

SUMMARY OF TOPICS

The following changes in requirements to the Standard for Discharge Lamp Control Devices, Part 1 – General Requirements, NMX-J-611/1-ANCE / CSA C22.2 No. 74-1 / UL 935-1, are being proposed for preliminary review and comment only:

1. For Preliminary Review Only: This Proposed First Edition of the Standard for Discharge Lamp Control Devices, Part 1 – General Requirements, NMX-J-611/1-ANCE / CSA C22.2 No. 74-1 / UL 935-1, includes the following proposals: a) Scope changes to include the use of the term “control gear” to encompass various discharge technologies, such as fluorescent and high intensity discharge; b) Revised definitions including appropriate terms for control gear and included lamp technologies; c) Revised general requirements for fire hazard, shock hazard and installation requirements to harmonize the requirements across the affected region; d) Revised requirements for components harmonized across the affected region, where possible; e) Lamp Control Gear environmental considerations were changed to Dry, Damp Type 1 (outdoor Type 1), Damp Type 2 (outdoor Type 2), and weather location (weatherproof) to harmonize them across the region; f) Harmonized construction requirements across the affected region, where possible; g) Revised resistance to corrosion requirements harmonized across the affected region, where possible; h) Revised compound, connection to mains, terminals, lead wires, other internal wires, plugs and cords and terminal parts requirements for harmonization across the affected region, where possible; i) Revised shock hazard considerations to harmonize across the affected region, where possible; j) Revised insulation materials and systems harmonized across the affected region, where possible; k) Requirements for bushings, coils, printed wiring boards, power capacitors, thermal protectors and protective devices in lamp control gear Class P harmonized across the affected region, where possible; l) Revised overcurrent protection, polymeric materials and markings to harmonize across the affected region, where possible; m) Revised lamp control gear general part testing requirements to harmonize across the affected region, where possible.

COMMENTS DUE: April 10, 2017

This proposal is for review and comment only (no ballot at this time). Please note that comments on a preliminary review document will not receive a response from the proposal author through CSDS. Instead, the proposal author will be asked to review the comments and adjust the proposals and/or supporting rationale as the author determines to be appropriate. The preliminary review process is an informal mechanism that provides authors with the opportunity to refine their proposals before they advance to the next stage in UL's standards development process.

In some cases, the author of the proposals may choose to discontinue them. In this case, the author need not do anything after preliminary review has ended. Normally, the next step in the process is the more formal STP ballot and stakeholder review process. Only comments posted during the STP ballot and stakeholder review process will be provided with a response in CSDS.

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<http://ulstandards.ul.com/develop-standards/participation/interest-categories/>

If you are interested in applying for STP 935 membership or are aware of potential candidates for this STP, please contact the STP Project Manager, Ritu Madan at Ritu.Madan@ul.com.

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~.

1. For Preliminary Review Only: This Proposed First Edition of the Standard for Discharge Lamp Control Devices, Part 1 – General Requirements, NMX-J-611/1-ANCE / CSA C22.2 No. 74-1 / UL 935-1, includes the following proposals: a) Scope changes to include the use of the term “control gear” to encompass various discharge technologies, such as fluorescent and high intensity discharge; b) Revised definitions including appropriate terms for control gear and included lamp technologies; c) Revised general requirements for fire hazard, shock hazard and installation requirements to harmonize the requirements across the affected region; d) Revised requirements for components harmonized across the affected region, where possible; e) Lamp Control Gear environmental considerations were changed to Dry, Damp Type 1 (outdoor Type 1), Damp Type 2 (outdoor Type 2), and weather location (weatherproof) to harmonize them across the region; f) Harmonized construction requirements across the affected region, where possible; g) Revised resistance to corrosion requirements harmonized across the affected region, where possible; h) Revised compound, connection to mains, terminals, lead wires, other internal wires, plugs and cords and terminal parts requirements for harmonization across the affected region, where possible; i) Revised shock hazard considerations to harmonize across the affected region, where possible; j) Revised insulation materials and systems harmonized across the affected region, where possible; k) Requirements for bushings, coils, printed wiring boards, power capacitors, thermal protectors and protective devices in lamp control gear Class P harmonized across the affected region, where possible; l) Revised overcurrent protection, polymeric materials and markings to harmonize across the affected region, where possible; m) Revised lamp control gear general part testing requirements to harmonize across the affected region, where possible.

RATIONALE

Proposal submitted by: Karen Willis, THSC 34C Secretary, on Behalf of the Technical Harmonization Subcommittee for Ballasts

CANENA Technical Harmonization Subcommittee (THSC) 34C has prepared a draft proposal to harmonize the ballast safety requirements in the North America region. The THSC noted that the countries involved (NAFTA countries Canada, U.S., and Mexico) share similar electrical installation codes and electrical safety practices, yet, different standards requirements for products have been applicable in the different countries. The results of the THSC activity is this tri-national ballast standard draft which is intended to harmonize the technical requirements in the region.

The following contains the proposed requirements for the First Edition of the Standard for Discharge Lamp Control Devices, Part 1 – General Requirements, NMX-J-611/1-ANCE / CSA C22.2 No. 74-1 / UL 935-1. This proposal is considered Part 1, which describes general requirements applicable to all type of ballasts, unless specifically exempted. General requirements include construction requirements, components requirements, electrical spaces, and other. This tri-national standard has been developed with the inclusive participation of representatives from the three countries.

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This Proposed First Edition includes the following major changes in requirements:

- a) Scope changes: to include the use of the term “control gear” to encompass various discharge technologies, such as fluorescent and high intensity discharge.
- b) Definitions changes: to include appropriate terms for control gear and included lamp technologies.
- c) General Requirements: fire hazard, shock hazard and installation requirements have been revised to harmonize the requirements across the affected region.
- d) Components Requirements: component requirements have been harmonized across the affected region, where possible. Where harmonization was not possible, appropriate national deviations have been included in the proposed standard.
- e) Environmental Considerations: Lamp Control Gear environmental considerations were changed to Dry, Damp Type 1 (outdoor Type 1), Damp Type 2 (outdoor Type 2), and weather location (weatherproof) to harmonize them across the region.
- f) Construction Requirements: construction requirements have been harmonized across the affected region, where possible. Where harmonization was not possible, appropriate national deviations have been included in the proposed standard. Items such as enclosure thickness, openings, paints and varnishes have also been included.
- g) Resistance to Corrosion: these requirements have been harmonized across the affected region, where possible. Where harmonization was not possible, appropriate national deviations have been included in the proposed standard. The original proposal, from UL, included damp location, indoor user corrosion protection, wet location requirements and others.
- h) Compound, connection to mains, terminals, lead wires, other internal wires, plugs and cords and terminal parts requirements: these requirements have been harmonized across the affected region, where possible. Where harmonization was not possible, appropriate national deviations have been included in the proposed standard. Items such as compound, terminals and means of connection to the mains were added.
- i) Shock Hazard Considerations: these have been harmonized across the affected region, where possible. Where harmonization was not possible, appropriate national deviations have been included in the proposed standard. In addition, the THSC felt it important to include information for different lamp control gear technologies.
- j) Insulation Materials and Systems have been harmonized across the affected region, where possible. Where harmonization was not possible, appropriate national deviations have been included in the proposed standard.
- k) Bushings, coils, printed wiring boards, power capacitors, thermal protectors and protective devices in lamp control gear Class P requirements have been harmonized across the affected region, where possible. Where harmonization was not possible, appropriate national deviations have been included in the proposed standard.
- l) Overcurrent protection, polymeric materials and markings have been harmonized across the affected region, where possible. Where harmonization was not possible, appropriate national deviations have been included in the proposed standard. Items such as fuses, PCB fuses, polymer properties and labels were included.

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m) Lamp control gear general part testing requirements have been harmonized across the affected region, where possible.

Part 2's of this standard will be published at a later date and will include descriptions of test procedures, test modules, and specific requirements. Until the appropriate Part 2 is published, the current editions of United States (UL 935, UL 1029), Canada (CSA C22.2 No. 74 and CSA-E61347-2-3), and Mexico (NMX-J-156, 198, 230, 503, 513-ANCE) are to be used.

Part 2 will be divided into several parts covering the following types:

Part 2-1: Control devices both conventional magnetic and electronic, for fluorescent lamps, rapid-start, instant-start, pre-heat, and hybrid types.

Part 2-2: Control devices both conventional magnetic and electronic, for high-pressure sodium vapor, mercury vapor, metal halide, and low-pressure sodium lamps.

Part 2-3: Glow starters.

Part 2-4: Fluorescent accessories.

Part 2-5: Ignitors and auxiliaries.

Part 2-6: (Reserved for future use)

Note: The fluorescent lamps are of heated or cold cathode types.

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PROPOSAL

1 Scope

1.1 This standard applies to lamp controlgear of the resistance, reactance, and electronic (solid state) types for use with electric discharge lamps that are intended to be installed or used on branch circuits of 600 V nominal or less, in accordance with the Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, CSA C22.1 (CEC Part I); the Canadian Electrical Code, Part II, General Requirements, CSA C22.2 No. 0; the National Electrical Code (NEC), ANSI/NFPA 70; and La Norma de Instalaciones Electricas [Mexican Electrical Code (MEC)], NOM-001-SEDE.

1.2 This Standard also applies to other auxiliary equipment associated with discharge lighting.

1.3 This Standard does not apply to:

- a) Neon transformers or power supply sources covered by CSA C22.2 No. 255 and UL 2161;
- b) Power supplies for low voltage landscape lighting covered by CSA C22.2 No. 250.7 and UL 1838; and
- c) LED drivers, controllers, arrays, modules, or packages.

1.4 This Part 1 is to be used in conjunction with the appropriate Part 2, which contains clauses to supplement or modify the corresponding clauses in this standard.

