UL 2196

STANDARD FOR SAFETY

Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables

UL Standard for Safety for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables, UL 2196

Third Edition, Dated June 26, 2025

Summary of Topics

This new Third Edition of ANSI/UL 2196 dated June 26, 2025 is being issued as a binational joint standard and incorporates changes from proposals dated November 22, 2024, and April 11, 2025.

The new requirements are substantially in accordance with Proposal(s) on this subject dated November 22, 2024, and April 11, 2025.

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Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables

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NATIONAL STANDARD OF CANADA
STANDARDS COUNCIL OF CANADA
CONSEIL CANADIEN DES NORMES
NORME NATIONALE DU CANADA

Commitment for Amendments

This Standard is issued jointly by ULSE Inc. (ULSE) and ULC Standards. Amendments to this Standard will be made only after processing according to the Standards writing procedures by ULSE and ULC Standards.

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

This ANSI/UL Standard for Safety consists of the Third Edition.

The most recent designation of ANSI/UL 2196 as an American National Standard (ANSI) occurred on June 26, 2025. 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.

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Preface

This is the common ULSE and ULC Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables. It is the Fourth edition of CAN/ULC 139, and the Third edition of ANSI/UL 2196.

This common Standard was prepared by UL Standards & Engagement Inc. (ULSE), ULC Standards, and the Joint UL/ULC Task Group on Integrity of Cables. The efforts and support of the Joint Task Group are gratefully acknowledged.

This Standard was formally approved by the ULC Standards Committee on Fire Tests and ULSE Technical Panel on Fire Resistive Cables.

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Annexes A, B, and C are identified as Normative, as such, form mandatory parts of this Standard.

Annex D identified as Informative, is for information purposes only.

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 is published as an identical standard between ULSE and ULC Standards.

An identical standard is a standard that is the same in technical content except for conflicts in Codes and Governmental Regulations. Presentation shall be word for word except for editorial changes.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard shall be 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 shall be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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INTRODUCTION

1 Scope

1.1 The intent of this Standard is to evaluate the integrity of power, control, instrumentation, and data/communications cables (such as copper, coaxial, or optical fiber) for their ability to maintain circuit integrity when subjected to standard fire test exposure and associated hose stream test.

1.2 The power, control, instrumentation, and data/communications cables covered by this Standard are intended to comply with the following requirements:

a) In Canada:

1) CSA C22.1, Canadian Electrical Code (CEC), and the National Building Code of Canada;

b) In the United States:

1) NFPA 70®, *National Electrical Code*® (NEC®), and/or the International Fire Code, and/or NFPA 72, National Fire Alarm and Signaling Code, and/or NFPA 130, the Standard for Fixed Guideway Transit and Passenger Rail Systems, and/or NFPA 502, the Standard for Road Tunnels, Bridges, and Other Limited Access Highways, and/or NFPA 1225, the Standard for Emergency Services Communications

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1.3 Cables are subjected to the fire exposure in accordance with ULC S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials and UL 263, Standard for Fire Tests of Building Construction and Materials. Following the fire test, the assembly shall be subjected to a hose stream test.

1.4 During the fire test, cables other than optical-fiber cables are continuously energized at their maximum rated voltage or maximum utilization voltage and evaluated for circuit integrity. Insulation resistance measurements are also taken to quantify leakage current.

1.5 In addition, during the fire tests, the data/communications cables are evaluated to determine their ability to support the transmission of data or communication signals per manufacturer's performance specifications.

1.6 The fire exposure and hose stream tests are not intended to be representative of all fire conditions and impact conditions, respectively. It is likely that conditions will vary with changes in the amount, nature, distribution of fire loading, ventilation, compartment size and configuration, and heat conducting and dissipating characteristics of the compartment in which the cables are installed. These requirements provide a relative measure of fire performance of comparable assemblies under these specified fire exposure conditions. It is possible that any variation from the construction or operating condition tested, such as size, method of assembly and materials, will substantially change the performance characteristics of the cables.

1.7 The standardized fire and hose stream exposures for comparing the performance of cables represents one factor in determining the acceptability of cables for use in specific applications.

1.8 The construction and operation of the furnace and the general test conditions are intended to be in accordance with the requirements in ULC S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials and UL 263, Standard for Fire Tests of Building Construction and Materials.

2 Units of Measurement

2.1 The metric unit shall be designated as the official unit for purposes of this Standard. Where values of measurement are specified in both SI and English units, either unit is used. In cases of dispute, the metric unit shall be used.

3 Referenced Publications

3.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

3.2 Products covered by this Standard shall comply with the referenced installation codes and standards noted in this Section 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.

3.3 Throughout this Standard, the ULC standard references apply to products intended for use in Canada, while the UL standard references apply to products intended for use in the United States. Combined references are separated by a slash (“ / “) to denote the difference between the applicable requirements specified for use in Canada and the United States.

3.4 The following publications are referenced in this Standard:

CSA C22.1, *Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations*

CSA C22.2 No. 208, *Fire Alarm and Signal Cable*

National Building Code of Canada

NFPA 70®, *National Electrical Code®* (NEC®)

NFPA 72, *National Fire Alarm and Signaling Code*

NFPA 130, *Fixed Guideway Transit and Passenger Rail Systems*

NFPA 502, *Road Tunnels, Bridges, and Other Limited Access Highways*

NFPA 1225, *Emergency Services Communications*

UL 13, *Power-Limited Circuit Cables*

UL 263, *Fire Tests of Building Construction and Materials*

UL 444, *Communications Cables*

UL 1425, *Cables for Non-Power-Limited Fire-Alarm Circuits*

UL 1651, *Optical Fiber Cable*

UL 1655, *Community-Antenna Television Cables*

UL 1709, *Rapid Rise Fire Tests of Protection Materials for Structural Steel*

ULC S101, *Standard Methods of Fire Endurance Tests of Building Construction and Materials*

ULC 524, *Installation of Fire Alarm Systems*

4 Glossary

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

4.1 CABLE CONSTRUCTION – A distinct design type as evidenced by number and size of conductors, conductor type, insulation type, shield type, and any individual insulation or overall jacket type, armor type, etc.

4.2 CABLE CONSTRUCTION FAMILY – A distinct group of cable construction types that have similar design features for a range of sizes and/or number of conductors all having the same circuit integrity rating.

