# UL 2263

## STANDARD FOR SAFETY

Electric Vehicle Cable

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER
REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

UL Standard for Safety for Electric Vehicle Cable, UL 2263

First Edition, Dated May 9, 2022

***Summary of Topics***

***This revision of ANSI/UL 2263 dated April 17, 2026 is an editorial update to remove ANCE logo from the titlepage and Preface. No other changes have been made.***

***As noted in the Commitment for Amendments statement located on the back side of the title page, ULSE and CSA are committed to updating this harmonized standard jointly. However, the revision pages dated April 17, 2026 will not be jointly issued by ULSE and CSA as these revision pages only address removal of references to ANCE from the Titlepage and Preface. While ANCE continues to participate in the technical development of this trinational standard, the ANCE logo has been removed from the title page and Preface as standards cannot be formally published in Mexico at this time.***

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

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of ULSE Inc. (ULSE).

ULSE provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will ULSE be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if ULSE or an authorized ULSE representative has been advised of the possibility of such damage. In no event shall ULSE's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold ULSE harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

*ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.*

No Text on This Page

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

CSA Group
CSA C22.2 No. 332:22
First Edition

ULSE Inc.
UL 2263
First Edition

# Electric Vehicle Cable

May 9, 2022

(Title Page Reprinted: April 17, 2026)

Approved American National Standard

ANSI/UL 2263-2022

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

**Commitment for Amendments**

This standard is issued jointly by 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 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 978-1-4883-3016-2 © 2022 Canadian Standards Association**

All rights reserved. No part of this publication may be reproduced in any form whatsoever without the prior permission of the publisher.

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.

To purchase CSA Group Standards and related publications, visit CSA Group's Online Store at www.csagroup.org/store/ or call toll-free 1-800-463-6727 or 416-747-4044.

---

**© 2026 ULSE Inc. All rights reserved.**

Our Standards for Safety are copyrighted by ULSE Inc. Neither a printed nor electronic copy of a Standard should be altered in any way. All of our Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of ULSE Inc.

This ANSI/UL Standard for Safety consists of the First Edition including revisions through April 17, 2026. The most recent designation of ANSI/UL 2263 as an American National Standard (ANSI) occurred on May 9, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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

For information on ULSE Standards, visit https://www.shopulstandards.com, call toll free 1-888-853-3503 or email us at ClientService@shopULStandards.com.

---

*ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.*

## CONTENTS

**PREFACE ..... 5**

1 Scope ..... 7
1.1 General ..... 7
1.2 Products included ..... 7
2 Reference Publications ..... 7
3 Definitions and Units of Measurement ..... 9
3.1 Definitions ..... 9
3.2 Units of measurement ..... 10
4 Construction Requirements ..... 10
4.1 General construction requirements ..... 10
5 Performance and Test Requirements ..... 17
5.1 Physical properties ..... 17
5.2 Electrical properties ..... 20
5.3 Fluid resistance (optional) ..... 23
6 Markings ..... 24
6.1 General ..... 24
6.2 Product marking ..... 24
6.3 Optional markings ..... 26
6.4 Package marking ..... 26
Tables ..... 28

**Annex A (Informative) French and Spanish translations of caution markings**

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

No Text on This Page

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

# PREFACE

This is the harmonized CSA Group and ULSE standard for electric vehicle cable. It is the first edition of CSA C22.2 No. 332 and UL 2263. This harmonized standard has been revised by ULSE on July 15, 2022. CSA Group are issuing an Errata dated July 15, 2022.

This harmonized standard was prepared by CSA Group and ULSE. The efforts and support of the Technical Harmonization Subcommittee, TC 20 Electrical Wires and Cables 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.

While ANCE continues to participate in the technical development of this trinational standard, the ANCE logo has been removed from the title page as standards cannot be formally published in Mexico at this time.

This standard was reviewed by the CSA Subcommittee on Flexible Cords/Equipment and Appliance Wires and Cables, 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 the 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 considered equivalent to, an IEC standard.

This standard is published as an identical standard for CSA Group and ULSE.

