



UL 1993

STANDARD FOR SAFETY

Self-Ballasted Lamps and Lamp Adapters

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UL Standard for Safety for Self-Ballasted Lamps and Lamp Adapters, UL 1993

Fifth Edition, Dated January 27, 2017

Summary of Topics

This revision of ANSI/UL 1993 includes the Addition Of Risk Of Electric Shock Re-Lamping Test To Supplement SC.

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated May 25, 2018.

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Association of Standardization and Certification
NMX-J-578/1-ANCE
Third Edition



CSA Group
CSA C22.2 No. 1993-17
Third Edition



Underwriters Laboratories Inc.
UL 1993
Fifth Edition

Self-Ballasted Lamps and Lamp Adapters

January 27, 2017

(Title Page Reprinted: August 6, 2018)



ANSI/UL 1993-2018

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This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through August 6, 2018. The most recent designation of ANSI/UL 1993 as an American National Standard (ANSI) occurred on August 6, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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Preface

This is the harmonized ANCE, CSA Group, and UL standard for Self-Ballasted Lamps and Lamp Adapters. It is the third edition of NMX-J-578/1-ANCE, the third edition of CSA C22.2 No. 1993, and the fifth edition of UL 1993. This harmonized standard has been jointly revised on August 6, 2018. For this purpose, CSA Group and UL are issuing revision pages dated August 6, 2018, and ANCE is issuing a new edition dated August 6, 2018.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Committee for Self-Ballasted Lamps, of the Council of the Harmonization of Electrotechnical Standards for the Nations of the Americas (CANENA), are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

The present Mexican standard was developed by the CT 34 – Iluminación from the Comité de Normalización de la Asociación de Normalización y Certificación, A.C., CONANCE, with the collaboration of the lamps and ballasts manufacturers and users.

This standard was reviewed by the CSA Integrated Committee on Lighting Products, under the jurisdiction of the CSA Technical Committee on Consumer and Commercial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

In Canada, for general information on the Standards of the Canadian Electrical Code, Part II, see the preface to CAN/CSA-C22.2 No. 0.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specific number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of Harmonization

This standard is published as an equivalent standard for CSA Group and UL and a proposed equivalent standard for ANCE.

An equivalent standard is a standard that is substantially the same in technical content, except as follows. Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

IEC Copyright

For CSA Group, the text, figures, and tables of International Electrotechnical Commission Publication 61347-2-3, Lamp control gear – Part 2-3: Particular requirements for a.c. and/or d.c. supplied electronic control gear for fluorescent lamps, copyright 2011, are used in this standard with the consent of the International Electrotechnical Commission.

These materials are subject to copyright claims of IEC and UL. No part of this publication may be reproduced in any form, including an electronic retrieval system, without the prior written permission of UL. All requests pertaining to the Lamp control gear – Part 2-3: Particular requirements for a.c. and/or d.c. supplied electronic control gear for fluorescent lamps, IEC 61347-2-3 Standard should be submitted to UL.

1 Scope

1.1 These requirements are intended to cover both self-ballasted lamps and self-ballasted lamp adapters rated 120 to 347 V AC nominal for connection to screw-base, pin-base, or recessed single contact (RSC or R7) lampholders. These devices are intended for use in accordance with the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code Part I, CSA C22.1, in non-hazardous locations, and the Instalaciones Eléctricas (utilización), NOM-001-SEDE.

1.2 These devices incorporate resistance, reactance, or electronic (solid-state) type ballasts or power supplies. These devices employ various lamp technologies including, but not limited to, incandescent, fluorescent, high-intensity discharge lamps, light-emitting diodes.

1.3 These requirements also include Supplemental Requirements for Light-Emitting Diodes (LED), Supplement SA, for:

- a) Self-contained LED lamps, rated 120 to 347 V AC nominal for connection to screw-, pin-base, and recessed single contact (RSC or R7) lampholders,
- b) Lamps for replacement of an ANSI standardized fluorescent lamp, and consisting of light-emitting-diode (LED) lamp technologies, with control circuitry, and a driver or power supply. The LED driver and control circuitry will be either integral with the lamp or remote from the lamp, and
- c) Component LED lamps, with or without control circuitry, an ANSI base other than bases mentioned in (a), for connection to LED driver having a low voltage output, such as replacement for tungsten-halogen, MR11 and MR16 shaped lamps.

1.4 This standard does not apply to medium-to-medium base (E26) fittings that incorporate controls such as photocells, motion detectors, radio controls, or dimmers covered by other standards.

1.5 These devices are not intended for use with emergency exit fixtures or emergency exit lights.

2 Reference Publications

2.1 Normative references

2.1.1 For undated references to standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this standard was approved. For dated references to standards, such reference shall be considered to refer to the dated edition and all revisions published to that edition up to the time the standard was approved.

ANCE (Mexican National Standards)

NMX-J-024-ANCE

Iluminación – Portalámparas roscados tipo Edison – Especificaciones y métodos de prueba

NMX-J-325-ANCE

Iluminación – Portalámparas para lámparas fluorescentes – Especificaciones y métodos de prueba

NMX-J-565/2-11-ANCE

Prueba de riesgo de incendio – Parte 2-10: Métodos de prueba basados en hilo incandescente/caliente – Método de prueba de inflamabilidad de hilo incandescente para productos finales

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NOM-001-SEDE

Instalaciones Eléctricas (utilización)

NOM-058-SCFI

Productos eléctricos – Balastros para lámparas de descarga eléctrica en gas – Especificaciones de seguridad

NMX-J-578-ANCE

Iluminación – Lámparas fluorescentes compactas autobalastadas – Seguridad y métodos de prueba

CSA Group

C22.1-15

Canadian Electrical Code (CEC), Part I, Safety Standard for Electrical Installations

CAN/CSA-C22.2 No. 0-10 (R2015)

General Requirements – Canadian Electrical Code, Part II

C22.2 No. 0.1-M1985 (R2013)

General Requirements for Double-Insulated Equipment

C22.2 No. 0.15-15

Adhesive labels

CAN/CSA-C22.2 No. 0.17-00 (R2013)

Evaluation of Properties of Polymeric Materials

C22.2 No. 43-08 (R2013)

Lampholders

C22.2 No. 66.1-06 (R2015)

Low Voltage Transformers – Part 1: General Requirements

CAN/CSA-C22.2 No. 74-16

Equipment for use with electric discharge lamps

C22.2 No. 250.0-08 (R2013)

Luminaires

C22.2 No. 250.13-14

Light Emitting Diode (LED) Equipment for Lighting Applications

C22.2 No. 256-14

Direct Plug-In Nightlights

CAN/CSA-C22.2 No. 60065:16

Audio, Video and Similar Electronic Apparatus – Safety Requirements

CAN/CSA-C22.2 No. 60950-1-07 (R2016)

Information Technology Equipment – Safety – Part 1: General Requirements

CAN/CSA-E60384-14:14

Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

UL (Underwriters Laboratories Inc.)

