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

Second Edition, Dated August 29, 2017

Summary of Topics

This revision of ANSI/UL 2196 dated December 21, 2020 includes the following changes in requirements:

- ***Removal of word "minimum" for raceway length as a tolerance is specified; 5.3.4***

- ***Modification of marking requirements; 1.2, 8.1***

- ***Installation instruction requirements; 9.1***

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 revised requirements are substantially in accordance with Proposal(s) on this subject dated April 17, 2020.

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ULC Standards
CAN/ULC-S139
Third Edition

Underwriters Laboratories Inc.
ANSI/UL 2196
Second Edition

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

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ANSI/UL 2196-2020

Commitment for Amendments

This Standard is issued jointly by Underwriters Laboratories Inc. (UL) and ULC Standards. Amendments to this Standard will be made only after processing according to the Standards writing procedures by UL 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 On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com/canada.

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through December 21, 2020.

The most recent designation of ANSI/UL 2196 as an American National Standard (ANSI) occurred on October 9, 2020. 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 common UL and ULC Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables. It is the Third edition of CAN/ULC-S139, and the Second edition of ANSI/UL 2196.

This common Standard was prepared by Underwriters Laboratories Inc., 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 UL Standard 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, forms mandatory parts of this Standard.

Annex D, identified as informative, is for informational 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 UL 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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1 Scope

1.1 The intent of this Standard is to evaluate the integrity of power, control, instrumentation, and data cables 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 cables covered by this Standard are intended to comply with the following requirements :

In Canada:

Canadian Electrical Code (CEC) and the National Building Code of Canada;

In the United States:

National Electrical Code (NEC), and/or the National Fire Alarm and Signaling Code, and/or the Standard for Fixed Guideway Transit and Passenger Rail Systems, and/or the Standard for Road Tunnels, Bridges, and Other Limited Access Highways.

1.3 Power, control, and instrumentation cables are subjected to the fire exposure in accordance with CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, and ANSI/UL 263, Standard for Fire Tests of Building Construction and Materials. During the fire test, cables are continuously energized at their maximum rated voltage or maximum utilization voltage (power cables); or at their maximum utilization voltage (control and instrumentation cables) and evaluated for circuit integrity. Insulation resistance measurements are also taken to quantify leakage current. Following the fire test, the assembly shall be subjected to a hose stream test.

1.4 Data cables are subjected to the fire exposure in accordance with CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, and ANSI/UL 263, Standard for Fire Tests of Building Construction and Materials. During the fire tests, the data cables are evaluated for their ability to maintain error free data transfer and retrieval at the specified protocol and data rates. Following the fire test, the assembly shall be subjected to a hose stream test.

1.5 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.

1.6 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.

1.7 The construction and operation of the furnace and the general test conditions are intended to be in accordance with the requirements in CAN/ULC S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, and ANSI/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 REFERENCE PUBLICATIONS

3.1 See Annex A for a list of publications referenced in this standard. 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. When the latest edition of a standard is not applicable, the appropriate edition is indicated accordingly in Annex A.

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 cable to maintain error free data transfer and retrieval.

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 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.

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

4.8 FREE AIR INSTALLATION CIRCUIT INTEGRITY CABLE – Power, instrumentation, control or data cable in free air (no installed within a raceway) and evaluated in accordance with Annex C.

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

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

4.11 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.

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

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

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

5 TESTS

5.1 FIRE TESTS

5.1.1 Test Samples

5.1.1.1 General

5.1.1.1.1 Representative samples of each power, instrumentation, control, and data 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, nonshielded, 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 fibre designs are simplex, distribution, and breakout. Optical fibre cables refer to the complete assembly of fibres, strength members and insulating jackets.

NOTE 3: Fibre material and doping, cladding, thickness, buffering, coloring, water blocking, armor, ripcords, etc. may all affect fibre function during a fire. Electrical data cables may have similar critical 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.

