UL 486D

STANDARD FOR SAFETY

Sealed Wire Connector Systems

UL Standard for Safety for Sealed Wire Connector Systems, UL 486D

Sixth Edition, Dated June 19, 2015

Summary of Topics

Revision pages have been issued for the Standard for Safety for Sealed Wire Connector Systems, UL 486D, to incorporate the following:

- ***Sealed wire connector systems rated 601 - 1500 V***
- ***Standard scope clarification***
- ***Sunlight resistance / salt water immersion***

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 July 14, 2017.

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NMX-J-519-ANCE
Third Edition

Canadian Standards Association
CSA C22.2 No. 198.2
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Sixth Edition

Sealed Wire Connector Systems

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ANSI/UL 486D-2017

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 Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA Group, or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, 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. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA Group and UL pages.

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This Standard is subject to review 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.

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This ANSI/UL Standard for Safety consists of the Sixth Edition. The most recent designation of ANSI/UL 486D as an American National Standard (ANSI) occurred on October 20, 2017. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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PREFACE

This is the harmonized ANCE, CSA Group, and UL standard for sealed wire connector systems. It is the third edition of NMX-J-519-ANCE, the third edition of CSA C22.2 No. 198.2, and the sixth edition of UL 486D. This edition of NMX-J-519-ANCE supersedes the previous edition published in 2006. This edition of CSA C22.2 No. 198.2 supersedes the previous edition published in 2005. This edition of UL 486D supersedes the previous edition published in 2005.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Committee for Connectors, THC 99, 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 Subcommittee on C22.2 No. 198.2, 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 approved by the American National Standards Institute (ANSI) as an American National Standard.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number shall 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 shall it be considered equivalent to, an IEC standard. This standard is published as an equivalent standard for ANCE, CSA, 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 sealed wire connector systems. 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.

1 Scope

1.1 The requirements in this standard cover sealed wire connector systems, including insulating caps, covers, resins, tubing, and tapes provided with, or for use with, specific wire connectors. These systems are intended for wet or damp locations, and other installations such as direct burial, below grade, or above grade where protected from direct exposure to sunlight. The wire connectors covered by these requirements are intended for use with copper conductor, aluminum conductor, or both in accordance with installations covered by the National Electrical Code, NFPA 70; the Canadian Electrical Code, Part I, C22.1; and NOM 001 SEDE, Standard for Electrical Installations.

Note 1: Unless marked for the purpose, these wire connector systems have not been evaluated for direct exposure to sunlight. Additional performance considerations to show equivalency to the connected conductors should be considered for UV exposure.

Note 2: These wire connector systems have only been evaluated for fresh water unless marked for direct exposure to salt or seawater.

Note 3: These wire connector systems may also be used indoors.

1.2 These requirements also cover sealed wire connector systems intended for use with single or multiple conductor underground feeder cable, golf course sprinkler cable, underground low energy cable, irrigation cable, or other cable with insulation acceptable for direct burial, below grade use, or wet locations.

1.3 These requirements apply to sealed wire connector systems intended for use with 30 AWG (0.05 mm^2) through 2,000 kcmil (1,012 mm^2) conductors with currents not exceeding the ampacity of insulated conductors rated either 75°C (167°F) or 90°C (194°F) and intended for use at 1500 V or less.

1.4 This standard does not apply to twist-on style splicing sealed wire connectors.

2 Reference publications

2.1 Undated and dated references

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

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

2.2 Normative references

2.2.1 ANCE Standards

NMX-J-543-ANCE-13
Wire Connectors

NMX-J-548-ANCE-13
Splicing Wire Connectors

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

2.2.2 CSA Standards

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

C22.1-15
Canadian Electrical Code, Part I

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

C22.2 No. 65-13
Wire Connectors

C22.2 No. 188-13
Splicing Wire Connectors

2.2.3 UL Standards

UL 486A-486B
Wire Connectors

UL 486C
Splicing Wire Connectors

2.2.4 ASTM Standards (American Society for Testing and Materials)

ASTM G21-13
Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

ASTM G151-10
Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

ASTM G153-13
Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

ASTM G155-13
Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

2.2.5 NEMA Standards (National Electrical Manufacturers Association)

ANSI C119.1-2011
American Standard for Electric Connectors – Sealed Insulated Underground Connector Systems Rated 600 Volts

2.2.6 NFPA Standards (National Fire Protection Association)

ANSI/NFPA 70-2014
National Electrical Code (NEC)

2.2.7 NOM Standards (Mexican Secretary of Energy)

NOM-001-SEDE
Standard for Electrical Installations

3 Units of measurement

3.1 The dimensional values given in SI (metric) units shall be normative. Any other values provided in parenthesis are for information purposes only.

3.2 Conductor sizes expressed in AWG/kcmil units shall be normative. Conductor sizes expressed in mm^2 are for information only and represent a soft conversion of AWG/kcmil wire sizes. These wire sizes in mm^2 do not typically exist.

Note: 4 AWG (21.2 mm^2) – A typical commercially available wire size would be 25 mm^2, not 21.2 mm^2.