UL 94

Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 101

Leakage Current for Appliances

UL 496

Lampholders

UL 746C

Polymeric Materials – Use in Electrical Equipment Evaluations

UL 796

Printed-Wiring Boards

UL 796F

Flexible Materials Interconnect Constructions

UL 840

Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment

UL 935

Fluorescent-Lamp Ballasts

UL 969

Marking and Labeling Systems

UL 1029

High-Intensity-Discharge Lamp Ballasts

UL 1310

Standard for Class 2 Power Units

UL 1412

Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances

UL 1446

Systems of Insulating Materials – General

UL 1577

Optical Isolators

UL 1598

Luminaires

UL 1694

Standard for Tests for Flammability of Small Polymeric Component Materials

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UL 2097

Reference Standard for Double Insulation Systems for Use in Electronic Equipment

UL 60384-14

Fixed Capacitors for Use in Electronic Equipment - Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains

UL 8750

Standard for Light Emitting Diode (LED) Equipment for Use In Lighting Products

UL 60730-1

Standard for Safety Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements

UL 60730-2-6

Standard for Safety Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements

UL 60950-1

Information Technology Equipment – Safety – Part 1: General Requirements

ANSI (American National Standards Institute)**ANSI C78.24**

Electric Lamps: Two-inch (51-mm) Integral-Reflector Lamps with Front Covers and GU5.3 of GX5.3 Bases

ANSI C81.61

Specifications for Bases (Caps) for Electric Lamps

ANSI C81.62

Electric Lampholders

ANSI C81.63

Gauges for Electric Lamp Bases and Lampholders

ANSI/ISA (American National Standards Institute/Instrumentation, Systems, and Automation Society)**ANSI/ISA MC96.1**

Temperature Measurement Thermocouples

ASTM (American Society for Testing and Materials)**ASTM D36/D36M**

Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and -Ball Apparatus

ASTM D56

Standard Test Method for Flash Point by Tag Closed Cup Tester

ASTM D93

Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

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ASTM D 1000

Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications

ASTM D1525

Standard Test Methods for Vicat Softening Temperature of Plastics

ASTM E 28

Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus

IEC (International Electrical Commission)

IEC 60081

Double-Capped Fluorescent Lamps - Performance Specifications

NEMA (National Electrical Manufacturers Association)

NEMA C82.3

Electric Lamps - Reference Ballasts for Fluorescent Lamps

NEMA C78.375A

Electric Lamps - Fluorescent Lamps - Guide for Electrical Measures

NEMA C78.81

Electric Lamps - Double-Capped Fluorescent Lamps - Dimensional and Electrical Characteristics

NEMA C78.901

Electric Lamps - Single Base Fluorescent Lamps - Dimensional and Electrical Characteristics

NFPA (National Fire Protection Association)

NFPA 70

National Electrical Code (NEC)

NFPA 704

Standard System for the Identification of the Hazards of Materials for Emergency Response

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2.2 Informative references

2.2.1 See Annex A for a list of component standards.

3 Definitions

3.1 The following terms and definitions apply in this standard. See Figure 3.1 for illustrations of the definitions in Clauses 3.4, 3.5, and 3.21.

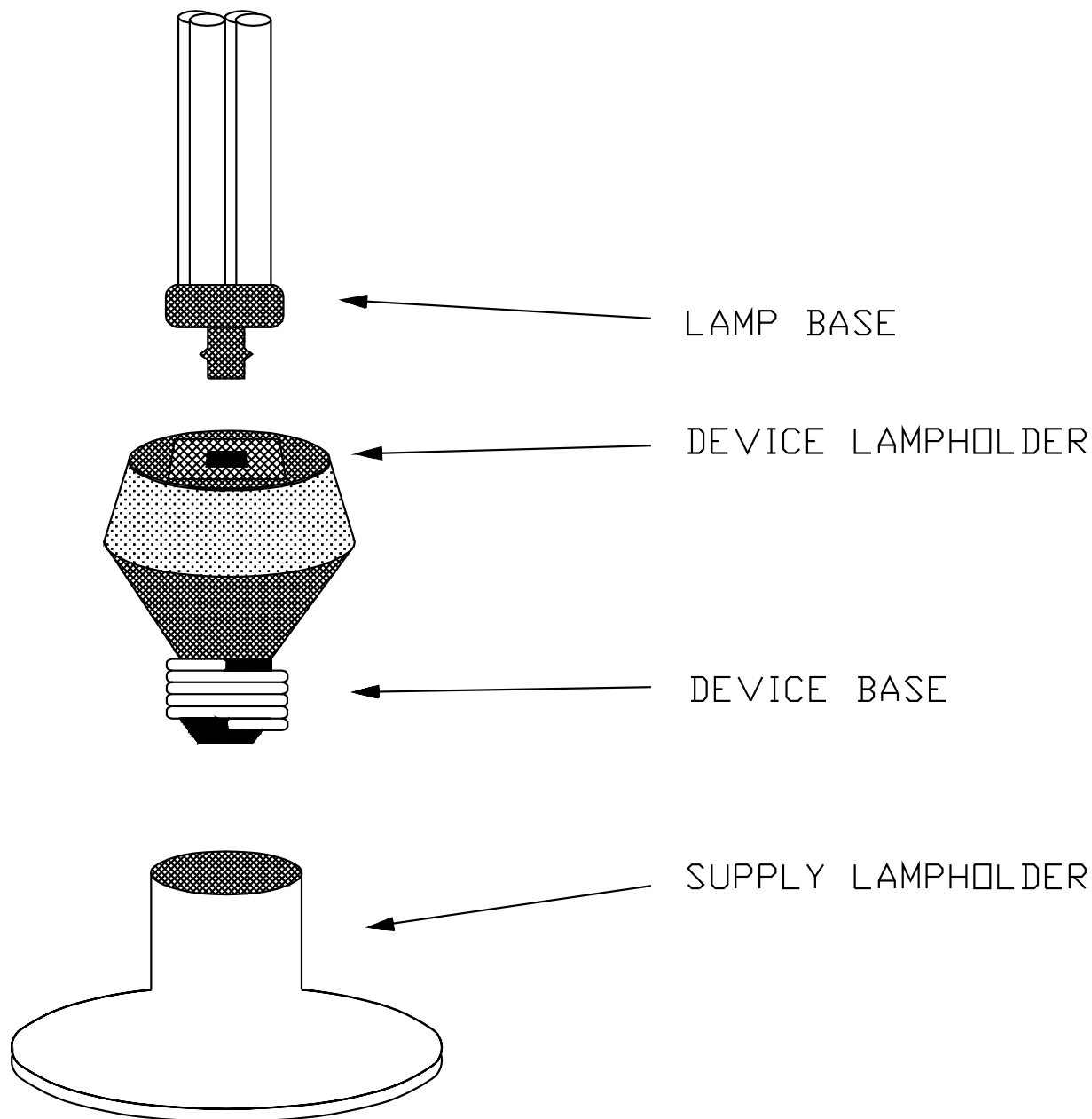
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Figure 3.1
Example of terminology for lamp adapters
(See Clause 3.1)



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3.2 ACCESSIBLE NON-CURRENT-CARRYING CONDUCTIVE (METAL) PART – a conductive part without basic insulation that, under normal operating conditions, carries no electrical current. A grounded dead conductive part may carry leakage current.

3.3 DEVICE – a self-ballasted lamp or lamp adapter. The specific name is used when it applies to only one of the devices.

3.4 DEVICE BASE – a screw-base or other ANSI base that connects the device to a mating lampholder for outlet boxes or to lampholders provided in luminaires, portable luminaires, or signs.