1.5 In Mexico, this standard applies only to control devices with a single-phase or two-phase voltage of 2,000 V or less, based on that which is described in NOM-001-SEDE. The nominal supply voltage of these control devices includes one or more of the following: 120 V, 127 V, 220 V, 240 V, 254 V, 277 V, 440 V, and 480 V a.c. with momentary variances of $\pm 10\%$, 60 Hz and 24 V d.c. This standard also applies to electronic control devices that can operate on a continuous range of supply voltages, as long as this range includes one or more of the voltages mentioned above.

In Canada and the United States, this requirement does not apply.

1.6 In Mexico, for multi-voltage or multi-terminal control devices, specifications are verified at the voltage indicated by the corresponding test method.

In Canada and the United States, this requirement does not apply.

2 Reference Publications

2.1 Where undated reference is made to any standard, such reference shall be considered to refer to the latest edition and all amendments published to that edition up to the time when this standard was approved. See Annex A.

2.2 The product shall comply with the latest edition of the installation codes and standards as appropriate for the country where the product is 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 the countries in which it is intended to be used.

2.3 The following national electrical codes are referenced in this standard:

Canadian Electrical Code, Part 1 (CE Code, Part 1), CSA C22.1

National Electrical Code (NEC), ANSI/NFPA 70

La Norma de Instalaciones Electricas [Mexican Electrical Code (MEC)], NOM-001-SEDE

3 Definitions

3.1 The following terms and definitions apply in this standard.

In Mexico, Clause 3 is not applicable. See NMX-J-619-ANCE for all definitions applicable to Mexico.

3.2 Ballast – A device that by means of reactance or resistance, singly or in combination, limits the current of a lamp to the required value for proper operation and, where necessary, provides adequate starting voltage; and in the case of rapid start circuits, provides for low-voltage lamp filament heating.

3.3 Class P protected (ballast) – A ballast that is integrally protected from overheating, where the ballast and protection combination comply with the requirements in this standard.

3.4 Compact fluorescent lamp – A fluorescent lamp of a small compact shape (such as, folded construction) with all contacts terminating in a single base that performs the entire mechanical support function.

3.5 Conditioned lamp – A previously unused lamp that has been operated for a minimum of 100 hr before testing.

3.6 Control device (ballast) – A unit inserted between the supply and one or more discharge lamps which by means of inductance, capacitance, or a combination of inductance and capacitance, serves mainly to limit the current of the lamp(s) to the required value. It may also include means for transforming the supply voltage and arrangements, which help, provide starting voltage and pre-heating current.

3.7 Control device, Class P protected – A control device that is integrally protected from overheating, where the control device and protection combination comply with the requirements of this standard. Class P protection may be achieved by a discrete thermal protector or inherent protection, such as over-current device or other electronic means.

3.8 Control device, conventional magnetic – A control device that consists of a coil of wire wound on a core and operates at the supply line frequency. A conventional magnetic control device is either a transformer type or a simple reactance type. A power capacitor can be provided with the magnetic control device.

3.9 Control device, fixed – A control device intended to be permanently connected electrically.

3.10 Control device, built-in – A device generally designed to be built into a luminaire, a box, an enclosure, or the like and not intended to be mounted outside a luminaire, etc. without special precautions.

3.11 Control device, independent – A control device that has its own enclosure and can be mounted separately or attached to the outside of a luminaire.

3.12 Control device, multiple-terminal (-tap) – A control device operated with more than one nominal voltage as marked on the control device (one lead at a time).

3.13 Control device, non-recessed – A control device intended to be mounted in a remote location, such as an equipment closet, that would not encounter building thermal insulation.

3.14 Control device, reactance – A control device, the impedance of which is provided by inductive reactance, capacitive reactance, or both inductive and capacitive reactance.

3.15 Control device, recessed – A thermally protected control device intended to be mounted in a recessed space that may be remote from a fixture. All insulation is intended to be spaced at least 76.2 mm (3 in) from the sides of the control device. However, if insulation contacts the control device it is provided with thermal protection that will prevent it from overheating.

3.16 Control device, remote – A control device that is not intended for mounting on a fixture or that is intended to be mounted on the fixture 460 mm (18 in) or more from the housing as measured from the nearest point on the control device to the nearest point (other than an incidental projection) on the housing. The control device may be either recessed or non-recessed. The control device may or may not be provided with the luminaire.

3.17 Control device, resistance – A control device in which the impedance is provided by a resistor or resistance wire.

3.18 Control device, two-winding transformer (isolating type) – A control device having independent insulated primary and secondary windings with no common connection between them, except that a minimum resistor of 470,000 Ω may be connected between the windings to aid in lamp starting.

3.19 Deactivated lamp – A lamp end-of-life failure mode that is caused by the depletion of the filament emission material so that the lamp cannot be ionized. For rapid start and preheat circuits, a deactivated lamp may be simulated with two lamps having a lampholder connected to one end of each lamp. For instant start circuits employing a circuit-interrupting lampholder, a deactivated lamp may be simulated by removing the lamp and shorting the circuit-interrupting lampholder.

3.20 Instant-start circuit – Circuit that employs a high open-circuit voltage to start lamps, usually having a single contact at each end.

3.21 Live part – A conductive part without basic insulation, where there is a risk of electric shock. The neutral conductor is considered to be a live part.

3.22 Live part, hazardous – A live part and where a risk of electric shock exists. Electric shock exists when a potential difference of more than 42.4 V-peak is found between a live part and ground, or another live part.

3.23 Measured indication unit (MIU) – The output voltage across the meter, in milli-volts RMS, in the measurement instrument in Figure 9.2, divided by 500 ohms. The instrument indication is equal to the RMS value in milli-amperes when the frequency is 60 Hz (sinusoidal current). The reading is not always a direct indication of the RMS or other common amplitude quantifier of leakage current when the leakage current is of complex waveform or frequency other than 50 or 60 Hz.

3.24 Potting compound – An insulating material that is applied as a liquid and becomes a solid to either partially or totally surround electrical components. Materials can be thermal setting – such as epoxy, polyester, or silicone rubber – or thermoplastic such as asphalt or wax.

3.25 Power capacitor – A capacitor that is connected:

- a) In series with a lamp or lamps and provides the control device impedance for the lamp current,
- b) Across the primary winding of the control device or across an extension of the primary winding for power-factor correction, or
- c) Across a tertiary winding for voltage regulation.

3.26 Preheat circuit – A circuit with a control device connected in series with a lamp, and having a manual or automatic starter to cause an initial heating of the lamp filaments prior to ionizing the lamp. The starter, when closed, connects the two lamp filaments in series in the control device circuit.

3.27 Rated maximum temperature, t_C – Highest permissible temperature which may occur on the outer surface of the control device (at the indicated place, if marked) under normal operating conditions and at rated voltage or the maximum of the rated voltage range. The value of t_C would be determined by the device manufacturer and would be where the luminaire design measurement would be taken.

3.28 Type test – Test or series of tests made on a type-test sample for the purpose of checking compliance of the design of a given product with the requirements of the relevant standard.

3.29 Type-test sample – Sample consisting of one or more similar units submitted by the manufacturer or the responsible vendor for the purpose of the type test.

4 General Requirements

4.1 Fire and shock hazards and installation considerations

4.1.1 A control device shall be so constructed and assembled that it has the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without increasing its risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacing of electrical parts, loosening or displacement of parts, or other serious defects.

4.1.2 To verify the specifications given in this standard, the test methods referred to in each specification shall be applied.

4.1.3 Materials employed in a control device shall not be adversely affected by the temperature to which they are subjected during normal operation. See Normal Temperature Test, Clause 8.5.

4.1.4 In Mexico, unless otherwise specified, the tests are made preferably in the order of this standard.

In Canada and the United States, this requirement does not apply.

4.1.5 In Mexico, control devices must be designed and constructed in such a way that in normal use, they prevent and eliminate the risks of bodily harm to users.

In Canada and the United States, this requirement does not apply.

4.2 Units of measurement

4.2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4.2.2 All values of voltage and current are true rms values unless otherwise indicated.

4.2.3 For customary purposes, wire sizes are in AWG (American Wire Gauge).

4.2.4 In Canada and the United States, either a comma or period may be used as a decimal indicator.

In Mexico, the comma shall be used to follow SI convention in this standard.

4.3 Components

4.3.1 Except as indicated in Clause 4.3.2, a component of a product covered by this standard shall comply with the requirements for that component. See Annex A for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the ANCE, CSA, or UL standards as appropriate for the country where the product is to be used.

4.3.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

4.3.3 A component shall be used in accordance with its rating established for the intended conditions of use.

4.3.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

4.3.5 A capacitor shall not contain polychlorinated biphenyl (PCB).

Note: This is verified in Mexico by visual inspection through the marking of the product. In the United States and Canada, the use of capacitors with PCB oil is prohibited by federal standards.

5 Environmental Considerations (Classification)

5.1 In Canada and the United States, a device is categorized according to the use for which it is intended. A device in one category is acceptable for use in the category that precedes it in the following list. Parentheses () indicate the former designation.

- a) Dry, device intended for use only in indoor locations.
- b) Damp – Type 1 (outdoor – Type 1) location; device is acceptable for use with:
 - 1) Outdoor equipment,
 - 2) A luminaire intended for use in wet or damp locations, or

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- 3) An outdoor sign if the control device is within an overall electrical enclosure.
- c) Damp – Type 2 (outdoor – Type 2) location; device is acceptable for use with:
 - 1) Outdoor equipment,
 - 2) A luminaire intended for use in wet or damp locations, or
 - 3) An outdoor sign if the control device, in addition to its own enclosure, is within an overall enclosure (not rain tight).
- d) Wet location (weatherproof); device is intended for exposure to the weather without an additional enclosure.