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

5.1.1.1.3 Cables representative of the cable construction family for which a circuit integrity rating is desired shall be tested. The construction details of the cable samples or cable and cable system samples shall be identified and recorded. As a minimum, the following features shall be recorded, as applicable:

ELECTRICAL POWER, CONTROL, AND DATA CABLES

A) Conductor

i) Material

ii) Size

iii) Type, stranded or solid

a) If stranded, number of strands and lay length

iv) Plating material and thickness

v) Number of conductors

a) If more than one conductor, parallel or cabled

1) If cabled, the length of lay

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

B) Insulation

i) Material

ii) Thickness and/or distance between conductors

iii) Manufacturing process

iv) Jacket over insulated conductor

a) Material

b) Thickness

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

C) Shielded, unshielded, or barrier tape

i) If taped,

a) Number of layers

b) Material

c) Thickness

d) Type (tape wrap or longitudinally applied)

e) Overlap

f) Drain wire for control or data cable

1) Material

2) Size

3) Plating

D) Layup

i) Number of conductors

a) If more than one conductor, parallel or cabled

1) If cabled, length of lay

ii) Ground wires

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

iii) Filler

a) Material

b) Thickness

c) Overlap

d) Helical or parallel

E) Armor

i) Material

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

iii) Thickness

iv) Number of convolutions per unit length

F) Inner or Overall Jacket

i) Material(s)

ii) Thickness(es)

iii) Manufacturing process

OPTICAL FIBRE CONTROL AND DATA CABLE

A) Configuration

i) Simplex

ii) Distribution

iii) Breakout

B) Single mode or multimode

i) Optical characteristics

C) Fibre material

i) Doping

ii) Cladding

iii) Thickness of layers

D) Buffering

i) Material

ii) Thickness

E) Coloring

i) Material

ii) Thickness

F) Water blocking

i) Material

G) Assembly

i) Type or lay

H) Strength members

i) Material

ii) Thickness

I) Jackets

i) Material

ii) Thickness

iii) Ripcords

INSTALLATION

A) Cable within raceway or without raceway

i) If cable without raceway,

a) Cable support/grip or Cable tray system

1) Type

I) Hook

II) Ladder

III) Solid bottom

IV) Trough

V) Channel

VI) Wire Mesh

VII) Single rail

2) Support spacing

3) Material

4) Thickness

5) Description

6) Fasteners

I) Material

II) Coating

III) Description

b) Cable bend radius

ii) If cable within raceway,

a) Raceway support

1) Spacing

2) Material

3) Thickness

4) Description

5) Fasteners

I) Material

II) Description

b) Raceway

1) Material

2) Properties

3) Coatings

I) Coating thicknesses

4) Thickness

5) Diameter

c) Raceway bend radius

d) *Raceway* coupling

1) Type

2) Material

3) Coatings

I) Coating thicknesses

II) Coating properties

4) Thickness

5) Diameter

6) Fasteners

I) Material

II) Description

e) Raceway cable fill ratio combinations

f) Pulling lubricant

g) Cable support/grip

B) Orientation

i) Horizontal with the minimum bend radius

ii) Vertical

5.1.1.1.4 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 (120 in) beyond the confines of the test furnace. Each cable or cable system is not to be closer than 305 mm (12 in) from the furnace edge.

A 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.

B 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.

5.1.1.1.5 Each cable construction shall be tested in both vertical and horizontal orientation. 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 B). The basis of the selection process used are acknowledged and documented as part of the reporting.

5.1.1.2 Power, Instrumentation, Control, and Data Cables

5.1.1.2.1 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.

5.1.1.2.2 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.

5.1.1.2.3 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).

5.1.1.2.4 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).

5.1.1.2.5 The cables shall be tested at their maximum rated voltage or the maximum utilization voltage. In any case, the test voltage shall not be less than 50 V. The test voltage applied shall be in AC volts (phase to phase).

5.1.1.3 Data Cables

5.1.1.3.1 Cables used for data, such as communication cables or optical fibre cables, shall be tested for Bit Error Rate (BER) as described in Clause 5.1.1.3.2 through 5.1.1.3.5.

5.1.1.3.2 The BER Test (BERT) shall consist of a test pattern generator and a receiver that are set to the same test pattern. The generator and receiver are used in pairs with one at either end of the transmission link, or alternatively, with a loop back at the remote end. See FIGURE 6.

NOTE 1: BERT units are typically stand-alone specialized instruments, but can also be a personal computer based system.

NOTE 2: A function within the BER testing device compares the outgoing source signal with the return signal and determines any discrepancy in the incoming data. The discrepancy is reported as a bit error rate relative to the sources data rate over a time period.

5.1.1.3.3 The source data shall be an RS-485 type protocol with a minimum data rate of 9600 b/s up to and including 10 Gb/s. See TABLE 1. The data rate shall be the rate intended for the intended application and rating as determined by the submitter.