An identical standard is a standard that is exactly the same in technical content except for national differences resulting from conflicts in codes and governmental regulations. Presentation is word for word except for editorial changes.

### Reasons for Differences From IEC

This standard provides requirements for insulated cords and cables in accordance with the codes of Canada, Mexico, and the United States. At present there is no IEC standard for cords and cables for use in accordance with these codes. 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

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

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.

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

# 1 Scope

## 1.1 General

This standard specifies the requirements for electric vehicle cables rated up to 1000V AC and DC intended to be part of a cord set carried in the vehicle for connection to a charging station or for permanent or temporary connection to Electric Vehicle Supply Equipment (EVSE) or for connection to the branch circuit supplying the EVSE or vice versa for use in accordance with CSA C22.1, Canadian Electrical Code (CE Code), Part I in Canada, NOM-001-SEDE, La Norma de Instalaciones Electricas (Mexican Electrical Code [MEC]), in Mexico, and NFPA 70, National Electrical Code (NEC), in the United States.

## 1.2 Products included

This standard covers sunlight and oil resistant electric vehicle cables rated 300V, 600V and 1000V AC and DC, and 60 °C, 75 °C, 90 °C, or 105 °C cables meeting the construction requirements for Electric Vehicle cables designated EV, EVE, EVJ, EVJT, EVT, EVJE as appropriate. These cables may contain data, signal, communications and/or optical fiber cables.

# 2 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.

**ANCE (Association of Standardization and Certification)**

NMX-J-008-ANCE
*Wires and Cables – Tinned Soft or Annealed Copper Wire for Electrical Purposes – Specifications*

NMX-J-036-ANCE
*Wires and Cables – Soft or Annealed Copper Wire for Electrical Purposes – Specifications*

NMX-J-040-ANCE
*Wires and Cables – Determination of the Moisture Absorption in Insulations of Electrical Conductors – Test Method*

NMX-J-066-ANCE
*Wires and Cables – Determination of the Diameter of Electrical Conductors – Test Method*

NMX-J-177-ANCE
*Wires and Cables – Determination of the Thicknesses in Semiconducting Shields, Insulations and Jackets of Electrical Conductors – Test Method*

NMX-J-178-ANCE
*Wires and Cables – Ultimate Strength and Elongation of Insulation, Semiconducting Shields and Jackets of Electrical Conductors – Test Method*

NMX-J-190-ANCE
*Wires and Cables –Thermal Shock Resistance of PVC Insulations and Protective Coverings of Electrical Conductors – Test Method*

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

NMX-J-191-ANCE
*Wire and Cables – Heat Distortion of Insulations And Protective Coverings of Electrical Conductors – Test Method*

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

NMX-J-193-ANCE
*Wires and Cables – Cold Bend of Insulation and Non Metallic Protective Jackets Used on Insulated Wire and Cable – Test Method*

NMX-J-205-ANCE
*Wires and Cables – Determination of Dissipation Factor, Ionization Factor, on Insulated Electrical Conductors – Test Methods*

NMX-J-212-ANCE
*Wires and Cables – Electrical Resistance, Resistivity and Conductivity – Test Method*

NMX-J-293-ANCE
*Wires and Cables - Dielectric Voltage Withstand - Test Method*

NMX-J-294-ANCE
*Wires and Cables – Insulation Resistance – Test Method*

NMX-J-436-ANCE
*Conductors Flexible Cords and Cables Specification*

NMX-J-473-ANCE
*Wires and Cables – Spark Test – Test Method*

NMX-J-516-ANCE

*Wires and Cables – Determination of Direction and Length of Lay for Bare and Insulated Conductors – Test Method*

NMX-J-553-ANCE
*Wires and Cables – Weather Resistance of Insulation or Jacket of Electrical Conductors – Test Method*