4 Definitions

4.1 Connector – a device for connecting a conductor to an equipment terminal or for connecting two or more conductors to each other.

4.2 Fresh water – water generally drawn from lakes, streams, or underground sources and delivered by a private well or a municipality for industrial, commercial, or household use.

4.3 Salt treated water – fresh water treated with salt for sanitation purposes, which is considered fresh water for the purposes of this standard.

4.4 Sea water – salt water generally found in seas and oceans.

4.5 Sealed wire connector system – a connector and its associated insulating and sealing components.

5 Symbols and abbreviations

5.1 ° – Degree

5.2 A – Amps, Amperes

5.3 Al – Aluminum

5.4 AWG – American Wire Gage

5.5 C – Celsius

5.6 Cu – Copper

5.7 d – Days

5.8 h – Hour

5.9 Hz – Hertz, cycles per second

5.10 in – Inches

5.11 kcmil – Thousand circular mils

5.12 m – Meter

5.13 mil – Thousandth of an inch

5.14 min – Minutes

5.15 mL – Milliliter

5.16 mm – Millimeter

5.17 mm^2 – Square millimeter

5.18 N – Newton – kilogram meter/sec^2

5.19 sol – Solid

5.20 str – Stranded

5.21 V – Volts

6 Construction

6.1 Wire connectors

6.1.1 Wire connectors shall comply with UL 486A-486B, CSA C22.2 No. 65, or NMX-J-543-ANCE; or with UL 486C, CSA C22.2 No. 188, or NMX-J-548-ANCE, as applicable.

6.2 Insulation

6.2.1 Material used in the outer cover to insulate a sealed wire connector system shall be resistant to fungi attack. Materials not known to be resistant to fungi shall comply with Level 0 or 1. A natural, organic fiber such as cotton, paper, jute, or hemp shall not be used. Materials known to be resistant to fungi, such as polypropylene, polyvinyl chloride, EPDM rubber, or glass, need not be investigated for fungi resistance.

In the United States and Canada ANSI/ASTM G21 shall be used to determine compliance.

In Mexico a national standard to evaluate the fungi attack does not exist. It is recommended that ANSI/ASTM G21 be used as a supplemental document in performing the evaluation.

7 Test requirements

7.1 General

7.1.1 A wire connector used in a sealed wire connector system shall comply with the performance tests, described in UL 486A-486B, CSA C22.2 No. 65, or NMX-J-543-ANCE; or in UL 486C, CSA C22.2 No. 188, or NMX-J-548-ANCE, as applicable.

7.1.2 A sealed wire connector system shall be subjected to all of the tests in Table 1 and to any additional test sequences in Table 2, as applicable (see 10.3). After subjecting the assemblies to a test sequence, the insulating properties of the covers or the like shall not be adversely affected as determined by the specified tests.

Note: A sealed wire connector system test assembly is hereafter abbreviated as an assembly or assemblies.

7.1.3 A sealed wire connector system, such as a cap, cover, shrinkable tubing, or the like, not provided with a wire connector, shall be tested using the specified wire connector. See additional marking in 10.4.

7.2 Test sequence A, General

7.2.1 Insulation resistance

7.2.1.1 The initial insulation resistance of a sealed wire connector system shall not be less than 6 MΩ.

7.2.1.2 Following any conditioning and tests specified within the sequences, the repeated insulation resistance (other than the initial insulation resistance; see 7.2.1.1) of a sealed wire connector system shall be greater than the lesser of:

a) 90 percent of the initial insulation resistance; or

b) 1 GΩ.

7.2.2 Dielectric withstand

7.2.2.1 A sealed wire connector system shall withstand the applied voltage without breakdown.

7.2.3 Leakage current

7.2.3.1 The leakage current through a sealed wire connector system shall not exceed 1 mA.

7.3 Test sequence B, shelf aging

7.3.1 Following the conditioning and tests within the sequence, the insulation resistance of a sealed wire connector system shall not be less than 6 MΩ.

7.4 Test sequence C, use aging

7.4.1 Following the conditioning and tests specified within the sequence, the insulation resistance of a sealed wire connector system shall be greater than the lesser of:

a) 90 percent of the initial resistance recorded for Sequence A; or

b) 1 GΩ.

7.5 Test sequence D, direct burial

7.5.1 A sealed wire connector system marked for “direct burial” [see 10.3(a)] shall additionally be subjected to the direct burial sequence.

7.5.2 Following the conditioning and tests within this sequence, a sealed wire connector system shall withstand the applied voltage without breakdown.

7.6 Test sequence E, rain

7.6.1 A sealed wire connector system marked as “Raintight” [see 10.3(b)] shall additionally be subjected to the rain sequence.

7.6.2 Following the conditioning and tests in this sequence, a sealed wire connector system shall withstand the applied voltage without breakdown.

7.7 Test sequence F, hosedown

7.7.1 A sealed wire connector system marked as “Watertight” [see 10.3(c)] shall additionally be subjected to the hosedown sequence.

7.7.2 Following the conditioning and tests in this sequence, a sealed wire connector system shall withstand the applied voltage without breakdown.