5.1.1.3.4 No error correction shall be employed during the BERT.

5.1.1.3.5 Prior to the commencement of the fire test, the BERT set-up shall be verified to ensure that the source data transmission and reception through the system reports a zero bit error rate.

5.1.2 Test Assembly

5.1.2.1 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.

5.1.2.2 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.

5.1.2.3 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 fibre 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.

5.1.2.4 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 (9 ft 10 in). See FIGURE 2.

5.1.2.5 The supporting structure used shall be a wall structure. 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 (12 ft by 12 ft) and shall be provided with openings for the cables or cable system spaced 3000 mm (9 ft 10 in) apart. See FIGURE 2 for a typical combined set up of vertical and horizontal tests.

5.1.2.6 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 CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, and ANSI/UL 263, Standard for Fire Tests of Building Construction and Materials.

5.1.3 Test Furnace

5.1.3.1 The test furnace shall comply with the equipment specified in CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, and ANSI/UL 263, Standard for Fire Tests of Building Construction and Materials.

5.1.4 Time-Temperature Curve

5.1.4.1 Fire tests shall be controlled by the standard time-temperature curve in CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, and ANSI/UL 263 , Standard for Fire Tests of Building Construction and Materials, as shown in FIGURE 1.

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.

5.1.5 Furnace Temperature Measurement

5.1.5.1 The measurements, control and instrumentation shall comply with CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, and ANSI/UL 263, Standard for Fire Tests of Building Construction and Materials.

5.1.6 Application Of Load (Maximum Rated Or Maximum Utilization) Voltage, $E_{applied}$ (Circuit Integrity Test For Power, Instrumentation, Control And Data Cables As Applicable)

5.1.6.1 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 3 and FIGURE 4. The maximum voltage shall be as stipulated in Clause 5.1.1.2.5.

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

5.1.6.3 The load (maximum rated or maximum utilization) voltage ($E_{applied}$) shall be monitored and maintained at the voltage value determined in Clause 5.1.6.4.

5.1.6.4 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.

5.1.6.5 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 Clause 5.1.6.6.

5.1.6.6 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.

5.1.6.7 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 3 and FIGURE 4.

5.1.7 Insulation Resistance

5.1.7.1 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 3 and FIGURE 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.

5.1.7.2 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 3 and FIGURE 4, the voltage drop across the known resistance shall be measured and the insulation resistance calculated using the formula in Equation (1):

Equation (1)

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

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

5.1.8 Leakage Current

5.1.8.1 General

5.1.8.1.1 The leakage current shall be determined by the method described in Clause 5.1.8.2, Current Transducer Method, during the fire exposure test and after the hose stream test.

5.1.8.2 Current Transducer Method

5.1.8.2.1 Two current transducers shall be installed on the selected conductor. One current transducer (CT_1) is to be located between the fuse in accordance to Clause 5.1.6.6 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 3 and FIGURE 4.

5.1.8.2.2 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 5 minute period following the hose stream test.

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

Leakage Current = current measured by CT_1 – current measured by CT_2

5.1.9 Bit Error Rate Test For Data Cables

5.1.9.1 Prior to the initiation of the fire tests, each sample circuit shall be connected to the BERT device. The BERT set-up shall be started and verified to confirm that the source data transmission and reception through the system reports a zero bit error rate.

5.1.9.2 The source data rate as determined in Clause 5.1.1.3.3 and the verified bit error BER shall be recorded.

5.1.9.3 The furnace shall be ignited only after the BERT circuit has been verified as indicated in Clause 5.1.9.1.

5.1.9.4 The source data rate shall be monitored and maintained for the duration of the test period.

5.1.9.5 The source data rate and BER shall be recorded at intervals not exceeding 1 minute during the fire test.

5.1.10 Conduct Of Fire Endurance Test

5.1.10.1 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 to 32 °C (50 to 90 °F). If mechanical ventilation is employed during the test, no air stream shall be directed across the surface of the sample.

5.1.10.2 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.

5.1.10.3 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.

5.2 HOSE STREAM TEST

5.2.1 Test Assembly

5.2.1.1 The hose stream test shall be conducted no longer than 5 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 Clause 6.2.1.

5.2.1.2 The hose stream test shall be conducted in accordance with the requirements in CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, or ANSI/UL 263, Standard for Fire Tests of Building Construction and Materials.

5.3 TENSILE STRENGTH TEST

5.3.1 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 Clauses 5.3.2 through 5.3.7.