3.5 DEVICE LAMPHOLDER – a lampholder provided for the replaceable light source.

3.6 DEVICE LAMPHOLDER KEYING – a lampholder design that can accommodate only matching lamp bases.

3.7 DIMMER, STANDARD – a dimmer or control that modifies the amplitude or waveshape of the lamp's power source in order to reduce light output or energy consumption. This includes the 2-wire triac-based dimmers typically used to dim incandescent lamps.

3.8 DOUBLE INSULATION – an insulation system comprised of both basic insulation and supplementary insulation.

3.9 ELECTRONIC BALLAST – a ballast, generally involving high-frequency switching that is controlled by active components (transistors, thyristors, and the like), and with the lamp ballasting impedance provided by a series capacitive or inductive reactance appropriate for the high switching frequency. "Ballast" also refers to other drivers or supplies that operate lamp technologies other than fluorescent.

3.10 ENCLOSURE – a material provided to enclose parts and components that can involve the risk of fire or electric shock hazard.

3.11 LAMP ADAPTER –

In Canada and the United States, a self-ballasted lamp with a replaceable light source.

In Mexico, a device with an Edison screwbase provided with its controller and lampholder for the replaceable light source.

3.12 LAMP CONNECTOR – a set of contacts attached to flexible conductors that provides a removable means for electrical connection to a lamp but does not provide mechanical support.

3.13 LAMP, SELF-BALLASTED – a device provided with a lamp base and incorporating a non-replaceable light source and any additional elements necessary for starting and stabilizing operation of the light source, which cannot be dismantled without being permanently damaged.

3.14 LIVE PART – a metal or other conductive part that, during intended use, has an electrical potential difference with respect to earth ground or any other conductive part. The grounded (or neutral) supply conductor is considered to be a live part.

3.15 LIVE PART, HAZARDOUS – a conductive part without basic insulation, where a risk of electric shock exists.

3.16 LOCATION, DAMP – an exterior or interior location that is normally or periodically subject to condensation of moisture in, on, or adjacent to electrical equipment, including partially protected locations. The interior of a luminaire or sign intended for wet locations is considered a damp location.

Note 1: Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold storage warehouses.

Note 2: Devices intended for damp locations may also be used in dry locations.

3.17 LOCATION, DRY – a location not normally subject to dampness, but could include a location subject to temporary dampness.

Note: For example, a building under construction.

3.18 LOCATION, WET – a location in which water or other liquid can drip, splash, or flow on or against a device.

Note 1: For example, vehicle washing areas, showers, or unprotected locations exposed to weather.

Note 2: Devices intended for wet locations may also be used in dry and damp locations.

3.19 LUMINAIRE, RECESSED – a luminaire that is designed to be either wholly or partially recessed in a mounting surface.

3.20 POWER CAPACITOR – a capacitor used with a magnetic ballast that is connected:

- a) In series with a lamp or lamps and provides the ballast impedance for the lamp current, or
- b) For power-factor correction across the input leads of the ballast or across an extension of the primary winding.

3.21 SUPPLY LAMPHOLDER – a lampholder of a luminaire or portable luminaire or sign that can accommodate and supply power to a self-ballasted lamp or lamp adapter.

3.22 TYPE TEST – testing of a representative sample of the device with the objective of determining if the device, as designed and manufactured, can meet the requirements of this standard.

4 General Requirements

4.1 Components

4.1.1 Except as indicated in Clause 4.1.2, 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.

In Mexico, the requirements of Clause 4.1 do not apply.

4.1.2 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.

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

4.1.4 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.

4.2 Application of requirements

4.2.1 The requirements of the national installation codes and other practices of Canada, Mexico, and the United States have been addressed in the requirements of this standard.

4.2.2 A product intended to be used in Canada, Mexico, and the United States shall comply with the requirements of this standard for those countries.

4.2.3 A product to be used only in Canada, Mexico, or the United States shall comply with the common requirements of this standard and the applicable country-specific requirements, where so noted.

4.2.4 In Canada, general requirements applicable to these products are provided in CAN/CSA-C22.2 No. 0.

4.3 Units of measurement

4.3.1 The values given in SI (metric) units shall be normative. Any other values are for information only.

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

4.3.3 All values of voltage and current are root mean square (rms) values unless otherwise noted.

4.3.4 Temperatures are given in Celsius only.

4.4 Assembly and packaging

4.4.1 A device shall be completely assembled and wired with each electrical component mounted in place and with each splice and connection completed when shipped from the factory. The lamp may be packaged separately in the case of a lamp adapter.

4.5 Principles

4.5.1 Risk of electric shock

4.5.1.1 Risk of electric shock can occur due to a number of factors, including:

- a) Voltage between conductive parts,
- b) Current available,
- c) Whether the current is pulsed or continuous,
- d) Frequency of voltage and current,
- e) Pathway through the human body, and
- f) Skin resistance.

4.5.1.2 Risk of electric shock is usually defined only in terms of electrical voltage, current, and frequency. Throughout this standard, voltage between parts greater than $30 V_{\text{rms}}$, $42.4 V_{\text{peak}}$ (and DC) – half of these limits for wet locations – is considered to be a risk of electric shock. When the current available is greater than $0.5 \text{ mA}_{\text{rms}}$ for perception and greater than $5.0 \text{ mA}_{\text{rms}}$ for let-go, for direct current and alternating current up to 1 kHz, the current is considered to be a risk of electric shock. A passive network connected across the meter input terminals of a measuring instrument compensates for the pathway body impedance and frequency. The test method and meter network are described in UL 101.

4.5.2 Risk of fire

4.5.2.1 The risk of fire can occur when electrical energy is converted to heat, and the heat is entrapped. It is difficult to define the energy level in terms of electrical parameters alone because the degree of entrapped heat will determine whether or not there would be combustion. In addition, risk of fire can be abated by a suitable enclosure (fire can be confined by the enclosure).

4.5.2.2 There are several possible indicators that are used while conducting a given test. Throughout this standard, the check for fire hazard is either by a specific temperature limit or a change of an indicator. For example, one fire indicator is a layer of cheesecloth, and its change of state occurs when it ignites and causes combustion.

4.5.2.3 Throughout this standard, an energy level of 15 VA is considered to be a sufficient level to support a fire. A circuit having less than 15 VA of available power, as determined by the test method described in Clause 8.19 is considered not to be a fire-hazardous circuit.

4.5.2.4 Throughout this standard, a suitable enclosure is described in Clauses 5.1 and 5.3.

5 Mechanical Construction

5.1 Enclosures

5.1.1 Enclosures shall have the strength and rigidity to resist the abuses to which they are subjected, without increasing the risk of fire, electric shock, or injury to persons due to a reduction of the required spacing for live parts or the loosening or displacement of live parts.

5.1.2 An enclosure shall be of metal or of a polymeric material that complies with Clause 5.3.

5.1.3 A metal enclosure shall comply with the minimum thickness specified in Table 5.1.

Table 5.1
Thickness of metal enclosures
(See Clause 5.1.3)

Metal	Minimum thickness, mm (in)	
Cast metal	1.2	(0.047)
Uncoated sheet steel	0.66 ^a	(0.026)
Nonferrous sheet metal	0.81	(0.032)
^a Uncoated sheet steel with a minimum of 0.51 mm (0.020 in) is acceptable if the ballast part of the device is filled with potting compound.		

