5.3.1.3 The mating connector shall not pull free from the mated connector during application of the test force.

5.3.2 Connector separation (luminaire disconnect)

5.3.2.1 A luminaire disconnect shall be subjected to the test specified in Clause 7.3.2.

5.3.2.2 A luminaire disconnect shall separate prior to the pullout of any contact(s) or conductor(s) from the housing.

5.4 Abnormal overload

5.4.1 A separable-type wire connector shall perform acceptably when subjected to an abnormal overload test specified in Clause 7.4.

5.4.2 There shall be no electrical or mechanical failure of the device or pitting or burning of the contacts that could affect the intended function.

5.4.3 The grounding fuse shall not open during the test.

5.5 Temperature

5.5.1 The temperature rise test shall be conducted after the abnormal overload test using the same test specimens.

5.5.2 The temperature rise shall not exceed:

a) 50°C when the device is carrying the current specified in Table 7 for the maximum conductor size; or

b) 30°C when the device is carrying the ampere rating for a luminaire disconnect device while carrying its maximum rated current.

5.6 Dielectric voltage withstand

5.6.1 Following the temperature rise test, the dielectric voltage withstand test shall be conducted in accordance with Clause 7.6.

5.6.2 There shall be no breakdown when devices are subjected to the dielectric voltage withstand test.

5.7 Dielectric withstand – Puncture

5.7.1 An insulated wire connector shall withstand, without breakdown, the dielectric withstand puncture tests specified in Clause 7.7.

5.7.2 The insulation of an insulated connector shall not crack or break when the connector is assembled as intended on the conductor.

5.7.3 The oven conditioning specified in Clauses 7.7.3 and 7.7.4 shall not cause the connector insulation to harden, soften, crack, deform, loosen, or otherwise change in a way that adversely affects the insulating properties of the conductor insulation or the connector insulation.

Note: *Discoloration of the connector insulation is allowed.*

5.8 Mold stress relief

5.8.1 As a result of the conditioning specified in Clause 7.8.1, there shall not be any warpage, shrinkage, or other distortion that results in any of the following:

(a) making uninsulated live parts, other than exposed wiring terminals or internal wiring, accessible to contact by the probe shown in Figure 1;

(b) defeating the integrity of the enclosure so that acceptable mechanical protection is not afforded to internal parts of the device;

(c) interference with the operation, function, or installation of the device. The outlet openings of a female device shall be capable of having a mating male device of the intended configuration fully inserted;

(d) a reduction of spacing below the minimum acceptable values specified in Clause 4.4.1 between an uninsulated live part and

(1) an uninsulated live part of opposite polarity;

(2) an uninsulated grounded metal part; or

(3) a non-current-carrying metal part that is exposed to contact by persons when the device is installed and used in the intended manner; and

(e) any other evidence of damage that could increase the risk of fire or electric shock.

5.8.2 Following the conditioning specified in Clause 5.8.1, the connector shall be subjected to and comply with the dielectric voltage withstand test specified in Clause 5.6.

5.8.3 A molded rubber component shall show no deterioration. The change in hardness shall be less than or equal to 5 between the average original hardness reading and the average reading taken after exposure to oxygen as specified in Clause 7.8.3.

5.9 Current cycling

5.9.1 The specimen sets shall complete 500 continuous cycles of current-on and current-off operations while carrying:

a) the current corresponding to the maximum conductor size specified in Table 7; or

b) 200% of the ampere rating for a luminaire disconnect device.

Note: *A current source may be maintained at or above the required value by regulation or frequent adjustment.*

5.9.2 The current cycling test shall be completed without any connector exceeding a 125°C rise above the ambient temperature for any recorded cycle.

5.9.3 The stability factor, S_i (see Clause 5.9.4), shall not exceed ±10 for connector temperature measurements taken at approximately 25, 50, 75, 100, 125, 175, 225, 275, 350, 425, and 500 cycles.

5.9.4 The stability factor, S_i, for each of the 11 temperature measurements specified in Clause 5.9.3 shall be determined by applying the following equation:

$$S_i = d_i - D$$

where

D = the average temperature deviation

= [(d1 + d2 + ... + d11) / 11]

where

i = a number from 1 to 11 and signifies one of the 11 individual temperature measurements

d_i = a temperature deviation for an individual temperature measurement

Note: *The value for di is determined by subtracting the control-conductor temperature from the connector temperature. The value for di is a positive number when the connector temperature is more than that of the control conductor and a negative number when the connector temperature is less than that of the control conductor. The average of the 11 temperature deviations is then determined. See Annex A for an example of a stability factor calculation.*

5.10 Mechanical sequence

5.10.1 The joint between a connector and the conductor shall be intact after being subjected for 30 min to the test specified in Clause 7.10.1.

5.10.2 The joint between a connector and the conductor shall be intact after being subjected for 1 min to the test specified in Clause 7.10.2.

5.10.3 As a result of the tests, there shall be no breakage of the conductor or any strand of a stranded conductor, stripping of threads, shearing of parts, separation of the contact from the housing, or other damage to the connector. Breakage of the conductor or any strand of a stranded conductor shall be determined by examination of the complete connector assembly while it is still intact after the secureness or pullout tests. Breakage shall be deemed to have occurred if the conductor or a strand of a stranded conductor is visibly detached.

5.11 Stress corrosion/moist ammonia (NH_4)

5.11.1 A copper alloy part containing more than 15% zinc shall be tested for stress corrosion cracking.

Note: *The moist ammonia test is considered an alternative to the mercurous nitrate test (see Clause 5.12).*

5.11.2 A copper alloy part containing more than 15% zinc shall show no evidence of cracking when examined using 25x magnification after being subjected to the stress corrosion/moist ammonia (NH_4) test specified in Clause 7.11.

5.12 Stress corrosion/mercurous nitrate ($HgNO_3$)

5.12.1 A brass part containing less than 80% copper shall not crack when subjected to the stress corrosion/mercurous nitrate ($HgNO_3$) test specified in Clause 7.12.

Note: *The mercurous nitrate test is considered an alternative to the moist ammonia test (see Clause 5.11).*

5.13 Spring action

5.13.1 When tested as specified in Clause 7.13.2, a spring-action connector shall not exceed a temperature rise of:

a) 50°C when carrying the current corresponding to the maximum conductor size specified in Table 7, or

b) 30°C when carrying the ampere rating for a luminaire disconnect device.

5.13.2 A spring-action connector shall withstand without dielectric breakdown the application of the test voltage when tested as specified in Clause 7.13.3.

