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ULSE Inc.
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Eighth Edition

Splicing Wire Connectors

June 30, 2023

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Standard for Safety for Splicing Wire Connectors

Fifth Edition, Dated June 30, 2023

Summary of Topics

This Fifth Edition dated June 30, 2023 includes clarification regarding insulating covers during stress corrosion tests, the addition of Annex G – Conductor Stranding and testing with metric and non-standard size conductors.

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

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This ANSI/UL Standard for Safety consists of the Eighth Edition. The most recent designation of ANSI/UL 486C as an American National Standard (ANSI) occurred on June 30, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

The Department of Defense (DoD) has adopted UL 486C on January 28, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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Preface

This is the harmonized ANCE, CSA Group, and ULSE standard for Splicing Wire Connectors. It is the fifth edition of NMX-J-548-ANCE, the fifth edition of CSA C22.2 No. 188, and the eighth edition of UL 486C. This edition of NMX-J-548-ANCE supersedes the previous edition published May 5, 2021. This edition of CSA C22.2 No. 188 supersedes the previous edition published on May 5, 2021. This edition of UL 486C supersedes the previous edition published May 5, 2021.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), the CSA Group, and ULSE. 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.

The present Mexican standard was developed by the SC 20D – Conectadores part of the CT 20 – Conductores from the Comite de Normalizacion de la Asociacion de Normalizacion y Certificacion, A.C., CONANCE, with the collaboration of the connectors manufacturers and users.

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. 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 several IEC standards that address electrical wire connectors included in the scope of this standard. The IEC standards for electrical wire connectors are recognized as being generally system-specific, containing the requirements for the relevant wire connectors and cables in many discrete IEC standards.

The THC determined the safe use of electrical wire connectors is dependent on the design and performance of the wire connectors in relation to the North American electrical codes with which they are intended to be installed. The THC agreed such future investigation would be facilitated by the harmonization of the North American electrical codes for wire connectors with IEC installation practices.

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.

1 Scope

1.1 This Standard applies to single-polarity, hand-, or tool-applied splicing wire and cable connectors intended for use with all alloys of copper, aluminum conductors, or copper-clad aluminum conductors, or all three, in accordance with the Canadian Electrical Code Part I, CSA C22.1, in Canada, the National Electrical Code, NFPA-70, in the United States of America, or the Standard for Electrical Installations, NOM-001-SEDE, in Mexico, as follows:

Note: Copper-clad aluminum conductors are for use only in the United States in accordance with the National Electrical Code, NFPA 70.

a) Connectors intended to hold two or more conductor(s);

b) Connectors intended for use in appliances and equipment that comply with the requirements for such appliances and equipment;

c) Connectors intended for use with 6 AWG (13.3 mm^2) or smaller conductors;

d) Uninsulated connectors that are used in circuits rated 8 000 V and less;

e) Connectors intended for use in air-handling spaces; and

f) Exothermically welded wire connectors.

Note: Examples of splicing wire connectors include twist-on connectors, insulation-piercing or displacement connectors, spring-action connectors, tool-applied crimp, mechanical set-screw connectors, etc.

1.2 This Standard is intended for splicing wire connectors suitable for use with conductors in the size ranges as follows:

a) Aluminum:

1) 12 AWG (3.3 mm^2) and 10 AWG (5.3 mm^2) solid;

2) 12 AWG (3.3 mm^2) to 6 AWG (13.3 mm^2) stranded, Class B concentric, compressed, and compact; and

3) 12 AWG (3.3 mm^2) to 6 AWG (13.3 mm^2) stranded single input wire (SIW).

In Mexico, the use of aluminum conductors is permitted only with thermoset insulation and for sizes of 6 AWG (13.3 mm^2) and higher.

b) Copper-clad aluminum:

1) In Canada, this construction is not allowed.

2) In Mexico, this construction is not allowed.

3) In the United States:

i) 12 AWG (3.3 mm^2) and 10 AWG (5.3 mm^2) solid; and

ii) 12 AWG (3.3 mm^2) to 6 AWG (13.3 mm^2) stranded, Class B concentric, compressed, and Class C concentric.

c) Copper:

1) 30 AWG (0.05 mm^2) to 10 AWG (5.3 mm^2) solid; and

2) 30 AWG (0.05 mm^2) to 6 AWG (13.3 mm^2) stranded, Class B concentric and compressed, and Class C concentric.

d) Compact-stranded copper conductors:

In Canada and Mexico, for 8 AWG (8.4 mm^2) and 6 AWG (13.3 mm^2).

In the United States this is not applicable.

e) Rigid (solid and stranded) metric wire sizes, Classes 1, 2, 5, and 6, in the range of 0.5 – 10 mm^2, in addition to AWG sizes, with AWG ratings mandatory and metric wire ratings optional.

Note 1: Metric wire sizes are based on the IEC Standard for Conductors of Insulated Cables, IEC 60228.

Note 2: For example, a connector rated for 6 AWG (13.3 mm^2) – 14 AWG (2.1 mm^2) may be additionally rated for 10 – 2.5 mm^2. See Annex C for example.

f) Other class and strand configurations as indicated by marking.

1.3 These requirements cover splicing wire connectors intended for:

a) Copper-to-copper;

b) Aluminum-to-aluminum;

c) Copper-clad aluminum-to-copper-clad aluminum;

d) Copper-to-aluminum or copper-clad aluminum and aluminum-to-copper-clad aluminum conductor combinations intended for intermixing of conductors and dry locations only; or

e) All of the above.

1.4 This Standard is intended for splicing wire connectors suitable for currents not exceeding the ampacity of insulated conductors rated 75 °C or 90 °C, in accordance with the rating of the connector.