5.1.4 An enclosure constructed of iron or steel shall be protected against corrosion by plating, painting, or the equivalent on both inside and outside surfaces.

5.2 Openings

5.2.1 An enclosure shall not have openings wider than 2 mm (0.078 in), unless they do not permit a 2 mm (0.078 in) diameter rod of any length to contact live parts. The uninsulated live parts of a lampholder into which a lamp connects are not required to comply.

5.2.2 The enclosure openings in a lamp adapter shall be evaluated with the lamp removed.

5.2.3 A hole in an enclosure through which wires emerge to connect with a lamp connector shall be:

- Close-fitting to the emerging lead wires,
- Free of burrs, sharp edges, and the like, that can abrade the insulation, and
- Provided with a strain-relief means that complies with the strain relief test for lamp connectors of Clause 8.11.

5.3 Polymeric materials

5.3.1 In Canada, a polymeric material shall comply with the requirements in CAN/CSA-C22.2 No. 0.17 and with the requirements of Clauses 5.3.2 to 5.3.4 and Clause 5.3.6 when the material is used to:

- a) Enclose electrical parts,
- b) Provide direct or indirect support of live parts, or
- c) Both.

In Mexico, the parts of insulating material that contain live parts and external parts of insulating material that provide protection against electrical shock shall be subjected to the glow-wire test in accordance with NMX-J-565/2-11-ANCE and to the following:

- a) The test specimen shall be an end product. If it is necessary to take a part from the lamp in order to perform the test, care shall be taken to assure that the test conditions are not significantly different from that which occurs in normal use conditions;
- b) The temperature in the tip of the glow-wire shall be 650 °C.

In the United States, a polymeric material shall comply with the requirements for portable equipment specified in UL 746C and with the requirements of Clauses 5.3.2 to 5.3.6 when the material is used to:

- a) Enclose electrical parts,
- b) Provide direct or indirect support of live parts, or
- c) Both.

5.3.2 A polymeric material used to enclose electrical parts shall have a Relative Thermal Index (RTI), including electrical and mechanical, with impact properties of at least the temperature measured during the temperature test of Clause 8.5, unless the measured temperature is less than 65 °C.

5.3.3 A polymeric material used as an enclosure shall have a flammability rating of 5-VA, 5-VB, or V-0 in accordance with UL 94 or CAN/CSA-C22.2 No. 0.17. Polymeric materials used solely to enclose electrical parts that are not part of a fire-hazardous circuit may have a minimum flammability rating of 94-HB.

5.3.4 A polymeric material used as an enclosure of a device marked for wet location use shall comply with the ultraviolet light exposure test specified in UL 746C or CAN/CSA-C22.2 No. 0.17.

5.3.5 With respect to UL 746C, the following tests are not required to be conducted:

- a) The abnormal operation and severe conditions test,
- b) The input after mold-stress relief distortion test, and
- c) The volume resistivity test.

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5.3.6 A device shall comply with the mold-stress relief distortion test of Clause 8.9.

5.3.7 A polymeric material used for direct support as electrical insulation shall be able to withstand the hot wire ignition (HWI), the comparative tracking index test (CTI), and the high current arc ignition (HAI) to a level of at least the values in accordance with Table 5.2.

Table 5.2
Ratings of polymeric materials^a
(See Clause 5.3.7)

Test	Environmental Rating	Minimum Potential	PLC ^d
CTI ^c	Dry location	≥100 volts	4 or less
	Damp location	≥175 volts	3 or less
	Wet location	≥250 volts	2 or less
Test	Flammability Classification ^b	Minimum Time	PLC ^d
HWI ^c	V-0, VTM-0	≥7 seconds	4 or less
	5-VA or 5-VB only	≥15 seconds	3 or less
Test	Flammability Classification ^b	Minimum Time	PLC ^d
HAI ^c	V-0, VTM-0	≥15 seconds	3 or less
	5-VA or 5-VB only	≥30 seconds	2 or less

^a Enclosures of phenolic, urea, or other thermoset materials are acceptable as legacy materials. Thermoplastic materials shall comply with this table.

^b Flammability classification determined by prior classification or the end product shall be evaluated to the 12 mm flame test in accordance with UL 746C or CAN/CSA-C22.2 No. 0.17. Subsequently, the HWI and HAI requirements are determined as a function of the flammability classification.

^c Determined by prior classification or by the end-product tested in accordance with UL 746C or CAN/CSA-C22.2 No. 0.17.

^d For materials with other than VTM flammability classifications, the performance level class (PLC) for material shall be evaluated using the specimen thickness employed in the end product. PLCs have been established in order to give a consistent numbering for improved performance (PLC=0 is best; PLC=5 is poorest) and avoid an excessive level of implied precision. Material performances for several tests and recorded as PLC values are based on the mean test results rather than recording the exact numerical results.

5.4 Weight and moment

5.4.1 A device shall have weight and moment limitations as specified in Table 5.3.

Table 5.3
Weight and moment limitations
(See Clause 5.4.1)

Device base	Maximum weight, ^{a,c}	Maximum moment, ^{a,b}
	kg (lbs)	N·m (in-lbs)
E12 (Candelabra)	0.50 (1.15)	0.60 (5.54)
E17 (Intermediate)	0.75 (1.63)	0.90 (7.85)
E26 (Medium), GU10, GU24	1.15 (2.5)	1.35 ^c (12)
E39 (Mogul)	1.70 (3.75)	2.05 (18)
^a For weight and moment measurements, lamp adapters shall be provided with lamps. ^b The moment is the weight of a device multiplied by the distance between the center contact of the device lamp base and the center of gravity of the device. ^c Includes the weight of any glassware and/or shade provided with the device. See Clause 5.4.3.		

5.4.2 A device that is constructed so that the alignment with the existing incandescent luminaire or portable luminaire requires an adjustment greater than ± 20 degrees shall be provided with adjustment of the device base with relation to the remainder of the device. Examples include:

- a) A rectangular-shaped device in which the device is to be parallel with existing walls when installed in a ceiling surface luminaire, and
- b) A device incorporating a ballast compartment or lamp support arms that will in some cases have to be rotated more than 20 degrees to properly clear harps in portable luminaires.

5.4.3 A device intended to be used with a shade, glassware, or diffuser shall be provided with that accessory.

5.4.4 A lamp adapter shall be provided with a positive means to retain the lamp or lamps in place in any possible mounting orientation, such as by clips, retaining springs, or the equivalent. A securing means relying solely on the electrical contacts of the lampholder does not meet this requirement.

5.4.5 When the integrity of the lamp securing means of a lamp adapter cannot be determined, the device lampholder shall comply with the minimum retention force values specified in ANSI C81.62, using the appropriate plug gauge specified in ANSI C81.63 for the intended lamp type.

6 Electrical Construction

6.1 Lamp bases and lampholders

6.1.1 A device lampholder and device base shall comply with the requirements of CSA C22.2 No. 43 and UL 496. The screw base metal shell, including double contact types (3-way), shall comply with the material, thickness, and dimensional construction requirements. The screw base metal shall be subjected to the pull, torque, and go/not-go tests. A device screw base intended to lock in place and be non-removable shall be provided with a ratcheting mechanism, or the equivalent, so that the lampholder in which it is installed is not damaged. A skeleton type of construction shall not be used on a device screw base.