NOTE 1: For Canada, CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations, contains the requirements for supporting of cables in vertical runs of raceway. For the United States, ANSI/NFPA 70, National Electrical Code, 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, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations, and/or ANSI/NFPA 70, National Electrical Code, 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.

5.3.2 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.

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

5.3.4 The length of the raceway exposed in the furnace shall be 2400 mm ± 150 mm (8 ft ± 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 5.

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

5.3.6 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).

5.3.7 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.

5.3.8 The test sample shall be subjected to the fire exposure test described in Clause 5.1.4.1 for a period at least equal to the cable integrity test.

6 CONDITIONS OF ACCEPTANCE

6.1 DETERMINATION OF CIRCUIT INTEGRITY

6.1.1 For power, instrumentation, and control cables, the conductors shall maintain continuity and supply voltage and current to the load as described in Clauses 6.1.1.1 and 6.1.1.2.

6.1.1.1 The fuse required in Clause 5.1.6.6 shall not open for the duration of the test.

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

6.1.1.3 The insulation resistance of the power, instrumentation, and control cable shall be reported.

6.1.2 For data cables, the cable shall maintain error free data transfer and retrieval throughout the test as described in Clause 6.1.2.1.

6.1.2.1 The bit error rates during the BER test shall not exceed the maximum for the total bits transferred as shown in TABLE 1.

6.1.3 Each fire-resistive cable system shall have a single hourly rating. The system hourly rating shall be the lesser of the hourly rating achieved by the system that is required to be tested.

6.2 HOSE STREAM TEST

6.2.1 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 cables, verify that the source data transmission and reception through the system is not broken.

6.3 TENSILE STRENGTH TEST

6.3.1 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 Clause 5.3.6.

7 REPORT

7.1 RESULTS

7.1.1 The report of the performance of cable samples during these tests shall include the information contained in Clause 5.1.1.2, Power, Instrumentation, Control and Data 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 behaviour 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;

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 Clause 6.3.1;

M For power, instrumentation, and control cables, 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 and control 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; and

P For data cables, recorded data on the test protocol, transferred data rate, error count and the total bits transferred.

8 MARKINGS

8.1 The cable shall be marked with the following information:

A The type of cable, such as, MI, RC-90, RW90, FAS105, or otherwise in accordance with the CEC and/or MI, MC, RHW-2, FPLR, 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 ANSI/UL 2196, S139 for CAN/ULC-S139, 2196/S139 for ANSI/UL 2196 / CAN/ULC-S139, as appropriate);

C One of the following:

(i) Maximum fire-resistive rated voltage; or

(ii) Data rate and protocol.

D *Deleted*

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

F Manufacturer's Identification.

9 INSTALLATION INSTRUCTIONS

9.1 Each shipment of cable shall be provided with installation instructions that include the following:

A All relevant construction details of cable or cable system tested as listed in Clause 5.1.1.1.3 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, maximum data rate and/or loss, dedicated raceway required, etc.;

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:

(i) CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations;

(ii) CAN/ULC-S524, Installation of Fire Alarm Systems;

(iii) ANSI/NFPA 70, National Electrical Code;

(iv) ANSI/NFPA 72, National Fire Alarm and Signaling Code;

(v) ANSI/NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems;

(vi) ANSI/NFPA 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways;

(vii) Any applicable local standards and/or Codes.

TABLES

TABLE 1
DATA INTEGRITY BIT ERROR RATE (BER) RATIO

(Reference: Clauses 5.1.1.3.3, 6.1.2.1)

Data Rate	Error Count	Per Total Bits Transferred
9600 baud	1	1,000,000 (1^{06})
14,400 baud	1	1,000,000
28,800 baud	1	1,000,000
56K baud	1	1,000,000
115K baud	1	1,000,000
1 Mb/s	1	1,000,000
2.048 Mb/s	1	1,000,000
10 Mb/s	1	1,000,000
100 Mb/s	1	100,000,000 (1^{08})
1000 Mb/s – 10 Gb/s	1	100,000,000

FIGURES

FIGURE 1

STANDARD TIME-TEMPERATURE CURVE FOR CONTROL OF FIRE TESTS

(Reference: Clause 5.1.4.1)