NMX-J-556-ANCE
*Wires and Cables Test Methods*

**CSA Group**

C22.1
*Canadian Electrical Code, Part I*

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

CAN/CSA-C22.2 No 49
*Flexible cords and cables*

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

CAN/CSA-C22.2 No. 2556
*Wire and cable test methods*

**UL (Underwriters Laboratories Inc.)**

UL 62
*Flexible Cords and Cables*

UL 2556
*Wire and Cable Test Methods*

**ASTM (American Society for Testing and Materials)**

ASTM B3
*Standard Specification for Soft or Annealed Copper Wire*

ASTM B33
*Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes*

**Government of Mexico**

NOM-001-SEDE
*La Norma de Instalaciones Electricas (Mexican Electrical Code)*

**NFPA (National Fire Protection Association)**

NFPA 70
*National Electrical Code*

## 3 Definitions and Units of Measurement

### 3.1 Definitions

The following definitions apply in this standard:

**Equipment grounding (bonding) conductor** – a conductor that is defined in Mexico, in NOM-001-SEDE, and in the United States, in the *NEC*, as "Grounding Conductor, Equipment", and in Canada, in the *Canadian Electrical Code Part I*, as "Bonding conductor".

**Bunch stranding** – a group of wires twisted together without a predetermined pattern.

**Data, communication, and signal cables** – a complete manufactured assembly of one or more insulated conductor which may also include optical fiber member(s), strength member(s), insulating and protecting material having a continuous overall covering providing electrical, mechanical and environmental protection to the assembly used for transmitting data or signals.

**Direction of lay** – the longitudinal direction, designated as left-hand (counterclockwise) or right-hand (clockwise), in which the wires of a member or units of a conductor run over the top of the member or conductor as they recede from an observer looking along the axis of the member or conductor.

**Electric vehicle cable** – a cable intended to connect the electric vehicle supply equipment to the electric vehicle or vice versa.

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

**Grounded conductor** – a system or circuit conductor that is intentionally grounded.

**Neutral conductor** – a circuit conductor that normally carries current, and is connected to ground (earth) at the main electrical panel. The conductor of a 2-wire circuit connected to the supply neutral point and earth ground is referred to as the "neutral".

**Normal vision** – vision without any aid other than the examiner's normal corrective lenses, if any.

**Room temperature** – 25 ±10 °C (77 ±18 °F)

**Rope-lay-stranded conductor** – a conductor composed of groups of twisted strands having one or more layers.

**Thermoplastic** – a polymeric-based material that can be repeatedly softened by heating and hardened by cooling, and that in the softened state can be shaped through the application of force.

**Thermoplastic elastomer (TPE)** – a thermoplastic that complies with the deformation test in 5.1.3 for compound classes 14, 15, 16, 1.9, 1.10, 1.11 and the heat-shock resistance test in 5.1.8 for TPE materials.

**Thermoset** – a cross-linked polymeric-based material that will not soften to the point of flowing with subsequent application of heat.

**Ungrounded Conductor** – circuit conductor that is not connected to ground.

### 3.2 Units of measurement

The values given in SI (metric) units shall be normative. Any other values are for information only. Except for conductor sizes, the equivalent "inch/pound" values are in parentheses.

## 4 Construction Requirements

### 4.1 General construction requirements

These cables have a temperature rating of 60 °C – 105 °C dry and 60 °C wet; 300, 600 or 1000V AC and DC, employing oil-resistant and sunlight-resistant jacket suitable for use in wet locations.

#### 4.1.1 Conductors

##### 4.1.1.1 General

All conductors shall be stranded in accordance with Table 2.

##### 4.1.1.2 Material

Conductors shall be of annealed copper in compliance with ASTM B3 or NMX-J-036-ANCE, or annealed coated copper in compliance with ASTM B33 or NMX-J-008-ANCE.

##### 4.1.1.3 Size

4.1.1.3.1 The conductor size shall be determined by both items (a) and (b):

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

a) The cross-sectional area shall not exceed the maximum values given in Table 1. The cross-sectional area shall be determined in accordance with the method specified in the test, Cross-sectional area, by diameter method described in CAN/CSA-C22.2 No. 2556, UL 2556, or Annex C of NMX-J-066-ANCE. The diameter shall be determined in accordance with the method specified in the test, Conductor Diameter, described in CAN/CSA-C22.2 No. 2556, UL 2556, or NMX-J-066-ANCE.

b) The DC resistance of each uncoated copper or tin-coated copper conductor in a finished cable shall be as specified in Table 4, Table 5, Table 6, and Table 7. A plus tolerance of 2 percent shall be permitted in the case of a conductor in a twisted multiconductor construction having a single layer of conductors. For a twisted multiconductor construction having more than one layer, a plus tolerance of 3 percent shall be permitted. Compliance shall be determined in accordance with the test, DC Resistance, in CAN/CSA-C22.2 No. 2556, UL 2556, or NMX-J-212-ANCE. If results of any measurement in a twisted multiconductor product are not acceptable, the results of referee measurements made by using a straight specimen of the conductor from the cable without the plus tolerance shall be permitted.