In Mexico, a device lampholder and device base shall comply with the requirements of NMX-J-024-ANCE and NMX-J-325-ANCE.

6.1.2 A screwshell metal of a device base intended for damp or wet locations shall be made from:

- a) Copper alloy with a minimum of 80 percent copper,
- b) Nickel alloy,
- c) Stainless steel, or
- d) Aluminum or copper alloy electroplated with nickel alloy covering all surfaces (after forming and trimming).

Unplated aluminum is acceptable as a screwbase metal only for devices intended for dry and damp locations.

6.1.3 In Canada and the United States, a device lampholder of a fluorescent lamp adapter shall be tested with the lamp or lamps that the device is intended to accommodate. The lampholder shall be keyed to accommodate a specific lamp or lamps or comply with Clause 6.1.4. The lampholder keying shall comply with ANSI C81.61, C81.62, and C81.63.

In Mexico, a device lampholder of a fluorescent lamp adapter shall be tested with the lamp or lamps that the device is intended to accommodate. The lampholder shall be keyed to accommodate a specific lamp or lamps or comply with Clause 6.1.4. The lampholder keying shall comply with NMX-J-024-ANCE and NMX-J-325-ANCE.

6.1.4 A device which does not comply with Clause 6.1.3 shall comply with the lamp starting and operating measurements of Clause 8.3.

6.2 Current-carrying parts

6.2.1 A wire shall have insulation rated for the voltage, temperature, and conditions of intended use.

6.2.2 Where loosening or breaking of electrical connections involves a risk of fire or electric shock, the connections shall be soldered, welded, or otherwise securely connected. A soldered joint shall be mechanically secure before soldering. A surface mount component not exceeding a maximum dimension of 13 mm (0.5 in) need not comply with this requirement.

6.2.3 A wire is considered to be mechanically secure when one or more of the following is provided:

- a) At least one full wrap around a terminal,
- b) At least one right angle bend when passed through an eyelet or opening, except on printed-wiring boards where components are properly inserted and soldered or mechanically secured by design, or
- c) It is twisted with other conductors.

6.2.4 Iron or steel, plain or plated, shall not be used for current-carrying parts unless it is a wire integral to the lamp light source or parts used for the containment of electromagnetic or electrostatic fields.

6.2.5 With respect to Clause 6.2.4, stainless-steel is acceptable to be used for current carrying parts.

6.2.6 An uninsulated live part shall be permanently mounted and secured in accordance with Clause 6.2.3 to reduce the likelihood of turning or shifting position if such motion can result in a reduction of spacings below minimum acceptable values.

6.2.7 An accessible wire between a lamp connector for a circular lamp and the device enclosure shall:

- a) Be a continuous length of stranded wire with no splices,
- b) Incorporate a conductor of 0.52 mm² (20 AWG) or larger,
- c) Have insulation 0.8 mm (1/32 in) thick or greater, and
- d) Comply with the strain relief test of Clause 8.11.

6.3 Printed circuit boards

6.3.1 In Canada, printed circuit wiring boards shall comply with Annex E.

In the United States, printed circuit wiring is considered part of the ballast, and shall comply with UL 935 (see Clause 6.4.1).

In Mexico, Clause 6.3 does not apply because in Mexico the tests are carried out on the end product, not to components.

6.4 Ballasts and LED drivers

6.4.1 In Canada, a conventional magnetic ballast for discharge lamps shall comply with the requirements of CSA C22.2 No. 74 and have a thermal protector. Electronic ballasts for discharge lamps may be inherently protected.

In Mexico, a ballast shall comply with the requirements of NOM-058-SCFI and have a thermal protector.

In the United States, a ballast for fluorescent lamps shall comply with the requirements of UL 935 and have Class P thermal protection. A ballast for high-intensity discharge lamps shall comply with the requirements of UL 1029 and UL 935.

6.4.2 A ballast not previously investigated as described in Clause 6.4.1 shall be evaluated in the device. The construction requirements of UL 935 or CSA C22.2 No. 74 or NOM-058-SCFI shall apply. See the appropriate standard for details on coil insulation materials, thermal and overcurrent protective components, printed wiring boards, and spacing of electrical parts on the printed wiring board.

6.4.3 A ballast for fluorescent lamps shall be subjected to the following tests:

- a) For the normal temperature test of Clause 8.5, the device shall be installed in the test fixture described therein. The maximum surface ballast temperature shall be measured by a thermocouple on the outer surface of the device, and
- b) The abnormal-temperature test and fault-condition test (Class P) thermally protected ballasts described in UL 935 or the fault conditions test described in CSA C22.2 No. 74 or the Condición de falla described in NOM-058-SCFI.

6.4.4 Regarding the fault condition testing specified in Clause 6.4.3 (b), the following fault conditions shall be introduced, one at a time – not necessarily in the order indicated:

- a) For a transformer winding or power inductor, two outer layers of a layer wound coil or 20 percent of the turns of a random wound coil are short-circuited, and
- b) Any electrolytic capacitor or semiconductor junctions shall be short-circuited or open-circuited.

6.4.5 A fusing resistor used for thermal protection shall comply with UL 1412 or the requirements of CAN/CSA-C22.2 No. 60065-03 (R2008) or the requirements of NMX-J-578-ANCE. Testing shall include the Limited Short Circuit test while installed in the application, unless the test was previously conducted in accordance with UL 1412 or CSA C22.2 No. 256, using a 20 A test circuit with a 200 A short circuit capacity. If a clearance to combustible materials was used during the Overload Test, as permitted in UL 1412, the clearance shall be maintained or, the Overload Test shall be conducted while the resistor is installed in the application.

6.4.6 A printed wiring board trace intended to open as a result of an abnormal condition is not permitted.

6.4.7 In Canada, a magnetic coil shall have an insulation system complying with the General Requirements – Canadian Electrical Code, Part II, CAN/CSA-C22.2 No. 0.

In the United States, a magnetic coil operating above Class 105 temperature limits shall have an insulation system complying with UL 1446. A ballast completely enclosed in a polymeric enclosure complying with Clause 5.3, and with no accessible current-carrying (such as low voltage circuitry) or non-current-carrying (such as a ferrite core) metal parts that are capable of being energized is not required to comply with UL 1446. However, the respective electrical Relative Thermal Index (RTI) of the individual materials shall be greater than the operating temperature determined during the temperature test in Clause 8.5.

In Mexico, Clause 6.4.7 does not apply.

6.4.8 Drivers for light-emitting diodes (LEDs) vary in complexity from simple to complex circuits. For the circuits, the requirements for construction and testing would be similar to what is required for fluorescent lamp ballasts. The construction features of the overall device affect the evaluation of the LED driver. When the LEDs are accessible to the user, it is necessary to determine that the LEDs are not hazardous live parts and that basic insulation exists in the driver circuitry between the accessible live parts and the source of supply. When the LEDs are inaccessible and enclosed in a suitable electrical enclosure, it will in some cases not be necessary to determine that a basic insulation exists in the driver circuitry between the internal live parts of the LEDs and the source of supply.