6 Sampling requirements

Note: *See Table 8 for the minimum number of specimens required for testing.*

6.1 Specimen sets shall be tested using both solid and stranded conductors for 30 to 10 AWG (0.05 to 5.3 mm^2) sizes, and using stranded conductor for 8 AWG (8.4 mm^2) and larger sizes, unless the connector is marked as specified in Clauses 8.6 and 8.7, in which case the conductor used shall be of the type marked on the connector.

6.2 For the mechanical sequence, if the conductor range of a connector includes sizes 14 to 10 AWG (2.1 to 5.3 mm^2), and these sizes are not included in the test sample selection, additional sample sets shall be tested using the maximum size solid conductor in the range of 14 to 10 AWG (2.1 to 5.3 mm^2).

6.2A For a connector intended for use with a range of conductor sizes and intended to secure a single conductor in an opening, the mechanical sequence test shall be conducted on separate specimens using the maximum and minimum size conductors.

6.2B For a connector intended to secure more than one conductor at a time by a single clamping means and intended for use with two or more combinations differing in number of conductors, conductor sizes, or both, the following combinations of conductors shall be subjected to the tests specified in Clause 7.10:

a) smallest total circular-mil area of stranded conductors;

b) smallest total circular-mil area of solid conductors;

c) largest total circular-mil area of stranded conductors;

d) largest total circular-mil area of solid conductors;

e) largest number of smallest solid conductors;

f) largest number of smallest stranded conductors;

g) smallest number of largest conductors;

h) a single maximum AWG or mm^2 size conductor with a single minimum AWG (mm^2) size conductor.

6.3 For the connector separation test (luminaire disconnect), only the smallest (solid and stranded) conductor size need be tested.

7 Test methods

7.1 General

7.1.1 Temperature measurement

7.1.1.1 Temperatures shall be measured by thermocouples consisting of conductors not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.005 mm^2).

7.1.2 Ambient temperature measurement

7.1.2.1 Test assemblies shall be located in a substantially vibration-free and draft-free location where the average ambient air temperature can be maintained in the range of 15 to 35°C. The ambient temperature shall be kept within ± 4°C during the test.

7.1.2.2 Thermocouples to measure the ambient temperature for a connector specimen under test shall be installed on 50.8 mm (2 in) square by 6.4 mm (1/4 in) thick sections of unplated copper bus. All buses shall be mounted in a vertical plane at the same elevation as the wire connectors being tested. All measurements shall be made to the centreline of the nearest connector or control conductor. If all thermocouples employed are the same length, they shall be connected in parallel to provide an average ambient temperature.

7.1.2.3 For vertically mounted connectors, one bus shall be located 610 mm (2 ft) in front and one bus 610 mm (2 ft) in back of the specimens and control conductor. For test assemblies employing an insulating backboard specified in Clause 7.1.10.9, no bus section shall be mounted behind the test assembly.

7.1.2.4 For horizontally mounted connectors in an assembly of one or more specimens of connectors, bus sections shall be located 610 mm (2 ft) in front, 610 mm (2 ft) in back, and 610 mm (2 ft) on each side of the test assembly. As an alternative method of locating the thermocouple for a horizontal test assembly, one bus may be placed at the centre of a loop formed by the specimens and control conductor.

No Text on This Page

7.1.3 Control conductor temperature measurement

7.1.3.1 A thermocouple shall be located on each control conductor.

7.1.3.2 A thermocouple on a control conductor used in the current-cycling test shall be located at the midpoint of the conductor and under the conductor insulation. The thermocouple shall be secured by soldering, an adhesive, or equivalent means. The conductor insulation shall be replaced over the thermocouple location. The surface of the conductor metal shall not be penetrated. Drilling and peening shall not be used.

7.1.3.3 For temperature measurements on a control conductor, the following technique shall be employed:

(a) a small flap shall be cut into the conductor insulation and rolled back to expose the conductor;

(b) the thermocouple bead shall be positioned in the valley between conductor strands or on the surface of a solid conductor. A thermally conductive adhesive may be used; and

(c) the flap of insulation shall be repositioned and secured by a tightly wrapped double layer of black thermoplastic tape extending not more than 12.7 mm (1/2 in) on each side of the flap or by a similar means of holding the test conductor insulation in place.

7.1.3.4 When a thermally conductive adhesive is not used, the following technique shall be employed:

(a) a 25.4 mm (1 in) minimum length of insulation over the full circumference of the conductor shall be removed;

(b) for a solid conductor, the thermocouple shall be secured to the surface of the conductor;

(c) one conductor strand shall be pried out of the stranding just enough to insert the end of a soft copper ribbon 6.4 mm (1/4 in) wide by 0.13 mm (0.005 in) thick to a length that overlaps approximately 3.2 mm (1/8 in), as illustrated in Figure 2. The conductor strand shall then be lightly tapped back down on the copper ribbon;

(d) the copper ribbon shall be wrapped partially around the conductor strands back to the one strand that has been pried out;

(e) the thermocouple shall be located on the copper ribbon in the valley formed by the pried-out strand and the adjacent strand and shall be soldered in place. The copper ribbon shall be wrapped completely around the bundle of strands and shall be cut off so that a 3.2 mm (1/8 in) overlap results. The ribbon shall be secured in place by reheating the solder behind the ribbon where the thermocouple is located; and

(f) the section of insulation shall be reattached, with the slit side directly opposite the thermocouple junction. Thin-walled heat-shrinkable 125°C tubing or a tightly wrapped double layer of black thermoplastic tape extending not more than 12.7 mm (1/2 in) on each end of the section of insulation shall be used to hold it in place.

7.1.4 Specimen temperature measurement

7.1.4.1 A thermocouple on a wire connector shall be positioned to sense the highest temperatures generated by the connector. A thermocouple shall be installed so as to obtain thermal and mechanical bonding with the surface of a connector and without causing an appreciable change in the temperature of the connector.

7.1.4.2 When the size of the connector is such that the thermocouple cannot be attached to the body of the connector, one of the following methods shall be used:

(a) the thermocouple shall be attached to the maximum size conductor not more than 12.7 mm (1/2 in) from the edge of the connector using the technique specified in Clause 7.1.3.3 or 7.1.3.4; or

(b) the thermocouple shall be installed inside the assembled connector at the location where direct contact is made with the bundled conductors.

7.1.4.3 A test specimen shall be considered stable during the static-heating test when three temperature readings taken at not less than 10 min intervals show not more than a 2°C variation between the three consecutive readings.

7.1.5 Test and control conductors

7.1.5.1 All test specimen conductors and control conductors shall comply with Tables 9 to 11. All test specimen conductors and control conductors shall be new (previously unused) or, with the concurrence of those concerned, shall be previously used conductors that have not attained a temperature greater than 120°C. For previously used conductors, used conductor ends shall be cut off and the resulting new ends of the conductor restripped in accordance with Clause 7.1.6.