4.1.1.3.2 The individual wires used in a stranded conductor are usually drawn to a specified diameter, which in some cases does not correspond with the diameter of any standard size. Not all of the individual strands of the completed conductor are required to have the same diameter.

#### 4.1.1.4 Joints

A joint or splice in one of the individual wires of a stranded conductor shall neither increase the diameter nor decrease the strength of the conductor or the individual wire. A joint or splice shall not be made in a stranded conductor as a whole. For rope-lay- stranded conductor construction, the splicing of a stranded member (primary group) as a unit shall be permitted provided that no joints are made closer than two lay lengths apart.

#### 4.1.1.5 Coating

If the conductor and insulation have been shown to be mutually compatible in accordance with 5.2.6, omission of the coating shall be permitted. Otherwise, if a separator is not provided over the conductor, all the individual wires of the conductor shall be separately tinned.

#### 4.1.1.6 Separator

4.1.1.6.1 When the conductor is neither coated nor shown to be mutually compatible with the insulation in accordance with 5.2.6, a separator as described in 4.1.1.6.3 shall be provided over the conductor.

4.1.1.6.2 A separator shall be permitted on other constructions, but is not required.

4.1.1.6.3 A separator, when provided, is not required to cover the conductor completely unless it is required in order to comply with the copper corrosion test specified in 5.2.6. It shall be of a color contrasting to that of the conductor, except clear or green or green/yellow shall not be permitted. The separator shall consist of

a) Close spiraling of fine fibrous yarn or tape;

b) Braid of fine fibrous yarn; or

c) Longitudinally applied tape.

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

#### 4.1.1.7 Stranding

##### 4.1.1.7.1 General

Flexible conductors shall be bunch-stranded or rope-lay-stranded and shall be composed of wires as shown in Table 2, except that conductors 13.3 $mm^2$ (6 AWG) and larger shall be rope-lay-stranded.

##### 4.1.1.7.2 Lay of strands

4.1.1.7.2.1 The length of lay of rope-stranded and bunch-stranded conductors shall be not greater than the values shown in Table 3, when tested in accordance with the test, Length of Lay (uncovered components), in CAN/CSA-C22.2 No. 2556, UL 2556, or NMX-J-516-ANCE. The direction of lay is not specified.

4.1.1.7.2.2 The length of lay of the individual strands comprising each bunch-stranded member in a rope-lay conductor shall be not more than 30 times the overall diameter of the member. The direction of lay of the individual strands comprising each bunch-stranded member is not specified.

4.1.1.7.2.3 For 8.37 $mm^2$ (8 AWG) and larger conductors with rope-lay-stranded conductors, the conductor shall be laid up as follows:

a) The length of lay of the outer layer of a rope-lay-stranded conductor shall be as specified in Table 3. The length of lay of other layers is not specified.

b) The length of lay of the individual strands comprising each concentric-lay - stranded member in a rope-lay conductor shall be neither less than 8 nor more than 16 times the outside diameter of the member. The direction of lay of the individual strands comprising each concentric-lay-stranded member is not specified. Bunch-stranded members shall be in accordance with 4.1.1.7.2.2.

4.1.1.7.2.4 The length of lay of the wires of a seven-strand 0.325 $mm^2$ (22 AWG) conductor shall be not less than 8 nor more than 16 times the overall diameter of the conductor.

#### 4.1.1.8 Equipment grounding (bonding) and grounded (neutral) conductors

4.1.1.8.1 For cable with conductor sizes 5.26 $mm^2$ (10 AWG) and smaller, the equipment grounding (bonding) conductor shall be the same size or larger than the largest circuit conductors.