6.5 Power capacitors

6.5.1 In Canada, a power capacitor shall comply with the applicable requirements specified in CSA C22.2 No. 74.

In the United States, a power capacitor shall comply with the applicable requirements specified in UL 935.

6.6 Spacing of electrical parts

6.6.1 For other than on a printed wiring board, the spacing of electrical parts through air (clearance) and over the surface of insulating material (creepage distance) shall be at least as described in Clauses 6.6.2 and 6.6.3 for the following:

- a) Uninsulated live parts of opposite polarity, and
- b) An uninsulated live part and a non-current-carrying metal part exposed to contact by persons.

6.6.2 Alternate spacing requirements may be applied as specified in Clauses 6.6.5 to 6.6.7.

6.6.3 A spacing described in Clause 6.6.1 shall not be less than the values specified in Table 6.1.

Table 6.1
Minimum spacing, dry, damp, and wet locations
(See Clause 6.6.3)

Location Type	Potential, V ^a	Minimum spacing, mm (in)	
		Through air or over surface	
Dry or damp	300 or less (425)	1.2	(0.046)
Dry or damp	301 – 600 (426 – 846)	3.2	(0.125)
Wet	Less than 600 (848)	4.8	(0.187)

^a The figures in parentheses are peak voltages. When evaluating the voltage of a circuit that produces other than sinusoidal waveform, both rms and peak values are evaluated and the requirement for the larger spacing shall be applied.

6.6.4 For a printed wiring board, the spacing of electrical parts for the ballast shall comply with the requirements of UL 935 or CSA C22.2 No. 74 as applicable. However,

- a) When the power available between two insulated parts is less than 50 W when determined in accordance with the fault condition test of UL 935 (maximum: 1 minute), the spacing is not required to comply with this requirement.
- b) When the minimum spacing is determined by the dielectric voltage-withstand test to a dielectric potential of $2 V + 1000 V$ DC for 1 min, where V equals the maximum peak potential, in volts, between the foil traces, the spacing is not required to comply with this requirement.

6.6.5 In the United States, as an alternative to the spacing requirements specified in Clauses 6.6.2 to 6.6.4, the clearance and the creepage distance between conductive parts that are rigidly held in place and reliably spaced in production may be evaluated for compliance with UL 840. The spacing requirements in UL 840 shall not be applied to a spacing to an exposed non-current-carrying metal enclosure. Creepage distances shall not be less than clearances.

6.6.6 In the United States, when applying the requirements specified in UL 840 to determine clearances, the device may be considered as operating on a supply circuit having an over-voltage of Category II.

6.6.7 In the United States, when applying the requirements specified in UL 840 to determine environmental pollution, the device may be evaluated with different environmental pollution degrees. The following conditions apply:

- a) A device marked for wet use shall be exposed to environmental pollution degree 3.
- b) A device intended for dry or damp locations shall be exposed to environmental pollution degree 2.
- c) The portion of a printed wiring board covered with a potting compound or a conformal coating that complies with the requirements in conformal-coating tests described in UL 746C shall be exposed to environmental pollution degree 1.

6.6.8 In Canada, printed circuit boards covered with potting compound or a conformal coating shall comply with the requirements of Annex E.

6.7 Accessibility of live parts

6.7.1 Accessibility of hazardous live parts shall be determined when the articulated probe of Clause 9.6 is inserted through any opening without contacting any hazardous live parts.

6.7.2 The articulated probe of Clause 9.6 shall not contact any bare live parts of the lampholder contacts of a fluorescent adapter with the lamp removed.

6.7.3 A non-current-carrying metal part, such as the head of a screw or rivet, is not considered to be exposed to contact if it is recessed to clear the surface by at least 5 mm (0.197 in) in a hole not more than 7 mm (0.275 in) in diameter.

6.8 Light source – fluorescent lamps

6.8.1 Fluorescent discharge lamps shall be tested to simulate end-of-lamp-life conditions as follows:

- a) For a lamp operated with a conventional magnetic ballast, the lamp shall be subjected to a shorted starter or deactivated lamp condition as described in the abnormal temperature test in UL 935 or in CSA C22.2 No. 74.
- b) For either self-ballasted lamps or lamp adapters that employ an electronic ballast, the lamp fault conditions test as described in Clause 8.16 shall be conducted.
- c) For lamp adapters that employ an electronic ballast, one of the end-of-lamp-life tests as described in Clause 8.17 shall be conducted. Note that there are three tests described although it is only necessary to comply with one of the tests.
- d) For self-ballasted lamps that employ an electronic ballast, the one filament, emissive-mix-free test as described in Clause 8.18 shall be conducted.

6.9 Light source – light emitting diodes (LED)

6.9.1 Light-emitting diodes (LEDs) emitting coherent light shall not be used.

6.9.2 LEDs used in the subject screw-base lamps shall not be user replaceable.

6.9.3 LEDs used in the subject screw-base lamps shall not be provided with shunt devices that would handle the current in the event the LEDs had open-circuited.

6.10 Light source – non-discharge lamps

6.10.1 Adapters with a lamp containment barrier and employing replaceable tungsten halogen lamps shall be marked with a lamp caution in accordance with Table 10.1, Items 8 and 17.

In Canada, the caution marking of Table 10.1, Item 8, is not required.

6.10.2 Adapters employing replaceable tungsten halogen lamps where the lamp has an integral containment barrier shall be marked with a maximum lamp caution in accordance with Table 10.1, Items 8 and 16.

6.10.3 Adapters complying with Clause 6.10.1 or Clause 6.10.2 may be marked indicating the lamp is suitable for use in an open type luminaire in accordance with Table 10.1, Item 18. Alternatively, the adapter may be marked with the symbol shown in Annex F, Figure F.1, along with instructions on the packaging explaining the symbol and that this type of lamp does not require additional shielding.

7 Environmental Locations

7.1 Dry locations

7.1.1 A device intended for use only in dry locations shall be marked in accordance with Table 10.1, Item 9.

7.1.2 The device or packaging of a device intended for use in dry locations shall not be marked in any manner that could imply or depict that it is suitable for a damp or wet use location.

7.2 Damp locations

7.2.1 A device intended for use in damp locations and marked in accordance with Table 10.1, Item 10, shall:

- a) Comply with the spacing requirements for damp locations or pollution degree 2 of Clause 6.6,
- b) Have base contacts made of materials suitable for use in damp locations that comply with the requirements in Clause 6.1.2, and
- c) Comply with the humidity test of Clause 8.13 if the device has accessible non-current-carrying metal parts.

7.3 Wet locations

7.3.1 A device intended for use in wet locations and marked in accordance with Table 10.1, Item 11 or 12, shall:

- a) Comply with the spacing requirements for wet locations or pollution degree 3 of Clause 6.6,
- b) Have base contacts made of materials suitable for use in wet locations that comply with the requirements in Clause 6.1.2,
- c) Have polymeric enclosures comply with the UV rating of Clause 5.3,
- d) Comply with the humidity test of Clause 8.13 if the device has accessible non-current-carrying metal parts,
- e) Comply with the water spray test of Clause 8.14, and
- f) Comply with the cold impact test of Clause 8.15.