7.1.5.2 With regard to Clause 7.1.5.1, in Canada, test conductors for connectors rated for stranded copper conductors 8 to 6 AWG (8.4 to 13.3 mm^2) shall be Class B and compact rather than concentric or compressed, as specified in Table 9.

7.1.5.3 A connector for flexible copper conductor other than Class B or Class C stranding shall be subjected to all test sequences using the other stranding.

7.1.5.4 The insulation for conductors shall be black or, with the concurrence of those concerned, a color other than black may be used.

7.1.5.5 The conductor shall be examined to verify that the insulation has not penetrated beyond the first strand layer during manufacturing.

Note: *A separator may be located between the conductor and the insulation of a stranded conductor to attain the required separation.*

7.1.5.6 The minimum conductor length measured from the conductor entry face of the test connector to the equalizer for the current-cycling test or to the face of the connector at the other end of the test conductor for the mechanical or static-heating test shall be as specified in Table 12.

7.1.5.7 The minimum length for the control conductors used in the current-cycling test shall be twice the length of the test conductors used for the test connector specimens specified in Clause 7.1.5.6.

7.1.6 Conductor stripping

7.1.6.1 Conductors shall be stripped immediately prior to installation for a distance that is proper for insertion into the connector and shall be assembled in the connector in the intended manner. A conductor shall not be brushed or abraded prior to installation into the connector. The insulation shall be stripped off the conductor so as to provide a clean abrupt end (not pencilled).

Notes:

(1) Care should be taken in stripping conductors to avoid cutting, nicking, scraping, or other damage to the conductors. Care should be taken in removing all foreign materials such as insulation and separators from the stripped ends.

(2) For an insulation-piercing connector, the removal of the outer sheath of a cable, if necessary, is not considered to be stripping.

7.1.6.2 For an insulated or non-insulated connector marked with a nominal strip length in accordance with Clause 8.9(c), all tests, except for the dielectric withstand test, shall be performed with the conductors stripped to the nominal value minus the strip-length tolerance specified in Table 13. The dielectric withstand test on an insulated connector shall be performed with the conductors stripped to the marked nominal strip length.

7.1.6.3 For an insulated connector marked with a maximum conductor strip length and a minimum conductor strip length in accordance with Table 14, all tests, except the dielectric withstand test, shall be performed with the conductors stripped to the minimum length. The dielectric withstand test shall be performed with the conductors stripped to the maximum length.

7.1.6.4 When the strip length is not marked on the connector, the carton, or the information sheet, the insulation of the test conductor shall be stripped to allow the conductor to make contact with the full available length of the connector that contains the securing means. The conductor shall be positioned so that 6.4 to 12.7 mm (1/4 to 1/2 in) of bare conductor is exposed between the conductor-entry face of the connector and the beginning of the insulation. At the opposite end, if the conductor projects through the wire connector without interference, the conductor shall be installed to project not more than 6.4 mm (1/4 in).

7.1.7 Equalizer

7.1.7.1 For the current-cycling test, each stranded control conductor and each stranded conductor that has been terminated or is intended to be terminated in a test connector shall have the free end welded or brazed to an equalizer to make a thorough electrical connection for each strand. Tool-applied compression connectors without welding may be used.

Notes:

(1) An equalizer is not required but may be used for a solid test conductor.

(2) Equalizers are typically not used on specimens intended for any other tests, as it is necessary to insert the open end of the conductor through a bushing for the secureness test.

7.1.7.2 An equalizer shall be constructed using

(a) short length of copper bus having one or more holes slightly larger than the conductor;

(b) a tool-applied compression connector; or

(c) a pressure-screw-type wire connector having an open end opposite the conductor insertion end.

7.1.7.3 The end of the conductor that projects through the equalizer shall be welded into a homogeneous mass with the bus (see Clause 7.1.7.2(a)) or the connector (see Clause 7.1.7.2(c)). A wire connector used as an equalizer shall not be larger than that needed for the conductor size involved. An equalizer bus shall not be larger than the applicable bus size specified in Table 15. Connectors of the same type as those under test or of a type that maintains the electrical connection may be used if the connector is rated and marked AL9CU or is made from copper alloy.

7.1.8 Preparation of specimens

7.1.8.1 Representative specimens of the connector shall be assembled to conductors of the proper type, length, and size and in the manner used in service. For the current-cycling test, control conductors shall also be prepared. These control conductors shall be wired in series with the specimens used for the current-cycling test and shall carry the same test current.

7.1.8.2 a connector is intended for assembly by means of a specific tool, this tool shall be used in the intended manner.

7.1.8.3 When the device is designed to be assembled to a conductor by means of more than one type of specific tool, the device shall meet the performance requirements when any intended type of specific tool is employed in the assembly operations.

Note: *This can necessitate additional series of tests being carried out to assess the performance of the device when it is assembled using each intended type of specific tool. In some cases, repeated testing is not necessary if the tools are sufficiently similar (based on the features specified in Clause 7.1.8.4).*

7.1.8.4 With reference to Clause 7.1.8.3, in selecting tools for assembly of a connector to a conductor, the following features shall be considered:

(a) profile, width, and depth of the connector;

(b) material of connector body;

(c) crimping die geometry;

(d) the number of crimps; and

(e) similarity of crimp forces.

7.1.8.5 If instructions for assembling the connector to the conductor are furnished with the connector, such instructions shall be followed in the preparation of the specimens, except that the conductor shall not be brushed or abraded. (See Clause 8.9(d).)

7.1.8.6 For a spring-action connector, the conductor shall be stripped to the appropriate length and pushed into the connector in accordance with the manufacturer's instructions.

7.1.9 Tightening torque

7.1.9.1 The connection between the conductor and the connector shall be made before the start of the first test on any specimen set. Once the initial tightening torque is completed, there shall be no retightening.

7.1.9.2 The specified torque shall be applied by tightening the connection means between the conductor and the connector until the specified value of torque is maintained for at least 5 s.

7.1.9.3 All connectors intended for use with screwdriver-type slotted heads shall be tightened to the torque values specified in Table 16. Specimens prepared for the current-cycling test shall be tightened using the values in column A. For all other tests the specimens shall be prepared using the values in column B.

7.1.10 Test assembly

7.1.10.1 Specimen sets and the control conductor shall be connected in series and to a current source. Equalizers shall be bolted together or to lengths of bus using the hardware specified in Clause 7.1.10.2.