7.8 Test sequence G, submersion

7.8.1 A sealed wire connector system marked as “Submersible” [see 10.3(d)] shall additionally be subjected to the submersion sequence.

7.8.2 Following the conditioning and tests in this sequence, a sealed wire connector system shall withstand the applied voltage without breakdown.

7.9 Test sequence H, weather (sunlight) resistance

7.9.1 A sealed wire connector system marked as Sunlight resistant (Sun–Res) shall be additionally subjected to the sunlight sequence [see 10.3(e)].

7.9.2 Following the conditioning and tests in this sequence, a sealed wire connector system shall withstand the applied voltage without breakdown.

7.10 Salt water immersion test

7.10.1 A sealed wire connector system marked as ″Salt water resistant″, ″Sea water- Res″, or equivalent shall be additionally subjected to the salt water sequence [see 10.3(f)].

7.10.2 Following any conditioning and tests specified within the sequences, the repeated insulation resistance (other than the initial insulation resistance; see 7.2.1.1) of a sealed wire connector system shall be greater than the lesser of:

a) 90 percent of the initial insulation resistance; or

b) 1 GΩ.

7.10.3 Following the conditioning and tests in this sequence, a sealed wire connector system shall withstand the applied voltage without breakdown.

8 Sampling requirements

8.1 General

8.1.1 The term ″maximum size wire″ refers to the maximum wire size for a range-taking connector and refers to the maximum circular mil area for a connector rated for multiple wire combinations.

8.1.2 The term ″minimum size wire″ refers to the minimum wire size for a range-taking connector and refers to the minimum circular mil area for a connector rated for multiple wire combinations.

8.1.3 For a sealed wire connector system having multiple cutoff rings consisting of different sizes, the following rings shall be tested:

a) the largest and the smallest sizes, if the number of cutoff rings consists of four sizes or less;

b) the largest, smallest, and one intermediate size, if the number of cutoff rings consist of five sizes; or

c) the largest, smallest, and two intermediate sizes, if the number of cutoff rings consists of more than five sizes.

8.2 Test sequence A, general

8.2.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire, and the six assemblies shall be subjected to this test sequence.

8.3 Test sequence B, shelf aging

8.3.1 Three assemblies shall be prepared with the maximum size wire and shall be subjected to this test sequence.

8.4 Test sequence C, use aging

8.4.1 Three assemblies shall be prepared with the maximum size wire and shall be subjected to this test sequence.

8.5 Test sequence D, direct burial

8.5.1 Twelve assemblies shall be prepared with the maximum size wire and shall be subjected to this test sequence.

8.6 Test sequence E, rain

8.6.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire, and the six assemblies shall be subjected to this test sequence.

8.7 Test sequence F, hosedown

8.7.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire, and the six assemblies shall be subjected to this test sequence.

8.8 Test sequence G, submersion

8.8.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire, and the six assemblies shall be subjected to this test sequence.

8.9 Test sequence H, sunlight resistance

8.9.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire.

8.10 Test sequence I, salt water

8.10.1 Three assemblies shall be prepared with the maximum size wire and three assemblies shall be prepared with the minimum size wire.

9 Test methods

9.1 General

9.1.1 New assemblies shall be used for each test sequence.

Note: With the concurrence of those concerned, test assemblies may be reused for different test sequences.

9.1.2 The preparation of the connector shall be as specified in 10.5(a) and in accordance with UL 486A-486B, CSA C22.2 No. 65, or NMX-J-543-ANCE; or in accordance with UL 486C, CSA C22.2 No. 188, or NMX-J-548-ANCE, as applicable.

9.1.3 The associated insulating and sealing components shall be assembled in accordance with the manufacturer's instructions. See 10.5(b).

9.1.4 For conductors 14 AWG and larger, the conductor shall be Type RHW, USE, XHHW, RW90 EP, RW90 XLPE, TWU or one of the other types specified in 1.2. See 10.6. For conductors 16 AWG and smaller, the conductor insulation shall be thermoplastic at least 0.76 mm (0.030 in) thick.

9.2 Test sequence A, general

9.2.1 Immersion

9.2.1.1 The assemblies shall be immersed in a tank that contains tap water at a temperature of 25 ±5°C (77 ±9°F) for 24 h. All parts of the assemblies shall be immersed to a minimum depth of 305 mm (1 ft).

9.2.2 Insulation resistance

9.2.2.1 While still immersed, the insulation resistance of each assembly shall be measured by applying a minimum direct-current voltage of 500 V for 1 min. The length of the immersed conductor shall be constant. The total length of the immersed conductors along with each connector assembly shall not exceed 2.4 m (8 ft). The conductor/assembly shall be connected to the positive side of the dc voltage and the electrode in the tap water connected to the negative side. If the tracking distance from the end of the conductor to the water surface is short, a guarded circuit may be used. See Annex B.

9.2.3 Dielectric withstand

9.2.3.1 Immediately after the insulation resistance test and while still immersed, each assembly rated 600 V shall be subjected to a 2200 V, 60 Hz potential for 1 min. The potential shall be applied between the conductor/assembly and the water.