4.1.1.8.2 For cable with conductor sized 6.63 $mm^2$ (9 AWG), the equipment grounding (bonding) conductor shall be 5.26 $mm^2$ (10 AWG) or larger.

4.1.1.8.3 For cable with conductor sizes 8.37 – 33.6 $mm^2$ (8 – 2 AWG), the reduction of the equipment grounding (bonding) conductor by not more than two AWG or equivalent $mm^2$ sizes from the largest ungrounded circuit conductor shall be permitted (e.g., a cable having an 8.37 $mm^2$ (8 AWG) ungrounded circuit conductor may have a minimum 5.26 $mm^2$ (10 AWG) equipment grounding (bonding) conductor).

4.1.1.8.4 For cable with conductor sizes larger than 33.6 $mm^2$ (2 AWG), the equipment grounding (bonding) conductor shall not be smaller than indicated in Table 25 and may be sectioned.

4.1.1.8.5 A grounded circuit conductor (oversized neutral) larger than the largest ungrounded circuit conductor shall be permitted.

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

### 4.1.2 Insulation

#### 4.1.2.1 General

4.1.2.1.1 The classes of insulation materials covered in this standard are shown in Table 8. The insulation shall be applied directly over the conductor or the separator if one is used; if applied in more than one layer of the same insulation grade or combination thereof, adjacent layers shall not be readily separable. The insulation shall be applied concentrically about the conductor. Insulation from one of the following three groups – PVC, TPE, or thermoset – may be interchanged within their groups from classes shown in Table 8 provided that the insulation materials to be substituted are included in the construction tables for use on the same product.

Higher temperature rated insulation materials may be substituted when a lower temperature rated insulation material is specified.

NOTE: Due to possible incompatibility, TPE material of the styrenic type is in some cases not suitable for use in cables where direct contact with PVC can occur. A separator is one acceptable means of avoiding direct contact. Other combinations of materials that could be incompatible, if any, have yet to be detected.

4.1.2.1.2 The classes, thickness, and required testing of insulation to be used on a particular type shall be as shown in Table 12. Insulation thickness of signal and communication conductors 0.824 $mm^2$ (18 AWG) and smaller shall comply with the requirements for 0.824 $mm^2$ (18 AWG) circuit conductors.

4.1.2.1.3 The minimum average and minimum thickness at any point of insulation shall be determined in accordance with the test Thickness in CAN/CSA-C22.2 No. 2556, UL 2556, or NMX-J-177-ANCE.

#### 4.1.2.2 New materials

Insulation materials that are generically different from those named in the index tables shown in Table 8 shall be evaluated for the requested temperature rating as described in 5.1.12. Investigation of the electrical, mechanical, and physical characteristics of the construction using the new material shall show comparable performance to the materials currently indicated for the application.

### 4.1.3 Covering

#### 4.1.3.1 General

The application of a covering over the insulation of individual conductors shall be permitted. When a covering is used, the requirements of 4.1.3.2 and 4.1.3.3 apply.

#### 4.1.3.2 Tapes

4.1.3.2.1 Tape shall not be used as the final outer covering.

#### 4.1.3.3 Nylon covering

An extruded nylon covering applied over the individual insulated conductors of jacketed cables shall have a minimum thickness of 0.05 mm (0.002 in) at any point or the insulation thickness and nylon thickness shall comply with the requirements in Table 12. The nylon-covered conductor shall comply with the bend test specified in 5.1.9.

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

### 4.1.4 Conductor assembly

#### 4.1.4.1 Lay of conductors

4.1.4.1.1 Cables shall have the individual conductors twisted together with a length of lay not greater than 15 times the overall diameter of the conductor assembly under the jacket. For multiple-layer cables, the conductors in each layer shall be twisted, but the lay is not specified, except that in the outer layer the lay shall be not more than 15 times the overall diameter of that layer.