1.5 This Standard does not apply to:

a) Insulated splicing wire connectors intended for use at voltage levels in excess of 2 000;

b) Terminal wire connectors;

c) Wire binding screw terminals;

d) Built-in terminal connectors on devices rated less than 30 A and intended for outlet box mounting or having provision for stress relief;

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

f) Flat quick connect terminals; and

g) Soldering lugs.

2 Reference publications

2.1 Normative references

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

2.1.1 ANCE Standards

NMX-J-192-ANCE, *Wires and Cables – Flame Test on Electrical Cables – Test Methods*

NMX-J-417-ANCE, *Wires and Cables – Forced-Convection Air Ovens for Evaluation of Polymeric Materials Used in Cables, Electrical Equipment and Devices – Specifications*

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

2.1.2 CSA Standards

C22.1, *Canadian Electrical Code, Part I(CE Code)*

C22.2 No. 0, *General-requirements – Canadian Electrical Code, Part II*

C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

2.1.3 IEC† Standards

IEC 60228, *Conductors of Insulated Cables*

† *International Electrotechnical Commission*

2.1.4 UL Standards

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 2043, *Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces*

2.1.5 NFPA* Standards

ANSI/NFPA 70, *National Electrical Code (NEC)*

NFPA 90A, *Installation of Air-Conditioning and Ventilating Systems*

* National Fire Protection Association

2.1.6 NOM Standards – Mexican Secretary of Energy

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

2.1.7 ULC Standards

ULC/ORD-C2043, *Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces*

2.1.8 Other Codes

International Mechanical Code

Uniform Mechanical Code

2.2 Informative references

2.2.1 See Annex A for a listing of supplemental standards.

3 Units of measure

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

3.2 For conductor sizes, AWG conductor sizes are noted with their metric equivalents in parenthesis, followed by the closest metric conductor size covered by the IEC Standard for Conductors of Insulated cables, IEC 60228.

Note 1: Specifications for conductor sizes for both AWG and metric are shown as follows: 12 – 6 AWG (3.31 – 13.3) / 4.0 – 10.0 mm^2.

Note 2: IEC 60228 covers conductors in the metric range of 0.5 – 2 500 mm^2. For requirements covering AWG wire ranges outside this scope, the specification for the metric conductor will be limited to the conductor range covered by IEC 60228.

4 Definitions

For the purpose of this Standard, the following terms and definitions apply.

4.1 Circular Mil (Cmil) – the area of a circle with a diameter of 0.001 in.

4.2 Control Conductor – an unbroken conductor that is included in the current-cycling test loop.

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

Note: Crimping dies may have a separate or integral section for compressing the insulation grip, if provided.

4.4 Equalizer – a busbar that provides for equipotential and uniform current flow in a stranded conductor without adversely affecting the temperature of the connector(s).

4.5 Packaging Container – the container in which the unit containers are packaged.

4.6 Single Input Wire (SIW) – a stranded conductor that varies the number of wires within a range of conductor sizes in order to permit that range of conductor sizes to be constructed from a single wire size.

4.7 Splicing Wire Connector – a connector that establishes a connection between two or more conductors by means of mechanical pressure and is not intended to be permanently mounted.

4.8 Stability Factor S – the measure of temperature stability of a connector during the current-cycling test.

4.9 Temperature Rating – the maximum temperature of an insulated connector assigned by the manufacturer.

4.10 Temperature Rise – the difference of the temperature of the connector, measured under load, and the ambient temperature.

4.11 Unit Container – the smallest container in which connectors are packaged.

4.12 Voltage Rating – the maximum voltage of an insulated connector.

5 Symbols and abbreviations

5.1 ° – Degree

5.2 A – Amps, Amperes

5.3 Al – Aluminum

5.4 AWG – American Wire Gage/gauge

5.5 C – Celsius

5.6 CC or CCA – Copper-clad aluminum

5.7 Cu – Copper

5.8 d – Days

5.9 f – Flexible

5.10 h – Hour

5.11 $HgNO_3$ – Mercurous nitrate

5.12 Hz – Hertz, cycles per second

5.13 in – Inches

5.14 m – Meter

5.15 mil – Thousandth of an inch

5.16 min – Minutes

5.17 ml – Milliliter

5.18 mm – Millimeter

5.19 mm^2 – Square millimeter

5.20 N – Newton – Kilogram meter/sec^2

5.21 NH_4 – Ammonia

5.22 r – Rigid solid and rigid stranded

5.23 rpm – Revolutions per minute

5.24 s – Seconds

5.25 SAE – Society of Automotive Engineers

5.26 sol – Solid

5.27 str – Stranded

5.28 V – Volts

6 Construction requirements

6.1 General

6.1.1 For products intended for use in Canada, general requirements are given in CSA C22.2 No. 0.

6.1.2 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.

6.1.3 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. Examples of clamping means are:

a) Direct-bearing screws with or without use of a pressure plate;

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

c) Element for insulation piercing or insulation displacement;

d) Spring-action clamp;

e) Helical coiled spring; and

f) Formed insulation cavity (no spring).

6.1.4 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 10.11.

6.1.5 There shall be no sharp edges or corners on the outer surface of a connector that result in damage to insulation that the connector contacts.

6.2 Intermixing

6.2.1 Intermixing (direct conductor contact) between conductors of different materials shall be permitted if the connector meets the performance requirements of this Standard and is marked in accordance with 10.5(d).

6.3 Materials

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

6.3.2 Except as specified in 6.3.3, a connector body of a copper, copper alloy, aluminum, or aluminum alloy and intended for aluminum conductor shall be coated with an electrically conductive coating, such as tin, that will inhibit oxidation and corrosion.