In Mexico, a device is categorized according to the use for which it is intended. A device in one category is acceptable for use as in the category that precedes it in the following list:

- a) Dry, device intended for use only in indoor locations.
- b) Damp location (outdoor), device is acceptable for use with:
 - 1) Outdoor equipment,
 - 2) A luminaire intended for use in wet or damp locations, or
 - 3) An outdoor sign if the control device is within an overall electrical enclosure.
- c) Wet location (weatherproof), device is intended for exposure to the weather without an additional enclosure.

6 Construction

6.1 Enclosure

6.1.1 General

6.1.1.1 In Mexico and the United States, a device enclosure shall have the strength and rigidity required to resist the abuses to which it is liable to be subjected, without increasing the risk of electric shock or fire due to a reduction of the required spacing for live parts or the loosening or displacement of live parts. The acceptability of the enclosure is further determined by intended usage of the device and factors such as the enclosure material, the enclosure material thickness, and the openings in the enclosure.

In Canada, a control device enclosure shall:

- a) As a metallic electrical enclosure, prevent accessibility to live parts and parts insulated from live parts by only operational or basic insulation; or
- b) As a fire enclosure, be designed and constructed to minimize the spread of fire and contain molten metal, flaming or glowing particles, or flaming drops in the event of a fault in the electrical parts.

6.1.1.2 Control devices shall have the necessary strength and rigidity to resist abuses to which they are liable to be subjected without the specified spacing being reduced or parts becoming loosened or displaced and without the fire and shock hazard being increased when the ballast is properly installed in a luminaire.

6.1.1.3 For guidance in the use of this section, the intended usage would first be determined to be either an independent device or built-in device.

6.1.1.4 A simple reactance, open core-and-coil, control device is not required to have a complete enclosure.

6.1.1.5 A control device with lead wires or terminals on the side intended for mounting to, but outside of, the electrical enclosure of a luminaire would be considered an independent control. The requirements for independent control devices within this section would apply.

6.1.1.6 In Mexico and the United States, laminated core sections are not required to be enclosed.

In Canada, electrical components shall conform to the particular CSA C22.2 No. 0 standard covering such components and shall be suitable for the application.

6.1.2 Material and thickness

6.1.2.1 A control device shall be provided with an enclosure of metal or of a polymeric material that has been evaluated for the intended use. See Polymeric Materials, Clause 6.15 for requirements for a polymeric material used as an enclosure.

6.1.2.2 The thickness of a cast- or sheet-metal enclosure shall be in accordance with Table 6.1.

Table 6.1
Thickness of metal enclosures
(Clause 6.1.2.2)

Metal	Minimum thickness, in mm (in)					
	Independent		Independent		Built-in	
	> 5 kg	(> 11 lb)	≤ 5 kg	(≤ 11 lb)		
Die-cast metal	2.0	(5/64)	1.2	(3/64)		
Other cast metal	3.0	(1/8)	1.6	(1/16)		
Cast metal, non-reinforced flat surface	3.0	(1/8)				
Weatherproof rated						
Sheet steel, galvanized	1.40	(0.056)	1.40	(0.056)		
Sheet steel, uncoated	1.35	(0.053)	1.35	(0.053)		
Sheet steel, non-ferrous	0.80	(0.032)	0.80	(0.032)		
Other than weatherproof						
Sheet steel, galvanized	0.75	(0.029)	0.75	(0.029)	0.75	(0.029)
Sheet steel, uncoated	0.65	(0.026)	0.65	(0.026)	0.65	(0.026)
Sheet steel, uncoated or metal non-ferrous			0.50	(0.020)	0.50	(0.020)

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Table 6.1 Continued on Next Page



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Table 6.1 Continued

Metal	Minimum thickness, in mm (in)					
	Independent		Independent		Built-in	
	> 5 kg	(> 11 lb)	≤ 5 kg	(≤ 11 lb)		
Potted, Sheet steel uncoated or metal non-ferrous					0.40	(0.016)
Unpotted, and with insulated liner surrounding printed circuit board					0.40	(0.016)
Sheet metal, non-ferrous, including extruded			0.80	(0.032)		
Point of wiring system conduit connection						
Sheet steel, galvanized (other than WP)	0.85	(0.034)	0.85	(0.034)		
Sheet steel, uncoated (other than WP)	0.80	(0.032)	0.80	(0.032)		
Sheet steel non-ferrous	1.15	(0.045)	1.15	(0.045)		
Notes:						
These are minimum dimensions based on nominal metal gauge thicknesses. For example, 22 Manufacturers' Sheet Gauge, is 0.033 in, nominal, 0.026 in minimum. Because of the tolerance in metal gauge sizes, it may be necessary to increase the metal thickness so it is never less than the specified minimum.						
Metal is described as uncoated. However, when measured, it will have an additional metallic or organic coating when the control device is marked "Damp (Outdoor) – Type 1."						

6.1.2.3 Fibre or phenolic-composition sheet material can be used:

- a) For an end piece of the enclosure of a reactance control device when the material is not less than 1.6 mm (1/16 in) thick, secured in place so that all seams are closed, and rigidity supported to prevent displacement or removal; or
- b) As a bushing for a lead wire when the material is not less than 0.8 mm (1/32 in) thick, the exposed area of the piece is not more than 6.4 mm² (1/4 in²), and the insulating material is supported in a complete frame or rests on the metal enclosure around the entire perimeter. See Clause 6.9.2.

6.1.2.4 Fibre shall not be employed for any part of the enclosure or for lead wire bushings of a control device intended for damp or wet applications, and fibrous material shall not be used for any internal part of a control device damp or wet applications unless it is covered completely with a material that will prevent the absorption of moisture by the fibrous material.

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6.1.3 Openings

6.1.3.1 A control device that is potted is determined to be enclosed when:

- a) All seams are overlapped, except that a total length of not more than 75 mm (3 in) of butt seam meets the intent of this requirement when no opening in such seam is more than 3.2 mm² (0.005 in²) in area and the total area of such openings is no more than 160 mm² (0.250 in²); and
- b) The perimeter of each opening for a lead wire fits closely around the wire that it encircles. An opening of 3.2 mm (0.125 in) diameter or less complies with this requirement.

6.1.3.2 A control device that is potted with a closure for a hole no larger than 3.2 mm² (0.5 in²) in area in the base of a metal enclosure complies with this requirement, if:

- a) The closure is not less than 0.35 mm (0.014 in) thick;
- b) The surrounding metal is reinforced by forming; and
- c) The closure is secured in place so that it cannot be removed without the use of a tool.

6.1.3.3 A Class P control device without potting is not required to have lapped seams where parts of the enclosure are joined.

6.1.3.4 For an independent control device, parts that are required to be enclosed shall not be accessible through any opening during operation, or during normal servicing. The probe illustrated in Figure 6.5 shall be used to determine accessibility. It shall not contact parts that are required to be enclosed when inserted in every position. Where necessary, an electrical indicator shall be used to determine whether or not contact is made. Regardless of shape, openings, if provided, shall not adversely affect the strength or rigidity of the enclosure.

6.1.3.5 For an independent control device, openings located 12.5 mm (0.5 in) or less from the surface on which an enclosure is intended to be mounted shall be considered as mounting holes, and all other openings shall be considered as ventilating holes, except for drain holes. Drain holes shall not be less than 3.2 mm (0.125 in) nor more than 6.4 mm (0.250 in) in diameter.

6.1.3.6 For an independent control device, there shall not be more mounting holes where alternative means of mounting are provided; otherwise no more than two shall be provided open. Other mounting holes may be in knock-out form.

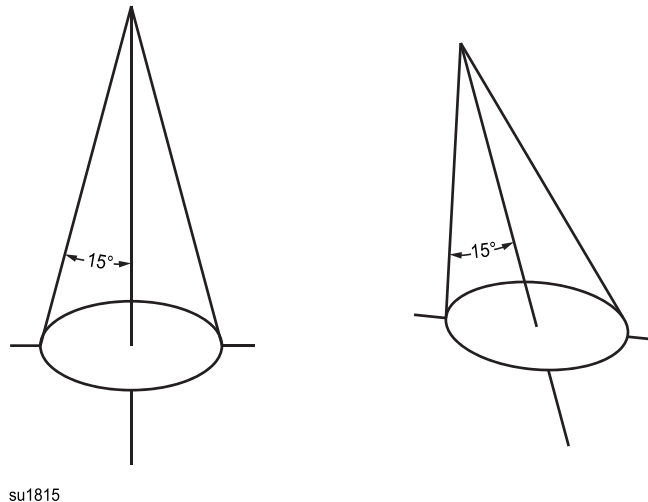
6.1.3.7 For an independent control device, ventilating and drain holes may be located in any surface, except none shall be provided directly below parts that are required to be enclosed in accordance with Clause 6.1.3.4, unless the parts are baffled. Ventilating holes shall not exceed 15% of the total area of the enclosure.

6.1.3.8 For an independent control device, a baffle as specified above:

- a) Be made of metal meeting the appropriate requirements of Clause 6.1.2 or of non-metallic material complying with flame resistance requirements for Polymeric Materials, Clause 6.15;
- b) Be without perforations, except as noted below; and

- c) Be located within, and having a dimension at least equal to the perimeter of the cone shown in Figure 6.1.

Figure 6.1
Interpretation of “directly below”
 (Clause 6.1.3.8)



“Directly below” is determined by drawing an imaginary cone as shown from the part involved. The cone shall always be drawn vertically regardless of the slope on the bottom of the enclosure. Any opening in the area of this circle is considered directly below the part involved.

6.1.3.9 In Canada and the United States, a built-in, Class P, electronic control device is able to have openings when:

- The control device is provided with an overcurrent protective device rated 5 A or less or is provided with a foil trace that meets the requirements of this standard;
- Circular openings have a diameter not exceeding 3 mm (0.12 in) and minimum spacing between circular openings is 3 mm (0.12 in);
- Rectangular (or square) openings have dimensions not exceeding 3 mm (0.12 in) across and 30 mm (1.18 in) in length;
- The pattern of openings for metal enclosures is such that the through air clearance between live parts and the dead metal enclosure is not reduced below the values specified in Spacing Between Live Parts, Clause 6.8, when the enclosure is subjected to the Rod Pressure Loading Test, Clause 8.16. The pattern of openings for plastic enclosures is not specified;
- Openings are due to the fit between an enclosure and a printed wiring board that extends beyond the enclosure for push-in connectors; and

- f) The Class P, electronic control device is marked in accordance with Clause 7.4.3.