4.3 CABLE TRAY – A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.

4.4 CIRCUIT INTEGRITY – The ability of a power, instrumentation, or control cable to maintain voltage and current to the load or the ability of a data/communications cable to maintain the appropriate levels of data or communications transmission.

4.5 CIRCUIT INTEGRITY RATING – The time period during which the cable or cable system continues to operate in its designated manner under specified fire conditions and after the hose stream test for fire-resistive cable or free air installation circuit integrity cable.

4.6 DATA/COMMUNICATIONS CABLE – Cable used to transmit analog and/or digital signaling.

4.7 FIRESTOP SYSTEM – A specific construction of materials intended to prevent the spread of fire through an opening made in a fire-resistive structure for passage of penetrating items such as cables.

4.8 FIRE-RESISTIVE CABLE – Power, control, instrumentation, or data/communications cable in a system and evaluated in accordance with this Standard.

4.9 FREE AIR INSTALLATION CIRCUIT INTEGRITY CABLE – Power, instrumentation, control or data/communications cable in free air (not installed within a raceway) and evaluated in accordance with Annex B.

4.10 LOAD VOLTAGE ($E_{applied}$) – The voltage applied between phase and ground to the cable that determine circuit integrity and insulation resistance.

4.11 RACEWAY – An enclosed channel of metallic or nonmetallic materials designed expressly for support and routing wires or cables.

4.12 TEST ASSEMBLY – The cable and its means of securement, firestop system and any structure used to support the cable during the fire and hose stream tests.

4.13 UTILIZATION VOLTAGE – The maximum voltage anticipated during intended usage of a power, instrumentation, control or data/communications cable.

NOTE: Typical utilization voltages are 600 V, 480 V, 208 V, and 120 V.

4.14 VERTICAL WALL ASSEMBLY – The vertical structure that supports the test samples and cable systems.

PERFORMANCE

5 Fire Tests

5.1 Test samples

5.1.1 General

5.1.1.1 Representative samples of each power, instrumentation, control, and data/communications cable construction family shall be tested. Each cable construction tested shall include a minimum of five separate samples.

NOTE 1: Examples of different cable designs are multi-conductor, single conductor, twisted, parallel, shielded, non-shielded, stranded and solid conductor(s) cables. Cables with bare or insulated bonding conductor or grounding conductor are other examples of cable design.

NOTE 2: Examples of different optical-fiber designs are simplex, distribution, and breakout. Optical-fiber cables refer to the complete assembly of fibers, strength members and insulating jackets.

NOTE 3: Fiber material and doping, cladding, thickness, buffering, coloring, water blocking, armor, ripcords, etc. may all affect fiber function during a fire. Electrical data/communications cables may have similar optical characteristics as described in NOTE 1 but may also include center filler, pair lay length, cable lay length, type of shield material, application of shield, lap, barrier tapes, etc.

NOTE 4: Unless mutually agreeable between all parties, cable construction samples within a cable construction family are selected based upon known parameters, variables, or performance measures (See Annex A). The basis of the selection process used are acknowledged and documented as part of the reporting.

5.1.1.2 The results of the fire test are restricted to the cable construction family tested.

5.1.1.3 As a minimum, the following features shall be recorded for electrical power, control, and data/communications cables, as applicable:

a) Conductor

1) Material

2) Size

3) Type, stranded or solid

i) If stranded, number of strands and lay length

4) Plating material and thickness

5) Number of conductors

i) If more than one conductor, parallel or cabled

A) If cabled, the length of lay

6) Separator tape over the conductor (such as Mica/glass or others)

b) Insulation

1) Material

2) Thickness and/or distance between conductors

3) Manufacturing process

4) Jacket over insulated conductor

i) Material

ii) Thickness

iii) Manufacturing process (e.g., coextrusion)

c) Shielded, unshielded, or barrier tape

1) If taped,

i) Number of layers

ii) Material

iii) Thickness

iv) Type (tape wrap or longitudinally applied)

v) Overlap

vi) Drain wire for control or data/communications cable

A) Material

B) Size

C) Plating

d) Layup

1) Number of conductors

i) If more than one conductor, parallel or cabled

A) If cabled, length of lay

2) Ground wires

i) Bare or insulated (same information on conductor and insulation)

3) Filler

i) Material

ii) Thickness

iii) Overlap

iv) Helical or parallel

e) Armor

1) Material

2) Type (interlocked, corrugated and welded, smooth)

3) Thickness

4) Number of convolutions per unit length

f) Inner or Overall Jacket

1) Material(s)

2) Thickness(es)

3) Manufacturing process

5.1.1.4 As a minimum, the following features shall be recorded for optical-fiber cable, as applicable:

a) Configuration

1) Simplex

2) Distribution

3) Breakout

b) Single mode or multimode

1) Optical characteristics

c) Fiber material

1) Doping

2) Cladding

3) Thickness of layers

d) Buffering

1) Material

2) Thickness

e) Coloring

1) Material

2) Thickness

f) Water blocking

1) Material

g) Assembly

1) Type or lay

h) Strength members

1) Material

2) Thickness

i) Jackets

1) Material

2) Thickness

3) Ripcords

5.1.1.5 As a minimum, the following features shall be recorded for installation, as applicable:

a) Cable within raceway or without raceway

1) If cable without raceway,

i) Cable support/grip or Cable tray system

A) Type

I) Hook

II) Ladder

III) Solid bottom

IV) Trough

V) Channel

VI) Wire mesh

VII) Single rail

B) Support spacing

C) Material

D) Thickness

E) Description

F) Fasteners

I) Material

II) Coating

III) Description

ii) Cable bend radius

2) If cable within raceway,

i) Raceway support

A) Spacing

B) Material

C) Thickness

D) Description

E) Fasteners

I) Material

II) Description

ii) Raceway

A) Material

B) Properties

C) Coatings

I) Coating thicknesses

D) Thickness

E) Diameter

iii) Raceway bend radius

iv) Raceway coupling

A) Type

B) Material

C) Coatings

I) Coating thicknesses

II) Coating properties

D) Thickness

E) Diameter

F) Fasteners

I) Material

II) Description

v) Raceway cable fill ratio combinations

vi) Pulling lubricant

vii) Cable support/grip

b) Orientation

1) Horizontal with the minimum bend radius

2) Vertical

5.1.1.6 The cables shall be installed as complete systems, including, connectors, clamps, supports, raceway, vertical supports, pull point/box, and optional splices, pulling lubricants, etc. The cables are to

terminate a maximum of 3.0 m (118 inches) beyond the confines of the test furnace. Each cable or cable system is not to be closer than 305 mm (12 inches) from the furnace edge.