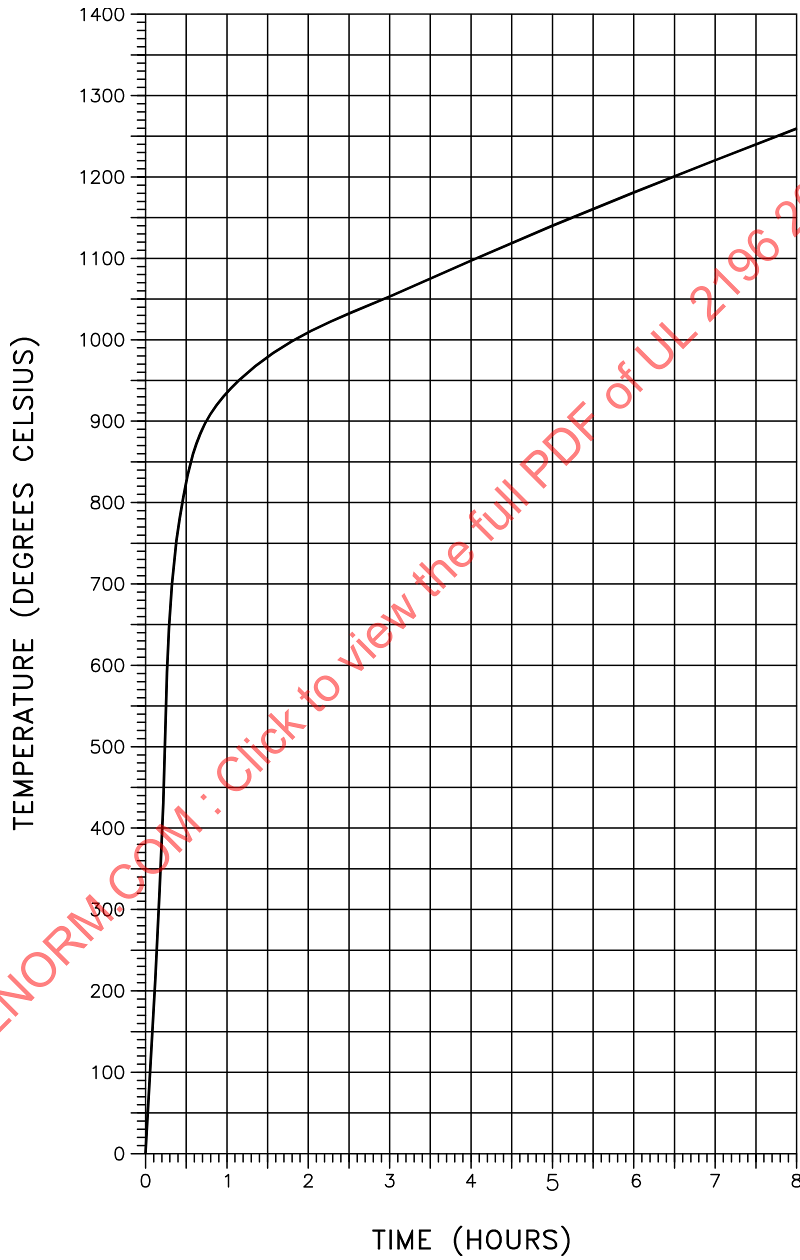
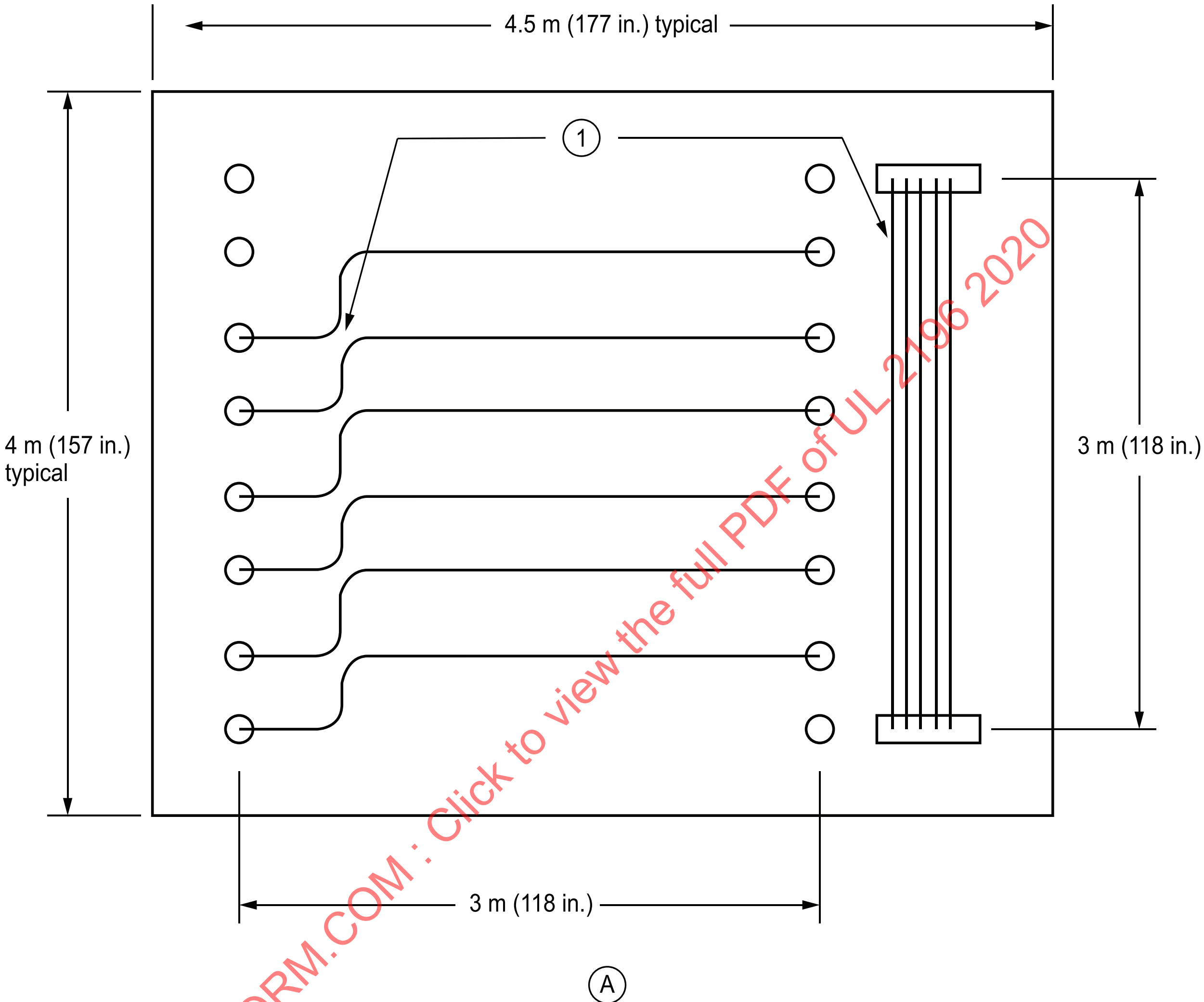