7.1.10.2 The following hardware shall be used to make the connections:

(a) a bolt shall be plated steel, SAE Grade 2, UNC thread having a maximum standard diameter compatible with the hole or holes in the connector tang and a minimum standard length allowing at least a two-thread projection through the nut. The projection shall not exceed 6.4 mm (1/4 in) after assembly;

(b) a single flat washer shall be used on each side of the tang-to-bus connection. These washers shall be plated steel having an SAE configuration compatible with the diameter of the bolt;

(c) a nut shall be plated steel and shall have a Class 2B, UNC thread and a hexagonal configuration;

(d) clean, dry, non-lubricated screws, bolts, and nuts shall be used; and

(e) the assembled hardware shall be torqued to the values specified in Table 17.

Once the initial assembly is completed, there shall be no retightening.

7.1.10.3 The lengths of the bus bars specified in Clause 7.1.10.1 shall be the minimum necessary to provide sufficient contact area for the equalizers while maintaining the centre-to-centre specimen spacing specified in Clauses 7.1.10.4 to 7.1.10.6. The cross-sectional dimensions of the copper bar shall be sufficient to prohibit a test-current density exceeding 1.55 A/mm^2 (1000 A/in^2). (See Table 15.)

7.1.10.4 Individual connector/conductor specimens shall be separated by a distance of at least 457 mm (18 in) when measured centre-to-centre.

7.1.10.5 With reference to Clause 7.1.10.4, the spacing may be reduced with the concurrence of those concerned.

7.1.10.6 With reference to Clause 7.1.10.4, the spacing may be reduced to a minimum of 152 mm (6 in) if a thermal barrier is used between assemblies. The thermal barrier shall extend at least 152 mm (6 in) in a vertical direction and 25.4 mm (1 in) in a horizontal direction beyond the extremities of the connector.

7.1.10.7 Test assemblies and the control conductor shall be suspended vertically or horizontally in open air by the use of loose-fitting, non-metallic tie straps around the conductors or by suspension from the equalizers, supported in turn by non-metallic blocks. The method used shall reduce the disturbance of the test connections during handling of the specimens and reduce the transmission of tensile loads to the test connectors. (See Figure 3 for an example of a vertical arrangement.)

7.1.10.8 The temperature measurement location for the control conductor and connector samples shall be at least 610 mm (24 in) from the building floor, ceiling, and walls.

7.1.10.9 With reference to Clause 7.1.10.8, the spacing need not be maintained if a solid insulating backboard separates the test samples from the building floor, ceiling, or walls. Samples shall be spaced at least 102 mm (4 in) from the insulating backboard.

7.2 Grounding contact – Short-time withstand current

7.2.1 When the devices are provided with instructions for assembling the grounding contact of the connector to the conductor, such instructions shall be followed in the preparation of the test specimen.

7.2.2 A connector shall be assembled in the intended manner using the largest rated conductors.

7.2.3 The grounding conductor shall be at least 610 mm (2 ft) long.

7.2.4 The test current specified in Table 6 shall be based on the maximum size rated wire and shall be applied only through the grounding contacts. The test current shall be applied for 4 s for 30 to 8 AWG (0.05 to 8.4 mm^2) conductors and 6 s for 6 AWG (13.3 mm^2) conductors.

7.2.5 After the current specified in Clause 7.2.4 has been carried, continuity shall be determined between the grounding conductors as measured at a connection point 6.4 mm (1/4 in) from each end of the assembled connector halves. For non-mating connectors, continuity shall be determined between the grounding conductors as measured at a connection point 6.4 mm (1/4 in) from each end of the connector.

7.2.6 Any indicating device, such as an ohmmeter or battery-and-buzzer combination, may be used to determine whether continuity exists.

7.3 Latching or locking mechanism

7.3.1 General

7.3.1.1 The latching or locking mechanism shall be operated to lock the connector halves together. The mechanism shall then to be operated to release the connector halves and the mating connector halves shall be physically separated. This sequence shall be repeated for 50 cycles.

> **Note:** *Luminaire disconnects are not required to have a latching or locking mechanism (see Clause 4.5.1.2) and those with a latch or lock would not be subjected to the latching mechanism test.*

7.3.1.2 Following repetition of the specified number of cycles, the latching or locking mechanism shall be operated to lock the connector halves together. A static force of 133 N (30 lbf) or, for 14 AWG (2.11 mm^2) or smaller, the applicable force from Table 20, shall be applied to the connector halves for 1 min in a direction perpendicular to the plane of the connector's mated face.

7.3.2 Connector Separation (luminaire disconnect)

7.3.2.1 A tensile pull force shall be applied by grasping an individual conductor of each half of a luminaire disconnect and applying increasing force until either the connector halves separate or a contact or conductor pulls out of the housing. If the luminaire disconnect contains a latch feature, that feature shall be defeated prior to performing this test.

7.4 Abnormal overload

7.4.1 The connector shall be mounted and wired to represent actual service conditions.

7.4.2 Any additional material that is intended to reduce or confine the arcing in the contact chamber of the device, and decomposes or is otherwise affected by the arcing, shall be removed for this test.

7.4.3 The latching or locking mechanism used to secure the two halves of a separable wire connector may be removed or defeated so as to permit the unrestricted connection and disconnection of the mating halves.

7.4.4 Mating devices shall be inserted and withdrawn manually or mechanically while connected to a suitable load. The device shall make and break the current for ten cycles of operation at a rate not greater than 10 cycles/min. Contacts shall not be adjusted, lubricated, or otherwise conditioned before or during the test. The current shall be:

a) 150% of the temperature test current corresponding to the maximum conductor size specified in Table 7; or

b) 150% of the ampere rating for a luminaire disconnect device.

7.4.5 The equipment grounding contact, if provided, shall be connected to ground through a fuse. Exposed metal parts and any pole that is not part of the test circuit shall be connected through a fuse to ground or to the grounded conductor of the test circuit.

7.4.6 The fuses specified in Clause 7.4.5 shall be rated at not more than 15 A when the device under test is rated 30 A or lower, and shall be 30 A fuses when the device under test is rated at more than 30 A. For devices rated at less than 15 A, the fuses in the test circuit shall not exceed the rating of the device.

7.4.7 A device (such as a luminaire disconnect device) that has multiple voltage and ampere ratings shall be tested at

(a) 150% of the rated current that corresponds to the maximum rated voltage;

(b) 150% of the maximum rated current at the corresponding rated voltage; and

(c) 150% of the rated current at the corresponding rated voltage that results in the maximum power per pole.

7.4.8 The voltage of the test circuit shall be 95 to 105% of the device voltage rating.

7.4.9 The test shall be conducted using alternating current, with a power factor of 0.75 to 0.80.

7.5 Temperature rise

7.5.1 The temperature rise test shall be conducted after the abnormal overload test using the same test specimens.

7.5.2 Tests shall be made in a draft-free area having an ambient temperature of 25 ±5°C. Tests conducted at an ambient temperature other than 25°C shall have their results adjusted to the specified ambient temperature.