In Mexico, a built-in, Class P, electronic control device is able to have openings when:

- a) The control device is provided with an overcurrent protective device rated 5 A or less or is provided with a foil trace that meets the requirements of this standard;
- b) Circular openings have a diameter not exceeding 3 mm (0.12 in) and minimum spacing between circular openings is 3 mm (0.12 in);
- c) Rectangular (or square) openings have dimensions not exceeding 3 mm (0.12 in) across and 30 mm (1.18 in) in length;
- d) Openings are due to the fit between an enclosure and a printed wiring board that extends beyond the enclosure for push-in connectors; and
- e) Openings are due to the fit between an enclosure and a printed wiring board that extends beyond the enclosure for push-in connectors; and
- f) The Class P, electronic control device is marked in accordance with Clause 7.4.3.

6.1.3.10 An independent, Class P, electronic control device is able to have openings when the control device is provided with an overcurrent protective device rated at 5A or less or is provided with a foil trace that meets the requirements of this standard.

6.1.4 Special conditions

6.1.4.1 Independent control devices intended for mounting on outlet box covers shall be provided with an outlet box cover of not less than 1.3 mm (0.052 in) in thickness and shall conform to the requirements of Clause 6.1.4.3. Covers shall have mechanical strength and rigidity at least equivalent to that of steel 1.3 mm (0.052 in) thick. Covers made from material other than metal shall be subject to evaluation.

6.1.4.2 Where a control device has a mass greater than 11.3 kg (25 lb), it shall be supported independently of the outlet box or by means of a hanger with an integral outlet box.

6.1.4.3 If covers of enclosures are provided to give access to fuses, thermal protectors, or other overload devices that require renewal, the covers shall be hinged or otherwise held captive. Electrical parts shall not be mounted on covers unless the covers are hinged and prevented from opening to a degree that causes strain on wiring.

6.1.4.4 Removable parts secured by friction or spring retained shall comply with the bonding requirements of Provision for Grounding and Bonding, Clause 6.6.

6.1.4.5 Wet location (weatherproof) control devices shall comply with the Water Spray Test, Clause 8.11.

6.2 Resistance to corrosion

6.2.1 General

6.2.1.1 Enclosures or other parts constructed of iron or steel shall be suitably protected from rusting by painting, plating, or an equivalent. Both inside and outside surfaces of an enclosure shall be protected. A protective coating need not be applied to:

- a) The interior of a control device enclosure that is completely filled with potting compound; or
- b) Flat metal surfaces that are tightly clamped together.

6.2.1.2 Exposed surfaces of the iron from which a core is assembled shall be protected from rusting, typically by paint or electrical varnish.

6.2.2 Devices designated for damp locations (outdoor)

6.2.2.1 A control device marked for a Damp – Type 1 rating shall comply with Clause 6.2.1.1 and 6.2.1.2, any relevant requirement of this section, and have lead wire insulation that complies with Clause 6.5.3.8.

6.2.2.2 A control device marked with a Damp – Type 1 rating and that is not provided with an enclosure, such as in an open, core-and-coil control device, shall comply with the following:

- a) Be impregnated to reduce the risk of absorption of moisture. However, a bobbin of nylon or other molded plastic is acceptable without further impregnation.
- b) Have lead wire insulation that complies with Clause 6.5.3.8.
- c) Comply with the Insulation Resistance Test, Clause 8.7.

6.2.2.3 A control device marked for a Damp – Type 1 rating and incorporating pre-painted steel or steel with a metallic ASTM coating designated G60 or G90 is permitted to have untreated sheared edges or punched holes.

6.2.2.4 In Canada and the United States, a control device marked for Damp – Type 2 rating shall be potted or compound filled and protected against corrosion as specified in Table 6.2. In lieu of corrosion resistance the metallic coatings specified in Table 6.2, a steel enclosure provided with an organic coating complies with this requirement if comparative tests with galvanized-sheet steel (without annealing, wiping, or other surface treatment) conforming to ASTM coating designation G60 indicate the coating provides equivalent protection. Among the factors that are to be taken into consideration when judging the acceptability of such a coating system are exposure to salt spray and moist carbon dioxide-sulphur dioxide-air mixtures. The interior of a compound filled section of a control device need not be so protected.

In Mexico, this requirement does not apply.

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Table 6.2
Sheet-metal coatings
(Clause 6.2.2.4)

Type of coating	Coating designation or thickness in mm (in)
(A) Hot-dipped mill-galvanized steel	G60 or A60 ^a
(B) Zinc coating other than Type A	0.0104 (0.00041) ^b
^a Conforming with the coating Designation G60 (galvanized) or A60 (alloy) in Table 1 of the ASTM A525 with no less than 40% of the zinc on any side, based on the minimum single-spot-test requirement in this ASTM designation.	
^b Average thickness with a spot minus tolerance of 0.00178 mm (0.00007 in).	

6.2.3 Devices designated for wet locations (weatherproof)

6.2.3.1 A ferrous metal enclosure of a weatherproof control device shall be protected against corrosion with a coating of zinc that complies with one of the following:

a) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G90 in Table 1 of ASTM ASTM 653 with not less than 40% of the zinc on any side, based on the minimum single-spot-test requirement in the ASTM specification. The weight of zinc coating may be determined by any acceptable method; however, in case of question, the weight of coating shall be established in accordance with ASTM ASTM 490.

b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.015 mm (0.00061 in) on each surface with a minimum thickness of 0.014 mm (0.00054 in). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Clause 8.10. An annealed coating shall also comply with the requirement in Clause 6.2.3.5.

6.2.3.2 Ordinary painting or ordinary baked enamel is not considered to provide the necessary degree of protection for a cast-iron enclosure or exposed parts of a control device core of a weatherproof control device.

6.2.3.3 Hinges and other attachments of a weatherproof control device shall be resistant to corrosion by being non-ferrous metal that will not cause galvanic action with other metals of the control device.

6.2.3.4 Metals shall be used in combinations that are galvanized compatible.

6.2.3.5 An annealed zinc coating that is bent or similarly formed, after annealing shall also be painted in the bent or formed area if the bending or forming process damages the zinc coating. The zinc coating is considered damaged if flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25-power magnification. Simple sheared or cut edges and punched holes are not considered to be formed but extruded and rolled edges and holes shall comply with this requirement.

6.2.3.6 Hinge pins and other attachments shall be of a suitable non-ferrous metal that will not cause galvanic action with other metals of the control device.

6.2.3.7 Weatherproof control devices shall be marked in accordance with Clause 7.1.3.

6.3 Means for mounting

6.3.1 Control devices for permanent installation shall be provided with at least two mounting feet or ears external to the enclosure, or be arranged otherwise for at least two-point support to prevent turning.

6.3.2 A control device without a means for mounting shall have appropriate mounting in the end product application.

6.3.3 A control device that is connected in a supply cord (through cord control device) shall not be provided with any means, such as flanges, that may be used for permanent mounting.

6.3.4 In Canada, a direct plug-in control device shall not have a tab for securing the control device to a wall receptacle.

In Mexico and the United States, this requirement does not apply.

6.4 Compound (potting)

6.4.1 Compound shall not soften to the extent that it does not perform its intended function at the temperature to which it is likely to be subjected during normal and abnormal operation.

6.4.2 When subjected to the normal and abnormal temperature tests, there shall be no emission of potting or sealing compound used in control devices that would cause dripping.

6.4.3 In the case of resistor-type control devices, heat-resisting insulating cement or the equivalent shall be used.

6.4.4 An electronic control device marked for a Damp – Type 2 rating shall have the enclosure potted or compound filled.

6.4.5 An electronic control device marked for a Damp – Type 1 rating need not be filled with compound if:

- a) The printed circuit board(s) are provided with a conformal coating that shows no evidence of peeling, cracking, separation from the substrate, blistering, or the like, when subjected to the conditioning tests described in tests for conformal coatings of printed circuit boards shown in UL 746C or Annex B;
- b) The interior surfaces are protected against corrosion; and
- c) Spacing of uninsulated live parts is maintained for any uncovered components.

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6.5 Installation – supply mains and load connections (terminals)

6.5.1 Terminal box volume

6.5.1.1 A terminal or splice compartment for the connection of the source of supply and lamp lead wires shall provide field wiring space for the incoming wires and splices to the control device lead wires. Field wire size is expected to be 3.3 mm² (12 AWG). See Clause 6.5.1.3. However, a control device marked for use only in signs is expected to have 2.1 mm² (14 AWG) field wires.

6.5.1.2 The field wiring compartment volume shall be at least the sum of the number of the specific wire volume allowances from Table 6.3 multiplied by the number of specific wire sizes. See Volume Method of Measurement, Clause 8.17, for the procedure to determine the field wiring compartment volume.

Table 6.3
Conductor size for determination of the minimum terminal or splice compartment volume
(Clause 6.5.1.2)

Size of conductor, mm ² (AWG)	Conductor volume	
	cm ³	(in ³)
0.82 (18)	8.2	(0.5)
1.31 (16)	9.8	(0.6)
2.08 (14)	12.3	(0.75)
3.31 (12)	16.4	(1.0)
5.26 (10)	27.9	(1.7)

Example:
An autotransformer ballast has a 120 V input and operates two F32T8 lamps in a rapid start design. All ballast wires (2 supply and 6 lamp) are 0.82 mm² (18 AWG). There are 2 incoming 3.31 mm² (12 AWG) supply wires and 6 incoming 0.82 mm² (18 AWG) wires from the lampholders.