8 Tests

8.1 General

8.1.1 Compliance with this standard is checked by conducting the tests specified and appropriate for the product. Tests according to this standard are tests that are done on samples that represent others of similar construction. The requirements and tolerances permitted by this standard are related to testing of representative samples submitted by the manufacturer for that purpose. Compliance of the sample does not ensure compliance of the whole production of a manufacturer with this safety standard. Conformity of production is the responsibility of the manufacturer and can additionally include routine factory audits, tests, and quality assurance.

8.1.2 Tests described in this section use instrumentation, apparatus, and environmental conditions that are described in Clause 9.

8.1.3 Manufacturing and production tests shall be carried out in accordance with Annex D.

8.1.4 The tests shall be conducted on samples as specified in Table 8.1. The test plan summary provides the number and any special preparation of the sample or samples.

Table 8.1
Test plan summary
(See Clause 8.1.4)

Test description	Reference	Number and description of samples
Electrical Tests		
Input measurements	8.2	1 sample of device along with lamps it is intended to operate with.
Lamp starting and operating measurements	8.3	1 sample of device along with lamps it is intended to operate with; can be same as used in the input test.
Enclosure leakage-current test	8.4	1 sample of device along with lamps it is intended to operate with; can be same as used in the input test.
Normal temperature test	8.5	1 sample of device along with lamp that drew the greatest wattage in input test. If the device were normally potted, it would be necessary to prepare a sample with thermocouples attached prior to potting. If acceptable to all parties concerned, the sample for test can be unpotted.
Dielectric voltage-withstand test	8.6	1 sample of the device – can be the same as used for input measurements, but not the sample for temperature test as the thermocouples can interfere with the test.
Harmonic distortion test	8.7	1 sample of the device – can be the same as used for input measurements.
Mechanical Tests		
Lamp base test in UL 496 or CSA 22.2 No. 43	6.1.1	6 samples, assembled (Pull test); 6 samples, assembled (Torque); 6 samples, unmounted (Go / Not-go gauging tests)
Drop impact test	8.8	If the enclosure is plastic, one sample of each enclosure type can be subjected to 3 drops, or if suitable to all concerned, three samples each of which can be subjected to one drop.
Enclosure mold-stress relief conditioning	8.9	1 sample of each enclosure type; may be same as used in drop test.
Deflection test	8.10	1 sample of each enclosure type; may be same as used in drop test.
Strain relief test	8.11	If device has lead wires and is not potted, 1 sample; can be the same as used above.
Special Tests		
Tests with dimmer circuits	8.12	1 sample; may be used in previous tests.
Humidity conditioning test	8.13	For damp location rating, 1 sample; may be used in previous tests.
Water spray test	8.14	For wet location rating and device is not potted, 1 sample of each enclosure type; can be the same as used above.
Cold impact test	8.15	For wet location rating, three samples of each enclosure type.
Lamp fault conditions tests	8.16	For devices with electronic ballast, multiple test conditions are defined in this section. Samples should be easily disassembled to access lamp filament connections; minimum of 6 samples recommended.
End of lamp life tests for adapters	8.17	For lamp adapters with electronic ballasts, three tests are described in this section. If previously determined which test of the three will be conducted, only one sample is needed. If the test has not been previously determined, one sample would be needed for each of the three tests.
End of lamp life tests for self-ballasted fluorescent lamps	8.18	For self-ballasted lamps with electronic ballasts, specially prepared samples are needed. Three samples shall have no emission mix on one lamp filament, and three samples shall have no emission mix on the other filament.
Component abnormal conditions	6.4.3 (b)	1 sample for each component fault, or less if it can be determined that fewer samples would be needed if the fault condition would cause the sample to be unusable. Potted samples would need to have additional wires to attach to internal connections so that the short condition can easily be created. Devices that are normally potted can be tested without potting if agreeable to all parties concerned.
Miscellaneous		

Table 8.1 Continued

Test description	Reference	Number and description of samples
Sample for report description		1 sample that is easily disassembled or unpotted.
Note: This table is a summary of test samples typically needed. Actual number of samples may vary where agreeable to all parties concerned.		

8.1.5 All tests shall be conducted with the device connected to a supply circuit of rated frequency. The supply voltage shall be the maximum rated voltage, but not less than 120 V.

8.1.6 A device rated 50 – 60 Hz need only be tested at 60 Hz unless testing at 50 Hz represents a more severe condition. A device without a frequency rating shall be tested at 60 Hz.

8.1.7 Prior to taking the measurements required by Clauses 8.2 to 8.4, it will in some cases be necessary to take preliminary measurements using an oscilloscope to determine the nature of the available currents. An AC/DC meter shall be used for measuring DC.

8.1.8 A device with discharge lamp or lamps shall be aged for 100 hours while connected to a supply of nominal rated voltage, and then all lamp types being tested shall be connected to a regulated source of supply at rated voltage and operated for 30 minutes prior to conducting the input measurements test of Clause 8.2.

8.1.9 Where more than one fluorescent lamp has a common base, for example a G-23 base for 5-, 7-, and 9-W twin tube lamps, and a G-24q-1 base for 10- and 13-W quad lamps, tests on lamp adapters shall be conducted with the lamps that will result in the most severe condition. See Clause 6.1.3.

8.2 Input measurements

8.2.1 With the ballast energized at the input voltage and frequency in accordance with Clauses 8.1.5, 8.1.6, and 8.1.8, the input current shall not be more than 110 percent of the marked rating, and, if additionally marked for wattage, the input wattage shall not be more than 110 percent of the marked rating plus 0.5 W with the device in the base up position controlling:

- a) A lamp or lamps which the device lampholder can accommodate, and
- b) No lamp in the case of a lamp adapter.

8.2.2 For devices intended for use on a dimmer circuit, the input current measured during the test of Clause 8.12.2.1 shall not be more than 110 percent of the marked rating.

8.2.3 For a device with a marked power factor rating, the power factor (PF) shall be calculated using the following formula:

$$P.F. = \frac{\text{input wattage}}{(\text{input voltage}) \times (\text{input current})}$$

in which the input wattage, voltage, and current are measured in accordance with Clause 8.2.1. The calculated power factor shall be equal to or greater than the marked rating. See Table 10.1, Item 7, for additional marking requirements.

8.3 Lamp starting and operating measurements

8.3.1 Lamp adapters with the lamp adapter energized at the input voltage and frequency as specified in Clauses 8.1.5 and 8.1.6, and with device lampholders not keyed in accordance with ANSI C81.61, C81.62, and C81.63, shall be in accordance with the lamp manufacturer's specifications. The measurements shall be carried out for each lamp type that can be accommodated by the device lampholder. The measured lamp voltage and current shall not differ by more than 10 percent from the rated value.

8.4 Leakage-current test

8.4.1 A device with an exposed non-current-carrying metal part shall comply with the leakage current requirements in UL 935 or CSA C22.2 No. 74 or NOM-058-SCFI. The measurement shall be made from any accessible non-current-carrying metal part of the enclosure of the device.

8.5 Temperature test

8.5.1 A device shall be tested as described in Clauses 8.5.2 to 8.5.13.

8.5.2 The maximum temperatures shall not exceed those specified in Table 8.2 when corrected to a room ambient temperature of 25 ± 5 °C. Ambient temperature variations above or below 25 °C shall be respectively subtracted from or added to temperatures recorded at points on the device.