4.1.4.1.2 When fiber optic member(s), data, communication, and/or signal cables are assembled with circuit conductors, they shall be cabled in the same direction and with the same length of lay as the circuit conductors. These cables may be individual(s) or pairs or groups and either shielded or unshielded and jacketed or unjacketed. The jacket, if present, shall meet the requirements of SV, SVE or SVT for wall thickness, tensile, elongation, heat shock, deformation, cold bend, jacket resistance, as applicable as described in CAN/CSA-C22.2 No. 49, UL 62, NMX-J-436-ANCE.

4.1.4.1.3 Length of lay shall be determined in accordance with the test, Length of Lay (covered components), in CAN/CSA-C22.2 No. 2556, UL 2556, or NMX-J-516-ANCE.

#### 4.1.4.2 Fillers

If fillers are used, they shall be of suitable material and shall be twisted with the individual conductors to form a compact assembly having an essentially circular cross-section.

#### 4.1.4.3 Binder

The application of a binder, consisting of a braid, tape, or wrap of suitable material over the conductor assembly, shall be permitted.

### 4.1.5 Shielding

4.1.5.1 A shield shall be permitted over one or more conductors or over the entire assembly under the jacket.

4.1.5.2 The shield shall be a braid of copper wires, copper wire wrapped shields, a metallized polyester tape with a drain wire, or a metal tape with or without a drain wire.

4.1.5.3 A braided or wrapped shield shall be composed of 0.013 $mm^2$ or 0.020 $mm^2$ (36 AWG or 34 AWG) copper wires for cables with conductors of 5.26 $mm^2$ (10 AWG) and smaller, and of 0.032 $mm^2$ or 0.051 $mm^2$ (32 AWG or 30 AWG) copper wires for cables with conductors larger than 5.26 $mm^2$ (10 AWG). If the shield wires and contacting compounds have been shown to be mutually compatible in accordance with 5.2.7, bare copper wires shall be permitted. Otherwise, if a separator is not provided, all the individual wires of the shield shall be separately tinned. The braided or wrapped shield shall provide a minimum coverage of 85 percent when calculated in accordance with Calculation of Coverage of Shielding – Annex G, in CAN/CSA C22.2 No. 2556, UL 2556, NMX-J-556-ANCE.

4.1.5.4 A laminated tape of polyester film and aluminum foil shall be applied longitudinally or helically so that it has at least a 1.52 mm (0.060 in) overlap. The total thickness of the tape shall be 0.038 mm (0.0015 in) minimum for cables with conductors 6.63 $mm^2$ (9 AWG) and smaller and 0.0635 mm (0.0025 in) for cables with conductors 8.37 $mm^2$ (8 AWG) and larger. The minimum size of drain wire shall be 0.325 $mm^2$ (22 AWG) seven-strand minimum tinned copper for cables with conductors 2.63 $mm^2$ (13 AWG) and smaller, 0.519 $mm^2$ (20 AWG) seven-strand minimum tinned copper for cables with conductors of 3.31 $mm^2$ to 6.63 $mm^2$ (12 – 9 AWG), and 0.824 $mm^2$ (18 AWG) seven-strand minimum tinned copper for

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

cables with conductors of 8.37 $mm^2$ (8 AWG) and larger. The drain wire shall be in contact with the aluminum.

4.1.5.5 Cables employing shields of different materials or constructions than those described in 4.1.5.3 and 4.1.5.4 shall be examined and tested in accordance with 5.2.8.

### 4.1.6 Jackets

#### 4.1.6.1 General

4.1.6.1.1 The classes, thickness, and required testing of jackets to be used on a particular type shall be as shown in Table 12.

4.1.6.1.2 The conductor assembly of the cable shall be covered by and properly centered within the jacket. The jacket shall be applied directly to the conductor assembly or binder, if one is used, and shall fill all the spaces, if any, around the conductor assembly.

4.1.6.1.3 Jackets with a total thickness of 1.52 mm (0.060 in) and greater may have a reinforcement consisting of an open weave or the like, placed between adjacent layers of the same class, that shall not be readily separable. Jackets with a total thickness of 2.41 mm (0.095 in) and greater may consist of separable or non-separable adjacent layers of the same class. If separable, the outside layer shall be at least 50 percent of the total thickness measured. If applied in more than one layer, both layers shall be of the same class. Adjacent layers shall not be readily separable when the total jacket thickness is less than 2.41 mm (0.095 in).