9.2.3.2 The dielectric withstand test value for sealed wire connector systems rated 601 – 1500 volts shall be 2000 volts, 60 HZ, plus 2.25 times maximum rated voltage.

9.2.4 Heat conditioning

9.2.4.1 Following the dielectric withstand test, the assemblies shall be removed from the water and conditioned in an air-circulating oven at a temperature of 90 ±5°C (194 ±9°F) for 72 h. With the concurrence of those concerned, the test values may be increased to 113 ±5°C (235 ±9°F) for 168 h (see note in 9.4).

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9.2.5 Flexing and twisting

9.2.5.1 Following the heat-conditioning, the assemblies shall be removed from the air-circulating oven and allowed to cool to room temperature. Each seal formed by the insulation cover and the conductor insulation shall be subjected to this test. The insulated conductor shall be securely clamped at a distance (H) equal to:

a) 25 times the diameter of the insulated conductor for 4 AWG (21.2 mm^2) or smaller sizes; or

b) 15 times the diameter for sizes larger than 4 AWG (21.2 mm^2).

The distance shall be measured from the end of the clamp to the seal formed by the insulation cover and the conductor insulation. The assembly shall be bent 90 degrees to one side and returned to the starting position, and then bent 90 degrees in the opposite direction and returned to the starting position. This cycle shall be repeated nine more times. Figure 1 illustrates a typical test assembly for a splicing-type connector. Figure 3 illustrates a typical test assembly for a terminal-type connector.

9.2.5.2 For each end of the sample (for each seal), immediately following the flexing test and with the conductor still clamped as described in 9.2.5.1, each assembly shall be twisted about the axis of the conductor 15 degrees clockwise from the starting position and returned to the starting position; then twisted 15 degrees counterclockwise and returned to the starting position. This cycle shall be repeated four more times. Figure 2 illustrates a typical test assembly for a splicing-type connector. Figure 3 illustrates a typical test assembly for a terminal-type connector.

9.2.5.3 Immediately following the flexing and twisting tests, the assemblies shall be subjected to repeated immersion and insulation resistance tests described in 9.2.1 and 9.2.2.

9.2.6 Cold conditioning

9.2.6.1 Immediately following the immersion and insulation resistance tests, the assemblies shall be removed from the water and conditioned at a temperature of minus 18 ±2°C (0 ±4°F) for 4 h.

9.2.6.2 Within 15 min after removal from the cold conditioning, the assemblies shall be subjected to repeated flexing and twisting tests as described in 9.2.5.

9.2.6.3 Immediately following the flexing and twisting tests, the assemblies shall be subjected to repeated immersion and insulation resistance tests.

9.2.7 Current cycle and water immersion

9.2.7.1 Following the immersion and insulation resistance tests, the assemblies shall be subjected to 50 cycles of heating and cooling. The insulation resistance shall be measured after the 25th and 50th cooling period.

9.2.7.2 For the heating portion of each cycle, the assemblies shall be suspended in air and subjected to a continuous current for 1 h. The current shall correspond to the static-heating test current for the wire size and shall be selected from UL 486A-486B, CSA C22.2 No. 65, or NMX-J-543-ANCE; or from UL 486C, CSA C22.2 No. 188, or NMX-J-548-ANCE, as applicable.

9.2.7.3 At the end of 1 h, the current shall be terminated and within 3 min the assemblies shall be subjected to a cooling period by immersion of the assemblies in water at a temperature of 25 ±5°C (77 ±9°F) at a minimum depth of 305 mm (1 ft) for not less than 30 min.

9.2.8 Dielectric withstand

9.2.8.1 Following the 50th cooling period and while still immersed, the assemblies shall be subjected to a repeated dielectric withstand test.

9.2.9 Leakage current

9.2.9.1 Following the dielectric withstand test and while still immersed, assemblies rated 600 V shall be subjected to a 600 V, 60 Hz potential between the water and conductor/assembly and the resulting leakage current measured.

9.2.9.2 Following the dielectric withstand test and while still immersed, assemblies rated 601 – 1500 V shall be subjected to a test voltage of the rated voltage potential (at 60 Hz) between the water and conductor/assembly and the resulting leakage current measured.

9.3 Test sequence B, shelf aging

9.3.1 Heat conditioning before assembly, flexing and twisting

9.3.1.1 The individual components of three assemblies shall first be conditioned in a circulating air oven at:

a) 40 ±3°C (104 ±5°F) for 1440 h; or

b) 65 ±3°C (149 ±5°F) for 240 h.

9.3.1.2 After being allowed to cool to room temperature, the components shall be assembled to the maximum size wire using the assembly information in 10.5. The assemblies shall then be subjected to the flexing and twisting test (9.2.5), followed by the immersion (9.2.1), and insulation-resistance (9.2.2) tests.

9.4 Test sequence C, use aging

Note: Sequence C need not be conducted when the heat conditioning specified in Sequence A is performed at 113°C (235°F) for 168 h; see 9.2.4.1.