5.1.1.7 Each cable construction shall be tested in both vertical and horizontal orientation.

5.1.1.8 Each horizontal cable or cable system shall incorporate at least one 90° bend of the cable or cable with raceway with the manufacturer's minimum bend radius which represents the type of support and spacing which shall be installed with the system.

5.1.1.9 Each vertical cable or cable system shall incorporate the cable or cable with raceway which represents the type of support and spacing which shall be installed with the system.

5.1.2 Power, instrumentation, control, and data/communications cables

5.1.2.1 Multi-conductor cable may also include a grounding conductor in addition to the other circuit conductors. Single or multi-conductor cables in a metallic raceway may include a grounding conductor. Cables in non-metallic raceways shall require a ground wire when required by Code(s). The grounding conductor may be insulated or bare.

5.1.2.2 Where three single-conductor cables (or more) or 3/C (or more) multi-conductor cables are to be evaluated, only three conductors in closest proximity to each other and to the outside of the cable (for each multi-conductor cable), shall be energized with the other conductors grounded. For two single-conductor cables or 2/C or multiple 2/C cables, each conductor shall be energized.

5.1.2.3 For single-conductor cables intended to be installed in a raceway, the test assembly shall consist of a minimum of two and the maximum number of single-conductors of the same design and size installed in a raceway so to comply with the maximum percent-fill specified in the manufacturer's installation instructions; but, not greater than the maximum percent-fill permitted by the prevailing Code(s).

5.1.2.4 For multi-conductor cable intended to be installed in a raceway, the test assembly shall consist of a single multi-conductor cable and the maximum number of multi-conductor cables of the same design and size intended to be installed in a raceway to comply with the maximum percent-fill specified in the manufacturer's installation instructions; but, not greater than the maximum percent-fill permitted by the prevailing Code(s).

5.1.2.5 The cables shall be tested at their maximum rated voltage or the maximum utilization voltage. In any case where a current-carrying element is tested, the test voltage shall not be less than 50 V. The test voltage applied shall be in AC volts (phase to phase).

5.1.3 Data/communications cable testing

5.1.3.1 In addition to the sample requirements in 5.1.1.1, a minimum of two additional samples shall be installed for fire testing to verify data transmission.

5.1.3.2 Cable samples shall meet the manufacturer's performance specifications under normal conditions. The maximum and final (after test completion) degradation from the manufacturer's specifications during the fire endurance and hose stream tests shall be reported on the manufacturer's specification sheet. Cable tested shall have a data sheet that delineates the performance requirements under normal and fire conditions that will ensure that the cable is able to transfer a signal during the fire endurance test and following the hose stream test either under an industry standard test such as TIA (568.2-D), IEC (11801-1) or Military slant sheets or as specified in Annex C of this document.

5.1.3.3 The test samples shall be verified to meet the manufacturer's performance specifications in advance of any testing. All transmissions shall be measured before and during the fire endurance test, and

following the hose stream test. Data shall be collected at least every five minutes during the testing for the additional horizontal and vertical samples. After the hose stream test, the transmission characteristics shall be tested again for at least a five-minute duration for the same samples.

5.1.3.4 Samples are to be installed, one horizontally and one vertically for fire testing. Samples representative of each cable construction family shall be tested, and the same rules used for power/control cables for multiple conductors/fibers as well as cables in a raceway shall be used. The minimum continuous length within the furnace must be 3048 mm (10 feet) with the remainder of the necessary footage to be outside the fire zone to comply with the communication standard or protocol being tested.

5.1.3.5 Appropriate terminations shall be used to match the characteristic impedance of the cable as required to minimize return loss. See Annex C.

5.1.3.6 Cables shall be tested as a cable system using equipment designed to analyze the signal transmission characteristics.

NOTE: The signal may be transmitted from a signal generator at the manufacturers required range of frequencies, through the cable under test, and received by a signal analyzer. Test leads, switches, or other passive components may be utilized in order to expedite the measurements of multiple cable samples at applicable frequencies over the duration of the fire test. Signal may be a range of frequencies.

5.1.3.7 Where the cable or system specifies a DC bias voltage, the maximum voltage shall be applied.

5.2 Test assembly

5.2.1 Cables shall be installed using compatible raceways, cable trays or supports as permitted for that cable type by the prevailing Code(s) and the manufacturer's installation instructions.

5.2.2 The supporting structure used in the conduct of the fire test shall be constructed of material which provides adequate support for the cable or cable system during the fire and hose stream tests but which does not influence the physical fire performance of the cable or cable system due to excessive deflection or falling debris.