Required Volume = (14 × 8.2) + (2 × 16.4) = 147.6 cm³

6.5.1.3 The wire count shall include:

- Lamp wires entering a terminal or wire compartment;
- Grounding wires provided with the control device;
- Control device wires for the supply and alternate taps;
- Control device wires for the lamp;
- Control device wires for a capacitor, when the capacitor is externally connected; and
- Any accessory control wires.

For the purposes of calculating compartment volume, incoming supply wires are assumed to be 3.3 mm² (12 AWG) or 2.1 mm² (14 AWG) per the exception to Clause 6.5.1.1, and the lamp circuit wires are assumed to be 0.82 mm² (18 AWG).

6.5.1.4 There shall be no openings in a terminal or splice compartment other than those provided for drainage and those required for mounting the control device.

6.5.1.5 A hole for conduit in a weatherproof control device shall be threaded unless it is located entirely below the lowest live part of the device. Insulated lead wires are not considered live parts.

6.5.1.6 A bushed hole for open wiring shall not be located in the top or back of a weatherproof control device unless a hood fitting is provided. If a bushed hole is located in a side above live parts, it shall provide for a downward direction of the wires leaving the enclosure.

6.5.1.7 A nipple provided with a weatherproof control device for field connection to a splice box:

- a) Shall provide a smooth, rounded opening for the lead wires; and
- b) Shall be located in the bottom of the enclosure unless the lead wires are sealed within the nipple.

6.5.1.8 The words “below,” “lowest,” “top,” “back,” “side,” “above,” “downward,” and “bottom” in Clauses 6.5.1.5 – 6.5.1.7 denote relative positions while the control device is oriented as it is intended to be when mounted.

6.5.1.9 If threads for the connection of conduit are tapped all the way through the hole in a box wall, or if an equivalent construction is employed, there shall not be less than 3.5 or more than 5 threads in the metal. The construction of the device shall be such that a conduit bushing can be properly attached.

6.5.1.10 If threads for the connection of conduit are not tapped all the way through a hole in a box wall, conduit hub, or the like, there shall not be less than five full threads in the metal. An inlet hole for the conductors shall be smooth, rounded, and afford protection to the conductors equivalent to that provided by a standard conduit bushing. The inlet hole shall have an internal diameter approximately equal to that of the corresponding trade size or rigid conduit.

6.5.1.11 A terminal or splice compartment shall have provision for grounding when the incoming supply is other than metallic conduit. The ground connection means shall be either a pig-tail lead wire or a wiring terminal. A pig-tail lead wire shall be green in color, at least 150 mm (6 in) in length, and equal in gauge to the control device primary lead wires. A wiring terminal shall comply with the requirements in Clause 6.5.2. A sheet metal screw shall not be used.

6.5.2 Terminals and terminal parts

6.5.2.1 Field-wiring terminals shall be prevented from turning.

6.5.2.2 A pressure type wire connector intended for the connection of supply lead wires shall meet the requirements for that component. See Annex A.

6.5.2.3 A push-in (screw-less) wiring terminal, i.e., one in which a stripped copper conductor is inserted and automatically locked in a wire entrance hole, is acceptable as a current-carrying connection if it complies with the component requirements. See Annex A.

6.5.2.4 A push-in (screw-less) field wiring terminal (one in which a stripped copper conductor is inserted and automatically locked in a wire entrance hole) meets the intent of providing a current-carrying connection if it complies with the requirements in Push-in Terminals, Clause 9.15, and the marking requirements specified in Clause 7.6.2. A push-in wiring terminal shall only allow for the termination of the branch circuit conductor supplying the control device, and not provide for additional connections, unless the push-in wiring terminal has been evaluated to handle full branch circuit current.

6.5.2.5 A push-in (screw-less) terminal shall be rated for electrical voltage and current and environmental temperature and pollution degrees. The electrical voltage rating shall be greater than the working voltage in normal operation and a surge voltage, such as lamp starting. The electrical current rating shall exceed the current the terminal will be carrying during various modes of normal operation. The environmental temperature rating shall exceed the value measured during the normal temperature test. The environmental pollution degrees rating shall be 2 or 3. See UL 840 or CSA C22.2 No. 0.2 for additional information about environmental pollution degrees.

6.5.2.6 Wire binding screws or pressure-type terminals for field wiring terminals shall comply with Clauses 6.5.2.7 – 6.5.2.16.

6.5.2.7 A terminal intended for the connection of a grounded power-supply conductor shall be:

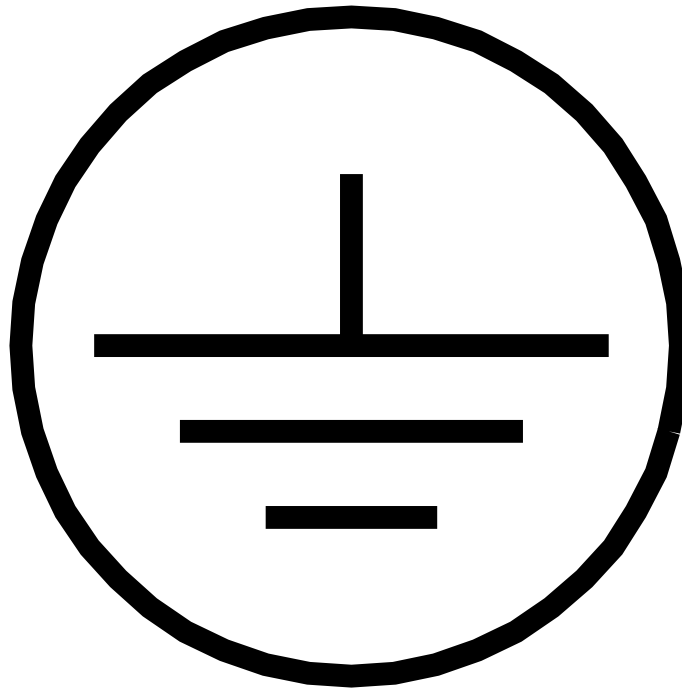
- a) A pressure-type wire connecting means identified by a plating substantially white in color (such as nickel);
- b) Of a metal that is substantially white in color;
- c) Otherwise colored white, marked with letters “WH,” “WHT,” or “COM;” or
- d) Identified on an attached wiring diagram in some manner. For example, the location of the terminal on an attached diagram directly corresponds with the terminal location in the unit itself.

6.5.2.8 A terminal intended for the connection of the earth grounding supply conductor shall be identified by one of the following methods:

- a) Identified by a plating substantially green in color;
- b) A machine thread screw, at least 8-32 thread, with a hexagonal head, green in color;
- c) The word “ground,” the letters “G,” “GND,” or “GR,” or the symbol in Figure 6.2;
- d) Identified on an attached wiring diagram in some manner. For example, the location of the grounding wire or terminal on the diagram directly corresponds with the grounding wire or terminal location in the unit itself; or

- e) A pan head screw colored green, when used as a pressure terminal means for grounding in junction boxes and in other wiring compartments.

Figure 6.2
Grounding symbol (circle is optional)
[Clause 6.5.2.8(c)]



6.5.2.9 A wiring terminal shall be provided with a soldering lug or pressure-wire connector, bolted or held by a screw.

6.5.2.10 A wiring terminal employing a wire-binding screw shall be provided with upturned lugs or the equivalent to hold a wire under the head of the screw.

6.5.2.11 A wire-binding-screw terminal or a pressure terminal connector shall be recessed or located so that it will be unlikely that wires will contact live parts after installation of the device. However, wire binding screws need not be recessed or otherwise located provided the spacing between the field wiring terminals is at least the dimensions given in Table 6.4 between parts of opposite polarity or between live parts and dead metal parts.

6.5.2.12 A terminal plate having a tapped hole for a wire-binding screw shall be of metal not less than 0.76 mm (0.030 in) thick and shall have not less than two full threads in the metal.

6.5.2.13 For a binding screw having 32 or more threads per 25.4 mm (1 in), a terminal plate formed from stock 0.76 mm (0.030 in) thick may have the metal extruded at the tapped hole for the binding screw to provide two full threads.

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6.5.2.14 A wire-binding screw shall thread into metal.

6.5.2.15 A wire-binding screw shall not be smaller than No. 6, and shall not have more than 36 threads per 25.4 mm (1 in).

6.5.2.16 A push-in field-wiring terminal shall be provided with a 9.5 mm (3/8 in) over-surface and through-air spacing to dead metal.

6.5.3 Lead wires and other wires for internal connections

6.5.3.1 Lead wires shall comply with the following paragraphs. In addition, an outer braid, if provided on the insulation, shall be treated with a moisture-resistant compound.

6.5.3.2 Lead wires intended for connections to primary and secondary circuit wires outside enclosures shall be soldered, brazed, welded, or otherwise suitably connected to the windings.

6.5.3.3 A control device lead shall be not less than 152 mm (6 in) in length.

Note: Lead lengths for control devices intended for compact fluorescent or circline lamps are not specified.

6.5.3.4 If control device temperatures exceed 150 °C (302 °F), as in the resistor type, soldered connections shall not be used.

6.5.3.5 A control device may be provided with a connector for connection of non-integral lead wires by means of a wiring harness with at least 150 mm (6 in) lead wires for connection to the supply circuit and a mating connector. The connector shall be suitable for the application. The mating connector shall have a detent, and shall be wired or keyed uniquely in order to reduce the risk of electric shock due to improper connection of the mating parts.

6.5.3.6 A control device lead wire shall be 0.82 mm² (18 AWG) or larger. The lead wire may consist of a solid or stranded conductor. Control devices with a factory-attached lampholder of a type that involves handling by the user during re-lamping (lamp connector) shall employ stranded conductors in lead wires to the lampholder.

6.5.3.7 In Canada, lead wires, in addition to Clause 6.5.3.6, shall be in accordance with CE Code Conditions of use and conductor temperature rates of CSA C22.2 No. 250.0.