9.4.1 Heat conditioning, immersion and insulation resistance

9.4.1.1 The assemblies shall be prepared with the maximum size wire using the assembly information in 10.5. The assemblies shall then be conditioned in an air-circulating oven at:

a) 113 ±5°C (235 ±9°F) for 168 h; or

b) 81 ±3°C (178 ±5°F) for 1440 h.

9.4.1.2 After being removed from the oven, the assemblies shall be allowed to cool to room temperature. The assemblies shall then be subjected to the immersion and insulation resistance tests described in 9.2.1 and 9.2.2.

9.5 Test sequence D, direct burial

9.5.1 Heat and cold conditioning

9.5.1.1 The assemblies shall be prepared so that a minimum of 76 mm (3 in) of conductor extends from the ends of the seal formed by the insulation cover and the conductor insulation. Six assemblies shall be oven conditioned as specified in 9.4.1.1. The other six assemblies shall be cold conditioned at minus 10 ±2°C (14 ±4°F) for 2 h.

9.5.2 Impact

9.5.2.1 No assembly shall be subjected to more than one impact. The assemblies shall be placed on a concrete surface.

9.5.2.2 The assemblies that have been cold conditioned shall be subjected to the impact test within 2 min of removal from the cold chamber.

9.5.2.3 The impact test shall consist of dropping a steel sphere, 51 mm (2 in) in diameter and with a mass of 0.54 kg (1.18 lb), onto the assembly from a height of 914 mm (3 ft). Three assemblies subjected to cold conditioning and three assemblies subjected to the heat conditioning shall be impacted on the weakest wall, generally the thinnest wall section. The three remaining assemblies subjected to cold conditioning and the three remaining assemblies subjected to the heat conditioning shall be impacted at the seal formed by the insulation cover and the conductor insulation. See Annex A for a typical impact test apparatus.

9.5.3 Immersion

9.5.3.1 Following the impact test, the assemblies shall be immersed to a minimum depth of 305 mm (1 ft) in tap water at 25 ±5°C (77 ±9°F) for 4 h.

9.5.4 Dielectric withstand

9.5.4.1 Following the impact test and while still immersed, the assemblies shall be subjected to a dielectric withstand test as specified in 9.2.3.

9.6 Test sequence E, rain

9.6.1 Rain

9.6.1.1 The components shall be assembled in accordance with the manufacturer's instructions in 10.5. The assembly shall be positioned in the focal area of the spray heads so that the greatest quantity of water is likely to enter the assembly. The assembly shall be exposed to the water spray for 1 h.

9.6.1.2 The water-spray-test apparatus shall consist of three spray heads mounted in a water supply pipe rack as shown in Figure 4. Spray heads shall be constructed in accordance with the details shown in Figure 5. The water pressure shall be maintained at 34.5 kPa (5 lb/in^2) at each spray head.

9.6.1.3 The water spray shall produce a uniform spray over the entire assembly. The various surfaces of the assembly shall be tested separately or collectively, provided that a uniform spray is simultaneously applied to both the top surfaces and the floor outside the assembly for a distance of approximately 914 mm (3 ft) in front of the assembly.

9.6.2 Immersion

9.6.2.1 Following the rain test, the assemblies shall be immersed to a minimum depth of 305 mm (1 ft) in tap water at 25 ±5°C (77 ±9°F) for a minimum of 5 min.

9.6.3 Dielectric withstand

9.6.3.1 Following the rain test and while immersed, the assemblies shall be subjected to a dielectric withstand test as specified in 9.2.3.

9.7 Test sequence F, hosedown

9.7.1 Hosedown

9.7.1.1 The components shall be assembled in accordance with the manufacturer's instructions in 10.5. The assembly shall be sprayed by water from a hose having a 25 mm (1 in) inside diameter nozzle that delivers at least 246 L (65 gallons) of water per min. The water stream shall be directed at the assembly from a distance of 3.0 – 3.7 m (10 – 12 ft) and shall be moved along the seals or surface at a minimum rate of 1.6 sec/cm (4 sec/in). The duration of the water stream contact with the assembly shall be 5 min.

9.7.2 Immersion

9.7.2.1 Following the hosedown test, the assemblies shall be immersed to a minimum depth of 305 mm (1 ft) in tap water at 25 ±5°C (77 ±9°F) for a minimum of 5 min.

9.7.3 Dielectric withstand

9.7.3.1 Following the hosedown test and while still immersed, the assemblies shall be subjected to a dielectric withstand test as specified in 9.2.3.

9.8 Test sequence G, submersion

9.8.1 Submersion test

9.8.1.1 The components shall be assembled in accordance with the manufacturer's instructions in 10.5. The assembly shall be submersed in a tank filled with tap water for 30 min. The highest point on the assembly shall be 1.8 m (6 ft) below the surface of the water.