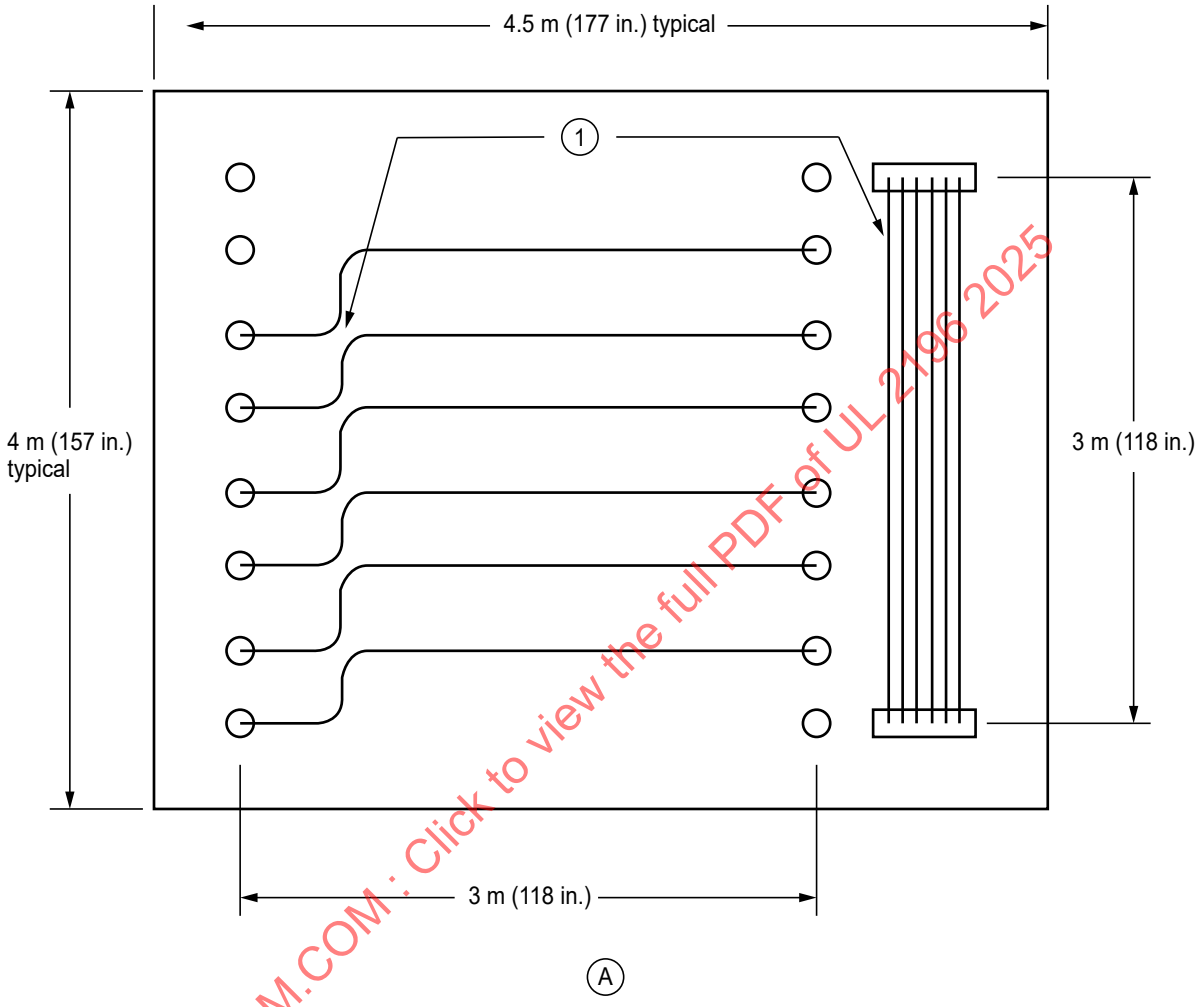
5.2.3 Unless the rating is specified for a specific firestop construction, the firestop system for the opening in the structure made for passage of the cable or cable system shall be constructed using materials and techniques that provide an effective fire barrier without influencing the performance of the cable or cable system as a result of degradation.

NOTE: Commercially available ceramic fiber blanket packed the depth of the opening in the structure and around the cable or cable system with a layer of cementitious firestop material on the fire exposed side of the structure over the opening may be sufficient.

5.2.4 The minimum distance between the point of entrance and point of exit of the cable or cable system through the furnace shall be 3000 mm (118 inches) in either the horizontal or vertical orientation. See Figure 5.1.

Figure 5.1

Vertical Wall Assembly Constructed of Brick and Mortar



A – Fire Exposed Side

1 – Five samples, each horizontal and vertical, terminating on the other side of the wall. One additional vertical and one additional horizontal sample to represent signal integrity samples, when applicable.

5.2.5 The supporting structure shall be a vertical wall assembly consisting of masonry of adequate thickness for the desired rating. The wall assembly shall minimally measure 3660 mm by 3660 mm (144 inch by 144 inch) and shall be provided with openings for the cables or cable system spaced 3000 mm (118 inches) apart. See Figure 5.1 for a typical combined set up of vertical and horizontal tests.

5.2.6 Where the test assembly is constructed of a material which may be subject to spalling, the assembly shall be cured and conditioned to minimize the risk of spalling. For cast concrete, the relative humidity (RH) measurement shall be 75 % or less when calculated by the method described in ULC S101 / UL 263.