4.1.6.1.4 The jacket on a cable containing at least one conductor larger than 33.6 $mm^2$ (2 AWG) shall be reinforced by a tape, two servings, or braid of natural or synthetic material. If two servings are used, they shall be applied in opposite directions of lay. The reinforcing layer shall be under the single layer jacket, or between the layers of the two-layered construction. The total jacket thickness shall be in accordance with Table 23 and Table 24.

4.1.6.1.5 All jackets shall provide an essentially circular cross-section for the finished cable. The classes of jacket are shown in Table 10.

4.1.6.1.6 The minimum average and minimum thickness at any point of the jacket shall be determined in accordance with the test Thickness in CAN/CSA-C22.2 No. 2556, UL 2556, or NMX-J-177-ANCE.

#### 4.1.6.2 Interchangeable jackets

Jackets in the PVC, TPE, and thermoset groups may be interchanged within their group from classes shown in Table 10 provided that the material to be substituted is included in the construction tables for use on the same product type having a higher temperature rating.

NOTE: Due to possible incompatibility, TPE material of the styrenic type is in some cases not suitable for use in cables where direct contact with PVC can occur. A separator is one acceptable means of avoiding direct contact. Other combinations of materials that could be incompatible, if any, have yet to be detected.

#### 4.1.6.3 New materials

Jacket materials that are generically different from those named in the index tables shown in Table 10, if selected for use, shall be evaluated for the requested temperature rating as described in 5.1.12. Investigation of the electrical, mechanical, and physical characteristics of the construction using the new material shall show comparable performance to the materials indicated for the application.

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.

### 4.1.7 Coiled cables

4.1.7.1 Coiled cables shall comply with the requirements specified for the standard construction and, except as noted in 4.1.7.2, all tests and measurements shall be conducted on specimens obtained from the straight ends at each end of the coiled portion of the cable.

4.1.7.2 The dielectric strength test of 5.2.2 shall be conducted on the entire length of the coiled cable. The mechanical strength test of 5.1.4 shall be conducted on the coiled portion of the cable. The minimum average thickness of the jacket on the coiled portion of round cables shall be not less than the applicable value given in this standard.

### 4.1.8 Method of distinguishing conductors

4.1.8.1 Conductors shall be distinguished as follows:

a) Grounded (neutral) conductors shall be distinguished by one of the following methods, and these colors shall be restricted to such use:

1) White or grey colored braid;

2) White or grey colored insulation;

b) Bonding / Equipment Grounding conductors shall be distinguished by the color green or a combination of the colors green and yellow. On a bonding / equipment grounding conductor colored green, one or more yellow stripes that cover no less than 5 percent and not more than 70 percent of the calculated circumference of the finished conductor insulation shall be permitted.

4.1.8.2 The use of a thin, non-separable colored coating of a suitable material that is compatible with the insulation over the surface of the insulation on the individual conductors, in lieu of colored insulation, shall be permitted.

### 4.1.9 Support members

4.1.9.1 The incorporation of a supporting member(s) in the center or cabled with conductors shall be permitted. Supporting members of metallic, nonmetallic, fibrous, or other suitable material shall be permitted.

4.1.9.2 When metal is used, the support member shall consist of a flexible, stranded metal that is insulated with the same grade and thickness of insulation as used on the circuit conductors and surface marked “support member” at intervals of 1 m (39 in). The color of the insulation shall not be white, grey, green or green with yellow stripe.

4.1.9.3 The overall jacket shall be marked to show that a metal support member is present (see 6.2.4(c)).

### 4.1.10 Optical fiber members

4.1.10.1 Cables may have optical fiber members incorporated in their construction.

4.1.10.2 The cables containing fiber optic members shall comply with all of the requirements for the standard construction of these cables. The optical fiber members shall be cabled with the insulated conductors. See 4.1.4.1.2.

4.1.10.3 Optical fiber members shall not contain any current-carrying or electrically conductive elements and may contain nonmetallic strength members.

ULSE INC. COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM ULSE INC.