In Mexico and the United States, this requirement does not apply.

6.5.3.8 The insulation on the lead wires of a control device marked weatherproof, Type 1 outdoor, or Type 2 outdoor shall be a material resistant to moisture absorption, such as polyvinyl chloride (PVC). An outer braid on a lead shall be treated to resist moisture absorption.

6.5.3.9 A rubber-insulated lead wire shall employ an outer braid.

6.5.3.10 The insulation on a lead wire shall be rated for the temperature and voltage involved. The insulation shall be rated for a temperature of at least 90 °C (194 °F), or shall be rated for a temperature of 75 °C (167 °F) and have an outer braid. Primary lead wires and other lead wires in the primary circuit shall have insulation rated for the maximum rated input voltage. All other lead wires shall have insulation rated for the rated input voltage or output voltage, whichever is greater.

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6.5.3.11 Primary lead wires are intended for connection to the supply source. Other lead wires in the primary circuit, as described in Clause 6.5.3.10, include:

- a) A lead wire connected to a tap in the primary winding; or
- b) A lead wire connected to a winding intended to provide current to heat the cathodes of a rapid-start circuit if such a winding has one end common with either a primary lead wire or a tap in the primary winding.

6.5.3.12 A lead wire intended for the connection of a grounded power-supply conductor shall be:

- a) Identified by white or gray color;
- b) Marked with the letters, "WHITE," "WH," "WHT," "COM," or "NEUTRAL;" or
- c) Identified on an attached wiring diagram in some manner. For example, the location of the lead wire exit on the diagram directly corresponds with the lead wire exit location in the unit itself.

6.5.3.13 A primary lead wire intended to be grounded shall:

- a) Not be provided on a control device intended for a line-to-line source of supply; or
- b) Be provided on a control device intended for a line-to-neutral source of supply, unless the control device operates correctly with either primary lead wire connected to the grounded supply conductor.

6.5.3.14 A control device having a rated input voltage outside the ranges specified in Table 8.1 may or may not have a primary lead wire that is intended to be grounded, depending upon the intended supply system.

6.5.3.15 For electronic control devices having the ability to accept a range of input voltages that are either selected manually by wiring the control device during installation or by automatic, self-adjusting circuitry, the primary lead wires are not required to be identified.

6.5.3.16 The insulation on a lead wire not provided with a braid or a nylon jacket shall be at least 0.8 mm (1/32 in) thick unless investigated and found to have properties intended for the application.

6.5.3.17 Except as noted immediately below, thermoplastic-insulated wire, used as a lead wire or for internal connections, shall have an insulation having a minimum thickness of:

- a) 0.40 mm (1/64 in) for a starting voltage of 600 V peak or less;
- b) 0.80 mm (1/32 in) for a starting voltage of 2500 V peak or less; or
- c) 1.20 mm (3/64 in) for a starting voltage of 5000 V peak or less.

If thermoplastic-insulated wire is rated for the voltage involved, such wire with thinner insulation meets the intent of this requirement.

6.5.3.18 A neoprene-insulated lead wire provided on a control device intended for outdoor use shall employ an outer braid unless the insulation on the lead is at least 1.2 mm (3/64 in) thick.

6.5.3.19 Strain relief shall be provided on all lead wires to prevent a pull on such lead wires being transmitted to interior wiring or connections. Such strain relief shall meet the requirements of Clause 8.13. Lead wires embedded in suitable sealing compound are considered to have sufficient strain relief.

6.5.3.20 Strain relief shall be provided on a lead wire or a flexible cord to resist stress on the lead wire or cord from being transmitted to the interior wiring or connections or to the terminals of the attachment plug. See the Strain Relief Test, Clause 8.13.

6.5.3.21 For a lead wire or flexible cord that is embedded in compound inside the enclosure at the wire entrance, the necessary strain relief is considered to be provided.

6.5.4 Plugs and cords

6.5.4.1 For a simple reactance control device of a through-cord or a direct plug-in type, the conductor of the incoming cord or plug blade that is intended to be grounded shall be directly connected to the conductor of the outgoing cord that is intended to be grounded. For the through-cord control device, there shall be no difference in potential between the conductors of the incoming and outgoing cords that are intended to be grounded when the control device is in operation. For the direct plug-in control device, there shall be no difference in potential between the plug blade and the outgoing cord that is intended to be grounded when the control device is in operation.

6.5.4.2 An attachment plug of a through-cord or other cord connected control device shall be provided on the supply-end of a cord. The overall length of the supply and lamp cords and control device shall not be less than 1.83 m (6 ft) and the length of the supply cord between the plug and the control device shall be between 0.6 – 1.22 m (2 – 4 ft).

6.5.4.3 The insulation of a cord shall be rated for the temperature and voltage to which it will be subjected during normal operation.

6.5.4.4 In Mexico, a power-supply cord of a through-cord or other cord connected control device, or the blades of a direct plug-in control device, shall terminate in a 2-pole, 3-wire, 15-A, 125-V grounding attachment plug or in a 2-pole, 2-wire, 15-A, 125-V polarized plug.

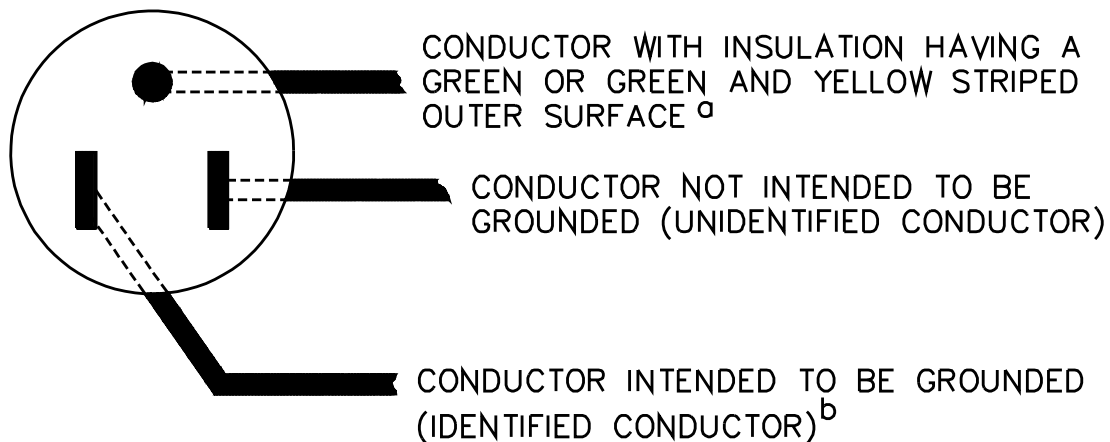
In Canada, a power-supply cord of a through-cord or other cord connected control device, or the blades of a direct plug-in control device, shall terminate in a 2-pole, 3-wire, 15-A, 125-V grounding attachment plug or in a 2-pole, 2-wire, 15-A, 125-V polarized plug. The power-supply cord shall comply with the requirements of CSA C22.2 No. 21.

In the United States, a power-supply cord of a through-cord or other cord connected control device, or the blades of a direct plug-in control device, shall terminate in a 2-pole, 3-wire, 15-A, 125-V grounding attachment plug or in a 2-pole, 2-wire, 15-A, 125-V polarized plug. The power-supply cord shall comply with the requirements of UL 817.

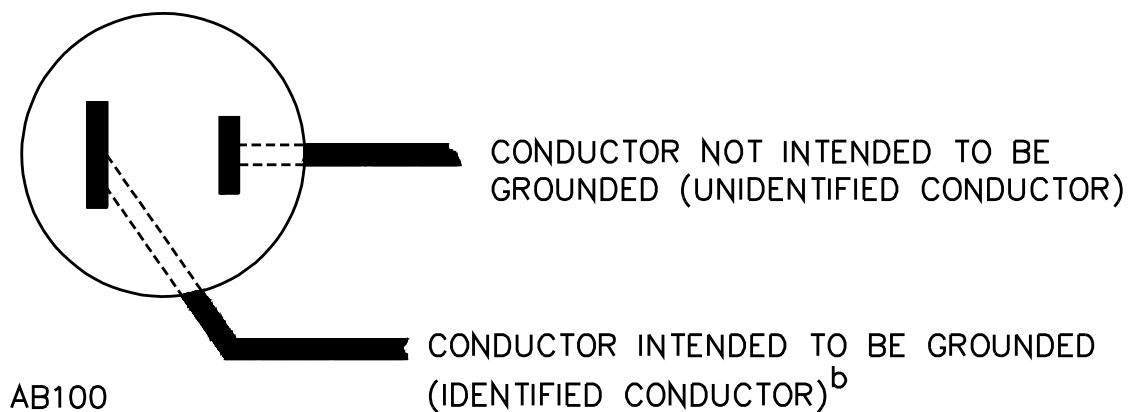
6.5.4.5 If a 2-conductor flexible cord is provided for connection to the source of supply, the conductors shall be connected to a parallel-blade attachment plug as illustrated in Figure 6.3. If only two blades are provided with a direct plug-in control device, the blades shall be connected as shown in Figure 6.3. The dimensions of the blades are to be as shown in Figure 6.4. For a simple reactance control device, the smaller blade shall connect directly to the control device. The larger blade shall connect to outgoing cord as described in 6.5.4.1.

Figure 6.3
Connectors to attachment plug
 (Clause 6.5.4.5)

CONNECTIONS OF CORD CONDUCTORS TO GROUNDING – TYPE ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



CONNECTIONS OF CORD CONDUCTORS TO POLARIZED ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



AB100

^a The blade to which the green or green and yellow conductor is connected may have a U-shaped cross-section instead of the circular cross-section shown.