5.3 Test furnace

5.3.1 The test furnace shall comply with the equipment specified in ULC S101 / UL 263.

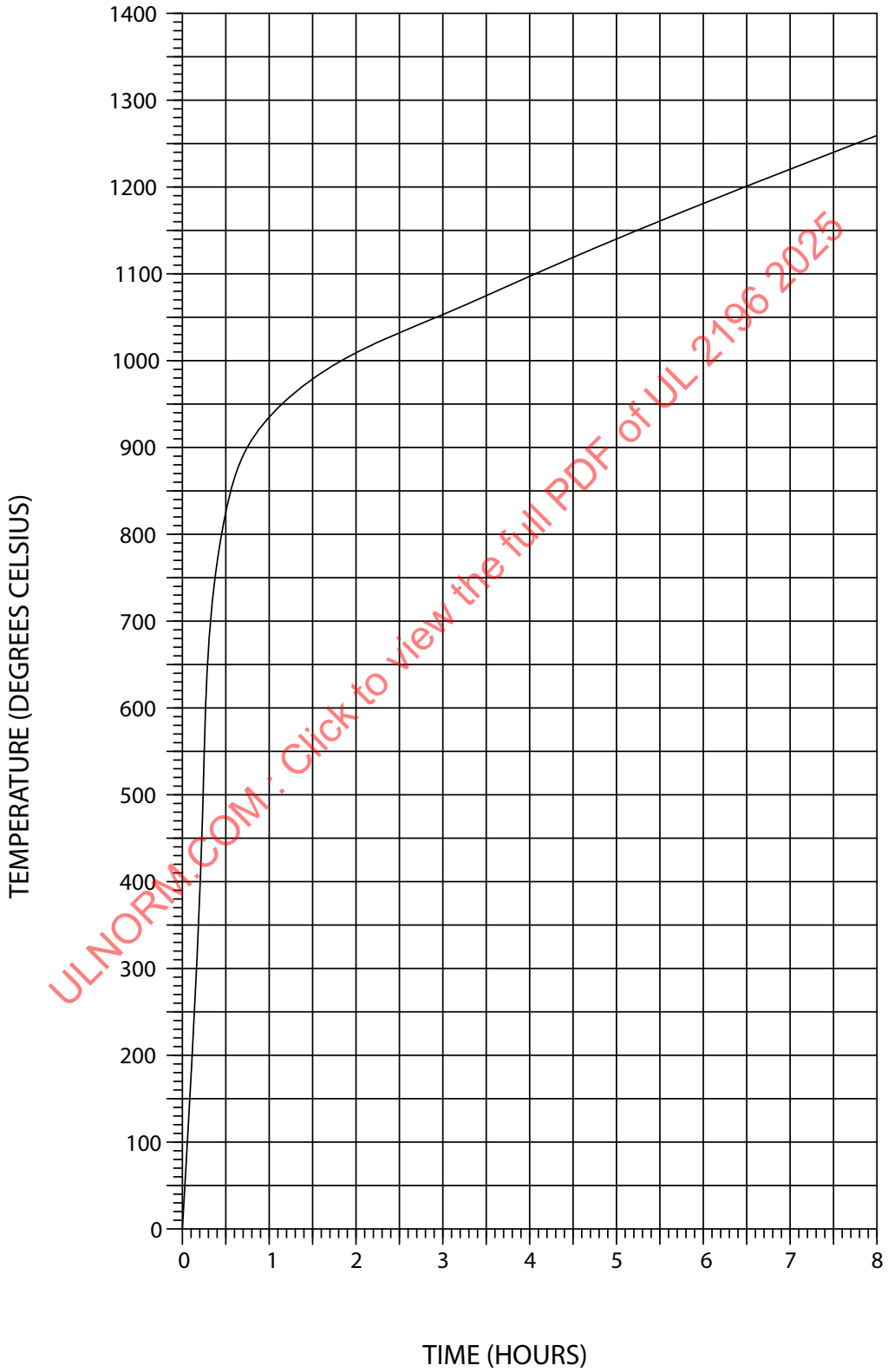
5.4 Time-temperature curve

5.4.1 Fire tests shall be controlled by the standard time-temperature curve in ULC S101 / UL 263, as shown in Figure 5.2.

NOTE: At the request of the submitter, alternate standard fire exposures may be used (See Annex D). The results of the fire exposure used, are acknowledged and documented as part of the reporting.

Figure 5.2

Standard Time-Temperature Curve for Control of Fire Tests



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5.5 Furnace temperature measurement

5.5.1 The measurements, control and instrumentation shall comply with ULC S101 / UL 263.

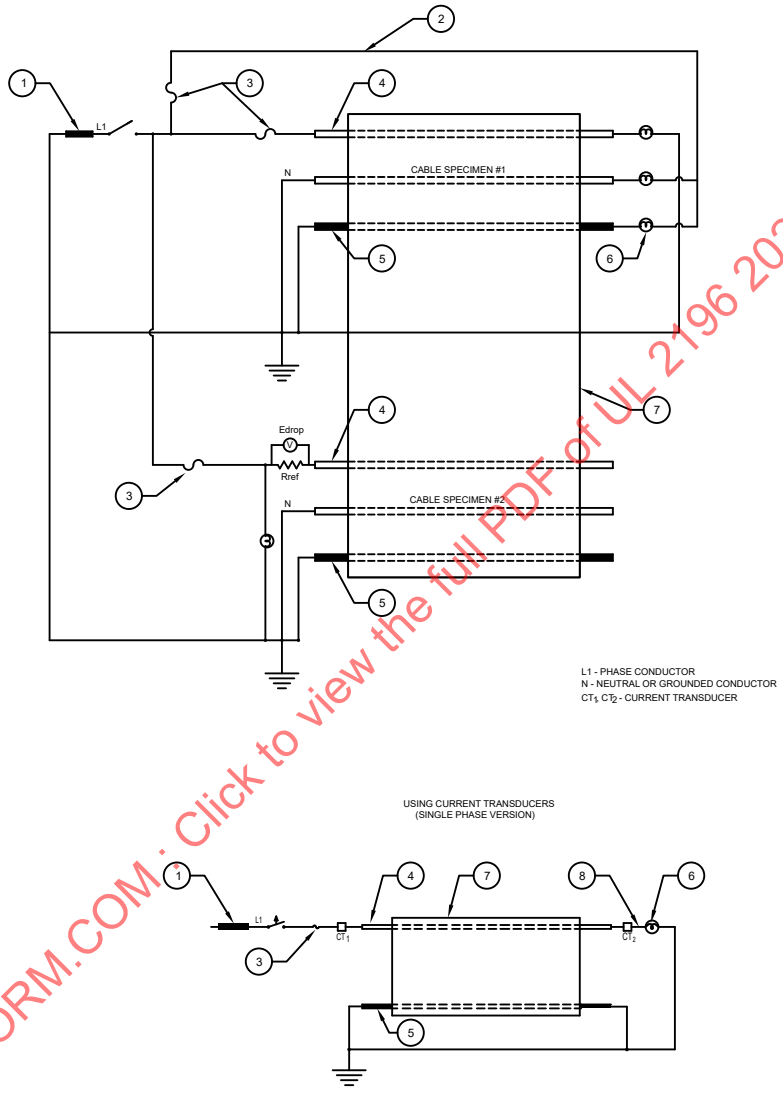
5.6 Application of load (maximum rated or maximum utilization) voltage, $E_{applied}$ (circuit integrity test for power, instrumentation, control and data/communications cables as applicable)

5.6.1 Prior to initiation of the fire test, each sample circuit shall be connected to a load with visual or electrical circuit integrity indication and shall be energized by a load (maximum rated or maximum utilization) voltage ($E_{applied}$) through a fuse. See Figure 5.3 and Figure 5.4. The maximum voltage shall be as stipulated in 5.1.2.5. For data/communications cables being tested for signal transmission, see 5.1.3.