9.8.2 Dielectric withstand

9.8.2.1 While still immersed, the assemblies shall be subjected to a dielectric withstand test as specified in 9.2.3.

9.9 Test sequence H, sunlight resistance test

9.9.1 General

9.9.1.1 A sealed wire connector system assembly shall be conditioned for 1000 hours using the apparatus in (a) or (b) below and be subjected to the requirements of Clause 9.9.2 and 9.9.3.

a) Xenon-arc: Xenon-arc radiation and water-spray exposure equipment shall comply with ASTM G151 and ASTM G155 or NMX-J-553-ANCE. The specimens shall be mounted in the specimen holders of the equipment. The xenon-arc apparatus shall be provided with a Daylight Filter. The spectral power distribution (SPD) shall conform to the requirements of ASTM G155, Table 1, for a xenon lamp with a Daylight Filter. Operation of the lamp assembly shall maintain a level of spectral irradiance at the specimens of at least 0.35 W/m^2 monitored at a wavelength of 340 nm.

Carbon-arc: The apparatus shall comply with ASTM G151 and ASTM G153 or NMX-J-553-ANCE. The apparatus shall include twin arcs struck between two sets of vertical carbon electrodes that are 13 mm (1/2 inch) in diameter and are individually enclosed in clear globes of heat-resistant optical glass (9200-PX Pyrex glass or its equivalent) that is opaque at

wavelengths shorter than 275 nm (1 % transmission at 275 nm as the nominal cutoff point) and whose transmission improves to 91 % at 370 nm. The spectral power distribution of the emission from the globes shall comply with Table 1 of ASTM G153 or NMX-J-553-ANCE;

9.9.2 Impact

9.9.2.1 The assembly shall be subjected to no more than one impact. The assembly shall be placed on a concrete surface.

9.9.2.2 The assemblies that have been sunlight conditioned shall be subjected to the impact test within 2 min of removal from the cold chamber.

9.9.2.3 The impact test shall consist of dropping a steel sphere, 51 mm (2 in) in diameter and with a mass of 0.54 kg (1.18 lb), onto the assembly from a height of 914 mm (3 ft). Three assemblies subjected to sunlight conditioning and three assemblies subjected to the heat conditioning shall be impacted on the weakest wall, generally the thinnest wall section. The three remaining assemblies subjected to cold conditioning and the three remaining assemblies subjected to the heat conditioning shall be impacted at the joint where the conductor insulation meets the sealed wire connector system. See Annex A for a typical impact test apparatus.

9.9.3 Immersion

9.9.3.1 Following the impact test, the assemblies shall be immersed to a minimum depth of 305 mm (1 ft) in tap water at 25 ±5°C (77 ±9°F) for 4 h.

9.9.4 Dielectric withstand

9.9.4.1 Following the impact test and while still immersed, the assemblies shall be subjected to a dielectric withstand test as specified in 9.2.3.

9.10 Test sequence I, salt water resistant

9.10.1 General

9.10.1.1 A complete sealed wire connection system shall be immersed in a 20% (by weight) solution of common salt (sodium chloride) and water at 60 ±1°C (140 ±1.8°F) for 1 h and an initial insulation resistance measurement shall be taken per Clause 9.10.2.

9.10.1.2 The complete sealed wire connection system shall continue to be immersed for 100 h and while still immersed in the solution the system shall be subjected to Clauses 9.10.2 and 9.10.3.

9.10.2 Insulation resistance

9.10.2.1 While still immersed, the insulation resistance of each assembly shall be measured by applying a minimum direct-current voltage of 500 V for 1 min. The length of the immersed conductor shall be constant. The total length of the immersed conductors along with each connector assembly shall not exceed 2.4 m (8 ft). The conductor/assembly shall be connected to the positive side of the dc voltage and the electrode in the tap water connected to the negative side. If the tracking distance from the end of the conductor to the water surface is short, a guarded circuit may be used. See Annex B.

9.10.3 Dielectric withstand

9.10.3.1 Immediately after the insulation resistance test and while still immersed, each assembly shall be subjected to a 2200 V, 60 Hz potential for 1 min. The potential shall be applied between the conductor/assembly and the water.

10 Marking, labeling, and packaging

10.1 A sealed wire connector system shall be marked with the:

a) manufacturer's name or trademark;

b) catalog number;

c) wire range or wire combinations;

Note: Devices with multiple wire ranges, e.g., cutoff rings, are to clearly identify the wire range for each cutoff ring.

d) voltage rating;

e) operating temperature rating;

f) following wording: "For use in wet or damp locations"; and

g) special conductor types (see 10.6).

10.2 The markings in 10.1, 10.3, 10.4, 10.5, and 10.6 shall be on any of the following:

a) all parts that comprise the system;

b) the packaging carton;

c) the unit container; or

d) the information sheet provided in each unit container.

10.3 A sealed wire connector system may be additionally marked:

a) “Direct Burial”, if the system complies with the requirements for the direct burial sequence in 7.5;

b) ″Raintight″, if the system complies with the requirements for the rain sequence in 7.6;

c) ″Watertight″, if the system complies with the requirements of the hosedown sequence in 7.7; or

d) ″Submersible″, if the system complies with the requirements of the submersion sequence in 7.8;

e) ″Sun-Res″ or ″Sunlight resistant″ or equivalent, if the system complies with Clause 7.9;

f) ″Salt Water resistant″ or ″Sea Water resistant″ or equivalent, if the system complies with Clause 7.10; and

g) Sealed wire connectors meeting both Clauses 7.9 and 7.10 may be marked ″Sun-Salt Res″ or equivalent.