^b The conductor intended to be grounded signifies a conductor identified in one of the following ways:

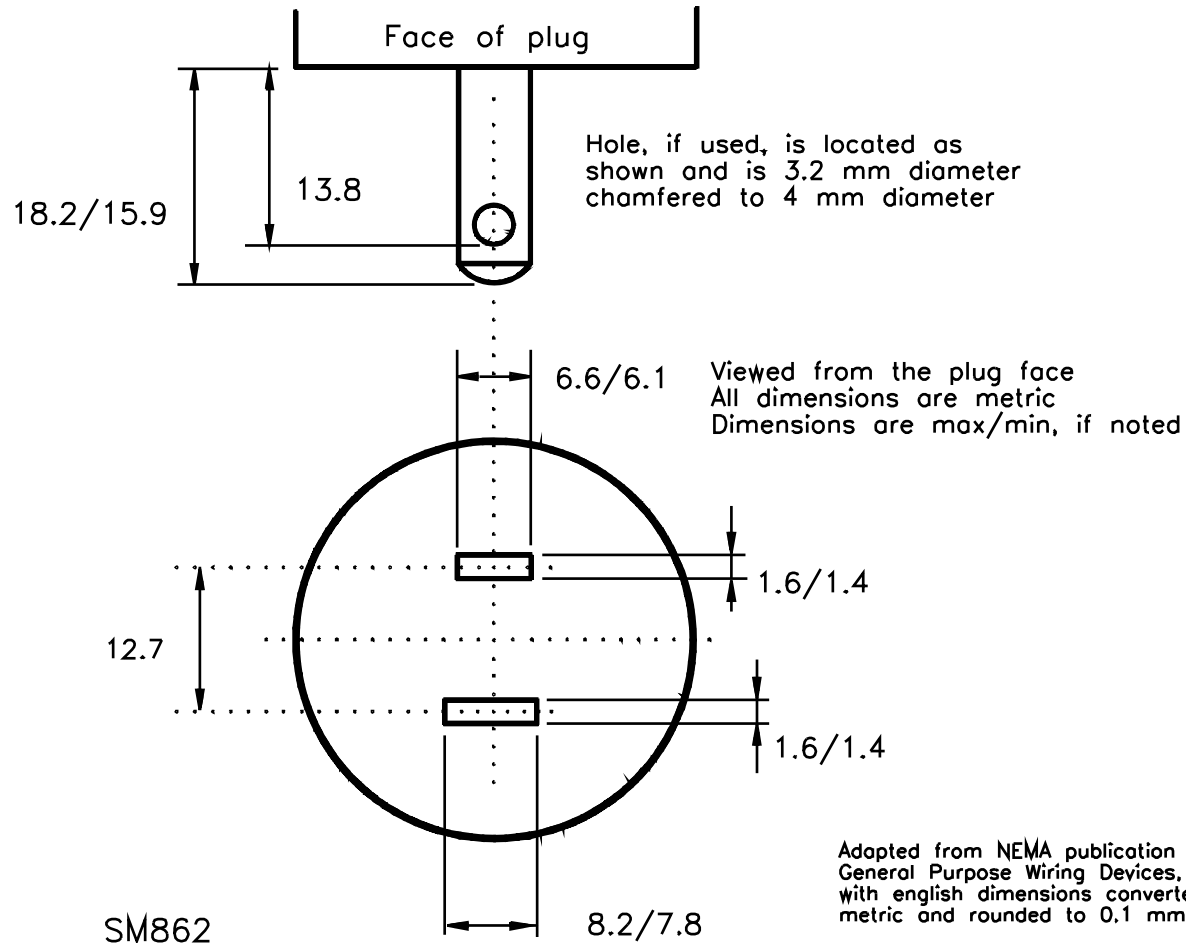
- 1) A white or natural gray colored conductor insulation;
- 2) A light blue colored conductor insulation when the other conductors are colors other than white or natural gray;
- 3) Have a rib or ribs running the length of the cord; or
- 4) Have tinned or white metal on all strands of the conductor.

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Figure 6.4
Polarized plug dimensions
(Clause 6.5.4.5)



mm	(in)
18.2	(0.717)
15.9	(0.626)
13.8	(0.543)
12.7	(0.500)
8.2	(0.323)
7.8	(0.307)
6.6	(0.260)
6.1	(0.240)
4	(0.157)
3.2	(0.125)
1.6	(0.0625)
1.4	(0.0551)

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6.5.4.6 When the flexible cord includes an equipment-grounding conductor, that conductor shall be green in color with or without one or more yellow stripes. The conductors of the flexible cord shall be connected to a parallel-blade, 3-wire grounding attachment plug as illustrated in Figure 6.3. The grounding conductor shall be connected to the control device enclosure, when constructed of metal. The grounding lead is to be crimped, or crimped and soldered, to the control device enclosure. The dimensions of the blades are to be as shown in Figure 6.4. The grounding conductor shall also connect to a conductor on the outgoing cord and shall be green in color with or without one or more yellow stripes. For a simple reactance control device, the smaller blade shall connect directly to the control device. When both blades are the same size, the right blade shall connect directly to the control device when viewed with the ground pin on top.

6.5.4.7 A control device that is connected in a flexible cord for use with a portable lamp (120 V nominal input voltage) shall not involve output potentials in excess of 300 V during starting or normal operation. If the control device controls more than one lamp, the lamps shall be connected in series with each other.

6.5.4.8 The weight of a control device equipped with a flexible cord shall not exceed 1.13 kg (2.5 lb).

6.5.4.9 If the control device is less than 0.91 kg (2 lb) in weight, the cord shall not be lighter than Type SPT-2; otherwise, it shall be at least Type SJ.

6.5.4.10 A suitable attachment plug cap shall be provided on the supply end of the cord.

6.5.4.11 A control device designed for through-cord use and having an output voltage greater than 150 V (maximum output voltage) shall be grounded. A suitable three-conductor plug cap, supply cord, and load cord shall be used to enable the luminaire to be grounded.

6.6 Provision for grounding and bonding

6.6.1 In Mexico and the United States, Exposed non-current-carrying metal parts shall be in good electrical connection with one another for purposes of grounding and bonding. A control device will typically have grounding through its mounting means, and therefore not be provided with a grounding conductor.

In Canada, exposed non-current-carrying metal parts shall be in good electrical connection with one another for purposes of grounding and bonding. A control device will typically have grounding through its mounting means, and therefore not be provided with a grounding conductor. Compliance is determined with bonding of electrical equipment, CAN/CSA-C22.2 No. 0.4.

6.6.2 The surface of an insulated lead wire intended for connection of an equipment grounding-conductor shall be green with or without one of more yellow stripes, and no other lead shall be so identified. For an electronic control device, a lead wire brought out and intended to be grounded shall be green in color with or without one or more yellow stripes and shall be bonded directly to the accessible metal parts of the enclosure.

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6.7 Shock hazard considerations (protection against accidental contact with live parts)

6.7.1 Iron or steel, plain or plated, shall not be used for parts that are depended upon to carry current, except that:

- a) This requirement does not apply to current-carrying parts of a component covered by requirements separate from this standard. See Clause 4.3.1.
- b) Steel may be a live part if it is in a parallel path with copper or aluminum magnet wires, and would not be subject to corrosion – for example, a steel ring that is crimped around two conductors to splice them.

6.7.2 A soldered connection shall be mechanically secured before being soldered. The connection shall be insulated unless the spacings are in accordance with the requirements for Spacing Between Live Parts, Clause 6.8. However, if mechanical security of a soldered joint is impractical or impossible, a joint may be made without mechanical security before soldering, provided both sides of the joint are secured in such a way that stress on the connection, either during or after manufacturing process, will be unlikely.

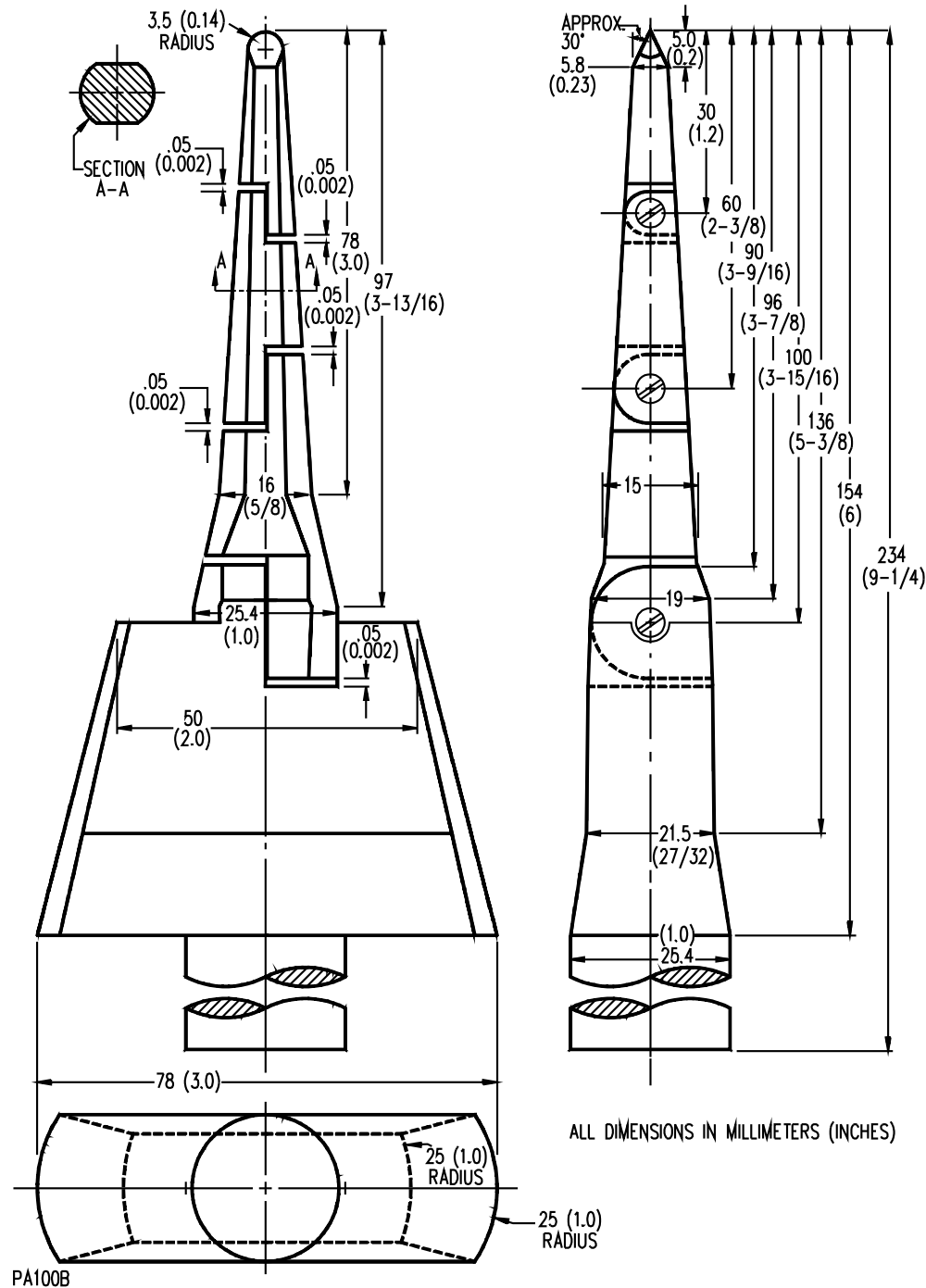
6.7.3 An un-insulated live part shall be permanently mounted and secured to resist turning or shifting in position if such motion may result in a reduction of spacing below minimum values.