7.5.3 The test shall be conducted in accordance with the device manufacturer's instructions on wire size, pole location, number of terminations, and ampacity.

7.5.4 The device shall carry the specified current until stabilized temperatures are attained.

7.5.5 Temperature measurements shall be made on the device wiring terminals if they are accessible for mounting thermocouples. When the wiring terminals are inaccessible, temperatures shall be measured as close as possible to the device's current-carrying contacts. (See Clause 7.1.4.)

7.6 Dielectric voltage withstand

7.6.1 The dielectric voltage withstand test shall be conducted after the temperature test using the same test specimens.

Note: *Openings added to the insulation for the routing of thermocouples to facilitate conducting the temperature test may be repaired or closed with an insulating material such as wax before the dielectric voltage withstand test is performed.*

7.6.2 The test voltage shall be applied between

(a) live parts of opposite polarity;

(b) live parts and exposed non-current-carrying metal parts; and

(c) live parts and exterior surfaces wrapped in foil or embedded in No. 7-1/2 conductive shot.

7.6.3 The test voltage shall be 1000 V plus twice the rated voltage.

7.6.4 The test voltage shall be supplied from a 500 VA or larger capacity testing transformer whose output is essentially sinusoidal and can be varied.

7.6.5 The applied voltage shall be increased from zero until the required test voltage is reached, and shall be held at that voltage for 1 min. The increase in the applied potential shall be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

7.7 Dielectric withstand – Puncture

7.7.1 No specimen shall be subjected to more than one dielectric withstand test.

7.7.2 Three sets of specimens shall be subjected to this testing in as-received condition and conditioned in accordance with Clauses 7.7.3 and 7.7.4. Mating-type (separable-type) connectors shall be tested in the mated and unmated condition.

7.7.3 Specimens previously assembled to conductors shall be conditioned in an air-circulating oven at an elevated temperature corresponding to the insulation temperature rating, in accordance with Table 18.

7.7.4 The specimens not previously assembled to conductors shall be conditioned for 168 h in an air-circulating oven at 100 °C. Connectors employing extended covers or sleeves may have the wires pre-installed, but not crimped, before oven aging. The specimens shall then be allowed to cool to room temperature. Following the oven conditioning, the specimens having insulation made of hygroscopic material, such as nylon, shall be conditioned for 24 h at a relative humidity of 85 ± 5% at 30 ± 2°C. The specimens shall then be assembled (or crimped) to conductors in the intended manner.

7.7.5 Each specimen shall be connected to the conductor(s) in the intended manner and subjected to a test voltage applied between the conductor(s) and an outer electrode. The test voltage shall be applied for 1 min and shall be in accordance with Table 1, based on the rated connector voltage.

Note: *Puncture of the conductor (wire) insulation during this test is inconclusive and can require repeated testing.*

7.7.6 Only that portion of the outer insulating surface that covers current-carrying parts shall be covered with the outer electrode. Each specimen shall be embedded in No. 7-1/2 conductive shot that is to serve as the outer electrode. A smaller than No. 7-1/2 (higher size number) shot may be used with the concurrence of those concerned. Conductive metal foil shall be used as the outer electrode for a connector that uses a separable cap that is intended to be applied after assembly of the conductors to the connector, or when a connector has openings that will allow entry of the shot.

7.7.7 A connector that has openings that allow entry of shot, potentially resulting in flashover, shall have those openings closed with tape, petrolatum, epoxy, silicone, rubber, or another suitable material. This supplementary insulating material shall not be applied to supplement the connector insulation where it covers live parts. If flashover between the electrode and a normally insulated live part occurs, the supplementary insulation may be repaired and the test repeated.

7.8 Mold stress relief

7.8.1 Fully assembled mated and unmated devices shall be placed in a full-draft circulating-air oven for 7 h. A uniform temperature of at least 90°C and at least 10°C higher than the maximum intended operating temperature of the devices shall be maintained.

7.8.2 The devices shall be removed from the oven and allowed to cool to room temperature before compliance is determined.

7.8.3 A molded rubber component shall be exposed to oxygen at a pressure of 2070 ± 70 kPa and a temperature of 70 ± 1°C for 96 h. Where possible, the complete component shall be tested. The original hardness shall be the average of five readings before oxygen exposure. The component shall be allowed to condition at room temperature for 4 h or more after removal from the oxygen. Following oxygen exposure, five additional readings shall be recorded and their average calculated.

7.9 Current cycling

7.9.1 Connectors intended for use with snap-on molded insulating covers or packaged with insulating materials that are intended to be wrapped around the completed connector/conductor termination shall be tested without the insulating covers or material installed.

7.9.2 Temperatures shall be measured and recorded for at least one cycle of each working day.

7.9.3 Each cycle of operation shall consist of 1 h on and 1 h off. The current-off times may be reduced after the first 25 cycles of testing to 5 min more than the maximum time it takes any connector to reach a stable temperature during the current-off period. Forced-air cooling may be used to reduce the current-off time with the concurrence of those concerned. A test specimen shall be considered to have attained a stable temperature when three readings at 10 min intervals show not more than a 2°C variation between any two of the readings. The time to temperature stabilization shall be the current-off time at which the first of three readings indicating stable temperature was recorded.

7.9.4 Temperatures shall be measured not sooner than the last 5 min of the normal current-on time. If the size of the test specimen set or the speed of the data acquisition system is such that not all measurements can be completed within the 5 min, the current-on time may be extended as necessary to complete such measurements.

7.10 Mechanical sequence

7.10.1 Secureness

7.10.1.1 Except as specified in Clause 7.10.1.5, the set-up shall be as shown in Figure 4. When evaluating a mating wire connector (separable-type), the two halves shall be tested independently from each other.

7.10.1.2 A connector shall be fastened to a length of conductor at least 76 mm (3 in) longer than the height specified in Table 19 and shall be rigidly secured in a vertical position simulating actual service conditions. The free end of the conductor shall be passed through a bushing of the size specified in Table 19. The bushing shall be attached to an arm driven by a motor at a rate of approximately 9 rpm and in such a manner that the centre of the bushing describes a circle in a horizontal plane (see Figure 4). The circle shall have a diameter of 76 mm (3 in) and its centre shall be vertically below the centre of the conductor opening in the connector. The distance between the upper side of the bushing and the mouth of the connector shall be within 12.7 mm (1/2 in) of height specified in Table 19. The bushing shall be lubricated so that there is no binding, twisting, or rotation of the insulated conductor. A mass as specified in Table 19 shall be suspended from the free end of the conductor.