10.4 A sealed wire connector system not provided with a wire connector in the same unit container shall include a statement that the sealed wire connector system is intended to be used only with certified wire connectors and shall be marked with one or more of the following:

a) the wire connector manufacturer’s name or trademark and the catalog number of the specific wire connector intended to be used;

b) the physical dimensions of a specific wire connector intended to be used; or

c) the minimum and maximum envelope dimensions of any wire connector intended to be used.

10.5 In addition to the marking information specified in 10.1 – 10.4, the system shall be marked with:

a) all required wire connector markings and assembly information; and

b) complete assembly instructions for the sealed wire connector system.

10.6 A sealed wire connector system tested with the conductor types used for the applications specified in 1.2 (see 9.1.4) shall also be marked with those conductor types in the same location as the other markings specified in 10.1.

Table 1 – Required test sequences (Clause 7.1.2)

A – General[+]	B – Shelf Aging	C – Use Aging[++]
Immersion	Heat condition before assembly	Heat conditioning
Insulation resistance (initial)	Flexing and twisting	Immersion
Dielectric withstand	Immersion	Insulation resistance
Heat conditioning	Insulation resistance	
Flexing and twisting		
Immersion		
Insulation resistance (repeated)		
Cold conditioning		
Flexing and twisting		
Immersion		
Insulation resistance (repeated)		
Current cycle and water immersion		
Insulation resistance (repeated)		
Dielectric withstand		
Leakage current		
[+] Test sequence A is based on ANSI C119.1.		
[++] See 9.4 note.		

Table 2 – Additional test sequences (Clause 7.1.2)

D Direct Burial	E Rain	F Hosedown	G Submersion	H Sunlight	I Salt Water
Heat and cold conditioning	Rain	Hosedown	Submersion	Weather conditioning	Insulation resistance (initial)
Impact	Immersion	Immersion	Dielectric withstand	Impact	Salt water immersion
Immersion	Dielectric withstand	Dielectric withstand		Immersion	Insulation resistance (repeated)
Dielectric withstand				Dielectric	Dielectric

Figure 1 – Flexing test for splicing-type connector

(Clause 9.2.5.1)