6.7.4 Live parts that are mechanically secured and positioned with respect to dead metal parts and that are covered with compound are considered to be insulated.

6.7.5 Foils on a printed wiring board shall be subjected to the requirements for Printed Wiring Boards, Annex B.

6.7.6 For an independent control device, parts that are required to be enclosed shall not be accessible through any opening during operation, or during normal servicing. Accessibility shall be determined by the probe illustrated in Figure 6.5. It shall not contact parts that are required to be enclosed when inserted in every position. Where necessary, an electrical indicator shall be used to determine whether or not contact is made. Regardless of shape, openings, if provided, shall not adversely affect the strength or rigidity of the enclosure.

Figure 6.5
Articulate probe
 (Clause 6.1.3.4, 6.7.6)



Material: Metal; pointed end to first knuckle

Tolerances: 0.2 mm except gaps between knuckles

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6.8 Spacing between live parts

6.8.1 General

6.8.1.1 The spacing between live parts as a clearance (through air) and creepage distance (over surface of insulating material), including the connection point of field wiring, shall be at least as described in this section and Table 6.4 for:

- a) Un-insulated live parts of opposite polarity; and
- b) An un-insulated live part and a dead metal part that is able to be grounded, a metal part exposed to contact by persons, or a metal surface on which the control device is mounted as intended.

Table 6.4
Spacing for indoor and outdoor locations
(Clause 6.8.1.1)

Locations	Maximum voltage between parts, V_{rms} (V_{peak})								
	Dimensions in mm (clearance/creepage distance)								
	50 (71)	150 (212)	300 (424)	450 (636)	600 (848)	750 (1061)	900 (1273)	1050 (1485)	1200 (1697)
Row 1 Parts potted or subsequently coated	-/0.18 ^a	-/0.3 ^a	-/0.7	-/0.8	-/0.8	-/1.6	-/2.4	-/3.2	-/4.2 (-/5.8 for 1500V)
Row 2 For indoor and outdoor Type 1: Live parts reliably positioned AND insulator CTI ≥ 600 ; Example: Lead wires or a transistor or diode to its mounting. ^b	0.2/0.6	0.5/0.8	1.5/1.5	-/2.25	3.0/3.0	-/3.75	-/4.5	-/5.8	-/6.0
Row 3 For indoor and outdoor Type 1: Live parts reliably positioned AND insulator CTI < 400 ; Examples: Adjacent foils on printed wiring board or lead wires of a transistor or diode to its mounting. ^c	0.2/1.2	0.5/1.6	1.5/3.0	2.25/4.5	3.0/6.1	-/7.5	-/9.0	-/10.5	-/12.0
Row 4 Parts on printed wiring boards that are soldered in place, but can move in production prior to soldering to fixed parts, or parts on printed wiring board to enclosure where enclosure and can deflect. ^d		3.0/-	3.9/-	4.7/-	5.6/-	6.5/-	7.4/-	8.2/-	
Row 5 Live parts and dead metal parts in a conventional magnetic control device construction where the coil size can vary due to random wind OR where coil assembly placement can vary in production.	3.2/6.4 ^e	3.2/6.4 ^e	6.4/9.5 ^e	6.4/9.5 ^e	9.5/9.5 ^e	9.5/9.5 ^e	9.5/9.5 ^e	9.5/12.7 ^f	9.5/12.7 ^f
Row 6 Field wiring terminals to each other and fixed live or dead metal parts	Not defined	6.4/6.4	6.4/6.4	6.4/6.4	6.4/6.4	Not defined	Not defined	Not defined	Not defined

^a Or as determined from the evaluation of the conformal coating, whichever is less.

Table 6.4 Continued

	Maximum voltage between parts, V_{rms} (V_{peak})
	Dimensions in mm (clearance/creepage distance)
^b Other dimensions of creepage distance calculated by the following for voltages less than or equal to 600 V:	
$D = 0.002V + 0.5$	
And the following formula for voltages greater than 160 V:	
$D = 0.005V + 0.007$	
in which D is distance and V is volts.	
^c Other dimensions of creepage distance calculated by the following for voltages less than or equal to 160 V:	
$D = 0.004V + 0.976$	
And the following formula for voltages greater than 160 V:	
$D = 0.01V + 0$	
in which D is distance and V is volts.	
^d Other dimensions of clearance calculated by the following formula for voltages between 150 and 1050 V:	
$D = 0.0059V + 2.096$	
in which D is distance and V is volts.	
^e Film-coated wire is to be considered an uninsulated live part. However, a spacing of not less than 2.4 mm (0.094 in) measured over-surface and through-air between film-coated wire that is rigidly supported and held in place on a coil and a dead metal part is acceptable where the potential involved does not exceed 600 V.	
^f When the insulating material involved is not readily carbonized – for example, porcelain or urea-formaldehyde porcelain – the minimum required creepage distance is 9.5 mm (0.374 in).	

6.8.1.2 For conventional magnetic control devices, the spacing between un-insulated live parts of opposite polarity and between un-insulated live parts and metal that may be grounded, in the case of a control device not intended for outdoor use, shall be as indicated in Table 6.4, Row 5. The spacing between un-insulated live parts of opposite polarity and between un-insulated live parts and metal that may be grounded, in the case of a control device intended for outdoor use, shall not be less than 9.5 mm (3/8 in) through air and 12.7 mm (1/2 in) over the surface of insulating material, regardless of the voltage rating of the control device.

6.8.1.3 Live parts that are recessed at least 3.2 mm (0.125 in) and covered with a suitable insulating compound at least 1.6 mm (0.0625 in) thick are considered to be insulated.

6.8.1.4 When measuring spacing, an isolated dead metal part located between un-insulated live parts of opposite polarity, or between an un-insulated live part and a dead metal part, is determined to reduce the spacing by an amount equal to the dimension of the isolated dead metal part in the direction of the measurement.

6.8.1.5 For an uncoated printed wiring board, the minimum spacing between adjacent foil traces shall be at least as specified in Table 6.4, Row 3. For printed wiring boards that are covered with potting compound or a conformal coating, the minimum spacing between the adjacent foil traces prior to coating shall be as specified in Table 6.4, Row 1.

In the United States, where a conformal coating is used as described above, the conformal coating shall comply with the requirements in UL 746C.

In Canada, a conformal coating shall comply with CSA C22.2 No. 250.0.

6.8.1.6 Live parts shall be securely mounted in such a manner that there will be no reduction of the required spacing.

6.8.1.7 Insulating liners and barriers may be used to obtain the spacing required by Table 6.4, provided that the materials are as specified in Clause 6.9 and are not less than 0.66 mm (0.8 mm nominal) (0.025 in minimum, 0.031 in nominal), thick. Fibre materials, if used, shall be treated to resist moisture. Alternatively, insulating materials with equivalent electrical and mechanical properties to vulcanized fibre may be used.

6.8.1.8 Spacing between un-insulated live parts of a circuit containing a component, such as a rectifier, a resistor, a capacitor, a transistor, or other solid state device and grounded non-current-carrying metal parts, including the enclosure, or other circuits shall be in accordance with Table 6.4. These dimensions do not apply to parts on or within components such as thermal protectors, capacitors, etc., which meet the requirements of that component's standard; however, the dimensions are applicable between live parts of such components and other parts of the control device construction.

6.8.1.9 Spacing between live parts of different voltages in a circuit containing a component as mentioned in Clause 6.8.1.1 is not specified if:

- a) The spacing between such parts is capable of withstanding the dielectric strength test specified in Clause 8.6.1.
- b) No risk of fire or electric shock results from the test described in Clause 8.6.1; or
- c) The location and relative arrangement of components are such that acceptable separation will be maintained.

6.8.1.10 In Canada, the requirements in Clauses 6.8.1.11 and 6.8.1.12 do not apply to extra-low-voltage Class 2 circuits or to extra-low-voltage and low-voltage secondary circuits in which the short-circuit power between conductors is limited to 100 VA and no fire hazard will result from a short circuit.

In Mexico and the United States, this requirement does not apply.

6.8.1.11 In the United States, when the power available between two insulated parts is less than 50 watts when determined in accordance with Clause B.3.4, or when the minimum spacing is determined by the dielectric voltage withstand test described in Clause 8.6.1, the spacing between these parts is not specified.

In Canada and Mexico, this requirement does not apply.