7.10.1.3 For the test of a splicing connector or the independent halves of a separable mating connector in which the conductors lie parallel to or in line with each other, the set-up shall be as shown in Figure 4. If the connector is secured to conductors of different sizes, the mass shall be attached to the smallest conductor, and the entire assembly of connector, conductors, and mass shall be suspended from the largest conductor. The values of mass and height shall be selected from Table 19 in accordance with the size of the conductor to which the mass is attached. Terminal connectors or other means that will distribute the stress uniformly among the strands of the conductor shall be employed for attaching the mass and for securing the assembly to the frame of the testing machine.

7.10.1.4 When the connector is such that the conductors are intended to extend all the way through it, the ends of the conductors not secured to the testing machine or to the mass may project not more than 6.4 mm (1/4 in) beyond the body of the connector.

7.10.1.5 A splicing connector in which the conductors do not lie parallel to or in line with each other shall be assembled to a length of through conductor and a length of tap conductor, each of the size for which the connector is intended. The assembly shall be supported by a U-shaped yoke, the arms of which grasp the through conductor on each side of the connector approximately 50 mm (2 in) from the ends of the connector. The depth of the yoke shall be approximately 76 mm (3 in). The yoke shall be secured firmly to the frame of the testing machine so that the tap conductor hangs vertically. The mass, which shall be suspended from the free end of the tap conductor after it has passed through the bushing of the testing machine, shall be as specified in Table 19 for the applicable size of the tap conductor. The length of the tap conductor shall be not less than 76 mm (3 in) more than the height specified in Table 19, for the applicable size of the tap conductor (see Figure 5). The testing machine shall be operated as specified in Clause 7.10.1.2.

7.10.2 Pullout

7.10.2.1 The same connectors and entry holes subjected to the secureness test shall be subjected to a direct pull of the applicable value specified in Table 20.

7.10.2.2 For an insulated connector in which the insulation is assembled to the connector during installation, the test shall be conducted with the insulation in place if it is always supplied with the connector by the manufacturer. Otherwise, the test shall be conducted without the insulation assembled to the connector.

7.10.2.3 The pull shall be exerted by means of a tension-testing machine, dead weights, or other equivalent means so that there is no sudden application of force or jerking during the test. Breakage or tearing of the insulation of an insulated connector during the pullout test shall be permitted.

7.10.2.4 The connector shall be suspended from the largest conductor. Beginning with the smallest conductor, one conductor of each size of conductors in the combination shall be separately subjected to the force specified in Table 20.

Note: *See Annex B for an example.*

7.11 Stress corrosion/moist ammonia (NH_4)

7.11.1 Each test specimen shall be subjected to the physical stresses normally imposed on or within a part as the result of assembly. Such stresses shall be applied to the specimens before and during the test. Specimens shall be assembled to a 152 mm (6 in) length of the maximum rated size conductor and torqued to the value specified in Clause 7.1.9.

7.11.2 The specimens shall be degreased and then continuously exposed in a set position for 10 d to a moist ammonia-air mixture maintained in a glass chamber that is approximately 305 x 305 x 305 mm (12 x 12 x 12 in) and has a glass cover.

7.11.3 Approximately 600 ml of aqueous ammonia with a specific gravity of 0.94 shall be maintained at the bottom of the glass chamber below the specimens. The specimens shall be positioned 38 mm (1-1/2 in) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber shall be maintained at atmospheric pressure and a temperature of 34 ± 2°C.

7.12 Stress corrosion/mercurous nitrate ($HgNO_3$)

7.12.1 Specimens shall be immersed in an aqueous solution of 100 g of mercurous nitrate and 13 ml of nitric acid (specific gravity of 1.42) per litre for 15 min.

7.12.2 Evidence of cracking shall be determined using normal or corrected vision without magnification.

7.13 Spring-action sequence

7.13.1 Conditioning

7.13.1.1 A spring-action clamp-type connector intended for reuse shall be subjected to the conditioning specified in Clause 7.13.1.4 and subsequently subjected to the tests specified in Clauses 7.13.2 and 7.13.3.

7.13.1.2 A spring-action clamp-type connector intended for one-time use only and marked in accordance with Clause 8.13 shall not be subjected to the conditioning specified in Clause 7.13.1.1 and shall be subjected only to the tests specified in Clauses 7.13.2 and 7.13.3.

7.13.1.3 Specimens shall be selected and prepared as specified in Clauses 6 and 7.1.8.

7.13.1.4 The connectors shall be subjected to conditioning consisting of nine insertions and withdrawals of a conductor of the same size and type to be used for the tests specified in Clauses 7.13.2 and 7.13.3. A tenth insertion of a newly stripped, previously unused length of conductor shall be made and left in place for the tests specified in Clauses 7.13.2 and 7.13.3.

7.13.2 Temperature

7.13.2.1 The specimens conditioned in accordance with Clause 7.13.1 shall be subjected to the temperature test.

7.13.2.2 The specimens shall be connected in series and the specified current shall be passed through the circuit. The test shall be run for 30 d without interruption. Temperatures shall be measured and recorded every 24 h.

7.13.2.3 Upon completion of this test, the connector shall be subjected to the test specified in Clause 7.13.3.

7.13.3 Dielectric withstand

7.13.3.1 The specimens that have been subjected to the test specified in Clause 7.13.2 shall be used for the dielectric withstand test. The connector surface shall be wrapped in foil and serve as the outer electrode.

7.13.3.2 A test voltage of 1000 V plus twice the rated voltage of the connector shall be applied between

(a) live parts that are not conductively interconnected; and

(b) live parts and the metal foil that serves as the outer electrode.

7.13.3.3 In order to determine whether a spring-action connector complies with Clause 7.13.3.2, the connector shall be tested by means of a transformer with a suitable capacity and an output voltage that is essentially sinusoidal and can be varied.

7.13.3.4 The applied voltage shall be increased from zero until the required test level is reached and shall be held at that level for 1 min. The increase in the applied potential shall be at a substantially uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

8 Marking, labelling, and packaging

Note: *In Canada there are two official languages, English and French. Annex C provides French translations of the markings specified in this Standard. Markings required by this Standard may be in other languages to conform to the language requirements where the product is to be used.*

8.1 Marking locations shall be as specified in Clauses 8.2 to 8.16.

Note: *Refer to Table 21 for a guide to marking locations.*

8.2 A connector shall be legibly marked with

(a) the manufacturer's name, trade name, or both, or any other acceptable marking whereby the organization responsible for the product can be readily identified;

(b) the catalog number; and

(c) the conductor size or range of sizes. If the connector has openings that accommodate different conductor sizes or ranges of sizes, each opening having a unique wire range shall have its wire range identified.