FIGURE 2

VERTICAL WALL ASSEMBLY CONSTRUCTED OF BRICK AND MORTAR

(Reference: Clause 5.1.2.4, 5.1.2.5 A)



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LEGEND

A Fire Exposed Side

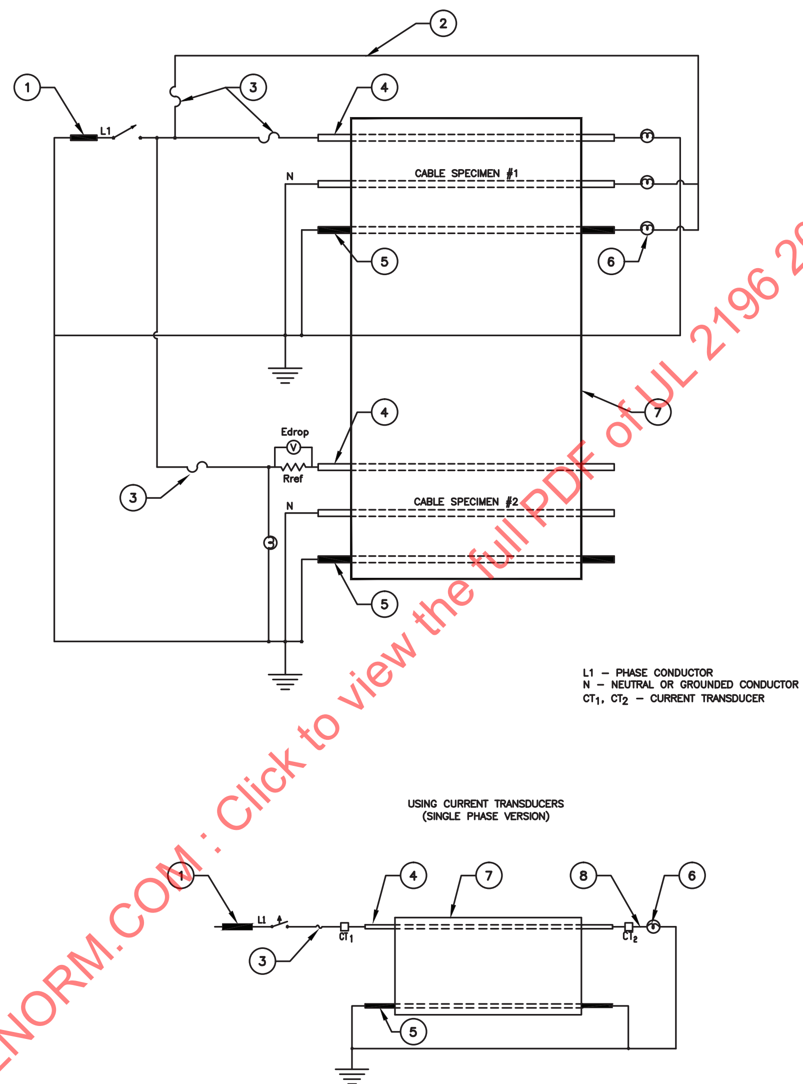
1 Five samples, each horizontal and vertical, terminating on the other side of the wall.