Figure 5.3

Continuity and Insulation Resistance Test Circuits

(Single Phase Version)



1 – Electrical Supply ($E_{applied}$)

2 – Return to Phase Conductor

3 – Fuse (3A)

4 – Test Conductor

5 – Metal Shield for use with Single Conductor Cable without Grounding

6 – Lamp or Resistive Load

7 – Furnace

8 – Load Current (0.25 – 0.50 Amp)

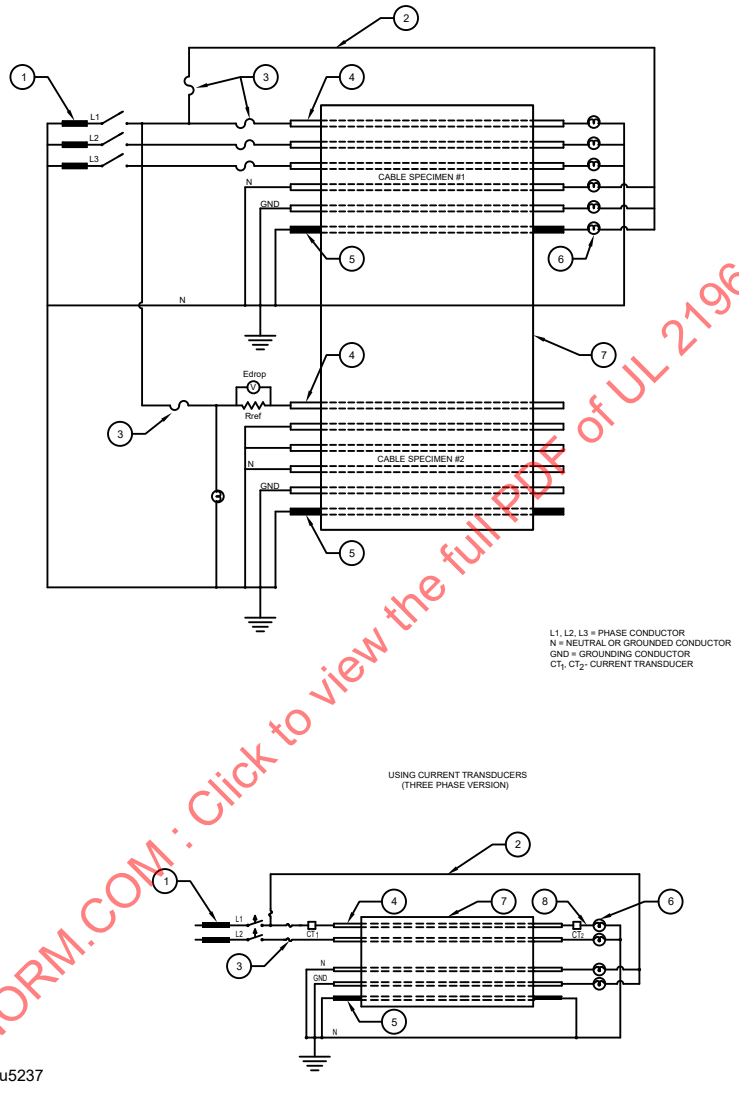
9 – Isolation Transformers between each Power Source and its Circuit (not identified in figure)

NOTE: This figure is a circuit schematic only and does not represent the actual location of conductors in the test assembly. Cable specimen 1 is for measuring circuit integrity. Cable specimen 2 is for measuring insulation resistance. See 5.7.1.

Figure 5.4

Continuity and Insulation Resistance Test Circuits

(Three Phase Version)



1 – Electrical Supply ($E_{applied}$)

2 – Return to Phase Conductor

3 – Fuse (3A)

4 – Test Conductor

5 – Metal Shield for use with Single Conductor Cable without Grounding

6 – Lamp or Resistive Load

7 – Furnace

8 – Load Current (0.25 – 0.50 Amp)

9 – Isolation Transformers between each Power Source and its Circuit (not identified in figure)

NOTE: This figure is a circuit schematic only and does not represent the actual location of conductors in the test assembly. Cable specimen 1 is for measuring circuit integrity. Cable specimen 2 is for measuring insulation resistance. See 5.7.1.

5.6.2 The furnace shall be ignited only after the circuit has been energized and the load indicators show circuit integrity.

5.6.3 The load (maximum rated or maximum utilization) voltage ($E_{applied}$) shall be monitored and maintained at the voltage value determined in 5.6.4.

5.6.4 Prior to the beginning of the test, each conductor of each cable used to monitor circuit integrity shall be energized from an AC electrical source of supply. The supply voltage shall be the maximum rated voltage of the cable or the maximum utilization voltage of the cable, whichever is larger, and in no case shall the supply voltage be less than 50 V.

5.6.5 The supply shall be a three-phase wye-connected source. The supply shall be of sufficient capacity to maintain the initially applied voltage at the indicated load in addition to any overload current allowed by the fuse specified in 5.6.6.

5.6.6 A 3 A Class K, non-time delay fuse suitable for branch circuit protection shall be located in each ungrounded conductor of the supply. New, previously unused fuses shall be installed prior to each test and the fuse holder contacts shall be cleaned prior to installation.

5.6.7 A lamp or resistive load shall be connected to each conductor or groups of conductors at the end of the cable opposite from the supply. The lamp or resistive load shall be sized to produce a load current of 0.25 to 0.50 A in each conductor. A schematic diagram for the application of the allowable voltage to the cable is shown in Figure 5.3 and Figure 5.4.

5.7 Insulation resistance on power, instrumentation, control cables

5.7.1 Insulation resistance measurements shall be obtained before and after the fire test. The insulation resistance measurements shall be made conductor to ground for all cables and also conductor to conductor for multi-conductor cables and multiple single-conductor cables.

NOTE: Figure 5.3 and Figure 5.4 show acceptable methods of obtaining insulation resistance measurements. Other methods may be used, for example, the need for a second cable sample can be eliminated by measuring differential conductors on the test sample.

5.7.2 When insulation resistance measurements are made, by placing the cable in a series circuit with a known resistance and a regulated AC voltage as shown in Figure 5.3 and Figure 5.4, the voltage drop across the known resistance shall be measured and the insulation resistance calculated using the following formula:

$$R_I = \left[\frac{E_{applied} - E_{drop}}{E_{drop}} \right] \times R_{ref}$$

where:

R_I = Insulation resistance (ohm) of the sample length

$E_{applied}$ = Supply AC voltage (volt)

E_{drop} = Measured voltage across the known resistor (volt)

R_{ref} = Reference resistance (ohm), not greater than 10 Ω

5.8 Leakage current on power, instrumentation, control cables

5.8.1 General

5.8.1.1 The leakage current shall be determined by the method described in 5.8.2, Current Transducer Method, during the fire exposure test and after the hose stream test.