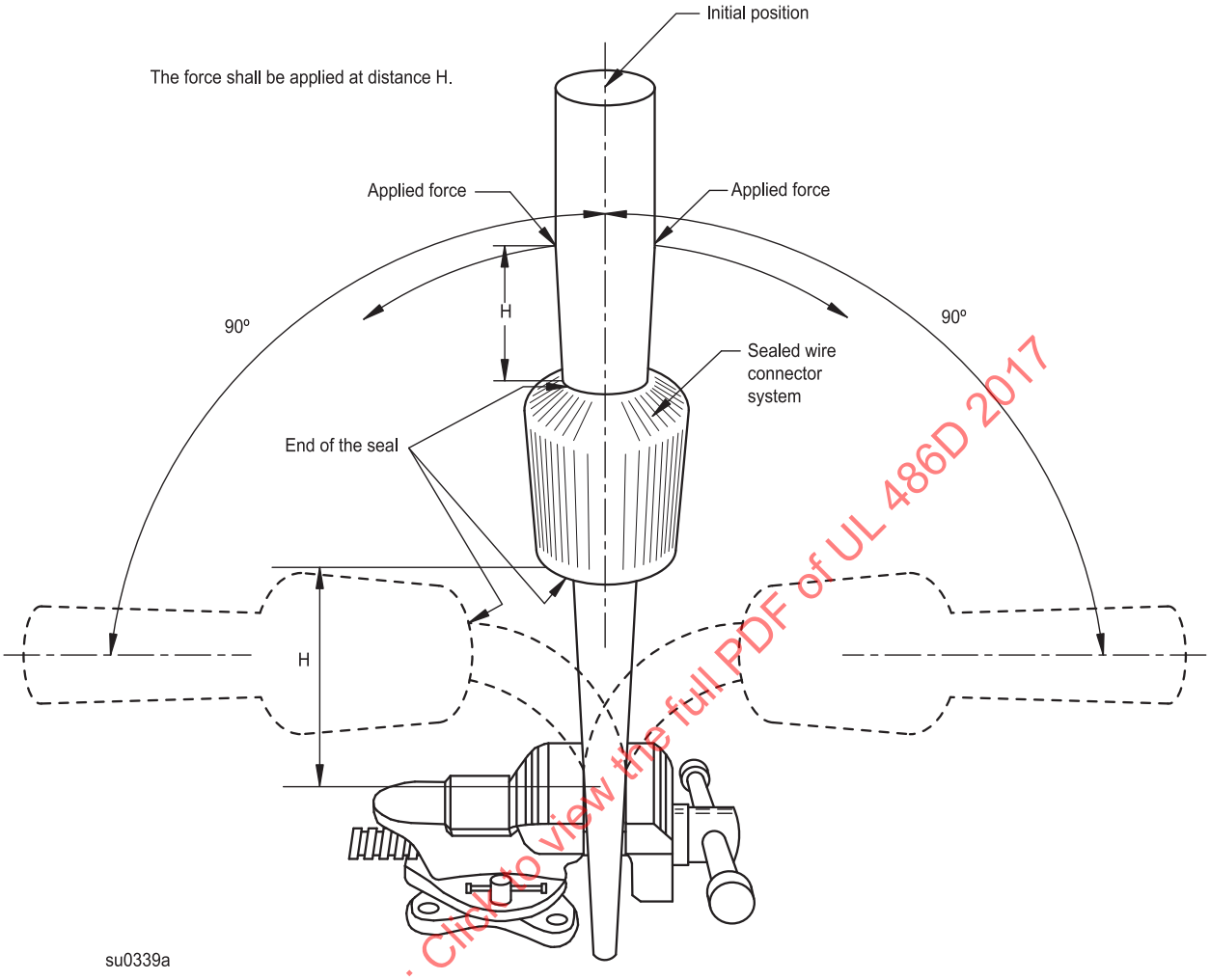

Figure 2 – Twisting test for splicing-type connector

(Clause 9.2.5.2)

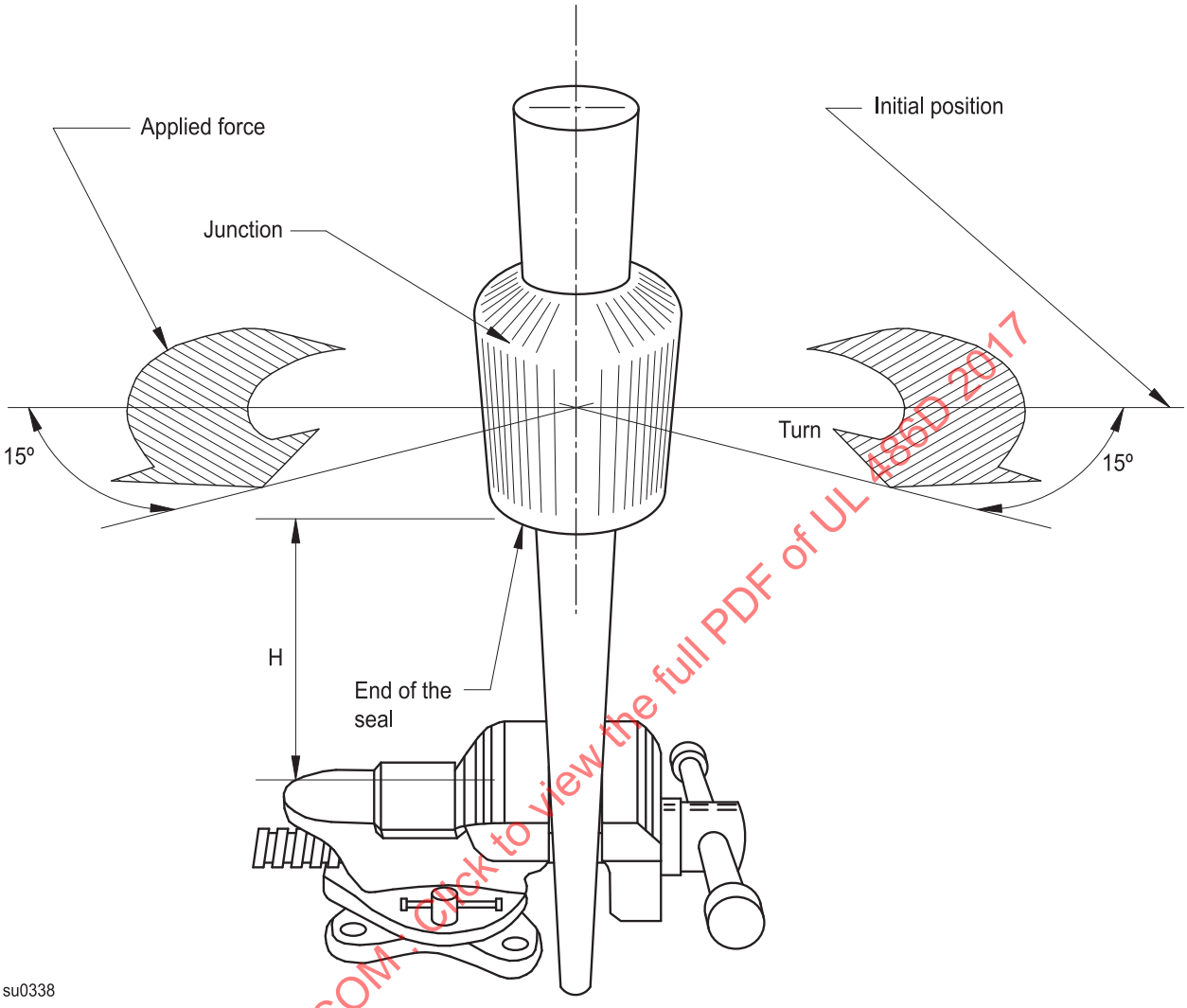

Figure 3 – Flexing and twisting for terminal-type connector

(Clauses 9.2.5.1 and 9.2.5.2)