FIGURE 3

CONTINUITY AND INSULATION RESISTANCE TEST CIRCUITS

(SINGLE PHASE VERSION)

(Reference: Clauses 5.1.6.1, 5.1.6.7, 5.1.7.1 Note, 5.1.7.2, 5.1.8.2.1)



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 Clause 5.1.7.1.

LEGEND

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)

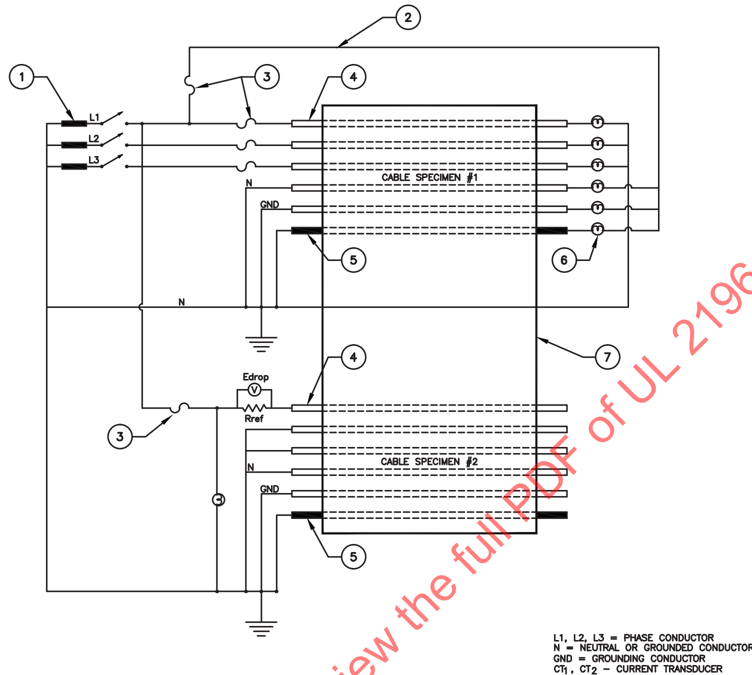
9 Isolation Transformers between each Power Source and its Circuit (not identified in figure)

FIGURE 4

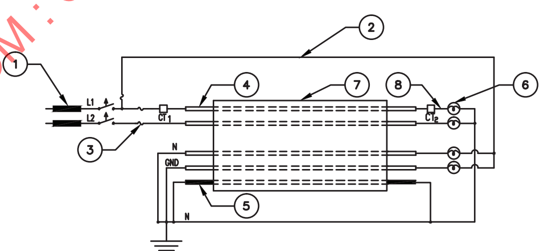
CONTINUITY AND INSULATION RESISTANCE TEST CIRCUITS

(THREE PHASE VERSION)

(Reference: Clauses 5.1.6.1, 5.1.6.7, 5.1.7.1 Note, 5.1.7.2, 5.1.8.2.1)



USING CURRENT TRANSDUCERS
(THREE PHASE VERSION)



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 Clause 5.1.7.1.

LEGEND

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)