5.8.2 Current transducer method

5.8.2.1 Two current transducers shall be installed on the selected conductor. One current transducer (CT_1) is to be located between the fuse in accordance with 5.6.6 and the entry of the conductor into the furnace and one current transducer (CT_2) is to be located after the conductor exits the furnace and prior to the lamp or resistive load as shown in Figure 5.3 and Figure 5.4.

5.8.2.2 The currents measured by CT_1 and CT_2 shall be recorded at intervals not exceeding 1 minute during the fire endurance test and at intervals not exceeding 1 minute for a minimum five-minute period following the hose stream test.

5.8.2.3 The leakage current is to be the difference in current measured by the current transducers as expressed by the following equation:

$$\text{Leakage Current} = \text{current measured by } CT_1 - \text{current measured by } CT_2$$

5.9 Fire endurance test

5.9.1 The testing equipment, test sample and assembly, shall be protected from any condition of wind or weather that might influence the test results. The ambient air temperature at the beginning of the test shall be within the range of 10 – 32 °C (50 – 90 °F). If mechanical ventilation is employed during the test, no air stream shall be directed across the surface of the sample.

5.9.2 Observations of the test assembly are to be made throughout the fire test. Significant observations, such as but not limited to deformation, cracking, development of openings, smoke or flame exiting through the conduit and burning of elements of the test assembly shall be made.

5.9.3 The fire test shall be continued until the test specimen has been exposed to the test conditions for a period of time equal to the desired circuit integrity hourly rating.

6 Hose Stream Test

6.1 Test assembly

6.1.1 The hose stream test shall be conducted no longer than five minutes after the fire exposure test and shall be conducted on the test assembly. The cable shall not be energized during the hose stream test. See 8.2.1.

6.1.2 The hose stream test shall be conducted in accordance with the requirements in ULC S101 / UL 263.

7 Tensile Strength Test

7.1 For conductors or cables intended for use in raceways or free air installation circuit integrity (CI) cable, the maximum allowable length between cable supports in vertical runs shall be determined during the fire exposure test as described in 7.2 through 7.7.

NOTE 1: For Canada, CSA C22.1 contains the requirements for supporting of cables in vertical runs of raceway. For the United States, the National Electrical Code (NEC), NFPA 70 contains the requirements for supporting of cables in vertical runs of raceways. The tensile strength test is conducted to evaluate the maximum spacing on a specimen exposed to fire for a period of time at least equal to the time determined for the cable circuit integrity test. The tensile strength test may be conducted using the maximum spacing for the cable specified in the CSA C22.1 and/or the National Electrical Code (NEC), NFPA 70 or the submitter may select a lesser spacing for qualification.

NOTE 2: The test is performed on five separate specimens selected for the tensile strength test, not on the specimens for the circuit integrity test.

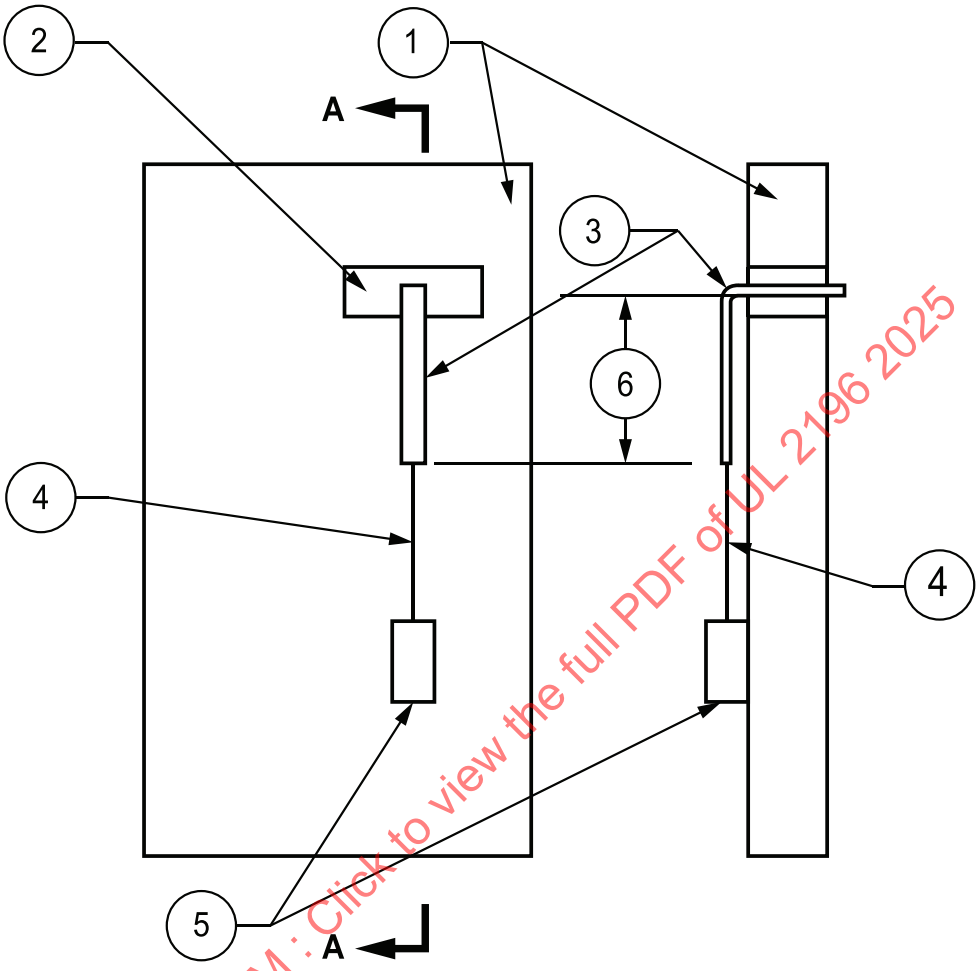
7.2 In a range of cable sizes of each design, the cable selected for the tensile strength test shall be that for which the ratio of mass per unit length divided by total conductor, metallic or fibrous load bearing elements cross section area is a maximum.

7.3 Each type of conductor alloy material or cable design shall be tested.

7.4 The length of the raceway exposed in the furnace shall be 2438 ±150 mm (96 ±6 in). The cable shall extend beyond the lower end of the raceway sufficiently to provide enough exposed conductor to affix the weight without allowing the weight to contact the floor of the furnace during or after the test. See Figure 7.1.