8.3 In lieu of the markings specified in Items (b) and/or (c) of Clause 8.2, a connector may be marked with a single identifying symbol. This symbol may be an individual catalog number, a type designation, a size designation (such as "12"), or an equivalently significant symbol. Each unit container containing connectors so identified or an information sheet packed in the unit container shall be marked with the information specified in Clause 8.2.

Note: *A type designation is intended primarily to identify a particular design, which may include various features covered by different catalog numbers.*

8.4 The unit container or an information sheet packed in the unit container shall be marked with the following or equivalent wording, as applicable:

(a) the manufacturer's name, trade name, or any other acceptable marking whereby the organization responsible for the product can be readily identified;

(b) the catalog number;

(c) the conductor size or range of sizes;

(d) "CU" or "Copper";

(e) the voltage rating;

(f) the operating temperature rating;

(g) the ampere rating for a luminaire disconnect device; and

Note: *Based on voltage ratings, more than one ampere rating may be assigned.*

(h) "LUMINAIRE DISCONNECT" (for a connector intended for use as a luminaire disconnect).

8.5 The following words shall also appear on or in the unit container: "TO BE SOLD ONLY WITH INSTALLATION INSTRUCTIONS".

8.6 A connector tested with solid or stranded conductor other than as specified in Clause 6.2 shall be marked "Solid", "Stranded", or both, as applicable. (See Clause 8.7).

8.7 The "solid" and "stranded" markings specified in Clause 8.6 may be

(a) abbreviated "Sol" and "Str", respectively; or

(b) provided on the unit container or on an information sheet packed in the unit container, if there is insufficient space on the connector for either the complete or abbreviated marking.

8.8 Unless rearrangement or adjustment of a connector necessary to adapt it to various sizes of conductor is obvious, it shall be clearly indicated by size markings or other instructions appearing on

(a) the connector;

(b) its unit container; or

(c) an information sheet packed in the unit container.

8.9 A procedure that must be followed for proper assembly of a wire connector to a conductor shall be provided as follows:

(a) USE OF A SPECIFIC TOOL REQUIRED: If a connector is intended to be assembled to one or more conductors by a specific tool, the tool designation or the designation of a removable tool part, such as a pressing die, shall be marked on the connector or on or within the unit container in which the connector is packed. The marking shall include at least one of the following:

(1) catalog or type designation;

(2) color coding;

(3) die index number; or

(4) other equivalent means.

(b) MULTIPLE CRIMPING OPERATIONS: Information shall appear

(1) on the unit container in which the connector is packed;

(2) on the tool or pressing die that needs to be used for its application;

(3) on the carrying case provided for permanent storage of the tool and dies; or

(4) on the connector.

The location of the crimping points only, without additional instructions, may be marked on the connector if the additional required information is located as specified in Item (a), (b), or (c).

(c) CONDUCTOR STRIP LENGTH: The strip length marking specified in Table 14 shall appear

(1) on the connector;

(2) on the unit container or an information sheet contained therein;

(3) on an insulating cover; or

(4) on the tool or on the carrying case provided for its permanent storage if

(i) the connector requires the use of a specific tool for its application; and

(ii) the strip length applies to all insulated connectors with which the tool is used.

(d) PRELIMINARY PREPARATION OF CONDUCTOR REQUIRED: Instructions for preparation of the conductors, such as use of compound or twisting conductors together before assembly, shall appear on the unit container or an information sheet packed in the unit container.

8.10 A separable cover of a splicing connector shall be marked with

(a) the manufacturer's name;

(b) the catalog number;

(c) the voltage rating; and

(d) the operating-temperature limit (see also Clause 8.4(f) and Table 18).

8.11 The information in a marking shall not be divided between a unit container and an information sheet. If any of the required markings are placed either on the unit container or on the information sheet packed in the unit container, rather than on the connector, all applicable markings specified in Clause 8 shall be placed in the same location in their entirety.

8.12 The flammability classification of the insulating material may be marked on the connector, the smallest unit container, or an information sheet placed in the smallest unit container. (See Clause 4.2.2.3.1.)

8.13 For a spring-action-type connector intended for one-time use only, the connector, the unit container, or an information sheet packed in the unit container shall be marked “One-Time Use Only – Do Not Reuse” or the equivalent.

8.14 A connector or the smallest unit container shall be marked “Limited Number of Current-Interrupting Operations” or the equivalent.

8.15 Unless provided with integral pigtail leads as specified in Clause 4.6, the connector body shall be marked to identify each terminal with the intended conductor polarity or type.

Note: *Examples include “G”, ”Ground”, ”Green”, or the color green; “B”, ”Black”, “L1”, or the color black; and “W”, ”White”, ”Neutral”, or the color white.*

8.16 Unless provided with integral pigtail leads as specified in Clause 4.6, the ground terminal of the connector body shall be marked with the symbol shown in Figure 6 or with “G”, “GR”, “GND”, “Ground”, “Grounding”, or a similar marking.

TABLES

Table 1 – Insulation puncture test voltages
(See Clauses 4.2.2.1.1 and 7.7.5.)

Connector insulation voltage rating	Test voltage
300	2200
600	3400

Table 2 – Hot wire ignition (HWI) and high-current arc resistance to ignition (HAI) ratings of insulating materials
(See Clauses 4.2.2.4.2.)

Flammability classification*	HWI†		HAI‡	
	Mean ignition time, s	PLC§	Mean no. of arcs	PLC§
V0, VTM0	7–15	4	15–30	3
V1, VTM1	15–30	3	15–30	3
V2, VTM2	15–30	3	15–30	3

* Flammability classification as described in CAN/CSA-C22.2 No. 0.17 or UL 94.
† Hot wire resistance to ignition as described in CAN/CSA-C22.2 No. 0.17 or UL 746A.
‡ High-current arc resistance to ignition as described in CAN/CSA-C22.2 No. 0.17 or UL 746A.
§ Performance level class.

Table 3 – Minimum relative thermal indices of insulating materials used in the insulation and enclosure applications, °C*
(See Clause 4.2.2.5.1.)

Electrical	Mechanical (impact)	Mechanical (strength)
90	90	90

* Relative thermal index as described in CAN/CSA-C22.2 No. 0.17 or UL 746B.

Table 4 – Minimum spacings
(See Clause 4.4.1.)

Voltage involved, V	Through air and over surface, mm (in)
0 – 30	0.8 (1/32)
31 – 250	1.2 (3/64)
251 – 600	3.2 (1/8)

Table 4A – Minimum spacings for the United States

Table 4A deleted

Table 4B – Minimum spacings for Canada

Table 4B deleted

Table 5 – Test sequences (all connectors)
(See Clause 5.1.1.)