Table 8.2
Maximum acceptable temperature limits
(See Clause 8.5.2)

Item	Components	Maximum °C, thermocouple method	Maximum °C, rise of resistance method
1.	Capacitor	a, b	
2.	Fuses	90	
3.	Coil insulation systems	b, e	
	Class 105 insulation systems	90/95 ^f	95
	Class 130 insulation systems	110/120 ^f	120
	Class 155 insulation systems	135/140 ^f	140
	Class 180 insulation systems	150/165 ^f	165
4.	Potting compound	c	
5.	Printed-wiring boards	a, b	
6.	Internal wiring	a	
7.	Soldered joint of a resistance ballast	150	
8.	Lamp base without an integral starter	150	

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Table 8.2 Continued

Item	Components	Maximum °C, thermocouple method	Maximum °C, rise of resistance method
	Electrical Insulation		
9.	Vulcanized fiber employed as electrical insulation for other than coil systems	90 ^d	
	Surfaces		
10.	Any outer polymeric surface	a, b	

^a The manufacturer's rated temperature of the material or component shall be used.

^b For a self-ballasted lamp, the temperature limit of a polymeric material may be increased above the established RTI value for 70,000 hours to correspond with the maximum expected lamp life. For fluorescent lamps, 5,000 to 10,000 hours life is typical. See UL 746C clauses on RTI for discussion of this technique.

^c Unless the material is thermosetting, the maximum potting compound temperature, when corrected to the nominal test ambient temperature, shall be:

- a) at least 15 °C less than the softening point of the compound as determined by the test methods of ASTM E 28;
- b) at least 15 °C less than the softening point of the compound as determined by the test methods of ASTM D36; or
- c) at least 25 °C less than the softening point of the compound as determined by the test methods of ASTM D1525.

^d For vulcanized fiber that has been investigated for use at a higher temperature, that higher temperature would apply.

^e Regarding insulation systems and Clause 6.4.7, the maximum acceptable coil temperature shall be the lowest temperature rating of any insulating material or component used in the ballast.

^f For coil assemblies weighing 250 g (0.5 lbs) or less.

8.5.3 A device shall be tested as follows:

- a) If the device is capable of being installed in the smaller test fixture shown in Figure 9.1, it shall have temperatures measured with the device mounted in the test fixture that simulates operation in a typical recessed luminaire. The device shall be tested base up.
- b) A device that will not fit in the smaller test fixture shown in Figure 9.1 but that can be installed in the larger test fixture shall be tested in such a test fixture. The device shall be tested base up.
- c) A device exceeding the diameter of the test fixture shall have temperatures measured with the device mounted on a draft-free bench. The device shall be tested with both a base-up and base-down orientation, unless it is obvious that one orientation would result in less severe heating.
- d) A device with a candelabra base shall be tested in the same test described in (a), except that it shall be permissible either to use a medium to candelabra adapter or to change the lampholder to a candelabra type.
- e) A device with an input rating greater than 50 W and
 - 1) Marked for installation in a fully enclosed luminaire with minimum lamp compartment dimensions in accordance with Table 10.1, Items 25 and 26, shall be normal temperature tested with the device mounted base up in the test fixture described in Clause 9.5.2,

2) Marked for installation only in an open surface-mounted luminaire in accordance with Table 10.1, Item 27, shall be normal temperature tested with the device in a lampholder mounted to the outlet box on the insulated test ceiling described in Clause 9.5.3 and depicted in Figure 9.2, or

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3) Marked for installation in a specific luminaire only in accordance with Table 10.1, Item 28, shall be normal temperature tested in the specified luminaire in accordance with UL 1598 and CSA C22.2 No. 250.0 for the luminaire type.

8.5.4 The normal temperature test shall be conducted with the device energized in accordance with Clause 8.1.5.

8.5.5 A device that is not marked in accordance with Table 10.1, Item 13, shall comply with the dimmer tests of Clause 8.12.

8.5.6 A device that is not designed for use in a totally enclosed luminaire, and that is marked in accordance with Table 10.1, Item 15, shall be subjected to the normal temperature test with the device mounted base-up in the test fixture as shown in Figure 9.1 and with the bottom open. The open bottom of the test fixture shall remain open for the temperature test, or the device shall be tested with a 3 mm (0.125 in) thick lens applied to the test fixture opening.

8.5.7 A lamp adapter that can accommodate various lamp types and wattages shall be tested with the lamp that will result in the most severe temperatures. More than one test will in some cases be required to determine this condition.

8.5.8 The test shall be continued until constant temperatures are obtained. A temperature is considered to be constant if:

- a) The test has been running for at least 3 hours, and
- b) Three successive readings, taken at 15 minute intervals, are within 1 °C of one another and are still not rising.

8.5.9 Thermocouples shall comply with Clause 9.3.

8.5.10 A thermocouple junction and the adjacent thermocouple lead wire shall be securely held in thermal contact with the surface of the material of which the temperature is being measured. In most cases, adequate thermal contact will result from securely cementing the thermocouple in place. If a metal surface is involved, brazing or soldering the thermocouple to the metal might be necessary.

8.5.11 The temperature of a winding shall be measured by a thermocouple or by the rise of resistance method in accordance with Clause 8.5.12.

8.5.12 The temperature of a winding shall be calculated by the following formula:

$$T_H = \frac{R_H}{R_C} (T_C + k) - k + (T_{AT} - T_A)$$

in which:

T_H is the temperature of the coil in degrees C at the end of the test, normalized for a target ambient temperature, normally 25 °C,

R_H is the resistance of the coil, in ohms, at the end of the test,

R_C is the resistance of the coil, in ohms, at the beginning of the test,

T_C is the temperature of the coil in degrees C at the beginning of the test when R_C is measured,

k is 234.5 for copper or 225.0 for electrical conductor grade (EC) aluminum. Values of the constant for other grades must be determined,

T_{AT} is the target ambient temperature, normally 25 °C, unless the device is being tested for a higher ambient rating such as 40, 55, 65, etc. degrees C, and

T_A is the temperature of the ambient air in degrees C at the end of the test when R_H is measured.

8.5.13 As it is generally necessary to de-energize the winding before measuring R, the value of R at the end of the test may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values versus time may be plotted and extrapolated to give the value of R at the end of the test.

8.6 Dielectric voltage-withstand test

8.6.1 A device with accessible non-current-carrying metal parts that could be energized from within shall withstand for 1 minute, without breakdown, the application of a test potential of twice the rated voltage + 1000 V between all live parts and all accessible non-current-carrying metal parts.

8.6.2 A device with accessible nonmetallic parts and openings in the enclosure shall withstand for 1 minute, without breakdown, the application of a test potential of 2500 V between live parts and metal foil in contact with accessible nonmetallic parts. The test shall be performed while the device is hot from normal operation.

8.6.3 The dielectric voltage-withstand test shall be conducted using test equipment having a 500 VA or larger transformer, the output voltage of which can be varied. The applied potential shall be increased from zero until the required test value is reached, and shall be held at that value for 1 minute. The increase in the applied potential shall be at a substantially uniform rate and as rapidly as consistent with its value being correctly indicated by a voltmeter.