Figure 7.1

Tensile Strength Test



SECTION 'A - A'

su2859

1 – Supporting Structure

2 – Firestop System

3 – Raceway (as applicable)

4 – Test Specimen

5 – Mass

6 – 2438 ±150 mm (96 ±6 in)

NOTES:

Mass is to be attached to the conductor or cable.

Raceway secured to supporting structure.

7.5 The raceway shall be of the same type and minimum nominal size tested for circuit integrity.

7.6 The mass of the steel object secured to the bottom of the conductor or cable shall be equal to the mass of the unsupported cable length being represented (less the length of the cable exposed to the fire).

7.7 The mass and connection used to secure the mass to the conductor or cable shall be capable of withstanding the furnace temperatures anticipated during the fire exposure test. The mass and exposed cable may be shielded from direct flame exposure provided that there is no obstruction to hinder the free falling of the mass.

7.8 The test sample shall be subjected to the fire exposure test described in 5.4.1 for a period at least equal to the cable integrity test.

8 Conditions of Acceptance

8.1 Determination of circuit integrity

8.1.1 For all cables other than fiber, the conductors shall maintain continuity and supply voltage and current to the load as described in 8.1.2 and 8.1.3.

8.1.2 The fuse required in 5.6.6 shall not open for the duration of the test.

8.1.3 The visual or electrical indicator connected to the cable shall continue to indicate circuit integrity for the duration of the test.

8.1.4 The insulation resistance of all cables other than fiber shall be reported.

8.1.5 Each fire-resistive cable system shall have a single hourly rating.

8.2 Hose stream test

8.2.1 After the hose stream test is conducted, the cables shall be re-energized and tested for circuit integrity within 24 hours of completion of the hose stream test. For data/communications cables, verify that the source data/communications transmission and reception through the system is maintained as prescribed in 5.1.3.2.

8.3 Tensile strength test

8.3.1 The conductor or cable in the tensile strength test shall support the mass of the steel object connected to the conductor or cable for the duration of the fire test only. See 7.6.

8.4 Determination of signal integrity

8.4.1 For data/communications, and optical-fiber cables, the cable shall maintain acceptable signal integrity per the manufacturer's performance specifications as outlined in 5.1.3.

8.4.2 Data/communications cables shall comply with 8.1.

9 Report

9.1 Results

9.1.1 The report of the performance of cable samples during these tests shall include the information contained in 5.1.2, Power, Instrumentation, Control and Data/Communications Cables, and the following:

a) Identification of the testing laboratory and identification of the submitter of the samples for testing;

b) A detailed description of the assembly, component materials and installation procedures for the cables tested, including drawings (and photographic or video readings, if practicable) depicting the geometry and location of each cable within the test assembly;

c) A detailed description of the selection process and the basis used for the cable construction samples selected from within a cable construction family;

d) Include details of any splices, connectors, clamps, supports, etc.;

e) The relative humidity of the test assembly, if applicable;

f) The temperatures of the furnace recorded throughout the fire test and the time-temperature curve utilized;

g) Observations and significant details of the behavior of the cables tested, during the fire and hose stream tests;

h) A tabulation of the times for which circuit integrity was maintained for each sample;

i) Insulation resistance measurements obtained on each one of the cable samples tested before and after the hose stream test;

j) A record of the leakage current per exposed length, when applicable;

k) In Canada, the circuit integrity rating or in the United States, the fire-resistive rating attained by the cables under test;

l) For cables intended to be installed in raceways, the maximum allowable spacing between supports in a vertical run determined in the Tensile Strength Test. See 8.3.1;

m) For all cables other than fiber, recorded data of the leakage current test measurements;

n) The electrical rating (for power cables, the maximum rated voltage or maximum utilization voltage as tested; for instrumentation, control, and data/communications cables, the maximum utilization voltage as tested);

o) Observations of the visual or electrical circuit integrity indicators during the test and following the hose stream application;

p) For data/communications cables, recorded data, test protocol, tested cable length both inside the furnace and outside of the furnace, and other information in accordance with the manufacturer's performance specifications; and

q) For data/communications cables, the maximum and final (after test completion) degradation from the manufacturer's performance specifications during the fire endurance and hose stream tests, per 5.1.3.2.

MARKINGS

10 Marking of Cable

10.1 The cable shall be marked with the following information:

a) The type of cable, such as, MI, RC-90, RW90, FAS105, CM or otherwise in accordance with the CEC and/or MI, MC, RHW-2, FPLR, CM or otherwise in accordance with the NEC;

b) Fire-Resistive Rating (or FRR), test duration (in hours or h), and alphanumeric designation to represent the reference Standard(s) (e.g., 2196 for UL 2196, 139 for ULC 139, 2196 / 139 for UL 2196 / ULC 139, as appropriate);

c) Maximum fire-resistive rated voltage;

d) Data/communications transmission capability per manufacturer's performance specifications, when applicable;

e) Product's identification, such as a distinct part number; and

f) Manufacturer's Identification.

11 Marking on Tag, Reel, or Carton

11.1 A statement shall be on the tag, reel, or carton on how to access digital installation instructions that are provided for compliance with Section 12 when the manufacturer does not provide the required installation instructions in print.

INSTRUCTIONS

12 Installation Instructions

12.1 Each shipment of cable shall be provided with installation instructions, in print or digital, that include the following:

a) All relevant construction details of cable or cable system tested as listed in 5.1.1.3 – 5.1.1.5 in this Standard;

b) Description of the cable markings for correlation to the product;

c) Any unique design and installation features or limitations specific to the cable or cable system such as the following as applicable: vertical installation, horizontal installation, distance between supports, maximum allowable vertical distance, maximum percent fill, allowable ground wire, allowable pull box/conduit body, allowable splice, allowable pulling lubricants, allowable raceway material, allowable connector materials, support material, maximum voltage, , dedicated raceway required, and for data/communications cables, the manufacturer's minimum bend radius and manufacturer's performance specifications, etc.; and

d) These instructions form a part of the manufacturer's instructions. In addition, installation or application of parts of the following applicable Code(s) and Standard(s) may be required:

1) CSA C22.1;

2) ULC 524;

3) the National Electrical Code (NEC), NFPA 70;