Clause	Test
7.2	Grounding contact – Short-time withstand current
7.3	Latching or locking mechanism
7.3.2	Connector separation (luminaire disconnect)
7.4	Abnormal overload
7.5	Temperature
7.6	Dielectric voltage withstand
7.7	Dielectric withstand – Puncture
7.8	Mold stress relief
7.9	Current cycling
7.10	Mechanical sequence
7.10.1	Secureness
7.10.2	Pullout
7.11	Stress corrosion/moist ammonia (NH_4) or
7.12	Stress corrosion/mercurous nitrate ($HgNO_3$)
7.13	Spring-action sequence
7.13.1	Conditioning
7.13.2	Temperature
7.13.3	Dielectric withstand

Table 6 – Short-time test currents
(See Clauses 5.2.1 and 7.2.4.)

Grounding conductor size, AWG (mm^2)	Test current, A
30 (0.05)	–
28 (0.08)	–
26 (0.13)	–
24 (0.20)	–
22 (0.32)	–
20 (0.52)	70
18 (0.82)	115
16 (1.3)	185
14 (2.1)	300
12 (3.3)	470
10 (5.3)	750
8 (8.4)	1180
6 (13.3)	1530

Table 7 – Current cycling test current (See Clauses 5.5.2, 5.9.1, 5.13.1, and 7.4.4.)

Conductor size, AWG (mm^2)	Temperature test current, A	Current cycling current, A
30 (0.05)	3.0	3.5
28 (0.08)	3.5	4
26 (0.13)	5.5	6
24 (0.20)	7.0	8
22 (0.32)	9.0	12
20 (0.52)	12	16
18 (0.82)	17	19
16 (1.3)	18	20
14 (2.1)	30	33
12 (3.3)	35	39
10 (5.3)	50	56
8 (8.4)	70	80
6 (13.3)	95	105

Table 8 – Minimum number of specimens for testing (See Clause 6.)

Clause	Test	Minimum number of specimens
7.2	Grounding contact – Short-time withstand current Dielectric voltage withstand	3
7.3	Latching or locking mechanism	6
7.3.2	Connector separation (luminaire disconnect)	3
7.4	Abnormal overload	3
7.5	Temperature	*
7.6	Dielectric voltage withstand	*
7.7	Dielectric withstand – Puncture	
	(a) As received	6
	(b) After oven conditioning with specimens assembled to conductor before such conditioning	6
	c) After oven conditioning with specimens assembled to conductor after such conditioning	6
7.8	Mold stress relief	3
7.9	Current cycling	4 of each combination of connector and test conductor(s)
7.10	Secureness Pullout	2 of each combination of connector and test conductor(s)
7.11 or 7.12	Stress corrosion/moist ammonia (NH_4) or stress corrosion/ mercurous nitrate ($HgNO_3$)	3
7.13	Conditioning	6 of each combination of connector and test conductor(s)
	Temperature	
	Dielectric voltage withstand	

* Continuing test from Clause 7.4.

Table 9 – Conductor materials
(See Clauses 7.1.5.1 and 7.1.5.2.)

Type of copper	Size, AWG (mm^2)	Test and control conductors
Solid	30–16 (0.05–1.31)	Soft annealed, tinned or untinned
	14 (2.1) and larger	Soft annealed and untinned
Stranded	30–16 (0.05–1.31)	Soft annealed, tinned or untinned
	14 (2.1) and larger	Soft annealed, tinned or untinned. The stranding shall be concentric or compressed Class B or concentric Class C.*
* In Canada, 8 AWG (8.4 mm^2) and larger compact-stranded copper conductors shall be used.		

Table 10 – Conductor insulation (solid and stranded copper)
(See Clause 7.1.5.1.)

Size, AWG (mm^2)	Type of insulation
30–24 (0.05–0.20)	Black thermoplastic, at least 0.254 mm (0.010 in) thick
22–16 (0.32–1.31)	Black thermoplastic, at least 0.762 mm (0.030 in) thick
14 (2.1) and larger	T90 or THHN, THW, RW90 (1000V) or USE, RW90 (600V) or XHHW

Table 11 – Conductor stranding
(See Clause 7.1.5.1.)

Size of stranded conductor to which connector is to be assembled, AWG (mm^2)	Number of strands	
	Class B copper	Class C copper
30–24 (0.05–0.20)	May vary	–
22 (0.32)	7	–
20 (0.52)	10	–
18 (0.82)	16	–
16 (1.3)	26	–
14–6 (2.1–13.3)	7	19

Table 12 – Minimum test conductor length
(See Clause 7.1.5.6.)

Conductor size, AWG (mm^2)	Minimum length, mm (in)*
30–8 (0.05–8.4)	203 (8)
6 (13.3)	305 (12)
* The conductor length for the secureness test in the mechanical or static-heating sequence shall not be less than that specified in Clause 7.10.1.2.	

Table 13 – Strip-length tolerances for conductors
(See Clause 7.1.6.2.)

Conductor size, AWG (mm^2)	Tolerance, mm (in)
30–14 (0.05–2.1)	± 0.8 (± 1/32)
12–10 (3.3–5.3)	± 1.2 (± 3/64)
8–6 (8.4–13.3)	± 1.6 (± 1/16)

Table 14 – Required wire strip length marking
(See Clauses 7.1.6.3 and 8.9.)

Maximum strip length	Minimum strip length
*†	*†‡
* The strip length shall be specified as a single nominal value if tested as specified in Clause 7.1.6.2. † Strip length marking shall be optional if the connector is provided with an open end opposite the conductor insertion end through which the end of the conductor is visible after it is connected. ‡ Strip length marking shall be optional if the connector is provided with an inspection hole opposite the conductor insertion end through which the end of the conductor is visible after it is connected.	

Table 15 – Copper busbar dimensions
(See Clauses 7.1.7.3 and 7.1.10.3.)

Range of test current, A	Maximum cross-section, mm (in)
0–50	3.2 x 12.7(1/8 x 1/2)
51–125	3.2 x 25 (1/8 x 1)

Table 16 – Tightening torque for screws
(See Clause 7.1.9.3.)

Size or diameter of screw	Torque, N·m (lbf-in)	
	A	B
4.8 mm diameter (No. 10) or smaller	0.55 (4.8)	0.68 (6)
6.4 mm (1/4 in)	0.72 (6.4)	0.91 (8)
7.9 mm (5/16 in) and larger	0.99 (8.8)	1.24 (11)
Note: *Use a 6.4 mm size torque for M6 screws.*		